SITE ASSESSMENT REPORT

FOR THE

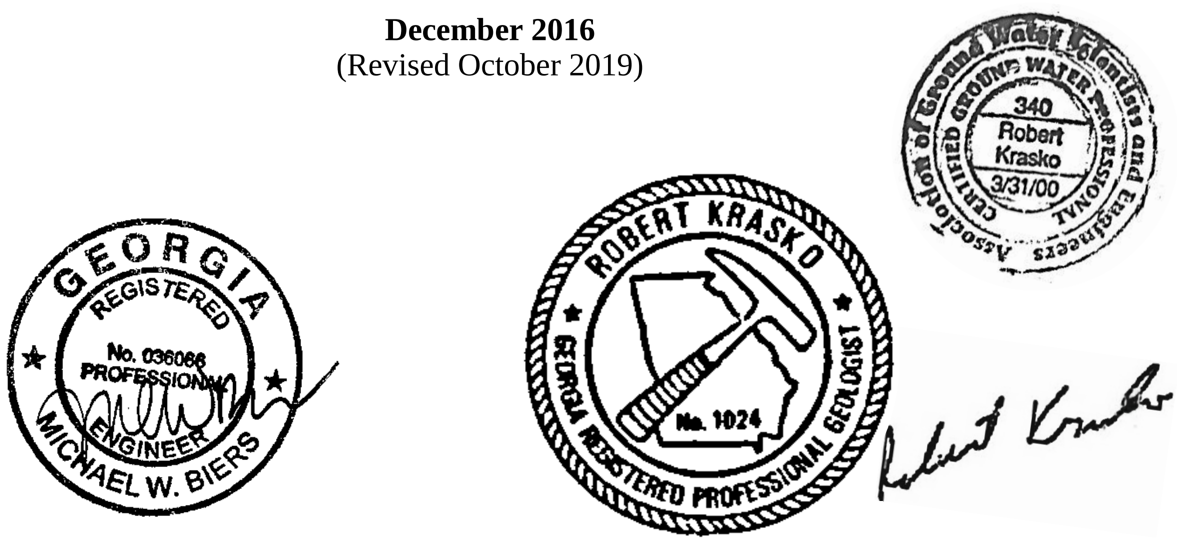
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC (BCDP)

U.S. 82 SOLID WASTE HANDLING FACILITY - SOUTH

Prepared for

Brantley County Development Partners, LLC
918 Fieldstone Drive
Macon, Georgia 31210

December 2016
(Revised October 2019)



Report Prepared by

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INTRODUCTION

Innovative Engineering Strategies, LLC (IES) has completed this revision per EPD review comments (November 9, 2018, October 23, 2019) to a site assessment report for the proposed Brantley County Development Partners, LLC (BCDP) - U.S. 82 Solid Waste Handling Facility – South prepared by Harbin Engineering, P.C. (H.E.) in December 2016. IES performed the site assessment report in general accordance with the sitting requirements for a municipal solid waste landfill (MSWL) as required by "Circular 14", published by the Georgia Department of Natural Resources Environmental Protection Division (EPD). Other requirements from the Georgia Comprehensive Solid Waste Management Act and Rules of Georgia Chapter 391-3-4-.05 were also evaluated. Based on this report the proposed site meets the criteria required by EPD for permitting as a MSWL.

1.0 GENERAL SITE AREA

1.1 Description of General Site Area

The proposed landfill site is located south of U.S. Highway 82 approximately nine (9) miles east of the City of Nahunta in Brantley County, Georgia as shown on Figure 1-01. The proposed site is a ±463 acre portion of a larger ±2,389 acre tract owned by the Brantley County Development Partners, LLC. All of this ±2,389 tract is forested flatwood land between the unincorporated rural communities of Atkinson to the west and Waynesville to the east. The subject property is generally flat with the highest elevations in the north-central portion of the site between 72 and 74 feet above mean sea level (msl), sloping downward at slopes less than 2% towards the property boundaries at elevations ranging between 52 and 70 feet msl, as shown in Figure 1-02. The property is bound by U.S. Highway 82 to the north, rural residential properties to the east and southwest and agricultural/industrial property also owned by Brantley County Development Partners, LLC to the west, as shown in Figure 1-03. The majority of the rural residential properties to the east are undeveloped lots of several subdivisions.

1.1.1. Legal Description

A legal description of the surveyed property line and proposed permit boundary by Charles H. Tomberlin, RLS 2973 is indicated on Figure 1-02. Supporting documentation is enclosed in Appendix O, and the legal description is also provided below:

> BEGINNING AT A REBAR ON THE SOUTHERN RIGHT OF WAY OF U.S. 82 WHOSE NORTHING IS 446734.8098 AND WHOSE EASTING IS 769953.9010; THENCE BEARING S 10-33-23 E A DISTANCE OF 968.19, TO A REBAR FOUND; THENCE A BEARING S 79-10-17 W A DISTANCE OF 4691.00, TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING S 3-56-8 W A DISTANCE OF 5134.75, TO A REBAR FOUND; THENCE A BEARING S 84-3-14 W A DISTANCE OF 1693.44, TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING

S 11-43-18 E A DISTANCE OF 599.36, TO A 12" REBAR SET; THENCE A BEARING N 90-0-00 W A DISTANCE OF 208.37 TO A POINT; THENCE A BEARING N 58-26-02 W A DISTANCE OF 515.07, TO A POINT; THENCE A BEARING N 86-23-36 W A DISTANCE OF 853.05, TO A POINT; THENCE A BEARING N 6-34-09 E A DISTANCE OF 270.11, TO A POINT; THENCE A BEARING S 84-59-54 E A DISTANCE OF 312.08,TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING N 5-11-24 E A DISTANCE OF 865.00, TO A 12" REBAR SET; THENCE A BEARING N 85-0-48 W A DISTANCE OF 528.07,TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING N 51-49-58 W A DISTANCE OF 422.88, TO A POINT; THENCE A BEARING N 28-8-45 E A DISTANCE OF 3423.14, TO A POINT; THENCE A BEARING N 31-7-4 E A DISTANCE OF 2760.02, TO A 12" REBAR SET ON THE SOUTHERN RIGHT OF WAY U.S. 82; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A BEARING N 80-17-09 E A DISTANCE OF 719.68, TO A POINT; THENCE CONTINUING ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A CURVE TO THE RIGHT, HAVING A RADIUS OF 10645.365 A DELTA ANGLE OF 03° 57' 09.97", AND WHOSE LONG CHORD BEARS N 82-15-48 E A DISTANCE OF 734.27, TO A POINT; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 BEARING N 84-14-23 E A DISTANCE OF 856.43, TO A REBAR FOUND; THENCE A BEARING S 5-45-37 E A DISTANCE OF 1090.28, TO A REBAR FOUND; THENCE A BEARING N 79-10-17 E A DISTANCE OF 1051.982, TO A REBAR FOUND; THENCE A BEARING N 6-18-41 W A DISTANCE OF 997.40, TO A REBAR FOUND ON THE SOUTHERN RIGHT OF WAY OF U.S. 82; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A BEARING N 84-14-23 E A DISTANCE OF 1928.25 TO A REBAR FOUND,SAID POINT BEING THE POINT OF BEGINNING.

1.2 Proximity to Roads, Airports and Railroads

The most proximate road is U.S. Highway 82 which borders the site to the north. The nearest interstate is I-95 which is located approximately 16 miles east of the site.

The most proximate airport is the Brantley County Airport (4J1) located approximately 4.5 miles west of the site with the runways oriented north to south. Since this public-use airport is located within 5 miles of the proposed site, the affected airport and the Federal Aviation Administration (FAA) have been notified. Please see Appendix A regarding this notification dated December 26, 2017. The site is more than 10,000 feet from the runway, therefore, demonstrations that the facility will not pose a bird hazard to aircraft are not required. The Brantley County Airport is a general aviation airport under control of a public agency (Brantley County Board of Commissioners) that is the recipient of several FAA grants. According to correspondence with the FAA and County (see Appendix A), the Brantley County Airport does not serve scheduled air carrier operations conducted in aircraft with less than 60 seats and does not have total annual enplanements consisting of at least 51% of scheduled air carrier enplanements conducted in aircraft with less than 60 passenger seats. Therefore, there is no limitation for the construction of the proposed landfill per 49 U.S.C. § 44718(d) because the Brantley County Airport, located within six (6) miles of the proposed site, does not have any regularly scheduled flights for its small aircraft. See Figure 1-06 for the Map showing Proximity to Airports.

The nearest railroad line is the CSX Transportation railway which is located north of and adjacent to U.S. Highway 82 north of the proposed site.

1.3 Proximity to County Boundaries and National Historic Sites

The proposed site is located in Brantley County, Georgia, which is surrounded by Glynn County to the east, Wayne County to the northeast, Pierce County to the northwest, Ware County to the west, Charlton County to the south and Camden County to the southeast. The closest county boundary to the proposed site is Glynn County which is approximately 2.2 miles to the east, as shown in Figure 1-07.

The only incorporated communities in Brantley County are the cities of Nahunta and Hoboken. The limits of each city are approximately 8.5 (Nahunta) and 17.1 (Hoboken) miles to the west of the proposed facility.

In Georgia there are only three (3) National Historic Sites (NHS): These sites are Andersonville Prison in Americus, Georgia; Martin Luther King, Jr. Memorial in Atlanta, Georgia; and Jimmy Carter Preservation District in Plains, Georgia. None of these sites are within 5,708 yards of the proposed facility, as shown in Figure 1-12.

1.4 Proximity to Floodplains

According to the Federal Emergency Management Authority (FEMA) National Flood Hazard Layer (NFHL) Panel Nos. 13025C0230C (effective September 25, 2009) and 13025C0235C (effective September 25, 2009), the 100-year floodplain (Zone A) of Satilla River is greater than 1.5 miles west of the property. The nearest Base Flood Elevation (BFE) of the Regulatory Floodway in Satilla River indicated on the FEMA Panel is 37 feet, located approximately 600 feet north of U.S. Highway 82 bridge. The lowest elevation on the proposed site is 52 feet, well above and away from the floodplain. All of the proposed site is located in Zone X, or "Area of Minimal Flood Hazard." The 100-year floodplain draining towards the headwaters of Turtle Creek is located greater than 1.0 mile northeast of the proposed site. These floodplains are shown on Figure 1-08.

According to a Sea, Lake and Overland Surges from Hurricanes (SLOSH) model of storm surge heights calculated by the National Weather Service (NWS), the proposed site is located outside the limits of potential tidal flooding from a Category 5 hurricane (see Figure 1-14). The SLOSH model is a computerized numerical model developed by the NWS to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes by taking into account the atmospheric pressure, size, forward speed, and track data. These parameters are used to create a model of the wind field which drives the storm surge. The reference model shown in Figure 1-14 was presented by the U.S. Army Corps of Engineers for the 2013 Coastal Georgia Evacuation Study.

1.5 Proximity to Streams and Wetlands

The most proximate stream is a tributary of the Little Satilla River which begins approximately 1.2 miles southeast of the proposed site. The Little Satilla River (Reach ID: R030702030301), not the tributary, is considered a coastal stream and according to the 2014 Integrated 305(b)/303(d) List an assessment is pending to make a determination whether or not its designated use (fishing) is being met. The tributary to the Little Satilla River, as shown in Figure 1-01, is not identified on the list.

The next most proximate stream is the Satilla River which is approximately 2 miles west of the proposed site. The segment of the Satilla River (Reach ID: R030702011105) west of the proposed site is categorized as an “impaired stream” on the 2014 Integrated 305(b)/303(d) List for not supporting its designated use (fishing). The criteria violated for this segment is the Trophic-Weighted Residue (TWR) Value of Mercury in fish tissue exceeding the EPD human standard of 0.3 mg/kg, potentially caused by non-point (NP) sources or unknown sources. A Total Maximum Daily Load (TMDL) Report was completed in 2002 for this watershed.

There are no continuously flowing streams or trout streams on the site or adjacent to the site boundaries.

Prior to a field wetlands delineation, a desktop survey was performed using the U.S. Fish & Wildlife Service (FWS) National Wetlands Inventory (NWI). A partially drained/ditched wetland was observed to border the proposed site to the west and a wetland coded as an “excavation” borders the south. Intermittent within the property are several isolated wetlands where runoff drains to areas of slightly lower topographic elevations. The following wetland classifications are indicated on the proposed site by the FWS in no particular order:

PSS3/4Bd	Palustrine System, Scrub-Shrub Class, Broad-Leaved Evergreen Subclass, Needle-Leaved Evergreen Subclass, Seasonally Saturated Water Regime, Partially Drained/Ditched
PFO4/1Bd	Palustrine System, Forested Class, Needle-Leaved Evergreen Subclass, Broad-Leaved Deciduous Subclass, Seasonally Saturated Water Regime, Partially Drained/Ditched
PFO2/1C	Palustrine System, Forested Class, Broad-Leaved Deciduous Subclass, Needle-Leaved Deciduous Subclass, Seasonally Flooded Water Regime
PFO2/1F	Palustrine System, Forested Class, Needle-Leaved Deciduous Subclass, Broad-Leaved Deciduous Subclass, Seasonally Semi-permanently Flooded Water Regime
PEM1C	Palustrine System, Emergent Class, Persistent Subclass, Seasonally Flooded Water Regime
PFO4/1C	Palustrine System, Forested Class, Needle-Leaved Evergreen Subclass, Broad-Leaved Deciduous Subclass, Seasonally Flooded Water Regime
PFO6C	Palustrine System, Forested Class, Deciduous Subclass, Seasonally Flooded Water Regime
PFO1/2C	Palustrine System, Forested Class, Broad-Leaved Deciduous Subclass, Needle-Leaved Deciduous Subclass, Seasonally Flooded Water Regime

PFO1/4C	Palustrine System, Forested Class, Broad-Leaved Deciduous Subclass, Needle-Leaved Evergreen Subclass, Seasonally Flooded Water Regime
PSS1C	Palustrine System, Scrub-Shrub Class, Broad-Leaved Deciduous Subclass, Seasonally Flooded Water Regime
PSS1/2C	Palustrine System, Scrub-Shrub Class, Broad-Leaved Deciduous Subclass, Needle-Leaved Deciduous Subclass, Seasonally Flooded Water Regime
PEM1Cx	Palustrine System, Emergent Class, Persistent Subclass, Seasonally Flooded Water Regime, Excavated

Between June and December 2015, Environmental Services, Inc. (ESI) performed preliminary and subsequent wetlands delineations at the proposed site. ESI submitted a request for Jurisdictional Determination (JD) to U.S. Army Corps of Engineers (CE) in October 2015 with supplemental information in February and March 2016. On May 5, 2016, the CE issued a letter verifying the preliminary and approved JD's. The preliminary JD's totaled approximately 115.10 acres and are associated with the jurisdictional boundaries, as shown in Figure 1-02 and also in Figure 1-09. The preliminary JD's are advisory in nature and valid until May 2021. The approved JD's totaled approximately 16.67 acres and are associated with the isolated, non-jurisdictional boundaries, as shown in Figure 1-02 and also in Figure 1-09. The approved JD's for the isolated, non-jurisdictional boundaries would not require prior authorization from the CE to disturb these areas. A copy of the U.S. Army Corps of Engineers Preliminary and Approved Jurisdictional Determination, in addition to the Habitat Assessment for Threatened & Endangered Species Report prepared by ESI are enclosed in Appendix B.

On July 19, 2019, Environmental Services, Inc. (ESI) completed their update to the proposed site's 2016 Habitat Assessment for Threatened and Endangered Species, which is enclosed in Appendix B. As stated in their cover letter, "the potential for any listed species within the potential impact area is low. No federally protected species or evidence thereof was noted by ESI during the recent habitat evaluation."

1.6 Proximity to Most Significant Ground-Water Recharge Areas

The Hydrological Atlas Number 18, of the Georgia Geological Survey, was utilized to determine the nearest proximity of significant groundwater recharge areas to the site. The atlas shows a recharge area for Miocene/Pliocene-recent unconfined aquifers approximately 0.5 mile west of the proposed site, as shown on Figure 1-03.

1.7 Proximity to Public and Domestic Water Supplies

1.7.1. Proximity to Surface Water Intakes

The proposed site is located in the Satilla River Basin. According to Georgia EPD's Watershed Protection Branch's List of Non-Farm Surface Water Withdrawal Permits (Revised April 2018), there are two (2) permits within this basin and both are for industrial purposes and not governmentally owned. Listed below is a summary of each permit and proximity to the proposed site.

Table 1: Satilla River Basin Non-Farm Surface Water Withdrawal Permits (Revised April 2018)

Permit No.	Permit Holder	Distance to Site (miles)
063-0712-01	Georgia Power Company – Plant McManus	±14.9 E
063-0712-02	Brunswick Celluose, Inc.	±16.8 E

There are no permits located within seven (7) miles of the proposed site.

1.7.2. Proximity to Public Drinking Water Wells

According to Georgia EPD's Watershed Protection Branch's List of Public Drinking Water Systems (Revised 2018), there are 13 systems within Brantley County. A public water system provides water for human consumption through pipes or other conveyances to at least 15 services connections or serves an average of at least 25 people for at least 60 days a year. Listed below is a summary of each public water system and proximity to the proposed site:

Table 2: Public Drinking Water Systems in Brantley County (Revised 2018)

Water System Identification (WSID)	Water System Name	Owner Type	Federal Type	Distance to Site Property Line (miles)
GA0250028	Hawks Landing	Private	CWS	±0.3 E
GA0250022	Waynesville Area Elementary School	Local/Municipal	NTNCWS	±0.7 E
GA0250026	Satilla Plantation/Eagle Crest	Private	NTNCWS	±1.0 SW
GA0250004	Deerwood Subdivision	Private	CWS	±1.6 SW
GA0250021	River Ridge Subdivision	Private	CWS	±2.1 NW
GA0250020	Happy Landing Fishing Club	Private	CWS	±3.2 SW
GA0250003	Satilla Estates	Private	CWS	±4.2 SW
GA0250027	Satilla Water System	Private	TNCWS	±6.7 NW
GA0250002	Nahunta	Local/Municipal	CWS	±9.0 W
GA0250019	Brantley County Middle School	Local/Municipal	NTNCWS	±11.8 W
GA0250014	Brantley County High School	Local/Municipal	NTNCWS	±12.0 W
GA0250000	Hoboken	Local/Municipal	CWS	±18.1 W
GA0250006	Whispering Pines Subdivision	Private	CWS	±22.7 W
CWS – Community Water System NTNCWS – Non-Transient Non-Community Water System TNCWS – Transient Non-Community Water System				

Groundwater is the source for all 13 of these water systems. Only four (4) of these water systems are located within two (2) miles of the proposed site: Hawks Landing, Waynesville Area Elementary School, Satilla Planation/Eagle Crest and Deerwood Subdivision. These four (4) locations are shown on Figure 1-04. Both the Waynesville Area Elementary School and Satilla Plantation/Eagle Crest are Non-Transient, Non-Community Water Systems (NTNCWS) which means they are a public water system that regularly supplies water to at least 25 of the same people at least six (6) months per year. Both Hawks Landing and Deerwood Subdivision are Community Water Systems (CWS) which means they are a public water system that supplies water to the same population year-round.

The only Non-Farm Groundwater Withdrawal Permit in Brantley County indicated by Georgia EPD Watershed Protection Branch's database is the City of Nahunta (Permit No. 013-0001).

1.7.3. Proximity to Private (Domestic) Drinking Water Wells

The proposed site is located in a rural area where water is supplied by private (domestic) wells. The private (domestic) well survey was preliminarily performed using the Brantley County Tax Assessor website. The area roads were driven on March 15, 2016 to verify the records search data for properties within one-half (0.5) mile of the proposed site and verified again on May 25, 2019. On July 9, 2019, IES contacted the Brantley County Health Department at (912) 462-6165 and spoke to Ms. Rachel James. Ms. James provided a list of all new residential well applications filed at the department since January 1, 2016, and clarified this list does not represent new wells that actually were constructed since this date (See Appendix C). Based on this information provided by Brantley County Health Department, there was only one (1) new residential well application since 2016 at an address within a half-mile of the proposed site (1027 Picketts Mill Trail). The Health Department listed this residence as applying for a well on May 21, 2019, which was not observed during the May 25, 2019 windshield survey nor located on the Brantley County Tax Assessor website. Conservatively, the distances used for this are the same as the house address closer to the landfill at the end of the cul-de-sac, 1089 Picketts Mill Trail; address numbers on this street increase from south to north, so the 1027 address would have to be further south and away from the proposed site than the 1089 address. The well inventory is presented in the table shown below and also on Figure 1-05. See Figures 3-02 and 4-01 regarding the Map Showing Areas Favorable and Unfavorable for Municipal Solid Waste Landfilling. The property owner records are included in Appendix C.

Table 3: Private (Domestic) Water Well Inventory Within 0.5 mile of Proposed Site

Tax Parcel Identi-fication	Owner Name (Last Name, First Name)	Tax Parcel Site Address		Well Location Field Verified? (Y/N)	Distance To Site Boundary (feet)	Distance To Favorable Area (feet)
B073 002	Dowling, David	5500	S.R. 110 W	N	±50 W	> ±550
B072 049	Clyde, Theresa	24478	U.S. 82 E	N	±50 NE	> ±550
B072 050	Carter, Wesley	0	U.S. 82 E	N	±220 NE	> ±720
B073D 041	Lane, Lorie	961	Picketts Mill Trail	Y	±260 S	> ±760
B072 003	B.C. Devel. Partners, LLC	23125	U.S. 82 E	Y	±630 W	> ±830
B073D 036	Land, Edgar Jr.	1089	Picketts Mill Trail	N	±360 S	> ±860
N/A	Not Available (N/A)	1027	Picketts Mill Trail	N	±360 S	> ±860
B072 051	Carter, David Jr.	24546	U.S. 82 E	N	±450 NE	> ±950
B073D 042	Williams, Matthew Sr.	655	Picketts Mill Trail	N	±530 S	> ±980
B072 032	Strickland, Wanda	797	Hazelhurst Road	N	±640 NE	> ±1,140

Table 3 (continued): Private (Domestic) Water Well Inventory Within 0.5 mile of Proposed Site

Tax Parcel Identi-fication	Owner Name (Last Name, First Name)	Tax Parcel Site Address		Well Location Field Verified? (Y/N)	Distance To Site Boundary (feet)	Distance To Favorable Area (feet)
B072 047	Gibson, William	0	U.S. 82 W	N	±650 NE	> ±1,150
B072 033	Taylor, Troy	0	Hazelhurst Road	N	±720 NE	> ±1,220
B072 031	Smith, Linda	0	Hazelhurst Road	N	±860 NE	> ±1,360
B072 035	Ross, William	583	Hazelhurst Road	N	±1,310 NE	> ±1,810
B072 034	Lindsey, Todd	745	Hazelhurst Road	N	±1,360 NE	> ±1,860
B072 045	Beach, Raphael	24743	U.S. 82 W	N	±1,430 NE	> ±1,930
B072 036	Story, Richard	555	Hazelhurst Road	Y	±1,530 NE	> ±2,030
B072 071	N/A	0	Hope Road	N	±1,850 E	> ±2,050
B072 072	Bodie, Joni	711	Hope Road	N	±1,970 E	> ±2,170
B072 043	Gibson, William	0	Crandel Road	Y	±1,690 NE	> ±2,190
B073 013	Ellis, John	211	Franklin Trail	N	±2,060 SE	> ±2,260
B072 042	Jacob, Tony	0	Crandel Road	Y	±1,770 NE	> ±2,270
B072 041	Bradley, Karen	118	Crandel Road	Y	±1,780 NE	> ±2,280
B072 024	Thornton, Rosalyn	132	Thornton Road	Y	±1,780 NE	> ±2,280
B072 073	McCullough, Patricia	701	Hope Road	Y	±2,100 E	> ±2,300
B072 037	Hickox, Carl	519	Hazelhurst Road	Y	±1,840 NE	> ±2,340
B072 025	Thornton, Allen	468	Hazelhurst Road	N	±1,850 NE	> ±2,350
B072 040	Morgan, Joesph Jr.	0	U.S. 82 W	N	±1,910 NE	> ±2,410
B072 038	Alexander, Billy	26	Crandel Road	Y	±1,940 NE	> ±2,440
B072 039	Wilson, Elta	53	Crandel Road	Y	±2,000 NE	> ±2,500
B073 023	Westover, Amanda	190	Franklin Trail	Y	±2,470 SE	> ±2,670
B072 079	Whittington, Richard	0	Old Waynesville Rd	N	±2,640 E	> ±2,840
B079 060	Gaskin, Judy	0	Hazelhurst Road	Y	±2,420 NE	> ±2,920
B073 022	Westover, Amanda	0	Franklin Trail	Y	±2,750 SE	> ±2,950

As Table 3 indicates, the exact well location on several residential properties visited on March 15, 2016 and again on May 25, 2019 could not be verified. This was due to the restricted line of sight during the windshield survey accessed along only public roads. For the locations not verified in the field, the location of the well was assumed using aerial imagery provided by Google Earth Pro and was conservatively placed near the residence.

1.7.4. Proximity to Wellhead Protection Area

The Drinking Water Program with Georgia EPD was contacted in April 2019 regarding the subject property. Ms. Vicki Trent with EPD confirmed via e-mail the proposed site is not located within the outer management zone of an established well head protection area (See Appendix C). EPD was unable to provide information on the extent of the outer management zones, however, Georgia Rule 391-3-5-.40-(6)-(a) states:

wells determined by the Division as drawing water only from confined aquifers shall have an inner management zone extending outward from the center of the borehole for a radius of 100 feet. No outer management zone is required for such wells.

Because public wells within two (2) miles of the site documented in the 2016 SAR (Hawks Landing, Waynesville Area Elementary School, Satilla Planation/Eagle Crest and Deerwood Subdivision) are understood to be withdrawing water from a confined aquifer, IES assumes per Rule 391-3-5-.40-(6)-(a) no outer management zone is required, therefore, the extents of this zone are not indicated on Figure 1-04.

1.8 Zoning and Notification

Brantley County at the present time does not have a zoning ordinance. The proposed ±463 acre site is a part of a larger ±2,389 acre tract which was previously owned by Magnolia Landholdings, LLC and is now currently owned by the applicant, the Brantley County Development Partners, LLC. The following previously submitted Brantley County letters associated with this proposed site are included in Appendix D:

November 21, 2014	Consistency with Solid Waste Management Plan, County Manger
November 21, 2014	No zoning and consistency with Land Use Plan, County Manger
February 6, 2015	Consistency with Solid Waste Management Plan, Chairman
February 6, 2015	No zoning and consistency with Land Use Plan, Chairman
August 19, 2015	Acknowledgement of ownership name change

A copy of the most recently adopted Solid Waste Management Plan and the Land Use Plan are included in Appendix E and F, respectively. The Solid Waste Management Needs Meeting (O.C.G.A. §12-8-26[a]) is not required since the proposed site will be a privately owned facility. The Siting Decision Meeting (O.C.G.A. §12-8-26[b]) has not yet taken place. The required Notice for this meeting and also the required Notice for this application submission (O.C.G.A. §12-8-32[a]) will be sent to EPD as these take place.

1.9 Proximity to Other Solid Waste Facilities

No solid waste facility is within two (2) miles of the proposed site. The nearest facility is the Brantley County – Smyrna Church Road landfill (Permit No. 013-003D[S]), which ceased accepting waste on April 1, 1992 and officially closed on June 9, 1995. See Figure 1-11. This facility is located approximately ±4.0 miles northwest of the proposed site.

1.10 Proximity to Private Recreational Camps

The proposed site is not located within one (1) mile of any private recreational camp operated primarily for use by persons under 18 years of age and has been so operated at its location for 25 years or more. See Figure 1-13. The camps identified on this figure are Twin Oaks Camp, approximately ±1.7 miles northeast; Deep Bend Landing, approximately ±6.0 miles southwest; and Hortense Wesleyan Camp, approximately ±11 miles northwest of the proposed site.

1.11 Proximity to Federally Restricted Airspace

As indicated on Figure 1-06, the proposed site is located within the "Coastal 4" Military Operations Area (MOA). An MOA is defined by the Federal Aviation Administration (FAA) as an airspace established outside Class A airspace to separate or segregate certain nonhazardous military activities from Instrument Flight Rules (IFR) Traffic and to identify Visual Flight Rules (VFR) traffic where these activities are conducted; an MOA is not a bombing range. Therefore, the proposed site is not located within two (2) miles of a federally restricted military air space which is used for a bombing range.

2.0 SURFACE AND SUBSURFACE INVESTIGATIONS

2.1 Topographic Description

Site topography described in this section is based upon review of the following: Harbin Engineering, P.C. (H.E.) and IES field observations and topographic information provided by Metro Engineering & Surveying Co., Inc. (MES) and captured on April 24, 2016. MES's certification of accuracy is stated on the Boundary Survey and Topographic Map of Site – Figure 1-02.

The topography of the site is generally flat with higher elevations to the north and center portions of the site and lowest elevations in the southeast corner of the site. The higher elevations in the center of the site generally slope to the perimeter of the site at slopes less than 2%. According to Figure 1-02 the elevation on site ranges between 52 and 74 feet mean seal level (msl).

2.2 Boring and Sampling Program

Between March 15 and 17, 2016, Advanced Environmental Management, Inc. (AEM) and their subcontractor Drilling Solutions, Inc. installed twelve (12) piezometers P-01 through P-12 and between April 10 and 15, 2019, ECS Florida, LLC (ESC), under the direction of Michael W. Biers, P.E., installed twelve (12) additional piezometers P-13 through P-24 across the proposed ±463 acre site. One (1) boring per 20 acres is considered excessive for this proposed site's total configuration, because significant areas including the northeast and southern portions of the site are not practical therefore not favorable for landfill development (See Figure 4-01). The acreage requiring site suitability is one (1) boring per ±9 of ±227 usable acres, or one (1) boring per 19 of the total ±463 acres.

The borings were of sufficient depth at approximately ±25 feet below ground surface (bgs) because they extended through all perched water zones to at least twenty feet below the water table, approximately ±1-4 feet below ground surface at the time of drilling. Borings for P-01 through P-12 were witnessed and logged by geotechnical engineer Darrell L. Webb, P.E. with AEM, and borings for P-12 through P-24 were witnessed and logged by geotechnical engineer Michael W. Biers, P.E. with IES. See Figure 2-01 for boring locations and Appendix G for supporting documentation prepared by AEM and IES. The boring logs in this report include the boring number, dates of drilling, drilling contractor, boring method (hollow stem auger), surveyed elevation, depth, description of cuttings, sample intervals (at least one [1] split spoon every five [5] feet), blow counts, core recovery, and water levels.

Undisturbed samples in a Shelby Tube were collected from ten (10) of the 12 borings in the first mobilization in 2016 (P-01 through P-12). Shelby Tube samples could not be recovered from the remaining two (2) borings (P-05 and P-09). Undisturbed Shelby Tube samples from P-08, P-11 and P-12 were selected for laboratory analysis of grain size, hydraulic conductivity and sorptive capacity (cation exchange capacity [CEC]). These samples were analyzed by Test America Laboratories, Inc. who analyzed the CEC and then subcontracted the grain size and hydraulic conductivity analysis to Kemron Environmental Services. The undisturbed samples were collected at different stratigraphic intervals to provide a representative picture of the subsurface distribution of soil properties. Unfortunately, the remaining seven (7) Shelby tubes samples from P-01, P-02, P-03, P-04, P-06, P-07 and P-10 recovered during the first mobilization (April 2016) were discarded due to extended shelf-life.

18 new Shelby Tube samples were recovered from 11 of the 12 borings in the second mobilization in 2019 (P-13 through P-24). Shelby tube samples could not be recovered from the P-24 boring, where a tube was pushed at 25 feet below ground surface (ft bgs) and had no recovery. The Shelby tube pushed at 20 ft bgs in the P-19 also had no recovery. The Shelby Tube recovered in the P-17 boring pushed at ±1 ft bgs had insufficient volume for laboratory analysis, therefore, only 17 samples were analyzed from this second mobilization. Shelby tube samples were analyzed for grain size, Atterberg limits, hydraulic conductivity, sorptive capacity (cation exchange capacity [CEC]) and Standard Proctor based upon sample size. These samples were analyzed by ECS who analyzed the grain size, Atterberg limits, hydraulic conductivity and Standard Proctor and then subcontracted the CEC analysis to Analytical Environmental Services, Inc (AES). Similar to the first mobilization, the undisturbed samples were collected at different stratigraphic intervals to provide a representative picture of the subsurface distribution of soil properties.

After the borings for P-01 through P-12 were drilled and the soil samples were collected, the bottom ten (10) feet of each 25-ft deep borehole was backfilled and a 15 feet deep piezometer well was installed. After the borings for P-13 through P-24 were drilled and the soil samples were collected, ECS backfilled each borehole and offset a new location within five (5) horizontal feet to install a 15 feet deep piezometer well. The lower ten (10) feet of every 15-ft deep well was screened so that future water level measurements and pumping tests could be performed as necessary.

Drilling Solutions, Inc. who constructed the borings and installed the piezometer wells P-01 though P-12 have a valid bond on file with the Water Well Strandards Advisory Council and were under the supervision of a geotechnical engineer (Darrell L. Webb, P.E.). ECS who constructed the borings and installed the piezometer wells P-13 through P-24 have a valid bond on file with the Water Well Standards Advisory Council and were under the supervision of a geotechnical engineer (Michael W. Biers, P.E.). A copy of the bond is included in Appendix G.

2.3 Description of Soils and Rocks

No rock or bedrock was encountered in all 24 borings P-01 through P-24. The stratigraphy is generally consistent in all 24 borings, which encountered silty SAND (SM) at varying layers of color, grain size and density. However, soils with generally more clay content were encountered in the three (3) borings in the northeast section of the property: P-13, P-14 and P-15: clayey SAND (SC) was encountered in borings for P-13 and P-14; low plasticity sandy CLAY (CL) was also encountered in the boring for P-13; high plasticity sandy CLAY (CL) was also encountered in the boring for P-15. Boring logs, grain size curves and other tests (cation exchange capacity, vertical hydraulic conductivity and organic content) are included in Appendix G.

Black/brown/red/tan fine to medium silty SAND (SM) with trace clay was generally encountered in all 24 borings at varying depths in the 25-ft deep strata. A very dense (greater than 50 blow counts, "N") lense of this soil was encountered in 18 of the 24 borings at depths ranging between 7.5 and 22.5 feet below ground surface (bgs). Only borings for P-09, P-11, P-13, P-14, P-15 and P-21 did not encounter this very dense lense of silty SAND (SM). Lastly, gray/light brown/green very loose to medium dense fine to medium silty SAND (SM) with trace clay was encountered at the bottom of 23 of the 24 borings at depths beneath 13.0 feet bgs. Only boring P-02 did not encounter this gray/light brown/green silty SAND (SM).

Eight (8) geologic cross-sections developed from the boring data are shown on Figure 2-02 and Figure 2-02a which presents this stratigraphy.

Results from the laboratory analyses performed on the Shelby Tubes are summarized in Table 4 below and also in Appendix G.

Table 4: Summary of Shelby Tube Sample Laboratory Analyses

Boring No.	Sample Depth Interval (feet bgs)	USCS Classification	Total Cation Exchange Capacity (meq/100g)	Vertical Hydraulic Conductivity (cm/sec)	Plasticity Index (PI)	% Passing No. 200 Sieve (%)	Max. Dry Density (pcf)	Optimum Moisture Content (%)
P-08	9-11	SAND (SM)	6.5	**1.9×10^{-5}**	NA	**12.1**	NA	NA
P-11	14-16	SAND (SM)	1.1	**3.2×10^{-6}**	NA	**21.2**	NA	NA
P-12	20-22	SAND (SP-SM)	2.8	**2.4×10^{-4}**	NA	**8.7**	NA	NA
P-13	25-28	CLAY (CL)	20	**9.0×10^{-7}**	**30**	**62.1**	**110.7**	**16.0**
P-14	5-8	SAND (SM)	24	**3.5×10^{-5}**	NP	**23.1**	**112.0**	**14.4**
P-14	9.5-12.5	SAND (SM)	23	**2.0×10^{-5}**	NP	**27.7**	NA	NA
P-15	5-8	SAND (SM)	16	**4.4×10^{-4}**	NP	**15.3**	**105.7**	**11.9**
P-15	9.5-12.5	CLAY (CH)	18	**6.3×10^{-5}**	**29**	**82.3**	NA	NA
P-16	20-23	SAND (SP-SM)	10	**4.0×10^{-4}**	NP	**8.0**	NA	NA
P-16	25-28	SAND (SM)	21	**8.1×10^{-5}**	NP	**29.1**	NA	NA
P-17	5-8	SAND (SM)	33	**1.6×10^{-4}**	NP	**11.1**	NA	NA
P-18	20-23	SAND (SM)	15	**1.9×10^{-5}**	NP	**18.7**	NA	NA
P-19	1-4	SAND (SM)	40	**4.1×10^{-4}**	NP	**12.2**	NA	NA
P-19	15-18	SAND (SM)	15	**1.1×10^{-4}**	NP	**15.5**	NA	NA
P-20	1-4	SAND (SM)	7.3	**1.9×10^{-4}**	NP	**14.1**	NA	NA
P-20	2.5-5.5	SAND (SP)	19	**4.0×10^{-4}**	NP	**4.3**	NA	NA

Table 4: Summary of Shelby Tube Sample Laboratory Analyses (continued)

Boring No.	Sample Depth Interval (feet bgs)	USCS Classification	Total Cation Exchange Capacity (meq/100g)	Vertical Hydraulic Conductivity (cm/sec)	Plasticity Index (PI)	% Passing No. 200 Sieve (%)	Max. Dry Density (pcf)	Optimum Moisture Content (%)
P-21	20-23	SAND (SM)	15	**4.1×10^{-5}**	NP	**24.0**	NA	NA
P-22	20-23	SAND (SM)	9.5	**1.8×10^{-4}**	NP	**12.8**	NA	NA
P-23	1-4	SAND (SM)	7.6	**3.5×10^{-4}**	NP	**13.2**	**110.3**	**11.9**
P-23	2.5-5.5	SAND (SP-SM)	26	**8.9×10^{-5}**	NP	**9.4**	NA	NA

NP = Not Plastic NA = Not Analyzed

Vertical hydraulic conductivities for sands ranged between 3.2×10^{-6} and 4.4×10^{-4} centimeters per second (cm/sec), whereas the two (2) clay samples from P-13 and P-15 were 9.0×10^{-7} and 6.3×10^{-5} cm/sec, respectively. Grain size distribution for sands ranged between 4.3% and 29.1% passing the No. 200 sieve, whereas the two (2) clay samples from P-13 and P-15 were 62.1% and 82.3%, respectively. Maximum dry densities ranged between 105.7 and 112.0 pounds per cubic foot (pcf) and Optimum Moisture Content ranged between 11.9 and 16.0 percent (%).

The dark brown-black colorizations in some of the samples appear to be a function of humic and tannic stains, as concluded by Ginn Minerals Technology who performed an organic content analysis (Loss on Ignition) on select surficial split spoon samples collected five (5) feet beneath the ground surface. The organic content results from six (6) different split spoon samples (P-02, P-03, P-06, P-07, P-10 and P-12) range between 1.8% and 6.27%, which are relatively low results for organic rich soils.

2.3.1. Site Geology

The proposed site is located in the Barrier Island Sequence District (BIS) of the Sea Island Section of the Coastal Plain Physiographic Province of Georgia (VI). As indicated on Georgia Department of Natural Resource's "Physiographic Map of Georgia" dated 1976:

> Barrier Island Sequence District-Pleistocene sea levels advanced and retreated several times over the Barrier Island Sequence District to form a step-like progression of decreasing altitudes toward the sea. These former, higher sea levels existed as barrier island-salt marsh environments similar to the present coast. The former sea levels left shore line deposit complexes parallel to the present coastline at characteristic elevations: Wicomico, 160-95 feet; Penholoway, 70-76 feet; Talbot, 40-46 feet; Pamlico, 25 feet; Princess Anne, 13 feet; Silver Bluff, 5 feet; Holocene, the present mean sea level. There has been slight to moderate dissection of these former levels allowing marshes to exist in poorly drained low areas. Generally, dissection is further advanced toward the western portion of the district. Relief varies from 50 to 75 feet on the east side of Trail Ridge to just a few feet near marshes and along the coast. Maximum elevations are approximately 160 feet on Trail Ridge. The western boundary is at the western base of Trail Ridge as far north as the Altamaha River, where the ridge becomes obscure. North of the Altamaha River the western boundary is the base of the Orangeburg Escarpment which approximates the 150 foot elevation.

According to the "Georgia Geologic Map" issued by the Georgia Geologic Survey dated 1976, the geology of the proposed site consists of the Talbot shoreline complex – marsh and lagoonal facies (Qtm) from the Pleistocene Epoch (between ±11,700 and .±2.588 million years ago). See Figure 2-03. The following is an excerpt from pages 146-147 from "A Revision of the Lithostratigraphic Units of the Coastal Plain of Georgia: The Miocene Through Holocene" by Paul F. Huddlestun (See Appendix H):

> The “Talbot” is that terrace complex, in Georgia, constructed when sea level stood at approximately 50 feet (15 m).
>
> The "Talbot" barrier complex in Georgia is mainly represented by emergent barrier islands and beach ridge complexes. Generally, the "Talbot" barrier islands were constructed against the seaward faces of the adjacent Penholoway barrier islands, analogous to the Holocene barrier islands constructed against the Silver Bluff barrier islands, and the Princess Anne barrier islands against the Pamlico barrier islands. Only between Brantley County and the St. Marys River are the emergent "Talbot" barrier islands separated from the emergent Penholoway barrier islands by what appears to have been a "Talbot" backbarrier tract (now the valley and flood plain of the Satilla River). The only surviving tract of "Talbot" back-barrier in Georgia occurs in Wayne County.
>
> South of the Altamaha River in Georgia, the "Talbot" barrier islands are prominent and equally developed, showing little if any difference in construction from the vicinity of the Altamaha River to reaches far from the river. On the other hand, north of the Altamaha River, the "Talbot" barrier islands are prominent only near the Savannah, Ogeechee, and Altamaha Rivers.
>
> The summit elevations on the emergent "Talbot" barrier islands in Georgia range from 55 feet to 75 feet (17 m to 23 m), a relief of 20 feet (6 m). The elevation of the "Talbot" back-barrier tract ranges from 45 to 50 feet (13.5 to 15 m). The total relief on the "Talbot" terrace complex in Georgia is approximately 30 feet (9 m).
>
> The Cypresshead Formation directly underlies both the "Talbot" terrace surface and the undifferentiated surficial sands that mantle the emergent "Talbot" barrier islands."

According to the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey for the site, the majority of the soils in the rises and flatwood areas are classified as either a Leon (LeA), Pottsburg (PbA) or Mandarin (MaA) fine sand series (generally 0 to 2 percent) and the drainage ways and depressions are generally classified as Lynn Haven, Allanton and Kingsferry soils (LYA). See Figure 2-04.

These soils are poorly to very poorly drained sandy marine deposits with a low to very low runoff class. According to the NRCS, the capacity of the most limiting layer of each soil series to transmit water is listed below:

Table 5: Summary of Soil Series Range of Hydraulic Conductivity

Soil Series	Range (cm/sec)	Hydrologic Soil Group
Leon	1.41×10^{-4} - 1.40×10^{-3} cm/s	A/D
Pottsburg	4.23×10^{-4} - 4.20×10^{-3} cm/s	A/D
Mandarin	1.41×10^{-4} - 1.41×10^{-2} cm/s	A
Lynn Haven	4.23×10^{-4} - 4.20×10^{-3} cm/s	A/D
Allanton	4.23×10^{-4} - 4.20×10^{-3} cm/s	A/D
Kingsferry	4.23×10^{-5} - 1.41×10^{-4} cm/s	A/D

2.3.2. Pumping Tests

To prepare for the pumping tests in 2016, Harbin Engineering, P.C. (H.E.) performed well development on three (3) "interior" piezometer wells P-04, P-06 and P-08 on June 28, 2016 (See Figure 2-01). To prepare for the two additional pumping tests requested by EPD in 2019, IES performed well development on two (2) "interior" piezometer wells P-02 and P-10 on April 16, 2019 and again on May 24, 2019. These five (5) wells are considered "interior" because they are in the general location of the areas favorable for solid waste disposal. For development of the wells, new disposable Teflon bailers and/or a submersible pump was used to both over-pump and mechanically surge by plunging the pump at varying locations along the 10-ft well screen.

A Horiba U-52 meter was used to measure Specific Conductance, pH, Temperature, Turbidity, Dissolved Oxygen, Salinity and Oxidation Reduction Potential. The meter was calibrated in the field before use. These field parameters were recorded at intervals during well development to confirm that development was adequate to establish stabilized water quality conditions, remove drilling impacts on the wells and provide representative flow for aquifer testing. The last measurements, recorded after removal of the total volumes removed, were used as the stabilized water quality values for these parameters and are presented in Table 6. All of the intermediate readings are presented on the Water Quality Sampling Field Measurement Forms included in Appendix I.

Table 6: Summary of Well Development Logs

Piezometer No.	Estimated Development Volume (gallons)	Stabilized Water Quality Parameters		
		Specific Conductance (x1,000) (mS/cm)	pH	Turbidity (NTU's)
P-02	130.0	0.061	3.94	0.0
P-04	100.0	0.063	4.40	12.6
P-06	100.0	0.062	4.59	26.7
P-08	140.0	0.050	4.51	22.5
P-10	130.0	0.056	4.20	0.0

On August 19, 2016, Harbin Engineering, P.C. performed step-drawdown pumping tests in piezometer wells P-04 and P-08 and on May 24, 2019 IES performed step-drawdown pumping tests in piezometer wells P-02 and P-10. Using a four-stage flow controllable submersible pump and an In-Situ Level TROLL 700 data logger, the well drawdown was recorded at subsequent intervals of constant flow rates. The comprehensive logs and time-drawdown plots are included in Appendix I and summarized below.

Table 7: Summary of Step-Drawdown Pumping Tests

Piezometer No.	Stabilized Draw-down, *s* (ft)	Constant Well Yield, *Q* (gpm)	Unconfined Aquifer Empirical Factor	Trans-missivity, *T* (gpd/ft)	Well Screen Interval, *b* (ft)	Hydraulic Conductivity, *K* (gpd/ft^2)	Hydraulic Conductivity, *K* (cm/sec)
P-02	1.32	0.652	1,500	742	10	74.2	3.50×10^{-3}
P-02	1.68	1.071	1,500	957	10	95.7	4.51×10^{-3}
P-02	2.03	1.500	1,500	1,106	10	110.6	5.22×10^{-3}
						AVERAGE, P-02	4.41×10^{-3}
P-04	3.61	2.00	1,500	831	10	83.1	3.92×10^{-3}
P-04	4.34	2.14	1,500	741	10	74.1	3.49×10^{-3}
						AVERAGE, P-04	3.71×10^{-3}
P-08	0.90	0.50	1,500	833	10	83.3	3.93×10^{-3}
P-08	3.53	1.88	1,500	797	10	79.7	3.76×10^{-3}
						AVERAGE, P-08	3.86×10^{-3}
P-10	6.46	0.811	1,500	188	10	18.8	8.88×10^{-4}
P-10	8.31	1.200	1,500	217	10	21.7	1.02×10^{-3}
P-10	9.47	1.111	1,500	176	10	17.6	8.30×10^{-4}
						AVERAGE, P-10	9.13×10^{-4}
						OVERALL AVERAGE	$\mathbf{3.11 \times 10^{-3}}$
						OVERALL MAXIMUM	$\mathbf{5.22 \times 10^{-3}}$

Hydraulic Conductivity was calculated by first using an empirical equation developed from Jacob's modified nonequilibrium equation and provided by Driscoll (Appendix 16.D, Groundwater and Wells, Second Edition) for estimating Transmissivity in an unconfined aquifer:

$$T\ (\text{gpd/ft}) = 1{,}500\ \frac{Q\ (\text{gpm})}{s\ (\text{ft})}$$

Next, Hydraulic Conductivity was calculated by dividing the Transmissivity by the saturated portion of the well screen before the pumping test began.

$$K\ (\text{gpd/ft}^2) = \frac{T\ (\text{gpd/ft})}{b\ (\text{ft})}$$

Finally, the units of Hydraulic Conductivity were converted to centimeters per second (cm/sec) by the following conversion factor:

$$1 \frac{\text{gallon}}{(\text{day})\,(\text{ft}^2)} \times \frac{1 \quad \text{ft}^3}{7.48 \quad \text{gallons}} \times \frac{30.48 \quad \text{cm}}{1 \quad \text{ft}} \times \frac{1 \quad \text{day}}{86{,}400 \quad \text{sec}} = 4.72\text{x}10^{-5} \frac{\text{cm}}{\text{sec}}$$

Based upon the field pumping tests in P-02, P-04, P-08 and P-10, the maximum hydraulic conductivity was calculated to be 5.22 x 10^{-3} cm/sec and the average hydraulic conductivity was calculated to be 3.11 x 10^{-3} cm/sec.

Based on the results of the laboratory permeability test and the field pumping tests, the horizontal hydraulic conductivity is greater than the vertical hydraulic conductivity, which is generally typical of depositional deposits which contain micro-bedding of sands and lower permeability silt and clay lenses. The data indicates that horizontal dispersivity is greater than the vertical dispersivity in the aquifer.

2.4 Description of Unconfined Aquifer

The unconfined aquifer at the proposed site is the uppermost aquifer. Groundwater elevations were observed by Advanced Environmental Management, Inc. (AEM) to be approximately ±1-4 feet below ground surface at the time of drilling in March 2016. This first reading took place in the wet season during which the highest groundwater elevations were observed. Subsequent water level measurements were performed on April 18, 2016; June 28, 2016; and August 19, 2016 by Harbin Engineering, P.C. Potentiometric maps of each event are included in Appendix I. The January 30, 2019 event is shown on Figure 2-01 because it is considered the seasonal high groundwater table.

The following is excerpted from the Groundwater Resources Table in the USGS Scientific Investigations Report (SIR) 2011-5048: "Groundwater Conditions and Studies in Georgia, 2008-2009" (See Appendix J):

> The surficial aquifer system in Georgia consists of unconsolidated sediments and residuum and are generally unconfined. In the coastal area of the Coastal Plain, however, at least two semiconfined aquifers have been identified. Wells installed in the surficial aquifer system typically range in depth between 11 and 300 feet below ground surface (bgs). The typical range of yield for these wells is between 2 and 25 gallons per minute (gpm), but may exceed 75 gpm.
>
> Water-level fluctuations in the surficial aquifer system are caused mainly by variations in precipitation, evapotranspiration, and natural drainage or discharge. In addition, water levels in the City of Brunswick area are influenced by nearby pumping, precipitation, and tidal fluctuations (Clarke and others, 1990). Water levels generally rise rapidly during wet periods and decline slowly during dry periods. Prolonged droughts may cause water levels to decline below pump intakes in shallow wells, particularly those located on hilltops and

> steep slopes, resulting in temporary well failures. Usually, well yields are restored by precipitation (Clarke, 2003).

The following is excerpted from a paper by USGS Hydrologist John S. Clarke entitled "The surficial and Brunswick Aquifer Systems-Alternative Ground-Water Resources for Coastal Georgia" dated April 2003 (See Appendix K):

> The surficial aquifer system consists of interlayered sand, clay, and thin limestone beds of Miocene and younger age (Fig. 2), which were formerly called the surficial aquifer (Clarke and others, 1990). The aquifer system designation proposed herein is based on Leeth (1999), who subdivided the aquifer into three zones—the water-table zone and the confined upper and lower water-bearing zones. Weems and Edwards (2001) assigned the confined zones to the Ebenezer Formation and the water-table zone to the Satilla and Cypresshead Formations. The areal extent of the confined units of the surficial aquifer system is currently unknown. Leeth (1999) reported two confined water-bearing zones in Camden County; and Clarke and others (1990) reported one confined water-bearing zone at Brunswick, Glynn County, and one at Skidaway Island, Chatham County. Multiple confined water-bearing zones are believed to occur mostly in areas where deposits are thick, such as in the southeast Georgia embayment.
>
> For the water-table zone, Clarke and others (1990) and Leeth (1999) reported well yields ranging from 2 to 140 gallons per minute (gal/min) and transmissivity ranging from 14 to 6,700 ft^2/d in Glynn and Camden Counties. For the confined water-bearing zones, Clarke and others (1990) reported well yields ranging from 40 to 180 gal/min and transmissivity ranging from 150 to 6,000 ft^2/d. Leeth (1999) reported well yields from 15 to 100 gal/min and a transmissivity of 180 ft^2/d at Camden County. Industrial supply wells near Jesup, Wayne County, formerly yielded about 250 gal/min from the confined water-bearing zones, with a total withdrawal of about 0.86 Mgal/d during 1986 (Clarke and others, 1990).

Based on these studies the surficial aquifer system for the proposed site is the unconfined water-table zone in the Satilla Formation.

2.5 Description of Confined Aquifers

Confined aquifers were not encountered during field subsurface exploration for this report. Confined aquifers beneath the uppermost aquifer system consist of the Upper and Lower Brunswick and the Upper and Lower Floridan aquifer systems.

The following is excerpted from the Groundwater Resources Table in the USGS Scientific Investigations Report (SIR) 2011-5048: "Groundwater Conditions and Studies in Georgia, 2008-2009" (See Appendix J):

> The Brunswick aquifer system in Georgia, including the upper and lower Brunswick aquifers, consists of phosphatic and dolomitic quartz sand and is generally confined. Wells installed in the Brunswick aquifer system typically range in depth between 85 and 390 feet

below ground surface (bgs). The typical range of yield for these wells is between 10 and 30 gallons per minute (gpm), but may exceed 180 gpm.

In the coastal area, the Brunswick aquifers may respond to pumping from the Upper Floridan aquifer as a result of the hydraulic connection between the aquifers. Elsewhere, the water level mainly responds to seasonal variations in recharge and discharge. In Bulloch County, unnamed aquifers equivalent to the upper and lower Brunswick aquifers are unconfined to semiconfined and are influenced by variations in recharge from precipitation and by pumping from the Upper Floridan aquifer; in the Wayne and Glynn County area, the aquifers are confined and respond to nearby pumping (Clarke and others, 1990; Clarke, 2003).

The Upper and Lower Floridan aquifers in Georgia, consists of limestone, dolomite, and calcareous sand and is generally confined. Wells installed in the Floridan aquifer typically range in depth between 40 and 900 feet below ground surface (bgs). The typical range of yield for these wells is between 1,000 and 5,000 gallons per minute (gpm), but may exceed 11,000 gpm.

In and near outcrop areas, the Floridan aquifers are semiconfined, and water levels in wells tapping the aquifers fluctuate seasonally in response to varia-tions in recharge rate and pumping. Near the coast, where the aquifers are confined, water levels primarily respond to pumping, and fluctuations related to recharge are less pronounced (Clarke and others, 1990).

2.6 Potential of Unconfined and Confined Aquifers as Sources of Drinking Water

The following is excerpted from the USGS Scientific Investigations Report (SIR) 2011-5048: "Groundwater Conditions and Studies in Georgia, 2008-2009" (See Appendix J):

> The surficial aquifer system is the "primary source of water for domestic and livestock supply in rural areas. The surficial aquifer system is the supplemental source of water for irrigation supply in coastal Georgia."
>
> The Brunswick aquifers are "not a major source of water in coastal Georgia, but considered a supplemental water supply to the Upper Floridan aquifer."
>
> The Floridan aquifers "supply about 50 percent of groundwater in Georgia. The aquifer system is divided into the Upper and Lower Floridan aquifers. In the Brunswick area, the Upper Floridan aquifer includes two freshwater-bearing zones—the upper water-bearing zone and the lower water-bearing zone. In the Brunswick area and in southeastern Georgia, the Lower Floridan aquifer includes the brackish-water zone, the deep freshwater zone, and the Fernandina permeable zone (Krause and Randolph, 1989). The Lower Floridan aquifer extends to more than 2,700 ft in depth and yields high-chloride water below 2,300 ft (Jones and Maslia, 1994)."

Based upon correspondence with a local well driller (Woodrow Sapp Well Drilling and Water Management) who installs public water systems and residential wells within two (2) miles of the proposed site, the public water system wells in this area of Brantley County, Georgia are unscreened wells with the well casing terminated into a confining unit within of the Upper Floridan aquifer approximately ±720-730 feet below ground surface; the domestic water wells are also unscreened but the casing is terminated into a confining unit approximately ±260 feet below ground surface. Correspondence with this driller and copies of the drilling logs for the public water wells are included in Appendix L.

2.7 Description of Geologic and/or Natural Hazards and for Seismic Impact Zone

2.7.1. Fault Areas

Review of the "Georgia Geologic Map" prepared by the Georgia Geologic Survey dated 1976 did not identify any features representative of a fault within 200 feet (60 meters) of the proposed site. See Figure 2-03.

According to the 1997 "Circular 14: Criteria for Performing Site Acceptability Studies for Solid Waste Landfills in Georgia" issued by the Georgia Geologic Survey it states on Page 15, "very few [faults], if any, have been recognized as having had displacement in Holocene time." It also states on Page 5 in a footnote, "With the possible exception of a single fault shown between Dooly and Sumter Counties on the 1976 1:500,000 Geologic Map of Georgia, there are no known Holocene faults in Georgia."

According to the United States Geologic Service (USGS) Interactive Fault Map for Quaternary Faults (earthquake.usgs.gov/hazards/qfaults/map), no faults which are believed to be sources of earthquakes with a magnitude greater than 6 in Holocene time (less than 15,000 ± years) are indicated within 200 feet of the site. In fact, no such Quaternary faults or associated folds are indicated in Georgia. See Figure 2-05.

2.7.2. Seismic Impact Zones

According to Map C from the 1990 U.S. Geological Survey (USGS) Miscellaneous Field Study Map MF-2120 entitled "Probabilistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico", Brantley County, Georgia lies approximately at 9% gravity (or 0.09g) for horizontal acceleration. This indicates Brantley County is not in a "Seismic Impact Zone," as defined by the Rules. See Figure 2-06.

2.7.3. Unstable Areas

There are no unstable areas "susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the landfill structure components responsible for preventing releases from a landfill" including the following:

> "On-site or local soil conditions that may result in significant differential settling;"

Georgia Rule 391-3-4-.05-(1)-(h)-1-a

"On-site or local geologic or geomorphic features;"

Georgia Rule 391-3-4-.05-(1)-(h)-1-b

"On-site or local human-made features or events (both surface and subsurface)"

Georgia Rule 391-3-4-.05-(1)-(h)-1-c

"Structural components... liners, leachate collection systems, final covers, run-on/run-off systems, and any other component used in the construction and operation of the landfill that is necessary for protection of human health and the environment."

Georgia Rule 391-3-4-.05-(1)-(h)-2-b

"Poor foundation conditions... those areas where features exist which indicate that a natural or man-induced event may result in inadequate foundation support for the structural components of a landfill unit."

Georgia Rule 391-3-4-.05-(1)-(h)-2-c

"Areas susceptible to mass movement... those areas of influence (i.e., areas characterized as having an active or substantial possibility of mass movement) where the movement of earth material at, beneath, or adjacent to the landfill unit, because of natural or man-induced events, results in the downslope transport of soil and rock material by means of gravitational influence. Areas of mass movement include, but are not limited to, landslides, avalanches, debris slides and flows, soil fluction, block sliding, and rock fall."

Georgia Rule 391-3-4-.05-(1)-(h)-2-d

"Karst terrains... areas where karst topography, with its characteristic surface and subterranean features, is developed as the result of dissolution of limestone, dolomite, or other soluble rock. Characteristic physiographic features present in karst terrains include, but are not limited to, sinkholes, sinking streams, caves, large springs, and blind valleys."

Georgia Rule 391-3-4-.05-(1)-(h)-2-e

3.0 PATHWAY ANALYSIS

The purpose of this section is to evaluate how leachate might percolate downward from the waste burial areas to the water table and then migrate offsite to potential human receptors.

3.1 Description of Inter-Relationships Between the Vadose Zone, the Uppermost Aquifer and Deeper Aquifers

On August 19, 2016, representatives with Harbin Engineering, P.C. measured the water level in an offsite domestic well previously installed on the adjacent property also owned by the Brantley County Development Partners, LLC in addition to the subject site's piezometers P-01 through P-12. This offsite domestic well is believed to have been installed unscreened to a depth approximately 260 feet below ground surface (See Section 2.6 and also Appendix L). The location of this offsite well is also adjacent to a ±5 acre surface water body created by prior soil excavation activities (See Figure 3-02). The shallow surface water elevation of the pond was observed to be less than five (5) feet below ground surface and thus connected to the shallow unconfined surficial aquifer based upon historical data collected for the subject site. However, the water level recorded in this offsite domestic well was observed to be approximately ±30 feet lower than the depth measured in the onsite piezometer wells P-01 through P-12 (See August 19, 2016 Field Notes in Appendix I). The noticeably lower elevation recorded in this well approximately ±630 feet west of the proposed site means there are confining units beneath the water table zone of the surficial aquifer and the intake elevation of this domestic well.

See Figure 3-01 for the schematic cross-sectional diagram showing the relationship of the groundwater aquifers for the general area of where the proposed site is located. Figure 3-01 is excerpted from a paper by USGS Hydrologist John S. Clarke entitled "The surficial and Brunswick Aquifer Systems-Alternative Ground-Water Resources for Coastal Georgia" dated April 2003.

As previously discussed in Sections 2.5 and 2.6, the vadose zone and uppermost aquifer for the proposed site is within the water-table zone of the Satilla Formation. As depicted in Figure 3-01, various confining units within the surficial aquifer system itself and also below, isolate the water-table zone from the underlying Brunswick and Floridan aquifer systems. Drillers Well Logs from the public water system wells installed in the vicinity of the proposed site confirm the existence of these confining units (See Appendix L).

Since the site's vadose zone is relatively negligible and the surficial groundwater table is very shallow (within ±1 to ±4 feet below existing ground surface), design recommendations for the landfill include an underdrain or capillary break system and soil fill placed over the existing ground surface to maintain the required separation under a liner and leachate collection system (See Section 4.0). By installing an underdrain or capillary break system and vertical soil buffer beneath the proposed landfill liner and leachate collection system, this system and buffer can control seasonal and yearly fluctuations in the water table and recharge mechanisms, including leackage from overlying and underlying strata, pinchouts or lenses of permeable and impermeable materials, variation of hydraulic conductivity with depth and variations of flow velocity and flow direction from the surfical aquifer.

3.2 Calculated Ground-Water Flow Velocities

For most Coastal Plain soil sites where the uppermost aquifer is a porous media, the calculation for horizontal groundwater flow velocities should be based on the Darcy Equation:

$$V = \frac{K \, \Delta h}{n \, \Delta l}$$

where:

V = linear velocity (feet/day)
K = hydraulic conductivity (feet/day)
n = effective porosity (%)

$\frac{\Delta h}{\Delta l}$ = hydraulic gradient (based on the potentiometric map of the uppermost aquifer)

To calculate effective porosity, n, the following equation is used:

$$n = 1 - \frac{SG_{BULK\ DENSITY}}{SG_{SOIL\ PARTICLE}}$$

where:

n = effective porosity (%)
$SG_{BULK\ DENSITY}$ = specific gravity of bulk density of soil sample
$SG_{SOIL\ PARTICLE}$ = specific gravity of soil particle = 2.66

Conservatively, the largest bulk density measured in the laboratory was used for this calculation. According to the laboratory analysis in Appendix G, the undisturbed sample from boring P-11 was measured to have a bulk density of 122.8 pcf, or a specific gravity of 1.97 (122.8 pcf ÷ 62.4 pcf H_2O). Using the equation above, the effective porosity, n, is calculated to be 0.26 or 26%.

The maximum and average horizontal hydraulic conductivities calculated earlier in this report (See Section 2.3.2) are 5.22 x 10^{-3} cm/sec and 3.11 x 10^{-3} cm/sec, respectively. This is equal to 8.81 and 14.79 feet/day, respectively.

The maximum and average hydraulic gradients ($\Delta h/\Delta l$) measured from the potentiometric map in Figure 2-01 are 0.010 ft/ft and 0.005 ft/ft, respectively.

Therefore, using Darcy's Law equation above, the maximum and average linear velocities are calculated to be 0.57 and 0.17 feet/day.

3.3 Groundwater Pollution Potential

This section is to address groundwater pollution potential of sites in their natural state. Pollutants in groundwater generally tend to be removed or reduced in concentration with time and with distance traveled. Mechanisms such as attenuation include: filtration, soprtion, chemical processes, microbiological decomposition and dilution. Sorptive capacity (cation exchange capacity) was measured in 20 undisturbed samples collected at varying depths from 14 of the 24 borings (P-08, P-11, P-12, P-13, P-14, P-15, P-16, P-17, P-18, P-19, P-20, P-21, P-22, P-23) at concentrations ranging between 1.1 and 40 meq/100g, as Table 4 in Section 2.4 and Appendix G indicate.

The Hydrological Atlas Number 20, of the Georgia Geological Survey, was utilized to determine the nearest proximity of groundwater pollution susceptibility areas to the site. The atlas shows the site within an average susceptibility area however also within proximity to a higher susceptibility area with a DRASTIC rating greater than 181, as shown on Figure 3-03. The DRASTIC rating is based upon several factors, such as depth to water, sorption above the water table, aquifer permeability, water table gradient, horizontal distance, thickness of unconsolidated media at two-media sites, recharge, aquifer media, impact of vadose zone, hydraulic conductivity, soil media, and topography.

Again, the DRASTIC pollution susceptibility methodology only considers sites in their natural state and does not take into account engineered sites having liner and leachate collection systems. As previously addressed in Section 3.1 and again in Section 4.0, design of an underdrain or capillary break system and installation of a vertical soil buffer beneath the landfill liner and leachate collection system is not only recommended but required by Georgia Rule 391-3-4-.07-(1)-(d) to control groundwater separation from the liner system and mitigate the pollution susceptibility and containment pathway.

3.3.1. LeGrand's Method

The overall pollution potential for the landfill was estimated using the LeGrand concept for loose granular materials extending 100 feet or more below the ground surface (typical Coastal Plain sites) as described in Circular 14 (Rating Chart excerpt shown on Figure 3-04). The following values are for the flow most typical of the site and were calculated to develop a total LeGrand score, as follows:

- Depth to groundwater beneath landfill – 5-foot average to create required separation from seasonal high water table (0.7 point)
- Soil sorption – maximum sorption for composite liner with leachate collection system (6 points)
- Aquifer permeability – "clayey sand" permeability rating for composite liner with leachate collection system (3 points)
- Gradient – maximum of 2 percent with favorable flow direction (4 points)
- Distance to receptor – Approximately 550 feet from the favorable area for landfilling (8 points)

The total score for the LeGrand calculation for the nearest drinking water receptor is 21.7 points, which is considered "possible, but not likely" pollution potential. As discussed in Sections 3.4 & 3.5 of the 2016 SAR, the residential wells are withdrawing water from a confined unit approximately 260 feet below ground surface and not withdrawing from the shallow, unconfined aquifer, which makes the groundwater pollution potential even less likely.

3.4 Description of the Inter-Relationship Between Groundwater Flow Directions and Potential Receptors

Horizontal directions of groundwater flow are shown on both Figure 2-01 and Figure 3-02. The groundwater flow directions generally follow the natural topography; that is, flowing predominantly in the southeasterly direction and towards the perimeter of the site to the east and west. Potential receptors are located immediately down-gradient of the proposed site to the south, whose properties border the site. Locations of these receptors are shown in Figure 3-02.

Of the 33 domestic (private) drinking water wells located within 0.5 mile of the proposed site's boundary, 11 are down-gradient. Four (4) of the down-gradient wells are located less than 500 feet southwest or south of the proposed site's boundary, however neither of these four (4) domestic (private) wells are located within 500 feet of the favorable area for solid waste disposal (potential waste disposal boundary). A number of other domestic wells are located within 0.5 miles of the site; however, based on the groundwater potentiometric maps (Figure 2-01 and Figure 3-02) these other domestic wells are located hydraulically up-gradient or lateral gradient of the site. These domestic wells are identified in Table 3 (Section 1.7.3) and on Figure 1-05 and Figure 3-02.

The approximate horizontal distances between the private groundwater wells and the proposed site property line are indicated on Table 3 in Section 1.7.3. The distance between the private wells and areas favorable for solid waste disposal (See Figure 3-02 and Figure 4-01) are also on Table 3 because a significant portion of the southern part of the site is not viable for waste unit development due to wetlands and horizontal limitations which preclude cost effective waste unit development. As mentioned earlier in Section 2.6 and documented in Appendix L, the public water wells within 2.0 miles of the proposed site are unscreened wells installed ±720-730 feet below ground surface and the domestic water wells in the vicinity are also unscreened but installed into a confining unit approximately ±260 feet below ground surface. Based on the hydraulic conductivity testing (laboratory vertical and pumping test horizontal), the horizontal direction of groundwater flow through the unconfined aquifer is greater than the potential for vertical migration through the uppermost aquifer and through the lower confining units, making it less likely the deeper drinking water wells within proximity to the proposed site will be affected by potential pathways in groundwater flow.

3.5 Estimated Travel Time for Leachate to Reach Potential Receptors

As shown in Section 3.2, the maximum and average linear groundwater flow velocities are calculated from Darcy's Law to be 0.57 and 0.17 feet/day. The nearest hydraulically down-gradient receptor is approximately ±550 feet from a favorable area for waste disposal (See Table 3 in Section 1.7.3 and also Figure 3-02). Using the conservative, maximum flow velocity, the estimated travel time for groundwater to flow horizontally from the favorable area (potential waste disposal boundary) to this well location is approximately 2.6 years. This estimate is not an adequate measure of travel time to potential receptors and should not be used for mitigation because of the following actual limitations to this estimate:

1. The actual travel time is expected to be longer than this estimate because of the vertical and diagonal pathway to the actual well intake elevation of unscreened casing bottom, estimated to be ±260 feet below ground surface into a confining unit; the travel time vertically by gravity alone through each underlying strata or confining unit cannot be calculated although it is understood this vertical pathway takes far more time than the horizontal pathway through the surficial unconfined aquifer; each subsequent vertical strata with varying densities further filters the groundwater before it reaches this deeper elevation;

2. Surface water and natural depressions or drainage ways can intercept discharged groundwater between future waste limits and property boundary;

3. The actual travel time is expected to be longer than this estimate because of the anticipated longer horizontal travel distance. This distance is anticipated to be longer due to the actual limits of the waste disposal boundary and also actual horizontal groundwater flow direction, which is not linear;

4. The actual pathway of the theoretical contaminant may not ever reach the potential receptor because of the likely considerable dilution and natural attenuation processes and the intrinsic chemical properties that would retard transport under actual conditions; and

5. The actual travel time is expected to be longer than this estimate because the waste disposal unit is required to have a liner and leachate collection system.

In conclusion, in the unlikely occurrence of a failure in the required liner and leachate collection system, the estimated travel time of a theoretical contaminant is anticipated to be much greater than 2.6 years.

3.6 Mitigation of Geologic and/or Natural Hazards

Based on the information presented in Section 2.7, there are no geologic and/or natural hazards in the site area which would warrant special mitigation or design criteria.

4.0 RECOMMENDATIONS FOR DESIGN

4.1 Favorable Areas

Areas favorable for landfill operations include all of the areas outside the unfavorable areas for waste disposal (see Section 4.2). Favorable areas for solid waste disposal are indicated on Figure 4-01. Based upon this figure, approximately ±227 acres of the ±463 acres are favorable. As it states on Note 1, favorable areas indicated on this figure do not represent the actual waste disposal boundary. As defined in Georgia Rule 391-3-4-.07-(1)-(b), the waste disposal boundary is defined as “the limit of all waste disposal areas, appurtenances, and ancillary activities (including but not limited to internal access roads and drainage control devices).” The actual horizontal limits of waste disposal boundary will be determined during the design and permitting process and will be less than the favorable areas shown on this figure as areas impractical for disposal unit development are omitted.

4.2 Unfavorable Areas

Areas unfavorable for landfill operations include jurisdictional wetlands with setbacks, property line buffers and areas that are difficult or impractical to access. Unfavorable areas for solid waste disposal are indicated on Figure 4-01. Based upon this figure, approximately ±236 acres of the ±463 acres are unfavorable. Note 2 states that jurisdictional wetlands (and their 50 ft buffer) outside the property line buffer may become favorable areas for solid waste disposal only if proper permitting is obtained as required by the U.S .Army Corps of Engineers. Note 3 states that unfavorable areas indicated beyond the 200 ft property line buffer and within the 500 ft property line buffer may become favorable areas for solid waste disposal as actual locations of the private (domestic) wells adjacent to the property line are confirmed.

4.3 Liner/Leachate Collection Systems

As required by Georgia Rule 391-3-4-.07-(1)-(d), a liner and leachate collection system shall be designed for the solid waste disposal area.

The liner and leachate collection system must ensure that the concentration values listed in Table 1 in Rule 391-4-1-.07-(1)-(d) shall not be exceeded in the uppermost aquifer at the relevant point of compliance as defined by 391-4-1-.07-(1)-(d)-2. The liner and leachate collection system must be designed and installed with construction review by a professional engineer registered to practice in Georgia who shall certify the installation.

Since the proposed site is located in an area of higher pollution susceptibility (See Section 3.3), the liner and leachate system must, at a minimum, be designed with:

a. a composite liner, as defined in Georgia Rule 391-4-1-.07-(1)-(d)-1-c and a leachate collection system that is designed and constructed to maintain less than a 30-cm depth of leachate over the liner.
b. at least a five foot separation between the synthetic liner and the seasonal high ground water elevation.

The liner and leachate collection system should be underlain with an underdrain or capillary break system and an adequate vertical soil buffer to maintain and control the separation from groundwater.

4.4 Cell Depths (including relationship to water table)

Because of the shallow groundwater table, the bottom of cells will most likely require some fill rather than extensive excavation below the existing ground surface. As previously mentioned, an adequate vertical soil buffer and an underdrain or capillary break system are recommended beneath the required liner and leachate collection system to control the required separation from groundwater. Based on Georgia Rule 391-3-4-.07-(d)-1-b, at least five (5) foot separation is required between the synthetic liner and the seasonal high ground water elevation. See Figure 2-01 for potentiometric surface of seasonal high groundwater table and Figure 2-02 showing cross-sections of recommended maximum cell depths (which equal the minimum bottom of clay liner elevations). Lastly, Figure 4-02 illustrates the recommended location of an underdrain or capillary break system.

4.5 Site Drainage and Erosion Control

Site drainage will be maintained by down-drains, berms perimeter ditches and culverts. Currently surface water drains through the wetlands to the south, east and west perimeter of the proposed site. Excavation of a surface water pond (for borrow soils and also for added buffer) in the lower portions of the site in the south may also be necessary to achieve required storm water control and sediment storage over the life of the facility.

Design of a surface water drainage and management system including an erosion and sedimentation plan for controlling run-on and run-off at developed portions of the site should take the storm water run-off, groundwater discharge and wetlands areas into consideration.

4.6 Buffer Zones

As required by Georgia Rule 391-3-4-.07-(1)-(b), the proposed solid waste facility:

> must provide a minimum 200 foot buffer between the waste disposal boundary and the property line and a minimum 500 foot buffer between the waste disposal boundary and any occupied dwelling and the dwelling's operational private, domestic water supply well in existence of the date of permit application. The 500-foot buffer may be reduced if the current owner of the dwelling provides a written waiver consenting to the waste disposal boundary being closer than 500 feet. The waste disposal boundary is defined as the limit of all waste disposal areas, appurtenances, and ancillary activities (including but not limited to internal access roads and drainage control devices). No land disturbing activities are to take place in these buffers, except for construction of groundwater monitoring wells and access roads for direct ingress or egress, unless otherwise specified in a facility design and operation plan or corrective action plan approved by the Division.

Actual site buffers will be greater in unfavorable areas due to site conditions (i.e, southern portion of the site). A required 50 foot buffer should be maintained between the waste disposal cells and any jurisdictional wetlands. A minimum vertical 5 foot soil buffer should be maintained between the seasonal high groundwater elevation and the synthetic liner. The seasonal high groundwater table is indicated in Figure 2-01, Figure 2-02 and Figure 4-02. The minimum bottom of clay liner elevations (maximum cell depths) are also shown on the cross sections presented in Figure 2-02, Figure 2-02a and Figure 4-02.

4.7 Monitoring

Groundwater and Methane gas monitoring should be designed as required by the Rules for Solid Waste Management and guidance from U.S. EPA Region 4 and Georgia EPD. A groundwater and methane monitoring plan will be required as part of the D&O Plans for the new landfill. This plan will include the location of all future monitoring wells, a schedule of abandonment and installation, monitoring well design recommendations and required monitoring schedule.

The location of several piezometer wells were strategically placed for purposes of converting them into the monitoring network. The piezometers were installed consistent with groundwater monitoring well completions, excluding well development, the metal lock box and concrete pad, which can be implemented later for those wells which can be converted to groundwater monitoring wells.

The site will also require storm water monitoring for the storm water management system including retention pond(s) required by the permit.

4.8 Disposition of Borings/Piezometers

Piezometers installed within a future footprint of the proposed landfill cell will be abandoned in accordance with the rules and EPD guidance. The remainder of the piezometers will continue to provide water level data and can be converted into a permanent monitoring well as part of the monitoring network. As mentioned earlier, these piezometers will need to be developed and completed with lock boxes and pads and re-surveyed for continued use.

4.9 Other Recommendations

Based upon field observations and review of historical site aerial imagery, several surface water ponds were observed to be created as a result of previous owners excavating soils for an unknown use. The subgrade soils of these previously excavated areas outside jurisdictional wetlands are recommended for further geotechnical evaluation prior to backfilling with suitable structural fill.

5.0 REFERENCES CITED/METHODS

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FIGURES

NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) 7.5-MINUTE SERIES QUADRANGLE MAPS FOR WAYNESVILLE (2014) AND NANHUNTA (2014). IMAGE OVERLAY METHODS ARE APPROXIMATE.

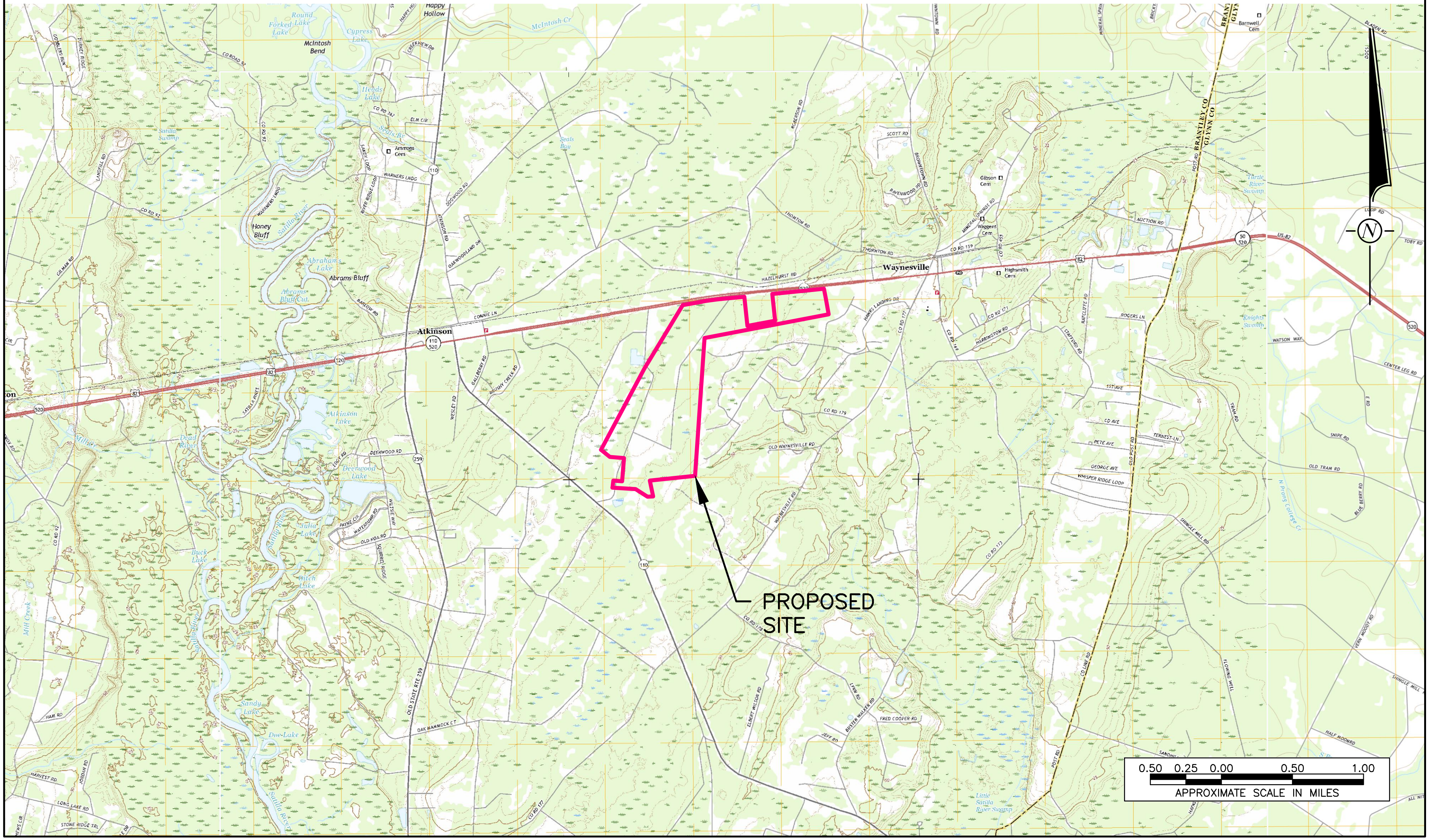


FIGURE 1-01

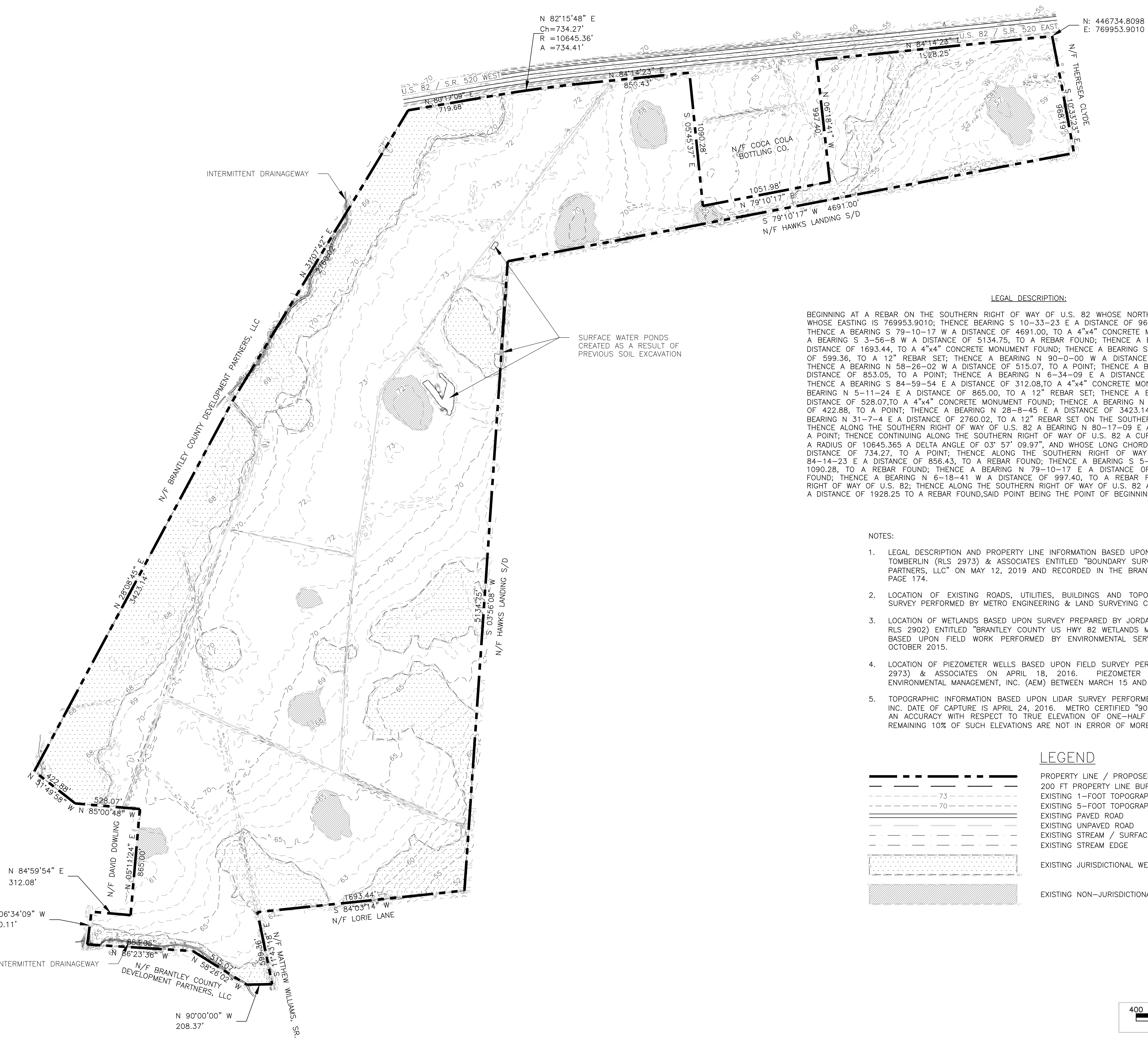
SITE SUITABILITY ASSESSMENT REPORT

TOPOGRAPHIC MAP OF GENERAL SITE AREA

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

Innovative Engineering Strategies, LLC
CIVIL · ENVIRONMENTAL
IES
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609



LEGAL DESCRIPTION:

BEGINNING AT A REBAR ON THE SOUTHERN RIGHT OF WAY OF U.S. 82 WHOSE NORTHING IS 446734.8098 AND WHOSE EASTING IS 769953.9010; THENCE BEARING S 10–33–23 E A DISTANCE OF 968.19, TO A REBAR FOUND; THENCE A BEARING S 79–10–17 W A DISTANCE OF 4691.00, TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING S 3–56–8 W A DISTANCE OF 5134.75, TO A REBAR FOUND; THENCE A BEARING S 84–3–14 W A DISTANCE OF 1693.44, TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING S 11–43–18 E A DISTANCE OF 599.36, TO A 12" REBAR SET; THENCE A BEARING N 90–0–00 W A DISTANCE OF 208.37 TO A POINT; THENCE A BEARING N 58–26–02 W A DISTANCE OF 515.07, TO A POINT; THENCE A BEARING N 86–23–36 W A DISTANCE OF 853.05, TO A POINT; THENCE A BEARING N 6–34–09 E A DISTANCE OF 270.11, TO A POINT; THENCE A BEARING S 84–59–54 E A DISTANCE OF 312.08,TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING N 5–11–24 E A DISTANCE OF 865.00, TO A 12" REBAR SET; THENCE A BEARING N 85–0–48 W A DISTANCE OF 528.07,TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING N 51–49–58 W A DISTANCE OF 422.88, TO A POINT; THENCE A BEARING N 28–8–45 E A DISTANCE OF 3423.14, TO A POINT; THENCE A BEARING N 31–7–4 E A DISTANCE OF 2760.02, TO A 12" REBAR SET ON THE SOUTHERN RIGHT OF WAY U.S. 82; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A BEARING N 80–17–09 E A DISTANCE OF 719.68, TO A POINT; THENCE CONTINUING ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A CURVE TO THE RIGHT, HAVING A RADIUS OF 10645.365 A DELTA ANGLE OF 03° 57' 09.97", AND WHOSE LONG CHORD BEARS N 82–15–48 E A DISTANCE OF 734.27, TO A POINT; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 BEARING N 84–14–23 E A DISTANCE OF 856.43, TO A REBAR FOUND; THENCE A BEARING S 5–45–37 E A DISTANCE OF 1090.28, TO A REBAR FOUND; THENCE A BEARING N 79–10–17 E A DISTANCE OF 1051.982, TO A REBAR FOUND; THENCE A BEARING N 6–18–41 W A DISTANCE OF 997.40, TO A REBAR FOUND ON THE SOUTHERN RIGHT OF WAY OF U.S. 82; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A BEARING N 84–14–23 E A DISTANCE OF 1928.25 TO A REBAR FOUND,SAID POINT BEING THE POINT OF BEGINNING.

NOTES:

1. LEGAL DESCRIPTION AND PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "BOUNDARY SURVEY FOR BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC" ON MAY 12, 2019 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 1, PAGE 174.
2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
3. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.
5. TOPOGRAPHIC INFORMATION BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & SURVEYING, INC. DATE OF CAPTURE IS APRIL 24, 2016. METRO CERTIFIED "90% OF THE ELEVATIONS DETERMINED... HAVE AN ACCURACY WITH RESPECT TO TRUE ELEVATION OF ONE–HALF CONTOUR INTERVAL OR BETTER AND THE REMAINING 10% OF SUCH ELEVATIONS ARE NOT IN ERROR OF MORE THAN ONE CONTOUR INTERVAL."

LEGEND

PROPERTY LINE / PROPOSED PERMIT BOUNDARY
200 FT PROPERTY LINE BUFFER
EXISTING 1–FOOT TOPOGRAPHIC CONTOUR
EXISTING 5–FOOT TOPOGRAPHIC CONTOUR
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
EXISTING NON–JURISDICTIONAL WETLANDS

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
CIVIL · ENVIRONMENTAL
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
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GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT

BOUNDARY SURVEY AND TOPOGRAPHIC MAP OF SITE

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
1-02

INITIAL SUBMITTAL DATE: AUG-2019 DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF GEORGIA GEOLOGIC SURVEY HYDROLOGIC ATLAS HA-18 ENTITLED "MOST SIGNIFICANT GROUND-WATER RECHARGE AREAS OF GEORGIA", DATED 1989. IMAGE OVERLAY METHODS ARE APPROXIMATE.

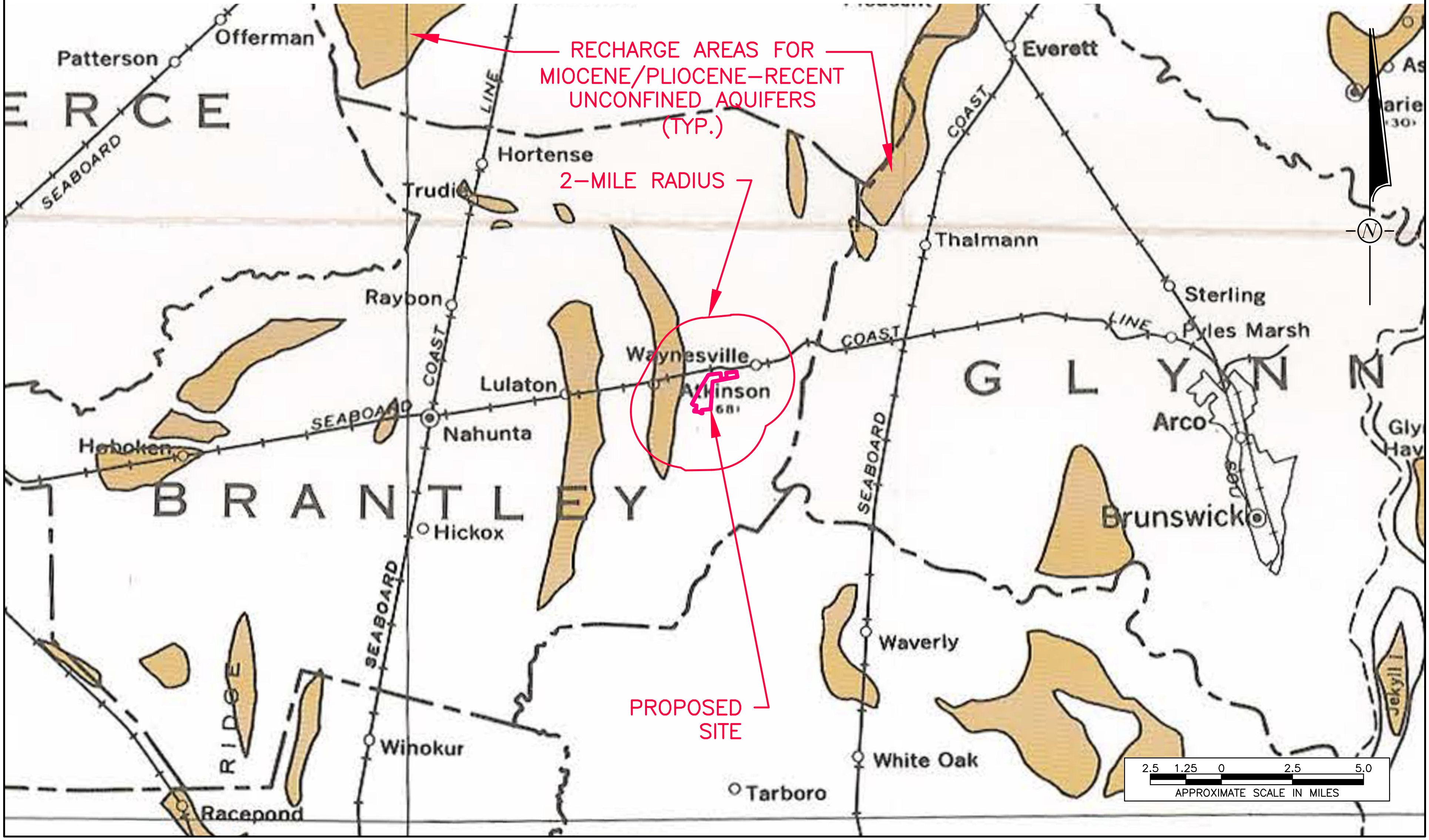

FIGURE 1-03	SITE SUITABILITY ASSESSMENT REPORT MOST SIGNIFICANT GROUNDWATER RECHARGE AREAS	BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC BRANTLEY COUNTY - S.R. 50 MSWL	Innovative Engineering Strategies, LLC CIVIL · ENVIRONMENTAL IES P.O. Box 560 Smarr, Georgia 31086 Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG-2019   DRAWING: 1390-013 SAR Figures.dwg   IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) 7.5-MINUTE SERIES QUADRANGLE MAPS FOR WAYNESVILLE (2014) AND NANHUNTA (2014). IMAGE OVERLAY METHODS ARE APPROXIMATE.

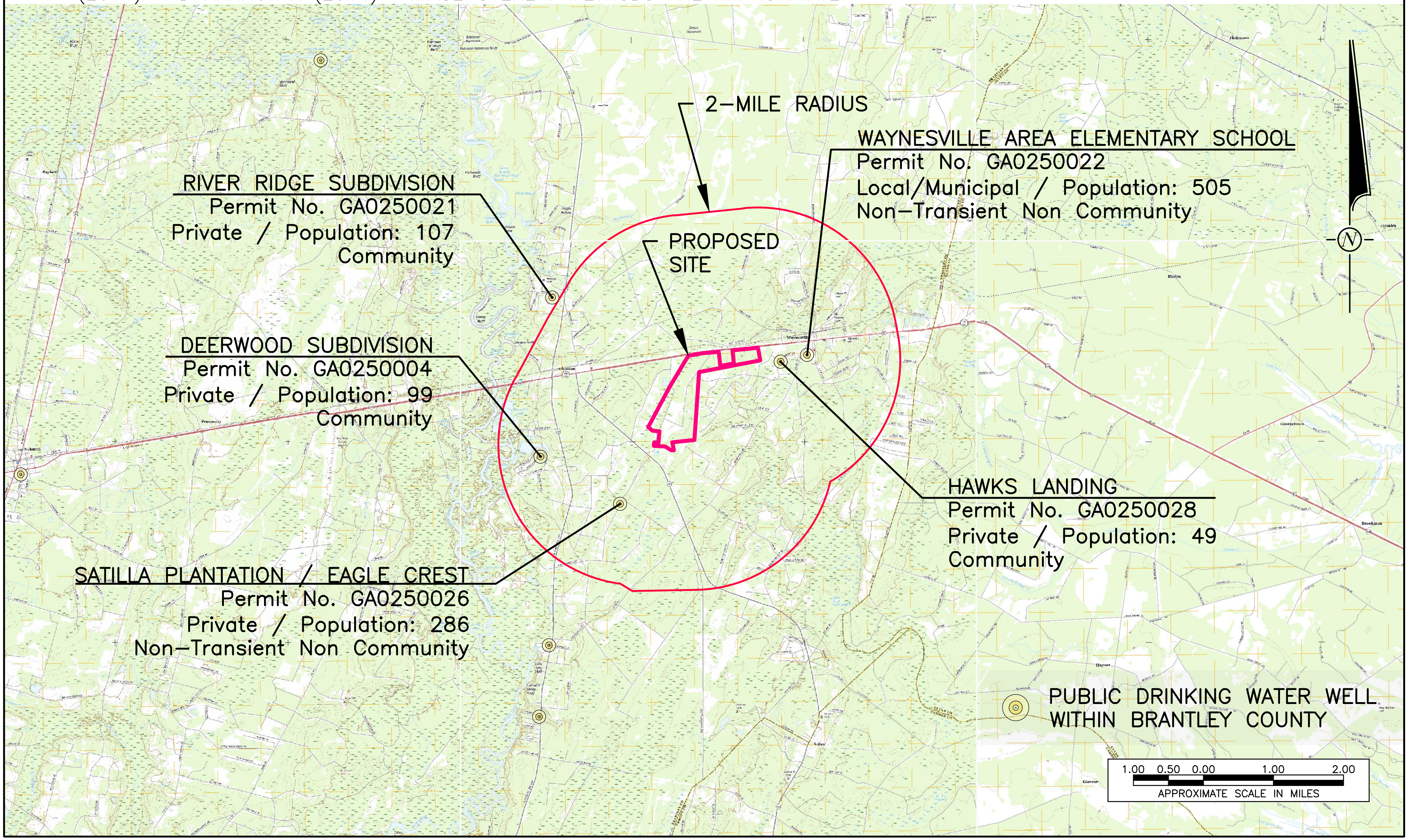

FIGURE 1-04

SITE SUITABILITY ASSESSMENT REPORT

PUBLIC WATER SUPPLIES

BRANTLEY COUNTY
DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY -
S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) 7.5-MINUTE SERIES QUADRANGLE MAPS FOR WAYNESVILLE (2017) AND NANHUNTA (2014). IMAGE OVERLAY METHODS ARE APPROXIMATE.

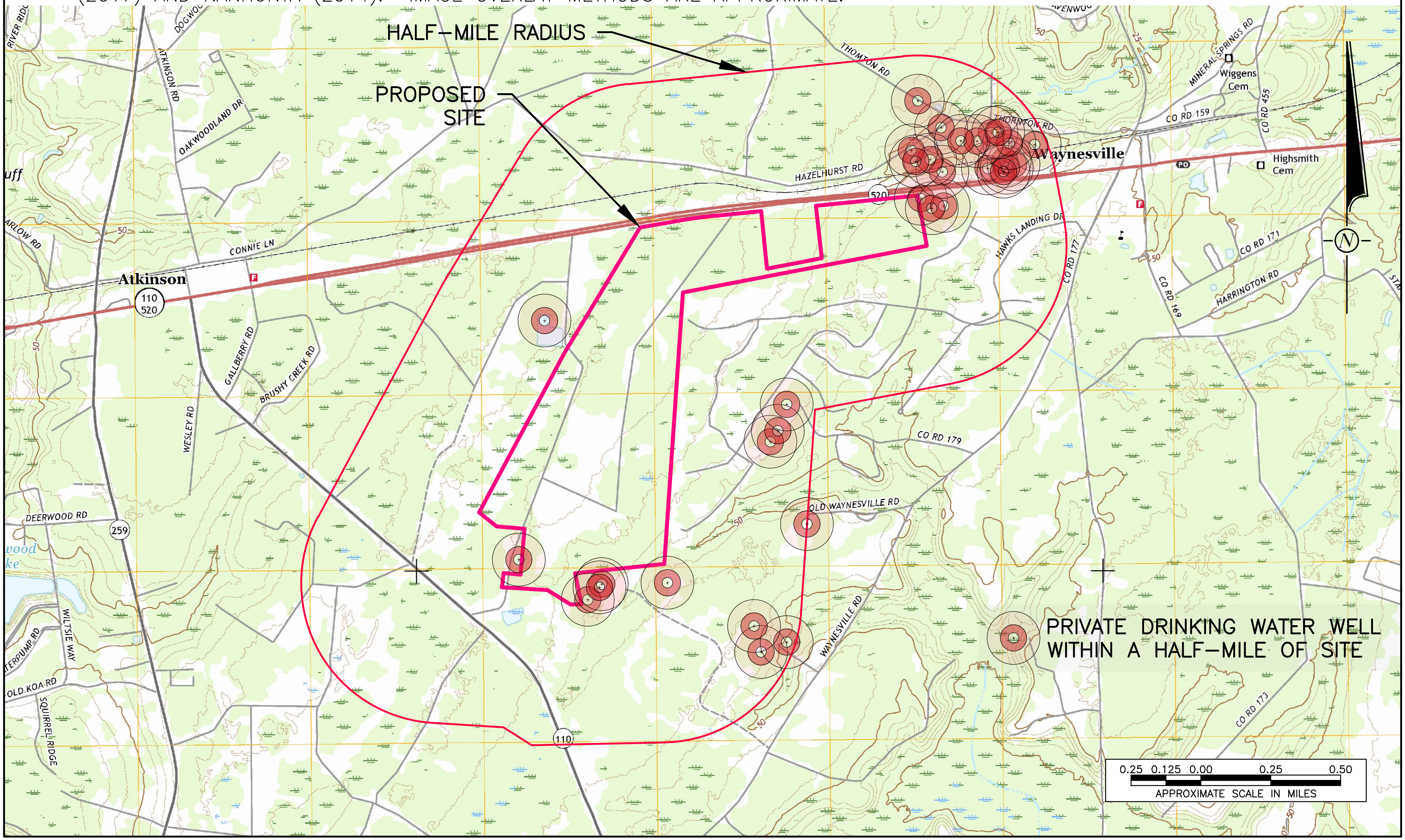

FIGURE 1-05

SITE SUITABILITY ASSESSMENT REPORT

DOMESTIC WATER SUPPLIES WITHIN HALF-MILE OF SITE

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF FEDERAL AVIATION ADMINISTRATION (FAA) SECTIONAL VISUAL FLIGHT RULES (VFR) CHART FOR JACKSONVILLE (FEBRUARY 4, 2016 EDITION). IMAGE OVERLAY METHODS ARE APPROXIMATE.

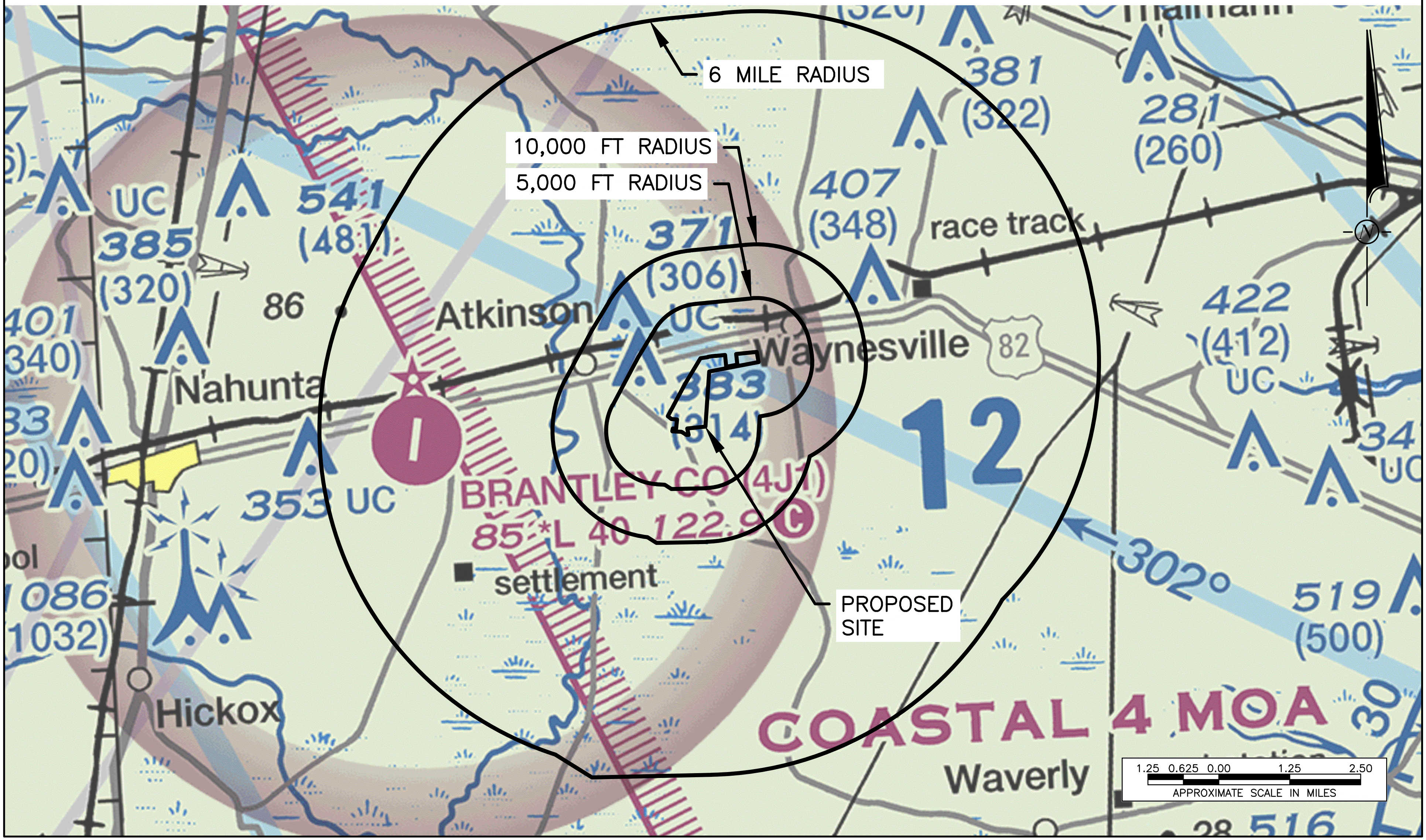

FIGURE 1-06	SITE SUITABILITY ASSESSMENT REPORT AIRPORTS AND FEDERALLY RESTRICTED AIRSPACE	BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC BRANTLEY COUNTY - S.R. 50 MSWL	Innovative Engineering Strategies, LLC CIVIL · ENVIRONMENTAL IES P.O. Box 560 Smarr, Georgia 31086 Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG-2019 DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF GEORGIA DEPARTMENT OF TRANSPORTATION (GDOT) GENERAL HIGHWAY MAPS FOR BRANTLEY COUNTY (2013) AND GLYNN COUNTY (2013). IMAGE OVERLAY METHODS ARE APPROXIMATE.

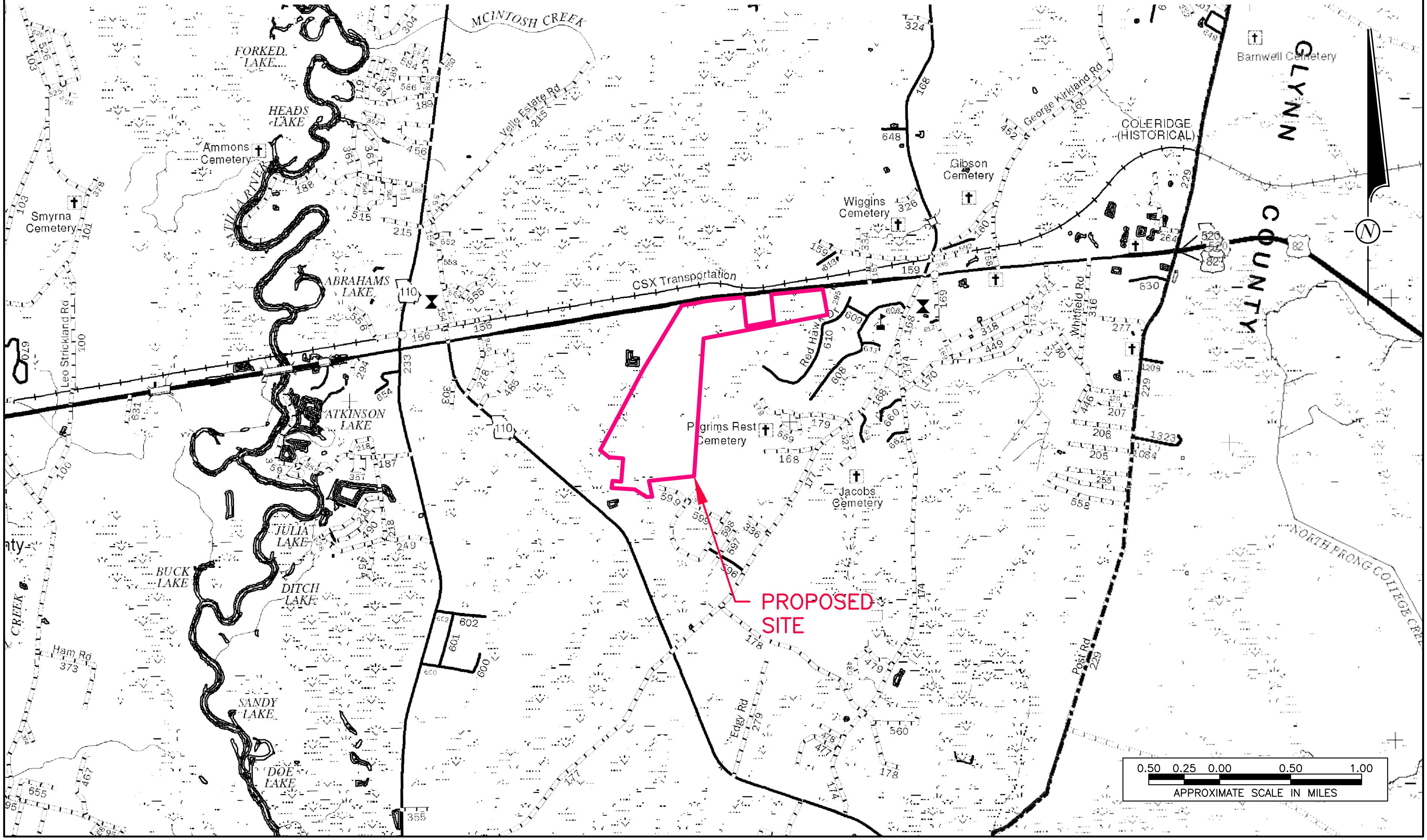

FIGURE 1-07

SITE SUITABILITY ASSESSMENT REPORT

COUNTY BOUNDARIES

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF NATIONAL FLOOD INSURACE PROGRAM (NFIP) FLOOD INSURANCE RATE MAP (FIRM) PANELS 13025C0230C & 13025C0235C, EFFECTIVE SEPTEMBER 25, 2009. IMAGE OVERLAY METHODS ARE APPROXIMATE.

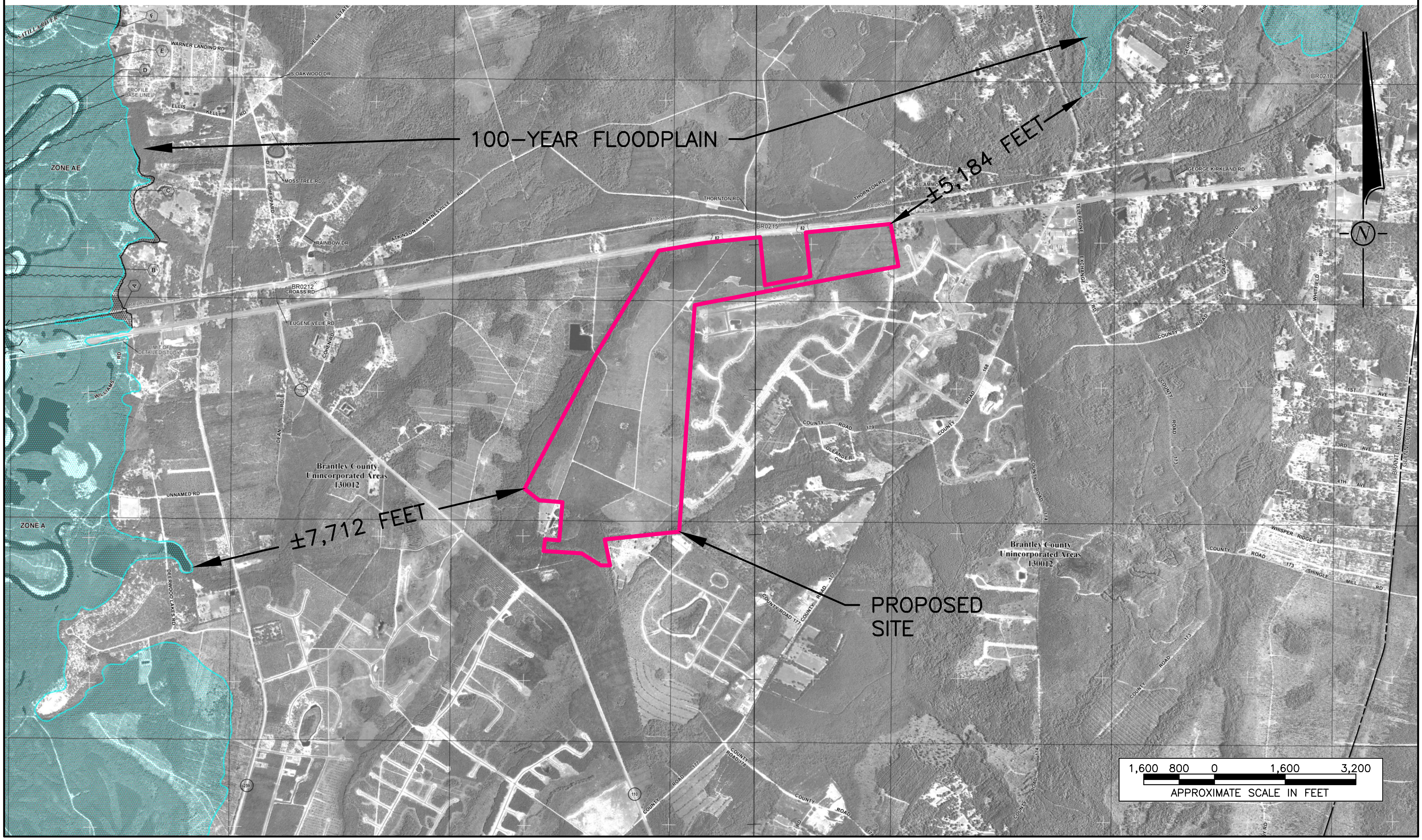

FIGURE 1-08

SITE SUITABILITY ASSESSMENT REPORT

FLOODPLAINS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF WETLANDS MAPPING SURVEY PREPARED BY JORDAN ENGINEERING, DATED DECEMBER 23, 2015, AND BASED UPON FIELD DELINEATION OF WETLANDS PERFORMED BY ENVIRONMENTAL SERVICES, INC. IN DECEMBER 2015.

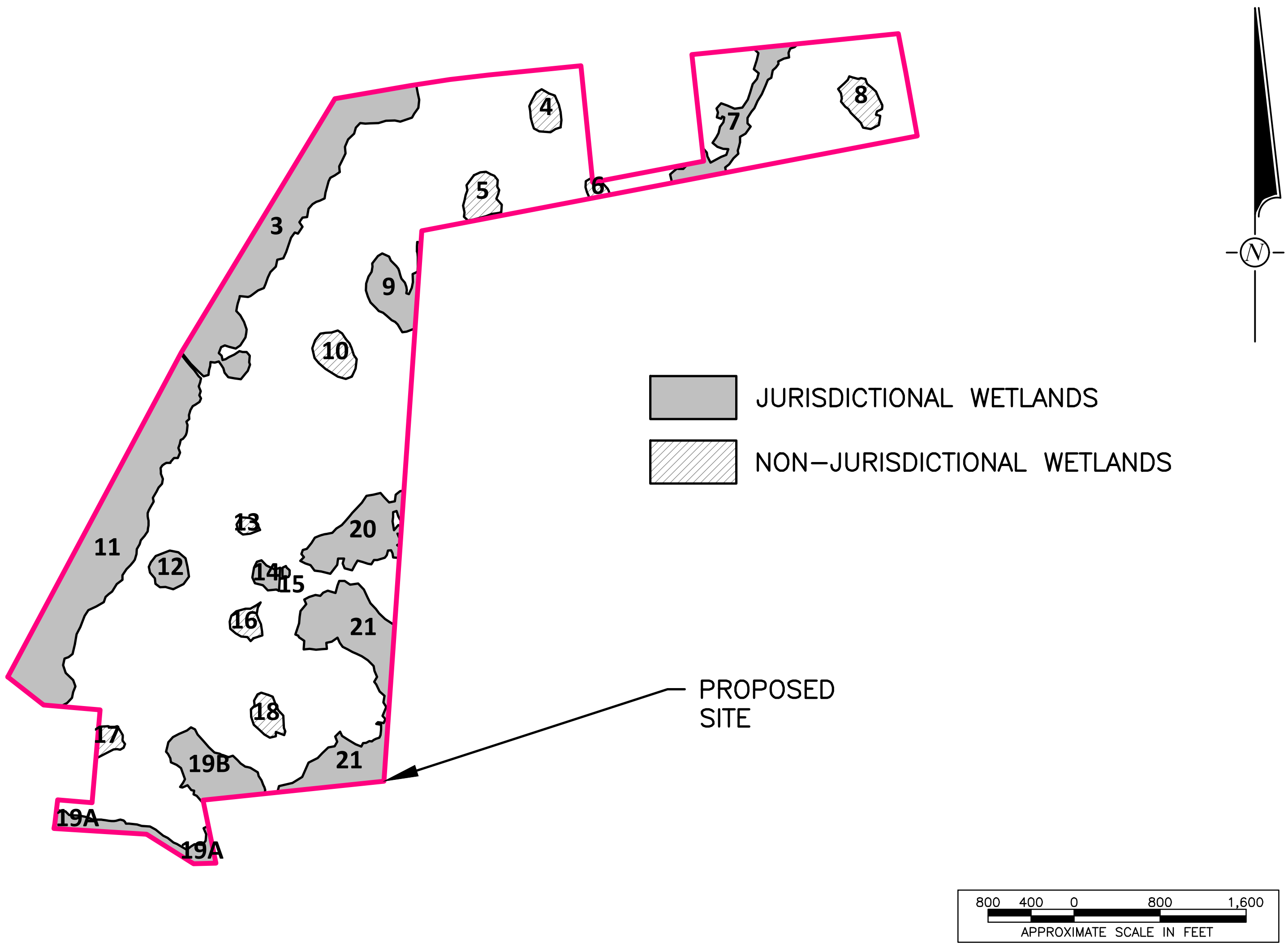

FIGURE 1-09

SITE SUITABILITY ASSESSMENT REPORT

JURISDICTIONAL WETLANDS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF U.S. FISH & WILDLIFE SERVICE (FWS) NATIONAL WETLANDS INVENTORY (NWI) WETLANDS MAPPER (https:// www.fws.gov/wetlands/data/mapper.html).

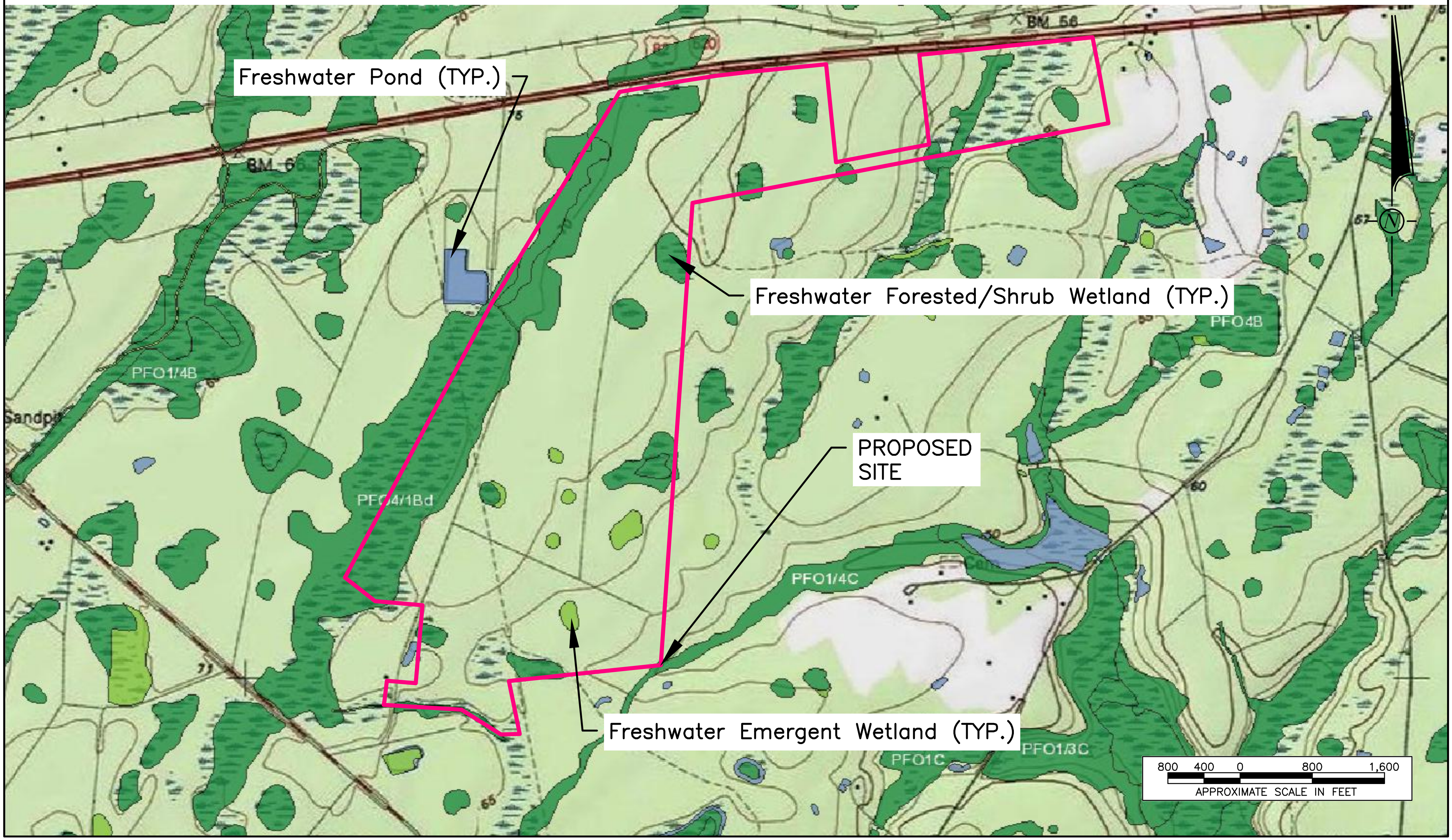

FIGURE 1-10

SITE SUITABILITY ASSESSMENT REPORT

NATIONAL WETLANDS INVENTORY

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) 7.5-MINUTE SERIES QUADRANGLE MAPS FOR WAYNESVILLE (2014) AND NANHUNTA (2014). IMAGE OVERLAY METHODS ARE APPROXIMATE.

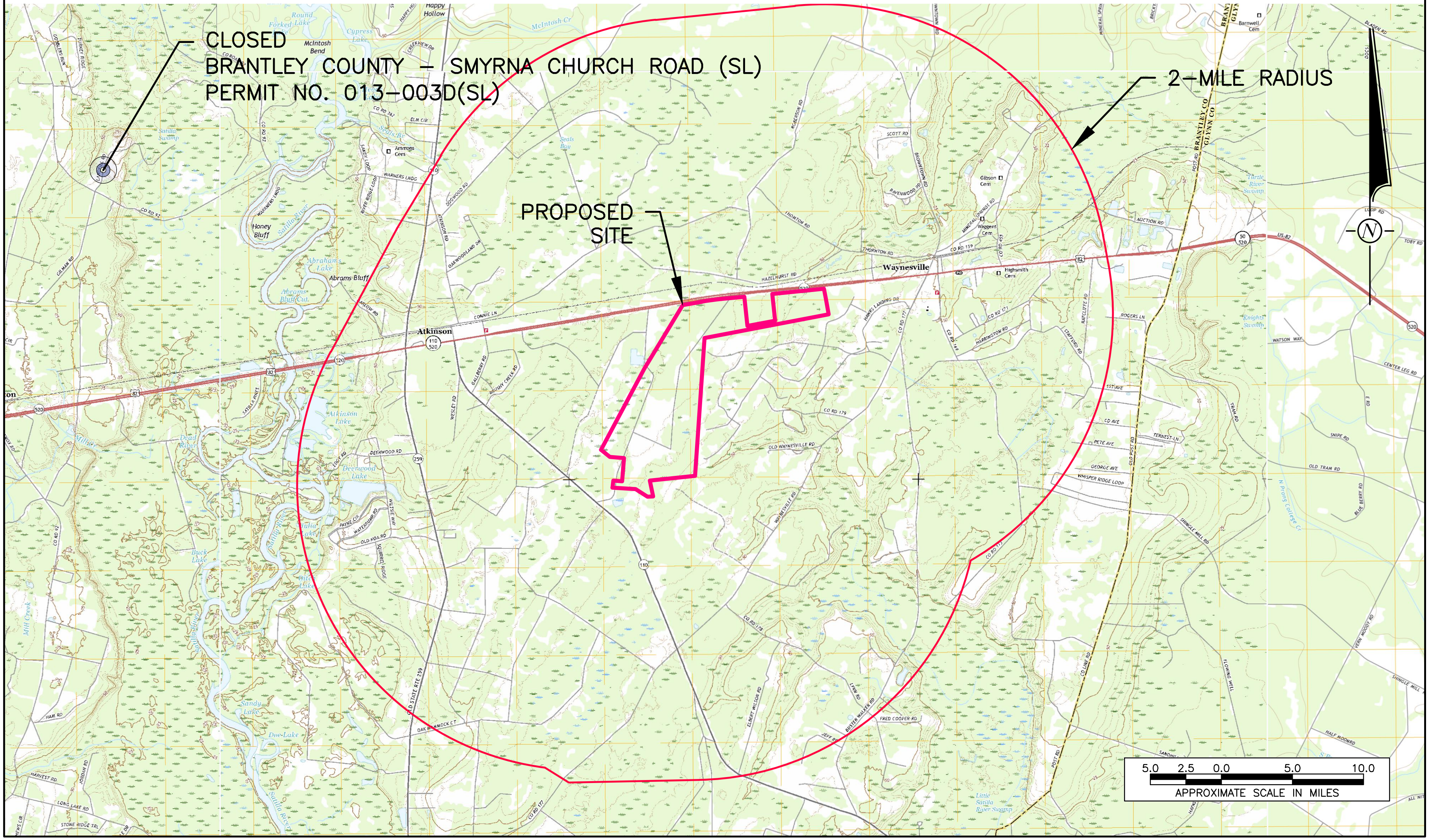

FIGURE 1-11

SITE SUITABILITY ASSESSMENT REPORT

SOLID WASTE FACILITIES WITHIN TWO (2) MILES OF SITE

BRANTLEY COUNTY
DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY -
S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF GEORGIA DEPARTMENT OF TRANSPORTATION (GDOT) "GEORGIA COUNTIES" MAP. IMAGE OVERLAY METHODS ARE APPROXIMATE.

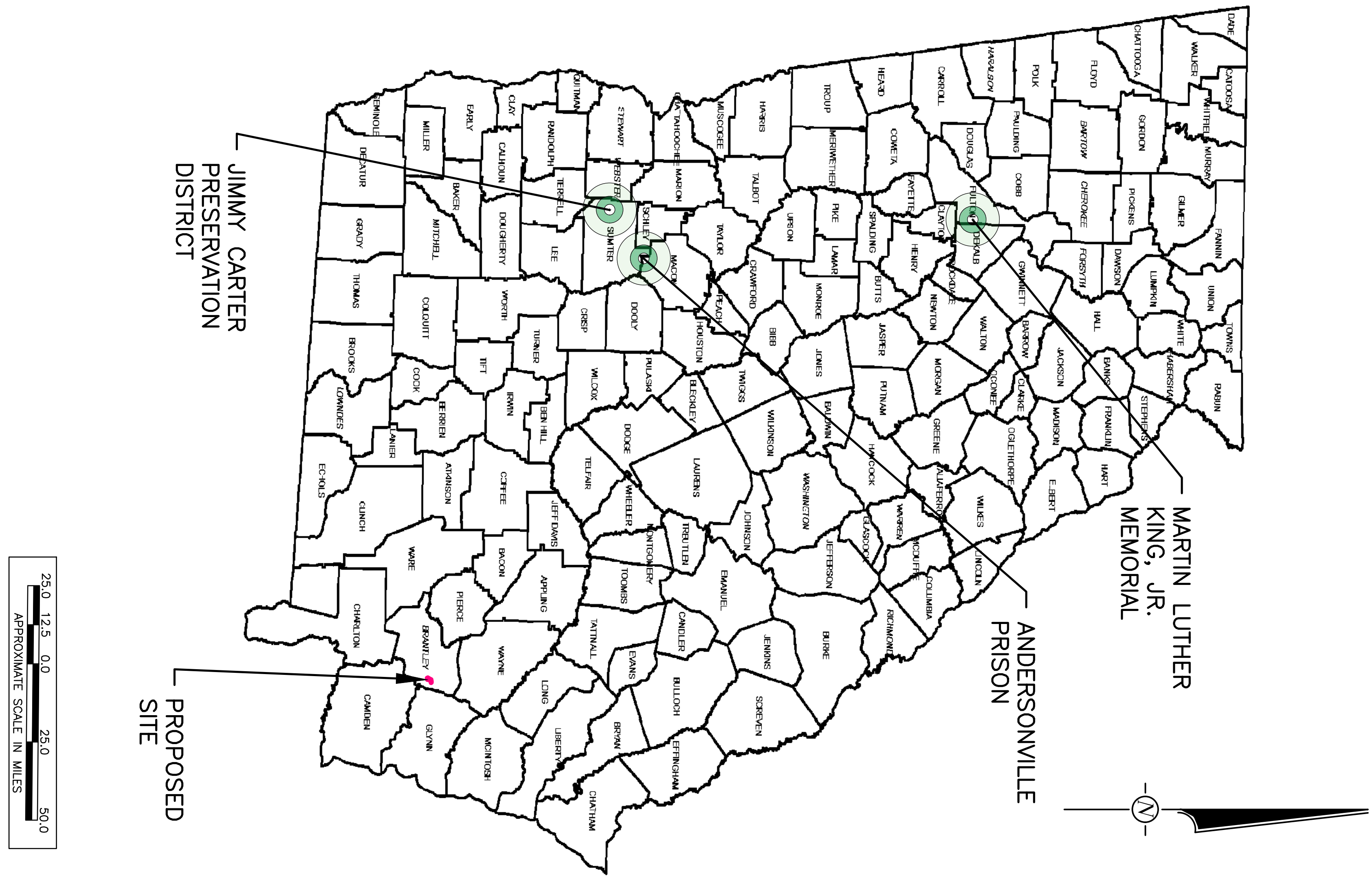

FIGURE 1-12

SITE SUITABILITY ASSESSMENT REPORT

NATIONAL HISTORIC SITES (NHS)

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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NOTE: BASE IMAGE COURTESY OF GEORGIA DEPARTMENT OF TRANSPORTATION (GDOT) "GEORGIA OFFICIAL HIGHWAY AND TRANSPORTATION MAP - 2015-2016." IMAGE OVERLAY METHODS ARE APPROXIMATE.

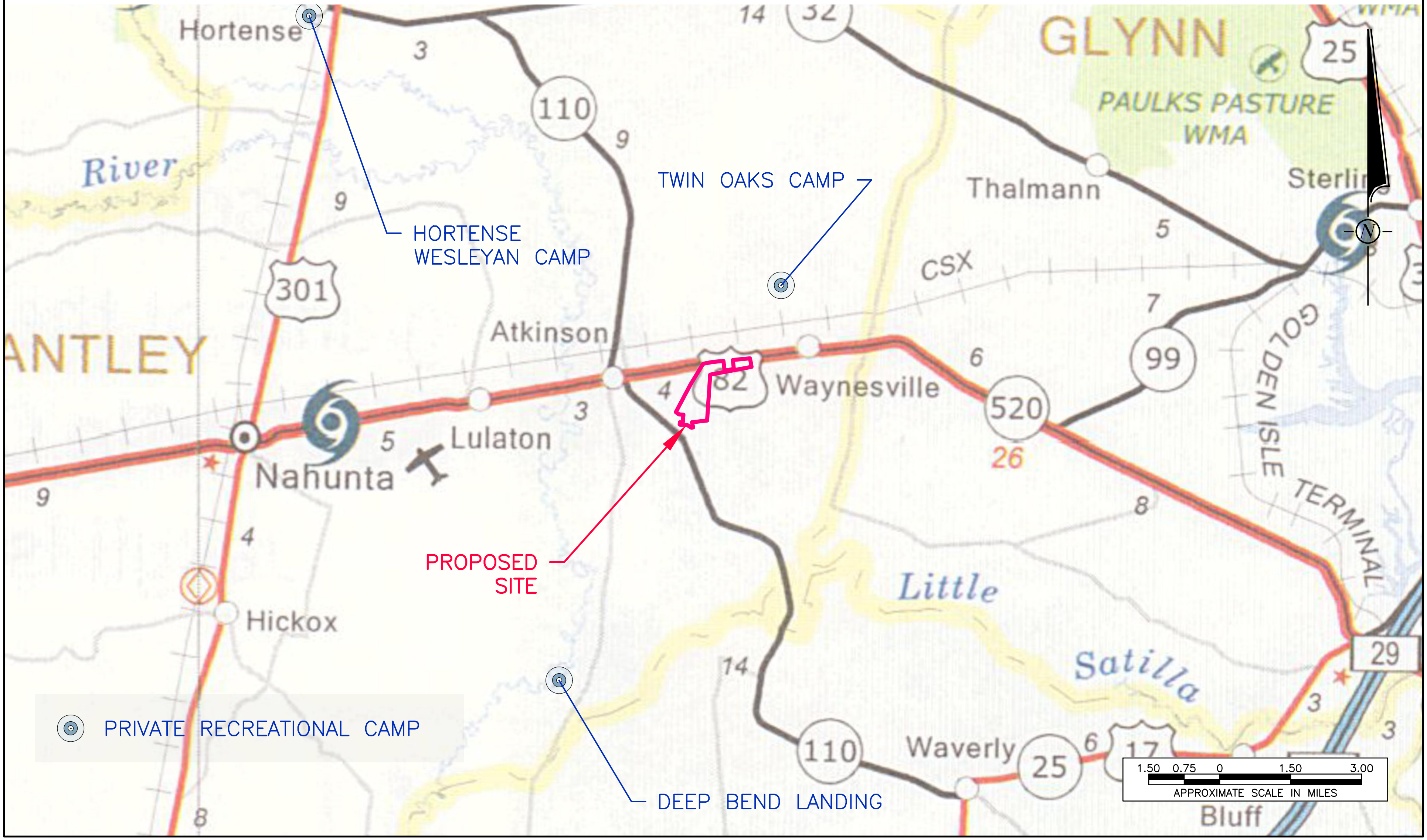

FIGURE 1-13

SITE SUITABILITY ASSESSMENT REPORT

PRIVATE RECREATION CAMPS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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INITIAL SUBMITTAL DATE: AUG-2019 DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF U.S. ARMY CORPS OF ENGINEERS "2013 COASTAL GEORGIA EVACUATION STUDY: HURRICANE EVACUATION STUDY PROCESS AND GEOPDF DEMONSTRATION." IMAGE OVERLAY METHODS ARE APPROXIMATE.

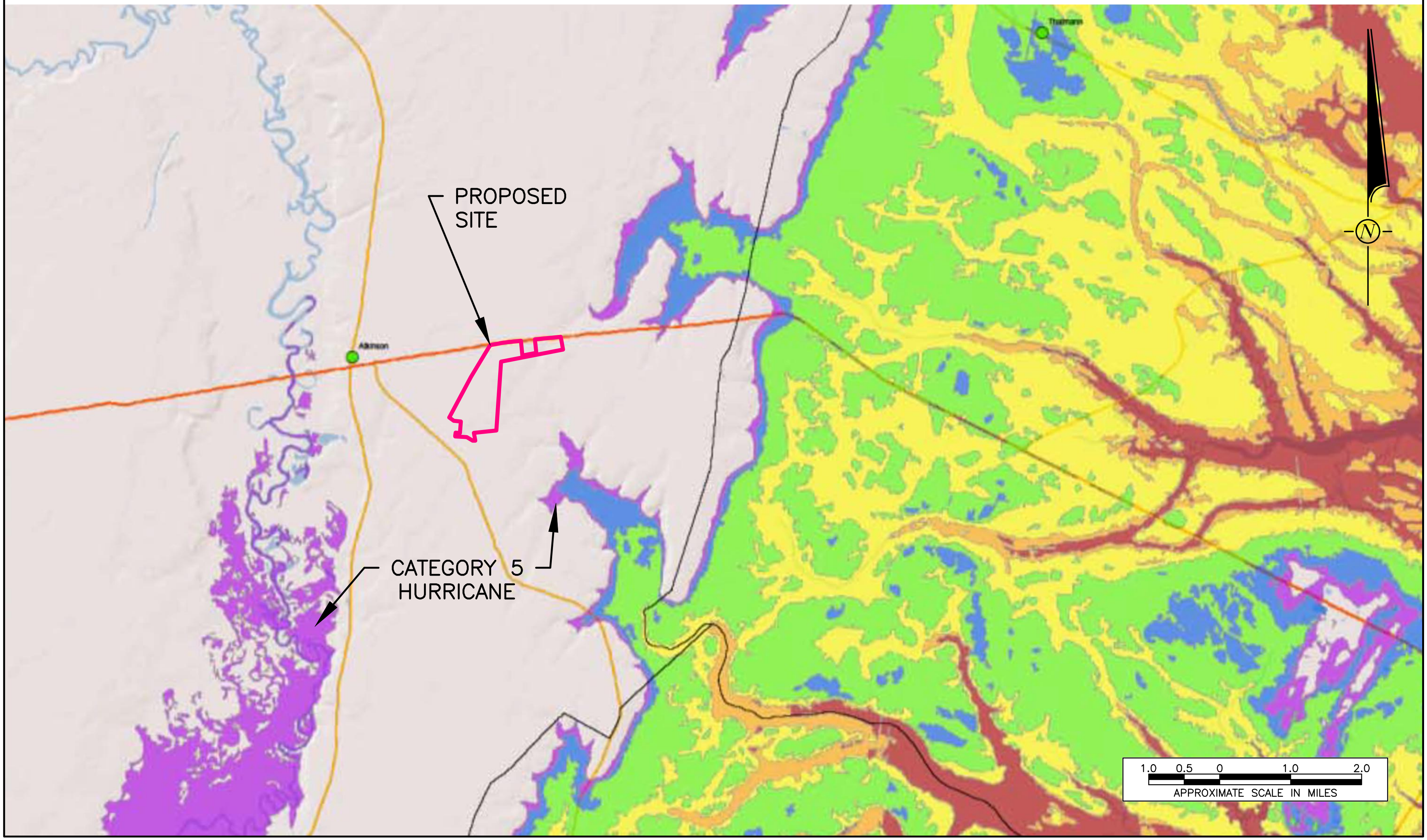

FIGURE 1-14

SITE SUITABILITY ASSESSMENT REPORT

POTENTIAL TIDAL FLOODING FROM HURRICANES

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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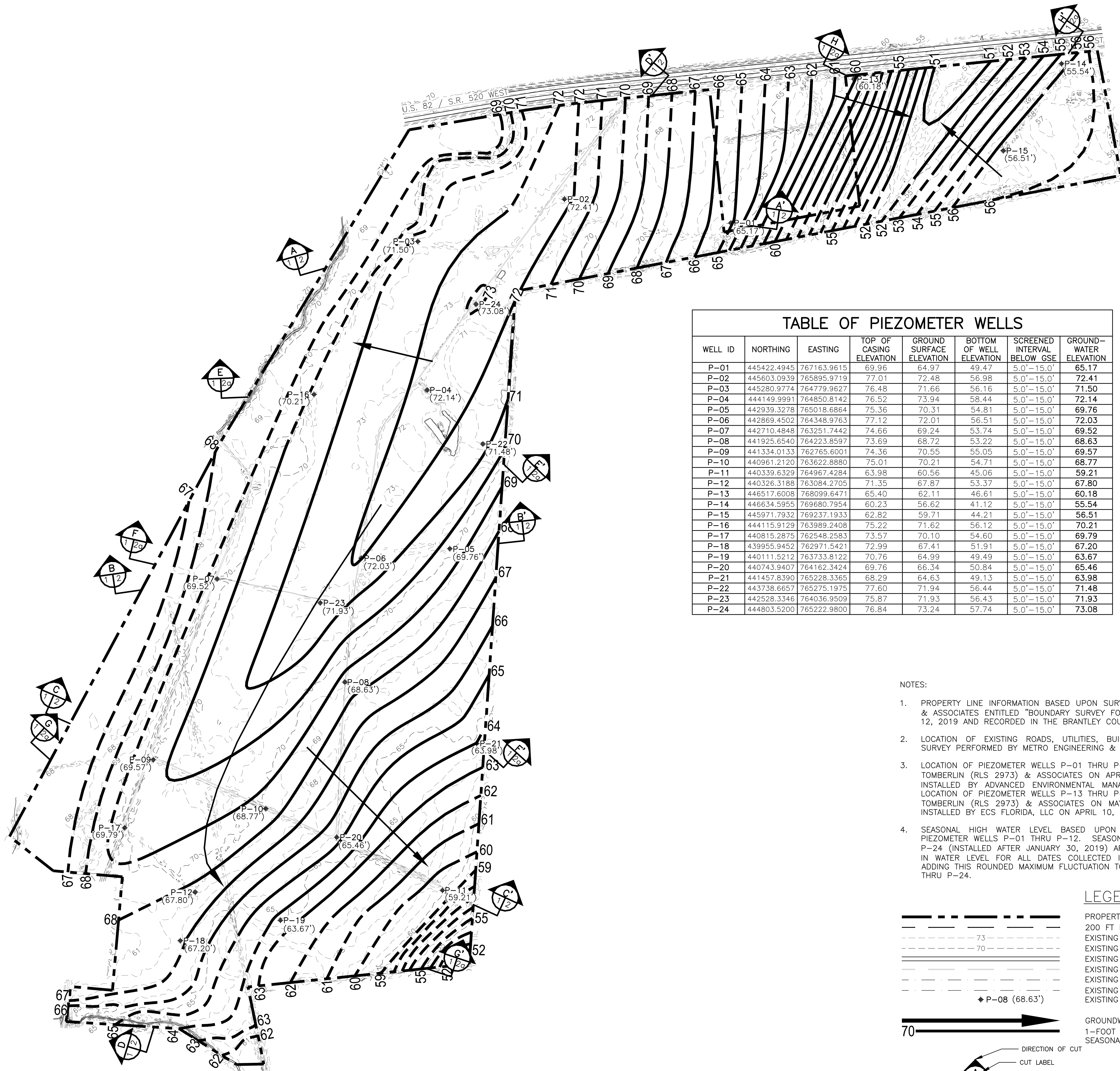

TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**65.17**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**72.41**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**71.50**
P-04	444149.9991	764850.8142	76.52	73.94	58.44	5.0'-15.0'	**72.14**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**69.76**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**72.03**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**69.52**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**68.63**
P-09	441334.0133	762765.6001	74.36	70.55	55.05	5.0'-15.0'	**69.57**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**68.77**
P-11	440339.6329	764967.4284	63.98	60.56	45.06	5.0'-15.0'	**59.21**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**67.80**
P-13	446517.6008	768099.6471	65.40	62.11	46.61	5.0'-15.0'	**60.18**
P-14	446634.5955	769680.7954	60.23	56.62	41.12	5.0'-15.0'	**55.54**
P-15	445971.7932	769237.1933	62.82	59.71	44.21	5.0'-15.0'	**56.51**
P-16	444115.9129	763989.2408	75.22	71.62	56.12	5.0'-15.0'	**70.21**
P-17	440815.2875	762548.2583	73.57	70.10	54.60	5.0'-15.0'	**69.79**
P-18	439955.9452	762971.5421	72.99	67.41	51.91	5.0'-15.0'	**67.20**
P-19	440111.5212	763733.8122	70.76	64.99	49.49	5.0'-15.0'	**63.67**
P-20	440743.9407	764162.3424	69.76	66.34	50.84	5.0'-15.0'	**65.46**
P-21	441457.8390	765228.3365	68.29	64.63	49.13	5.0'-15.0'	**63.98**
P-22	443738.6657	765275.1975	77.60	71.94	56.44	5.0'-15.0'	**71.48**
P-23	442528.3346	764036.9509	75.87	71.93	56.43	5.0'-15.0'	**71.93**
P-24	444803.5200	765222.9800	76.84	73.24	57.74	5.0'-15.0'	**73.08**

NOTES:

1. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "BOUNDARY SURVEY FOR BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC" ON MAY 12, 2019 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 1, PAGE 174.

2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.

3. LOCATION OF PIEZOMETER WELLS P-01 THRU P-12 BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS P-01 THRU P-12 WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016. LOCATION OF PIEZOMETER WELLS P-13 THRU P-24 BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON MAY 12, 2019. PIEZOMETER WELLS P-13 THRU P-24 WERE INSTALLED BY ECS FLORIDA, LLC ON APRIL 10, 11, 12 AND 15, 2019.

4. SEASONAL HIGH WATER LEVEL BASED UPON MEASUREMENTS COLLECTED ON JANUARY 30, 2019 FOR PIEZOMETER WELLS P-01 THRU P-12. SEASONAL HIGH WATER LEVELS FOR PIEZOMETER WELLS P-13 THRU P-24 (INSTALLED AFTER JANUARY 30, 2019) ARE ESTIMATED AND BASED UPON ROUNDED MAXIMUM CHANGE IN WATER LEVEL FOR ALL DATES COLLECTED IN PIEZOMETER WELLS P-01 THRU P-12 (+3.0 FEET) AND ADDING THIS ROUNDED MAXIMUM FLUCTUATION TO THE LOWEST LEVEL RECORDED IN PIEZOMETER WELLS P-13 THRU P-24.

LEGEND

PROPERTY LINE / PROPOSED PERMIT BOUNDARY
200 FT PROPERTY LINE BUFFER
73 EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
70 EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
P-08 (68.63') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
GROUNDWATER FLOW DIRECTION
70 1-FOOT POTENTIOMETRIC CONTOUR (DASHED LINE = ESTIMATED) SEASONAL HIGH GROUNDWATER TABLE

DIRECTION OF CUT
CUT LABEL
A 1 2
FIGURE 2-X WHERE CUT IS TAKEN
FIGURE 2-X WHERE CUT IS SHOWN

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
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BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT

BORING LOCATIONS AND SEASONAL HIGH GROUNDWATER TABLE MAP

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

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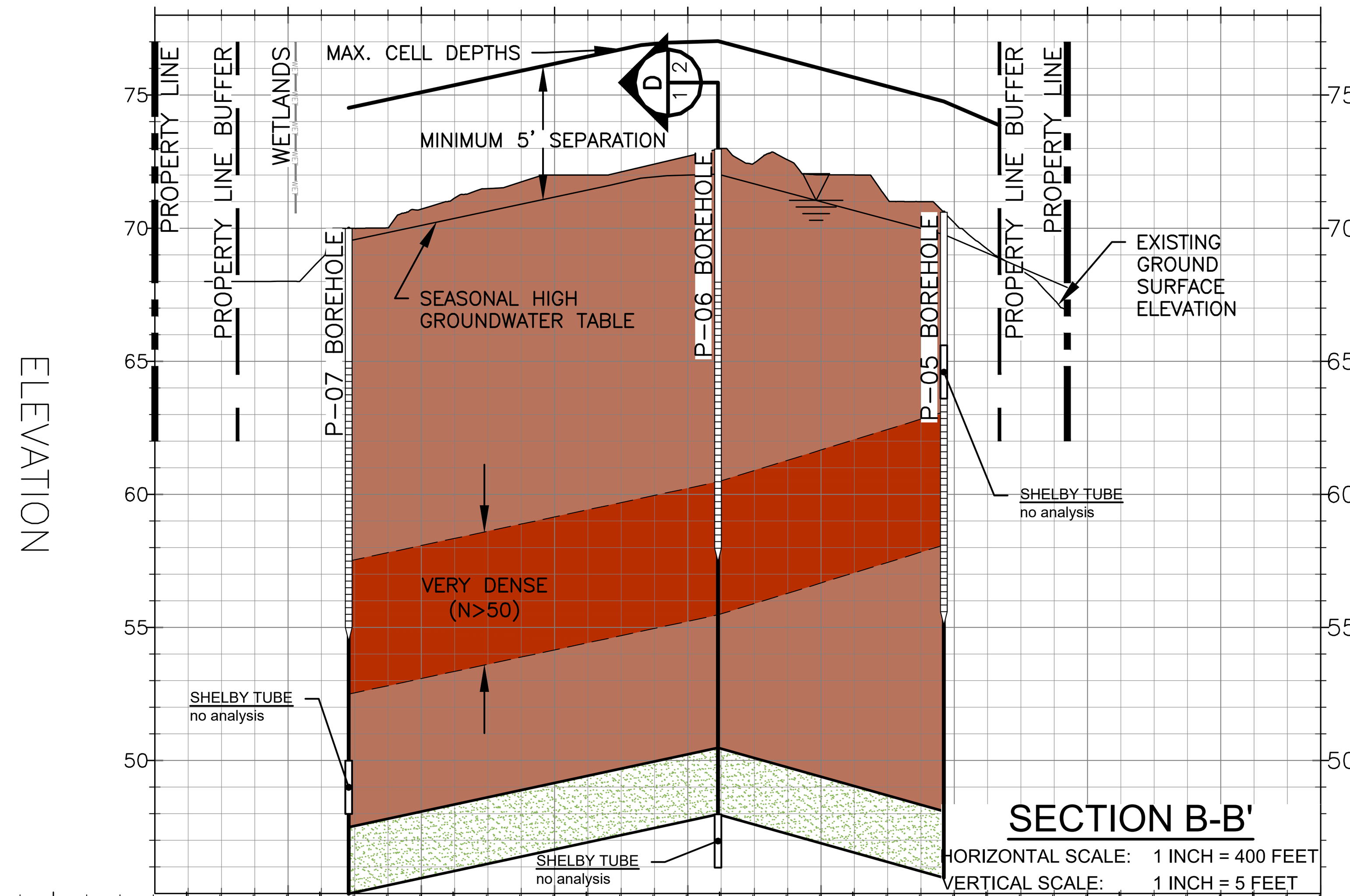
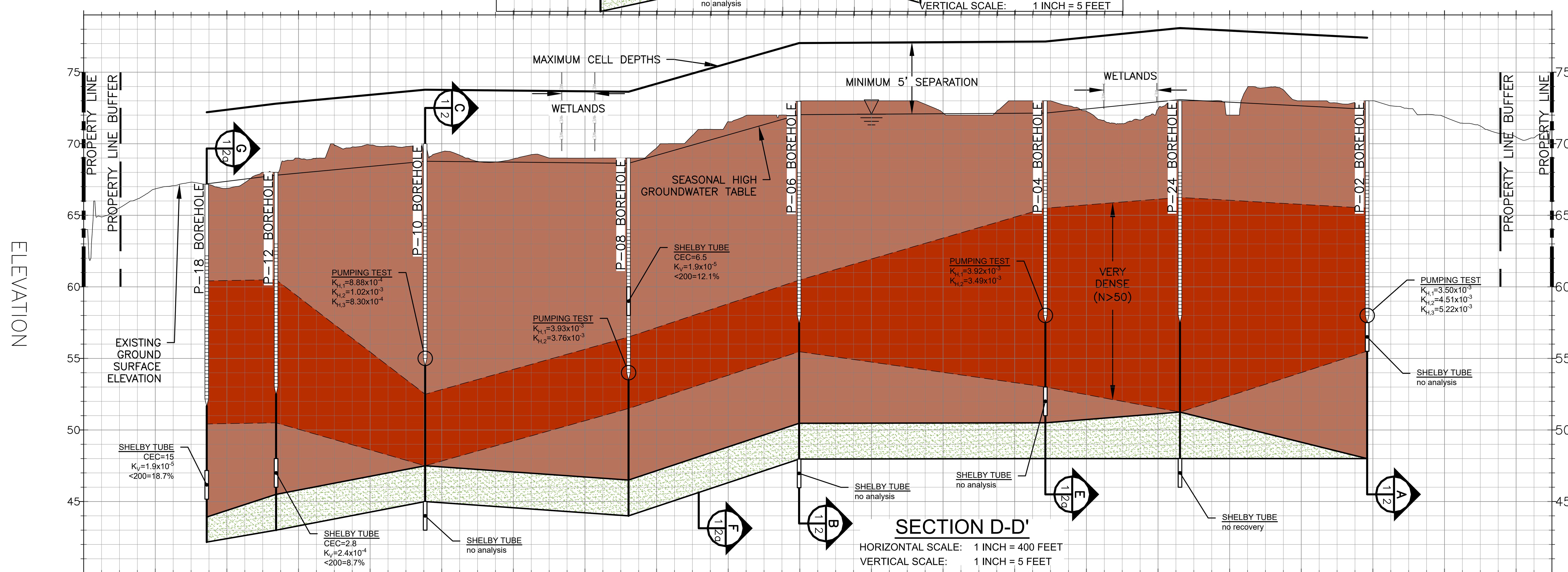
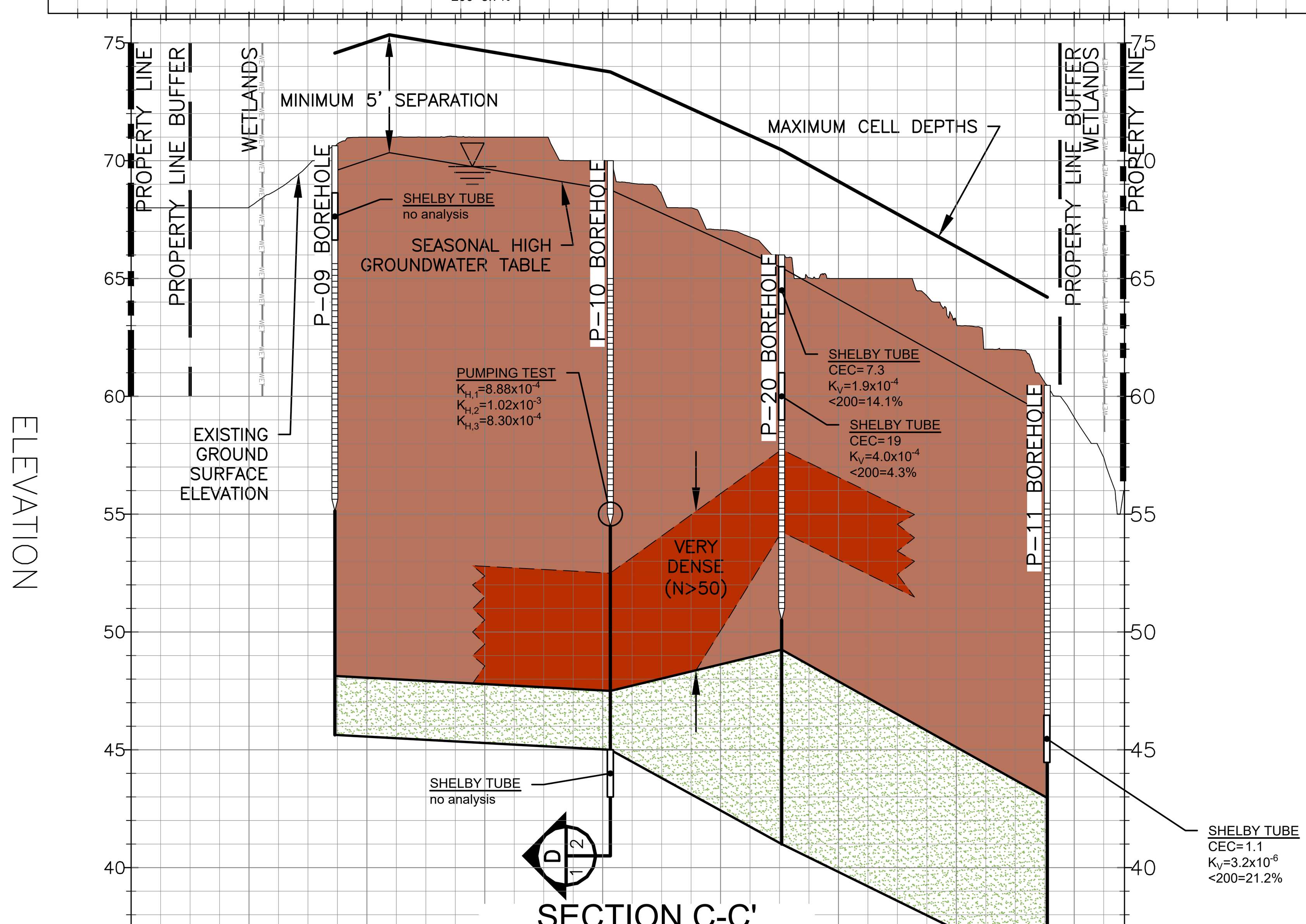
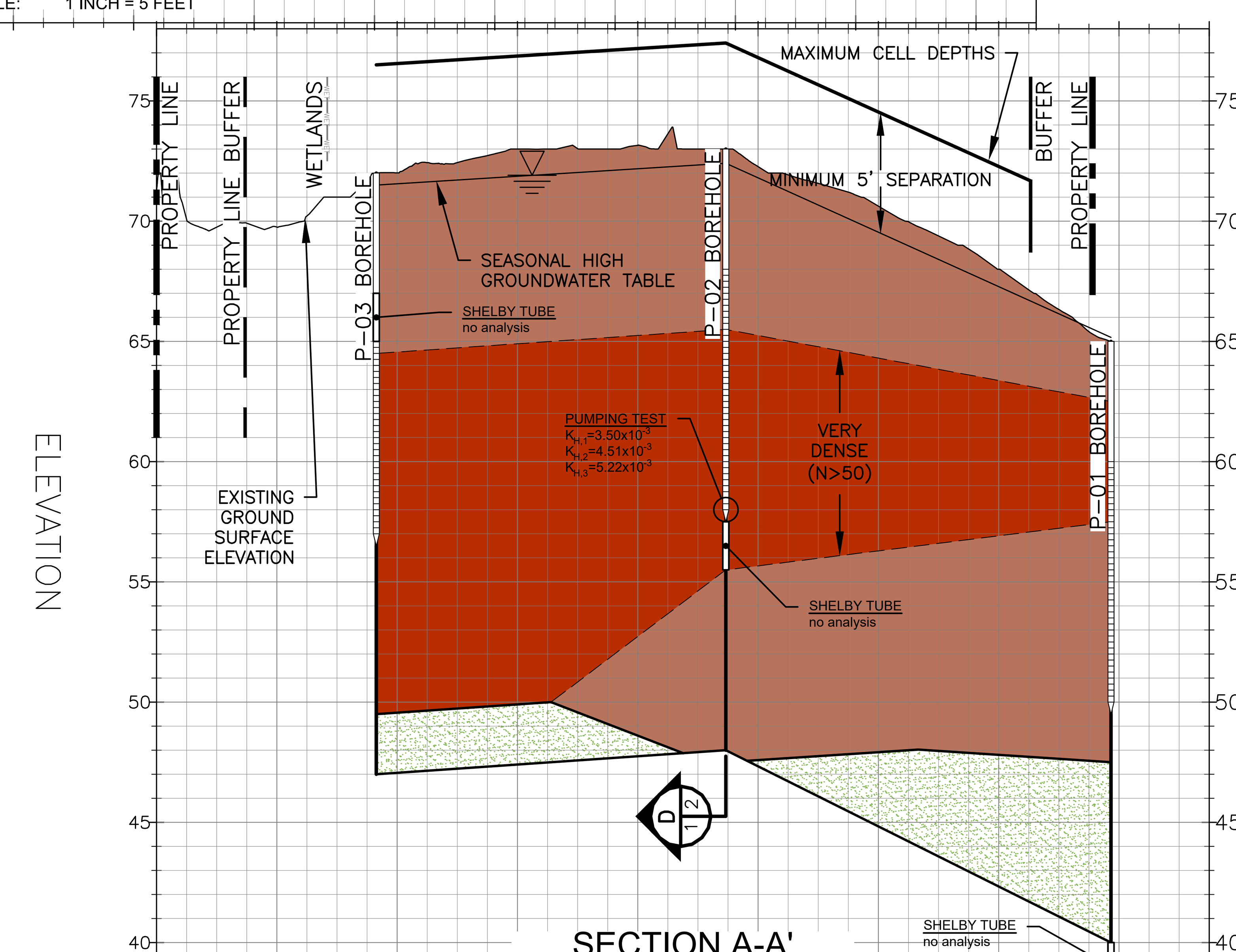
IES PROJECT NO.1390-013-01

FIGURE
2-01









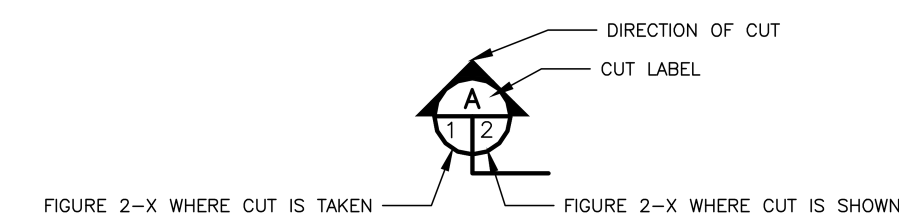
NOTES:

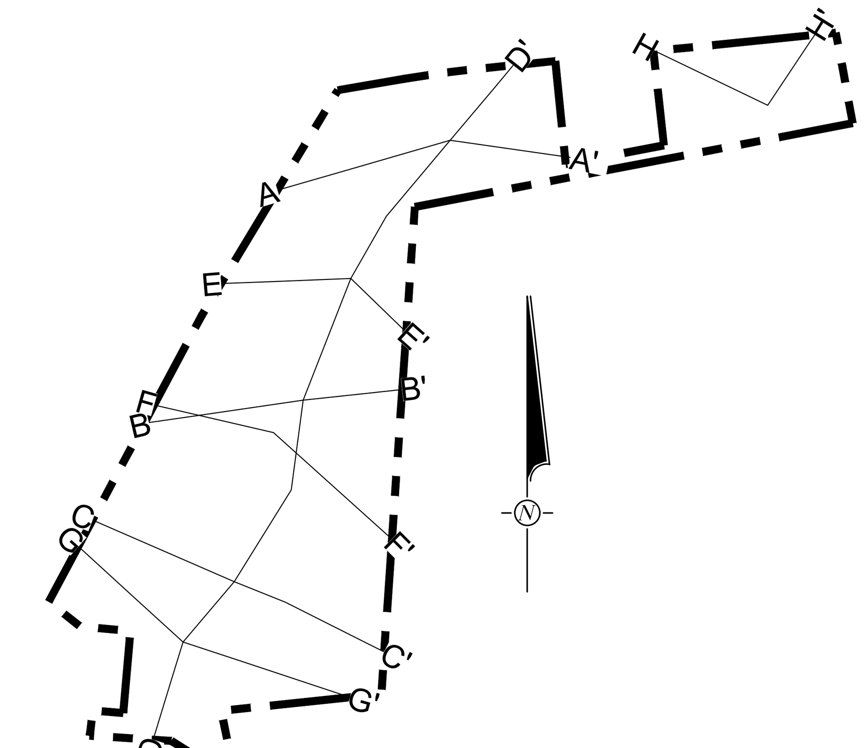
1. THE SEASONAL HIGH GROUNDWATER TABLE IS BASED UPON HISTORICAL WATER LEVEL DATA COLLECTED BETWEEN MARCH AND AUGUST 2016 AND BETWEEN JANUARY AND JUNE 2019 AND REPRESENT THE EVENT WITH THE HIGHEST ELEVATIONS OBSERVED (JANUARY 30, 2019).
2. EXISTING GROUND SURFACE ELEVATION BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
3. SOIL PROFILE INFORMATION FOR PIEZOMETER WELLS P-01 THRU P-12 BASED UPON "FINAL REPORT FOR DRILLING AND PIEZOMETER WELL INSTALLATION SERVICES" PREPARED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) ON JULY 9, 2016. SOIL PROFILE INFORMATION FOR PIEZOMETER WELLS P-13 THRU P-24 BASED UPON FIELD WORK PERFORMED BY ECS FLORIDA, LLC AND SUPERVISED BY MICHAEL W. BIERS, P.E., BETWEEN APRIL 10-15, 2019.

LEGEND

- PROPERTY LINE / PROPOSED PERMIT BOUNDARY
- LIMITS OF PROPERTY LINE BUFFER
- EXISTING GROUND SURFACE ELEVATION
- SEASONAL HIGH GROUNDWATER TABLE
- MAXIMUM CELL DEPTH = MINIMUM BOTTOM OF CLAY LINER ELEVATION DUE TO MINIMUM FIVE (5) FT SEPARATION FROM GROUNDWATER
- LIMITS OF JURISDICTIONAL WETLANDS
- Black/Brown/Red/Tan very loose to dense fine to medium silty SAND (SM) with trace clay (N<50)
- Black/Brown/Red/Tan **very dense** fine to medium silty SAND (SM) with trace clay (N>50)
- Gray/Lt. Brown/Green very loose to medium dense fine to medium silty/clayey SAND (SM/SC)
- Gray/Lt. Brown/Green firm to stiff very fine sandy CLAY (CL/CH)

CEC	TOTAL CATION EXCHANGE CAPACITY, meq/100g
K_v	VERTICAL HYDRAULIC CONDUCTIVITY, cm/sec
$K_{h,n}$	HORIZONTAL HYDRAULIC CONDUCTIVITY, cm/sec (STEP-DRAWDOWN TEST "n")
<200	PERCENT PASSING NO. 200 SIEVE, %
PI	PLASTICITY INDEX
D	MAXIMUM DRY DENSITY, pcf
OMC	OPTIMUM MOISTURE CONTENT, %





CROSS-SECTION OVERVIEW MAP

NOT TO SCALE

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BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT

GEOLOGIC CROSS-SECTIONS

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

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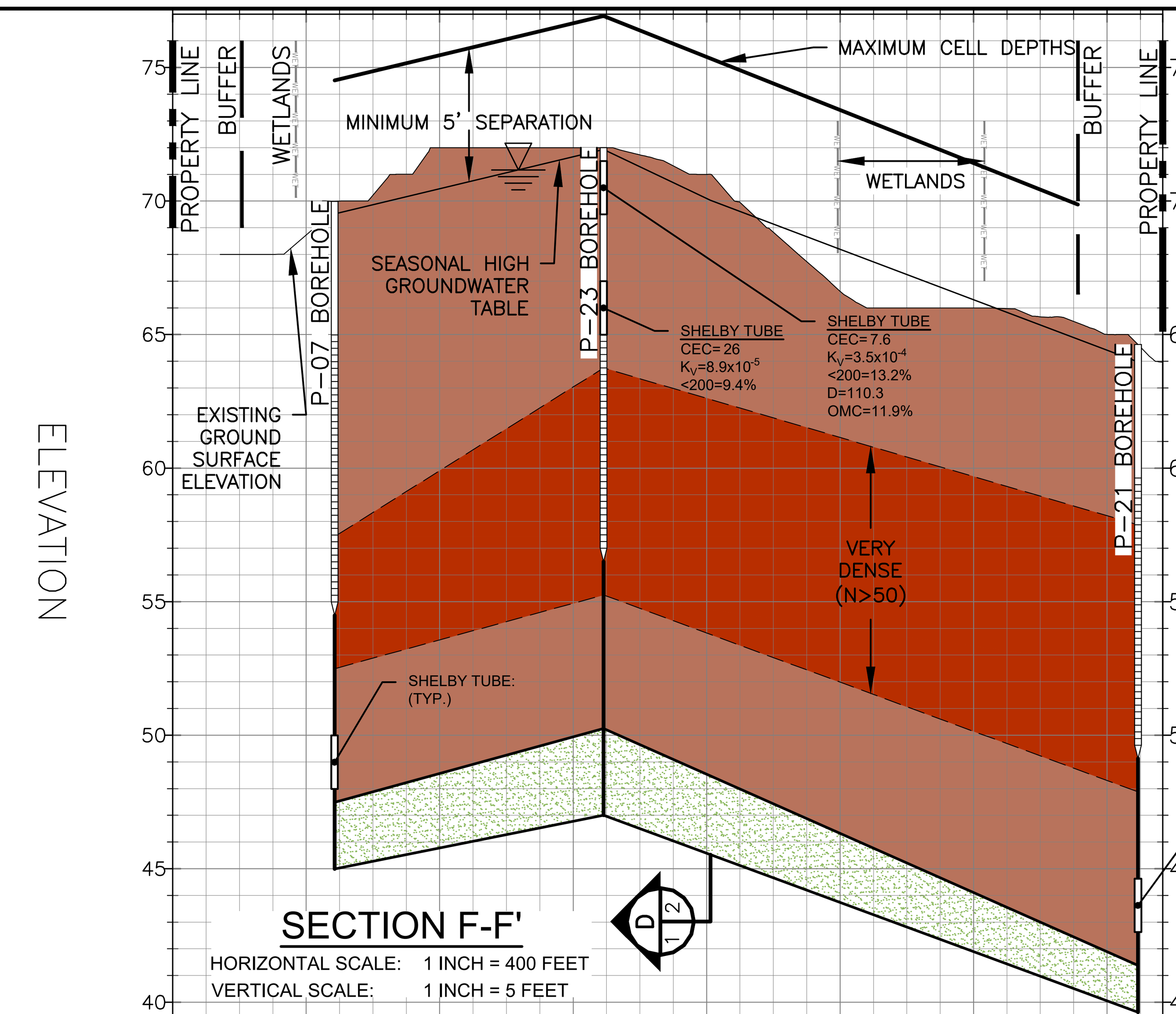
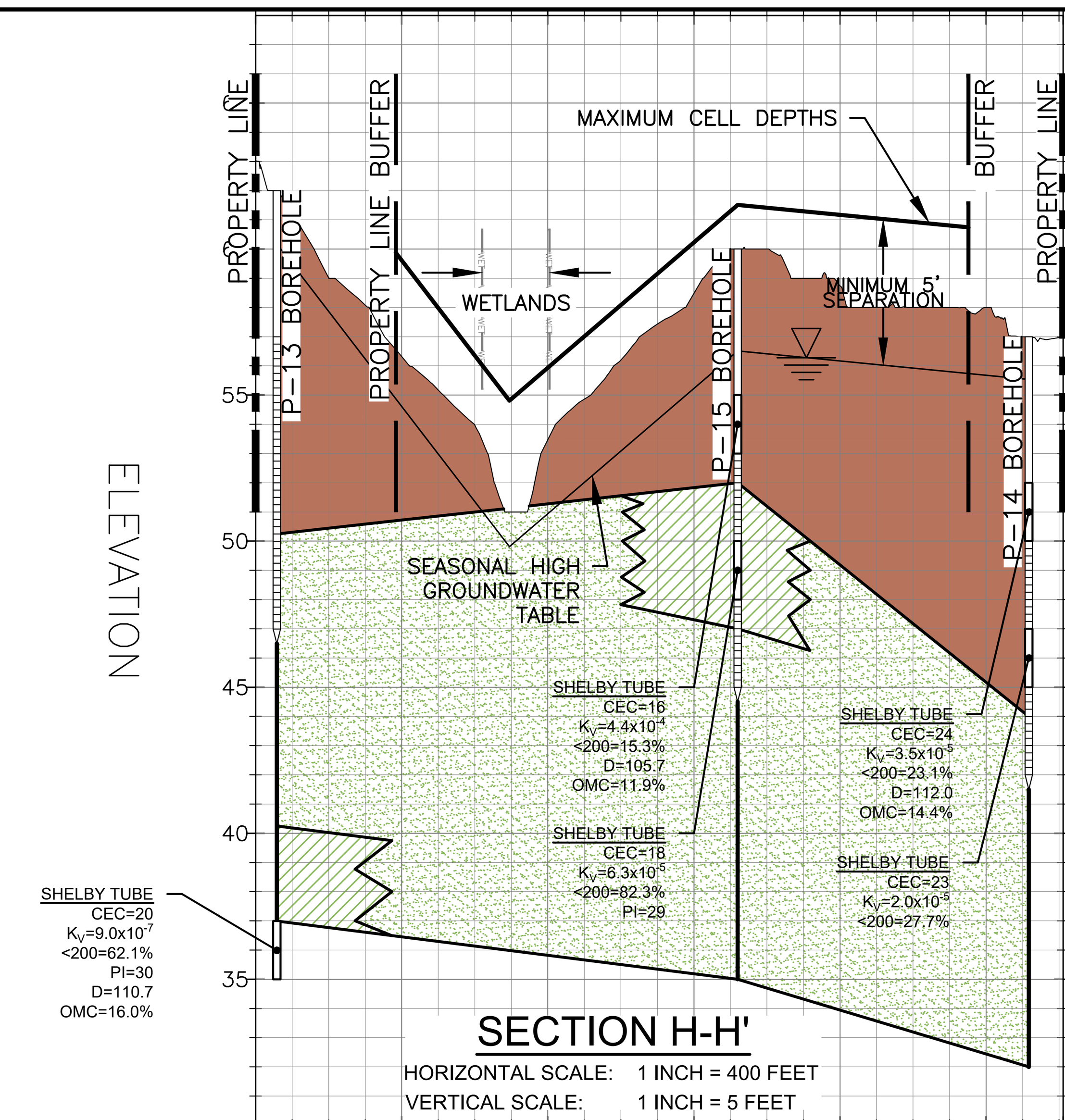
IES PROJECT NO.1390-013-01

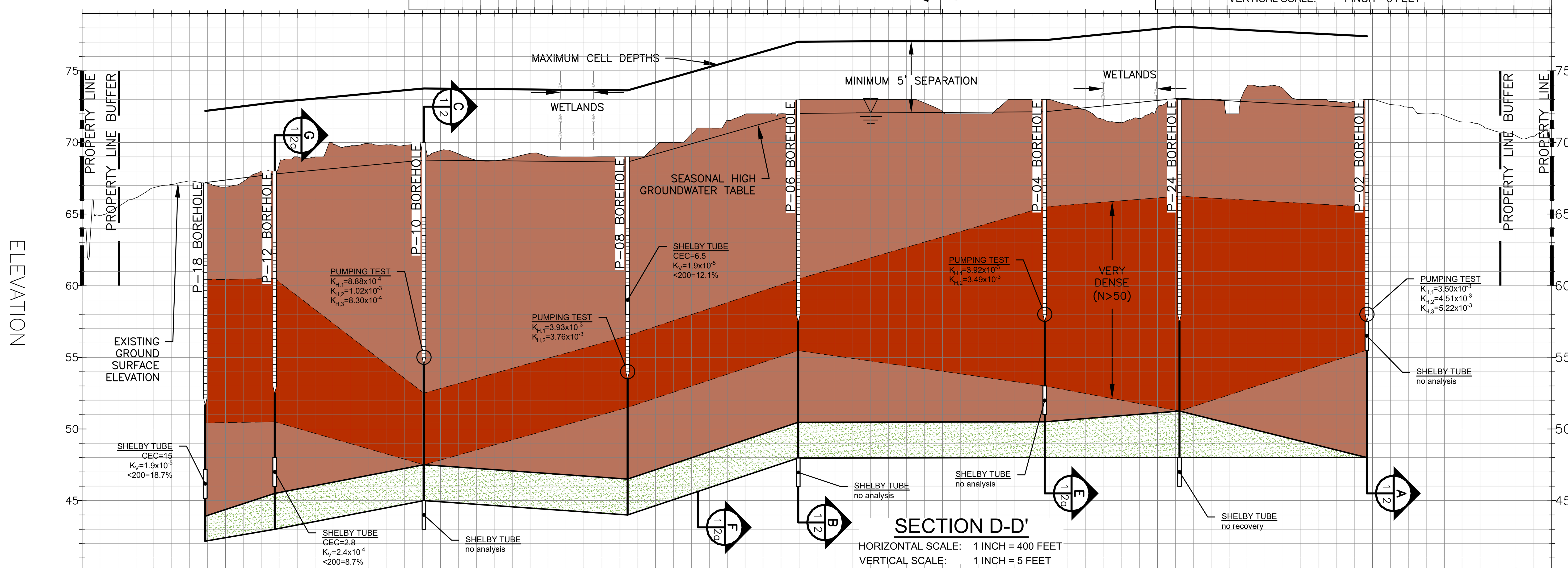
FIGURE
2-02



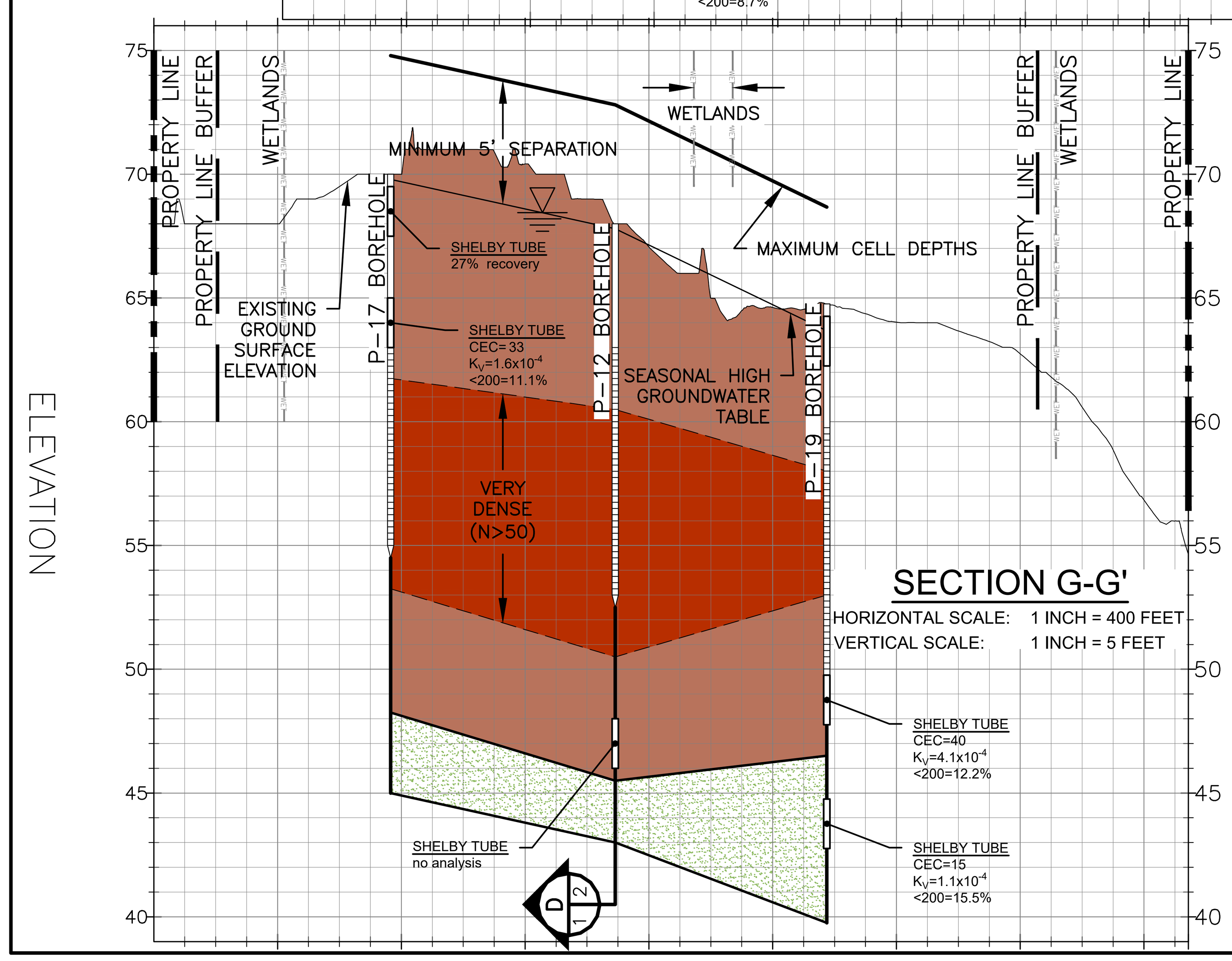
SECTION F-F'
HORIZONTAL SCALE: 1 INCH = 400 FEET
VERTICAL SCALE: 1 INCH = 5 FEET



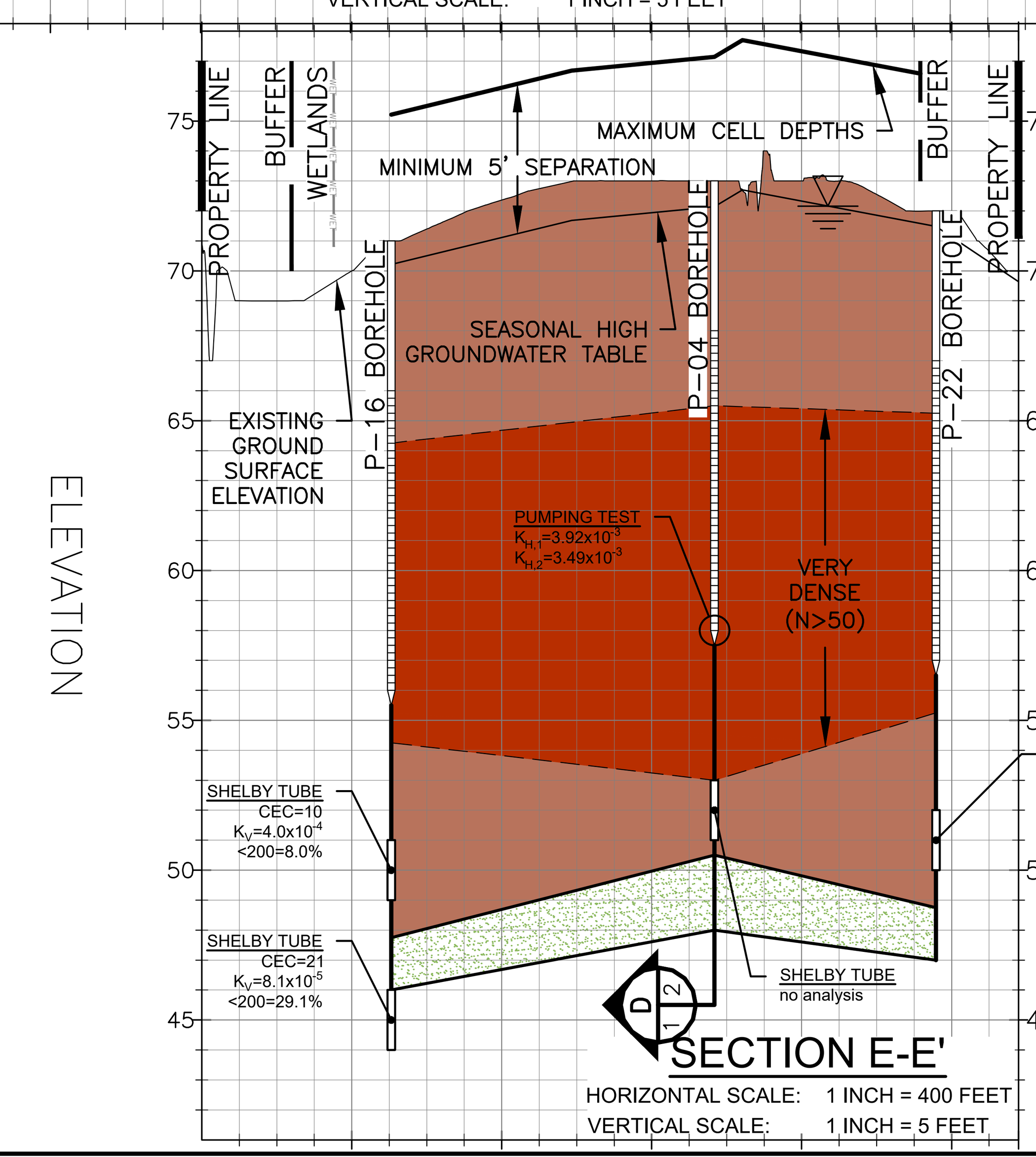
SECTION H-H'
HORIZONTAL SCALE: 1 INCH = 400 FEET
VERTICAL SCALE: 1 INCH = 5 FEET



SECTION D-D'
HORIZONTAL SCALE: 1 INCH = 400 FEET
VERTICAL SCALE: 1 INCH = 5 FEET



SECTION G-G'
HORIZONTAL SCALE: 1 INCH = 400 FEET
VERTICAL SCALE: 1 INCH = 5 FEET



SECTION E-E'
HORIZONTAL SCALE: 1 INCH = 400 FEET
VERTICAL SCALE: 1 INCH = 5 FEET

NOTES:

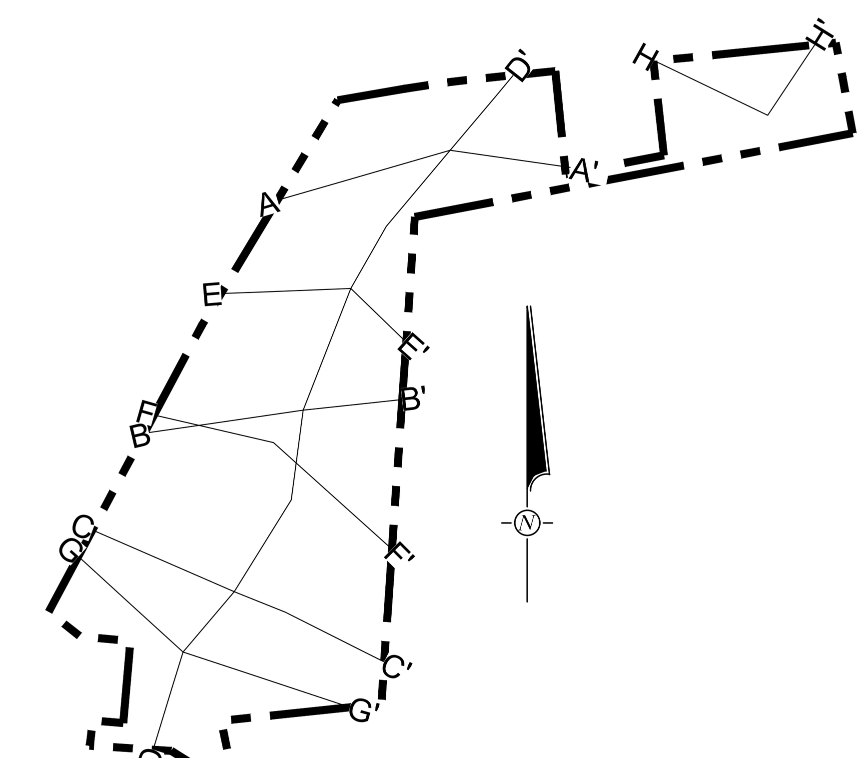
1. THE SEASONAL HIGH GROUNDWATER TABLE IS BASED UPON HISTORICAL WATER LEVEL DATA COLLECTED BETWEEN MARCH AND AUGUST 2016 AND BETWEEN JANUARY AND JUNE 2019 AND REPRESENT THE EVENT WITH THE HIGHEST ELEVATIONS OBSERVED (JANUARY 30, 2019).
2. EXISTING GROUND SURFACE ELEVATION BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
3. SOIL PROFILE INFORMATION FOR PIEZOMETER WELLS P-01 THRU P-12 BASED UPON "FINAL REPORT FOR DRILLING AND PIEZOMETER WELL INSTALLATION SERVICES" PREPARED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) ON JULY 9, 2016. SOIL PROFILE INFORMATION FOR PIEZOMETER WELLS P-13 THRU P-24 BASED UPON FIELD WORK PERFORMED BY ECS FLORIDA, LLC AND SUPERVISED BY MICHAEL W. BIERS, P.E., BETWEEN APRIL 10-15, 2019.

LEGEND

PROPERTY LINE / PROPOSED PERMIT BOUNDARY
LIMITS OF PROPERTY LINE BUFFER
EXISTING GROUND SURFACE ELEVATION
SEASONAL HIGH GROUNDWATER TABLE
MAXIMUM CELL DEPTH = MINIMUM BOTTOM OF CLAY LINER ELEVATION DUE TO MINIMUM FIVE (5) FT SEPARATION FROM GROUNDWATER
LIMITS OF JURISDICTIONAL WETLANDS
Black/Brown/Red/Tan very loose to dense fine to medium silty SAND (SM) with trace clay (N<50)
Black/Brown/Red/Tan **very dense** fine to medium silty SAND (SM) with trace clay (N>50)
Gray/Lt. Brown/Green very loose to medium dense fine to medium silty/clayey SAND (SM/SC)
Gray/Lt. Brown/Green firm to stiff very fine sandy CLAY (CL/CH)

CEC	TOTAL CATION EXCHANGE CAPACITY, meq/100g
K_V	VERTICAL HYDRAULIC CONDUCTIVITY, cm/sec
$K_{H,n}$	HORIZONTAL HYDRAULIC CONDUCTIVITY, cm/sec (STEP-DRAWDOWN TEST "n")
<200	PERCENT PASSING NO. 200 SIEVE, %
PI	PLASTICITY INDEX
D	MAXIMUM DRY DENSITY, pcf
OMC	OPTIMUM MOISTURE CONTENT, %

DIRECTION OF CUT
CUT LABEL
FIGURE 2-X WHERE CUT IS TAKEN
FIGURE 2-X WHERE CUT IS SHOWN



CROSS-SECTION OVERVIEW MAP
NOT TO SCALE

Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
IES
CIVIL · ENVIRONMENTAL

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT
ADDITIONAL GEOLOGIC CROSS-SECTIONS

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
2-02a

INITIAL SUBMITTAL DATE: AUG-2019 DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF GEORGIA GEOLOGIC SURVEY "GEOLOGIC MAP OF GEORGIA" SURVEY MAP SM-3 DATED 1976. IMAGE OVERLAY METHODS ARE APPROXIMATE.

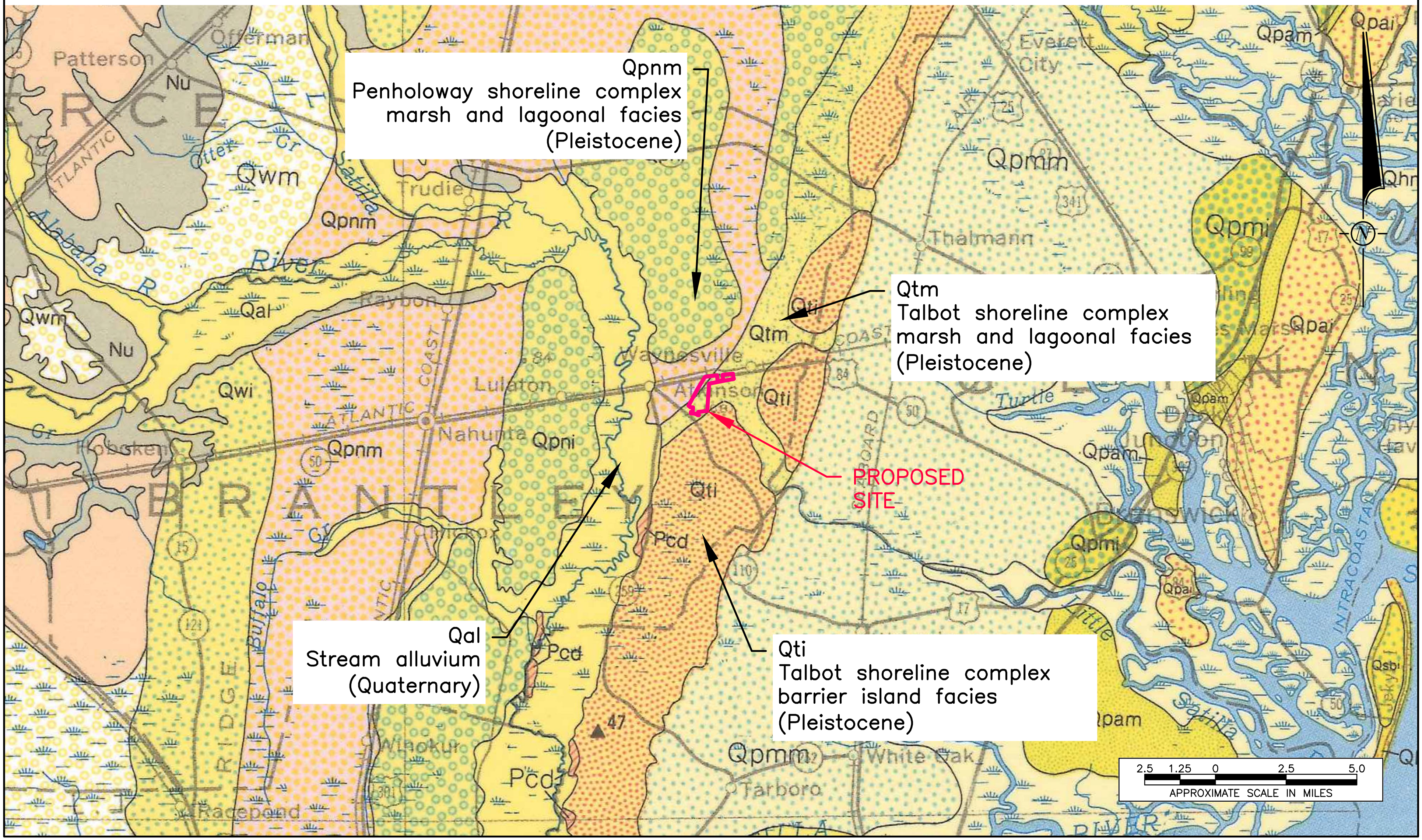


FIGURE 2-03

SITE SUITABILITY ASSESSMENT REPORT

GEORGIA GEOLOGIC MAP

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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IES
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG–2019 DRAWING: 1390–013 SAR Figures.dwg IES PROJECT NO: 1390–013–01

NOTE: BASE IMAGE COURTESY OF NATURAL RESOURCES CONSERVATION SERVICE (NRCS) WEB SOIL SURVEY AND NATIONAL COOPERATIVE SOIL SURVEY DATED SEPTEMBER 17, 2014. IMAGE OVERLAY METHODS ARE APPROXIMATE.

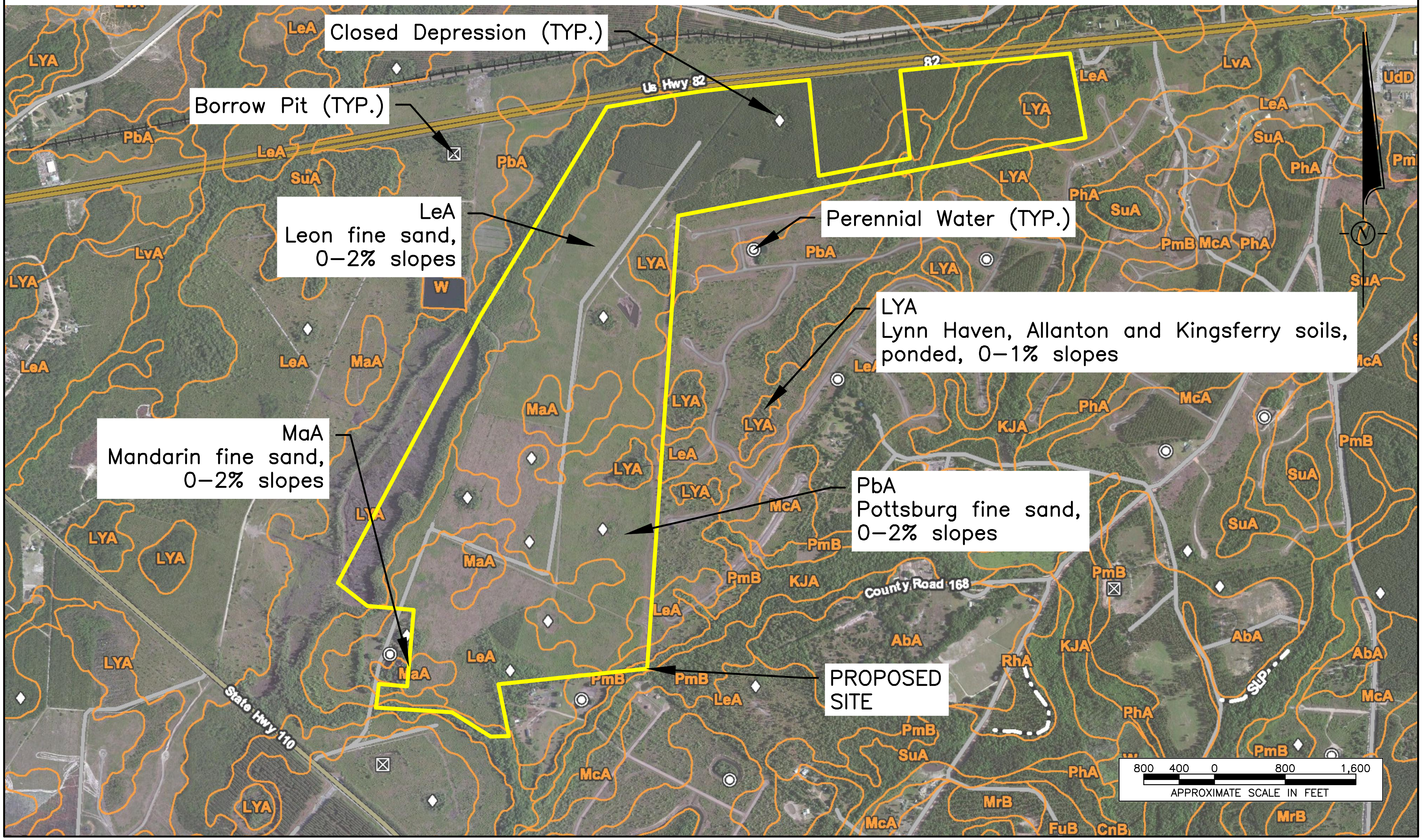

FIGURE 2-04

SITE SUITABILITY ASSESSMENT REPORT

SOIL SURVEY

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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IES
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Smarr, Georgia 31086
Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG–2019 DRAWING: 1390–013 SAR Figures.dwg IES PROJECT NO: 1390–013–01

NOTE: BASE IMAGE COURTESY OF "QUATERNARY INTERACTIVE FAULT MAP" (EARTHQUAKE.USGS.GOV/HAZARDS/QFAULTS/MAP/) ON UNITED STATES GEOLOGIC SURVEY (USGS) WEBSITE. IMAGE OVERLAY METHODS ARE APPROXIMATE.

FIGURE 2-05

SITE SUITABILITY ASSESSMENT REPORT

FAULT MAP

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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Smarr, Georgia 31086
Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG-2019   DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) "MAP C: HORIZONTAL ACCELERATION (90 PERCENT PROBABILITY OF NOT BEING EXCEEDED IN 250 YEARS)" FROM "PROBABILISTIC EARTHQUAKE ACCELERATION AND VELOCITY MAPS FOR THE UNITED STATES AND PUERTO RICO" FROM MISCELLANEOUS FIELD STUDY MF-2120, DATED 1990. IMAGE OVERLAY METHODS ARE APPROXIMATE.

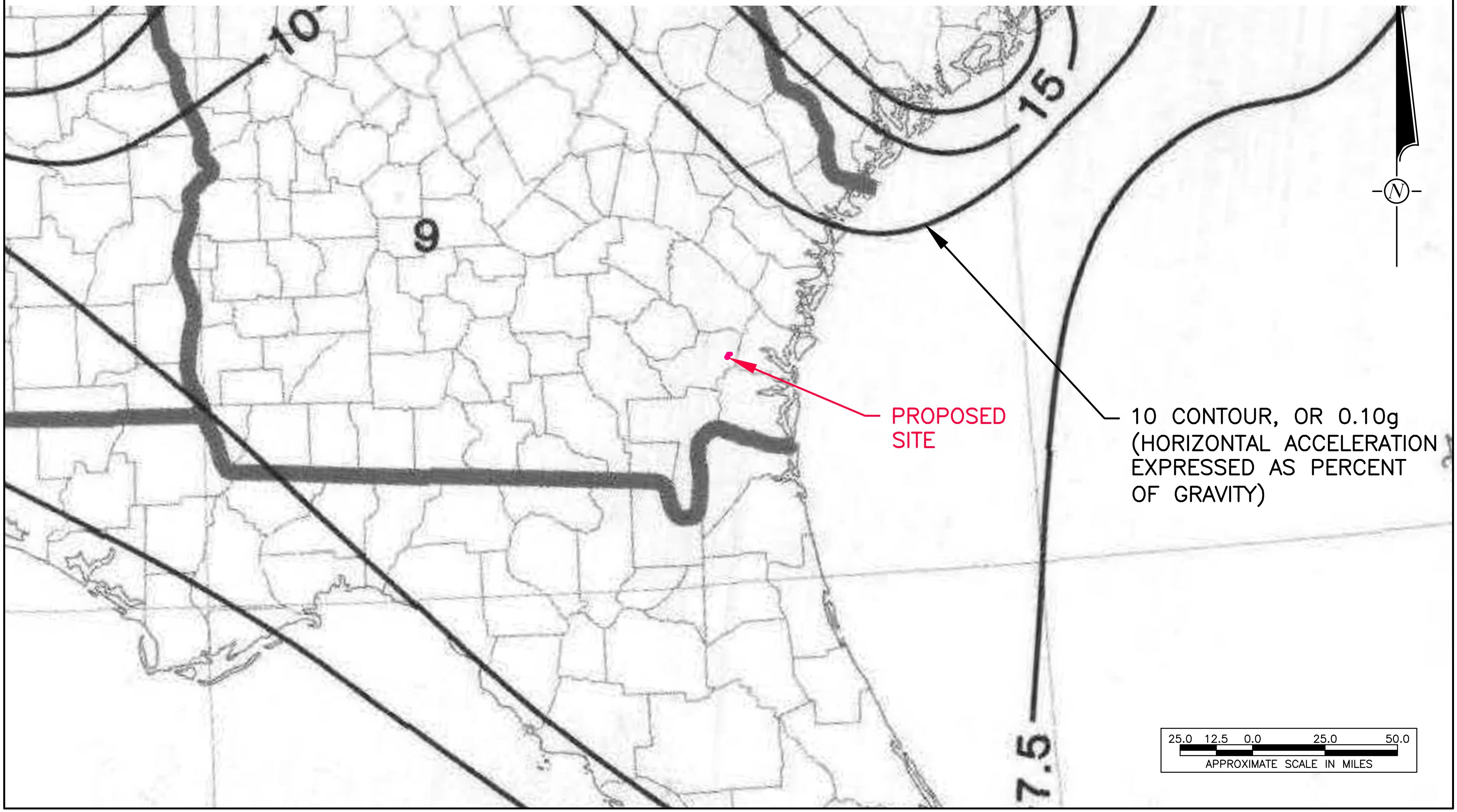

FIGURE 2-06

SITE SUITABILITY ASSESSMENT REPORT

SEISMIC IMPACT ZONE MAP

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BRANTLEY COUNTY - S.R. 50 MSWL

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Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG-2019 DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) "GROUNDWATER FLOW IN THE BRUNSWICK/GLYNN COUNTY AREA, GEORGIA, 2000-2004," SCIENTIFIC INVESTIGATIONS REPORT (SIR) 2015-5061. IMAGE OVERLAY METHODS ARE APPROXIMATE.

NOTE: CONTOURS INDICATED ON THIS FIGURE REPRESENT SIMULATED 2004 POTENTIOMETRIC SURFACE, IN FEET.

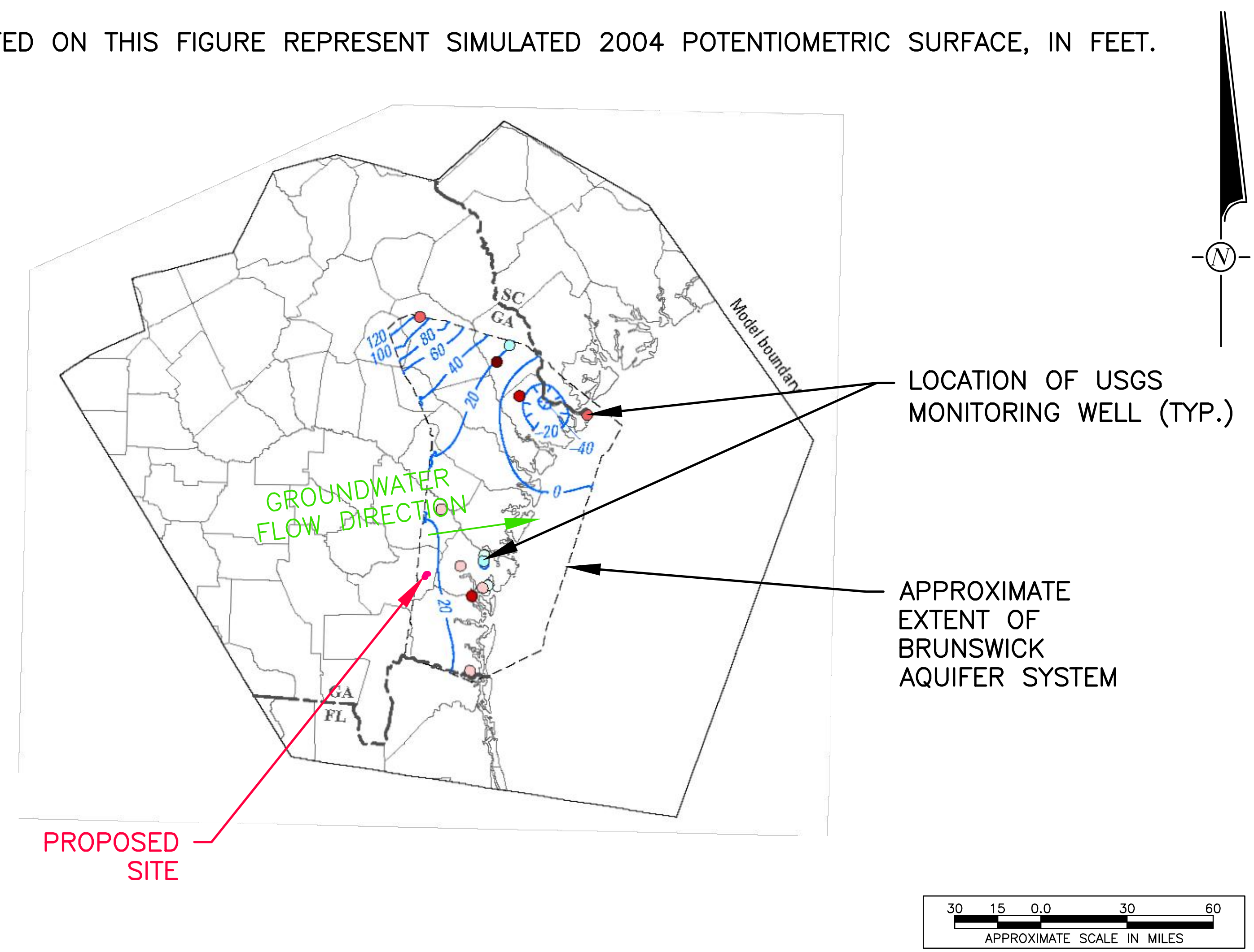
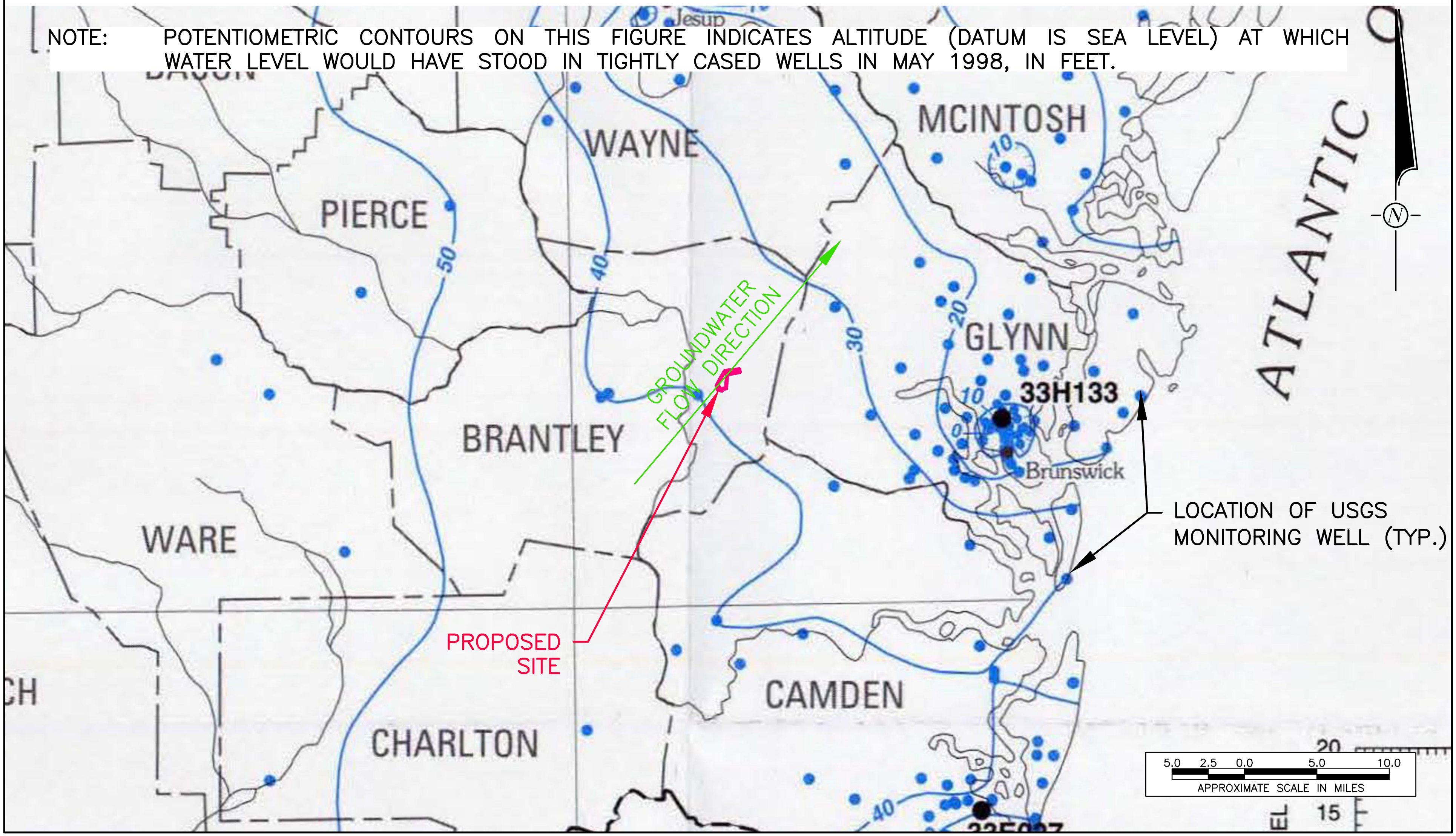


FIGURE 2-07	SITE SUITABILITY ASSESSMENT REPORT UPPER BRUNSWICK AQUIFER POTENTIOMETRIC MAP	BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC BRANTLEY COUNTY - S.R. 50 MSWL	Innovative Engineering Strategies, LLC CIVIL · ENVIRONMENTAL IES P.O. Box 560 Smarr, Georgia 31086 Phone (478) 365-8609

NOTE: BASE IMAGE COURTESY OF GEORGIA GEOLOGIC SURVEY HYDROLOGIC ATLAS HA-22 ENTITLED "POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN GEORGIA AND ADJACENT PARTS OF ALABAMA, FLORIDA, AND SOUTH CAROLINA, MAY 1998, AND WATER LEVEL TRENDS IN GEORGIA, 1990-98" DATED 1999. IMAGE OVERLAY METHODS ARE APPROXIMATE.



SITE SUITABILITY ASSESSMENT REPORT

FLORIDAN AQUIFER MAP

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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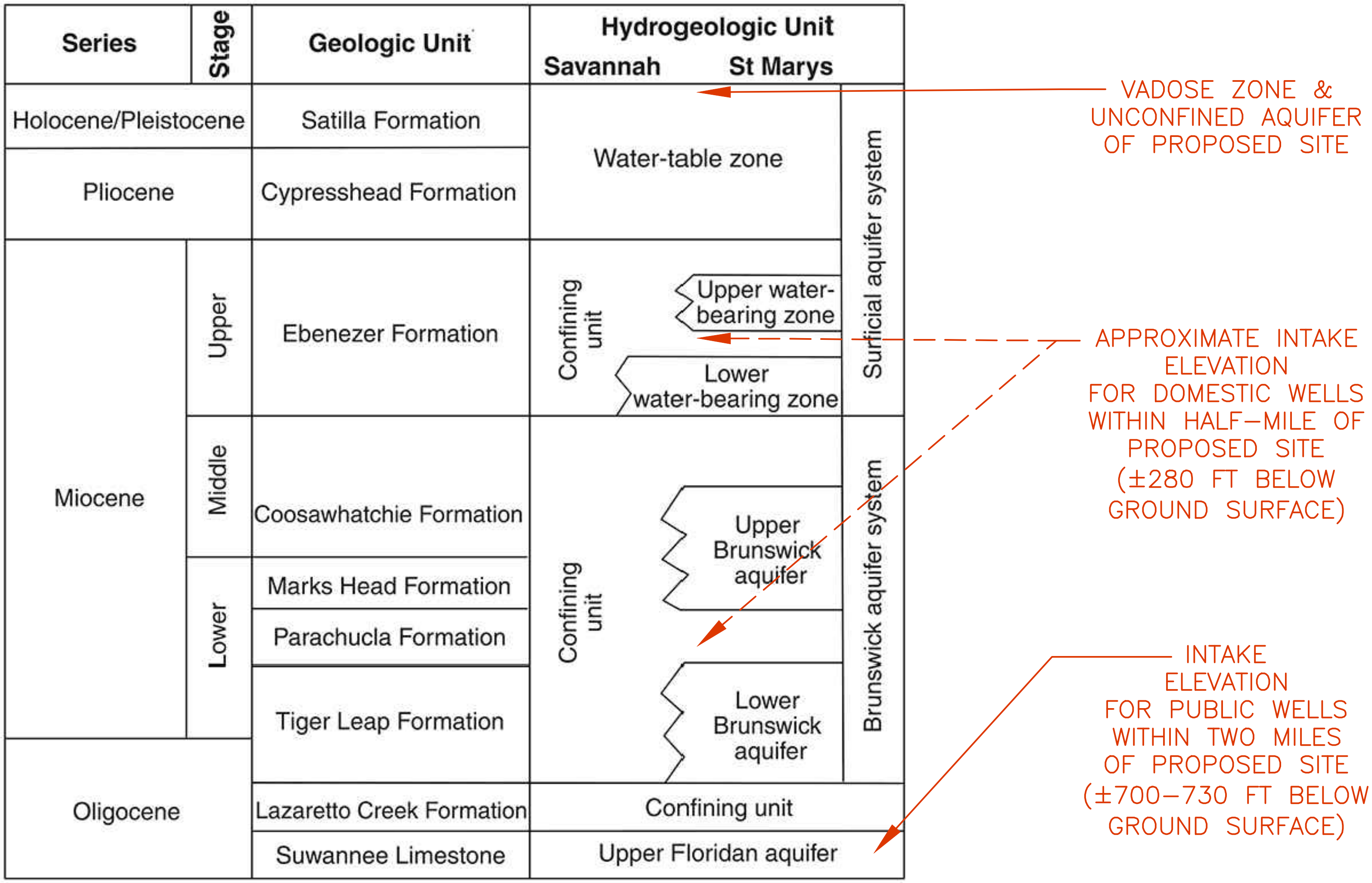
Phone (478) 365-8609

NOTE: THE CROSS-SECTION BELOW IS FIGURE 2: GEOLOGIC AND HYDROGEOLOGIC UNIT OF OLIGOCENCE AND YOUNGER AGE, COASTAL GEORGIA FROM "THE SURFICIAL AND BRUNSWICK AQUIFER SYSTEMS-ALTERNATIVE GROUND-WATER RESOURCES FOR COASTAL GEORGIA" PREPARED BY JOHN S. CLARKE, USGS HYDROGEOLOGIST DATED APRIL 2003.



NOTE: RELATIONSHIP BETWEEN PROPOSED SITE AND UNDERLYING AQUIFERS BASED UPON AREA DRILLING LOGS (SEE APPENDIX L).

FIGURE 3-01

SITE SUITABILITY ASSESSMENT REPORT

SCHEMATIC CROSS SECTION SHOWING RELATIONSHIP BETWEEN AQUIFERS

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Phone (478) 365-8609

INITIAL SUBMITTAL DATE: OCT–2019 DRAWING: 1390–013 SAR Figures.dwg IES PROJECT NO: 1390–013–01

NOTE: BASE IMAGE COURTESY OF UNITED STATES GEOLOGIC SURVEY (USGS) 7.5–MINUTE SERIES QUADRANGLE MAPS FOR WAYNESVILLE (2014) AND NANHUNTA (2014). IMAGE OVERLAY METHODS ARE APPROXIMATE.

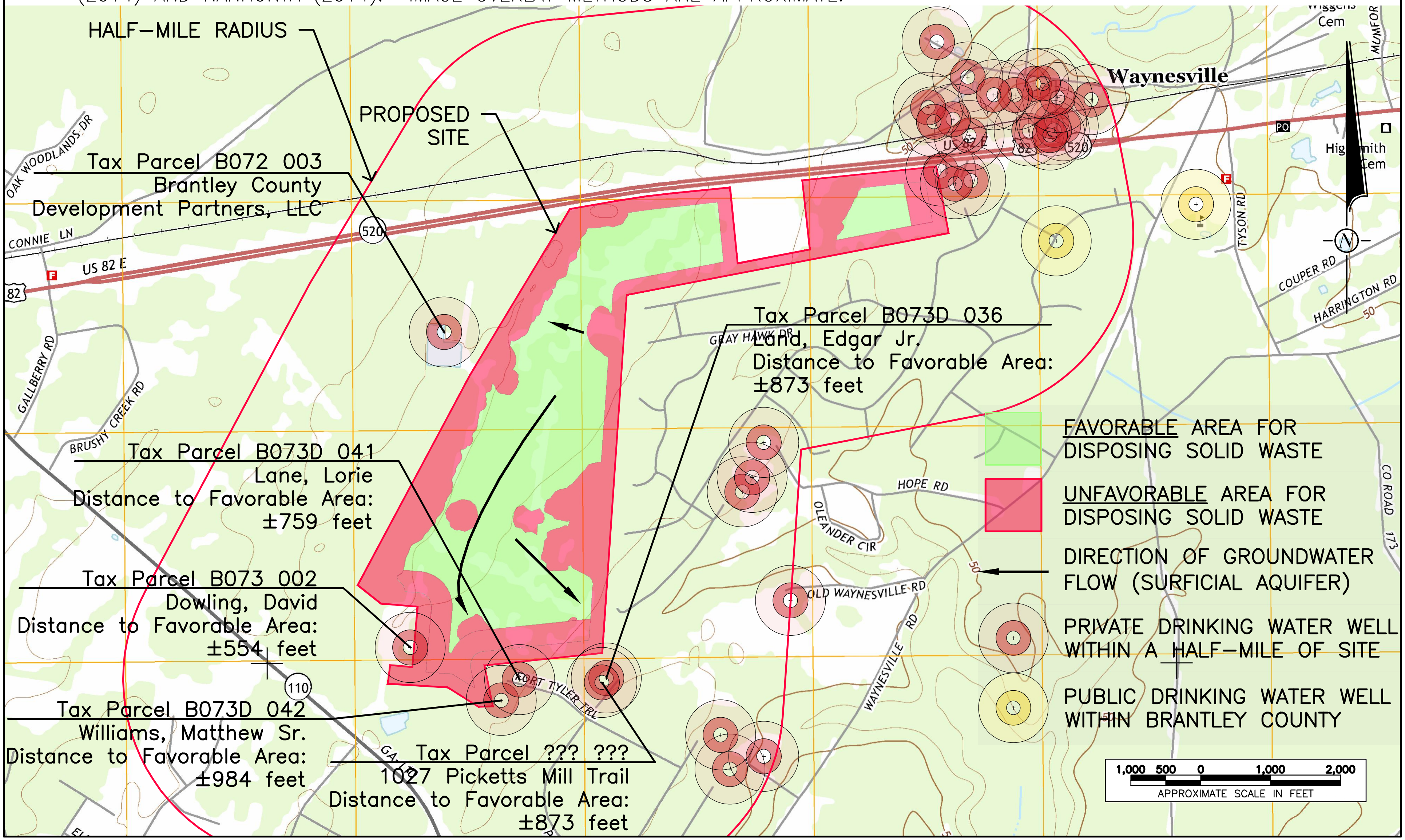

FIGURE 3-02

SITE SUITABILITY ASSESSMENT REPORT

DOWN-GRADIENT RECEPTORS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

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IES
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Phone (478) 365-8609

INITIAL SUBMITTAL DATE: AUG-2019 DRAWING: 1390-013 SAR Figures.dwg IES PROJECT NO: 1390-013-01

NOTE: BASE IMAGE COURTESY OF GEORGIA GEOLOGIC SURVEY HYDROLOGIC ATLAS HA-20 ENTITLED "GROUND-WATER POLLUTION SUSCEPTIBILITY MAP OF GEORGIA," DATED 1992. IMAGE OVERLAY METHODS ARE APPROXIMATE.

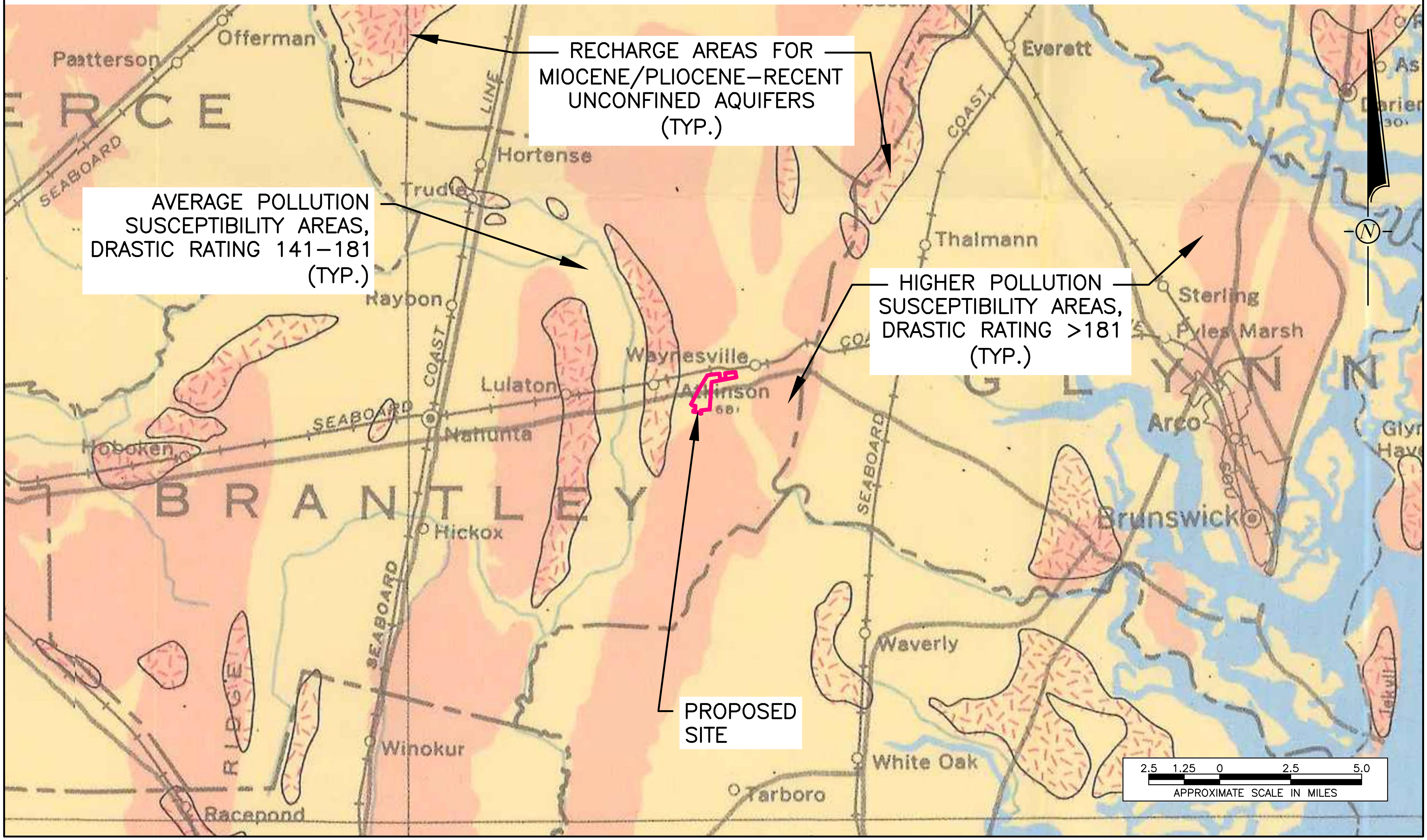
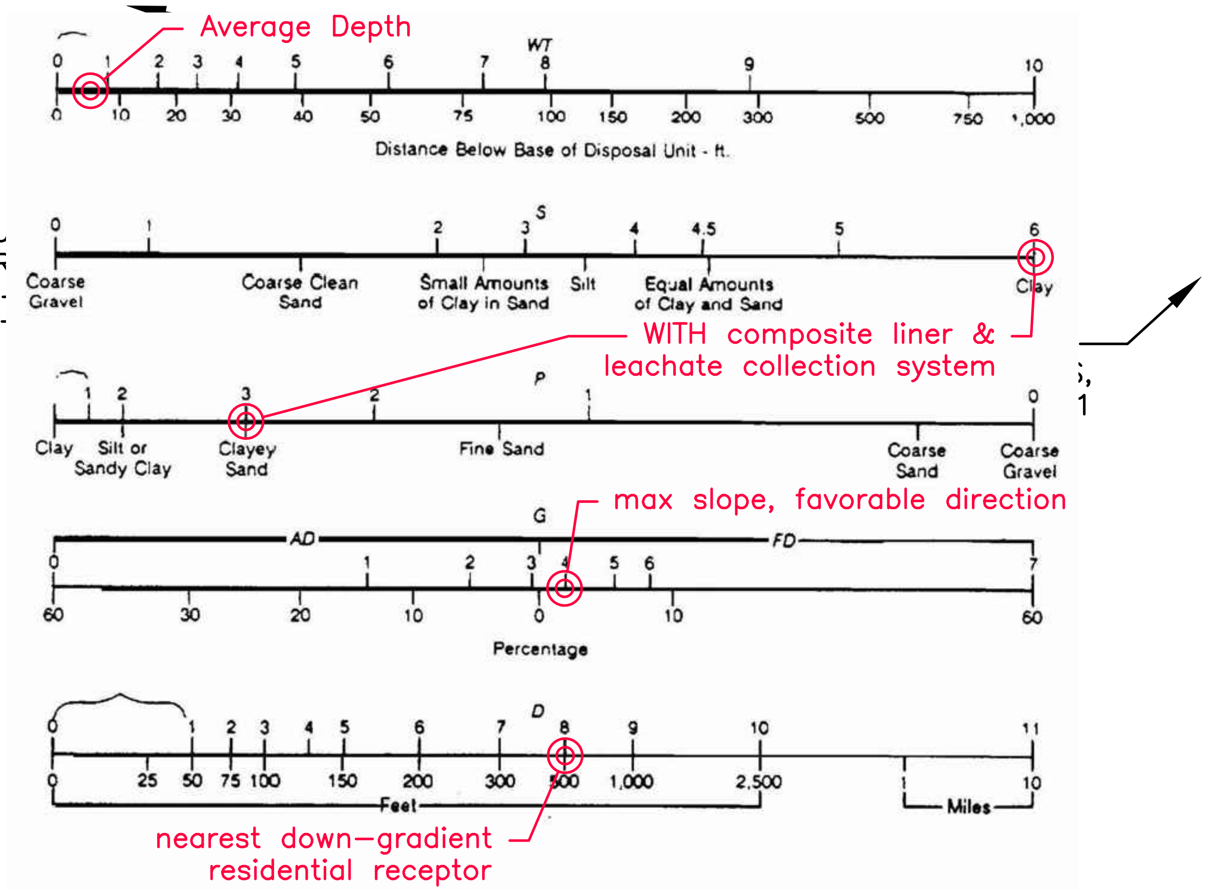


FIGURE 3-03	SITE SUITABILITY ASSESSMENT REPORT GROUNDWATER POLLUTION SUSCEPTIBILITY MAP	BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC BRANTLEY COUNTY - S.R. 50 MSWL	Innovative Engineering Strategies, LLC CIVIL · ENVIRONMENTAL IES P.O. Box 560 Smarr, Georgia 31086 Phone (478) 365-8609

NOTES: BASE IMAGERY COURTESY OF GEORGIA ENVIRONMENTAL PROTECTION DIVISION (EPD) CIRCULAR 14: CRITERIA FPR PERFORMING SITE ACCEPTABILITY STUDIES FOR SOLID WASTE LANDFILLS IN GEORGIA, "FIGURE 3: RATING CHART FOR SITES IN LOOSE GRANULAR MATERIALS," DATED 1997. IMAGE OVERLAY METHODS ARE APPROXIMATE

AVERAGE POLLU
SUSCEPTIBILITY AR
DRASTIC RATING 141-
(



The scales for the various factors are labeled as follows: WT, water table; S, sorption; P, permeability; G, gradient; and D, distance. On all scales the point values are indicated by the upper scale; the brackets indicate unacceptable ranges for any factor, except the two brackets on the gradient scale, one labeled AD, which is for an adverse direction of flow (toward point of water use), and one FD, which is for a favorable direction of flow. (From LeGrand, 1964).

FIGURE 3-04

SITE SUITABILITY ASSESSMENT REPORT

LEGRAND METHOD
POLLUTION POTENTIAL RATING CHART

BRANTLEY COUNTY
DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY -
S.R. 50 MSWL

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IES
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Smarr, Georgia 31086
Phone (478) 365-8609

	AREA (AC)
FAVORABLE	±227
UNFAVORABLE	±236
TOTAL	±463

NOTES:

1. FAVORABLE AREAS FOR SOLID WASTE DISPOSAL INDICATED ON THIS FIGURE DO NOT REPRESENT ACTUAL WASTE DISPOSAL BOUNDARY. HORIZONTAL LIMITS OF THE WASTE DISPOSAL BOUNDARY WILL BE DETERMINED DURING THE DESIGN AND PERMITTING PROCESS AND ARE ANTICIPATED TO BE LESS THAN THE FAVORABLE AREAS SHOWN ON THIS FIGURE AS AREAS IMPRACTICAL FOR DISPOSAL UNIT DEVELOPMENT ARE OMITTED. FAVORABLE AREAS ARE INDICATED ON THIS FIGURE TO ILLUSTRATE THE EXTENTS OUTSIDE JURISDICTIONAL WETLANDS, BUFFERS, SETBACKS AND DIFFICULT AREAS TO ACCESS, ETC. (UNFAVORABLE AREAS).
2. JURISDICTIONAL WETLANDS (AND THEIR 50 FT BUFFERS) OUTSIDE THE PROPERTY LINE BUFFER MAY BECOME FAVORABLE AREAS FOR SOLID WASTE DISPOSAL ONLY IF PROPER PERMITTING IS OBTAINED AS REQUIRED BY THE U.S. ARMY CORPS OF ENGINEERS.
3. UNFAVORABLE AREAS INDICATED BEYOND THE 200 FT PROPERTY LINE BUFFER AND WITHIN THE 500 FT PROPERTY LINE BUFFER MAY BECOME FAVORABLE AREAS FOR SOLID WASTE DISPOSAL AS ACTUAL LOCATIONS OF THE PRIVATE (DOMESTIC) WELLS ADJACENT TO THE PROPERTY LINE ARE CONFIRMED.
4. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "BOUNDARY SURVEY FOR BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC" ON MAY 12, 2019 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 1, PAGE 174.
5. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
6. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.

LEGEND

PROPERTY LINE / PROPOSED PERMIT BOUNDARY
200 FT PROPERTY LINE BUFFER
500 FT PROPERTY LINE BUFFER
EXISTING 1-FOOT TOPOGRAPHIC CONTOUR (73)
EXISTING 5-FOOT TOPOGRAPHIC CONTOUR (70)
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
EXISTING NON-JURISDICTIONAL WETLANDS
50 FT WETLANDS BUFFER
AREAS FAVORABLE FOR DISPOSAL OF SOLID WASTE
AREAS UNFAVORABLE FOR DISPOSAL OF SOLID WASTE (WETLANDS, BUFFERS, SETBACKS, ACCESS, ETC.)

400 200 0 400 800
GRAPHIC SCALE IN FEET

Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
IES
CIVIL · ENVIRONMENTAL

GEORGIA REGISTERED PROFESSIONAL ENGINEER NO. 36066 MICHAEL W. BIERS

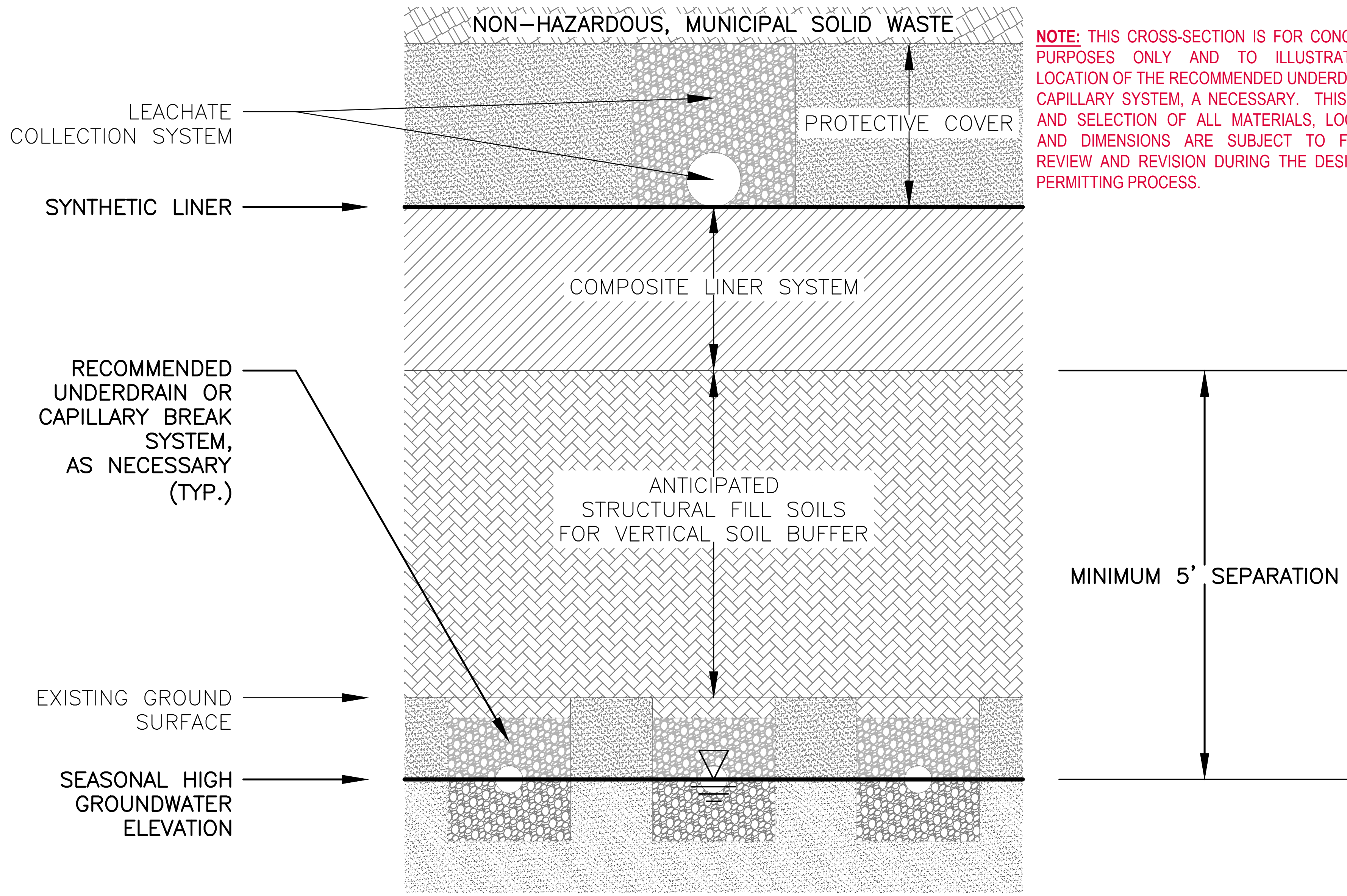
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT
AREAS FAVORABLE AND UNFAVORABLE FOR MUNICIPAL SOLID WASTE LANDFILLING

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
4-01



NOTE: THIS CROSS-SECTION IS FOR CONCEPTUAL PURPOSES ONLY AND TO ILLUSTRATE THE LOCATION OF THE RECOMMENDED UNDERDRAIN OR CAPILLARY SYSTEM, A NECESSARY. THIS FIGURE AND SELECTION OF ALL MATERIALS, LOCATIONS AND DIMENSIONS ARE SUBJECT TO FURTHER REVIEW AND REVISION DURING THE DESIGN AND PERMITTING PROCESS.

FIGURE 4-02

SITE SUITABILITY ASSESSMENT REPORT

CONCEPTUAL CROSS-SECTION OF RECOMMENDED UNDERDRAIN OR CAPILLARY SYSTEM (AS NECESSARY)

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

Innovative Engineering Strategies, LLC
CIVIL · ENVIRONMENTAL
IES
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609

APPENDIX A

Brantley County Development Partners, LLC
2255 Cumberland Pkwy, Building 1700
Atlanta, Georgia 31029

December 27, 2016

Mr. Larry Clark
Atlanta Airports District Office (ADO)
Southern Region Airports Division
Federal Aviation Administration (FAA)
1707 Columbia Airports District Office
College Park, Georgia 303337

Subject: **Proposed Municipal Solid Waste Landfill (MSWL)**
Brantley County – U.S. 82 MSWL
Brantley County, Georgia

Dear Mr. Clark:

As required by 40 CFR §258.10(b) and Georgia Rule 391-3-4-.05-(1)-(c)-2, this letter shall serve as notification to the Federal Aviation Administration (FAA) a new municipal solid waste landfill (MSWL) is being proposed to site within a five (5) mile radius of the airport runway for the Brantley County Airport (K4J1). The closest boundary of the proposed solid waste facility is approximately ±4.5 miles east of the closest runway at KJ41. Both runways at this airport are oriented along the north-south direction. Please find enclosed with this letter the location of the site with respect to the airport.

Should you have any questions, please call.

Sincerely,

Mr. John Kelly

cc: Carl Rowland

INITIAL SUBMITTAL DATE: SEPT-2016   DRAWING: 1390-010 SAR Figures.dwg   HE PROJECT NO: 1390-010-01

NOTE: BASE IMAGE COURTESY OF FEDERAL AVIATION ADMINISTRATION (FAA) SECTIONAL VISUAL FLIGHT RULES (VFR) CHART FOR JACKSONVILLE (FEBRUARY 4, 2016 EDITION). IMAGE OVERLAY METHODS ARE APPROXIMATE.

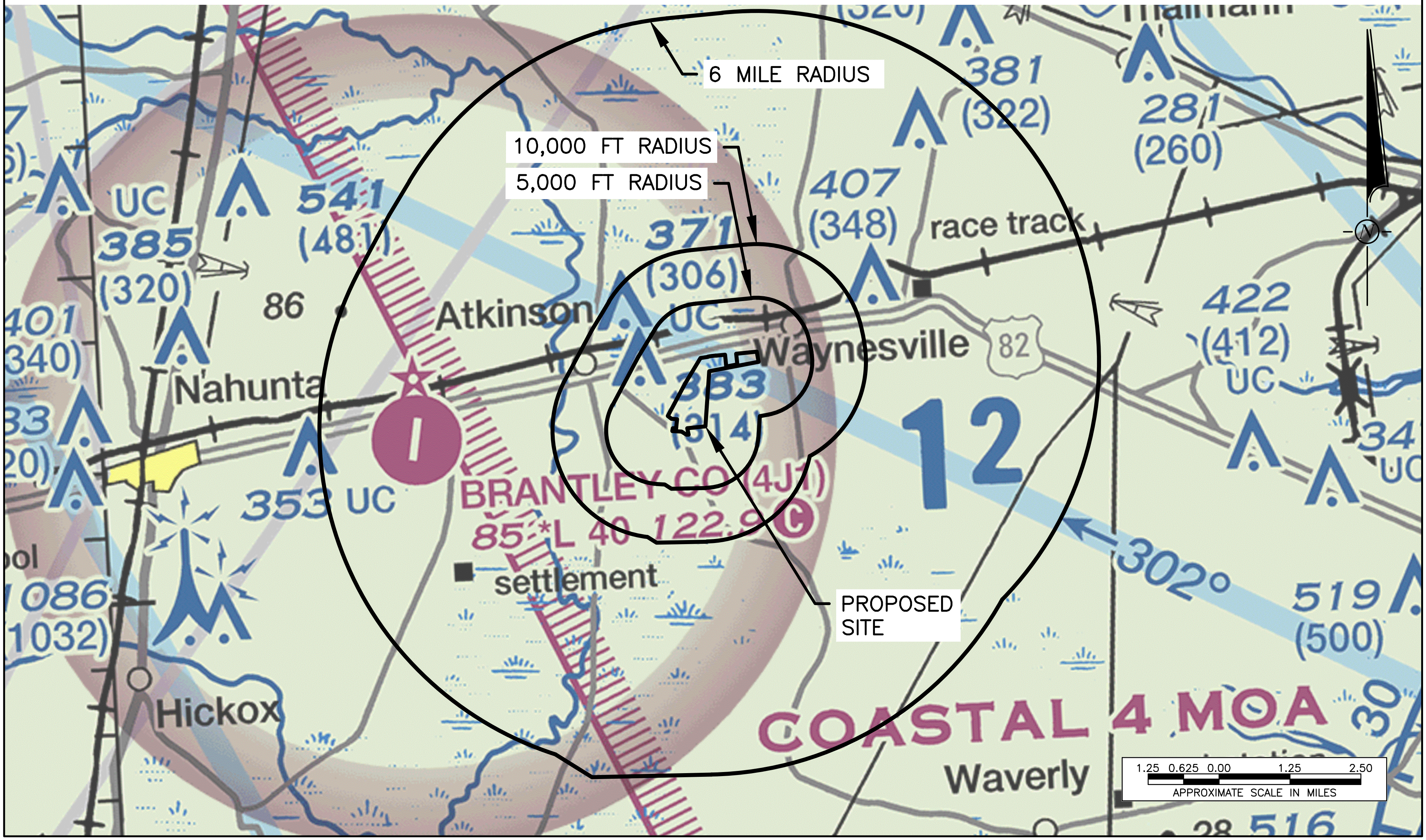


FIGURE 1-06

SITE SUITABILITY ASSESSMENT REPORT

AIRPORTS AND FEDERALLY RESTRICTED AIRSPACE

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

BRANTLEY COUNTY - S.R. 50 MSWL

HARBIN ENGINEERING, P.C.
41 West Johnston Street
Forsyth, Georgia 31029

Phone (478) 992-9122

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Mr. Larry Clark
Atl. Airports District office
Southern Region Airports Div.
FAA
1707 Columbia Airports District office
College Park, GA. 30337

9590 9402 2228 6193 5566 10

2. Article Number *(Transfer from service label)*

7016 0750 0000 5598 8917

COMPLETE THIS SECTION ON DELIVERY

A. Signature

X W. Collins ☑ Agent ☐ Addressee

B. Received by *(Printed Name)* W. Collins

C. Date of Delivery 1-3-17

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type

- ☐ Adult Signature
- ☐ Adult Signature Restricted Delivery
- ☒ Certified Mail®
- ☐ Certified Mail Restricted Delivery
- ☐ Collect on Delivery
- ☐ Collect on Delivery Restricted Delivery
- ☐ Insured Mail
- ☐ Insured Mail Restricted Delivery (over $500)
- ☐ Priority Mail Express®
- ☐ Registered Mail™
- ☐ Registered Mail Restricted Delivery
- ☒ Return Receipt for Merchandise
- ☐ Signature Confirmation™
- ☐ Signature Confirmation Restricted Delivery

USPS TRACKING #

9590 9402 2228 6193 5566 10

First-Class Mail
Postage & Fees Paid
USPS
Permit No. G-10

United States
Postal Service

• Sender: Please print your name, address, and ZIP+4® in this box•

L & M

Lovett & Myers, LLC
530 Forest Hill Road
Macon, Georgia 31210

Re: FAA Letter (Kelly)

APPENDIX B

ENVIRONMENTAL SERVICES, INC.
101 B Estus Drive
Savannah, GA 31404

Phone 912-236-4711 * Fax 912-236-3668

www.environmentalservicesinc.com

10 May 2016

Mr. John Kelly & Mr. Lee Wooddall
Brantley County Developing Partners, LLC
2255 Cumberland Parkway, Building 1700/ 2nd Floor
Atlanta, Georgia 30339

RE: **Brantley County Development Partners, LLC** **ES14020.01**
Brantley County, Georgia
Reg. Branch Number SAS-2015-00746

Dear Mr. Kelly & Wooddall:

Attached is a copy of a letter from the U.S. Army Corps of Engineers (CE), dated 5 May 2016, that represents both the Preliminary Jurisdictional Determination (PJD) and Approved Jurisdictional Determination (AJD), regarding the above-referenced property located south of Georgia Highway 82, near the city of Waynesville, in Brantley County, Georgia. This letter states that the CE, upon reviewing the Jurisdictional Determination Request (JDR) submitted by Environmental Services, Inc. (ESI), agrees with the delineation performed by ESI on the subject property.

The attached **PJD** states that the survey entitled "Brantley County US Hwy 82 Wetlands Mapping, Brantley County, Georgia, Wetlands Boundary Mapping-Index", dated March 29, 2016, and signed by Registered Land Surveyor Robert O. Jordon of Jordan Engineering, Registration No. 2902, is an accurate delineation of all the **jurisdictional boundaries** on the site. Disturbance to these areas **would require** prior authorization from the CE pursuant to Section 404 of the Clean Water Act. The delineation as depicted on the survey will remain valid for a period of five (5) years, expiring **5 May 2021**, unless new information warrants revision prior to that date.

The attached **AJD** states that the survey entitled "Brantley County US Hwy 82 Wetlands Mapping, Brantley County, Georgia, Wetlands Boundary Mapping-Index", dated March 29, 2016, and signed by Registered Land Surveyor Robert O. Jordon of Jordan Engineering, Registration No. 2902, is an accurate delineation of the location/boundaries of all the **isolated, non-jurisdictional wetlands** on the site, specifically **Wetland 4-6, Wetland 8, Wetland 10, Wetland 13, Wetland 16-18**. Disturbance to these areas **would not require** prior authorization from the CE pursuant to Section 404 of the Clean Water Act. The delineation as depicted on the survey will remain valid for a period of five (5) years, expiring **5 May 2021**, unless new information warrants revision prior to that date

Also attached is the Habitat Assessment for Threatened and Endangered Species report for the above-referenced tract. It is the opinion of ESI that the potential for any listed species to occur within the potential impact area is low. No federally protected species or evidence thereof was noted by ESI during the recent habitat evaluation.

Should you require future assistance, have any questions or wish to discuss this information further, please do not hesitate to contact us at the number listed above.

Sincerely,

ENVIRONMENTAL SERVICES, INC.

Mike DeMell
Senior Vice President

Kristen Stauff
Project Scientist

MD/ks
ES14020.01
Brantley Co client verif ltr/May 2016

Xc: Mr. Steve Harbin, Harbin Engineering

U.S. Army Corps of Engineers

Preliminary Jurisdictional Determination

&

Approved Jurisdictional Determination

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
100 W. OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401-3604

REPLY TO
ATTENTION OF:

MAY 05 2016

Regulatory Division
SAS-2015-00746

Mr. John W. Kelly and Mr. C. Lee Wooddall
Brantley County Development Partners, LLC
2255 Cumberland Parkway, Building 1700/2nd Floor
Atlanta, Georgia 30339

RECEIVED 5/10/16

Dear Mr. Kelly and Mr. Wooddall:

I refer to a letter dated October 19, 2015, and supplemental information received February 23, 2016, and March 29, 2016, submitted on your behalf by Mr. Michael J. DeMell, Environmental Services, Inc., requesting a Jurisdictional Determination (JD) for your 487.61 acre site located south of Georgia Highway 82, near the City of Waynesville, in Brantley County, Georgia (Latitude 31.2186, Longitude -81.8189). This project has been assigned number SAS-2015-00746 and it is important that you refer to this number in all communication concerning this matter.

We have completed a preliminary JD for the site. The wetlands were delineated in accordance with criteria contained in the 1987 "Corps of Engineers Wetland Delineation Manual," as amended by the most recent regional supplements to the manual.

We have also completed an approved JD for the site for the isolated, non-jurisdictional wetlands. These wetlands were delineated in accordance with criteria contained in the 1987 "Corps of Engineers Wetland Delineation Manual," as amended by the most recent regional supplements to the manual. I have enclosed an "Approved JD Form," which details whether streams, wetlands and/or other waters present on the site are subject to the jurisdiction of the U.S. Army Corps of Engineers and how the Corps determined jurisdiction.

The wetlands/other waters on the subject property, with exceptions of wetlands and waters: "Wetland 4", "Wetland 5", "Wetland 6", "Wetland 8", "Wetland 10", "Wetland 13", "Wetland 16", "Wetland 17", and "Wetland 18", may be waters of the United States within the jurisdiction of Section 404 of the Clean Water Act (33 United States Code (U.S.C.) 1344) and/or Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). The enclosed survey entitled "Brantley County US Hwy 82 Wetlands Mapping, Brantley County, Georgia, Wetlands Boundary Mapping - Index", Sheet No. 1.0 through Sheet No. 9.0, dated March 29, 2016, and signed by Registered Land Surveyor Robert O. Jordan of Jordan Engineering, Registration Number 2902, is an accurate delineation of all the jurisdictional boundaries on the site. This delineation will remain valid for a period of 5-years unless new information warrants revision prior to that date.

The placement of dredged or fill material into any waterways and/or their adjacent wetlands or mechanized land clearing of those wetlands would require prior Department of the Army authorization pursuant to Section 404. Please note: this preliminary JD and any Corps approved survey and/or GPS delineation, can be used for the purpose of supporting a future permit application.

Preliminary JDs are advisory in nature and may not be appealed (see 33 Code of Federal Regulations (CFR) 331.2). If you are not in agreement with this preliminary JD, then you may request an approved JD for your project site or review area.

There are isolated non-jurisdictional waters present that are not subject to Clean Water Act jurisdiction. Specifically, wetlands: "Wetland 4", "Wetland 5", "Wetland 6", "Wetland 8", "Wetland 10", "Wetland 13", "Wetland 16", "Wetland 17", and "Wetland 18", as identified on the exhibit entitled "Brantley County US Hwy 82 Wetlands Mapping, Brantley County, Georgia, Wetlands Boundary Mapping - Index", Sheet No. 1.0 through Sheet No. 9.0, dated March 29, 2016, and signed by Registered Land Surveyor Robert O. Jordan of Jordan Engineering, Registration Number 2902 is/are isolated, non-jurisdictional wetlands. Department of the Army authorization, pursuant to Section 404 of the Clean Water Act (33 United States Code 1344), is not required for dredge and/or fill activities in these areas. This approved JD will remain valid for a period of 5-years unless new information warrants revision prior to that date.

You may request an administrative appeal for any approved JD under the Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Administrative Appeal Options and Process and Request for Appeal form.

If you intend to sell property that is part of a project that requires Department of the Army Authorization, it may be subject to the Interstate Land Sales Full Disclosure Act. The Property Report required by Housing and Urban Development Regulation must state whether, or not a permit for the development has been applied for, issued or denied by the Corps (Part 320.3(h) of Title 33 of the Code of Federal Regulations).

This communication does not convey any property rights, either in real estate or material, or any exclusive privileges. It does not authorize any injury to property, invasion of rights, or any infringement of federal, state or local laws, or regulations. It does not obviate your requirement to obtain state or local assent required by law for the development of this property. If the information you have submitted, and on which the Corps has based its determination is later found to be in error, this decision may be revoked.

A copy of this letter is being provided to the following party: Mr. Michael J. DeMell, Environmental Services, Inc., 101B Estus Drive, Savannah, Georgia 31404.

Thank you in advance for completing our on-line Customer Survey Form located at http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey. We value your comments and appreciate your taking the time to complete a survey each time you interact with our office.

If you have any questions, please call me, at 912-652-5086.

Sincerely,

Shaun Blocker
Project Manager, Coastal Branch

Enclosures

REFERENCES:
PRELIMINARY WETLANDS SKETCH PROVIDED BY ENVIRONMENTAL SERVICES, INC.

PLAT RECORD. PLAT PREPARED BY CHARLES H. TOMBERLIN AND ASSOCIATES, MAY 6, 2013

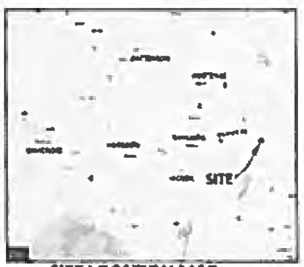
BOUNDARY-THE FIELD DATA WAS COLLECTED USING A JAVAD TRIUMPH-LS DUAL FREQUENCY RTK GLOBAL POSITIONING SYSTEM RECEIVER REFERENCING THE eGPS STATEWIDE NETWORK AND HAVING A RELATIVE POSITIONAL ACCURACY OF LESS THAN 0.04 FEET

WETLANDS MAPPING FIELD DATA WAS COLLECTED USING A TRIMBLE GEO 7X GPS RECEIVER HAVING A RELATIVE POSITIONAL ACCURACY OF LESS THAN 3 FEET.

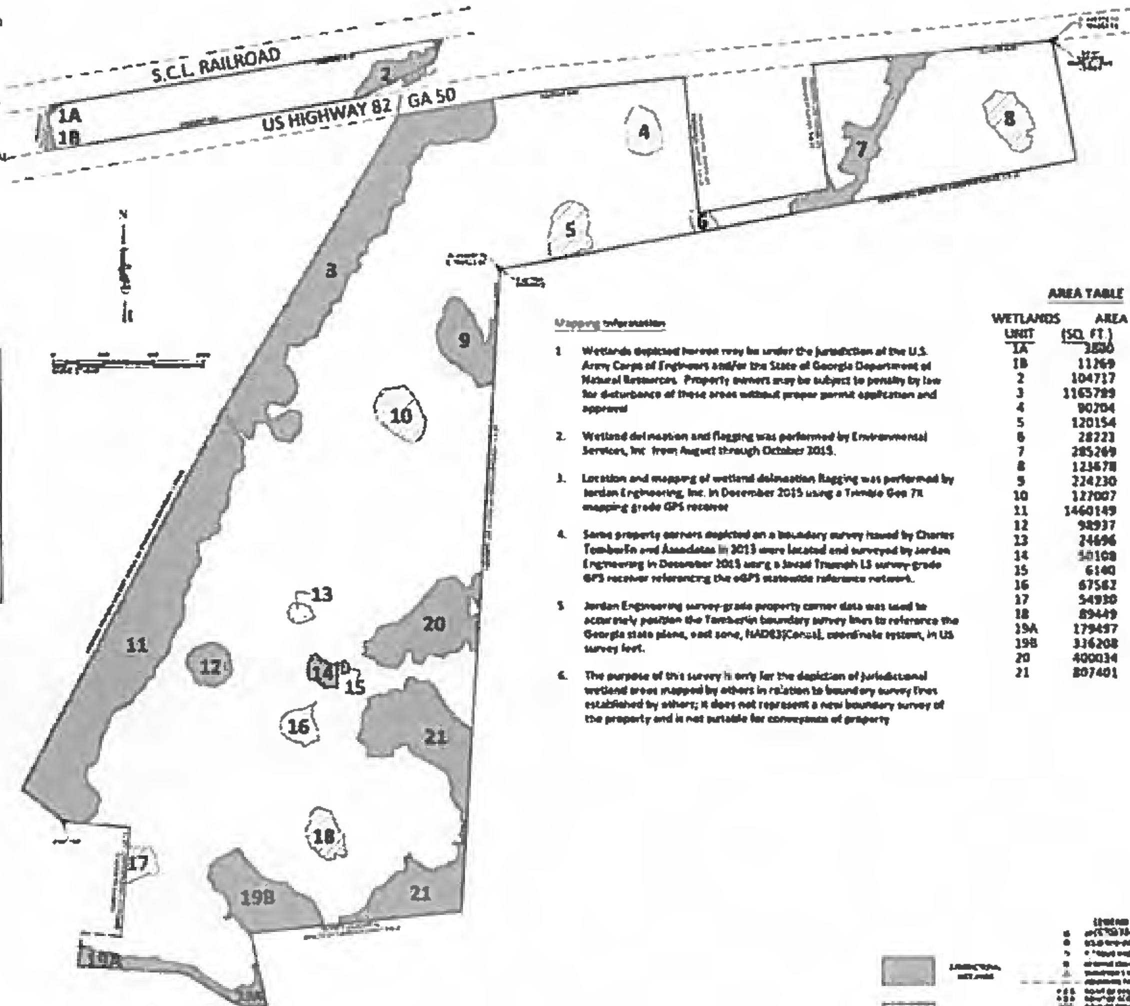
THE FIELD DATA WAS COLLECTED IN DECEMBER 2015.

EASEMENTS OR RIGHTS-OF-WAY MAY EXIST WHICH ARE NOT SHOWN HEREON AND MAY BE RECORDED OR UNRECORDED.

COORDINATES DEPICTED HEREON REFERENCE THE GEORGIA STATE PLANE SYSTEM, EAST ZONE, NAD83(CONUS), IN US FEET VERTICAL INFORMATION WHERE PROVIDED HEREON REFERENCES THE NAVD88 VERTICAL DATUM.



SITE LOCATION MAP



Mapping Information

1. Wetlands depicted hereon may be under the jurisdiction of the U.S. Army Corps of Engineers and/or the State of Georgia Department of Natural Resources. Property owners may be subject to penalty by law for disturbance of these areas without proper permit application and approval

2. Wetland delineation and flagging was performed by Environmental Services, Inc from August through October 2015.

3. Location and mapping of wetland delineation flagging was performed by Jordan Engineering, Inc. in December 2015 using a Trimble Geo 7X mapping grade GPS receiver

4. Some property corners depicted on a boundary survey issued by Charles Tomberlin and Associates in 2013 were located and surveyed by Jordan Engineering in December 2015 using a Javad Triumph LS survey-grade GPS receiver referencing the eGPS statewide reference network.

5. Jordan Engineering survey-grade property corner data was used to accurately position the Tomberlin boundary survey lines to reference the Georgia state plane, east zone, NAD83(Conus), coordinate system, in US survey feet.

6. The purpose of this survey is only for the depiction of jurisdictional wetland areas mapped by others in relation to boundary survey lines established by others; it does not represent a new boundary survey of the property and is not suitable for conveyance of property

AREA TABLE

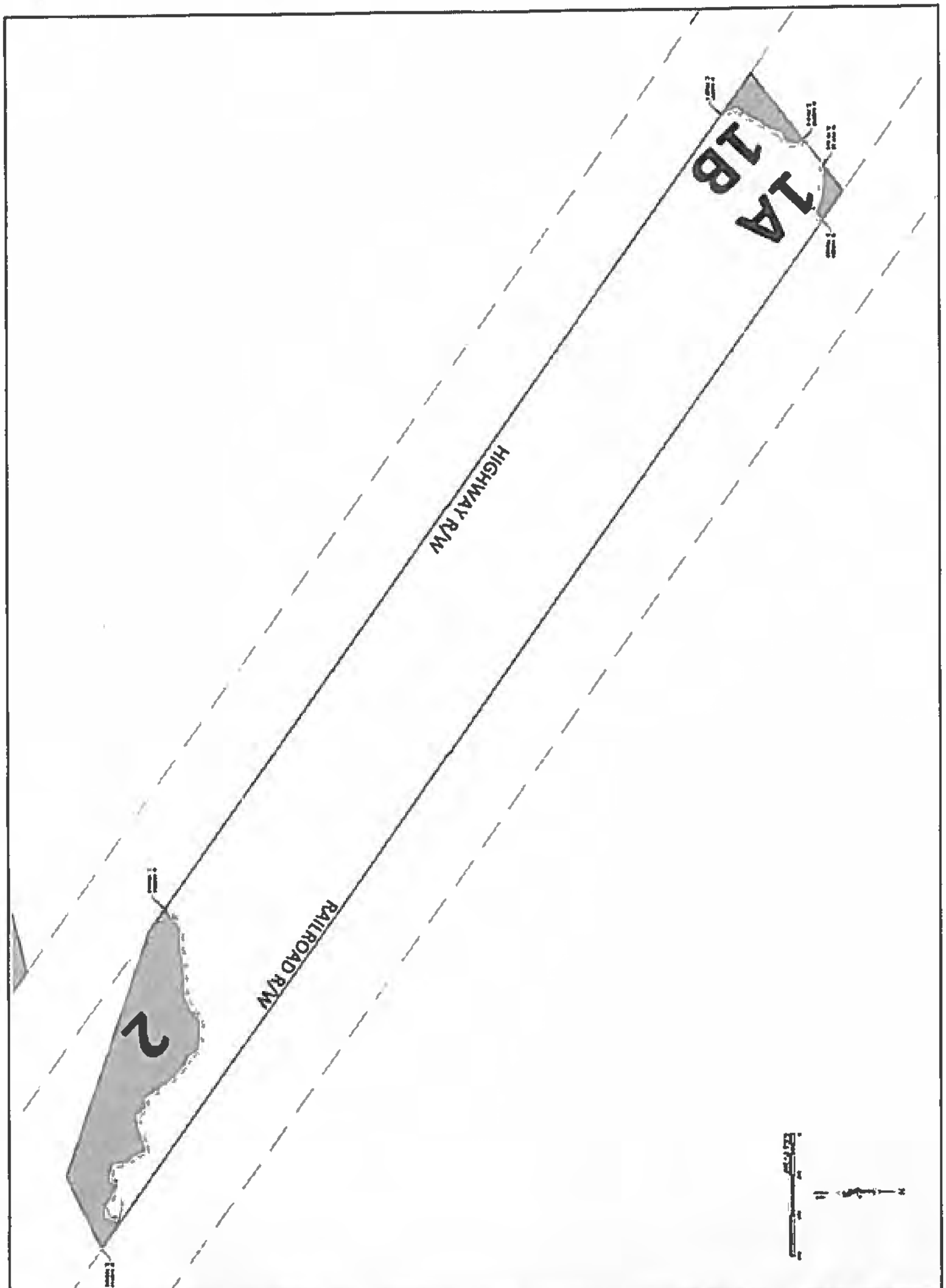
WETLANDS UNIT	AREA (SQ. FT.)	AREA (ACRES)
1A	3890	0.09
1B	11269	0.26
2	104717	2.40
3	1165789	26.76
4	90704	2.07
5	120154	2.76
6	28221	0.65
7	285269	6.55
8	123678	2.84
9	224230	5.14
10	127007	2.92
11	1460149	33.52
12	98937	2.27
13	24696	0.57
14	50108	1.15
15	6140	0.14
16	67582	1.55
17	54930	1.26
18	89449	2.05
19A	179497	4.12
19B	336208	7.72
20	400034	9.18
21	807401	18.54

JORDAN

WETLANDS BOUNDARY MAPPING - INDEX

Brantley County US Hwy 82 Wetlands Mapping
Brantley County, Georgia

Sheet No.
1.0

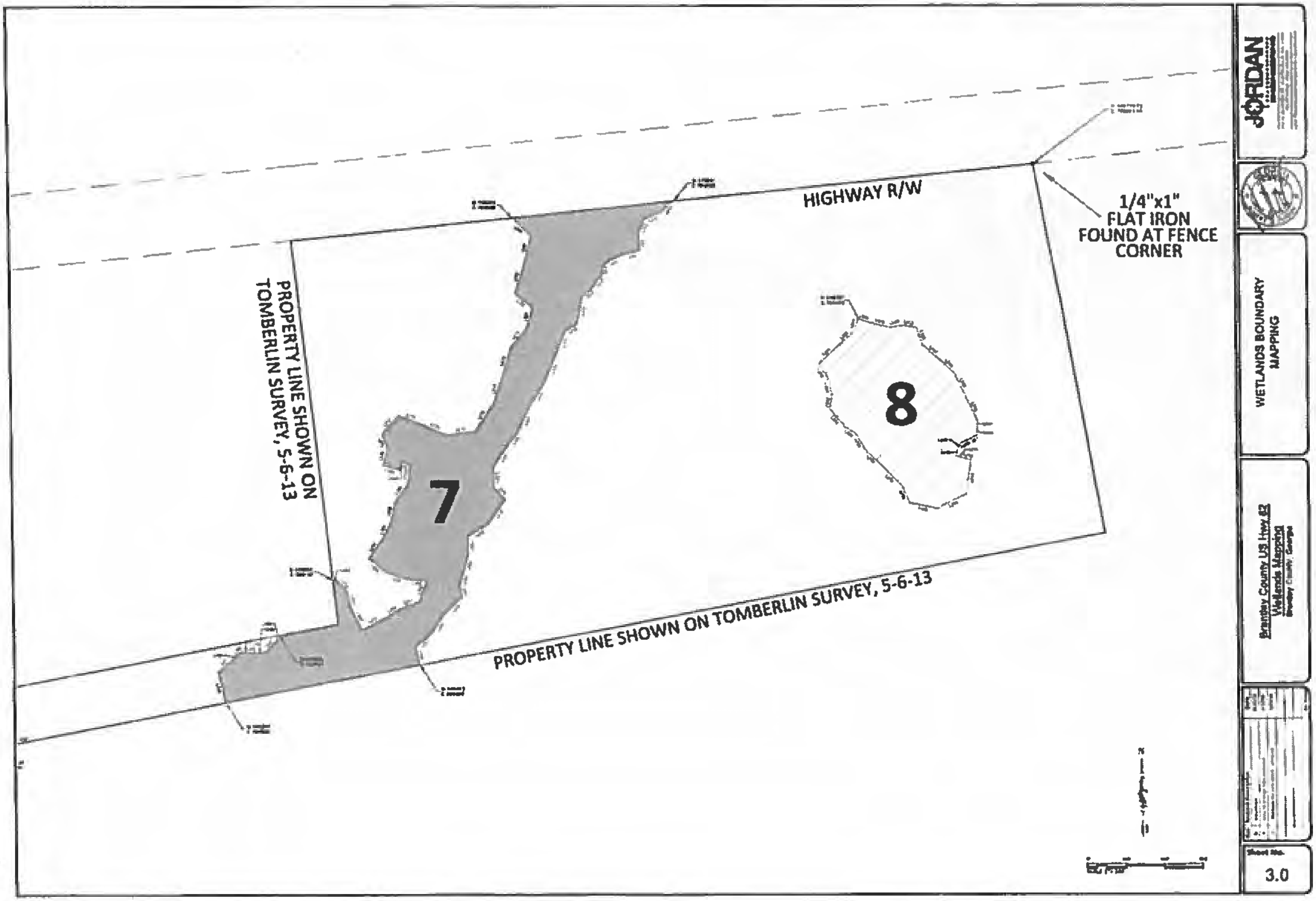


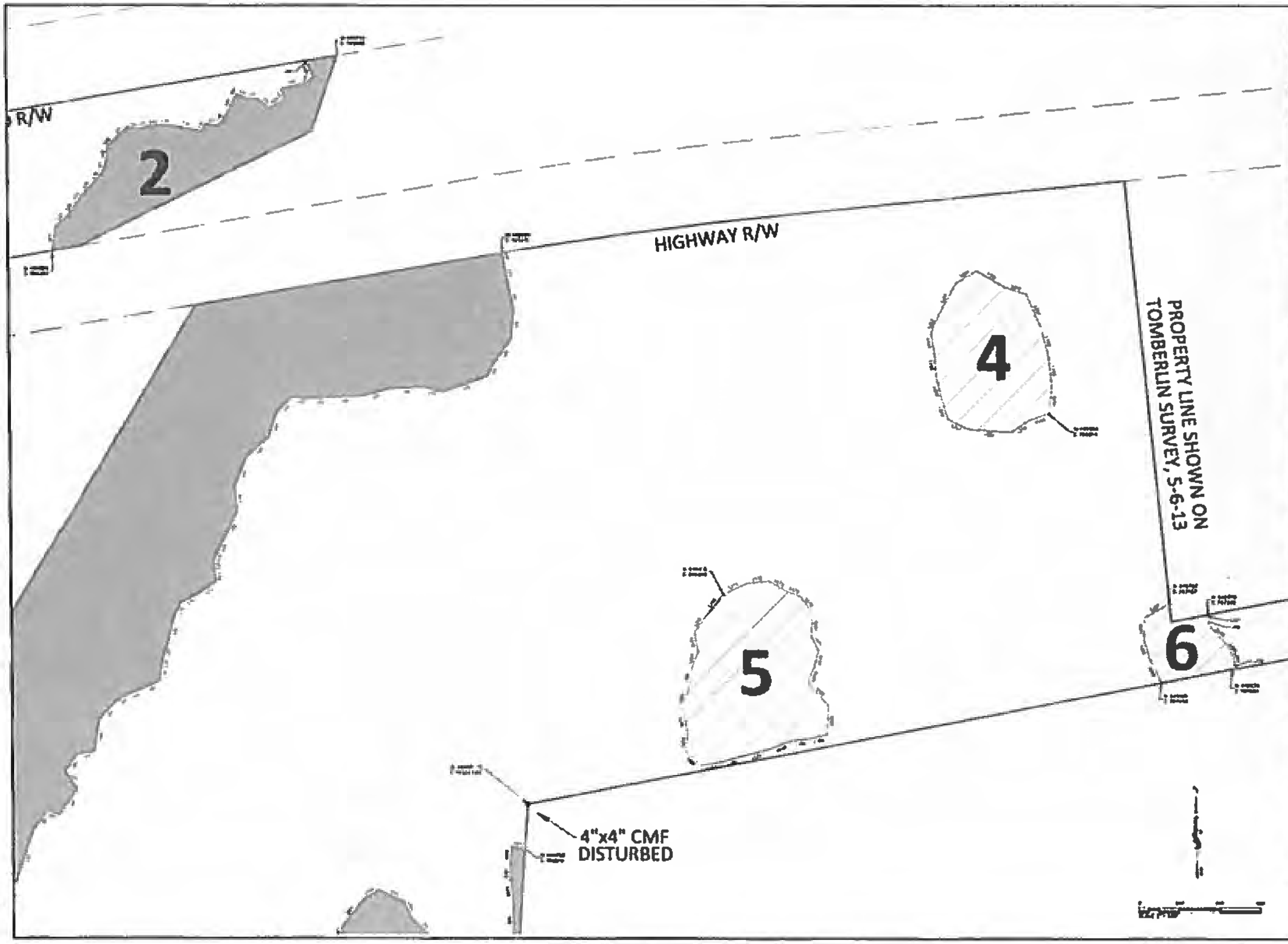
Sheet No. 2.0

Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

WETLANDS BOUNDARY MAPPING

JORDAN


HIGHWAY R/W
1/4"x1"
FLAT IRON
FOUND AT FENCE
CORNER
PROPERTY LINE SHOWN ON
TOMBERLIN SURVEY, 5-6-13
7
8
PROPERTY LINE SHOWN ON TOMBERLIN SURVEY, 5-6-13
JORDAN
WETLANDS BOUNDARY
MAPPING
Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia
3.0

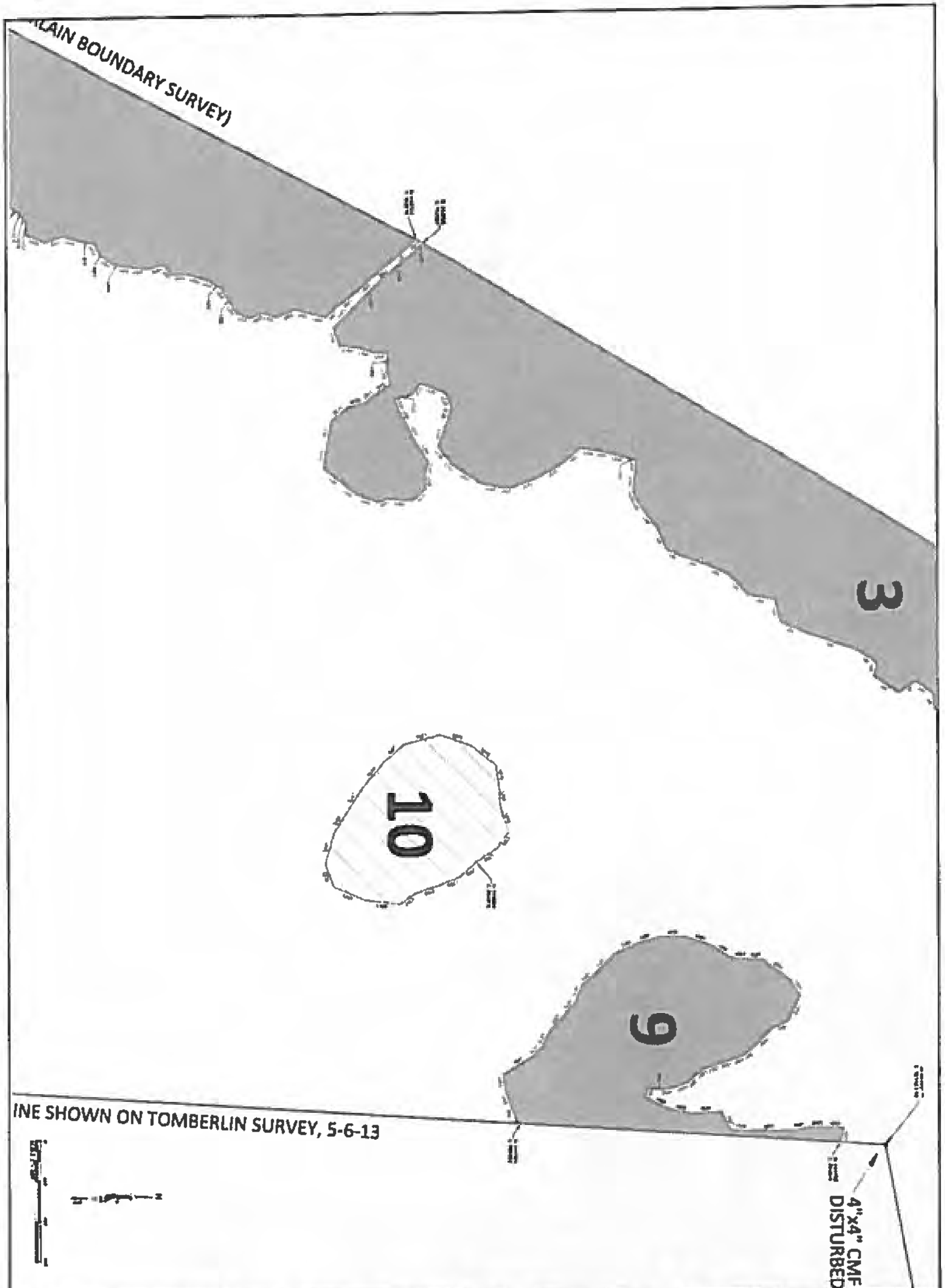


JORDAN

WETLANDS BOUNDARY
MAPPING

Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

Sheet No.
4.0

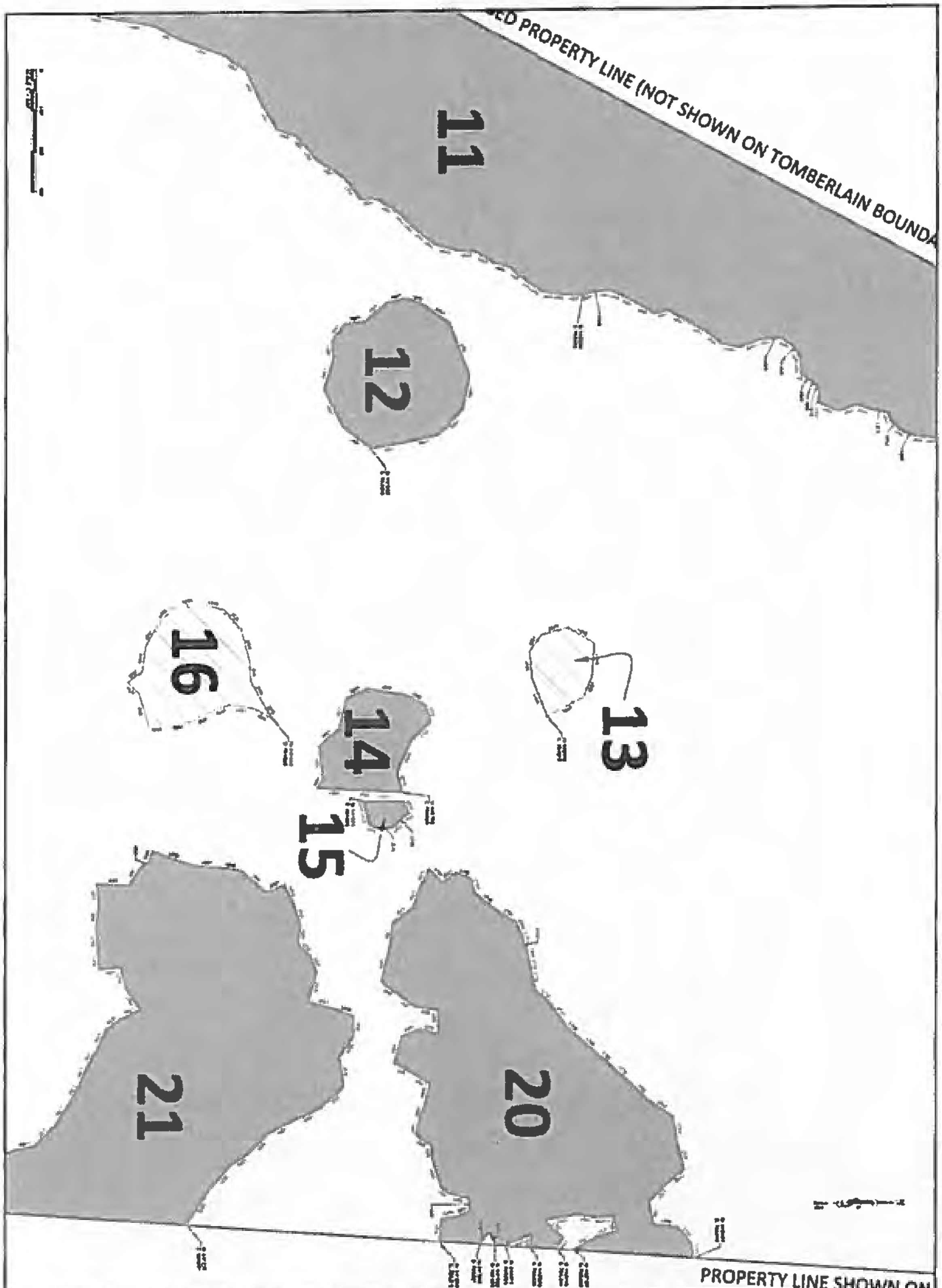


Sheet No. 5.0

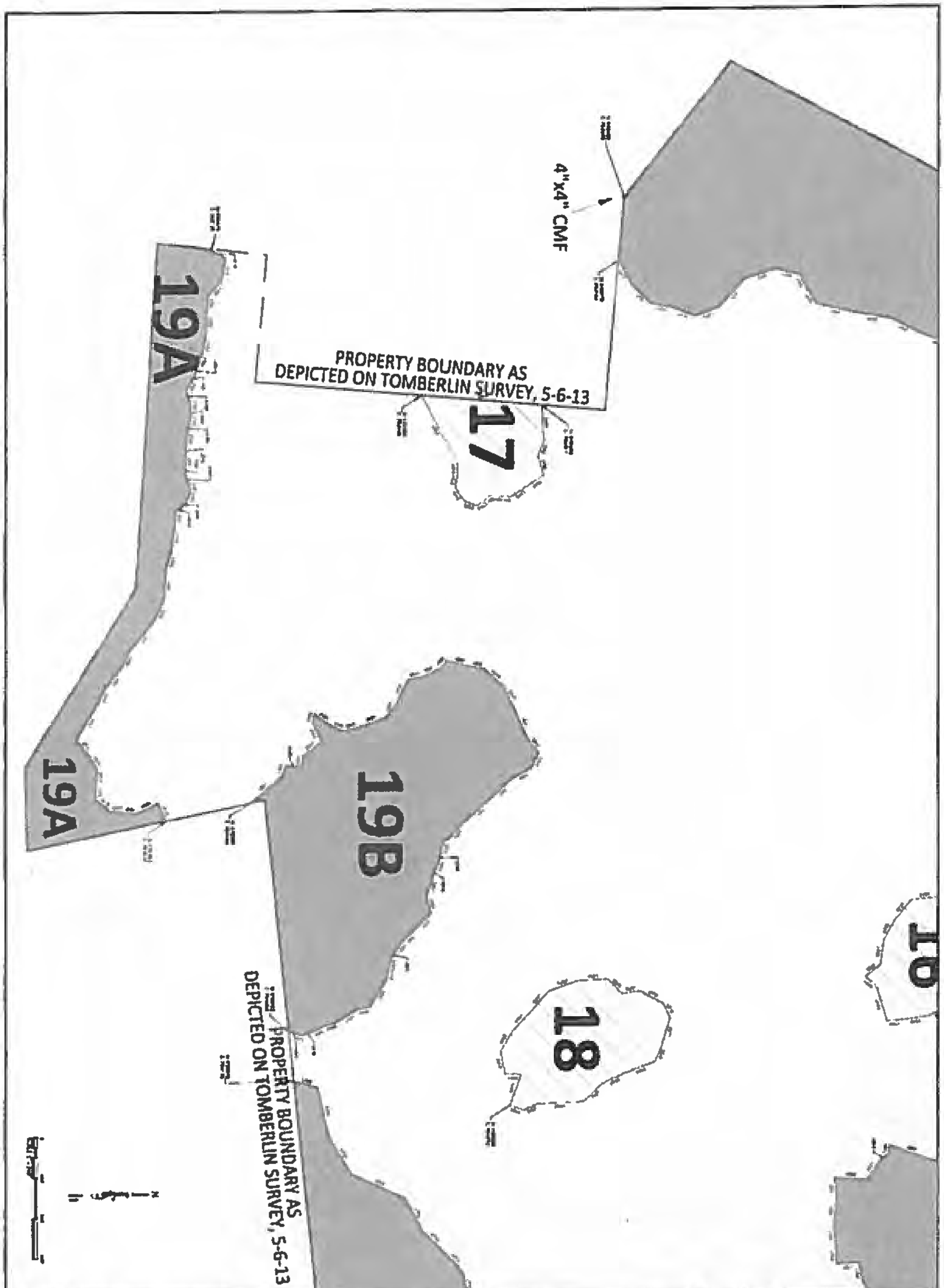
Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

WETLANDS BOUNDARY MAPPING

JORDAN



Sheet No.	Brantley County US Hwy 82 Wetlands Mapping Brantley County, Georgia	WETLANDS BOUNDARY MAPPING	JORDAN
6.0			

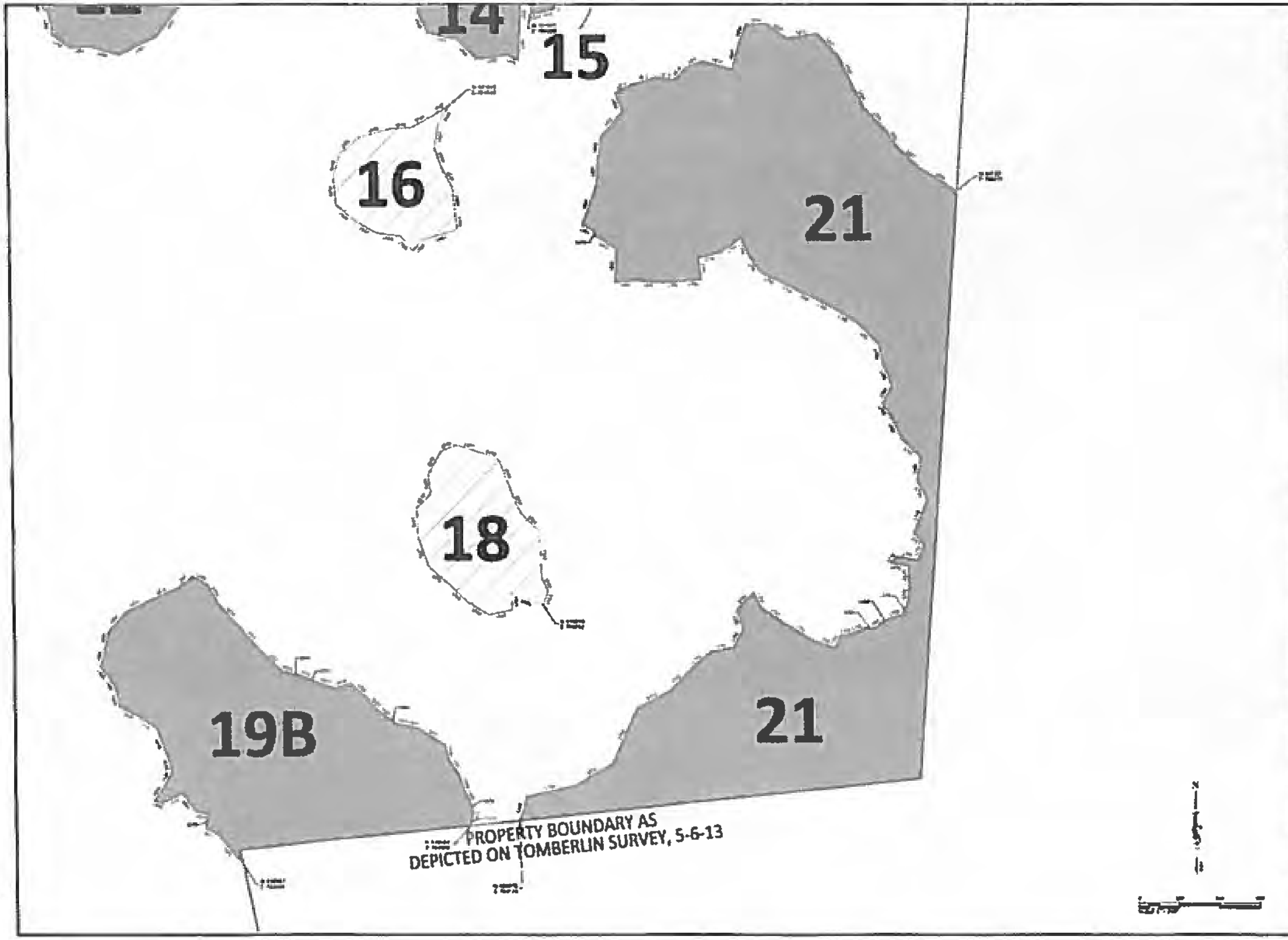


Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

WETLANDS BOUNDARY MAPPING

JORDAN

Sheet No.
7.0



JORDAN

WETLANDS BOUNDARY MAPPING

Brantley County US Hwy 82
Wetlands Mapping
Brantley County Georgia

Sheet No.
8.0

Sheet No.

9.0

Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

WETLANDS BOUNDARY
MAPPING
LINE SEGMENT TABLES

JORDAN

Appendix D
(Revised January 4, 2013)

EXPANDED PRELIMINARY JURISDICTIONAL DETERMINATION (JD) FORM

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR EXPANDED PRELIMINARY JD:

March 29, 2016

B. NAME AND ADDRESS OF PERSON REQUESTING EXPANDED PRELIMINARY JD:

Harbin Engineering c/o Mr. Steve Harbin 41 W. Johnston Street Forsyth, GA 31029

C. DISTRICT OFFICE, FILE NAME, AND NUMBER:

Savannah - Brantley County Developmental Partners, SAS-2015-00746

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE ATTACHED TABLE TO DOCUMENT MULTIPLE WATERBODIES AT DIFFERENT SITES)

State: GA County/parish/borough: Brantley City: Hortense
Center coordinates of site (lat/long in degree decimal format): Lat. 31.2190 , Long. -81.8203
Universal Transverse Mercator: NAD83
Name of nearest waterbody: Satilla River

Identify (estimate) amount of waters in the review area:
Non-wetland waters: linear feet: width (ft) and/or acres.
Cowardin Class:
Stream Flow:
Wetlands: 117.840(acres.
Cowardin Class: Forested

Name of any water bodies on the site that have been identified as Section 10 waters:
Tidal:
Non-Tidal:

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☑ Office (Desk) Determination. Date: April 26, 2016
☑ Field Determination. Date(s): November 20, 2015

1. The Corps of Engineers believes that there may be jurisdictional waters of the United States on the subject site, and the permit applicant or other affected party who requested this expanded preliminary JD is hereby advised of his or her option to request and obtain an approved jurisdictional determination (JD) for that site. Nevertheless, the permit applicant or other person who requested this expanded preliminary JD has declined to exercise the option to obtain an approved JD in this instance and at this time.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an approved JD for the activity, the permit applicant is hereby made aware of the following: (1) the permit applicant has elected to seek a permit authorization based on a expanded preliminary JD, which does not make an official determination of jurisdictional waters; (2) that the applicant has the option to request an approved JD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an approved JD could possibly result in less compensatory mitigation being required or different special conditions; (3) that the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) that the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) that undertaking any activity in reliance upon the subject permit authorization without requesting an approved JD constitutes the applicant's acceptance of the use of the expanded preliminary JD, but that either form of JD will be processed as soon as is practicable; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a expanded preliminary JD constitutes agreement that all wetlands and other water bodies on the site affected in any way by that activity are jurisdictional waters of the United States, and precludes any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7) whether the applicant elects to use either an approved JD or a expanded preliminary JD, that JD will be processed as soon as is practicable. Further, an approved JD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331, and that in any administrative appeal, jurisdictional

issues can be raised (see 33 C.F.R. 331.5(a)(2)). If, during that administrative appeal, it becomes necessary to make an official determination whether CWA jurisdiction exists over a site, or to provide an official delineation of jurisdictional waters on the site, the Corps will provide an approved JD to accomplish that result, as soon as is practicable. This expanded preliminary JD finds that there *"may be"* waters of the United States on the subject project site, and identifies all aquatic features on the site that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA. Data reviewed for expanded preliminary JD (check all that apply - checked items should be included in case file and, where checked and requested, appropriately reference sources below):

- [x] Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: Brantley County US Hwuy 82 Wetlands Mapping
  - [x] Survey Signed by Registered Land Surveyor
  - [ ] GPS Survey with GPS Datasheet
- [x] Data sheets prepared/submitted by or on behalf of the applicant/consultant.
- [x] Office concurs with data sheets/delineation report.
- [ ] Office does not concur with data sheets/delineation report.
- [ ] Data sheets prepared by the Corps: . Corps navigable waters' study:
- [ ] Geological Survey Hydrologic Atlas:
  - [ ] USGS NHD data.
  - [ ] USGS 8 and 12 digit HUC maps.
- [x] Geological Survey map(s). Cite scale & quad name: Figure 2: USGS Topographic Map
- [x] USDA Natural Resources Conservation Service Soil Survey. Citation: Figure 3: NRCS Soil Survey Map, Brantley County
- [x] National wetlands inventory map(s). Cite name: Figure 4: USFWS NWI Map
- [ ] State/Local wetland inventory map(s):
- [ ] FEMA/FIRM maps:
- [ ] 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
- [x] Photographs: [x] Aerial (Name & Date): Figure 6: Approximate Wetland Sketch (NAIP 2013 Aerial)
  - [x] Other (Name & Date): Wetland & Upland Vegetation/Soils Photos
- [ ] Previous determination(s). File no. and date of response letter:
- [x] Other information (please specify): Figure 5: LiDAR Digital Elevation Map

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

BLOCKER.SHAUN.L.1258532682 Digitally signed by BLOCKER.SHAUN.L.1258532682 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=BLOCKER.SHAUN.L.1258532682 Date: 2016.08.03 10:14:37 -04'00'

Signature and date of
Regulatory Project Manager
(REQUIRED)

Signature and date of
person requesting expanded preliminary JD
(REQUIRED, unless obtaining the signature is impracticable)

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD): February 18, 2016

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:
Savanah, Brantley County Developmental Partners, SAS-2015-00746

C. PROJECT LOCATION AND BACKGROUND INFORMATION:
State:Georgia County/parish/borough: Brantley City: near Hortense
Center coordinates of site (lat/long in degree decimal format): Lat. 31.219042° N, Long. -81.820281° E.
Universal Transverse Mercator: NAD83
Name of nearest waterbody: Satilla River
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: N/A
Name of watershed or Hydrologic Unit Code (HUC): 03070203 & 03070201
☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):
☒ Office (Desk) Determination. Date: April 26, 2016
☒ Field Determination. Date(s): November 20, 2015

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There Are no *"navigable waters of the U.S."* within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]
☐ Waters subject to the ebb and flow of the tide.
☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There Are no *"waters of the U.S."* within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
   ☐ TNWs, including territorial seas
   ☐ Wetlands adjacent to TNWs
   ☐ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
   ☐ Non-RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
   ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
   ☐ Impoundments of jurisdictional waters
   ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
   Non-wetland waters: linear feet: width (ft) and/or acres.
   Wetlands: acres.

   c. **Limits (boundaries) of jurisdiction** based on: **1987 Delineation Manual**
   Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   ☒ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: **The Isolated Wetlands 4, 5, 6, 8, 10, 13, 16, 17, and 18 within the Brantley County Development Parners, LLC tract are completely surrounded by uplands and do not contain surface or subsurface connections with jurisdictional wetlands; therefore they are considered isolated non-jurisdictional. (See Section IV.B for more information).**

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[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).
[3] Supporting documentation is presented in Section III F.

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: N/A.

   Summarize rationale supporting determination: N/A.

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": N/A.

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) **General Area Conditions:**
   Watershed size: Pick List
   Drainage area: Pick List
   Average annual rainfall: inches
   Average annual snowfall: inches

   (ii) **Physical Characteristics:**
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☐ Tributary flows through Pick List tributaries before entering TNW.

   Project waters are Pick List river miles from TNW.
   Project waters are Pick List river miles from RPW.
   Project waters are Pick List aerial (straight) miles from TNW.
   Project waters are Pick List aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain:

   Identify flow route to TNW[5]:
   Tributary stream order, if known:

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[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.
[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

(b) General Tributary Characteristics (check all that apply):

Tributary is: ☐ Natural
☐ Artificial (man-made). Explain: .
☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: feet
Average depth: feet
Average side slopes: Pick List.

Primary tributary substrate composition (check all that apply):
☐ Silts ☐ Sands ☐ Concrete
☐ Cobbles ☐ Gravel ☐ Muck
☐ Bedrock ☐ Vegetation. Type/% cover:
☐ Other. Explain: .

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: .
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: Pick List
Tributary gradient (approximate average slope): %

(c) Flow:
Tributary provides for: Pick List
Estimate average number of flow events in review area/year: Pick List
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: Pick List. Characteristics: .

Subsurface flow: Pick List. Explain findings: .
☐ Dye (or other) test performed: .

Tributary has (check all that apply):
☐ Bed and banks
☐ OHWM[6] (check all indicators that apply):
☐ clear, natural line impressed on the bank
☐ changes in the character of soil
☐ shelving
☐ vegetation matted down, bent, or absent
☐ leaf litter disturbed or washed away
☐ sediment deposition
☐ water staining
☐ other (list):
☐ the presence of litter and debris
☐ destruction of terrestrial vegetation
☐ the presence of wrack line
☐ sediment sorting
☐ scour
☐ multiple observed or predicted flow events
☐ abrupt change in plant community
☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):
☐ High Tide Line indicated by:
☐ oil or scum line along shore objects
☐ fine shell or debris deposits (foreshore)
☐ physical markings/characteristics
☐ tidal gauges
☐ other (list):
☐ Mean High Water Mark indicated by:
☐ survey to available datum;
☐ physical markings;
☐ vegetation lines/changes in vegetation types.

(iii) Chemical Characteristics:
Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: .
Identify specific pollutants, if known: .

[6]A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7]Ibid.

(iv) **Biological Characteristics. Channel supports (check all that apply):**

- ☐ Riparian corridor. Characteristics (type, average width): .
- ☐ Wetland fringe. Characteristics: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) **Physical Characteristics:**

(a) General Wetland Characteristics:

Properties:

Wetland size: acres

Wetland type. Explain: .

Wetland quality. Explain: .

Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:

Flow is: **Pick List**. Explain: .

Surface flow is: **Pick List**

Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .

☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:

- ☐ Directly abutting
- ☐ Not directly abutting
  - ☐ Discrete wetland hydrologic connection. Explain: .
  - ☐ Ecological connection. Explain: .
  - ☐ Separated by berm/barrier. Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **Pick List** river miles from TNW.

Project waters are **Pick List** aerial (straight) miles from TNW.

Flow is from: **Pick List**.

Estimate approximate location of wetland as within the **Pick List** floodplain.

(ii) **Chemical Characteristics:**

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .

Identify specific pollutants, if known: .

(iii) **Biological Characteristics. Wetland supports (check all that apply):**

- ☐ Riparian buffer. Characteristics (type, average width): .
- ☐ Vegetation type/percent cover. Explain: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **Pick List**

Approximately ( ) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)

Summarize overall biological, chemical and physical functions being performed: .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: N/A.

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: N/A.

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: N/A.

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   ☐ TNWs: linear feet width (ft), Or, acres.
   ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   ☐ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: .
   ☐ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
- ☐ Tributary waters: linear feet width (ft).
- ☐ Other non-wetland waters: acres.
  Identify type(s) of waters: .

3. **Non-RPWs[8] that flow directly or indirectly into TNWs.**
   ☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

   Provide estimates for jurisdictional waters within the review area (check all that apply):
   - ☐ Tributary waters: linear feet width (ft).
   - ☐ Other non-wetland waters: acres.
     Identify type(s) of waters: .

4. **Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.**
   ☐ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
   - ☐ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

   - ☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

   Provide acreage estimates for jurisdictional wetlands in the review area: acres.

5. **Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.**
   ☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

   Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. **Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.**
   ☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

   Provide estimates for jurisdictional wetlands in the review area: acres.

7. **Impoundments of jurisdictional waters.[9]**
   As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
   - ☐ Demonstrate that impoundment was created from "waters of the U.S.," or
   - ☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
   - ☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]

- ☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
- ☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
- ☐ which are or could be used for industrial purposes by industries in interstate commerce.
- ☐ Interstate isolated waters. Explain: .
- ☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

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[8] See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] **Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.***

Provide estimates for jurisdictional waters in the review area (check all that apply):
- [ ] Tributary waters: linear feet width (ft).
- [ ] Other non-wetland waters: acres.
  Identify type(s) of waters: .
- [ ] Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
- [ ] If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
- [x] Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
  - [x] Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
- [ ] Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
- [ ] Other: (explain, if not covered above): .

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
- [ ] Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
- [ ] Lakes/ponds: acres.
- [ ] Other non-wetland waters: acres. List type of aquatic resource: .
- [x] Wetlands: Wetlands 4=2.07 acres, Wetland 5=2.76 acres, Wetland 6=0.65 acres, Wetland 8=2.84 acres, Wetland 10=2.92, Wetland 13=0.57 acres, Wetland 16=1.55 acres, Wetland 17=1.26 acres, and Wetland 18= 2.05 acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
- [ ] Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
- [ ] Lakes/ponds: acres.
- [ ] Other non-wetland waters: acres. List type of aquatic resource: .
- [ ] Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
- [x] Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: .
- [x] Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  - [x] Office concurs with data sheets/delineation report.
  - [ ] Office does not concur with data sheets/delineation report.
- [ ] Data sheets prepared by the Corps: .
- [ ] Corps navigable waters' study: .
- [ ] U.S. Geological Survey Hydrologic Atlas: .
  - [ ] USGS NHD data.
  - [ ] USGS 8 and 12 digit HUC maps.
- [x] U.S. Geological Survey map(s). Cite scale & quad name: 1"=1400', Sterling & Darien Quadrangles.
- [x] USDA Natural Resources Conservation Service Soil Survey. Citation: USDA Camden County Soil Survey.
- [x] National wetlands inventory map(s). Cite name: National Wetlands Inventory Map. Tradewinds.
- [ ] State/Local wetland inventory map(s): .
- [x] FEMA/FIRM maps: Attachment from QPublic Branltey County Data.
- [ ] 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
- [x] Photographs: [x] Aerial (Name & Date): Wetland Sketch NAIP Aerial, 2013.
  or [x] Other (Name & Date): Photo Sheets, June & August 2015.
- [ ] Previous determination(s). File no. and date of response letter: .
- [ ] Applicable/supporting case law: .
- [ ] Applicable/supporting scientific literature: .
- [x] Other information (please specify): Figure 5 - LiDAR Elevation Map

B. ADDITIONAL COMMENTS TO SUPPORT JD:

Wetland 4 is 2.07 acres and located at 31.225861, -81.813148. The wetland is located approximately 925 feet from the nearest jurisdictional water, 3.1 miles from the nearest TNW (Satilla River), and 2.6 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found between the wetland and other jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 4, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the Wetland 4 and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland.

Wetland 5 is 2.76 acres and located at 31.223684, -81.815033. The wetland is located approximately 825 feet from the nearest jurisdictional water and approximately 3.0 miles from the nearest TNW (Satilla River), and 2.5 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found between the wetland and other jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 5, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the Wetland 5 and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland.

Wetland 6 is 0.65 acres and located at 31.223971, -81.811615. The wetland is located approximately 630 feet from the nearest jurisdictional water and approximately 3.2 miles from the nearest TNW (Satilla River), and 2.7 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found to run downhill to any other wetland or jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 6, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland.

Wetland 8 is 2.84 acres and located at 31.226096, -81.80374. The wetland is located approximately 600 feet from the nearest jurisdictional water and approximately 3.7 miles from the nearest TNW (Satilla River), and 2.9 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found to run downhill to any other wetland or jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 8, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland.

Wetland 10 is 2.92 acres and located at 31.219647, -81.819402. The wetland is located approximately 500 feet from the nearest jurisdictional water and approximately 2.9 miles from the nearest TNW (Satilla River), and 2.1 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found between the wetland and other jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 10, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland.

Wetland 13 is 0.57 acres and located at 31.21531, -81.821964. The wetland is located approximately 550 feet from the nearest jurisdictional water and approximately 2.4 miles from the nearest TNW (Satilla River), and 1.9 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found to run downhill to any other wetland or jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 13, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland.

Wetland 16 is 1.55 acres and located at 31.31.21288, -81.822015. The wetland is located approximately 500 feet from the nearest jurisdictional water and approximately 2.4 miles from the nearest TNW (Satilla River), and 1.9 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found to run downhill to any other wetland or jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 16, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland

Wetland 17 is 1.26 acres and located at 31.20982, -81.826018. The wetland is located approximately 650 feet from the nearest jurisdictional water and approximately 2.1 miles from the nearest TNW (Satilla River), and 1.6 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found to run downhill to any other wetland or jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 17, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland

Wetland 18 is 2.05 acres and located at 31.21045, -81.8214. The wetland is located approximately 350 feet from the nearest jurisdictional water and approximately 2.4 miles from the nearest TNW (Satilla River), and 1.9 miles from the 100-Year Floodplain. During the field visit, no surface connections, such as ditches, swales, and other connections, were found to run downhill to any other wetland or jurisdictional waters. As depicted in the attached LiDAR and topographic maps, the uplands that surround Wetland 18, are higher in elevation than the surface elevation of the wetland. In addition, these maps also show that there is no depressional surface feature between the isolated wetland and nearest jurisdictional wetland, prohibiting the flow of water after events like heavy rainfall. The upland soils between the isolated wetland and jurisdictional wetland has a texture of sand, allowing for percolation of water. Based on observed site conditions and soil permeability, it appears that any subsuface flow would occur from the upland into the wetland

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: Mr. John Kelly and Mr. C. Lee Wooddall – Brantley County Development Partners, LLC	File Number: SAS-2015-00746	Date: May 3, 2016

	Attached is:	See Section below
	INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)	A
	PROFFERED PERMIT (Standard Permit or Letter of permission)	B
	PERMIT DENIAL	C
X	APPROVED JURISDICTIONAL DETERMINATION	D
X	PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/CECW/Pages/reg_materials.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit.

ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.

APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. The division engineer must receive this form within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact: Mr. Shaun Blocker U.S. Army Corps of Engineers, Savannah District 100 W. Oglethorpe Avenue Savannah, Georgia 31401-3604 912-652-5086	If you only have questions regarding the appeal process you may also contact: Administrative Appeal Review Officer CESAD-PDS-O U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15-day notice of any site investigation, and will have the opportunity to participate in all site investigations.

_______________________ Signature of appellant or agent.	Date:	Telephone number:

Habitat Assessment for Threatened & Endangered Species Report

Brantley County Development Partners, LLC

Habitat Assessment for Threatened and Endangered Species
Brantley County Developmental Partners, LLC
Brantley County, Georgia

I. INTRODUCTION

A. Purpose

Environmental Services, Inc., (ESI) was contracted to perform a due diligence assessment for protected species and habitat essential to these species within the ±487-acre site in Brantley County, Georgia (Figure 1). The primary purpose of the assessment was to determine whether habitat suitable for any species currently listed or proposed for listing as endangered or threatened by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), or Georgia Department of Natural Resources (GADNR) was present on or near the property. Given that protected species may not be present or observed during our field investigations, observations were made for the habitats that exist in attempt to determine if listed species could utilize the site during other times of the year.

B. Project Location

The ±487-acre property is located adjacent and south of Highway 82, approximately 10 miles northeast of Nahunta, Brantley County, Georgia (Figure 1). Coordinates for the approximate center of the site are Latitude 31.219042 and Longitude -81.820281. The property is currently accessed from Highway 82 and from several dirt roads that traverse the site.

II. SITE OVERVIEW

A. Existing Conditions and Habitats

ESI personnel conducted vehicular and pedestrian assessments within the above-referenced tract between the months of June through October 2015. Three general habitats were found on the property, which were pine plantation upland, early successional scrub/shrub upland, and hardwood/pine wetland. These areas were identified and delineated by ESI to assist in determining the potential for habitation by any listed species. The following habitats, along with the associated flora, were observed on the property.

Pine Plantation Uplands

As shown on the attached *Approximate Habitat Type* (Figure 3) approximately 99-acres of the ±487-acre (20%) parcel is characterized as pine plantation uplands. The pine plantation uplands are mostly located in the northern panhandle of the property, adjacent to Highway 82, with the exception of the 3-acre area located in the southern section. The upland plant communities are dominated by pine flats, planted pine stands of various ages, and areas of mixed pine/hardwood. The upland vegetation community within the pine plantation uplands consist mostly of loblolly pine (*Pinus taeda*), a few live oaks *(Quercus virginiana)*, Water oaks (*Q. nigra*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), wax myrtle (*Myrica cerifera*), saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), and bracken fern (*Pteridium aquilinum*).

Early Successional Scrub/Shrub Uplands

Approximately 254-acres of the ±487-acre (52%) parcel displays characteristics of an early successional scrub/shrub habitat. These areas appear to have been taken out of silvicultural rotation following the last clear-cut, as is evident from the lack of planted and/or bedded young pines. These areas lack a mature over-story, but are are dominated by 4-15 foot mid-story of trees consisting of red bay (*Persea borbonia*), loblolly pine, gallberry, coastal sweet-pepperbush (*Clethra alnifolia*), sweet gum, blueberry (*Vaccinium sp.*), and wax myrtle. The ground cover consists of saw palmetto, honeysuckle (*Lonicera japonica*), muscadine (*Vitis rotundifolia*), and bracken fern.

Hardwood/Pine Wetlands

As illustrated on Figure 3, approximately ±134-acres of the ±487-acre (28%) parcel consist of what would be considered jurisdictional freshwater wetlands. These wetland systems within the project study area are generally forested, located on hydric soils, and are seasonally flooded. The dominant vegetation in these systems consist of sweetgum, red maple, black gum (*Nyssa biflora*), bald cypress (*Taxodium distichum*), sweet bay (*Magnolia virginiana*), little-leaf Titi (*Cyrilla racemiflora*), water oak (*Quercus nigra*), gallberry, myrtle dahoon (*Ilex myrtifolia*), coastal sweet-pepperbush, netted chain-fern (*Woodwardia areolata*), Virginia chain-fern (*Woodwardia virginiana*), and cinnamon fern (*Osmunda cinnamomea*). As illustrated on Figure 3 and verified by the 5 May 2016 Jurisdictional Determination, ±117.84-acres of these wetlands may be considered jurisdictional wetlands. The remaining ±16.67-acres of wetland habitat are considered to be isolated non-jurisdictional wetlands. Both types of wetlands have similar vegetation communities, only differing in their geomorphic positions or connectivity to other jurisdictional features.

III. ASSESSMENT METHODOLOGY

This section describes the methodologies used to determine the presence or likelihood for occurrence of listed species within the project site. This includes a review of existing literature, coordination with wildlife regulatory agencies, and field assessment of habitat types.

A. Field Studies

The habitat assessment conducted by ESI staff consisted of vehicular and pedestrian surveys at representative locations across the property to identify available habitat types. Major community types were identified and observations concerning dominant vegetation, condition, and habitat quality were noted during the investigation. In general, all wetland and upland areas within the project study area were investigated.

B. Literature Review and Agency Coordination

In addition to our field investigations and subsequent review of available printed material for current listed species (See Appendix A for IPaC), we also provided notice of our investigation to USFWS, NMFS, and GADNR. Through these notifications, we requested that the agencies provide us with any information regarding the known presence of any listed endangered / threatened species on or within the vicinity of the project area. Appendix B contains copies of the wildlife regulatory agency coordination letters and specific responses from NMFS, USFWS and GADNR.

IV. LISTED SPECIES

For the purposes of this report, it should be noted that protection of listed species is provided by the Endangered Species Act for both private and public lands, regardless of permitting needs. For species listed by the State of Georgia as rare, unusual, or in danger of extinction under the Endangered Wildlife Act, the state's jurisdiction is limited to the capture, killing, selling, and protection of suitable habitat of protected species on public land. For plants listed by the state as rare, unusual, or in danger of extinction under the Wildflower Preservation Act, jurisdiction is also limited to those species found on public land. Species of Management Concern (SMC) are not being evaluated within this report, but were identified by GADNR in their response letter (Appendix B). These SMC include the Common Rainbow Snake (*Farancia erytrogramma ertrogramma*), Serviceberry Holly (*Ilex amelanchier*), Pineland Plaintain (*Plantago spariflora*), and Bartman's Air-Plant *(Tillandsia bartramii*). These SMC have no federal or state listing, so are therefore not legally protected, but are worthy to note because they have potential to be listed in the future. Another species that does not have federal protection, but was identified in the USFWS response letter to be considered rare by GADNR (Appendix B), was the Rafinesque's big-eared bat (*Plecotus rafinesquii*).

Listed species that are federally and/or state classified as Threatened or Endangered that have a documented range encompassing Brantley County are compiled in the following **Table 1**. Several of the species listed as potentially occurring in Brantley County are not anticipated to occur within the project site due to habitat requirements and distribution. Species identified to occupy habitats similar to those found on or near the project site are listed below **Table 2**, along with a brief description and statement about their potential for occurrence

Table 1. Listed Species for Brantley County, Georgia. (GADNR List Updated December 2014)

Species	Federal Status	State Status	Habitat	Threats
Bird				
Wood stork *Mycteria americana*	T	E	Primarily feed in fresh and brackish wetlands and nest in cypress or other wooded swamps.	Decline due primarily to loss of suitable feeding habitat, particularly in south Florida. Other factors include loss of nesting habitat, prolonged drought/flooding, raccoon predation on nests, and human disturbance of rookeries.

Red-cockaded woodpecker *Picoides borealis*	E	E	Needs large areas of open and mature forests, particularly consisting of longleaf pine, slash pine, or loblolly pine. Trees selected for cavities must be mature living pines and often times are infected with the red heart fungus.	The main threat has been due to destruction, fragmentation, and degradation of previously existing vast areas of mature pine forests. In addition, most private land practices, such as clearing or agriculture, are incompatible with the success of the species.
Reptile				
Eastern indigo snake *Drymarchon corais couperi*	T	T	During winter, den in xeric sandridge habitat preferred by gopher tortoises; during warm months, forage in creek bottoms, upland forests, and agricultural fields	Habitat loss due to uses such as farming, construction, forestry, and pasture and to overcollecting for the pet trade
Gopher tortoise *Gopherus polyphemus*	Candidate	T	Well-drained, sandy soils in forest and grassy areas; associated with pine overstory, open understory with grass and forb groundcover, and sunny areas for nesting	Habitat loss and conversion to closed canopy forests. Other threats include mortality on highways and the collection of tortoises for pets.
Plant				
Hairy rattleweed *Baptisia arachnifera*	E	E	Sandy soils in open pine flatwoods, intensively managed slash pine plantations, and along road and powerline right-of-ways	Clearcutting of pines for timber, followed by intensive site preparation (chopping and bedding with heavy machinery)

Table 2. Species with Common Habitats as is Present on the Property.

Species	Federal Status	State Status	Potential Habitat Present	Project Potential for Impacts	Biological Conclusion
Bird					
Wood stork *Mycteria americana*	T	E	Yes	Low[1]	May Affect – Not Likely to Adversely Affect
Red cockaded woodpecker *Picoides borealis*	E	E	No	None	No Effect
Reptile					
Eastern indigo snake *Drymarchon corais couperi*	T	T	Yes	Low[1]	May Affect – Not Likely to Adversely Affect
Gopher tortoise *Gopherus polyphemus*	Candidate	T	No	None	No Effect
Plant					
Hairy rattleweed *Baptisia arachnifera*	E	E	Yes	Low[1]	May Affect – Not Likely to Adversely Affect

[1] Low was assigned to all those species that could not be completely eliminated as being potentially utilizing the property in some regard. In this case all of these species were assigned a Biological Conclusion of May Affect – Not Likely to Adversely Affect.

A. Animals

<u>Wood stork</u> (*Mycteria americana*)

The State and Federally Endangered wood stork occupies swamps and wetlands, usually nesting in cypress or mangrove swamps and feeding in freshwater or brackish wetlands (Bentzien 1986). Wood storks are large long-legged wading birds that feed on small fish. The potential for sporadic roosting habitation exists throughout coastal Georgia.

Habitat Present: YES

No wood storks or evidence thereof was observed during the habitat evaluation or the wetland delineation that was conducted on the property. Suitable foraging habitat that has an adequate hydrologic regime does exist within the project site. This is primarily due to the generic habitat description used for the wood stork that, in essence, rarely allows for a no effect determination for this species throughout its range in coastal Georgia. The responses from both the USFWS and the GADNR do not indicate known wood stork rookeries on the property or within 3 miles of the property. Since USFWS indicated that the project is within a 13-mile core foraging area for two wood stork rookies, wood storks could use the property for roosting or for foraging purposes (Figure 3). However, given the fact that this site does not offer any unique habitat for this species, the likelihood of the project negatively affecting this species is low.

<u>Red-cockaded woodpecker (RCW)</u> (*Picoides borealis*)

This state and federally endangered woodpecker inhabits old growth, open pine forests, and makes its cavities in live pine trees of sufficient age to produce heartwood, a sapless component in the bole of the tree. The preferred nesting habitat is old-growth pine trees that are 60 years or older with a relatively thin understory. Additionally, the birds' preferred foraging habitat is in pines older than 30 years of age, where they can occupy a foraging range of over 100-acres (Lennartz and Henry 1985, Henry 1989). The potential for foraging habitat exists throughout coastal Georgia.

Habitat Present: NO

No known occurrences of RCWs have been documented within the project and no cavity trees were visually observed by ESI personnel during the extensive field work conducted on the property. There are no pine or pine/hardwood stands that meet the above defined age criteria for roosting habitat of 60 years or greater. There are pine stands on site that meet the age criteria for foraging habitat of pines older than 30 years of age, but given the site or the surrounding areas do not offer any roosting habitat, the likelihood of this project affecting the species is very low. In addition, most of the pine areas on this site are excluded as potentially suitable habitat due to the intensive management that has occurred over the years for silvicultural purposes.

<u>Eastern indigo snake</u> (*Drymarchon corais couperi*)

The indigo snake is federally listed as threatened and seems to be strongly associated with high, dry, well-drained sandy soils, closely paralleling the sandhill habitat preferred by the gopher tortoise. During warmer months, indigos also frequent streams and swamps, and individuals are occasionally found in flatwoods. Gopher tortoise burrows and other subterranean cavities are commonly used as dens and for egg laying. The eastern indigo snake is a large, docile, non-poisonous snake growing to a maximum length of about 8 feet. The color in both young and adults is shiny bluish-black, including the belly, with some red or cream coloring about the chin and sides of the head.

Habitat Present: YES

No eastern indigo snakes or evidence thereof was observed within the project site. Potentially suitable habitat, consisting of well-drained sandy areas, does not exist within the project site. The project site inclusive of the uplands, does not exhibit excessively or well-drained sandy soils. Additionally, due to the altered nature of the site from past silvicultural activities as well as the prevalence of a dense shrub understory throughout most of the site, use of these areas by the gopher tortoises is unlikely. The lack of gopher tortoise burrows within the site further decreases the probability for occurrence of this species to low. However, given the summer habitat description including swamps, which are present on the property, completely excluding this species is not possible. Furthermore, as stated in the attached GADNR letter (Appendix B), there is a known occurrence of this species within three miles of the project site (Figure 3). The eastern indigo snake could use the property's wetland areas during the summer months; however, given the fact that this site does not offer any unique habitat for this species and the primary preferred habitat is not present, the likelihood of the project negatively affecting this species is low.

<u>Gopher tortoise</u> (*Gopherus polyphemus*)

This species is federally listed as a candidate species and state listed Threatened species. The gopher tortoise typically occurs in well drained, sandy soils in relatively open grassy areas with a sparse pine overstory. Gopher tortoises dig burrows, typically ranging in size from 20 to 30 feet long and from six to eight feet deep, with their shovel-like front legs. The burrows are found in dry places such as sandhills, flatwoods, prairies and coastal dunes or in human-made environments such as pastures, grassy roadsides and old fields. The gopher tortoise is a keystone species, meaning its extinction would result in measurable changes to the ecosystem in which it occurs. Specifically, other animals, such as gopher frogs, several species of snakes and several small mammals, depend on tortoise burrows. For the gopher tortoise to thrive, the animal generally needs three things: well-drained sandy soil (for digging burrows), plenty of low plant growth (for food) and open, sunny areas (for nesting and basking).

Habitat Present: NO

No known occurrences of the gopher tortoise have been documented within the project or were visually observed by ESI personnel during the extensive field work conducted on the property. Potentially suitable habitats, consisting of well-drained sandy areas, do not exist within the project site. The project site inclusive of the uplands, does not exhibit excessively or well-drained sandy soils. Additionally, due to the altered nature of the site from past silvicultural activities as well as the prevalence of a hindering shrub understory throughout most of the site, use of these areas by gopher tortoises is unlikely. No burrows or individuals were found and no evidence of activity was observed. This project should not affect habitats commonly utilized by gopher tortoise populations.

B. Plants

<u>Hairy rattleweed</u> (*Baptisia arachnifera*)

Hairy rattleweed is a Federal and State Endangered Species occurring in Wayne and Brantley

County. It is found in sandy soils in open pine flatwoods, intensively managed slash pine plantations, and along road and powerline right-of-ways.

Habitat Present: YES

Hairy rattleweed was not observed within the project study area during the habitat assessment and the wetland delineation efforts. All of the potential habitat areas within the project site were surveyed, however a species specific systematic survey was not conducted. If a species specific survey were to be conducted, the recommended time-frame, according to the GADNR, is when the plant flowers between June-August, or when it is fruiting between August-October. Both of these recommended time-frames fall under the time period when most of the field work was conducted; therefore presence of Hairy Rattleweed would have most likely been observed. Even disregarding the fact that the survey was conducted during the preferred timeframe, since the hairy stems and leaves are distinction throughout the growing season, probability of detection would have been considerably high.

Most of the uplands on this site are excluded as potentially suitable habitat due to the silvicultural practices occurring up until recently, including intensively managed pine stands and very recent site prep methods of aggressive drum chopping, bedding, and planting. Some areas on site that could be considered potentially habitat for this species include pine plantation areas that were not recently harvested, all of the trail road margins, and portions of the upland/wetland transition that are pine/hardwood.

Although the entirety of the project boundary exists within the GADNR designated “Possible Hairy Rattleweed Range”, there is only one known population of this species that exists in the United States (Figure 3). This known population is located within eight miles of the project site, as stated in the USFWS letter (Appendix B), but does not extend anywhere that would be considered close to the project site.

V. CRITICAL HABITAT

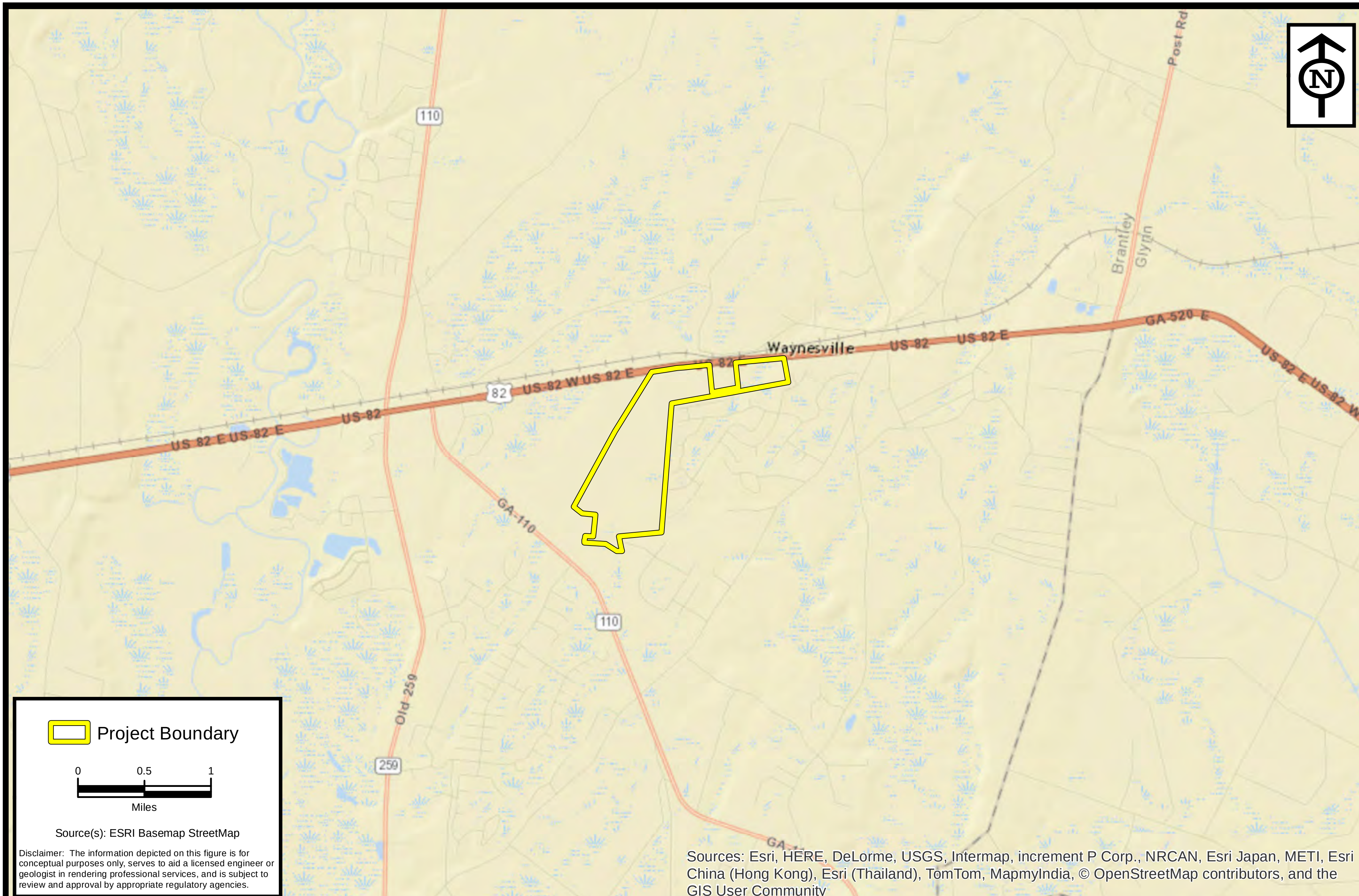
The project site was reviewed for the presence of areas designated as critical habitat for protected species by the USFWS. "Critical habitat" is a term in the Endangered Species Act referring to specific areas that contain physical or biological features essential to the conservation of a threatened or endangered species. No species with associated critical habitat designations are documented to have a range encompassing Brantley County (see attached USFWS IPaC, Appendix A). This includes the hairy rattleweed, which has not had any critical habitat rules published. Therefore, areas designated as critical habitat for listed species will not be affected by the proposed project and no designated critical habitat exists within the site.

VI. CONCLUSION

Based on visual surveys of the property, document search, and knowledge of the habitat ranges of threatened and endangered species in this area, it is the *opinion* of ESI that the potential for any of the listed species to occur within the potential impact area is either low or very low. No listed endangered or threatened species were observed during the field investigation.

Potentially suitable habitat for federally protected species is present for the wood stork, eastern indigo snake, and hairy rattleweed. This determination is primarily based upon the extremely broad habitat descriptions favored by these species, which thereby precludes ESI from eliminating some areas as potential habitat. No protected species or evidence thereof was noted by ESI during the habitat evaluation or wetland delineation field assessments. In addition, both GADNR and NOAA state that there are no records of any listed species within the project area (Appendix B). In the attached letter dated 7 October 2015, USFWS mentions the occurrence of Hairy Rattleweed, wood storks, Rafinesque's big-eared bat, and the eastern indigo snake greater than 3 miles away from the project site; however they do not mention known occurrences of any listed species within the project limits. (Appendix B). Please remain aware that although the potentially suitable habitat for the species discussed is either low or very low, we cannot guarantee that listed species would not nor could not use this site currently or in the future.

Figures



Project Boundary

0 0.5 1

Miles

Source(s): ESRI Basemap StreetMap

Disclaimer: The information depicted on this figure is for conceptual purposes only, serves to aid a licensed engineer or geologist in rendering professional services, and is subject to review and approval by appropriate regulatory agencies.

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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(912) 236-4711
(912) 236-3668 Fax
www.environmentalservicesinc.com

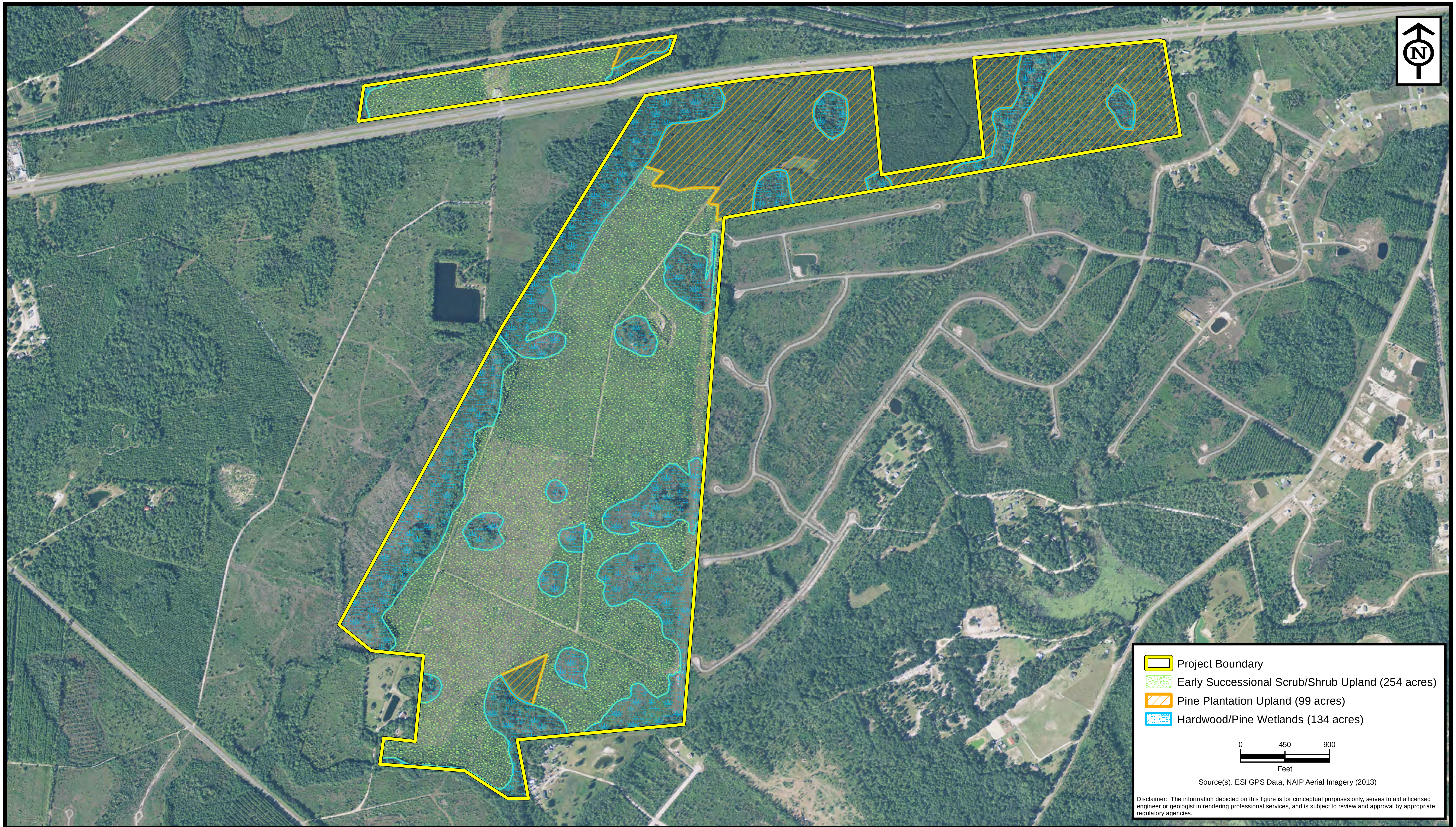
Vicinity

Brantley County Development Partners, LLC

Brantley County, Georgia

Project:	ES14020.01
Date:	Sep. 2015
Drwn/Chkd:	KHS/MJD
Figure:	1

File: P:\Projects\Graphics\2014\ES14020.01\figures\ECO\Vicinity.mxd Date: 9/18/2015 9:40:39 AM



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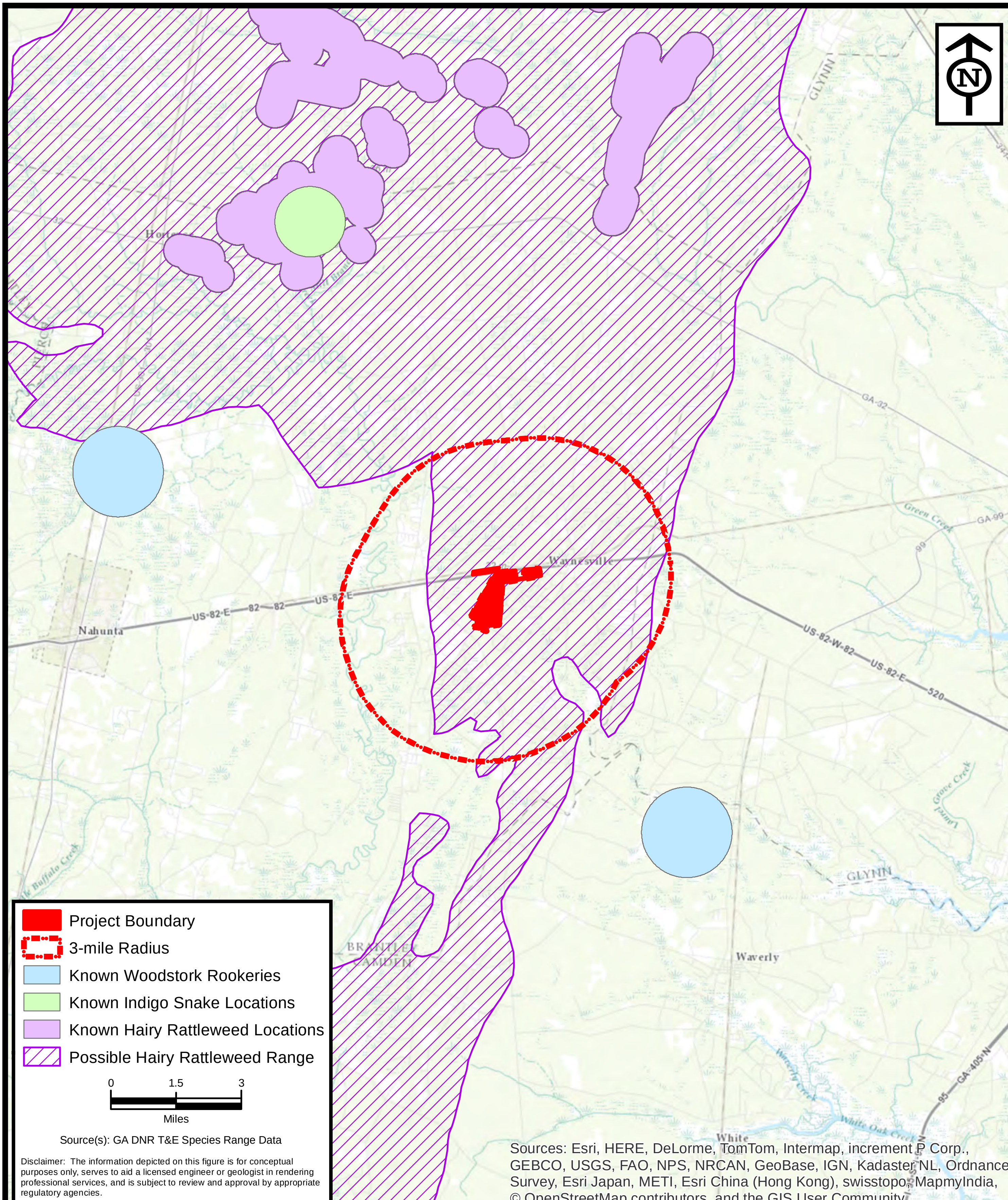
Approximate Habitat Type

Brantley County Development Partners, LLC

Brantley County, Georgia

Project:	ES14020.01
Date:	Oct. 2015
Drwn/Chkd:	KHS/MJD
Figure:	2



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Threatened and Endangered Species
Known Locations & Possible Ranges Map

Brantley County Development Partners, LLC

Brantley County, Georgia

Project:	ES14020.01
Date:	Oct. 2015
Drwn/Chkd:	KHS/MJD
Figure:	3

File: P:\Projects\Graphics\2014\ES14020.01\figures\ECO\KnownT&E_Map.mxd Date: 4/4/2016 3:55:30 PM

Appendix A

IPaC Trust Resource Report

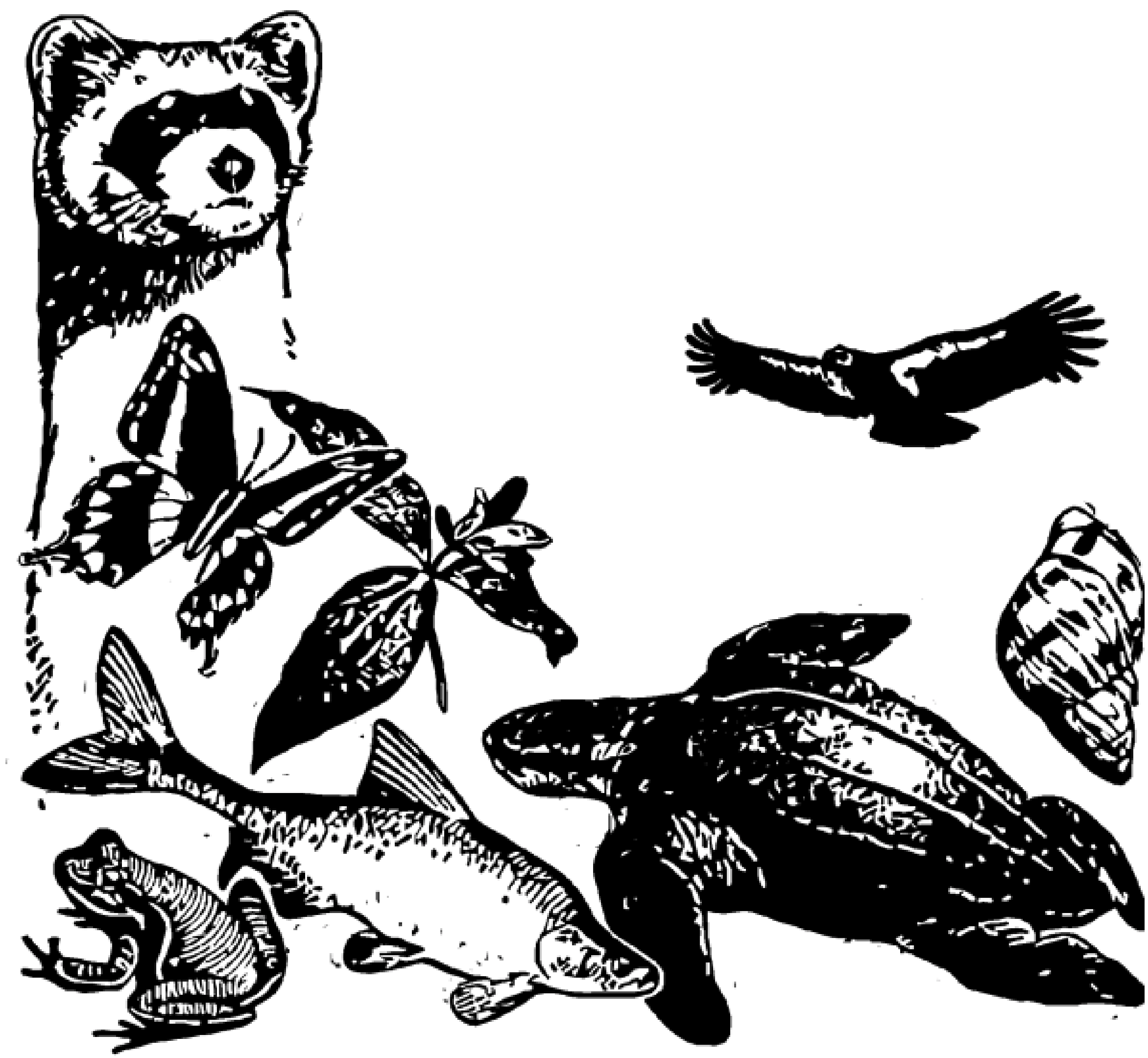
U.S. Fish & Wildlife Service

Brantley County Development Partners, LLC

IPaC Trust Resource Report

Generated September 28, 2015 02:46 PM MDT

This report is for informational purposes only and should not be used for planning or analyzing project-level impacts. For projects that require FWS review, please return to this project on the IPaC website and request an official species list from the Regulatory Documents page.



US Fish & Wildlife Service

IPaC Trust Resource Report

Project Description

NAME

Brantley County Development Partners, LLC

PROJECT CODE

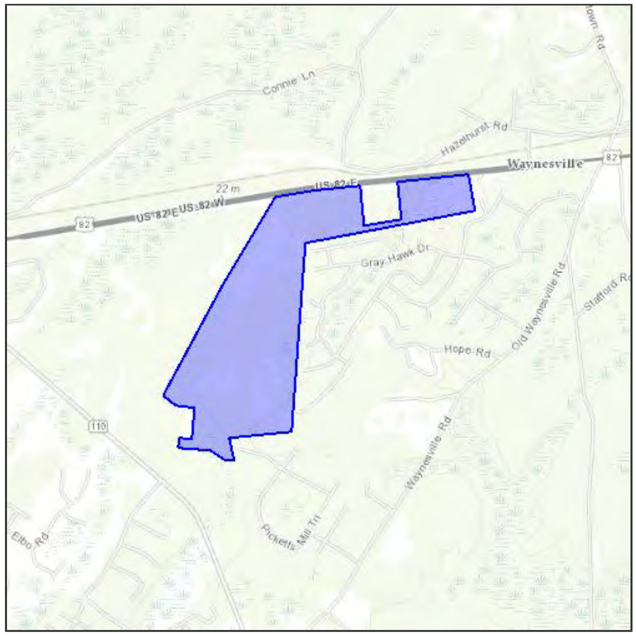
IH4IB-RRZFZ-AYDOO-3AZJ4-N3CSL4

LOCATION

Brantley County, Georgia

DESCRIPTION

No description provided



U.S. Fish & Wildlife Contact Information

Species in this report are managed by:

Georgia Ecological Services Field Office
105 Westpark Drive
WESTPARK CENTER SUITE D
Athens, GA 30606-3175
(706) 613-9493

Endangered Species

Proposed, candidate, threatened, and endangered species that are managed by the Endangered Species Program and should be considered as part of an effect analysis for this project.

This unofficial species list is for informational purposes only and does not fulfill the requirements under Section 7 of the Endangered Species Act, which states that Federal agencies are required to "request of the Secretary of Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action." This requirement applies to projects which are conducted, permitted or licensed by any Federal agency.

A letter from the local office and a species list which fulfills this requirement can be obtained by returning to this project on the IPaC website and requesting an official species list on the Regulatory Documents page.

Birds

Red-cockaded Woodpecker Picoides borealis — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B04F

Wood Stork Mycteria americana — Threatened

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B06O

Flowering Plants

Hairy Rattleweed Baptisia arachnifera — Endangered

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=Q1TD

Reptiles

Eastern Indigo Snake Drymarchon corais couperi — Threatened

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C026

Gopher Tortoise Gopherus polyphemus — Candidate

CRITICAL HABITAT
No critical habitat has been designated for this species.

https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=C044

Critical Habitats

Potential effects to critical habitat(s) within the project area must be analyzed along with the endangered species themselves.

There is no critical habitat within this project area

Migratory Birds

Birds are protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Any activity which results in the take of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service (1). There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured.

You are responsible for complying with the appropriate regulations for the protection of birds as part of this project. This involves analyzing potential impacts and implementing appropriate conservation measures for all project activities.

American Kestrel Falco sparverius paulus — Bird of conservation concern
Year-round

American Oystercatcher Haematopus palliatus — Bird of conservation concern
Year-round
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0G8

American Bittern Botaurus lentiginosus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0F3

Bachman's Sparrow Aimophila aestivalis — Bird of conservation concern
Year-round
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B07F

Bald Eagle Haliaeetus leucocephalus — Bird of conservation concern
Year-round
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B008

Black Rail Laterallus jamaicensis — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B09A

Brown-headed Nuthatch Sitta pusilla — Bird of conservation concern
Year-round

Chuck-will's-widow Caprimulgus carolinensis — Bird of conservation concern
Season: Breeding

Common Ground-dove Columbina passerina exigua — Bird of conservation concern
Year-round

Fox Sparrow Passerella iliaca — Bird of conservation concern
Season: Wintering

Henslow's Sparrow Ammodramus henslowii — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B09D

Le Conte's Sparrow Ammodramus leconteii — Bird of conservation concern
Season: Wintering

Least Bittern Ixobrychus exilis — Bird of conservation concern
Season: Breeding

Lesser Yellowlegs Tringa flavipes — Bird of conservation concern
Season: Wintering

Loggerhead Shrike Lanius ludovicianus — Bird of conservation concern
Year-round
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0FY

Marbled Godwit Limosa fedoa — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0JL

Mississippi Kite Ictinia mississippiensis — Bird of conservation concern
Season: Breeding

Peregrine Falcon Falco peregrinus — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0FU

Prairie Warbler Dendroica discolor — Bird of conservation concern
Season: Breeding

Prothonotary Warbler Protonotaria citrea — Bird of conservation concern
Season: Breeding

Red Knot Calidris canutus rufa — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0DM

Red-headed Woodpecker Melanerpes erythrocephalus — Bird of conservation concern
Year-round

Rusty Blackbird Euphagus carolinus — Bird of conservation concern
Season: Wintering

Saltmarsh Sparrow Ammodramus caudacutus — Bird of conservation concern
Season: Wintering

Seaside Sparrow Ammodramus maritimus — Bird of conservation concern
Year-round

Sedge Wren Cistothorus platensis — Bird of conservation concern
Season: Wintering

Short-billed Dowitcher Limnodromus griseus — Bird of conservation concern
Season: Wintering

Swainson's Warbler Limnothlypis swainsonii — Bird of conservation concern
Season: Breeding

Swallow-tailed Kite Elanoides forficatus — Bird of conservation concern
Season: Breeding
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0GB

Wood Thrush Hylocichla mustelina — Bird of conservation concern
Season: Breeding

Worm Eating Warbler Helmitheros vermivorum — Bird of conservation concern
Season: Migrating

Yellow Rail Coturnicops noveboracensis — Bird of conservation concern
Season: Wintering
https://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0JG

Refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. If your project overlaps or otherwise impacts a Refuge, please contact that Refuge to discuss the authorization process.

There are no refuges within this project area

Wetlands

Impacts to NWI wetlands and other aquatic habitats from your project may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes.

Project proponents should discuss the relationship of these requirements to their project with the Regulatory Program of the appropriate U.S. Army Corps of Engineers District.

DATA LIMITATIONS

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

DATA EXCLUSIONS

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

DATA PRECAUTIONS

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

There are no wetlands identified in this project area

Appendix B

Agency Correspondence Letters

ENVIRONMENTAL SERVICES, INC.
P.O. Box 2383
Savannah, GA 31402

Phone 912-236-4711 * Fax 912-236-3668

www.environmentalservicesinc.com

28 September 2015

Ms. Anna Yellin
Georgia Department of Natural Resources
Environmental Review Coordinator, Nongame Conservation Section
2065 US Hwy 278 SE
Social Circle, Georgia 30025

RE: Request for Known Occurrences of Endangered or Threatened Species:
Brantley County Developing Partners E&T Habitat Assessment
Brantley County, Georgia
ESI Project No.: ES14020.01 Lat.: 31.219042 Long: 81.82081

Dear Ms. Yellin:

Environmental Services, Inc., (ESI), as an authorized agent for Harbin Engineering, is currently conducting an endangered species habitat assessment for the above referenced property and we hereby request coordination with your agency. We are currently reviewing the list of Federal Endangered and Threatened Species and State of Georgia Endangered and Threatened Species for Brantley County. Through this notification we respectfully request that you review your files and provide ESI with any information regarding the known presence of any endangered or threatened species on or in the vicinity of the proposed project area (Figures 1-5, attached).

Please submit this information to ESI at the address shown at the top of this letter. Should you have any questions regarding this project, please do not hesitate to call me at (912) 236-4711.

Sincerely,
ENVIRONMENTAL SERVICES, INC.

Michael J. DeMell
Senior Vice President II/ Technical Director

MD/al
ES14020.01/TECoorLetters
Sept 2015

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION

MARK WILLIAMS
COMMISSIONER

DAN FORSTER
DIRECTOR

November 2, 2015

Michael DeMell
Vice-President and Operations Manager
Environmental Services, Inc.
PO Box 2383
Savannah, GA 31402

Subject: Known occurrences of natural communities, plants and animals of highest priority conservation status on or near ESI Project No: ES14020.01, Brantley County, Georgia

Dear Mr. DeMell:

This is in response to your request of September 29, 2015. According to our records, within a three-mile radius of the project site, there are the following Natural Heritage Database occurrences:

US *Drymarchon couperi* (Eastern Indigo Snake) approx. 3.0 mi. S of site
Farancia erytrogramma erytrogramma (Common Rainbow Snake) [HISTORIC?] approx. 2.0 mi. W of site
US *Gopherus polyphemus* (Gopher Tortoise) approx. 3.0 mi. SE of site
Ilex amelanchier (Serviceberry Holly) [HISTORIC?] approx. 2.5 mi. W of site
Plantago sparsiflora (Pineland Plantain) [HISTORIC] approx. 1.0 mi. W of site
Tillandsia bartramii (Bartram's Air-plant) in an uncertain location near the project site
Wading Bird Colony (Wading Bird Colony) approx. 1.0 mi. NW of site
Satilla River [High Priority Stream] approx. 2.5 mi. W of site

* Entries above proceeded by “US” indicates species with federal status in Georgia (Protected or Candidate). Species that are federally protected in Georgia are also state protected; “GA” indicates Georgia protected species.

Recommendations:

We have no records of high priority species or habitats within the project area. However, a federally listed species, *Drymarchon couperi* (Eastern Indigo Snake), has been documented within three miles of the proposed project. To minimize potential impacts to this or other federally listed species, we recommend consultation with the United States Fish and Wildlife Service. For southeast Georgia, please contact Strant Colwell (912) 832-8739 ext 1 or Strant_Colwell@fws.gov). Surveys for species of conservation concern should be conducted prior to commencement of construction.

This project is within three miles of several state protected species. For information about these species, including survey recommendations, please visit our webpage at http://www.georgiawildlife.org/rare_species_profiles.

Construction activities in the vicinity of water-bird rookeries should be approached with caution. Disturbance near the colony can lead to nest failure and possible abandonment. The nesting season extends from Mid-February to the end of July. Please avoid activities within 400 m (1300 ft.) from the periphery of rookeries during this time if possible.

This project occurs near the Satilla River, a high priority stream. As part of an effort to develop a comprehensive wildlife conservation strategy for the state of Georgia, the Wildlife Resources Division developed and mapped a list of streams that are important to the protection or restoration of rare aquatic species and aquatic communities. High priority waters and their surrounding watersheds are important for aquatic biodiversity conservation, but do not receive any additional legal protections. We now have GIS ESRI shapefiles of GA high priority waters available on our website (http://www.georgiawildlife.com/node/1377). Please contact this office if you would like additional information on high priority waters.

We are concerned about stream habitats that could be impacted by construction activities. In order to protect aquatic habitats and water quality, we recommend that all machinery be kept out of streams during construction. We urge you to use stringent erosion control practices during construction activities. Further, we strongly advocate leaving vegetation intact within 100 feet of streams wherever possible, which will reduce inputs of sediments, assist with maintaining riverbank integrity, and provide shade and habitat for aquatic species. We realize that some trees may have to be removed, but recommend that shrubs and ground vegetation be left in place.

Disclaimer:

Please keep in mind the limitations of our database. The data collected by the Nongame Conservation Section comes from a variety of sources, including museum and herbarium records, literature, and reports from individuals and organizations, as well as field surveys by our staff biologists. In most cases the information is not the result of a recent on-site survey by our staff. Many areas of Georgia have never been surveyed thoroughly. Therefore, the Nongame Conservation Section can only occasionally provide definitive information on the presence or absence of rare species on a given site. Our files are updated constantly as new information is received. **Thus, information provided by our program represents the existing data in our files at the time of the request and should not be considered a final statement on the species or area under consideration.**

If you know of populations of highest priority species that are not in our database, please fill out the appropriate data collection form and send it to our office. Forms can be obtained through our web site (http://www.georgiawildlife.com/node/1376) or by contacting our office. If I can be of further assistance, please let me know.

Sincerely,

Anna Yellin
Environmental Review Coordinator

Data Available on the Nongame Conservation Section Website

- Georgia protected plant and animal profiles are available on our website. These accounts cover basics like descriptions and life history, as well as threats, management recommendations and conservation status. Visit http://www.georgiawildlife.com/node/2721.

- Rare species and natural community information can be viewed by Quarter Quad, County and HUC8 Watershed. To access this information, please visit our GA Rare Species and Natural Community Information page at: http://www.georgiawildlife.com/conservation/species-of-concern?cat=conservation.

- Downloadable files of rare species and natural community data by quarter quad and county are also available. They can be downloaded from: http://www.georgiawildlife.com/node/1370.

ENVIRONMENTAL SERVICES, INC.
P.O. Box 2383
Savannah, GA 31402

Phone 912-236-4711 * Fax 912-236-3668

www.environmentalservicesinc.com

28 September 2015

Mr. Strant Colwell
Assistant Field Supervisor
U.S. Fish and Wildlife Service
4980 Wildlife Drive NE
Townsend, GA 31331

RE: Request for Known Occurrences of Endangered or Threatened Species: Brantley County Developing Partners E&T Habitat Assessment
Brantley County, Georgia
ESI Project No.: ES14020.01 Lat.: 31.219042 Long: 81.82081

Dear Mr. Colwell:

Environmental Services, Inc., (ESI), as an authorized agent for Harbin Engineering, is currently conducting an endangered species habitat assessment for the above referenced property and we hereby request coordination with your agency. We are currently reviewing the list of Federal Endangered and Threatened Species and State of Georgia Endangered and Threatened Species for Brantley County. Through this notification we respectfully request that you review your files and provide ESI with any information regarding the known presence of any endangered or threatened species on or in the vicinity of the proposed project area (Figures 1-5, attached).

Please submit this information to ESI at the address shown at the top of this letter. Should you have any questions regarding this project, please do not hesitate to call me at (912) 236-4711.

Sincerely,
ENVIRONMENTAL SERVICES, INC.

Michael J. DeMell
Senior Vice President II/ Technical Director

MD/al
ES14020.01/TECoorLetters
Sept 2015

United States Department of the Interior

Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606
Phone: (706) 613-9493
Fax: (706) 613-6059

West Georgia Sub-Office
Post Office Box 52560
Fort Benning, Georgia 31995-2560
Phone: (706) 544-6428
Fax: (706) 544-6419

Coastal Sub-Office
4980 Wildlife Drive
Townsend, Georgia 31331
Phone: (912) 832-8739
Fax: (912) 832-8744

October 7, 2015

Mr. Michael J. DeMell
Environmental Services, Inc.
Post Office Box 2383
Savannah, Georgia 31402

RE: USFWS File Number 2015-1071

Dear Mr. DeMell:

The Fish and Wildlife Service (Service) has reviewed your correspondence regarding your endangered species habitat assessment for a property located in Brantley County, Georgia (Latitude 31.219042, Longitude 81.82081). Your letter stated that you are currently reviewing the list of Federal Endangered and Threatened Species and State of Georgia Endangered and Threatened Species for Brantley County. You requested any information regarding the known presence of and federally listed species on or in the vicinity of the project area. We submit the following comments of this action under provisions of the Endangered Species Act of 1973, as amended; (16 U.S.C. 1531 *et seq.*).

For a list of Federal Endangered and Threatened Species and the State of Georgia Endangered and Threatened Species in your project area, please visit our Information, Planning, and Conservation System, IPaC. It can be accessed through our Georgia Ecological Services website at www.fws.gov/athens/. For more site-specific information, please contact the Georgia Natural Heritage Program at 770-918-6411 or visit their website, found at www.georgiawildlife.com. Please note, though the State's database is an initial indicator of species occurrence within a given region, the omission of a species within a specified quarter quad does not, for survey purposes, eliminate that species from concern if the species is listed for that county and suitable habitat exists in the action area. Both databases are works in progress and not all areas in Georgia have been thoroughly surveyed.

The project area falls within the range of the federally endangered Red-Cockaded woodpecker (Picoides borealis), the federally threatened Wood stork (*Mycteria americana*) and Federally Endangered plant, Hairy Rattleweed (*Baptisia arachnifera*), the federally threatened Eastern indigo snake *(Drymarchon corais couperi)* (indigo) as well as the federal candidate Gopher tortoise (Gopherus polyphemus) and state listed Rafinesque's big-eared bat *(Plecotus rafinesquii)*.

There are several known occurrences of Hairy Rattleweed (*Baptisia arachnifera*) within eight miles of the project site. The project location is located within the thirteen mile core foraging areas for two wood stork (*Mycteria americana*) colonies. There are several known occurrences of Rafinesque's big-eared bat *(Plecotus rafinesquii)* within five miles of the project site. There are also known occurrences of the indigo in the area, the closest occurring within three miles from the project site. The indigo is a wide-ranging species that requires a mosaic of habitats to complete its annual life cycle. During summer months, these snakes prefer wetland edges where prey is abundant but snakes move to drier habitats in the winter. Indigoes use gopher tortoise burrows as shelter during the winter and during the warmer months for nesting and refuge from intense summer heat. We recommend complete wildlife surveys for listed and candidate species in order to complete your environmental review of the project site.

Thank you for the opportunity to provide comments during the planning stages of your project. Should you have further questions or need additional assistance please contact our Coastal Georgia Sub Office staff biologist, Gail Martinez, at 912-832-8739 extension 7.

Sincerely,

Strant Colwell

Strant Colwell
Coastal Office Supervisor

ENVIRONMENTAL SERVICES, INC.
P.O. Box 2383
Savannah, GA 31402

Phone 912-236-4711 * Fax 912-236-3668

www.environmentalservicesinc.com

28 September 2015

Mr. David Bernhart
NOAA, National Marine Fisheries Service
236 13th Avenue South
St. Petersburg, Florida 33701

RE: Request for Known Occurrences of Endangered or Threatened Species:
Brantley County Developing Partners E&T Habitat Assessment
Brantley County, Georgia
ESI Project No.: ES14020.01 Lat.: 31.219042 Long: 81.82081

Dear Mr. Bernhart:

Environmental Services, Inc., (ESI), as an authorized agent for Harbin Engineering, is currently conducting an endangered species habitat assessment for the above referenced property and we hereby request coordination with your agency. We are currently reviewing the list of Federal Endangered and Threatened Species and State of Georgia Endangered and Threatened Species for Brantley County. Through this notification we respectfully request that you review your files and provide ESI with any information regarding the known presence of any endangered or threatened species on or in the vicinity of the proposed project area (Figures 1-5, attached).

Please submit this information to ESI at the address shown at the top of this letter. Should you have any questions regarding this project, please do not hesitate to call me at (912) 236-4711.

Sincerely,
ENVIRONMENTAL SERVICES, INC.

Michael J. DeMell
Senior Vice President II/ Technical Director

MD/al
ES14020.01/TECoorLetters
Sept 2015

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

October 1, 2015

Michael J. DeMell
Senior Vice President II/Technical Director
Environmental Services, Inc.
P.O. Box 2383
Savannah, GA 31402

Dear Mr. DeMell:

Pursuant to section 7(a)(2) of the Endangered Species Act (ESA), the Protected Resources Division of NOAA's National Marine Fisheries Service has reviewed your letter dated September 28, 2015, concerning ESI Project No.: ES14020.01 – Brantley County, Georgia.

There are no ESA-listed species or designated critical habitat under our purview in the action area. If you have any questions, please contact our ESA section 7 Coordinator, Kelly Shotts at (727) 824-5312 or by e-mail at Kelly.shotts@noaa.gov.

Sincerely,

Teletha Mincey
Program Analyst
Protected Resources Division

ENVIRONMENTAL SERVICES, INC.
A Terracon COMPANY

2201 Rowland Ave.
Savannah, Georgia 31404
P (912) 629 4000
F (912) 629 4001
environmentalservicesinc.com

19 July 2019

Mr. Michael Biers
c/o Mr. J. Steven Harbin
Harbin Engineering, P.C.
41 W. Johnston Street
Forsyth, Georgia 31029

RE: Brantley County Developmental Partners, LLC
US 82 Solid Waste Handling Facility - South
Habitat Assessment for Threatened and Endangered Species
Brantley County, Georgia **ES14020.05**

Dear Mr. Biers:

The purpose of this letter is to submit the attached updated Habitat Assessment for Threatened and Endangered Species report for the above-referenced tract. Per a request from Harbin Engineering ESI was asked to update the 2015 habitat assessment in order to address EPD comment no. 1 within their 9 November 2018 letter. These assessments were conducted on the ±487-acre property located adjacent and south of Highway 82, approximately 10 miles northeast of Nahunta, Brantley County, Georgia (Figure 1).

Environmental Services Inc. (ESI) visited the above-referenced property in June-October of 2015 for the purposes of wetland delineation. During these investigations, data needed for habitat assessments for threatened and endangered species was also collected. Subsequent to the delineation work, ESI revisited the site to more specifically review certain habitats related to specific species, and most recently ESI visited the site in July 2019 to conduct an additional assessment in order to update the report. Based upon recent visual surveys of the subject property, document search, and knowledge of the habitat ranges of the threatened and endangered species in the area, it is the opinion of ESI that the potential for any listed species to occur within the potential impact area is low. No federally protected species or evidence thereof was noted by ESI during the recent habitat evaluation.

In addition to the field investigation, ESI also provided notice of our investigation to the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the Georgia

Department of Natural Resources (GADNR). These notifications were submitted both in 2015 and 2019. Reponses from USFWS and GADNR were received for the original 2015 report, in addition to the updated 2019 report. Reponses from NMFS was only received in 2015.

We trust that this information is helpful as part of your project development planning process. Should you wish to discuss this project any further, or should you have any questions, please do not hesitate to contact us at the number listed above.

Sincerely,

ENVIRONMENTAL SERVICES, INC.

Michael J. DeMell
Department Manager

Kristen Deason
Senior Staff Scientist

MD/kd
ES14020.05/CoverLetter.docx
(July 2019)

Habitat Assessment for Threatened and Endangered Species

Brantley County Developmental Partners, LLC

US 82 Solid Waste Handling Facility - South
Brantley County, Georgia

I. INTRODUCTION

A. Purpose

Environmental Services, Inc., (ESI) was contracted in 2015 to perform a due diligence assessment for protected species and habitat essential to these species within the ±487-acre site in Brantley County, Georgia (Figure 1). Recently, per a request from Harbin Engineering ESI was asked to update the 2015 habitat assessment in order to address EPD comment no. 1 within their 9 November 2018 letter. The primary purpose of the assessment was to determine whether habitat suitable for any species currently listed or proposed for listing as endangered or threatened by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), or Georgia Department of Natural Resources (GADNR) was present on or near the property. Given that protected species may not be present or observed during our field investigations, observations were made for the habitats that exist in attempt to determine if listed species could utilize the site during other times of the year.

B. Project Location

The ±487-acre property is located adjacent and south of Highway 82, approximately 10 miles northeast of Nahunta, Brantley County, Georgia (Figure 1). Coordinates for the approximate center of the site are Latitude 31.219042 and Longitude -81.820281. The property is currently accessed from Highway 82 and from several dirt roads that traverse the site.

II. SITE OVERVIEW

A. Existing Conditions and Habitats

ESI personnel conducted vehicular and pedestrian assessments within the above-referenced tract between the months of June through October 2015 for the original 2016 habitat assessment, and again in July 2019 for the purpose of updating the habitat assessment. Five general habitats were found on the property during the most recently July 2019 visit, which were pine plantation upland, early successional scrub/shrub upland, mid successional pine-saw palmetto flatwood uplands, hardwood/pine wetland, and borrow pits. These areas were identified and approximated on the attached Figure 2 by ESI to assist in determining the potential for habitation by any listed species. The following habitats, along with the associated flora, were observed on the property.

Pine Plantation Uplands

As shown on the attached *Approximate Habitat Type* (Figure 2) approximately 35-acres of the ±487-acre (7%) parcel is characterized as pine plantation uplands. There are only three areas that remain in pine plantation, including the 32-acre area in the far northeastern panhandle of the property adjacent to Highway 82, a small 3-acre triangular area located in the southern section, and a small 2-acre rectangle north of Highway 82. These upland plant communities are dominated by pine flats, planted pine stands of various ages, and areas of mixed pine/hardwood. The upland vegetation community within the pine plantation uplands consist mostly of loblolly pine (*Pinus taeda*), a few live oaks *(Quercus virginiana)*, water oaks (*Q. nigra*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), wax myrtle (*Myrica cerifera*), saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), and bracken fern (*Pteridium aquilinum*). Please refer to Photo Sheet 1 Photos 1 and 2 for representative pictures of the pine plantation upland habitat type (Appendix 1).

Early Successional Scrub/Shrub Uplands

Approximately 217-acres of the ±487-acre (45%) parcel displays characteristics of an early successional scrub/shrub habitat. These areas appear to have been taken out of silvicultural rotation following the last few clear-cuts, as is evident from the lack of planted and/or bedded young pines. These areas vary in successional stage, but all areas lack a mature over-story, and instead have an 8-20 foot tall mid-story consisting of a low density of loblolly bay (*Gordonia lasianthus*), loblolly pine, sweet gum, red maple, water oak (*Quercus nigra*), and live oak. The understory is categorized by thick scrub/shrub species dominated by gallberry and saw palmetto, with supplemental species consisting of coastal sweet-pepperbush (*Clethra* *alnifolia*), blueberry (*Vaccinium sp.*), rusty staggerbush (*Lyonia ferruginea*), and wax myrtle. The ground cover consists of broom-sedge (*Andropogon virginicus*), honeysuckle (*Lonicera japonica*), Carolina jessamine (*Gelsemium sempervirens*), blackberry (*Rubus argutus*), muscadine (*Vitis rotundifolia*), bracken fern, and reindeer lichen (*Cladonia rangiferina*). Please refer to Photo Sheet 2 and 3 Photos 3-6 for representative pictures of the early successional scrub/shrub upland habitat type (Appendix 1).

Mid Successional Pine-Saw Palmetto Flatwoods Uplands

Approximately 100 acres of the ±487-acre (20%) parcel would be considered pine-saw palmetto flatwoods. These uplands also appear to have been taken out of silvicultural rotation, but are in a later successional stage as compared to the above mentioned early successional scrub/shrub uplands. Unlike, the above-mentioned habitat type, these uplands are dominated by a mid-story of 20-40 foot loblolly pine, and also currently lack a mature overstory. The understory would be considered fairly open and is dominated by saw palmetto, broom-sedge, and wax myrtle, with sporadic occurrence of other understory species including bracken fern, rusty lyonia, sweet gum, and gallberry. Please refer to Photo Sheet 4 Photos 7 and 8 for representative pictures of the mid successional pine-saw palmetto flatwoods uplands habitat type (Appendix 1).

Hardwood/Pine Wetlands

As illustrated on Figure 2, approximately ±134-acres of the ±487-acre (28%) parcel consist of freshwater wetlands. These wetland systems within the project study area are generally forested, located on hydric soils, and are seasonally flooded. The dominant vegetation in these systems consist of sweetgum, red maple, black gum (*Nyssa biflora*), pond cypress (*Taxodium ascendens*), loblolly bay, sweet bay (*Magnolia virginiana*), swamp titi (*Cyrilla racemiflora*), buckwheat titi (*Cliftonia* monophyla), water oak, gallberry, myrtle dahoon (*Ilex myrtifolia*), coastal sweet-pepperbush, netted chain-fern (*Woodwardia areolata*), Virginia chain-fern (*Woodwardia virginiana*), cinnamon fern (*Osmunda cinnamomea*), yellow eyed grass (*Xyris sp.*), sedges (*Carex sp.*), and sphagnum moss (*Sphagnum sp.*). As illustrated on Figure 2 and verified by the 5 May 2016 Jurisdictional Determination, ±117.84-acres of these wetlands may be considered jurisdictional wetlands (Appendix 4). The remaining ±16.67-acres of wetland habitat are considered to be isolated non-jurisdictional wetlands. Both types of wetlands have similar vegetation communities, only differing in their geomorphic positions or connectivity to other jurisdictional features. Please refer to Photo Sheet 5 and 6 Photos 9-12 for representative pictures of the hardwood/pine wetlands habitat type (Appendix 1).

Borrow Pit

Approximately 1 acre of upland dug borrow pit occur within the ±487-acre (0.2%) parcel. The first is located just north of Non-Jurisdictional Wetland #10 (Appendix 4). This U-shaped feature appears to have been dug in or around 2009. The pond itself is void of vegetation, but the top of its banks is dominated by wax myrtle, broom-sedge, saw palmetto, and loblolly pine. There is another smaller pond, located 500 feet west of Non-Jurisdictional Wetland #5 (Appendix 4). This small pond is characterized by a macrophytic floating aquatic plant that covers the pond surface. Please refer to Photo Sheet 7 Photos 13 and 14 for representative pictures of the borrow pit habitat type (Appendix 1).

III. ASSESSMENT METHODOLOGY

This section describes the methodologies used to determine the presence or likelihood for occurrence of listed species within the project site. This includes a review of existing literature, coordination with wildlife regulatory agencies, and field assessment of habitat types.

A. Field Studies

The habitat assessment conducted by ESI staff consisted of vehicular and pedestrian surveys at representative locations across the property to identify available habitat types. Major community types were identified and observations concerning dominant vegetation, condition, and habitat quality were noted during the investigation. In general, all wetland and upland habitat types within the project study area were investigated.

B. Literature Review and Agency Coordination

In addition to our field investigations, in 2015 and 2019, and subsequent review of available printed material for current listed species (See Appendix 2 for IPaC), we also provided notice of our investigation to USFWS, NMFS, and GADNR on 13 June 2019. Through these notifications, we requested that the agencies provide us with any updated information to their previously issued 2015 letters regarding known occurrences of any listed endangered / threatened species on or within the vicinity of the project area. The USFWS response indicated that the information provided in the original letter, dated 7 October 2015, still stands and there have been no updates. No response has been received by NOAA, but it is safe to assume their 2015 response letter remains valid due to the fact that no species within their purview existed within the action area and site conditions have not changed (Appendix 3).

The GADNR letter, dated 5 July 2019, included a few updates. The first of which is the inclusion of the federally endangered Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) within the Satilla River 2.4 miles west of the site and the federally threatened west Indian manatee (*Trichechus manatus*) 7.5 miles east of the site. Due to this update and the fact that Atlantic sturgeon are also listed in Brantley County, the below Table 1 has been updated to include a species profile; however, they are not included in Table 2 due to their aquatic habitat requirements of rivers, estuaries, and oceans, which are not present on the project site. Manatees are not included in our assessment due to their habitat requirements of open water, which is not present on property. The GADNR letter also included the state listed hooded pitcherplant (*Tillandsia bartramii*) within 2.7 of the site. It is worthy to note the most recent July 2019 field study, a hooded pitcherplant was observed on the edge of a ditch within the southern end of the property (approximately located at 31.210942, -81.819982). Since protection of state protected plants is limited to public lands, this species is not assessed below. The other updates were to state listed animals including the spotted turtle (*Clemmys* guttata) within 9 miles of the site and the swallow-tailed kite (*Elanoides* forficatus) occurring 3 miles southwest of the site. Since protection to these animal species are limited to take of the animal itself and destruction of habitat on public land, neither are assessed below. The final update to the GADNR letter was inclusion of pine woods snake (*Rhadinaea flabilata*) as a species of management concern with no state or federal listed, which is discussed further below. All of the above-mentioned species show up on the attached Figure 4 *Georgia Rare Species and Natural Community Data*.

Appendix 3 contains copies of the original 2015 responses from NMFS, USFWS and GADNR, in addition to the recent responses for this updated 2019 report.

IV. LISTED SPECIES

For the purposes of this report, it should be noted that protection of listed species is provided by the Endangered Species Act for both private and public lands, regardless of permitting needs. For species listed by the State of Georgia as rare, unusual, or in danger of extinction under the Endangered Wildlife Act, the state's jurisdiction is limited to the capture, killing, selling, and protection of suitable habitat of protected species on public land. For plants listed by the state as rare, unusual, or in danger of extinction under the Wildflower Preservation Act, jurisdiction is also limited to those species found on public land.

Species of Management Concern (SMC) are not being evaluated within this report, but were identified by GADNR in their response letter (Appendix 3). These SMC include the Common Rainbow Snake (*Farancia erytrogramma ertrogramma*), Serviceberry Holly (*Ilex amelanchier*), Pineland Plaintain (*Plantago spariflora*), Pine Woods Snake (*Rhadinaea flavilata*), and Bartman's Air-Plant *(Tillandsia bartramii*). These SMC are neither federally or state listed as threatened or endangered, so are therefore not legally protected on private lands, but are worthy to note because they have potential to be listed in the future. Another species that does not have federal protection, but was identified in the USFWS response letter to be considered rare by GADNR (Appendix 3), was the Rafinesque's big-eared bat (*Plecotus rafinesquii*).

Listed species that are federally and/or state classified as Threatened or Endangered that have a documented range encompassing Brantley County are compiled in the following **Table 1**. Several of the species listed as potentially occurring in Brantley County are not anticipated to occur within the project site due to habitat requirements and distribution. Species identified to occupy habitats similar to those found on or near the project site are listed below **Table 2**, along with a brief description and statement about their potential for occurrence.

Table 1. Listed Species for Brantley County, Georgia. (GADNR List Updated July 2019)

Species	Federal Status	State Status	Habitat	Threats
Bird				
Wood stork *Mycteria americana*	T	E	Primarily feed in fresh and brackish wetlands and nest in cypress or other wooded swamps.	Decline due primarily to loss of suitable feeding habitat, particularly in south Florida. Other factors include loss of nesting habitat, prolonged drought/flooding, raccoon predation on nests, and human disturbance of rookeries.
Red-cockaded woodpecker *Picoides borealis*	E	E	Needs large areas of open and mature forests, particularly consisting of longleaf pine, slash pine, or loblolly pine. Trees selected for cavities must be mature living pines and often times are infected with the red heart fungus.	The main threat has been due to destruction, fragmentation, and degradation of previously existing vast areas of mature pine forests. In addition, most private land practices, such as clearing or agriculture, are incompatible with the success of the species.
Reptile				
Eastern indigo snake *Drymarchon corais couperi*	T	T	During winter, den in xeric sandridge habitat preferred by gopher tortoises; during warm months, forage in creek bottoms, upland forests, and agricultural fields	Habitat loss due to uses such as farming, construction, forestry, and pasture and to overcollecting for the pet trade
Gopher tortoise *Gopherus polyphemus*	Candidate	T	Well-drained, sandy soils in forest and grassy areas; associated with pine overstory, open understory with grass and forb groundcover, and sunny areas for nesting	Habitat loss and conversion to closed canopy forests. Other threats include mortality on highways and the collection of tortoises for pets.
Plant				
Hairy rattleweed *Baptisia arachnifera*	E	E	Sandy soils in open pine flatwoods, intensively managed slash pine plantations, and along road and powerline right-of-ways	Clearcutting of pines for timber, followed by intensive site preparation (chopping and bedding with heavy machinery)
Fish				
Atlantic Sturgeon *Acipenser oxyrinchus oxyrinchus*	E	E	Anadromous fish. Inhabit large areas of coastal ocean. Spawning occurs near the fall line, in habitat featuring hard substrates such as gravel or cobble. Larvae gradually migrate downstream to the upper estuary. River-resident juveniles reside in nursery areas below the head of tide, and marine migratory juveniles inhabit coastal marine waters.	Overharvested, commercial fisheries bycatch, poaching, habitat modification, and water pollution.

Table 2. Species with Common Habitats as is Present on the Property.

Species	Federal Status	State Status	Potential Habitat Present	Project Potential for Impacts	Biological Conclusion
Bird					
Wood stork *Mycteria americana*	T	E	Yes	Low[1]	May Affect – Not Likely to Adversely Affect
Red cockaded woodpecker *Picoides borealis*	E	E	No	None	No Effect
Reptile					
Eastern indigo snake *Drymarchon corais couperi*	T	T	Yes	Low[1]	May Affect – Not Likely to Adversely Affect
Gopher tortoise *Gopherus polyphemus*	Candidate	T	No	None	No Effect
Plant					
Hairy rattleweed *Baptisia arachnifera*	E	E	Yes	Low[1]	May Affect – Not Likely to Adversely Affect

[1] Low was assigned to all those species that could not be completely eliminated as being potentially utilizing the property in some regard. In this case all of these species were assigned a Biological Conclusion of May Affect – Not Likely to Adversely Affect.

A. Animals

<u>Wood stork</u> (*Mycteria americana*)

The State and Federally Endangered wood stork occupy swamps and wetlands, usually nesting in cypress or mangrove swamps and feeding in freshwater or brackish wetlands (Bentzien 1986). Wood storks are large long-legged wading birds that feed on small fish. The potential for sporadic roosting habitation exists throughout coastal Georgia.

Habitat Present: YES

No wood storks or evidence thereof was observed during the habitat evaluation or the wetland delineation that was conducted on the property. Suitable foraging habitat that has an adequate hydrologic regime does exist within the project site. This is primarily due to the generic habitat description used for the wood stork that, in essence, rarely allows for a no effect determination for this species throughout its range in coastal Georgia. The responses from both the USFWS and the GADNR do not indicate known wood stork rookeries on the property or within 3 miles of the property. However, as the attached Figure 3 shows, there are

2 known wood stork rookeries approximately 6-7 miles from the site. Since USFWS indicated that the project is within a 13-mile core foraging area for two wood stork rookies, wood storks could use the property for roosting or for foraging purposes (Figure 2). However, given the fact that this site does not offer any unique habitat for this species, the likelihood of the project negatively affecting this species is low.

Red-cockaded woodpecker (RCW) (*Picoides borealis*)

This state and federally endangered woodpecker inhabits old growth, open pine forests, and makes its cavities in live pine trees of sufficient age to produce heartwood, a sapless component in the bole of the tree. The preferred nesting habitat is old-growth pine trees that are 60 years or older with a relatively thin understory. Additionally, the birds' preferred foraging habitat is in pines older than 30 years of age, where they can occupy a foraging range of over 100-acres (Lennartz and Henry 1985, Henry 1989). The potential for foraging habitat exists throughout coastal Georgia.

Habitat Present: NO

No known occurrences of RCWs have been documented within the project and no cavity trees were visually observed by ESI personnel during the extensive field work conducted on the property. There are no pine or pine/hardwood stands that meet the above defined age criteria for roosting habitat of 60 years or greater. There are pine stands on site that meet the age criteria for foraging habitat of pines older than 30 years of age, but given the site or the surrounding areas do not offer any roosting habitat, the likelihood of this project affecting the species is very low. In addition, most of the pine areas on this site are excluded as potentially suitable habitat due to the intensive management that has occurred over the years for silvicultural purposes.

Eastern indigo snake (*Drymarchon corais couperi*)

The indigo snake is federally listed as threatened and seems to be strongly associated with high, dry, well-drained sandy soils, closely paralleling the sandhill habitat preferred by the gopher tortoise. During warmer months, indigos also frequent streams and swamps, and individuals are occasionally found in flatwoods. Gopher tortoise burrows and other subterranean cavities are commonly used as dens and for egg laying. The eastern indigo snake is a large, docile, non-poisonous snake growing to a maximum length of about 8 feet. The color in both young and adults is shiny bluish-black, including the belly, with some red or cream coloring about the chin and sides of the head.

Habitat Present: YES

No eastern indigo snakes or evidence thereof was observed within the project site. Potentially suitable habitat, consisting of well-drained sandy areas, does not exist within the project site. The project site inclusive of the uplands, does not exhibit excessively or well-drained sandy soils (Figure 5). Additionally, due to the altered nature of the site from past silvicultural activities as well as the prevalence of a dense shrub understory throughout most of the site, use of these areas by the gopher tortoises, which is a commensal species to the indigo snake, is unlikely. The lack of gopher tortoise burrows within the site further decreases the probability for occurrence of this species to low. However, given the summer habitat description including swamps, which are present on the property, completely excluding this species is not possible. Furthermore, as stated in the attached GADNR letter (Appendix 3), there is a known occurrence of this species within three miles of the project site, as shown on the attached Figure 3. The eastern indigo snake could use the property's wetland areas during the summer months; however, given the fact that this site does not offer any unique habitat for this species and the primary preferred habitat is not present, the likelihood of the project negatively affecting this species is low.

<u>Gopher tortoise</u> (*Gopherus polyphemus*)

This species is federally listed as a candidate species and state listed Threatened species. The gopher tortoise typically occurs in well drained, sandy soils in relatively open grassy areas with a sparse pine overstory. Gopher tortoises dig burrows, typically ranging in size from 20 to 30 feet long and from six to eight feet deep, with their shovel-like front legs. The burrows are found in dry places such as sandhills, flatwoods, prairies and coastal dunes or in human-made environments such as pastures, grassy roadsides and old fields. The gopher tortoise is a keystone species, meaning its extinction would result in measurable changes to the ecosystem in which it occurs. Specifically, other animals, such as gopher frogs, several species of snakes and several small mammals, depend on tortoise burrows. For the gopher tortoise to thrive, the animal generally needs three things: well-drained sandy soil (for digging burrows), plenty of low plant growth (for food) and open, sunny areas (for nesting and basking).

Habitat Present: NO

No known occurrences of the gopher tortoise have been documented within the project or were visually observed by ESI personnel during the extensive field work conducted on the property. The project site inclusive of the uplands, does not exhibit excessively or well-drained sandy soils. However, the GADNR information displayed in Figure 6 identifies Mandarin Fine Sand as a suitable gopher tortoise soil type, even though it is considered somewhat poorly drained soil. These small pockets of suitable soil are isolated from one another and would also be considered highly isolated from other gopher tortoise populations. Due to the altered nature of the site from past silvicultural activities as well as the prevalence of a hindering shrub understory throughout most of the site, use of these areas by gopher tortoises is unlikely. No burrows or individuals were found, and no evidence of activity was observed. This project should not affect habitats commonly utilized by gopher tortoise populations.

B. Plants

Hairy rattleweed (*Baptisia arachnifera*)

Hairy rattleweed is a Federal and State Endangered Species occurring in Wayne and Brantley County. It is found in sandy soils in open pine flatwoods, intensively managed slash pine plantations, and along road and powerline right-of-ways.

Habitat Present: YES

Hairy rattleweed was not observed within the project study area during the habitat assessment and the wetland delineation efforts. Some of its potential habitat areas within the project site were traversed by foot, however a species-specific systematic survey was not conducted. If a species-specific survey were to be conducted, the recommended time-frame, according to the GADNR, is when the plant flowers between June-August, or when it is fruiting between August-October. Both of these recommended time-frames fall under the time period when most of the field work was conducted both in 2015 and 2019; therefore, presence of Hairy Rattleweed would have most likely been observed. Even disregarding the fact that the survey was conducted during the preferred timeframe, since the hairy stems and leaves are distinction throughout the growing season, probability of detection would have been considerably high.

Most of the uplands on this site are excluded as potentially suitable habitat due to the silvicultural practices occurring up until recently, including intensively managed pine stands and very recent site prep methods of aggressive drum chopping, bedding, and planting. Some areas on site that could be considered potentially habitat for this species include pine plantation areas that were not recently harvested, all of the trail road margins, and portions of the upland/wetland transition that are pine/hardwood.

Although the entirety of the project boundary exists within the GADNR designated “Possible Hairy Rattleweed Range”, there is only one known population of this species that exists in the United States (Figure 3). This known population is located within eight miles of the project site, as stated in the USFWS letter (Appendix 3) and shown on the attached Figure 3, but does not extend anywhere that would be considered close to the project site.

V. CRITICAL HABITAT

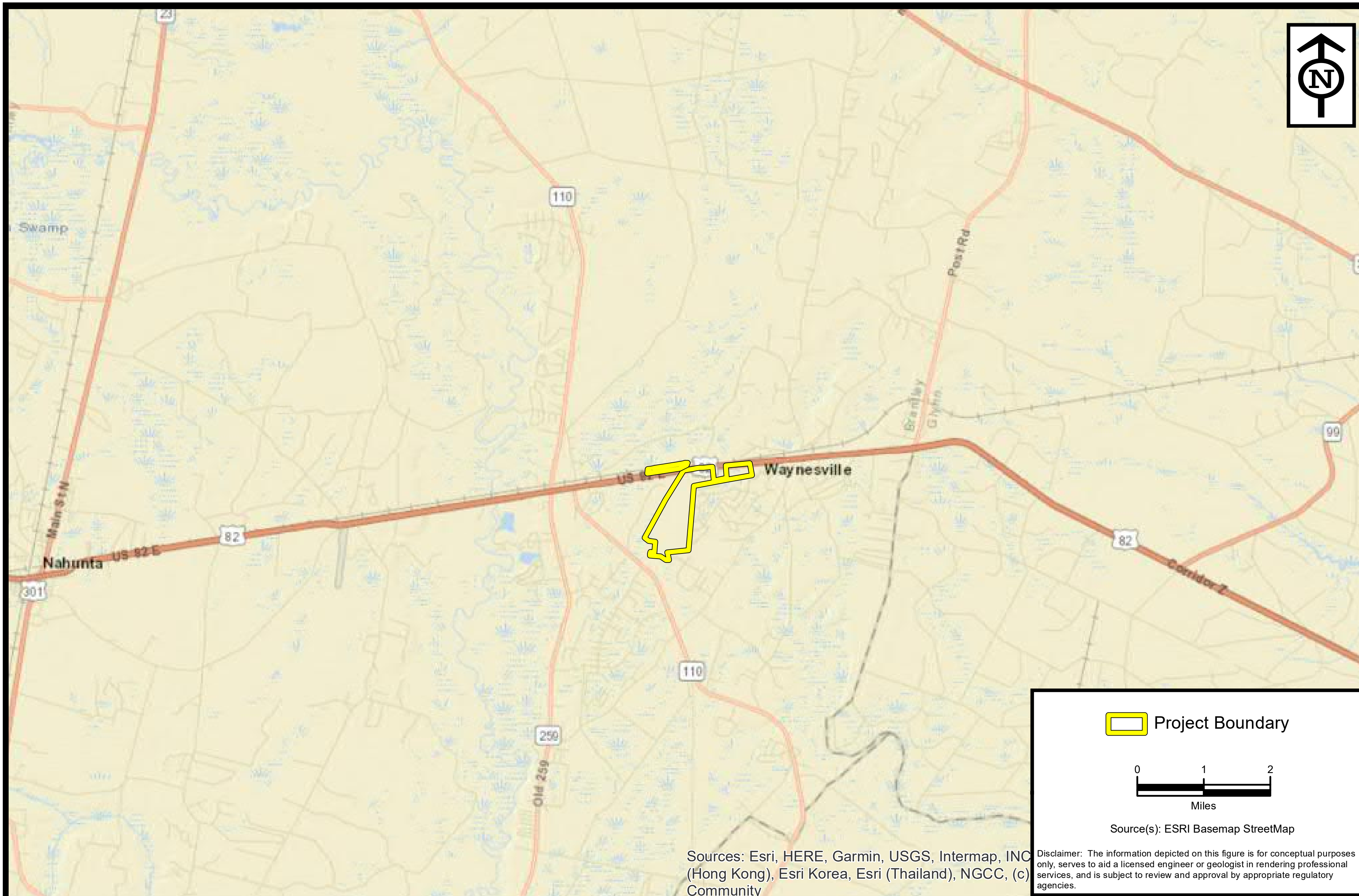
The project site was reviewed for the presence of areas designated as critical habitat for protected species by the USFWS. "Critical habitat" is a term in the Endangered Species Act referring to specific areas that contain physical or biological features essential to the conservation of a threatened or endangered species. No species with associated critical habitat designations are documented to have a range encompassing Brantley County (see attached USFWS IPaC, Appendix 2). This includes the hairy rattleweed, which has not had any critical habitat rules published. Therefore, areas designated as critical habitat for listed species will not be affected by the proposed project and no designated critical habitat exists within the site.

VI. CONCLUSION

Based on visual surveys of the property, document search, and knowledge of the habitat ranges of threatened and endangered species in this area, it is the *opinion* of ESI that the potential for any of the listed species to occur within the potential impact area is either low or very low. No listed endangered or threatened species were observed during the field investigation.

Potentially suitable habitat for federally protected species is present for the wood stork, eastern indigo snake, and hairy rattleweed. This determination is primarily based upon the broad habitat descriptions favored by these species, which thereby precludes ESI from eliminating some areas as potential habitat. No protected species or evidence thereof was noted by ESI during the habitat evaluation or wetland delineation field assessments. The original and updated letters from both GADNR and NOAA state that there are no records of any listed species within the project area (Appendix 3). In the attached letter dated 7 October 2015, USFWS mentions the occurrence of hairy rattleweed, wood storks, Rafinesque's big-eared bat, and the eastern indigo snake greater than 3 miles away from the project site; however, they do not mention known occurrences of any listed species within the project limits. (Appendix 3). It is also worthy to note that although the USFWS recommended complete wildlife surveys for listed and candidate species, it is the *opinion* of ESI that species specific surveys are not necessary or warranted given the results of the 2015 and 2019 habitat assessments discussed herein. Please remain aware that although the potentially suitable habitat for the species discussed is either low or very low, we cannot guarantee that listed species would not nor could not use this site currently or in the future.

Figures



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Project Vicinity

US 82 Solid Waste Handling Facility - South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV/KHD
Figure:	1

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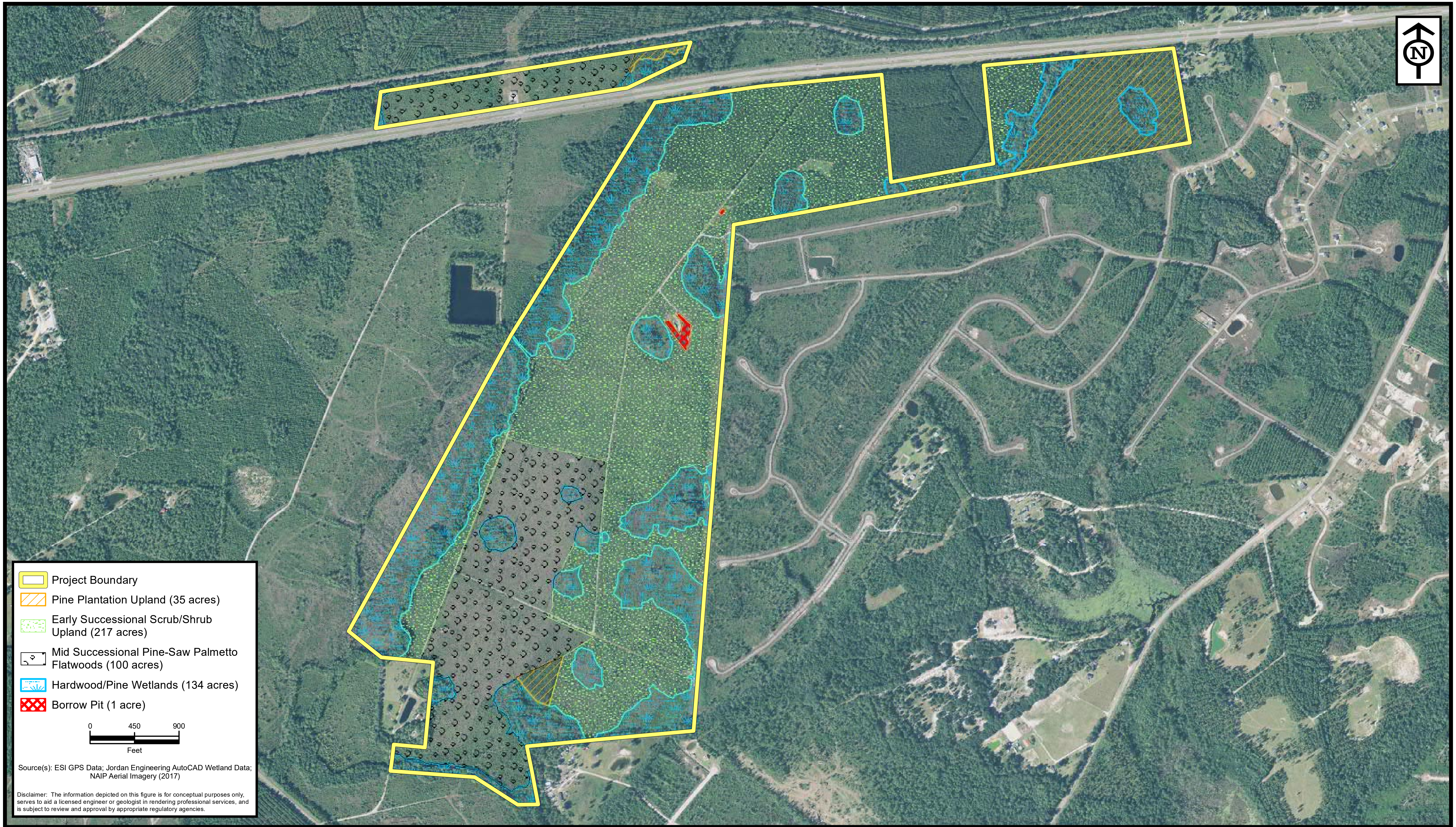

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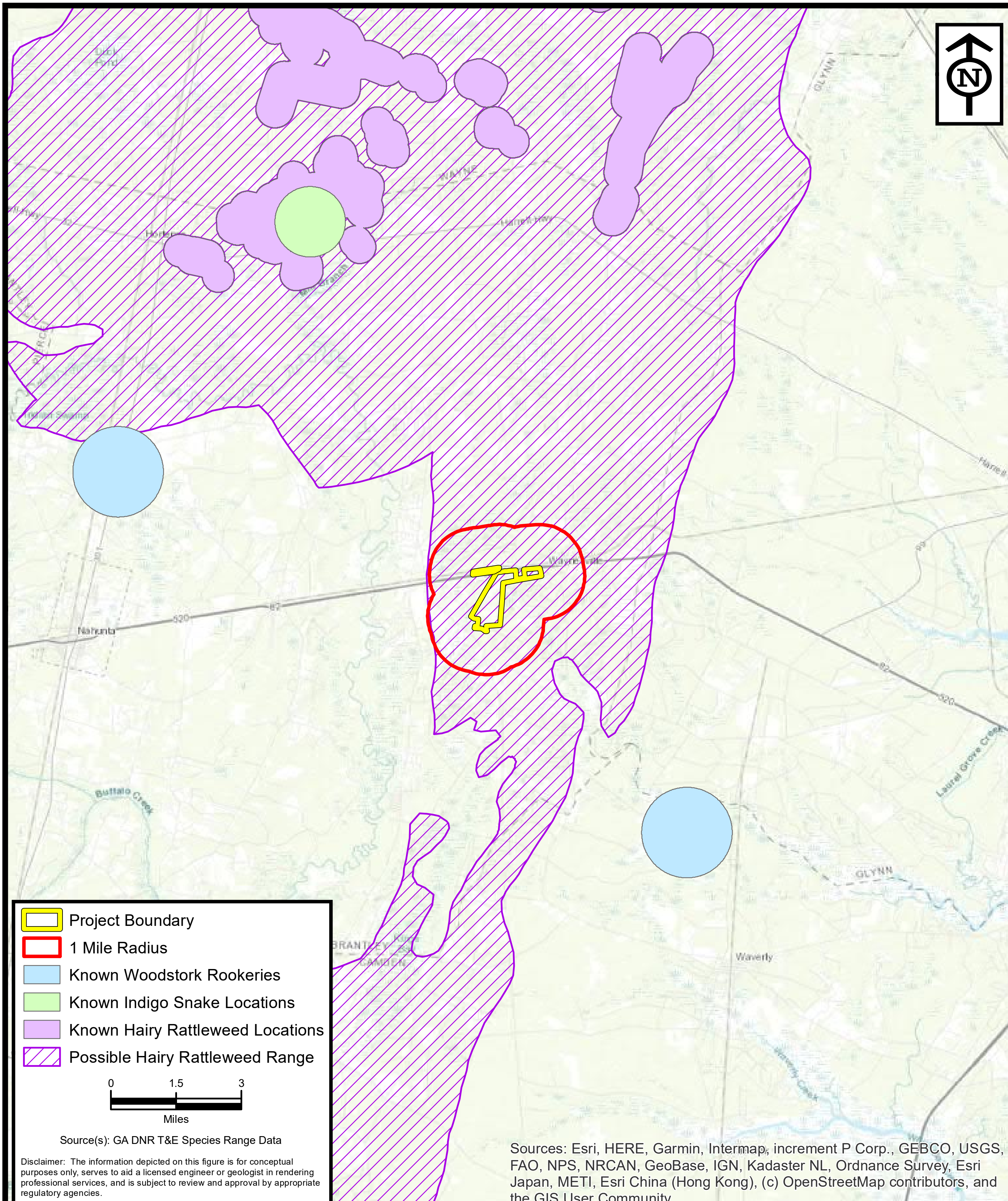
Approximate Habitat Type

US 82 Solid Waste Handling Facility - South

Brantley County, Georgia

Project:	ES14020.05
Date:	June 2019
Drwn/Chkd:	KHD/MJD
Figure:	2

File: N:_ESILegacy\Data\Projects\Graphics\2014\ES14020.05\figures\ECO\Habitat_Map.mxd Date: 7/18/2019 2:19:39 PM



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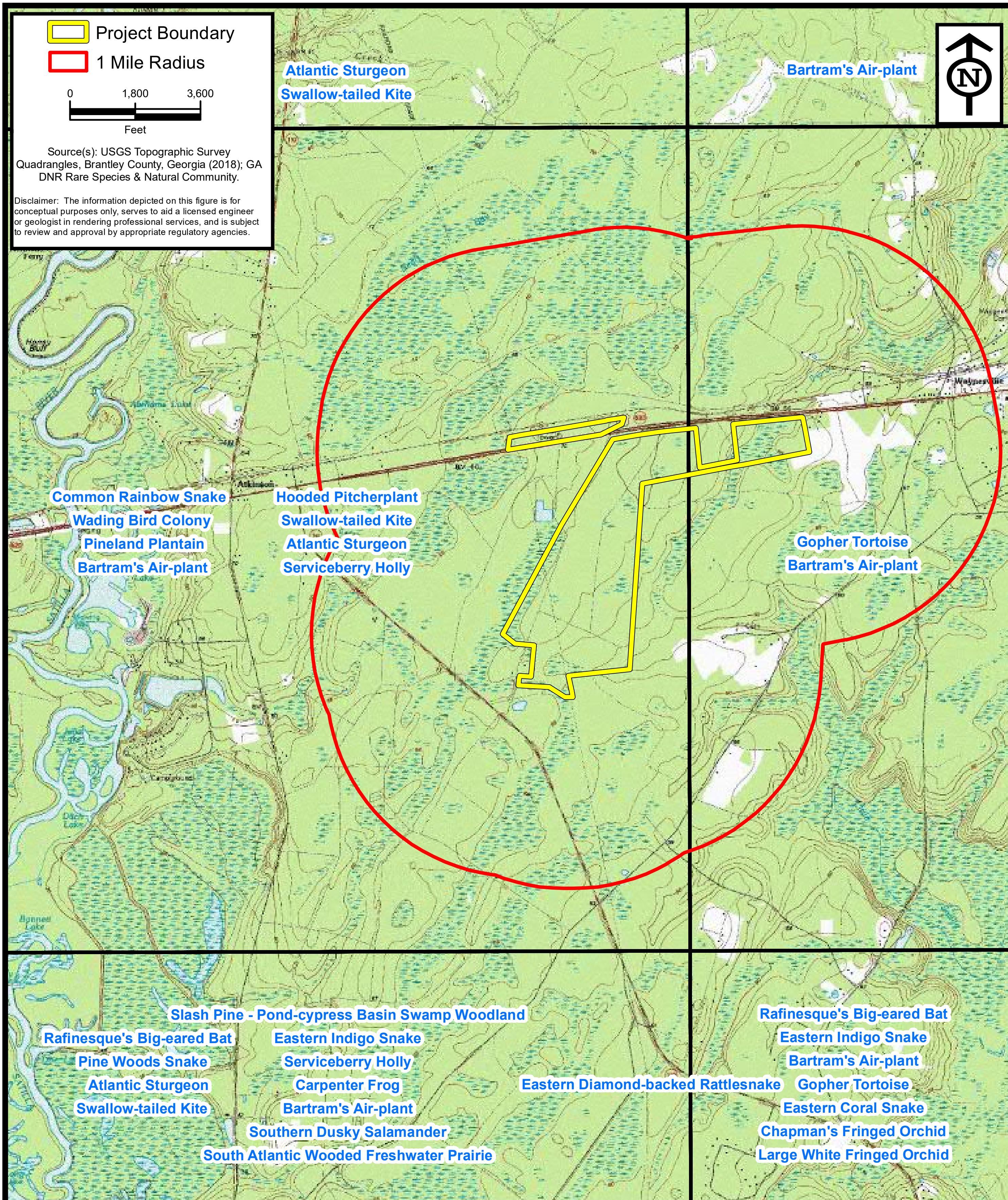
Threatened and Endangered Species
Known Locations & Possible Ranges

US 82 Solid Waste Handling Facility - South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV/KHD
Figure:	3

File: N:_ESILegacy\Data\Projects\Graphics\2014\ES14020.05\figures\ECO\KnownT&E_Map.mxd Date: 7/18/2019 2:33:41 PM



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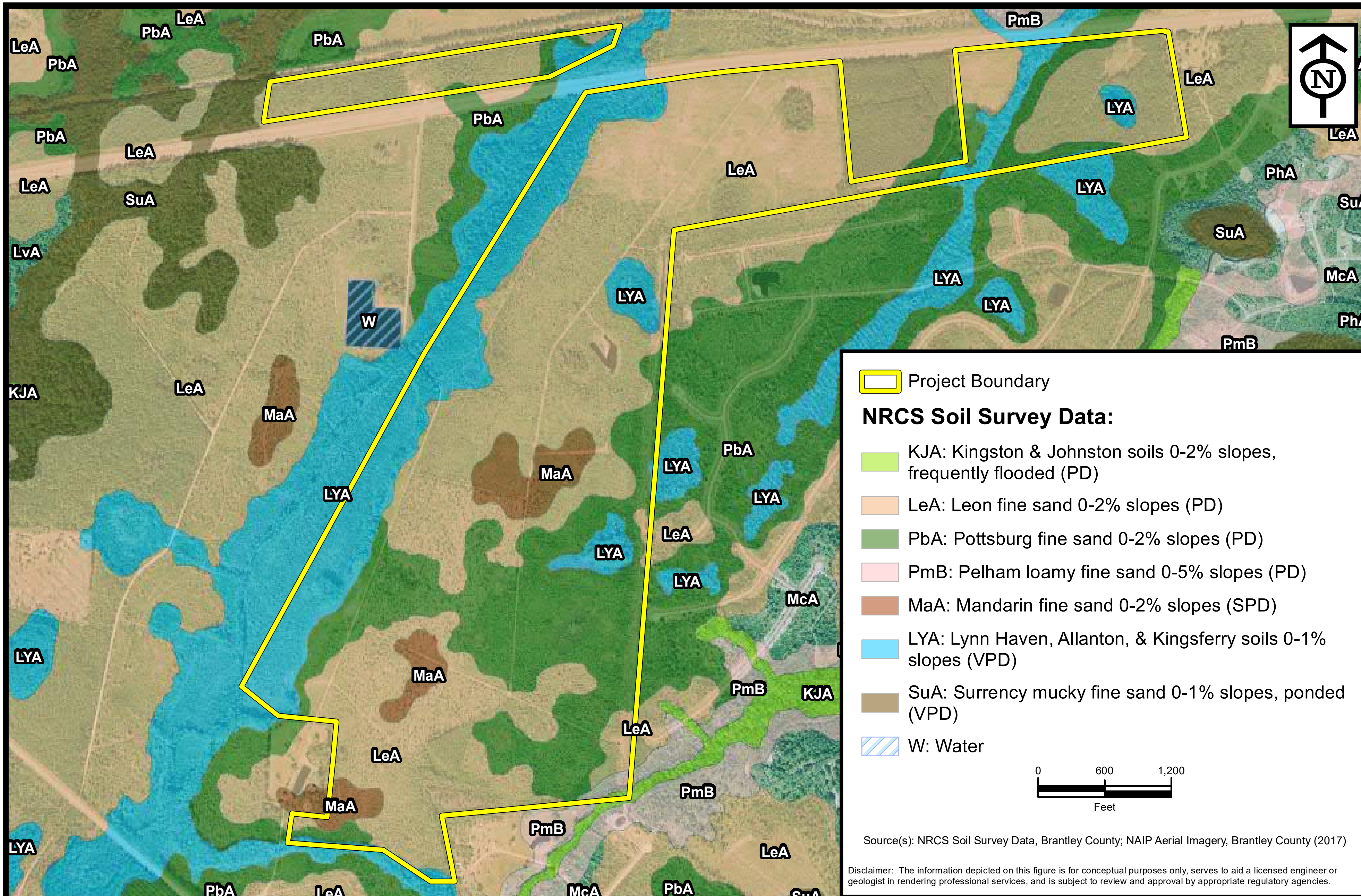
Georgia Rare Species & Natural Community Data

Brantley County Development Partners, LLC

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV/KHD
Figure:	4



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NRCS Soil Survey Data

US 82 Solid Waste Handling Facility - South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV/KHD
Figure:	5

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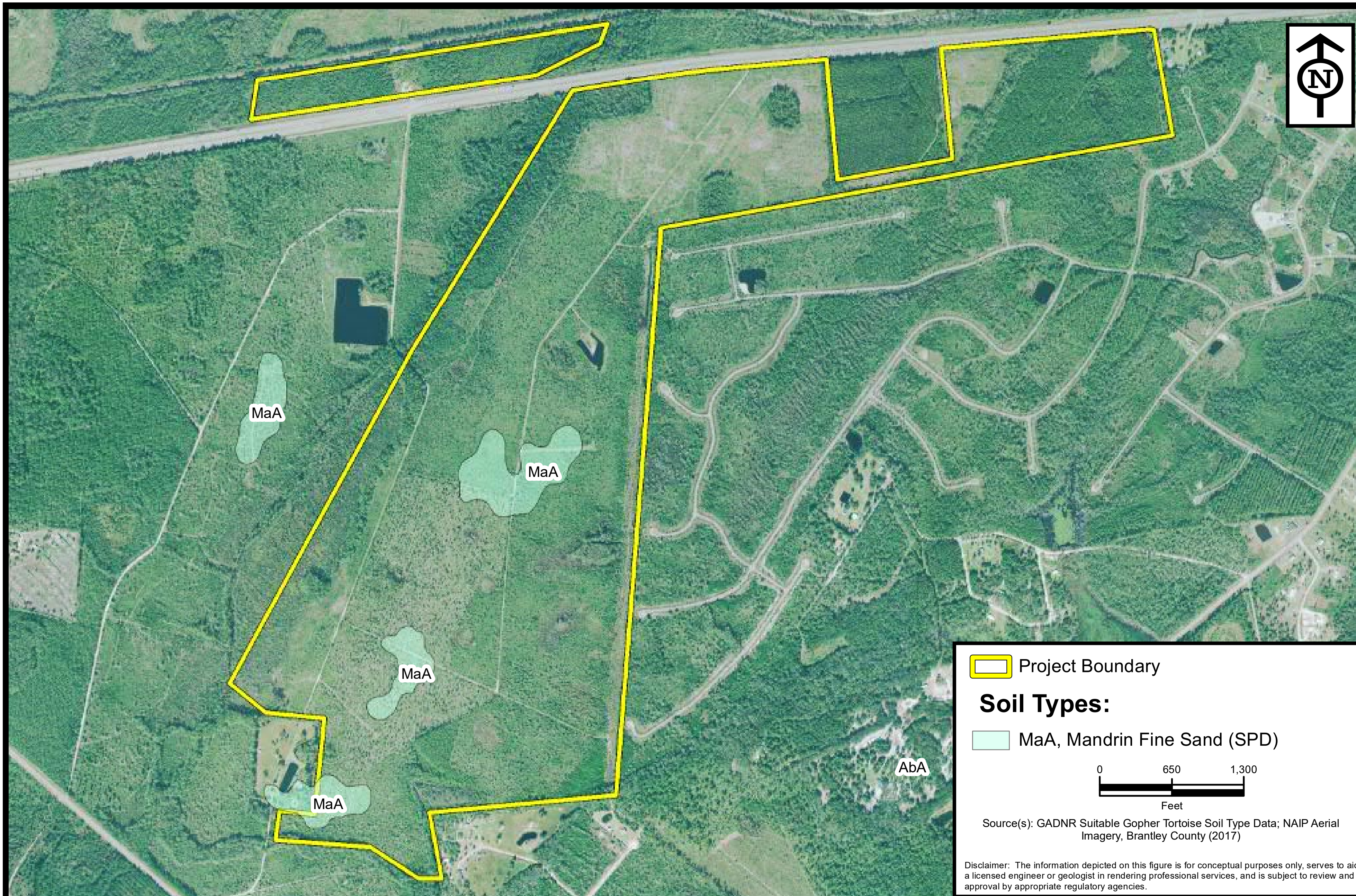

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Suitable Gopher Tortoise Soil

US 82 Solid Waste Handling Facility - South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV/KHD
Figure:	6

File: N:_ESILegacy\Data\Projects\Graphics\2014\ES14020.05\figures\ECO\GT Habitat.mxd Date: 7/18/2019 2:33:07 PM

Appendix 1

Photosheets

Photo 1: Pine Plantation Upland

Photo 2: Pine Plantation Upland

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Photo Sheet 1

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-1**

Photo 3: Early Successional Scrub / Shrub Uplands

Photo 4: Early Successional Scrub / Shrub Uplands

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Photo Sheet 2

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-2**

Photo 5: Early Successional Scrub / Shrub Uplands

Photo 6: Early Successional Scrub / Shrub Uplands

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Photo Sheet 3

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-3**

Photo 7: Mid-Successional Pine-Saw Palmetto Flatwoods Upland

Photo 8: Mid-Successional Pine-Saw Palmetto Flatwoods Upland

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Photo Sheet 4

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-4**

Photo 9: Hardwood/Pine Wetland

Photo 10: Hardwood/Pine Wetland

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Photo Sheet 5

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-5**

Photo 11: Hardwood/Pine Wetland

Photo 12: Hardwood/Pine Wetland

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Photo Sheet 6

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-6**

Photo 13: Borrow Pit

Photo 14: Borrow Pit

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Photo Sheet 7

Brantley County - US 82 Solid Waste Handling Facility –South

Brantley County, Georgia

Project:	ES14020.05
Date:	July 2019
Drwn/Chkd:	TLV / KHD
Figure:	**P-7**

Appendix 2

IPaC

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Brantley County, Georgia

Local office

Georgia Ecological Services Field Office

(706) 613-9493
(706) 613-6059

355 East Hancock Avenue

Room 320
Athens, GA 30601

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

---

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Birds

NAME	STATUS
Red-cockaded Woodpecker *Picoides borealis* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7614	Endangered
Wood Stork *Mycteria americana* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8477	Threatened

Reptiles

NAME	STATUS
Eastern Indigo Snake *Drymarchon corais couperi* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/646	Threatened
Gopher Tortoise *Gopherus polyphemus* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6994	Candidate

Flowering Plants

NAME	STATUS
Hairy Rattleweed *Baptisia arachnifera* No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8029	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

THERE ARE NO MIGRATORY BIRDS OF CONSERVATION CONCERN EXPECTED TO OCCUR AT THIS LOCATION.

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ “What does IPaC use to generate the migratory birds potentially occurring in my specified location”. Please be aware this report provides the “probability of presence” of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the “no data” indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ “Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds” at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER EMERGENT WETLAND

- PEM1C
- PEM1Fx
- PEM1Cx

FRESHWATER FORESTED/SHRUB WETLAND

- PFO4/1Bd
- PFO1/4C
- PSS3/4Bd
- PSS1/4C
- PFO1/2C
- PFO3Bd
- PFO2/1F
- PFO4B
- PFO1/3B
- PSS1/2C
- PSS1C
- PFO4/1C
- PFO6C
- PSS3/1C

FRESHWATER POND

- PUBHx

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix 3

2019 USFWS Response Email
2015 USFWS Response Letter
2019 GADNR Letter
2015 GADNR Letter
2015 NOAA Response Letter

2019 USFWS Response Email

Deason, Kristen H

From: gail_martinez@fws.gov on behalf of GAES Assistance, FW4 <gaes_assistance@fws.gov>
Sent: Tuesday, July 9, 2019 12:14 PM
To: Deason, Kristen H
Subject: Re: [EXTERNAL] Brantley County T&E Known Occurrence Request

Thank you for your request. Our records show that the information provided in your original request (USFWS file number 2015-1071) still stands and there have been no updates. Please feel free to contact me with any additional questions or concerns.
Thank you,
Gail Martinez

Georgia Ecological Services
US Fish and Wildlife Service
RG Stephens, Jr. Federal Building
355 East Hancock Avenue, Room 320, Box 7
Athens, GA 30601

On Tue, Jun 18, 2019 at 11:29 AM Kristen Deason <kdeason@esinc.cc> wrote:

Good Afternoon,

Please see the attached letter requesting known occurrences of T&E within the Brantley County parcel.

Kristen Deason

Senior Staff Scientist I Savannah, GA

Environmental Services, Inc., A Terracon Company

101 B Estus Drive I Savannah, GA 31404

D (912) 236 4711 I F (904) 470 2112 I M (301) 481 4921

kdeason@esinc.cc I www.esinc.cc I terracon.com

ENVIRONMENTAL SERVICES, INC.
A Terracon COMPANY

2015 USFWS Response Letter

United States Department of the Interior

Fish and Wildlife Service
105 West Park Drive, Suite D
Athens, Georgia 30606
Phone: (706) 613-9493
Fax: (706) 613-6059

West Georgia Sub-Office
Post Office Box 52560
Fort Benning, Georgia 31995-2560
Phone: (706) 544-6428
Fax: (706) 544-6419

Coastal Sub-Office
4980 Wildlife Drive
Townsend, Georgia 31331
Phone: (912) 832-8739
Fax: (912) 832-8744

October 7, 2015

Mr. Michael J. DeMell
Environmental Services, Inc.
Post Office Box 2383
Savannah, Georgia 31402

RE: USFWS File Number 2015-1071

Dear Mr. DeMell:

The Fish and Wildlife Service (Service) has reviewed your correspondence regarding your endangered species habitat assessment for a property located in Brantley County, Georgia (Latitude 31.219042, Longitude 81.82081). Your letter stated that you are currently reviewing the list of Federal Endangered and Threatened Species and State of Georgia Endangered and Threatened Species for Brantley County. You requested any information regarding the known presence of and federally listed species on or in the vicinity of the project area. We submit the following comments of this action under provisions of the Endangered Species Act of 1973, as amended; (16 U.S.C. 1531 *et seq.*).

For a list of Federal Endangered and Threatened Species and the State of Georgia Endangered and Threatened Species in your project area, please visit our Information, Planning, and Conservation System, IPaC. It can be accessed through our Georgia Ecological Services website at www.fws.gov/athens/. For more site-specific information, please contact the Georgia Natural Heritage Program at 770-918-6411 or visit their website, found at www.georgiawildlife.com. Please note, though the State's database is an initial indicator of species occurrence within a given region, the omission of a species within a specified quarter quad does not, for survey purposes, eliminate that species from concern if the species is listed for that county and suitable habitat exists in the action area. Both databases are works in progress and not all areas in Georgia have been thoroughly surveyed.

The project area falls within the range of the federally endangered Red-Cockaded woodpecker (Picoides borealis), the federally threatened Wood stork (*Mycteria americana*) and Federally Endangered plant, Hairy Rattleweed (*Baptisia arachnifera*), the federally threatened Eastern indigo snake *(Drymarchon corais couperi)* (indigo) as well as the federal candidate Gopher tortoise (Gopherus polyphemus) and state listed Rafinesque's big-eared bat *(Plecotus rafinesquii).*

There are several known occurrences of Hairy Rattleweed (*Baptisia arachnifera*) within eight miles of the project site. The project location is located within the thirteen mile core foraging areas for two wood stork (*Mycteria americana*) colonies. There are several known occurrences of Rafinesque's big-eared bat *(Plecotus rafinesquii)* within five miles of the project site. There are also known occurrences of the indigo in the area, the closest occurring within three miles from the project site. The indigo is a wide-ranging species that requires a mosaic of habitats to complete its annual life cycle. During summer months, these snakes prefer wetland edges where prey is abundant but snakes move to drier habitats in the winter. Indigoes use gopher tortoise burrows as shelter during the winter and during the warmer months for nesting and refuge from intense summer heat. We recommend complete wildlife surveys for listed and candidate species in order to complete your environmental review of the project site.

Thank you for the opportunity to provide comments during the planning stages of your project. Should you have further questions or need additional assistance please contact our Coastal Georgia Sub Office staff biologist, Gail Martinez, at 912-832-8739 extension 7.

Sincerely,

Strant Colwell

Strant Colwell
Coastal Office Supervisor

2019 GADNR Letter

MARK WILLIAMS
COMMISSIONER

RUSTY GARRISON
DIRECTOR

July 5, 2019

Kristen Deason
Senior Staff Scientist
101 Estus Drive
Suite B
Savannah, GA 31404

Subject: Known occurrences of natural communities, plants and animals of highest priority conservation status on or near Brantley County in Brantley County, Brantley County, GA.

Dear Kristen Deason:

This is in response to your request of July 3, 2019. Within a three-mile radius of the project site, there are the following Natural Heritage Database occurrences:

Brantley County Point 1 (Site Center: -81.819010, 31.217828 , WGS84)

US *Acipenser oxyrinchus oxyrinchus* (Atlantic Sturgeon)
2.4 miles W of site in Satilla River Huc 8 - 03070201
GA *Clemmys guttata* (Spotted Turtle) 8.9 miles NW of site in GA 32
GA *Clemmys guttata* (Spotted Turtle) 10.7 miles W of site in Rr Tracks
GA (Round-tailed Muskrat) 23.1 miles SW of site in
US *Trichechus manatus* (West Indian Manatee) 7.5 miles E of site in Coastal Georgia
US *Drymarchon couperi* (Eastern Indigo Snake) 2 miles S of site
GA *Elanoides forficatus* (Swallow-tailed Kite) 3 miles SW of site
Farancia erytrogramma erytrogramma (Common Rainbow Snake) [HISTORIC?]
1.4 miles W of site
US *Gopherus polyphemus* (Gopher Tortoise) 2.3 miles SE of site
Ilex amelanchier (Serviceberry Holly) [HISTORIC?] 1.7 miles W of site
Plantago sparsiflora (Pineland Plantain) [HISTORIC] 0.8 miles NW of site
Rhadinaea flavilata (Pine Woods Snake) [HISTORIC] 2.8 miles S of site
GA *Sarracenia minor var. minor* (Hooded Pitcherplant) 2.7 miles W of site
***Tillandsia bartramii* (Bartram's Air-plant) [HISTORIC] in an uncertain location on or near the project site**
Wading Bird Colony (Wading Bird Colony) 0.6 miles NW of site
Wading Bird Colony (Wading Bird Colony) 0.6 miles NW of site
Wading Bird Colony (Wading Bird Colony) 0.6 miles NW of site
Wading Bird Colony (Wading Bird Colony) 0.6 miles NW of site
Wetlands Reserve Program 2.1 miles W of site
0307020111 Satilla River 2 (0307020111) [SWAP High Priority Watershed]

0307020303 Satilla River Coast 2 (0307020303) [SWAP High Priority Watershed]
0307020301 Turtle River (0307020301) [SWAP High Priority Watershed]

Recommendations:

Federally listed terrestrial species have been documented within three miles of the proposed project. Aquatic protected species have been documented in the same watershed. To minimize potential impacts to federally listed species, we recommend consultation with the United States Fish and Wildlife Service. Please contact the following: In North Georgia, email Robin Goodloe at GAES_Assistance@fws.gov. In Southeast Georgia, call the Coastal Georgia Office at 912-832-8739. In Southwest Georgia, please contact John Doresky at 706-544-6030 or John_Doresky@fws.gov.

Please be aware that state protected terrestrial species have been documented within three miles of the proposed project and aquatic species have been documented within the same watershed. For information about these species, including survey recommendations, please visit our webpage at http://www.georgiawildlife.org/rare_species_profiles. Surveys for species of conservation concern should be conducted prior to commencement of construction.

If the applicant is willing to assume presence and implement provisions to protect state listed aquatic species identified during this review, it may not be necessary to complete any additional surveys for aquatic species. Please refer to the Aquatic Survey Determination Protocol for State Listed Species in determining whether surveys are recommended. For any additional questions about aquatics, please contact Paula Marcinek at Paula.Marcinek@dnr.ga.gov.

Disclaimer:

Please keep in mind the limitations of our database. The data collected by the Wildlife Conservation Section comes from a variety of sources, including museum and herbarium records, literature, and reports from individuals and organizations, as well as field surveys by our staff biologists. In most cases the information is not the result of a recent on-site survey by our staff. Many areas of Georgia have never been surveyed thoroughly. Therefore, the Wildlife Conservation Section can only occasionally provide definitive information on the presence or absence of rare species on a given site. Our files are updated constantly as new information is received. **Thus, information provided by our program represents the existing data in our files at the time of the request and should not be considered a final statement on the species or area under consideration.**

If you know of populations of highest priority species that are not in our database, please fill out the appropriate data collection form and send it to our office. Forms can be obtained through our web site https://georgiawildlife.com/conservation/species-of-concern#providing or by contacting our office.

If I can be of further assistance, please let me know.

Sincerely,

Anna Yellin
Wildlife Biologist II

Data Available on the Nongame Conservation Section Website

- Georgia protected plant and animal profiles are available on our website. These accounts cover basics like descriptions and life history, as well as threats, management recommendations and conservation status. Visit http://georgiabiodiversity.org/natels/general-info.html.

- Rare species and natural community information can be viewed by Quarter Quad, County and HUC8 Watershed. To access this information, please visit our GA Rare Species and Natural Community Data Portal at: http://georgiabiodiversity.org/

- Downloadable files of rare species and natural community data by Quarter Quad and County are also available. Please visit: http://georgiabiodiversity.org/natels/natural-element-locations.html

2015 GADNR Letter

MARK WILLIAMS
COMMISSIONER

DAN FORSTER
DIRECTOR

November 2, 2015

Michael DeMell
Vice-President and Operations Manager
Environmental Services, Inc.
PO Box 2383
Savannah, GA 31402

Subject: Known occurrences of natural communities, plants and animals of highest priority conservation status on or near ESI Project No: ES14020.01, Brantley County, Georgia

Dear Mr. DeMell:

This is in response to your request of September 29, 2015. According to our records, within a three-mile radius of the project site, there are the following Natural Heritage Database occurrences:

US *Drymarchon couperi* (Eastern Indigo Snake) approx. 3.0 mi. S of site
Farancia erytrogramma erytrogramma (Common Rainbow Snake) [HISTORIC?] approx. 2.0 mi. W of site
US *Gopherus polyphemus* (Gopher Tortoise) approx. 3.0 mi. SE of site
Ilex amelanchier (Serviceberry Holly) [HISTORIC?] approx. 2.5 mi. W of site
Plantago sparsiflora (Pineland Plantain) [HISTORIC] approx. 1.0 mi. W of site
Tillandsia bartramii (Bartram's Air-plant) in an uncertain location near the project site
Wading Bird Colony (Wading Bird Colony) approx. 1.0 mi. NW of site
Satilla River [High Priority Stream] approx. 2.5 mi. W of site

* Entries above proceeded by "US" indicates species with federal status in Georgia (Protected or Candidate). Species that are federally protected in Georgia are also state protected; "GA" indicates Georgia protected species.

Recommendations:

We have no records of high priority species or habitats within the project area. However, a federally listed species, *Drymarchon couperi* (Eastern Indigo Snake), has been documented within three miles of the proposed project. To minimize potential impacts to this or other federally listed species, we recommend consultation with the United States Fish and Wildlife Service. For southeast Georgia, please contact Strant Colwell (912) 832-8739 ext 1 or Strant_Colwell@fws.gov). Surveys for species of conservation concern should be conducted prior to commencement of construction.

This project is within three miles of several state protected species. For information about these species, including survey recommendations, please visit our webpage at http://www.georgiawildlife.org/rare_species_profiles.

Construction activities in the vicinity of water-bird rookeries should be approached with caution. Disturbance near the colony can lead to nest failure and possible abandonment. The nesting season extends from Mid-February to the end of July. Please avoid activities within 400 m (1300 ft.) from the periphery of rookeries during this time if possible.

This project occurs near the Satilla River, a high priority stream. As part of an effort to develop a comprehensive wildlife conservation strategy for the state of Georgia, the Wildlife Resources Division developed and mapped a list of streams that are important to the protection or restoration of rare aquatic species and aquatic communities. High priority waters and their surrounding watersheds are important for aquatic biodiversity conservation, but do not receive any additional legal protections. We now have GIS ESRI shapefiles of GA high priority waters available on our website (http://www.georgiawildlife.com/node/1377). Please contact this office if you would like additional information on high priority waters.

We are concerned about stream habitats that could be impacted by construction activities. In order to protect aquatic habitats and water quality, we recommend that all machinery be kept out of streams during construction. We urge you to use stringent erosion control practices during construction activities. Further, we strongly advocate leaving vegetation intact within 100 feet of streams wherever possible, which will reduce inputs of sediments, assist with maintaining riverbank integrity, and provide shade and habitat for aquatic species. We realize that some trees may have to be removed, but recommend that shrubs and ground vegetation be left in place.

Disclaimer:

Please keep in mind the limitations of our database. The data collected by the Nongame Conservation Section comes from a variety of sources, including museum and herbarium records, literature, and reports from individuals and organizations, as well as field surveys by our staff biologists. In most cases the information is not the result of a recent on-site survey by our staff. Many areas of Georgia have never been surveyed thoroughly. Therefore, the Nongame Conservation Section can only occasionally provide definitive information on the presence or absence of rare species on a given site. Our files are updated constantly as new information is received. **Thus, information provided by our program represents the existing data in our files at the time of the request and should not be considered a final statement on the species or area under consideration.**

If you know of populations of highest priority species that are not in our database, please fill out the appropriate data collection form and send it to our office. Forms can be obtained through our web site (http://www.georgiawildlife.com/node/1376) or by contacting our office. If I can be of further assistance, please let me know.

Sincerely,

Anna Yellin
Environmental Review Coordinator

Data Available on the Nongame Conservation Section Website

- Georgia protected plant and animal profiles are available on our website. These accounts cover basics like descriptions and life history, as well as threats, management recommendations and conservation status. Visit http://www.georgiawildlife.com/node/2721.

- Rare species and natural community information can be viewed by Quarter Quad, County and HUC8 Watershed. To access this information, please visit our GA Rare Species and Natural Community Information page at: http://www.georgiawildlife.com/conservation/species-of-concern?cat=conservation.

- Downloadable files of rare species and natural community data by quarter quad and county are also available. They can be downloaded from: http://www.georgiawildlife.com/node/1370.

2015 NOAA Response Letter

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701-5505
http://sero.nmfs.noaa.gov

October 1, 2015

Michael J. DeMell
Senior Vice President II/Technical Director
Environmental Services, Inc.
P.O. Box 2383
Savannah, GA 31402

Dear Mr. DeMell:

Pursuant to section 7(a)(2) of the Endangered Species Act (ESA), the Protected Resources Division of NOAA's National Marine Fisheries Service has reviewed your letter dated September 28, 2015, concerning ESI Project No.: ES14020.01 – Brantley County, Georgia.

There are no ESA-listed species or designated critical habitat under our purview in the action area. If you have any questions, please contact our ESA section 7 Coordinator, Kelly Shotts at (727) 824-5312 or by e-mail at Kelly.shotts@noaa.gov.

Sincerely,

Teletha Mincey
Program Analyst
Protected Resources Division

Appendix 4

5 May 2016 Jurisdictional Determination (USACE)

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
100 W. OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401-3604

REPLY TO
ATTENTION OF:

MAY 05 2016

Regulatory Division
SAS-2015-00746

Mr. John W. Kelly and Mr. C. Lee Wooddall
Brantley County Development Partners, LLC
2255 Cumberland Parkway, Building 1700/2nd Floor
Atlanta, Georgia 30339

RECEIVED
5/10/16

Dear Mr. Kelly and Mr. Wooddall:

I refer to a letter dated October 19, 2015, and supplemental information received February 23, 2016, and March 29, 2016, submitted on your behalf by Mr. Michael J. DeMell, Environmental Services, Inc., requesting a Jurisdictional Determination (JD) for your 487.61 acre site located south of Georgia Highway 82, near the City of Waynesville, in Brantley County, Georgia (Latitude 31.2186, Longitude -81.8189). This project has been assigned number SAS-2015-00746 and it is important that you refer to this number in all communication concerning this matter.

We have completed a preliminary JD for the site. The wetlands were delineated in accordance with criteria contained in the 1987 "Corps of Engineers Wetland Delineation Manual," as amended by the most recent regional supplements to the manual.

We have also completed an approved JD for the site for the isolated, non-jurisdictional wetlands. These wetlands were delineated in accordance with criteria contained in the 1987 "Corps of Engineers Wetland Delineation Manual," as amended by the most recent regional supplements to the manual. I have enclosed an "Approved JD Form," which details whether streams, wetlands and/or other waters present on the site are subject to the jurisdiction of the U.S. Army Corps of Engineers and how the Corps determined jurisdiction.

The wetlands/other waters on the subject property, with exceptions of wetlands and waters: "Wetland 4", "Wetland 5", "Wetland 6", "Wetland 8", "Wetland 10", "Wetland 13", "Wetland 16", "Wetland 17", and "Wetland 18", may be waters of the United States within the jurisdiction of Section 404 of the Clean Water Act (33 United States Code (U.S.C.) 1344) and/or Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). The enclosed survey entitled "Brantley County US Hwy 82 Wetlands Mapping, Brantley County, Georgia, Wetlands Boundary Mapping - Index", Sheet No. 1.0 through Sheet No. 9.0, dated March 29, 2016, and signed by Registered Land Surveyor Robert O. Jordan of Jordan Engineering, Registration Number 2902, is an accurate delineation of all the jurisdictional boundaries on the site. This delineation will remain valid for a period of 5-years unless new information warrants revision prior to that date.

The placement of dredged or fill material into any waterways and/or their adjacent wetlands or mechanized land clearing of those wetlands would require prior Department of the Army authorization pursuant to Section 404. Please note: this preliminary JD and any Corps approved survey and/or GPS delineation, can be used for the purpose of supporting a future permit application.

Preliminary JDs are advisory in nature and may not be appealed (see 33 Code of Federal Regulations (CFR) 331.2). If you are not in agreement with this preliminary JD, then you may request an approved JD for your project site or review area.

There are isolated non-jurisdictional waters present that are not subject to Clean Water Act jurisdiction. Specifically, wetlands: "Wetland 4", "Wetland 5", "Wetland 6", "Wetland 8", "Wetland 10", "Wetland 13", "Wetland 16", "Wetland 17", and "Wetland 18", as identified on the exhibit entitled "Brantley County US Hwy 82 Wetlands Mapping, Brantley County, Georgia, Wetlands Boundary Mapping - Index", Sheet No. 1.0 through Sheet No. 9.0, dated March 29, 2016, and signed by Registered Land Surveyor Robert O. Jordan of Jordan Engineering, Registration Number 2902 is/are isolated, non-jurisdictional wetlands. Department of the Army authorization, pursuant to Section 404 of the Clean Water Act (33 United States Code 1344), is not required for dredge and/or fill activities in these areas. This approved JD will remain valid for a period of 5-years unless new information warrants revision prior to that date.

You may request an administrative appeal for any approved JD under the Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Administrative Appeal Options and Process and Request for Appeal form.

If you intend to sell property that is part of a project that requires Department of the Army Authorization, it may be subject to the Interstate Land Sales Full Disclosure Act. The Property Report required by Housing and Urban Development Regulation must state whether, or not a permit for the development has been applied for, issued or denied by the Corps (Part 320.3(h) of Title 33 of the Code of Federal Regulations).

This communication does not convey any property rights, either in real estate or material, or any exclusive privileges. It does not authorize any injury to property, invasion of rights, or any infringement of federal, state or local laws, or regulations. It does not obviate your requirement to obtain state or local assent required by law for the development of this property. If the information you have submitted, and on which the Corps has based its determination is later found to be in error, this decision may be revoked.

A copy of this letter is being provided to the following party: Mr. Michael J. DeMell, Environmental Services, Inc., 101B Estus Drive, Savannah, Georgia 31404.

Thank you in advance for completing our on-line Customer Survey Form located at http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey. We value your comments and appreciate your taking the time to complete a survey each time you interact with our office.

If you have any questions, please call me, at 912-652-5086.

Sincerely,

Shaun Blocker
Project Manager, Coastal Branch

Enclosures

REFERENCES:
PRELIMINARY WETLANDS SKETCH PROVIDED BY ENVIRONMENTAL SERVICES, INC.

PLAT RECORD: PLAT PREPARED BY CHARLES H. TOMBERLIN AND ASSOCIATES, MAY 6, 2013.

BOUNDARY-TIE FIELD DATA WAS COLLECTED USING A JAVAD TRIUMPH-LS DUAL FREQUENCY RTK GLOBAL POSITIONING SYSTEM RECEIVER REFERENCING THE eGPS STATEWIDE NETWORK AND HAVING A RELATIVE POSITIONAL ACCURACY OF LESS THAN 0.04 FEET.

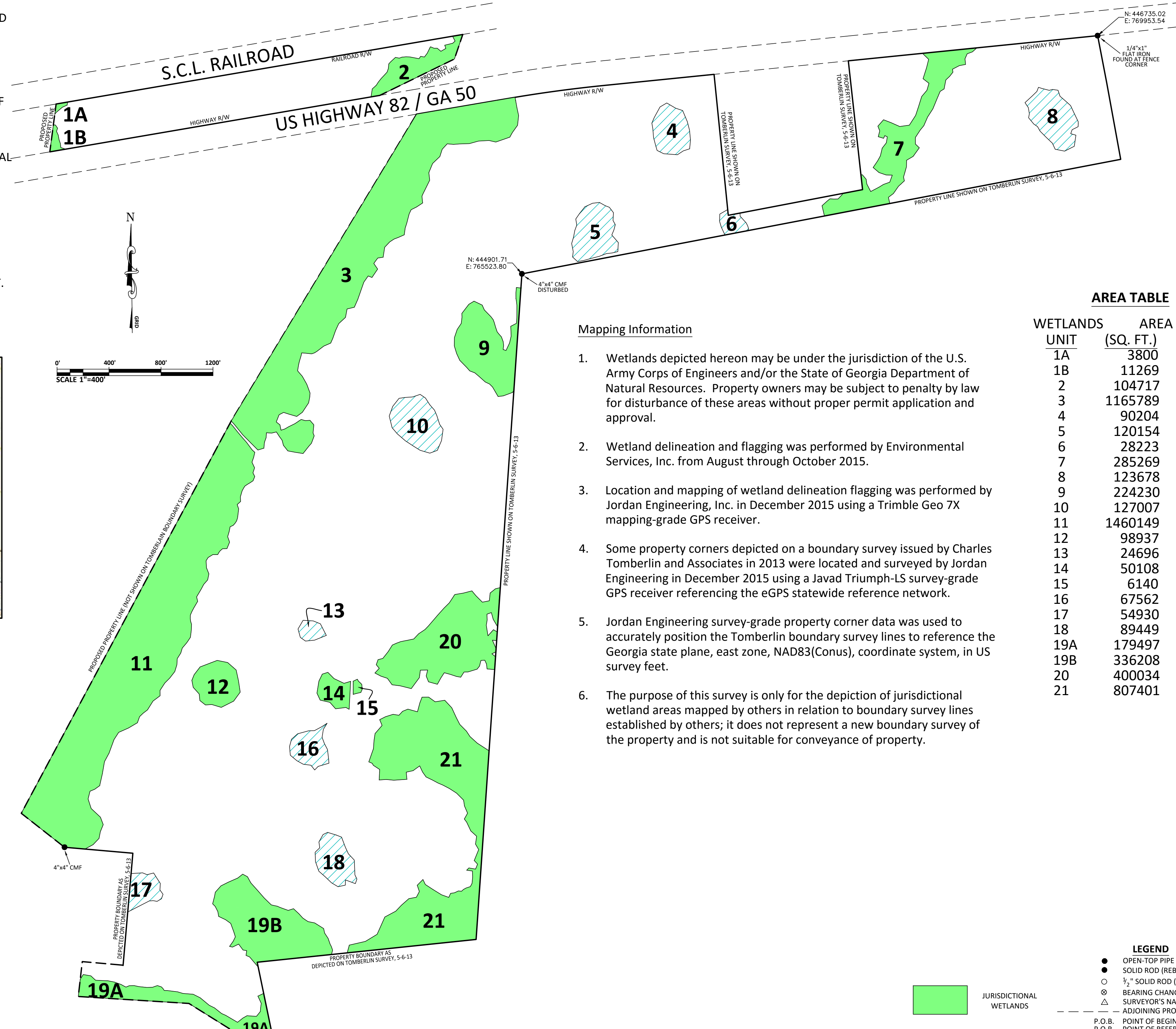
WETLANDS MAPPING FIELD DATA WAS COLLECTED USING A TRIMBLE GEO 7X GPS RECEIVER HAVING A RELATIVE POSITIONAL ACCURACY OF LESS THAN 3 FEET.

THE FIELD DATA WAS COLLECTED IN DECEMBER 2015.

EASEMENTS OR RIGHTS-OF-WAY MAY EXIST WHICH ARE NOT SHOWN HEREON AND MAY BE RECORDED OR UNRECORDED.

COORDINATES DEPICTED HEREON REFERENCE THE GEORGIA STATE PLANE SYSTEM, EAST ZONE, NAD83(CONUS), IN US FEET. VERTICAL INFORMATION WHERE PROVIDED HEREON REFERENCES THE NAVD88 VERTICAL DATUM.

SITE LOCATION MAP



Mapping Information

1. Wetlands depicted hereon may be under the jurisdiction of the U.S. Army Corps of Engineers and/or the State of Georgia Department of Natural Resources. Property owners may be subject to penalty by law for disturbance of these areas without proper permit application and approval.

2. Wetland delineation and flagging was performed by Environmental Services, Inc. from August through October 2015.

3. Location and mapping of wetland delineation flagging was performed by Jordan Engineering, Inc. in December 2015 using a Trimble Geo 7X mapping-grade GPS receiver.

4. Some property corners depicted on a boundary survey issued by Charles Tomberlin and Associates in 2013 were located and surveyed by Jordan Engineering in December 2015 using a Javad Triumph-LS survey-grade GPS receiver referencing the eGPS statewide reference network.

5. Jordan Engineering survey-grade property corner data was used to accurately position the Tomberlin boundary survey lines to reference the Georgia state plane, east zone, NAD83(Conus), coordinate system, in US survey feet.

6. The purpose of this survey is only for the depiction of jurisdictional wetland areas mapped by others in relation to boundary survey lines established by others; it does not represent a new boundary survey of the property and is not suitable for conveyance of property.

AREA TABLE

WETLANDS UNIT	AREA (SQ. FT.)	AREA (ACRES)
1A	3800	0.09
1B	11269	0.26
2	104717	2.40
3	1165789	26.76
4	90204	2.07
5	120154	2.76
6	28223	0.65
7	285269	6.55
8	123678	2.84
9	224230	5.14
10	127007	2.92
11	1460149	33.52
12	98937	2.27
13	24696	0.57
14	50108	1.15
15	6140	0.14
16	67562	1.55
17	54930	1.26
18	89449	2.05
19A	179497	4.12
19B	336208	7.72
20	400034	9.18
21	807401	18.54

JURISDICTIONAL WETLANDS

NON-JURISDICTIONAL WETLANDS

LEGEND

- ● OPEN-TOP PIPE FOUND
- ● SOLID ROD (REBAR) FOUND
- ○ 1/2" SOLID ROD (REBAR) SET
- ⊗ BEARING CHANGE (NO PIN SET)
- △ SURVEYOR'S NAIL SET
- — — — ADJOINING PROPERTY LINE
- P.O.B. POINT OF BEGINNING
- P.O.R. POINT OF REFERENCE
- NOF NOW OR FORMERLY
- D.B. DEED BOOK
- P.B. PLAT BOOK
- LL LAND LOT
- OTP OPEN-TOP PIPE
- CMF CONCRETE MONUMENT FOUND

JORDAN ENGINEERING
144 N. WARREN ST. MONTICELLO, GA. 31064
TELEPHONE: (706) 468-8999
Land Planning • Surveying • Soils Classification

GEORGIA REGISTERED No. 2902 LAND SURVEYOR ROBERT O. JORDAN

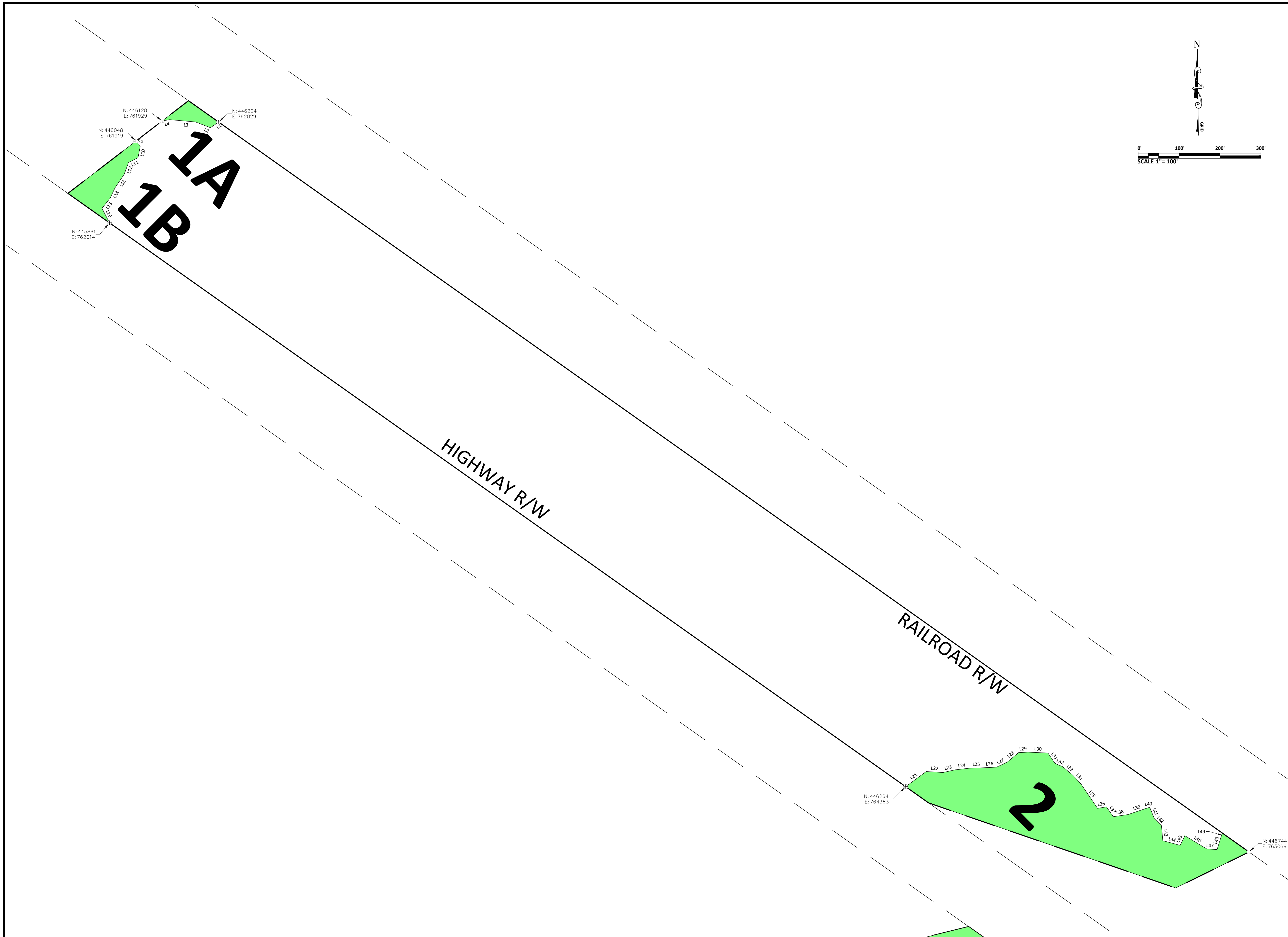
WETLANDS BOUNDARY MAPPING - INDEX

Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

Rev	Revision Description	Date
0	Initial Issue	12/23/15
1	Area 1A acreage typo corrected	2/17/16
2	Wetlands line calls added - all sheets	3/29/16

As Noted

Sheet No.
1.0



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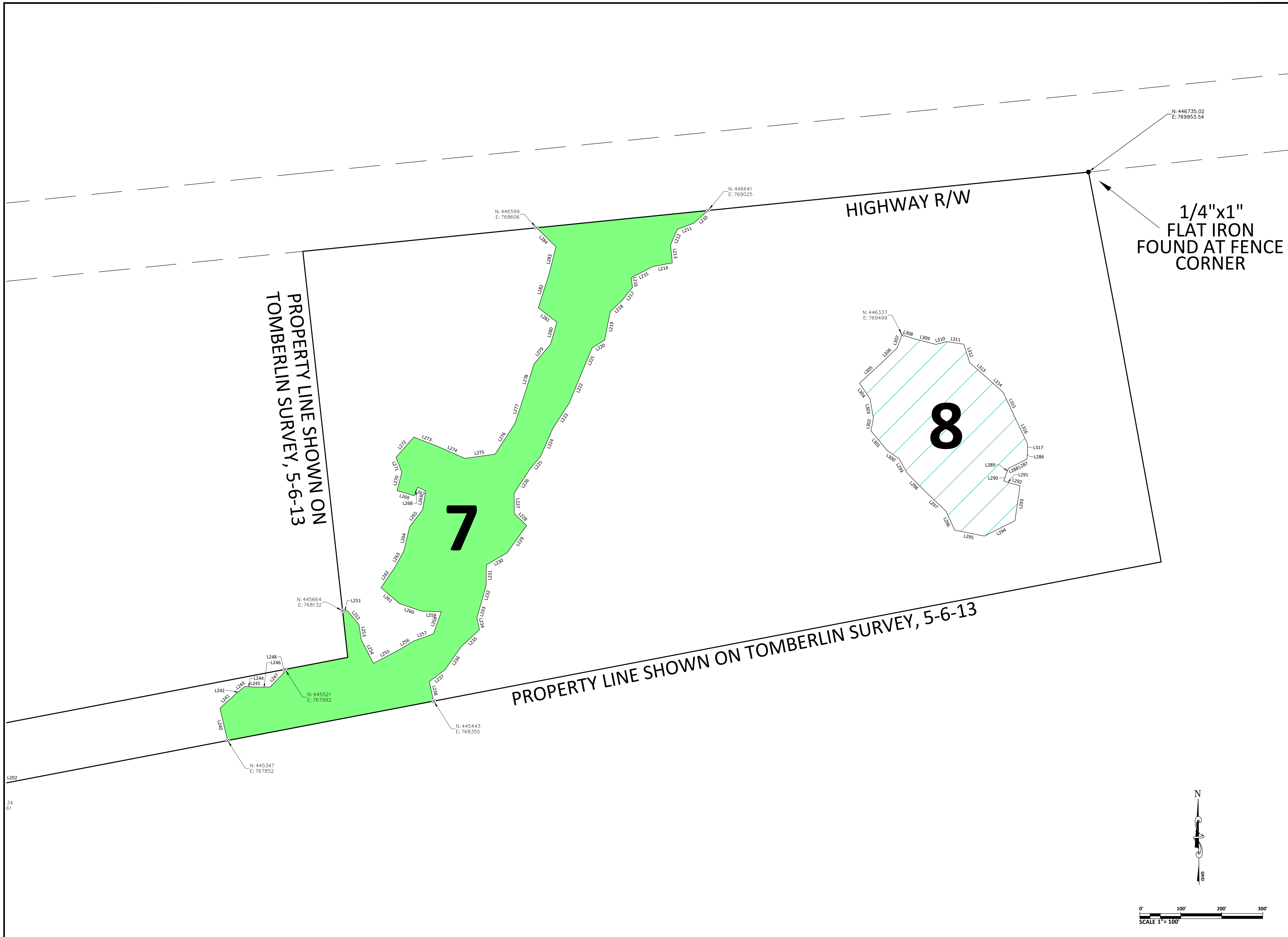
Sheet No.
2.0



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WETLANDS BOUNDARY MAPPING

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Wetlands Mapping
Brantley County, Georgia

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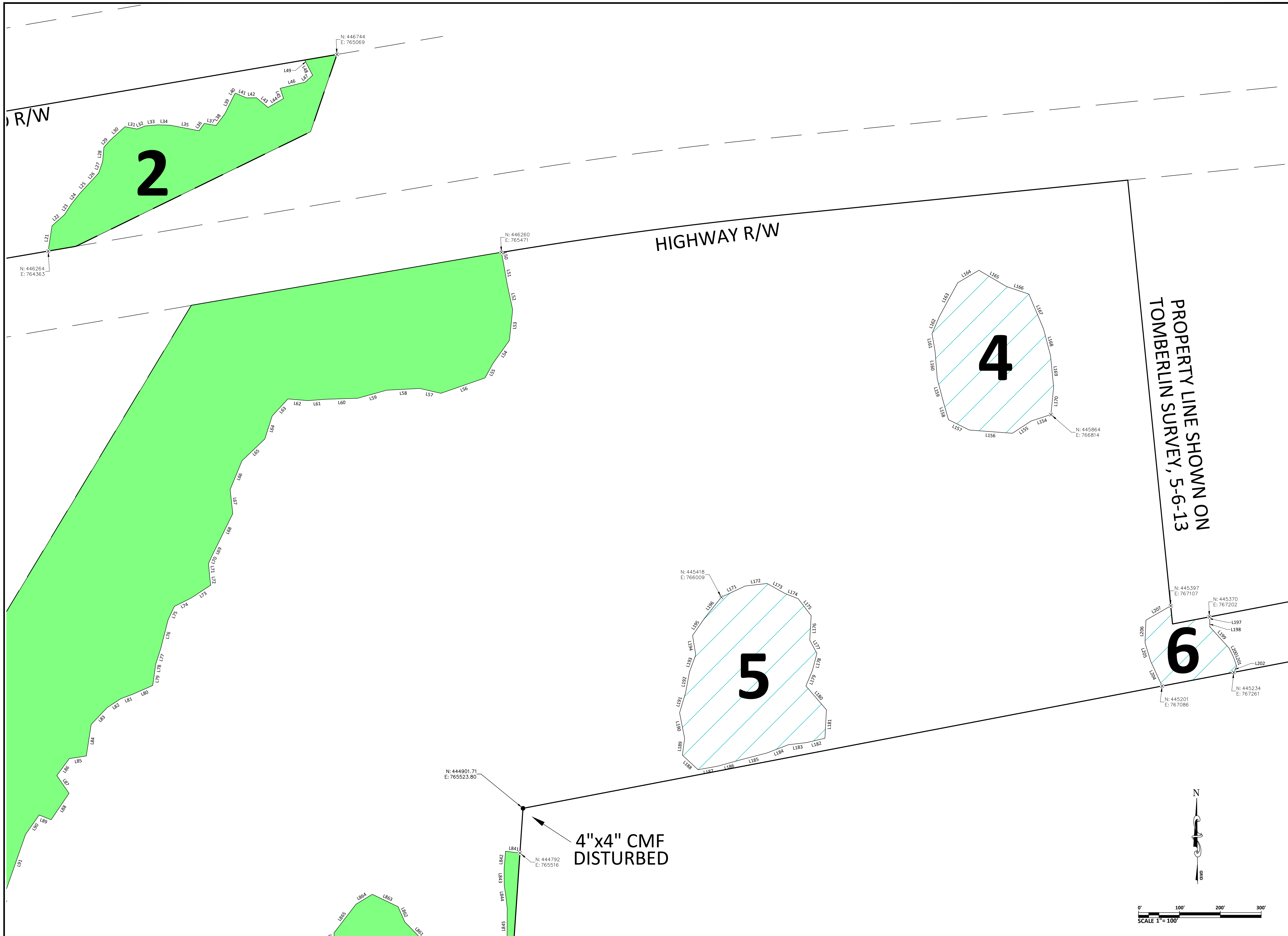
Sheet No.
3.0



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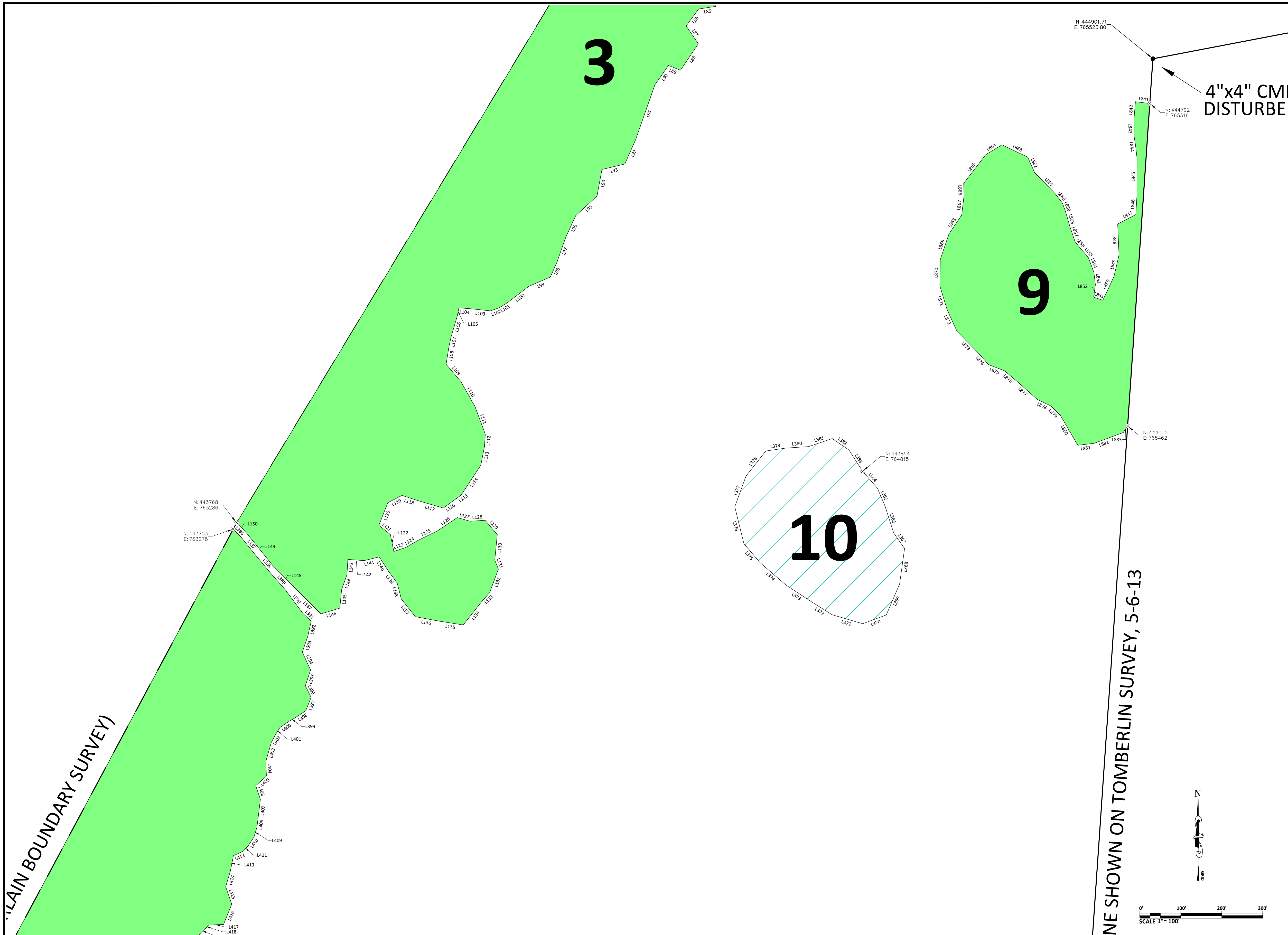
Sheet No.
4.0



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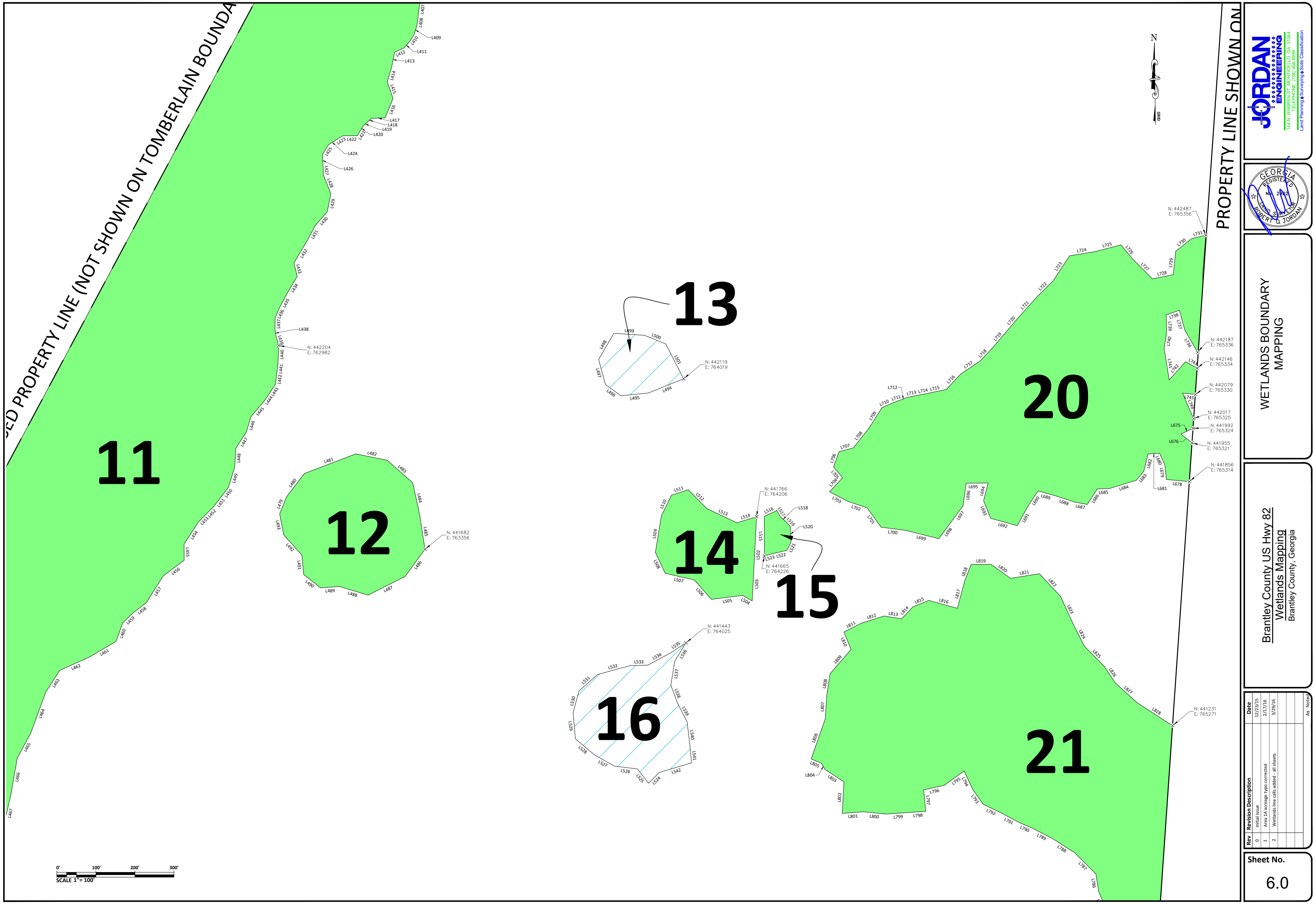
Sheet No.
5.0


ED PROPERTY LINE (NOT SHOWN ON TOMBERLAIN BOUNDA
PROPERTY LINE SHOWN ON
N
11
12
13
14
15
16
20
21
0'
100'
200'
300'
SCALE 1" = 100'
JORDAN ENGINEERING
WETLANDS BOUNDARY MAPPING
Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia
Rev
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Date
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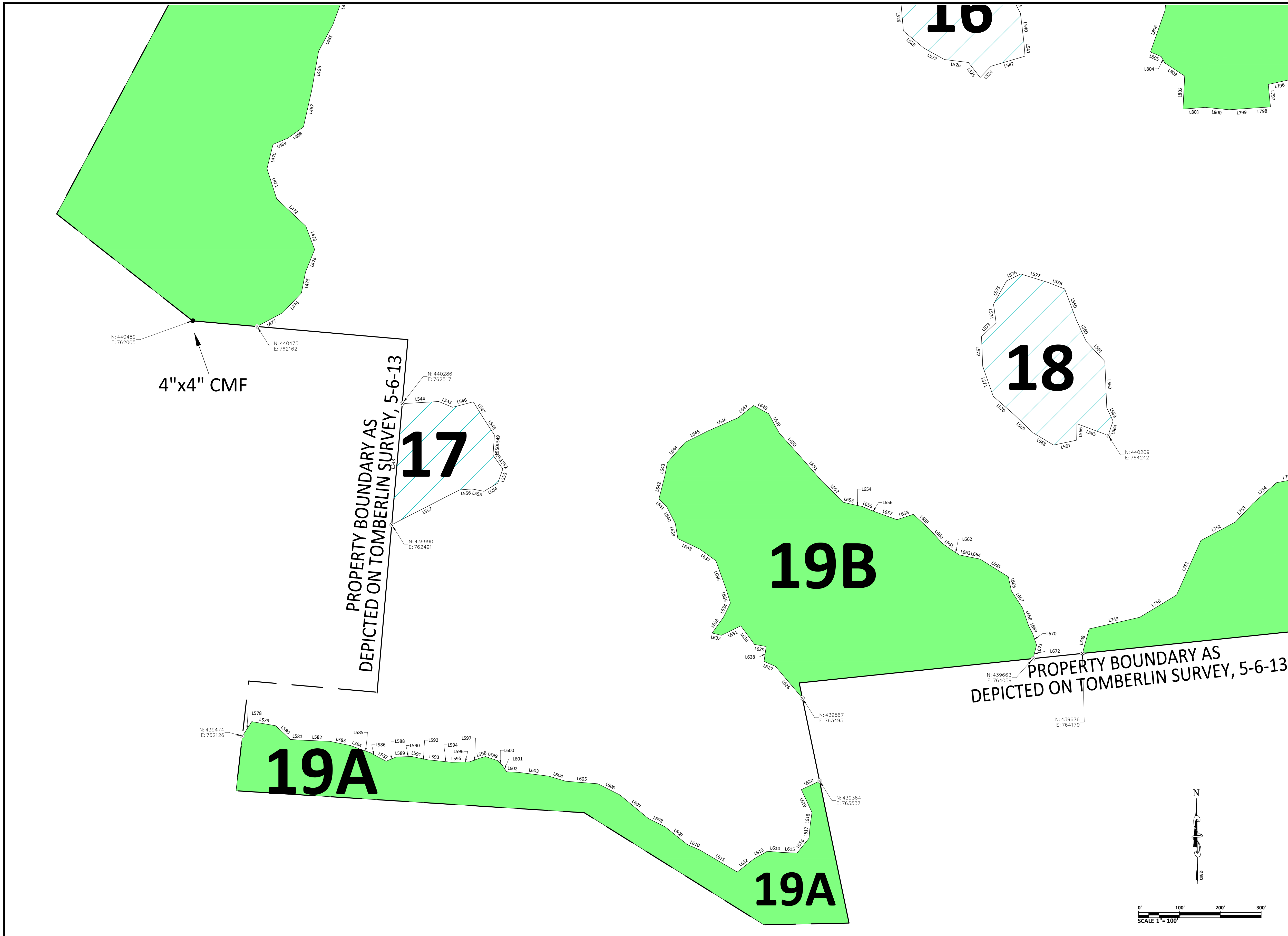

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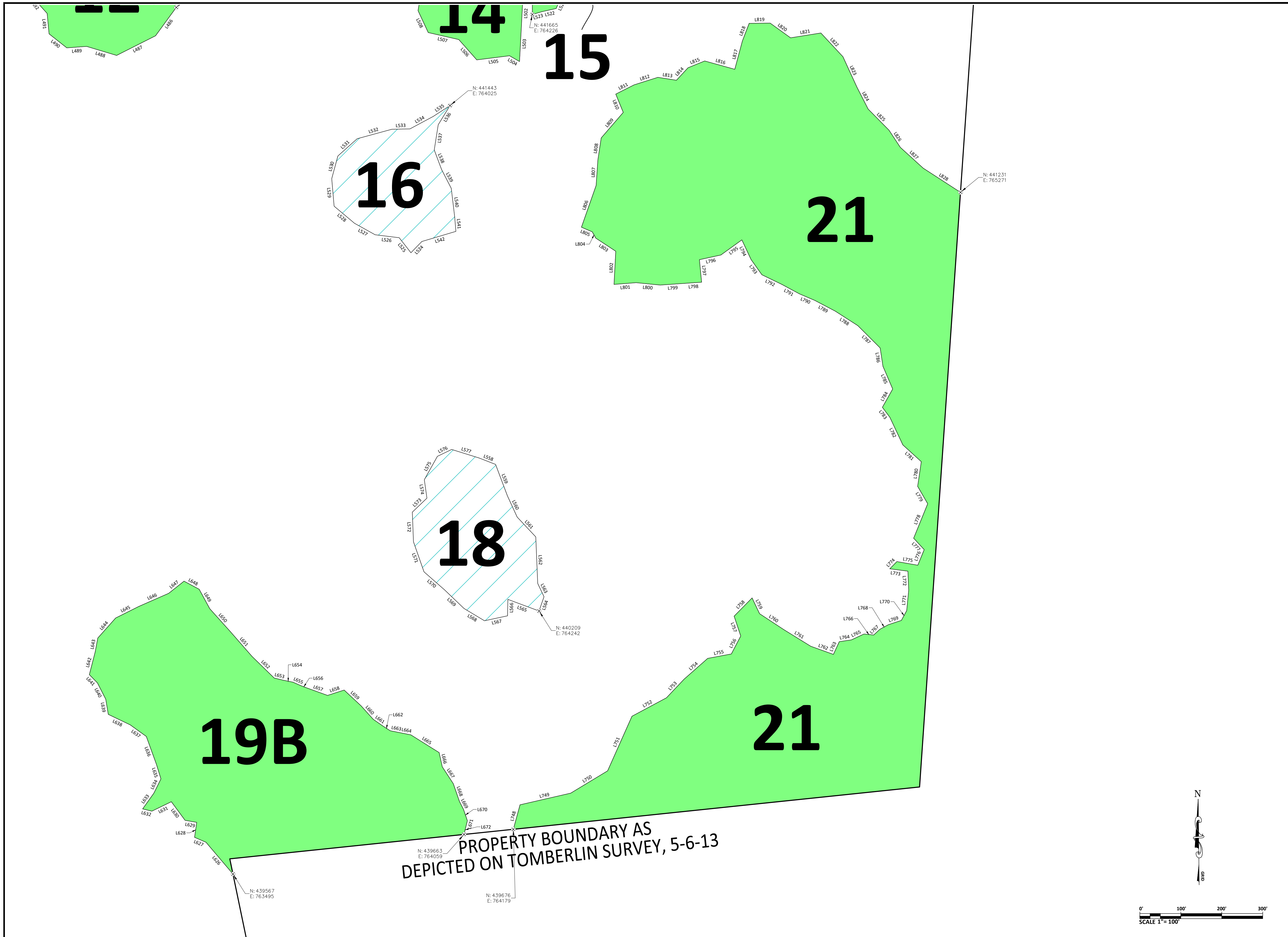

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As Noted

Sheet No.
8.0

Parcel Line Table

Line	Direction	Length
L1	S10°32'21"W	24.39'
L2	S66°06'46"W	38.96'
L3	S50°03'50"W	63.39'
L4	S35°10'14"W	18.82'
L9	S86°52'50"E	16.13'
L10	S33°53'41"E	29.13'
L11	S17°45'54"W	26.18'
L12	S24°49'44"E	30.42'
L13	S10°41'53"E	38.93'
L14	S19°26'59"E	28.64'
L15	S6°18'00"E	31.73'
L16	S72°09'21"E	39.86'
L21	N8°37'32"E	62.40'
L22	N48°16'42"E	41.06'
L23	N32°32'16"E	29.84'
L24	N38°33'02"E	36.44'
L25	N43°18'05"E	32.66'
L26	N42°25'54"E	33.03'
L27	N19°11'32"E	29.65'
L28	N4°55'49"E	35.22'

Parcel Line Table

Line	Direction	Length
L29	N42°13'33"E	23.05'
L30	N47°28'57"E	48.83'
L31	S79°03'35"E	30.43'
L32	N68°44'49"E	20.88'
L33	N84°53'23"E	31.48'
L34	S88°11'18"E	29.38'
L35	S79°15'11"E	72.44'
L36	N35°34'31"E	21.95'
L37	S80°05'53"E	29.24'
L38	N36°55'58"E	35.94'
L39	N26°12'00"E	52.49'
L40	N38°47'53"E	3.95'
L41	S67°05'53"E	29.38'
L42	N89°31'07"E	24.39'
L43	S50°10'40"E	36.87'
L44	N60°00'06"E	43.75'
L45	N18°26'38"W	26.24'
L46	N76°07'30"E	62.93'
L47	N47°39'21"E	24.74'
L48	N27°31'59"W	41.99'

Parcel Line Table

Line	Direction	Length
L49	N27°31'59"W	41.99'
L50	S11°03'03"E	24.66'
L51	S10°05'01"E	57.51'
L52	S12°10'34"E	60.61'
L53	S6°10'29"W	75.54'
L54	S35°28'42"W	68.74'
L55	S28°58'18"W	40.75'
L56	S70°47'38"W	114.11'
L57	N77°06'44"W	52.99'
L58	S86°58'03"W	80.98'
L59	S74°29'55"W	73.61'
L60	S88°09'13"W	77.56'
L61	S85°41'33"W	44.49'
L62	N85°04'44"W	48.75'
L63	S42°40'49"W	56.85'
L64	S17°48'32"W	58.83'
L65	S46°16'21"W	77.25'
L66	S22°24'45"W	75.97'
L67	S6°19'49"E	59.19'
L68	S26°11'23"W	82.90'

Parcel Line Table

Line	Direction	Length
L69	S26°46'59"W	27.67'
L70	S24°27'33"W	24.90'
L71	S4°46'01"E	31.02'
L72	S7°09'39"E	22.39'
L73	S56°42'42"W	56.56'
L74	S63°21'00"W	46.68'
L75	S24°53'37"W	36.08'
L76	S14°24'09"W	73.03'
L77	S17°58'08"W	39.15'
L78	S7°54'16"W	18.85'
L79	S8°03'36"W	34.18'
L80	S66°11'57"W	50.63'
L81	S69°28'49"W	33.97'
L82	S56°43'47"W	39.98'
L83	S43°27'33"W	56.49'
L84	S8°48'44"W	77.95'
L85	S81°13'51"W	42.10'
L86	S36°19'44"W	51.34'
L87	S34°24'35"E	52.71'
L88	S34°05'48"W	78.06'

Parcel Line Table

Line	Direction	Length
L89	N68°17'47"W	31.51'
L90	S34°55'46"W	58.08'
L91	S19°19'42"W	141.32'
L92	S23°55'03"W	65.45'
L93	S76°36'44"W	57.40'
L94	S10°29'05"W	65.75'
L95	S47°13'36"W	70.98'
L96	S24°41'46"W	58.05'
L97	S19°31'51"W	65.14'
L98	S23°57'16"W	38.97'
L99	S66°28'39"W	57.69'
L100	S52°41'19"W	66.30'
L101	S57°57'19"W	21.87'
L102	S70°05'48"W	23.27'
L103	N83°54'57"W	47.83'
L104	N85°36'40"W	29.91'
L105	S10°39'52"W	18.77'
L106	S16°31'36"W	53.07'
L107	S12°29'41"W	24.41'
L108	S9°26'33"W	45.15'

Parcel Line Table

Line	Direction	Length
L109	S40°36'08"E	55.74'
L110	S29°26'06"E	69.97'
L111	S20°21'11"E	72.27'
L112	S3°47'54"W	29.86'
L113	S11°07'17"W	47.02'
L114	S33°25'06"W	87.17'
L115	???	0.00'
L116	S53°59'24"W	53.73'
L117	N73°44'04"W	62.53'
L118	N71°59'57"W	42.95'
L119	S62°54'50"W	38.86'
L120	S21°34'33"W	59.54'
L121	S51°29'50"E	35.83'
L122	S11°36'20"E	42.30'
L123	N71°45'21"E	30.20'
L124	N59°57'21"E	33.89'
L125	N63°46'54"E	54.68'
L126	N56°10'38"E	57.77'
L127	S74°00'13"E	32.55'
L128	N86°21'35"E	36.57'

Parcel Line Table

Line	Direction	Length
L129	S40°29'43"E	45.83'
L130	S5°35'43"W	62.88'
L131	S22°11'18"E	23.55'
L132	S20°24'42"W	61.47'
L133	S41°41'34"W	28.20'
L134	S38°20'51"W	73.62'
L135	N80°58'07"W	60.66'
L136	N79°25'00"W	58.22'
L137	N38°20'10"W	54.99'
L138	N14°29'37"W	40.41'
L139	N36°18'53"W	35.32'
L140	N32°55'47"W	42.05'
L141	S76°10'18"W	37.96'
L142	N85°48'12"W	39.80'
L143	S3°31'21"W	37.52'
L144	S19°41'04"W	38.72'
L145	S5°34'15"W	45.29'
L146	S72°59'46"W	48.27'
L147	N44°56'08"W	74.82'
L148	N44°42'21"W	92.24'

Parcel Line Table

Line	Direction	Length
L149	N38°57'09"W	102.27'
L150	N42°02'13"W	34.45'
L154	S71°48'01"W	51.01'
L155	S56°56'18"W	54.58'
L156	N85°43'45"W	105.56'
L157	N63°31'56"W	56.96'
L158	N16°02'17"W	42.27'
L159	N14°53'44"W	60.99'
L160	N4°29'54"W	66.49'
L161	N9°50'15"W	44.86'
L162	N23°08'10"E	46.66'
L163	N28°38'59"E	92.97'
L164	N59°28'22"E	60.03'
L165	S59°36'18"E	78.71'
L166	S71°16'39"E	57.42'
L167	S22°51'26"E	92.39'
L168	S14°30'47"E	67.94'
L169	S5°38'12"E	76.70'
L170	S5°39'44"W	67.42'
L171	N64°55'47"E	64.68'

Parcel Line Table

Line	Direction	Length
L172	N83°25'10"E	53.58'
L173	S60°51'10"E	50.09'
L174	S68°19'08"E	34.99'
L175	S37°21'22"E	52.10'
L176	S3°21'27"W	59.93'
L177	S28°33'06"E	36.72'
L178	S14°46'12"W	42.86'
L179	S22°45'46"W	41.44'
L180	S40°47'51"E	76.85'
L181	S3°02'22"W	69.69'
L182	S76°45'04"W	46.42'
L183	S83°19'30"W	44.44'
L184	S68°55'52"W	56.60'
L185	S75°31'18"W	70.10'
L186	S74°19'56"W	54.09'
L187	S79°55'57"W	48.81'
L188	N47°09'06"W	52.24'
L189	N7°29'28"E	41.63'
L190	N11°09'52"W	63.43'
L191	N16°35'32"E	51.10'

Parcel Line Table

Line	Direction	Length
L192	N10°36'47"E	51.90'
L193	N20°17'52"E	44.25'
L194	N9°25'26"W	47.94'
L195	N34°35'42"E	49.99'
L196	N38°37'02"E	67.27'
L197	S3°52'52"E	12.50'
L198	S0°52'01"E	11.83'
L199	S42°06'00"E	69.42'
L200	S26°55'04"E	23.95'
L201	S18°41'20"E	25.13'
L202	S25°43'33"W	16.08'
L204	N24°49'33"W	67.14'
L205	N16°48'03"W	46.93'
L206	N2°11'49"E	55.23'
L207	N60°05'52"E	70.00'
L210	S48°05'33"W	46.27'
L211	S69°50'30"W	42.81'
L212	S23°40'49"W	42.15'
L213	S5°45'25"E	43.85'
L214	S79°23'33"W	48.31'

Parcel Line Table

Line	Direction	Length
L215	S62°36'24"W	59.70'
L216	S7°59'51"E	23.40'
L217	S38°15'58"W	40.61'
L218	S46°36'29"W	40.39'
L219	S10°58'20"W	70.61'
L220	S58°18'37"W	35.73'
L221	S22°53'52"W	58.88'
L222	S22°22'59"W	86.88'
L223	S32°54'00"W	74.26'
L224	S23°33'32"W	73.46'
L225	S39°41'56"W	41.79'
L226	S33°11'54"W	70.02'
L227	S0°15'15"E	49.83'
L228	S46°06'12"E	42.12'
L229	S35°43'40"W	82.03'
L230	S59°42'25"W	58.31'
L231	S0°53'05"W	49.99'
L232	S15°34'07"W	44.68'
L233	S16°15'19"W	37.83'
L234	S12°27'27"E	29.78'

Parcel Line Table

Line	Direction	Length
L235	S47°15'43"W	61.90'
L236	S34°53'27"W	68.13'
L237	S53°02'31"W	47.93'
L238	S12°48'58"E	48.78'
L240	N13°20'15"W	81.11'
L241	N47°48'21"E	51.26'
L242	N50°04'16"E	15.04'
L243	N52°22'19"E	15.05'
L244	S85°41'13"E	18.11'
L245	S87°39'42"E	13.53'
L246	N88°49'11"E	29.85'
L247	N43°54'57"E	46.00'
L248	N23°48'32"E	10.54'
L251	N87°00'43"E	11.42'
L252	S39°41'57"E	45.33'
L253	S7°50'12"E	36.08'
L254	S27°16'04"E	65.49'
L255	N62°15'02"E	73.10'
L256	N58°31'41"E	39.12'
L257	N70°17'58"E	51.35'

Parcel Line Table

Line	Direction	Length
L258	N19°39'31"E	57.52'
L259	N88°08'10"W	48.06'
L260	N71°08'22"W	56.86'
L261	N49°18'50"W	59.77'
L262	N34°12'02"E	61.28'
L263	N28°44'45"E	44.06'
L264	N13°27'42"E	61.32'
L265	N37°31'58"E	51.92'
L266	N9°30'34"E	46.48'
L267	N64°34'51"W	21.65'
L268	S23°21'15"W	22.68'
L269	N73°10'26"W	43.27'
L270	N14°34'52"E	46.26'
L271	N21°44'01"W	38.99'
L272	N41°16'28"E	65.98'
L273	S68°49'12"E	62.05'
L274	S66°06'04"E	73.01'
L275	N82°04'56"E	74.65'
L276	N32°48'26"E	89.40'
L277	N18°20'09"E	68.22'

Parcel Line Table

Line	Direction	Length
L278	N17°22'06"E	84.58'
L279	N39°59'32"E	62.62'
L280	N16°09'22"E	55.94'
L281	N52°26'06"W	57.43'
L282	N17°42'32"E	88.75'
L283	N13°59'53"E	66.75'
L284	N45°51'52"W	66.21'
L286	S2°46'05"W	22.77'
L287	S62°44'11"W	30.19'
L288	S64°22'46"W	20.80'
L289	S21°11'45"W	13.78'
L290	S19°32'31"W	19.46'
L291	S73°33'11"E	22.09'
L292	S74°29'50"E	19.53'
L293	S8°18'37"W	86.31'
L294	S63°18'22"W	83.33'
L295	N78°41'41"W	74.06'
L296	N24°41'01"W	50.92'
L297	N46°27'12"W	66.47'
L298	N44°46'33"W	66.12'

Parcel Line Table

Line	Direction	Length
L299	N29°17'04"W	40.29'
L300	N55°10'48"W	35.49'
L301	N39°34'20"W	62.26'
L302	N10°55'09"E	31.50'
L303	N9°50'08"W	48.29'
L304	N34°05'59"W	45.63'
L305	N47°22'23"E	75.11'
L306	N45°50'31"E	50.48'
L307	N21°19'42"E	34.29'
L308	S71°30'15"E	26.14'
L309	S75°30'34"E	59.63'
L310	N75°19'33"E	26.91'
L311	S81°33'31"E	42.21'
L312	S18°25'24"E	48.56'
L313	S49°00'58"E	58.16'
L314	S48°02'48"E	50.30'
L315	S25°01'52"E	68.00'
L316	S25°33'53"E	69.96'
L317	S0°52'12"E	14.94'
L364	S41°09'27"E	55.10'

Parcel Line Table

Line	Direction	Length
L365	S23°00'00"E	46.51'
L366	S17°58'29"E	70.13'
L367	S34°55'07"E	46.02'
L368	S7°56'39"W	87.70'
L369	S23°18'39"W	82.04'
L370	S69°33'21"W	61.35'
L371	N73°38'39"W	77.73'
L372	N57°54'46"W	60.50'
L373	N56°42'27"W	74.03'
L374	N49°09'28"W	82.67'
L375	N40°25'24"W	61.55'
L376	N13°54'59"W	92.84'
L377	N20°05'44"E	79.68'
L378	N38°16'01"E	78.17'
L379	N81°48'42"E	50.16'
L380	N86°18'06"E	55.10'
L381	N71°06'14"E	60.71'
L382	S55°38'46"E	49.56'
L383	S32°44'00"E	61.72'
L386	S44°02'39"E	28.52'

Parcel Line Table

Line	Direction	Length
L387	S38°48'20"E	57.34'
L388	S40°01'08"E	63.07'
L389	S41°31'16"E	45.52'
L390	S36°40'25"E	73.10'
L391	S47°23'15"E	27.58'
L392	S12°55'45"W	38.24'
L393	S19°06'54"W	40.74'
L394	S24°54'31"E	48.01'
L395	S18°19'37"W	40.41'
L396	S26°11'45"E	31.84'
L397	S21°58'01"W	35.30'
L398	S56°25'14"W	29.43'
L399	S59°30'08"W	18.60'
L400	S55°57'29"W	27.08'
L401	S31°44'30"W	20.43'
L402	S28°24'11"W	21.63'
L403	S16°10'48"W	47.95'
L404	S2°15'36"E	36.24'
L405	S48°06'20"W	35.11'
L406	S18°50'31"E	35.12'

Parcel Line Table

Line	Direction	Length
L407	S6°56'25"W	52.80'
L408	S7°27'04"W	16.40'
L409	S16°50'56"W	25.03'
L410	S33°42'31"W	23.87'
L411	S42°05'00"W	19.37'
L412	S65°29'00"W	26.15'
L413	S11°14'20"W	38.71'
L414	S16°35'12"W	39.62'
L415	S19°04'41"E	44.96'
L416	S21°56'40"W	53.44'
L417	S87°37'44"W	34.66'
L418	S49°06'51"W	14.45'
L419	S46°48'36"W	14.23'
L420	S32°23'57"W	15.26'
L421	S29°45'53"W	14.25'
L422	S89°44'05"W	37.37'
L423	S58°23'21"W	20.27'
L424	S57°50'49"W	22.93'
L425	S32°01'25"W	29.52'
L426	S3°34'44"E	30.09'

Parcel Line Table

Line	Direction	Length
L427	S2°16'00"E	22.92'
L428	S21°48'28"E	51.14'
L429	S11°33'00"W	47.63'
L430	S41°23'20"W	45.60'
L431	S28°05'04"W	43.32'
L432	S30°40'07"W	67.66'
L433	S13°23'24"E	35.41'
L434	S30°28'02"W	57.08'
L435	S27°48'19"W	32.94'
L436	S23°40'41"W	30.30'
L437	S0°35'50"W	29.94'
L438	S8°49'35"E	18.90'
L439	S17°04'32"E	23.14'
L440	S2°30'57"W	45.11'
L441	S6°52'24"W	27.04'
L442	S7°03'02"W	27.90'
L443	S33°24'26"W	32.80'
L444	S34°46'39"W	19.96'
L445	S40°26'56"W	51.42'
L446	S16°32'56"W	40.18'

Parcel Line Table

Line	Direction	Length
L447	S32°23'33"W	50.81'
L448	S3°12'43"W	46.78'
L449	S17°03'37"W	55.59'
L450	S37°49'19"W	22.21'
L451	S37°49'19"W	40.41'
L452	S44°49'56"W	28.40'
L453	S44°49'56"W	26.03'
L454	S33°03'55"W	67.56'
L455	S0°26'56"E	41.61'
L456	S53°13'12"W	67.62'
L457	S32°03'26"W	80.44'
L458	S52°39'12"W	41.56'
L459	S46°19'05"W	38.21'
L460	S19°30'17"W	50.10'
L461	S59°30'50"W	79.88'
L462	S65°59'29"W	82.56'
L463	S32°54'03"W	65.57'
L464	S20°08'53"W	111.65'
L465	S28°14'35"W	74.10'
L466	S9°55'20"W	94.04'

Parcel Line Table

Line	Direction	Length
L467	S12°40'00"W	94.81'
L468	S54°25'21"W	47.05'
L469	S67°15'31"W	39.21'
L470	S13°55'27"W	61.08'
L471	S17°52'00"E	77.31'
L472	S46°48'19"E	97.62'
L473	S20°41'28"E	61.12'
L474	S22°03'01"W	59.16'
L475	S11°03'01"W	52.42'
L476	S43°33'00"W	66.34'
L477	S61°46'00"W	71.32'
L479	N22°01'13"E	47.47'
L480	N37°33'30"E	74.75'
L481	N69°05'55"E	140.84'
L482	S78°34'12"E	82.11'
L483	S48°37'40"E	87.33'
L484	S12°12'27"E	84.26'
L485	S8°39'51"E	89.03'
L486	S36°09'42"W	85.79'
L487	S63°14'21"W	106.49'

Parcel Line Table

Line	Direction	Length
L488	N73°15'27"W	76.60'
L489	S85°45'43"W	48.49'
L490	N51°44'17"W	55.07'
L491	N5°24'29"W	50.11'
L492	N41°54'38"W	69.38'
L493	N10°58'04"W	54.96'
L494	S68°00'19"W	97.60'
L495	S84°17'55"W	70.15'
L496	N54°26'19"W	48.71'
L497	N15°18'56"W	66.88'
L498	N30°11'58"E	77.68'
L499	S86°11'28"E	78.82'
L500	S67°52'35"E	58.59'
L501	S27°05'05"E	100.12'
L502	S2°56'57"W	127.97'
L503	S3°02'24"W	87.64'
L504	N60°09'50"W	28.23'
L505	S82°48'22"W	80.60'
L506	N41°28'02"W	66.28'
L507	N77°08'45"W	76.47'

Parcel Line Table

Line	Direction	Length
L508	N24°57'40"W	59.12'
L509	N9°16'04"E	94.26'
L510	N25°59'11"E	59.64'
L511	N72°11'52"E	44.98'
L512	S44°39'34"E	67.59'
L513	S64°37'20"E	85.08'
L514	N73°13'38"E	52.81'
L515	N0°08'59"W	101.44'
L516	N64°38'00"E	35.54'
L517	S29°07'52"E	17.58'
L518	S48°14'46"E	21.13'
L519	S41°44'56"E	15.30'
L520	S2°53'36"E	39.76'
L521	S25°39'50"W	23.96'
L522	S77°24'33"W	34.93'
L523	S73°52'58"W	24.87'
L524	S44°15'02"W	38.33'
L525	N38°00'18"W	46.51'
L526	N82°59'03"W	59.17'
L527	N60°55'09"W	57.51'

Parcel Line Table

Line	Direction	Length
L528	N50°01'09"W	65.21'
L529	N4°56'53"W	67.43'
L530	N15°15'11"E	57.34'
L531	N48°15'26"E	63.27'
L532	N74°42'50"E	87.57'
L533	N88°46'15"E	44.24'
L534	N61°51'48"E	64.41'
L535	N57°07'23"E	48.81'
L536	S31°33'22"W	54.87'
L537	S8°58'35"W	62.32'
L538	S20°32'22"E	50.94'
L539	S27°13'44"E	51.77'
L540	S6°49'10"E	70.54'
L541	S4°50'28"E	35.16'
L542	S73°27'47"W	86.68'
L543	N4°58'56"E	297.05'
L544	N86°37'03"E	89.12'
L545	S67°34'09"E	36.99'
L546	N75°10'47"E	52.12'
L547	S31°52'19"E	50.01'

Parcel Line Table

Line	Direction	Length
L548	S33°13'56"E	46.04'
L549	S3°54'25"W	23.29'
L550	S3°54'25"W	26.25'
L551	S35°29'53"E	25.53'
L552	S35°29'53"E	15.92'
L553	S19°48'42"W	36.63'
L554	S59°10'58"W	39.18'
L555	N79°07'57"W	30.17'
L556	S85°37'33"W	30.22'
L557	S62°50'11"W	186.40'
L558	S68°44'28"E	43.40'
L559	S20°39'22"E	82.02'
L560	S24°43'43"E	57.04'
L561	S43°08'04"E	66.38'
L562	S2°23'39"E	113.73'
L563	S25°27'37"E	35.88'
L564	S19°08'02"W	36.92'
L565	N69°35'18"W	81.27'
L566	S1°07'14"W	40.14'
L567	S77°56'15"W	57.61'

Parcel Line Table

Line	Direction	Length
L568	N59°01'22"W	58.20'
L569	N46°19'08"W	65.43'
L570	N48°41'48"W	67.18'
L571	N19°17'44"W	77.71'
L572	N2°14'24"W	72.36'
L573	N46°11'59"E	49.40'
L574	N8°04'19"W	45.35'
L575	N29°11'38"E	65.44'
L576	N64°15'50"E	38.74'
L577	S72°44'00"E	69.84'
L578	N33°09'05"E	42.14'
L579	S80°13'16"E	59.50'
L580	S46°48'30"E	49.00'
L581	S86°41'22"E	34.13'
L582	S87°38'30"E	62.47'
L583	S78°29'01"E	52.20'
L584	S69°23'59"E	26.13'
L585	S70°45'12"E	25.76'
L586	S60°30'21"E	17.84'
L587	S62°26'35"E	25.15'

Parcel Line Table

Line	Direction	Length
L588	N67°05'28"E	26.63'
L589	N88°28'12"E	20.04'
L590	N88°28'12"E	18.58'
L591	S78°16'04"E	18.33'
L592	S78°16'04"E	20.62'
L593	S84°03'29"E	31.14'
L594	S84°03'29"E	27.75'
L595	N88°38'14"E	23.86'
L596	N88°38'14"E	20.29'
L597	N69°59'14"E	26.09'
L598	N74°18'32"E	14.83'
L599	S71°34'38"E	31.84'
L600	S43°36'57"E	17.15'
L601	S32°53'14"E	17.63'
L602	S87°20'18"E	28.77'
L603	S82°55'29"E	74.98'
L604	S73°15'25"E	43.27'
L605	S85°29'11"E	78.49'
L606	S63°17'37"E	60.71'
L607	S50°18'30"E	90.39'

Parcel Line Table

Line	Direction	Length
L608	S63°46'37"E	45.02'
L609	S51°29'47"E	70.13'
L610	S66°24'14"E	33.47'
L611	S59°33'31"E	106.05'
L612	N51°43'51"E	53.13'
L613	N60°39'00"E	36.23'
L614	S85°31'48"E	37.97'
L615	S87°40'48"E	34.94'
L616	N38°51'38"E	46.62'
L617	N5°11'53"E	31.24'
L618	N8°01'24"E	32.24'
L619	N25°02'23"W	61.39'
L620	N64°31'34"E	49.28'
L626	N40°19'24"W	101.82'
L627	N66°38'43"W	30.35'
L628	N8°13'04"E	36.90'
L629	N79°57'27"W	29.01'
L630	N36°24'27"W	56.30'
L631	S64°07'36"W	52.79'
L632	N76°15'45"W	23.30'

Parcel Line Table

Line	Direction	Length
L633	N35°29'28"E	47.35'
L634	N26°18'47"E	38.76'
L635	N17°14'09"W	37.33'
L636	N19°53'39"W	72.23'
L637	N54°17'56"W	48.57'
L638	N64°25'44"W	59.21'
L639	N9°35'48"W	37.62'
L640	N27°03'02"W	44.44'
L641	N44°18'32"W	28.43'
L642	N14°29'23"E	57.01'
L643	N10°41'05"E	34.84'
L644	N41°41'29"E	65.40'
L645	N63°26'26"E	63.20'
L646	N66°18'39"E	79.74'
L647	N51°38'22"E	47.86'
L648	S61°51'16"E	41.94'
L649	S28°35'36"E	54.09'
L650	S41°57'03"E	76.39'
L651	S41°09'37"E	79.03'
L652	S45°41'27"E	75.84'

Parcel Line Table

Line	Direction	Length
L653	S76°39'00"E	23.13'
L654	S78°24'57"E	23.76'
L655	S66°17'40"E	21.51'
L656	S69°19'53"E	14.55'
L657	S70°09'09"E	54.37'
L658	N72°06'53"E	42.59'
L659	S47°00'39"E	56.66'
L660	S42°05'45"E	44.30'
L661	S55°09'34"E	27.92'
L662	S57°11'24"E	22.01'
L663	S78°41'52"E	27.38'
L664	S78°41'52"E	23.98'
L665	S57°56'52"E	81.49'
L666	S12°19'40"E	35.56'
L667	S33°11'08"E	49.38'
L668	S19°02'37"E	45.78'
L669	S27°03'30"E	21.64'
L670	S19°00'00"E	29.32'
L671	S13°58'32"W	11.70'
L672	S13°58'32"W	22.86'

Parcel Line Table

Line	Direction	Length
L675	S64°23'55"W	34.19'
L676	S51°36'07"E	36.07'
L678	N84°57'29"W	58.89'
L679	N6°27'19"W	38.00'
L680	N24°19'38"W	32.22'
L681	S86°15'25"W	29.52'
L682	S14°02'33"W	45.38'
L683	S39°08'11"W	29.71'
L684	S72°58'56"W	71.92'
L685	S87°44'42"W	31.61'
L686	S32°45'42"W	47.04'
L687	N79°51'20"W	32.52'
L688	N71°43'22"W	51.61'
L689	N74°45'28"W	47.21'
L690	S33°09'20"W	47.57'
L691	S28°46'47"W	55.83'
L692	N74°32'38"W	70.85'
L693	N21°48'58"W	48.45'
L694	N14°15'43"E	46.96'
L695	S89°07'59"W	56.24'

Parcel Line Table

Line	Direction	Length
L696	S7°44'04"W	58.19'
L697	S36°30'40"W	47.83'
L698	S36°21'51"W	56.83'
L699	N75°56'44"W	87.93'
L700	N82°38'28"W	63.00'
L701	N36°01'02"W	61.49'
L702	N71°31'12"W	52.41'
L703	N62°23'07"W	52.29'
L704	N42°44'03"E	49.09'
L705	N39°45'31"W	36.03'
L706	N19°49'39"E	41.56'
L707	N75°20'14"E	37.73'
L708	N38°23'52"E	66.17'
L709	N32°17'30"E	60.59'
L710	N66°15'24"E	36.07'
L711	N70°43'16"E	13.81'
L712	N68°25'07"E	18.61'
L713	N78°24'57"E	28.70'
L714	N79°43'27"E	18.70'
L715	N78°08'51"E	55.93'

Parcel Line Table

Line	Direction	Length
L716	N43°05'11"E	54.80'
L717	N56°18'48"E	58.55'
L718	N43°49'45"E	38.81'
L719	N40°42'27"E	77.52'
L720	N40°15'00"E	30.01'
L721	N41°58'38"E	74.46'
L722	N45°10'40"E	58.12'
L723	N33°16'39"E	76.22'
L724	N80°33'35"E	66.73'
L725	N75°28'53"E	68.01'
L726	S39°47'34"E	47.92'
L727	S44°58'19"E	70.76'
L728	N78°38'11"E	54.35'
L729	N6°01'58"E	60.29'
L730	N51°39'57"E	52.25'
L731	N76°25'32"E	37.10'
L736	N30°07'41"W	64.99'
L737	N15°22'32"W	53.17'
L738	S70°26'16"W	35.91'
L739	S1°47'30"E	45.64'

Parcel Line Table

Line	Direction	Length
L740	S9°35'33"W	40.22'
L741	S9°07'20"E	81.99'
L742	N41°58'18"E	62.97'
L743	S60°11'58"E	33.89'
L745	N83°40'05"W	32.94'
L746	S23°31'14"E	71.37'
L748	N15°16'37"E	62.02'
L749	N77°02'50"E	126.93'
L750	N58°50'38"E	105.35'
L751	N24°03'34"E	145.93'
L752	N61°50'04"E	95.53'
L753	N43°27'42"E	62.58'
L754	N48°36'46"E	76.79'
L755	N79°23'39"E	58.79'
L756	N27°38'09"E	49.40'
L757	N18°27'52"W	51.09'
L758	N44°37'14"E	62.56'
L759	S25°18'39"E	42.60'
L760	S56°45'13"E	71.40'
L761	S58°17'49"E	76.77'

Parcel Line Table

Line	Direction	Length
L762	S70°15'20"E	58.76'
L763	N24°39'19"E	34.19'
L764	N81°42'29"E	29.81'
L765	N64°58'10"E	34.02'
L766	S84°03'48"E	23.87'
L767	N47°18'43"E	20.77'
L768	N61°36'49"E	23.19'
L769	N71°40'02"E	33.53'
L770	N28°45'10"E	27.22'
L771	N5°35'51"E	50.26'
L772	N2°23'38"W	46.38'
L773	N82°31'45"W	44.69'
L774	N44°27'55"E	24.70'
L775	S80°09'36"E	51.95'
L776	N22°19'08"E	41.07'
L777	N42°47'21"W	37.96'
L778	N22°10'04"E	91.00'
L779	N30°04'59"W	49.01'
L780	N8°25'33"E	60.83'
L781	N47°41'51"W	60.88'

Parcel Line Table

Line	Direction	Length
L782	N25°13'31"W	74.55'
L783	N36°53'24"W	30.36'
L784	N29°22'36"E	51.38'
L785	N23°13'18"W	60.38'
L786	N8°36'57"W	45.22'
L787	N45°01'57"W	76.98'
L788	N57°16'25"W	65.61'
L789	N62°21'56"W	56.60'
L790	N66°51'27"W	40.63'
L791	N61°47'34"W	48.87'
L792	N64°10'38"W	54.00'
L793	N35°25'45"W	45.61'
L794	N25°05'51"W	52.93'
L795	S54°13'19"W	63.07'
L796	S77°42'06"W	53.67'
L797	S5°31'28"E	55.20'
L798	S86°04'54"W	40.73'
L799	S86°02'09"W	60.58'
L800	N84°19'26"W	59.03'
L801	S85°31'51"W	54.23'

Parcel Line Table

Line	Direction	Length
L802	N3°00'15"E	80.96'
L803	N56°41'30"W	58.49'
L804	N29°06'25"W	17.59'
L805	N66°52'28"W	28.66'
L806	N19°21'26"E	108.13'
L807	N3°57'22"E	62.70'
L808	N8°37'44"E	54.07'
L809	N40°49'21"E	82.27'
L810	N22°13'18"W	48.30'
L811	N63°16'06"E	50.11'
L812	N72°26'22"E	60.86'
L813	S81°11'04"E	45.86'
L814	N42°58'54"E	41.60'
L815	N67°50'51"E	44.01'
L816	S74°31'34"E	76.19'
L817	N14°59'58"E	71.32'
L818	N21°02'00"E	46.33'
L819	N89°24'20"E	51.37'
L820	S54°14'47"E	61.38'
L821	N80°53'32"E	74.87'

Parcel Line Table

Line	Direction	Length
L822	S42°59'02"E	79.03'
L823	S24°40'57"E	82.11'
L824	S27°04'41"E	59.97'
L825	S44°40'32"E	72.55'
L826	S33°22'26"E	49.96'
L827	S47°41'49"E	75.53'
L828	S57°02'54"E	108.57'

JORDAN ENGINEERING
144 N. WARREN ST. MONTICELLO, GA. 31064
TELEPHONE: (706) 468-8999
Land Planning ♦ Surveying ♦ Soils Classification

GEORGIA REGISTERED No 2902 LAND SURVEYOR ROBERT O. JORDAN

WETLANDS BOUNDARY MAPPING
LINE SEGMENT TABLES

Brantley County US Hwy 82
Wetlands Mapping
Brantley County, Georgia

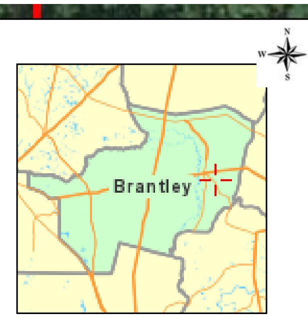
Rev	Revision Description	Date
0	Initial Issue	12/23/15
1	Area 1A acreage typo corrected	2/17/16
2	Wetlands line calls added - all sheets	3/29/16

As Noted

Sheet No.
9.0

APPENDIX C

Brantley County Assessor			
Parcel: B073 002 Acres: 10.51			
Name:	DOWLING DAVID	Land Value:	$33,794.00
Site:	5500 HWY 110 E	Building Value:	$97,566.00
Sale:	$100,800 on 05-2011 Reason=BK Qual=U	Misc Value:	$5,074.00
Mail:	5500 HWY 110 E WAYNESVILLE, GA 31566	Total Value:	$136,434.00



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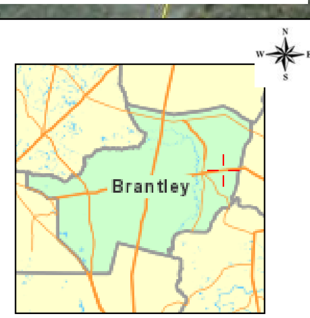
Brantley County Assessor			
Parcel: B072 049 Acres: 1.72			
Name:	CLYDE THERESA	Land Value:	$10,804.00
Site:	67 FOX RIDGE	Building Value:	$0.00
Sale:	$0 on 01-2014 Reason=GT Qual=U	Misc Value:	$2,000.00
Mail:	JEFFREY S HERNDON JR 24478 HWY 82 WAYNESVILLE, GA 31566	Total Value:	$12,804.00



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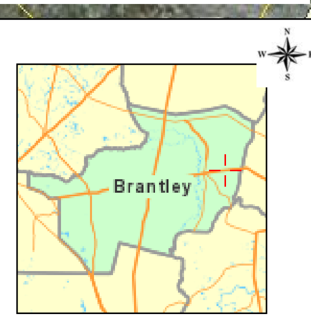
Brantley County Assessor

Parcel: B072 050 Acres: 1.72

Name:	CARTER WESLEY	Land Value:	$10,804.00
Site:	0 HWY 82 E	Building Value:	$0.00
Sale:	$0 on 07-2008 Reason=GT Qual=U	Misc Value:	$1,500.00
Mail:	P O BOX 311 WAYNESVILLE, GA 31566	Total Value:	$12,304.00



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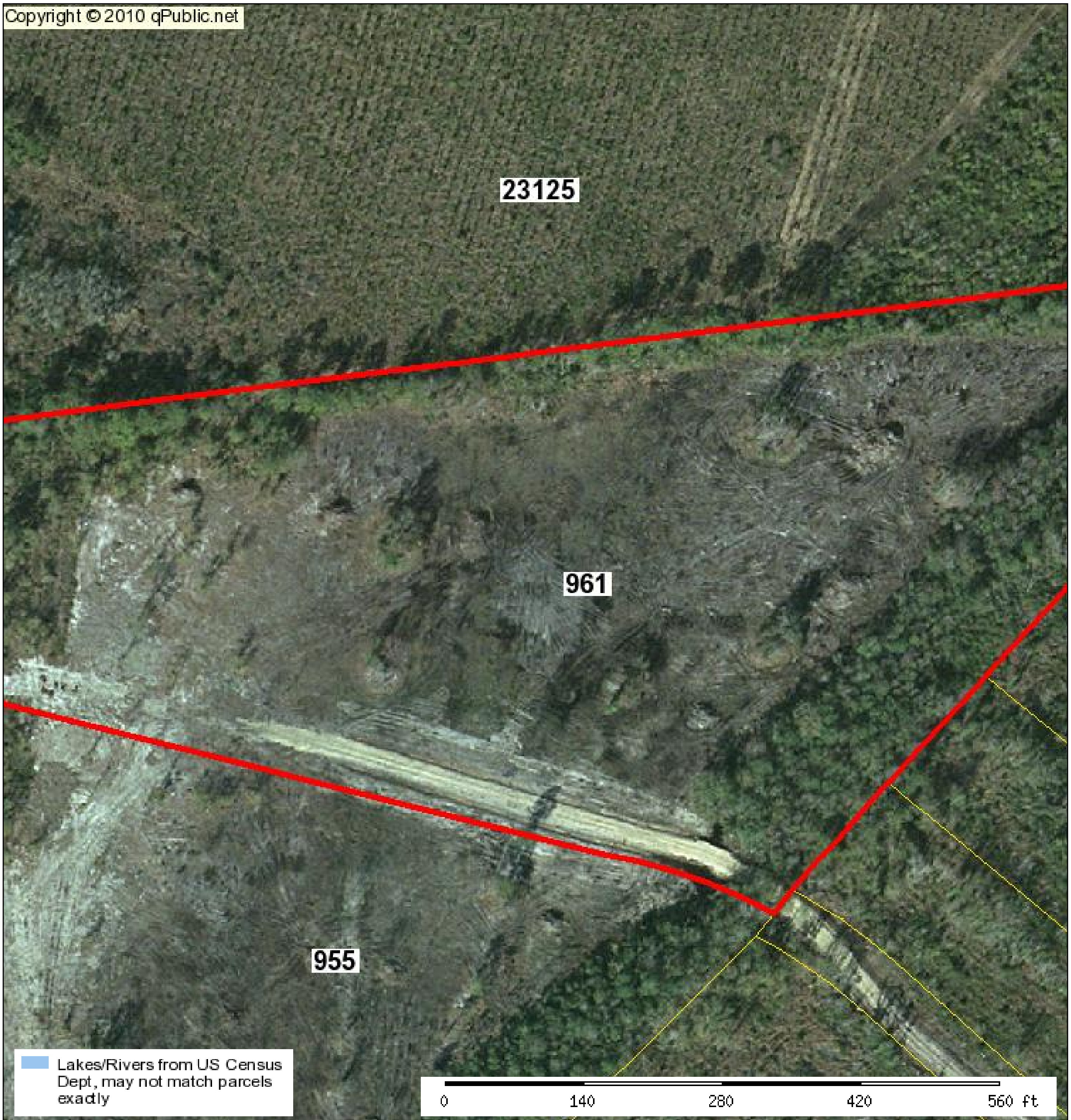
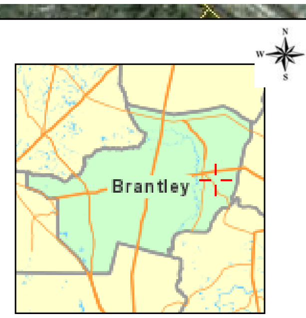


Brantley County Assessor			
Parcel: B073D 041 Acres: 11.5			
Name:	LANE LORIE	Land Value:	$32,500.00
Site:	961 PICKETTS MILL TRL	Building Value:	$64,699.00
Sale:	$0 on 06-2008 Reason=FS Qual=U	Misc Value:	$4,610.00
Mail:	DENNIS M LANE 961 PICKETTS MILL TRL WAYNESVILLE, GA 31566	Total Value:	$101,809.00



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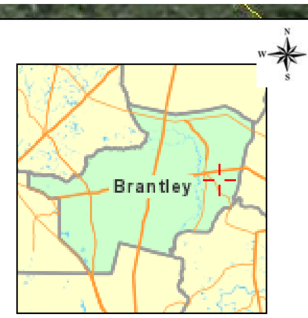
Brantley County Assessor

Parcel: B073D 036 Acres: 2.45

Name:	LAND EDGAR JR	Land Value:	$8,394.00
Site:	1089 PICKETTS MILL TRL	Building Value:	$100,444.00
Sale:	$15,919 on 12-2006 Reason=LM Qual=Q	Misc Value:	$2,588.00
Mail:	1089 PICKET MILLS TRL WAYNESVILLE, GA 31566	Total Value:	$111,426.00



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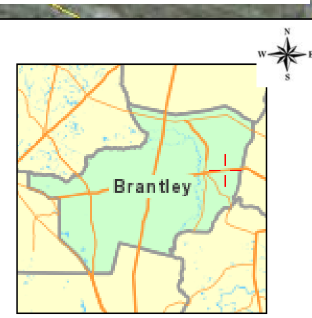
Brantley County Assessor

Parcel: B072 051 Acres: 1.71

Name:	CARTER DAVID JR	Land Value:	$10,745.00
Site:	24546 HWY 82	Building Value:	$0.00
Sale:	$0 on 07-2008 Reason=GT Qual=U	Misc Value:	$2,000.00
Mail:	P O BOX 82 WAYNESVILLE, GA 31566	Total Value:	$12,745.00



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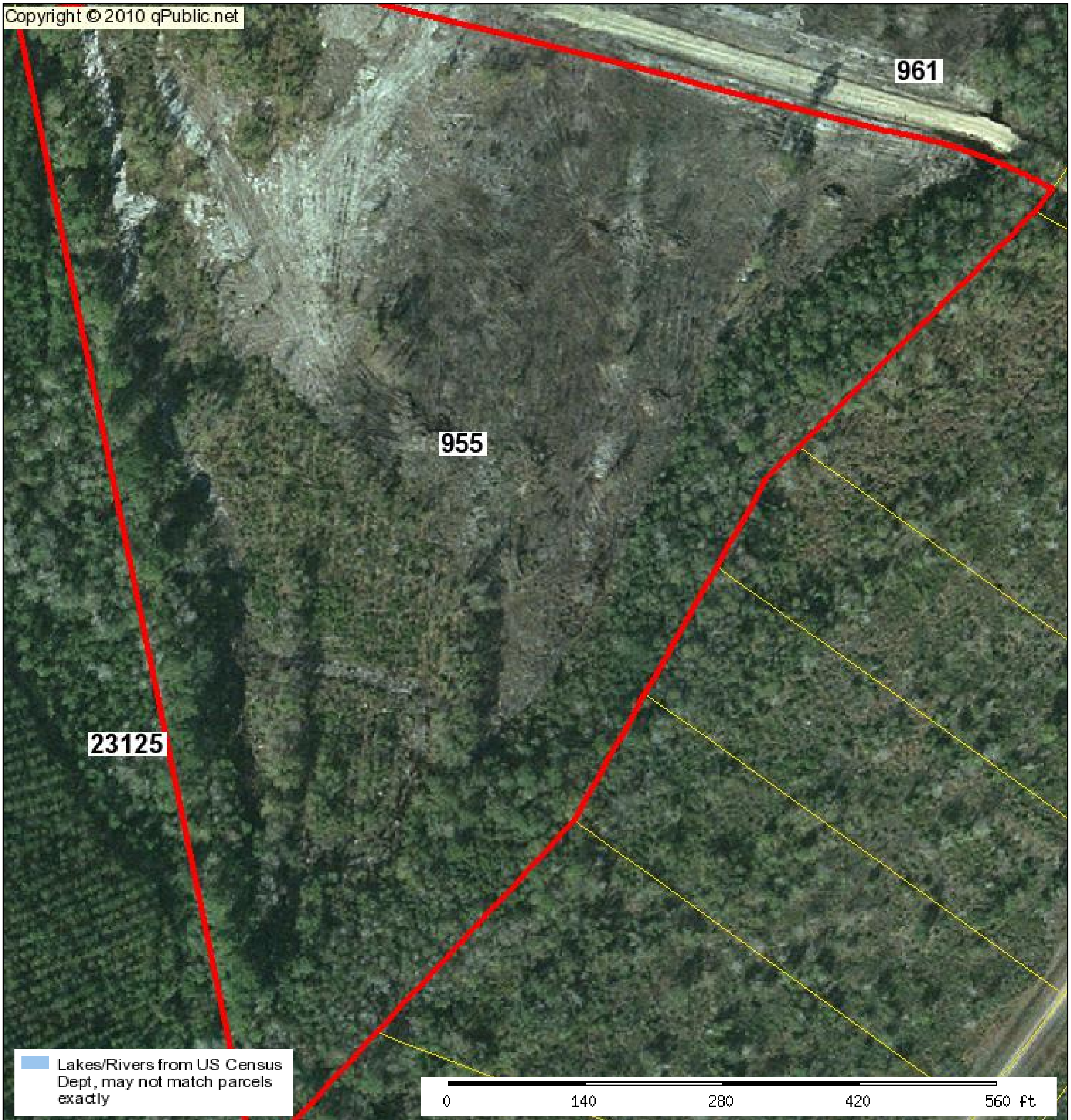
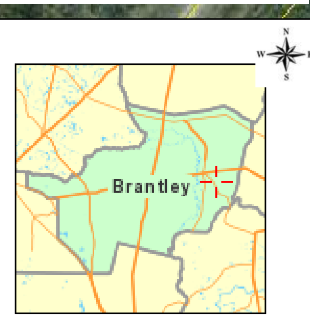


Brantley County Assessor

Parcel: B073D 042 Acres: 13.87

Name:	WILLIAMS MATTHEW SR	Land Value:	$31,126.00
Site:	955 PICKETTS MILL TRL	Building Value:	$50,618.00
Sale:	$0 on 09-2015 Reason=GT Qual=U	Misc Value:	$6,780.00
Mail:	MATTHEW J WILLIAMS JR 531 SATILLA CHURCH RD HORTENSE, GA 31543	Total Value:	$88,524.00



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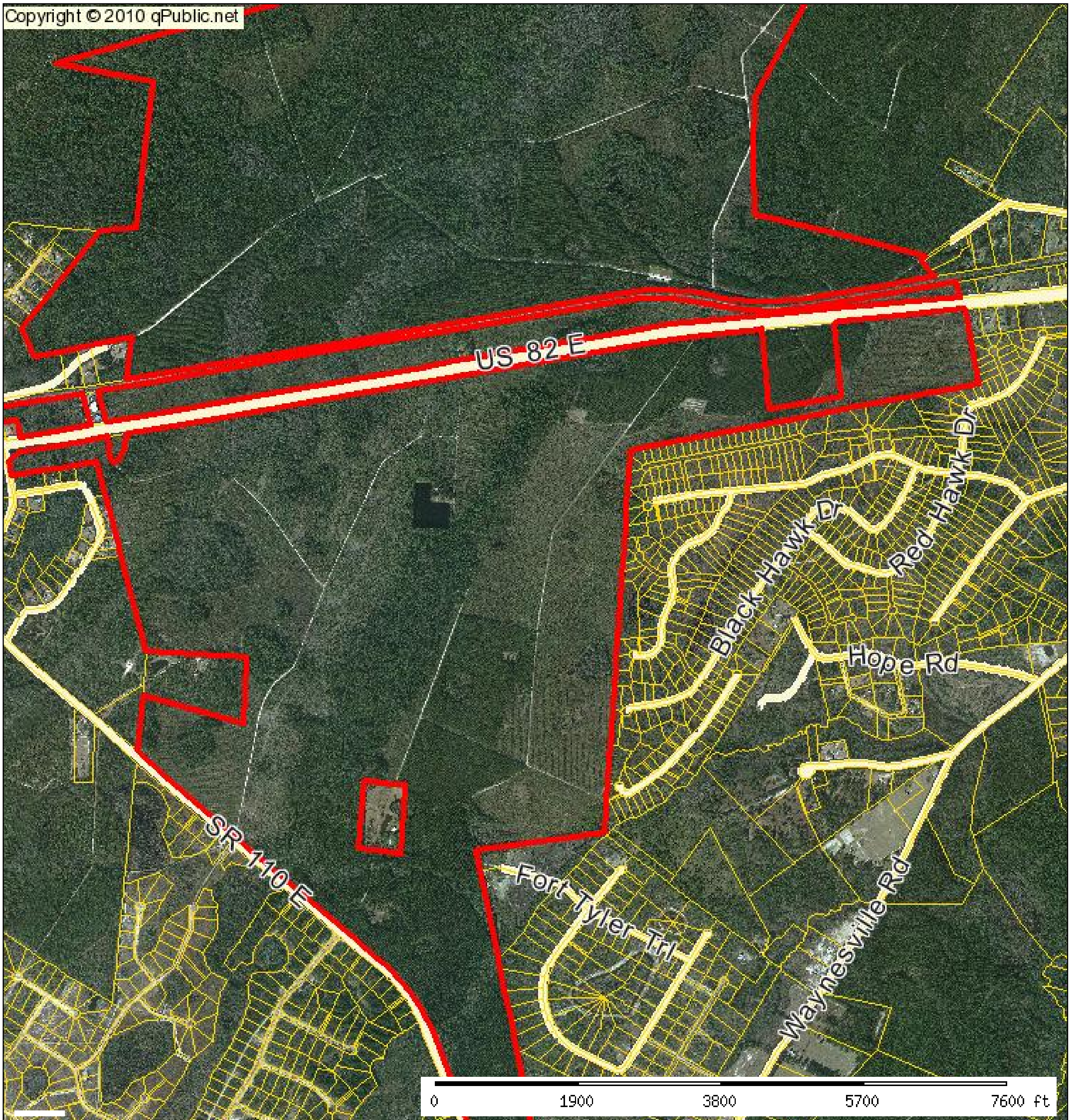
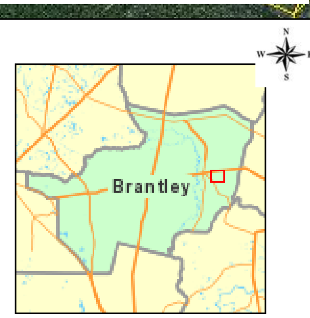


Brantley County Assessor			
Parcel: B072 003 Acres: 2389			
Name:	BRANTLEY COUNTY DEVELOPMENT PARTNERS LLC	Land Value:	$1,819,091.00
Site:	23125 HWY 82	Building Value:	$0.00
Sale:	$2,632,771 on 12-2014 Reason=FM Qual=Q	Misc Value:	$3,122.00
Mail:	2255 CUMBERLAND PKWY BLDG 1700 ATLANTA, GA 30339	Total Value:	$1,822,213.00



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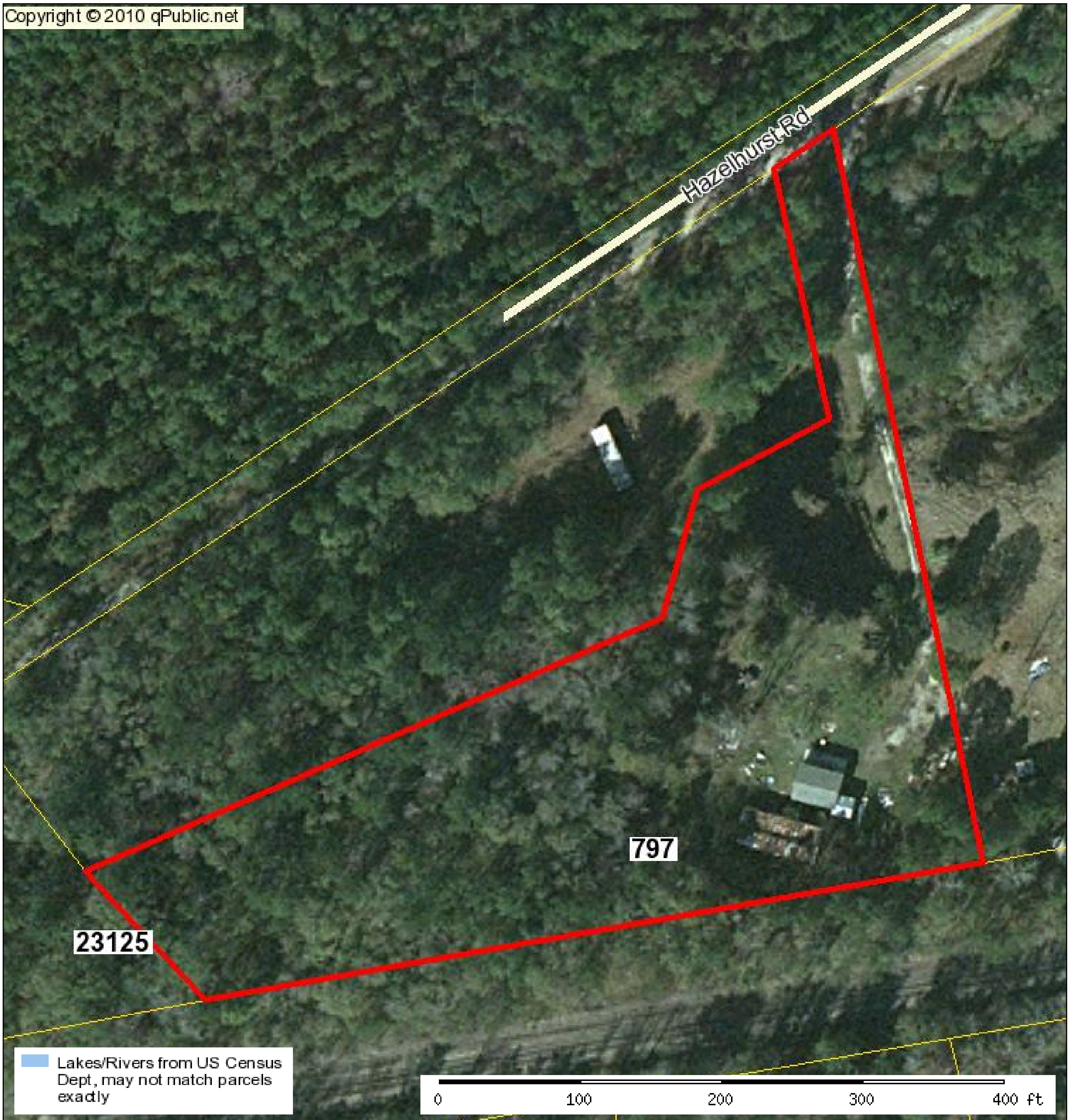
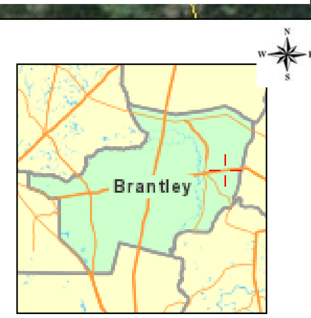


Brantley County Assessor			
Parcel: B072 032 Acres: 2.75			
Name:	STRICKLAND WANDA	Land Value:	$9,717.00
Site:	797 HAZELHURST RD	Building Value:	$28,620.00
Sale:	$20,000 on 08-2013 Reason=FM Qual=Q	Misc Value:	$1,711.00
Mail:	SAM STRICKLAND 743 RIVER MARSH BLVD WAVERLY, GA 31565	Total Value:	$40,048.00



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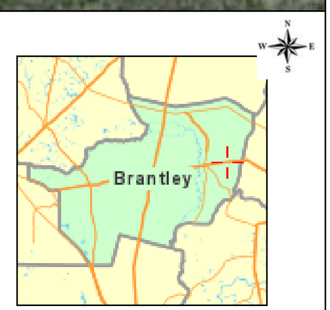
Brantley County Assessor

Parcel: B072 047 Acres: 4.41

Name:	GIBSON WILLIAM	Land Value:	$19,856.00
Site:	0 HWY 82 E	Building Value:	$0.00
Sale:	$4,238 on 04-1997 Reason=FS Qual=U	Misc Value:	$9,000.00
Mail:	P O BOX 100 WAYNESVILLE, GA 31566	Total Value:	$28,856.00



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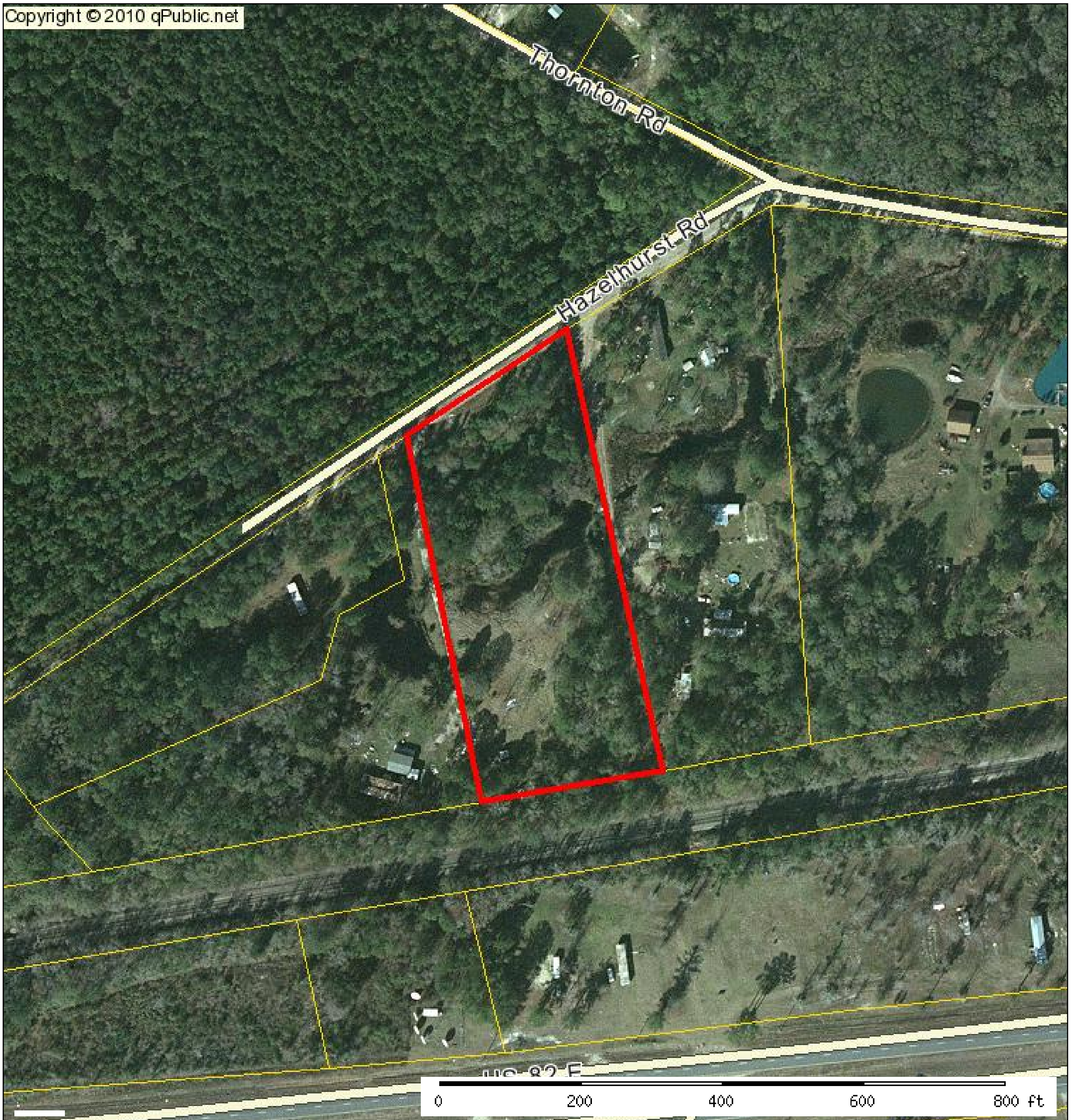
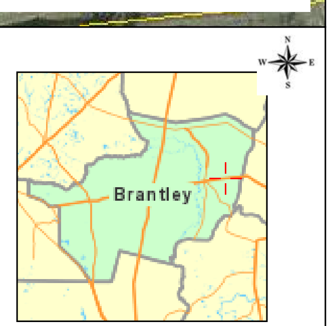


Brantley County Assessor			
Parcel: B072 033 Acres: 3.3			
Name:	TAYLOR TROY	Land Value:	$14,253.00
Site:	0 HAZELHURST RD	Building Value:	$0.00
Sale:	$0 on 11-2004 Reason=GT Qual=U	Misc Value:	$0.00
Mail:	626 PENNICK RD BRUNSWICK, GA 31520	Total Value:	$14,253.00



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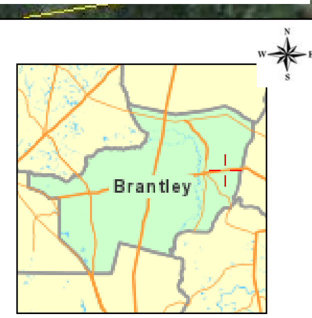
Brantley County Assessor			
Parcel: B072 031 Acres: 2.55			
Name:	SMITH LINDA	Land Value:	$9,085.00
Site:	0 HAZELHURST RD	Building Value:	$0.00
Sale:	$0 on 01-2007 Reason=10 Qual=U	Misc Value:	$1,500.00
Mail:	2003 MARY ELLEN LN STATE COLLEGE, PA 16803	Total Value:	$10,585.00



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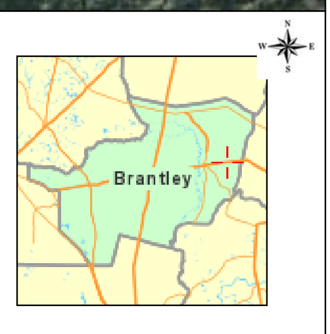
Brantley County Assessor			
Parcel: B072 035 Acres: 7.46			
Name:	ROSS WILLIAM	Land Value:	$27,189.00
Site:	583 HAZELHURST RD	Building Value:	$37,587.00
Sale:		Misc Value:	$6,326.00
Mail:	TINA M ROSS 583 HAZEL HURST RD WAYNESVILLE, GA 31566	Total Value:	$71,102.00



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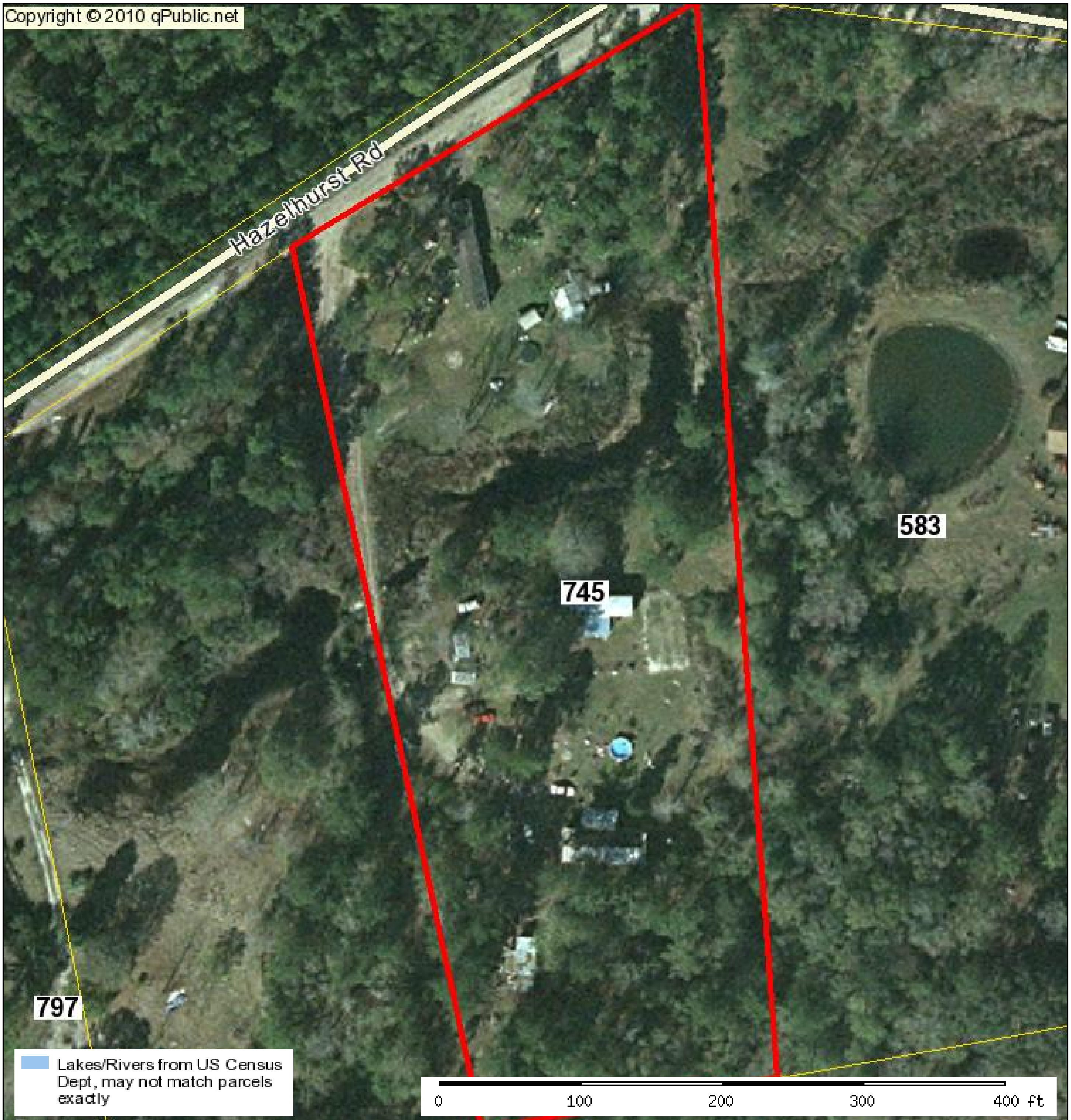
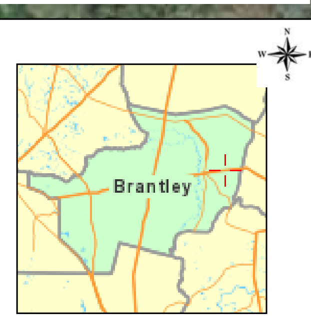


Brantley County Assessor

Parcel: B072 034 Acres: 4.22

Name:	LINDSEY TODD	Land Value:	$17,554.00
Site:	745 HAZELHURST RD	Building Value:	$6,999.00
Sale:	$12,000 on 10-1994 Reason=LM Qual=Q	Misc Value:	$4,307.00
Mail:	P O BOX 627 WAYNESVILLE, GA 31566	Total Value:	$28,860.00



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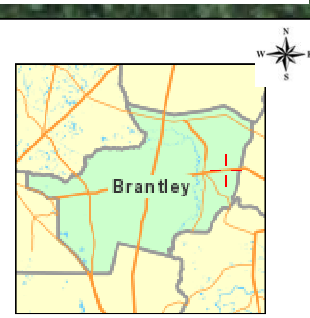
Brantley County Assessor			
Parcel: B072 045 Acres: 0.79			
Name:	BEACH RAPHAEL	Land Value:	$4,124.00
Site:	24743 HWY 82	Building Value:	$0.00
Sale:	$0 on 07-1990 Reason=LM Qual=Q	Misc Value:	$1,437.00
Mail:	FERN BEACH 6644 S 2125 E OGDEN, UT 844059717	Total Value:	$5,561.00



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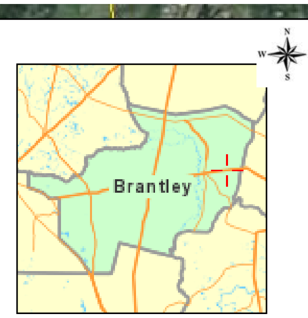
Brantley County Assessor			
Parcel: B072 036 Acres: 4.14			
Name:	STORY RICHARD	Land Value:	$17,277.00
Site:	555 HAZELHURST RD	Building Value:	$16,545.00
Sale:	$42,545 on 11-2004 Reason=PP Qual=U	Misc Value:	$6,442.00
Mail:	555 HAZEL HURST RD WAYNESVILLE, GA 31566	Total Value:	$40,264.00



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Brantley County Assessor			
Parcel: B072 043 Acres: 0.46			
Name:	GIBSON WILLIAM	Land Value:	$3,043.00
Site:	0 CRANDEL RD	Building Value:	$0.00
Sale:	$0 on 02-2005 Reason=11 Qual=U	Misc Value:	$10,336.00
Mail:	P O BOX 100 WAYNESVILLE, GA 31566	Total Value:	$13,379.00

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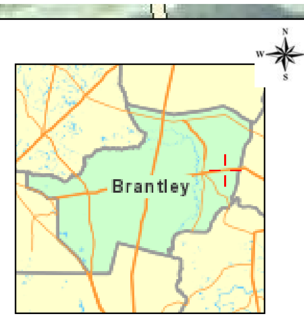
Date printed: 08/03/16 : 16:50:59

Brantley County Assessor			
Parcel: B072 042 Acres: 0.42			
Name:	JACOB TONY	Land Value:	$2,041.00
Site:	0 CRANDLE RD	Building Value:	$12,789.00
Sale:	$33,000 on 02-2014 Reason=MH Qual=U	Misc Value:	$1,500.00
Mail:	DANNY M JACOB 33336 N AGUA DULCE CYN RD STE 103 SANTA CLARITA, CA 91390	Total Value:	$16,330.00



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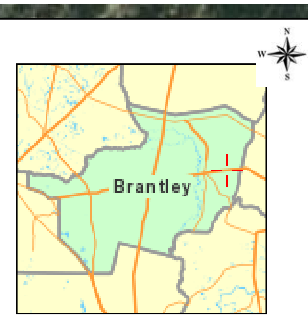
Brantley County Assessor			
Parcel: B072 041 Acres: 0.46			
Name:	BRADLEY KAREN	Land Value:	$2,232.00
Site:	118 CRANDLE RD	Building Value:	$10,999.00
Sale:	$25,000 on 09-2010 Reason=MH Qual=U	Misc Value:	$1,788.00
Mail:	118 CRANDAL RD WAYNESVILLE, GA 31566	Total Value:	$15,019.00



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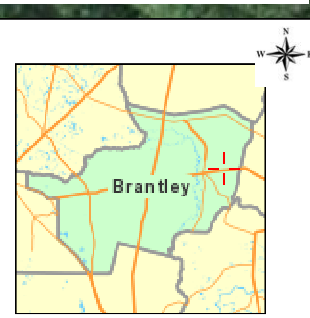
Brantley County Assessor			
Parcel: B072 024 Acres: 2.63			
Name:	THORNTON ROSALYN	Land Value:	$14,593.00
Site:	132 THORNTON RD	Building Value:	$6,004.00
Sale:	$0 on 04-1993 Reason=AD Qual=U	Misc Value:	$12,343.00
Mail:	108 THORNTON RD WAYNESVILLE, GA 31566	Total Value:	$32,940.00



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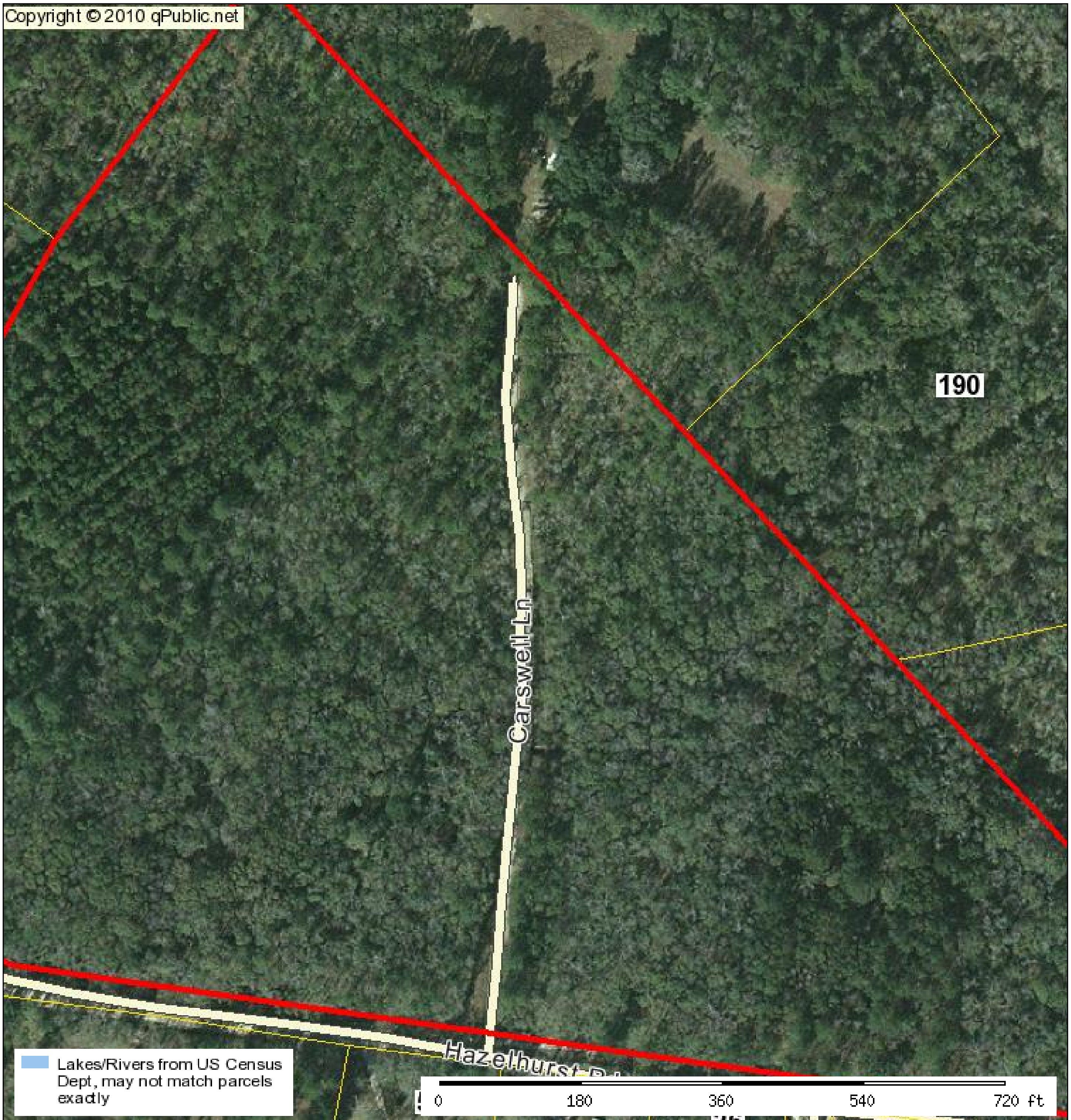
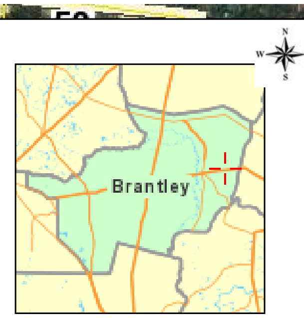


Brantley County Assessor			
Parcel: B072 025 Acres: 24.62			
Name:	THORNTON ALLEN	Land Value:	$21,321.00
Site:	468 HAZELHURST RD	Building Value:	$80,240.00
Sale:	$38,000 on 06-2013 Reason=LM Qual=Q	Misc Value:	$1,500.00
Mail:	SHANNON THORNTON 468 HAZELHURST RD WAYNESVILLE, GA 31566	Total Value:	$103,061.00



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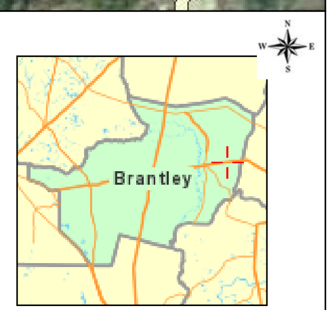
Date printed: 03/09/16 : 17:15:12

Brantley County Assessor

Parcel: B072 037 Acres: 1

Name:	HICKOX CARL	Land Value:	$4,743.00
Site:	519 HAZELHURST RD	Building Value:	$5,603.00
Sale:	$15,000 on 04-1997 Reason=PP Qual=U	Misc Value:	$2,904.00
Mail:	EVELYN J HICKOX 519 HAZELHURST RD WAYNESVILLE, GA 31566	Total Value:	$13,250.00



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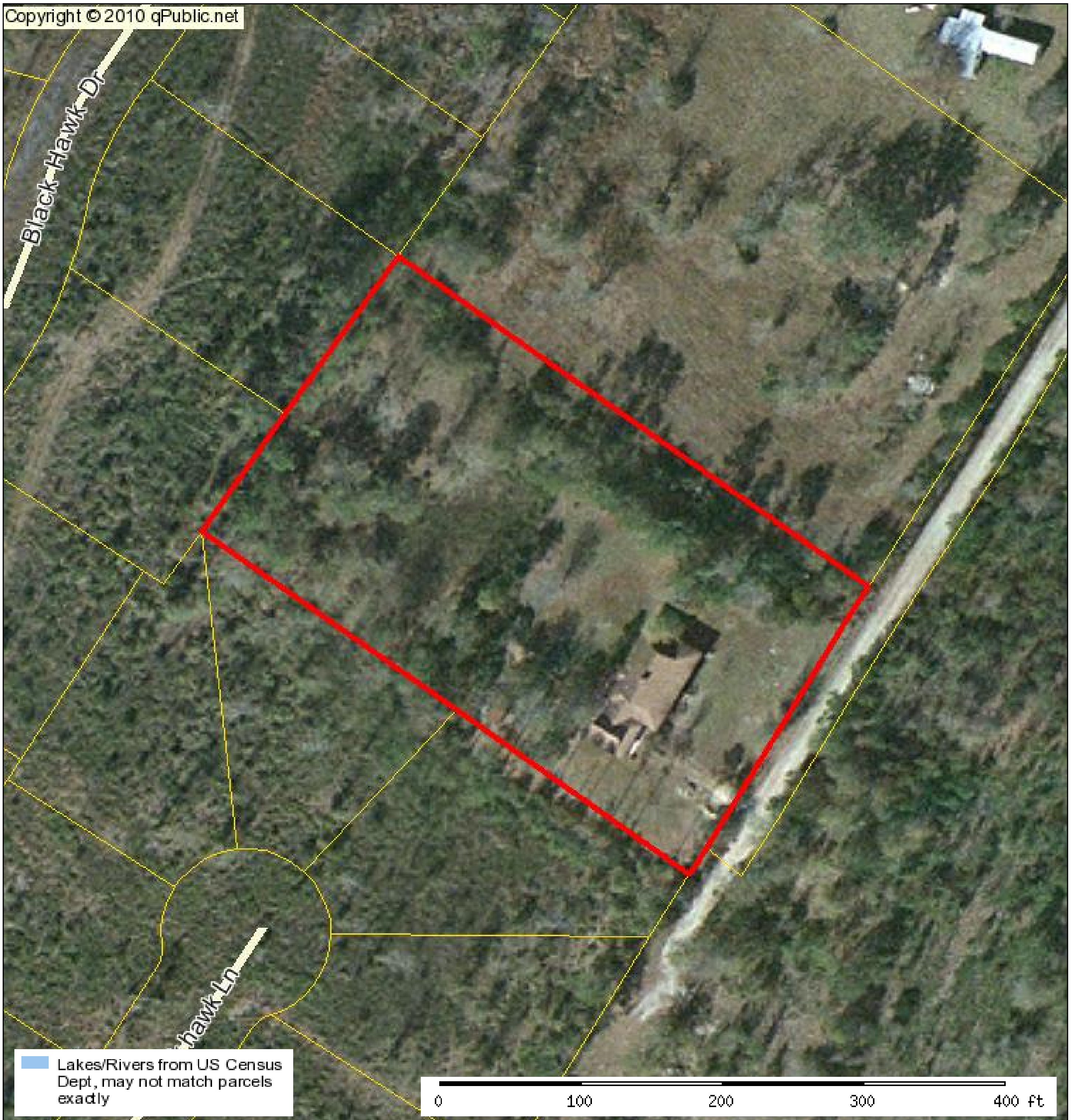
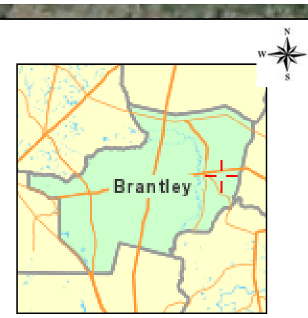


Brantley County Assessor

Parcel: B072 071 Acres:

Name:		Land Value:	
Site:		Building Value:	
Sale:		Misc Value:	
Mail:	,	Total Value:	



Brantley County makes every effort to produce the most accurate information possible. No warranties, expressed or implied, are provided for the data herein, its use or interpretation. The assessment information is from the last certified taxroll. All data is subject to change before the next certified taxroll.
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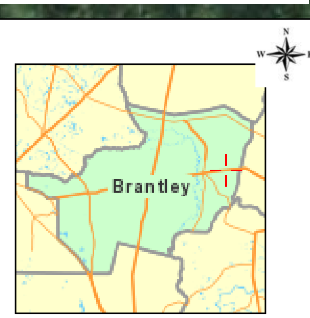


Brantley County Assessor			
Parcel: B072 040 Acres: 1.42			
Name:	MORGAN JOSEPH JR	Land Value:	$9,029.00
Site:	0 HWY 82 E	Building Value:	$0.00
Sale:	$4,900 on 01-1990 Reason=LM Qual=Q	Misc Value:	$1,500.00
Mail:	459 TERRI WAY HOBOKEN, GA 31542	Total Value:	$10,529.00

Date printed: 03/09/16 : 17:17:29

Brantley County Assessor

Parcel: B072 038 Acres: 2.01

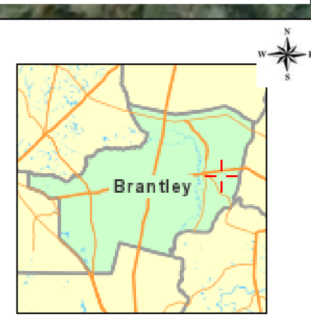
Name:	ALEXANDER BILLY	Land Value:	$9,149.00
Site:	26 CRANDAL RD	Building Value:	$24,578.00
Sale:	$18,000 on 05-1998 Reason=PP Qual=U	Misc Value:	$5,442.00
Mail:	KATHY J ALEXANDER 26 CRANDAL RD WAYNESVILLE, GA 31566	Total Value:	$39,169.00

Date printed: 03/09/16 : 17:12:46

Brantley County Assessor

Parcel: B072 072 Acres: 3.5

Name:	BODIE JONI	Land Value:	$14,983.00
Site:	711 HOPE RD	Building Value:	$0.00
Sale:	$58,000 on 11-2014 Reason=LE Qual=U	Misc Value:	$2,865.00
Mail:	711 HOPE RD WAYNESVILLE, GA 31566	Total Value:	$17,848.00



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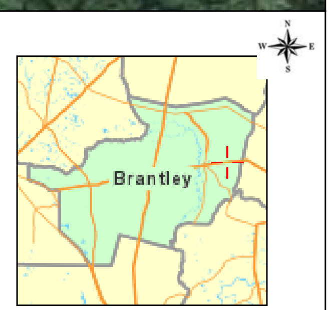
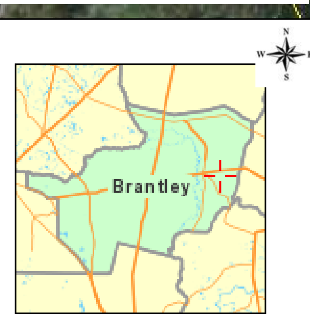


Brantley County Assessor			
Parcel: B072 039 Acres: 2			
Name:	WILSON ELTA	Land Value:	$9,107.00
Site:	53 CRANDAL RD	Building Value:	$22,983.00
Sale:	$0 on 05-1991 Reason=NF Qual=U	Misc Value:	$3,024.00
Mail:	53 CRANDAL RD WAYNESVILLE, GA 31566	Total Value:	$35,114.00

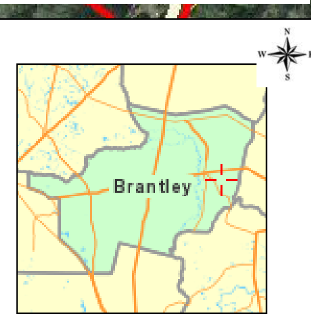
Date printed: 03/09/16 : 17:13:13

Brantley County Assessor			
Parcel: B072 073 Acres: 3.5			
Name:	MCCULLOUGH PATRICIA	Land Value:	$18,743.00
Site:	701 HOPE RD	Building Value:	$67,706.00
Sale:	$125,000 on 06-2008 Reason=20 Qual=U	Misc Value:	$2,556.00
Mail:	P O BOX 88 WAYNESVILLE, GA 31566	Total Value:	$89,005.00



Date printed: 03/09/16 : 15:13:43

Brantley County Assessor			
Parcel: B073 013 Acres: 20			
Name:	ELLIS JOHN	Land Value:	$43,680.00
Site:	211 FRANKLIN TRL	Building Value:	$138,768.00
Sale:	$30,000 on 05-2003 Reason=PP Qual=U	Misc Value:	$20,845.00
Mail:	211 FRANKLIN TRL WAYNESVILLE, GA 31566	Total Value:	$203,293.00



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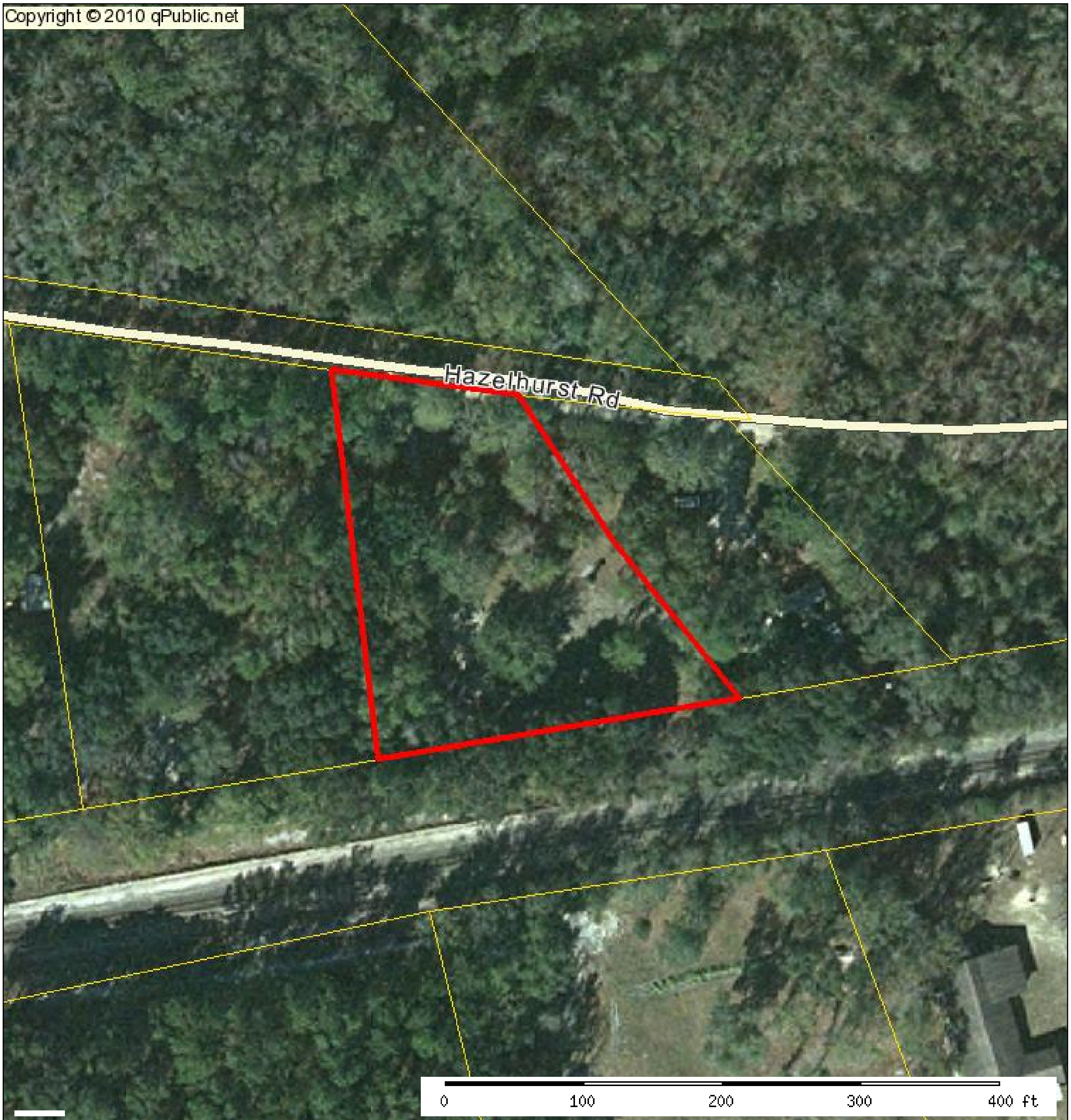
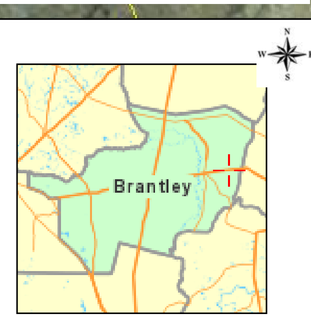


Brantley County Assessor

Parcel: B079 060 Acres: 1

Name:	GASKIN JUDY	Land Value:	$4,743.00
Site:	0 HAZELHURST RD	Building Value:	$0.00
Sale:	$1,000 on 05-2008 Reason=IT Qual=U	Misc Value:	$2,436.00
Mail:	4540 US HWY 17 N BRUNSWICK, GA 31525	Total Value:	$7,179.00



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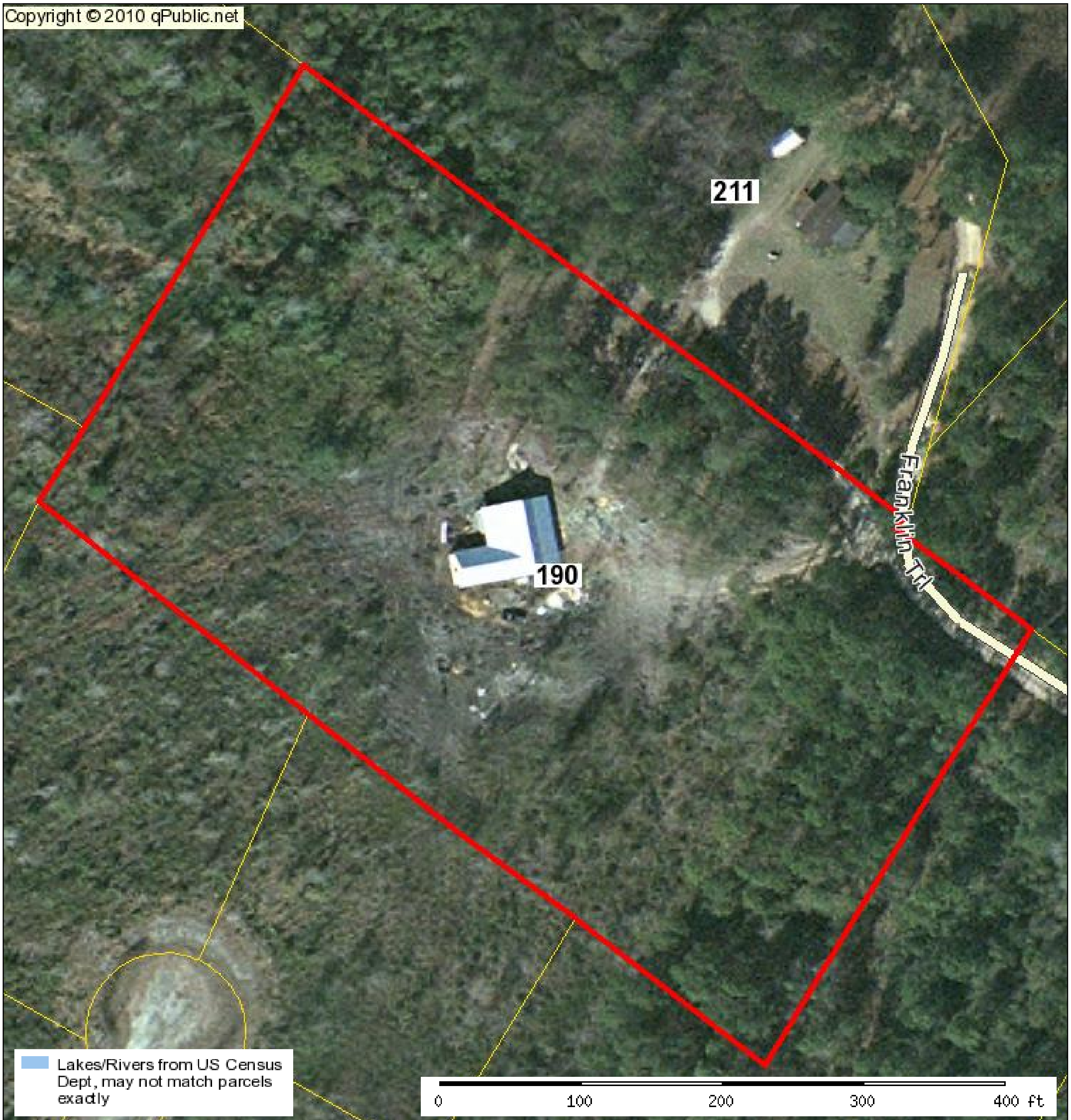
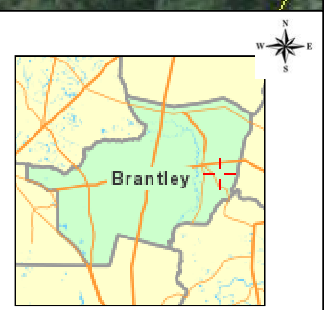
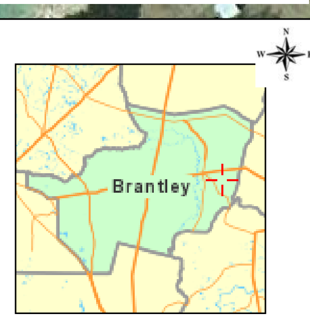


Brantley County Assessor			
Parcel: B073 023 Acres: 4.52			
Name:	WESTOVER AMANDA	Land Value:	$23,218.00
Site:	190 FRANKLIN TRL	Building Value:	$127,846.00
Sale:	$0 on 06-2010 Reason=LE Qual=U	Misc Value:	$8,344.00
Mail:	BRIAN WESTOVER 190 FRANKLIN TRL WAYNESVILLE, GA 31566	Total Value:	$159,408.00



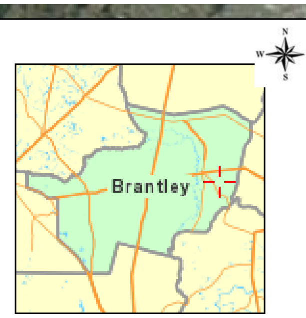
Date printed: 03/10/16 : 09:04:07

Brantley County Assessor			
Parcel: B072 079 Acres: 2			
Name:	WHITTINGTON RICHARD	Land Value:	$9,107.00
Site:	0 OLD WAYNESVILLE RD	Building Value:	$0.00
Sale:	$2,500 on 03-2014 Reason=FS Qual=U	Misc Value:	$1,000.00
Mail:	4613 OLD WAYNESVILLE RD WAYNESVILLE, GA 31566	Total Value:	$10,107.00



Date printed: 08/29/16 : 12:58:44

Brantley County Assessor			
Parcel: B073 022 Acres: 3.27			
Name:	WESTOVER AMANDA	Land Value:	$14,140.00
Site:	0 FRANKLIN TRL	Building Value:	$0.00
Sale:	$0 on 05-2009 Reason=09 Qual=U	Misc Value:	$0.00
Mail:	205 FRANKLIN TRL WAYNESVILLE, GA 31566	Total Value:	$14,140.00



Date printed: 08/29/16 : 13:00:45

IES
CIVIL · ENVIRONMENTAL

Michael Biers <mbiers@ie-strategies.com>

Question on wells near Waynesville area

7 messages

Michael Biers <mbiers@ie-strategies.com> Tue, Jul 9, 2019 at 6:09 PM
To: rachel.james@dph.ga.gov
Cc: wayne.nuenke@dph.ga.gov

Rachel,

It was a pleasure speaking with you earlier today. As discussed, I am wanting to know if there have been any new residential wells installed in the Brantley County area between Waynesville and the Atkinson community since January 1, 2016. I am looking for the general area between the Satilla River (± west boundary) and the Glynn County line (± east boundary), and between Kings Bay Road (± south boundary) and Stewart Road (± north boundary).

If you can provide me a list of the applications since this date I can research whether or not they were actually installed, etc.

Any assistance would be greatly appreciated!

Let me know if you have any questions.

Sincerely,

Michael W. Biers, P.E.
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
(478) 365-8609

James, Rachel <rachel.james@dph.ga.gov> Thu, Jul 11, 2019 at 4:11 PM
To: Michael Biers <mbiers@ie-strategies.com>

I can send you the list today, if you can complete and send back the attached Open Records Request form.

Thank you!

Rachel James
Environmental Health Specialist I
Southeast Health District
Brantley County Health Department
173 Florida Avenue
Nahunta, GA 31553
Phone: 912-462-6165
Email: rachel.james@dph.ga.gov

From: Michael Biers <mbiers@ie-strategies.com>
Sent: Tuesday, July 9, 2019 6:09 PM

To: James, Rachel
Cc: Nuenke, Wayne
Subject: Question on wells near Waynesville area

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

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Michael Biers <mbiers@ie-strategies.com> Thu, Jul 11, 2019 at 4:12 PM
To: "James, Rachel" <rachel.james@dph.ga.gov>

Thanks,

Coming to you in about 15 minutes...

Sincerely,

Michael W. Biers, P.E.
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
(478) 365-8609

[Quoted text hidden]

James, Rachel <rachel.james@dph.ga.gov> Thu, Jul 11, 2019 at 4:18 PM
To: Michael Biers <mbiers@ie-strategies.com>

It would help if I actually attached it...

Rachel James
Environmental Health Specialist I
Southeast Health District
Brantley County Health Department
173 Florida Avenue
Nahunta, GA 31553
Phone: 912-462-6165
Email: rachel.james@dph.ga.gov

From: Michael Biers <mbiers@ie-strategies.com>
Sent: Thursday, July 11, 2019 4:12 PM
To: James, Rachel
Subject: Re: Question on wells near Waynesville area

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Open Records Request.pdf
26K

Michael Biers <mbiers@ie-strategies.com> Thu, Jul 11, 2019 at 4:30 PM

To: "James, Rachel" <rachel.james@dph.ga.gov>

See attached.

Sincerely,

Michael W. Biers, P.E.
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
(478) 365-8609

[Quoted text hidden]

---

memo R James 2019-07-11.pdf
229K

James, Rachel <rachel.james@dph.ga.gov> Thu, Jul 11, 2019 at 4:47 PM
To: Michael Biers <mbiers@ie-strategies.com>

Let me know if you need anything else.

Thanks!

Rachel James
Environmental Health Specialist II
Southeast Health District
Brantley County Health Department
173 Florida Avenue
Nahunta, GA 31553
Phone: 912-462-6165
Email: rachel.james@dph.ga.gov

From: Michael Biers <mbiers@ie-strategies.com>
Sent: Thursday, July 11, 2019 4:30 PM
[Quoted text hidden]

[Quoted text hidden]

Permits Issued 2016 Onward.pdf
64K

Michael Biers <mbiers@ie-strategies.com> Thu, Jul 11, 2019 at 4:48 PM
To: "James, Rachel" <rachel.james@dph.ga.gov>

Thank you very much!!

Sincerely,

Michael W. Biers, P.E.
Innovative Engineering Strategies, LLC

P.O. Box 560
Smarr, Georgia 31086
(478) 365-8609

[Quoted text hidden]

IES
CIVIL · ENVIRONMENTAL

Innovative
Engineering
Strategies, LLC

P.O. Box 560
Smarr, Georgia 31086
(478) 365-8609
mbiers@ie-strategies.com

July 11, 2019

Ms. Rachel James
Southeast Health District
Brantley County Health Department
173 Florida Avenue
Nahunta, Georgia 31553

Subject: **Open Records Request**
New Residential Wells Since 2016
Waynesville, Georgia Area
IES Project No. 1390-010-01

Dear Ms. James:

IES is wanting to know if there have been any new residential wells installed in the Brantley County area between Waynesville and the Atkinson community since January 1, 2016. Specifically, IES is looking for the general area between the Satilla River (± west boundary) and the Glynn County line (± east boundary), and between Kings Bay Road (± south boundary) and Stewart Road (± north boundary).

If you can provide IES a list of the applications since this date we can research whether or not they were actually installed, etc.

Any assistance would be greatly appreciated!

Should you have any questions or comments do not hesitate to contact us.

Sincerely,
INNOVATIVE ENGINEERING STRATEGIES, LLC

Michael W. Biers, P.E.
Project Manager

This is a list of permits issued from 1/1/2016 to 7/2/2019 by the Brantley County Health Department. Hoboken and Waycross addresses were removed, as they are certainly out of your research area. An issued permit does not necessarily mean an installed well. Also, there may be installed wells that were not properly permitted in the area.

ADDRESS_FULL_MAILING	CITY_MAILING	PERMITISSUEDATE
2892 MINERAL SPRINGS WAYNESVILLE, GA 31566	WAYNESVILLE	7/2/2019
806 HOKE CIR NAHUNTA, GA 31553	NAHUNTA	6/26/2019
1820 STAFFORD RD WAYNESVILLE, GA 31566	WAYNESVILLE	6/20/2019
750 WAINRIGHT LOOP NAHUNTA, GA 31553	NAHUNTA	6/14/2019
637 SAWGRASS RD HORTENSE, GA 31543	HORTENSE	6/17/2019
559 DEER RUN TRL HORTENSE, GA 31543	HORTENSE	7/3/2018
481 MATTHEW CIR NAHUNTA, GA 31553	NAHUNTA	6/4/2019
12797 W RAYBON RD NAHUNTA, GA 31553	NAHUNTA	5/24/2019
1027 PICKETTS MILL TRL WAYNESVILLE, GA 31566	WAYNESVILLE	5/21/2019
243 BILLY JACOBS RD HOBOKEN, GA 31542	HOBOKEN	5/15/2019
580 GIBSON CIR HORTENSE, GA 31543	HORTENSE	4/29/2019
153 BRYAN RD HORTENSE, GA 31543	HORTENSE	5/1/2019
453 HONEYSUCKLE DR NAHUNTA, GA 31553	NAHUNTA	4/26/2019
13845 W HWY 110 NAHUNTA, GA 31553	NAHUNTA	4/19/2019
3523 OAK GROVE RD NAHUNTA, GA 31553	NAHUNTA	4/2/2018
121 CHRISTY LN WAYNESVILLE, GA 31566	WAYNESVILLE	4/12/2019
1679 BUSTER WALKER RD WAYNESVILLE, GA 31566	WAYNESVILLE	4/12/2019
405 JEFF RD WAYNESVILLE, GA 31566	WAYNESVILLE	4/2/2019
1681 BUSTER WALKER RD WAYNESVILLE, GA 31566	WAYNESVILLE	4/3/2019
000 BUFFALO CREEK DR NAHUNTA, GA 31553	NAHUNTA	3/19/2019
3701 TAYLOR BAY NAHUNTA, GA 31553	NAHUNTA	3/19/2019
38 LONG LAKE RD NAHUNTA, GA 31553	NAHUNTA	3/1/2019
2067 BUSTER WALKER RD WAYNESVILLE, GA 31566	WAYNESVILLE	1/30/2019

720 HOKE CIR NAHUNTA, GA 31553	NAHUNTA	3/14/2019
368 DRURY LN HORTENSE, GA 31543	HORTENSE	12/11/2018
29336 KNOX RD NAHUNTA, GA 31553	NAHUNTA	8/15/2018
384 AUTUMN LN NAHUNTA, GA 31553	NAHUNTA	11/9/2018
3375 WAYNESVILLE RD WAYNESVILLE, GA 31566	WAYNESVILLE	11/15/2018
82 BARLOW RD HORTENSE, GA 31543	HORTENSE	1/1/1900
184 THROWER RD HORTENSE, GA 31543	HORTENSE	10/24/2018
1863 MURPHY RD WAYNESVILLE, GA 31566	WAYNESVILLE	8/21/2018
129 LANE CEMETERY RD HORTENSE, GA 31543	HORTENSE	10/30/2018
175 LANE CEMETERY RD HORTENSE, GA 31543	HORTENSE	10/22/2018
14099 N HWY 301 NAHUNTA, GA 31553	NAHUNTA	7/12/2018
277 CARL BURNEY RD HORTENSE, GA 31543	HORTENSE	10/3/2018
219 CONNIE LN HORTENSE, GA 31543	HORTENSE	1/22/2018
551 MATTHEWS CIR NAHUNTA, GA 31553	NAHUNTA	8/27/2018
7795 BROWNTOWN RD HORTENSE, GA 31543	HORTENSE	3/5/2018
2546 BOOTS HARRISON RD HORTENSE, GA 31543	HORTENSE	7/23/2018
191 LANE CEMETERY RD HORTENSE, GA 31543	HORTENSE	7/16/2018
822 JESS ALLEN RD NAHUNTA, GA 31553	NAHUNTA	6/5/2018
2381 BUSTER WALKER RD WAYNESVILLE, GA 31566	WAYNESVILLE	6/19/2018
289 GILMAN RD NAHUNTA, GA 31553	NAHUNTA	4/30/2018
2301 HIGH BLUFF RD HOBOKEN, GA 31542	HOBOKEN	5/9/2018
2517 BUFFALO CREEK DR NAHUNTA, GA 31553	NAHUNTA	5/9/2018
320 PINE RIDGE RD HOBOKEN, GA 31542	HOBOKEN	4/18/2018
602 CREEK DR HOBOKEN, GA 31542	HOBOKEN	4/16/2018
290 SLOAN HILL RD HORTENSE, GA 31543	HORTENSE	3/27/2018
8624 HWY 121 HOBOKEN, GA 31542	HOBOKEN	3/5/2018
908 CHRISTOPHER CIR NAHUNTA, GA 31553	NAHUNTA	11/27/2017
7706 HWY 110 HORTENSE, GA 31543	HORTENSE	3/12/2018
199 LONG LAKE RD NAHUNTA, GA 31553	NAHUNTA	1/17/2018
64 CHERRY DR WAYCROSS, GA 31503	WAYCROSS	2/21/2018

181 FIRE FLY RD NAHUNTA, GA 31553	NAHUNTA	2/19/2018
1404 WARNERS LANDING HORTENSE, GA 31543	HORTENSE	12/18/2017
000 THRIFT LOOP NAHUNTA, GA 31553	NAHUNTA	2/15/2018
1137 ELLIS HIGHSMITH RD NAHUNTA, GA 31553	NAHUNTA	12/7/2017
73 TIMBER LN WAYCROSS, GA 31503	WAYCROSS	11/16/2017
341 HERITAGE CIR HORTENSE, GA 31543	HORTENSE	11/3/2017
6154 OLD HWY 259 WAYNESVILLE, GA 31566	WAYNESVILLE	9/1/2017
938 MILES STILL RD WAYCROSS, GA 31503	WAYCROSS	10/10/2017
000 WHITE FORD RD NAHUNTA, GA 31553	NAHUNTA	9/18/2017
94 DAVID TRL WAYNESVILLE, GA 31566	WAYNESVILLE	8/25/2017
000 DIXON RD WAYCROSS, GA 31503	WAYCROSS	8/11/2017
243 HARVEST RD NAHUNTA, GA 31553	NAHUNTA	6/9/2017
4919 RIVERSIDE RD NAHUNTA, GA 31553	NAHUNTA	6/2/2017
5287 RIVERSIDE RD NAHUNTA, GA 31553	NAHUNTA	6/2/2017
15429 W HWY 110 HORTENSE, GA 31543	HORTENSE	5/16/2017
648 MATTHEW CIR NAHUNTA, GA 31553	NAHUNTA	4/3/2017
5669 OLD WAYNESVILLE RD WAYNESVILLE, GA 31566	WAYNESVILLE	2/21/2017
66 LISA LN HORTENSE, GA 31543	HORTENSE	2/21/2017
7175 RIVERSIDE		12/9/2016
505 HIGHTOWER RD NAHUNTA, GA 31553	NAHUNTA	2/14/2017
1178 BENNETT RD WAYCROSS, GA 31503	WAYCROSS	2/2/2017
257 ROBERT ST NAHUNTA, GA 31553	NAHUNTA	1/23/2017
102 WAINRIGHT LOOP NAHUNTA, GA 31553	NAHUNTA	1/23/2017
4181 WAYNESVILLE RD WAYNESVILLE, GA 31566	WAYNESVILLE	1/19/2017
24743 HWY 82 WAYNESVILLE, GA 31566	WAYNESVILLE	1/5/2017
27611 KNOX RD NAHUNTA, GA 31553	NAHUNTA	1/3/2017
703 HOKE CIR NAHUNTA, GA 31553	NAHUNTA	8/19/2016
21317 HIGHWAY 82 HWY HORTENSE, GA 31543	HORTENSE	3/28/2016

APPENDIX D

BRANTLEY COUNTY BOARD OF COMMISSIONERS
Post Office Box 398
33 Allen Road
Nahunta, Georgia 31553
(912) 462-5256
FAX (912) 462-5538
Email: bcbc@btconline.net

Charles D. Summerlin, Jr., Chairman
Mike Edgy, Commissioner
James A. Spradley, Commissioner
Brian Hendrix, Commissioner
Skipper Harris, Commissioner

Carl L. Rowland, County Manager
Dale J. Halligan, County Clerk
René T. Herrin, Accounting Coordinator
Cindy Lukas, Office Clerk

November 21, 2014

Ms. Claudia Moeller, Program Manager
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

RE: Proposed Solid Waste Handling Facility
Magnolia Holdings Business Park
Brantley County, Georgia

Dear Ms. Moeller,

In my official capacity as County Manager of Brantley County, I have reviewed the approved Solid Waste Management Plan adopted by Brantley County and the Cities of Hoboken and Nahunta on June 22, 2006 and its most recent 2011 Five-Year Short-Term Work Program 2010-2019, adopted on August 9, 2011, and have determined that the proposed Solid Waste Handling Facility to be located at the Magnolia Holdings Business Park is consistent with that plan. I further certify that Brantley County has a strategy and is actively engaged in meeting the state-wide goal of reducing waste.

Sincerely,

Carl Rowland
County Manager,
Brantley County Board of Commissioners

BRANTLEY COUNTY BOARD OF COMMISSIONERS

Post Office Box 398
33 Allen Road
Nahunta, Georgia 31553
(912) 462-5256
FAX (912) 462-5538
Email: bcbc@btconline.net

Charles D. Summerlin, Jr., Chairman
Mike Edgy, Commissioner
James A. Spradley, Commissioner
Brian Hendrix, Commissioner
Skipper Harris, Commissioner

Carl L. Rowland, County Manager
Dale J. Halligan, County Clerk
René T. Herrin, Accounting Coordinator
Cindy Lukas, Office Clerk

November 21, 2014

Ms. Claudia Moeller, Program Manager
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

RE: Proposed Solid Waste Handling Facility
Magnolia Holdings Business Park
Brantley County, Georgia

Dear Ms. Moeller,

The proposed private Solid Waste Handling Facility located at the Magnolia Holdings Business Park complies with Brantley County's local land use plan. Brantley County at the present time does not have a zoning ordinance.

Sincerely,

Carl Rowland
County Manager,
Brantley County Board of Commissioners

BRANTLEY COUNTY BOARD OF COMMISSIONERS

Post Office Box 398
33 Allen Road
Nahunta, Georgia 31553
(912) 462-5256
FAX (912) 462-5538
Email: bcbc@btconline.net

August 19, 2015

Brantley Development Partners, LLC
2255 Cumberland Parkway
Bldg. 1700
Atlanta, GA 30339

Dear Sirs:

Brantley County considers the property of Brantley Development Partners, LLC, formerly Magnolia Landholdings, LLC, situated on the North and South boundaries of State Highway 520 as one and the same tract of land.

Please let me know if I can be of further assistance.

Sincerely,

Carl

Carl L. Rowland
County Manager

BRANTLEY COUNTY BOARD OF COMMISSIONERS
Post Office Box 398
33 Allen Road
Nahunta, Georgia 31553
(912) 462-5256
FAX (912) 462-5538
Email: bcbc@btconline.net

Charles D. Summerlin, Jr., Chairman
Mike Edgy, Commissioner
James A. Spradley, Commissioner
Brian Hendrix, Commissioner
Skipper Harris, Commissioner

Carl L. Rowland, County Manager
Dale J. Halligan, County Clerk
René T. Herrin, Accounting Coordinator
Cindy Lukas, Office Clerk

February 6, 2015

Ms. Claudia Moeller, Program Manager
4244 International Parkway. Suite 104
Atlanta, Georgia 30354

RE: Proposed Solid Waste Handling Facility
Brantley Development Partners
Former Magnolia Holding Business Park
Brantley County, Georgia

Dear Ms. Moeller:

The proposed private Solid Waste Handling Facility proposed by the Brantley County Development Partners, LLC at the former Magnolia Holdings Business Park is consistent with Brantley County's local land use plan. Brantley County at the present time does not have a zoning ordinance.

Sincerely,

Charles D. Summerlin, Jr.
Chairman

BRANTLEY COUNTY BOARD OF COMMISSIONERS
Post Office Box 398
33 Allen Road
Nahunta, Georgia 31553
(912) 462-5256
FAX (912) 462-5538
Email: bcbc@btconline.net

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Mike Edgy, Commissioner
James A. Spradley, Commissioner
Brian Hendrix, Commissioner
Skipper Harris, Commissioner

Carl L. Rowland, County Manager
Dale J. Halligan, County Clerk
René T. Herrin, Accounting Coordinator
Cindy Lukas, Office Clerk

February 6, 2015

Ms. Claudia Moeller, Program Manager
4244 International Parkway. Suite 104
Atlanta, Georgia 30354

RE: Proposed Solid Waste Handling Facility
Brantley Development Partners
Former Magnolia Holding Business Park
Brantley County, Georgia

Dear Ms. Moeller:

The Board of Commissioners and its staff have reviewed the approved Solid Waste Management Plan adopted by Brantley County and the Cities of Hoboken and Nahunta on June 26, 2006 and our most recent 2011 Five – year Short Term Work Program 2010 – 2019 and have determined that the solid waste handling facilities being proposed by Brantley Development Partners, LLC to be located on a site formerly known as Magnolia Holdings Business Park is consistent with the plans and programs cited above.

We further certify that Brantley County has a strategy and is actively engaged in meeting the statewide goal of reducing waste.

Sincerely,

Charles D. Summerlin, Jr.
Chairman

APPENDIX E

Building Brantley
Today – Tomorrow and Beyond

Brantley County, City of Hoboken, and City of Nahunta
Solid Waste Management Plan

March 2006

SOLID WASTE MANAGEMENT PLAN

OF

BRANTLEY COUNTY, GEORGIA

Prepared for:
Brantley County Board of Commission
City of Hoboken and City of Nahunta

SOLID WASTE MANAGEMENT PLAN

OF

BRANTLEY COUNTY, GEORGIA

Prepared for:

Brantley County Board of Commissioners
Nahunta, Georgia

Terry Thomas, Chairman
Brian Hendrix, Commissioner
Ernest Hunter, Commissioner
Darlene Jones, Commissioner
Dru Smith, Commissioner

City of Hoboken, Georgia

Charles H. Lee, Mayor
Greg Buie, Council member
Kenneth Jordan, Sr., Council member
Kenneth Jordan, Jr., Council member
James Ray, Council member
Chris Thomas, Council member
David E. Sapp, Council member

City of Nahunta, Georgia

Robert H. Wilson, Mayor
Judy Blount, Council member
Joel M. Chambless, Council member
Christopher Davis, Council member
Michael L. Moore, Council member

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SUMMARY

Introduction

Brantley County and its two municipalities, Hoboken and Nahunta, have prepared an updated joint Solid Waste Management Plan in compliance with the Georgia Comprehensive Solid Waste Management Act, Official Code of Georgia Annotated, Section 12-8-20 et seq., and in response to the Rules of the Georgia Department of Community Affairs as set forth in Chapter 110-4-3, which require every city and county to develop a SWMP, or to update their existing SWMP every ten years.

This plan was guided by the minimum planning standards and procedures for solid waste management set out in Chapter 110-4-3 of the Rules of the Georgia Department of Community Affairs and as set out in the Georgia Solid Waste Management Act.

The City of Hoboken currently provides for collection and disposal services of municipal solid waste for its residents and will continue to do so in the future, but it has delegated some disposal services of other types of solid waste for its residents to Brantley County. The City of Hoboken currently provides collection and disposal service via a private contractor, but may in the future provide collection services without the assistance of private contractors, but would continue to use disposal services outside the county.

The City of Nahunta currently provides for collection and disposal services of municipal solid waste for its residents and will continue to do so in the future, but it has delegated some disposal services of other types of solid waste for its residents to Brantley County. The City of Nahunta currently provides collection and disposal services with a private contractor, but may in the future provide collection without the assistance of private contractors, but would continue to use disposal services outside the county.

The Brantley County Board of Commissioners currently provides for collection and disposal services with a private contractor of the municipal solid waste for the residents of the unincorporated areas of the county. The County may in the future provide collection without the assistance of private contractors.

The cities and county realize that the management of solid waste has become an increasing problem due to continued population growth, an increased awareness of the environmental risks associated with solid waste management, more stringent regulation of disposal methods, and the fact that the solid waste landfill in Brantley County has reached capacity and has now been closed. This landfill will be monitored as required by the Georgia Environment Protection Division.

Purpose and Objectives

The Georgia Solid Waste Management Act (the Act) requires that each SWMP meet the following criteria:

1. Each solid waste management plan is to provide for the assurance of adequate solid waste collection capability and disposal capacity within the planning area for at least ten years from the date of plan completion.

2. Each solid waste management plan relying upon a landfill in Georgia for waste disposal shall have a program in effect to reduce the rate of municipal solid waste disposed statewide in solid waste facilities.

3. Each solid waste plan must identify all solid waste handling facilities within the plan's area as to size and type.

4. Each solid waste management plan must identify land areas unsuitable for solid waste handling facilities based on environmental and land use factors.

The regulations also require the County to use extensive public participation in the development of the SWMP, which the County did by holding public information sessions and public hearings. The Act encourages cities and counties to develop multijurisdictional plans, this is the procedure Brantley County, and its municipalities chose to follow.

It is the intent of the County and municipalities to prepare this Plan in furtherance of their responsibility to help protect the public health, safety and well being of their residents and to protect and enhance the quality of their environment. Specifically, the county and its municipalities intended to institute and maintain a comprehensive program for waste management which will help assure that solid waste management facilities, whether publicly or privately owned or operated, do not adversely affect the health, safety, and well-being of the public and do not degrade the quality of the environment by reason of their location, design, method of operation, or by other means.

In preparing this Plan, the county and its municipalities recognized that the other counties which share common borders with Brantley also share the vital natural resources of clean air and clean surface waters which flow across those common borders, and that these bordering counties therefore share Brantley's interest in managing waste, including solid waste, in a manner that does not threaten to contaminate the shared natural resources. In this regard, Brantley County and its municipalities intend to be particularly mindful of the need to monitor, inspect, and closely regulate not only the waste generated within the borders of Brantley County, but also any waste generated outside its borders but handled, transported, collected, stored, or disposed within its borders.

It is also the intent of the county and its municipalities that this Plan shall apply to any solid waste disposal facility which is operated exclusively by a private solid waste generator on property owned by the private solid waste generator for the purpose of accepting solid waste exclusively from the private solid waste generator.

Public Participation

Three public hearings were held in Brantley County to elicit community input during the planning process. The first public hearing was held before preparing the Plan on March 3, 2005. The second public hearing was held following the completion of the first draft of the Plan on May 9, 2005. The comments and suggestions at both of these public hearings were considered for incorporation into this Plan. Planning meetings were also held at the Brantley County Courthouse from January 2005, through March 31, 2005, to elicit comments and suggestions from citizens. Finally, the Georgia Department of Community Affairs was sent copies of the Plan to review and comment on the contents of the Plan. Copies of the hearing notices and announcements of planning meetings can be seen in **Appendix A** to this Plan.

Resolution Authorizations

The Brantley County Board of Commissioners and the Mayors and Councils of the cities of Hoboken and Nahunta authorized the preparation of this joint solid waste management plan. All governing bodies in Brantley County have reviewed this plan.

The Southeast Georgia Regional Development Center (RDC) contracted with the City of Hoboken, City of Nahunta, and Brantley County Board of Commissioners to develop the plan with citizen participation, and many evaluations and mapping necessary to prepare this plan have been prepared by the RDC. The RDC also prepared and printed the final draft of this Plan. Brantley County and its municipalities are grateful for their assistance and cooperation.

Overview of Plan Elements

The County's SWMP contains two major components:

A. Base document: The base document is structured to meet state requirements for solid waste planning. The base document includes: (1) the County's waste management strategy for the next ten years, goals, objectives, an implementation schedule, and how the County plans to meet recycling requirements; (2) a strategy for public involvement and education; (3) updated population and waste generation projections;

The plan addresses the following seven elements:

1. Waste disposal stream analysis
2. Waste Reduction
3. Collection
4. Disposal
5. Land limitation

6. Education and public involvement
7. Implementation and implementation schedule

The plan gives actions and financing information for implementation of solid waste management for the next decade.

B. Development of Voluntary Programs: The County has identified in its Plan several voluntary programs that it may develop.

These include:

1. A voluntary recycling program for commercial and multi-family developments (e.g. subdivisions, apartment buildings and apartment complexes) for items such as aluminum, corrugated cardboard, and newspapers.

2. Enhancement of the green box collection sites, which may include recycling centers and drop off areas for white goods and bulky items, to make these sites as clean and convenient as possible to all residents of the County.

3. Implementation of hazardous material collection for residents if feasible.

4. Improvement of enforcement of solid waste ordinances and programs.

5. Study of various collection proposals and pricing structures for residential waste collection.

6. Implementation of food waste and grease collection programs for businesses if feasible.

7. Improvement of litter programs and implements an anti-litter education campaign if feasible.

The voluntary programs identified above reflect recommendations put forth during citizen sessions and public hearings. The actual implementation of these programs is subject to annual budgets, grant availability, feasibility studies, and priorities set by the County and two cities

SECTION I: DEFINING THE PLANNING JURISDICTION ELEMENT

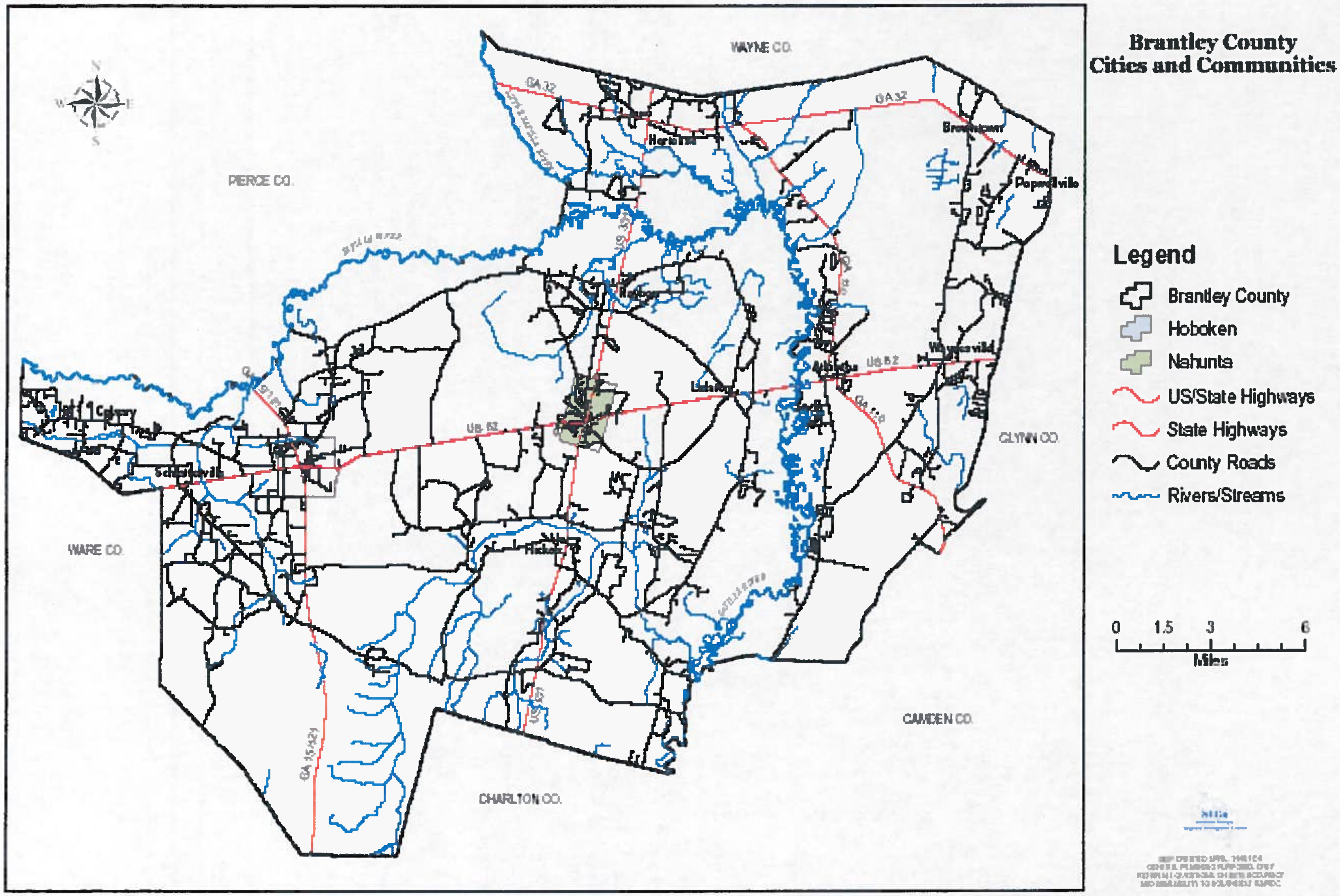
<u>Overview of the Area Covered by the Plan</u>

Brantley County is a rural county of 445 square miles, but is categorized as a metropolitan county because it is adjacent to the growing Brunswick and Glynn County area. The county seat is the City of Nahunta, located near the center of the county. The county is divided by the Satilla River, which enters the county from the northwest, then winds through the county from north to south, and bisects the land area of the county into two-thirds west of the river and one-third east of the river. The Little Satilla River enters the county from the North and merges with the Satilla River in the northern section of the county. The highest elevation point in Brantley County is 144 feet. The banks of the Satilla River are approximately at the 25-foot contour level at the U.S. Highway 82 bridges between the communities of Atkinson and Lulaton.

The nationally known Okefenokee Swamp lies to the south and west of the county. The 35,789 acre Dixon Memorial State Forest is shared by Brantley and Ware counties and lies in the western area of the county and to the south

Figure 1 presents a general map of the county. The county has two incorporated municipalities: Hoboken and Nahunta. There are several unincorporated communities throughout the county, and these include Calvary and Schlatterville (western portion of the county), Raybon and Hortense (northern portion of the county), Hickox (southern portion of the county), Lulaton and Atkinson (eastern portion of the county) and Waynesville, Browntown, and Popwellville (extreme eastern portion of the county). The communities of Hortense and Waynesville and the cities of Hoboken and Nahunta, each have a U. S. Post Office located therein. See **Figure 1**, which shows the approximate location of the various communities.

FIGURE 1


Brantley County
Cities and Communities
WAYNE CO.
PIERCE CO.
WARE CO.
CHARLTON CO.
CAMDEN CO.
GLYNN CO.
GA 32
US 82
Legend
Brantley County
Hoboken
Nahunta
US/State Highways
State Highways
County Roads
Rivers/Streams
0
1.5
3
6
Miles

For quite a few years, Brantley County has had four major development areas: Central Avenue near the Ware County line, City of Hoboken, City of Nahunta, and the Atkinson/Waynesville area.

Commercial activity in Brantley County is predominately school and government space. Retail establishments are located in the county, but currently mainly in the Cities of Hoboken and Nahunta. There are several combination gasoline station/convenience stores located throughout the county in each of the communities and in both municipalities. Total developed commercial, school, and government space has grown significantly in the past decade.

The school system, state, and local governments employ the largest proportion of the labor force. With little industry located in the county, service sector jobs provide the next largest group of employment. The major employers in the county are the Brantley County Board of Education, Brantley County government, Bay view Nursing Home, Brantley Telephone Company, Inc., Okefenokee Rural Electric Membership Corporation, Paige's Minit Market, Inc., Piggly Wiggly (Nahunta), and Varn Wood Products Co. **Table 1** lists the major industries, businesses, and service sectors, which have an impact on the amount and content of the solid waste stream.

Brantley County has many transportation assets, including an airport for small aircraft, the four-lane United States Highway No. 82 which bisects the county running east and west from Glynn County to Ware County; the two-lane United States Highway No. 301 which bisects the county, running north and south from Wayne County to Charlton County; a north-south rail line which parallels United States Highway No. 301; an east-west rail line which parallels Unites States Highway No. 82; the two-lane United States Highway No. 110 which relatively parallels the Satilla River running north-south from Camden County to Wayne County; and the United States Highway No. 32, which parallels the northern boundary of the county and runs from Glynn County to Pierce County. The county has 616.24 total miles of roads; 96.82 miles are state roads, 519.42 are county roads and 415.42 miles of county roads are unpaved. Growth in the county and in the southeast region has added to the traffic in and through the county in recent years **Figure 2** shows the major rail lines and road corridors in the county.

TABLE 1
Types of Commercial, Manufacturing, and Industrial Business in the Planning Area

The Brantley Enterprise 109 N. Main St. Nahunta, GA 31553 Mailing Address: P.O. Box 454 Nahunta, GA 31553 Brantley County	CEO: Ken Buchanan, Publ. Sales Exec: Dot Mims, Sales Phone: 912-462-6776 Fax: 9124628406 Web Address: www.brantleyenterprise.com	SIC / Products: 2711 / Newspaper Publishing Total Employment: 3
Ira Brown Mills, Inc. 109 Taft St. Nahunta, GA 31553 Mailing Address: P.O. Box 112 Nahunta, GA 31553 Brantley County	CEO: Mrs. Ira F. Brown, Owner Phone: 912-462-5337	SIC / Products: 2048 / Dairy Cattle Feed 2048 / Hog Feed 2048 / Horse Feed Total Employment: 4
Designing Windows & More, Inc. Hwy. 82 Waynesville, GA Mailing Address: P.O. Box 7 Waynesville, GA 31566 Brantley County	CEO: Janice L. Morris, Pres. Purchase Agent: Janice L. Morris Phone: 912-778-9375 Fax: 9127785501	SIC / Products: 2391 / Custom Window Treatments Total Employment: 6
GSO Georgia Hwy. 82 E. Nahunta, GA 31553 Mailing Address: P. O. Box 828 Nahunta, GA 315530828 Brantley County	CEO: Sherri Crews, Ofc. Mgr. Phone: 912-462-7461 Fax: 912-462-7758	SIC / Products: 2421 / Cypress Mulch Total Employment: 60
H & H Sawing & Lumber RR 2, Box 395A Hortense, GA 315439226 Mailing Address: RR 2, Box 395A Hortense, GA 315439226 Brantley County	CEO: Daniel Herrin, Owner Phone: 912-473-2724	SIC / Products: 2421 / Lumber Processing Total Employment: 6

Lang Manufacturing & Welding

U. S. Hwy. 82 W.
Nahunta, GA 31553
Mailing Address:
P. O. Box 547
Nahunta, GA
315530547
Brantley County

CEO: B. C. Lang, Owner
Phone: 912-462-6146
Fax: 912-462-6146

SIC / Products:
3631 / Barbecue Cooking Equipment
Total Employment: 4

Middleton Logging, Inc.

Hwy. 110 N.
Nahunta, GA
Mailing Address:
P.O. Box 1021
Nahunta, GA 31553
Brantley County

Phone: 912-778-5320

SIC / Products:
2411 / Timber
Total Employment: 18

Joe Miller Logging

R.R. 1, Box 160 A
Waynesville, GA
315669611
Mailing Address:
R.R. 1, Box 160 A
Waynesville, GA
315669611
Brantley County

CEO: Joe Miller, Owner
Phone: 912-778-4348

SIC / Products:
2411 / Timber
Total Employment: 6

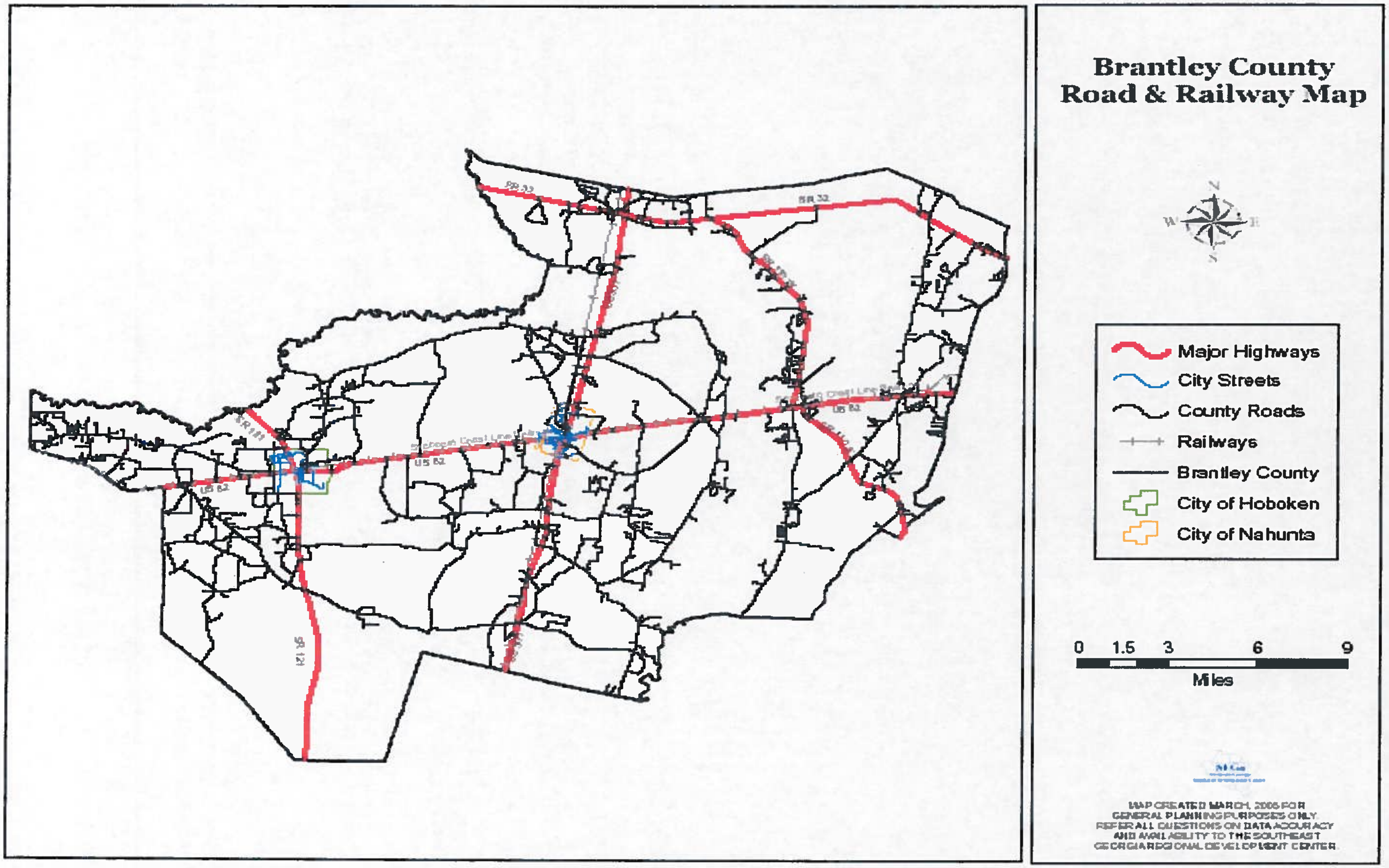
Varn Wood Products

107 N. Brantley Ave.
Hoboken, GA 31542
Mailing Address:
P.O. Box 128
Hoboken, GA 31542
Brantley County

CEO: Thomas J. Shave III, Gen. Mgr.
Sales Exec: Patti Fichett, Sls. Mgr.
Phone: 912-458-2188
Fax: 912-458-2190

SIC / Products:
2421 / Lumber
2421 / Wood Chips
Total Employment: 69

FIGURE 2



SR 32
SR 32
US 82
US 82
US 82
SR 121
Brantley County
Road & Railway Map
N
S
W
E
Major Highways
City Streets
County Roads
Railways
Brantley County
City of Hoboken
City of Nahunta
0
1.5
3
6
9
Miles
MAP CREATED MARCH, 2006 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

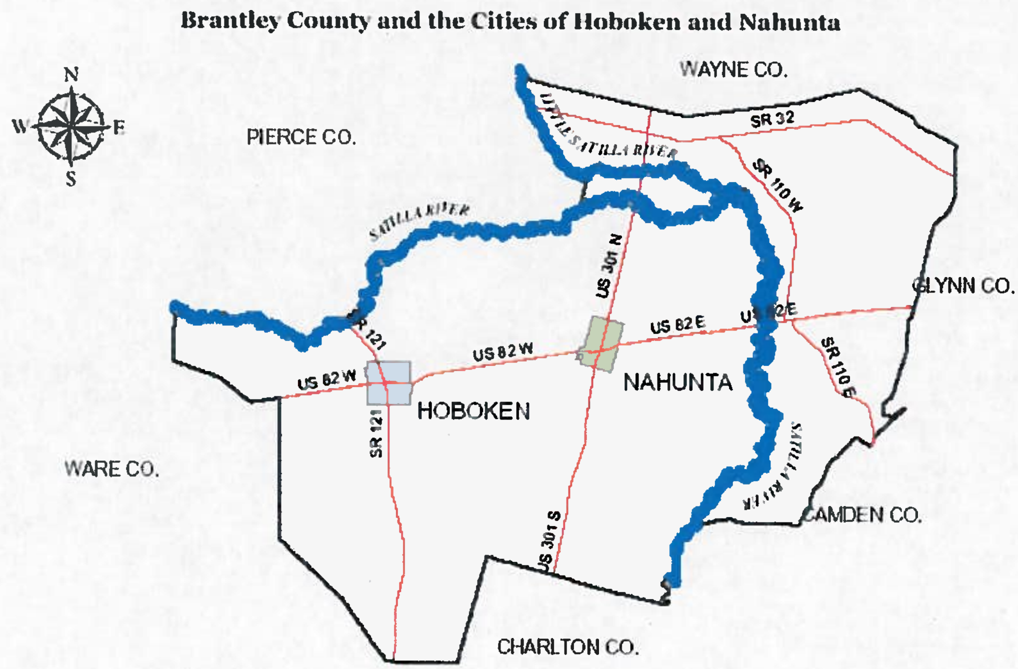
The Brantley County School System is an integral part of Brantley County and an important resource. The Brantley County Board of Education has its central office in the southeastern section of Nahunta, adjacent to the Nahunta Elementary School. There are two additional elementary schools located in the City of Hoboken and the community of Waynesville on U. S. Highway 82. The county has one middle school located about 2.5 miles west of Nahunta on U.S. Highway 82. Adjacent to this school is the sole high school for the county, comprised of grades 9 through 12. The school system had 3300 total students enrolled for the school year 2004-2005.

Brantley County is one of the nine counties that comprise the Southeast Georgia Regional Development Center ("SEGRDC"). The SEGRDC is located in Waycross, Georgia.

Location in the State

The map shown in **Figure 3** shows the two cities and their location in the county. This map also shows the location of Brantley County within the State of Georgia. Brantley County is located between Ware County (county seat, Waycross) on the West and Glynn County (county seat, Brunswick) on the East and is located between Wayne County (county seat, Jesup) on the North and Charlton County (county seat, Folkston) and Camden County (county seat, Woodbine), both on the South.

FIGURE 3
BRANTLEY COUNTY



Topographic Information

The Satilla River with substantial flood plain areas flows many miles through the County beginning at the western northwestern corner of the County and winds through the county in an easterly direction, past the center of the County and then turns in a southerly direction and exits the County into Charlton County.

The Little Satilla River enters the County from the North border and flows several miles until it merges with the Satilla River. Buffalo Creek, McIntosh Creek, Big Creek, and many other creeks and streams with significant flood plains crisscross the County.

The Okefenokee Swamp is located a few miles from the Brantley County line. A significant of the Brantley County watershed drains into the Okefenokee Swamp, which is the mouth of the St. Mary's River and the Suwannee River.

The total land area for Brantley County is 286,080 acres. Of this, approximately 45,770 acres or 16 percent is classified as wetlands and an additional 67,260 acres or 24 percent is classified as flood prone land; thus, 113,030 acres of the total 286,080-land area acreage is classified as either wetland or flood prone. Of all the counties in the Southeast Regional Development district, Brantley County has the largest area of wetlands outside the flood prone areas.

Groundwater supplies of the County are composed of three main aquifers: the shallow groundwater aquifer, the Miocene aquifer, and the deeper Ocala limestone aquifer, commonly called the Floridian aquifer. The groundwater recharge areas and the significant groundwater recharge area comprise a large area of the County.

Population

In the past decade, the population of Brantley County has grown rapidly, in part because of the Kings Bay Nuclear Base in Camden County, and in part because of the rapid growth of the entire southeastern Georgia area. In 1980, the county had a population of 8701 according to the U. S. Census, but by 1990, the figure had climbed to11, 077. In the year 2000, the population had again climbed to 14,629, an estimated increase during this decade of about 3.2% per year. At 445 square miles, the population density is 32.9 persons per square mile. The population density of the State of Georgia is 141.4 persons per square mile.

Table 2 shows the county population in year 2000, as well as population projections for 2005 through 2014. Average household size has remained stable in recent years and the county projects it will remain stable for the next decade.

TABLE 2

Brantley County & Municipal Population
Calendar Years 2000 through 2015

	2000	2005	2010	2015
Population*	**14629**	**16111**	**17593**	**19075**

Brantley County Household Projection
Calendar Year 2000 through 2015

	2000	2005	2010	2015
Number of **Households	**5436**	**6099**	**6762**	**7425**

*2000 population from U.S. Census data. Population in 2005, 2010, and 2015 based projections using rate of increase from 1990 to 2000.
**Source of Household Data: Southeast Georgia Regional Development Center. Projected years beyond 2004 are estimated using the population growth from 1990 to 2000.

The 2000 Census showed a population of the entire county to be14, 629. Brantley County consists of two municipalities with the largest land area being the unincorporated areas. The City of Hoboken lies in the western area of the county and according to the 2000, Census had a population of 463 residents. The county seat is Nahunta and it lies in the approximate center of the county. Nahunta according to the 2000 Census has a population of 930 residents. Listed in **Table 3** is population data from the 2000 Census showing the incorporated and unincorporated areas of the county. Population in Brantley County has increased since 1990 and is likely to increase due to its location to Kings Bay Naval Base and its location along the four-lane U.S. Highway 82 and possible four-laning of U.S. Highway 301. These highways intersect at the county seat of Nahunta and approximately divide the county into four quadrants. Most of the businesses in the county are located along these two highways.

TABLE 3

2000 Census Data: Population Data of Municipalities and Unincorporated Areas of Brantley County

Municipalities	2000 Population
Hoboken	463
Nahunta	930
Unincorporated Brantley County	13,236
Total 2000 Population	14629

Note: Data taken from the 2000 U.S. Census.

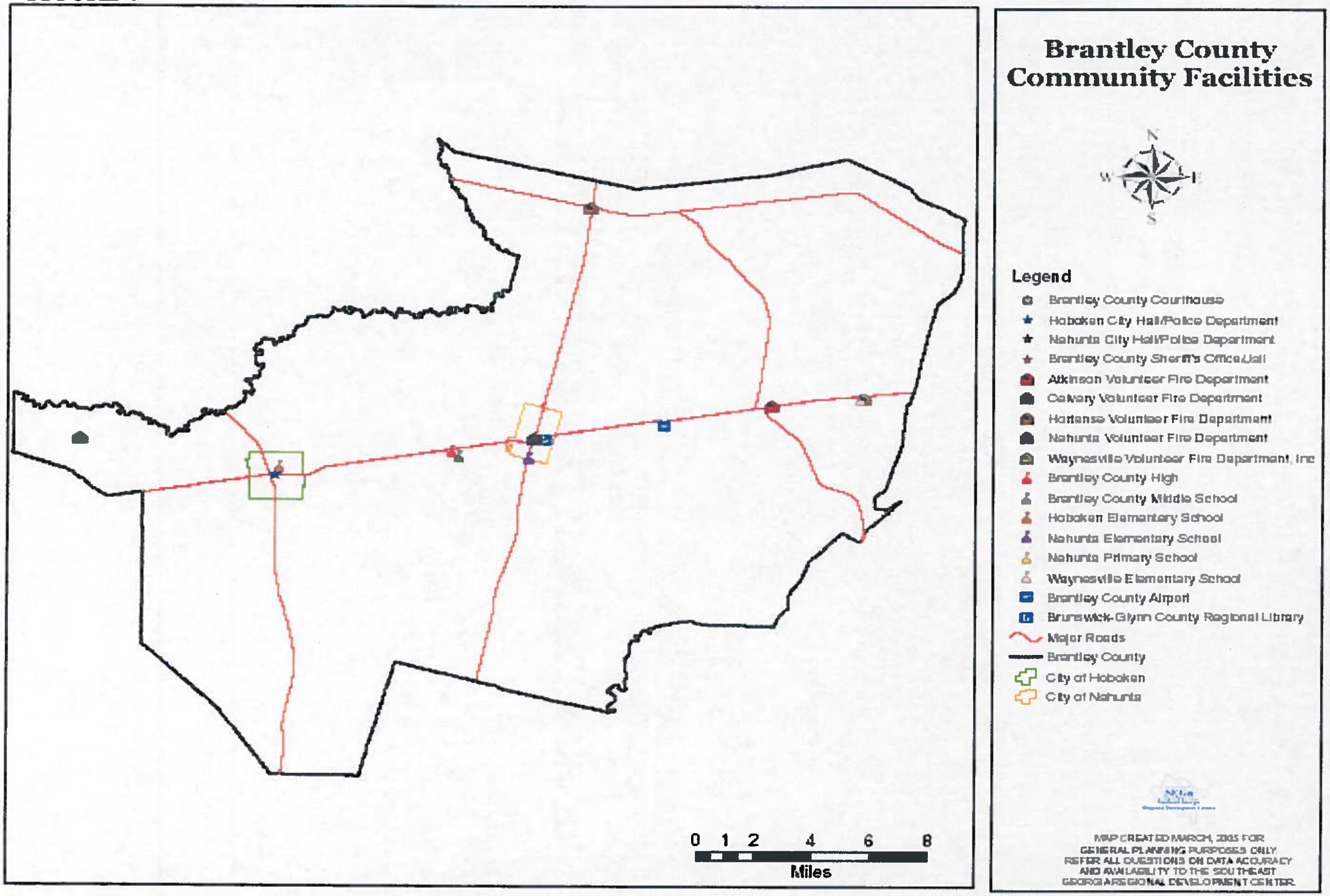
Seasonal Population Variation

Brantley County has no variation in its seasonal population.

Number of Households

Brantley County is composed of mainly single-family houses and mobile homes. The 2000 Census showed 6490 housing units in Brantley County of which 5436 were occupied. The 2000 Census showed the number of households in Brantley County to be 5436 and the persons living in households to be 14,629, this averages 2.68 persons per household. **Table 2** shows the number of households in the County for the year's 2000-2015. Most of the expected growth will likely occur in the eastern portion of the county from the Satilla River to the Glynn and Camden County lines.

FIGURE 4



Brantley County Community Facilities
N
W
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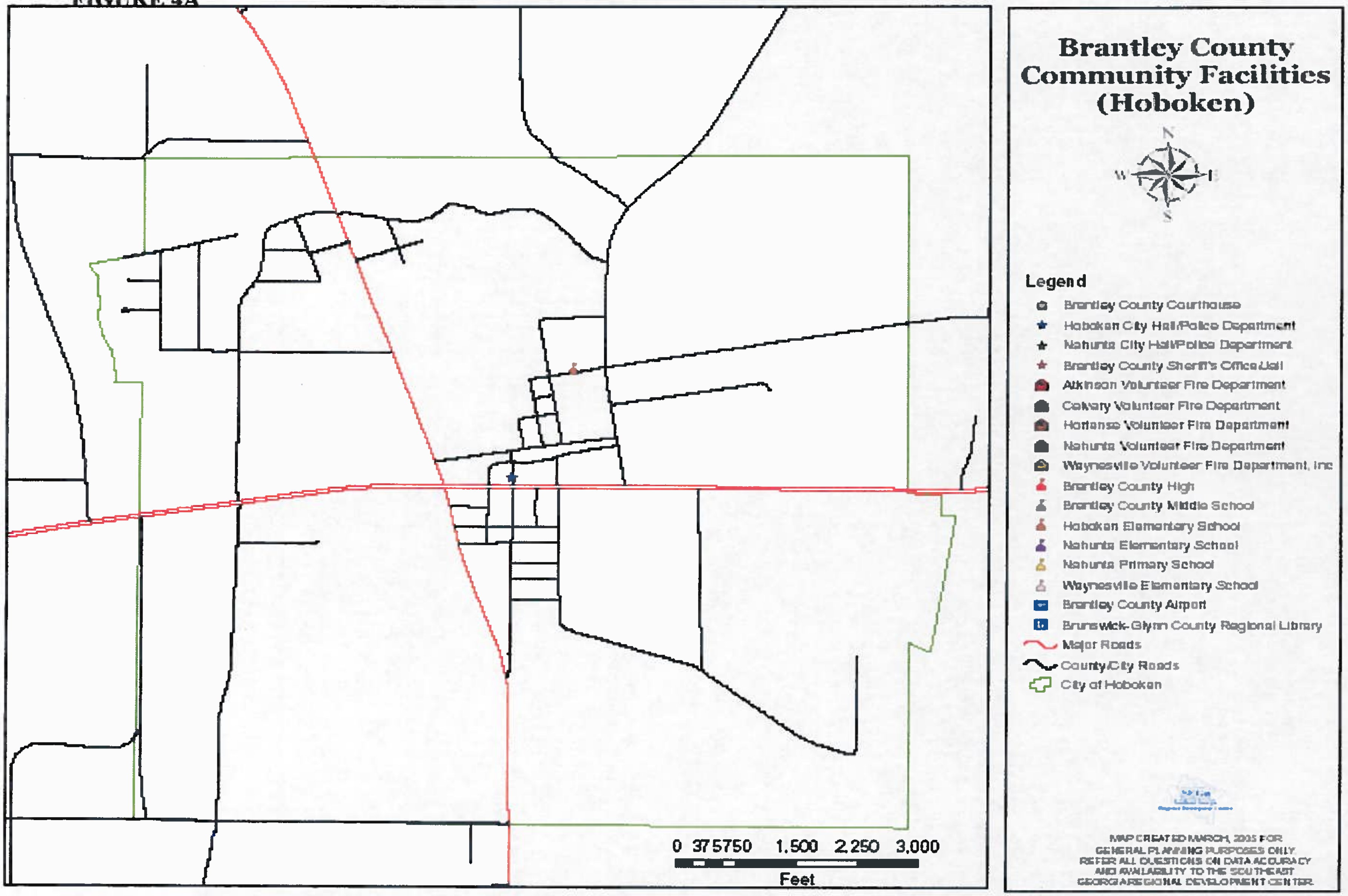
S
Legend
Brantley County Courthouse
Hoboken City Hall/Police Department
Nahunta City Hall/Police Department
Brantley County Sheriff's Office/Jail
Atkinson Volunteer Fire Department
Calvary Volunteer Fire Department
Hortense Volunteer Fire Department
Nahunta Volunteer Fire Department
Waynesville Volunteer Fire Department, Inc
Brantley County High
Brantley County Middle School
Hoboken Elementary School
Nahunta Elementary School
Nahunta Primary School
Waynesville Elementary School
Brantley County Airport
Brunswick-Glynn County Regional Library
Major Roads
Brantley County
City of Hoboken
City of Nahunta
0 1 2 4 6 8
Miles
MAP CREATED MARCH, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

FIGURE 4A



Brantley County
Community Facilities
(Hoboken)
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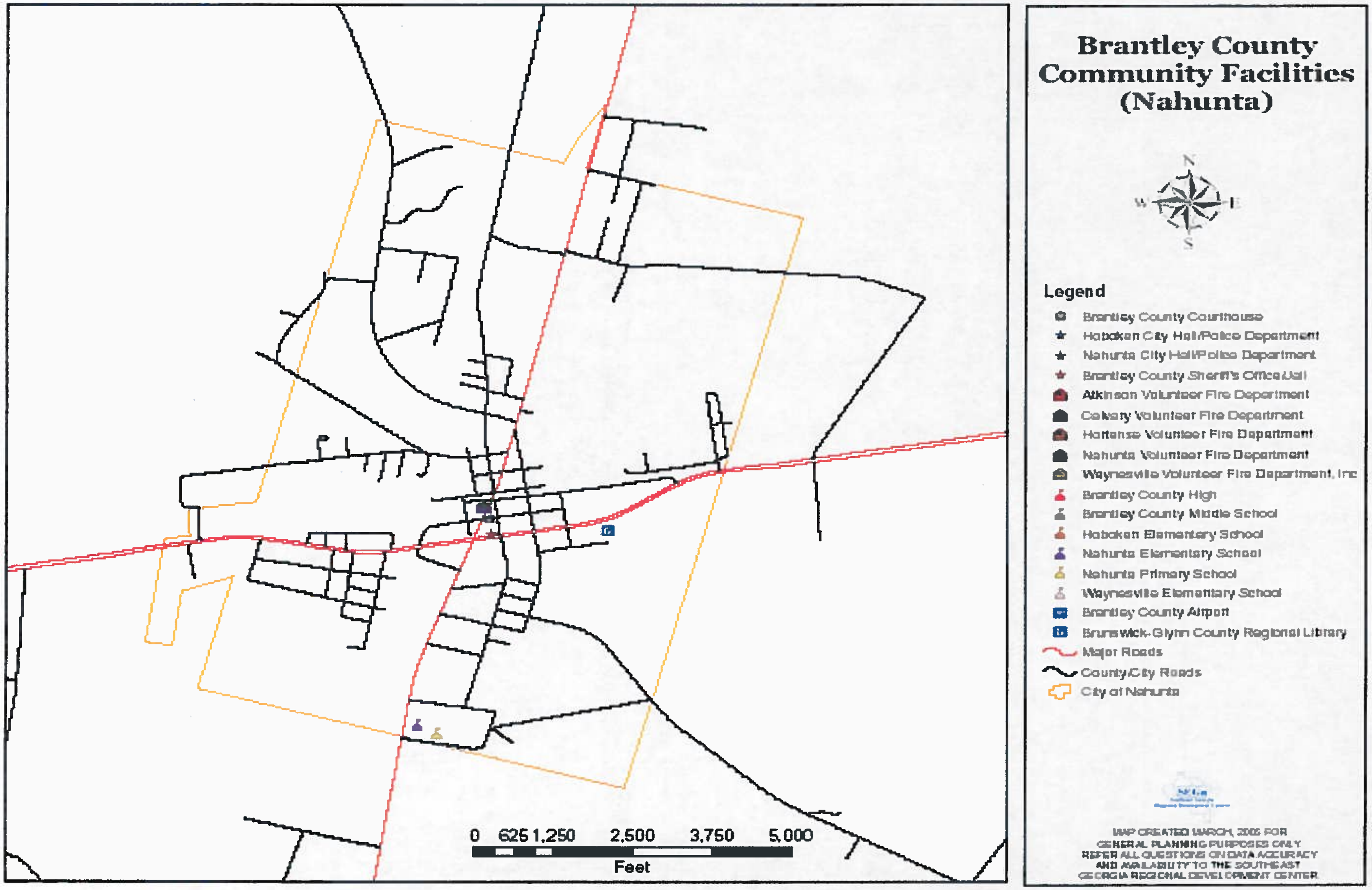
Legend
Brantley County Courthouse
Hoboken City Hall/Police Department
Nahunta City Hall/Police Department
Brantley County Sheriff's Office/Jail
Atkinson Volunteer Fire Department
Calvary Volunteer Fire Department
Hortense Volunteer Fire Department
Nahunta Volunteer Fire Department
Waynesville Volunteer Fire Department, Inc
Brantley County High
Brantley County Middle School
Hoboken Elementary School
Nahunta Elementary School
Nahunta Primary School
Waynesville Elementary School
Brantley County Airport
Brunswick-Glynn County Regional Library
Major Roads
County/City Roads
City of Hoboken
MAP CREATED MARCH, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.
0 375 750 1,500 2,250 3,000
Feet

FIGURE 4B


Brantley County
Community Facilities
(Nahunta)
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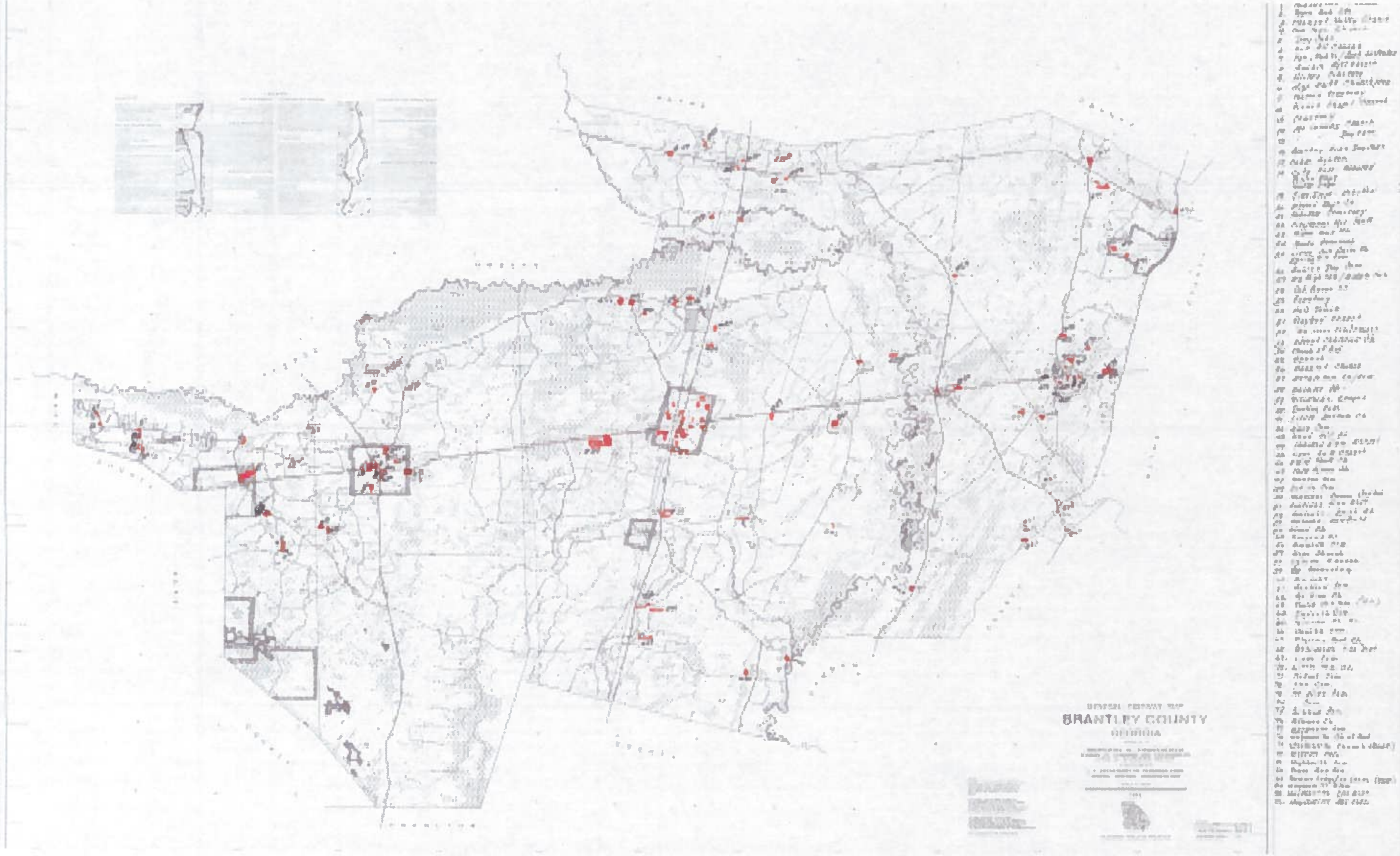
Brantley County Courthouse
Hoboken City Hall/Police Department
Nahunta City Hall/Police Department
Brantley County Sheriff's Office/Jail
Atkinson Volunteer Fire Department
Calvary Volunteer Fire Department
Hortense Volunteer Fire Department
Nahunta Volunteer Fire Department
Waynesville Volunteer Fire Department, Inc
Brantley County High
Brantley County Middle School
Hoboken Elementary School
Nahunta Elementary School
Nahunta Primary School
Waynesville Elementary School
Brantley County Airport
Brunswick-Glynn County Regional Library
Major Roads
County/City Roads
City of Nahunta
0 625 1,250 2,500 3,750 5,000
Feet
MAP CREATED MARCH, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

FIGURE 4C



SECTION II: WASTE DISPOSAL STREAM ANALYSIS

Inventory of waste stream generators

Residential. The City of Hoboken has 227 residential units utilizing 90-gallon containers in its curbside collection of municipal waste. The City of Nahunta has approximately 470 residential units utilizing 90-gallon containers in its curbside collection of municipal waste. Both cities contract with private collection services to collect, haul, and dispose of their residential municipal waste.

The unincorporated areas of Brantley County utilize green boxes throughout the county for collection of residential waste.

The city's private contractor collects white goods from residential generators within the corporate limits of Hoboken on an "as needed/call" basis, but the residents may also self-haul to the Brantley County Transfer Station.

A private contractor transports white goods from residential generators within the corporate limits of Nahunta to Brantley County Transfer Station for collection, hauling, and disposal. The City of Nahunta's employees operate a collection service for white goods of its residents, or the residents may haul their white goods directly to the transfer station. The city's private contractor will also collect white goods from residents on an "as-needed/call" basis. The generator to the Brantley County Transfer Station must transport white goods from residential generators outside the municipal limits of Hoboken and Nahunta.

Commercial/Business. Businesses that generate large amounts of waste will contract with a private collection service for collection, hauling and disposal of their commercial waste. Some small businesses in the county use the green box containers located throughout the county for disposal of their waste; and some businesses in the municipalities that generate small quantities of waste use the curbside collection boxes. All the schools located in the County contract with a private service for collection, hauling, and disposal of their waste from green box containers located at each school.

.

Industrial. The industries in both cities and in the county contract with private collection services for collection, hauling, and disposal of their waste.

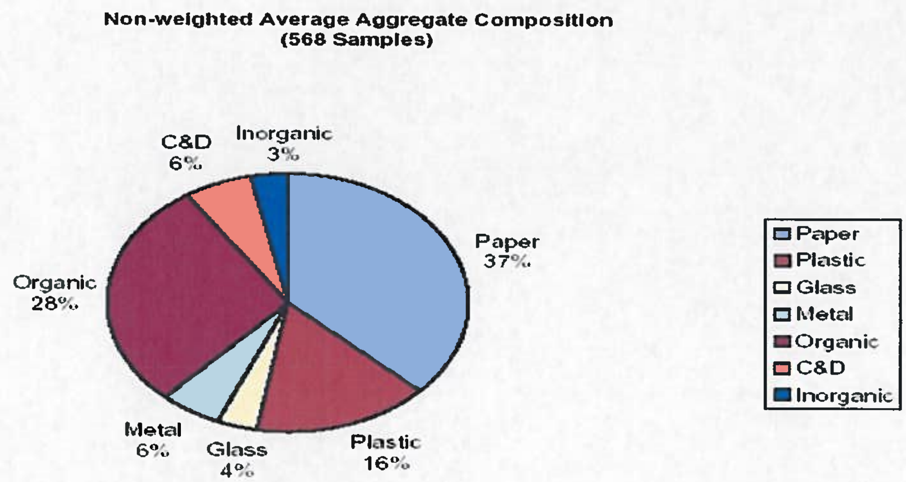
Construction and Demolition (C&D). Residential small-quantity generators of C&D waste are responsible for hauling their C&D waste to the Brantley County Transfer Station. The county has contracted with a private collection service to collect, haul, and dispose of these C&D wastes from the Brantley County Transfer Station. Non-residential generators of C&D, contract with private collection services to collect, haul, and dispose of their C&D waste.

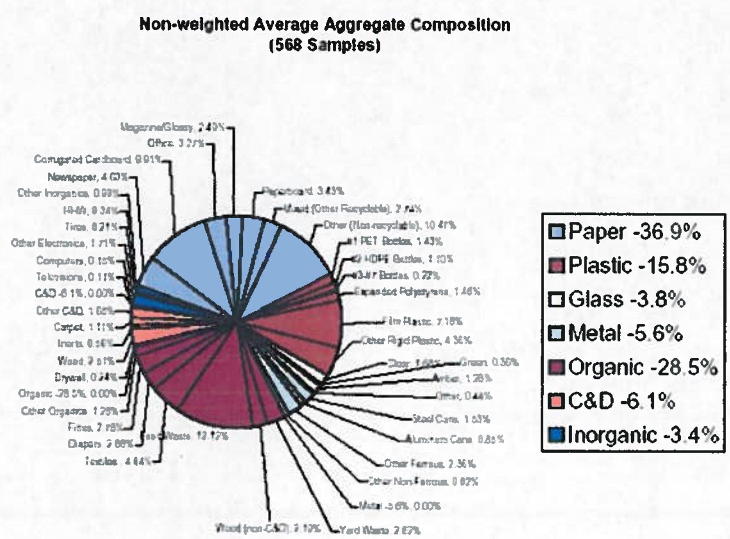
Types of Waste Contributed to the Waste Disposal Stream for Brantley County

Residential Types of Waste. See **Table 4** for the projected characterization of municipal solid waste disposed of by residential generators of Brantley County.

TABLE 4

Brantley County Projected Characterization





Commercial/Business Types of Waste. See **Table 1** for the list of commercial/businesses, schools, institutions that generate waste in Brantley County and a general characterization of the types of waste they generate.

Industrial Types of Waste. **Table 1** includes the few industries located in Brantley County, and general characterizations of the type of waste they generate.

Construction and Demolition (C&D) Waste.
Construction and demolition (C&D) wastes are generated from the construction and renovation of commercial buildings, houses, pavements, and other structures. Also included but not limited to, are wastes resulting from mobile home manufacturing plants, other development activities, such as land clearing and demolition of old mobile homes and buildings, asbestos containing waste, wood, bricks, metal, concrete, wall board, paper cardboard. According to the records of the Chesser Island Landfill located in Charlton County and one of the two primary disposal sites of Brantley County waste, state a total of 14.74 tons of C&D disposed of in 2003 and a total of 27.31 tons of C&D disposed of in 2004. Broadhurst Environmental Landfill in Wayne County reports no C&D tonnage for Brantley County.

The management of most C&D waste is handled in the private sector or is self-hauled to a private disposal facility; and all of the recycling, materials recovery, and disposal takes place outside the county. Although private haulers report tonnage to the county, neither the county nor the private waste haulers keep data on the composition breakdown of the C&D waste.

Hazardous Waste. According to information obtained from the United States Environmental Protection Agency (EPA) (as of March 28, 2005), there are no Superfund sites in Brantley County or its municipalities. There are no hazardous waste disposal sites in Brantley County or its municipalities and the County does not intend any such facilities to be sited in the County.

Inert Materials. Inert materials from the residential generator within the corporate limits of Hoboken and Nahunta are: (1) small quantities are buried on site when allowed by law; (2) large quantities are collected and transported by the Cities or transported by its residents, to the Brantley County Inert Landfill; or (3) collected and disposed by private contractors. Inert materials from residential generators within the county, outside of the municipalities are either: (1) buried on site when allowed by law; (2) collected and disposed of by private contractors; or (3) self-hauled to the Brantley County Inert Landfill.

Medical Waste. Currently, the county does not have a program in place for separating out, collecting, and disposing of household medical wastes. Residents are advised to put household medical wastes like sharps in a hard plastic container, securely capped and placed in the refuse container for disposal.

The medical waste generated by dental and doctor offices, medical clinics, emergency medical services, health department and two funeral homes is managed by private contractors and transported out of the county for disposal.

Sludge. The City of Nahunta is the only facility currently in the county that has a sewage treatment system; an oxidation pond system with spray field. The City of Nahunta is currently studying various options for removal and disposal of sludge from its sewage facility, in the event that disposal becomes necessary at some time in the future.

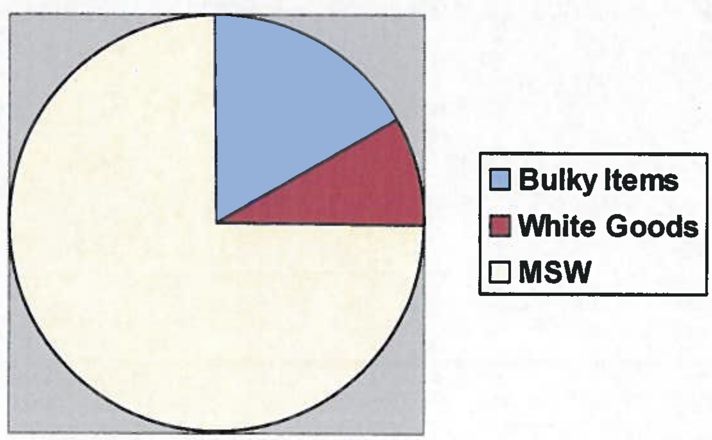
Tires. In Brantley County, tires come from a number of sources, with the greatest volume coming from individual residents and auto service shops. Individual residents are allowed to self-haul tires to the Brantley County Transfer Station, where a private hauler collects and transports to a disposal facility. Commercial businesses must contract with private haulers to collect and dispose of tires. The county has a scrap tire ordinance in place.

Yard Trimmings and Debris. Yard trimming and debris from residential generators within both municipalities and the county are either (1) burned on site as permitted by the Georgia Forestry Commission; (2) self-hauled to the Brantley County Inert Landfill; or (3) composted on site by the residence or business; or (4) within the municipalities, limited quantities of yard debris are collected and hauled to the inert landfill by city crews. No yard trimmings may be placed in or mixed with municipal solid waste pursuant to Georgia law.

Estimate of Various Components as a Percentage of the Waste Stream

See **Figure 5,** which shows an estimate of the waste character of the municipal solid waste, white goods, and bulky items that were disposed of in year 2004.

FIGURE 5 Brantley County Municipal Solid Waste Characteristics* for 2004



Fluctuations in Quantities Disposed Due to Known Events.

Neither Brantley County nor the municipalities have significant seasonal variations in population.

TABLE 5

Brantley County Seasonal Units		
Category	**1990**	**2000**
Seasonal housing units	**265**	**387**
Hoboken City Seasonal Units		
Category	**1990**	**2000**
Seasonal housing units	**1**	**4**
Nahunta City Seasonal Units		
Category	**1990**	**2000**
Seasonal housing units	**4**	**6**

Hurricanes, floods, tornadoes, and other natural disasters occur at varying frequency and severity and have the potential to create short-term and long-term problems and challenges to cities and counties and to the services they provide. Most natural disasters create substantial quantities of tree and limb debris; however, some can destroy or damage thousands of homes and businesses and generate unbelievable quantities of waste, as was seen in Florida during the 2004 hurricane season. Brantley County and its cities anticipate assistance in loan equipment and personnel from other communities in the State in the event of a natural disaster of significant proportions. The County emergency preparedness plan helps address issues created from natural disasters.

Waste Projections

Table 6 to this plan shows the County solid waste tonnage disposed of in landfills for the past 5 years. The cities' data is included in the County's data. **Table 7** shows the total tonnage of waste disposal of by the county, including municipal solid waste and white goods.

Table 8 uses the information gathered in the inventory of the waste stream for the county and extrapolates anticipated waste amounts for the ten-year planning period. The amounts are reasonably consistent with population trends and population projections. The projections are annual projections.

Table 6

Tonnage Disposed of 2000-2004

County	Facility Name	Permit Number	Year	Qtr	Source Of Waste	Tonnage Reported
Charlton	Chesser Island Road Landfill, Inc. MSWL	024-006D(SL)	03	3	Brantley Co	83.43
Charlton	Chesser Island Road Landfill, Inc. MSWL	024-006D(SL)	03	4	Brantley Co	196.16
Charlton	Chesser Island Road Landfill, Inc. MSWL	024-006D(SL)	04	1	Brantley Co	142.19
Charlton	Chesser Island Road Landfill, Inc. MSWL	024-006D(SL)	04	2	Brantley Co	133.56
Charlton	Chesser Island Road Landfill, Inc. MSWL	024-006D(SL)	04	3	Brantley Co	191.85
Charlton	Chesser Island Road Landfill, Inc. MSWL	024-006D(SL)	04	4	Brantley Co	430.20
Wayne	Broadhurst Environmental	151-014D(SL)	00	1	Brantley Co	1,969.35
Wayne	Broadhurst Environmental	151-014D(SL)	00	2	Brantley Co	2,169.55
Wayne	Broadhurst Environmental	151-014D(SL)	00	3	Brantley Co	2,200.86
Wayne	Broadhurst Environmental	151-014D(SL)	00	4	Brantley Co	1,988.00
Wayne	Broadhurst Environmental	151-014D(SL)	01	1	Brantley Co	2,167.93
Wayne	Broadhurst Environmental	151-014D(SL)	01	2	Brantley Co	2,221.85
Wayne	Broadhurst Environmental	151-014D(SL)	01	3	Brantley Co	2,269.10
Wayne	Broadhurst Environmental	151-014D(SL)	01	4	Brantley Co	2,194.38
Wayne	Broadhurst Environmental	151-014D(SL)	02	1	Brantley Co	2,228.54
Wayne	Broadhurst Environmental	151-014D(SL)	02	2	Brantley Co	2,460.21
Wayne	Broadhurst Environmental	151-014D(SL)	02	3	Brantley Co	2,487.06
Wayne	Broadhurst Environmental	151-014D(SL)	02	4	Brantley Co	2,434.91
Wayne	Broadhurst Environmental	151-014D(SL)	03	1	Brantley Co	2,042.86
Wayne	Broadhurst Environmental	151-014D(SL)	03	2	Brantley Co	2,022.78
Wayne	Broadhurst Environmental	151-014D(SL)	03	3	Brantley Co	2,126.49
Wayne	Broadhurst Environmental	151-014D(SL)	03	4	Brantley Co	2,055.34
Wayne	Broadhurst Environmental	151-014D(SL)	04	1	Brantley Co	2,515.30
Wayne	Broadhurst Environmental	151-014D(SL)	04	2	Brantley Co	2,575.03
Wayne	Broadhurst Environmental	151-014D(SL)	04	3	Brantley Co	2,512.95
Wayne	Broadhurst Environmental	151-014D(SL)	04	4	Brantley Co	2,326.31

TABLE 7

Brantley County Disposal[1] and Population

Category	2000	2001	2002	2003	2004
Total Population	**14,629**	**14,924**	**14,877**	**15621**	**15,503**
Pounds Per Person	**3.12**	**3.25**	**3.54**	**2.99**	**3.83**
Annual Short Ton Per Person	**.57**	**.59**	**.65**	**.55**	**.70**
Annual County Short Ton Total	**8327.76**	**8853.26**	**9610.72**	**8527.06**	**10827.39**

TABLE 8

Projected Waste Amounts

Source	2005		2006		2007		2008		2009	
Tonnage	Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
MSW	29.98	10,942	30.30	11,057.99	30.62	11,175.20	30.94	11,293.66	31.27	11,413.37
White Goods		172.69		174.44		176.20		177.99		179.77

Source	2010		2011		2012		2013		2014	
Tonnage	Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual	Daily	Annual
MSW	31.60	11,534.35	31.94	11,656.61	32.27	11,780.17	32.62	11,905.04	32.96	12,031.2
White Goods		181.59		183.43		185.27		187.14		189.04

Note: The calculations of daily and annual tonnage projections of MSW are based on the Average rate of change of the annual waste disposal amounts shown for Brantley County on the Georgia EPD records for years 2000-2004. To estimate the population for the years 2005 through 2014, calculations were made using the average rate of change in the population of Brantley County for years 2000-2004.

The County began to record the white goods disposal amounts in 2004and the projections were calculated using the 2004 estimated tonnage disposed of per person times the projected population for each year from 2005-2014.
2004 estimated tonnage of 170.81 tons divided by 2004 population of 15,542 equals .0110 tons per person.

SECTION III: WASTE REDUCTION ELEMENT

Waste Reduction: Goal

To ensure a practical reduction of the amount of solid waste being received at disposal facilities within the State, by promotion of source reduction, reuse, composting, recycling, and other waste reduction programs today and in the future, thereby maintaining and enhancing the quality of life throughout Brantley County.

Waste Reduction Programs

Residential waste. The most effective way to meet residential waste reduction goals is increased recycling. A home composting program is another way to reduce waste. Promoting yard sales, consignment shops, and used furniture and furnishings shops can encourage reuse. Small business loans may be available to assist residents in opening shops for reusable items. In addition, there are many churches and charitable organizations such as the Salvation Army that take donations of reusable materials. A "swap" event as part of the spring clean-up day would help keep material from the waste stream. Residents with fixable and reusable items, including furniture, office items, household items, clothing and miscellaneous electronics, including computers, have the opportunity to drop them off in an area so that the items will not go into a landfill but instead are picked up and taken by other residents. This annual "swap" event could be named the Spring Clean and Swap Day.

An annual event at which residents could bring discarded household hazardous items would be a most beneficial program for the County. Other special wastes are currently being diverted from the waste stream, and these include tires, white goods, lead acid batteries, and used motor oil/antifreeze.

Guide to Best Management Practices for Household Hazardous Waste, which was produced by the Georgia Department of Natural Resources, Pollution Prevention Assistance Division.[2] This guide can be viewed online, downloaded, or printed to educate residents on the household hazardous wastes as a means of controlling the amount of household hazardous waste that is generated in the county. Household Guide to Best Management Practices for Household Hazardous Waste and Radon [From the Source - Summer 1997] Do you receive calls on how to **dispose**
http://www.ganet.org/dnr/p2ad/newsletter/news/hhwguide.html - 2.3KB - GeorgiaNet

Commercial waste. The County should stress to the commercial sector the benefits of becoming involved in waste reduction and the County should promote recycling to these waste stream generators.

[2]This brochure can be obtained by contacting the Georgia DNR.

Waste Reduction Programs: An Inventory

Table 9 shows an inventory of current waste reduction programs, and public and private recyclers, in Brantley County that target waste streams in the County including residential, commercial/business, institutional, construction and demolition, and yard trimmings.

Source Reduction. There are currently no organized source reduction programs or facilities in place in Brantley County, Hoboken, or Nahunta. However many communities participate in a program to promote source reduction known as the annual "Day without Trash, which could be incorporated in Brantley County. Coordinating with local newspapers and radio stations, local civic clubs, and the Brantley County School System, the "Day without Trash" will challenge city and county residents to go for 24 hours without putting one single thing in trashcans, green boxes, or littering. Promotions will include tips on how to not generate trash and how to reuse the trash you might be forced to generate. If the county continues this program annually, the amount of waste that will not enter the waste stream will be substantial. Businesses will be encouraged to sponsor this day, perhaps for one day during the week in conjunction with the annual "Brantley County Clean up Day."

Table 9

Waste Reduction/Recycling Facilities and Programs

Program/Business	Public/Private	Residents/businesses served	Types of recyclables
Brantley School System	Public	Annual Fundraiser	Aluminum cans
Charlton-Brantley Development Service Center	State of Georgia Agency	Countywide	Corrugated cardboard, newspaper, aluminum
Barber Recycling	Private	Residents sell directly to vendors in Brunswick	Scrap
Dixie Recyclers	Private	Residents sell directly to vendors in Brunswick	Aluminum cans, copper, steel.scrap.brass
Junk Man	Private	Residents sell directly to vendors in Brunswick	Ferrous metals
Waycross Recycling	Private	Residents sell directly to vendors in Brunswick	Aluminum cans, copper, steel.scrap.brass
Recycle America Today	Private	Dispose directly to vendor in Waycross	Computer equipment
Ralph's Salvage	Private	Sell directly to vendor	Iron, metals, aluminum, ferrous metals

Resource Reuse. There are no organized programs to promote the processing of current waste for use or reuse. Future goals include the promotion of reusable containers and instruction programs on how to reuse waste in innovative ways. These projected programs will again be targeted at the school age children, due to the follow-up effect children have on their homes. Program promotions, through free media exposure, donated time, labor and printed materials will include instructions on how to reuse old lumber for small projects such as bird feeders or dog houses; the reuse of plastic bottles as planters, doorstops, and using the reverse of paper for scratch pads. The same program, in conjunction with implementation in the school, can be used at civic clubs and other meetings.

Recycling. Collection of recyclable material in the county is handled by public programs, as well as by the individual who may recycle his own recyclables. **Table 10** shows an inventory of public and private recycling programs.

TABLE 10

Current Recycling Locations

A. City of Nahunta-Burton St. accepts cardboard, newspaper and aluminum cans
B. Nahunta Elementary School- aluminum cans

Brantley County and its municipalities encourage all its residents and commercial/businesses to recycle. In the City of Nahunta, recycling bins are available for residents to self-haul and deposit at the site items such as aluminum, newspaper, and cardboard. Most businesses in the County, that generate corrugated cardboard, also have recycling bins located on site Some schools in the county have aluminum can collection drives for the students to recycle aluminum that they have collected during the year.

Brantley County has a site at the Transfer Station where residents can self-haul white goods for collection by a vendor who contracts with the County to purchase and haul these white goods for recycling (white goods include old washing machines, clothes dryers, refrigerators, water heaters, etc.). The Transfer Station also has an area where residents can self-haul and deposit metals, iron, steel, and aluminum, which is collected by a private service under contract with the county to collect and recycle these items.

The only existing recycling program in Brantley County, Hoboken, or Nahunta is The Charlton-Brantley County Developmental Service Center of Satilla Community Services, an agency of the State of Georgia (hereafter call the Training Center). The Training Center currently only collects cardboard, newspaper, and aluminum due to low market demand for other recyclables, the safety to its consumers in collecting and processing glass, and the expense of transporting other items from the County to its processing facility.

The Training Center has collection bins for cardboard at most convenience stores, grocery stores, the schools, and at many other businesses throughout the County, and at one central site in Nahunta at the Brantley County Office Building Annex located on Burton Street. The collection site in Nahunta also has bins for collection of newspapers. Collection is done at least once a week, and more frequent if warranted. The businesses are charged a small fee for collection services of recyclables. The cost of the program is partially offset by marketable material sales A list of the businesses in the County which are currently serviced by the Training Center is included **Table 11.**

The Training Center collects the materials and transports them to its recycling facility in Charlton County. The newspapers are bundled and tied and when a semi truckload has been accumulated, the materials are sold to a vendor. The cardboard and aluminum are baled and when a semi truckload has accumulated, a vendor purchases and picks up the load.

Projected additional programs for recycling will be considered as the population continues to grow. Such as Brantley County, opening its first unmanned "trial" municipal waste collection site, a recycling area for newspaper, cardboard, aluminum, white goods, and bulky items may be installed. The recycling program costs for the recycling area will be minimal and will be related in part to the advertising and educational costs for the program; but since there is such a national emphasis on recycling, the program will target residents' awareness of where to take recyclable items.

TABLE 11

<u>List of Businesses Currently Serviced by the Training Center</u>

Flash Foods #93	Flash Foods #195	J&J Quick Stop
Precious Stages	Elementary School	Paint & Body Shop
Hardware Store	OREMC	Moody Furniture
Ruth & Della's Restaurant	Piggly Wiggly	Dollar General
Gold House Restaurant	Carters Chicken	Flash Foods
BP Store	Racepond store	Griffin's
Shell Station	Garage	Dairy Queen
Huddle House	Nursing Home	Middle School
High School	Paige's Store	

Yard Trimming, Mulching, and Composting Programs. There is currently no organized program or promotion of composting. Brantley County, Hoboken and Nahunta have low amounts of yard wastes in their collective waste stream, due to the rural nature of our communities and traditional practices. However, as the County grows and residential lots are reduced in size in traditional subdivisions, home composting may decrease.

Future composting programs could be developed with civic clubs and agricultural organizations, including the successful state program on home composting. Homeowners will be instructed on how to construct a back-yard composting bin and the use of the composted material. The residents will be encouraged to sort, stockpile, chip, compost, use as mulch, or otherwise beneficially reuse yard trimmings to the maximum extent feasible. .

Special Items. Listed are private facilities that handle and accept specialty items such as oil, antifreeze, etc.

Wal-Mart, Waycross and Brunswick
Advance Auto Parts
Auto Zone

Education and Public Involvement Implementation Strategy on Waste Reduction

To create an effective recycling program, back-yard composting operations and litter control programs, education of the residents will be necessary. Public information meetings, printed materials, will initiate the education process and materials can be provided through the school systems. Topics to be addressed in the educational materials initially are: solid waste collection and disposal costs and reduction of waste programs. Civic clubs, garden clubs, and school organizations will be asked to participate in the educational programs.

Objectives to Accomplish Solid Waste Reduction

One of the key requirements of the solid waste planning regulations of the Georgia Solid Waste Management Act is that each solid waste management plan shall have a program in effect to reduce the per capita rate of municipal solid wastes disposed statewide in solid waste facilities. Both the County and Cities has developed a set of goals in order to meet the State's requirements.

In addition, the County has developed a set of voluntary goals and objectives for solid waste management to meet this reduction. The County will strive to meet these additional voluntary goals and objectives as resources or grants are available. These goals are shown in **Table 12.**

Table 12

Voluntary Goals for Solid Waste Reduction

1. Encourage residents, businesses, schools, and government agencies to practice source reduction principles that reduce waste at the source.

2. Encourage the reuse of reusable items by residents, businesses, schools, and government agencies located in the County.

3. Provide recycling programs for residents, businesses, schools, and government agencies located in the County.

4. Provide regular collection of recyclable material from the Nahunta central recycling site.

5. Request that multi-family properties and all commercial and institutional properties complete a questionnaire and develop a recycling plan that documents their waste reduction and recycling programs.

6. Actively participate in the development of a recycling plan from all residents and businesses, schools, and institutions so all corrugated cardboard, aluminum, metals, and other recyclables are removed from the disposal facilities.

7. Ensure that all residents and commercial properties have access to convenient, safe, and sanitary recycling collection areas.

8. Evaluate existing collection locations and containers for recyclables and develop additional sites for residents to deposit recyclables.

9. Examine needs of elderly and disabled residents with respect to collection of household waste and household hazardous wastes.

10. Study hazardous materials disposal and medical waste disposal needs of the County's small businesses and evaluate options for enhancing the existing programs.

11. Study additional litter control programs and reevaluate any litter ordinances, which either the County or cities may have.

12 Encourage public participation in the County's waste management programs through a combination of education and compliance programs. Provide financial incentives, as funds are available.

13. Increase knowledge of existing waste reduction and recycling activities by all residents and commercial establishments in the County, especially of the large numbers of new residents locating in the County.

14. Educate all commercial building owners and managers so they understand the County's goal of reducing waste and goal of recycling.

15 Study the cost and benefits of collecting and disposing of household hazardous waste at annual collection events.

16. Seek and apply for grants to help with recycling programs and investigate other sources of funding reduction programs, such as new equipment and recycling bins can be procured either by grants or included in the annual solid waste budgets for each local government.

Waste Reduction Programs: An Assessment.

The current recycling programs and waste reduction programs target the waste streams to achieve a waste disposal reduction goal. The current programs are successful in removing a percentage of cardboard, tires, white goods, newspapers, metals, and aluminum from the waste stream. The County being so rural in nature and since it has its own transfer station and inert landfill area, has adequate space to stockpile yard debris and C&D type material until it can be transported directly to disposal facilities. The road department and each of the cities have adequate equipment and personnel to handle significant volumes of such waste, but emergency funds can be used to purchase additional equipment and personnel if needed during a natural disaster.

Waste Reduction Programs: Needs and Goals.

Brantley County and its cities will better coordinate waste reduction efforts with each other to improve waste reduction, recycling, composting, and reuse among the residential and commercial sectors. The County will investigate whether others items, such as plastic and glass, should be added to its drop-off collection center for recyclables.

The County will investigate whether additional equipment such as balers, baling twine, compactors, or other equipment may enable the collection of residential recyclables to be more efficient or effective.

A countywide environment investment fee could fund solid waste management services other than the residential collection programs. An environmental investment fee system could be charged on all property tax bills. The charges would cover such services as litter collection, county-wide recycling efforts, closed landfill monitoring, equipment purchases and maintenance needed for current solid waste management programs, and waste management planning. This method will spread the county's waste management capital, operating, and planning costs across all waste generators, and not just the residential household waste generators.

SECTION IV: COLLECTION ELEMENT

Collection: Goal

To ensure a safe, efficient, and effective collection of solid waste and recyclable materials within each jurisdiction of Brantley County.

Residential Collection Overview

Brantley County and its municipalities contract with private contractors for both collection and disposal and some recycling from single-family residents and a few small business generators. Managers or owners of other commercial/business properties, schools, and institutions are responsible for securing refuse and recycling collection services from private waste haulers. The County anticipates that the amount of waste generated in the county by both the residential and commercial sectors will continue to increase (as shown in the waste projection in **Table 6**). However, the County also anticipates that collection capacities in the county will expand accordingly. Additionally, several haulers collect and recycle waste generated by commercial and single-family homes. The solid waste collection vendors are sufficient to meet future collection needs.

Service Areas. The Brantley County service area includes 162 green boxes located at approximately 17 locations throughout the County. Waste is collected about five times a week, for 260 collection days per year. The collection service is provided by Stateline Disposal Services. White goods are collected by contract with Glynn Iron and Steel Company. The county currently charges each household an annual fee of $75.00 for collection and disposal. This fee is placed on the property tax bill for each household in the unincorporated areas of the county. The county then submits payment to contractors pursuant to their contracts.

The service area for the County should not change over the next ten years, although the route length and number of collection points may increase with the increase in population. The County could examine and investigate plans to resume or restart their former collection service of the green boxes in the next ten years.

The service area of the City of Hoboken includes 207customers. The City of Hoboken provides once-weekly curbside collection for its residents and small businesses by contract with a Stateline Disposal Services; larger quantity commercial/business waste generators utilize the green box collection system by contract with a Stateline Disposal and/or Southland Disposal Services. The private hauler collects white goods on a “per call/as needed” basis. The hauler will collect a limited list of bulky items at the same time as the residential waste collection container is collected. Other items are self-hauled by the residents to the Brantley County Transfer Station for collection and disposal. Small quantities of limbs and leaf debris are collected by the City employees and hauled to the County’s inert area at the Transfer Station. The City of Hoboken currently charges its residents and small businesses per collection container at a cost of $9.00 per month, which appears monthly on the water bill of all customers. The city remits a portion of these funds to the contractor, and the city uses the remainder for the administrative costs associated with solid waste management that the city incurs. The actual service area of the City will include only minor route adjustments over the next ten years as new customers are added. At the present, the City of Hoboken does not plan to handle the curbside collection of residential household waste in the next ten years.

The City of Nahunta service area includes approximately 470 customers. The City of Nahunta provides once-weekly curbside collection for its residents and small businesses by contract with Stateline Disposal Services; larger quantity commercial/business waste generators utilize the green box collection system by contact with Stateline Disposal Services and Southland Waste Disposal Services. The private hauler collects white goods on a "per call/as needed" basis. The hauler will collect certain bulky items at the same time as the residential waste collection. Other items usually are self-hauled by the residents to the Brantley County Transfer Station for collection and disposal; on occasion, the City collects and transports to the Brantley County Transfer Station white goods and bulky items for its residents. Small quantities of limbs and leaf debris are collected by the City employees and chipped for mulch and either given to the residents or hauled to the County's inert area near the Transfer Station. The City of Nahunta currently charges its residents and small businesses "a per container" charge and this charge appears monthly on each customer's water bill at a charge of $10.00 per month. The city remits a portion of these funds to the contractor and the city uses the remainder for the administrative costs associated with solid waste management that the city incurs.

The actual service area of the City will include only minor route adjustments over the next ten years as new customers are added. At the present, the City of Nahunta does not plan to resume or restart the curbside collection of residential household waste by municipal employees in the next ten years.

Both cities intend to examine instituting an exempt service for citizens who are at least 65 years of age or who are physically unable to move a roll-out container to the curb. If the cities develop this service, exempt residents may have their garbage collected from a designated area by the city and its collection contractor, e.g. from backyard pickup sites.

Commercial, Business, School, and Institutional Collection. Each large generator of commercial, business, school, and institutional waste requiring a green box type container contracts with a private collector and disposer for its waste. The local government agencies in the county and in the municipalities, which likewise require a green box type container, also contract with a collector and disposer for their waste. Small-quantity generators in the cities utilize the roll-out containers for a $15.00 per month fee, paid to the City, as do the residential users. Small-quantity generators in the county utilize the green boxes located throughout the county.

Yard Waste Collection. This program is designed to redirect debris from the waste stream by recycling it into a reusable earth product. The yard waste from both cities is offered to the public for use in gardens, farms, and composting programs. Debris too large for composting and mulching is taken to the Brantley County inert landfill.

The City of Hoboken provides an "as needed/per call" collection of yard trimmings. Residents who desire this service must telephone the city and schedule a pick up. The City of Nahunta provides a similar "as needed/call" collection of yard trimmings. Residents who desire this service must telephone the city and schedule a pick up. The City of Nahunta has a chipper that will chip limbs up to 8 inches in diameter; however, the chipper will not shred pine straw. The City of Nahunta offers this mulch program of yard trimmings for its residents and, after mulching; most residents are able to keep the debris for their gardens, home landscaping, and mulching programs.

There is no collection service for yard waste provided by the county to the residents of the unincorporated areas of the county. Residents must self-haul to the inert landfill or contract with a private contractor for collection and disposal of yard trimmings.

Corrugated Cardboard Collection. The county and its cities do not provide for collection of corrugated cardboard; however, residents, businesses, and schools may participate in a voluntary recycling program.

Bulky Item Collection. In both the City of Hoboken and City of Nahunta, bulky item pickup service is provided to residents who have large items, such as large household appliances (white goods) and old furniture, which are too large to be collected by the container collection crews. This service is provided to the residents in the monthly charge for garbage service that each resident pays. In the county, residents must self haul their bulky and white goods to the transfer station.

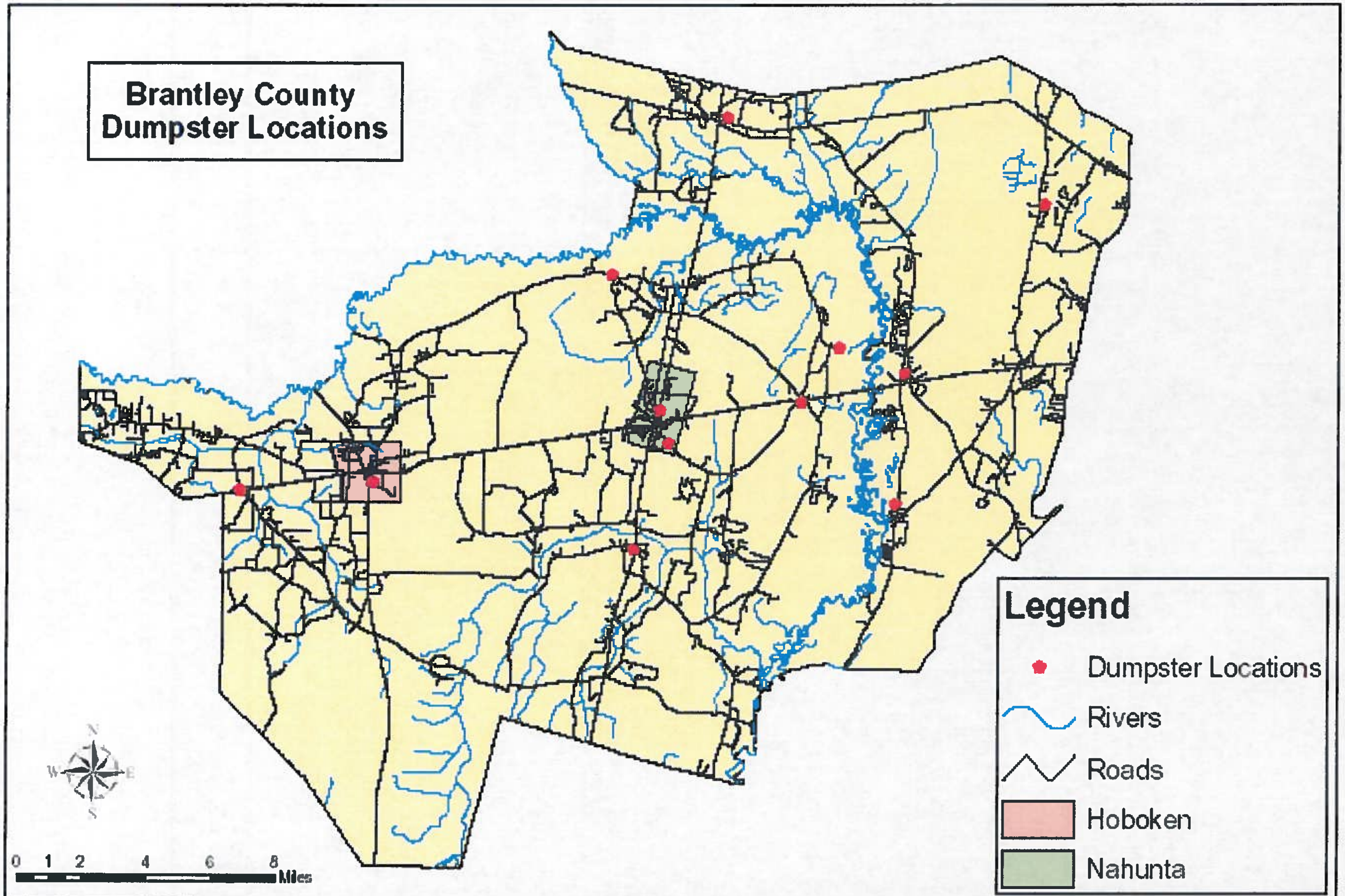
Public and Private Collection Service. For the next 10 years, collection methods will be the same as the present methods. The Cities of Hoboken and Nahunta will continue curbside collection by contract with a private collection service and hauler, but each City may investigate operating the collection service itself. Larger quantity commercial/business waste generators will continue to utilize green box collection containers by private contract with a collection and disposal service or with a county-owned collection service should the county resume this operation. The unincorporated areas of the county will continue to be serviced by green box collection containers by contract with a private collection and disposal service until the county may resume operation of the collection and disposal. The location and quantity of the green box to be determined as the demand indicates. These collection sites will be cleaned and maintained by the county. These two service systems are more than adequate to handle the waste collection needs throughout the County and the two cities. The county and the two cities will regulate any private residential or commercial collection service operating within the county. The county and cities will implement rules, regulations and ordinances pertaining to operation of private solid waste collection systems and operators and pertaining to the granting of permits or licenses to private haulers. Only waste generated within Brantley County shall be deposited at green boxes, in roll-out curbside containers, or deposited at the Brantley County Transfer Station or deposited to any collection, handling, or disposal facilities in Brantley County. The County and the cities will continue to review and reevaluate their contracts with private collection and disposal services to ensure safe, efficient, and effective collection and disposal of the solid waste.

Green Box Containers. See **Figure 6** for a map of the locations of the green box containers in the County for residential household waste. Concentrated areas of green box collection and placement include: in and around Hoboken, Calvary, and Schlatterville in the western section of the County; in and around Nahunta, Hickox, and Lulaton in the central section of the County; around Raybon and Hortense in the northern section of the County; and around Atkinson, Browntown, and Waynesville in the eastern section of the County, between the Satilla River and the Glynn County line.

Projected Goals for Dumpster Sites

Projected green box usage in the collection system includes reducing the number of green box sites to approximately 10-12 sites and implementing an unmanned collection site system. Each site will have regular household waste bins, as well as bins for marketable recyclables, an area to deposit white goods and an area to deposit bulky items. Compactors may be utilized to reduce the collection and disposal expenses. A planned trial unmanned collection site will be implemented first, and based on its success, other locations will be chosen for unmanned sites. These sites are expected to be approximately one acre in size, paved as needed, possibly with roll-off containers instead of green boxes to facilitate easy removal of the waste containers for disposal. Design of the sites is anticipated to be similar to sites in McIntosh County and Lowndes County.

Figure 6


Brantley County
Dumpster Locations
Legend
Dumpster Locations
Rivers
Roads
Hoboken
Nahunta
N
W
E
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0 1 2 4 6 8
Miles

Solid Waste Employees and Equipment Used. The City of Hoboken uses the part-time services of one of its employees to handle litter cleanup and to handle the limited collection services that the City provides for debris collection. The number of employees needed to operate the City's services should not increase over the next ten years. The City of Hoboken owns a truck, which is in good condition that is used on a part-time basis for the collection services provided by the City. . The City needs no additional equipment for the next ten years, unless equipment becomes necessary to implement recycling programs for the City or unless the City starts its own curbside collection program.

The City of Nahunta uses the part-time services of two of its employees to handle litter cleanup and to handle the limited collection services that the City provides for debris collection. The number of employees needed to operate the City's services should not increase over the next ten years. The City of Nahunta owns a truck, which is in fair condition that is used on a part-time basis for the collection services provided by the City. This vehicle, with proper maintenance, should last through this planning period. The City also has a chipper that is used on a part-time basis for chipping limbs and debris collected in the city. The City needs no additional equipment for the next ten years, unless equipment becomes necessary to continue or implement additional recycling programs for the City, or unless the City resumes the operation of the curbside collection system. .

The County employs one person to run operations at the Smyrna Transfer Station and Inert Landfill. One additional employee is used to clean the grounds around the green box sites. The number of personnel needed to operate the County system should not increase over the next ten years, unless the County resumes operations of the collection system.

The systems used by the County and its two municipalities should be adequate to handle collection demands over the next ten years.

Collection Fees. For the year 2004, the Brantley County Board of Commissioners authorized an annual household fee of $75.00 to pay for solid waste services. The total operating budget for the Brantley for the year 2004 –2005 is $549,850. No general fund revenue is anticipated to supplement the solid waste expenditures for collection, disposal, green box site maintenance, and landfill monitoring and closure.

Commercial/business and institutional customers in the County pay a flat fee per month to the private contractor based on the size container or quantity of waste generated and collected. The contract for private collection services of the green box containers of the County is due to expire 2008and the County will seek bids for collection services prior to that expiration.

The City of Hoboken currently charges a flat fee of $9.00 per month per customer for household curbside collection. Commercial/business and institutional customers in Hoboken pay a flat fee per month to the private contractor based on the size container or quantity of waste generated and collected. The total budget for the City of Hoboken for the year 2004 was $21,735. The contract for collection services is due to expire on January 1, 2008 and the City of Hoboken will seek bids for collection services before that expiration.

The City of Nahunta currently charges a flat fee of $10.00 per month per residential customer. Commercial/business and institutional customers in Nahunta pay a flat fee per month to the private contractor based on the size container or quantity of waste generated and collected. The total budget for the City of Nahunta for the fiscal year 2004-2005 is $46,000, and the Revenue budget is $47,311. The contract for collection services is due to expire on January 1, 2008 and the City of Nahunta will seek bids for collection services before that expiration.

Agreements. Brantley County and its two municipalities have an informal unlimited-time agreement for the municipalities to utilize the Transfer Station to deposit bulky items, white goods and inert materials. These agreements will remain in effect over the next ten years, as they are needed.

<u>Adequacy of the Collection Program</u>.

Brantley County collects its waste through two primary means: (1) curbside collection for the two municipalities in the County and curbside collection for some residences located in the western portion of the County; and (2) a series of dumpster/green box sites located throughout the County. Municipal collection and disposal for both Hoboken and Nahunta are provided by contract with a private hauler. Curbside collection for some residential units in the western portion of the County is provided by contract between the residential owners/tenants directly with the private hauler. Brantley County also contracts with a private hauler for collection and disposal of the dumpsters/green boxes. Private collectors serve industry, commercial/business, and institution needs by contracts directly with these entities.

Brantley County further contracts with a private hauler to haul bulky items from the Brantley County Transfer Station to a private landfill outside the county (bulky items meaning old mattresses, old furniture, sofas, chairs, and other items too large and bulky to dispose of in the dumpster/green boxes or in the curbside collection programs).

Now, the collection programs in place throughout the county are adequately addressing current local needs and are able to handle the volume of solid waste by residential and commercial generators. However, concerns about litter, changing regulations, and accommodating the rapid growth in the County may necessitate further evaluation in the future. As other areas in the county grow and the population density increases, various collection methods will be considered.

One issue of concern as to the County collection element is the appearance and odor of roadside dumpsters/green box containers. Often the sites are unattractive as people dump items, especially larger items, next to the dumpster instead of into the dumpster, creating an eyesore along the roadside. Adding to this problem is the fact that trash deposited on the ground around the dumpsters is scattered by the wind and animals. The County will work toward improving this negative aspect of green boxes by studying alternative green box re-locations that are not so readily visible from the roads, by redesigning each collection site to facilitate the deposit of the waste and make it easier for the resident, by evaluating ways to improve the odor of the boxes (e.g. prompt collection of the boxes by the hauler), and by working with and educating the public on keeping the sites clean.

Dumpster containers have long proven to be an efficient and cost effective means of collection of residential waste if the sites are aesthetically pleasing, convenient, and collected frequently, and if the area around the containers is kept clean and safe.

Brantley County will concentrate its efforts to improve the appearance and ease of use of its green box/dumpster sites; and the County believes this method of collection will continue to provide a safe, efficient, and cost effective method of collection for the County.

Adequacy of Recycling Collection Programs

The current collection programs are adequate for serving present community needs. The education campaign to familiarize the public and newcomers to the community of the recyclable items and location of recycling locations will facilitate progress towards the waste reduction goals of this plan.

Adequacy of the Yard Trimmings Collection Program

At this time, the County's existing programs to handle yard trimmings collection appears to be adequate to handle the volume of yard wastes generated by the population. The County will continue to monitor and address this issue during the planning period and will examine other steps that may need to be taken to reduce yard trimmings disposal.

Illegal Dumping

Illegal dumping in the unincorporated areas of the county is a frequent occurrence in the Planning area. Brantley County has enacted a litter control ordinance and has employed an enforcement officer hired to patrol the green box sites throughout the county in an attempt to enforce its anti-litter and dumpster ordinance.

The county plans to investigate a neighborhood watch program through which residents will be able to report an illegal dumping incident. The county plans to develop a method to prevent out-of-county residents or passers-by from disposing of trash illegally in the green boxes and develop a method to punish offenders. It is also to be remembered that passers-by could also dispose of waste into the hundreds of blue boxes or curbside collection containers that line so many streets and roadways in the state. There is no total control for people who intend to litter and dispose of waste illegally.

In addition, the county plans to implement a method to distribute information brochure to new residents and businesses, which will include information on solid waste disposal methods and locations of disposal facilities, including the Transfer Station and green box locations. A recital of the anti-dumping, anti-littering ordinance will be included in the brochure. This information brochure can be disseminated to each new resident or new business at the time of issuance of a building or mobile home permit, septic tank permit, electrical permit or hook up, telephone service hook up, cable or satellite dish service hook up, water meter hook up, or at the time of application for a business license from the municipalities or the county. In addition, a brochure could be mailed to each new resident or business purchasing property in the municipality or county. The county will evaluate each method of dissemination and select the method or methods that will best inform its residents and businesses.

Needs and Goals: Collection Programs.

Brantley County's goal for collection is to ensure effective, efficient and affordable collection of solid waste in the county for the next ten years. Additional goals and needs are:

(a) Evaluate collection efficiency periodically to determine if new collection efforts are needed.

(b) Study existing green box container collection system and determine if a different system would be more effective and efficient, and analyze costs to the county.

(c) Improve safety of the green box collection sites by redesigning, and possibly paving the sites to include control and management of storm water runoff.

(d) Maintain and purchase equipment needed for the solid waste program to properly and safely manage the solid waste program.

(e) Evaluate current contingency plans for solid waste and determine if changes are needed.

(f) Prepare a capital improvement schedule for solid waste programs for at least the next ten years.

(g) Evaluate funding for the County's solid waste collection and disposal programs. Funding can remain fee-based with a flat fee levied on each household located within the County. Other variations in funding can be evaluated.

(h) Identify and evaluate additional funding sources for waste programs, including fees to be charged by private haulers, in addition to the general business license which is required of all businesses in the County.

(i) Continue control over privately collected waste to monitor proper collection and disposal and understand the amounts and flow of waste generated in the County.

(j) Encourage active public participation in the County's waste planning and regulations.

Contingency Strategy for Interim Collection of Solid Waste.

In the event the primary c waste collection program for residential users within the Cities of Hoboken and Nahunta and the County becomes interrupted, in the event of a natural disaster or other event, the City/County will either: (1)) contact and contract with a different private collector and disposer; (2) contact and contract with a nearby city or county to provide the collection service for the city; (3) immediately rent, lease or purchase green boxes and install an un-staffed central location of green boxes where residents may haul and drop-off municipal solid waste and the city will contact and contract with a private service to collect and dispose of the waste from these boxes; or (4) lease or rent a collection vehicle and begin a municipal managed curbside collection and hauling service. The County and Cities has contacted a nearby government who has agreed to provide collection for the city on a contingency basis. The city and county governments maintain a list of private collectors and disposers who are available on a contingency basis and they maintain a list of vendors who rent, lease or sell collection vehicles and collection boxes, which are available on an emergency basis, i.e. within 48 to 72 hours. The cities have identified sites within the city and county for contingency green box locations. The City has also contacted a nearby government who has agreed to provide collection for Hoboken on a contingent basis. The Cities/ County maintains a list of the names, addresses and telephone numbers of private haulers who are licensed in the adjoining jurisdictions and who have agreed to collect and dispose on a contingent basis. This list will be updated annually.

SECTION V: DISPOSAL ELEMENT

Disposal: Goal

To ensure that solid waste treatment and disposal facilities serving the governments in Brantley County meet regulatory requirements and are in place when needed to support and facilitate effective solid waste handling programs, today and for the next ten years, thereby maintaining and enhancing the quality of life throughout Brantley County.

Disposal Overview

Landfill Utilization. The Brantley County/Smyrna Municipal Solid Waste Landfill, east of Nahunta, on County Road Number 103, has been closed since April 1992. Closure of the landfill has followed the closure plan submitted and approved by the Georgia Department of Natural Resources, Environmental Protection Division. The County monitors this landfill and will continue to do so pursuant to regulations from the Environmental Protection Division of the Georgia Department of Natural Resources. Since the Smyrna Landfill was closed, waste has been hauled outside the County to other disposal facilities. Some of the waste is collected and hauled from the Brantley County's Transfer Station.

All waste generated within the County and its two municipalities, with the exception of materials diverted from the waste stream, is collected and transported for disposal at a permitted landfill outside of the County. Only waste generated within the county their municipality is accepted for handling, sorting, transfer, or disposal in the county by any facilities located in the county. It is the County's desire that only waste or materials generated within the confines of the County and Cities are transferred, stored, or disposed at public or private facilities in Brantley County or its municipalities.

Currently all MSW collected in Brantley County is disposed primarily at the Broadhurst Environmental Landfill in Wayne County, Georgia, and to Chesser Island Landfill in Charlton County, Georgia. The Wayne County landfill is approximately ten miles from the Brantley County line at the community of Hortense. See **Figure 7** for a map of landfills in close proximity to Brantley County.

The Broadhurst Landfill in Wayne County has an estimated capacity estimated fill date of September 14, 2019, and 16 remaining estimated years.[3] This landfill has recently filed a request for a permit expansion and may acquire additional acreage adjacent to the present site, which will increase its life expectancy. As a result, Brantley County expects that the capacity of this facility will continue to meet its disposal needs of both the residential and commercial/business properties, even with the projected growth in the County. The County anticipates that these disposal facilities will continue to exist and that all future disposal needs will be met.

Brantley County constructed a solid waste transfer facility in April 1992, which has been in operation since that time. This transfer station is more than adequate to handle current

[3] List of Landfill Remaining Capacity, Revised January 2005, Georgia Department of Community Affairs.

and future solid waste amounts for the County. The transfer station is used currently only on a limited basis to collect and haul bulky item and white goods.

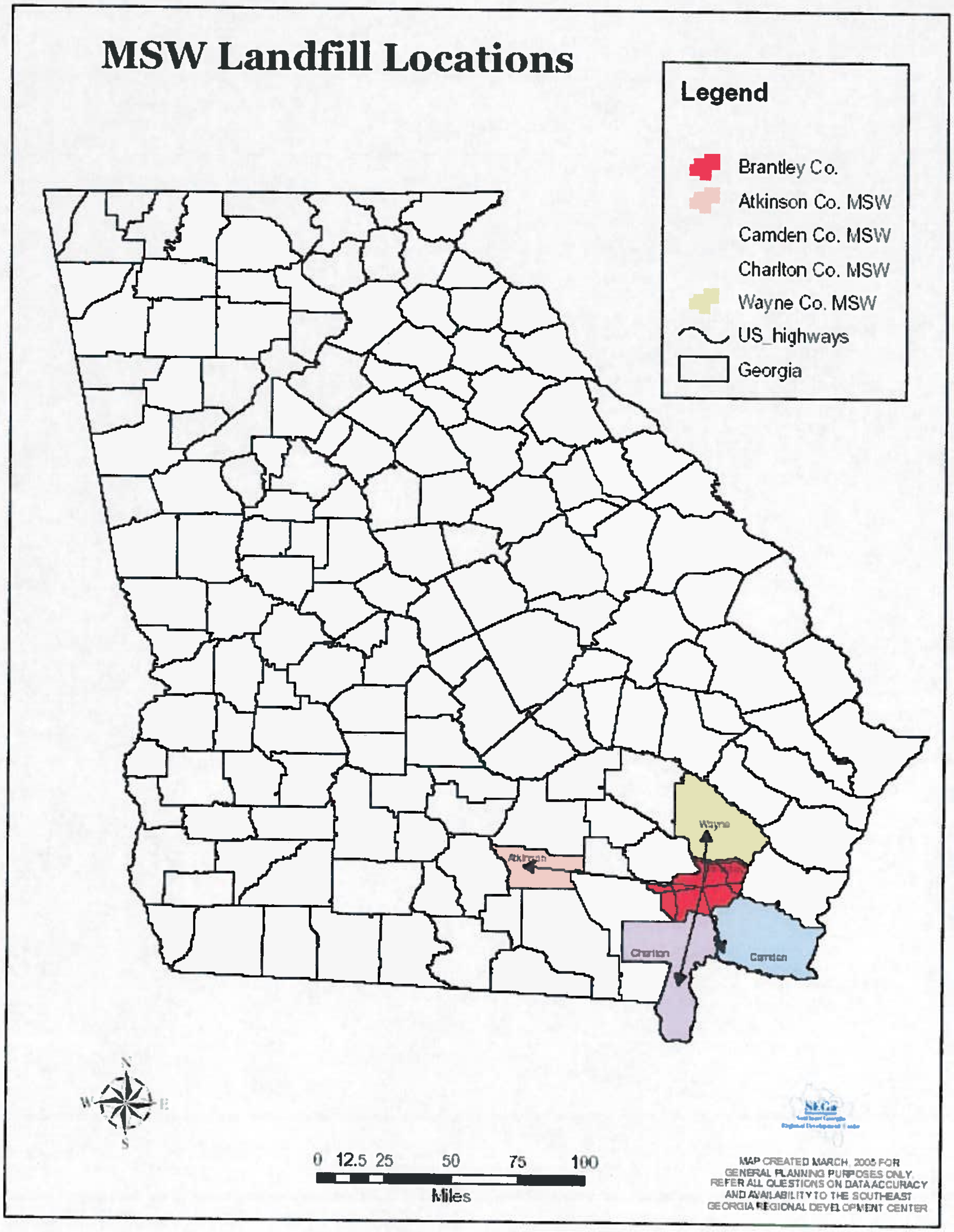
The County and its two municipalities will continue to have its waste transported to one of the private Subtitle D landfills listed on **Table 13**. These facilities have indicated a capacity to handle Brantley County's small tonnage of waste. Other public or private Subtitle D Landfills may become available in other counties in the southeast Georgia area.

Brantley County and its municipalities will carefully analyze and choose the disposal option most advantageous to the County considering economics, environmental concerns, land uses, and other issues.

Disaster and Storm Debris Collection

In the aftermath of a storm or any type of disaster, Either/or City and County employees, using county/city vehicles, will collect the debris created. Debris will be stored at a designated site until time will permit removal and disposal at the Wayne County Landfill.

Figure 7


MSW Landfill Locations
Legend
Brantley Co.
Atkinson Co. MSW
Camden Co. MSW
Charlton Co. MSW
Wayne Co. MSW
US_highways
Georgia
Wayne
Atkinson
Charlton
Camden
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Miles
MAP CREATED MARCH 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

Table 13

Disposal Facilities

County	Site	Dominion	Year	Remaining Capacity	Years Remaining	Pending Permit
Atkinson	SR50MSWL	Public	2004	217,009(MSW) 211,500(CD)	5 MSW 2 C&D	Yes
Camden	SR110MSWL	Public	2004	2,015,361	19	
Camden	SR110MSWL	Public	2004	23,383,986	543	
Charlton	Chesser Island	Commercial	2004	12,962,217	30	
Wayne	Broadhurst	Private	2004	11,298,034	16	Yes

Assessment of Existing Facilities and Disposal.

For the ten-year planning period, the existing disposal facilities located in close proximity to the County are adequate for the projected quantities of waste. The County and its municipalities have identified other sufficient alternatives for solid waste disposal in the future in the event that the current disposal arrangements need to be changed. The County's existing practices will continue to meet the needs of the County and its municipalities for the next ten years and beyond.

Needs and Goals of Current and Future Disposal Options.

Brantley County and its municipalities have two major goals in regard to current and future disposal: (1) to ensure that disposal facilities in the area meet all regulatory requirements and can continue to facilitate the county's solid waste handling and disposal needs for the next ten years; (2) to ensure that all disposal facilities in the area are compatible with the needs and goals and consistent with the County's Plan for waste management. Other goals of the County are:

a. Ensure that disposal facilities and other solid waste management or handling facilities are sited, built, and operated to protect the safety, health, and welfare of all residents and property owners in the County.

b. Strive to continue the goal of the Solid Waste reduction

c. Negotiate agreements for contingency needs with disposal facilities in adjoining jurisdictions or within close proximity to the County.

d. Continue to monitor collection and disposal services of the green box container system to ensure effective, efficient, and affordable service.

e. Enforce current and proposed litter control ordinances.

f. Evaluate funding for the County's solid waste collection and disposal programs. Funding can remain fee-based with a flat fee levied on each household located within the County. Other variations in funding can be evaluated.

g. Identify and evaluate additional funding sources for waste programs, including fees to be charged by private haulers, in addition to the general business license which is required of all businesses in the County.

h. Continue to monitor privately collected waste to monitor proper collection and disposal and understand the amounts and flow of waste generated in the County.

i. Encourage active public participation in the County's waste planning and regulations.

j. Enforce Ordinances to regulate waste containers and receptacles.

k. Enact and enforce Solid Waste Management Ordinance.

Capacity Assurance Letters

Copies of Capacity Assurance letters from Atkinson County MSW landfill, Broadhurst Landfill in Wayne County, and Chesser Island Landfill of Charlton County are included after table of contents at beginning of Plan.

Alternative Contingency Disposal Options.

In the event the primary method of disposal becomes interrupted, the cities of Hoboken and Nahunta and Brantley County have a contingent plan to use one of the other landfill disposal facilities identified in **Table 13**

The County has identified several other alternatives for solid waste disposal in the event existing arrangements need to be modified and the County would contact one of these other disposal facilities and make arrangements in sufficient time to meet the demands of disposal for the County. The county and its municipalities have adequately prepared and have the capability of ensuring that municipal solid waste can be disposed of for the next ten years.

The Estimated Length of Time to Bring Contingency Disposal Options on Line.

If necessary to utilize another landfill this option can be used immediately, within 24-48 hours, after the facility has been contacted to inform them of the need to utilize their facility.

VI. LAND LIMITATION ELEMENT

Environmental Characteristics Overview

The total land area for Brantley County is 286,080 acres. Of this, approximately 45,770 acres or 16 percent is classified as wetlands and an additional 67,260 acres or 24 percent is classified as flood prone land; thus, 113,030 acres of the total 286,080-land area acreage is classified as either wetland or flood prone.

Groundwater supplies of the County are composed of three main aquifers: the shallow groundwater aquifer, the Miocene aquifer, and the deeper Ocala limestone aquifer, commonly called the Floridian aquifer. The groundwater recharge areas and the significant groundwater recharge area lie underneath a large area of the County.

A. Needs and Goals

There are several needs and goals for this Land Limitation Element. One is to ensure that proposed solid waste management facilities are compatible with surrounding areas and are sited in areas suitable for the location of such facilities based on natural environmental limitations and land use factors. Another purpose of this Land Limitation Element is to provide an assessment of areas in Brantley County, which are unsuitable for solid waste management facilities. Unsuitability is determined based on environmental criteria and land use criteria.

Even though Brantley County does not anticipate opening a new solid waste management facility within its jurisdictional boundaries during this planning period any future waste disposal facilities, whether landfill or thermal energy, or other, should be constructed on a size-need basis dependent upon waste generated within the County and its municipalities. Brantley County, due to the many and varied land limitations, high rainfall, temperature inversions, and low elevations must conserve its scarce suitable disposal sites must limit use of such sites to disposal of wastes generated from only within the County

Other needs and goals include: (a) monitoring the closed Smyrna landfill; (b) monitoring the Brantley County Transfer Station and green box sites; and (c) continue to examine and monitor land uses and development in the County.

B. Environmental Limitations

The following environmental limitations must be satisfied prior to approval of any solid waste management facility, or expansion of any solid waste management facility, or the renewal of a solid waste handling permit. Interpretation of whether a proposed solid waste management facility is or is not satisfying such limitations shall be made by Brantley County.

Water Supply Watersheds. DNR Rule 391-3-16-01(7) (c)1 requires that at any location within a small water supply watershed, new solid waste landfills must have synthetic liners and leachate collection systems. There is no major watershed located in Brantley County.

Groundwater Recharge Areas.

No solid waste management facilities shall be located in any area designated a significant groundwater recharge area not having synthetic liners and leachate collection systems. DNR Rule391-3-16.02 (3)(a) There are five significant groundwater recharge areas in Brantley County: at and northeast of Hoboken, north of Racepond (Charlton County), south of Hortense under the Trudie community, along the west side of the Satilla at Lulaton, and along the east side of the Satilla at Atkinson. **Figure 8-10** represents recharge areas in Brantley County and its municipalities.

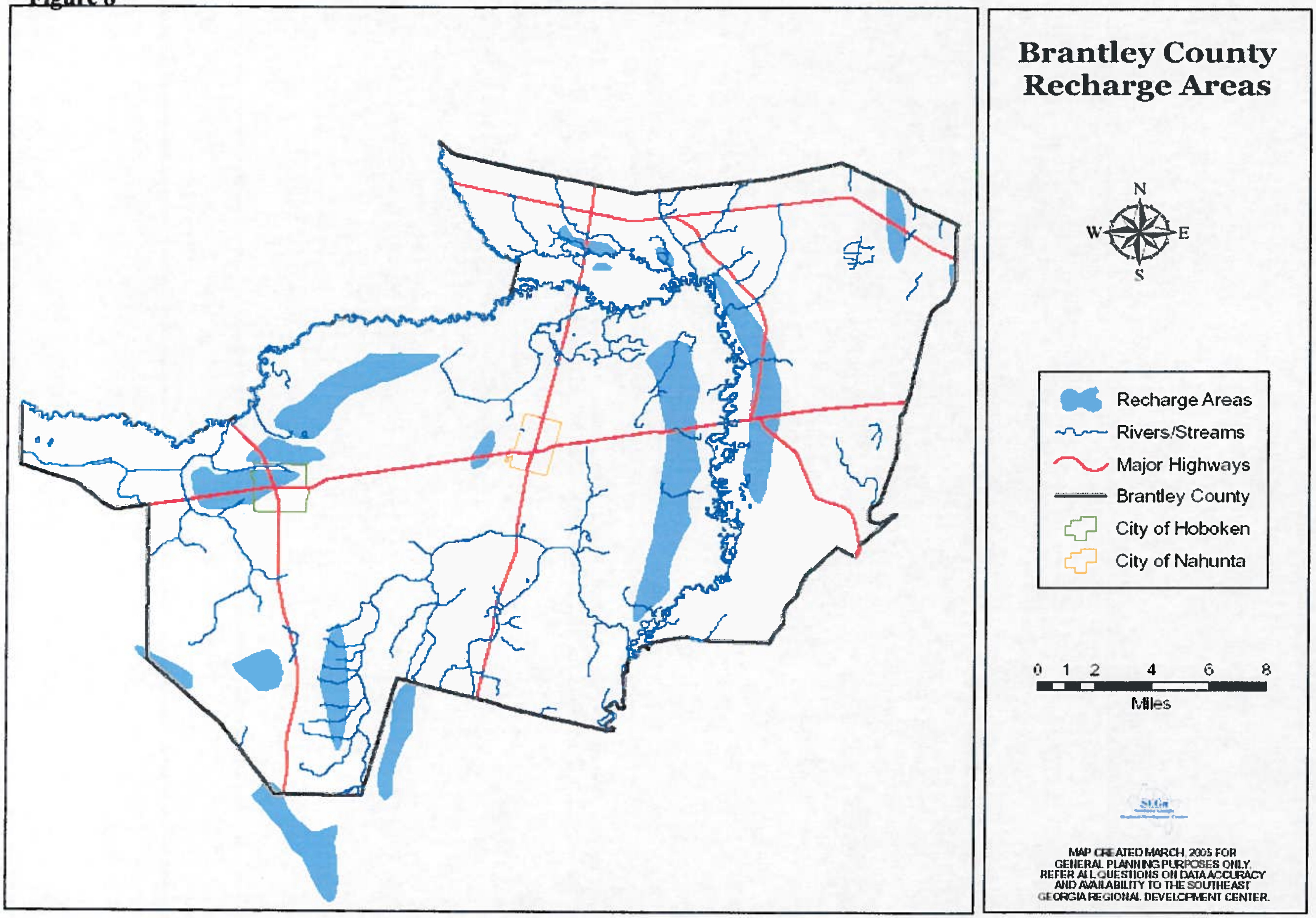
Wetlands Areas.

Solid waste landfills may constitute an unacceptable use of a wetland. (DNR Rule 391-3-16.03(3)(e). No solid waste handling facility should be located in a wetland, as defined by the US Army Corp of Engineers, unless there are no other alternative sites or methods available and the use of such wetlands complies with all applicable stated and federal regulations. See **Figure 11 through 13** for wetlands in Brantley County Nahunta, and Hoboken.

Protected River Corridor Areas

A protected river is defined as any perennial river or watercourse with an average annual flow of at least 400 cubic feet per second. The DNR has deemed rivers of this size to be of vital importance to Georgia in that they help serve as habitat for wildlife, a site for recreation, and a source for clean drinking water. River corridors also allow the free movement of wildlife from area to area within the state, help control erosion and river sedimentation, and help absorb floodwaters. DNR Rule 391-3-16-.04(4)(h) prohibits the development of new solid waste landfills within 1000 feet of protected river corridors. Protected River Corridor in Brantley County shown in **Figure 14**

Figure 8


Brantley County
Recharge Areas
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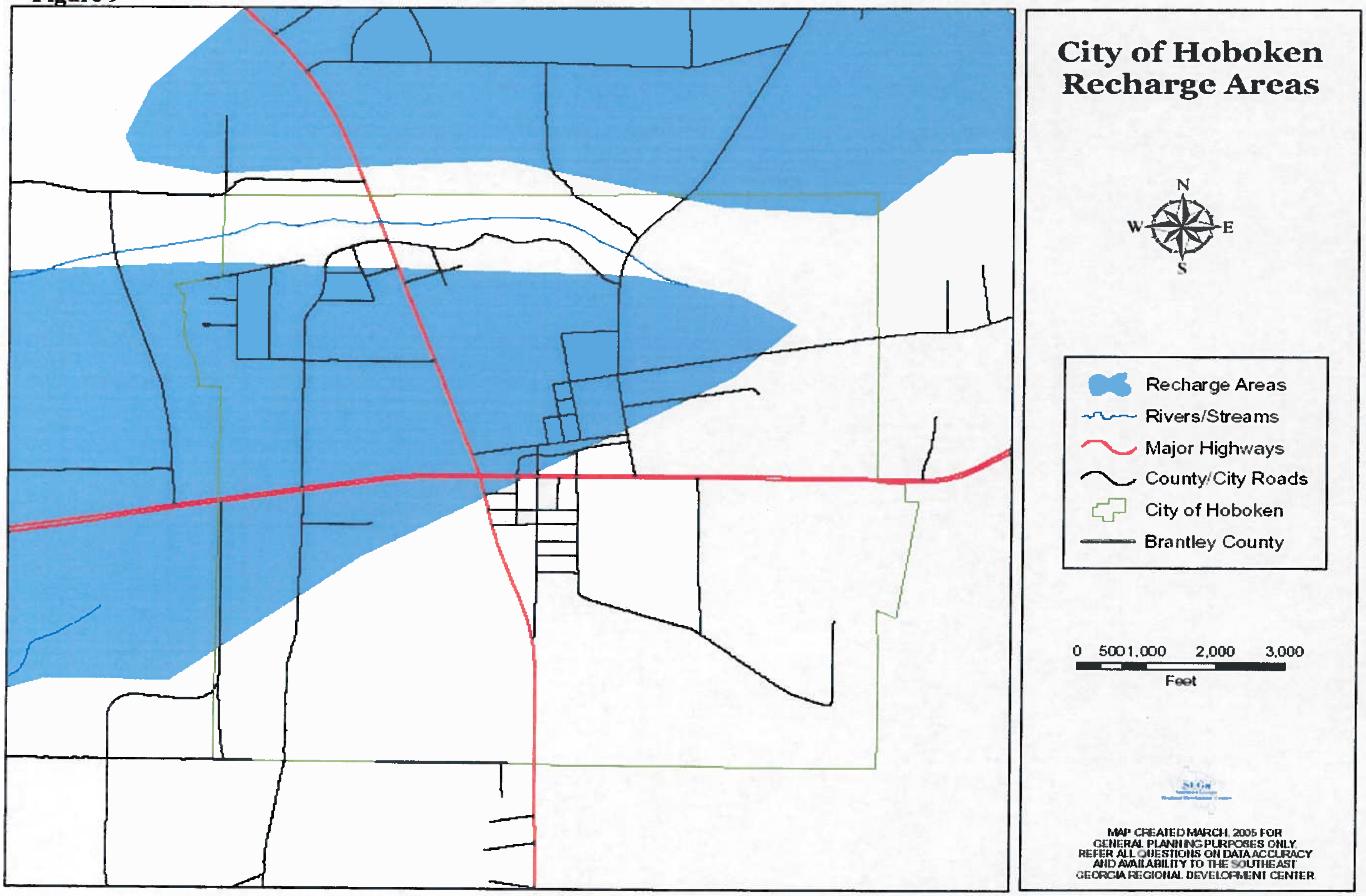
Recharge Areas
Rivers/Streams
Major Highways
Brantley County
City of Hoboken
City of Nahunta
0 1 2 4 6 8
Miles
MAP CREATED MARCH, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

Figure 9


City of Hoboken
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Rivers/Streams
Major Highways
County/City Roads
City of Hoboken
Brantley County
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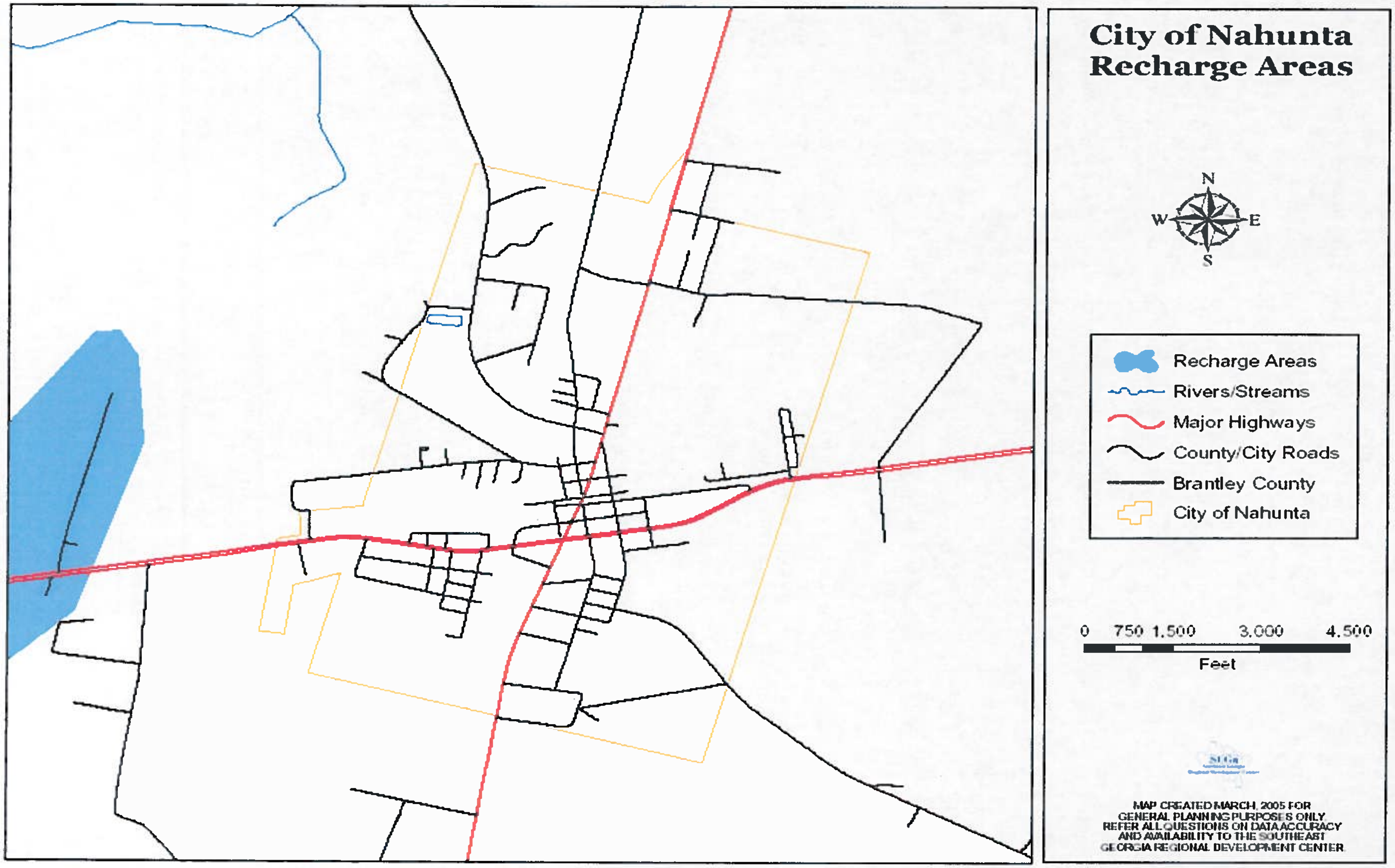
Feet
MAP CREATED MARCH, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

Figure 10



City of Nahunta
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Feet
MAP CREATED MARCH, 2005 FOR GENERAL PLANNING PURPOSES ONLY
REFER ALL QUESTIONS ON DATA ACCURACY AND AVAILABILITY TO THE SOUTHEAST GEORGIA REGIONAL DEVELOPMENT CENTER

Figure 11

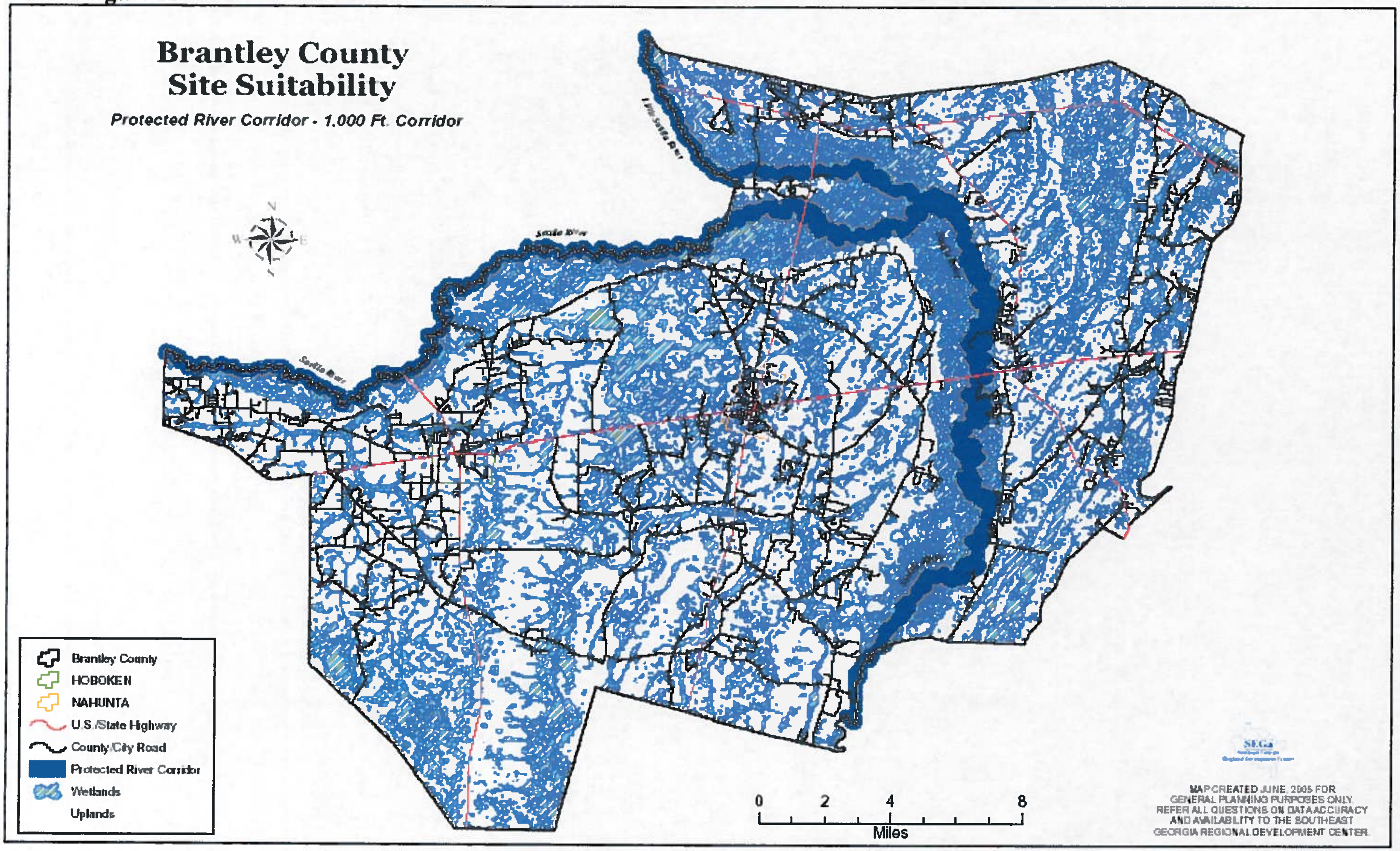
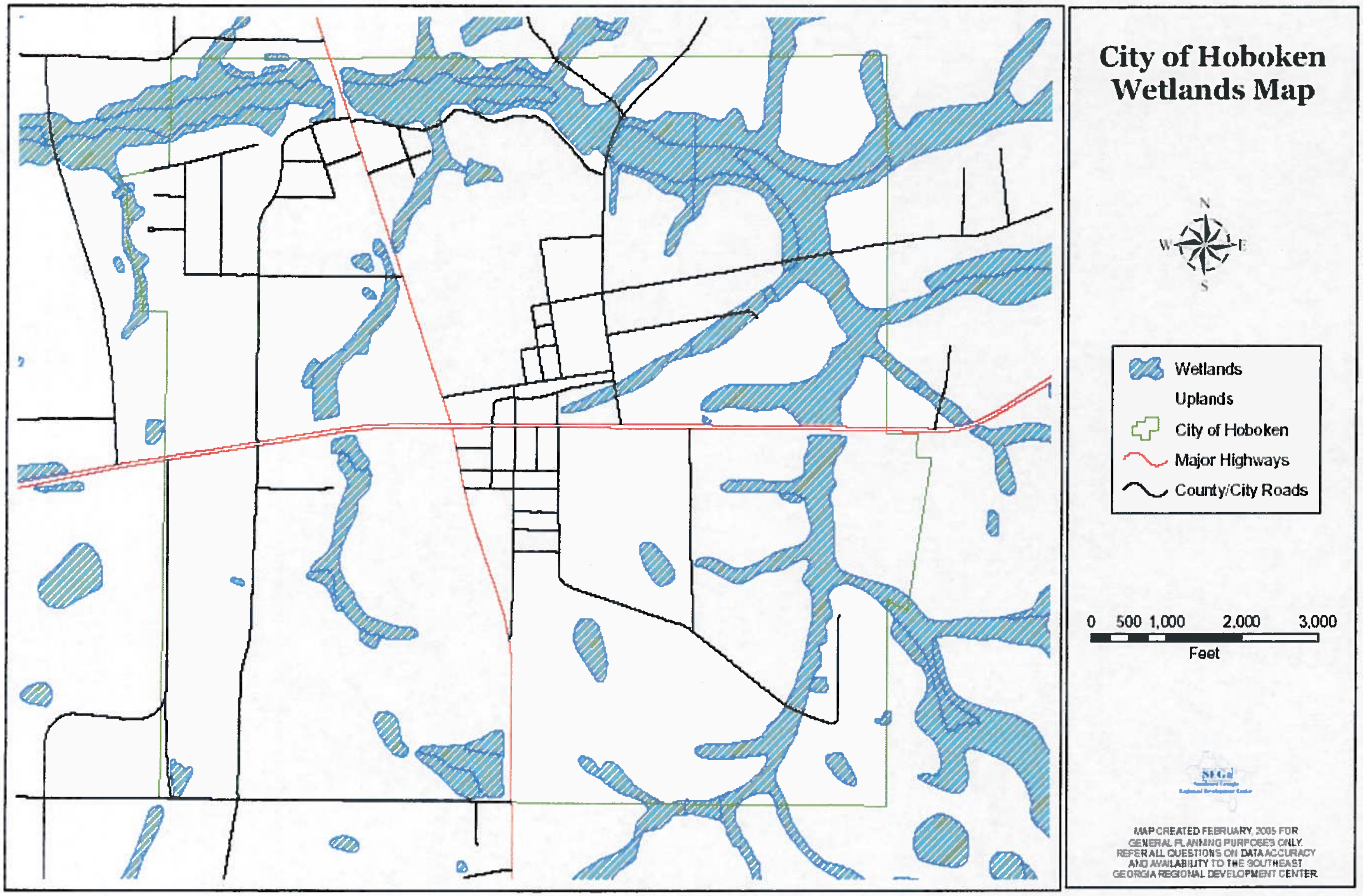

Brantley County
Site Suitability
Protected River Corridor - 1,000 Ft. Corridor
Satilla River
Brantley County
HOBOKEN
NAHUNTA
U.S./State Highway
County/City Road
Protected River Corridor
Wetlands
Uplands
0 2 4 8
Miles
MAP CREATED JUNE, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

Figure 12


City of Hoboken
Wetlands Map
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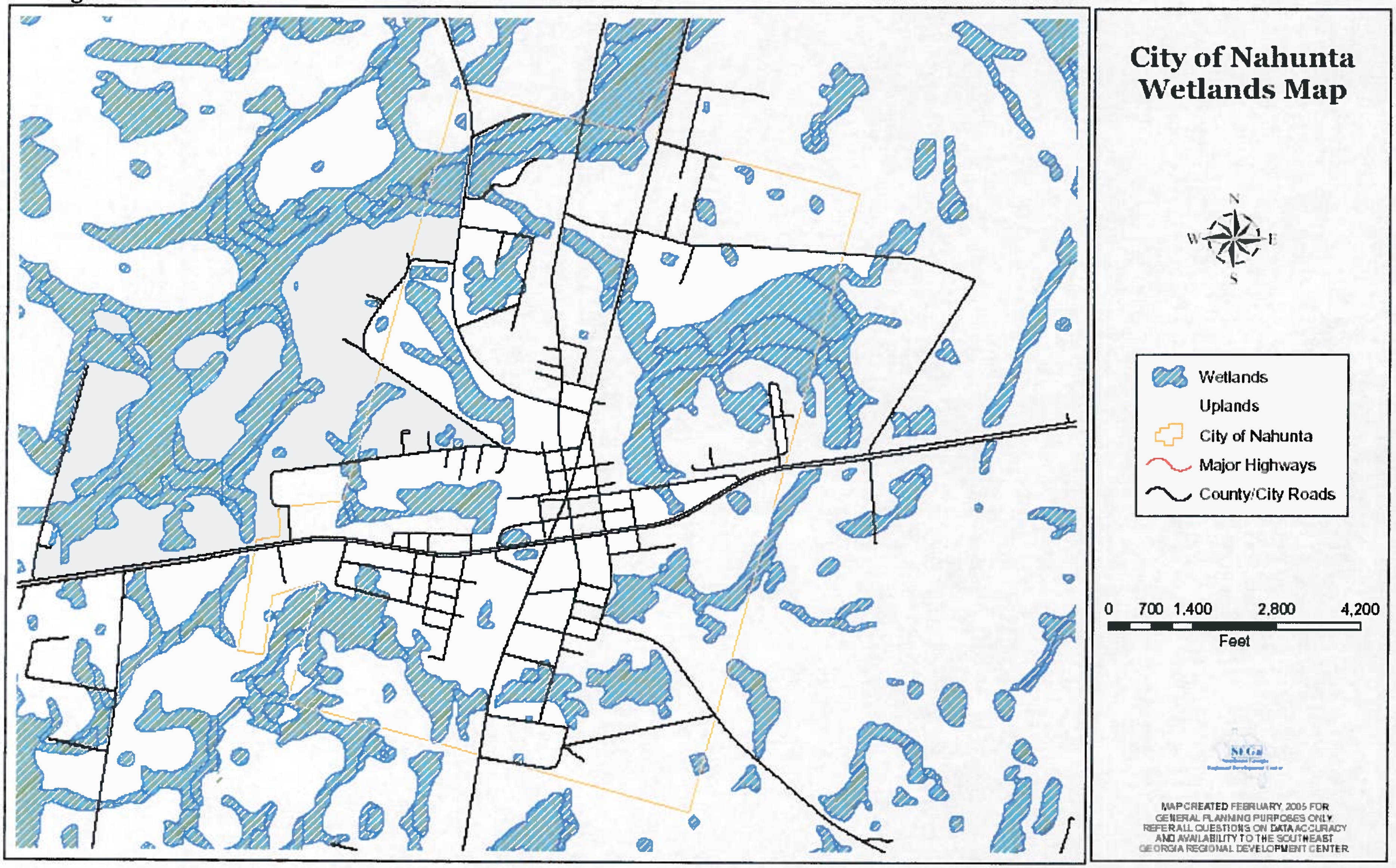
Wetlands
Uplands
City of Hoboken
Major Highways
County/City Roads
0 500 1,000 2,000 3,000
Feet
MAP CREATED FEBRUARY, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

Figure 13


City of Nahunta
Wetlands Map
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Wetlands
Uplands
City of Nahunta
Major Highways
County/City Roads
0
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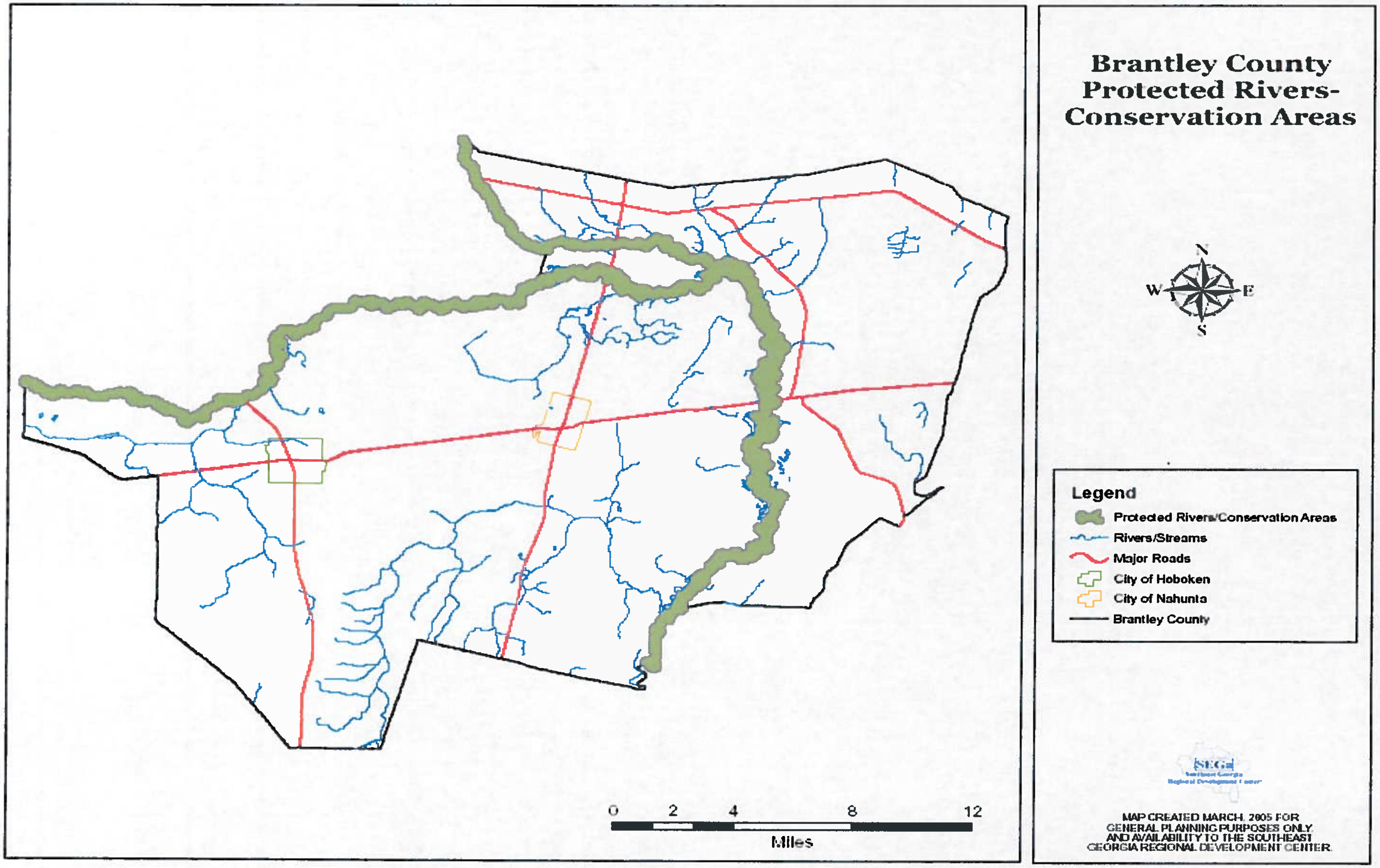
1,400
2,800
4,200
Feet
MAP CREATED FEBRUARY, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

Figure 14


Brantley County
Protected Rivers-
Conservation Areas
N
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Legend
Protected Rivers/Conservation Areas
Rivers/Streams
Major Roads
City of Hoboken
City of Nahunta
Brantley County
0
2
4
8
12
Miles
MAP CREATED MARCH, 2005 FOR
GENERAL PLANNING PURPOSES ONLY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

Protected Mountains

A protected mountain is defined as all land area 2,200 feet or more above mean sea level that has a percentage slope of 25% or greater for at least 500 feet horizontally. It also includes crests, summits, and ridge tops which lie at elevations higher than any such area. DNR Rule 391-3-16-.05(4)(l) prohibits the development of new solid waste landfills in areas designated as protected mountains. Brantley County has no area designated as protected mountains.

Criteria for Siting a landfill

Zoning. Requires that the site of a landfill must conform to all local zoning/land use ordinances and that written verification of such be submitted to EPD. (DNR Rule 391-3-16-.05(1)(a).

Airport Safety. This requires that new solid waste landfill units or lateral expansions of existing units shall not be within 10,000 feet of any public use or private use airport runway end used by turbojet aircraft or within 5,000 feet of any public use or private use airport runway end used by only piston type aircraft. (DNR Rule 391-3-4-.05(1)(c)).

Flood Plains. No solid waste facility located in the 100-year-flood plain shall not restrict the flow of the 100-year-flood, reduce the temporary water storage capacity of the flood plain, or result in a washout of solid waste as to pose a threat to human health or the environment. (DNR Rule 391-3-4-.05(1)(d)). **Figures 15 through 17** depict flood plains for the county and cities.

No inert, construction & demolition (C&D), municipal solid waste (MSW; lined; Subtitle D), C&D recycling center, MSW transfer station, or other waste-handling facility, or any surface or subsurface mining operation for minerals, sands, soils, or other earthlike-products, shall be sited within the 100-year floodplain of any creek or river in Brantley County, including but not limited to the Satilla River, Little Satilla River, Big Satilla Creek, Turtle River and all of their tributaries. These restrictions shall further apply to a 100' buffer upgrade of the 100 year floodplain, measured upgrade starting at the statistical elevation of such floodplain extent, without regard to land cover or existing use or zoning. These restrictions, including the buffer restrictions, shall further apply to all jurisdictional and non-jurisdictional wetlands ("flowing" and "non-flowing", "connected" and "non-connected/isolated", "depressional" and "linear" wetlands) under the Federal Clean Water Act, as defined by standard procedures used by the delegated authorities under the Act, for soil type and vegetation.

There shall be no additional permanent structures built in the 100-year floodplain of all wetlands, streams, creeks, and rivers within Brantley County, with explicit exceptions. Exceptions: ramp and (permeable) parking structures directly related to boating access, facilities for primitive, hike- or bike-in camping (pads for tents and lean-tos, no electricity, no running water, no restroom facilities, no parking facilities), access for nature-based education and tourism (boardwalks, outdoor classroom/assembly areas, canoe/kayak storage racks, boating equipment lockers, seating), hunting and fishing (game and fish-cleaning stations), and day-use (picnicking, swimming, but not food preparation other than that related to camping and picnicking). Specifically excluded from what we are recommending to allow are: dwellings, residences, offices, warehouses, manufacturing facilities, warehouse facilities, retail operations, concession stands or structures for retail operations, docks, riverside pavilions, docks, decks, roadways, culverts, parking areas, and like structures.

In the 100-year floodplain, best available technologies for saw-timber and fiber-timber culture may be practiced, however, fertilizers and herbicides may not be used, and a 100' natural vegetated buffer must be maintained around all wrested and depressional river channels, creek channels, slough channels, dead lake channels, ponded areas, cypress heads, and like formations.

Soil Suitability No solid waste management facility may be located in any area of unsuitable soil types. . In addition, no solid waste management facility may be located in any area identified as "Probable areas of thick soils" as these may be significant recharge areas. The general soil map for Brantley County is **Figure 18 through 20**

BRANTLEY COUNTY SOIL ASSOCIATIONS

BROOKMAN-BLADEN-POOLER (GA070) consists of a mixture of very deep, very poorly drained, slowly permeable soils; fine sandy loam poorly drained; and very deep, poorly drained, slowly permeable soils that formed in beds of marine sediments, dominantly sandy clays and clay, on flats and in depressions of the lower Coastal Plains.

LEEFIELD-PELHAM-IRVINGTON (GA065) consists of a mixture of very deep, somewhat poorly drained, moderately slowly to slowly permeable soils on the uplands of the Coastal Plain; very deep, poorly drained, moderately permeable soils; and moderately well drained, slowly permeable soils on nearly level to gently sloping uplands.

LEON-CHIPLEY-ELLABELLE (GA075) consists of a mixture of very deep, moderate to moderately slowly permeable, poorly and very poorly drained soils on upland flats, depressions, stream terraces, and tidal areas; very deep, somewhat poorly drained, very rapid or rapidly permeable soils on uplands in the lower Coastal Plain; and deep, very poorly drained soils of Coastal Plain depressions and drains. These soils have black loamy sand.

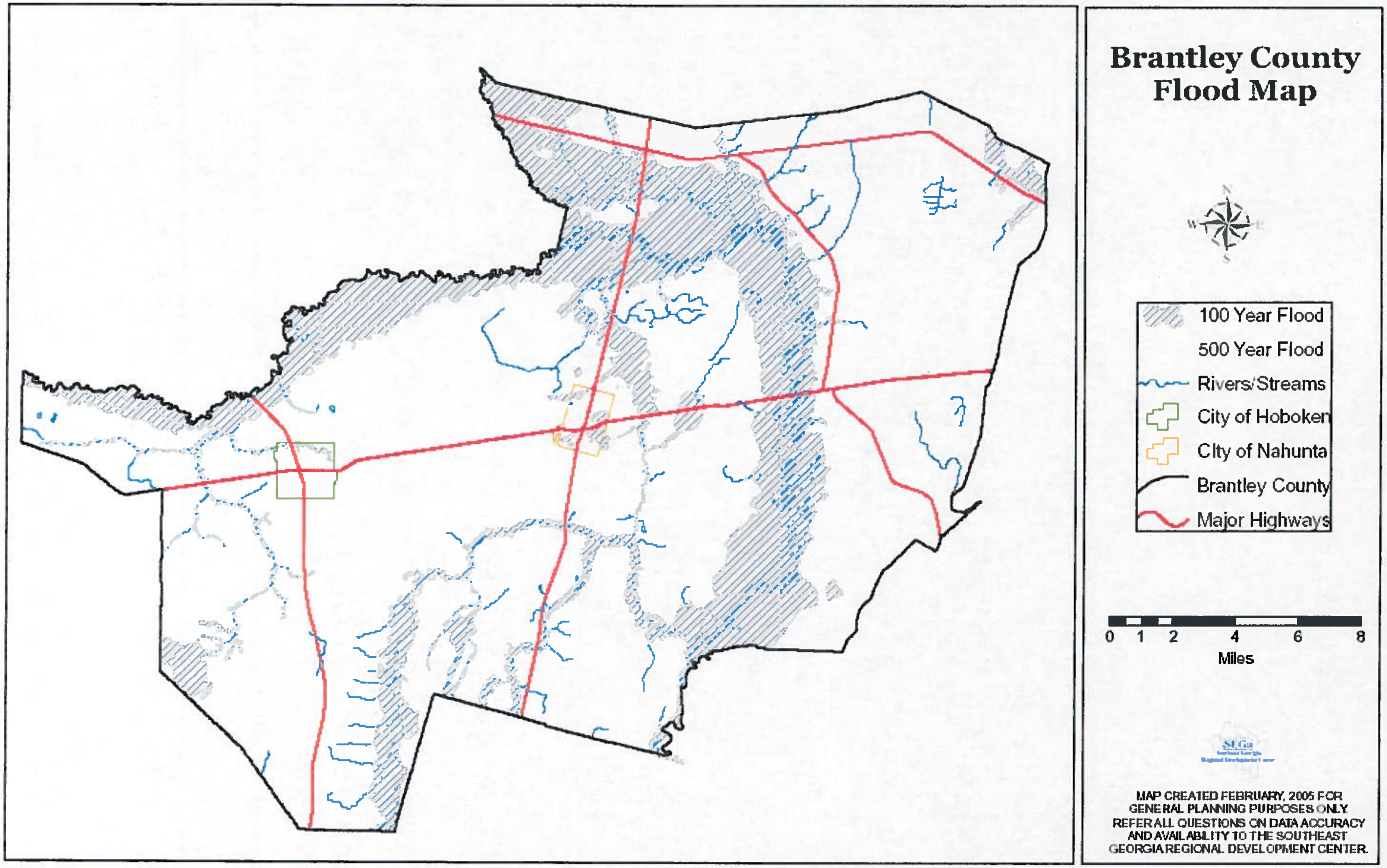
MANDARIN-RUTLEGE-LEON (GA068) consists of a mixture of very deep, somewhat poorly drained moderately permeable in the lower coastal plain; very deep, rapid permeability; lower and middle coastal plain and in flats, depressions, flood plains; and very deep, moderate to moderately slowly permeable, poorly and very poorly drained soils on upland flats, depressions, stream terraces, and tidal areas.

OSIER-OUSLEY-ELLABELLE (GA073) consists of a mixture of very deep, poorly drained, rapidly permeable soils on flood plains or low stream terraces; very deep, somewhat poorly drained, rapidly permeable soils on terraces and flood plains of the Coastal Plain; and deep, very poorly drained soils of Coastal Plain depressions and drains. These soils have black loamy sand.

PLUMMER-PAMLICO-CROATAN (GA079) consists of a mixture of very deep poorly and very poorly drained soil, moderate permeability, occurring in lower to upper coastal plain flats and depressions; very poorly drained underlain by dominantly sandy sediment on nearly level flood plains, bays, and depressions of the Coastal Plain; very poorly drained, organic soils underlain by loamy textured marine and fluvial sediment on the lower and middle Coastal Plain.

SATILLA-KINGSLAND-WATER (GA080) consists of a mixture of very poorly drained, moderately permeable soils saturated in winter and early spring and un-diked areas are flooded frequently; very poorly drained organic soils on flood plains adjacent to streams flooded daily with tidal action and saturated continuously with rapid permeability; very deep, poorly drained, moderately permeable soils that formed in alluvium on floodplains.

Figure 15


Brantley County Flood Map
N
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E
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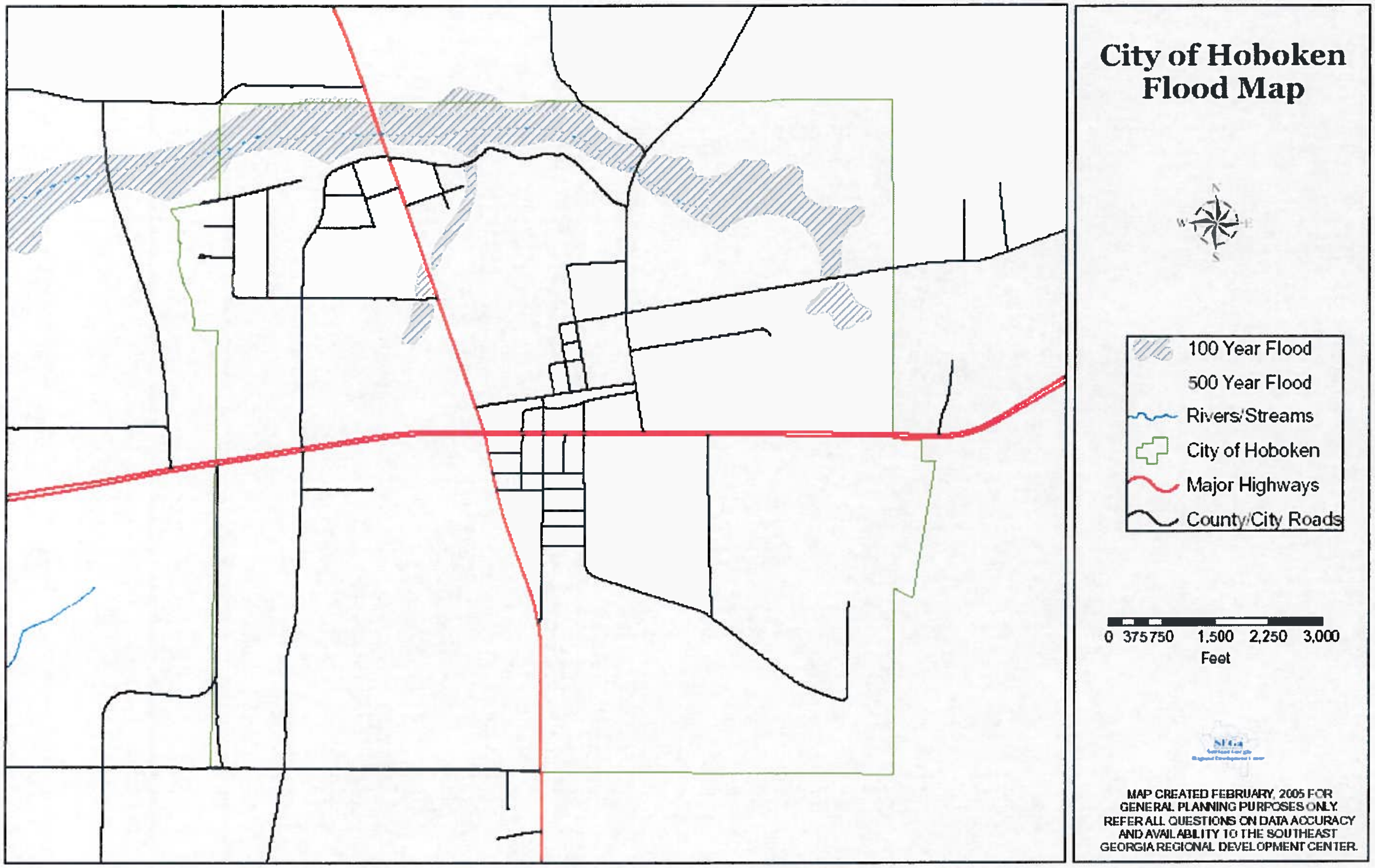
100 Year Flood
500 Year Flood
Rivers/Streams
City of Hoboken
City of Nahunta
Brantley County
Major Highways
0 1 2 4 6 8
Miles
MAP CREATED FEBRUARY, 2005 FOR GENERAL PLANNING PURPOSES ONLY. REFER ALL QUESTIONS ON DATA ACCURACY AND AVAILABILITY TO THE SOUTHEAST GEORGIA REGIONAL DEVELOPMENT CENTER.

Figure 16



City of Hoboken Flood Map
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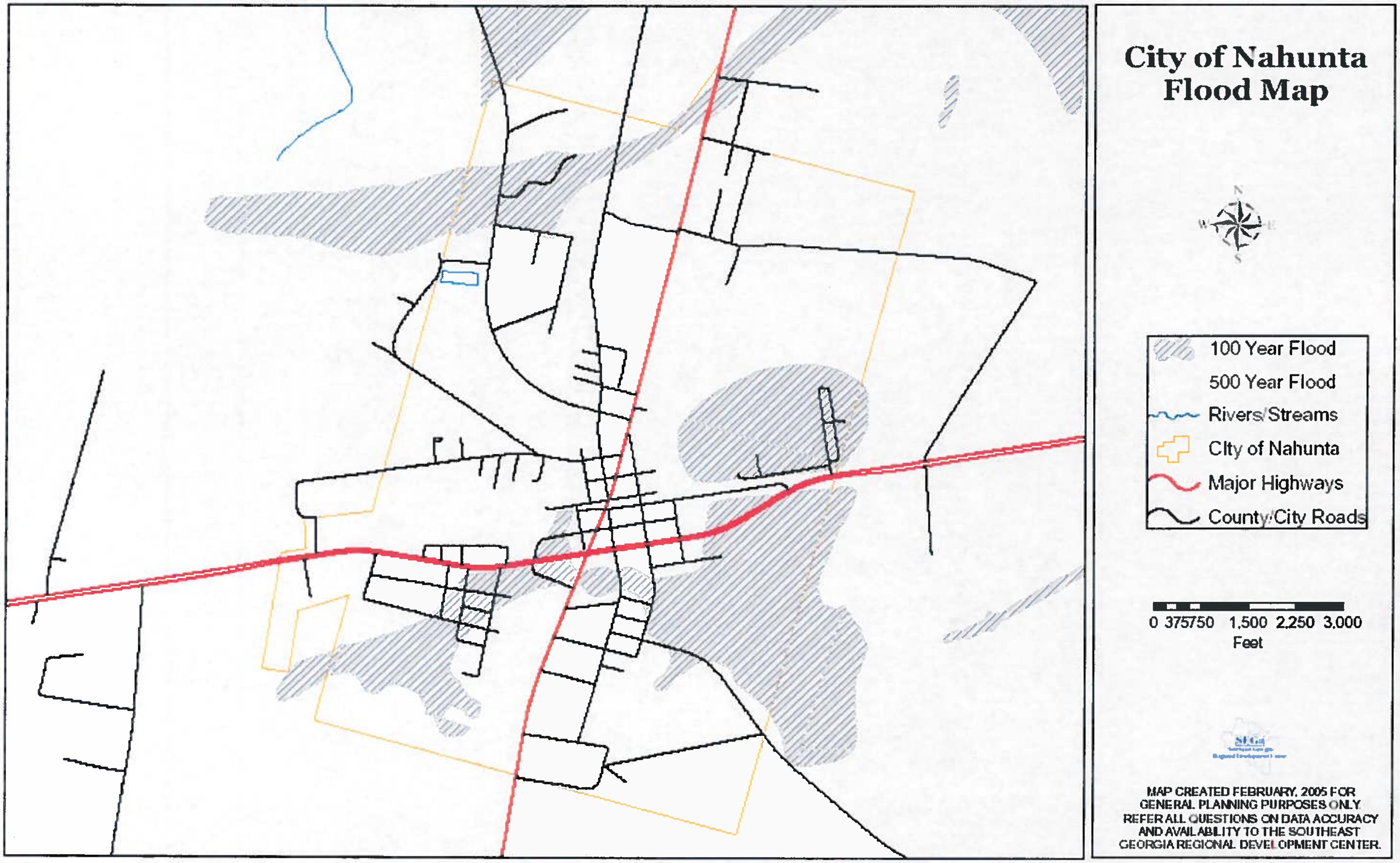
100 Year Flood
500 Year Flood
Rivers/Streams
City of Hoboken
Major Highways
County/City Roads
0 375 750 1,500 2,250 3,000
Feet
MAP CREATED FEBRUARY, 2005 FOR GENERAL PLANNING PURPOSES ONLY. REFER ALL QUESTIONS ON DATA ACCURACY AND AVAILABILITY TO THE SOUTHEAST GEORGIA REGIONAL DEVELOPMENT CENTER.

Figure 17


City of Nahunta
Flood Map
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100 Year Flood
500 Year Flood
Rivers/Streams
City of Nahunta
Major Highways
County/City Roads
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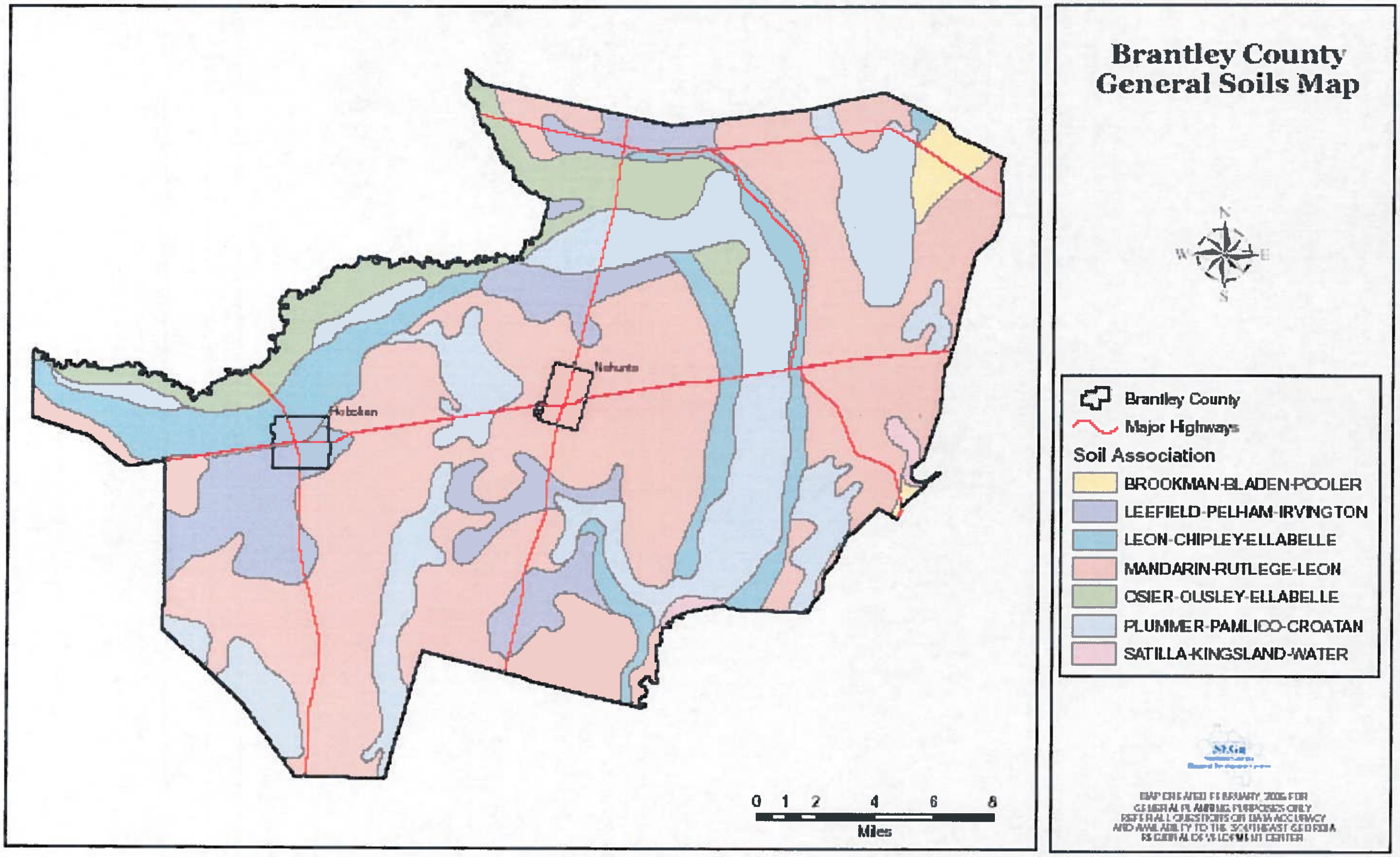
Feet
SEGa
MAP CREATED FEBRUARY, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

Figure 18



Brantley County General Soils Map
Nahunta
Hoboken
N
S
W
E
Brantley County
Major Highways
Soil Association
BROOKMAN-BLADEN-POOLER
LEEFIELD-PELHAM-IRVINGTON
LEON-CHIPLEY-ELLABELLE
MANDARIN-RUTLEGE-LEON
OSIER-OUSLEY-ELLABELLE
PLUMMER-PAMLICO-CROATAN
SATILLA-KINGSLAND-WATER
0 1 2 4 6 8
Miles

Figure 19

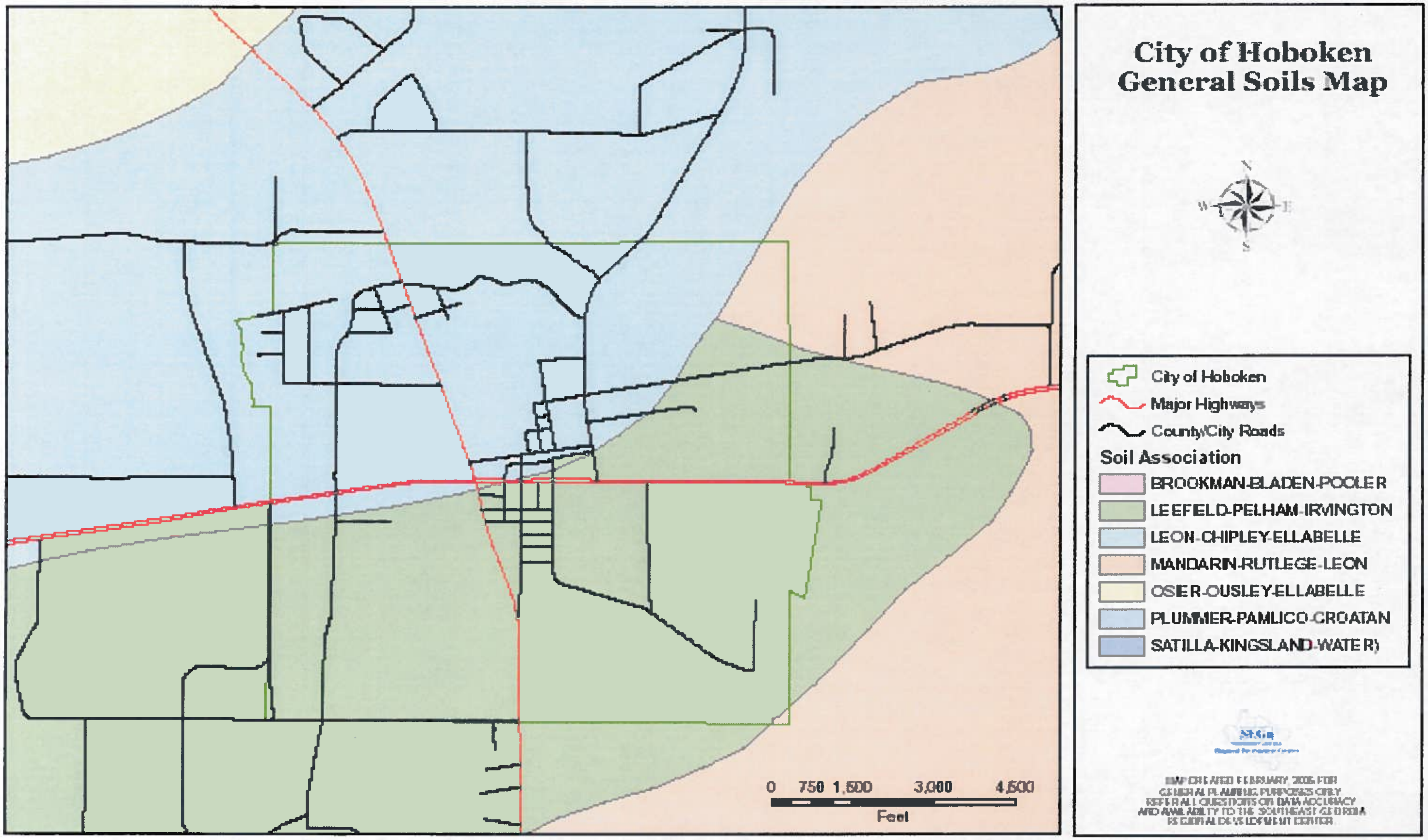
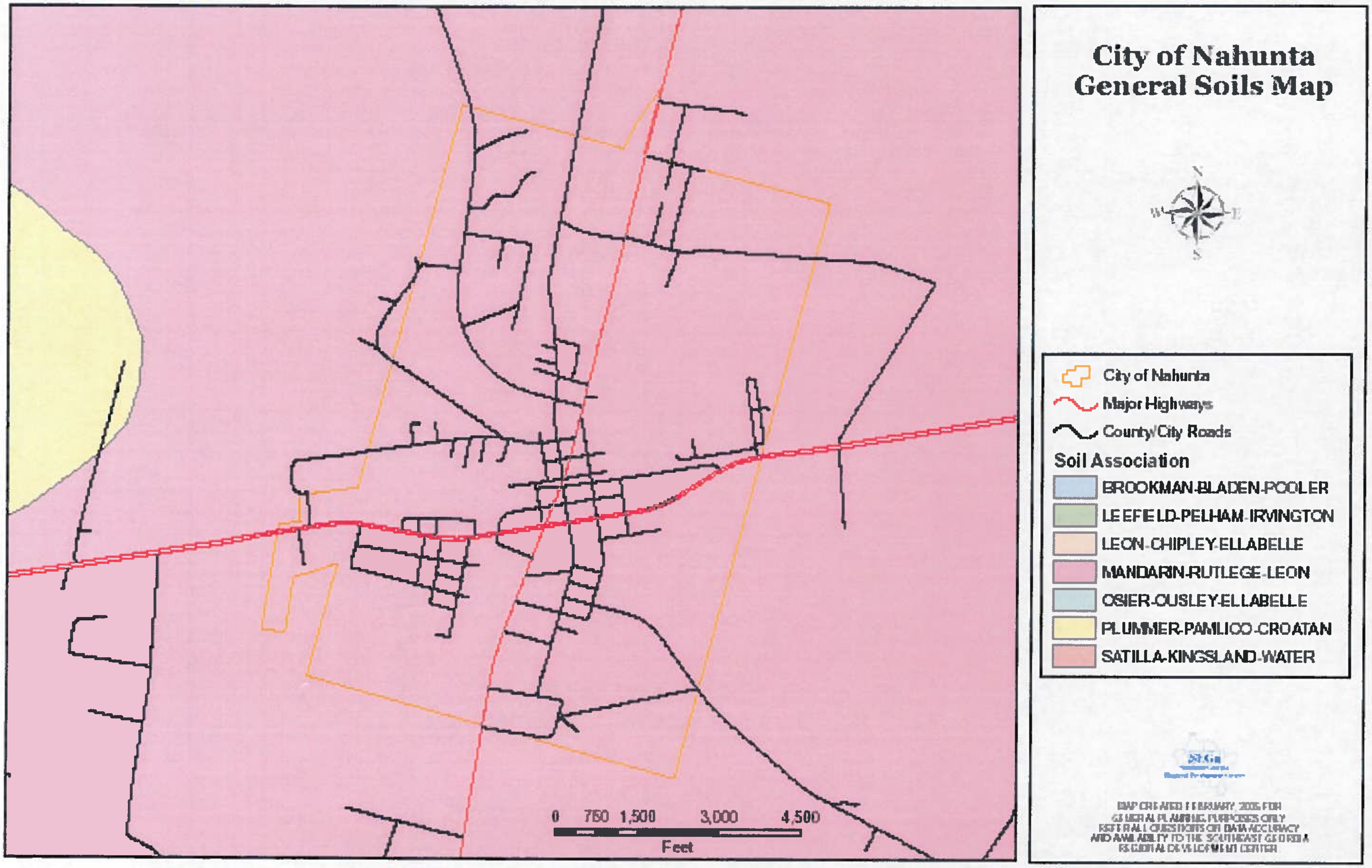

City of Hoboken
General Soils Map
N
W
E
S
City of Hoboken
Major Highways
County/City Roads
Soil Association
BROOKMAN-BLADEN-POOLER
LEEFIELD-PELHAM-IRVINGTON
LEON-CHIPLEY-ELLABELLE
MANDARIN-RUTLEGE-LEON
OSIER-OUSLEY-ELLABELLE
PLUMMER-PAMLICO-CROATAN
SATILLA-KINGSLAND-WATER
0 750 1,500 3,000 4,500
Feet

Figure 20


City of Nahunta
General Soils Map
N
S
W
E
City of Nahunta
Major Highways
County/City Roads
Soil Association
BROOKMAN-BLADEN-POOLER
LEEFIELD-PELHAM-IRVINGTON
LEON-CHIPLEY-ELLABELLE
MANDARIN-RUTLEGE-LEON
OSIER-OUSLEY-ELLABELLE
PLUMMER-PAMLICO-CROATAN
SATILLA-KINGSLAND-WATER
0 750 1,500 3,000 4,500
Feet

Fault Areas. New landfill units and lateral expansions of existing landfills shall not be located within 200 feet (60 meters) of a fault that has had displacement in Holocene time unless the owner or operator demonstrates to the Director that an alternative setback distance of less than 200 feet (60 meters) will prevent damage to the structural integrity of the landfill unit and will be protective of human health and the environment. (DNR Rule 391-3-4-.05(1)(f)

Seismic Impact Zones. New landfill units and lateral expansions shall not be located in seismic impacted zones, unless the owner or operator demonstrates to the County that all containment structures including liners, leachate collection systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. (DNR Rule 391-3-4-.05(1)(g)

Unstable Areas. Owners or operators of new landfill units, existing landfill units, and lateral expansions located in unstable areas must demonstrate that engineering measures have been incorporated in the landfill unit's design to ensure that the integrity of the structural components of the landfill unit will not be disrupted. (DNR Rule 391-3-4-.05(1)(h)

Hydrology. A hydrological site investigation shall be conducted with the following with the following factors at a minimum evaluated; nearest point to public or private drinking water supply: all public water supply wells or surface water intakes within two miles and private water supply wells within one-half mile of a landfill shall be identified, municipal solid waste landfills shall not be situated within two miles upgradient of any surface water intake for a public drinking water source unless liners, leachate collection system, and groundwater monitoring systems are provided.

Wetlands. DNR Rule 391-3-4-05(1)(e) prohibits the development of solid waste landfills in wetlands, as defined by the U.S. Army corps of Engineers, unless evidence is provided by the applicant to EPD that use of such wetlands has been permitted or otherwise authorized under all other applicable state and federal laws and rules.

All wetlands, semi-permanent streams, ephemeral springheads, perennial streams, rivers, other permanent flowing watercourses, and ephemeral streams shall be protected with a 100-foot vegetated buffer, experiencing minimal hand-thinning only, and no cutting of woody vegetation with DBH > 3". The functions of 25' of this buffer may be replaced with engineered grassy swales, rain gardens, sheet-flow absorption zones and other like-engineered structures as granted by governing authorities.

All wetlands should be protected from alteration of vegetation or hydrology, other than those activities designed and engineered to improve the values and functions of such areas.

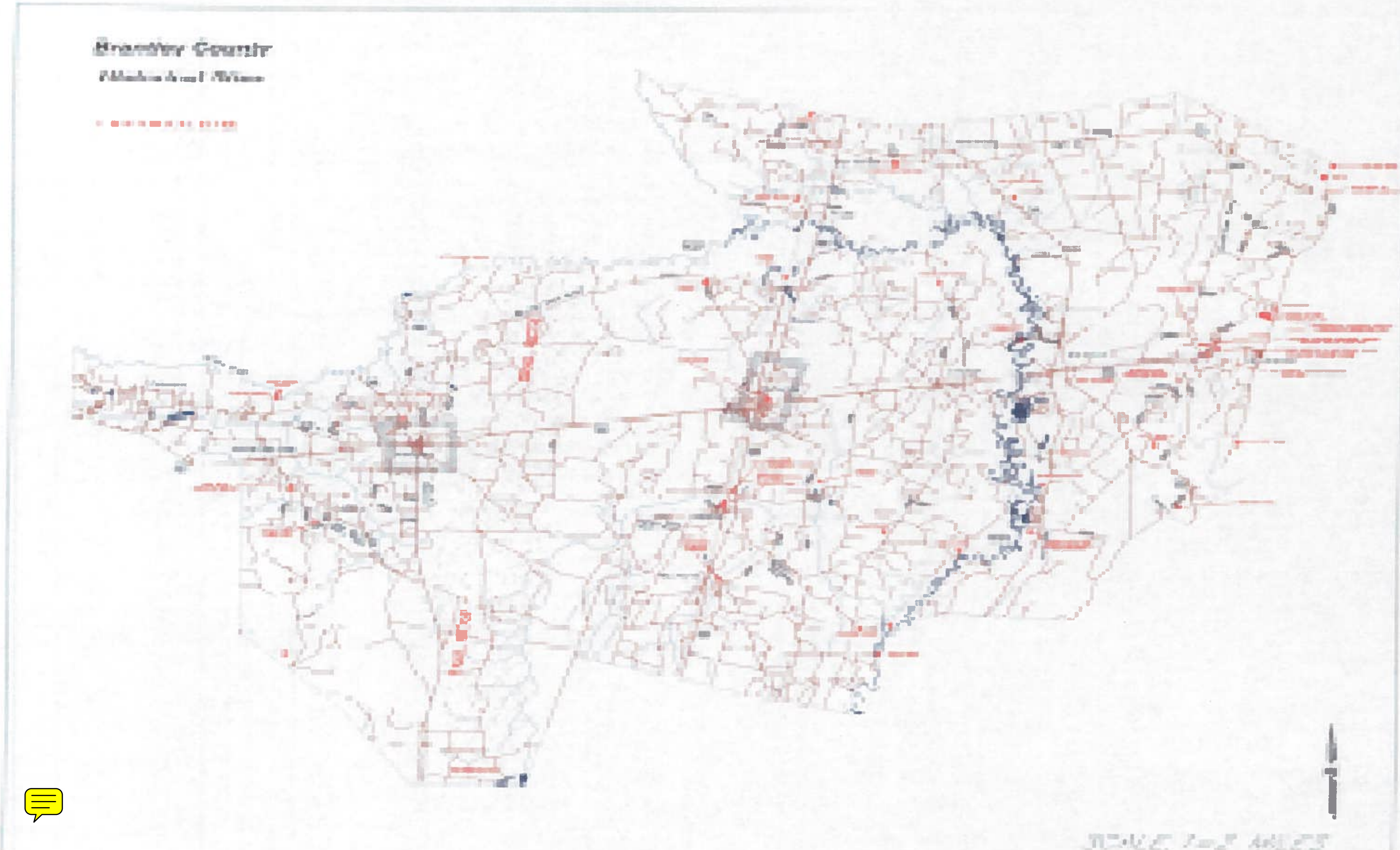
Proximity to National Historical Sites. Municipal solid waste landfills shall not be located within 5,078 yards of a National Historical Site.

Proximity to County Boundaries. Municipal solid waste landfills shall not be located within one-half (1/2) mile of a county boundary except when the governing authority of the adjoining county gives written approval.

Significant Groundwater Recharge Areas. DNR Rule 391-3-4-05(1)(j) requires new solid waste landfills or expansions of existing facilities within two miles of a significant groundwater recharge areas to have liners and leachate collection systems, with the exception of facilities accepting waste generated from outside the county in which the facility is located. In that case, the facility must be totally outside of any area designated as a significant groundwater recharge area.

Brantley County is in the process of adopting a Development Code or Zoning Ordinance, which will include the Cities of Hoboken and Nahunta. The County's proposed zoning ordinance addresses land uses in an effort to manage future growth. Additionally, in accordance with the Georgia Planning Act of 1989, the County has a Comprehensive Land Use Plan in place.

Figure 21



Required applicant actions relating to landfill siting. Applicants should always check with DNR and the local planning jurisdiction to verify procedures for siting solid waste management facilities that include but are not limited to the following:

(1) Disposal facility siting decision: DNR Rule 391-4-05-(1)(b) requires that whenever any applicant begins a process to select a site for a solid waste disposal facility, documentation demonstrating compliance with O.C.G.A.§ 12-8-26(a) be submitted to EPD; further, whenever any applicant takes action resulting in a siting decision for a publicly or privately owned solid waste disposal facility, documentation compliance with O.C.G.A.§ 12-8-26(b) be submitted to EPD

(II) Once a site has been selected, the applicant must conduct a Hydrological Assessment in accordance with the provisions of DNR Rule 391-4-05(1)(k). Preparation of the land limitation element of a solid waste management plan should comply with the Solid Waste Management (Chapter 391-3-4) relating to historic sites, airports, jurisdictional boundaries, access etc. These documents should be consulted for specifics on land limitations and siting of solid waste management facilities.

(III) If an applicant undertakes the Facilities Issues Negotiation Process pursuant to a facility siting decision, the process will be undertaken in accordance with O.C.G.A.§ 12-8-32 and any guidelines issued by the Department pursuant to State Law.

Plan Consistency

Suitable Site Location. The overall goal of the County and Cities is to insure that proposed solid waste handling facilities are in areas which are suitable for such developments, are compatible with surrounding uses, and are not considered for locations in areas which have been identified by the community or region as having environmental or other development or land use limitations. Therefore, no proposed facility or facility expansion will be sited in the planning area without a letter from the Governing entities (County and City) stating that the facility is consistent with the Solid Waste Management Plan.

To maintain consistency with the plan, the entity, which proposes to site a solid waste handling facility in the County, including within the City limits of Hoboken and Nahunta, must (1) pay a application fee of $500 and (2) must provide to the local government(s) at least 60 days prior to filing for a solid waste permit, or notifying EPD in the case of a solid waste handling facility that is permitted by rule, submit to the local governing entities (County and City) a written statement documenting the following:

- A method of notifying and involving the pubic in the process of consistency review. The applicant pursuing a permit for siting a landfill shall call a public meeting, placing an ad in the general circulation serving the municipality or county at least two weeks preceding the meeting, the ad shall state the time, place, and purpose of the meeting, provide written notice of the permit application to the governing bodies of each local government, request that the public notice be displayed prominently in the courthouse of the county and city halls of the municipalities

- A description of the anticipated impact the proposed facility will have upon the community; vehicle traffic and public safety around the proposed facility and throughout the planning area; financial impact to the financial viability of the existing solid waste management system within the planning area: impact to individual and business solid waste management rates; impact to other natural or cultural resources within the planning area and; impact to the current solid waste management infrastructure within the planning area, both public and private.
- An identification of the anticipated impact the proposed facility will have upon adequate collection and disposal capability within the planning area; and
- The effect the facility will have upon waste generated within the state achieving per capita waste disposal goal.
- How the owner/operator of the proposed facility will satisfy the financial assurance provisions of the solid waste plan.
- The Governing entities reserve the right to also require a Performance Bond for potential environmental liability.
- The Governing entities requires any entity whether public or private wishing to site a solid waste handling facility within the jurisdictional borders of Brantley County be constructed so as to only serve the disposal needs of said County.
- The Governing entities reserve the right to impose impact fees on the operation of any landfill located within their jurisdictional borders.

The Governing entities (County and City) shall review the Written Statement of Consistency and shall determine if the proposed facility or facility expansion is consistent with the Solid Waste Management Plan. Within 30 days of making their determination, the Board shall notify the developer whether or not the proposed facility or facility expansion is consistent with the Plan. If the proposed facility is not consistent with the Plan, the developer may address the inconsistencies and resubmit their request for another review.

In Public Hearings and public meetings, the citizens of Brantley County have overwhelmingly stated that the Satilla River must be protected, restored and preserved.

Our citizens are concerned that any landfill has the potential to harm the river and its environs. In the past, the county has banned all landfills.

Our goal is to mandate that any future landfill will be held to the highest federal, state and local standards and done in the public eye, so that we may participate in the permitting process and exercise our constitutional rights of stewardship.

See site suitability maps for Brantley County—**Figure 22-24.**

Figure 22

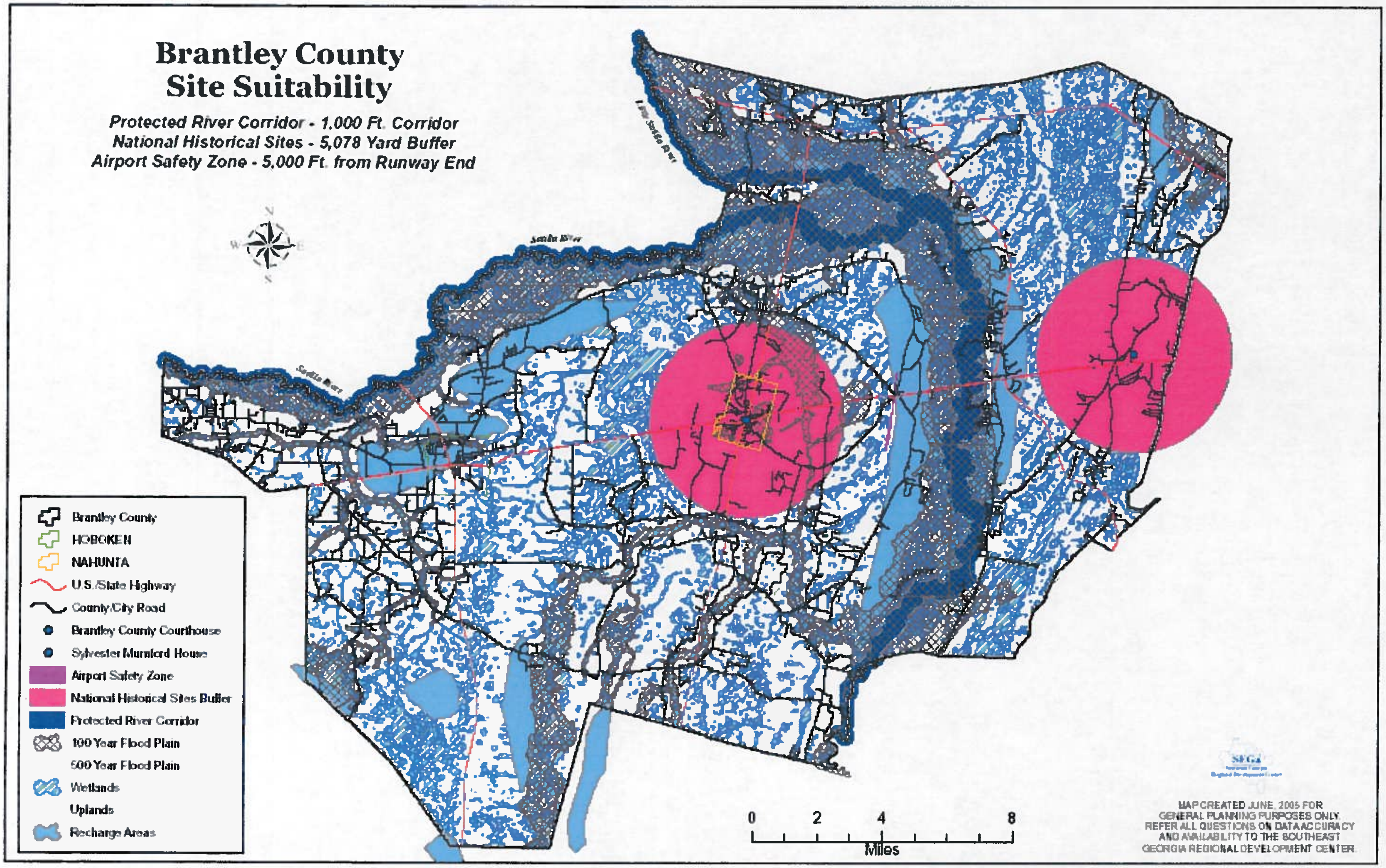
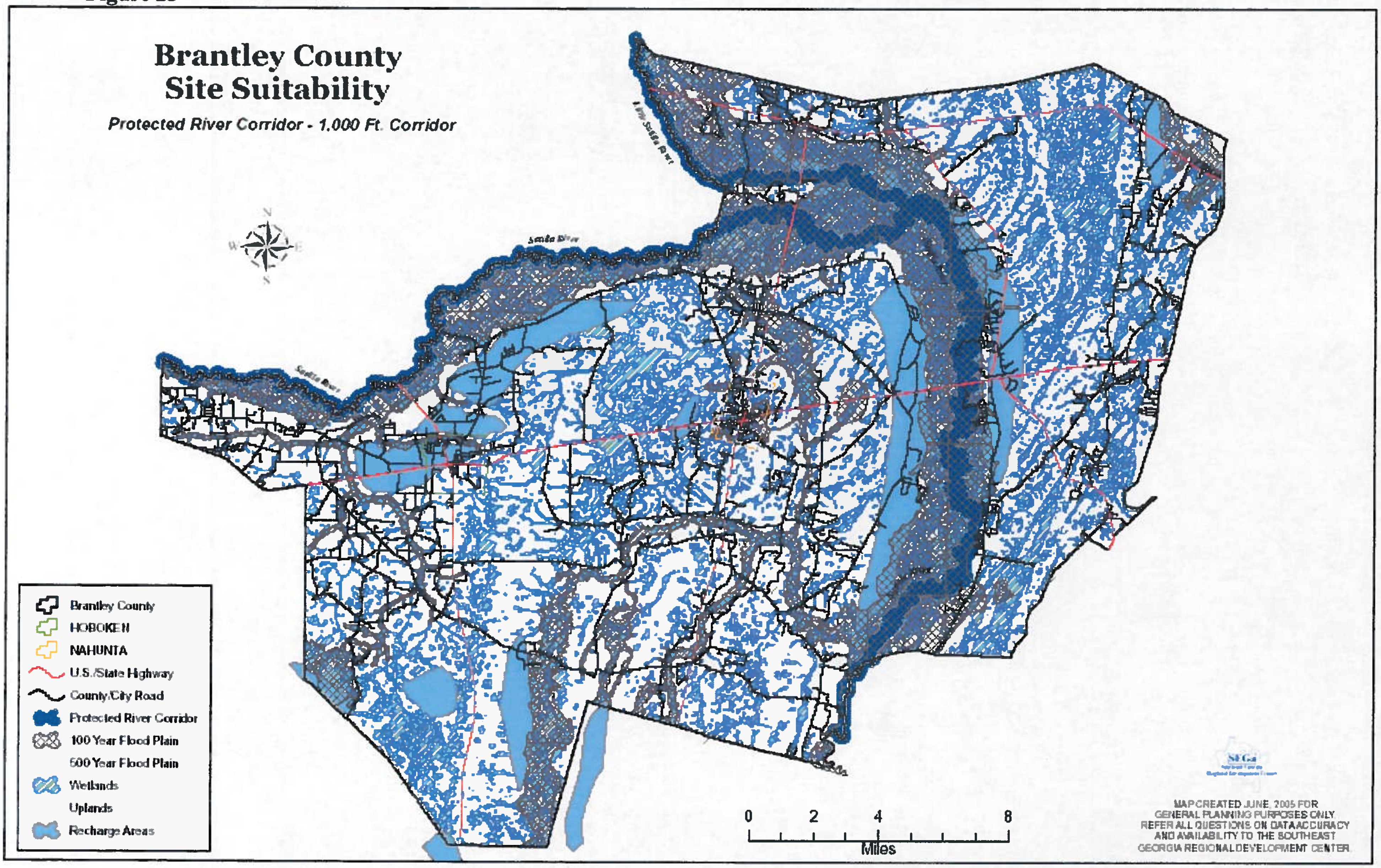

Brantley County
Site Suitability
Protected River Corridor - 1,000 Ft. Corridor
National Historical Sites - 5,078 Yard Buffer
Airport Safety Zone - 5,000 Ft. from Runway End
Brantley County
HOBOKEN
NAHUNTA
U.S./State Highway
County/City Road
Brantley County Courthouse
Sylvester Mumford House
Airport Safety Zone
National Historical Sites Buffer
Protected River Corridor
100 Year Flood Plain
500 Year Flood Plain
Wetlands
Uplands
Recharge Areas
0
2
4
8
Miles
MAP CREATED JUNE, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

Figure 23


Brantley County
Site Suitability
Protected River Corridor - 1,000 Ft. Corridor
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Brantley County
HOBOKEN
NAHUNTA
U.S./State Highway
County/City Road
Protected River Corridor
100 Year Flood Plain
500 Year Flood Plain
Wetlands
Uplands
Recharge Areas
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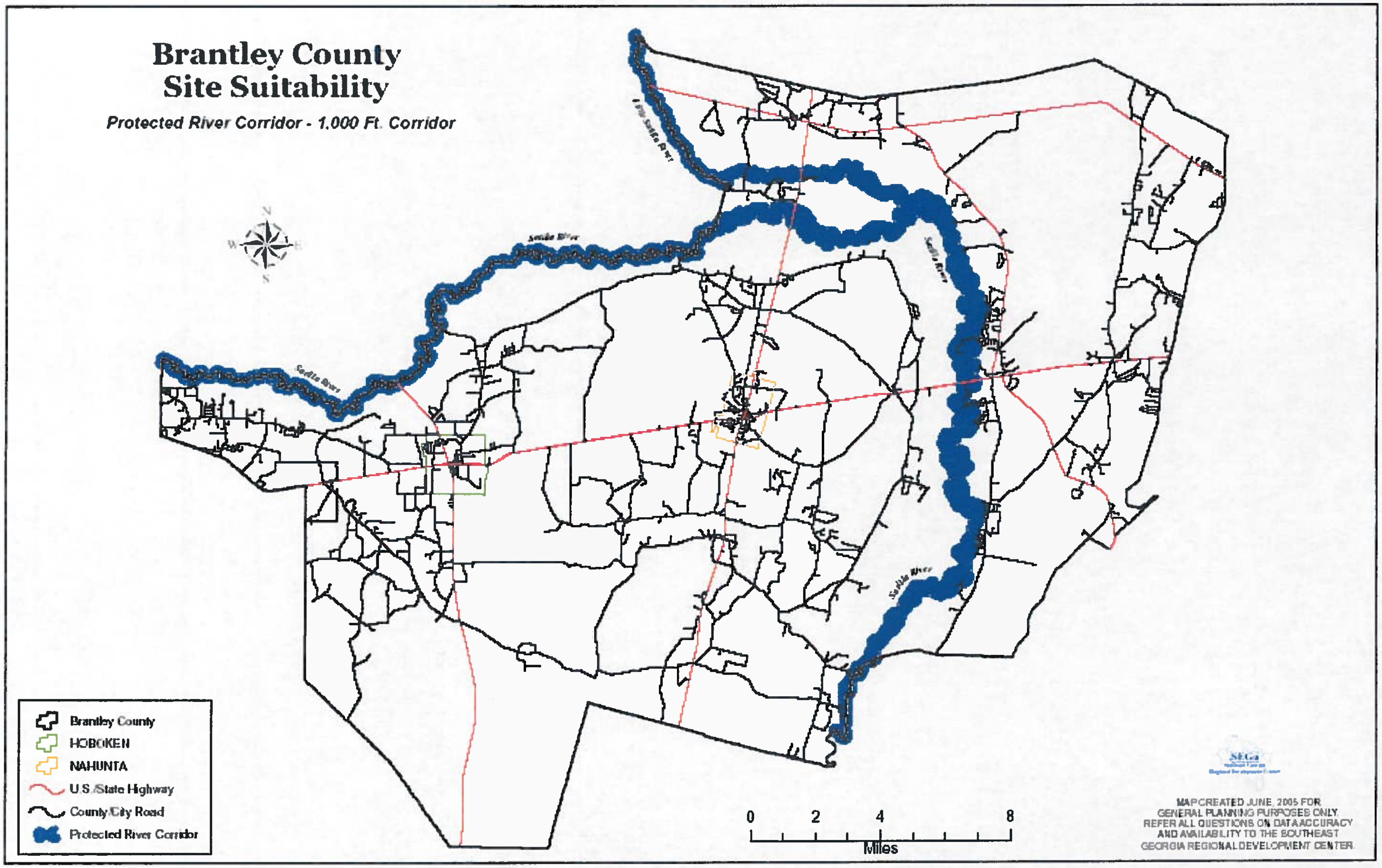
Miles
MAP CREATED JUNE, 2005 FOR
GENERAL PLANNING PURPOSES ONLY
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER

Figure 24


Brantley County
Site Suitability
Protected River Corridor - 1,000 Ft. Corridor
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Satilla River
Little Satilla River
Brantley County
HOBOKEN
NAHUNTA
U.S./State Highway
County/City Road
Protected River Corridor
0
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8
Miles
MAP CREATED JUNE, 2005 FOR
GENERAL PLANNING PURPOSES ONLY.
REFER ALL QUESTIONS ON DATA ACCURACY
AND AVAILABILITY TO THE SOUTHEAST
GEORGIA REGIONAL DEVELOPMENT CENTER.

SECTION VII: EDUCATION AND PUBLIC INVOLVEMENT ELEMENT

Introduction

A primary goal of this plan is to help the residents of Brantley County, Hoboken, and Nahunta achieve an awareness and understanding of the social and environmental issues, problems, concerns, and needs associated with solid waste and other waste management, especially in terms of littering, waste (source) reduction, recycling, composting, proper disposal of household hazardous wastes, processing, and to increase support for effective and safe waste management.

Inventory of Public Education and Involvement

Proposed/Projected Local Government Programs. There are currently only informal programs on solid waste management and related issues in the cities and in the county for public education and involvement. However, classroom-recycling materials are distributed in the elementary schools. Projected local programs, to be used throughout Brantley County, Hoboken, and Nahunta for waste reduction education, will rely heavily on "word of mouth" and on the various forms of the media because of the low-to-free cost of utilizing the press. Educational material on reducing, reusing and recycling waste can be published in the Brantley Enterprise, the Brantley Express, and the Waycross Journal-Herald newspapers, and possibly be distributed along with water, gas, and electric utility bills.

Public service announcements would be geared to highlight the three r's – reduce, reuse, and recycle- in addition to methods of disposal and the costs associated with each. The Georgia Municipal Association and the Association of County Commissioners in Georgia have public service announcement programs that can be utilized by the local governments. News articles and interviews about the progress of waste reduction to date, any Solid Waste Advisory Committee meetings, annual costs of waste management, new equipment purchases, new collection sites, advances in waste management and new collection opportunities for recyclables can be used periodically for general education.

Proposed Recycling Programs

- Collection of Christmas trees for chipping or other methods of disposal, with donated seedlings exchanged for each tree brought to the collection center;

- Recycling contests within the school system, to see which school can collect the greatest amount of recyclable and marketable items, with a yearly recycling award to the school with the highest collection rate;

- Exhibits and display boards in schools, public facilities, churches and businesses throughout Brantley County, Hoboken and Nahunta – constructed by students and/or 4-H Club members, highlighting source reduction, resource reuse, and recycling;

- Information booths, to be manned by volunteers or A Solid Waste Advisory Committee, at the Christmas parades, the county fair in Waycross, and periodically at the recycling centers.

- Earth Day/Earth Week activities. Churches, schools, civic clubs, and all residents will be encouraged to take part in special activities on environmental issues and recycling. The cities and county will coordinate activities and the local newspaper will be asked to give special promotional emphasis on Earth Day/Week activities.

- Awards Day. The county, in conjunction with the cities and civic groups, can use awards to encourage and promote waste reduction activities. A "waste reducer of the year" award can be presented to the business, school, or church that reduces the most to promote recycling and source reduction. Newspaper and radio coverage of such awards days and its winners will be instrumental in setting examples of what can be done and will act as a stimulus to others throughout the county.

The Brantley County Library can provide a section of its space for materials on recycling, composting, and waste reduction. Videos and printed brochures can be collected and made available at the library.

Solid Waste Advisory Committee. The original Solid Waste Advisory Committee was appointed by the local governments and had several volunteer members. The Committee acted, as an advisory committee to the Board of Commissioners and was responsible for developing and preparing the 1993 Multijurisdictional Solid Waste Management Plan for the County. Reactivating this committee would benefit Brantley County and its citizens in a number of ways. A Solid Waste Advisory Committee can coordinate volunteer-oriented programs like litter pickup and control, develop brochures for new businesses and residents on the waste management programs of the County, coordinate media announcements, civic and school programs, and local government programs. The Committee would act, as an advisory committee to the Board of Commissioners, and would assist the RDC with developing future updates and amendments to the county's solid waste plan. Any costs of the Committee will be offset by donation of supplies or materials as needed, or as funding allows, the local governments may fund expenses. The two municipalities and the county should appoint members to this Committee. The appointed members should actively seek volunteers. The participating governments should evaluate the number and composition of the group and other pertinent details.

Clean and Beautiful Program. There is currently no Clean and Beautiful Program in Brantley County, Hoboken, and Nahunta. Our goal is to develop such a program in conjunction with our Community of Pride organization in Nahunta or in connection with the "Neighbors Helping Neighbors" program in the County. The costs associated with this program will be raised through donations and local government contributions. A directory listing locations and names of businesses accepting recyclables should be developed and made available to the public. The directory could be printed in our local phone directory, county newspapers, and available at government and school offices.

School Programs. Coordinated with volunteers or through a Solid Waste Advisory Committee, the local government programs of recycling contests, waste reduction exhibits, and displays will be an integral part of the waste reduction educational program. Volunteers and teachers can coordinate the construction of the displays and exhibits, provide educational materials and discussions on the benefits of source reduction and other means of waste reduction, and encourage students to participate in recycling at school and at home. Teacher Assistance and Kids Web Pages on the EPD Pollution Assistance Division website can be of great assistance in developing environmental and recycling programs for children.

Projected programs include a countywide educational program for school-age children, which points out the benefits and achievability of reducing the amount of waste before it reaches the household garbage can. This reduction can be through source reduction, recycling, or reuse of waste resources; source reduction measures to be included in the program are buying less packaged items and not buying or using excessive items when less would perform the same task. The program will be developed with the assistance of local newspapers and civic clubs, and will be incorporated into the school curriculum as suggested by each school system. Projected costs include approximately $300 for printing costs, with the rest of the costs of the program absorbed by volunteer time, labor and supplies.

Cooperative Extension Service and 4-H Clubs. The Extension Service can provide educational assistance to a Solid Waste Advisory Committee in areas of composting and recycling. The extension agents can be responsible for public education in some areas because they have the essential tools, networks, and supportive services to administer some aspects proposed in this plan. The Cooperative Extension Service is expected to play a large role in education and will assist in the countywide programs.

Litter Control Program. The county has developed and will continue to expand a litter control program to enhance the appearance of the community and to protect the environment by removing pollutants that pose a threat to local streams and the Satilla River.

Brantley County contracts with the Georgia Department of Corrections to provide litter pick up along the highway right-of-ways in the county.

In addition, Brantley County works with several non-profit organizations to conduct litter clean-up events for area roads and the Satilla River. The Brantley County Chamber of Commerce sponsors an annual clean-up day in April of each year, and volunteers select a particular road right of way to collect litter. Several regional organizations organize an annual Satilla River clean-up day. The Satilla River keeper is instrumental in assisting with clean-up efforts of the Satilla River basin. The litter control program and these volunteer clean-up events are all key components of the county's litter control efforts.

The "Adopt a Highway" program of the Georgia Department of Transportation should be advertised more and civic and church groups should be encouraged to participate.

Other Goals and Needs

a. Participate in Georgia Municipal Association's and in the Association of County Commission Governments' programs designed to give cities and counties the opportunity to record public service announcements about environmental issues.

b. Work with the Georgia Recycling Coordinator to identify recycling projects that the County can participate in and to identify educational activities for its residents on environmental issues.

c. Continue to coordinate programs with the Satilla Riverkeeper, the Georgia Farm Bureau, Extension Service, the Chamber of Commerce, the school system, and other organizations as they are identified.

d. Publicize a reduction goal in disposal of waste at landfills in Georgia;

e. Solicit volunteers to research recycling options and markets and develop a brochure on recycling activities for the residents and newcomers to the communities.

f. Support community wide and school clean up of roadsides, clean up of the Satilla River, and other clean-up programs (like clean up of vacant or abandoned lots) to encourage civic involvement in waste management.

g. Encourage active public participation in the County's waste planning and regulations.

SECTION VIII: IMPLEMENTATION STRATEGIES, SCHEDULE

Implementation Plan

Brantley County and its municipalities currently meet the requirements of the solid waste planning rules of the Georgia Department of Community Affairs, and they anticipate that they will continue to do so over the next ten years of the planning period. The County has identified goals and voluntary goals and objectives for solid waste management over the next ten years.

Collection

Assessment of Implementation Strategy for Collection. The Implementation Strategy for Collection is adequate to meet the collection responsibilities of the county and its two municipalities for at least ten years. Brantley County and its municipalities will continue with its existing collection systems, while continuing to examine the efficiency and effectiveness of handling its collection services. The County and municipalities will review their collection systems during the planning period and will continue to budget for these collection methods currently in existence.

Assessment of Implementation of Contingency Collection Strategy. The contingent strategy for both the cities and the county appear to be adequate to address most contingencies that may occur. In the event of a natural disaster or other major event that the current contingent strategy will not handle, the County will open up areas around the green box collection sites throughout the county and open up the site at the Transfer Station where residents may haul and drop-off excess waste. When the additional waste is capable of being hauled away to a proper disposal facility, it will be collected, hauled, and disposed according to existing guidelines and procedures.

Waste Reduction

Assessment of Implementation Strategy for Waste Reduction. The governments involved in this Plan have decided to reduce the waste by voluntary source reduction and recycling programs in conjunction with voluntary back-yard composting operations.

A construction and demolition waste landfill has been considered for untreated wood, bricks, wallboard, concrete, and inert waste, from repair, remodeling, and new construction and from demolition operations reducing the quantity of waste disposed at a Solid Waste Subtitle D Landfill. Currently the County plans to continue to require building contractors and large quantity generators to contract with private contractors for disposal of their C&D waste at a permitted facility outside the County or they must self-haul to a permitted C&D Landfill or Subtitle D Landfill at a location outside of the County. The implementation strategy for waste reduction is adequate to meet waste reduction goals of the County during the planning period.

Disposal Element

Assessment of Implementation Strategy of Disposal. The Implementation Strategy for disposal is adequate to meet disposal needs of the county and its municipalities for at least ten years.

Land Limitation Element

Assessment of Land Limitation Implementation Strategy. Brantley County and its municipalities are somewhat limited in suitability for siting solid waste management facilities. The health, safety and welfare of the people of Brantley County is an important part of protecting the natural resources in the County and its municipalities. The implementation strategy for the land limitation element should be adequate for the planning period.

Education and Public Involvement

Assessment of Education and Public Involvement Implementation Strategy. While the County does have several programs and plans to involve the public and to distribute educational materials to its residents, Brantley County should examine the availability of other public education resources in the region and in the state. In order to implement many of the strategies in this plan, public assistance will be necessary, and the lack of public involvement and public apathy will be a hindrance. The success of recycling and waste reduction programs, in particular, depend on educating the residents and businesses and depend on involving them in the process. Residents, throughout the planning process, have expressed keen interests in recycling, litter control, illegal dumping, and regulation of disposal facilities, and public involvement in implementing this plan should be strongly encouraged.

The implementation strategy is adequate to meet the County's goals during the planning period.

Short-Term Work Program Schedule

The Implementation Strategy for each local government under this Plan is set out on the Implementation Schedule shown in the proposed activities to meet the goals of the Plan are outlined on this Schedule.

County emergency response teams turn out in force to honor retiring Forestry chief ranger .... Page 3

THE BRANTLEY Enterprise

Serving Brantley County since 1920 IT'S ALL ABOUT YOU!

THURSDAY, APR 2005 • VOL 85 • NO 14 • ONE SECTION • • AN INDEPENDENT NEWSPAPER

Public Hearing

Will be held at 6:00 PM on Friday, April 15, 2005 at the Brantley County Courthouse, 117 Brantley Street, Nahunta Georgia 31553 to invite public input and comment on the Brantley County, City of Hoboken, and City of Nahunta Joint Comprehensive and Solid Waste Management Plan.

The Brantley County Joint Comprehensive Plan is part of the regional planning process in which Regional Development Centers are required to participate by the Georgia Comprehensive Planning Act of 1989 to plan for the future of the cities and county for a twenty year term.

Persons with special needs relating to disability access or foreign language should contact Dale Halligan, Brantley County Clerk at (912) 462-5256. This person can be located at the Brantley County Commissioners Office, 117 Brantley Street, Nahunta Georgia, 31553 between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday, except holidays. Persons with hearing disabilities may consider using the Georgia Relay Service, at (Voice) 1-800-255-0135. All persons are invited to attend the Public Hearing. Community input is needed, welcomed and a vital componet of Community Planning. Hope to see you there. If you would like more information, please contact, Dale Halligan, Brantley County Clerk at (912) 462-5256.

l council OKs work schedule for employees, but mayor opposes

ity Council approved a
city workers this week
battle with mayor
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of federal highway.

• Heard a report from police chief Craig Pittman that the city's new police cruiser has been delivered, was having decals applied Monday and would be delivered to city hall Tuesday.

• Opened bids for a new computer system including one server and four workstations, but delayed action until some of the bids could be figured out.

There also was some question as to whether all vendors placed bids exactly as requested by the city.

• Considered an ordinance preventing parking along certain sections of Paloma and School Circle.

• Heard a report from Wilson that he has received a letter asking the city to have it budget complete by the end of May.

"What she's saying is we need to get on the stick," Chambless said.

"We were very late with our digest last year.

The council set a work session for May 12 at 4 p.m.

• Considered exploring the option of online banking after an offer from Southeastern Bank to send someone to set the system up on the city's computer system at no charge.

Chambless said the city should wait until its computer problems are solved before accepting the offer and the issue was table till a later meeting.

• Authorized overtime pay for employees to begin spraying for mosquitoes and gnats on Mondays, Wednesdays and Fridays.

• Authorized sending city clerk Donna Green to be certified as elections superintendent and assistant clerk Angela Wirth to be certified as registrar.

Green could not be certified as registrar because she does not live in

with the OREMC to work out a solution to the impasse.

• Tabled a decision on running water and sewer service to Jason Street for a $1,000 per house hookup fee. Councilman Michael Moore said the city needed a written agreement to prevent loss of revenue on the project and Wilson asked if the developer would sign a contract promising to place 10 houses there within four years.

City attorney Dan Smith said the city cannot borrow money for the project and would have to take the issue to the residents as a bond referendum unless it can secure a grant.

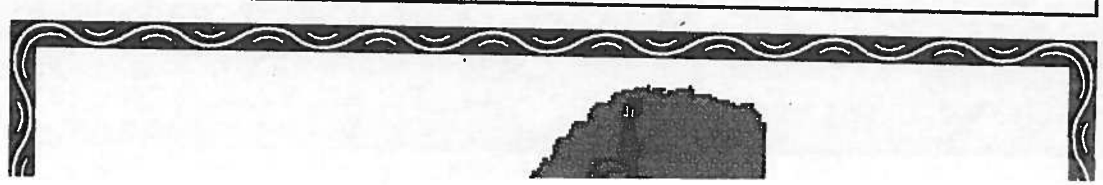
Solid Waste Public Hearing

Will be held at 4:00 PM on Monday May 9, 2005 at the Brantley County Courthouse, 117 Brantley Street, Nahunta Georgia 31553 to invite public input and comment on the Brantley County, City of Hoboken, and City of Nahunta Joint Comprehensive and Solid Waste Management Plan.

The Brantley County Solid Waste Management Plan is part of the regional planning process in which Regional Development Centers are required to participate by the Georgia Comprehensive Planning Act of 1989 to plan for the future of the cities and county for a twenty year term.

Persons with special needs relating to disability access or foreign language should contact Dale Halligan, Brantley County Clerk at (912) 462-5256. This person can be located at the Brantley County Commissioners Office, 117 Brantley Street, Nahunta Georgia, 31553 between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday, except holidays. Persons with hearing disabilities may consider using the Georgia Relay Service, at (Voice) 1-800-255-0135.

All persons are invited to attend the Public Hearing. Community input is needed, welcomed and a vital componet of Community Planning. Hope to see you there. If you would like more information, please contact, Dale Halligan, Brantley County Clerk at (912) 462-5256.
Please send Bill to: Sharon Caton, SEGa RDC, 1725 South Georgia Parkway, West, Waycross, GA 31503.



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criminals involved, rather than an innocent victim, might be in an early grave.

good. Lott cites cases where children as

A Public Hearing will be held at 6:00 PM on Thursday, March 3, 2005 at the Brantley County Courthouse, 117 Brantley Street, Nahunta Georgia 31553 to invite public input and comment on the Brantley County, City of Hoboken, and City of Nahunta. Joint Comprehensive and Solid Waste Management Plan.

The Brantley County Joint Comprehensive Plan is part of the regional planning process in which Regional Development Centers are required to participate by the Georgia Comprehensive Planning Act of 1989.

Persons with special needs relating to disability access or foreign language should contact Dale Halligan, Brantley County Clerk at (912) 462-5256. This person can be located at the Brantley County Commissioners Office, 117 Brantley Street, Nahunta Georgia, 31553 between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday, except holidays. Persons with hearing disabilities may consider using the Georgia Relay Service, at (Voice) 1-800-255-0135.

All persons are invited to attend the Public Hearing. Community input is needed, welcomed and a vital component of Community Planning. Hope to see you there. If you would like more information, please contact, Dale Halligan, Brantley County Clerk at (912) 462-5256.

ATKINSON COUNTY
Solid Waste Management Authority

OFFICE ADDRESS:
1000 Atkinson Blvd.
Willacoochee, GA 31650

Office: (912) 534-5972
Fax: (912) 534-5975
Email: swmaa@planttel.net

May 13, 2005

To: Chairman Terry Thomas and Commissioners
Brantley County Board of Commissioners
P.O. Box 398
Nahunta, Georgia 31533

Re: CERTIFICATION FOR CONTINGENT DISPOSAL CAPACITY AND PROJECTED LIFE OF ATNINSON COUNTY MSW LANDFILL

Dear Chairman Thomas and Commissioners:

This letter provides certification of the disposal capacity for the Atkinson County Landfill, Permit Number 002-009D (MSWL), located on U.S. Highway 82, near Willacoochee, Georgia.

As of July 6, 2004, the facility's estimated remaining capacity is calculated to be 248,823 cubic yards in the MSW landfill and 241,221 cubic yards in the C&D landfill. The estimated fill date is November, 2006 for the MSW and May 2009 for the C&D landfills. As Atkinson County is expecting the approval and opening of additional space at this site in the next six (6) months which will give 30 additional years of space at competitive rates. Assuming that the disposal rate from Brantley County's waste (which includes the municipalities of Hoboken and Nahunta) is approximately 30 tons per day (approximately 10,830 tons for 2004 with a gradual rate of increase for the next ten years), the disposal capacity of the Atkinson County MSW Landfill is sufficient to accept the estimated waste disposal quantities. Including Brantley County's waste stream plus waste already under contract for the next 25-30 years. Our landfill has the capacity to accept Brantley County's waste on a temporary contingent basis in the event your county's primary disposal facility is unable to take the waste due to some event or natural disaster.

We thank the Brantley County Board of Commissioners for considering the Atkinson County MSW Landfill for its disposal needs and please contact us if we can assist your County with providing environmentally sound waste disposal.

Sincerely,

R. Lamar Park

R. Lamar Park
S.W.M.A. Director for Atkinson County

WASTE MANAGEMENT

CHESSER ISLAND ROAD LANDFILL, INC.
P.O. Box 128
Highway 121 @ Chesser Island Road
Folkston, GA 31537
(912) 496-7918
(912) 496-1132 Fax

May 18, 2005

Chairman Terry Thomas and Commissioners
Brantley County Board of County Commissioners
Post Office Box 398
Nahunta, Georgia 31553

Re: **Certification for Disposal Capability and Capacity and Projected Life of Chesser Island Road Landfill, Folkston, Georgia**

Dear Chairman Thomas and Commissioners:

This letter provides certification of the disposal capability and capacity for the Chesser Island Road Landfill (CIRL), Permit Number 024-006D (SL), located on Charlton County Road Number 121, near Folkston, Georgia.

As of May 1, 2005, the facility's estimated remaining capacity is calculated to be 12.5 million cubic yards, and the remaining site life is 33 years. Assuming the disposal rate from Brantley County's waste (which includes Hoboken and Nahunta) is approximately 30-35 tons per day (approximately 10,830 to 12,000 tons annually), the disposal capacity of CIRL is sufficient to accept the estimated waste disposal quantities. Including Brantley County's waste stream, in addition to the waste stream currently under contract from other jurisdictions with our facility, the CIRL has sufficient disposal capacity to accept Brantley County's MSW, including bulky, commercial and C&D wastes, plus waste already under contract from other jurisdictions, for the next ten years.

We thank the Brantley County Board of Commissioners for considering CIRL for its disposal needs. We hope to continue to provide disposal for some of the waste from the two municipalities in Brantley County, and we have the capacity to provide disposal of all of Brantley County's waste for at least the next ten years, in the event you need to utilize our facility to serve all your county's waste disposal needs.

Sincerely,

Greg Mathes
Director of Landfill Operations

GM:lh

bcc: Janice M. / S.E. Ga. Reg. Devel Ctr

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Broadhurst
Environmental

P.O. Box 278
Screven, GA 31560
Phone: (912) 530-705
Fax: (912) 530-7070

May 18, 2005

City of Nahunta
Mayor Robert Wilson
Post Office Box 156
Nahunta, Georgia 31553

Re: CERTIFICATION FOR DISPOSAL CAPABILITY AND CAPACITY

Dear Mayor Robert Wilson:

This letter provides certification for the disposal capability and capacity of the Broadhurst Environmental Landfill, Permit Number: 151-014D(SL), located in Wayne County on Broadhurst Road West, Screven, Georgia.

As of May 1, 2005, the facility's estimated remaining capacity is calculated to be 12,000,000 cubic yards, and the estimated fill date is May, 2022. Assuming that the disposal rate from Brantley County's waste (which includes the municipalities of Hoboken and Nahunta) is approximately 30 to 35 tons per day (approximately 10,830 to 12,000 tons annually), the disposal capacity of the Broadhurst Environmental Landfill is sufficient to accept the estimated waste from Brantley County.

In addition, we have recently submitted a request to GA EPD for a horizontal expansion that will increase our total capacity by several million cubic yards.

We thank the Brantley County Board of Commissioners for using Broadhurst Environmental Landfill for its disposal needs. We hope to provide disposal for Brantley County's waste for the foreseeable future.

Sincerely,

John W. Simmons
General Manager

Broadhurst
Environmental

P.O. Box 278
Screven, GA 31560
Phone: (912) 530-705
Fax: (912) 530-7070

May 18, 2005

City of Hoboken
Mayor Charles H. Lee
Post Office Box 345
Hoboken, Georgia 31542

Re: CERTIFICATION FOR DISPOSAL CAPABILITY AND CAPACITY

Dear Mayor Charles H. Lee:

This letter provides certification for the disposal capability and capacity of the Broadhurst Environmental Landfill, Permit Number: 151-014D(SL), located in Wayne County on Broadhurst Road West, Screven, Georgia.

As of May 1, 2005, the facility's estimated remaining capacity is calculated to be 12,000,000 cubic yards, and the estimated fill date is May, 2022. Assuming that the disposal rate from Brantley County's waste (which includes the municipalities of Hoboken and Nahunta) is approximately 30 to 35 tons per day (approximately 10,830 to 12,000 tons annually), the disposal capacity of the Broadhurst Environmental Landfill is sufficient to accept the estimated waste from Brantley County.

In addition, we have recently submitted a request to GA EPD for a horizontal expansion that will increase our total capacity by several million cubic yards.

We thank the Brantley County Board of Commissioners for using Broadhurst Environmental Landfill for its disposal needs. We hope to provide disposal for Brantley County's waste for the foreseeable future.

Sincerely,

John W. Simmons
General Manager

Broadhurst

Environmental

P.O. Box 278
Screven, GA 31560
Phone: (912) 530-7050
Fax: (912) 530-7070

May 12, 2005

Terry Thomas, Chairman
Brantley County Board of Commissioners
Post Office Box 398
Nahunta, Georgia 31553

Re: CERTIFICATION FOR DISPOSAL CAPABILITY AND CAPACITY

Dear Chairman Thomas:

This letter provides certification for the disposal capability and capacity of the Broadhurst Environmental Landfill, Permit Number: 151-014D(SL), located in Wayne County on Broadhurst Road West, Screven, Georgia.

As of May 1, 2005, the facility's estimated remaining capacity is calculated to be 12,000,000 cubic yards, and the estimated fill date is May, 2022. Assuming that the disposal rate from Brantley County's waste (which includes the municipalities of Hoboken and Nahunta) is approximately 30 to 35 tons per day (approximately 10,830 to 12,000 tons annually), the disposal capacity of the Broadhurst Environmental Landfill is sufficient to accept the estimated waste from Brantley County.

In addition, we have recently submitted a request to GA EPD for a horizontal expansion that will increase our total capacity by several million cubic yards.

We thank the Brantley County Board of Commissioners for using Broadhurst Environmental Landfill for its disposal needs. We hope to provide disposal for Brantley County's waste for the foreseeable future.

Sincerely,

John W. Simmons
General Manager

A Resolution
of the
Brantley County Board of Commissioners

Adopting the
Brantley County Solid Waste Management Plan

WHEREAS Brantley County and the Cities of Hoboken and Nahunta jointly participated in the development and submission of their Solid Waste Management Plan, as required by the Georgia Solid Waste Management Planning Act of 1990; and

WHEREAS the Brantley County Solid Waste Management Plan, in compliance with the minimum Standards and Procedures of the Georgia Solid Waste Management Planning Act of 1990 has been reviewed by the Southeast Georgia Regional Development Center, forwarded to the Georgia Department of Community Affairs, and has been approved as being in compliance with the Solid Waste Management Planning Act;

THEREFORE the Brantley County Board of Commissioners does hereby authorize the adoption of the Brantley County Solid Waste Management Plan as submitted to and approved by the Georgia Department of Community Affairs, this 22 day of June, 2006.

On Behalf of the Brantley County Board of Commissioners

Terry Thomas

Terry Thomas, Chairman

Witnessed By

Dale J. Halligan

Dale Halligan/Brantley County Clerk

A Resolution
of the
City of Hoboken

Adopting the
Brantley County Solid Waste Management Plan

Whereas Brantley County and the Cities of Hoboken and Nahunta jointly participated in the development and submission of their Solid Waste Management Plan, as required by the Georgia Solid Waste Management Planning Act of 1990; and

Whereas the Brantley County Solid Waste Management Plan, in compliance with the minimum Standards and Procedures of the Georgia Solid Waste Management Planning Act of 1990 has been reviewed by the Southeast Georgia Regional Development Center, forwarded to the Georgia Department of Community Affairs, and has been approved as being in compliance with the Solid Waste Management Planning Act;

Therefore the City of Hoboken does hereby authorize the adoption of the Brantley County Solid Waste Management Plan as submitted To and approved by the Georgia Department of Community Affairs, this 6th day of June, 2006

On Behalf of the City of Hoboken

Charles H. Lee

Charles H. Lee, Mayor

Witnessed by

Linda Henderson

Linda Henderson, Hoboken City Clerk

A Resolution
of the
City of Nahunta

Adopting the
Brantley County Solid Waste Management Plan

WHEREAS Brantley County and the Cities of Hoboken and Nahunta jointly participated in the development and submission of their Solid Waste Management Plan, as required by the Georgia Solid Waste Management Planning Act of 1990; and

WHEREAS the Brantley County Solid Waste Management Plan, in compliance with the minimum Standards and Procedures of the Georgia Solid Waste Management Planning Act of 1990 has been reviewed by the Southeast Georgia Regional Development Center, forwarded to the Georgia Department of Community Affairs, and has been approved as being in compliance with the Solid Waste Management Planning Act;

THEREFORE the City of Nahunta does hereby authorize the adoption of the Brantley County Solid Waste Management Plan as submitted to and approved by the Georgia Department of Community Affairs, this 6 day of 5, 2006.

On Behalf of the City of Nahunta

Robert H Wilson

Robert Wilson, Mayor

Witnessed By

Donna Green, Nahunta City Clerk

Education and Public Involvement	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Responsible Agency	Annual Cost	Revenue Source
Continue improvement of anti-litter campaign	X	X	X	X	X	X	X	X	X	X	County and Cities	$200	Staff
Continue to encourage public participation in the waste programs through a combination of education and compliance programs and provide financial incentives as funding is available	X	X	X	X	X	X	X	X	X	X	County and Cities	$250	Staff
Continue to provide ways to increase knowledge of waste programs for new residents .	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	Staff
Continue to encourage active public involvement in waste planning and regulations	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	Staff
Continue to coordinate programs with Satilla River Keeper, Save Our Satilla, the Georgia Farm Bureau Chamber of Commerce to help with education and public participation in solid waste programs	X	X	X	X	X	X	X	X	X	X	County and Cities	N/A	Staff
Continue to work with law enforcement to control litter	X	X	X	X	X	X	X	X	X	X	County and Cities	N/A	Staff
Continue to educate residents on full cost of solid waste collection, disposal and reduction	X	X	X	X	X	X	X	X	X	X	County and Cities	$300	Staff

Collection	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Responsible Agency	Annual Cost	Revenue Source
Continue to maintain current equipment used in solid waste management and purchase additional equipment if needed	X	X	X	X	X	X	X	X	X	X	County	$6000	User fees
Continue to evaluate collection system for adequacy	X	X	X	X	X	X	X	X	X	X	County	$500	Staff
Continue to collect and dispose of tires	X	X	X	X	X	X	X	X	X	X	County	N/A	General funds and available grants
Continue to utilize inmate detail for collection and disposal	X	X	X	X	X	X	X	X	X	X	County	$1250	General funds and available grants
Continue to maintain contingency plan and evaluate periodically as needed	X	X	X	X	X	X	X	X	X	X	County	$125	General funds
Continue to collect and process yard waste at inert landfill	X	X	X	X	X	X	X	X	X	X	County/Cities	$5000	User fees
Continue to evaluate funding for County's solid waste collection program; identify additional sources for waste programs	X	X	X	X	X	X	X	X	X	X	County	$250	General funds
Continue to develop method and print forms for keeping accurate records of the volume of waste hauled from transfer station	X	X	X	X	X	X	X	X	X	X	County	$50	User fees
Continue to seek grants and other revenue for collection programs and equipment purchases	X	X	X	X	X	X	X	X	X	X	Cities	$1000	User fees, general funds
Continue examine needs of disabled and elderly residents with respect to collection of household waste and household hazardous waste	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds
Continue to create a county and city waste hauler policy to require private haulers to report solid waste volumes they collect and haul	X	X	X	X	X	X	X	X	X	X	County and Cities	$1000	General funds
Continue curbside collection of residential waste and review collection system annually	X	X	X	X	X	X	X	X	X	X	County and Cities	$2000	General funds

Waste Reduction	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Responsible Agency	Annual Cost	Revenue Source
Continue to review waste reduction annually	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds
Continue to pursue state waste reduction goals	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds
Continue to work with Georgia Recycling Coordinator to develop recycling in the county	X	X	X	X	X	X	X	X	X	X	County and Cities	$175	General funds
Continue to publicize locations where residents can self haul recyclables	X	X	X	X	X	X	X	X	X	X	County and Cities	$300	General funds
Continue to solicit public input on waste reduction	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds
Continue to divert white goods from waste stream and drop off sites for cardboard and newspaper	X	X	X	X	X	X	X	X	X	X	County and Cities	$500	General funds
Continue to encourage residents, businesses, schools and government agencies to practice source reduction	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds
Continue to develop plan to collect batteries, fence wire, hazardous waste	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds

Disposal	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Responsible Agency	Annual Cost	Revenue Source
Continue to use inert landfill	X	X	X	X	X	X	X	X	X	X	County and Cities	$5000	Staff
Continue to enforce illegal dumping and litter regulations	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	Staff

Land Limitation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Responsible Agency	Annual Cost	Revenue Source
Continue to monitor industry and business practices to minimize air, land and water pollution resulting from solid waste activities	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds
Adopt solid waste ordinance							X				County and Cities	N/A	General funds
Continue to evaluate disproportionate environmental impacts	X	X	X	X	X	X	X	X	X	X	County and Cities	$150	General funds
Continue to work on adoption of development code	X	X	X	X	X	X	X	X	X	X	County and Cities	$1000	General funds
Continue to enforce ordinances, natural environmental and land use limitation for siting solid waste facilities	X	X	X	X	X	X	X	X	X	X	County and Cities	$100	General funds

Activity	Status	Explanation
Collection Continue green box container collection system in County and in Nahunta and Hoboken until such time as County may resume collection program	Completed	Cities of Nahunta and Hoboken have curb side collection, and the county has adopted curbside collection along with a single site for large item collection since August 2010
Examine existing green box system and determine if changes are needed, such as redesigning sites, or adding green boxes if feasible	Completed	County no longer use green box system, has started curbside service since August 2010
Initiate drop-off sites for recyclables	Postponed	This is in pre-planning stage but with implementation of house to house collection recycling has been slowed.
Initiate a trial unstaffed collection site for recyclables including white goods and conduct feasibility study of consolidation of green box sites into 12 sites in County	No longer being considered	Collection site for recyclables has been set for the Smyrna Landfill and as mentioned above curbside service was initiated in August 2010 which eliminates the green box sites.
Continue to maintain current equipment used in solid waste management and purchase additional equipment if needed	Ongoing	
Continue to evaluate collection system for adequacy	Ongoing	Newly implemented curbside collection is working well, collection of large items and recyclables needs to continue to be evaluated
Prepare a ten-year capital improvement schedule for solid waste management purposes	Completed	
Continue to collect and dispose of tires	Ongoing	
Continue to utilize inmate detail for collection and disposal	Ongoing	
Maintain contingency plan and evaluate periodically as needed	Ongoing	
Continue to collect and process yard waste at inert landfill	Ongoing	

Activity	Status	Explanation
Continue curbside collection of residential waste and review collection system annually	Completed for first five years and continuing through next ten years.	Nahunta renewed contract with private collection company to continue door-to-door collection in 2009. Hoboken has door-to-door collection. County implemented door-to-door in August 2010
Evaluate funding for County's solid waste collection program; identify additional sources for waste programs	Ongoing	
Develop method and print forms for keeping accurate records of the volume of waste hauled form transfer station	Ongoing	
Study feasibility of city operated collection services	No longer being considered	County operation has been adopted
Continue to delegate collection form green boxes located in county	No longer being considered	County implemented door-to-door in August 2010
Seek grants and other revenue for collection programs and equipment purchases	Ongoing	
Seek grants or other funding to purchase knuckelboom truck to collect white goods and bulk items ad flat bed truck to assist in collection of bulky items and yard debris	Completed	Won this USDA Grant/loan but changed equipment to meet current needs
Examine needs of disabled and elderly residents with respect to collection of household waste and household hazardous waste	Ongoing	Curbside will assist disabled collection/hazardous waste is in planning-review stage
Create a county and city waste hauler policy to require private waste haulers to report solid waste volumes they collect and haul	Ongoing	Working with haulers to acquire reports
<u>Waste Reduction</u> Review waste reduction annually	Ongoing	Tracking waste stream through two vendors
Continue to pursue the State's waste reduction goals	Complete for first five years and underway for future years	
Work with Georgia Recycling Coordinator to develop recycling in the County	Ongoing	
Publicize locations where residents can self haul recyclables	Ongoing	
Seek grants or other funding sources to purchase a chipper	No longer being considered	No longer financially feasible

Activity	Status	Explanation
Solicit public input on waste reduction	Complete for first five years and underway for future years	
Solicit public and private sectors for promoting special waste reduction projected	No longer being considered	Does not have support from public at this time
County and Cities will join in a strong education campaign to control litter and recycling	No longer being considered	Due to budget constraints and lack of manpower and public interest
Continue to divert white goods from waste stream and drop off sites for cardboard and newspaper	Nahunta is no longer considering drop off sites, County is ongoing	Nahunta does not have the land or resources to put in place and keep it going.
Voluntary recycling program for all commercial and multifamily developments for marketable items such as cardboard, aluminum and newspaper	Partially ongoing	Metals have been marketable and working with local citizens, cardboard and newspaper have been lagging
Encourage residents, businesses , schools, and government agencies located to practice source reduction principles	Ongoing	
Provide regular collection of recyclable material from all recycling sites	No longer being considered	Due to budget constraints and lack of manpower and public interest
Participate in developing a recycling plan to remove recyclables from waste stream	No longer being considered	Due to budget constraints and lack of manpower and public interest
Continue to monitor markets for recyclables and study feasibility of collecting glass and plastic	No longer being considered	Due to budget constraints and lack of manpower and public interest
Investigate whether additional equipment such as balers will enable collection of recyclables to be more efficient/effective	No longer being considered	Due to budget constraints and lack of manpower and public interest
Develop plan to collect batteries, fence wire, hazardous waste	Ongoing	
Provide recycling programs for businesses, schools, and government agencies located in the county	No longer being considered	Not economically feasible

Activity	Status	Explanation
Disposal Continue to use inert landfill	Complete for first five years and underway for future years	
Study feasibility of Brantley County resuming operation of collection and disposal	Complete	County implemented curbside collection in August 2010
Seek grants or other funding to purchase scales for inert landfill and transfer station	No longer being considered	Currently not charging for disposal
Continue disposal agreements for management of residential solid waste	No longer being considered	Changed vendor and method of disposal
Enforce illegal dumping and litter regulations	Complete for first five years and underway for future years	
Seek funding and construct administrative building and bathroom for transfer station and inert landfill	Postponed	Financial burdens have not allowed this task to develop
Land Limitation Monitor industry and business practices to minimize air, land, and water pollution resulting from solid waste activities	Ongoing	
Adopt solid waste ordinance	Ongoing	
Adopt ordinances to protect groundwater recharge areas wetlands river corridor, etc	Complete	
Adopt amendments to Comprehensive Plan on current land use and adopt updated plan	Complete	
Evaluate disproportionate environmental impacts	Ongoing	
Study adoption of Development Code	Ongoing	
Enforce ordinances, natural environmental and land use limitation for siting solid waste facilities	Complete for first five years and underway for future years	
Education & Public Involvement Develop an Adopt-A-Highway program	No longer being considered	Due to budget constraints and lack of manpower and public interest
Support the training center in creation of recycling centers at convenient location	No longer being considered	Single location for recycling available through the county
Continue improvement of other anti-litter education campaigns	Ongoing	

Activity	**Status**	**Explanation**
Continue to provide ways to increase knowledge of waste programs for new residents	Ongoing	Latest program is curbside pick-up
Expand methods to educate commercial businesses	No longer being considered	Due to budget constraints and lack of manpower and public interest
Seek public involvement in studying the costs and benefits of collecting and disposing of household hazardous waste at annual collection events.	No longer being considered	Due to budget constraints and lack of manpower and public interest
Seek public involvement in applying for grants for solid waste reduction and recycling programs	No longer being considered	Due to budget constraints and lack of manpower and public interest
Continue to encourage active public involvement in waste planning and regulations	Complete for first five years and underway for future years	
Reactivate Brantley County Solid Waste Advisory Committee	No longer being considered	Due to budget constraints and lack of manpower and public interest
Work with the school board to educate teachers and develop school programs about solid waste with the help of County Extension Agent.	No longer being considered	Due to budget constraints and lack of manpower and public interest
Coordinate programs with Satilla River Keeper, Save Our Satilla, the Georgia Farm Bureau Chamber of Commerce to help with education and public participation in solid waste programs	Ongoing	
Work with law enforcement to control litter	Ongoing	
Place review of education and public involvement programs on government meetings	No longer being considered	Due to budget constraints and lack of manpower and public interest
Develop handouts/mail outs on solid waste programs	No longer being considered	Due to budget constraints and lack of manpower and public interest
Educate residents on full cost of solid waste collection, disposal and reduction	Ongoing	

Brantley County and the Cities of Hoboken and Nahunta Population Projections										
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total Population	19,005	19,599	20,193	20,787	21,381	21,975	22,569	23,163	23,757	24,351

Brantley County and the Cities of Hoboken and Nahunta Tonnage Projections										
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tonnage	11,657	11,780	11,905	12,031	12,064	12,191	12,446	12,575	12,705	12,836

Broadhurst

Environmental

P.O. Box 278
Screven, GA 31560
Phone: (912) 530-7050
Fax: (912) 530-7070

Chairman Ronald E. Ham, Chairman
Brantley County Commission
P.O. Box 398
Nahunta, GA 31533

Dear Chairman Ham,

This letter serves as a disposal capacity assurance for waste generated by Brantley County and the cities of Hoboken and Nahunta from 2011 to 2020. The Georgia EPD permit number for this facility is 151-014D(SL). This assurance is based upon Brantley County and the cities of Hoboken and Nahunta disposing of approximately 12,836 tons of waste at this facility on an annual basis.

We thank Brantley County and the cities of Hoboken and Nahunta for this business partnership and look forward to providing environmentally sound waste disposal options for the foreseeable future.

Sincerely,

Jeffrey McLellan

C: Mayor Charles H. Lee, City of Hoboken
Mayor Ronnie Jacobs, City of Nahunta

Resolution to Adopt
The Brantley County Solid Waste Management Plan
2011 Short Term Work Program (STWP) Update

WHEREAS, Brantley County has completed an update of the Brantley County and the Cities of Hoboken and Nahunta Solid Waste Management Five-Year Short-Term Work Program; and

WHEREAS, the Short Term Work Program (STWP) update of the Brantley County Solid Waste Management Plan has provided for the assurance of adequate solid waste handling capability and capacity within the planning area; and

WHEREAS, the proposal to update was published two weeks prior to adoption as required;

NOW, THEREFORE, BE IT RESOLVED, that Brantley County does hereby adopt the updated Solid Waste Management Plan Five-Year Short-Term Work Program 2010-2019.

SO ADOPTED THIS 9 DAY OF August, 2011

[signature]
Ronald E. Ham, Chairman

Dale Halligan
Dale Halligan
County Clerk

Resolution to Adopt
The Brantley County Solid Waste Management Plan
2011 Short Term Work Program (STWP) Update

WHEREAS, the City of Hoboken has completed an update of the Brantley County and the Cities of Hoboken and Nahunta Solid Waste Management Five-Year Short-Term Work Program; and

WHEREAS, the Short Term Work Program (STWP) update of the Brantley County Solid Waste Management Plan has provided for the assurance of adequate solid waste handling capability and capacity within the planning area; and

WHEREAS, the proposal to update was published two weeks prior to adoption as required;

NOW, THEREFORE, BE IT RESOLVED, that the City of Hoboken does hereby adopt the updated Solid Waste Management Plan Five-Year Short-Term Work Program 2010-2019.

SO ADOPTED THIS 2nd DAY OF August, 2011

Charles H. Lee

Charles H. Lee, Mayor

Linda Henderson

Linda Henderson
City Clerk

Resolution to Adopt
The Brantley County Solid Waste Management Plan
2011 Short Term Work Program (STWP) Update

WHEREAS, the City of Nahunta has completed an update of the Brantley County and the Cities of Hoboken and Nahunta Solid Waste Management Five-Year Short-Term Work Program; and

WHEREAS, the Short Term Work Program (STWP) update of the Brantley County Solid Waste Management Plan has provided for the assurance of adequate solid waste handling capability and capacity within the planning area; and

WHEREAS, the proposal to update was published two weeks prior to adoption as required;

NOW, THEREFORE, BE IT RESOLVED, that the City of Nahunta does hereby adopt the updated Solid Waste Management Plan Five-Year Short-Term Work Program 2010-2019.

SO ADOPTED THIS 5 DAY OF August, 2011

Ronnie Jacobs
Ronnie Jacobs, Mayor

Angela R. Wirth
Angela Wirth
City Clerk

APPENDIX F

2010

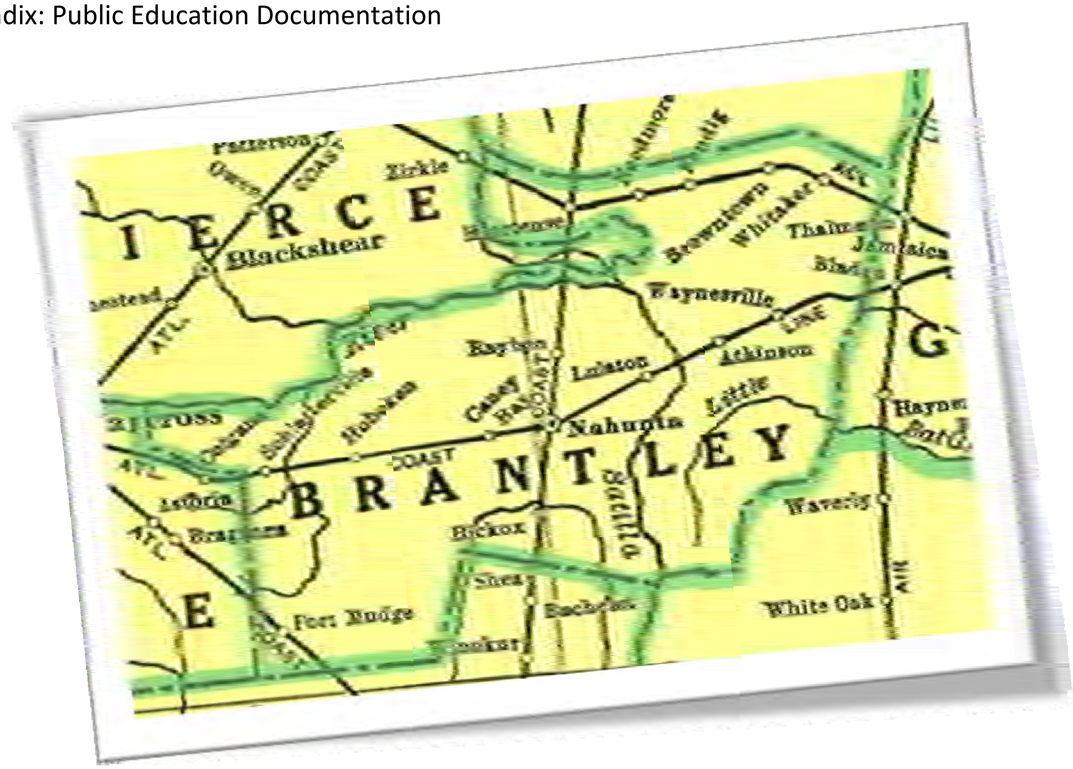
Brantley County Future Land Use Plan

SEPTEMBER 2010

Ecological Planning Group

7 East Congress Street Suite 801
Savannah, Georgia 31401

Table of Contents



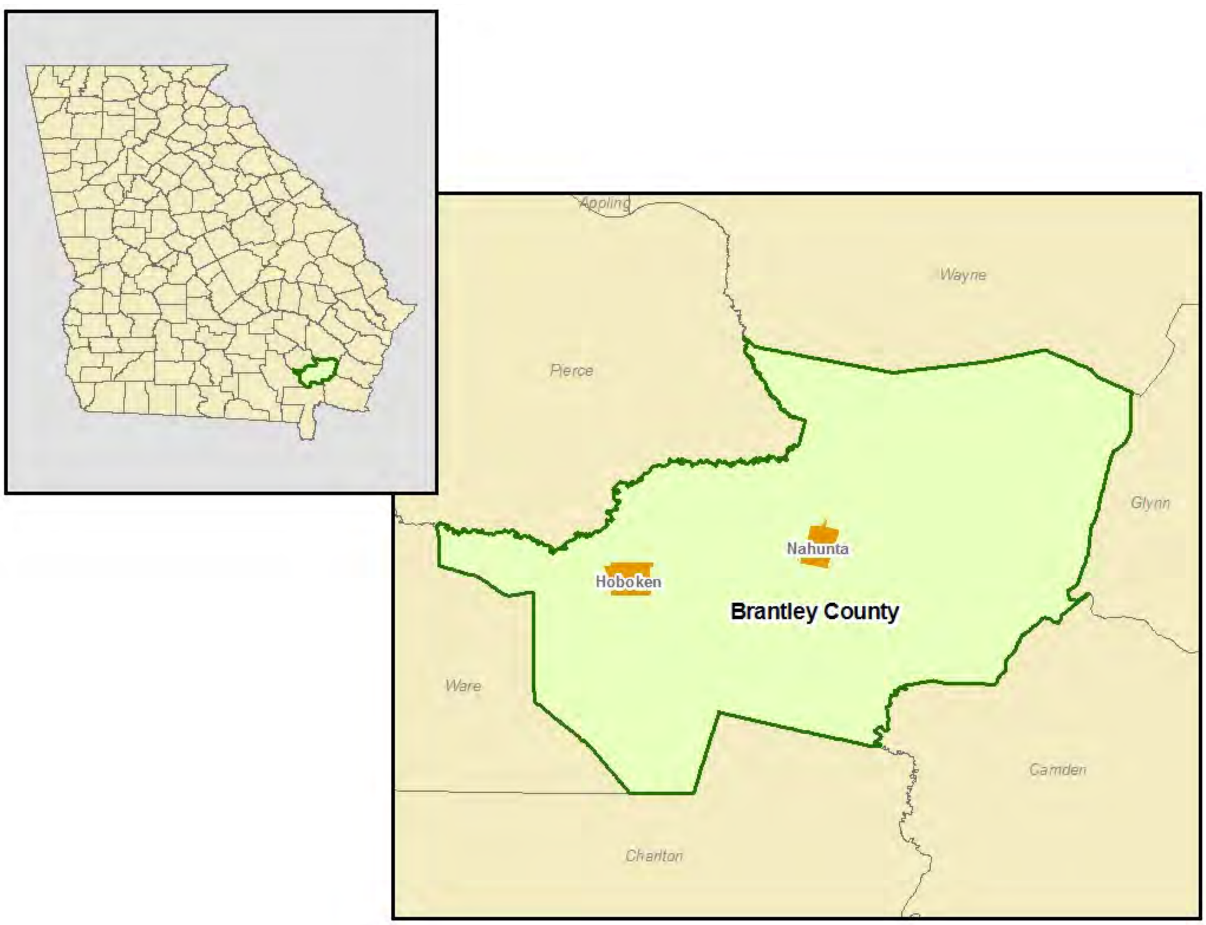
Introduction

Coastal Georgia's population is projected to increase over 50% by 2030 as reported in *Georgia Coast 2030: Population Projections for the 10-County Coastal Region* by Georgia Tech's Center for Quality Growth & Regional Development. Aware that growth is on the horizon, yet knowledgeable of its potential economic benefits to the community, Brantley County desires to set a Future Development Strategy that will support the County's Vision, protect the abundant natural resources, and promote economic development.

Brantley County citizens and officials agree that the tools are needed to manage the County's future growth, specifically a Future Land Use Plan that is consistent with the County's Comprehensive Plan and the Coastal Comprehensive Plan and can serve as the critical nexus for a future Zoning Ordinance.

This plan builds on the work completed during the County's Comprehensive Planning process and further analyzes recent development trends and identifies specific land use issues and opportunities. The Future Land Use Plan will provide the County with a foundation from which to evaluate future zoning regulations to ensure the character of new development is consistent with the community vision. This plan is designed to complement the County's Comprehensive Plan by spatially defining land uses within in the community, identifying the desired location of future development, and illustrating the preferred character of future development.

Figure 1: Location Map



Planning Area

Brantley County, located directly west of Glynn County and east of the City of Waycross in Ware County, was formed in 1920 from Charlton, Pierce, and Wayne counties. Brantley County is 444 square miles in area and has two incorporated cities: Nahunta, the County seat, and Hoboken. There are also ten other commonly recognized communities within the County including: Hickox, Atkinson, Waynesville, Post, Lulaton, Schlatterville, Raybon, Hortense, Popwellville, and Calvary. Major thoroughfares through the County include US Routes 82 and 301 and State Routes 32, 110, and 121. The Satilla River flows farther through Brantley County than any other County within its watershed, nearly 50 miles.

Historic Growth Patterns

During the middle to late 1800s, "timber was king" in the area now known as Brantley County. During this time, the railroad became the most reliable method of transporting timber, naval stores, and merchandise, and the Brunswick and Western Railroad was constructed through Brantley County (running westward from Brunswick to Waycross, initially in 1861). During the civil war, portions of this track were destroyed to prevent use by Federal forces, and it was not reconstructed until the 1870's. Side tracks were built to accommodate loading and unloading. At that time communities grew through their connection to the railroad, and subsequently became known as "railroad towns" or “whistle stops.”

Figure 2: Turpentine Still *Courtesy of www.rootsweb.ancestry.com.*

The north-south Jessup to Folkston Short Line was completed in 1902, and it brought development to the area including businesses, homes, and a workforce. This new rail line gave rise to the town of Nahunta near the location of the Ole Victoria Mill (sawmill). With the Okefenokee Swamp making travel difficult to the south and west, Brantley County was essential to the railroads running from the coast through the southern part of the state. Many of today’s small communities were once “whistle stops” along one of the major railroad routes that transversed the County. In fact, the railroads and silviculture based-industry they supported were so important, that the Brantley County Historical Society has said that, "… the entire area now identified as Brantley County could be viewed as a "Railroad County" in the early days."

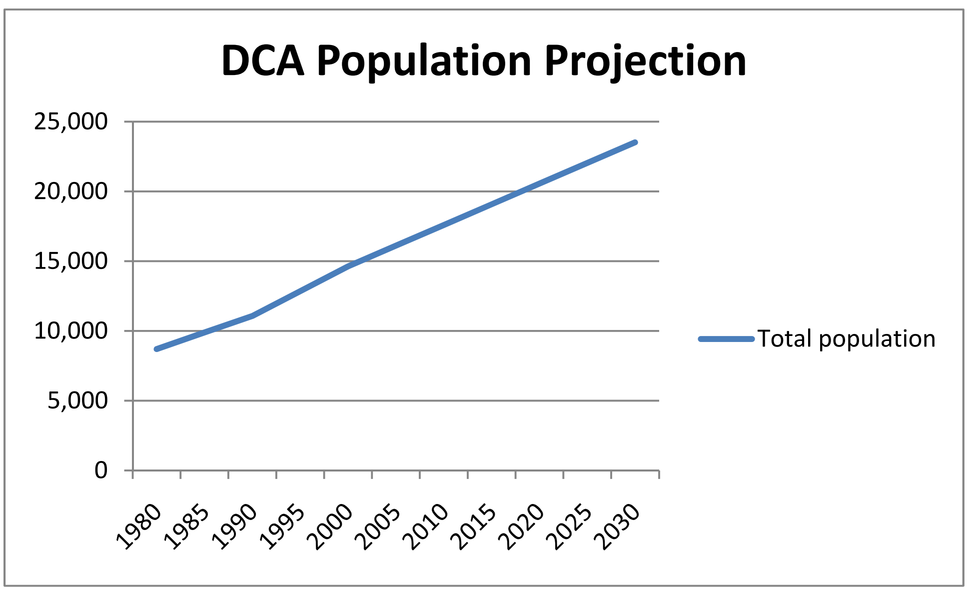
Population Trends

Brantley County lies in-between the metropolitan areas of Brunswick and Waycross, and population centers on the eastern and western sides of the County may be viewed as "bedroom communities" for these larger cities. The Brantley County Comprehensive Plan noted that the County has experienced a very large historical population growth rate of 27.3% from 1980 to 1990. This population increase was attributed to the Waynesville and Atkinson communities, near the Glynn County border, and in the western part of the County between Hoboken and Waycross near the Ware County line.

During the decade between 1990 and 2000, the County population continued to increase a rate of 32.1%. The Comprehensive Plan predicts that the population of the County will double between the years of 2000 and 2025, and projects the 2010 population to be 16,360. This 2010 population projection is slightly less than the projections made by the Georgia Department of Community Affairs as shown below; however, the DCA projection also indicates a 50% population increase by 2025.

Category	1990	2000	2005	2010	2015	2020	2025	2030
Population	11,077	14,629	16,111	17,593	19,075	20,557	22,039	23,521

Figure 3: Population Trend



In order to get a more accurate assessment of the current population within the County, a count of residential electricity accounts has been conducted, and that number has been utilized to estimate the total current population. Three major eletricity providers operate in Brantley County: Okefenokee Rural Electric Membership Corporation (OREMC), Satilla Electric Membership Cooperative (SEMC), and Georgia Power. Each proivder supplied the number of active residential electric accounts in Brantley County as well as the number of estimated "occupied" active residential accounts. The "occupied" resdiential accounts did not include meters serving secondary purposes such as well pumps or vacation homes that are unoccupied for a large portion of the year. This resulting number of "occupied" residential accounts is assumed to correspond to the number of permanent households currently within the County. The number of households was mulitplied by the projected number of people per houshold (per the Department of Community Affairs) to estimate the current population for April 2010.

Provider	No. of Active Residential Accounts	No. of Occpied Residential Accounts	Number of People per Household (DCA 2010 Projection)	Total Population
OREMC	6,432	5700	2.46	14,022
Georgia Power	698	550	2.46	1,353
SEMC	201	199	2.46	489
Total	**7,130**	**6,250**		**15,864**

Based on this analysis, it appears that the population projection in the County's 2006 Comprehensive Plan is fairly accurate, and that the DCA's population projection may not have anticipated the recent downturn in the residential market. However, as the market rebounds, and the 3,600 platted lots are occupied, the popluation curve may trend more towards the DCA's projection on the previous page.

Existing Development Patterns

Existing Land Use

Brantley County performed an existing land use survey in January 2010 to assist ongoing planning efforts related to the County's Future Land Use Plan. A field verification process was performed to create a parcel-based existing land use map. The land use categories collected as part of the County's survey are listed and described below:

- Agriculture / Forestry – Land that is actively being used for farming, forestry, logging, etc.
- Commercial – Land used for businesses such as retail and service establishments, restaurants, offices, entertainment, etc.
- Parks / Recreation / Conservation – Land used for both active and passive recreation. Includes County parks as well as permanently protected greenspace.
- Industrial – Land used for warehousing, manufacturing, transportation, utilities, plants, factories, wholesale trade facilities, solid waste facilities, etc.
- Public / Institutional – Local, state, and federal buildings and worship facilities. Includes municipal buildings, schools, police and fire stations, and churches.
- Residential – Land or parcels used for permanent living conditions. This includes single-family houses, multi-family houses, duplex, town houses, modular homes, apartments, etc.
- Transportation / Communication / Utilities – Land used by transportation (roads, railroads), communication or utility facilities; such as airports, cell towers, sewer plants, water towers, water treatment facilities, etc.
- Undeveloped / Other – Includes all vacant and undeveloped land that does not fit the definition of the other land use classifications.

The primary land uses in the County are agriculture, parks, and residential. Collectively, these land uses account for roughly 96% of the total land area in the County. It should be noted that the agriculture category contains a number of instances where residential structures are located on the same parcel as an active agricultural use. These parcels were classified under the agriculture land use category based on the size and intensity of the agricultural use. There is also an additional 4,000-5,000 acres of land that have been platted for new residential development. These sites remain in the agriculture or undeveloped category because they are currently vacant due to downturns in the economy and development markets. The high percentage of parks / recreation / conservation is attributed to the areas immediately adjacent to the Satilla and the Little Satilla Rivers where land was classified as conservation. The table below shows the current distribution of land uses based on the survey competed in January 2010.

County-wide Land Use

General Classifications	Acres	Percent
Agriculture/Forestry	242,732	84.8%
Commercial	353	0.1%
Industrial	196	0.1%
Parks/Recreation/Conservation	16,316	5.7%
Public/Institutional	461	0.2%
Residential	15,524	5.4%
Transportation/Communication/Utilities	5,456	1.9%
Undeveloped/Unused	5,169	1.8%

The chart below illustrates the distribution of land uses in the County.

Figure 4: Land Use Percentage Distribution

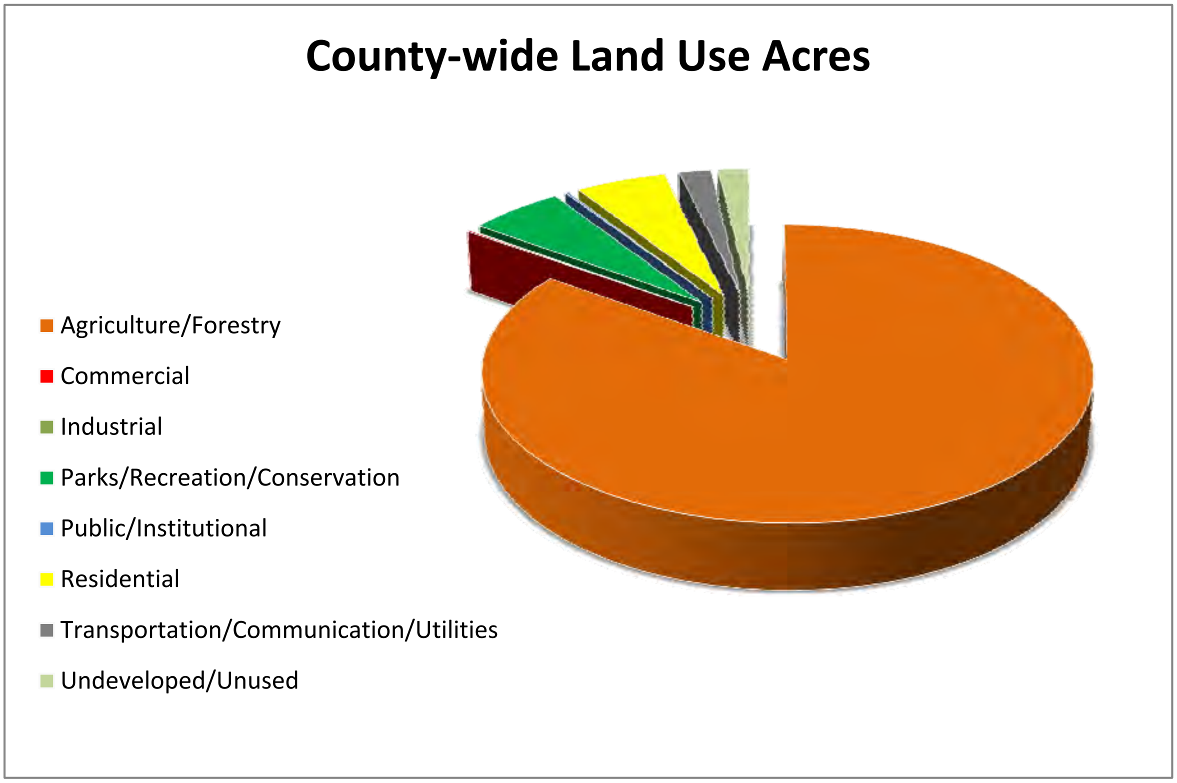
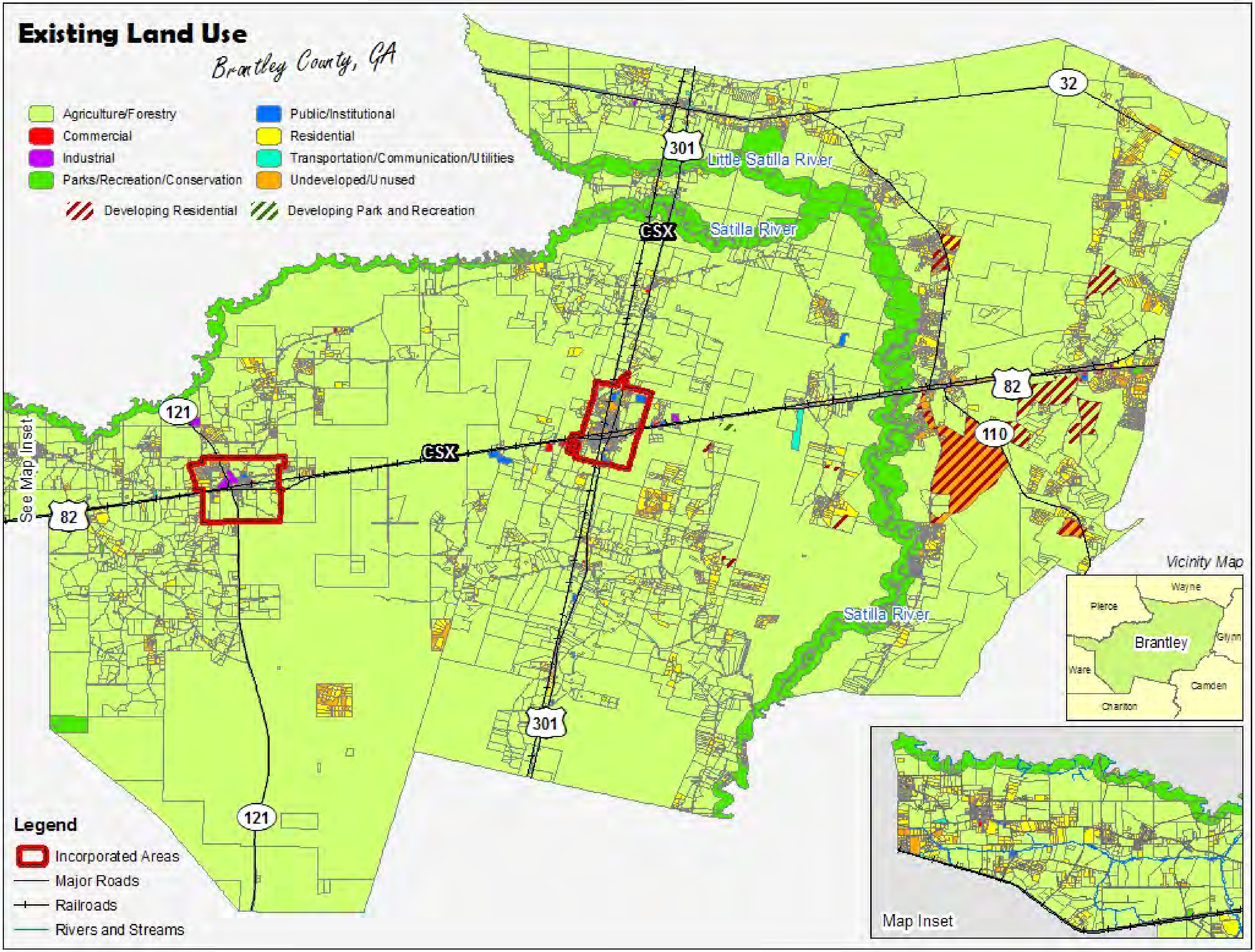


Figure 5: Existing Land Use Map



In examining land use patterns in the County, it is also important to look at the land characteristics of the incorporated areas. Brantley County contains two cities; Hoboken and Nahunta. The City of Nahunta contains a more balanced distribution of land uses when compared to the County as a whole. While nearly 50% of the land area is being used for agriculture, Nahunta contains higher percentages of land uses typically found in more "urbanized" areas including: residential, public / institutional, and commercial. Together these land uses account for roughly 30% of land area in the City. The City of Nahunta also contains a higher percentage of undeveloped land, which demonstrates the potential for future development opportunities within the City limits.

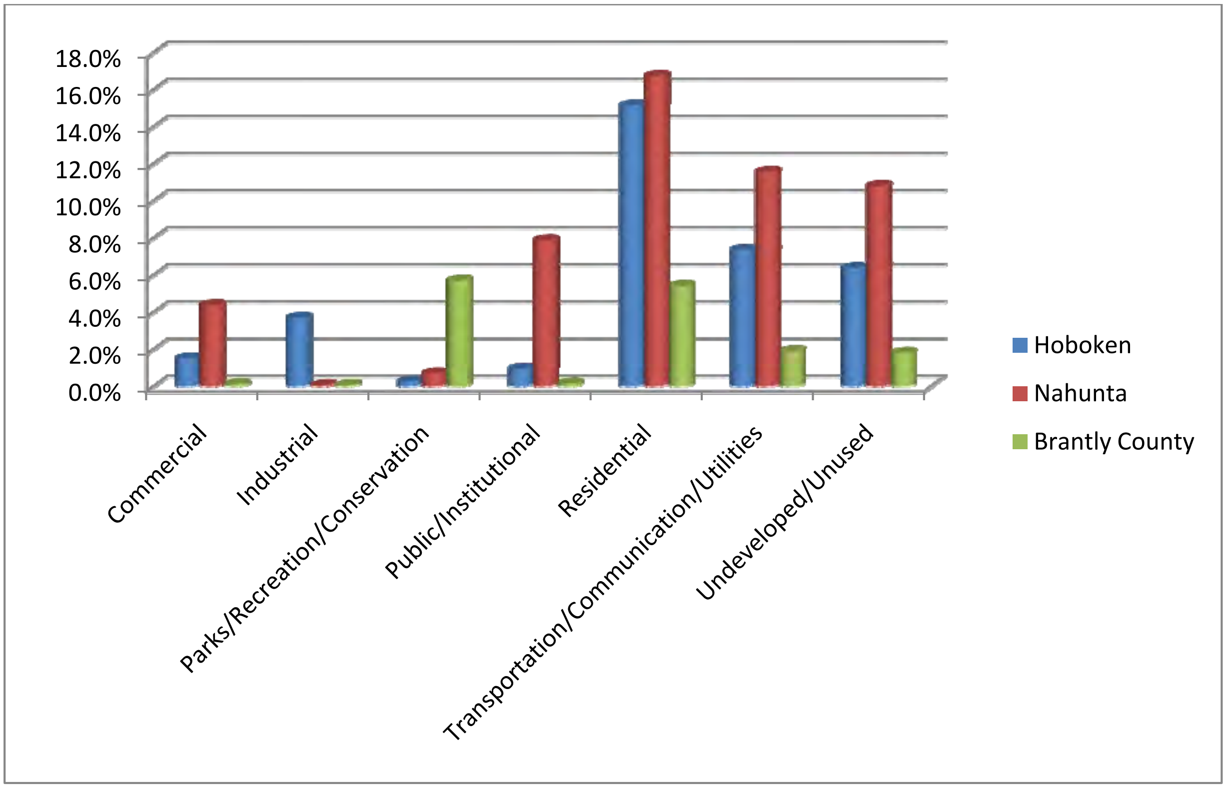
Nahunta Land Use		
General Land Use	Acres	Percent
Agriculture/Forestry	927	47.9%
Commercial	85	4.4%
Industrial	1	0.1%
Parks/Recreation/Conservation	14	0.7%
Public/Institutional	153	7.9%
Residential	324	16.7%
Transportation/Communication/Utilities	224	11.6%
Undeveloped/Unused	209	10.8%

Similar to Nahunta, the City of Hoboken also has a more "urbanized" distribution of land uses when compared to the County as a whole.

Hoboken Land Use		
General Land Use	Acres	Percent
Agriculture/Forestry	1,457	64.7%
Commercial	34	1.5%
Industrial	83	3.7%
Parks/Recreation/Conservation	6	0.3%
Public/Institutional	21	1.0%
Residential	341	15.2%
Transportation/Communication/Utilities	166	7.4%
Undeveloped/Unused	144	6.4%

The chart on the next page compares the distribution of land uses in the cities of Nahunta and Hoboken and Brantley County. For the sake of easier comparison, the agriculture land use category is not displayed on the following chart.

Figure 6: Existing Land Use Comparison



Future Development Strategy

Public Participation

In preparing a future development strategy, it is essential to work with citizens to identify the issues and challenges unique to their community. Effective involvement of key individuals/groups from the community will ensure that this effort gains community-wide support, addresses the issues and concerns of the County residents, and is ultimately implemented by the County staff and elected officials. The County implemented a public involvement program that included a stakeholder group and public meetings in an effort to develop consensus on the goals of this plan.

The County formed a stakeholder group named “Future Land Use Technical Advisory Committee (FLUTAC)”, which included five citizen appointees from the Board of Commissioners and representatives from the Brantley County Development Authority, Extension Service, the Brantley County Tax Assessor’s office, the Coastal Resources Division, local governments, and the Satilla River Keeper. This group met three times to provide feedback on the data analysis, future development strategy and recommendations of this plan. Meetings of the FLUTAC were held at the County Administrative Building on January 14, March 30, and June 1, 2010 and the minutes from these meetings are included in the appendix.

The County also held two public hearings on the Future Land Use Plan where the general public was invited to provide input on the recommendations of this Plan. These meetings were held during regularly scheduled Planning and Zoning Commission and Board of Commissioners meetings on June 24, 2010 and July 13, 2010, respectively. These meetings were publicly advertised per the County’s statutory procedure.

This Future Land Use Plan is the product of this public involvement process and the Vision, Future Development Strategy, and Recommendations of this plan are a reflection of the input provided by the citizens of Brantley County.

Community Vision

The citizens and officials of Brantley County developed the following vision for the future of their community as part of the 2006 Comprehensive Plan development process:

> *By the year 2025, Brantley County and the Cities of Hoboken and Nahunta will be a thriving and vibrant community. The County and Cities will endeavor to supply quality education for all citizens, offer diverse housing options, create a thriving economy through the recruitment of diverse employers, seek creative ways to promote and capitalize upon the distinct rural lifestyle, and pursue options to preserve and promote future economic growth from their unique natural and cultural heritage.*

In order to achieve the vision above, Brantley County has identified the following goals for the development of the Future Development Strategy. It is the County’s desire that these goals should also function as decision making criteria to guide County policy, code and future land use decisions.

- Understand and manage our expectation for growth.
- Ensure that future development is coordinated appropriately with water and sanitary sewer service areas.

- Consider the suitability of soils.
- Consider the impact to the functionality of the floodplain, and ensure that new development is protected from flooding.
- Consider the impact to the transportation system as well as local transportation plans and projects.
- Consider the impact to local economy, particularly the agricultural industry.
- Promote development on the existing 3,600 platted and vacant parcels.

It is the County's intent that implementation of this Future Land Use Plan will honor the vision and goals identified herein and protect the quality of life for current and future residents.

Future Land Use Map

Brantley County has created a strategy for future land use based on the Community Character Areas identified in the 2006 Comprehensive Plan and input provided through the public involvement process described above. The Future Land Use Map is intended to guide future land use decisions and may also be used as the basis for a future Zoning Ordinance. As development takes place in the future, the County's land use policies and regulations should ensure that development is conducted in a manner consistent with the Comprehensive Plan and this Future Land Use Map.

The sections below include a narrative description for each future land use area as follows:

- Development Area Description: This section provides a description of the unique and defining characteristics within each Future Development area.
- Implementation Measures: The strategies identified within this section are the objectives that have been identified to help achieve the vision for each area, as outlined in the Development Area Description.

Flood Plain Area

Definition: This area is defined by the regulatory FEMA flood plain associated with streams and rivers in Brantley County. This area includes ecologically significant resources such as wetlands, rivers, streams, forests, floodplains, etc. Development within this area should support open space established for active recreation, passive recreation, and conservation. This area is appropriate for tourism based commercial uses and residential uses where soils and elevations allow for development.

Development Strategy:

- Seek partners and funding to perform flood studies to update the FEMA regulatory Digital Flood Insurance Rate Map (DFIRM), and establish elevations in all floodplains throughout the County.
- Develop an inventory and prioritization system for ecologically or historically significant features within this region.
- Provide incentives for property owners who voluntarily protect ecological, cultural or historic resources through conservation easements, deed restrictions, etc.
- Encourage the voluntary inclusion of open space and land conservation in new developments.
- Land within this area should be kept in its natural state wherever feasible.

- Future development in these areas should support eco-tourism and passive recreation.
- Require natural buffers between any non-residential development within this area and the Satilla River area.
- Investigate a Purchase of Development Rights (PDRs) program to provide a financial incentive for the protection of ecologically valuable lands while preserving individual property rights.
- Investigate the potential for a County owned wetland mitigation bank for future road projects or sale of credits.

Satilla Protected River Corridor Area

Definition: This character area includes the land immediately adjacent to the Satilla River and the Little Satilla River that is subject to the provisions of the Protected River Corridor standards developed by the Georgia Department of Natural Resources, and adopted by Brantley County. This corridor includes the Satilla and Little Satilla Rivers and a 100 foot buffer on either side of those rivers, as measured from the bank of the river. This corridor contains environmentally sensitive land and provides habitat to a number of different plant and wildlife species. The main intent of this area is preservation of natural and environmental resources as well as the opportunity for natural recreational activities for residents and visitors.

Development Strategy:

- The standards of the Protected River Corridor Environmental Planning Criteria should be applied within this area.
- Residential development within this corridor should be consistent with the Protected River Corridor standards and only be located where soils and elevations allow for septic systems.
- Riparian buffers should be protected in their natural states, wherever possible.
- Restrict or discourage uses that have the potential to negatively impact the natural state of this area.
- Promote sustainable development that places focus on eco-tourism and utilization of this resource in the form of low impact recreational uses.
- Work to develop a "blueway" system that includes public docks or other input sites for boaters enjoying the Satilla River.
- Investigate the potential for a County owned wetland mitigation bank for future road projects or sale of credits.

- Investigate a Purchase of Development Rights (PDRs) program to provide a financial incentive for the protection of ecologically valuable lands while preserving individual property rights.

Agriculture / Forestry

Definition: This character area includes lands currently used or prime for agriculture or silviculture. These areas are as much an economic asset to the community as they are a contribution to the existing lifestyle and character of the community.

Development Strategy:

- Land should continue to be preserved and used for agriculture, logging, and production.
- Ensure that soils are suitable for septic systems before permitting residential development.
- Residential developments should be low density within these areas.
- Some institutional uses, such as churches, or commercial uses, such as farm stands, may be present along major thoroughfares within this area.
- Investigate a Purchase of Development Rights (PDRs) program to provide a financial incentive for the protection of valuable farmlands while preserving individual property rights.

Town Centers

Definition: These character areas are the incorporated areas of the county and encompass the city limits of Nahunta and Hoboken. These areas have a mix of land uses that serve the local and countywide population including commercial, public / institutional, and residential development. The following development strategies should be supported within the unincorporated areas.

Development Strategy:

- Allow for a mix of development including retail, office, public, residential, and other appropriate uses.
- Promote compatibility in terms of design and general architectural style for any new development.
- Promote open space and safe pedestrian movement within these areas through sidewalk improvements and connectivity.
- Encourage the voluntary creation of civic open spaces or other gathering areas.

- Promote redevelopment and adaptive reuse of vacant and/or dilapidated properties within these areas.
- Allow the extension of sanitary sewer services where feasible to serve areas adjacent to the city limits.

Neighborhood Commercial Center

Definition: Key intersections located throughout the County offer the opportunity for "commercial pockets" and neighborhood level commercial uses to serve surrounding residential areas. These areas provide residents the convenience of quickly running errands for basic household needs.

Development Strategy:

- Neighborhood scale commercial uses that meet residents' daily needs are appropriate for these areas.
- Development should be low impact and architecturally consistent with the residential areas they are designed to serve.
- These commercial areas should be connected to nearby residential neighborhoods through a system of continuous sidewalks.
- Landscaping and other aesthetic standards should be encouraged within these areas.

Major Highway Corridor

Definition: Auto-oriented commercial corridor that consists of major transportation routes. These corridors are located along US 82, US 301, SR 32, SR 110, and SR 121.

Development Strategy:

- Work with DOT to develop an Access Management Plan for Major Highway Corridors.
- Complete and integrate pedestrian improvements and crosswalks where these roadways pass through the Town Centers.
- These corridors should provide a mix of commercial, industrial, and public uses to accommodate residents as well as people traveling through the County.

Business Park

Definition: The Business Park character areas include those areas within the County masterplanned for commercial and industrial development. These areas are intended to provide jobs and a tax base for the County.

Development Strategy:

- Promote the continuation of masterplanning in business parks
- Encourage design and landscaping to improve general aesthetics
- Provide connections between business parks and major transportation corridors
- Protect environmentally sensitive areas
- Require buffers from surrounding land uses
- Ensure that these areas provide for community water and sanitary sewer consistent with the type of planned development.

Developing Residential

Definition: This character area encompasses property where suburban residential development has occurred or will likely occur in the future. These developments should be safe, pedestrian friendly neighborhoods that provide a mix of housing stock for people with varying income levels. Land use patterns in these areas are generally more suburban than rural in nature with lots sizes of 1 acre to 3 acres. Developments may also have community water and or sewerage systems allowing for lot sizes of less than 1 acre. Several residential developments within Developing Residential areas were planned, subdivided and developed prior to the crash of the real estate market. This has resulted in an inventory of approximately 3,600 lots that are ready for building, but are currently vacant.

Development Strategy:

- The County should work with local and regional agencies, including the Brantley County Development Authority, to develop a plan and marketing strategy for the 3,600 platted and vacant lots.
- Development of the vacant but platted lots, with existing infrastructure should be prioritized. Brantley County should look to provide incentives for the purchase of lots and building of homes within existing subdivisions.

- These developments should include a mix of housing types and densities to appeal to potential residents of all ages and lifestyles.
- Developments should include a system of sidewalks/paths that are connected to neighboring developments and uses.

Rural Residential

Definition: This character area includes rural residential development and undeveloped land with little pressure for more dense suburban-type development due to the distance from local job centers and lack of public water and/or sewer. Existing development characteristics generally consist of larger lot development (3 acres or more), high degree of building separation, and a close connection with agricultural lands.

Development Strategy:

- Maintain existing rural character of these areas
- Ensure adequate protection and consideration of surrounding agricultural land.
- New development can be accommodated through the promotion of cluster development and preservation agricultural subdivision design to allow for the most effective preservation of agricultural land.

The table and chart below show the distribution of future land use designations in the County based on acreage and percent of the County's land mass.

Future Land Use	Acres	Percent
Agriculture/Forestry	143,622	49.8%
Brantley Business Park	2,813	1.0%
Conservation	39,403	13.7%
Residential Developing	31,428	10.9%
Rural Residential	43,522	15.1%
Satilla River Area	17,591	6.1%
Town Center	4,189	1.5%
Major Highway Corridor	5,852	2.0%

Figure 7: Future Land Use Distribution

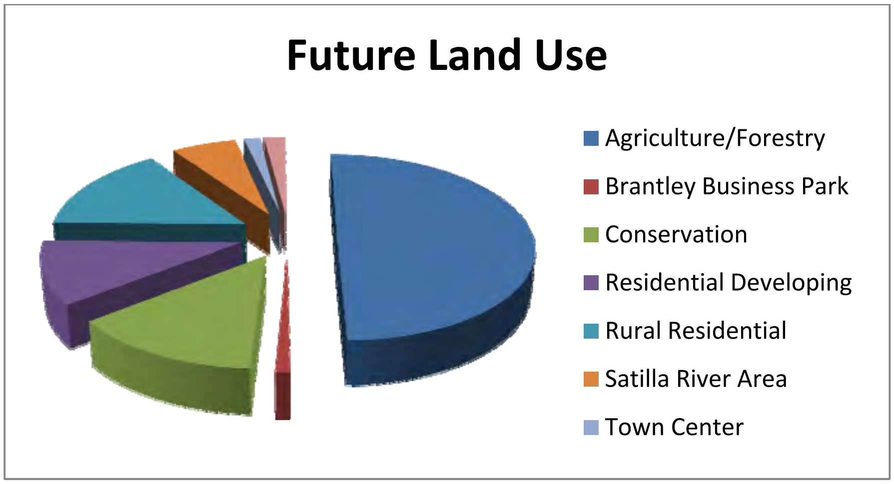
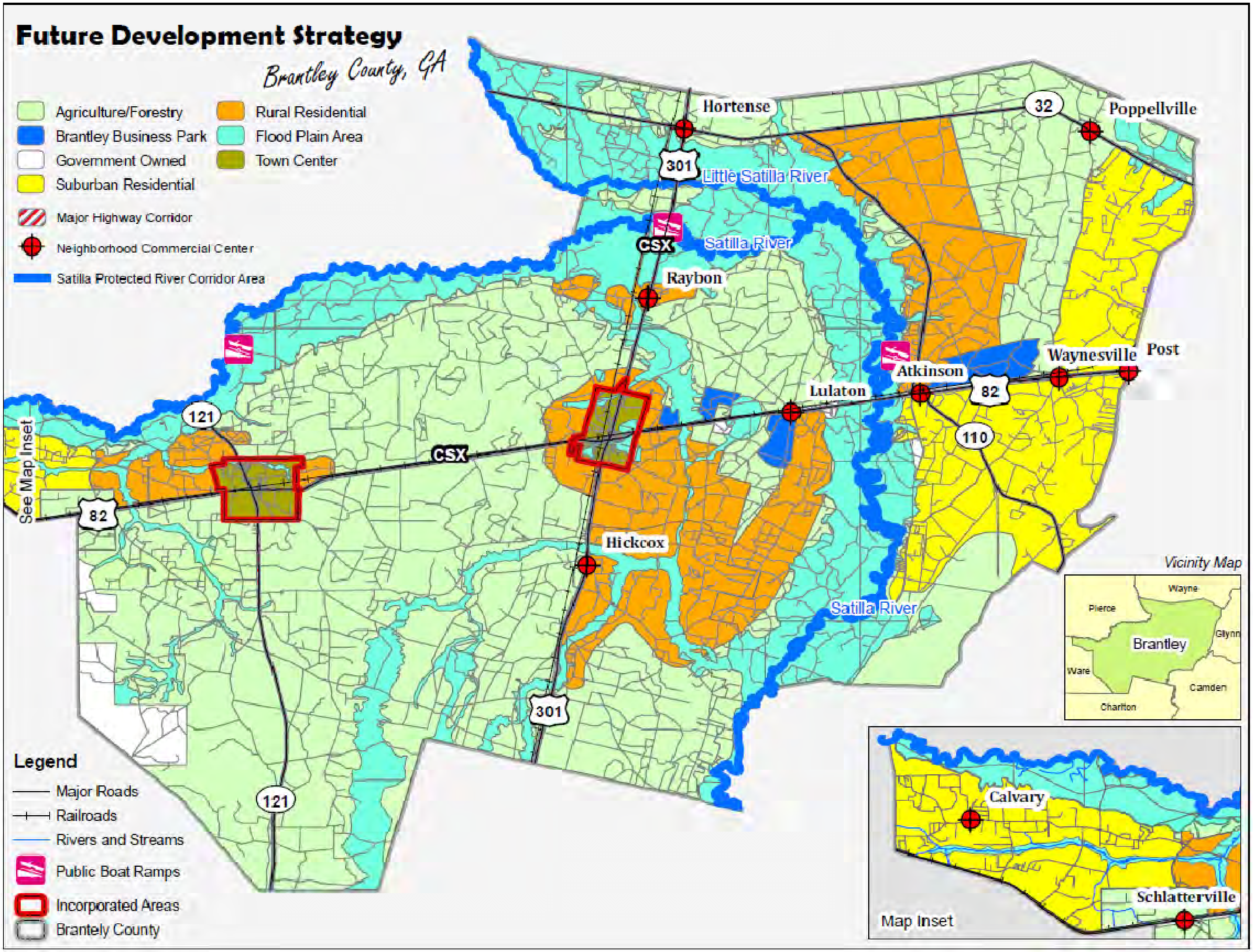


Figure 8: Future Land Use Map



Future Development Strategy – Impacts and Considerations

Natural and Cultural Resources

Brantley County contains a wealth of natural and coastal resources. The County has numerous water features that include freshwater forested wetlands, coastal wetlands, natural and manmade waterways, and the Satilla River. These waterways and wetlands provide opportunities for passive recreational and eco-tourism activities including fishing, boating, hiking, and kayaking. The proper management of these resources is important as the County faces anticipated development pressure.

The County also contains a significant amount of wetlands. Unregulated development of areas adjacent to wetlands can have a negative impact on the local economy, as well as the natural habitat. Due to its location in coastal Georgia and proximity to the Satilla River, Brantley has many low-lying areas. As the County continues to grow, it is essential that development in the floodplain and low-lying areas is regulated in accordance with FEMA standards through the Brantley County Flood Damage Prevention Ordinance, Subdivision Ordinance and Local Design Manual to protect the welfare and property of the residents of Brantley County.

The maps in Figures 9-13 illustrate the extent of the following natural resources:

- Figure 9: Wetland identified within the National Wetlands Inventory and various water features.
- Figure 10: Topography
- Figure 11: Soils
- Figure 12: FEMA Floodplains
- Figure 13: Protected River Corridor Areas and Groundwater Recharge Areas identified on the State of Georgia Digital Atlas

Figure 9: Environmental Resources

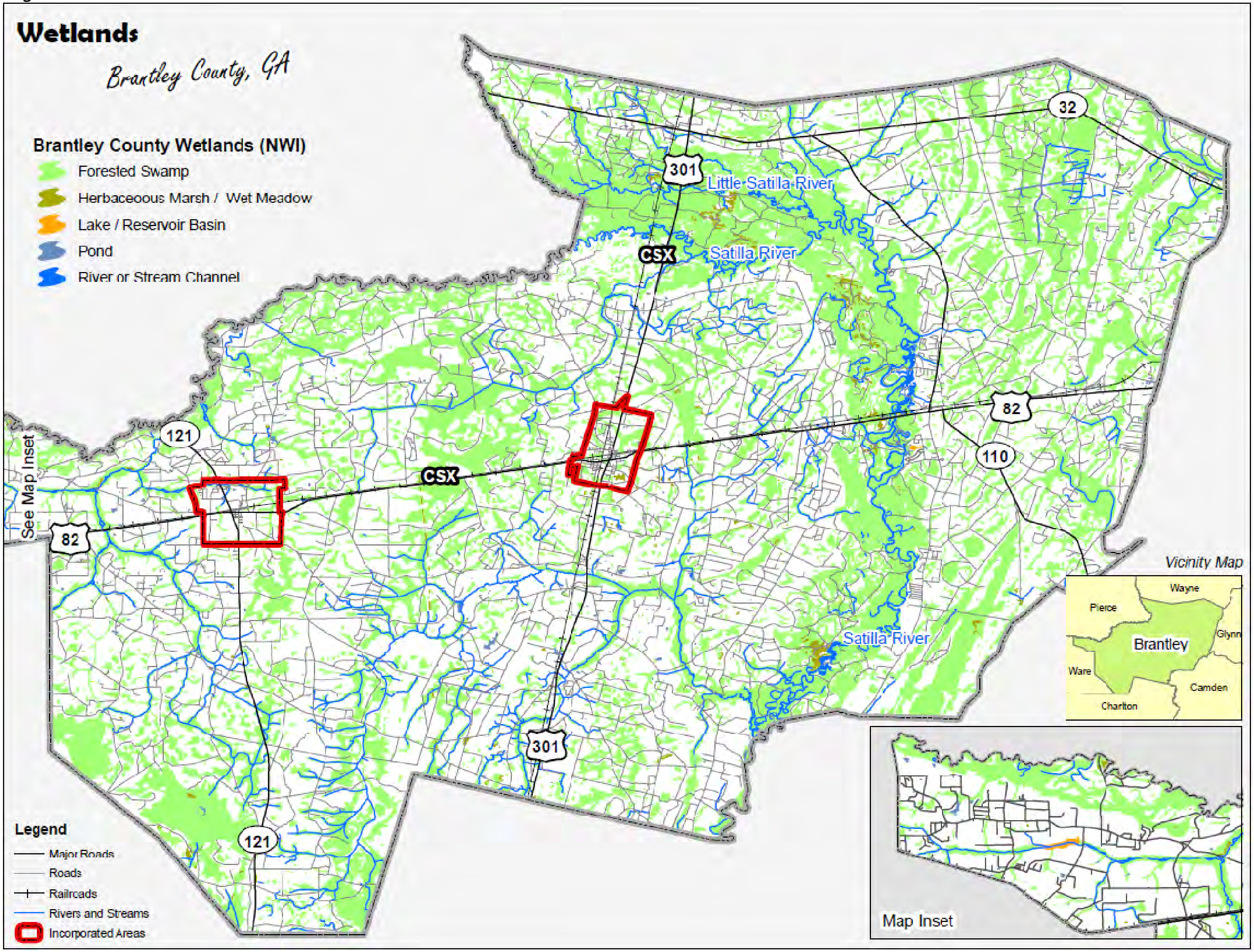


Figure 10: General Topography

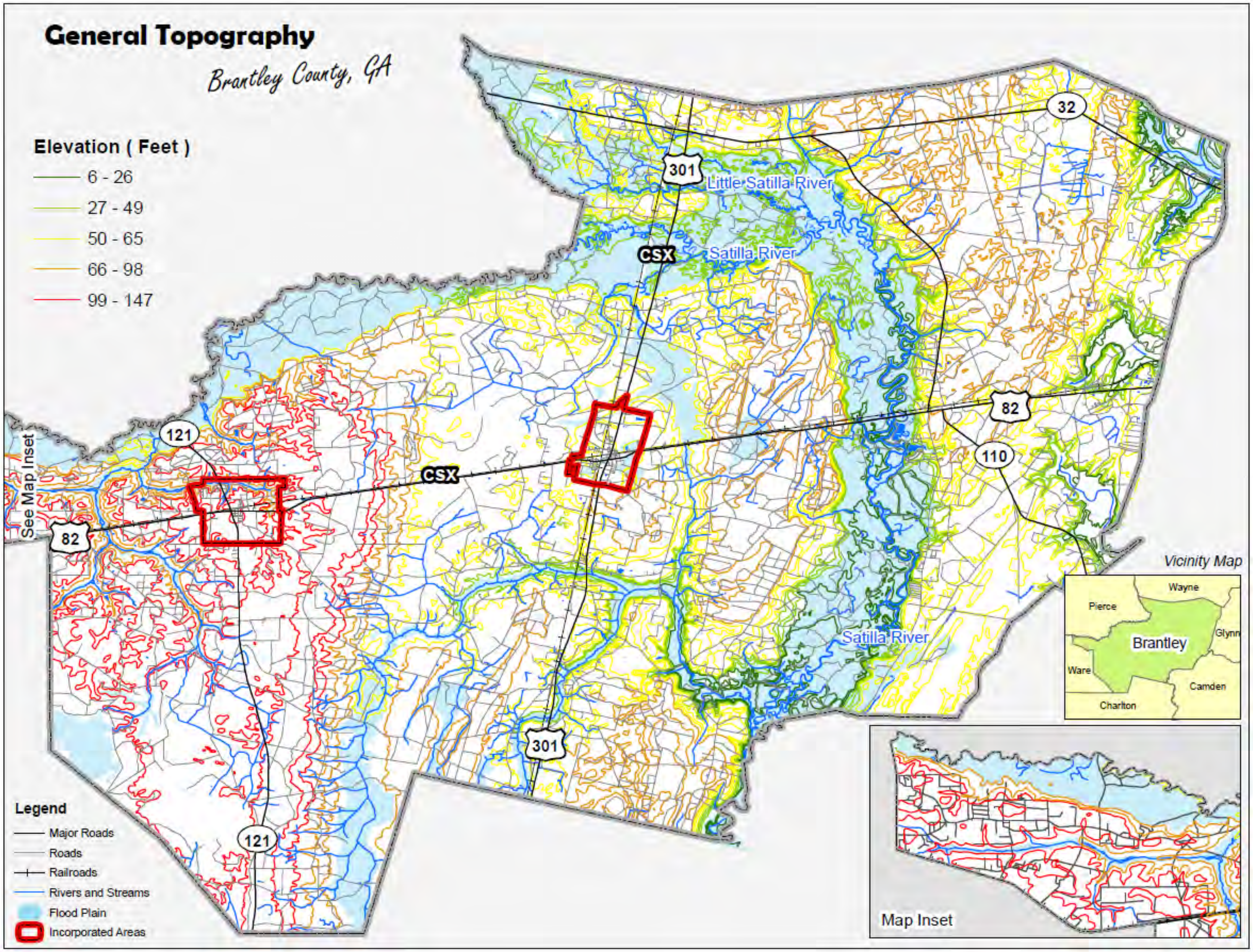


Figure 11: Soil Classification Map

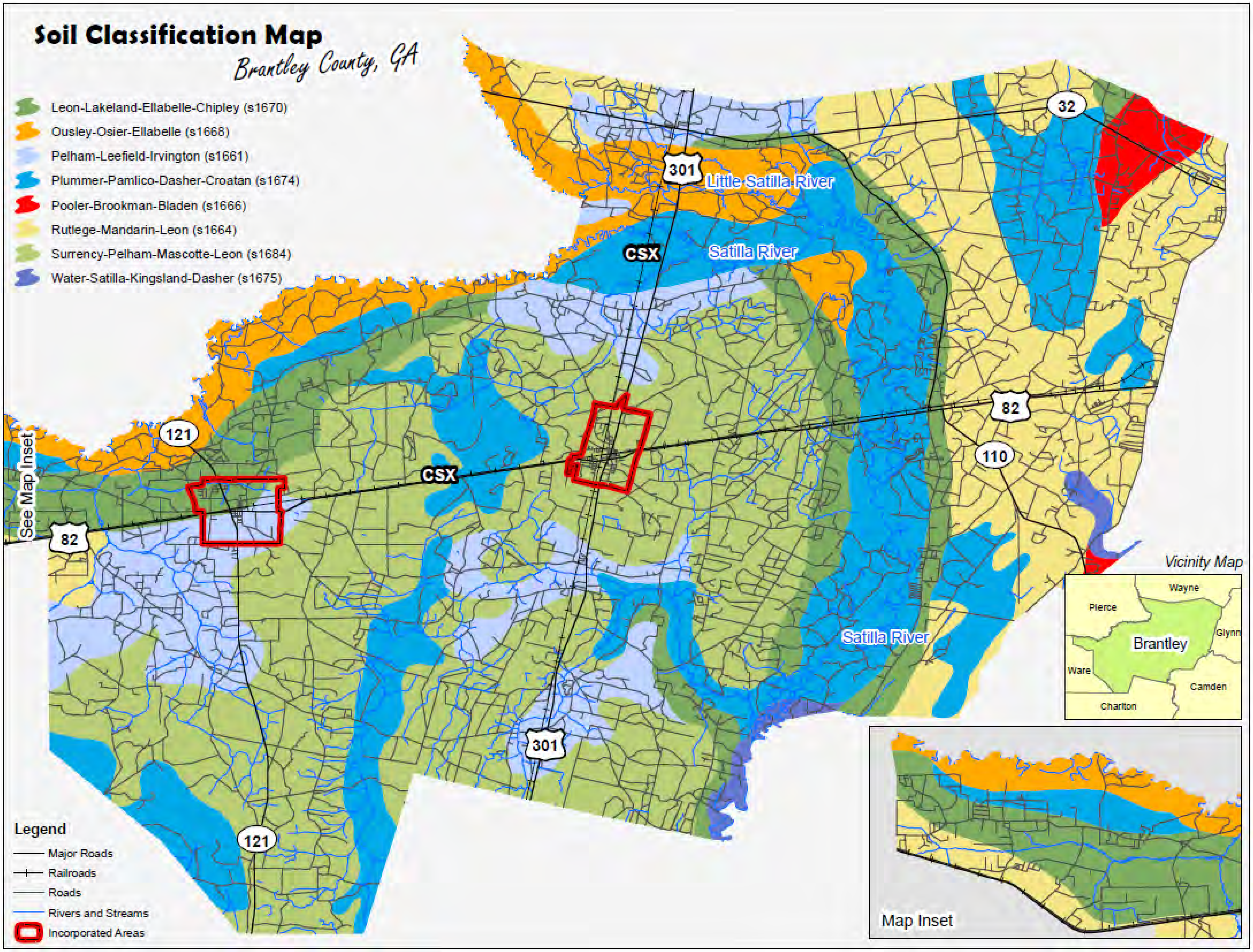


Figure 12: FEMA Floodplains

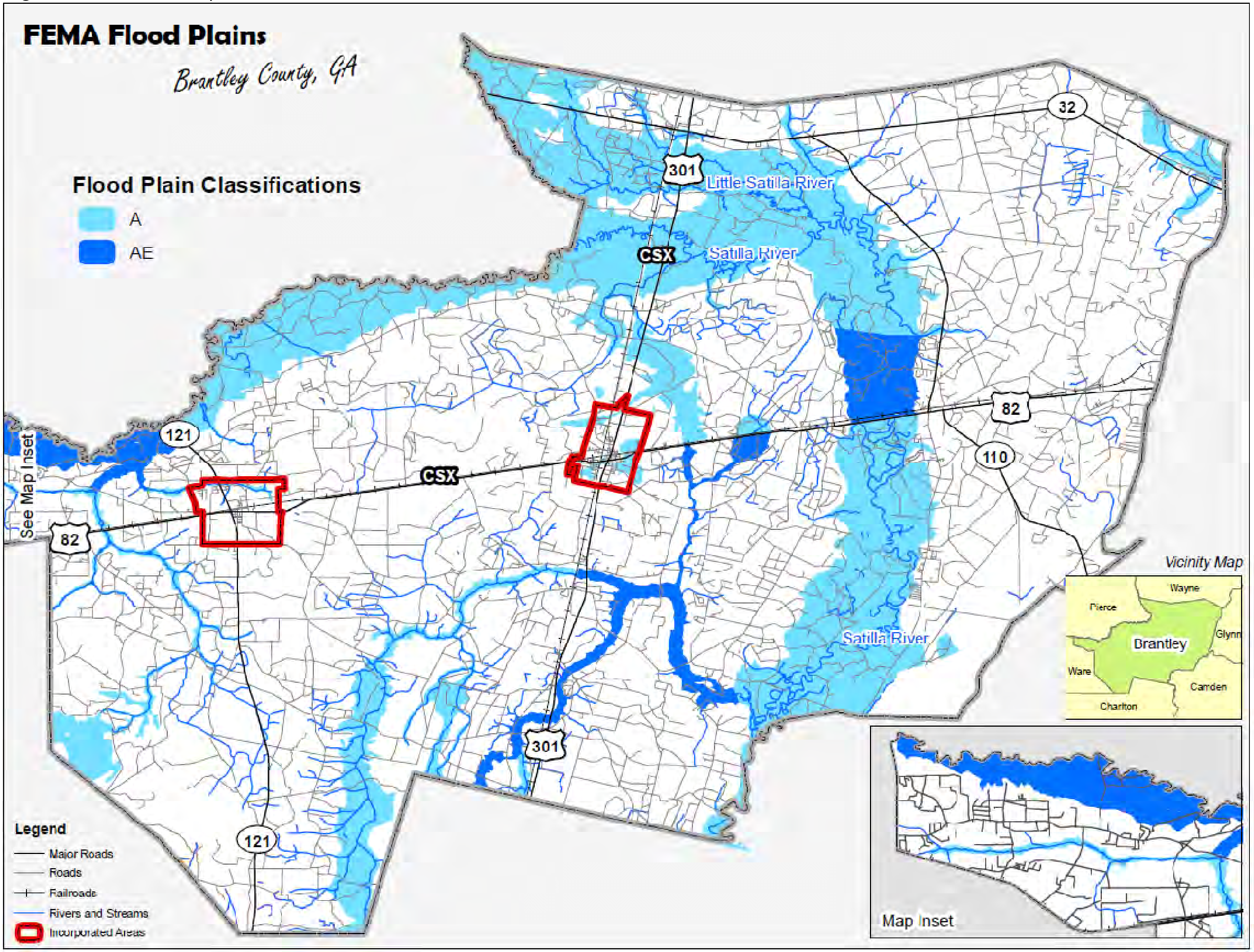
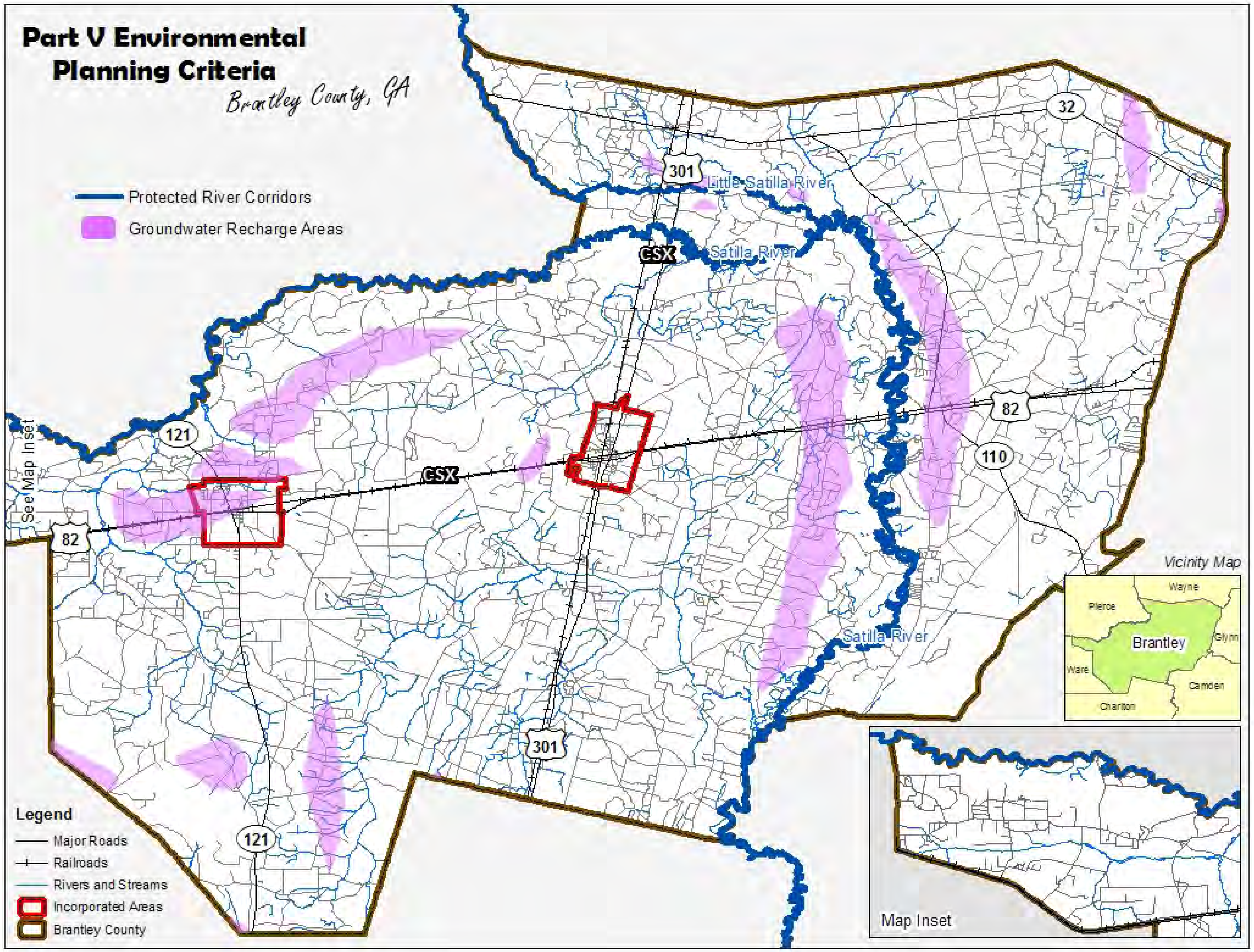


Figure 13: Part V Environmental Planning Criteria

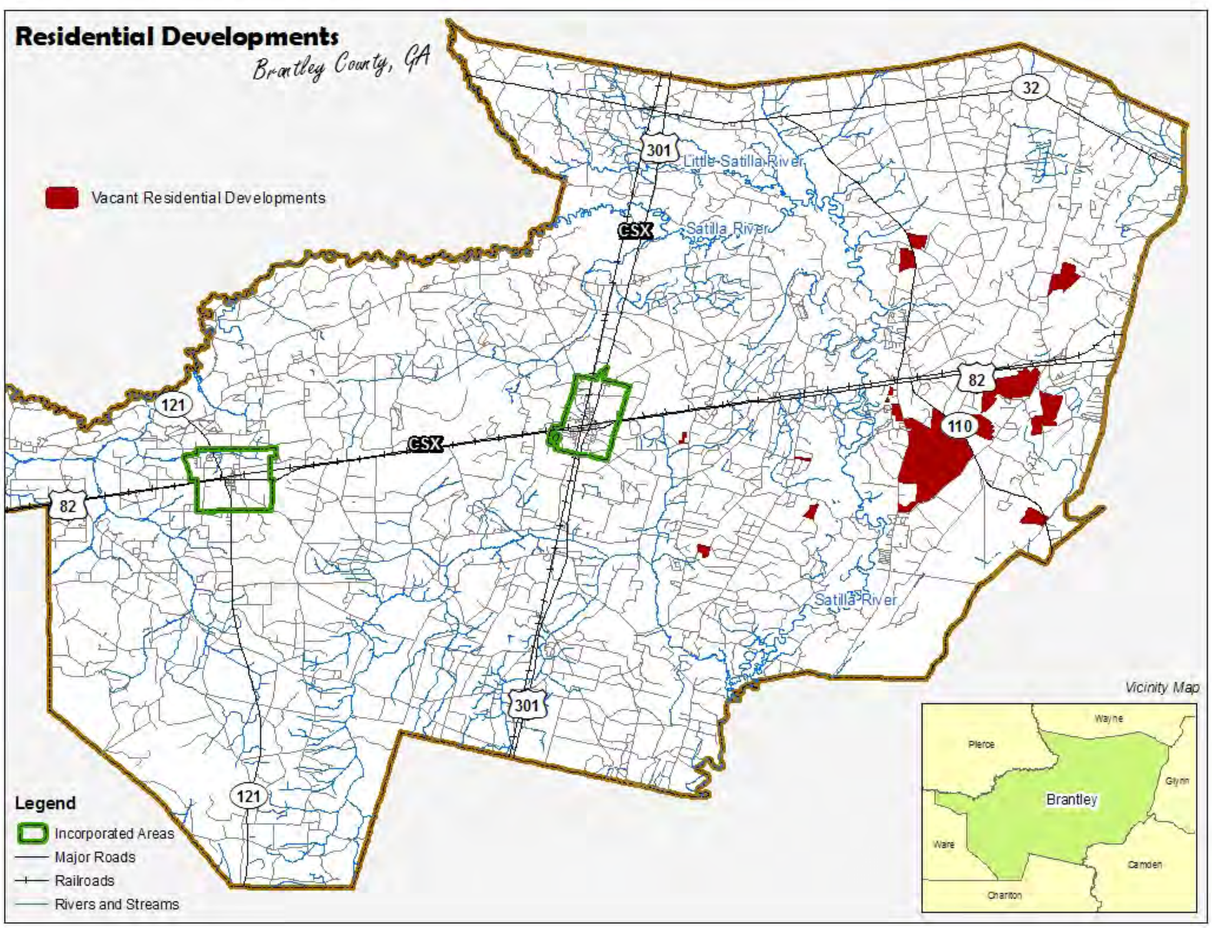


Infill Development Areas

Brantley County, like many communities in Georgia, is facing issues related to partially-developed, vacant land that is the result of the downturn in the housing market. There are currently 3,600 (approximate) platted, vacant lots within completed subdivision, as identified in Figure 13. The County should work with the local and regional development agencies to prioritize and market these properties for future homebuilding sites. Furthermore, the County should look to support infill development within these existing subdivisions as opposed to the conversion of agricultural or undeveloped land into new residential subdivision. This will help maintain the rural character of the County and protect the quality of life that is so valuable to current residents and an asset to those who might build in Brantley in the future.

The County should be aware that land uses and development within these existing subdivisions is largely controlled through the covenants that were put in place by the developer. These covenants are not enforceable by the County, and are only as good as the oversight of the developer and any existing residents. The County should consider the adoption of land use/zoning codes to protect these areas from undesirable and inconsistent types of development. However, in doing so, the County should be flexible in what it considers to be compatible types of development. For example, some neighborhood commercial uses, such as a café, may be appropriate within a residential area and may allow for the more rapid development of the 3,600 vacant lots.

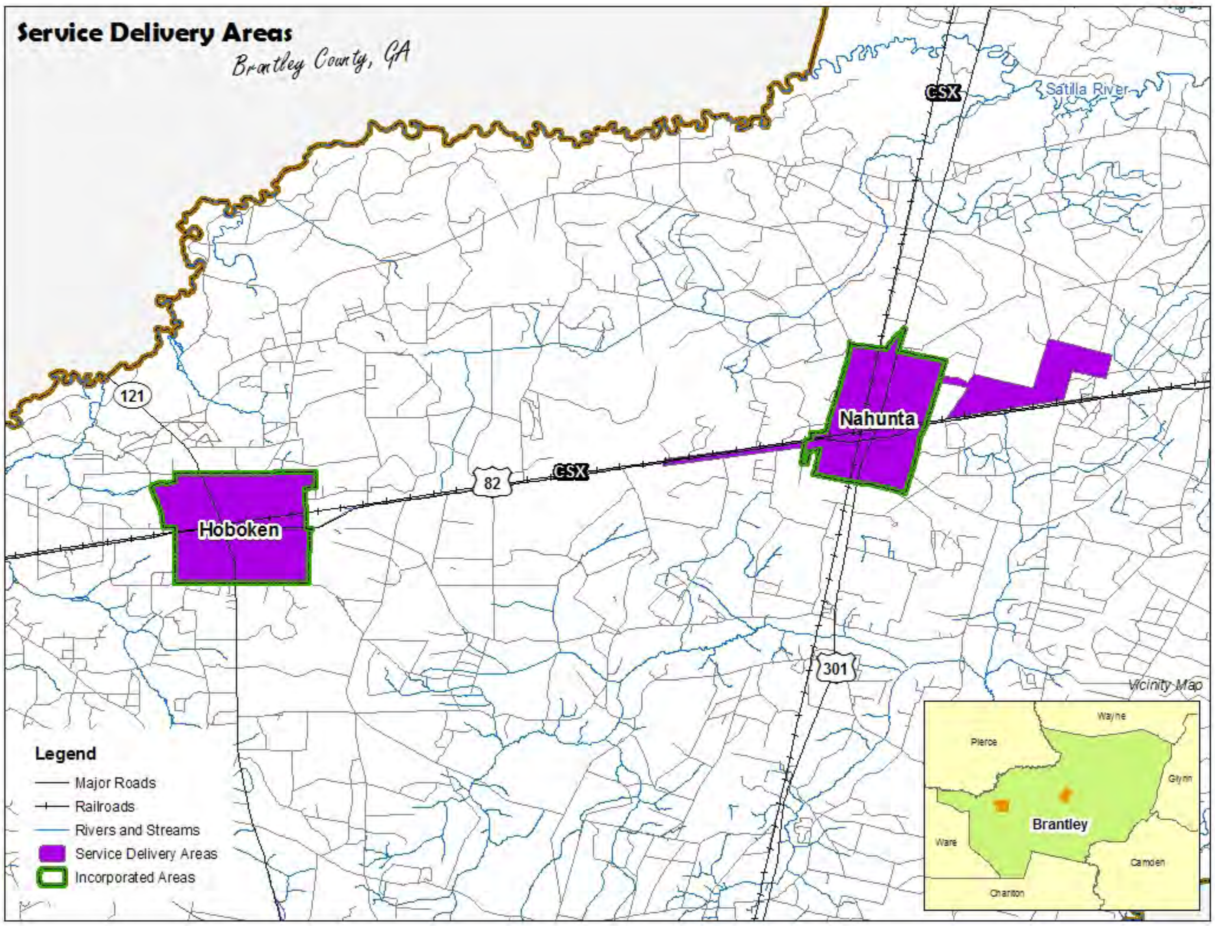
Figure 13: Vacant Residential Developments



Existing Infrastructure

The Cities of Nahunta operates water and sewer system and Hoboken operates a water system within their service areas as identified on the map in Figure 14. The Nahunta system includes the entire city as well as some areas within unincorporated Brantley County directly adjacent to State Route 82. There is potential for Nahunta to serve future development within unincorporated Brantley County with the existing infrastructure along SR 82, as long as the capacity is there within the systems. Hoboken service area is currently the municipal boundaries. Any potential for future service within unincorporated Brantley County will be contingent on capacity and the construction of additional infrastructure to expand the service area. All other areas of Brantley County are currently serviced either by private water and/or sanitary system or by individual well and septic systems.

Figure 14: Utility Service Delivery Area



Goals and Objectives

Brantley County has established the following list of goals and objectives to assist in guiding future growth within the County. The various elected and appointed Boards of Brantley County should consider the following goals and objectives when making decision related to future land use.

Goal: Understand and manage our expectation for growth

Objectives:

- Adopt a land use/zoning code that will ensure that future development is consistent with the Future Development Strategy
- Promote development on the existing 3,600 platted and vacant parcels. Infill development within these existing subdivisions should be prioritized above new development in undeveloped areas.
- Work with the Development Authority to better understand and support economic drivers for future growth.
- Identify and strive to protect the valuable natural and cultural resources within the County.

Goal: Ensure that future development is coordinated appropriately with water and sanitary sewer service areas.

Objectives:

- Review the future delivery strategy when approving new projects adjacent sanitary sewer or public water.
- Wherever feasible, require new development within the service delivery areas to tie onto public utilities.
- Work with Nahunta and Hoboken to increase the capacity to serve future development with public water and sewer.

Goal: Minimize impacts on natural resources

Objectives:

- Ensure that the County's land use codes offer adequate protection for natural resources. In particular, the County should enforce the applicable Part V Environmental Planning Criteria.
- Support projects that feature the Satilla River as an eco-tourism destination.
- Encourage the voluntary preservation of greenspace in new development through incentives.

Goal: Consider the suitability of soils for septic systems and proposed development

Objectives:

- Perform a soil survey of Brantley County.

- Brantley County should only approve subdivisions in areas with low soil suitability if the proposed wastewater system has been approved by the Brantley County Health Department or Georgia Environmental Protection Division.

Goal: Consider the impact to the functionality of the floodplain, and ensure that new development is protected from flooding.

Objectives:

- Participate with the Coastal Resources Division and neighboring Counties in the LIDAR project.
- Continue to participate in the National Flood Insurance Program.
- Work to secure funding and partnerships to update flood plain maps (DFIRMs) and prioritize areas likely to develop.
- Adopt and implement the most recent version of FEMA's flood damage prevention ordinance.
- Ensure that any future development in the regulated floodplain is consistent with FEMA standards.

Goal: Consider the impact to the transportation system as well as local transportation plans and projects.

Objectives:

- Work with DOT to develop an Access Management Plan for major State roadways and thoroughfares.
- Continue with the County paving program and the plan to pave prioritized roadways.
- Classify its roadways to help with future prioritization for paving.
- Require future development with potential regional impacts that is subject to the requirements of a "Development of Regional Impact" DRI to perform a traffic analysis prior to development approval by the County.

Goal: Consider impacts to local economy, particularly the agricultural industry.

Objectives:

- Provide incentives for the voluntary preservation of active agricultural lands.
- Ensure that agricultural uses are included in any future land use/zoning code.

Recommendations

It is the recommendation of this Future Land Use Plan that Brantley County considers the adoption of a zoning code as a tool for implementing the Future Development Strategy. Conventional zoning can be utilized to help achieve the goals set forth in this plan and to ensure the future land use decision are consistent with the Future Development Strategy. However, there may initially be some political and public resistance to adoption of a Zoning Ordinance, and the County must be considerate of this as they move forward with implementation of this plan. The County should review the zoning codes of surrounding counties with similar characteristics and determine what regulations may be applicable or desirable to Brantley County. The County may also wish to consider certain elements of the DCA's "Model Land Use Management Code" which was created for small agriculturally-based cities and counties that need protection from land use problems, are experiencing some growth, but have yet been unable to adopt conventional zoning.

Any land use/zoning regulations, adopted by the County, should address the desired development patterns for the character areas described herein. The regulations should attempt to address both the allowed uses and the design of the development. Based on the Character Areas presented herein, the County should consider regulations that address the following uses:

- Conservation
- Agriculture
- Low Density Residential
- High Density Residential
- Mixed Use
- Public/Institutional
- Neighborhood Commercial
- Highway Commercial
- Light Industrial
- Heavy Industrial

Any future zoning ordinance should be coordinated with the County's existing suite of ordinances, particularly the Subdivision Ordinance. Furthermore, the County should consider this document an extension of the 2006 Comprehensive Plan, and implementation of the goals and strategy herein will be part of the 2006 Comprehensive Plan compliance effort.

APPENDIX G

Report of Subsurface Investigation and Well Installation Project

Brantley County Site
Nahunta, Georgia
AEM Project No. J1557

prepared by:

Advanced Environmental Management, Inc.
3482 Keith Bridge Road
Cumming, Georgia 30041
770-242-8282

Darrell L. Webb, PE
Principal Engineer

July 9, 2016

Boring and Sampling Program

Twelve (12) Standard Penetration Test borings were conducted at the approximate locations shown in Attachment I in accordance with standard ASTM procedures. Borings were advanced using 4.25" I.D. hollow stem augers advanced into the ground using an ATV-mounted Drill Rig. This drilling method minimizes the disturbance of subsurface materials and contamination of the groundwater. All drilling equipment was steam cleaned before use and between locations to prevent introducing contamination. Split spoon samples were obtained at 5' intervals during drilling using the Standard Penetration Test (SPT) Method (ASTM D-1586). The SPT method involves driving the spoon 18" using a 140 pound hammer dropped 30". The number of blows required to drive the sampling spoon each 6" interval is recorded. The number of blows required to drive the spoon the final 12" is termed the Standard Penetration Resistance or N-value and is widely correlated with soil strength and density.

Subsurface Conditions

The borings typically encountered Sands (SM) of the Coastal Plain Province with varying but minor silt and clay fractions. Clay content tended to increase slightly with depth. Color generally ranged from dark brown/black near the ground surface to grey-green near termination depths. Groundwater was encountered at the time of boring within 5 feet of the ground surface in all twelve borings. Conditions were largely consistent across the site.

For a more detailed description of subsurface conditions encountered, please refer to the attached boring logs (Attachment II).

Sampling

In addition to the Split Spoon Samples collected from the SPT borings, relatively undisturbed (Shelby Tube) samples were collected for laboratory testing from 10 of the 12 borings. Shelby Tube samples could not be recovered from the remaining two borings (P-05 and P-09).

Laboratory Testing

Three (3) Shelby Tubes from representative strata were tested for Cation Exchange Capacity (CEC), Vertical Hydraulic Conductivity and Grain Size Distribution. Additionally, 6 SPT samples were submitted for Loss on Ignition (LOI) testing to quantify organic content.

Laboratory results are outlined in the following tables and complete reports are included in Attachment III. Laboratory results indicate a consistency in parameter values across the site. In AEM's opinion, the values across the remainder of the site are in line with the reported values.

Test Results – Shelby Tubes

Boring Number	*Depth of Sample*	*Total Cation Exchange Capacity*	*Vertical Hydraulic Conductivity (K_v)*
P-08	9’-11'	6.5 meq/100g	1.9 x 10^{-5} cm/sec
P-11	14’-16'	1.1 meq/100g	3.2 x 10^{-6} cm/sec
P-12	20’-22'	2.8 meq/100g	2.4 x 10^{-4} cm/sec

Test Results – SPT Samples

Boring Number	*Depth of Sample*	*Loss on Ignition (LOI)*
P-02	3.5’-5'	3.16%
P-03	3.5’-5'	6.09%
P-06	3.5’-5'	6.17%
P-07	3.5’-5'	6.27%
P-10	3.5’-5'	1.8%
P-12	3.5’-5'	3.77%

Monitoring Well Construction Material

Well construction materials used are generally considered sufficiently durable to resist chemical and physical degradation and yet not interfere with the quality of groundwater samples. This assumption is in keeping with the generally accepted practices of the environmental consulting profession. However, the soil chemistry in some locations may lead to chemical degradation of PVC materials. Materials used for the well casing, well screen, filter pack, and annular seal are covered in this section. See Attachment II for more detailed documentation of each well.

Well Casings and Screens

ASTM, NSF rated, Schedule 40, 2-inch PVC was used for the casing pipe and well screen for all wells at this site. The screen length for each well was 10 feet. PVC pipe sections are all flush threaded. No solvents or glues were used in well construction. All well casings and screens were factory cleaned prior to installation and were removed from their protective boxes and plastic covers immediately prior to placement in the well. Workers handling well materials wore new latex gloves.

Filter Pack and Annular Sealant

The materials used to construct the filter pack for the piezometer portion of each well was a chemically inert, NSF-Rated, clean, quartz, sand (Morie #00, 20-40 sand). A gradation curve for the filter pack is attached. Fabric filters were not used as filter pack materials. The sand filter packs were installed 1 to 2 feet above the top of the screen interval in each well.

The materials used to seal the annular space above the sand pack were designed to prevent cross contamination between strata. The materials are chemically inert to ensure seal integrity during the life of the monitoring well. Certified, coarse grit, sodium bentonite pellets were placed immediately over the filter pack to isolate the screened interval from shallower formations. The bentonite seal was placed above the filter pack by dropping pellets directly down the borehole. Field taping measurements were used to verify bridging did not occur. The seal was extended from the top of the sand pack to the ground surface. The bentonite pellets were hydrated using clean potable water from a public supply located onsite. No well water from the vicinity of the landfill was used for hydration or decontamination.

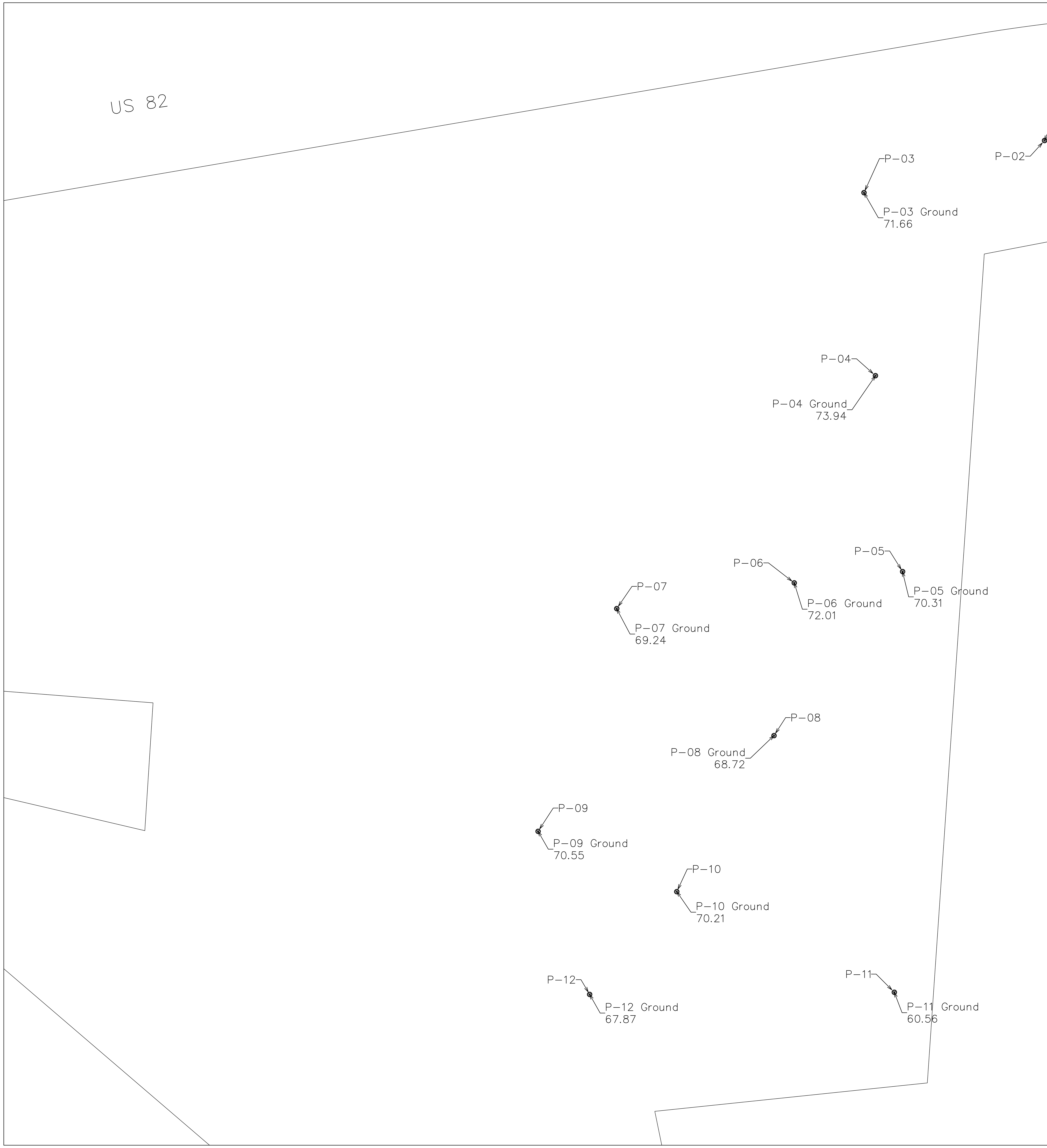
Well Intake Design

The design and construction of the piezometer intake of the monitoring well should: (1) allow sufficient groundwater flow to the well for water level measurement; (2) minimize the passage of formation materials (turbidity) into the well; and (3) ensure sufficient structural integrity to prevent the collapse of the intake structure.

The intake of the monitoring wells consists of a screen with openings sized to minimize the potential for formational material passing through the well. Screen size was selected to retain 90% of the filter pack. For quality-control purposes, only commercially manufactured screens were used.

ATTACHMENT I

BORING LOCATION PLAN



Point Table

Point #	Well Number	Top of Well Elevation	Northing	Easting	Latitude	Longitude
3	P-02	77.01	445603.0939	765895.9719	N31° 13' 29.142"	W81° 48' 56.185"
6	P-04	78.91	444149.9991	764850.8142	N31° 13' 14.792"	W81° 49' 08.275"
8	P-06	77.12	442869.4502	764348.9763	N31° 13' 02.134"	W81° 49' 14.101"
10	P-05	75.36	442939.3278	765018.6864	N31° 13' 02.804"	W81° 49' 06.386"
12	P-08	73.69	441925.6540	764223.8597	N31° 12' 52.796"	W81° 49' 15.576"
14	P-11	65.54	440339.6329	764967.4284	N31° 12' 37.075"	W81° 49' 07.070"
16	P-10	75.01	440961.2120	763622.8880	N31° 12' 43.269"	W81° 49' 22.531"
18	P-09	75.74	441334.0133	762765.6001	N31° 12' 46.985"	W81° 49' 32.390"
20	P-12	71.35	440326.3188	763084.2705	N31° 12' 37.002"	W81° 49' 28.756"
22	P-07	74.66	442710.4848	763251.7442	N31° 13' 00.594"	W81° 49' 26.743"
24	P-03	76.48	445280.9774	764779.9627	N31° 13' 25.988"	W81° 49' 09.050"
27	P-01	69.96	445422.4945	767163.9615	N31° 13' 27.314"	W81° 48' 41.588"

Point Table

Point #	DESCRIPTION	Ground Elevation
2	P-02 Ground	72.48
5	P-04 Ground	73.94
7	P-06 Ground	72.01
9	P-05 Ground	70.31
11	P-08 Ground	68.72
13	P-11 Ground	60.56
15	P-10 Ground	70.21
17	P-09 Ground	70.55
19	P-12 Ground	67.87
21	P-07 Ground	69.24
23	P-03 Ground	71.66
28	P-01 Ground	64.97

POINTS LISTED ARE BASED ON GEORGIA HORIZONTAL COORDINATE SYSTEM (NAD83), EAST ZONE AND THE NORTH AMERICAN VERTICAL DATUM 9navd0 OF 19888.

GEORGIA
REGISTERED
2973
LAND SURVEYOR
CHARLES H. TOMBERLIN

STATE OF GEORGIA

Field Work: CHT,DT
Survey Date: 04-18-2016
Plat By: David
Plat Date: 04-19-2016
Checked By: CHT
Ref. File TestWells

PREPARED BY:

CHARLES H.
TOMBERLIN and
ASSOCIATES

LAND SURVEYING

CHARLES H. TOMBERLIN REGISTERED LAND SURVEYOR #2973
PO BOX 71
WAYCROSS, GEORGIA 31502
PH. 912-283-2973

ATTACHMENT II

BORING AND WELL
CONSTRUCTION DOCUMENTATION

CONTINUATION CERTIFICATE
To be attached to and form a part of Bond described below.

Smith Manus
SURETY BONDS

Lexon Insurance Company
10002 Shelbyville Road
Suite 100
Louisville, KY 40223

Water Well Standards Advisory Council, c/o
Regulatory Support Program
2 Martin Luther King, Jr. Dr.
Suite 1366
Atlanta, GA 30334

Date: 19-Mar-14

Re: Drilling Solutions, Inc.
180 Gateway Drive
Canton, GA 30115
Bond #: 1088108

The Lexon Insurance Company, hereinafter called the "Company," as Surety on Bond No.: 1088108 issued on the 30th day of JUNE, 2012 on behalf of Drilling Solutions, Inc., Principal, in favor of Water Well Standards Advisory Council, c/o Regulatory Support Program, Obligee, hereby certify that this bond is continued in full force and effect until the 30th day of JUNE, 2016, subject to all covenants and conditions of said bond.

This bond, in the current sum of TWENTY THOUSAND AND 00/100 Dollars ($20,000.00), has been continued in force upon the express condition that the full extent of the Company's liability under said bond and all continuations thereof for any loss or series of losses occuring during the entire time the Company remains on said bond shall in no event exceed the sum of the bond.

In witness whereof the Company has caused this instrument to be duly signed, sealed and dated as of the 19th day of MARCH, 2014.

Lexon Insurance Company
Surety

By ______________________
Jill Kemp *Attorney-in-Fact*

Bond Number 1088108

Performance Bond For Water Well Contractors And Drillers

Name of Water Well Contractor or Driller Drilling Solutions, Inc.

Know All Men By These Present.
That we Drilling Solutions, Inc. and any and all Employees, Officers and Partners, as Principal, and Lexon Insurance Company as Surety, are held and firmly bound unto the Director of the Environmental Protection Division (Director), Department of Natural Resources, State of Georgia and his or her Successor or Successors in office, as Obligee, in the full sum of **TWENTY THOUSAND AND NO/OO DOLLARS ($20.000.00)** for the payment of which will and truly to be made, we bind ourselves, our heir, administrators, successors and assigns, jointly and severally, by the present.

WHEREAS, the WATER WELL STANDARDS ACT OF 1985 (Ga. Laws 1985.P 1192) (the "ACT") requires that water well contractors and drillers file performance bonds with the director to ensure compliance with the ACT; and WHEREAS the above bound PRINCIPAL is subject to the terms and provisions of said ACT. NOW, THEREFORE, the conditions of this obligation are such that if the above bound PRINCIPAL shall fully and faithfully perform the duties and in all things comply with the procedures and standards set forth in the ACT as now and hereafter amended, and the rules and regulations promulgated pursuant thereto, including but not limited to the correction of any violation of such procedures and standards upon discovery, irrespective of whether such discovery is made before completion of any well subject to this bond, then this obligation shall be void; otherwise of full force and effect.

And Surety, for value received, agrees that no amendment to existing laws, rules or regulations, or adoption of new laws, rules or regulations shall in anyway discharge its obligation on this bond, and does hereby waive notice of any such amendment, adoption or modification.

This bond shall be effective from date of issuance and shall continue in effect until terminated by expiration, mutual agreement or cancellation upon 60 days written notice to Principal and Obligee; provided that the rights of the obligee and beneficiaries under this bond which arose prior to such termination shall continue.

The bond is effective June 30, 2012 and unless sooner terminated, this bond shall terminate June 30, 2014. In Witness Thereof the Principal and Surety have caused these present to be duly signed and sealed, this 30th day of, June 2012.

Drilling Solutions, Inc.

PRINCIPAL, BY ______________________ (L.S.)
Anthony Trettel

TITLE: President

SURETY BY: ______________________
Jill Kemp, Attorney-in-Fact

GEORGIA REGISTERED AGENT N/A SEAL:

POWER OF ATTORNEY

Lexon Insurance Company

LX - 053590

KNOW ALL MEN BY THESE PRESENTS, that **LEXON INSURANCE COMPANY**, a Texas Corporation, with its principal office in Louisville, Kentucky, does hereby constitute and appoint: Brook T. Smith, Kathy Hobbs, Raymond M. Hundley, Jason D. Cromwell, James H. Martin, Sandra F. Harper, Myrtie F. Henry, Deborah Neichter, Jill Kemp, Jackie C. Koestel, Sheryon Quinn, Dawson West, Bonnie J. Wortham, Amy Meredith, Lynnette Long

its true and lawful Attorney(s)-In-Fact to make, execute, seal and deliver for, and on its behalf as surety, any and all bonds, undertakings or other writings obligatory in nature of a bond.

This authority is made under and by the authority of a resolution which was passed by the Board of Directors of **LEXON INSURANCE COMPANY** on the 1st day of July, 2003 as follows:

Resolved, that the President of the Company is hereby authorized to appoint and empower any representative of the Company or other person or persons as Attorney-In-Fact to execute on behalf of the Company any bonds, undertakings, policies, contracts of indemnity or other writings obligatory in nature of a bond not to exceed $ 4,000,000.00 Four million dollars ** dollars, which the Company might execute through its duly elected officers, and affix the seal of the Company thereto. Any said execution of such documents by an Attorney-In-Fact shall be as binding upon the Company as if they had been duly executed and acknowledged by the regularly elected officers of the Company. Any Attorney-In-Fact, so appointed, may be removed for good cause and the authority so granted may be revoked as specified in the Power of Attorney.

Resolved, that the signature of the President and the seal of the Company may be affixed by facsimile on any power of attorney granted, and the signature of the Assistant Secretary, and the seal of the Company may be affixed by facsimile to any certificate of any such power and any such power or certificate bearing such facsimile signature and seal shall be valid and binding on the Company. Any such power so executed and sealed and certificate so executed and sealed shall, with respect to any bond of undertaking to which it is attached, continue to be valid and binding on the Company.

IN WITNESS THEREOF, **LEXON INSURANCE COMPANY** has caused this instrument to be signed by its President, and its Corporate Seal to be affixed this 21st day of September, 2009.

LEXON INSURANCE COMPANY A TEXAS INSURANCE COMPANY

LEXON INSURANCE COMPANY

BY [signature]

David E. Campbell
President

ACKNOWLEDGEMENT

On this 21st day of September, 2009, before me, personally came David E. Campbell to me known, who being duly sworn, did depose and say that he is the President of **LEXON INSURANCE COMPANY**, the corporation described in and which executed the above instrument; that he executed said instrument on behalf of the corporation by authority of his office under the By-laws of said corporation.

"OFFICIAL SEAL"
MAUREEN K. AYE
Notary Public, State of Illinois
My Commission Expires 09/21/13

Maureen K. Aye
Maureen K. Aye
Notary Public

CERTIFICATE

I, the undersigned, Assistant Secretary of **LEXON INSURANCE COMPANY**, A Texas Insurance Company, DO HEREBY CERTIFY that the original Power of Attorney of which the foregoing is a true and correct copy, is in full force and effect and has not been revoked and the resolutions as set forth are now in force.

Signed and Sealed at Woodridge, Illinois this 30th Day of June, 2012.

LEXON INSURANCE COMPANY A TEXAS INSURANCE COMPANY

Philip G. Lauer
Philip G. Lauer
Assistant Secretary

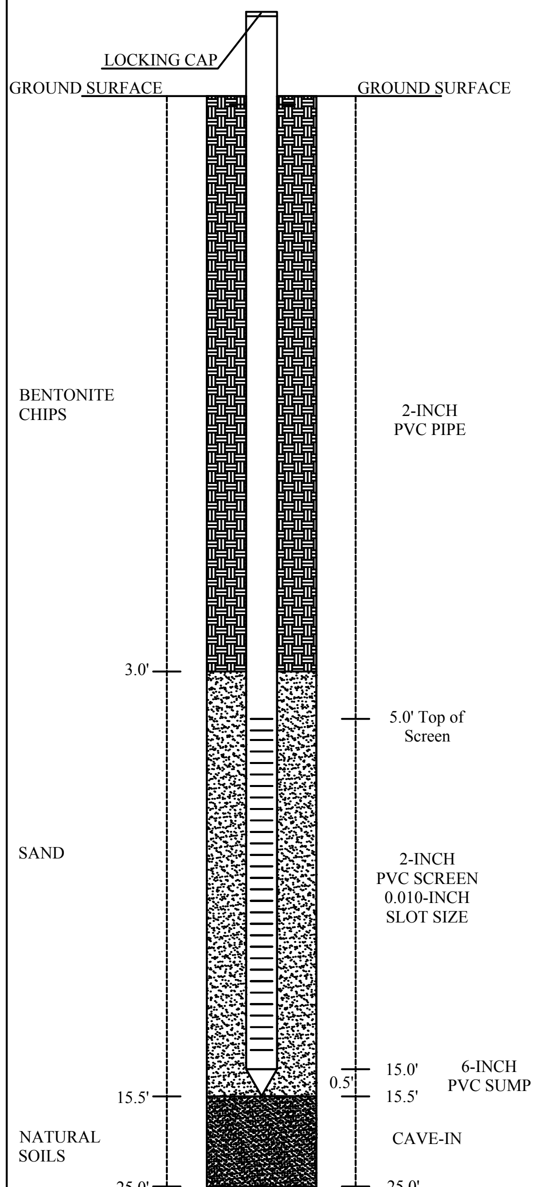
"WARNING: Any person who knowingly and with intent to defraud any insurance company or other person, files an application for insurance or statement of claim containing any materially false information, or conceals for the purpose of misleading, information concerning any fact material thereto, commits a fraudulent insurance act, which is a crime and subjects such person to criminal and civil penalties."

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-01

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-15-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.4 FEET 3-16-16
5	**SM** - Brown fine SAND w/trace Silt, wet (Coastal)	13-23-35	
10	- Tan	10-14-23	
15	- Tan-Brown	8-16-22	
20	- Tan-White	6-2-1	
25	- Light Grey with Green tint	2-4-3	
	Boring Terminated at 25'	UD	24" RECOVERY

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 6 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

WELL NO. P-01
Well Design and Construction Documentation

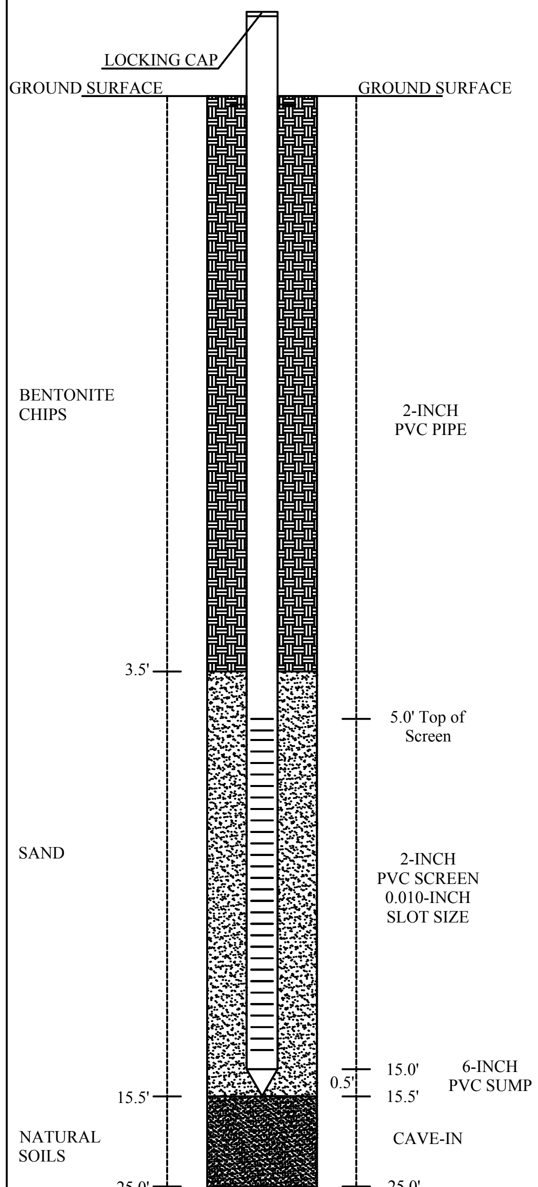
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/15/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5')
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	69.96 feet
Ground Elevation:	64.97 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.0 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.99 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.99 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-02

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-16-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.5 FEET 3-17-16
5	**SM** - Brown-Black fine SAND w/trace Silt, wet (Coastal)	8-11-19	
10		18-30-38	
15	- Brown, Red-Brown	28-30-42 UD	12" RECOVERY (refusal)
20	- Tan	9-19-23	
25	Boring Terminated at 25'	3-7-7	

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - __1__ BAG/50 LBS/0.5 FT³
SAND - __7__ BAGS/__50__ LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

<u>WELL NO. P-02</u>

Well Design and Construction Documentation

Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/16/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5’)
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	77.01 feet
Ground Elevation:	72.48 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.5 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.5 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.53 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.53 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-03

FACILITY NAME: BRANTLEY COUNTY

PERMIT NUMBER: NA

GEOLOGIST/ENGINEER: DARRELL L. WEBB

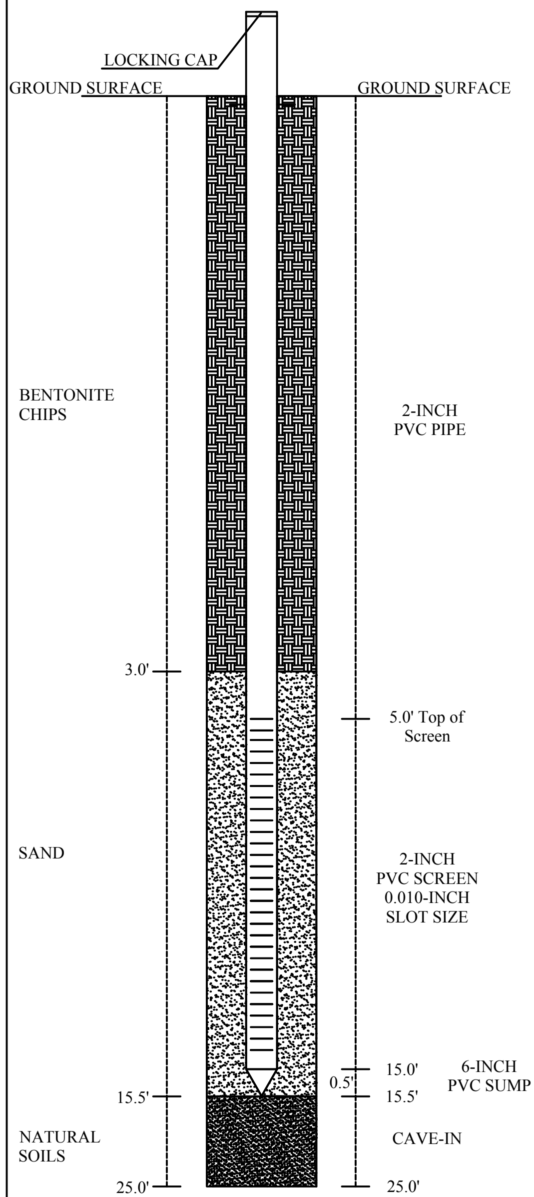
INSTALLATION DATE: 3-16-16

DRILLING COMPANY: DRILLING SOLUTIONS, INC.

DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.2 FEET 3-17-16
5	**SM** - Black fine SAND w/trace Silt, wet (Coastal)	7-11-20	6" RECOVERY (Refusal)
		UD	
10	- Mottled, Black and Brown	21-50/4"	
15	- Red-Brown	50/6"	
20	- Red-Brown, Tan	10-28-36	
25	- Grey-Green	2-2-2	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³

SAND - 8 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.

3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041

PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

<u>WELL NO. P-03</u>
Well Design and Construction Documentation

Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/16/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5')
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	76.48 feet
Ground Elevation:	71.66 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	4.0 feet^3
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.82 feet
Bentonite Volume (Theoretical):	0.5 feet^3
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.82 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

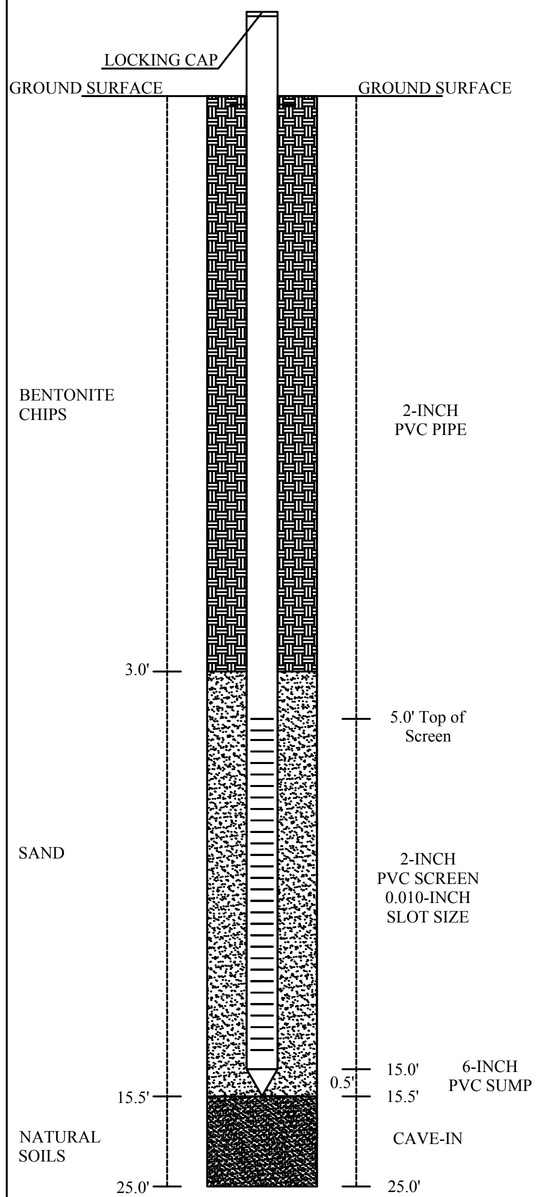
GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-04

FACILITY NAME: BRANTLEY COUNTY
GEOLOGIST/ENGINEER: DARRELL L. WEBB
DRILLING COMPANY: DRILLING SOLUTIONS, INC.

PERMIT NUMBER: NA
INSTALLATION DATE: 3-16-16
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 3.2 FEET 3-17-16
5	**SM** - Grey-White fine SAND w/trace Silt and organics, wet (Fill)	2-3-4	
10	**SM** - Black-Brown fine SAND w/trace Silt, wet (Coastal)	10-28-36	
15	- Brown to Red-Brown, Fine to Medium SAND	18-32-48	
20	- Tan	UD	24" RECOVERY
25	- Grey-Green, very fine SAND	3-2-3	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 8 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

WELL NO. P-04
Well Design and Construction Documentation

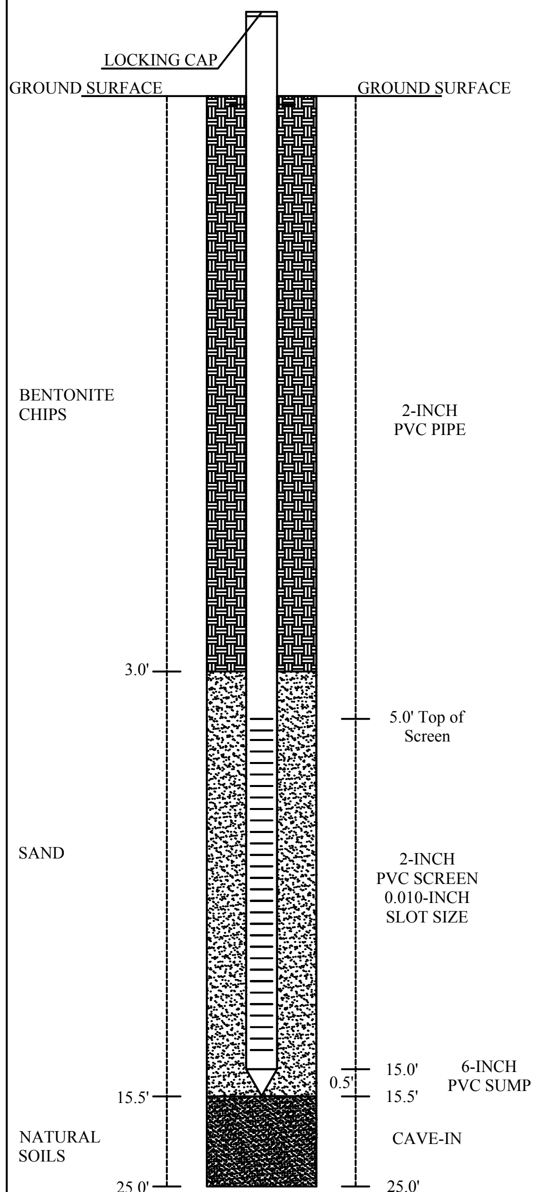
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/16/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5’)
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	78.91 feet
Ground Elevation:	73.94 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	4.0 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.97 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.97 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-05

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-16-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.5 FEET 3-17-16
5	**SM** - Brown SAND w/trace Silt, wet (Coastal)	UD	NO RECOVERY
10	- dark Brown	10-26-28	
15	- Brown	4-18-29	
20	- light Brown	8-12-15	
25	- Grey-Green, very fine SAND	3-4-6	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 7 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

WELL NO. P-05
Well Design and Construction Documentation

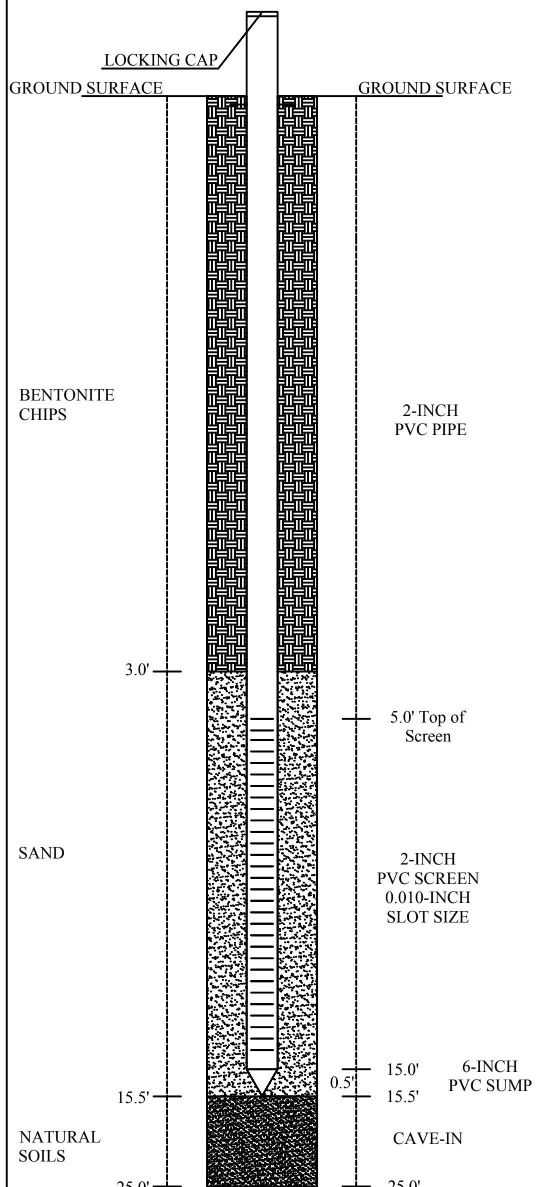
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/16/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5’)
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	75.36 feet
Ground Elevation:	70.31 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.5 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	10.05 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	5.05 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-06

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-16-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.1 FEET 3-17-16
5	**SM** - Black SAND w/trace Silt, wet (Coastal)	8-14-20	
10	- Brown, Black	6-20-26	
15		14-24-30	
20	- light Brown	3-6-8	
25	- Grey-Green, very fine SAND Boring Terminated at 25'	UD	12" RECOVERY

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 7.5 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

<u>WELL NO. P-06</u>
Well Design and Construction Documentation

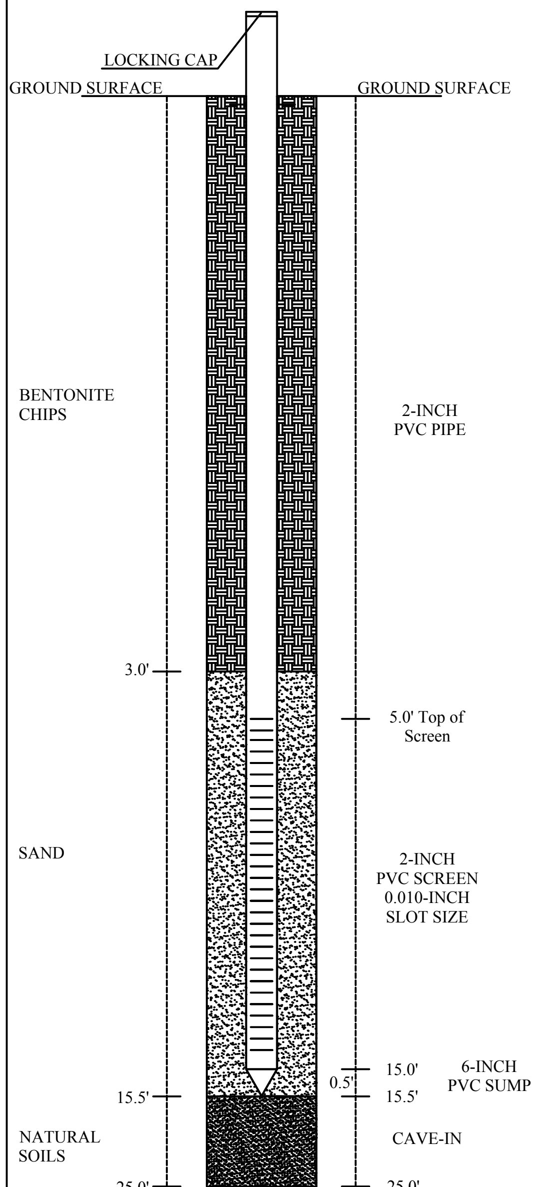
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/16/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5')
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	77.12 feet
Ground Elevation:	72.01 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.75 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	10.11 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	5.11 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-07

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-17-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.1 FEET 3-17-16
5	**SM** - Black SAND w/trace Silt and organics, wet (Coastal)	6-7-7	
10	- dark Brown	11-17-20	
15	- mottled Brown and Black	16-28-33	
20		UD	24" RECOVERY
25	- Grey-Green, very fine SAND	0-1-2	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 8 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

<u>WELL NO. P-07</u>
Well Design and Construction Documentation

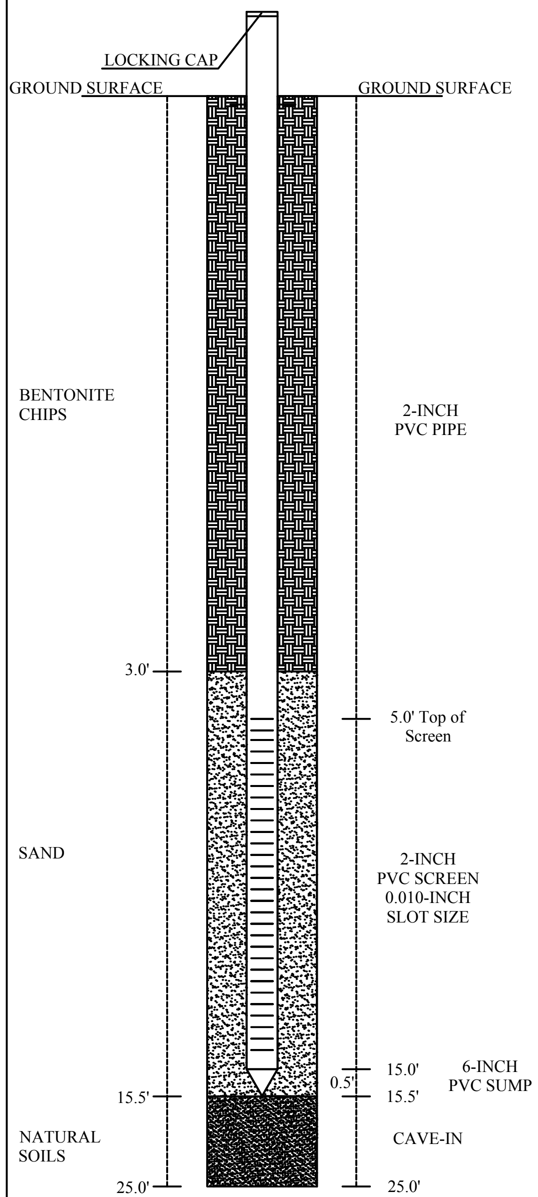
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/17/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5’)
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	74.66 feet
Ground Elevation:	69.24 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	4.0 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	10.42 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	5.42 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-08

FACILITY NAME: BRANTLEY COUNTY
GEOLOGIST/ENGINEER: DARRELL L. WEBB
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
PERMIT NUMBER: NA
INSTALLATION DATE: 3-17-16
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 3 FEET 3-17-16
5	**SM** - Black fine SAND w/trace Silt, wet (Coastal)	6-7-7	
10		UD	24" RECOVERY (tube deformed)
15	- Red-Brown and Tan with ¼" lenses of dark Brown medium SAND	20-32-45	
20		20-19-7	
25	- Grey-Green, very fine SAND	8-11-12	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 8 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

WELL NO. P-08
Well Design and Construction Documentation

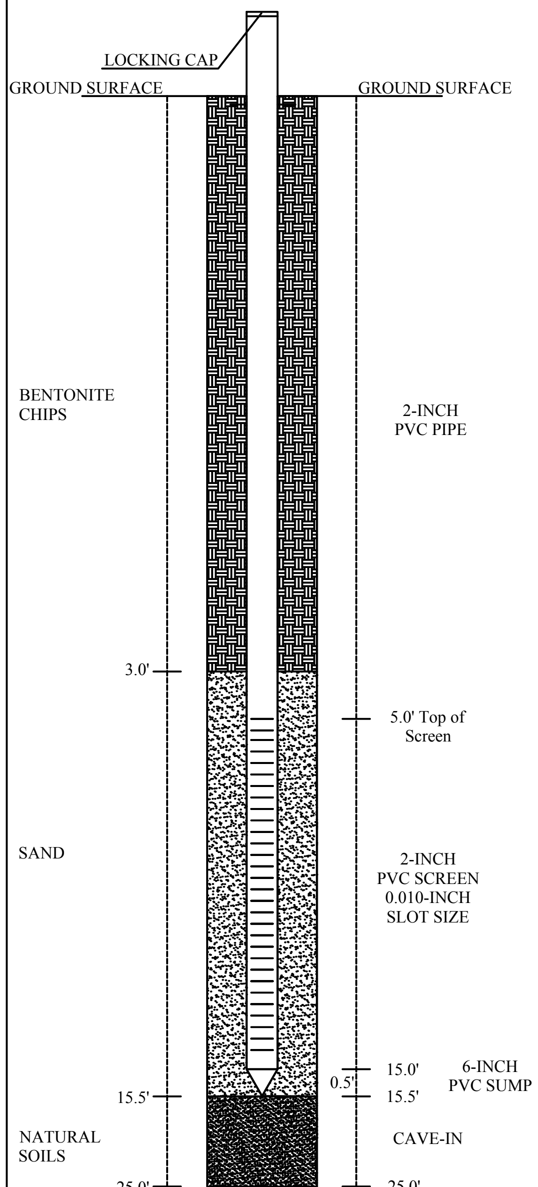
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/17/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5')
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	73.69 feet
Ground Elevation:	68.72 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	4.0 feet^3
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.97 feet
Bentonite Volume (Theoretical):	0.5 feet^3
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.97 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-09

FACILITY NAME: BRANTLEY COUNTY — PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB — INSTALLATION DATE: 3-17-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC. — DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
0–3			GROUNDWATER @ 3 FEET 3-17-16
5	**SM** - Black fine SAND w/trace Silt, wet (Coastal)	UD	NO RECOVERY
10	- dark Brown	13-20-24	
15	- Red-Brown	8-12-18	
20	- mottled Red-Brown and Tan	8-6-16	
25	- Grey-Green, very fine SAND	3-6-8	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 7.5 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

WELL NO. P-09
Well Design and Construction Documentation

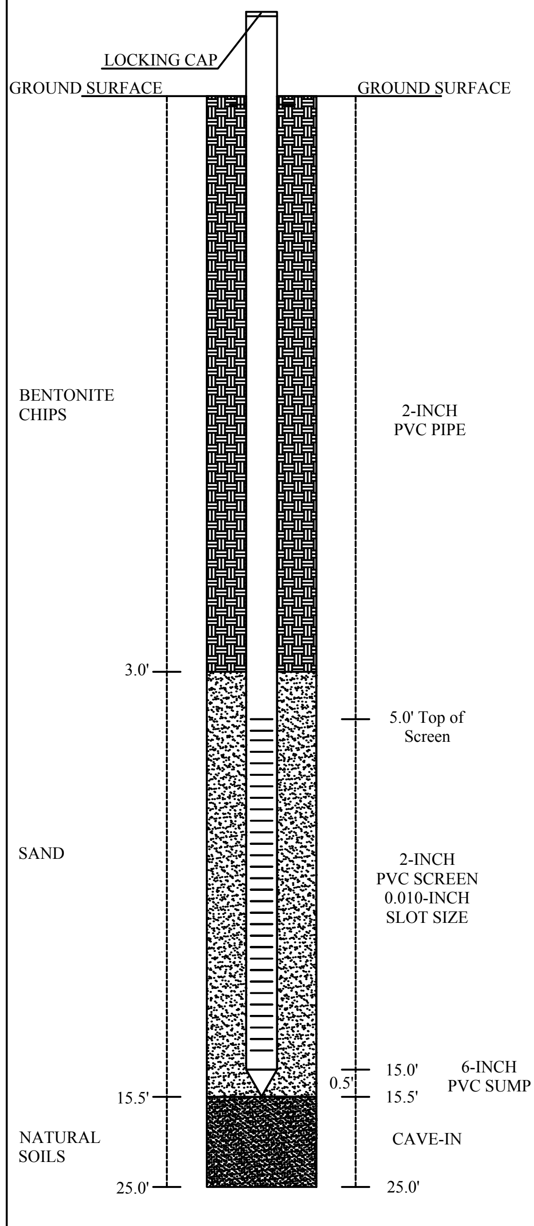
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/17/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5’)
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	75.74 feet
Ground Elevation:	70.55 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.75 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	10.19 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	5.19 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-10

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-17-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 1/4" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 3 FEET 3-17-16
5	**SM** - Black and Brown fine SAND w/trace Silt and organics, wet (Coastal)	2-2-2	
10	- Black	12-18-22	
15	- Brown and Black with $\frac{1}{4}$" lenses of dark Brown medium SAND	12-24-26	
20	- Red-Brown	7-24-35	
25	- Grey-Green, very fine SAND Boring Terminated at 25'	UD	24" RECOVERY

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 6.5 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.

3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

WELL NO. P-10
Well Design and Construction Documentation

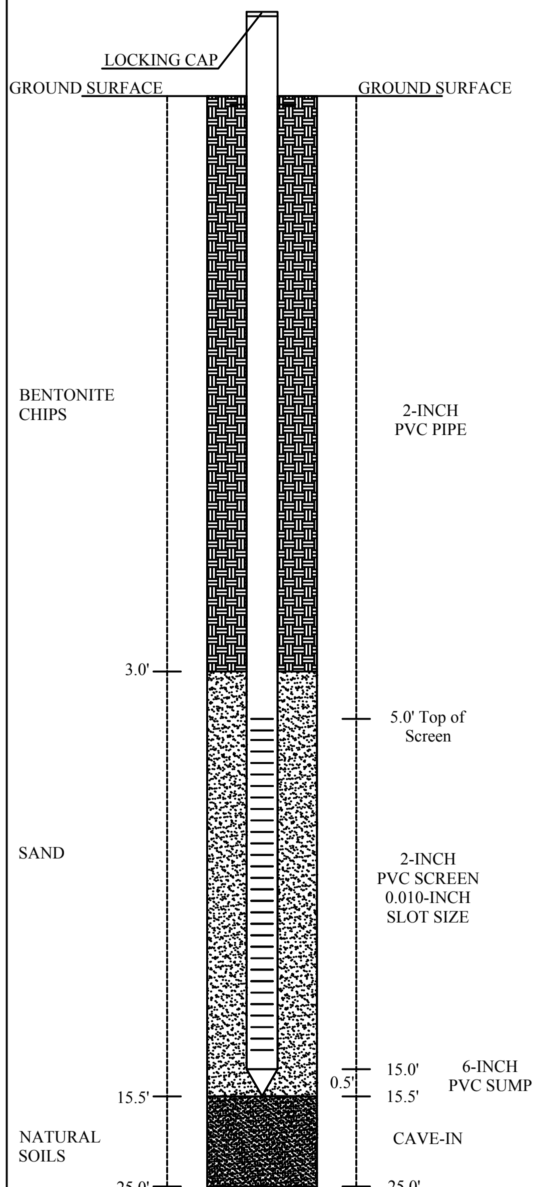
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/17/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5’)
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	75.01 feet
Ground Elevation:	70.21 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.25 $feet^3$
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.80 feet
Bentonite Volume (Theoretical):	0.5 $feet^3$
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.80 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-11

FACILITY NAME: BRANTLEY COUNTY
PERMIT NUMBER: NA
GEOLOGIST/ENGINEER: DARRELL L. WEBB
INSTALLATION DATE: 3-17-16
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 1.5 FEET 3-17-16
5	**SM** - Grey fine SAND w/trace Silt and organics, wet (Coastal)	3-2-1	
10	- Black	5-10-12	
15		UD	24" RECOVERY
20	**SC** - Grey-green fine SAND w/trace Clay (Coastal)	2-3-4	
25	- some Clay	6-7-8	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 6 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

<u>WELL NO. P-11</u>
Well Design and Construction Documentation

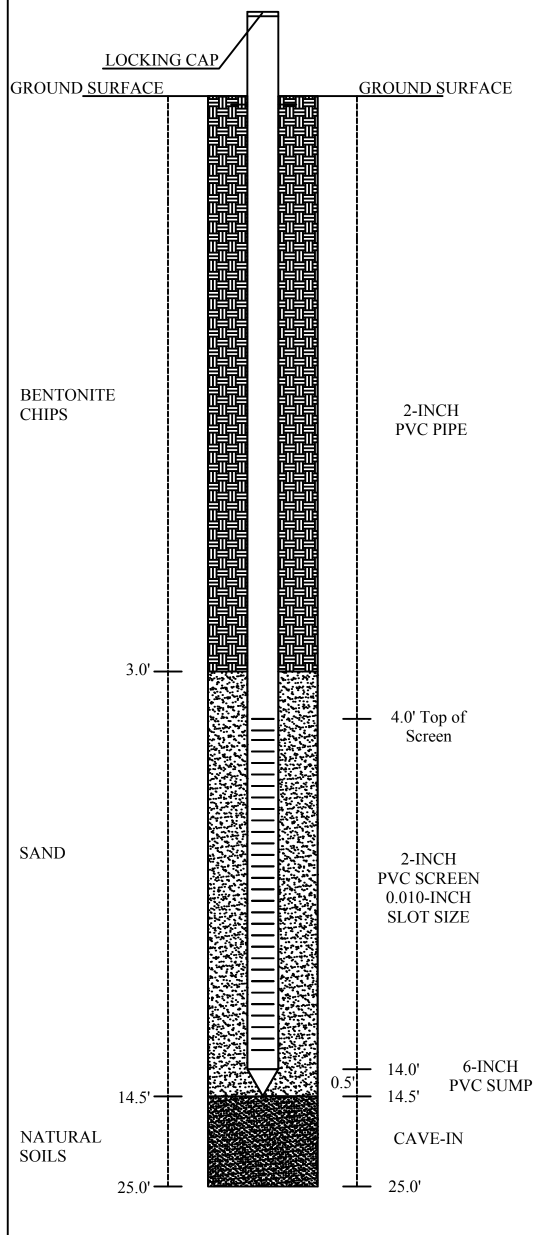
Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/17/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5')
Well Depth:	15.5 feet BGS
Top of PVC Casing Elev.:	65.54 feet
Ground Elevation:	60.56 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.0 feet^3
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	9.98 feet
Bentonite Volume (Theoretical):	0.5 feet^3
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	4.98 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

GROUNDWATER MONITORING WELL
LOG OF BORING AND COMPLETION DETAILS
P-12

FACILITY NAME: BRANTLEY COUNTY
GEOLOGIST/ENGINEER: DARRELL L. WEBB
DRILLING COMPANY: DRILLING SOLUTIONS, INC.
PERMIT NUMBER: NA
INSTALLATION DATE: 3-15-16
DRILLING METHOD: 4 ¼" HSA

DEPTH (FEET)	LITHOLOGIC DESCRIPTION	BLOWS PER 6"	NOTES
			GROUNDWATER @ 2.8 FEET 3-16-16
5	**SM** - Black fine SAND w/trace Silt and organics, wet (Coastal)	14-17-10	
10	- Mottled, Black and Brown	15-32-37	
15	- Red-Brown	40-50+	
20	- Tan	6-8-8	
		UD	24" RECOVERY
25	- Light Grey with Green tint	6-7-3	
	Boring Terminated at 25'		

CONSTRUCTION DETAILS



QUANTITIES

BENTONITE CHIPS - 1 BAG/50 LBS/0.5 FT³
SAND - 7 BAGS/ 50 LBS/____ FT³

ADVANCED ENVIRONMENTAL MANAGEMENT, INC.
3482 KEITH BRIDGE ROAD #137; CUMMING, GA 30041
PHONE: 770-242-8282; FAX: 678-648-1795; E-MAIL: DLW@AEM-GA.COM

<u>WELL NO. P-12</u>

Well Design and Construction Documentation

Job Name:	Brantley County Proposed Landfill
Date of Construction:	03/15/16
Well Construction Details:	Attached
Borehole Depth:	25.0 feet BGS (Caved to 15.5')
Well Depth:	14.5 feet BGS
Top of PVC Casing Elev.:	71.35 feet
Ground Elevation:	67.87 feet
Borehole Diameter:	8.25 inch
Length of end plug:	0.5 feet
Length of screen:	10.0 feet
Depth to top of filter pack:	3.0 feet BGS
Filter Pack Material/Size:	20/40 Silica Sand
Filter Pack Volume (Theoretical):	3.5 feet^3
Filter Pack Placement Method:	Gravity
Sealant Materials:	NSF Rated, Certified Coarse Grit Bentonite Chips
Length of Riser:	7.48 feet
Bentonite Volume (Theoretical):	0.5 feet^3
Sealant Placement Method:	Gravity/Washed-Hydrated with Potable Water
Depth to top of bentonite:	0.0 feet BGS
Screen Slot Size/Length:	0.010-inch X 10 feet
Stick-up:	3.48 feet
Type of Protective Cover:	NA
Surface Seal Design/Construction:	NA
Well Development Method:	NA
Driller:	Drilling Solutions, Inc.
Drill Rig:	ATV-Mounted
Drilling Method:	4.25" I.D. Hollow-stem Auger
Well Location:	Attached
Lithologic Logs:	Attached
Riser Materials:	ASTM 2" dia. PVC, NSF Rated
Screen Materials:	ASTM 2" dia. PVC, NSF Rated
Riser and Screen Joint Type:	Flush Threaded

ATTACHMENT III

LABORATORY REPORTS

1 2 3 4 5 6 7 8 9 10 11

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Savannah
5102 LaRoche Avenue
Savannah, GA 31404
Tel: (912)354-7858

TestAmerica Job ID: 680-123910-1
Client Project/Site: Brantley County

For:
Advanced Environmental Management Inc.
3842 Keith Bridge Road
#137
Cumming, Georgia 30041

Attn: Darrell Webb

Authorized for release by:
4/29/2016 2:59:05 PM

Jess Hornsby, Project Manager I
(813)885-7427
jess.hornsby@testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Sample Summary

Client: Advanced Environmental Management Inc.
Project/Site: Brantley County

TestAmerica Job ID: 680-123910-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
680-123910-1	P-08	Solid	04/08/16 00:00	04/08/16 13:00
680-123910-2	P-11	Solid	04/08/16 00:00	04/08/16 13:00
680-123910-3	P-12	Solid	04/08/16 00:00	04/08/16 13:00

Job ID: 680-123910-1

Laboratory: TestAmerica Savannah

Narrative

Receipt
The samples were received on 4/8/2016 1:00 PM; the samples arrived in good condition.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Subcontract Work
Methods Grain Size with Hydrometer, Hydraulic Conductivity: These methods were subcontracted to Kemron Environmental Svcs, Inc. - Atlanta. The subcontract laboratory certifications are different from that of the facility issuing the final report.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Detection Summary

Client: Advanced Environmental Management Inc.
Project/Site: Brantley County

TestAmerica Job ID: 680-123910-1

Client Sample ID: P-08

Lab Sample ID: 680-123910-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	6.5		1.0		meq/100gm	1		9081	Total/NA

Client Sample ID: P-11

Lab Sample ID: 680-123910-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	1.1		1.0		meq/100gm	1		9081	Total/NA

Client Sample ID: P-12

Lab Sample ID: 680-123910-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	2.8		1.0		meq/100gm	1		9081	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: P-08
Date Collected: 04/08/16 00:00
Date Received: 04/08/16 13:00

Lab Sample ID: 680-123910-1
Matrix: Solid

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	6.5		1.0		meq/100gm		04/19/16 12:11	04/28/16 17:12	1

Client Sample Results

Client: Advanced Environmental Management Inc.
TestAmerica Job ID: 680-123910-1
Project/Site: Brantley County

Client Sample ID: P-11
Lab Sample ID: 680-123910-2
Date Collected: 04/08/16 00:00
Matrix: Solid
Date Received: 04/08/16 13:00

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	1.1		1.0		meq/100gm		04/19/16 12:11	04/28/16 17:12	1

1 2 3 4 5 6 7 8 9 10 11

Client Sample Results

Client Sample ID: P-12
Date Collected: 04/08/16 00:00
Date Received: 04/08/16 13:00

Lab Sample ID: 680-123910-3
Matrix: Solid

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	2.8		1.0		meq/100gm		04/19/16 12:11	04/28/16 17:12	1

Method	Method Description	Protocol	Laboratory
9081	Cation Exchange Capacity (CEC)	SW846	TAL NSH
Grain Size with Hydrometer	General Sub Contract Method	NONE	Kemron ATL
Hydraulic Conductivity	General Sub Contract Method	NONE	Kemron ATL

Protocol References:

NONE = NONE

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

Kemron ATL = Kemron Environmental Svcs, Inc. - Atlanta, 1359A Ellsworth Industrial Blvd., Atlanta, GA 30318, TEL (404)636-0928

TAL NSH = TestAmerica Nashville, 2960 Foster Creighton Drive, Nashville, TN 37204, TEL (615)726-0177

Certification Summary

Client: Advanced Environmental Management Inc. TestAmerica Job ID: 680-123910-1
Project/Site: Brantley County

Laboratory: TestAmerica Savannah

The certifications listed below are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
GA Dept. of Agriculture	State Program	4	N/A	06-12-17
Georgia	State Program	4	803	06-30-16

Laboratory: TestAmerica Nashville

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
A2LA	A2LA		NA: NELAP & A2LA	12-31-16
A2LA	ISO/IEC 17025		0453.07	12-31-17
Alaska (UST)	State Program	10	UST-087	07-24-16
Arizona	State Program	9	AZ0473	05-05-17
Arkansas DEQ	State Program	6	88-0737	04-25-17
California	State Program	9	2938	10-31-16
Connecticut	State Program	1	PH-0220	12-31-17
Florida	NELAP	4	E87358	06-30-16
Georgia	State Program	4	N/A	06-30-16
Illinois	NELAP	5	200010	12-09-16
Iowa	State Program	7	131	04-01-16 *
Kansas	NELAP	7	E-10229	05-31-16 *
Kentucky (UST)	State Program	4	19	06-30-16
Kentucky (WW)	State Program	4	90038	12-31-16
Louisiana	NELAP	6	30613	06-30-16
Maine	State Program	1	TN00032	11-03-17
Maryland	State Program	3	316	03-31-17
Massachusetts	State Program	1	M-TN032	06-30-16
Minnesota	NELAP	5	047-999-345	12-31-16
Mississippi	State Program	4	N/A	06-30-16
Montana (UST)	State Program	8	NA	02-24-20
Nevada	State Program	9	TN00032	07-31-16
New Hampshire	NELAP	1	2963	10-09-16
New Jersey	NELAP	2	TN965	06-30-16
New York	NELAP	2	11342	03-31-17
North Carolina (WW/SW)	State Program	4	387	12-31-16
North Dakota	State Program	8	R-146	06-30-16
Ohio VAP	State Program	5	CL0033	07-10-17
Oklahoma	State Program	6	9412	08-31-16
Oregon	NELAP	10	TN200001	04-27-16 *
Pennsylvania	NELAP	3	68-00585	06-30-16
Rhode Island	State Program	1	LAO00268	12-30-15 *
South Carolina	State Program	4	84009 (001)	02-28-16 *
South Carolina (Do Not Use - DW)	State Program	4	84009 (002)	12-16-17
Tennessee	State Program	4	2008	02-23-17
Texas	NELAP	6	T104704077	08-31-16
USDA	Federal		S-48469	10-30-16
Utah	NELAP	8	TN00032	07-31-16
Virginia	NELAP	3	460152	06-14-16
Washington	State Program	10	C789	07-19-16
West Virginia DEP	State Program	3	219	02-28-17
Wisconsin	State Program	5	998020430	08-31-16
Wyoming (UST)	A2LA	8	453.07	12-31-17

* Certification renewal pending - certification considered valid.

KEMRON ENVIRONMENTAL SERVICES

1359-A Ellsworth Industrial Blvd • Atlanta, GA 30318 • TEL 404-636-0928 • FAX 404-636-7162

April 25, 2016

TestAmerical Laboratories, Inc.
2960 Foster Creighton Drive
Nashville, TN 37204

Re: Final Letter Report of Geotechnical Testing
Brantley County
TestAmerica Project No. 68013756
KEMRON ATG Project No. SH0604

Dear Ms. Hornsby:

Enclosed, please find the testing results for three samples received on April 8, 2016 for Geotechnical testing.

This letter report includes the supporting laboratory data and the sample chain of custody. KEMRON performed the following methods for the referenced samples:

Particle Size Distribution with Hydrometer – ASTM D422
Hydraulic Conductivity – ASTM D5084

KEMRON Environmental Services, Inc. appreciates this opportunity to provide laboratory services to TestAmerica Laboratories, Inc. If you have any questions, or require additional information, please contact me at (404) 636-0928.

Sincerely,

KEMRON Environmental Services, Inc.

Tommy A. Jordan, P.G.
Program Manager

Attachments: Table 1 – Summary of Geotechincal Testing
Particle Size Distribution Reports
Hydraulic Conductivity Data Sheets
Chain of Custoday

TESTAMERICA
BRANTLEY COUNTY
KEMRON PROJECT No. SH0616

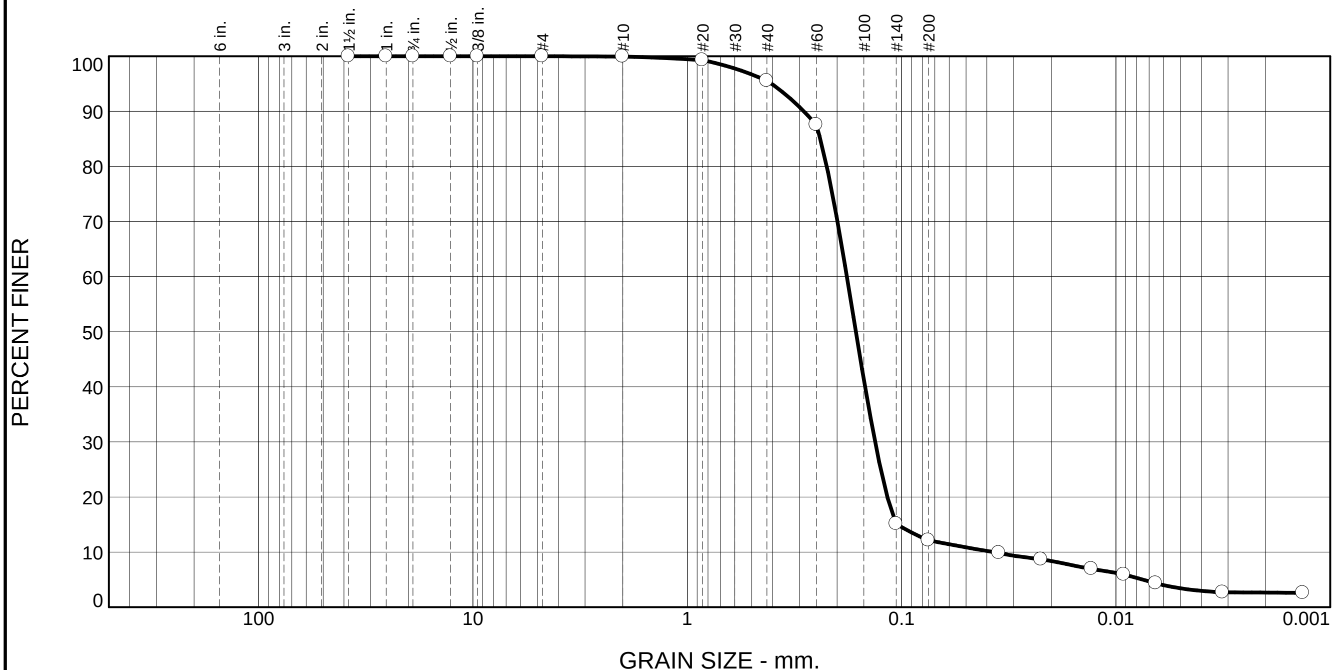
Table 1

Summary of Geotechnical Testing Results

Sample Identification	Soil Description	Soil Classification (USCS)	Natural ASTM Moisture %	Grain Size Distribution				Hydraulic Conductivity			
				% Gravel	% Sand	% Silt	% Clay	Moisture Content (%)	Bulk Density (lb/ft^3)	Dry Density (lb/ft^3)	K (cm/sec)
P-08 (680-123910-1)	Black silty sand	SM	28.5	0.0	87.9	8.7	3.4	30.34	114.7	88.0	1.9E-05
P-11 (680-123910-2)	Black silty sand	SM	30.6	0.0	78.8	14.9	6.3	28.80	122.8	95.3	3.2E-06
P-12 (680-123910-3)	Black poorly graded sand with silt	SP-SM	23.4	0.0	91.3	5.2	3.5	36.77	118.4	86.5	2.4E-04

Notes:
*Sample description and classification is based on visual classification where Atterberg limits were not perfomed
Color determined by Munsell's Color Chart for Soils
% - Percent
lb/ft^3 = Pounds Per Cubic Foot
Grain Size Distribution- ASTM D422
Moisture Content- ASTM D2216
Soil Classification USCS- ASTM D2487
Hydraulic Conductivity- ASTM D5084

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	4.3	83.5	8.7	3.4

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1.0	100.0		
0.75	100.0		
0.5	100.0		
0.375	100.0		
#4	100.0		
#10	99.9		
#20	99.3		
#40	95.6		
#60	87.6		
#140	15.1		
#200	12.1		
0.0351 mm.	9.8		
0.0223 mm.	8.7		
0.0130 mm.	6.9		
0.0092 mm.	5.9		
0.0065 mm.	4.3		
0.0032 mm.	2.7		
0.0013 mm.	2.6		

* (no specification provided)

Material Description

Black silty sand

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=**

Coefficients

D_{90}= 0.2859 D_{85}= 0.2396 D_{60}= 0.1800
D_{50}= 0.1634 D_{30}= 0.1330 D_{15}= 0.1047
D_{10}= 0.0372 C_u= 4.84 C_c= 2.64

Remarks

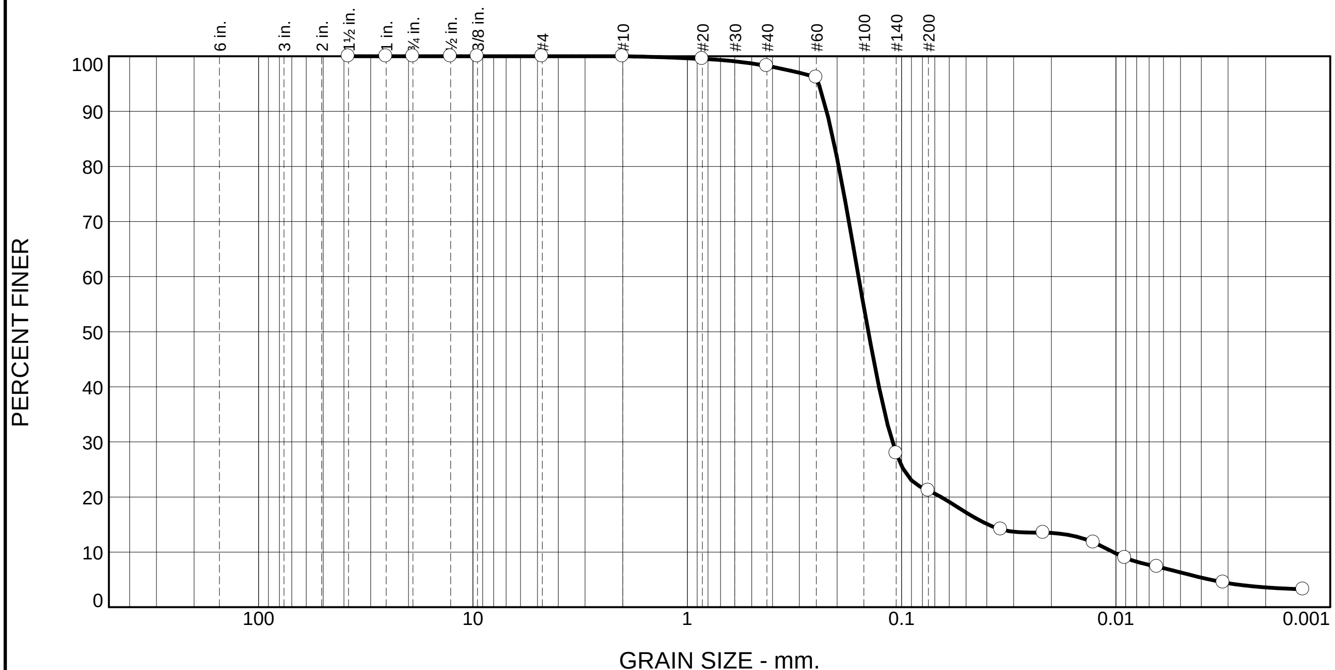
Date Received: 4/8/16 **Date Tested:** 4/13/16
Tested By: LC
Checked By: TAJ
Title: Program Manager

Sample Number: P-08 (680-123910-1) **Date Sampled:** 4/13/16

KEMRON Environmental Services Inc.
Atlanta, Georgia

Client: TestAmerica
Project: Brantley County
Project No: SH0616 **Figure** A781_GR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.8	77.0	14.9	6.3

TEST RESULTS (ASTM D 422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1.0	100.0		
0.75	100.0		
0.5	100.0		
0.375	100.0		
#4	100.0		
#10	100.0		
#20	99.5		
#40	98.2		
#60	96.2		
#140	27.9		
#200	21.2		
0.0344 mm.	14.1		
0.0218 mm.	13.5		
0.0127 mm.	11.8		
0.0091 mm.	9.0		
0.0064 mm.	7.4		
0.0032 mm.	4.5		
0.0013 mm.	3.2		

* (no specification provided)

Material Description

Black silty sand

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= SM **AASHTO (M 145)=**

Coefficients

D_{90}= 0.2237 D_{85}= 0.2089 D_{60}= 0.1588
D_{50}= 0.1430 D_{30}= 0.1104 D_{15}= 0.0395
D_{10}= 0.0103 C_u= 15.41 C_c= 7.44

Remarks

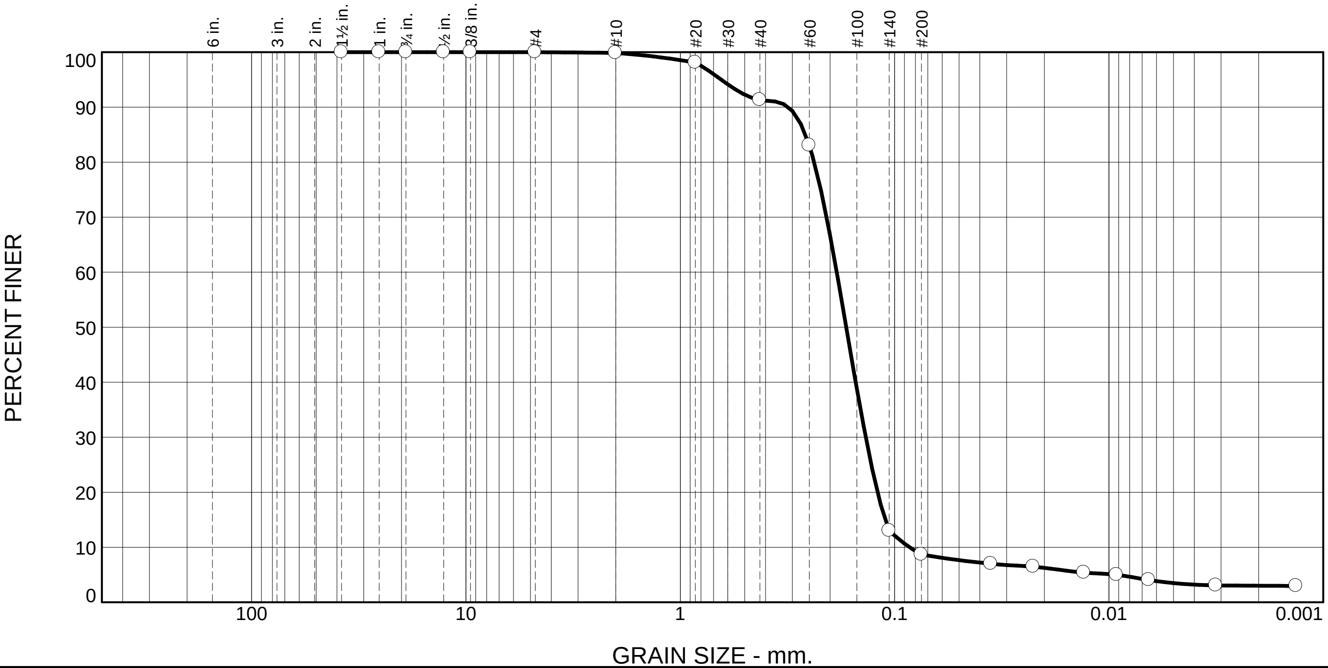
Date Received: 4/8/16 **Date Tested:** 4/13/16
Tested By: LC
Checked By: TAJ
Title: Program Manager

Sample Number: P-11 (680-123910-2) **Date Sampled:** 4/13/16

KEMRON Environmental Services Inc.
Atlanta, Georgia

Client: TestAmerica
Project: Brantley County
Project No: SH0616 **Figure** A782_GR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	8.5	82.6	5.2	3.5

TEST RESULTS (ASTM D 422)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1.0	100.0		
0.75	100.0		
0.5	100.0		
0.375	100.0		
#4	100.0		
#10	99.8		
#20	98.1		
#40	91.3		
#60	83.0		
#140	13.0		
#200	8.7		
0.0355 mm.	7.0		
0.0225 mm.	6.5		
0.0131 mm.	5.4		
0.0092 mm.	5.0		
0.0065 mm.	4.0		
0.0032 mm.	3.1		
0.0013 mm.	3.0		

* (no specification provided)

Material Description

Black poorly graded sand with silt

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)=

Coefficients

D_{90}= 0.3131 D_{85}= 0.2604 D_{60}= 0.1862
D_{50}= 0.1681 D_{30}= 0.1363 D_{15}= 0.1106
D_{10}= 0.0851 C_u= 2.19 C_c= 1.17

Remarks

Date Received: 4/8/16 **Date Tested:** 4/13/16

Tested By: LC

Checked By: TAJ

Title: Program Manager

Sample Number: P-12 (680-123910-3) **Date Sampled:** 4/13/16

KEMRON Environmental Services Inc.
Atlanta, Georgia

Client: TestAmerica
Project: Brantley County
Project No: SH0616 **Figure** A783_GR

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PERMEABILITY ASTM D5084

SPECIMEN CONDITIONS

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		

MOISTURE CONTENT (Dry Basis)	***INITIAL***		***FINAL***	
1. MOISTURE TIN NO.				
2. WT MOISTURE TIN (tare weight)	0.00	***g***	207.03	***g***
3. WT WET SOIL + TARE	437.70	***g***	637.20	***g***
4. WT DRY SOIL + TARE	335.82	***g***	542.85	***g***
5. WT WATER, Ww	101.88	g	94.35	g
6. WT DRY SOIL, Ws	335.82	g	335.82	g
7. MOISTURE CONTENT, W	30.34	%	28.10	%

SOIL SPECIMEN DIMENSIONS				
TRIPLICATE	***DIAMETER***		***HEIGHT***	
ANALYSES	***INITIAL***	***FINAL***	***INITIAL***	***FINAL***
No. 1	***2.72 in.***	***2.71 in.***	***2.61 in.***	***2.38 in.***
No. 2	***2.70 in.***	***2.77 in.***	***2.43 in.***	***2.31 in.***
No. 3	***2.72 in.***	***2.77 in.***	***2.49 in.***	***2.58 in.***
Average	2.72 in.	2.75 in.	2.51 in.	2.42 in.

SPECIMEN CONDITIONS	***INITIAL***	***FINAL***
Specimen WT, Wo	***437.70 g***	***430.17 g***
Area, Ao	5.79 in²	5.93 in²
Volume, Vo	14.53 in³	14.37 in³
Bulk Unit Weight	114.7 lb/ft³	114.0 lb/ft³
Dry Unit Weight	88.0 lb/ft³	89.0 lb/ft³

PERMEABILITY ASTM D5084

BACK-PRESSURE SATURATION

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		

			TEST PRESSURES (psi)						
TEST	***TIME***	***TESTED***	***APPLIED***		***PORE***		***PRESSURE CHANGE***		
DATE	***(military)***	***BY***	***CELL***	***BACK***	***SAT.***	***TEST***	***CELL***	***PORE***	***B-Value***
04/18/16	8 : 20	JDM	7.0	5.0	5.6	[redacted]			
04/18/16	10 : 12	JDM	17.0	15.0	15.5	10.9	10.0	5.3	0.53
04/18/16	15 : 52	JDM	27.0	25.0	25.5	22.5	10.0	7.0	0.70
04/18/16	14 : 15	JDM	37.0	35.0	35.5	33.7	10.0	8.2	0.82
04/18/16	15 : 15	JDM	47.0	45.0	45.4	44.3	10.0	8.8	0.88
04/18/16	15 : 49	JDM	57.0	55.0	55.6	54.8	10.0	9.4	0.94
04/19/16	8 : 15	JDM	67.0	65.0	*	65.5	10.0	9.9	0.99
04/19/16	8 : 15	JDM	57.0	55.0	*	*	*	*	*

* Saturation check - no data available.

PERMEABILITY ASTM D5084

SPECIMEN CONSOLIDATION

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		

CELL PRESSURE: 60 psi **BACK PRESSURE:** 55 psi **EFFECTIVE STRESS:** 5 psi

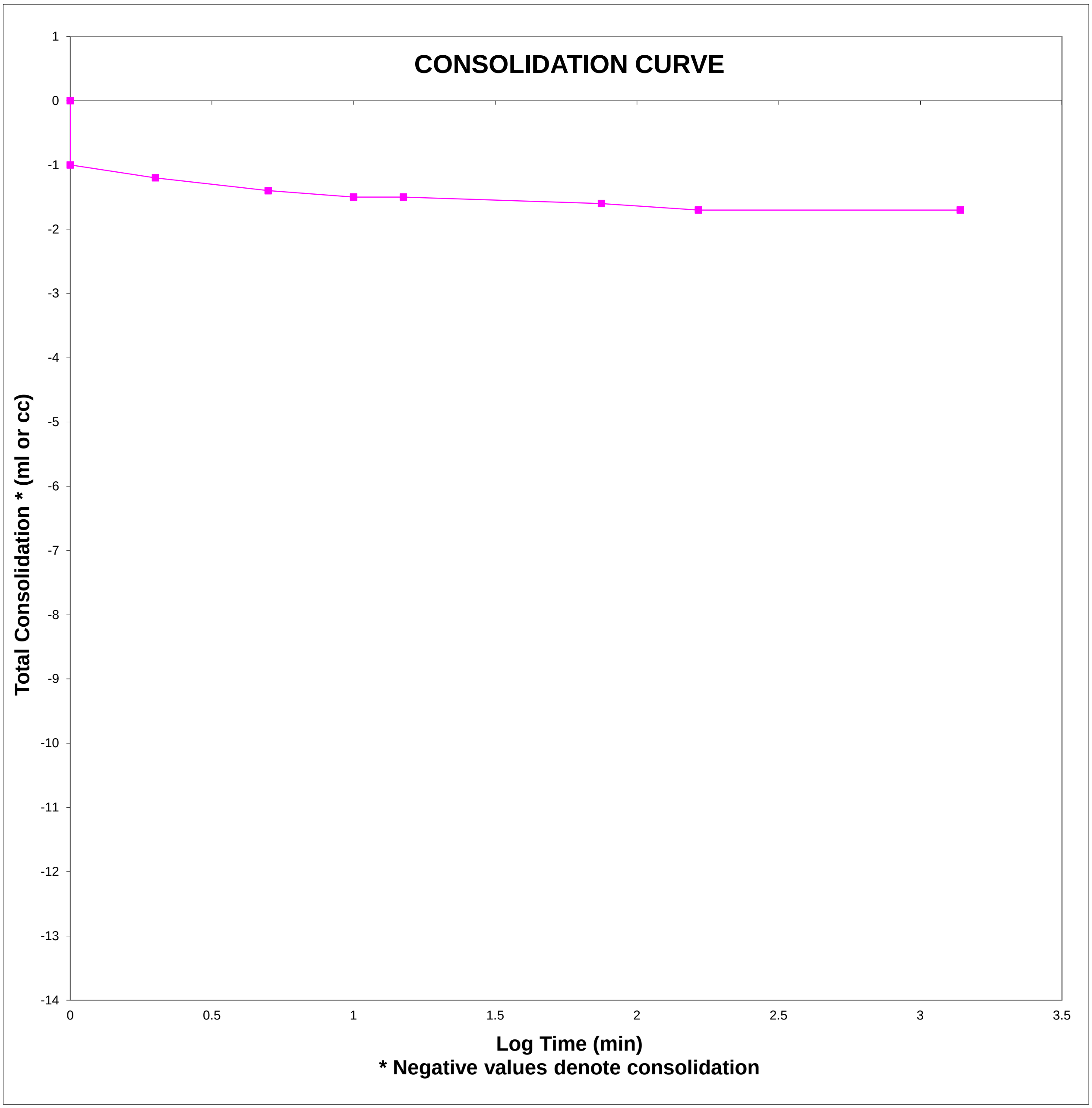
TEST DATE	TESTED BY	TIME (Military)	ELAPSED TIME (minutes)	TOTAL TIME (minutes)	TOTAL TIME (Log)	SPECIMEN CONSOLIDATION (ML) READING BOTTOM	READING TOP	ACTUAL TOTAL (Ct)
4 / 19 / 2016	JDM	8 : 20	0	0	0	24.0	24.0	0.0
4 / 19 / 2016	JDM	8 : 21	1	1	0.00	23.5	23.5	1.0
4 / 19 / 2016	JDM	8 : 22	1	2	0.30	23.4	23.4	1.2
4 / 19 / 2016	JDM	8 : 25	3	5	0.70	23.3	23.3	1.4
4 / 19 / 2016	JDM	8 : 30	5	10	1.00	23.3	23.2	1.5
4 / 19 / 2016	JDM	8 : 35	5	15	1.18	23.3	23.2	1.5
4 / 19 / 2016	JDM	9 : 35	60	75	1.88	23.3	23.1	1.6
4 / 19 / 2016	JDM	11 5	90	165	2.22	23.3	23.0	1.7
4 / 20 / 2016	JDM	7 25	1220	1385	3.14	23.3	23.0	1.7

PERMEABILITY ASTM D5084

CONSOLIDATION CURVE

Page 4 of 6

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		



PERMEABILITY ASTM D5084

TEST DATA

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		

DATE	TESTED BY	TIME (military)	ELAPSED TIME (minutes)	HYDRAULIC HEAD (cm)		TEMP. C°	GAUGE PRESSURE (psi)		
				INFLUENT	EFFLUENT		CELL	INFLUENT	EFFLUENT
4 / 20 / 16	JDM	7 : 31	0	1.0	24.0	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	7 : 34	3	1.5	23.5	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	7 : 37	3	2.0	23.0	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	8 : 17	40	6.1	18.9	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	8 : 42	25	7.8	17.2	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	10 : 59	RESET	1.0	24.0	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	11 : 9	10	2.2	22.8	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	11 : 20	11	3.6	21.4	20.0	60.0	55.0	55.0
4 / 20 / 16	JDM	13 : 5	105	10.0	15.0	20.0	60.0	55.0	55.0

PERMEABILITY ASTM D5084

TEST DATA (continued)

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		

ELAPSED TIME (minutes)	***HYDRAULIC HEAD DIFFERENCE (cm)***		***EFFLUENT - INFLUENT RATIO***	***HYDRAULIC GRADIENT (cm/cm)***	***HYDRAULIC CONDUCTIVITY (cm/sec)***	
	INFLUENT	***EFFLUENT***			***@ Temp.***	***@ 20° C***
RESET				3.608		
3	0.5	0.5	1.00	3.451	2.11E-05	2.12E-05
3	0.5	0.5	1.00	3.294	2.21E-05	2.22E-05
40	4.1	4.1	1.00	2.008	1.76E-05	1.77E-05
25	1.7	1.7	1.00	1.475	1.76E-05	1.76E-05
RESET				3.608		
10	1.2	1.2	1.00	3.232	1.57E-05	1.57E-05
11	1.4	1.4	1.00	2.792	1.89E-05	1.90E-05
105	6.4	6.4	1.00	0.784	1.72E-05	1.73E-05

PERMEABILITY ASTM D5084

SUMMARY OF RESULTS

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A781_PM
SAMPLE No.:	P-08 (680-123910-1)	EQUIPMENT No.:	6
TEST DATE:	4/13/16		

TESTING PARAMETER	INITIAL	FINAL
BULK UNIT WEIGHT	**114.7 lb/ft³**	**114.0 lb/ft³**
DRY UNIT WEIGHT	**88.0 lb/ft³**	**89.0 lb/ft³**
MOISTURE CONTENT	**30.3 %**	**28.1 %**
PERMEABILITY @ 20°C	**1.9E-05 cm/sec**	

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PERMEABILITY ASTM D5084

SPECIMEN CONDITIONS

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		

MOISTURE CONTENT (Dry Basis)	***INITIAL***		***FINAL***	
1. MOISTURE TIN NO.				
2. WT MOISTURE TIN (tare weight)	0.00	***g***	218.85	***g***
3. WT WET SOIL + TARE	564.33	***g***	762.80	***g***
4. WT DRY SOIL + TARE	438.15	***g***	657.00	***g***
5. WT WATER, Ww	126.18	g	105.80	g
6. WT DRY SOIL, Ws	438.15	g	438.15	g
7. MOISTURE CONTENT, W	28.80	%	24.15	%

SOIL SPECIMEN DIMENSIONS				
TRIPLICATE	***DIAMETER***		***HEIGHT***	
ANALYSES	***INITIAL***	***FINAL***	***INITIAL***	***FINAL***
No. 1	***2.82 in.***	***2.73 in.***	***2.57 in.***	***2.56 in.***
No. 2	***2.99 in.***	***2.77 in.***	***2.62 in.***	***2.63 in.***
No. 3	***2.98 in.***	***2.81 in.***	***2.61 in.***	***2.73 in.***
Average	2.93 in.	2.77 in.	2.60 in.	2.64 in.

SPECIMEN CONDITIONS	***INITIAL***	***FINAL***
Specimen WT, Wo	***564.33 g***	***543.95 g***
Area, Ao	6.74 in^2	6.03 in^2
Volume, Vo	17.51 in^3	15.91 in^3
Bulk Unit Weight	122.8 lb/ft^3	130.2 lb/ft^3
Dry Unit Weight	95.3 lb/ft^3	104.9 lb/ft^3

PERMEABILITY ASTM D5084

BACK-PRESSURE SATURATION

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		

TEST DATE	TIME (military)	TESTED BY	TEST PRESSURES (psi) APPLIED CELL	APPLIED BACK	PORE SAT.	PORE TEST	PRESSURE CHANGE CELL	PRESSURE CHANGE PORE	B-Value
04/18/16	8 : 27	JDM	7.0	5.0	5.8				
04/18/16	10 : 14	JDM	17.0	15.0	15.9	11.5	10.0	5.7	0.57
04/18/16	12 : 55	JDM	27.0	25.0	25.8	23.7	10.0	7.8	0.78
04/18/16	14 : 23	JDM	37.0	35.0	36.7	35.0	10.0	9.2	0.92
04/18/16	15 : 17	JDM	47.0	45.0	47.1	46.3	10.0	9.6	0.96
04/18/16	15 : 55	JDM	57.0	55.0	*	56.9	10.0	9.8	0.98
04/18/16	15 : 55	JDM	47.0	45.0	*	*	*	*	*

* Saturation check - no data available.

PERMEABILITY ASTM D5084

SPECIMEN CONSOLIDATION

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		

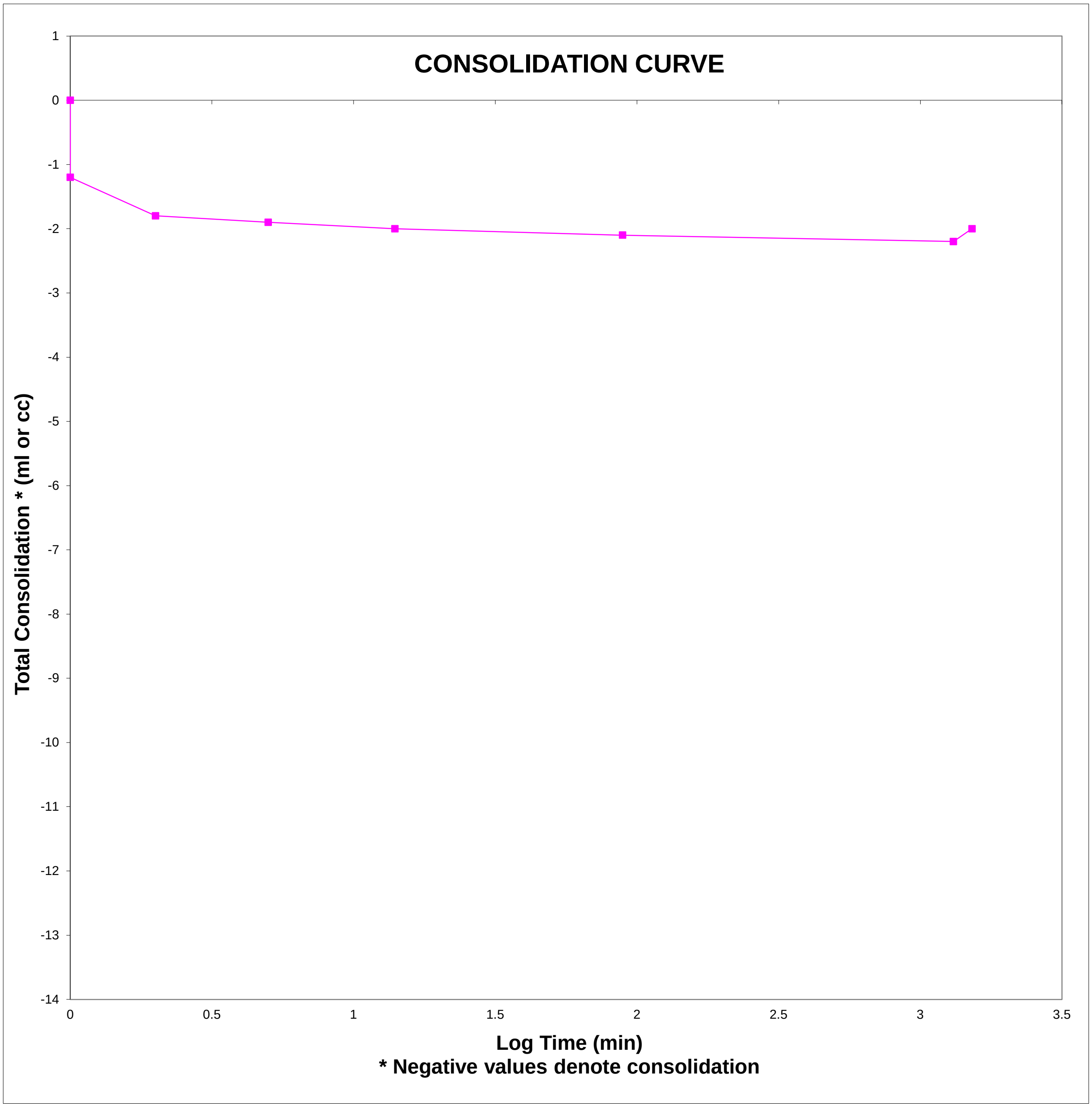
CELL PRESSURE: 50 psi **BACK PRESSURE:** 45 psi **EFFECTIVE STRESS:** 5 psi

TEST DATE	*TESTED BY*	*TIME (Military)*	*ELAPSED TIME (minutes)*	*TOTAL TIME (minutes)*	*TOTAL TIME (Log)*	*SPECIMEN CONSOLIDATION (ML)* READING *BOTTOM*	*TOP*	*ACTUAL TOTAL (Ct)*
4 / 19 / 2016	JDM	9 : 36	0	0	0	24.0	24.0	0.0
4 / 19 / 2016	JDM	9 : 37	1	1	0.00	23.5	23.3	1.2
4 / 19 / 2016	JDM	9 : 38	1	2	0.30	23.3	22.9	1.8
4 / 19 / 2016	JDM	9 : 41	3	5	0.70	23.3	22.8	1.9
4 / 19 / 2016	JDM	9 : 50	9	14	1.15	23.3	22.7	2.0
4 / 19 / 2016	JDM	11 : 5	75	89	1.95	23.3	22.6	2.1
4 / 20 / 2016	JDM	7 : 26	1221	1310	3.12	23.0	22.8	2.2
4 / 20 / 2016	JDM	10 59	213	1523	3.18	23.0	23.0	2.0

PERMEABILITY ASTM D5084

CONSOLIDATION CURVE

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		



PERMEABILITY ASTM D5084

TEST DATA

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PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		

DATE	TESTED BY	TIME (military)	ELAPSED TIME (minutes)	HYDRAULIC HEAD (cm)		TEMP. C°	GAUGE PRESSURE (psi)		
				INFLUENT	EFFLUENT		CELL	INFLUENT	EFFLUENT
4 / 20 / 16	JDM	11 : 1	0	1.0	24.0	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	11 : 21	20	1.5	23.5	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	11 : 46	25	2.0	22.5	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	13 : 3	77	4.0	21.0	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	13 : 32	29	4.6	20.4	20.0	50.0	45.0	45.0

PERMEABILITY ASTM D5084

TEST DATA (continued)

Page 6 of 6

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		

ELAPSED TIME (minutes)	*HYDRAULIC HEAD DIFFERENCE (cm)*		*EFFLUENT - INFLUENT RATIO*	*HYDRAULIC GRADIENT (cm/cm)*	*HYDRAULIC CONDUCTIVITY (cm/sec)*	
	INFLUENT	*EFFLUENT*			*@ Temp.*	*@ 20° C*
RESET				3.486		
20	0.5	0.5	1.00	3.334	2.81E-06	2.82E-06
25	0.5	1.0	2.00	3.107	3.57E-06	3.59E-06
77	2.0	1.5	0.75	2.576	3.07E-06	3.09E-06
29	0.6	0.6	1.00	2.394	3.19E-06	3.21E-06

PERMEABILITY ASTM D5084

SUMMARY OF RESULTS

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A782_PM
SAMPLE No.:	P-11 (680-123910-2)	EQUIPMENT No.:	7
TEST DATE:	4/13/16		

TESTING PARAMETER	INITIAL	FINAL
BULK UNIT WEIGHT	122.8 lb/ft³	130.2 lb/ft³
DRY UNIT WEIGHT	95.3 lb/ft³	104.9 lb/ft³
MOISTURE CONTENT	28.8 %	24.1 %
PERMEABILITY @ 20°C	3.2E-06 cm/sec	

PERMEABILITY ASTM D5084

SPECIMEN CONDITIONS

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		

MOISTURE CONTENT (Dry Basis)	***INITIAL***		***FINAL***	
1. MOISTURE TIN NO.				
2. WT MOISTURE TIN (tare weight)	0.00	***g***	223.11	***g***
3. WT WET SOIL + TARE	527.19	***g***	700.30	***g***
4. WT DRY SOIL + TARE	385.45	***g***	608.56	***g***
5. WT WATER, Ww	141.74	g	91.74	g
6. WT DRY SOIL, Ws	385.45	g	385.45	g
7. MOISTURE CONTENT, W	36.77	%	23.80	%

SOIL SPECIMEN DIMENSIONS				
TRIPLICATE	***DIAMETER***		***HEIGHT***	
ANALYSES	***INITIAL***	***FINAL***	***INITIAL***	***FINAL***
No. 1	***3.01 in.***	***2.83 in.***	***2.48 in.***	***2.02 in.***
No. 2	***3.00 in.***	***2.94 in.***	***2.36 in.***	***2.24 in.***
No. 3	***3.00 in.***	***2.89 in.***	***2.36 in.***	***2.07 in.***
Average	3.00 in.	2.88 in.	2.40 in.	2.11 in.

SPECIMEN CONDITIONS	***INITIAL***	***FINAL***
Specimen WT, Wo	***527.19 g***	***477.19 g***
Area, Ao	7.07 in²	6.53 in²
Volume, Vo	16.97 in³	13.79 in³
Bulk Unit Weight	118.4 lb/ft³	131.8 lb/ft³
Dry Unit Weight	86.5 lb/ft³	106.4 lb/ft³

PERMEABILITY ASTM D5084

BACK-PRESSURE SATURATION

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		

TEST	TIME	TESTED	TEST PRESSURES (psi)						
			APPLIED		PORE		PRESSURE CHANGE		
DATE	(military)	BY	CELL	BACK	SAT.	TEST	CELL	PORE	B-Value
04/18/16	8 : 24	JDM	7.0	5.0	5.7				
04/18/16	10 : 13	JDM	17.0	15.0	15.8	11.6	10.0	5.9	0.59
04/18/16	12 : 54	JDM	27.0	25.0	25.7	24.6	10.0	8.8	0.88
04/18/16	14 : 20	JDM	37.0	35.0	35.7	*	*	*	*
04/18/16	15 : 16	JDM	47.0	45.0	45.6	44.7	10.0	9.0	0.90
04/18/16	15 : 53	JDM	57.0	55.0	*	55.4	10.0	9.8	0.98
04/18/16	15 : 53	JDM	47.0	45.0	*	*	*	*	*

* Saturation check - no data available.

PERMEABILITY ASTM D5084

SPECIMEN CONSOLIDATION

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		

CELL PRESSURE: 50 psi **BACK PRESSURE:** 45 psi **EFFECTIVE STRESS:** 5 psi

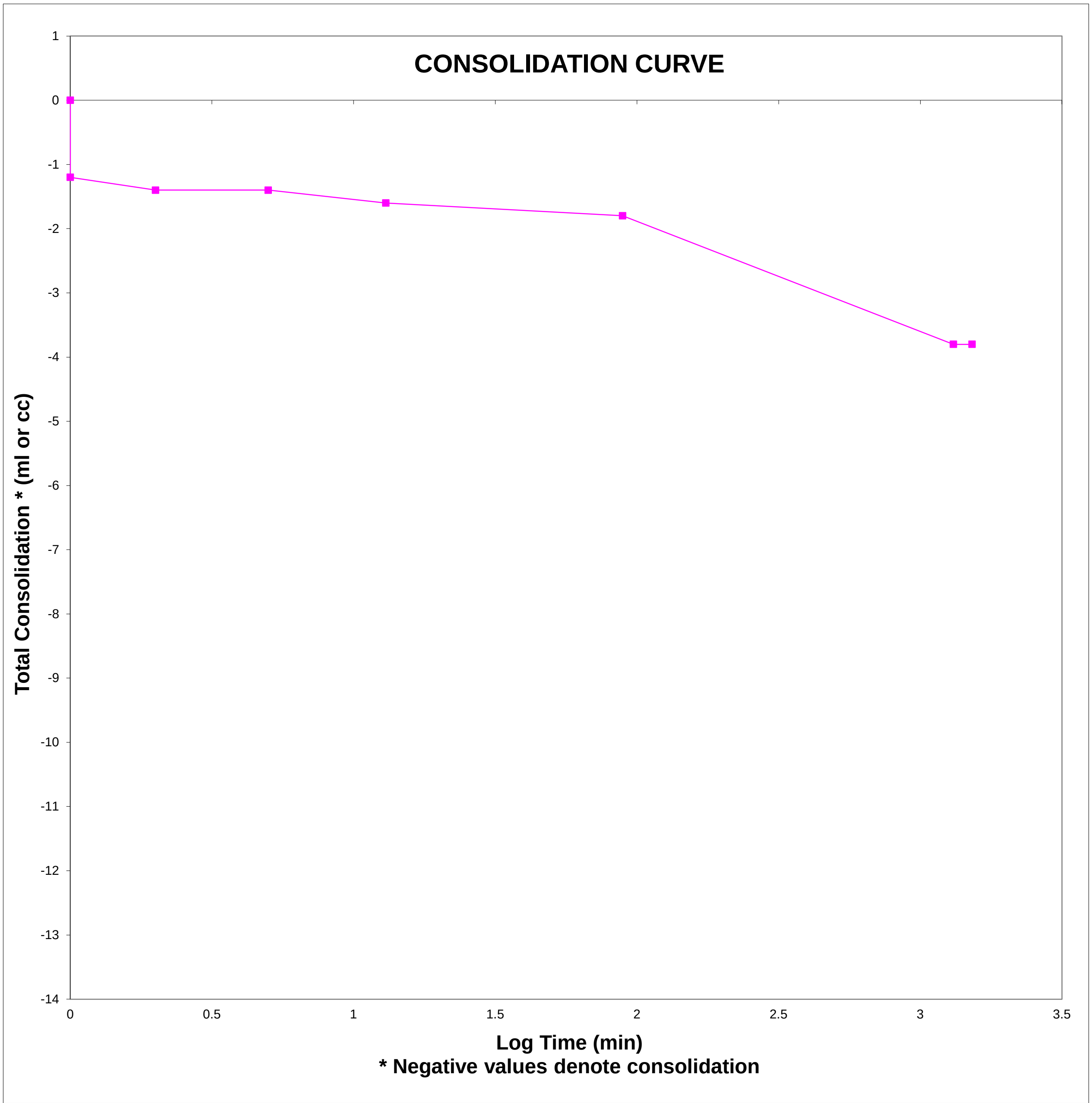
TEST DATE	TESTED BY	TIME (Military)	ELAPSED TIME (minutes)	TOTAL TIME (minutes)	TOTAL TIME (Log)	SPECIMEN CONSOLIDATION (ML) READING BOTTOM	READING TOP	ACTUAL TOTAL (Ct)
4 / 19 / 2016	JDM	9 : 36	0	0	0	24.0	24.0	0.0
4 / 19 / 2016	JDM	9 : 37	1	1	0.00	23.4	23.4	1.2
4 / 19 / 2016	JDM	9 : 38	1	2	0.30	23.3	23.3	1.4
4 / 19 / 2016	JDM	9 : 41	3	5	0.70	23.3	23.3	1.4
4 / 19 / 2016	JDM	9 : 49	8	13	1.11	23.2	23.2	1.6
4 / 19 / 2016	JDM	11 : 5	76	89	1.95	23.1	23.1	1.8
4 / 20 / 2016	JDM	7 : 25	1220	1309	3.12	22.1	22.1	3.8
4 / 20 / 2016	JDM	10 59	214	1523	3.18	22.1	22.1	3.8

PERMEABILITY ASTM D5084

CONSOLIDATION CURVE

Page 4 of 6

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		



PERMEABILITY ASTM D5084

TEST DATA

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		

DATE	TESTED BY	TIME (military)	ELAPSED TIME (minutes)	HYDRAULIC HEAD (cm) INFLUENT	HYDRAULIC HEAD (cm) EFFLUENT	TEMP. C°	GAUGE PRESSURE (psi) CELL	GAUGE PRESSURE (psi) INFLUENT	GAUGE PRESSURE (psi) EFFLUENT
4 / 20 / 16	JDM	13 : 22	0	1.0	24.0	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	13 : 25	3.0	6.8	18.2	20.0	50.0	45.0	45.0
4 / 22 / 16	JDM	7 : 56	Reset	1.0	24.0	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	7 : 59	3.0	6.4	18.6	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	8 : 1	RESET	1.0	24.0	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	8 : 4	3.0	6.2	18.8	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	10 : 30	RESET	1.0	24.0	20.0	50.0	45.0	45.0
4 / 20 / 16	JDM	10 : 33	3.0	6.3	18.7	20.0	50.0	45.0	45.0

PERMEABILITY ASTM D5084

TEST DATA (continued)

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		

ELAPSED TIME (minutes)	*HYDRAULIC HEAD DIFFERENCE (cm)*		*EFFLUENT - INFLUENT RATIO*	*HYDRAULIC GRADIENT (cm/cm)*	*HYDRAULIC CONDUCTIVITY (cm/sec)*	
	INFLUENT	*EFFLUENT*			*@ Temp.*	*@ 20° C*
RESET				3.775		
3	5.8	5.8	1.00	1.871	2.60E-04	2.62E-04
Reset				3.775		
3	5.4	5.4	1.0	2.002	2.35E-04	2.36E-04
RESET				3.775		
3	5.2	5.2	1.00	2.068	2.23E-04	2.24E-04
RESET				3.775		
3	5.3	5.3	1.00	2.035	2.29E-04	2.30E-04

PERMEABILITY ASTM D5084

SUMMARY OF RESULTS

PROJECT:	Brantley Co. Geotech	TESTED BY:	JDM
PROJECT No.:	SH0616	TRACKING CODE:	A783_PM
SAMPLE No.:	P-12 (680-123910-3)	EQUIPMENT No.:	8
TEST DATE:	4/13/16		

TESTING PARAMETER	INITIAL	FINAL
BULK UNIT WEIGHT	**118.4 lb/ft^3**	**131.8 lb/ft^3**
DRY UNIT WEIGHT	**86.5 lb/ft^3**	**106.4 lb/ft^3**
MOISTURE CONTENT	**36.8 %**	**23.8 %**
PERMEABILITY @ 20°C	**2.4E-04 cm/sec**	

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Hornsby, Jess	Carrier Tracking No(s):	COC No: 680-428806.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: jess.hornsby@testamericainc.com		Page: Page 1 of 1
Company: Kemron Environmental Services, Inc.		**Analysis Requested**		Job #: 680-123910-1
Address: 1359A Ellsworth Industrial Blvd., ,	**Due Date Requested:** 4/20/2016			**Preservation Codes:**
City: Atlanta	**TAT Requested (days):**			
State, Zip: GA, 30318				
Phone: 404-636-0928(Tel)	PO #:			
Email:	WO #:			
Project Name: Brantley County	Project #: 68013756			
Site:	SSOW#:			**Other:**

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - ph 4-5, Z - other (specify)

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	SUB (Grain Size with Hydrometer)/ Grain Size with Hydrometer	SUB (Hydraulic Conductivity)/ Hydraulic Conductivity	Total Number of containers	Special Instructions/Note:
			Preservation Code:							
P-08 (680-123910-1)	4/8/16	Eastern		Solid			X	X	1	
P-11 (680-123910-2)	4/8/16	Eastern		Solid			X	X	1	
P-12 (680-123910-3)	4/8/16	Eastern		Solid			X	X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ______ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:	
Relinquished by: [signature]	Date/Time: 13:36 4/8/16	Company: ADV	Received by: [signature]	Date/Time: 4/8/16 13:36	Company: TA
Relinquished by: [signature] 4/8/16 MB	Date/Time:	Company	Received by: [signature]	Date/Time: 4/8/16 1421	Company: KEMRON
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks:

681-Atlanta

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler: Tommy Jordan	Lab PM: Hornsby, Jess	Carrier Tracking No(s):	COC No: 680-428807.1
Client Contact: Shipping/Receiving	Phone: 404-516-3172	E-Mail: jess.hornsby@testamericainc.com		Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc				Job #: 680-123910-1
Address: 2960 Foster Creighton Drive, ,	Due Date Requested: 4/20/2016			
City: Nashville	TAT Requested (days):			
State, Zip: TN, 37204				
Phone: 615-726-0177(Tel) 615-726-3404(Fax)	PO #:			
Email:	WO #:			
Project Name: Brantley County	Project #: 68013756			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - ph 4-5, Z - other (specify)
Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9081/9081_Prep Cation Exchange Capacity	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
P-08 (680-123910-1)	4/8/16	Eastern 1415	G	Solid			X	1	
P-11 (680-123910-2)	4/8/16	Eastern 1425	G	Solid			X	1	
P-12 (680-123910-3)	4/8/16	Eastern 1510	G	Solid			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Relinquished by: [signature]	4/13/16 13:13	Kenn	Received by: [signature]	4/13/16 13:13	TA
Relinquished by: [signature]	4/13/16 15:26	TA	Received by: [signature]	4-14-16 0837	TAN
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 2.6

Loc: 680
123910

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING
Nashville, TN

COOLER RECEIPT FORM

Cooler Received/Opened On 4-14-16 @ 0837

Time Samples Removed From Cooler__________ Time Samples Placed In Storage__________ (2 Hour Window)

1. Tracking # N/A (last 4 digits, FedEx) Courier: Greyhound

IR Gun ID 18290455 pH Strip Lot HC568401 Chlorine Strip Lot 1211515B

2. Temperature of rep. sample or temp blank when opened: 2.6 *Degrees Celsius*

3. If Item #2 temperature is 0°C or less, was the representative sample or temp blank frozen? YES NO...NA

4. Were custody seals on outside of cooler? YES...NO...NA

If yes, how many and where: One front

5. Were the seals intact, signed, and dated correctly? YES...NO...NA

6. Were custody papers inside cooler? YES...NO...NA

I certify that I opened the cooler and answered questions 1-6 (intial) DA

7. Were custody seals on containers: YES NO and Intact YES...NO...NA

Were these signed and dated correctly? YES...NO...NA

8. Packing mat'l used? Bubblewrap Plastic bag Peanuts Vermiculite Foam Insert Paper Other None

9. Cooling process: Ice Ice-pack Ice (direct contact) Dry ice Other None

10. Did all containers arrive in good condition (unbroken)? YES...NO...NA

11. Were all container labels complete (#, date, signed, pres., etc)? YES...NO...NA

12. Did all container labels and tags agree with custody papers? YES...NO...NA

13a. Were VOA vials received? YES...NO...NA

b. Was there any observable headspace present in any VOA vial? YES...NO...NA

14. Was there a Trip Blank in this cooler? YES...NO...NA If multiple coolers, sequence #________

I certify that I unloaded the cooler and answered questions 7-14 (intial) DA

15a. On pres'd bottles, did pH test strips suggest preservation reached the correct pH level? YES..NO...NA

b. Did the bottle labels indicate that the correct preservatives were used YES...NO...NA

16. Was residual chlorine present? YES...NO...NA

I certify that I checked for chlorine and pH as per SOP and answered questions 15-16 (intial) DA

17. Were custody papers properly filled out (ink, signed, etc)? YES...NO...NA

18. Did you sign the custody papers in the appropriate place? YES...NO...NA

19. Were correct containers used for the analysis requested? YES...NO...NA

20. Was sufficient amount of sample sent in each container? YES...NO...NA

I certify that I entered this project into LIMS and answered questions 17-20 (intial) DA

I certify that I attached a label with the unique LIMS number to each container (intial) DA

21. Were there Non-Conformance issues at login? YES...NO Was a NCM generated? YES...NO...#________

BIS = Broken in shipment
Cooler Receipt Form.doc

LF-1
End of Form

Revised 12/15/15

Login Sample Receipt Checklist

Client: Advanced Environmental Management Inc. Job Number: 680-123910-1

Login Number: 123910 **List Source: TestAmerica Savannah**
List Number: 1
Creator: Hornsby, Jess

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Login Sample Receipt Checklist

Client: Advanced Environmental Management Inc. Job Number: 680-123910-1

Login Number: 123910
List Number: 2
Creator: Armstrong, Daniel

List Source: TestAmerica Nashville
List Creation: 04/16/16 12:24 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	2.6C
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Ginn Mineral Technology

Innovative Earth Technology

Michael Biers April 28, 2016

Harbin Engineering

Re: Soil Sample LOI Summary

Mr. Biers,

We have completed the requested LOI testing and analysis for 6 soil samples per our discussions. Loss on Ignition is a weight loss measurement as a function of temperature. This technique is an inferred and indicative measurement of organics when used in a case such as yours.

We took 6 samples from the upper portion of the holes that were the darkest. Once we collected and weighed the samples, we could tell the organic content was less than what appeared at first glance. We analyzed the LOI @ 1000˚ C. The resulting LOI's ranged from ~ 2% - 6% as illustrated in the table below. These are relatively low results for organic rich soils. The 6 samples we analyzed all contained < 6.3% organics.

We did remove some wood debris from a couple of samples. The dark brown-black colorizations appear to be a function of humic and tannic acid stains.

So, for the most part, the characterizations as described in the geotech report you sent us is accurate, with accurate conclusions.

Sample ID	*LOI*
P2-S-1	*3.16*
P3-S-1	*6.09*
P6-S-1	*6.17*
P7-S-1	*6.27*
P10-S-1	*1.8*
P12-S-1	*3.77*

Sincerely,

M Ginn

______________________ Michael Ginn

4/28/2016

______________________ Date

150 International Drive P.O. Box 6077 Sandersville, GA 31082
Telephone 478.553.1040 Fax 478.553.9393 Email: mginn@ginnmineral.com Website: www.ginnmineral.com

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Smarr, Georgia 31086
Phone (478) 365-8609
mbiers@ie-strategies.com

Lithologic & Well Construction Diagram for P-13

Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 10, 2019** Time: **11:00 AM** Well No. **P-13**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

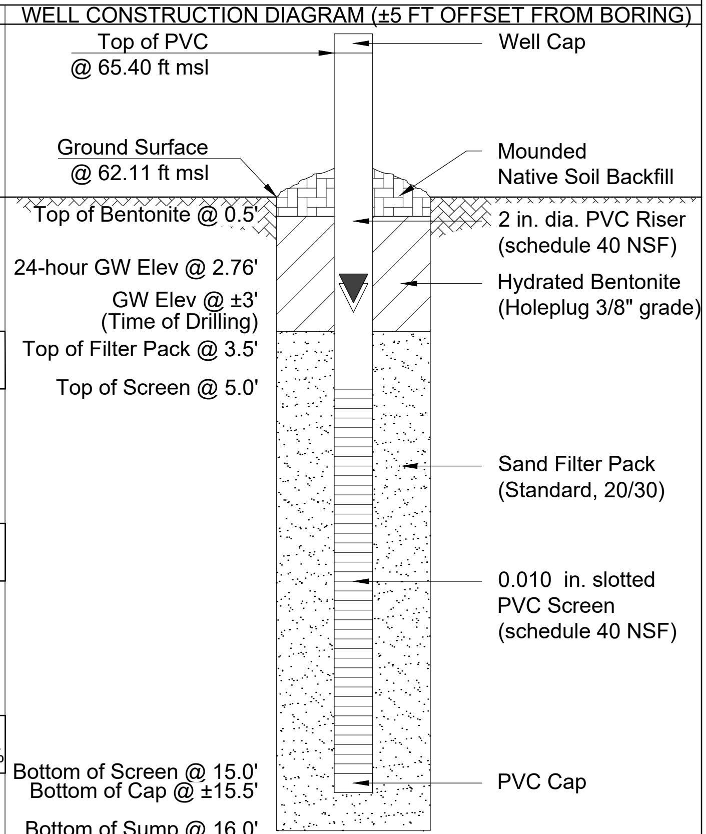
BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Symbol	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0 – ±11.7	SM	TALBOT BARRIER ISLAND medium dense, wet, dark brown to brownish yellow, fine to medium silty SAND (SM) with trace clay	6-14-13	27	SS 73%
			9-13-16	29	SS 80%
±11.7 – ±21.7	SC	very loose, wet, light brown with green tint, fine to very fine clayey SAND (SC) with trace silt	1-2-2	4	SS 100%
			1-1-2	3	SS 100%
±21.7 – 25.0	CL	firm, wet, light brown with green tint, very fine sandy CLAY (CL)	2-2-5	7	SS 80%
					ST 75%
25.0		BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

GEORGIA REGISTERED ★ NO. 36066 ★ PROFESSIONAL ENGINEER MICHAEL W. BIERS

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-13	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 10, 2019
Time of Well Construction:	12:30 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	6 x 0.5 cf bags; ±3.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	446517.6008, 768099.6471
Top of casing elevation:	65.40 ft msl
Ground surface elevation:	62.11 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

NOT TO SCALE HORIZONTALLY & ABOVE GROUND VERTICALLY

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P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
mbiers@ie-strategies.com

Lithologic & Well Construction Diagram for P-14

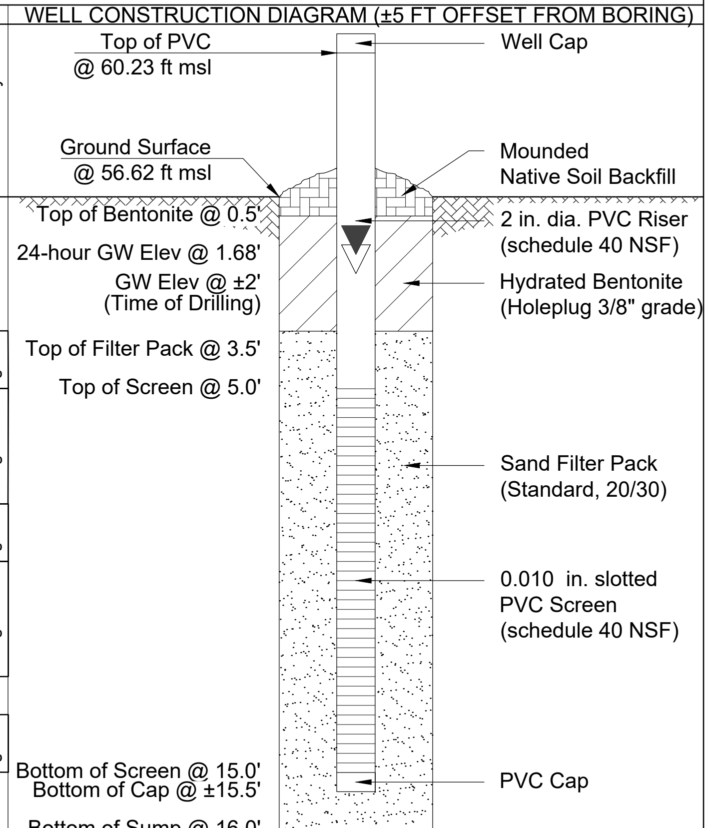
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 10, 2019** Time: **2:00 PM** Well No. **P-14**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0–13.0	TALBOT BARRIER ISLAND medium dense to loose, wet, brown fine silty SAND (SM) with clay	8-10-10	20	SS 73%
				ST 80%
		4-4-6	10	SS 87%
				ST 75%
13.0–25.0	very loose to loose, wet, light brown with green tint, very fine clayey SAND (SC) with silt	2-3-3	6	SS 87%
		1-2-2	4	SS 80%
		3-4-5	9	SS 67%
25.0	BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-14	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 10, 2019
Time of Well Construction:	3:45 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	6 x 0.5 cf bags; ±3.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	446634.5955, 769680.7954
Top of casing elevation:	60.23 ft msl
Ground surface elevation:	56.62 ft msl

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

NOT TO SCALE HORIZONTALLY & ABOVE GROUND VERTICALLY

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Lithologic & Well Construction Diagram for P-15

Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 10, 2019** Time: **4:45 PM** Well No. **P-15**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

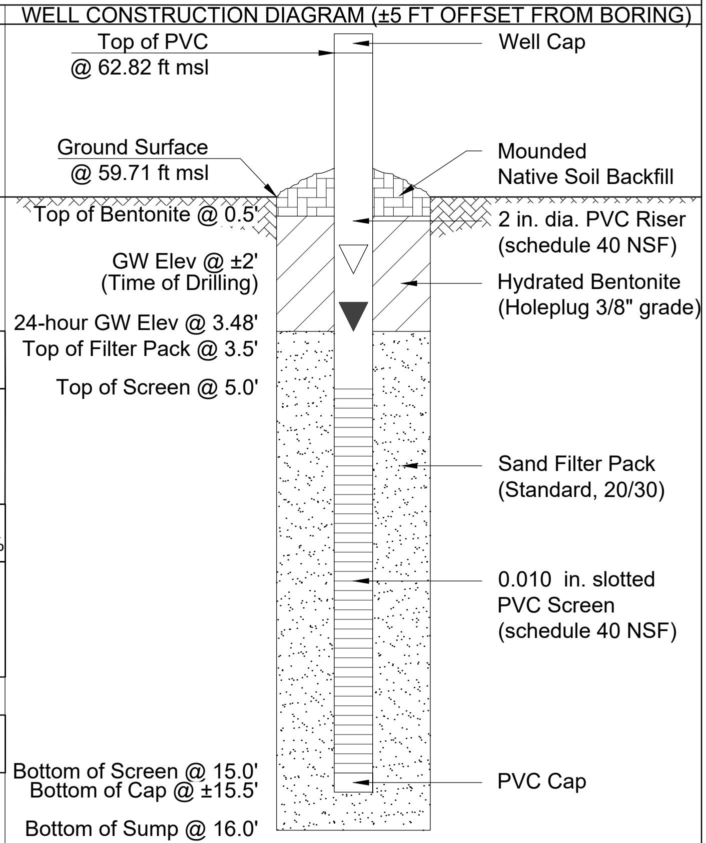
BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Symbol	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0–8.0		TALBOT BARRIER ISLAND medium dense, wet, dark brown fine silty SAND (SM) with clay	4-8-13	21	SS 93%
					ST 83%
8.0–13.0		stiff, wet, light brown/green, fine sandy CLAY (CH)	4-7-8	15	SS 100%
					ST 63%
13.0–25.0		very loose to medium dense, wet, light brown with green tint, fine to very fine silty SAND (SM) with clay	2-2-2	4	SS 73%
			1-1-3	4	SS 87%
			1-3-8	11	SS 80%
25.0		BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-15	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 11, 2019
Time of Well Construction:	8:30 AM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	7.5 x 0.5 cf bags; ±3.75 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	445971.7932, 769237.1933
Top of casing elevation:	62.82 ft msl
Ground surface elevation:	59.71 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

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Lithologic & Well Construction Diagram for P-16

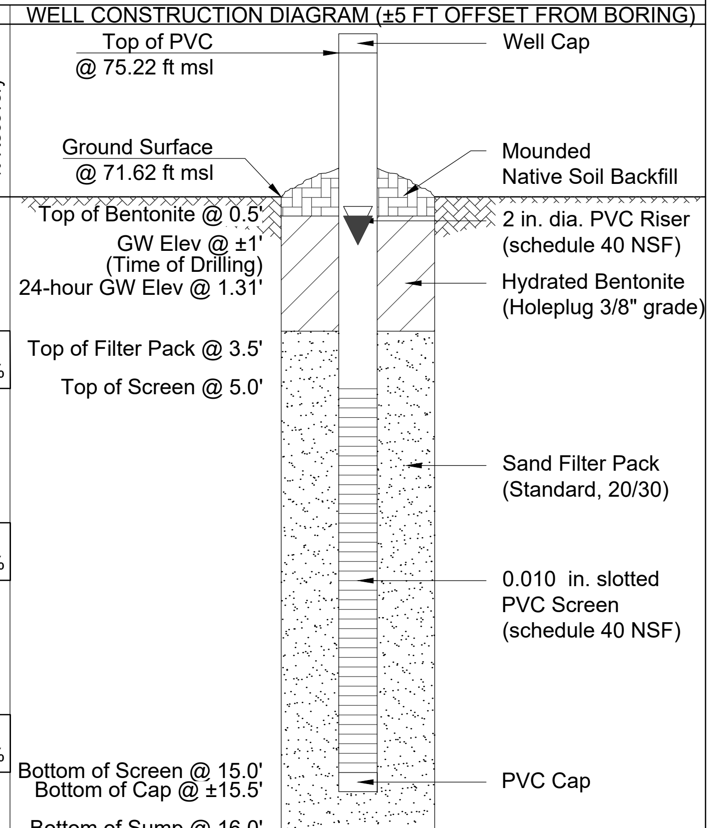
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 11, 2019** Time: **1:30 PM** Well No. **P-16**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Symbol	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0–6.7		TALBOT BARRIER ISLAND very loose, wet, dark brown, fine to medium silty SAND (SM) with trace clay	3-1-2	3	SS 93%
6.7–16.7		very dense, wet, dark brown to reddish brown, fine to medium silty SAND (SM) with trace clay	20-32-33	65	SS 87%
			24-43-50+	93+	SS 73%
16.7–23.2		medium dense, wet, brown to light brown, fine to very fine silty SAND (SM) with clay	9-8-10	18	SS 60%
					ST 47%
23.2–25.0		loose, wet, light brown/green fine silty SAND (SM) w/ clay	3-3-2	5	SS 100%
25.0		BORING TERMINATED AT 25 FT			ST 80%

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-16	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 11, 2019
Time of Well Construction:	3:00 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	7 x 0.5 cf bags; ±3.5 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	444115.9129, 763989.2408
Top of casing elevation:	75.22 ft msl
Ground surface elevation:	71.62 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

GEORGIA REGISTERED ★ NO. 36066 ★ PROFESSIONAL ENGINEER MICHAEL W. BIERS

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Lithologic & Well Construction Diagram for P-17

Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 12, 2019** Time: **4:00 PM** Well No. **P-17**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

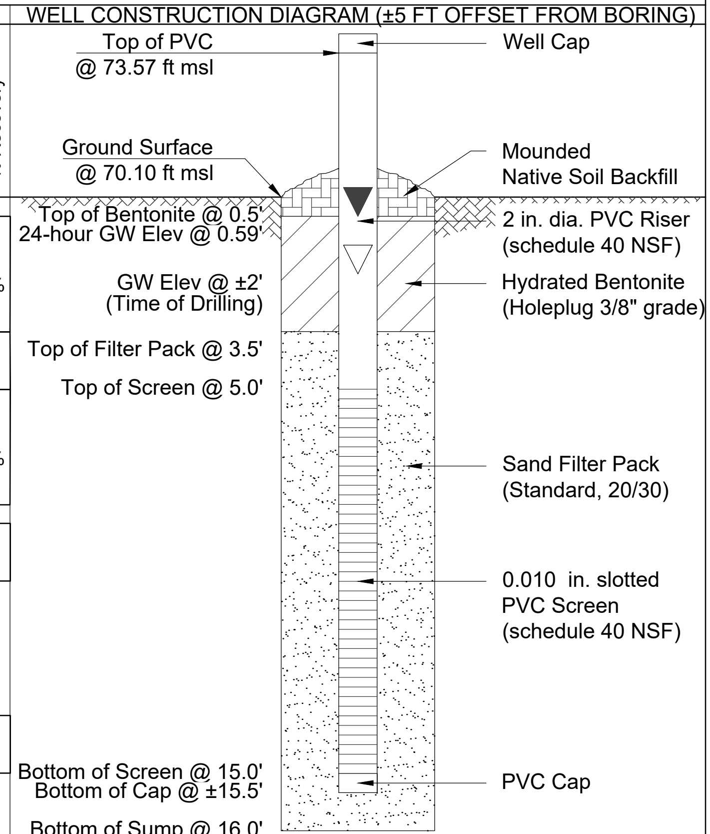
BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0 – ±8.2	TALBOT BARRIER ISLAND medium dense, wet, dark brown, fine silty SAND (SM) w/ trace clay			ST 27%
		3-5-8	13	SS
				ST 73%
±8.2 – ±16.7	very dense, wet, dark brown to reddish brown, fine to medium silty SAND (SM) with trace clay	42-50+	50+	SS
		43-50+	50+	SS
±16.7 – ±21.7	dense, wet, brown to light brown, fine silty SAND (SM)	24-24-20	44	SS
±21.7 – 25.0	loose, wet, light brown with green tint, very fine silty SAND (SM) with trace clay	6-3-6	9	SS
25.0	BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-17	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 12, 2019
Time of Well Construction:	5:00 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	6 x 0.5 cf bags; ±3.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	440815.2875, 762548.2583
Top of casing elevation:	73.57 ft msl
Ground surface elevation:	70.10 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

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Lithologic & Well Construction Diagram for P-18

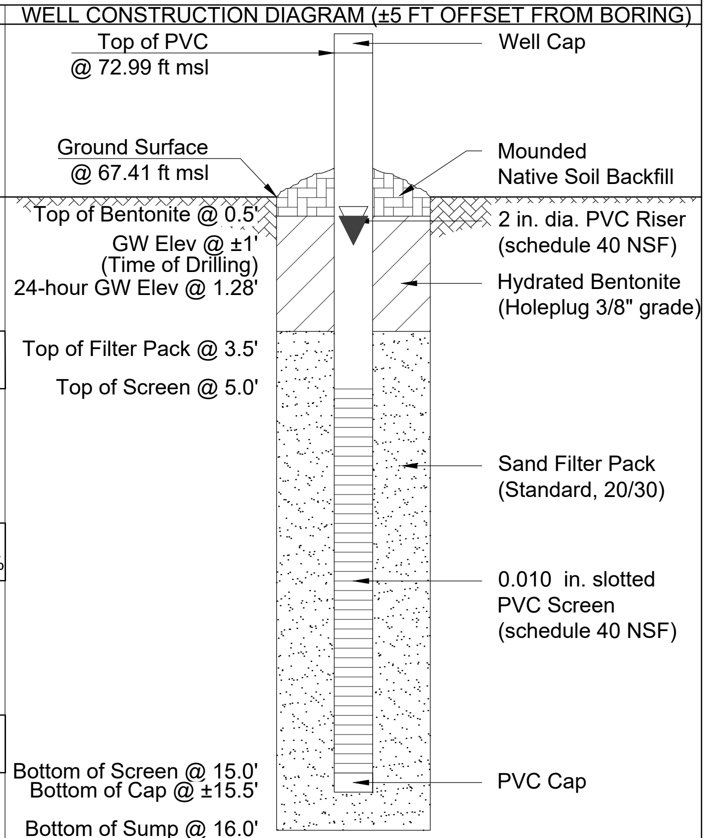
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 15, 2019** Time: **8:30 AM** Well No. **P-18**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Symbol	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0–5.0		TALBOT BARRIER ISLAND loose, wet, dark brown, fine to medium silty SAND (SM) with trace clay	3-4-5	9	SS 73%
5.0–15.0		very dense, wet, dark brown to reddish brown, fine to medium silty SAND (SM) with trace clay	44-50+	50+	SS 100%
			50+	50+	SS 80%
15.0–20.0		medium dense, wet, brown to light brown, fine silty SAND (SM) with trace clay	15-9-8	17	SS 73%
					ST 47%
25.0		very loose, wet, light brown/ green, fine silty SAND (SM)	1-1-2	3	SS 100%
25.0–35.0		BORING TERMINATED AT 25 FT			

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-18	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 15, 2019
Time of Well Construction:	9:00 AM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	7 x 0.5 cf bags; ±3.5 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	439955.9452, 762971.5421
Top of casing elevation:	72.99 ft msl
Ground surface elevation:	67.41 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

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Lithologic & Well Construction Diagram for P-19

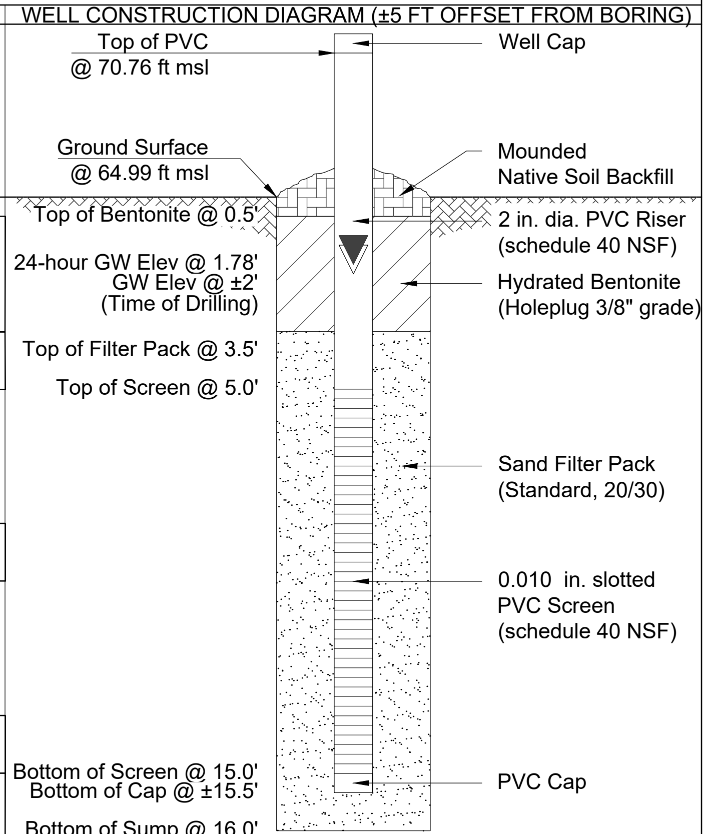
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 12, 2019** Time: **12:30 PM** Well No. **P-19**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Symbol	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0–6.75		TALBOT BARRIER ISLAND medium dense, wet, dark brown, fine to medium silty SAND (SM)			ST 63%
			2-7-14	21	SS
6.75–11.75		very dense, wet, dark brown, fine to medium silty SAND (SM) with trace clay	27-50+	50+	SS
11.75–18.25		loose, wet, brown to light brown fine silty SAND (SM) w/ clay	6-6-4	10	SS
					ST 77%
18.25–25.0		very loose to loose, wet, light brown with green tint, very fine silty SAND (SM) with trace clay	2-1-1	2	SS
					ST 0%
			4-6-3	9	SS
25.0		BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-19	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 12, 2019
Time of Well Construction:	2:30 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	8 x 0.5 cf bags; ±4.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	440111.5212, 763733.8122
Top of casing elevation:	70.76 ft msl
Ground surface elevation:	64.99 ft msl

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

SS = Split Spoon Sample		pcf = pounds per cubic foot	
ST = Shelby Tube Sample		M.C. = Moisture Content	
ft msl = feet mean sea level		PL = Plastic Limit	
ft bgs = feet below ground surface		LL = Liquid Limit	
lbs = pounds		PI = Plasticity Index	
cf = cubic feet		k = hydraulic conductivity	

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Lithologic & Well Construction Diagram for P-20

Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 12, 2019** Time: **9:00 AM** Well No. **P-20**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

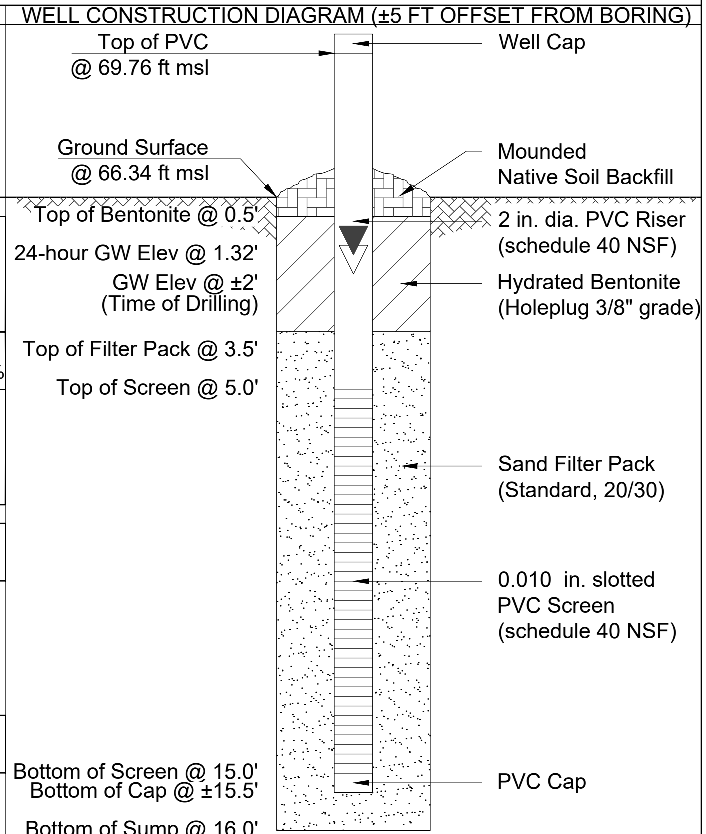
BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Symbol	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0–8.0		TALBOT BARRIER ISLAND medium dense, wet, dark brown, fine silty SAND (SM)			ST 50%
			1-4-7	11	SS 100%
					ST 60%
8.0–11.5		very dense, wet, yellowish red, fine to medium silty SAND (SM)	17-50+	50+	SS
11.5–16.5		medium dense, wet, brown to light brown, fine to medium silty SAND (SM)	10-8-7	15	SS
16.5–25.0		loose to very loose, wet, light brown with green tint, fine to very fine silty SAND (SM) with trace clay	2-4-4	8	SS
			2-1-1	2	SS
25.0		BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-20	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 12, 2019
Time of Well Construction:	10:30 AM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	6 x 0.5 cf bags; ±3.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	440743.9407, 764162.3424
Top of casing elevation:	69.76 ft msl
Ground surface elevation:	66.34 ft msl

SS	= Split Spoon Sample	pcf	= pounds per cubic foot
ST	= Shelby Tube Sample	M.C.	= Moisture Content
ft msl	= feet mean sea level	PL	= Plastic Limit
ft bgs	= feet below ground surface	LL	= Liquid Limit
lbs	= pounds	PI	= Plasticity Index
cf	= cubic feet	k	= hydraulic conductivity

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Lithologic & Well Construction Diagram for P-21

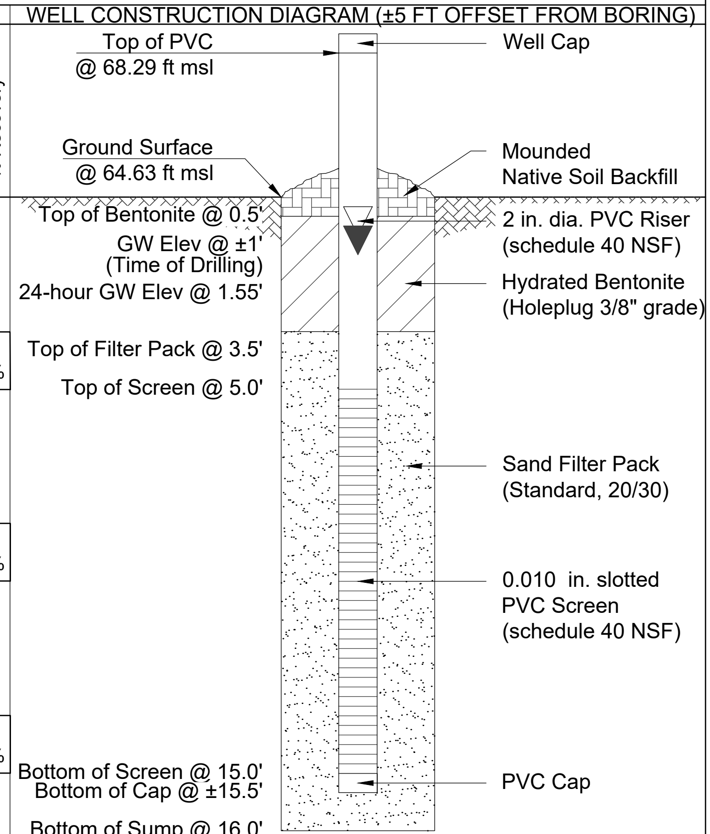
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 15, 2019** Time: **3:00 PM** Well No. **P-21**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0–6.75	TALBOT BARRIER ISLAND medium dense, wet, dark brown, fine silty SAND (SM)	1-3-24	25	SS 93%
6.75–16.75	dense, wet, dark brown to brownish yellow, fine silty SAND (SM)	13-17-27	44	SS 67%
		18-26-19	45	SS 53%
16.75–23.25	medium dense, wet, brown to light brown, fine silty SAND (SM)	5-7-4	11	SS 73%
				ST 40%
23.25–25	very loose, wet, light brown/ green, fine silty SAND (SM)	1-3-1	4	SS 73%
25.0	BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-21	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 15, 2019
Time of Well Construction:	4:30 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	6 x 0.5 cf bags; ±3.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	441457.8390, 765228.3365
Top of casing elevation:	68.29 ft msl
Ground surface elevation:	64.63 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet

pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

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Lithologic & Well Construction Diagram for P-22

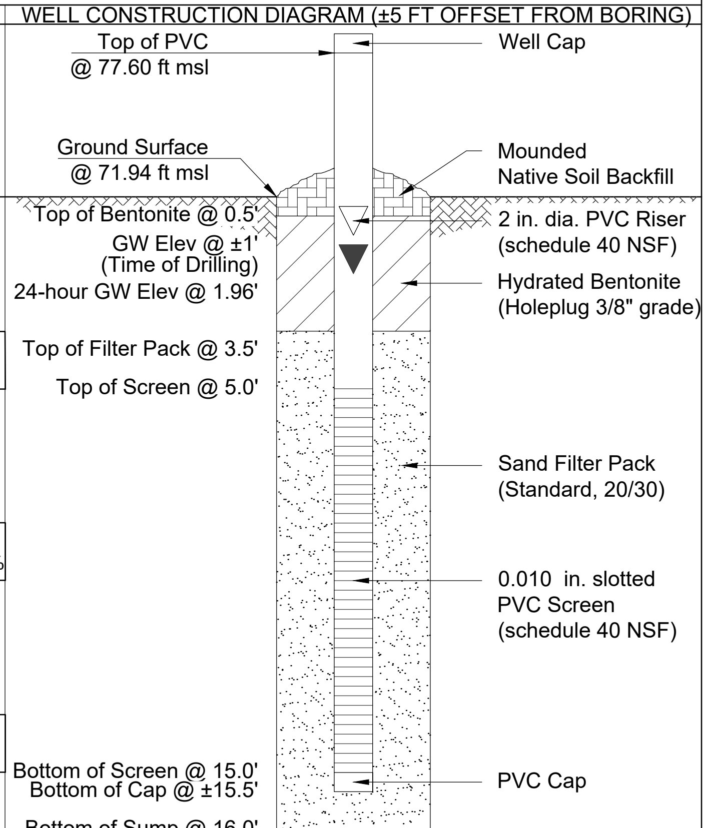
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 15, 2019** Time: **11:15 AM** Well No. **P-22**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0.0–6.7	TALBOT BARRIER ISLAND dense, wet, dark brown, fine silty SAND (SM)	1-16-26	42	SS 0%
6.7–16.7	very dense, wet, dark brown, fine silty SAND (SM)	25-40-35	75	SS 100%
		20-48-50+	98+	SS 73%
16.7–23.2	medium dense, wet, brown to light brown, fine silty SAND (SM)	7-7-8	15	SS 73%
				ST 40%
23.2–25.0	loose, wet, light brown/green, fine silty SAND (SM)	3-2-3	5	SS 60%
25.0	BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-22	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 15, 2019
Time of Well Construction:	12:45 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	7 x 0.5 cf bags; ±3.5 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	443738.6657, 765275.1975
Top of casing elevation:	77.60 ft msl
Ground surface elevation:	71.94 ft msl

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

SS	= Split Spoon Sample	pcf	= pounds per cubic foot
ST	= Shelby Tube Sample	M.C.	= Moisture Content
ft msl	= feet mean sea level	PL	= Plastic Limit
ft bgs	= feet below ground surface	LL	= Liquid Limit
lbs	= pounds	PI	= Plasticity Index
cf	= cubic feet	k	= hydraulic conductivity

NOT TO SCALE HORIZONTALLY & ABOVE GROUND VERTICALLY

Innovative Engineering Strategies, LLC
IES CIVIL ENVIRONMENTAL
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
mbiers@ie-strategies.com

Lithologic & Well Construction Diagram for P-23

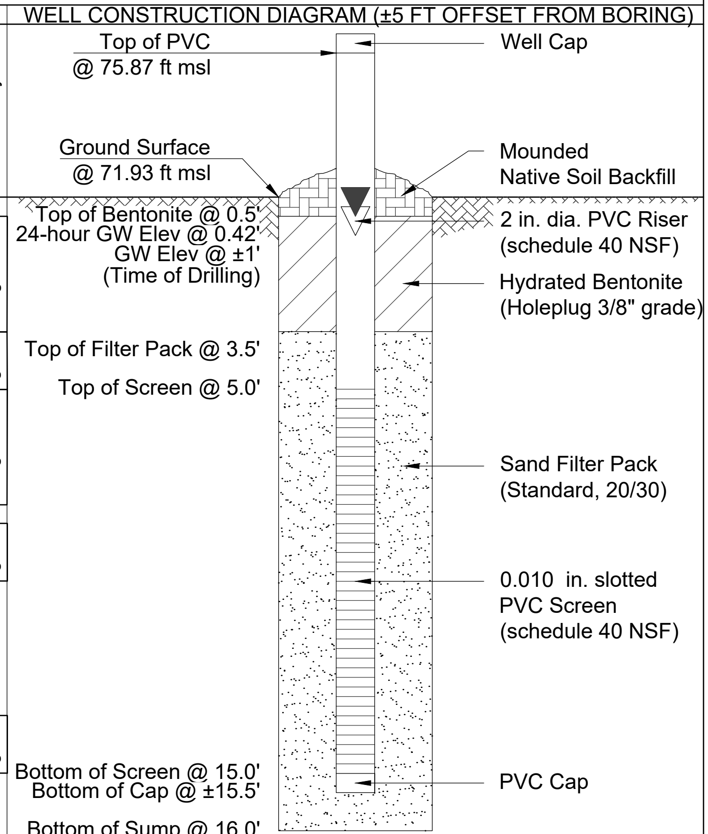
Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 11, 2019** Time: **4:30 PM** Well No. **P-23**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0–8.2	TALBOT BARRIER ISLAND loose, wet, dark brown, fine silty SAND (SM) w/ trace clay			ST 80%
		3-2-3	5	SS ??%
				ST 33%
8.2–16.7	very dense, wet, dark brown to brownish yellow, fine to medium silty SAND (SM) with trace clay	38-41-50+	91+	SS ??%
		31-50+	50+	SS ??%
16.7–21.7	medium dense, wet, brown to light brown, fine silty SAND (SM)	7-9-10	19	SS ??%
21.7–25.0	loose, wet, light brown with green tint, very fine silty SAND (SM) with trace clay	5-4-3	7	SS ??%
25.0	BORING TERMINATED AT 25 FT			

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-23	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 11, 2019
Time of Well Construction:	6:00 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	6 x 0.5 cf bags; ±3.0 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	442528.3346, 764036.9509
Top of casing elevation:	75.87 ft msl
Ground surface elevation:	71.93 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

NOT TO SCALE HORIZONTALLY & ABOVE GROUND VERTICALLY

Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
mbiers@ie-strategies.com
IES CIVIL ENVIRONMENTAL

Lithologic & Well Construction Diagram for P-24

Client: **Brantley County Development Partners, LLC**
Project: **New Municipal Solid Waste Landfill** Location: **Waynesville, GA**
Date: **April 11, 2019** Time: **10:00 AM** Well No. **P-24**
Driller: **ESC Florida, LLC** Driller Contact(s): **Lewis / Marshall**
Drilling Equipment / Method: **Mud Bug CME 45 / Mud Rotary / 4.25 ID HSA**

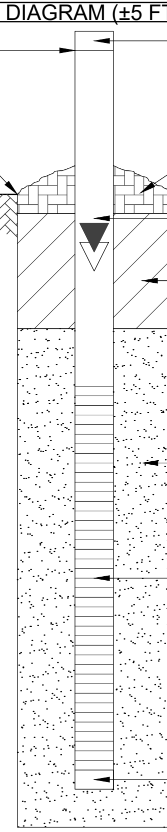
BORING LOG

Feet Below Ground Surface (ft bgs)	Soil Description	Blow Counts	N Value	Sample Type % Recovery
0–6.7	TALBOT BARRIER ISLAND loose, wet, dark brown, fine to medium silty SAND (SM) with trace clay	3-3-3	6	SS ??%
6.7–21.7	very dense, wet, dark brown to reddish brown, fine to medium silty SAND (SM) with trace clay	35-50+	50+	SS ??%
		30-50+	50+	SS ??%
		36-45-30	75	SS ??%
21.7–25.0	very loose, wet, light brown with green tint, fine silty SAND (SM) w/ clay	2-1-2	3	SS 0%
25.0	BORING TERMINATED AT 25 FT			ST 0%

Depth scale: 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

WELL CONSTRUCTION DIAGRAM (±5 FT OFFSET FROM BORING)



WELL DESIGN & CONSTRUCTION INFORMATION FOR P-24	
Driller:	ECS Florida, LLC
Supervising geolgist/engineer:	Michael W. Biers, P.E. 36066
Date of Well Construction:	April 11, 2019
Time of Well Construction:	3:00 PM
Borehole Diameter:	±8.0 in
Well casing diameter:	2.0 in
Total Well Depth:	±15.5 ft bgs
Casing and screen materials:	schedule 40 PVC
Joint type:	threaded
Screen slot size:	0.010 in
Screen length:	10 ft
Filter sand size:	Standard Sand & Silica, 20/30
Filter sand volume:	7.5 x 0.5 cf bags; ±3.75 cf
Filter sand placement method:	gravity
Sealant materials:	hydrated 3/8" grade Bentonite
Sealant volume:	2 x 50 lbs bags; ±1.0 cf
Sealant placement method:	gravity
Type of well completion:	mounded native soil
Well development procedures:	n/a
Well coordinates:	444803.5200, 765222.9800
Top of casing elevation:	76.84 ft msl
Ground surface elevation:	73.24 ft msl

SS = Split Spoon Sample
ST = Shelby Tube Sample
ft msl = feet mean sea level
ft bgs = feet below ground surface
lbs = pounds
cf = cubic feet
pcf = pounds per cubic foot
M.C. = Moisture Content
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
k = hydraulic conductivity

NOT TO SCALE HORIZONTALLY & ABOVE GROUND VERTICALLY

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Richard E. Dunn, Director

Agricultural Permitting Unit
531 Main Street, Suite D
Tifton, Georgia 31794
229-391-2400

March 14, 2019

ECS Florida, LLC
7064 Davis Creek Rd
Jacksonville, FL 32256
Attn: Lewis Johnson

Driller's Bond or Irrevocable Letter of Credit Renewal for 2019-2021

Your bond, letter of credit, or continuation notice as required by O.C.G.A § 12-5-135 has been received and will expire on June 30, 2021.

Reminder:

O.C.G.A. § 12-5-125 License requirement; drilling under direction of professional geologist or engineer. Except as provided in subsection (f) of Code Section 12-5-127, no person shall drill a water well or geothermal borehole without first having a water well contractor's license issued by the council. No person, including licensed water well contractors, shall drill any kind of well, borehole, or corehole, other than a water well or geothermal borehole, unless such person is acting under the direction of a professional geologist or a professional engineer.

If you have any questions, please contact Edward Rooks at (229) 391-2409.

Sincerely,

J. Edward Rooks

J. Edward Rooks

Bond Number 017231795

Performance Bond For Drillers

Name of Driller Lewis Johnson

Know All Men By These Presents

That we Lewis Johnson and ECS Florida, LLC any and all employees, officers and partners (collectively hereinafter, **Principal**), and we The Ohio Casualty Insurance Company, duly organized under the laws of the State of NH (hereinafter, **Surety**), are held and firmly bound unto the Director of the Environmental Protection Division, Department of Natural Resources, State of Georgia (**Director**) and his or her Successor or Successors in office, as **Obligee**, in the full sum of **FIFTEEN THOUSAND DOLLARS ($15,000.00)** for the payment of which will and truly to be made, the Principal and Surety bind ourselves, our heirs, administrators, successors and assigns, jointly and severally, by these presents.

WHEREAS, the Water Well Standards Act of 1985 (O.C.G.A. §§ 12-5-120 *et seq.*) (the Act) requires that a Driller, as that term is defined by the Act, have a performance bond with the Director to ensure compliance with the Act; and WHEREAS the above bound Principal is subject to the terms and provisions of said Act.

NOW, THEREFORE, the conditions of this obligation are such that if the above bound Principal shall fully and faithfully perform the duties and in all things comply with the procedures and standards set forth in the Act as now and hereafter amended, and the rules and regulations promulgated pursuant thereto, including but not limited to the correction of any violation of such procedures and standards upon discovery, irrespective of whether such discovery is made before completion of any well subject to this bond, then this obligation shall be void; otherwise it shall remain in full force and effect.

And Surety, for value received, agrees that no amendment to existing laws, rules or regulations, or adoption of new laws, rules or regulations shall in anyway discharge its obligation on this bond, and does hereby waive notice of any such amendment, adoption or modification.

This bond shall be effective from the 14th day of March, 2019 and shall continue in effect until June 30, 2021, unless sooner terminated by mutual agreement of Principal and Surety, provided that no such termination may be made unless sixty (60) days' prior written notice is made to the Director. In the event of such termination, the rights of the Director as Obligee and beneficiaries under this bond which arose prior to such termination shall continue.

IN WITNESS THEREOF the Principal and Surety have caused these present to be duly signed and sealed, this the 12th day of April, 2019.

Principal
Lewis Johnson and ECS Florida, LLC

Print name: Lewis Johnson
Title: Drilling Supervisor

Seal:

Surety
The Ohio Casualty Insurance Company

Print name: Frank C. Roddey, Jr.
Title: Attorney-In-Fact

Seal:

Revised 02.27.2019

This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated. Not valid for mortgage, note, loan, letter of credit, bank deposit, currency rate, interest rate or residual value guarantees. To confirm the validity of this Power of Attorney call 610-832-8240 between 9:00 am and 4:30 pm EST on any business day.

Liberty Mutual. SURETY

Liberty Mutual Insurance Company
The Ohio Casualty Insurance Company
West American Insurance Company

POWER OF ATTORNEY

KNOWN ALL PERSONS BY THESE PRESENTS: That The Ohio Casualty Insurance Company is a corporation duly organized under the laws of the State of New Hampshire, that Liberty Mutual Insurance Company is a corporation duly organized under the laws of the State of Massachusetts, and West American Insurance Company is a corporation duly organized under the laws of the State of Indiana (herein collectively called the "Companies"), pursuant to and by authority herein set forth, does hereby name, constitute and appoint, **Frank C. Roddey Jr.** of the city of Alexandria, state of VA its true and lawful attorney-in-fact, with full power and authority hereby conferred to sign, execute and acknowledge the following surety bond:

Principal Name: **Lewis Johnson**

Obligee Name: **State of Georgia, Department of Natural Resources, Environmental Protection Division**

Surety Bond Number: **017231795** Bond Amount: See Bond Form

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Companies and the corporate seals of the Companies have been affixed thereto this 12th day of December, 2018.

LIBERTY MUTUAL INSURANCE COMPANY INCORPORATED 1912 MASSACHUSETTS
THE OHIO CASUALTY INSURANCE COMPANY INCORPORATED 1919 NEW HAMPSHIRE
WEST AMERICAN INSURANCE COMPANY INCORPORATED 1991 INDIANA

The Ohio Casualty Insurance Company
Liberty Mutual Insurance Company
West American Insurance Company

By: David M. Carey
David M. Carey, Assistant Secretary

STATE OF PENNSYLVANIA ss
COUNTY OF MONTGOMERY

On this 12th day of December, 2018, before me personally appeared David M. Carey, who acknowledged himself to be the Assistant Secretary of Liberty Mutual Insurance Company, The Ohio Casualty Company, and West American Insurance Company, and that he, as such, being authorized so to do, execute the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at King of Prussia, Pennsylvania, on the day and year first above written.

TERESA PASTELLA COMMONWEALTH OF PENNSYLVANIA NOTARY PUBLIC

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Teresa Pastella, Notary Public
Upper Merion Twp., Montgomery County
My Commission Expires March 28, 2021
Member, Pennsylvania Association of Notaries

By: Teresa Pastella
Teresa Pastella, Notary Public

This Power of Attorney is made and executed pursuant to and by authority of the following By-laws and Authorizations of Liberty Mutual Insurance Company, The Ohio Casualty Insurance Company, and West American Insurance Company which resolutions are now in full force and effect reading as follows:

ARTICLE IV – OFFICERS – Section 12. Power of Attorney. Any officer or other official of the Corporation authorized for that purpose in writing by the Chairman or the President, and subject to such limitation as the Chairman or the President may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Corporation to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Corporation by their signature and execution of any such instruments and to attach thereto the seal of the Corporation. When so executed, such instruments shall be as binding as if signed by the President and attested to by the Secretary. Any power or authority granted to any representative or attorney-in-fact under the provisions of this article may be revoked at any time by the Board, the Chairman, the President or by the officer or officers granting such power or authority.

ARTICLE XIII – Execution of Contracts – SECTION 5. Surety Bonds and Undertakings. Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

Certificate of Designation – The President of the Company, acting pursuant to the Bylaws of the Company, authorizes David M. Carey, Assistant Secretary to appoint such attorneys-in-fact as may be necessary to act on behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

Authorization – By unanimous consent of the Company's Board of Directors, the Company consents that facsimile or mechanically reproduced signature of any assistant secretary of the Company, wherever appearing upon a certified copy of any power of attorney issued by the Company in connection with surety bonds, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

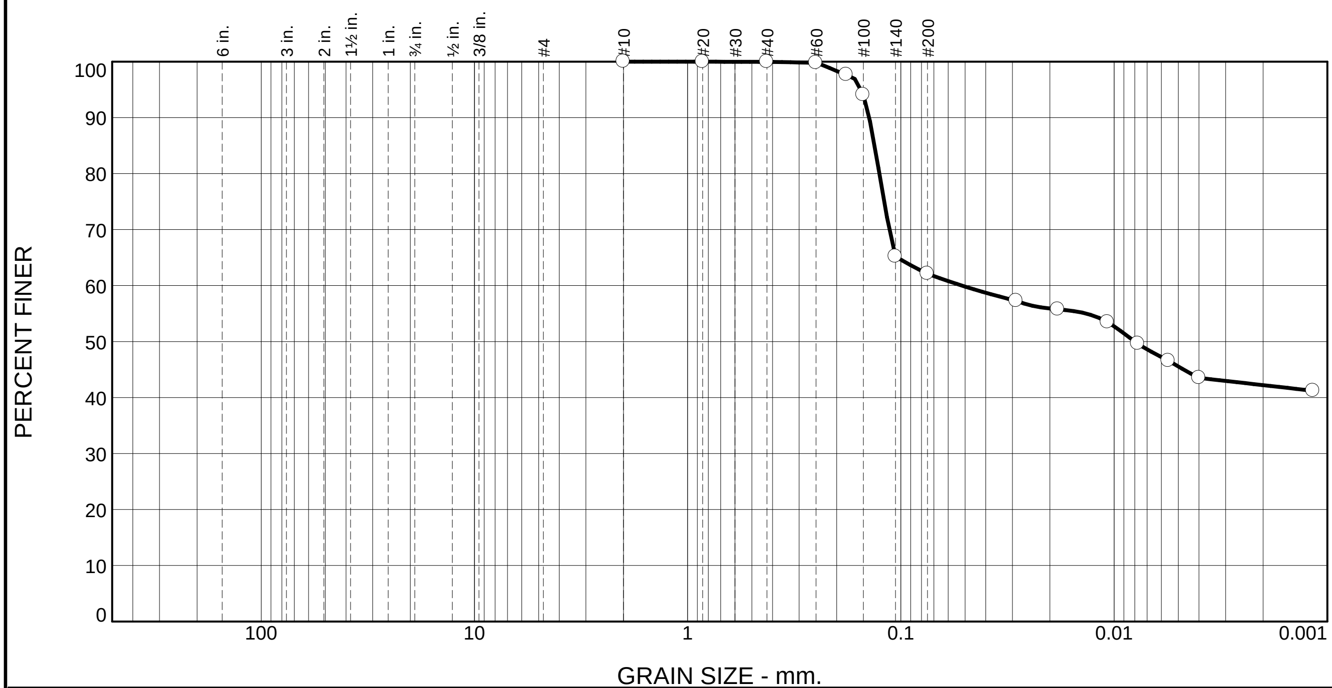
I, Renee C. Llewellyn, the undersigned, Assistant Secretary, of Liberty Mutual Insurance Company, The Ohio Casualty Insurance Company, and West American Insurance Company do hereby certify that this power of attorney executed by said Companies is in full force and effect and has not been revoked.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 12th day of April, 2019.

LIBERTY MUTUAL INSURANCE COMPANY INCORPORATED 1912 MASSACHUSETTS
THE OHIO CASUALTY INSURANCE COMPANY INCORPORATED 1919 NEW HAMPSHIRE
WEST AMERICAN INSURANCE COMPANY INCORPORATED 1991 INDIANA

By: Renee C. Llewellyn
Renee C. Llewellyn, Assistant Secretary

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	37.9	16.5	45.6

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	100.0		
#60	99.8		
#80	97.7		
#100	94.1		
#140	65.2		
#200	62.1		
0.0287 mm.	57.3		
0.0183 mm.	55.8		
0.0107 mm.	53.5		
0.0077 mm.	49.6		
0.0056 mm.	46.6		
0.0040 mm.	43.5		
0.0012 mm.	41.2		

* (no specification provided)

Material Description

Sandy Clay

Atterberg Limits (ASTM D 4318)

PL= 15 **LL=** 45 **PI=** 30

Classification

USCS (D 2487)= CL **AASHTO (M 145)=** A-7-6(15)

Coefficients

D_{90}= 0.1409 D_{85}= 0.1329 D_{60}= 0.0518
D_{50}= 0.0080 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Hydraulic Conductivity: 9 x 10-7
Porosity based on an assumed specific gravity of 2.65: 0.326

Date Received: **Date Tested:**
Tested By: SB
Checked By: SB
Title:

Location: P-13
Depth: 25'-28'

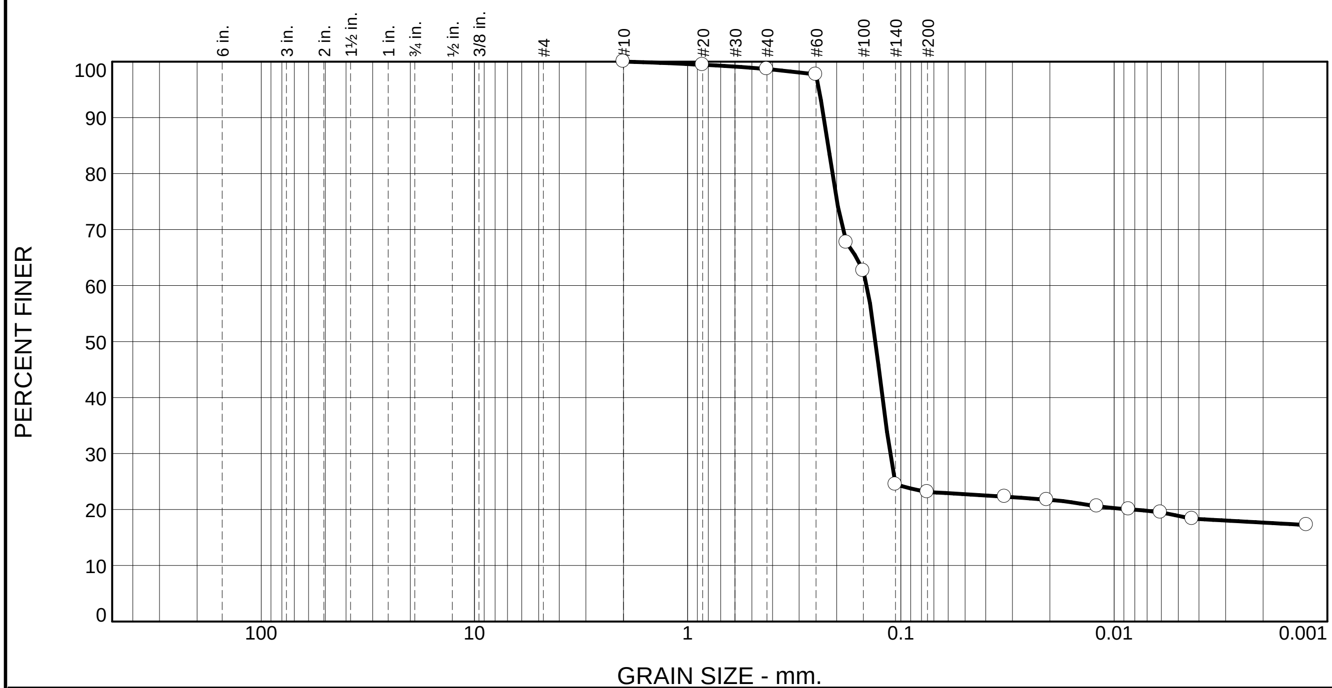
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.3	75.6	4.2	18.9

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.4		
#40	98.7		
#60	97.7		
#80	67.7		
#100	62.7		
#140	24.5		
#200	23.1		
0.0326 mm.	22.3		
0.0207 mm.	21.7		
0.0120 mm.	20.6		
0.0085 mm.	20.0		
0.0060 mm.	19.5		
0.0043 mm.	18.4		
0.0013 mm.	17.2		

* (no specification provided)

Material Description

Clayey Fine Sand trace Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2299 D_{85}= 0.2194 D_{60}= 0.1445
D_{50}= 0.1316 D_{30}= 0.1124 D_{15}=
D_{10}= C_u= C_c=

Remarks

Hydraulic Conductivity: 3.5 x 10-5
Porosity based on an assumed specific gravity of 2.65: 0.331

Date Received: ____________ **Date Tested:** ____________

Tested By: SB

Checked By: SB

Title: ____________

Location: P-14
Depth: 5'-8'

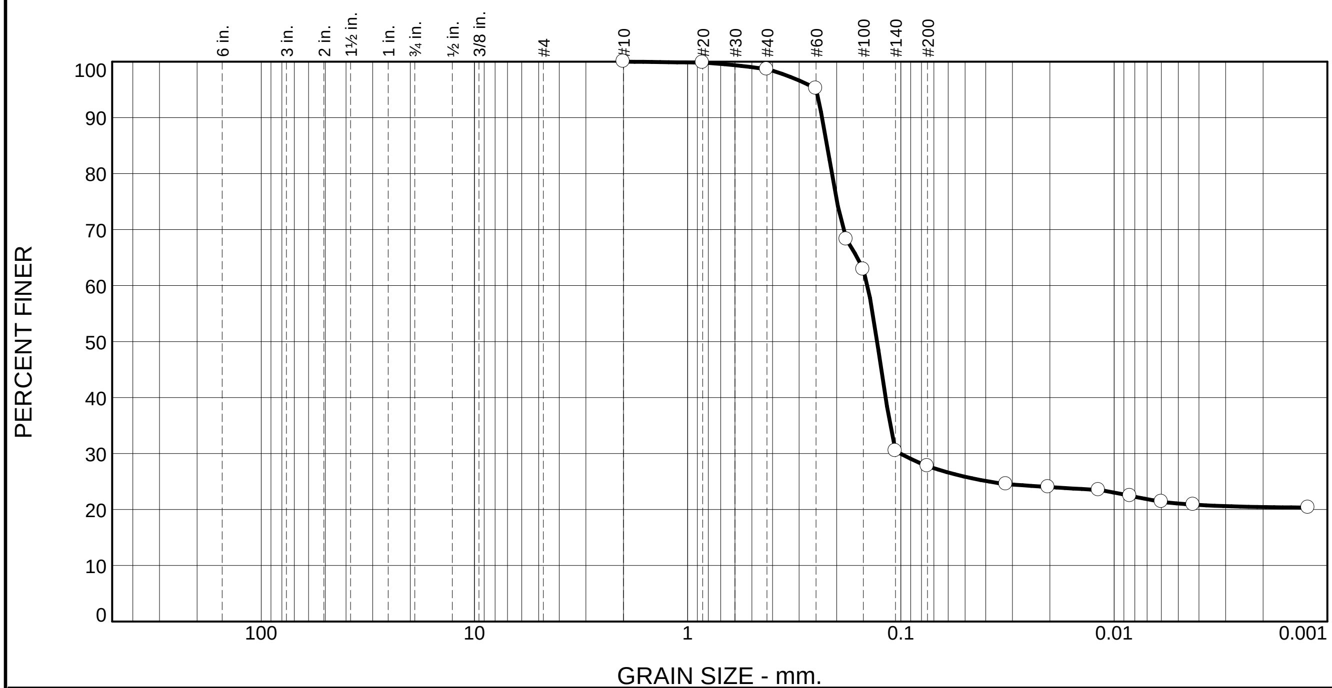
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.4	70.9	6.6	21.1

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	98.6		
#60	95.2		
#80	68.3		
#100	62.9		
#140	30.5		
#200	27.7		
0.0321 mm.	24.5		
0.0204 mm.	24.0		
0.0118 mm.	23.5		
0.0084 mm.	22.4		
0.0060 mm.	21.4		
0.0042 mm.	20.9		
0.0012 mm.	20.4		

* (no specification provided)

Material Description

Clayey Fine Sand with Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2343 D_{85}= 0.2220 D_{60}= 0.1434
D_{50}= 0.1292 D_{30}= 0.1007 D_{15}=
D_{10}= C_u= C_c=

Remarks

Hydraulic Conductivity: 2.0 x 10-5
Porosity based on an assumed specific gravity of 2.65: 0.390

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-14
Depth: 9.5'-12.5'

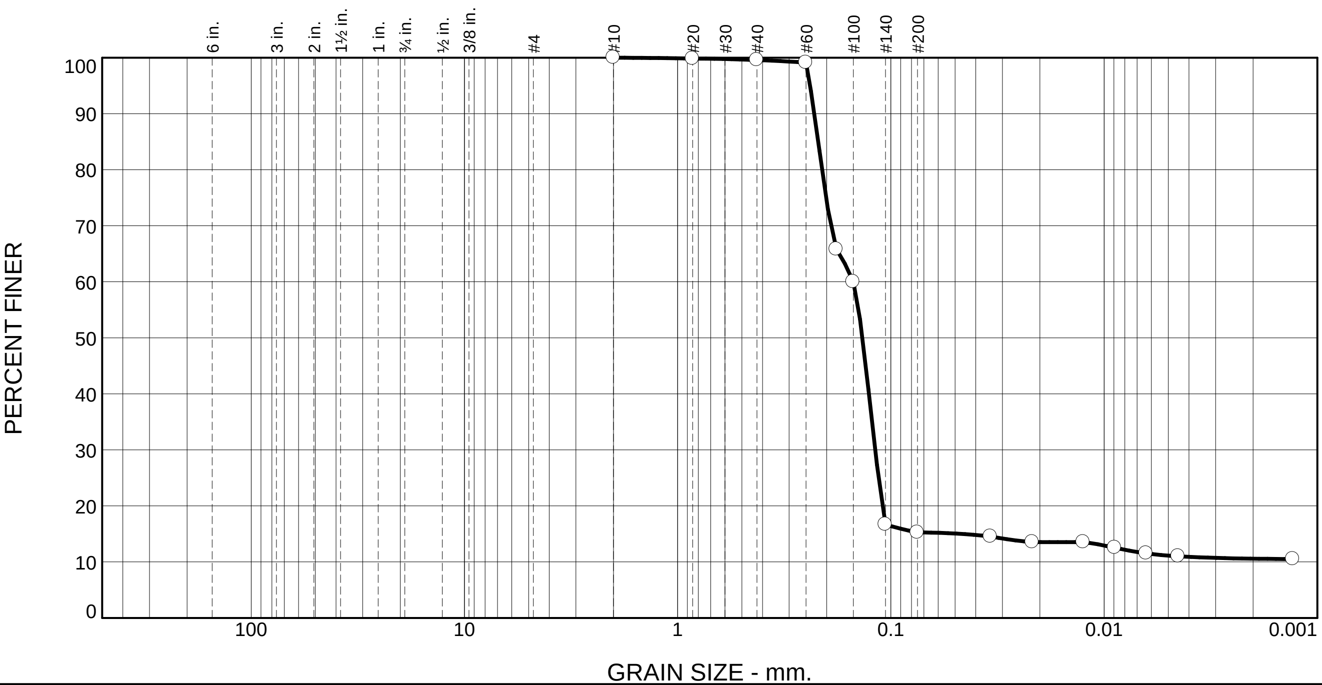
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	84.3	4.2	11.1

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	99.6		
#60	99.1		
#80	65.8		
#100	60.0		
#140	16.7		
#200	15.3		
0.0341 mm.	14.5		
0.0217 mm.	13.5		
0.0125 mm.	13.5		
0.0089 mm.	12.5		
0.0063 mm.	11.5		
0.0045 mm.	11.0		
0.0013 mm.	10.5		

* (no specification provided)

Material Description

Fine Sand with Clay & Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2287 D_{85}= 0.2192 D_{60}= 0.1501
D_{50}= 0.1360 D_{30}= 0.1184 D_{15}= 0.0469
D_{10}= C_u= C_c=

Remarks

Hydraulic Conductivity: 4.4 x 10-4
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.444

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-15
Depth: 5'-8'

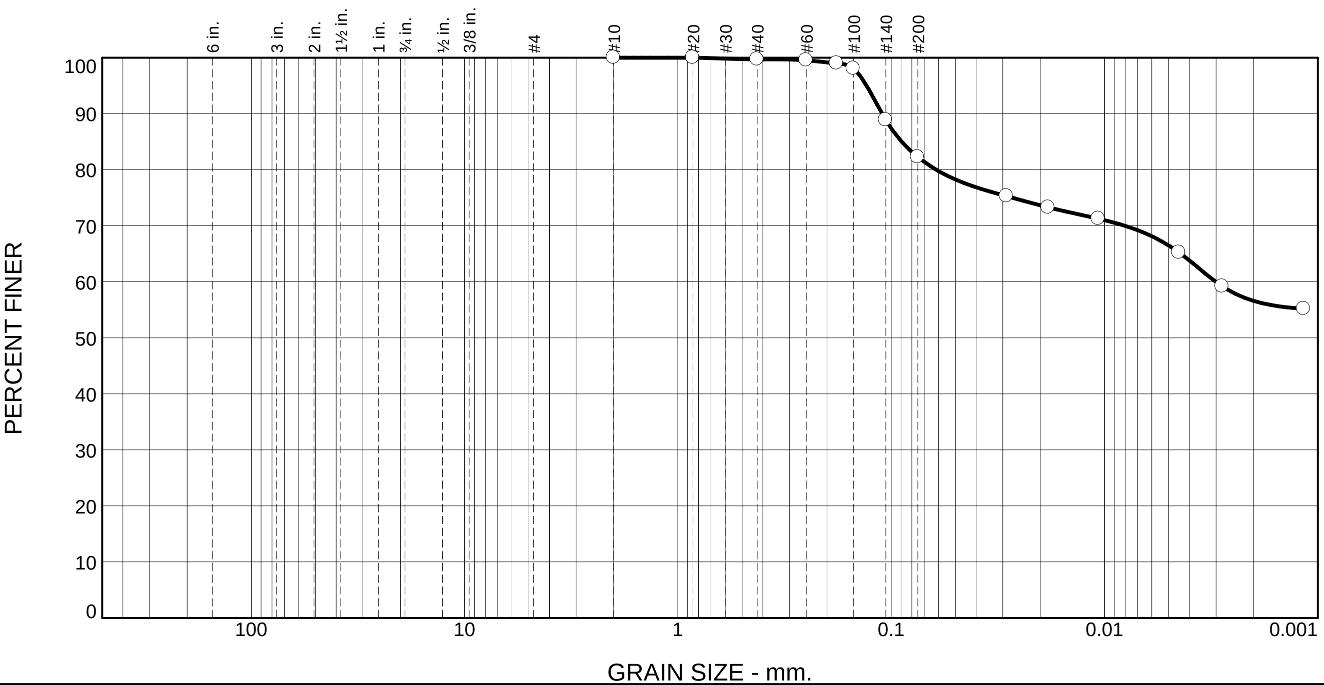
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.3	17.4	15.8	66.5

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	99.7		
#60	99.5		
#80	99.0		
#100	98.0		
#140	88.9		
#200	82.3		
0.0287 mm.	75.3		
0.0183 mm.	73.3		
0.0107 mm.	71.3		
0.0045 mm.	65.2		
0.0028 mm.	59.2		
0.0012 mm.	55.2		

* (no specification provided)

Material Description

Clay with Sand and Silt, Frequent Sand Seams

Atterberg Limits (ASTM D 4318)

PL= 22 **LL=** 51 **PI=** 29

Classification

USCS (D 2487)= CH **AASHTO (M 145)=** A-7-6(25)

Coefficients

D_{90}= 0.1103 D_{85}= 0.0893 D_{60}= 0.0030
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Hydraulic Conductivity: 6.3 x 10-5
Porosity based on an assumed specific gravity of 2.65: 0.479

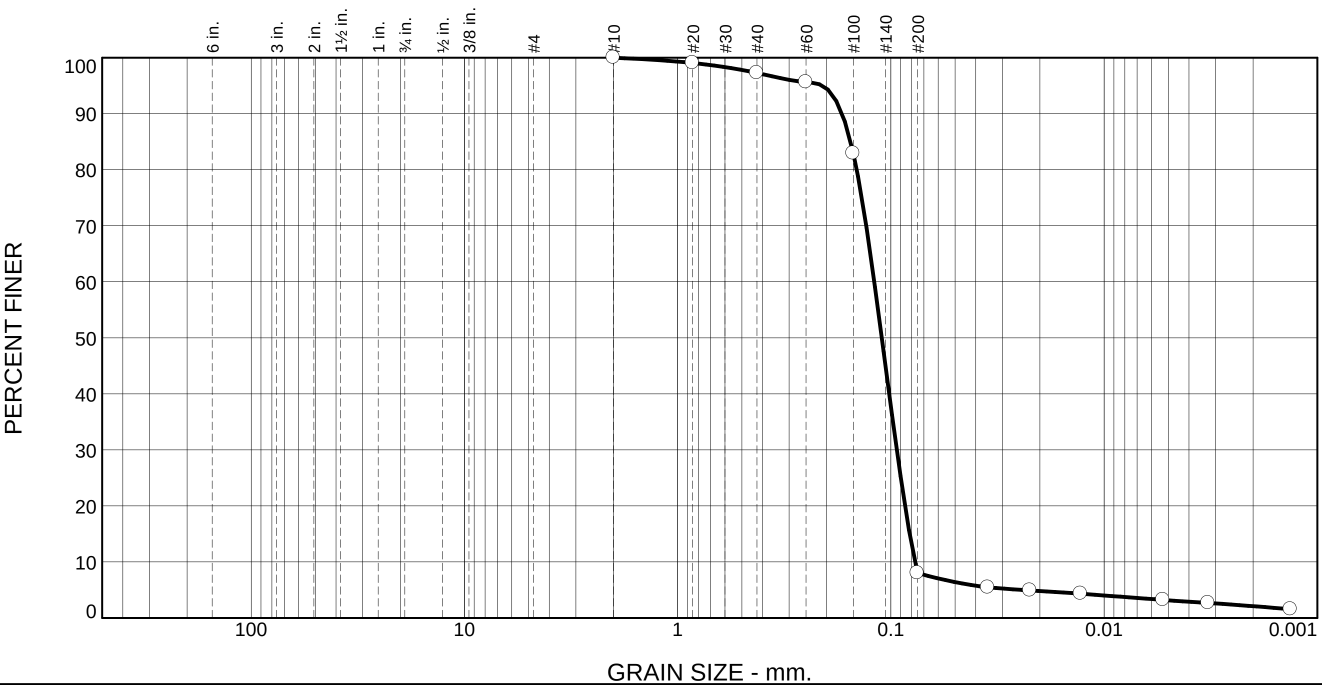
Date Received: **Date Tested:**
Tested By: SB
Checked By: SB
Title:

Location: P-15
Depth: 9.5'-12.5'
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2
Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.7	89.3	4.8	3.2

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.1		
#40	97.3		
#60	95.6		
#100	82.9		
#200	8.0		
0.0351 mm.	5.5		
0.0223 mm.	4.9		
0.0129 mm.	4.3		
0.0053 mm.	3.2		
0.0033 mm.	2.7		
0.0013 mm.	1.6		

* (no specification provided)

Material Description

Fine Sand trace Silt & Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.1694 D_{85}= 0.1545 D_{60}= 0.1196
D_{50}= 0.1103 D_{30}= 0.0938 D_{15}= 0.0816
D_{10}= 0.0770 C_u= 1.55 C_c= 0.96

Remarks

Hydraulic Conductivity: 4 x 10-4
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.458

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-16
Depth: 20'-23'

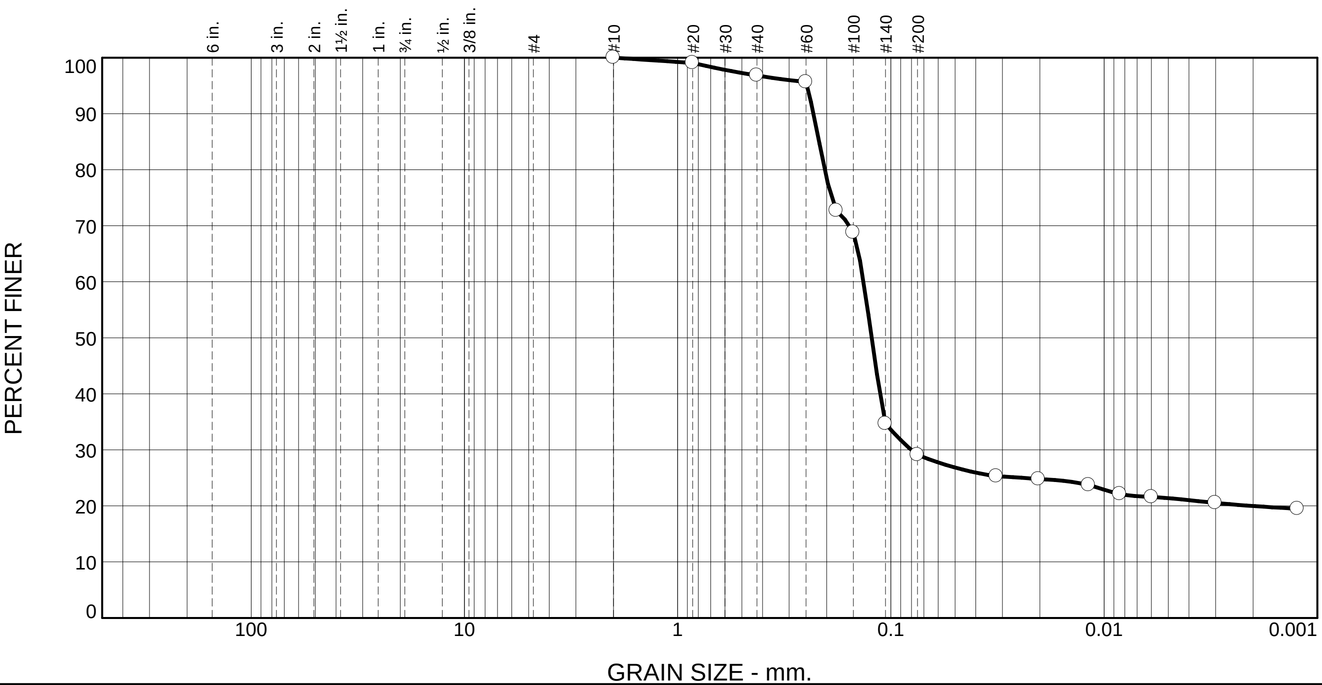
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.2	67.7	7.7	21.4

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.1		
#40	96.8		
#60	95.6		
#80	72.7		
#100	68.8		
#140	34.7		
#200	29.1		
0.0320 mm.	25.3		
0.0203 mm.	24.8		
0.0118 mm.	23.7		
0.0084 mm.	22.1		
0.0060 mm.	21.6		
0.0030 mm.	20.5		
0.0012 mm.	19.5		

* (no specification provided)

Material Description

Clayey Fine Sand with Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2308 D_{85}= 0.2172 D_{60}= 0.1343
D_{50}= 0.1230 D_{30}= 0.0801 D_{15}=
D_{10}= C_u= C_c=

Remarks

Hydraulic Conductivity: 8.1 x 10-5
Porosity based on an assumed specific gravity of 2.65: 0.412

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-16
Depth: 25'-28'

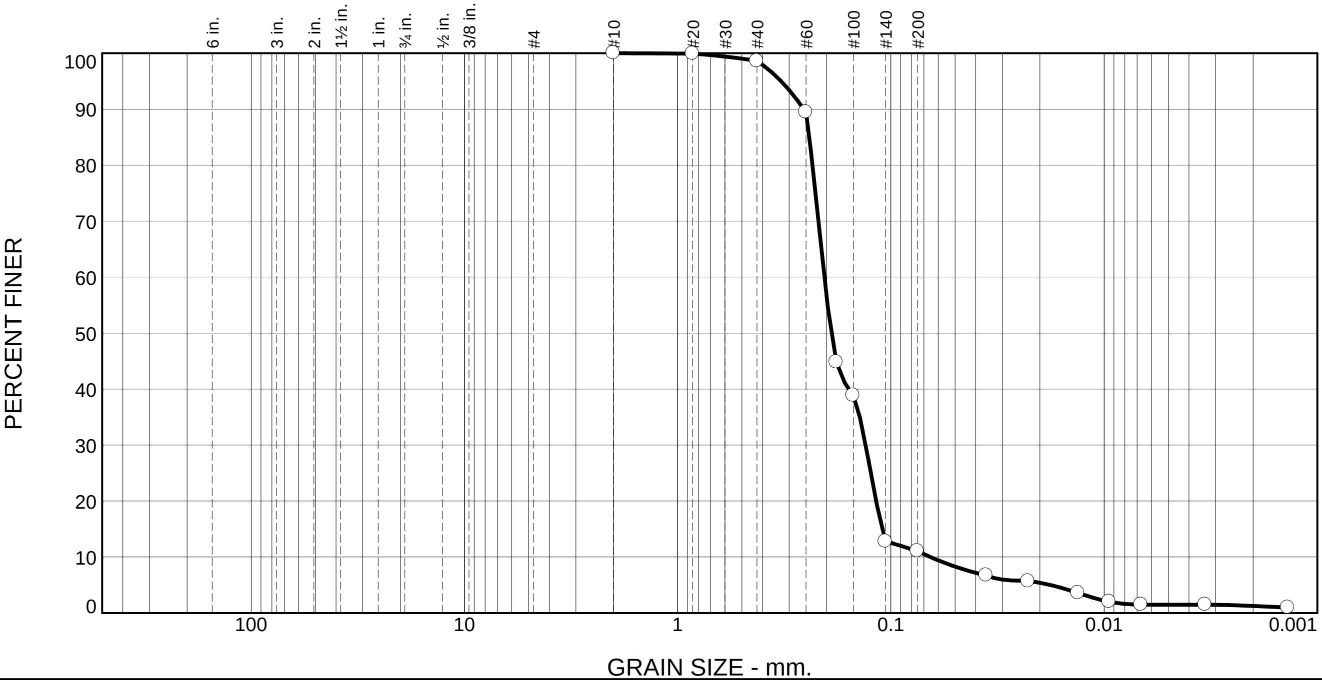
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.4	87.5	9.6	1.5

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	98.6		
#60	89.5		
#80	44.8		
#100	38.8		
#140	12.8		
#200	11.1		
0.0357 mm.	6.7		
0.0227 mm.	5.7		
0.0133 mm.	3.6		
0.0095 mm.	2.0		
0.0067 mm.	1.5		
0.0034 mm.	1.5		
0.0014 mm.	1.0		

* (no specification provided)

Material Description

Fine Sand with Silt trace Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2559 D_{85}= 0.2414 D_{60}= 0.2051
D_{50}= 0.1903 D_{30}= 0.1313 D_{15}= 0.1099
D_{10}= 0.0653 C_u= 3.14 C_c= 1.29

Remarks

Hydraulic Conductivity: 1.6 x 10-4
Porosity based on an assumed specific gravity of 2.65: 0.300

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-17
Depth: 5'-8'

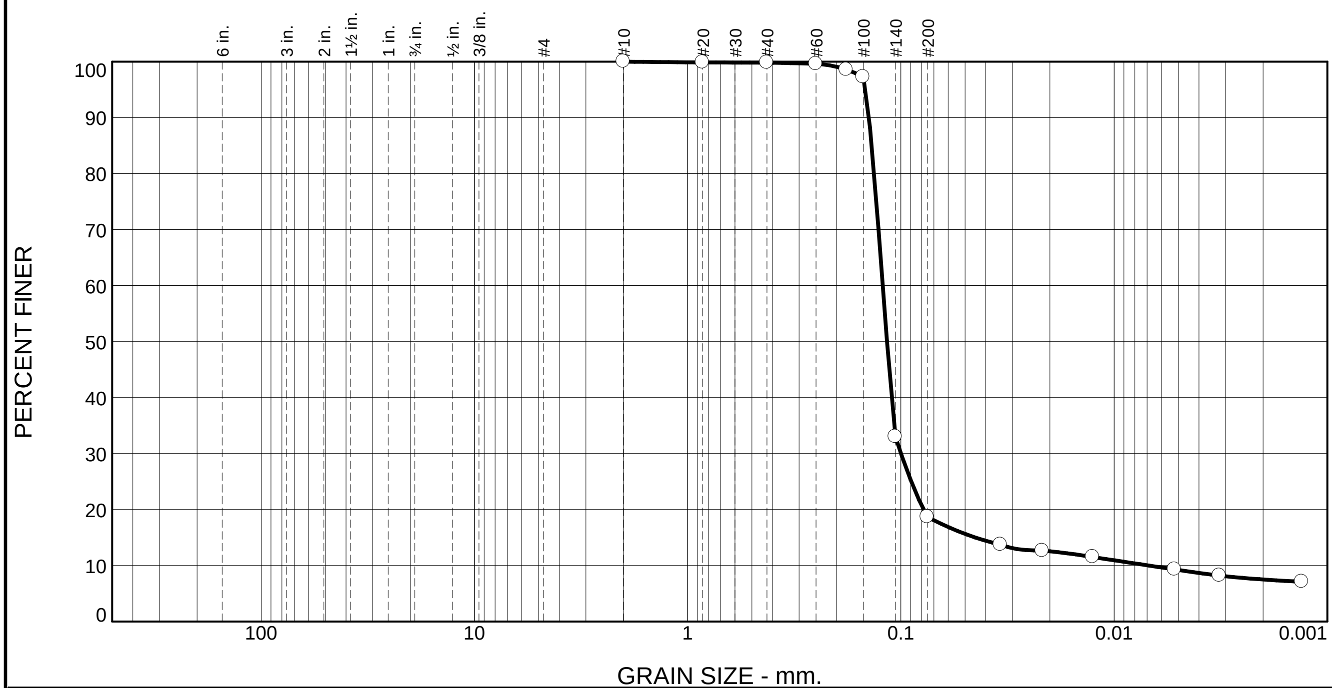
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	81.1	9.5	9.2

Test Results (ASTM D 422 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.6		
#80	98.6		
#100	97.3		
#140	33.0		
#200	18.7		
0.0341 mm.	13.7		
0.0217 mm.	12.6		
0.0126 mm.	11.5		
0.0052 mm.	9.3		
0.0032 mm.	8.2		
0.0013 mm.	7.1		

* (no specification provided)

Material Description

Fine Sand with Silt & Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.1412 D_{85}= 0.1371 D_{60}= 0.1216
D_{50}= 0.1161 D_{30}= 0.0999 D_{15}= 0.0447
D_{10}= 0.0069 C_u= 17.64 C_c= 11.91

Remarks

Hydraulic Conductivity: 1.9 x 10-5
Porosity based on an assumed specific gravity of 2.65: 0.407

Date Received: ____________ **Date Tested:** ____________
Tested By: SB
Checked By: SB
Title: ____________

Location: P-18
Depth: 20'-23'

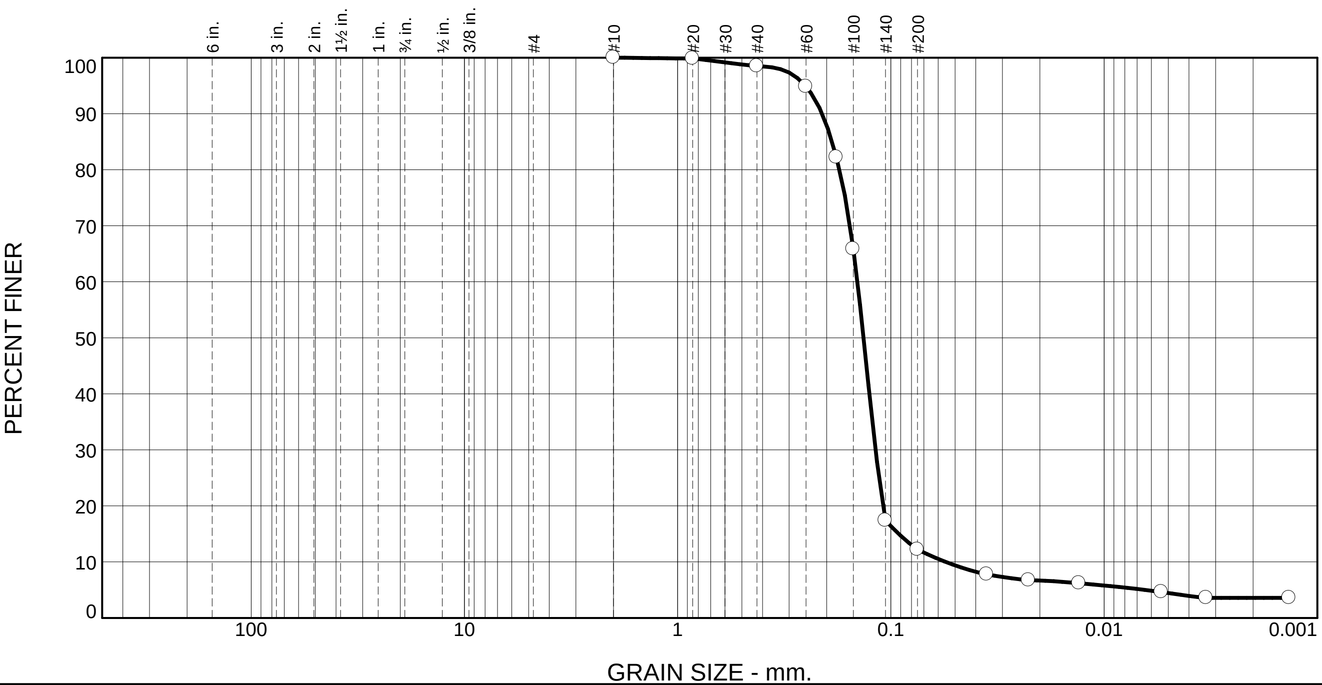
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.5	86.3	7.8	4.4

Test Results (ASTM D 422 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	98.5		
#60	94.8		
#80	82.2		
#100	65.8		
#140	17.4		
#200	12.2		
0.0355 mm.	7.8		
0.0226 mm.	6.7		
0.0131 mm.	6.2		
0.0054 mm.	4.6		
0.0033 mm.	3.6		
0.0014 mm.	3.6		

* (no specification provided)

Material Description

Fine Sand with Silt trace Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2102 D_{85}= 0.1886 D_{60}= 0.1436
D_{50}= 0.1344 D_{30}= 0.1180 D_{15}= 0.0918
D_{10}= 0.0554 C_u= 2.59 C_c= 1.75

Remarks

Hydraulic Conductivity: 4.1 x 10-4
Porosity based on an assumed specific gravity 2.65: 0.455

Date Received: ____________ **Date Tested:** ____________

Tested By: SB

Checked By: SB

Title: ____________

Location: P-19
Depth: 1'-4'

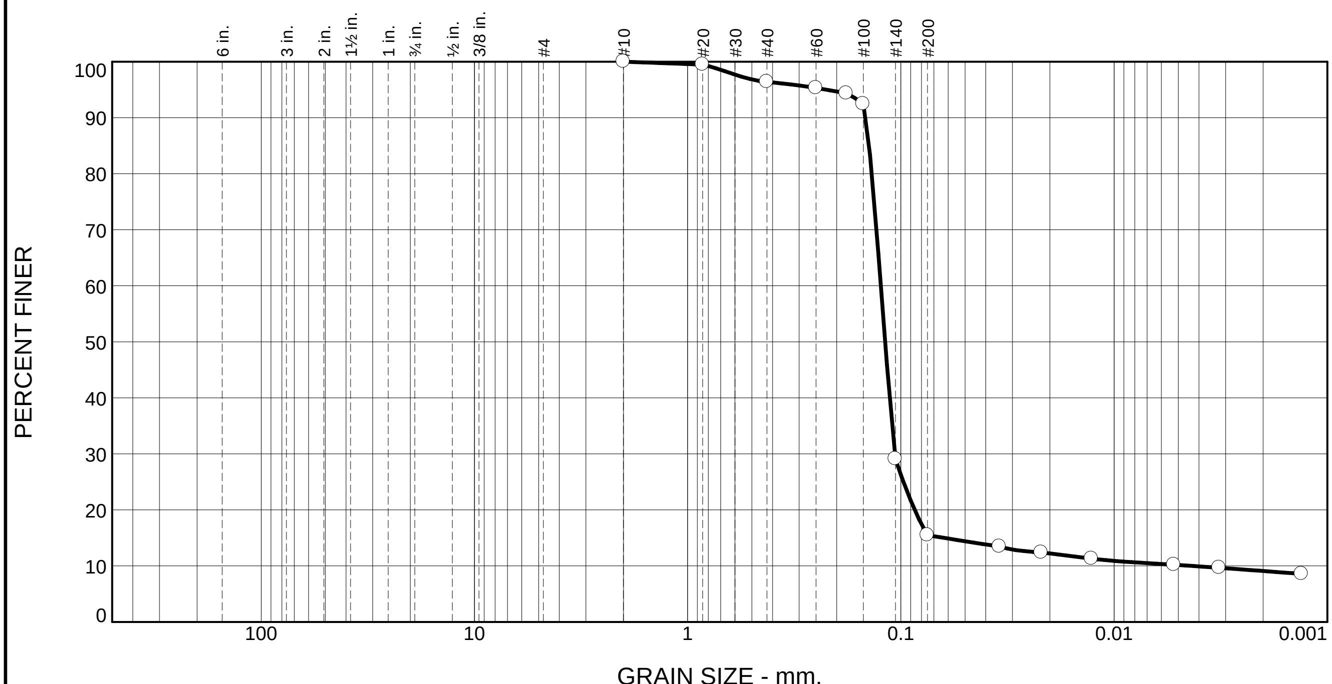
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	3.6	80.9	5.3	10.2

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.5		
#40	96.4		
#60	95.3		
#80	94.3		
#100	92.4		
#140	29.1		
#200	15.5		
0.0345 mm.	13.5		
0.0219 mm.	12.4		
0.0127 mm.	11.3		
0.0052 mm.	10.2		
0.0032 mm.	9.7		
0.0013 mm.	8.6		

* (no specification provided)

Material Description

Fine Sand with Clay & Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.1464 D_{85}= 0.1411 D_{60}= 0.1241
D_{50}= 0.1185 D_{30}= 0.1066 D_{15}= 0.0626
D_{10}= 0.0043 C_u= 28.86 C_c= 21.31

Remarks

Hydraulic Conductivity: 1.1 x 10-4
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.470

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-19
Depth: 15'-18'

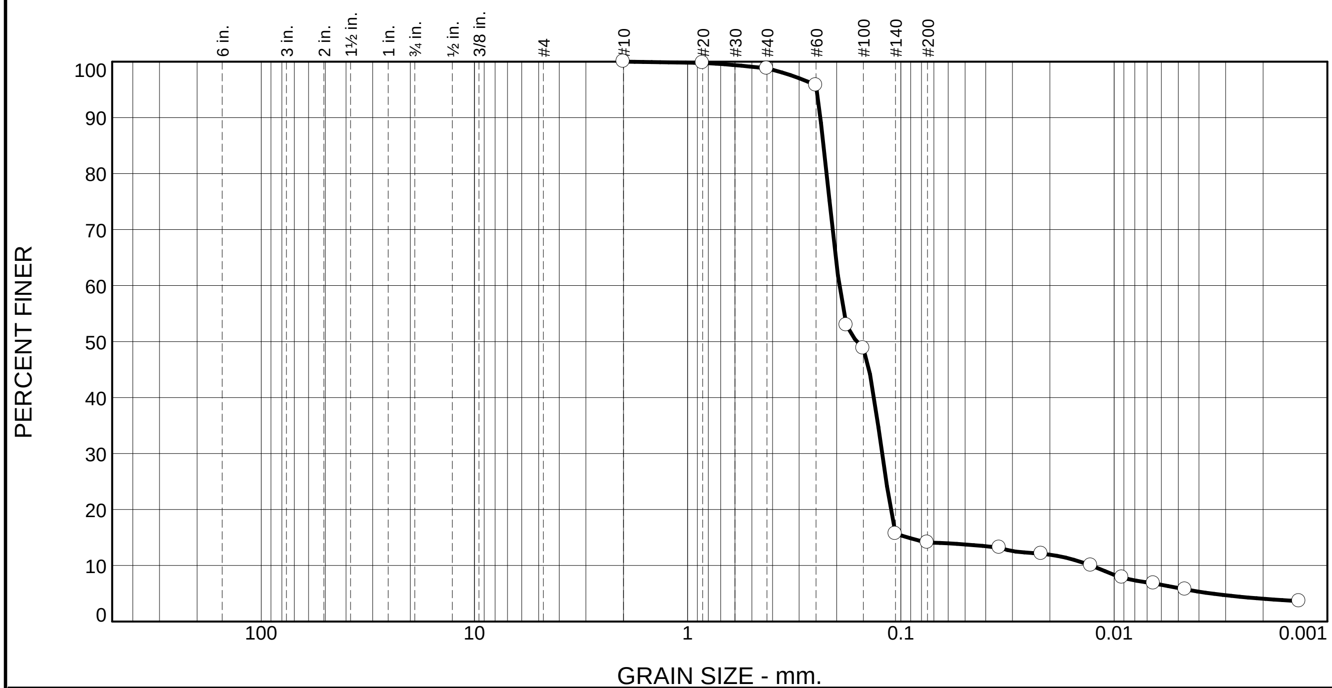
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.2	84.7	8.1	6.0

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	98.8		
#60	95.8		
#80	52.9		
#100	48.8		
#140	15.7		
#200	14.1		
0.0345 mm.	13.2		
0.0219 mm.	12.1		
0.0128 mm.	10.0		
0.0092 mm.	7.9		
0.0065 mm.	6.8		
0.0046 mm.	5.7		
0.0014 mm.	3.6		

* (no specification provided)

Material Description

Fine Sand with Silt & Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2387 D_{85}= 0.2305 D_{60}= 0.1944
D_{50}= 0.1573 D_{30}= 0.1223 D_{15}= 0.0929
D_{10}= 0.0128 C_u= 15.14 C_c= 5.99

Remarks

Hydraulic Conductivity: 1.9 x 10-4
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.425

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-20
Depth: 1'-4'

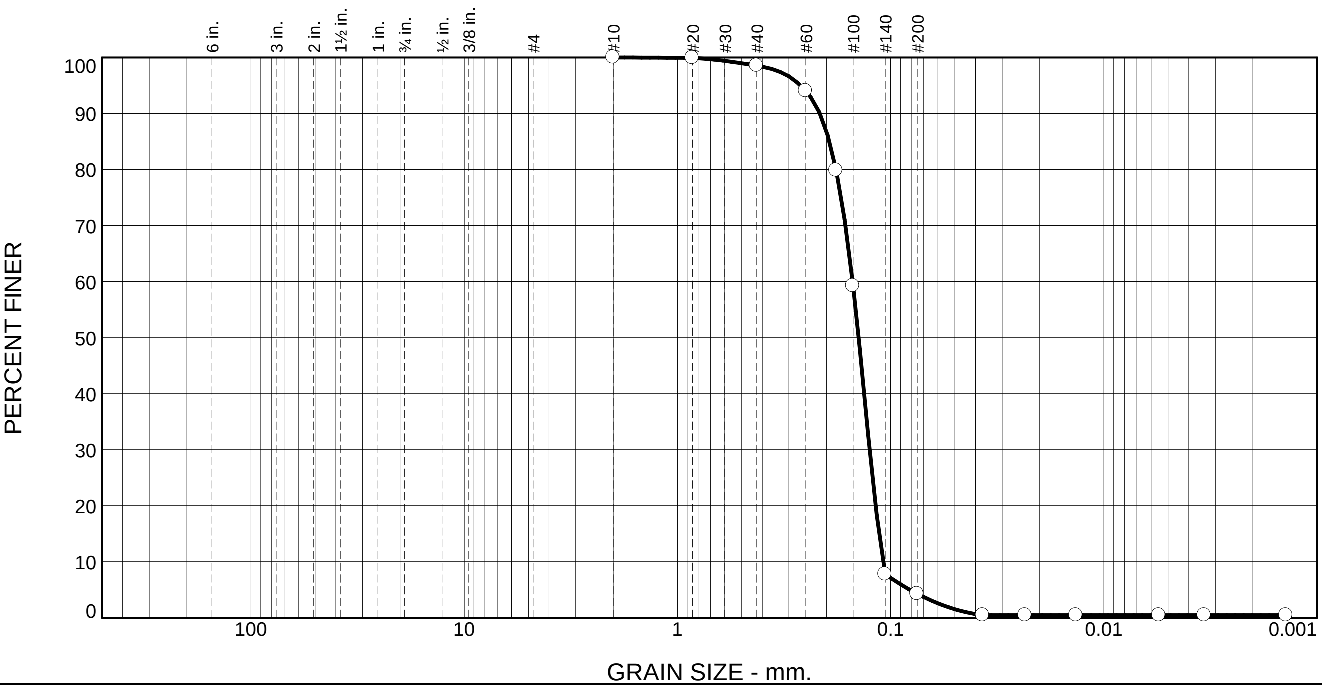
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.5	94.2	3.9	0.4

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	98.5		
#60	94.0		
#80	79.8		
#100	59.2		
#140	7.8		
#200	4.3		
0.0369 mm.	0.4		
0.0234 mm.	0.4		
0.0135 mm.	0.4		
0.0055 mm.	0.4		
0.0034 mm.	0.4		
0.0014 mm.	0.4		

* (no specification provided)

Material Description

Fine Sand trace Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.2149 D_{85}= 0.1936 D_{60}= 0.1508
D_{50}= 0.1414 D_{30}= 0.1254 D_{15}= 0.1133
D_{10}= 0.1085 C_u= 1.39 C_c= 0.96

Remarks

Hydraulic Conductivity: 4.0 x 10-4
Porosity based on an assumed specific gravity of 2.65: 0.372

Date Received: **Date Tested:**
Tested By: SB
Checked By: SB
Title:

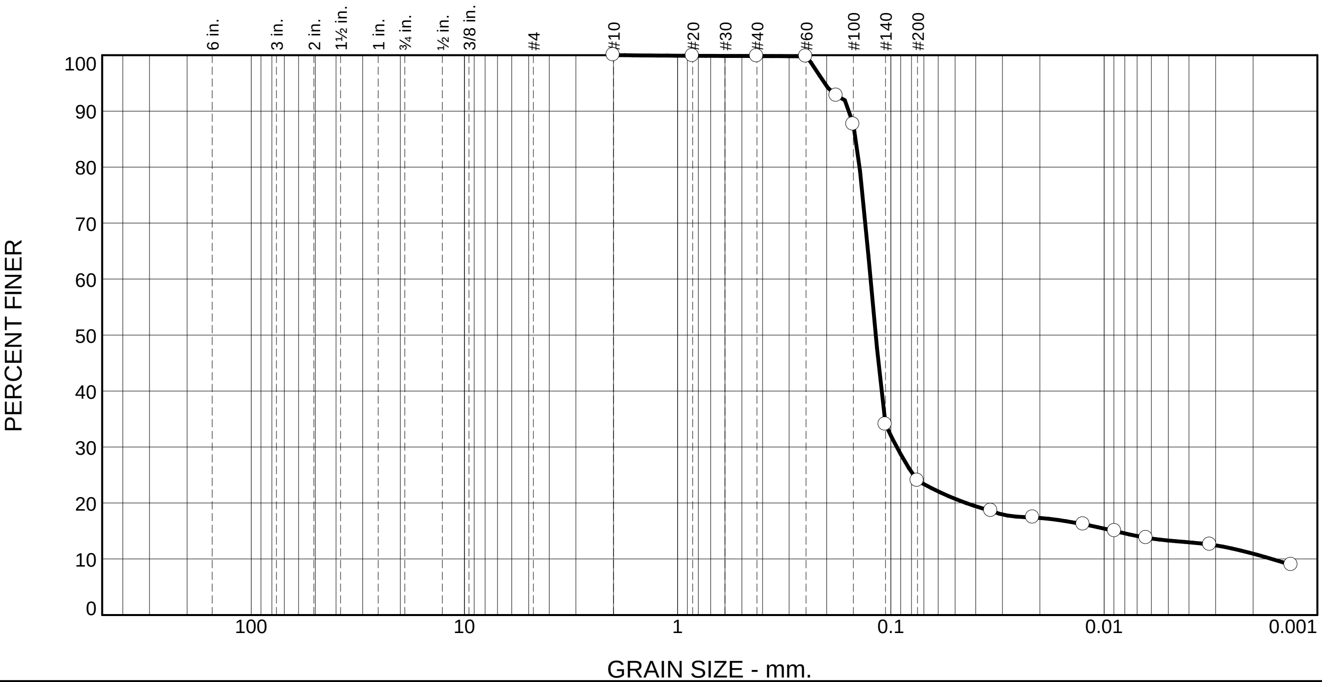
Location: P-20
Depth: 5.5'-8.5'

Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2
Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	75.8	10.7	13.3

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.8		
#80	92.8		
#100	87.6		
#140	34.1		
#200	24.0		
0.0339 mm.	18.6		
0.0215 mm.	17.4		
0.0125 mm.	16.2		
0.0089 mm.	15.0		
0.0063 mm.	13.8		
0.0032 mm.	12.6		
0.0013 mm.	9.0		

* (no specification provided)

Material Description

Clayey Fine Sand with Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.1553 D_{85}= 0.1460 D_{60}= 0.1245
D_{50}= 0.1177 D_{30}= 0.0939 D_{15}= 0.0089
D_{10}= 0.0016 C_u= 76.24 C_c= 43.38

Remarks

Hydraulic Conductivity: 4.1 x 10-5
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.451

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-21
Depth: 20'-23'

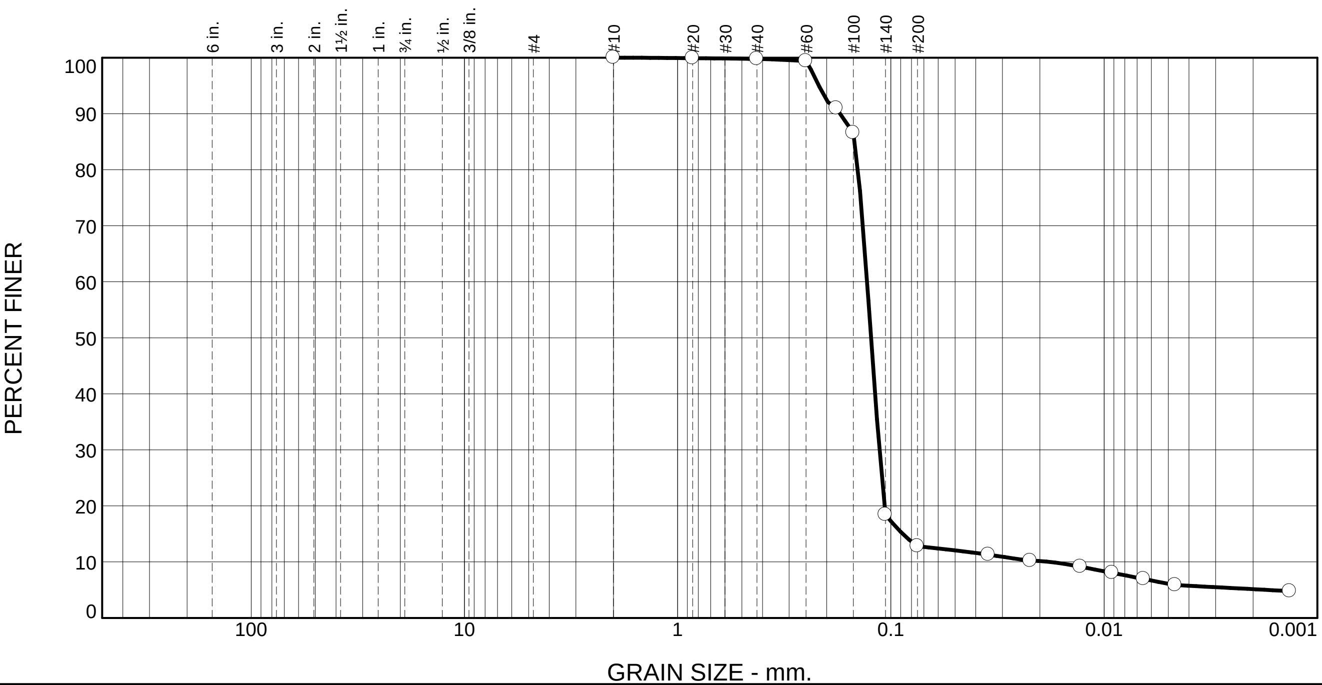
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	87.0	6.7	6.1

Test Results (ASTM D 422 & ASTM D 1140)			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.4		
#80	91.0		
#100	86.6		
#140	18.4		
#200	12.8		
0.0349 mm.	11.3		
0.0222 mm.	10.2		
0.0129 mm.	9.1		
0.0092 mm.	8.0		
0.0065 mm.	7.0		
0.0046 mm.	5.9		
0.0013 mm.	4.8		

* (no specification provided)

Material Description

Fine Sand with Silt & Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.1731 D_{85}= 0.1479 D_{60}= 0.1292
D_{50}= 0.1238 D_{30}= 0.1132 D_{15}= 0.0879
D_{10}= 0.0179 C_u= 7.21 C_c= 5.54

Remarks

Hydraulic Conductivity: 1.8 x 10-4
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.480

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-22
Depth: 20'-23'

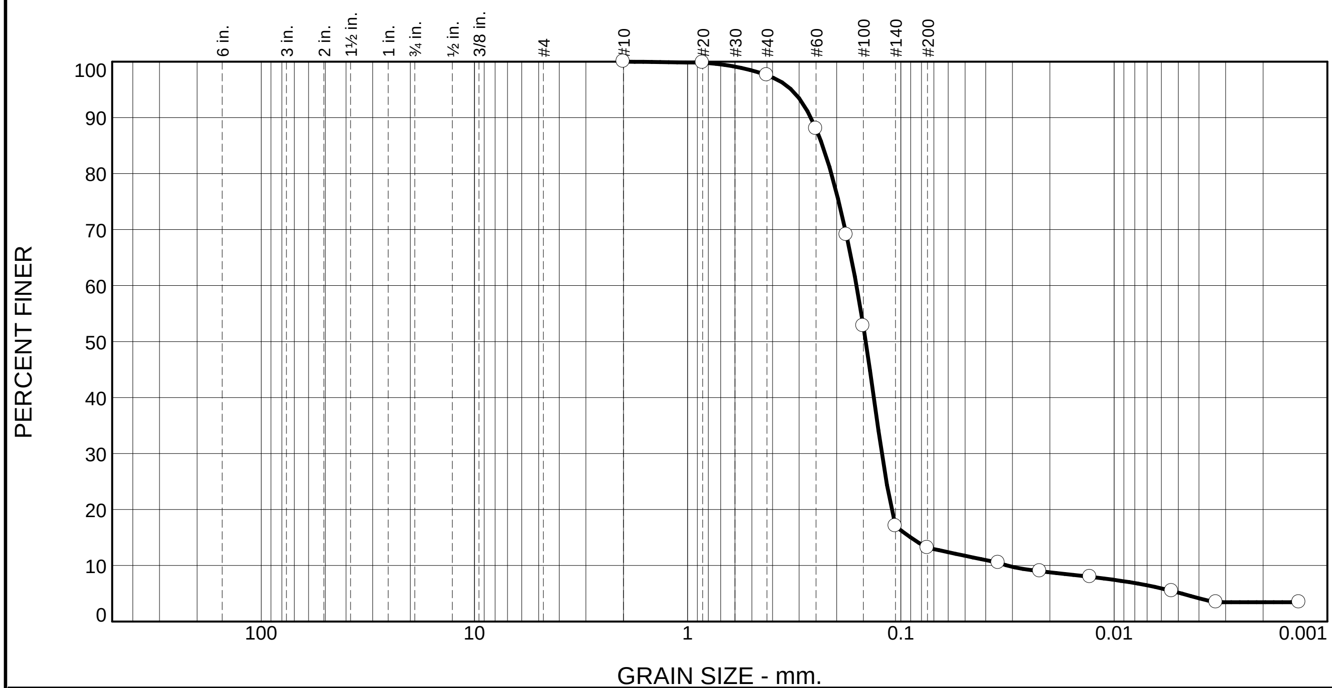
Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.4	84.4	8.0	5.2

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.8		
#40	97.6		
#60	88.0		
#80	69.1		
#100	52.8		
#140	17.1		
#200	13.2		
0.0349 mm.	10.5		
0.0223 mm.	9.0		
0.0129 mm.	8.0		
0.0054 mm.	5.5		
0.0033 mm.	3.4		
0.0014 mm.	3.4		

* (no specification provided)

Material Description

Fine Sand with Silt & Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2642 D_{85}= 0.2331 D_{60}= 0.1614
D_{50}= 0.1462 D_{30}= 0.1227 D_{15}= 0.0899
D_{10}= 0.0318 C_u= 5.07 C_c= 2.93

Remarks

Hydraulic Conductivity: 3.5 x 10-4
Porosity based on a remolded density and an assumed specific gravity of 2.65: 0.395

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

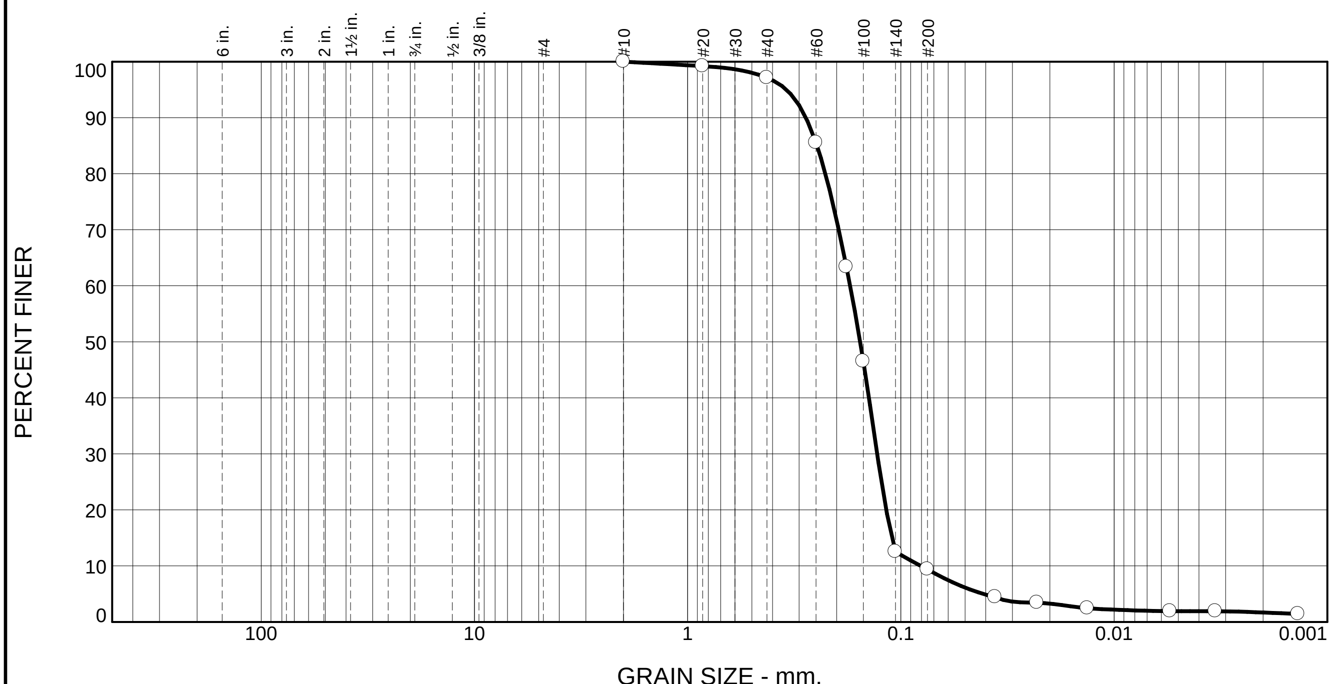
Location: P-23
Depth: 1'-4'

Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2
Project No: 28642 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	2.9	87.7	7.5	1.9

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	99.2		
#40	97.1		
#60	85.5		
#80	63.4		
#100	46.5		
#140	12.5		
#200	9.4		
0.0361 mm.	4.4		
0.0230 mm.	3.4		
0.0133 mm.	2.4		
0.0055 mm.	1.9		
0.0033 mm.	1.9		
0.0014 mm.	1.4		

* (no specification provided)

Material Description

Fine Sand with Silt trace Clay

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NP **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.2789 D_{85}= 0.2473 D_{60}= 0.1730
D_{50}= 0.1552 D_{30}= 0.1292 D_{15}= 0.1102
D_{10}= 0.0806 C_u= 2.15 C_c= 1.20

Remarks

Hydraulic Conductivity: 8.9 x 10-5
Porosity based on an assumed specific gravity of 2.65: 0.395

Date Received: **Date Tested:**

Tested By: SB

Checked By: SB

Title:

Location: P-23
Depth: 5.5' -8.5'

Date Sampled:

ECS FLORIDA, LLC
7064 Davis Creek Road
Jacksonville, Florida 32256
Phone: (904) 880-0960
Fax: (904) 880-0970

Client: Harbin Engineering PC
Project: Surface and Subsurface Investigation Phase 2

Project No: 28642 **Figure**

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P13-25'-28'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-001	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	20	1.0		meq/100g	283822	1	08/22/2019 11:52	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P14 5'-8'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-002	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	24	1.0		meq/100g	283822	1	08/22/2019 11:05	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P14 9.5'-12.5'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-003	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	23	1.0		meq/100g	283822	1	08/22/2019 11:07	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P15 5'-8'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-004	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	16	1.0		meq/100g	283822	1	08/22/2019 11:10	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P15 9.5'-12.5'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-005	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	18	1.0		meq/100g	283822	1	08/22/2019 11:12	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P16 20'-23'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-006	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	10	1.0		meq/100g	283822	1	08/22/2019 11:14	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P16 25'-28'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-007	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	21	1.0		meq/100g	283822	1	08/22/2019 11:16	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Client:	ECS Florida, LLC	**Client Sample ID:**	P17 1'-4'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-008	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	1.7	1.0		meq/100g	283822	1	08/22/2019 11:18	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P17 5'-8'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-009	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	33	1.0		meq/100g	283822	1	08/22/2019 11:20	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P18 20'-23'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-010	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	15	1.0		meq/100g	283822	1	08/22/2019 11:23	AJ

Qualifiers: *	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P19 1'-4'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-011	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	40	1.0		meq/100g	283822	1	08/22/2019 11:34	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P19 15'-18'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-012	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	15	1.0		meq/100g	283822	1	08/22/2019 11:36	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P20 1'-4'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-013	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	7.3	1.0		meq/100g	283822	1	08/22/2019 11:39	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P20 5.5'-8.5'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-014	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	19	1.0		meq/100g	283822	1	08/22/2019 11:41	AJ

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P21 20'-23'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-015	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	15	1.0		meq/100g	283822	1	08/22/2019 11:43	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P22 20'-23'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-016	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	9.5	1.0		meq/100g	283822	1	08/22/2019 11:45	AJ

Analytical Environmental Services, Inc **Date:** 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P23 1'-4'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-017	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	7.6	1.0		meq/100g	283822	1	08/22/2019 11:48	AJ

Qualifiers:
- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client:	ECS Florida, LLC	**Client Sample ID:**	P23 5.5'-8.5'
Project Name:	ECS Jacksonville-CAC	**Collection Date:**	7/9/2019
Lab ID:	1908H66-018	**Matrix:**	Solid

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
CEC of Soils (Na Saturation) SW9081				**(SW9081)**				
Cation Exchange Capacity	26	1.0		meq/100g	283822	1	08/22/2019 11:50	AJ

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Clear | Save as

ANALYTICAL ENVIRONMENTAL SERVICES, INC. (AES)

SAMPLE/COOLER RECEIPT CHECKLIST

1. Client Name: ECS   AES Work Order Number: 1908H66

2. Carrier: FedEx ☐ UPS ■ USPS ☐ Client ☐ Courier ☐ Other ______

		Yes	No	N/A	Details	Comments
3.	Shipping container/cooler received in good condition?	⊙	○	○	damaged ☐ leaking ☐ other ☐	
4.	Custody seals present on shipping container?	○	⊙	○		
5.	Custody seals intact on shipping container?	○	○	⊙		
6.	Temperature blanks present?	○	○	⊙		
7.	Cooler temperature(s) within limits of 0-6°C? [See item 13 and 14 for temperature recordings.]	○	○	⊙	Cooling initiated for recently collected samples / ice present ☐	
8.	Chain of Custody (COC) present?	⊙	○	○		
9.	Chain of Custody signed, dated, and timed when relinquished and received?	○	⊙	○		
10.	Sampler name and/or signature on COC?	⊙	○	○		Sampler signature on COC
11.	Were all samples received within holding time?	⊙	○	○		
12.	TAT marked on the COC?	⊙	○	○	If no TAT indicated, proceeded with standard TAT per Terms & Conditions. ☐	

13. Cooler 1 Temperature Ambient °C Cooler 2 Temperature ______ °C Cooler 3 Temperature ______ °C Cooler 4 Temperature ______ °C

14. Cooler 5 Temperature ______ °C Cooler 6 Temperature ______ °C Cooler 7 Temperature ______ °C Cooler 8 Temperature ______ °C

15. Comments: ______

I certify that I have completed sections 1-15 (dated initials). MDP 8/19/19

		Yes	No	N/A	Details	Comments
16.	Were sample containers intact upon receipt?	⊙	○	○		
17.	Custody seals present on sample containers?	○	⊙	○		
18.	Custody seals intact on sample containers?	○	○	⊙		
19.	Do sample container labels match the COC?	⊙	○	○	incomplete info ☐ illegible ☐ no label ☐ other ☐	
20.	Are analyses requested indicated on the COC?	⊙	○	○		
21.	Were all of the samples listed on the COC received?	⊙	○	○	samples received but not listed on COC ☐ samples listed on COC not received ☐	
22.	Was the sample collection date/time noted?	○	⊙	○		
23.	Did we receive sufficient sample volume for indicated analyses?	⊙	○	○		
24.	Were samples received in appropriate containers?	⊙	○	○		
25.	Were VOA samples received without headspace (< 1/4" bubble)?	○	○	⊙		
26.	Were trip blanks submitted?	○	○	⊙	listed on COC ☐ not listed on COC ☐	

27. Comments: ______

I certify that I have completed sections 16-27 (dated initials). MDP 8/20/19

This section only applies to samples where pH can be checked at Sample Receipt.

		Yes	No	N/A	Details	Comments
28.	Have containers needing chemical preservation been checked? *	○	○	⊙		
29.	Containers meet preservation guidelines?	○	○	⊙		
30.	Was pH adjusted at Sample Receipt?	○	○	⊙		

* Note: Certain analyses require chemical preservation but must be checked in the laboratory and not upon Sample Receipt such as Coliforms, VOCs and Oil & Grease/TPH.

I certify that I have completed sections 28-30 (dated initials). MDP 8/20/19

Checklist 6.9.17 Rev 2

Locked

Analytical Environmental Services, Inc

Date: 22-Aug-19

Client: ECS Florida, LLC
Project Name: ECS Jacksonville-CAC
Workorder: 1908H66

ANALYTICAL QC SUMMARY REPORT

BatchID: 283822

Sample ID: **1908H66-001ADUP** Client ID: **P13-25'-28'** Units: **meq/100g** Prep Date: **08/21/2019** Run No: **405455**
SampleType: **DUP** TestCode: **CEC of Soils (Na Saturation) SW9081** BatchID: **283822** Analysis Date: **08/22/2019** Seq No: **9110323**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Cation Exchange Capacity	19.00	1.0						20.50	7.59	20	

Qualifiers:
- > Greater than Result value
- BRL Below reporting limit
- J Estimated value detected below Reporting Limit
- Rpt Lim Reporting Limit
- < Less than Result value
- E Estimated (value above quantitation range)
- N Analyte not NELAC certified
- S Spike Recovery outside limits due to matrix
- B Analyte detected in the associated method blank
- H Holding times for preparation or analysis exceeded
- R RPD outside limits due to matrix

APPENDIX H

A REVISION OF THE LITHOSTRATIGRAPHIC UNITS OF THE COASTAL PLAIN OF GEORGIA

The Miocene Through Holocene

Paul F. Huddlestun

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

BULLETIN 104

A Revision of the Lithostratigraphic Units of the Coastal Plain of Georgia

THE MIOCENE THROUGH HOLOCENE

Paul F. Huddlestun

Georgia Department of Natural Resources
J. Leonard Ledbetter, Commissioner

Environmental Protection Division
Harold F. Reheis, Assistant Director

Georgia Geologic Survey
William H. McLemore, State Geologist

Atlanta
1988

Bulletin 104

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ILLUSTRATIONS (CONTINUED)

A Revision of the Lithostratigraphic Units of the Coastal Plain of Georgia

THE MIOCENE THROUGH HOLOCENE

Paul F. Huddlestun

ABSTRACT

Twenty-four formally defined lithostratigraphic units are described in this report: one group, thirteen formations, and ten members. In addition, two unnamed formations are briefly described, one informal unit described as "beds" is recognized, and three undifferentiated stratigraphic units and three kinds of undifferentiated deposits are described. Two named formations are new: the Cypresshead Formation and the Statenville Formation. Five formations that previously had been abandoned are reintroduced: the Parachucla Formation, Marks Head Formation, Altamaha Formation, Nashua Formation, and Satilla Formation. One informal member has been formalized and raised to formation rank, the Coosawhatchie Formation; and one formation has been raised to group rank, the Hawthorne Group. Seven named members are new: the Tybee Phosphorite, Berryville Clay, Ebenezer, and Meigs Members of the Coosawhatchie Formation; the Tiger Leap and Porters Landing Members of the Parachucla Formation; and the Screven Member of the Altamaha Formation. The Charlton, previously a formation, is reduced in rank to a member of the Coosawhatchie Formation.

The lithostratigraphy is described in terms of the Miocene-Holocene structural framework of Georgia. Four major structural elements are described: the Southeast Georgia Embayment, the Gulf Trough-Apalachicola Embayment, the Piedmont Slope, and the Ocala Platform. Two minor features are also described: the Beaufort Arch and the Ridgeland Trough. During the Miocene through Holocene, the Georgia Coastal Plain is determined to be structurally stable, with evidence of only minor uplift or subsidence.

Three geomorphic features that coincide with the geographic limits of lithostratigraphic units are described, the Pelham Escarpment, Orangeburg Escarpment, and Sea Island Escarpment (new name).

Twelve marine terraces are described and their relationships with the underlying lithostratigraphic units are discussed. Two marine terraces are reintroduced: the Claxton and Hazlehurst terraces of Cooke (1925). Three marine terraces are new: the Waycross, Argyle, and Pearson terraces; and three terraces are redefined: the "Talbot", "Wicomico", and Okefenokee terraces.

ACKNOWLEDGMENTS

Stratigraphic work that culminated in this report was initiated in 1972. During the past 15 years, many geologists on the staff of the Georgia Geological Survey have contributed to the results of this project. Mr. S.M. Pickering, Jr., former State Geologist of Georgia, encouraged and supported the early phases of this project. Dr. W.H. McLemore, State Geologist of Georgia, has continued in the encouragement and support of this project to its completion. I wish to express thanks to Mr. C.W. Hendry, former State Geologist of Florida, for sharing the resources of the Florida Geological Survey, and to Dr. T.M. Scott of the Florida Geological Survey for his time in discussion and his company in the field. I also wish to acknowledge the cooperation of the staff of the South Carolina Geological Survey, and especially of Mr. Paul Nystrom, Jr. Special thanks are extended to Mr. Gerald S. Grainger of Southern Services, Inc. for providing access to cores of Georgia Power Company. I acknowledge as well the generosity, cooperation, and assistance of Mr. H.E. Gill of the Georgia District of the United States Geological Survey. Dr. V.J. Henry of Georgia State University has assisted and cooperated with the author for many years on Plio-Pleistocene stratigraphic problems in the coastal area of Georgia. Ms. M.E. Hunter and the late Mr. J.E. Banks were most generous with their time spent in discussion of Miocene paleontological data and stratigraphy of the north Florida-south Georgia area.

Dr. K.E. Gwiasda of Iowa State University, Ames, Iowa, reviewed the text for technical writing and syntax. Ms. M.E. Hunter, Tallahassee, Florida; Dr. T. M. Scott of the Florida Geological Survey, Tallahassee, Florida; Dr. C.E. Weaver of Georgia Institute of Technology, Atlanta, Georgia; Dr. W.H. Abbott of Mobil Oil Exploration and Producing Services, Dallas, Texas; Dr. L.E. Edwards, Dr. L.W. Ward, and Dr. W.L. Newell of the U.S. Geological Survey, Reston, Virginia; and Ms. H.W. Markewich of the U.S. Geological Survey, Doraville, Georgia, reviewed text for technical content.

I also wish to extend my deepest thanks and gratitude to Mr. M.P. Crowell, Mr. D.M. Cannon, and Mr. H.D. Baker, drillers of the Georgia Geologic Survey, whose geologic efforts in coring have made this study possible.

INTRODUCTION

More than forty years have passed since Cooke (1943) presented the last comprehensive compilation of the stratigraphic units of the Coastal Plain (Fig. 1) of Georgia. That work represented the culmination of the efforts of many early investigators, including W.H. Dall, G.D. Harris, T.W. Vaughan, E. Sloan, J.O. Veatch, L.D. Stephenson, H.K. Shearer, C.W. Cooke, and J. Gardner. "The Geology of the Coastal Plain of Georgia" of Cooke (1943) also represents the culmination of a point of view of stratigraphic terminology that differs from that of the late twentieth century. Prior to the publication of the "Classification and nomenclature of rock units" (Committee on stratigraphic nomenclature, 1933), there had been no codification of stratigraphic terminology in North America, although policy was established in the U.S. Geological Survey as early as 1903 (United States Geological Survey, 1903). In the Coastal Plain of the southeastern United States, during the first half of the twentieth century, lithostratigraphic units, and formations in particular, were not based as much on lithologic content, as on stratigraphic association, stratigraphic position, and fossil content (United States Geological Survey, 1903; Grabau, 1924; Committee on stratigraphic nomenclature, 1933; 1939). Geologic time, therefore, was inherent in the concept of lithostratigraphic units. As a result of this looser usage of lithostratigraphic units and the lack of a codification of stratigraphic terminology, lithostratigraphic units in the first half of the twentieth century were variable in concept and application. Stratigraphic terminology was treated differently by different authors and there was a lack of uniformity in treatment of lithostratigraphic units.

The stratigraphic codes of 1961 and 1970 (American Commission on Stratigraphic Nomenclature, 1961; 1970), however, required that **only** lithology, "observable physical features", be used as the criterion on which to base lithostratigraphic definition and recognition.[1] As a result of these two codes and their gradual acceptance by geologists, there has been a reorientation in approach to lithostratigraphic terminology, and the adoption of a more consistent stratigraphic usage. For example, the old concept of the "Hawthorn formation" of Cooke (1943) was based on type of fauna, age implications of the fauna, and gross lithology (Cooke and Mossom, 1929; Cooke, 1936, 1943, 1945; Puri and Vernon, 1964). As a result of the preoccupation by geologists with fauna and age of formations, the "Hawthorn perhaps is the most misunderstood formational unit in the southeastern United States. It has been a dumping ground for alluvial, terrestrial, marine, deltaic, and pro-deltaic beds of diverse lithologic units in Florida and Georgia ...." (Puri and Vernon, 1964, p. 145). Lithologically the concept of the Hawthorne in the past has consisted of relatively pure carbonates(limestone and dolostone in southern Florida), phosphatic sands and clays that may or may not be calcareous or dolomitic, phosphatic clays and fuller's earth, and cross-bedded sands and gravels of fluvial origin. It has been possible, in this report, to conform to the stratigraphic codes of 1961, 1970, and 1983 and to subdivide the Hawthorne Formation of earlier authors into five named formations and one unnamed formation.

The use of well-cuttings (Herrick, 1961; Herrick and Vorhis, 1963; Applin and Applin, 1944, 1964) for recognition of stratigraphic units and for stratigraphic correlation has resulted in the construction of the subsurface stratigraphic framework of Georgia. Prettyman and Cave (1923) presented the first study of subsurface deposits based on well-cuttings, but full use of these materials was not made until Cushman (from approximately 1917 through 1951) had developed the taxonomy and shown the biostratigraphic utility of the smaller foraminifera. Applin and Applin (1944, 1947, 1964, 1967), Applin and Jordan (1945), E.R. Applin (1955), P.L. Applin (1952), Herrick (1961) and Herrick and Vorhis (1963) made invaluable contributions to the understanding of the stratigraphic framework of the Georgia Coastal Plain and, as a result of these contributions, the chronostratigraphic framework of the deeper subsurface of the Georgia Coastal Plain has been largely elucidated.

Since the middle 1960's, the availability of cores has added a large amount of stratigraphic information to our knowledge of the shallow subsurface, allowing lithostratigraphic recognition and correlation not normally possible in Georgia from scattered outcrop sections alone. For the present revision, seventy-eight cores (Figs. 2, 3, and 4) were examined, and all were at least partially logged and described. Sixty-three of the cores are from Georgia (Figs. 2 and 3), fourteen are from northern Florida (Fig. 4), and one is from southern South Carolina (Fig. 3).

Similarly, in recent years, employing more groups of microfossils for the solution of stratigraphic problems has contributed greatly to the biostratigraphic and chronostratigraphic delineation of the Georgia Coastal Plain deposits. During the first four decades of this century, only macrofossils (mollusks, echinoids, corals, vertebrates) had been employed in the biostratigraphic subdivision of Coastal Plain deposits. After the 1930's, however, various microfossil groups, including the smaller benthic foraminifera, ostracodes, palynomorphs, diatoms, radiolarians, planktonic foraminifera, nannofossils, and dinoflagellates were also employed.

It is now possible to further refine the stratigraphic framework of the Georgia Coastal Plain because of the more precise and refined stratigraphic codes available to modern stratigraphers; the greater wealth of Coastal Plain well cuttings; electric logs, and cores; and the larger assortment of paleontological tools with which to subdivide the

[1]In the 1983 code the concept of stratigraphic position has been reintroduced into the concept of lithostratigraphic units.

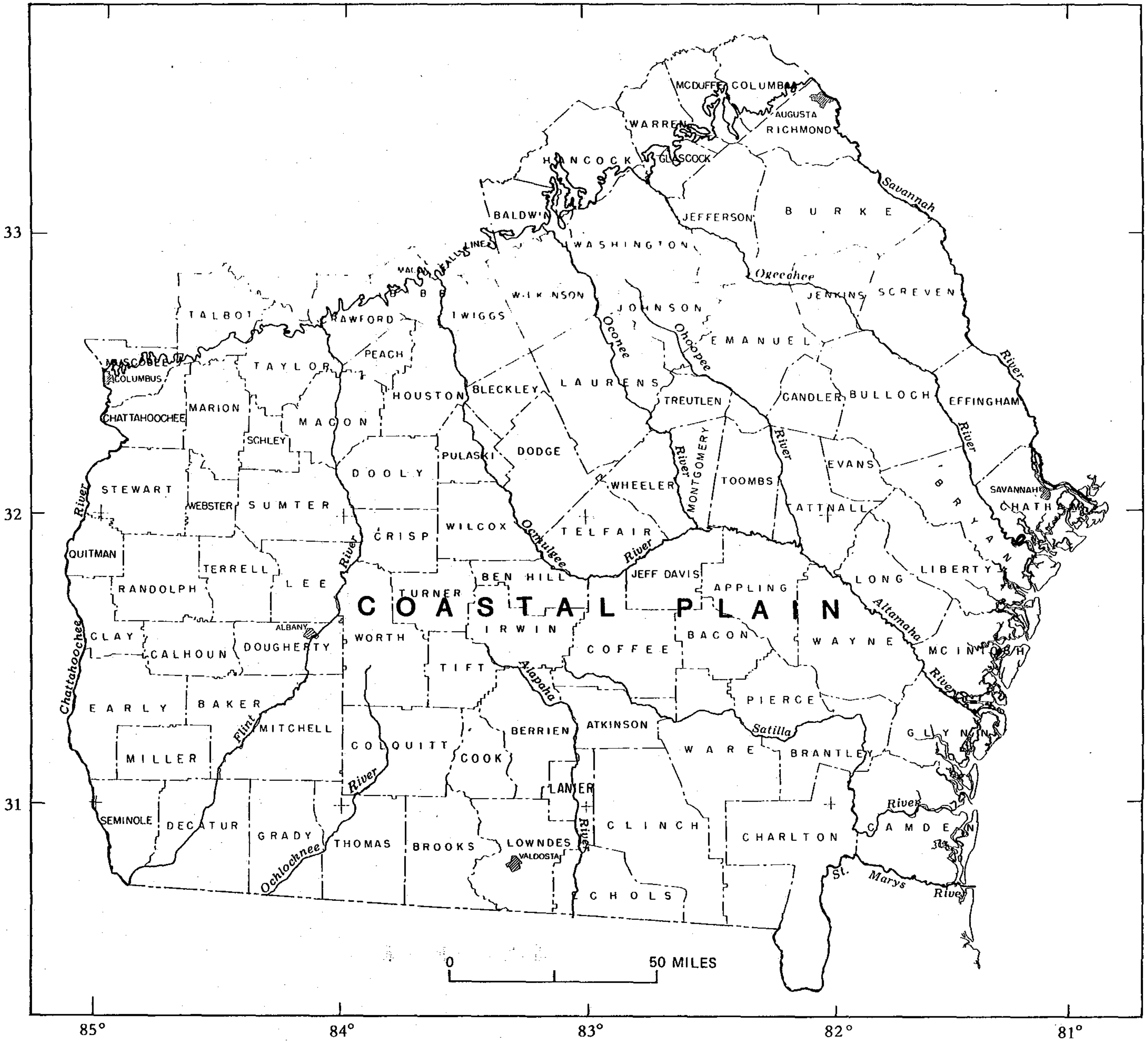


Figure 1. Location map of the Georgia Coastal Plain.

Explanation of Symbols on Figure 2

Type Localities and Principal Reference Localities

A ..... Dogtown Member of the Torreya Formation; LaCamellia fuller's earth mine Gadsden County, Florida

B ..... Charlton Member of the Coosawhatchie Formation; Stokes Bridge on St. Marys River Nassau County, Florida

C ..... Meigs Member of the Coosawhatchie Formation; Thomas County, Georgia

D ..... Statenville Formation; Alapaha River Echols County, Georgia

E ..... Altamaha Formation; Upper Sister Bluff on the Altamaha River, Appling County, Georgia

F ..... Screven Member of the Altamaha Formation; Wayne County, Georgia

G ..... Cypresshead Formation; Wayne County, Georgia

H ..... Satilla Formation; Satilla Bluff on the Satilla River, Camden County, Georgia

Reference Localities

a ...... Ebenezer Member of the Coosawhatchie Formation; core Wayne 2 (GGS-3512), Wayne County, Georgia

b ...... Charlton Member of the Coosawhatchie Formation; core Charlton 2 (GGS-3185), Charlton County, Georgia

c ...... Statenville Formation; Alapahoochee River, Echols County, Georgia, and Hamilton County, Florida

d ...... Altamaha Formation; Lower Sister Bluff, Altamaha River, Appling County, Georgia

e ...... Altamaha Formation; Lower Fort James Bluff, Altamaha River, Wayne County, Georgia

f ...... Altamaha Formation; bluffs on the Oconee River at highway Ga. 46 crossing, Wheeler County, Georgia

g ...... Altamaha Formation; Berryhill Bluff on the Oconee River, Treutlen County, Georgia

h ...... Screven Member of the Altamaha Formation; road cut on highway US 84, Wayne County, Georgia

i ...... Screven Member of the Altamaha Formation; Upper Sister Bluff on the Altamaha River, Appling County, Georgia

j ...... Cypresshead Formation; Linden Bluff on the Altamaha River, Wayne County, Georgia

k ...... Cypresshead Formation; road cut on highway US 301 at Trudie, Brantley County, Georgia

l ...... Satilla Formation; Roses and Bells Bluffs on Bells River, Nassau County, Florida

m ..... Satilla Formation; Reids Bluff on St. Marys River, Nassau County, Florida

n ...... Satilla Formation; Crooked River State Park, Camden County, Georgia

Core Sites and Well Sites*

1 ...... Wayne 1; Wayne County, Georgia**

a ...... Wayne 2 (GGS-3512); Wayne County, Georgia

2 ...... Wayne 3; Wayne County, Georgia

3 ...... Wayne 4; Wayne County, Georgia

b ...... Charlton 2 (GGS-3185); Charlton County, Georgia

4 ...... Cumberland Island 1 (GGS-3426); Camden County, Georgia

5 ...... Coffee 3 and 4 (GGS-3539 and 3541); Coffee County, Georgia

6 ...... Berrien 10 (GGS-3542); Berrien County, Georgia

7 ...... Colquitt 3 (GGS-3179); Colquitt County, Georgia

8 ...... Colquitt 5 and 9 (GGS-3199 and 3535); Colquitt County, Georgia

9 ...... Colquitt 10 (GGS-3544); Colquitt County, Georgia

10 ..... well cuttings (GGS-600); Montgomery County, Georgia

11 ..... Washington 8 (GGS-1178); Washington County, Georgia

12 ..... Washington 10 (GGS-1182); Washington County, Georgia

13 ..... Washington 17 (GGS-1189); Washington County, Georgia

14 ..... AMCOR 6002; continental shelf

15 ..... COST GE 1; continental shelf

16 ..... JOIDES J-1; continental shelf

17 ..... JOIDES J-2; continental shelf

*Cores and well-cuttings are available for examination at the Georgia Geologic Survey in Atlanta, Georgia.

**Core has been destroyed.

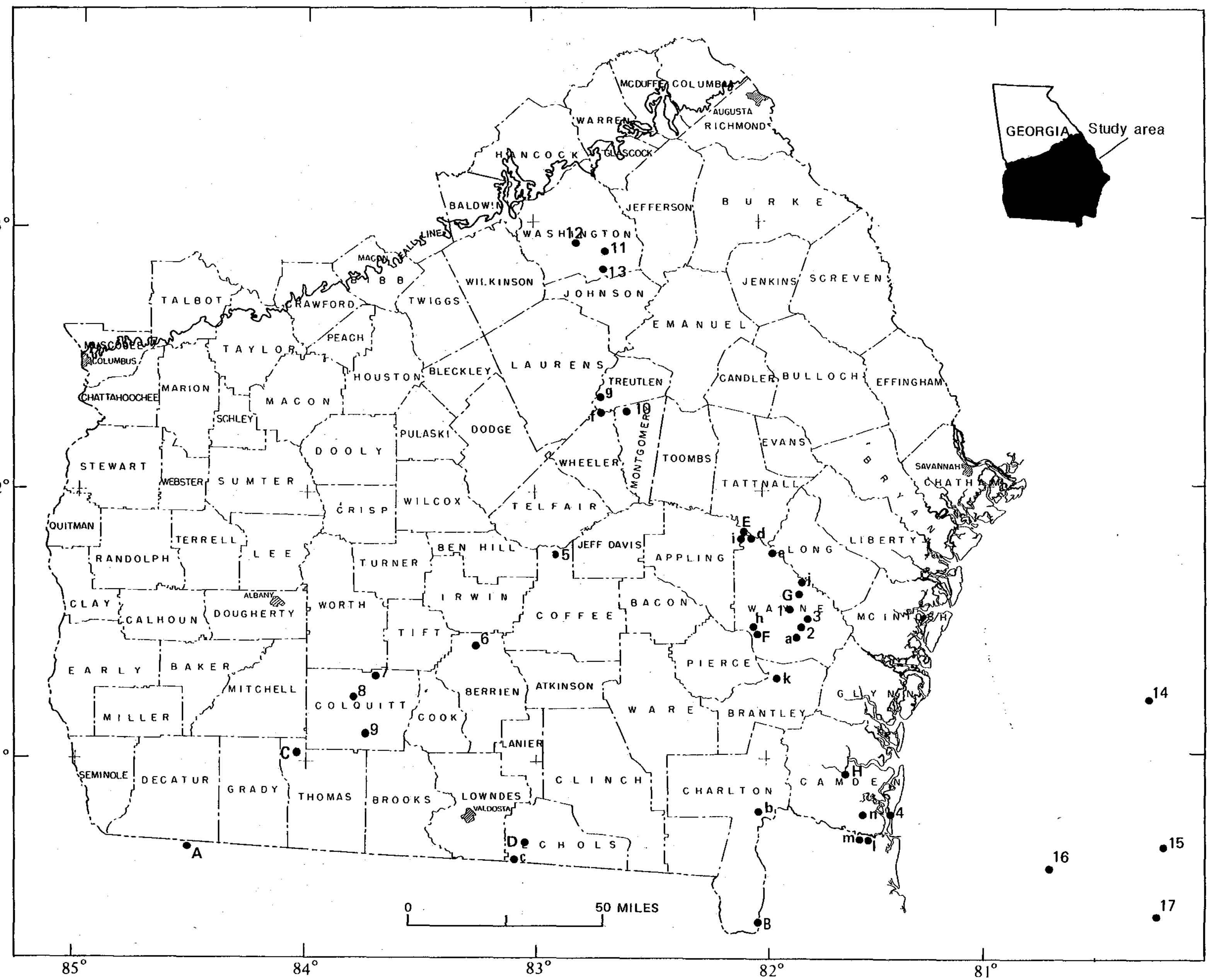


Figure 2. Location map of type localities, reference localities, core sites, and well sites in the Coastal Plain and continental shelf of Georgia exclusive of the Savannah River area.

Explanation of Symbols on Figure 3

Type Localities and Principal Reference Localities

I ...... Parachucla Formation; Porters Landing on the Savannah River, Effingham County, Georgia

I ...... Porters Landing Member of the Parachucla Formation; Porters Landing on the Savannah River, Effingham County, Georgia

J ...... Tiger Leap Member of the Parachucla Formation; Tiger Leap Bluff on the Savannah River, Screven County, Georgia

K ..... Marks Head Formation; Marks Head Run, Effingham County, Georgia

L ..... Berryville Clay Member of the Coosawhatchie Formation; Effingham County, Georgia

M ..... Ebenezer Member of the Coosawhatchie Formation; Ebenezer Landing on the Savannah River, Effingham County, Georgia

N ..... Tybee Phosphorite Member of the Coosawhatchie Formation; core Chatham 10 (GGS-1394), Tybee Island, Chatham County, Georgia

Reference Localities

o ...... Parachucla Formation; core Effingham 10 (GGS-3108), Effingham County, Georgia

o ...... Tiger Leap Member of the Parachucla Formation; core Effingham 10 (GGS-3108), Effingham County, Georgia

p ...... Coosawhatchie Formation of eastern Georgia; Savannah River, Effingham County, Georgia

q ...... Berryville Clay member of the Coosawhatchie Formation; core Effingham 14 (GGS-3155), Effingham County, Georgia

q ...... Ebenezer Member of the Coosawhatchie Formation; core Effingham 14 (GGS-3155), Effingham County, Georgia

r ...... Tybee Phosphorite Member of the Coosawhatchie Formation; core Chatham 3 (GGS-1341), Chatham County, Georgia

s ...... Cypresshead Formation; railroad cut at Birds, Effingham County, Georgia

Core Sites and Well Sites

18 ..... Screven 1 (GGS-1170); Screven County, Georgia

19 ..... Screven 4 (GGS-1007); Screven County, Georgia

20 ..... Screven 8 (GGS-3198); Screven County, Georgia

21 ..... Georgia Power Company cores B3**, B21**, B22**; Screven County, Georgia

22 ..... Effingham 3 (GGS-2175); Effingham County, Georgia

o ...... Effingham 10 (GGS-3108); Effingham County, Georgia

23 ..... Effingham 11 (GGS-3109); Effingham County, Georgia

24 ..... Effingham 12 (GGS-3110); Effingham County, Georgia

25 ..... Effingham 13 (GGS-3140); Effingham County, Georgia

q ...... Effingham 14 (GGS-3155); Effingham County, Georgia

26 ..... Effingham 6 (GGS-2179) and Georgia Power Company core B40**; Effingham County, Georgia

27 ..... Georgia Power Company core B41**; Effingham County, Georgia

28 ..... Chatham 1 (GGS-1164); Chatham County, Georgia

r ...... Chatham 3 (GGS-1341); Chatham County, Georgia

N ..... Chatham 10 (GGS-1394); Chatham County, Georgia

29 ..... Chatham 13 (GGS-1445); Chatham County, Georgia

30 ..... Chatham 14 (GGS-3139); Chatham County, Georgia

31 ..... Chatham 15 (GGS-3138); Chatham County, Georgia

32 ..... Chatham 17 (GGS-3554); Chatham County, Georgia

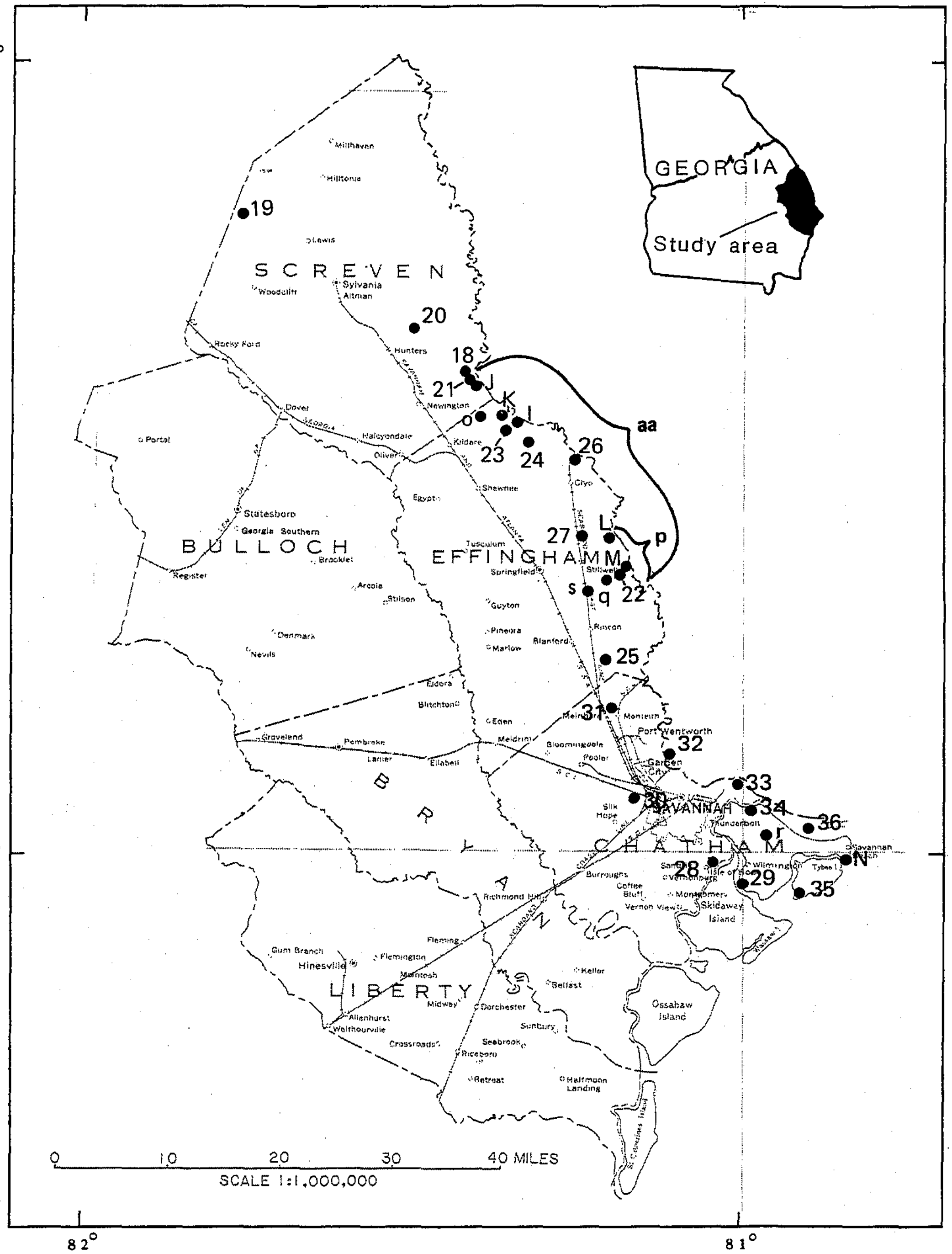
33 ..... cores from Elba Island in the Savannah River, B13**, B25**, B30**; Chatham County, Georgia

34 ..... core, U.S. Geological Survey Test Well 6; Chatham County, Georgia

35 ..... Petit Chou 1; Chatham County, Georgia

36 ..... well-cuttings, GGS-772 and GGS-381; Chatham County, Georgia

**Cores have been destroyed



Base from U.S. Geological Survey
State base map, 1:1,000,000

Figure 3. Location map of type localities, reference localities, core sites, and well sites in the Savannah River area of the Coastal Plain of Georgia.

Explanation of Symbols on Figure 4

Type Localities and Principal Reference Localities

O ..... Chattahoochee Formation; Gadsden County, Florida

P ..... Hawthorne Group, Alachua County, Florida

Q ..... Torreya Formation; Rock Bluff on the Appalachicola River, Liberty County, Florida

R ..... Sopchoppy Member of the Torreya Formation; Wakulla County, Florida

A ..... Dogtown Clay Member of the Torreya Formation; LaCamellia fuller's earth mine, Gadsden County, Florida

B ..... Charlton Member of the Coosawhatchie Formation; Stokes Bridge on St. Marys River, Nassau County, Florida

S ...... Miccosukee Formation; Jefferson County, Florida

T ..... Nashua Formation; St. Johns River, Putnam County, Florida

U ..... Alum Bluff Group; Alum Bluff, Liberty County, Florida

m ..... Satilla Formation; Reids Bluff on St. Marys River, Nassau County, Florida

Reference Localities

t ...... Hawthorne Group; Devil's Millhopper, Alachua County, Florida

t ...... Hawthorne Group; Millhopper 1 (W-14641) core, Alachua County, Florida

u ...... Hawthorne Group; Brooks Sink, Bradford County, Florida

v ...... Hawthorne Group; Varnes 1 (W-14280) core, Bradford County, Florida

w ..... Hawthorne Group; Suwannee River at White Springs, Hamilton and Columbia Counties, Florida

c ...... Statenville Formation; Alapahoochee River, Echols County, Georgia and Hamilton County, Florida

x ...... Statenville Formation; Suwannee River near Cones Bridge, Hamilton and Columbia Counties, Florida

y ...... Statenville Formation; Betty 1 (W-15121) core, Jennings, Hamilton County, Florida

z ...... Miccosukee Formation; Green 1 (W-6937) core, Leon County, Florida

l ...... Satilla Formation; Roses and Bells Bluffs on Bells River, Nassau County, Florida

Core Sites*

P ..... Hawthorne 1 (W-11486); Alachua County, Florida

37 ..... Wall 1 (W-7457); Liberty County, Florida

38 ..... Wall 2 (W-7458), Gadsden County, Florida

39 ..... Suber 1 (W-7539); Gadsden County, Florida

40 ..... Owenby 1 (W-7472); Gadsden County, Florida

41 ..... Gregory 1 (W-7528); Gadsden County, Florida

z ...... Green 1 (W-6937); Leon County, Florida

42 ..... Ashville 1 (W-6561); Jefferson County, Florida

y ...... Betty 1 (W-15121); Hamilton County, Florida

t ...... Millhopper 1 (W-14641); Alachua County, Florida

v ...... Varnes 1 (W-14280); Bradford County, Florida

43 ..... Trail Ridge 3 (W-10473); Baker County, Florida

44 ..... Cassidy 1 (W-13815); Nassau County, Florida

45 ..... National Lead 1 (W-12360); Bradford County, Florida

46 ..... Baywood 1 (W-8400); Putnam County, Florida

*Cores are available for examination at the Florida Geological Survey in Tallahassee, Florida

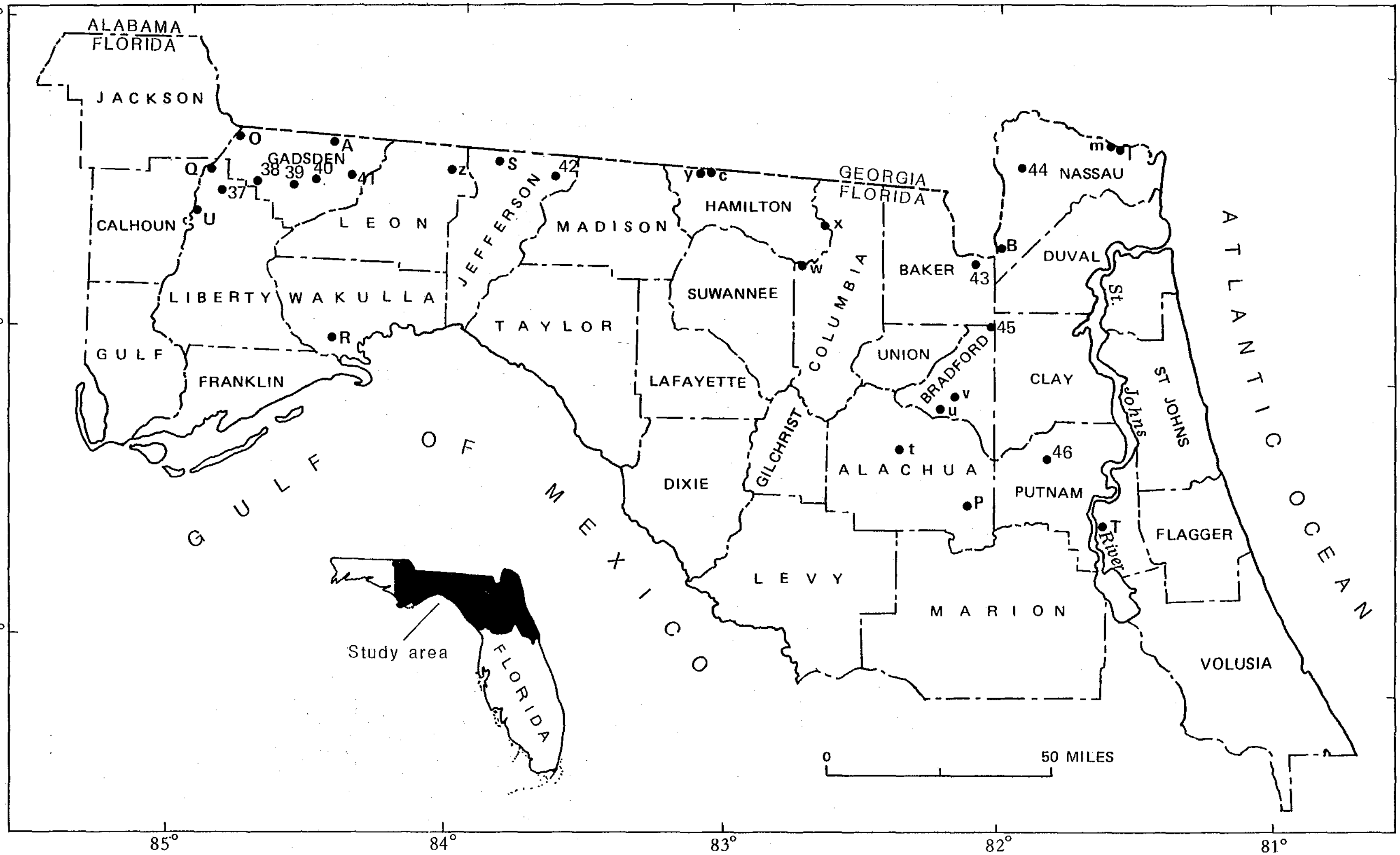


Figure 4. Location map of type localities, reference localities, and core sites in north Florida.

sections biostratigraphically and chronostratigraphically and to establish correlation. Twenty-four formally defined Neogene lithostratigraphic units are described in this report. These include one group, thirteen formations, and ten members. Two unnamed formations are described where there is sufficient information to indicate the presence of a formation, but not sufficient information formally to propose a new formation. In addition, an informal unit, known as the Wabasso beds, is recognized, and three kinds of undifferentiated deposits and three undifferentiated stratigraphic units are described. Two named formations are new: the Cypresshead and Statenville Formations. Five named formations that had been abandoned in the past are reintroduced in this report: the Parachucla, Marks Head, Altamaha, Nashua, and Satilla Formations. One previously informal member, the Coosawhatchie Formation, is raised to formation rank, and one formation is raised to group rank, the Hawthorne Group. Seven named members are new: the Tybee Phosphorite, Berryville Clay, Ebenezer, and Meigs Members of the Coosawhatchie Formation; the Porters Landing and Tiger Leap Members of the Parachucla Formation; and the Screven Member of the Altamaha Formation. One unit previously of formation rank has been lowered to the rank of member, the Charlton Member of the Coosawhatchie Formation.

Standard field and laboratory procedures were followed throughout the investigation that led to this report. In field descriptions, the terminology of Ingram (1954) is used for bedding thickness, the Wentworth (1922) scale for grain size, and the Munsell Color System for describing sediment or rock colors (Rock-Color Chart Committee, 1963). Field approximations for describing degrees of sand sorting are employed in this report.

THE MIOCENE TO HOLOCENE STRUCTURAL FRAMEWORK OF GEORGIA

The Georgia Coastal Plain (Fig. 1) is a relatively stable segment of the Atlantic Coastal Plain of eastern North America. The presence of relatively thick Miocene deposits (200-600 feet) of coastal to inner continental shelf origin (i.e., sediments deposited at or immediately below the sea level of their time) over most of the Georgia Coastal Plain indicates that there was minor subsidence and deposition to non-subsidence and non-deposition with minor subsequent erosion during the period of geologic time covered in this report. Subsidence and sediment accumulation, however, were periodic in that some intervals of geologic time are well-represented in the geologic column of the Coastal Plain, whereas sediments of other periods of time are uniformly absent, or have not been detected and identified (compare with Pl. 1). According to this model, subsidence and sediment accumulation in the Georgia Coastal Plain occurred during the early to middle Aquitanian, early to middle Burdigalian, and early Serravallian (see Pl. 1). During Pliocene, Pleistocene, and Holocene times, there is evidence of subsidence and minor sediment accumulation only in the coastal region. For the Pliocene, this region includes both the present Atlantic coastal area east of the vicinity of the Orangeburg Escarpment and Trail Ridge, and also the southern tier of counties in southwestern Georgia. During the late Pleistocene and Holocene, there appears to have been slight subsidence, if any, only in the coastal counties of eastern Georgia and on the continental shelf.

There is evidence of minor tectonic uplift in the Coastal Plain only in western Georgia. Coastal marine deposits believed to be mainly of late Pliocene age (Miccosukee Formation) occur at relatively high elevations (i.e., above 300 feet [91 m] above sea level) along the Pelham Escarpment near Pelham in Mitchell County, Georgia. Although Miocene deposits occur at elevations of more than 500 feet (152 m) above sea level immediately south of the Fall Line Hills in Georgia, these deposits are fluvial in origin (Altamaha Formation) and could have been deposited originally at relatively high elevations (above the contemporary sea level). Excluding the vicinity of Pelham, Georgia, where uplift can be inferred, all Miocene marine deposits of continental shelf origin (Hawthorne Group, Chattahoochee and Cooper Formations) generally occur at elevations of less than 200 feet (61 m) above modern sea level. As a result, over most of the Georgia Coastal Plain, uplift cannot be inferred from the present elevations of the deposits of marine origin.

The structural setting of the Georgia Coastal Plain was relatively simple during Late Tertiary time in Georgia. Four large-scale structural elements influenced sedimentation patterns and, therefore, the stratigraphy: (1) the Southeast Georgia Embayment, (2) the Gulf Trough-Apalachicola Embayment, (3) the Piedmont Slope, and (4) the Florida Platform (Fig. 5). Two structural elements, the Beaufort Arch and the Ridgeland Trough, are small-scale structures and appear to have had little or no influence on contemporary regional sedimentation patterns. These various structural elements of the Georgia Coastal Plain will be discussed in order.

Southeast Georgia Embayment

The Southeast Georgia Embayment (Fig. 5) (Toulmin, 1955, p. 29), also referred to as the Okefenokee Embayment of the Atlantic Basin (Pressler, 1947; Applin and Applin, 1967), the Savannah Basin (Murray, 1961), the Atlantic Embayment of Georgia (Herrick and Vorhis, 1963), and the Atlantic Embayment (Weaver and Beck, 1977), is a shallow, broad embayment or basin in the Coastal Plain of eastern Georgia (Fig. 5). The Southeast Georgia Embayment appears to have subsided relative to the surrounding regions (Cape Fear Arch in North Carolina, Piedmont Slope, Central Georgia Uplift of Pressler [1947], Suwannee Saddle of

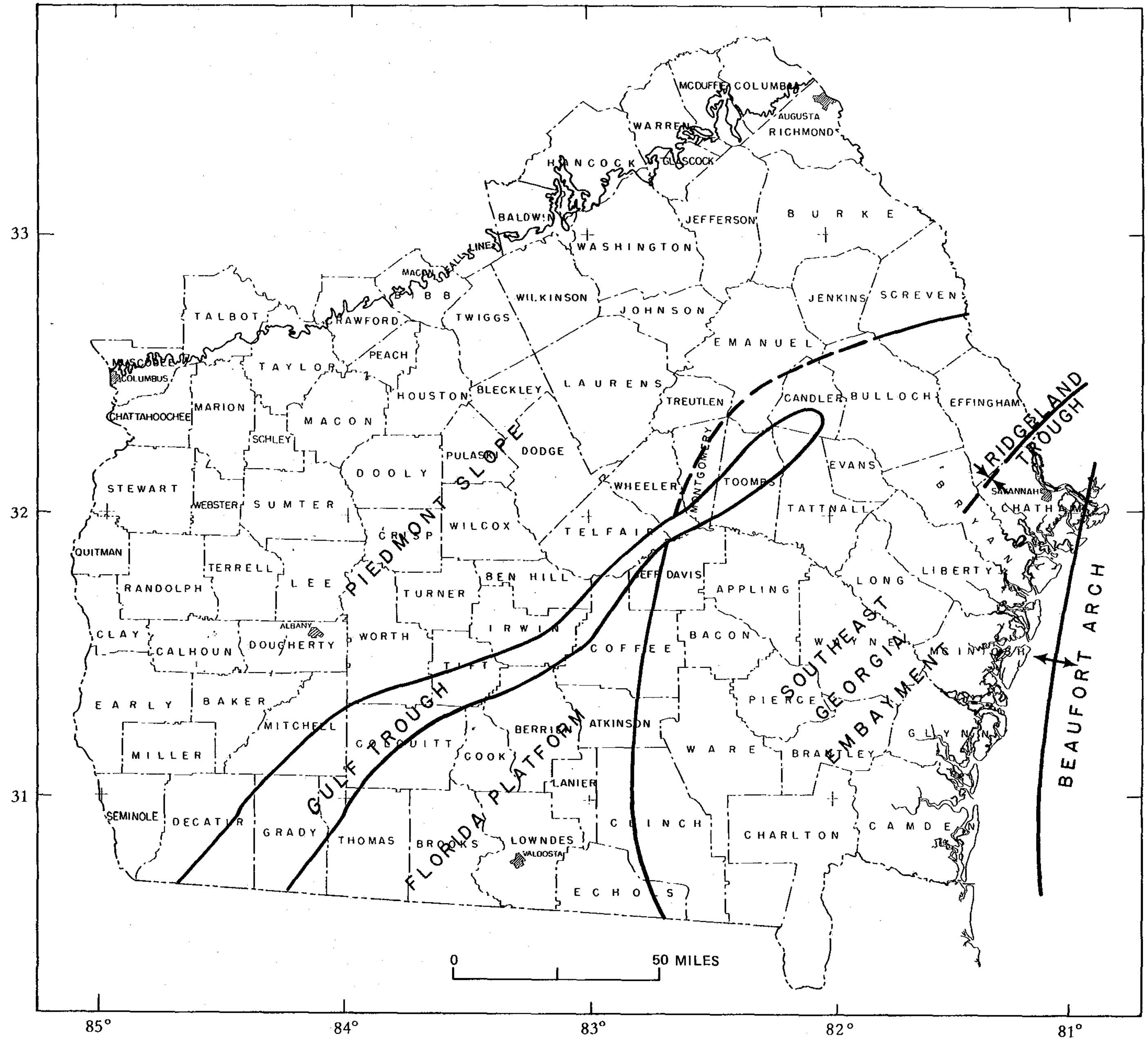


Figure 5. Major Upper Tertiary structural features of Georgia.

Applin and Applin [1967], Ocala Platform in Georgia and Florida, and the Peninsular Arch [Applin, 1951] and Sanford High [Vernon, 1951] in Florida). Subsidence appears to have been episodic within the Southeast Georgia Embayment. Deposits of some periods are exceptionally thick (e.g., the Miocene), whereas deposits of other periods show no evidence of differential thickening across the embayment (e.g., the Plio-Pleistocene) (compare with Herrick and Vorhis, 1963; Applin and Applin, 1967; Vorhis, 1974; Cramer and Arden, 1980). Based on the above studies, it also appears that the Southeast Georgia Embayment configuration, the position and configuration of depocenters, and the volumes of sediment accumulation varied considerably over time.

For the Miocene in Georgia, the inner limits of the Southeast Georgia Embayment are the foot of the Piedmont slope and the Ocala Arch (Fig. 5). The inner limits of the embayment can be approximated as extending from the vicinity of Beaufort, South Carolina (Straley and Richards, 1950; Straley, 1955), westward through Screven and Emanuel Counties, Georgia, thence southwestward through the lower Oconee and Ocmulgee Rivers area, and finally southward through Coffee, Atkinson, Clinch, and Echols Counties (Fig. 5). The Southeast Georgia Embayment also extends into northeastern Florida where it, or a segment of it, has been called the Jacksonville Basin (Goodell and Yon, 1960; Scott, in press).

Gulf Trough-Apalachicola Embayment

The Gulf Trough-Apalachicola Embayment is a northeast-southwest trending linear structure in southern Georgia and the eastern panhandle of Florida (Fig. 5). Although the Gulf Trough (Herrick and Vorhis, 1963, p. 55; Hendry and Sproul, 1966; Sever and others, 1967; Patterson and Herrick, 1971; Weaver and Beck, 1977; Zimmerman, 1977; Gelbaum, 1978; Gelbaum and Howell, 1982: Miller, 1982) and the Apalachicola Embayment (Pressler, 1947, p. 1853, 1856, fig. 1; Toulmin, 1955; Hendry and Sproul, 1966; Patterson and Herrick, 1971; Schmidt and Clark, 1980; Schmidt, 1984) generally have been treated separately in the past and have been given separate names, they are treated as one geologic feature in this report (also see Patterson and Herrick, 1971). The Gulf Trough and Apalachicola Embayment have common northwestern and southeastern margins, and they have common stratigraphic and structural characteristics. The only distinction known to this author between the Gulf Trough and the Apalachicola Embayment is the width of the structure. Near the coast in western Florida, the Apalachicola Embayment is wide, extending from westernmost Wakulla County in the east to Bay County in the west, a linear distance of approximately 90 miles (145 km) (also see Schmidt and Clark, 1980; Schmidt, 1984). The width of the structure diminishes northeastward and is approximately 35 miles (56 km) across near the Georgia-Florida state line; approximately 15 miles (24 km) across in Colquitt County, Georgia, between 10 and 15 miles (16 and 24 km) across in Berrien County, and approximately 5 miles (8 km) across in northern Coffee County (compare with Gelbaum and Howell, 1982). As applied in the past, the Gulf Trough is that component of the structure that is approximately 20 miles (32 km) across or less, and is largely confined to Georgia. The Apalachicola Embayment is that part of the structure that broadens to the southwest and has been confined to Florida.

The Gulf Trough-Apalachicola Embayment is bounded on the east by the Florida Platform but trends into the western part of the Southeast Georgia Embayment in eastern Georgia (Fig. 5). In southwestern Georgia, the Gulf Trough-Apalachicola Embayment is bounded on the west by the Piedmont Slope, and in Florida it is bounded on the northwest by the Chattahoochee Arch (Schmidt and Clark, 1980; Huddlestun, 1984).

The Gulf Trough-Apalachicola Embayment is characterized by unusual thicknesses of deposits within the structure, compared with the correlative deposits on the flanks and adjacent to the structure, and by an apparent different and unique stratigraphy. Exceptionally thick Miocene and Oligocene deposits have been reported from the trough-embayment by Moore (1955), Applin (1960), Herrick, and Vorhis (1963), Owen (1963b), Sever (1964, 1966b), Gremillion (1965), Sever and Herrick (1967), Patterson and Herrick (1971), Weaver and Beck (1977), Zimmerman (1977), Gelbaum (1978), Gelbaum and Howell (1982), Schmidt (1984), and McFadden and others (1986) indicating that the trough-embayment was a localized depocenter during at least parts of the Oligocene and Miocene. Although the information on the lithostratigraphy of the Gulf Trough-Apalachicola Embayment is still incomplete, lithostratigraphic anomalies are indicated. Both the type areas of the pre-Miocene Tallahassee limestone of Applin and Applin (1944) and the Gadsden limestone of Moore (1955) are from within the Gulf Trough-Apalachicola Embayment in Gadsden County, Florida. The lithology of the two units — fine grained, calcarenitic limestone with common smaller benthic foraminifera (Moore, 1955, p. 71-80; also see Applin and Applin, 1944, p. 1688) — is distinct from the presumably correlative units adjacent to the trough-embayment, and the two units (notwithstanding the use of the name Tallahassee limestone by Applin and Applin, 1944) are not found outside of the trough-embayment. Similarly, the lithologies of the Oligocene carbonates within the Gulf Trough referred to by Sever and Herrick (1967) and Zimmerman (1977) as Marianna Limestone are not characteristic of that formation. These Gulf Trough carbonate deposits are not, lithostratigraphically, the same as the Oligocene carbonate units adjacent to the trough, and they apparently constitute a distinct and separate formation. The Miocene fuller's earth deposits of southwestern Georgia and Gadsden County, Florida, also are restricted to the Gulf Trough-Apalachicola Embayment, and the Meigs Member of the Coosawhatchie Formation (new name) is known to occur only in the trough or on its northern flanks. Contrary to earlier reports (Herrick, 1961; Herrick and Vorhis, 1963; Gelbaum and Howell, 1982), but consistent with the observation of Moore (1955) and Zimmerman (1977), there is no Ocala lithostratigraphic unit or Ocala lithology within the Gulf Trough-Apalachicola Embayment.

There has been considerable controversy on the origin of the Gulf Trough-Apalachicola Embayment (Patterson and Herrick, 1971). The two most widely held views on the origin of the trough-embayment are (1) that it is tectonic in origin and is bounded by faults (and is, therefore, a graben or half-graben structure) (Moore, 1955; Sever, 1962, 1966a, 1966b; Gremillion, 1965; Hendry and Sproul, 1966; Tanner, 1966; Cramer and Arden, 1980; Gelbaum and Howell, 1982; Miller, 1982), or (2) that it is sedimentary in origin (Chen, 1965; Zimmerman, 1977). As observed by Patterson and Herrick (1971, p. 13), "none of the reports in which faults outlined above were proposed present adequate supporting evidence. Insofar as the authors of this article are aware, most of these faults are hypothetical". The above observation also holds for subsequent reports where the Gulf Trough is interpreted as being a fault-bounded structure (Cramer and Arden, 1980; Gelbaum and Howell, 1982; Miller, 1982). To date, all geologic models of the fault-bounded Gulf Trough-Apalachicola Embayment are based on the premise that abrupt thickening or thinning of deposits, especially accompanied by lithofacies change, can best be explained by faulting.

In contrast, the model preferred by Chen (1965) and Zimmerman (1977) is that an ocean current, analogous to the present Gulf Stream, scoured and eroded the seafloor under the current, thus producing a topographic trough or channel. I consider the current model of Chen (1965) and Zimmerman (1977) for the origin of the Gulf Trough-Apalachicola Embayment, the more likely of the two models. Isopach maps and structural contour maps presented by Herrick and Vorhis (1963) and Applin and Applin (1967) show no indication of anomalous thickness distributions or structural irregularities on the upper surfaces of Upper Cretaceous and Paleocene-lower Eocene units in the Gulf Trough-Apalachicola Embayment area. The spacing of the control points (wells) is sufficiently close so that fault displacements of several hundred feet or more (more than 100 m) should be evident on the maps. The top of the Cretaceous especially should be relatively easy to identify, and thickness and contouring anomalies should be most apparent and easily detected on that datum. Yet, neither Herrick and Vorhis (1963) nor Applin and Applin (1967) show any indication of systematic irregularities. As a consequence, this author concludes that there is evidence that the top of the Cretaceous and probably Paleocene and lower Eocene deposits have not been displaced in the Gulf Trough-Apalachicola Embayment. Therefore, it would be unlikely, under the above constraints, that the stratigraphic anomalies in the overlying Eocene through Miocene deposits would have originated through faulting.

Because there appear to be no structural or stratigraphic anomalies associated with the Gulf Trough-Apalachicola Embayment earlier than the Eocene (certainly none is associated with the Upper Cretaceous deposits [see Applin and Applin, 1967]), the time span of the Gulf Trough Apalachicola Embayment is considered in this report to be confined to the interval from the middle Eocene into the middle Miocene. An older Triassic through Cretaceous structural feature, centered in the Apalachicola River area of Florida and generally referred to under the same name as the younger Tertiary Apalachicola Embayment (Murray, 1961; Applegate and others, 1978; Gray, 1978), is considered in this report to be a separate and independent geologic feature. This Mesozoic structure, referred to as the Chattahoochee Embayment by Cramer and Arden (1980) (also Gray, 1978), is characterized by thick Triassic, Jurassic, and Lower Cretaceous deposits. Although this Mesozoic embayment is centered in the same area as the younger Apalachicola Embayment, the older structure is much larger, contains a much thicker section, and includes all of southwestern Georgia (see Gray, 1978).

Piedmont Slope

The Piedmont Slope (from Cramer and Arden, 1980, fig. 3) is a loosely defined segment of the Coastal Plain in Georgia characterized by a structurally simple wedge of Coastal Plain sediments over a consistently southward to southeastward dipping basement (Fig. 5). The northern limit of the Piedmont Slope is the Fall Line. The downdip or southern margin of the Piedmont Slope is a poorly defined area that approximates a change, or reduction, in the rate of dip of the basement, that is, a slight flattening out of the slope of the basement. This slope change is irregular but generally occurs along a trend from the southwestern corner of Georgia (the vicinity of Seminole and Decatur Counties), northeastward through Screven County (compare with Herrick and Vorhis, 1963, figs. 3, 6, 10, 14, 16, 18), and is close to and parallel with the trend of the Gulf Trough-Apalachicola Embayment. The Piedmont slope merges into the Southeast Georgia embayment in the east, the Gulf Trough-Apalachicola Embayment and, based on Gray (1978) and Cramer and Arden (1980), into the older Chattahoochee Embayment in the central and southwestern Coastal Plain.

Ocala Arch

The name Ocala Uplift (Hopkins, 1920; Gunter, 1921, p. 18-19; Cooke, 1945, p. 5-6; Vernon, 1951, p. 54-56; Puri and Vernon, 1964; and Hendry and Sproul, 1966) has been used interchangeably with the name Ocala Arch (Murray, 1963) in the past. I prefer the word "arch" to "uplift" in describing the structure because it cannot be clearly demonstrated that any part of the structure has undergone tectonic uplift at any time in its history. In order to show that there has been tectonic uplift of the platform, marine deposits on the arch would have to occur at elevations significantly above that at which sea level would stand today if there were no significant glacial ice (i.e., the deposit would probably be more than 300 feet [91 m] above present sea level). In all areas of the Ocala Arch in Georgia, all Miocene or older marine deposits in the geologic section occur below the elevation of 300 feet (91 m) above sea level. Therefore, uplift cannot be supported for the arch in Georgia. Similarly, in most areas of the Ocala Arch in Florida, the entire geologic section and reconstructed upper, presumably eroded, parts of the sections occur well below the elevation of 300 feet (91 m). Only at the present high part of the arch in Citrus and Levy Counties, Florida, could there be any possibility of tectonic uplift. There, middle Eocene carbonates are exposed at elevations of 25 feet (7.6 m) or less on the Pamlico terrace. Based on Vernon (1951, p. 118, 142, 158) the reconstructed maximum thickness for the Ocala Group in Citrus and Levy Counties is approximately 150 feet (46 m), and for the younger Suwannee Limestone, approximately 120 feet (37 m) (Vernon, 1951, p. 176). Although Vernon (1951) reported Hawthorne deposits in the Citrus-Levy County area, an average thickness of the Hawthorne in adjacent Alachua County may be construed to be approximately 100 feet (30 m) (Vernon, 1951, Fig. 33). In parts of Marion County, northwest of Ocala, an approximate average thickness near 50 feet (15 m) of lower Hawthorne sediments has been identified. Using the preceding estimated figures, one might assume that the reconstructed maximum thickness of upper Eocene through Miocene deposits in the Citrus-Levy County area could be approximately 450 feet (137 m). When added to the actual elevation of exposed middle Eocene beds in the area (25 feet or less), the upper elevation of this reconstructed section could stand at approximately 475 (145m) above sea level. Therefore, if the estimates of the thicknesses of the upper Eocene through Miocene deposits are accurate, and if all of these deposits covered the part of the Ocala Arch under Citrus and Levy Counties, then there could be evidence for minor uplift of no more than 175 feet (53 m). If, on the other hand, the thicknesses of the upper Eocene through Miocene deposits in Citrus and Levy Counties have been overestimated, or Miocene deposition never occurred in the area, then it can be argued that there is little or no evidence for uplift even in the structurally high areas of the Ocala Arch.

The Ocala Arch (Fig. 5) is a structurally stable arch that underlies the northern peninsula of Florida. Its northern limb extends into southern Georgia in Brooks and Lowndes Counties where it merges with normal continental margin structure. It trends southeastward into southern Florida. The Ocala Arch, as envisaged in this report, did not originate, for the most part, through uplift of the crest of the arch, but mainly through greater subsidence along the margins of the arch. The Ocala Arch is continuous with the Peninsular Arch of Applin (1951), and the Ocala Arch and Peninsular Arch constitute one structural entity (also see Murray, 1963, p. 98-100; compare with Chen, 1965, Figs. 7-12; Puri and Vernon, 1964, Figs. 2 and 3). The arch was "rejuvenated" periodically during periods of regional tectonism and it is evident that the crest of the arch shifted through time. The general location, however, of the arch in northern Florida remained constant. The name Ocala Arch is preferred to Peninsular Arch because the name Ocala has priority (i.e., Hopkins, 1920, as opposed to Applin, 1951).

The Florida Platform (Fig. 5) is an expansion of the concept of the Floridian Plateau (Vaughan, 1910b; Cooke and Mossom, 1929; Cooke, 1945) and the Florida-Bahama Platform (Owens, 1960; Chen, 1965). The Florida Platform of this report consists of the predominantly carbonate sediments that overlie the Florida basement and caps the structurally high Ocala Arch (and also caps the South Florida Basin of Murray, 1963, p. 101-103). As such, the Florida Platform is not a structural feature but rather the mass of flat-lying deposits lying on exotic continental basement (African basement rather than North American basement) with structural features superimposed on the basement. The Ocala Arch is the core of the Florida Platform in the northern part of the Florida peninsula.

The Florida Platform is bounded on the west by the Gulf of Mexico basin, on the east by the Blake Plateau-Florida Straits, and on the south by the Florida Straits (overthrust sheet or high-angle, tilted fault blocks of the Antilles according to Owens, 1960, and Chen, 1965). The northern boundary of the Florida Platform shifted through time due to facies change between the platform carbonates and the continental shelf clastics, and to changing configuration between the platform and the continental shelf to the north. The geomorphic or physiographic expression of the Florida Platform through much of the duration of the Coastal Plain province was a shallow water carbonate bank, much like the Bahama Banks of today. As a result, the Florida Platform constitutes a subprovince of the Coastal Plain, with a characteristic stratigraphy that, through much of the Cretaceous and Tertiary, was distinct from that of the adjacent continental shelf to the north (compare with Applin and Applin, 1944; Richards and Palmer, 1953; Cole and Applin, 1964). During the Eocene and Oligocene the northern margin of the Florida Platform coincided with the southern flanks of the Suwannee Straits or the Gulf Trough-Apalachicola Embayment. At that time the platform constituted a topographic (or bathymetric) high and formed a large bank or series of large banks. In the early Miocene, however, the northern margin of the Florida Platform (or banks) became more diffuse due to the inundation of the continental shelf by terrigenous clastics from the nearby Piedmont uplands. After the early Miocene, the Florida Platform neither stood out topographically nor depositionally in Georgia and, geomorphically, the platform was incorporated into the clastic shelf province of the southeastern Coastal Plain. During the Miocene, the northern margin of the Florida

Platform coincided with the southern flanks of the Gulf Trough-Apalachicola Embayment to the north and west, and with the Southeast Georgia Embayment to the north and east (Fig. 5).

The modern configuration of the northern part of the Florida Platform, as defined in this report, originated in the Miocene with the differential subsidence of the Southeast Georgia Embayment. Lithologies of upper Eocene and Oligocene formations are not significantly different between the platform area and the adjacent Southeast Georgia Embayment and the Florida Platform. Similarly, the thickness distributions of the upper Eocene and Oligocene deposits also show no changes in the vicinity of the Florida Platform and Southeast Georgia Embayment (compare with Applin and Applin, 1944; Herrick and Vorhis, 1963; Cramer and Arden, 1980).

The lithologies of the Miocene deposits, however, do appear to have been influenced by their positions on the Florida Platform and adjacent basinal areas. The typical Parachucla, Marks Head, and Coosawhatchie Formations are restricted to the Southeast Georgia Embayment (compare with Figs. 10 and 11) except that the Parachucla Formation also extends southwestward into the Gulf Trough and onto the Piedmont Slope (Fig. 15). The Statenville Formation and unnamed lower Miocene dolostone, clay and sand occur only on the eastern margins of the Florida Platform in northern Florida and southern Georgia. The Chattahoochee and Torreya Formations are known to occur only on the western part of the Florida Platform and in or on the flanks of the Gulf Trough-Apalachicola Embayment in southwesternmost Georgia and northwestern Florida. The Meigs Member of the Coosawhatchie Formation, on the other hand, is known to occur only in and adjacent to the Gulf Trough in Georgia.

Beaufort Arch

The Beaufort Arch (Fig. 5) was originally called the Beaufort High by Heron and Johnson (1966, p. 54) for the structurally high occurrence of Early Tertiary carbonate rocks in Beaufort County, South Carolina. It had earlier been referred to informally as the Burton Arch by Siple (1956, 1965), and later briefly referred to as the Beaufort Arch by Colquhoun and others (1969, p. 4). In Georgia, Furlow (1969, p. 14) recognized the feature in eastern Chatham County and called it the Tybee High.

The Beaufort Arch is a low, broad, structural high extending south-southwestward from Beaufort County, South Carolina, onto the continental shelf (Fig. 5). The Beaufort Arch is present onshore in Georgia only in eastern Chatham County. South of Chatham County, the Beaufort Arch occurs only on the inner continental shelf and has been traced as far south as offshore Cumberland Island (Woolsey, 1976, p. 59, fig. 3; Foley, 1981, p. 48-49, fig. 20).

There are no known Tertiary thickness or lithofacies anomalies associated with the Beaufort Arch in Georgia prior to or subsequent to the middle Miocene (compare with Woolsey, 1976, p. 59; also see Pl. 2). The Tybee Phosphorite Member of the Coosawhatchie Formation occurs only on the crest of the arch in Chatham County, and thins and pinches out on the western flank of the arch. The distribution of the Tybee Phosphorite Member on the crest of the Beaufort Arch suggest that the arch stood as a topographic high on the continental shelf during middle Miocene time.

Ridgeland Trough

The Ridgeland Trough (Fig. 5) is a minor structural feature named the Ridgeland Basin by Heron and Johnson (1966, p. 54), and the Ridgeland Trough by Colquhoun and others (1969, p. 4). It was named for the town of Ridgeland in Jasper County, South Carolina, through which the trough trends in a northeast-southwest direction. The Ridgeland Trough is identifiable in Georgia in southern Effingham and northern Chatham Counties (Pl. 2), but has not yet been traced farther south in Georgia.

The Ridgeland Trough is a structural artifact. It is formed by the southeastward structural dip of the Coastal Plain and the concomitant thickening of Miocene deposits; and the northwestward structural dip on the western flank of the Beaufort Arch, and the concomitant thinning of Miocene deposits over the Beaufort Arch (see Pl. 2). The Ridgeland Trough has, therefore, the appearance of a synclinal feature formed by the Beaufort Arch interrupting the normal seaward or basinward structural dip on the Coastal Plain.

STRATIGRAPHICALLY SIGNIFICANT GEOMORPHIC FEATURES OF THE GEORGIA COASTAL PLAIN

Geomorphic (or physiographic) features in themselves may or may not be associated with stratigraphic changes, depending on the nature of the geomorphic feature. The geomorphic features to be discussed in this report (Fig. 6) have two kinds of stratigraphic changes associated with them: the physical termination of stratigraphic units by erosional truncation, and the termination of stratigraphic units because of facies change. In the first case (e.g., a simple cuesta), there is no apparent relationship between the present geomorphic feature and the original depositional environment or depositional geography. In the second case, where there is associated facies change, either the geomorphic feature or an ancestral condition was present during one or more depositional episodes. For example, a recurring or periodic, down-to-the-basin fault in the basement in a

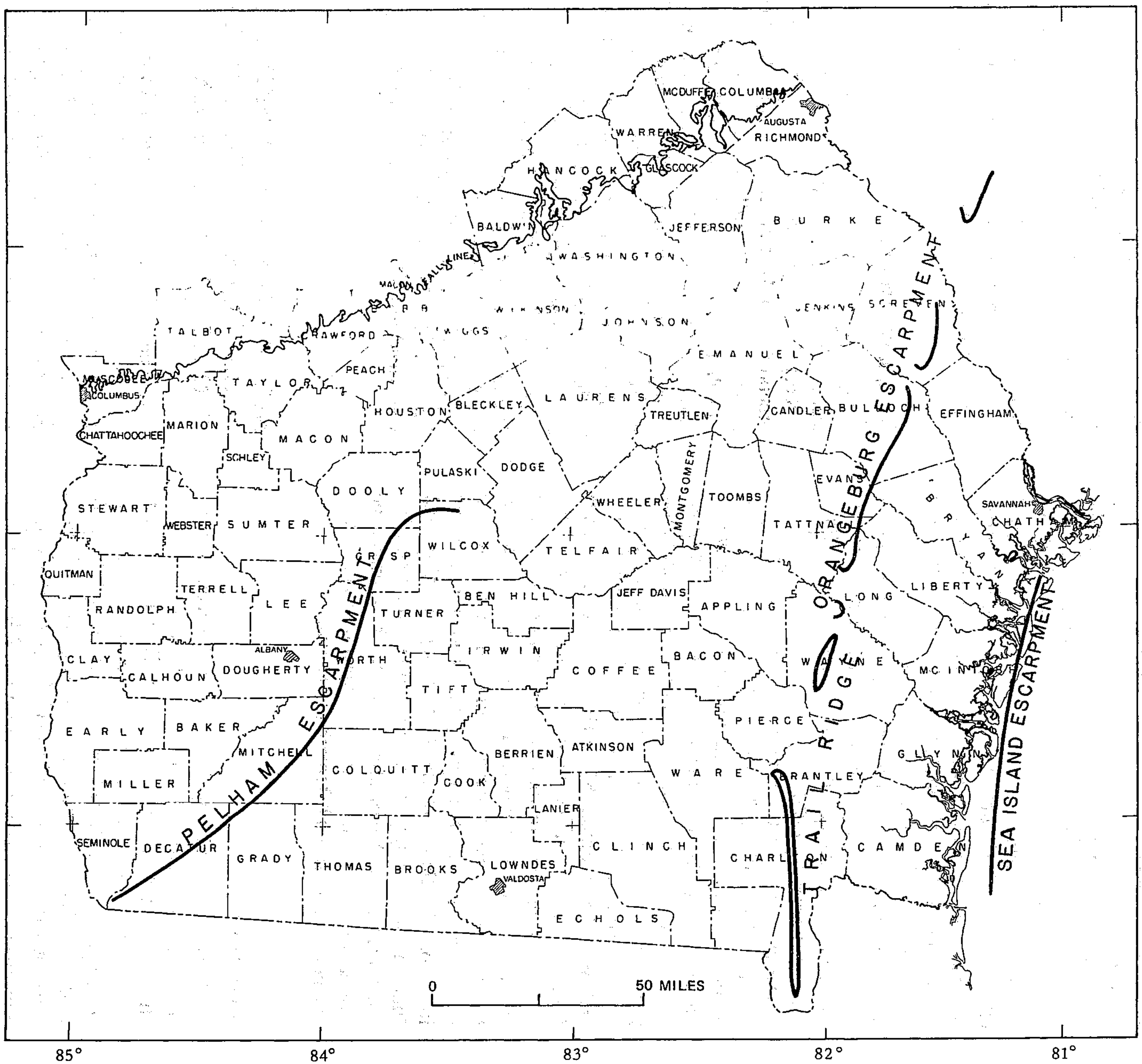


Figure 6. Stratigraphically significant physiographic features of the Georgia Coastal Plain.

coastal area could dictate a shoreline position or a facies-change position on the continental shelf at successive intervals in geologic time. A shoreline position for such a feature could result in a topographically conspicuous wave-cut escarpment. Three geomorphic features (escarpments) that have associated stratigraphic terminations are discussed in order.

Pelham Escarpment

The Pelham Escarpment (Fig. 6) was recognized but unnamed by Veatch and Stephenson (1911, p. 32) and Cooke (1925, p. 37), and has been called Curry Hill on both 1:62,500 and 1:24,000 quadrangle maps in Decatur and Grady Counties, Georgia. MacNeil (1947b) referred to the escarpment as "Solution escarpment", but Furcron and Fortson (1960) named the feature the Pelham Solution escarpment. The name has subsequently been shortened to Pelham Escarpment (Clark and Zisa, 1976; Clark, Zisa, and Jones, 1976).

The Pelham Escarpment is a cuesta that extends from the vicinity of Wilcox County, Georgia, southwestward to southwestern Decatur County, Georgia, where it merges into the eastern valley wall of the Flint River (Lake Seminole). Between the vicinities of Bristol and Chattachoochee, Florida, the Pelham Escarpment also forms the eastern wall of the Apalachicola River Valley, and large bluffs are formed where the river flows against the Pelham Escarpment. Between the vicinities of Chattahoochee, Florida, and Faceville, Georgia, the Pelham Escarpment forms the eastern valley wall of the Flint River (now Lake Seminole).

Various formations are present in the face of the Pelham Escarpment along its length. At Alum Bluff on the Apalachicola River, near Bristol, Florida, the lower Miocene Chipola Formation is overlain by the upper Pliocene Jackson Bluff Formation in the face of the escarpment, and the upper Pliocene Citronelle Formation caps the escarpment. The geologic section exposed in the face of the Pelham Escarpment rises northward into southwestern Georgia, exposing older formations. From Aspalaga Bluff in Gadsden County, Florida, northward into Decatur County, Georgia, the sections exposed in the bluffs of the Apalachicola and lower Flint Rivers consist of Chattahoochee Formation, overlain by Torreya Formation, and capped by Citronelle or Miccosukee Formations. From northeastern Mitchell County to its termination in Wilcox County, Oligocene limestones, or residuum thereof, occur at the base of the escarpment, and Altamaha Formation caps the escarpment.

From Decatur County to Crisp County, Georgia, the Pelham Escarpment separates the Tifton upland on the east from the Dougherty Plain on the west (Cooke, 1925; Clark and Zisa, 1976).

Orangeburg Escarpment

The name Orangeburg Escarpment (Fig. 6) was first applied by Pooser (1962, 1965) and Colquhoun (1962) to an escarpment that trends from Marlboro and Chesterfield Counties, South Carolina, near the North Carolina state line, southward through Orangeburg County to Allendale County in the Savannah River region. The Orangeburg Escarpment was described by Colquhoun (1965). Subsequently, Clark and Zisa (1976) recognized the Orangeburg Escarpment in Georgia. The name Orangeburg Escarpment (or scarp) has been used by most authors in South Carolina, but the name Citronelle Escarpment of Doering (1960) is still used by some (Colquhoun and others, 1983). In my opinion the name Citronelle for the escarpment in question is inappropriate because the escarpment was named by Doering (1960) for deposits (Altamaha Formation of this report; Hawthorne Formation of Cooke, 1936, 1943; Cooke and MacNeil, 1952; Siple, 1967) that were miscorrelated with the Citronelle Formation (named from the village of Citronelle in Mobile County, Alabama), an eastern Gulf Coastal Plain formation that occurs neither in Georgia nor South Carolina. The Orangeburg Escarpment was named for the town of Orangeburg, South Carolina, which is located on the escarpment. The name Orangeburg in this context has no stratigraphic implications. As a result, I prefer the name Orangeburg Escarpment to the name Citronelle Escarpment.

The Orangeburg Escarpment extends from North Carolina in the north, to the vicinity of the Altamaha River in Georgia in the south (Fig. 6). The escarpment is moderately dissected in Georgia, but the degree of dissection varies along its extent. In Georgia, the Orangeburg Escarpment trends southward from eastern Screven County, in the Savannah River area, through Bullock, Evans, and Long Counties (see Clark and Zisa, 1976). It is present immediately south of the Altamaha River in the vicinity of Jesup in Wayne County, but the face of the escarpment is deeply dissected there. Northwest of Jesup, the southern end of the Orangeburg Escarpment almost overlaps the northern end of Trail Ridge (Fig. 6).

The Orangeburg Escarpment is not only a geomorphic feature in Georgia, its position also coincides with or approximates stratigraphic boundaries. The Orangeburg Escarpment represents the eastern limits of the Miocene Altamaha Formation and the western limits of the upper Pliocene Raysor Formation (=Duplin formation of earlier authors) in Georgia (i.e., the Altamaha Formation is not known to occur east of the escarpment, and the Raysor Formation is not known to occur west of the escarpment). The western limits of the younger, upper Pliocene Cypresshead Formation generally occurs at the Orangeburg Escarpment, but the Cypresshead Formation also is known to occur in places a few miles west of the escarpment.

The Orangeburg Escarpment acts as a dividing line for the marine terraces in Georgia and South Carolina. The Okefenokee and higher terraces are found west of the line of the Orangeburg Escarpment-Trail Ridge south of the Satilla River. However, each successively higher terrace also occurs on the east side of the Orangeburg Escarpment progressively farther north (Figs. 56, 57) as a result of northward increasing elevation along the crest of the escarpment. Between the northernmost occurrence of a specific marine terrace west of the Orangeburg Escarpment and its southernmost occurrence east of the escarpment, there is a gap in the occurrence of that terrace, its elevation position occurring in the face of the Orangeburg Escarpment.

The origin of the Orangeburg Escarpment is not clear. It is certainly not, however, a simple erosional or solution cuesta like the Pelham Escarpment in southwestern Georgia. The following observations may contribute to an understanding of the Orangeburg Escarpment. (1) The Orangeburg Escarpment in Georgia occurs along a trend of lithofacies change involving middle Miocene (Serravillian) deposits (compare Fig. 6 with Figs. 31, 42, and 44). (2) The position of the Orangeburg Escarpment approximates the inner limits of the upper Pliocene Raysor Formation in South Carolina and Georgia (in the vicinity of the Altamaha River, it also marks the shoreward limits of the Raysor Formation [Fig. 47]). (3) The position of the Orangeburg Escarpment was overlapped in places by the upper Pliocene Cypresshead Formation (which overlies the Raysor Formation) (compare Fig. 6 with Fig. 50). (4) The positions of the Pleistocene marine terraces are influenced by the Orangeburg Escarpment (Figs. 56 and 57). (5) Trail Ridge, a sand ridge of coastal origin, extends southward along the same trend as the Orangeburg Escarpment, and the northern tip of Trail Ridge in Wayne County, Georgia, almost coincides with the southern limits of the Orangeburg Escarpment (Fig. 6). (6) The land elevations along the crest of the Orangeburg Escarpment diminish southward from approximately 300 feet (91 m) above sea level in northern South Carolina, to 230-250 feet (70-76 m) in Screven County, Georgia, to 140 feet (43 m) in Wayne County, Georgia, the southern end of the escarpment. In Wayne County, the crest of the Orangeburg Escarpment merges with the Waycross terrace, and the elevations on the crest of Trail Ridge in Wayne County are likewise 140 feet (43 m) above sea level.

The preceding observations indicate that, during the Miocene to Pleistocene, the position of the Orangeburg Escarpment periodically occupied a band of facies change from fluvial or shallow coastal waters on the west, to more open marine, inner continental shelf waters on the east, and that the present escarpment occurs in the vicinity of paleoshorelines. This line of recurring facies change suggests deep-seated structural control, possibly down-to-basin faulting in the basement.

The position of the Orangeburg Escarpment appears to have occupied the shoreline area during the period of Raysor deposition. But because the younger Cypresshead Formation occurs inland from the Orangeburg Escarpment in Bulloch and Wayne Counties, it is concluded that the present Orangeburg Escarpment did not exist during Raysor deposition and during Cypresshead deposition, or that the topographic relief on the escarpment was much lower during the Pliocene. On the other hand, the positions of all of the higher marine terraces (Okefenokee, Waycross, Argyle [new name], Claxton, Pearson [new name], and Hazlehurst terraces) are influenced by the Orangeburg Escarpment, and the position where each terrace passes from the west side of the escarpment to the east side of the escarpment occurs progressively farther north with each higher terrace (see Figs. 56 and 57). This phenomenon suggests that the Orangeburg Escarpment is a wave-cut escarpment that may not have existed with its present relief during late Pliocene time, but was constructed through increments during terrace construction events in the early and late Pleistocene (very roughly the period of construction of the higher terraces). It is also possible, however, that the Orangeburg Escarpment was constructed subsequent to deposition of the Cypresshead Formation, and was tectonically tilted to the south prior to the construction of the marine terraces. Available information does not allow selection between these two models at this time.

Sea Island Escarpment "new name"

The Sea Island Escarpment (Fig. 6) is a new name proposed herein for a buried escarpment that underlies the coastal area and inner continental shelf of Georgia. It has been detected only by seismic means (Woolsey and Henry, 1974, p. 167-168; Woolsey, 1976, p. 31-33; Foley, 1981, p. 20-24) and is not a present topographic feature. Therefore, the Sea Island Escarpment is in reality a paleoescarpment, but for brevity, will be referred to as an "escarpment" in this paper. The Sea Island Escarpment was a topographic feature probably from near the end of the Miocene through the early Pliocene, but was buried by prograding inner continental shelf deposits (unnamed Raysor-equivalent shelly sand) during the late Pliocene.

The Sea Island Escarpment extends in the north from southern coastal Chatham County, southward under St. Catherines, Blackbeard, and Sapelo Islands, and thence offshore as far south as the inner continental shelf off of Cumberland Island (Fig. 6).

The Sea Island Escarpment has been postulated as a wave-cut erosional escarpment that was cut during the interval between middle Miocene and Pliocene time (Woolsey, 1976; Foley, 1981). The sediments (or reflectors) in the escarpment have been called Hawthorne Formation (Woolsey, 1976) but are referred to here as the Coosawhatchie Formation. Large-scale clinoforms of the upper Pliocene Raysor-equivalent shelly sand overlie and occur seaward of the buried escarpment, and the lower Pliocene Wabasso beds appear to occur only seaward of the escarpment

(Huddlestun and others, 1982). It is suggested that the Sea Island Escarpment was cut during the late Miocene (Messinian) low-stand of the sea (compare with Huddlestun and Wright, 1977), either by wave action along the coast or by strong current action on the inner continental shelf. The early Pliocene sea level stand may have inundated the escarpment (deduced from the relatively deeper water, planktonic foraminiferal fauna of the Wabasso beds, but clastic input was not sufficient to bury the escarpment until late Pliocene time.

STRATIGRAPHY

Cooper Formation

Definition

The Cooper Formation (part of which is Miocene in age) is restricted to the continental shelf in the Georgia area, and consists of massive and structureless, generally unconsolidates, finely to very finely granular and even-textured, microfossiliferous, variably argillaceous limestone. The name Cooper was originally applied to calcareous deposits cropping out along the Cooper and Ashley Rivers in South Carolina (Tuomey, 1848). Sloan (1908, p. 462-464) referred to the Cooper variably as "Ashley-Cooper marls", "Cooper River marl", "Cooper marl", and "Ashley marl". He referred to the marl cropping out along the Cooper River as Cooper Marl, and the marl cropping out along the Ashley River he referred to as Ashley marl. Sloan (1908) considered the Ashley and Cooper marls to be lithologically similar enough that he included them also under the name Ashley-Cooper marl. He noted, however, that the Ashley marl tended to be more phosphatic than the Cooper marl. In addition, Sloan (1908, p. 463) considered the marl along the Cooper River to be of Eocene age whereas he suspected the marl along the Ashley River to be possibly of Oligocene age. Cooke (1936, p. 82-89) simplified the stratigraphic terminology by recognizing only the name Cooper Marl, noting, however, that the upper part of the formation is more phosphatic than the lower part.

The formation in Georgia previously referred to as Cooper Marl (Cooke and Munyan, 1938; Cooke, 1943, p. 74-77; Pickering, 1970, p. 13-14; Huddlestun and others, 1974, p. 9-10) is now called the Ocmulgee Formation (Huddlestun and Hetrick, 1986). The Ocmulgee Formation and the Cooper Formation of this report have little in common. The Cooper Formation in the type area in South Carolina and on the continental shelf of Georgia ranges from the upper Eocene (upper Jacksonian) to the lower Miocene (Aquitanian). The Ocmulgee Formation, on the other hand, is restricted to the upper Eocene (upper Jacksonian). The Cooper Formation extends from the Holly Hill and Charleston area of South Carolina southward on the continental shelf of South Carolina and Georgia (Fig. 7). The Ocmulgee Formation occurs only in a band south of the Fall Line Hills of Georgia from Houston and Pulaski Counties in the southwest, to Screven County in the Savannah River area. It is not clear at this time whether the Ocmulgee Formation grades laterally into the Cooper Formation in South Carolina, or whether the two units are stratigraphically separated. The Ocmulgee Formation has lithologic characteristics of both the Cooper and the Ocala Group. Like the Cooper Formation, the Ocmulgee tends to be granular, fine- to medium-grained and even-textured, tough and resistant to weathering, and very microfossiliferous. Like the Ocala Group, the Ocmulgee Formation is variably macrofossiliferous, and with a predominance of bryozoa. The Ocmulgee is lithologically more variable than the Cooper (Huddlestun and Hetrick, 1986), and the Ocmulgee is variably glauconitic, whereas the Cooper is variably phosphatic. The Ocmulgee Formation grades laterally seaward (southeastward) into the Crystal River Formation, and farther seaward, the Crystal River Formation grades laterally on the continental shelf into the lowest part of the Cooper Formation.

Type Section

The name Cooper is derived from the Cooper River north of Charleston, in South Carolina. No specific type locality has ever been designated for the Cooper, nor has the Cooper outcrop area along the Cooper River (or the Ashley River) been clearly delineated (compare with Cooke, 1936, p. 87, pl. 2). According to Ward (pers. com., 1984) and Ward and others (1979, p. 14), the exposures of the Cooper Formation along the Cooper River are poorly exposed and poorly preserved. As a result, Ward and others (1979, p. 14) proposed the section of Cooper Formation exposed in the quarry of the Giant Portland Cement Company near Holly Hill, Dorchester County, South Carolina, as a lectostratotype of the formation. In addition, Ward and others (1979, p. 14) designated as a reference section (hypostratotype) the Cooper Formation exposed in the bluff at Givhans Ferry on the left bank of the Edisto River in Dorchester County, South Carolina.

For reference purposes, the Miocene Cooper Formation occurs in the stratigraphic interval 289 feet to approximately 232 feet in the core AMCOR 6002 taken on the Georgia continental shelf.

Lithology

In the Georgia area, the Cooper Formation is known with certainty only from the core AMCOR 6002. The following description is based on the lithologies of the formation in that core. The Cooper consists of massive, structureless, granular, even-textured, finely granular to very finely granular, microfossiliferous, variably argillaceous, unconsolidated to slightly recrystallized limestone or "marl". Calcite or limestone is the predominant lithic component of the formation whereas clay minerals, fine-grained sand and silt, phos-

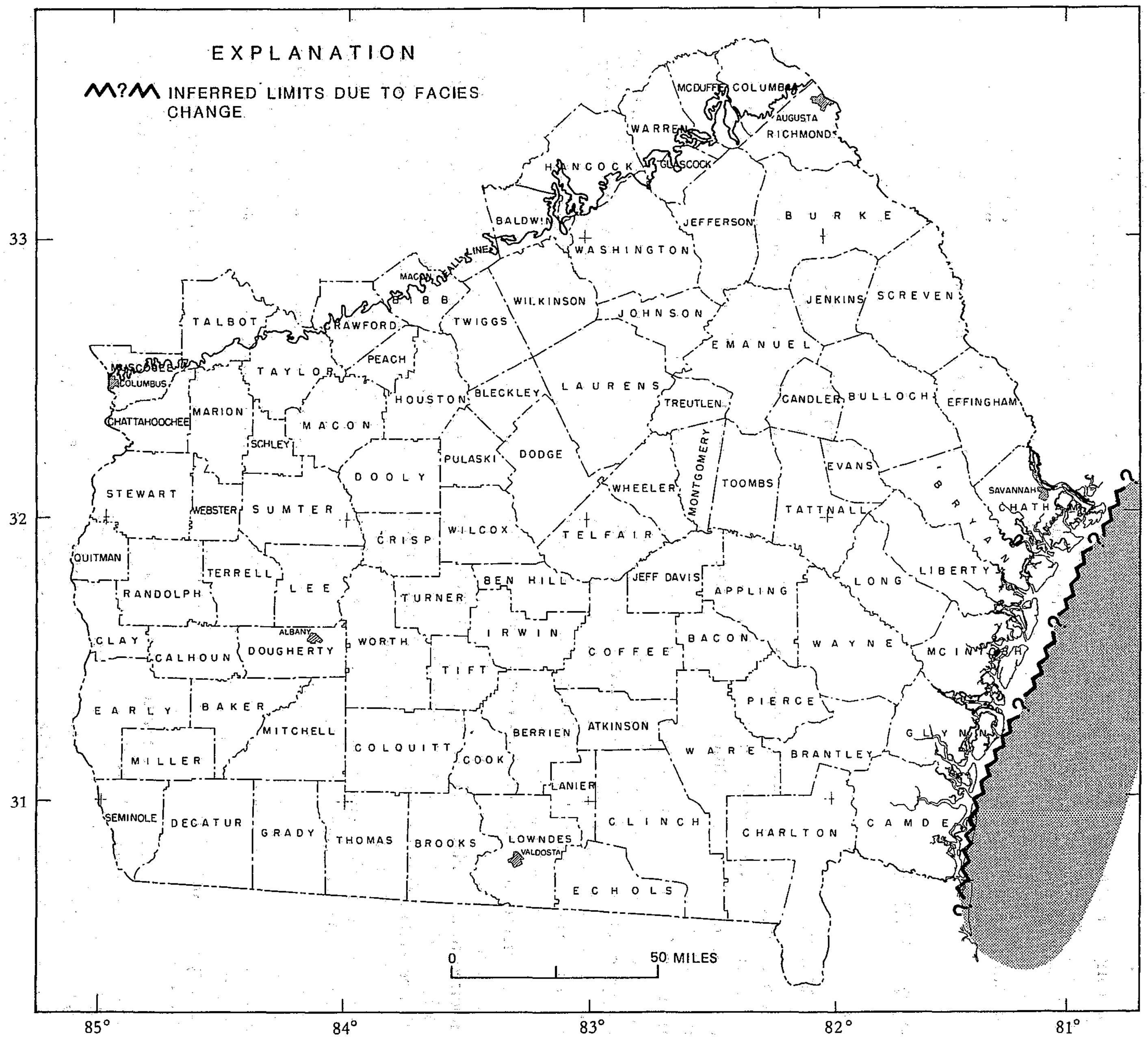


Figure 7. The areal distribution (subcrop) of the Cooper Formation under the continental shelf of Georgia.

phate, dolomite, and zeolite are minor or trace components of the lithology. The clay mineral suite of the lower part (upper Eocene and Oligocene) of the Cooper Formation in the core AMCOR 6002 is dominated by smectite with subordinate illite and kaolinite (J.H. Hetrick, pers. com., 1985). In the upper part of the Cooper Formation (Aquitanian, lower Miocene) in the core AMCOR 6002, however, the clay mineral suite also contains palygorskite and sepiolite (Hetrick and Friddell, 1984), apparently of detritial origin. Palygorskite is the dominant clay mineral near the top of the Cooper Formation in the core AMCOR 6002 (Hetrick and Friddell, 1984, p. 37, A37).

The upper part of the Cooper Formation appears to grade laterally westward into the Parachucla Formation of the Hawthorne Group under the inner continental shelf or coastal area of Georgia. In this area of facies change, the upper part of the Cooper would become more sandy, argillaceous, phosphatic, and dolomitic, with some stratigraphic intervals consisting predominantly of dolostone.

Stratigraphic Relationships

The Cooper Formation is restricted to the continental shelf in the Georgia area, but is probably continuous northward with the onshore Cooper Formation in the Charleston area of South Carolina. The upper part of the Cooper Formation under the Georgia continental shelf appears to grade laterally westward into the lower Miocene Parachucla Formation of the Hawthorne Group (see Fig. 11, Pls. 2, 3). The stratigraphic relationships of the Oligocene component of the Cooper with the onshore Oligocene section is unknown, however, due to lack of core control on the continental shelf. Because there are no Oligocene deposits present in the coastal area of Georgia south of the vicinity of Brunswick in Glynn County, it appears likely that the Oligocene component of the Cooper Formation thins westward and pinches out under the inner continental shelf off the southern coastal area of Georgia (Pls. 2,3). In the northern coastal area of Georgia, north of the vicinity of Brunswick, the upper Oligocene, Chickawashayan (Chatham) component of the Cooper likewise thins and pinches out under the inner continental shelf, whereas the lower Oligocene, Vicksburgian (Rupelian) component grades laterally westward into either the Lazaretto Creek Formation or into the Suwanee Limestone. There is no basis for speculation on the stratigraphic relationships between the upper Eocene component of the continental shelf Cooper Formation and the onshore Crystal River Formation, other than it appears that the lowest part of the Cooper Formation may grade laterally westward, by increase in coarse bioclastic material (primarily bryozoa), into the Crystal River Formation of the Ocala Croup.

In the core AMCOR 6002, the Cooper Formation is underlain by undifferentiated limestone of the Ocala Group and is overlain paraconformably by the Coosawhatchie Formation of the Hawthorne Group (Pls. 2, 3).

The upper part of the Cooper Formation is distinguished from the stratigraphically equivalent Parachucla Formation in being a finely granular, microfossiliferous, variably argillaceous limestone whereas the Parachucla Formation is a variably phosphatic, variably dolomitic or calcaerous, argillaceous sand or sandy clay. The overlying Berryville Clay Member of the Coosawhatchie Formation differs from the Cooper in consisting of thinly bedded to massive and structureless, variably phosphatic, variably diatomaceous, calcareous clay.

The thickness distribution of the Miocene part of the Cooper Formation under the continental shelf is unknown at this time due to insufficient core control. The thickness is at least 57 feet feet (17 m) in the core AMCOR 6002 but, due to uncertainty as a result of poor core recovery, it could be as much as 84 feet (26 m).

The environment of deposition of the Miocene component of the Cooper Formation was marine, middle to possibly outer neritic, continental shelf.

Age

The age of the Cooper Formation under the continental shelf of Georgia spans the latest part of the late Eocene (late Jacksonian) to the early Miocene (Aquitanian). The recognition of the early Miocene (Aquitanian) component of the Cooper Formation is based on the occurrence of the following species of planktonic formaminifera in the absence of *Cheilogumbelina cubensis:*

Globorotalia pseudokugleri
Globigerinita cf. *incrusta*
Globigerinoides primordius
Globigerina angulisuturalis.

The presence of *G. pseudokugleri* and the small and primitive *G. primordius* indicates that the Miocene Cooper in the core AMCOR 6002 is correlative with the Tiger Leap Member of the Parachucla Formation and not with the Porters Landing Member.

CHATTAHOOCHEE FORMATION

Definition

The Chattahoochee Formation generally consists of argillaceous, silty, finely sandy dolostone that is restricted to the western part of the Ocala Platform and to a small area between the Pelham Escarpment and Gulf Trough in southwestern Georgia (Fig. 10). As with most stratigraphic names that came into usage in the Coastal Plain of the southeastern United States in the last century, the name Chattahoochee evolved from casual mention, or from indefinite use as a sort of stratigraphic unit, to a stratigraphic unit that consistently can be identified in the field. As with other stratigraphic names originating at about the same time, the Chattahoochee Formation was never clearly defined by modern standards, and the application of the name by various authors was irregular. The name Chattahoochee was first used as the "Chattahoochee group" by Langdon (1889) and Foerste (1893). Dall (1892, p. 105-107) referred to the unit variously as "Chattahoochee group" and "Chattahoochee limestone", but Dall and Stanley-Brown (1894, p. 147-170) mostly called it the "Chattahoochee limestone" and used the name consistently in a lithostratigraphic sense. However, the application of the name varied from that of modern usage in the Apalachicola River area (the type area). For example, Dall and Stanley-Brown (1894, p. 163) included limestones (Ocheesee beds of Dall, 1892) of the lower calcareous phase of the Torreya Formation of the Hawthorne Group of this report in the Chattahoochee Formation. Because of its considerable impurities, Matson and Clapp (1909, p. 74-84) changed the unit term of the formation from Chattahoochee Limestone to Chattahoochee Formation, and this adjustment was followed by subsequent authors (Veatch and Stephenson, 1911; Matson, 1915; Brantly, 1916; Shearer, 1917; Sellards, 1917; Sellards and Gunter, 1918a, 1918b).

In spite of significant lithologic differences (compare with Dall, 1982; Matson and Clapp, 1909), the Chattahoochee Formation was abandoned in favor of the Tampa Limestone by Cooke and Mossom (1929, p. 79) because the Chattahoochee Formation appeared to be the same age as the Tampa Limestone. As a result, the name Tampa Limestone became widely applied in western Florida and Georgia for impure carbonates that overlie the Oligocene limestones, and underlie sands and clays of the Hawthorne and Alum Bluff (Mansfield, 1937; Vernon, 1942; Cooke, 1943, p. 86-89, 1945; MacNeil, 1944a, 1944b, 1944c, 1947a, 1947b; Fortson and Navarre, 1959; Herrick, 1961, p. 17-21; Owen, 1963b; Counts and Donsky, 1963). The concept of the Chattahoochee Formation as a distinct stratigraphic unit, however, was reintroduced by Puri (1953, p. 17-20) as the informal "Chattahoochee facies of the Tampa stage", and was later reintroduced as the Chattahoochee Formation by Puri and Vernon (1964, p. 118-123). Authors in Georgia, however, continued to use the name Tampa (Gremillion, 1965; Sever, 1966a, 1966b, 1969, 1972; Patterson and Buie, 1974; Weaver and Beck, 1977; also see Furlow, 1969, and Zimmerman, 1977) even though the Chattahoochee Formation had been reintroduced and the name applied in western Florida and Georgia (Hendry and Yon, 1958; Butler, 1963; Poag, 1972; Georgia Geological Survey, 1976).

As a result of the ambiguity concerning the names Chattahoochee and Tampa, I formally propose that the use of the name Tampa be abandoned in Georgia, that the dolomitic deposits in southwestern Georgia that had been called Tampa, in the sense of Cooke (1943), be included in the Chattahoochee Formation, and that the phosphatic, argillaceous, sandy carbonates at the base of the Miocene Series in southern and eastern Georgia, that have been related by some authors to the Tampa (Fortson and Navarre, 1959; Counts and Donsky, 1963; Furow, 1969) and by others to the Hawthorne (Wait, 1965; Wait and Gregg, 1973; Gregg and Zimmerman, 1974), be included in the Parachucla Formation.

The reasons for these proposals are as follows: (1) The lithostratigraphic unit, the Tampa Limestone (in the strict sense) is not present in Georgia. The Tampa Limestone is lithologically a finely sandy, variably fossiliferous limestone whereas the Chattahoochee Formation is more sandy and argillaceous and consists of a dolomitic fine-grained sand, clay and finely sandy dolostone with minor limestone. In contrast to the Tampa Limestone, the Chattahoochee Formation in Georgia is only sparsely fossiliferous. (2) Despite the widespread usage of the name Tampa in Florida and Georgia, the lithostratigraphic unit, Tampa Limestone, is known to occur only in the Tampa Bay area of Florida. The Chattahoochee Formation, on the other hand, occurs only in western Florida and in Georgia on the northwestern part of the Florida Platform, and the western flank of the Gulf Trough. The Tampa Limestone does not occur on the Florida Platform or east of the Florida Platform in peninsular Florida. Therefore, the Tampa Limestone and the Chattahoochee Formation are not continuous in outcrop or known occurrence, and evidence for interfingering or intergradation between the two units is lacking.

The basal carbonates of the Miocene Series in the subsurface of eastern Georgia are lithologically neither Tampa Limestone nor Chattahoochee Formation. These carbonates consist of phosphatic, sandy, variably argillaceous limestones and dolostones that locally are abundantly fossilferous. They are here included in the Tiger Leap Member of the Parachucla Formation (Hawthorne Group) because their overall lithology is compatible with that of the Tiger Leap in its type area in southern Screven County, Georgia.

The Chattahoochee Formation, as applied in this report, is approximately the same as that of Matson and Clapp (1909, p. 74-84) and Puri and Vernon (1964, p. 118-123), but differs significantly from the Chattahoochee Formation of Veatch and Stephenson (1911, p. 324-342). Deposits that constituted the Chattahoochee Formation of Veatch and Stephenson (1911) included not only Chattahoochee Formation of this report, but also residuum derived from various Oligocene limestones (later called Flint River formation by Cooke, 1935, 1943), Suwannee Limestone, some undifferentiated Oligocene limestone, Ocmulgee Formation (Huddlestun and Hetrick, 1986), and locally, some dolostones of the Hawthorne Group.

Type Section

The name Chattahoochee was taken from the town of Chattahoochee in Gadsden County, Florida. Although the name Chattahoochee had been used in a lithostratigraphic sense by earlier authors (Langdon, 1889; Dall, 1892; Foerste, 1893; Dall and Stanley-Brown, 1894), it was Matson and Clapp (1909, p. 74) who first referred the Chattahoochee Formation to a type locality, Chattahoochee Landing on the Apalachicola River at Chattahoochee, Florida (presumably the same as "old Chattahoochee Landing" of Dall and Stanley-Brown, 1894). All subsequent authors (Sellards and Gunter, 1909, 1918a; Mossom, 1925; Cooke and Mossom, 1929; Mansfield, 1937) accepted Chattahoochee Landing (or old Chattahoochee Landing) as the type locality of the Chattahoochee Formation.

There is uncertainty, however, concerning the site of the type section of the Chattahoochee Formation (i.e., the formation exposed at the type locality). Dall and Stanley-Brown (1894) presented two measured and described sections from "old Chattahoochee Landing", but the precise locations of the sections relative to the landing and the nearby bluffs are not clear from their descriptive. However, the sections must have been located between the river and the lower parts of the bluffs at Chattahoochee because the bases of the sections begin only 3 feet (1 m) above river level and extend to 26.5 feet (8 m) and 22.5 feet (6.9 m) above the river. Such a location is compatible with their comment that, "The exposures are mostly in gullies" (Dall and Stanley-Brown, 1894, p. 152), which would be true if the exposures occurred between the river and the bluffs.

All subsequent described sections from the "type locality" (G.D. Harris, in Maury, 1902; T.W. Vaughan, in Matson and Clapp, 1909; Sellards and Gunter, 1909, 1918a; Mossom, 1925; Cooke and Mossom, 1929; Mansfield, 1937; Cooke, 1945), however, differ from that of Dall and Stanley-Brown (1894) in that these later measured and described sections are from the roadcut in the bluff, at Chattahoochee, leading down to the landing (and later to the bridge over the Apalachicola River). The bases of all of these measured sections begin from 15 feet (4.6 m) to 25 feet (7.6 m) above river level and extend upwards to as much as 182 feet (55 m) above the river (in contrast to the sections of Dall and Stanley-Brown [1894] that begin near river level and extend upwards to 20 feet [6 m] above the river).

It is not clear whether this discrepancy is (1) the result of earlier exposures, measured and described by Dall and Stanley-Brown (1894), having been covered a few years later and being no longer accessible (the section of G.D. Harris was published in Maury [1902] eight years later), (2) whether the original site of "old Chattahoochee Landing" was accurately located by Dall and Stanley Brown,[1] or (3) whether the sections were mislocated and never existed at "old Chattahoochee Landing". However, since all subsequent authors (Matson and Clapp, 1909; Sellards and Gunter, 1909, 1918a; Mossom, 1925; Cooke and Mossom, 1929; Mansfield, 1937) accepted Chattahoochee Landing as the type locality of the formation, it logically follows that the section exposed (or once exposed) there is the stratotype of the formation. However, all of the authors subsequent to Matson and Clapp (1909) have applied the concept of "type locality" loosely to the Chattahoochee Formation and, except for Matson and Clapp (1909) and Sellards and Gunter (1909), did not distinguish between the locality below the bluff at "old Chattahoochee Landing" of Dall and Stanley-Brown (1894) and the "type locality" in the bluff. These two localities are not the same, and the sections exposed (or once exposed) there are not the same. In accordance with the various codes of stratigraphic nomenclature (American Commission on Stratigraphic Nomenclature, 1961, 1970; International Subcommission on Stratigraphic Classification, 1976; North American Commission on Stratigraphic Nomenclature, 1983), a type section (or type locality) must not be changed or amended (e.g., see North American Commission on Stratigraphic Nomenclature, 1983, Art. 22c). Therefore, it is concluded that the section exposed in the bluff along the road leading down to Chattahoochee Landing (or the old highway bridge) is not the type section of the Chattahoochee Formation, nor is that site the type locality of the formation. On the other hand, Sellards and Gunter (1909, 1918a), Mossom (1925), Cooke and Mossom (1929), and Mansfield (1937) referred to the section exposed in the roadcut in the bluff in the modern sense of a neostratotype (a new stratotype selected to replace an older one which has been destroyed or nullified [International Subcommission on Stratigraphic Classification, 1976, p. 26]) and principal reference locality.

None of the codes of stratigraphic nomenclature clearly address the difficulties in dealing with imprecise stratigraphic definition and usage in the years prior to stratigraphic codification. In the case of the Chattahoochee Formation, therefore, there is no simple and clear-out solution to the problem of the precise location of the type locality and type section. The solution to this problem requires a thorough understanding of the literature and stratigraphy of the formation, and balancing established stratigraphic usage and interpretation of the intent of the codes of stratigraphic nomenclature. Therefore, based on the above discussion, it is my interpretation that the type locality of the Chattahoochee Formation is at or near the site of Chattahoochee Landing (or "old Chattahoochee Landing"), between the Apalachicola River and the river bluffs at Chattahoochee, Florida, near the center of Section 32, T4N, R6W (see Fig. 7). The stratotype of the formation[2] (the original stratotype designated by the author at the time of establishment of a stratigraphic unit) is that section that was reported to be exposed in gullies at the type locality (see Dall and Stanley-Brown, 1894, p. 152). This section is no longer accessible. The principal reference locality of the Chattahoochee Formation is the roadcut in the bluff leading down to Chattahoochee Landing (or the old highway bridge) at

[1] Dall and Stanley-Brown (1894, p. 152) gave the site of "old Chattahoochee Landing" as Sec. 5, T3N, T6W, and about 1 mile above the railroad bridge. This location is internally inconsistent (see Fig. 7).

[2] Because a type section was not clearly designated by Dall and Stanley-Brown (1894), it is doubtful whether the stratotype can be considered to be the halostratotype.

Chattahoochee, Florida, in SW1/4, NE1/4, Sec. 32, T4N, R6W (see Fig. 8). The unit-stratotype (neostratotype) is that section of the Chattahoochee Formation exposed at the principal reference locality (see Matson and Clapp, 1909, p. 78-80).

Lithology

The dominant and characteristic lithic component of the Chattahoochee Formation is dolostone. Subordinate lithic components include quartz sand, clay, calcite, limestone, chert, mica, heavy minerals, phosphate, and fossils. The dolostone of the Chattahoochee Formation, commonly reported as limestone in the past (Dall 1892; Dall and Stanley-Brown, 1894; Matson and Clapp, 1909; Sellards, 1917; Sellards and Gunter, 1918a, 1918b; Mossom, 1925; Cooke and Mossom, 1929; Mansfield, 1937; Cooke, 1943, 1945; Puri, 1953; Puri and Vernon, 1964; Gremillion, 1965, 1966), is typically yellowish gray in color (5 Y 7/2 to 5 Y 7/1), uniform in texture, chalky to granular, rarely pelletal and foraminiferal, fine- to medium-grained, compact, prominently but rudely bedded*, and poorly to moderately consolidated and recrystallized. Limestone and calcite occur only rarely in the Chattahoochee Formation in Georgia, but are more common and widespread farther to the south and southwest in Florida. The dolomite in the Chattahoochee Formation appears to be secondary because the fossils that were once calcareous are now present only as molds and casts in the dolostone.

Fine-grained, well-sorted quartz sand and silt are characteristic of the Chattahoochee Formation. Typically the sand is evenly distributed throughout the dolostone, but it also occurs in medium to thick beds (Ingram, 1954) with variable admixtures of clay and dolomite. In some sections, significant proportions of the formation consist of fine-grained sand and clay (Cooke, 1943; Hendry and Yon, 1958, p. 28-33; Puri and Vernon, 1964, p. 121-122) and, in general, sand and clay appear to constitute a more significant component of the formation near the northern and eastern limits of the formation.

*Rude-bedding, as used in this report, is defined as bedding where the lithology change between beds is gradational over millimeters or centimeters. The bed contacts are, therefore, ill-defined and vague although the bedding may be prominent. This is in contrast to "fine", or sharply defined bedding, where the contacts between beds are very sharp or abrupt.

Clay occurs interstitially, in thin to thick beds of stratified or massive clay, and as clay intraclasts. At Forest Falls in Grady County, Cooke (1943, p. 92) reported most of the Chattahoochee Formation (Tampa of Cooke, 1943) as consisting of clay. Palygorskite and montmorillonite are the principal clay mineral components of the Chattahoochee formation, but kaolinite and illite occur in minor amounts (Gremillion, 1965, 1966; Weaver and Beck, 1977).

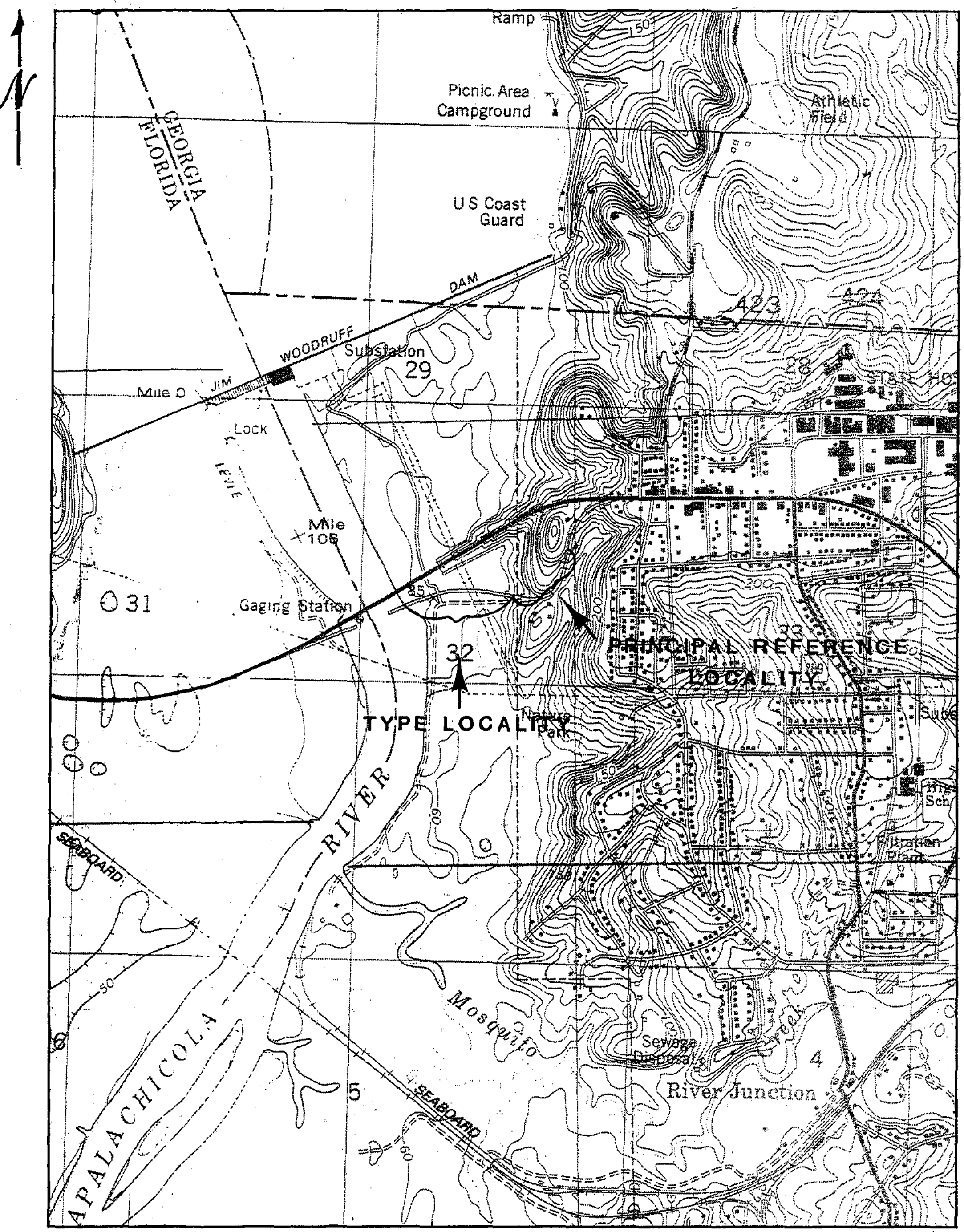
Chert occurs as nodules, concretions, and lenses within the dolostone, whereas mica, phosphate, and heavy minerals occur interstitially. Fossiliferous intervals are generally present but not common in the Chattahoochee Formation at any given site in Georgia. The frequency of occurrence of macrofossils in the Chattahoochee Formation in Georgia ranges from rare, scattered, fossil molds in the dolostone, to rich concentrations of fossil molds in scattered, thin to thick beds of dolostone. Most microfossils have been obliterated by dolomitization, but the benthic foraminifera *Sorites* and *Archaias* are locally common as molds and casts. The Chattahoochee Formation is more generally fossiliferous to the south in Florida where extensive faunal lists have been published from the type area (Dall and Stanley-Brown, 1894; Matson and Clapp, 1909; Mansfield, 1937; Cooke, 1945).

Characteristically, the Chattahoochee Formation is prominently bedded. Thickness of the beds is variable and ranges from thin to thick. The sediments within the beds are generally massive and devoid of primary sedimentary structures except for the intraclast beds, which are common and characteristic of the Chattahoochee Formation. The intraclasts variably consist of dolostone, limestone, or clay rubble (intraformational breccia or conglomerate) in matrices of dolostone, clay or sand. The intraclast beds range up to several feet (approximately 1 m) thick. Many are lenticular but there is some reason to think that a few intraclast beds may be widespread. The intraclasts typically range in size from granule-size to several centimeters (more than 1 inch) in diameter, and are characteristically angular although some are rounded.

Induration of the Chattahoochee Formation is variable. Typically the dolostone is lightly to moderately indurated, and forms resistant ledges in outcrop. Some dolostone, limestone, sand, or clay beds, however, are relatively unconsolidated, forming reentrants in outcrop.

Stratigraphic Relationships

The Chattahoochee Formation is restricted to that part of northern Florida that lies between the Choctawhatchee River in the west and the Suwannee River in the east, and to southwestern Georgia. In Georgia (Fig. 9), the western limit of the formation is the Pelham Escarpment where it occurs in outcrop between Chattahoochee, Florida, and the vicinity of Forest Falls in Grady County, Georgia. In the east it is found in sink-holes in southern Thomas and Brooks Counties, and in cores from eastern Thomas and western Brooks Counties. It is not present as far east as the Withlacoochee River in eastern Brooks County, where it appears to have graded into the Parachucla Formation. The Chattahoochee Formation occurs as far northeast as the vicinity of Moultrie in Colquitt County where it consists of sandy dolostone, dolomitic sand, and variably dolomitic clay. The Chattahoochee is not known to occur north and east of Colquitt County, and it is not known to occur in the Gulf Trough in Georgia. Available evidence indicates that the Chattahoochee Formation grades laterally eastward and northeast-



Base from U.S. Geological Survey
Chattahoochee, Ga.-Fla. 1:24,000, 1982

0 1/2 1 MILE

0 1/2 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 8. The type locality of the Chattahoochee Formation.

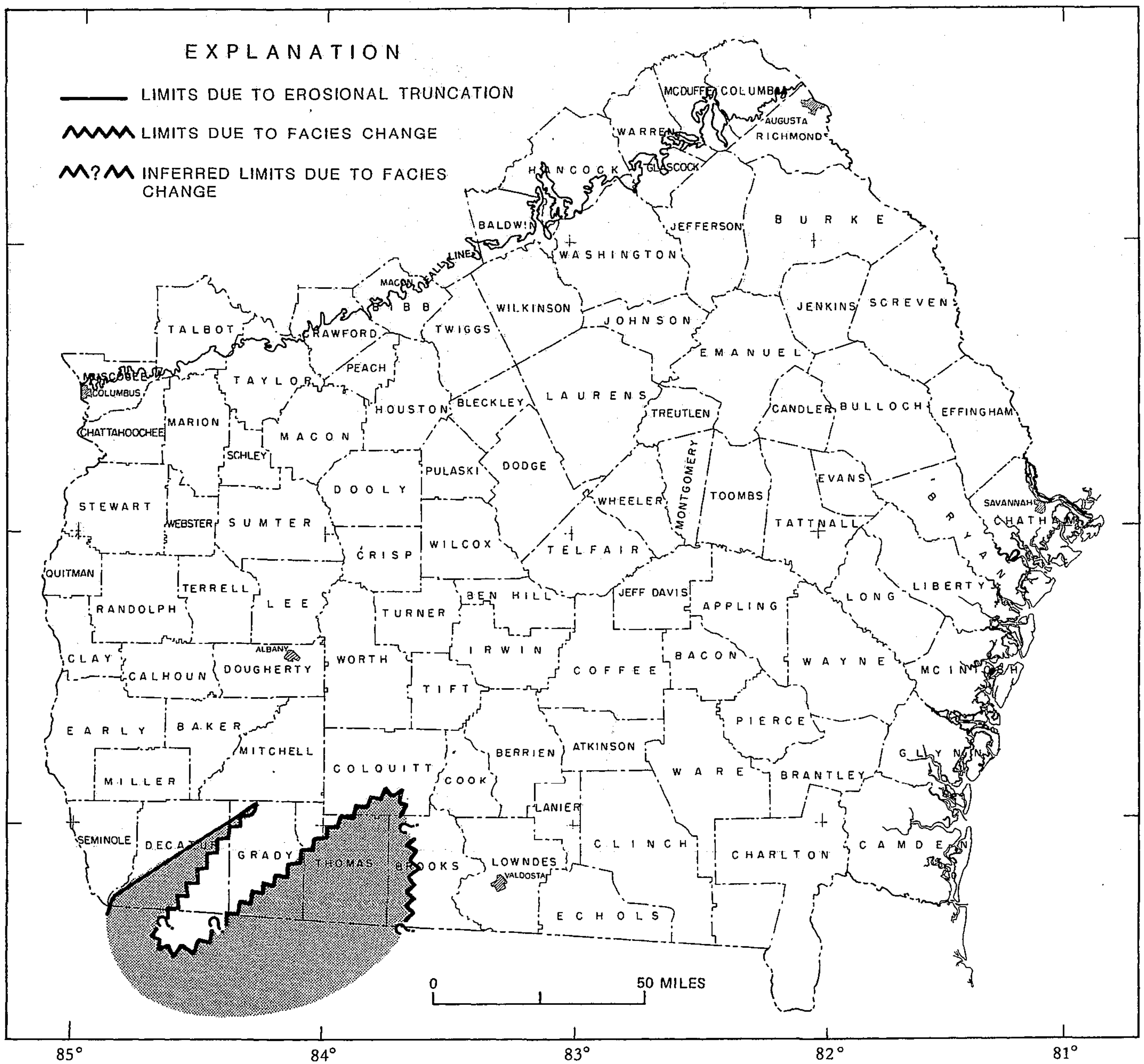


Figure 9. The areal distribution (outcrop and subcrop) of the Chattahoochee Formation in Georgia.

ward into fine sands, clays, dolostones and limestones of the Parachucla Formation (compare with Fortson and Navarre, 1959, p. 73-76; Herrick, 1961, p. 17-21; see Fig. 10).

The Chattahoochee Formation overlies the Suwannee Limestone east of the Gulf Trough, and Suwannee-equivalent limestone in and west of the Gulf Trough. In Georgia, the Parachucla Formation occupies the stratigraphic position of the Chattahoochee Formation within the Gulf Trough (Fig. 10). Generally the Chattahoochee Formation overlies the Oligocene units disconformably or paraconformably, but where the upper part of the Oligocene limestones have been dolomitized, the contact may be difficult to identify.

The Torreya Formation overlies the Chattahoochee Formation in Georgia. However, the nature of the upper contact of the Chattahoochee Formation in Georgia is not clear at this time. The conclusion of most authors has been that the Chattahoochee Formation (Tampa) (predominantly dolostone) is conformable with the Torreya Formation (Hawthorne of earlier authors) (predominantly sand and clay) (Cooke and Mossom, 1929; Cooke, 1943, 1945) although Mansfield (1937, p. 28) and Banks and Hunter (1973) regarded the contact disconformable at Chattahoochee. However, there is reputedly a considerable amount of fine sand and clay in the Chattahoochee Formation in Georgia (see Cooke, 1943, p. 87-89, 92). Because there are no known complete exposures of the Chattahoochee Formation in Georgia, and only one core (Colquitt 10, GGS-3544) shows the upper contact of the formation, it is not known, therefore, whether the upper part of the Chattahoochee Formation in Georgia consists generally of doloston, sand, or clay. The appearance of conformity between the Chattahoochee dolostones and "Hawthorne" sands or clays may be merely lithology change between dolostone and fine sand or clay within the Chattahoochee Formation. It is my observation, however, that in Florida, based on Florida Geological Survey cores, the dolostone of the Chattahoochee Formation extends to the top of the formation (as it does in the core Colquitt 10 [GGS-3544] in Colquitt County, Georgia), and the contact between the Chattahoochee and Torreya Formations is generally disconformable, and not conformable or gradational.

The Chattahoochee Formation is distinguished from the underlying Oligocene limestone in being finely sandy and argillaceous. The Oligocene limestones (or dolostones where locally dolomitized) are almost pure carbonates with no appreciable sand and clay. In addition, the Chattahoochee generally consists of dolostone whereas the Oligocene carbonates consist of limestone with local occurrences of dolostone at the top of the Series. The overlying Torreya Formation is distinguished from the Chattahoochee Formation in consisting of finely sandy limestone or noncalcareous argillaceous fine sand to finely sandy clay. Near the northern limits of its occurrence, the Chattahoochee Formation underlies noncalcareous and nondolomitic, variably siliceous, argillaceous fine sand and finely sandy clay of undifferentiated Hawthorne Group.

The Chattahoochee Formation grades laterally to the northeast, and on the flanks of the Gulf Trough, into the Parachucla Formation. The Parachucla Formation differs from the Chattahoochee Formation in generally being lithologically heterogeneous, consisting of finely sandy and variably argillaceous dolostones and limestones, and variably calcareous and dolomitic argillaceous sands and sandy clays. Locally the Parachucla Formation can consist predominantly of limestone, dolostone, or argillaceous sand, and the sand is generally calcareous and dolomitic to some degree.

The thickness distribution of the Chattahoochee Formation in Georgia is not known at this time because of insufficient outcrop and core control. Cooke (1943, p. 87, 88) reported 100 feet (30 m) of Tampa Limestone in Decatur County. Mansfield (1937, p. 31) reported at least 89.8 feet (27 m) of Chattahoochee Formation (Tampa) at the principal reference locality at Chattahoochee, Florida, and there is at least 90 feet (27 m) (also see Hendry and Yon, 1958, p. 28-33) of Chattahoochee Formation exposed at Jim Woodruff Dam at Chattahoochee. At Climax Cave in Decatur County, sandy dolostone of the Chattahoochee Formation is 24.5 feet (7.5 m) thick, but it not clear whether the overlying sandy clay is a part of the Chattahoochee Formation or Torreya Formation. The Chattahoochee is in excess of 50 feet (15 m) thick in a number of cores in Thomas and Brooks Counties, and is 42 feet (13 m) thick in the core Colquitt 10 (GGS-3544) in Colquitt County. If there are significantly thick beds of sand and clay in the Chattahoochee Formation in Georgia, and there is evidence that there are, then the formation probably ranges from 50 feet (15 m) to 100 feet (30 m) thick.

The Chattahoochee Formation was deposited on the inner continental shelf in an open-marine environment. Based on the macrofossil lists of Matson and Clapp (1909) and Mansfield (1937), it appears that the preserved molluscan fauna of the Chattahoochee Formation in its type area is of moderate to low diversity. The foraminiferal fauna, where one can be extracted from scattered calcareous beds, is characterized by low diversity and high faunal dominance by a few species. In addition, the common occurrence of the foraminifera *Sorities* sp., *Archaias* sp., and other peneroplids indicates shallow-water, well-aerated, clear, tropical to subtropical conditions with a climate probably similar to that of southern Florida today.

The prevalence of intraclast beds within the Chattahoochee Formation would suggest sporadically high-energy conditions, consistent with paleontological evidence for a shallow-water environment. However, the absence of mudcracks and ripple marks indicates that water-depth was not extremely shallow or intertidal. The gradational contacts between beds and the lack of well-defined thin bedding and lamination suggests good mixing and homogenization of the sediments due to infaunal bioturbation (except for the intraclast beds).

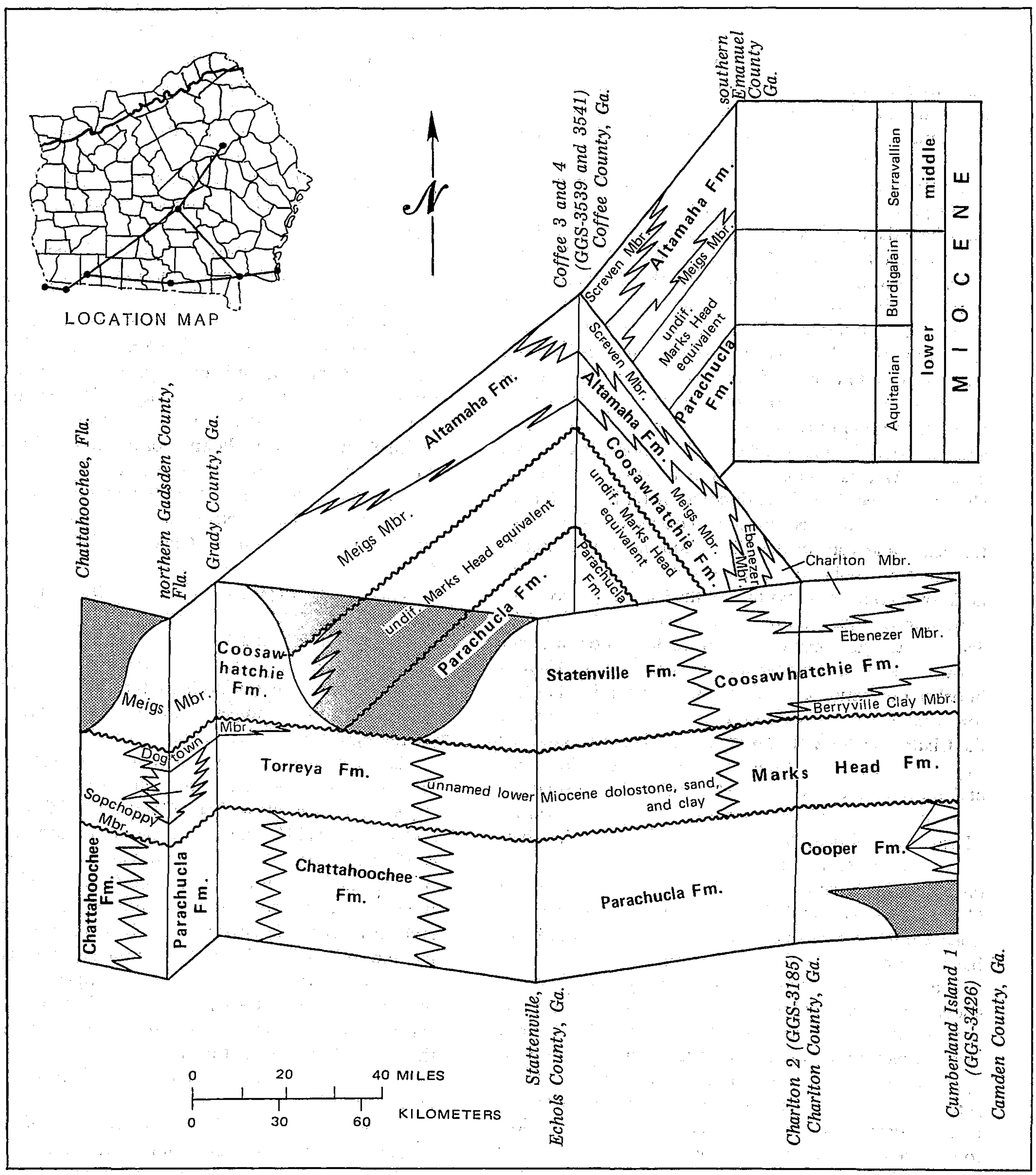


Figure 10. Fence diagram showing stratigraphic relationships of the Miocene deposits of southern and western Georgia.

Age

The Chattahoochee Formation and the Tampa Limestone of Florida have somewhat similar molluscan faunas; therefore, the two formations have traditionally been correlated. The Tampa Limestone is generally more fossiliferous than the Chattahoochee Formation. As a result, there have been many paleontological investigations on the Tampa Limestone (Heilprin, 1887; Dall, 1890-1903, 1892, 1898, 1915; Mansfield, 1937) and no paleontological investigations exclusively devoted to the Chattahoochee Formation. Consequently, the assigned age of the Chattahoochee Formation has varied with the assigned age of the Tampa Limestone. The age of the Chattahoochee Formation has generally been believed to be early Miocene (Dall and Harris, 1892; Dall and Stanley-Brown, 1894; Cooke and Mossom, 1929; Mansfield, 1937; Cooke, 1943, 1945; Puri, 1953; Puri and Vernon, 1964) except for the period 1896-1929 when it was believed to be Oligocene in age (Dall, 1896, 1915; Maury, 1902; Matson and Clapp, 1909; Veatch and Stephenson, 1911; Sellards, 1917; Sellards and Gunter, 1918).

It has recently been suggested (Butler, 1963; Poag, 1972), based on comparisons of ostracode faunas between the Chickasawhay Formation of Alabama and Mississippi, and the Chattahoochee Formation of western Florida, that the Chattahoochee Formation is late Oligocene and equivalent to the Chickasawhay Formation. The presence of the foraminiferal genera *Discorinopsis* and *Valvulina*, two taxa not previously known to occur above the Oligocene in the southeastern United States, supports an Oligocene age assignment for the Chattahoochee (Huddlestun, 1984). Physical correlation and lithology suggests, however, that the Chattahoochee Formation is a part of the lower Miocene. The Chattahoochee Formation occurs in the same stratigraphic position as the Aquitanian Parachucla Formation (Figs. 10 and 11) and grades eastward and northeastward into the Parachucla. The Chattahoochee Formation is sandy and argillaceous, as are all of the Miocene deposits in Georgia; it contains palygorskite; and it is sparsely phosphatic, which is an attribute of the Miocene deposits and not of the Oligocene deposits of southwestern Georgia.

The Chattahoochee Formation does not contain planktonic foraminifera, and other planktonic microfossils have not been reported. Therefore, the age of the formation cannot yet be assigned on purely *in situ* paleontological grounds. The presence of benthic faunas best known in the Oligocene is real but can be interpreted as an extension of the ranges of some Oligocene taxa of benthic microfossils. In the case of the Oligocene ostracodes in the Chattahoochee (Butler, 1963; Poag, 1972), the Miocene deposits overlying the Chickasawhay and Paynes Hammock Formations in Mississippi and western and central Alabama are noncalcareous and do not contain calcareous microfossils. Therefore, the taxa and ranges of the calcareous microfossils in the lower Miocene in that area are unknown, but it would be expected that that basal Miocene, Aquitanian faunas would have many taxa in common with the underlying upper Oligocene.

The age of the Chattahooche Formation, as suggested in this report, is based on its physical correlation with the Parachucla Formation in the Gulf Trough, and with the Parachucla Formation of eastern Georgia. On this basis, the Chattahoochee Formation is early Miocene (Aquitanian) in age, and is probably correlative with planktonic foraminiferal Zones N4 and N5 of Blow (1969) (Pl. 1).

HAWTHORNE GROUP

Definition

It is herein proposed that the name Hawthorne be raised to group rank. The Hawthorne Group of this report includes all deposits previously called Hawthorne Formation in Georgia (Cooke, 1936, 1943; MacNeil, 1947a, 1947b; Fortson and Navarre, 1959; Owen, 1963; Counts and Donsky, 1963; Gremillion, 1965; Brooks and others, 1966; Furlow, 1969; Patterson and Buie, 1974; Georgia Geological Survey, 1976; Weaver and Beck, 1977) exclusive of those strata now included in the Altamaha Formation. Other names that have been used for all or parts of the Hawthorne Group in Georgia in the past, but are no longer applicable or useful, include Combahee (Sloan, 1908), Alum Bluff Formation (Veatch and Stephenson, 1911; Brantly, 1916; Shearer, 1917; Teas, 1921), Alum Bluff Group (Sever, 1966a, 1966b; Zimmermann, 1977), Duplin Marl of Counts and Donsky (1963) and Furlow (1969), Chipola Formation of MacNeil (1947a, 1947b), Miocene (undifferentiated) (Applin and Applin, 1964; Sever, 1972), and Neogene undifferentiated (Georgia Geological Survey, 1976).

The name Hawthorne was first applied in an informal lithostratigraphic sense as "Hawthorne beds" by Dall (1892, p. 107-111) for phosphatic deposits being mined near Hawthorne, Alachua County, Florida. Matson and Clapp (1909, p. 69-74) raised the unit to formation rank. Vaughan and Cooke (1915, p. 250-253) abandoned the Hawthorne Formation in favor of the Alum Bluff Formation because the Hawthorne deposits at White Springs on the Suwannee River in Hamilton and Columbia Counties, Florida, were more reminiscent of the Alum Bluff Formation of western Florida, which at that time was a better known stratigraphic unit than the Hawthorne. Cooke and Mossom (1929, p. 115-137) reintroduced the unit as the Hawthorne Formation of the Alum Bluff Group because the "Alum Bluff has since been raised to the rank of group, and as the Hawthorn formation differs from other formations in the group, it is now possible to restore the name Hawthorn formation to good standing." The Hawthorne Formation was formally extended into Georgia by Cooke (1936, 1943) but without mention of it being part of the Alum Bluff Group. The concept of the Hawthorne as a formation of the Alum Bluff Group, or of undifferentiated Alum Bluff Group in Georgia,

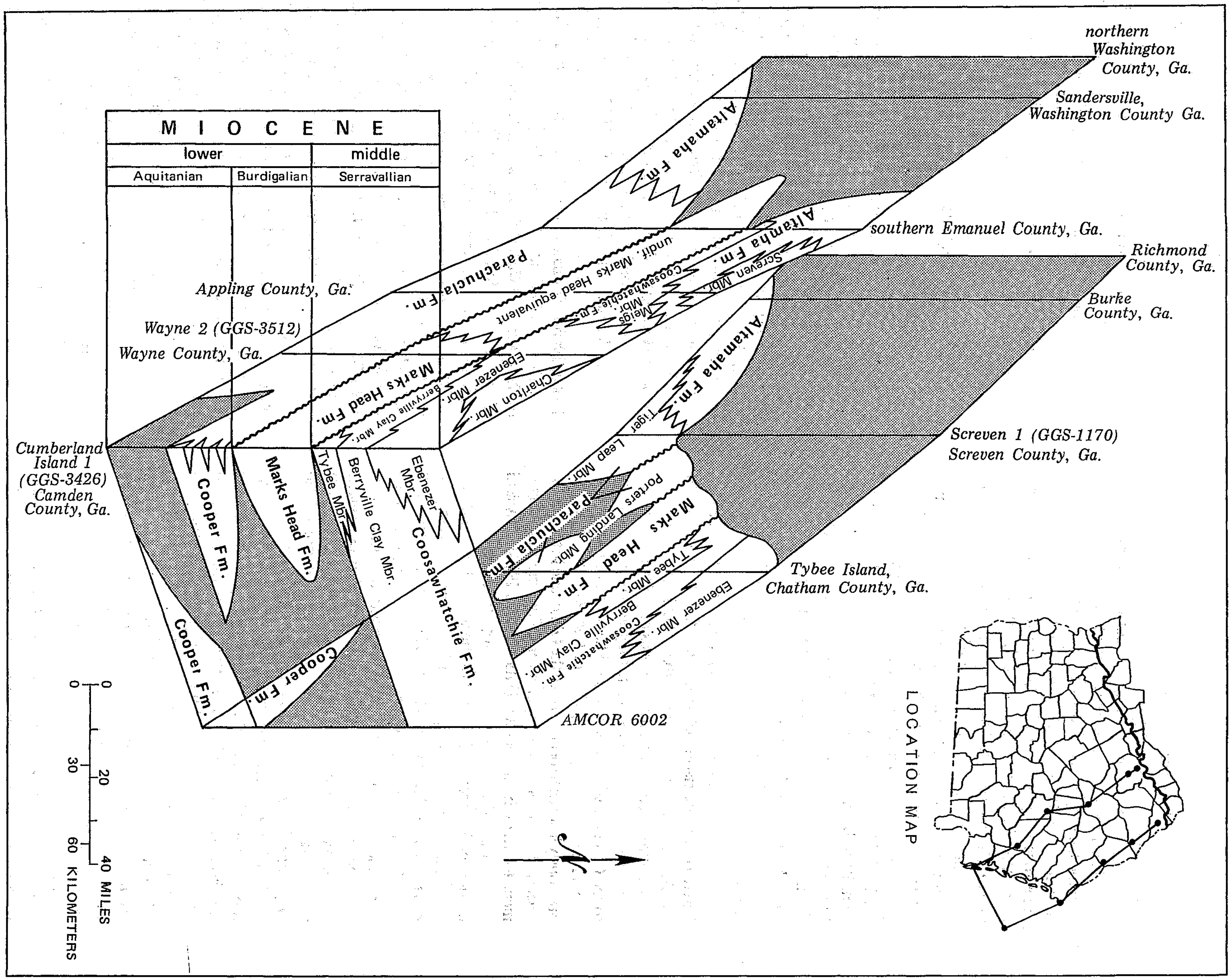


Figure 11. Fence diagram showing stratigraphic relationships of the Miocene deposits of eastern Georgia.

was applied by MacNeil (1947a, 1947b), Sever (1966a, 1966b), and Zimmerman (1977). The Alum Bluff Group, however, has not been generally adopted in Georgia for lithologic reasons and because of ambiguity in the definitions and usage of the name Alum Bluff (Gardner, 1926; Cooke and Mossom, 1929; Cook, 1943; Puri, 1953; Puri and Vernon, 1964).

I propose raising the Hawthorne to group rank in Georgia because the specific lithostratigraphic unit, or units, that constitute the type Hawthorne in Alachua County, Florida, are not present in Georgia. To restrict the name Hawthorne to the type lithostratigraphic unit would necessitate adopting another group name to apply to the various formations that had in the past been called Hawthorne Formation, and would result in more changes in stratigraphic terminology than are necessary. Therefore, retention of the name Hawthorne for this group serves to stabilize the stratigraphic nomenclature of the region.

Several lithologic parameters serve to distinguish the sediments of the Hawthorne Group. (1) Argillaceous sand and clay, rarely pure sand, are the dominant lithologies of the Hawthorne Group in Georgia. (2) Dolomite is the characteristic carbonate mineral of the Hawthorne; calcite is less common but locally dominant. (3) Generally, the Hawthorne is lacking in macrofossils. Locally there are casts and molds of macrofossils, but only rarely are calcareous macrofossils or microfossils preserved. (4) Most Hawthorne deposits are phosphatic, but the phosphate content declines in a westward direction, away from the Atlantic Ocean. Glauconite, on the other hand, is not known to occur in the Hawthorne. (5) The clays of the Hawthorne commonly contain an appreciable component of, and in places are dominated by, the magnesium-rich clay minerals, palygorskite and sepiolite. (6) Chert, siliceous claystone (opal-cristobalite), and diatomaceous sediments are locally common and conspicuous in Hawthorne Group deposits. Finally, (7) Hawthorne Group deposits are of marine, relatively shallow water, continental shelf origin that, in Georgia, grade laterally updip into fluvial deposits that are not Hawthorne. Neither sandy beach type deposits nor fluvial deposits occur within the mass of sediments included in the Hawthorne Group.

The Hawthorne Group is distinguished from the equivalent and adjacent Alum Bluff Group of western Florida (see Huddlestun, 1984) in four ways. (1) The Alum Bluff Group is never dolomitic, but is commonly calcareous and macro- and microfossiliferous. Shell beds formed of fossil shells consisting of original aragonitic shell material are a characteristic feature of the Alum Bluff Group. (2) Phosphate occurrence in the Alum Bluff Group is very minor and localized; whereas glauconite occurrence is scattered. (3) Alum Bluff clays are not known to contain palygorskite or sepiolite (Weaver and Beck, 1977). (4) Chert, siliceous claystone (opal-cristobalite), and diatomaceous sediments are not known to occur in Alum Bluff deposits.

The Hawthorne Group in Georgia and under the continental shelf of Georgia is divisible into five formally named formations with nine formally named members, and one unnamed formation. The formally recognized formations that constitute the Hawthorne Group are the Parachucla Formation with the Tiger Leap and Porters Landing Members, the Marks Head Formation, the Torreya Formation with the Dogtown and Sopchoppy Members, the Coosawhatchie Formation with the Tybee, Berryville, Ebenezer, Charlton and Meigs Members, and the Statenville Formation. The unnamed formation is a lower Miocene dolostone, clay and sand of south-central Georgia and northern peninsular Florida.

Type Section

The name Hawthorne was derived from the town of Hawthorne in Alachua County, Florida, approximately 15 miles (24 km) east of Gainesville, Florida. Dall (1892, p. 107-111) first used the name Hawthorne in a lithostratigraphic sense and referred to it as "Hawthorne beds". He did not explicitly designate a type locality for the unit, but stated that the Hawthorne beds were "being quarried and ground up as a fertilizer at Hawthorne, where the beds have a considerable thickness. For this reason I referred to these beds in my unpublished report as the 'Hawthorne beds', and to the chief facts of their occurrence in a paper read before the National Academy of Sciences in 1887. This name will, therefore, be adopted here for convenience in reference to the beds about to be described" (Dall, 1892, p. 108).

Matson and Clapp (1909, p. 69-74) accepted the concept of the Hawthorne stratigraphic unit of Dall (1892) and raised the rank of the Hawthorne beds to that of Hawthorne Formation. They also considered the pits at Hawthorne to be the type locality of the formation. Matson and Clapp (1909, p. 71) observed that "at the type locality near Hawthorne the rock is phosphatic and has been mined and crushed for use as a fertilizer." Most subsequent authors accepted the phosphate pits at Hawthorne as the type locality of the unit. Cooke and Mossom (1929, p. 130) later commented that "Old pits in phosphatic limestone about 3 miles west of Hawthorn and about 2 miles from Grove Park may be considered the type locality of the Hawthorn formation. They were opened in 1879 by Dr. C.A. Simmons of Hawthorn, who ground the material and used it as fertilizer. When visited by Cooke in 1913 the pits were so thickly overgrown that little could be seen except a few loose lumps of phosphatic limestone." In addition, E.C. Pirkle (1956, p. 200) noted, "At the time of Dall's visit, phosphatic rocks were being quarried near the town of Hawthorne in the old C.A. Simmon's pits. As these pits are the only ones in that area from which phosphatic rock has been quarried and ground up as a fertilizer, they must be the ones referred to by Dall. The pits are located between the towns of Grove Park and Hawthorne, about 1½ miles south of State Road 20 in the eastern part of Section 31, T. 10 S., R. 22 E..... " Pirkle (1956, p. 202) likewise accepted the Simmons pits as the type locality of the Hawthorne.

Puri and Vernon (1964, p. 146), however, presented a different opinion concerning the type locality of the Hawthorne. They apparently interpreted Dall's expression, "adopted here for convenience in reference to the beds about to be described" (Dall, 1892, p. 108), as indicating that Dall had little or no opinion as to a type locality, and had no clear intention of designating a type locality for the Hawthorne. They, therefore, saw no reason to consider the C.A. Simmons phosphate pits as the type locality. Instead, they believed that the sections drawn by Johnson and published in Dall (1892, p, 108-109), because they were included in the discussion by Dall, were, in fact, the type localities. Puri and Vernon (1964, p. 146) concluded, therefore, "The later workers have generally ignored this [above] statement by Dall and have referred to the section at Hawthorne which was not even described by Dall and which does not even exist today as the type locality. The type sections really are the ones measured by Johnson and reproduced by Dall. The section at Devil's Mill Hopper and Brooks Sink are closest to the type area and should form the basis of later correlation." Puri and Vernon (1964, p. 146) went on to refer to the exposures at Brooks Sink in Bradford County, Florida, as a "cotype locality".

Because (1) W.H. Dall neither designated nor referred to type localities in general (one, therefore, must conclude that type localities or type sections were not a part of Dall's concept of stratigraphy), (2) type localities or type sections at the time of Dall's writing were rarely mentioned in the geologic literature, and (3) no stratigraphic code existed at the time to offer guidelines in establishing stratigraphic units, the modern codes of stratigrapic nomenclature (American Commission on Stratigraphic Nomenclature, 1961, 1970; International Subcommission on Stratigraphic Classification, 1972, 1976; North American Commission on Stratigraphic Nomenclature, 1983), therefore, can not be applied rigorously to Dall (1892) or to his contemporaries. In my estimation, in applying the name "Hawthorne beds" to a deposit with consistent lithology in a consistent stratigraphic position in northern Florida, Dall (1892) showed sufficient intent of naming a stratigraphic unit. In specifically citing the pits near Hawthorne (C.A. Simmons' phosphate pits) where the deposit was being mined for fertilizer, and in naming the unit after the town of Hawthorne, Dall (1892) showed sufficient intent to "designate" a type or reference locality. Other subsequent authors concurred in this evaluation (Matson and Clapp, 1909; Cooke and Mossom, 1929; Pirkle, 1956).

Based on this interpretation, the C.A. Simmons phosphate pits must be considered the type locality and stratotype of the Hawthorne Group (Fig. 12). There are no longer any exposures at the type locality, and there have not been any for many years. However, it is incorrect to conclude that an original stratotype must be accessible to be valid. According to the various codes of stratigraphic nomenclature (American Commission on Stratigraphic Nomenclature, 1961, Art. 13h; 1970, Art. 13h; North American Subcommission on Stratigraphic Nomenclature, 1983, Art. 22c), type sections, once designated (in this case, accepted), must not be changed, even though the type section is no longer accessible. In addition, there can be only one type section (or type locality) (American Commission on Stratigraphic Nomenclature, 1961, Art. 13h; 1970, Art. 13h; North American Commission on Stratigraphic Nomenclature, 1983, Art. 22c), and, therefore, the concept of a "cotype locality" is not valid.

Because there have been no exposures at the type locality of the Hawthorne for many years, I propose that the Florida Geological Survey core Hawthorne 1 (W-11486) serve as the neostratotype (principal reference section) for the Hawthorne Group. The core Hawthorne 1 (W-11486) was taken at the type locality of the Hawthorne (after Pirkle, 1956, p. 200) in SW¼, NE¼, Sec. 31, T10S, R22E in Alachua County, Florida. The Hawthorne Group occurs in the interval 4.5 feet to 135 feet in the reference core.

Sections of the Hawthorne discussed by Dall (1892) that are still locatable and, therefore, may serve as parastratotypes (supplementary stratotypes used in the original definition by the original author to aid in elucidating the holostratotype) include the section exposed in Devil's Millhopper near Gainesville, Florida, and the section of the Hawthorne exposed on the Suwannee River at White Springs in Columbia and Hamilton Counties, Florida. Other Hawthorne sections mentioned or described by Dall (1892) are either covered now or the directions to the sites are too vague for the sections to be located with certainty.

Other reference sections have been promoted by workers over the years. The two most commonly cited are the exposures of the Hawthorne in the lime sinks called Devil's Millhopper at Gainesville and Brooks Sink in Bradford County. Pirkle and others (1965, p. 10-14) and Scott (1982, p. 137-146) referred to Devil's Millhopper as a "cotype locality". As noted above, the concept of a "cotype locality" has no validity in North American stratigraphic terminology. However, Devil's Millhopper was cited by Dall (1892, p. 108) and, therefore, can be considered a parastratotype and reference locality for the Hawthorne Group. In addition, the Florida Geological Survey core Milhopper 1 (W-14641), taken at Devil's Millhopper and designated a "cotype" core (Scott, 1982), is proposed herein as a reference section and hypostratotype (a stratotype designated to extend knowledge of the unit to other geological areas or to other facies; also called a reference section) of the Hawthorne Group.

The section exposed at Brooks Sink in Bradford County, Florida, although evidently known to the early authors (Sellards, 1909, p. 240), was not generally cited until the description of the exposure by Pirkle (1956, p. 207-215). Later, Puri and Vernon (1964, p. 146-148), Pirkle and others

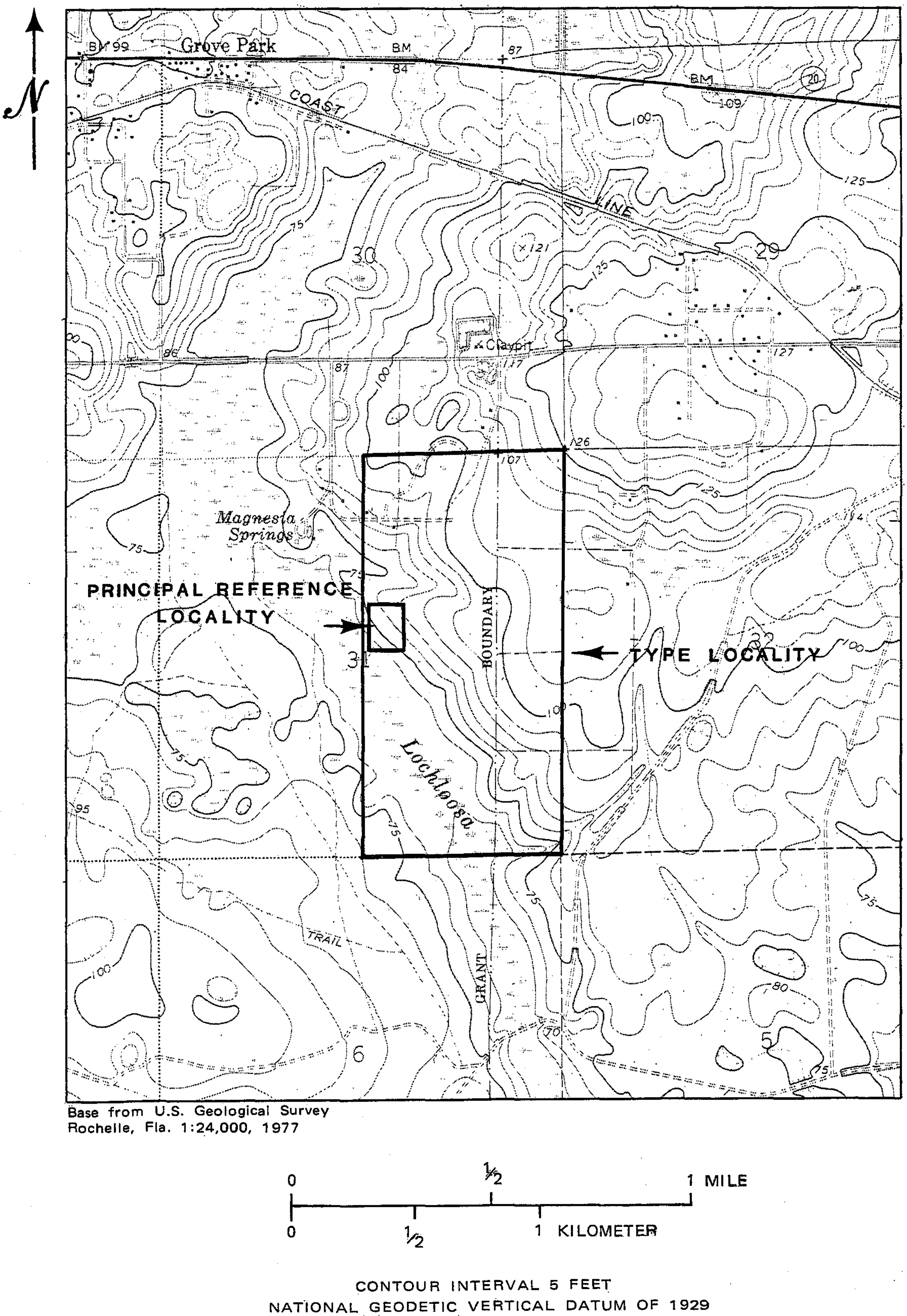


Figure 12. The type locality of the Hawthorne Group.

(1965, p. 15-19), and Scott (1982, p. 137-146) referred to Brooks Sink as a "cotype locality". It is proposed herein that the Brooks Sink section of the Hawthorne, and the core Varnes 1 (W-14280), taken near Brooks Sink (Scott, 1982), also serve as reference localities and hypostratotypes of the Hawthorne Groups.

All of these various sections of the Hawthorne Group in Alachua and Bradford Counties, Florida, are not lithologically representative of the Hawthorne Group in Georgia. However, exposures in the bluffs along the Savannah River from Tiger Leap Bluff in Screven County, to Old Wood Landing in central Effingham County, are lithologically representative of the eastern Georgia Hawthorne Group. Therefore, it is proposed herein that those sections of the Hawthorne Group exposed along the Savannah River in Georgia serve as a composite hypostratotype of the group for eastern Georgia (Fig. 3).

Lithology

The lithology of the Hawthorne Group is dominantly sand and clay. Subordinate lithic components of the Hawthorne Group include dolomite; dolostone; calcite; limestone; phosphorite; phosphate; silica in the forms of claystone (opal-cristobalite), chert, and siliceous microfossils; feldspar; heavy minerals; carbonaceous material and lignite; zeolites; and fossils. Locally, or in beds and lenses, dolostone, limestone, phosphorite, clay, or claystone constitute the dominant lithologies.

The quartz sand component of the Hawthorne Group generally dominates the clay component, but beds or lenses of relatively pure sand are rare in the Hawthorne Group. The sand of the Hawthorne is most commonly fine-grained and well-sorted.

The Hawthorne Group is characteristically argillaceous (see Weaver and Beck, 1977), and the clay occurs in all proportions to the sand. Beds and lenses of clay and sandy clay are common in the Hawthorne, and two members, the Dogtown Clay and Berryville Clay Members, consist principally of clay. Most commonly, however, the clay is interstitial to the sand, and the lithology of the sediment ranges from slightly argillaceous sand to sandy clay. The clay mineral suite of the Hawthorne Group consists of smectite (montmorillonite), illite, palygorskite, sepiolite, and kaolinite (Gremillion, 1965; Weaver and Beck, 1977; Hetrick and Friddell, 1984).

The carbonate content of the Hawthorne Group is variable (also see Weaver and Beck, 1977), being absent in some units and in some sections, and dominating the lithologies of some units in other sections. The most widely occurring and characteristic carbonate mineral of the Hawthorne Group in Georgia is dolomite. Calcite, although locally conspicuous and prominent, is not generally common in the Hawthorne Group in Georgia. Calcite constitutes the greatest proportion of the carbonate in the Hawthorne Group in the Savannah River area and in the continental shelf area. It is characteristic of the Tiger Leap Member of the Parachucla Formation and of the Torreya Formation, and it is locally prominent in the Porters Landing member of the Parachucla Formation and in the Charlton Member of the Coosawhatchie Formation. In all other units and in all other areas in Georgia, dolomite is the characteristic carbonate mineral of the Hawthorne Group.

The carbonate content of the Hawthorne Group generally increases southward across Georgia into Florida, where it is conspicuous in most subdivisions of the Hawthorne. The carbonate content of the Hawthorne also appears to increase seaward in Georgia, but this increase is not as noticeable as the increase in a southward direction. In addition, the dolomite content and proportion generally increase southward (with the exception of the Torreya Formation), and the calcite content tends to increase seaward so that the dolomite content is minor or absent on the continental shelf.

Phosphate is one of the most characteristic lithic components of the Hawthorne Group (also see Weaver and Beck, 1977), and the phosphate content of the group stands in sharp contrast to the nonphosphatic underlying, overlying, and adjacent formations and groups. The phosphate content of the Hawthorne Group is highest in the coastal area of Georgia and on the eastern margins of the Florida Platform. In general, the phosphate content decreases westward and upsection. It is very low or absent in southwestern Georgia and in the upper part of the Hawthorne in the central Georgia Coastal Plain. All of the known phosphate in Georgia consists of small, rounded, black, brown, amber, gray to buff grains or pellets of apatite. There are no known occurrences of hard rock phosphate or pebble phosphate in Georgia.

Siliceous sediments are also characteristic of the Hawthorne Group. Silica is most common in the form of siliceous claystone (opal-cristobalite) and siliceous microfossil-rich (diatoms, radiolarians, and silicoflagellates) sediments. Chert also occurs but is less common, and petrified wood occurs locally and rarely.

Stratigraphic Relationships

The Hawthorne Group underlies perhaps three-quarters of the Coastal Plain of Georgia and is, therefore, one of the most widespread lithostratigraphic units in the state. The western limit of the Hawthorne Group in southwestern Georgia is the Pelham Escarpment (Fig. 13). Farther north, the western limit approximates the Ocmulgee River although Hawthorne outliers occur west of the Ocmulgee River as far north as the vicinity of Hawkinsville in Pulaski County. Its northern limit in the subsurface approximates a trend eastward across Laurens County, central Emanuel County, and Screven County. The northern limit of the Hawthorne Group in Georgia represents a broad and ambiguous zone of facies change, in the subsurface, into the marginal marine to nonmarine Altamaha Formation. The Hawthorne Group extends northward into South Carolina and southward into

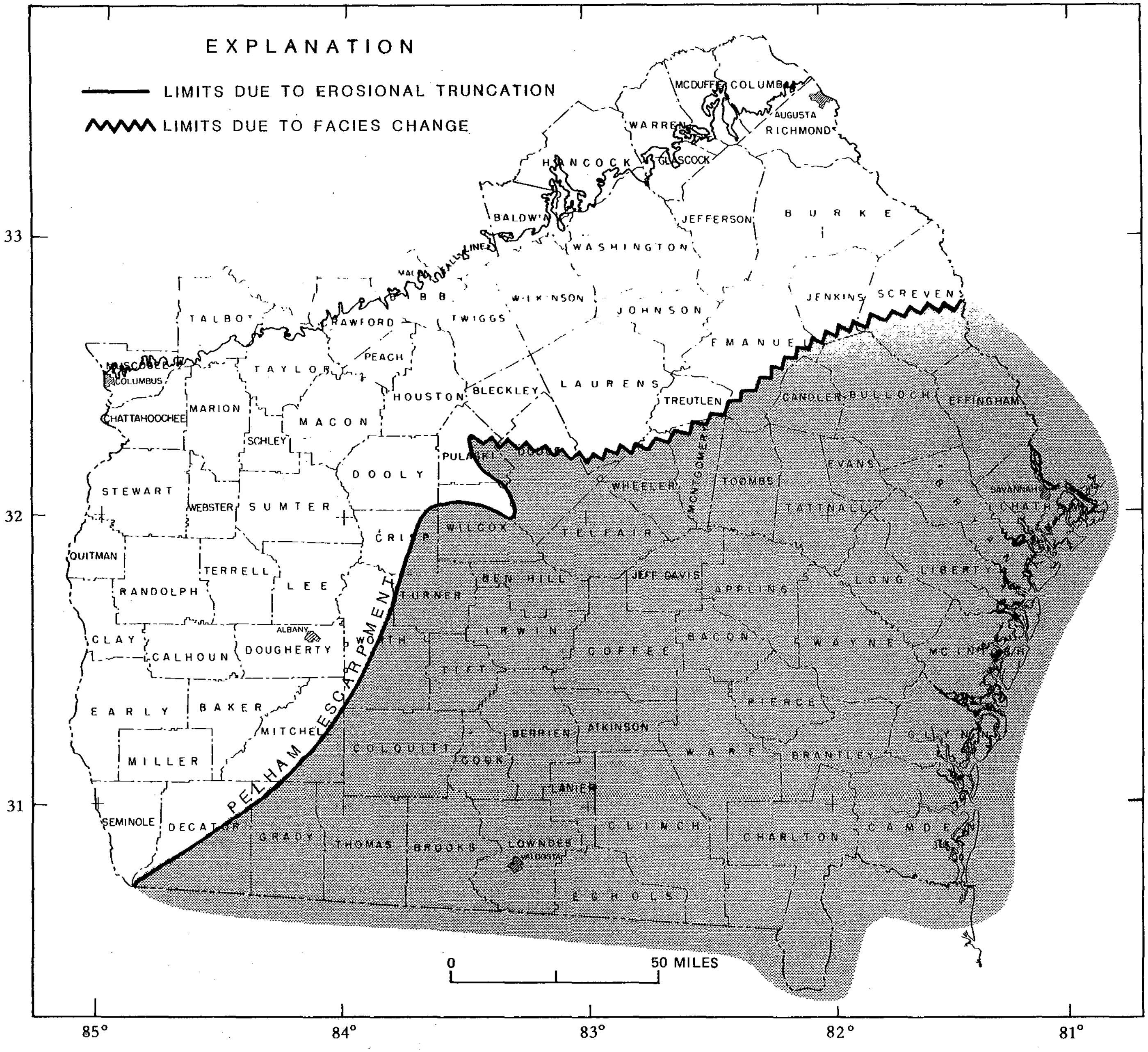


Figure 13. The areal distribution (outcrop and subcrop) of the Hawthorne Group in Georgia.

the eastern panhandle and peninsula of Florida, and it underlies the continental shelf of Georgia.

In most places, the Hawthorne Group overlies the Suwannee Limestone disconformably in Georgia. In southwestern Georgia, however, the Hawthorne Group paraconformably overlies the Chattahoochee Formation (Fig. 10) and in the region north of the occurrence of the Chattahoochee Formation, and west of the Gulf Trough, the Hawthorne Group disconformably overlies an unnamed, Suwannee-equivalent limestone. In Camden and parts of Glynn and Charlton Counties in the southeastern corner of the state, the Hawthorne Group disconformably overlies the Ocala Group. In Chatham County, the Hawthorne Group disconformably overlies a sandy stratigraphic equivalent of the Suwannee Limestone (Pl. 2), the Lazaretto Creek formation (Huddlestun, in review). On the continental shelf, the Hawthorne Group disconformably overlies the Cooper Formation.

The Hawthorne Group is overlain by several formations in Georgia (Pl. 1). Throughout most of its area of occurrence in Georgia, the Hawthorne Group is comformably overlain by the Altamaha Formation (Figs. 10 and 11). In the coastal area of eastern Georgia it is variously overlain disconformably by the Raysor Formation, Raysor-equivalent sand, Cypresshead Formation, or Satilla Formation. In southwestern Georgia, the Hawthorne Group is disconformably overlain by the Miccosukee Formation.

The Suwannee Limestone and other Oligocene carbonates are distinguished from the Hawthorne Group in consisting of relatively clastic-free, variably fossiliferous limestone and, less commonly, clastic-free dolostone whereas the Hawthorne Group consists of predominantly argillaceous sand and sandy clay. Where the basal Hawthorne consists predominantly of limestone and dolostone, the Hawthorne carbonates are sandy and variably argillaceous with some interbedded sand or clay. In southwestern Georgia, the Hawthorne is distinguished from the Chattahoochee Formation in consisting largely of finely sandy and variably argillaceous limestone, and argillaceous fine sand and finely sandy clay whereas the Chattahoochee Formation consists of finely sandy dolostone. Under the continental shelf of eastern Georgia, the Hawthorne Group is distinguished from the underlying Cooper Formation in consisting of variably calcareous clay whereas the Cooper Formation consists of massive and structureless, microfossiliferous, argillaceous, finely calcarenitic limestone.

The Hawthorne Group grades laterally updip or landward (and locally upsection) into the Altamaha Formation. The Altamaha Formation consists of variably siliceous, kaolinitic clays and kaolinitic claystones and argillaceous, pebbly, feldspathic, poorly sorted sands and sandstones that are devoid of phosphates, carbonates, high-magnesium clays, and fossils. The Hawthorne deposits, on the other hand, generally consist of variably phosphatic, variably dolomitic or calcareous, sporadically siliceous, fossiliferous to nonfossiliferous, argillaceous, well-sorted sand with variably magnesium-rich clays.

In southwestern Georgia and in eastern Georgia, the Hawthorne Group is overlain by the Miccosukee Formation and Cypresshead Formation respectively. The Miccosukee and Cypresshead Formations have similar lithologies and can be characterized as generally being nonphosphatic, noncalcareous, fine-grained sand with thin clay beds and laminae, and local occurrences of prominently crossbedded, medium-to coarse-grained, pebbly sand. The sand beds of the Miccosukee and Cypresshead are typically deficient in clay whereas the sand beds in the Hawthorne typically contain significant quantities of interstitial clay.

Locally in eastern Georgia, the Raysor Formation and Raysor-equivalent sand overlies Hawthorne Group deposits. The Raysor Formation is a variably fossiliferous and shelly, argillaceous, very calcareous fine sand to finely sandy limestone and the Raysor-equivalent sand is a fossiliferous, shelly, calcareous sand. Where the Satilla Formation directly overlies the Hawthorne Group, the Satilla consists of argillaceous fine sands with scattered occurrences of shells and other fossils, sandy clay, and clay beds with local occurrences of fossil oysters *(Crassostrea virginica)*. None of the above Plio-Pleistocene formations contain appreciable phosphate, dolomite, or magnesium-rich clay minerals.

The thickness distribution of the Hawthorne has been described by Weaver and Beck (1977). The greatest thicknesses of the Hawthorne Group in Georgia are found in the Southeast Georgia Embayment and in the Gulf Trough. It is thinnest on the crests of relatively stable or positive features such as the Florida Platform in southern Georgia and the Beaufort Arch in eastern Georgia. The average thickness of the Hawthorne Group in the Southeast Georgia Embayment is approximately 600 feet (183 m). In the Gulf Trough, however, the thickness distribution of the Group is variable, ranging from more than 700 feet (213 m) to as little as 200 feet (61 m). Part of this variation results from a real difference in the thickness of the Miocene deposits. In the southwestern part of the state, however, the Hawthorne Group is thinner because the lower and thickest part of the group grades laterally into the Chattahoochee Formation, which has never been considered to be a part of the Hawthorne Group. Elsewhere in Georgia, the Hawthorne Group is considerably thinner. In the Savannah River area, the thickness of the Hawthorne Group ranges from 0 feet in northern Screven County where it pinches out, to 215 feet (66 m) in southern Effingham County in the Ridgeland trough, to less than 65 feet (20 m) in coastal Chatham County on the Beaufort arch.

The environment of deposition of the Hawthorne Group was marine, continental shelf. The water-depth of Hawthorne deposits ranged from near sealevel with brackish-water faunas (based on the local abundance of the foraminifera *Ammonia beccarii, Elphidium* spp. and *Buliminella elegantissima*), to at least middle neritic with diverse, open-marine faunas (including relatively abundant and diverse planktonic foraminifera). The environment of the continental shelf water-mass was unique for the Georgia-Florida region during Miocene and early Pliocene time in that phosphates, magnesium-rich clays, and dolomitic sediments are characteristic of, and siliceous microfossils and siliceous sediments are locally abundant in, Hawthorne deposits.

The coastal configuration during the deposition of the Hawthorne Group was apparently different than it was during much of the Tertiary in Georgia. Sandy coastal/beach-type deposits (lithologically and genetically similar to Barnwell and Citronelle-Miccosukee-Cypresshead-type deposits) are absent in the Hawthorne Group. Because of the high clay content of the Hawthorne Group and the equivalent Altamaha Formation, it is probable that the coastal area was muddy and swampy and without well-defined barrier island systems.

Age

The time span of the Hawthorne Group in Georgia is from earliest Miocene (early Aquitanian Stage) through the early Pliocene (Zanclean Stage) (Pl. 1). Those stages identified in Georgia include the Aquitanian, Burdigalian, Serravallian, and Zanclean. The Langhian and Tortonian Stages have been identified to date on the continental shelf but not on the mainland in Georgia, and the Messinian Stage has not yet been identified with certainty anywhere in the southeastern United States. The specific ages of the various components of the Hawthorne Group will be discussed more fully in the following descriptions of each formation and member.

PARACHUCLA FORMATION OF THE HAWTHORNE GROUP (reintroduced and revised)

Definition

The Parachucla Formation of Sloan (1908, p. 273-274, 435, 465-466), referred to by him variously as Parachucla phase, Parachucla marl, Parachucla shale, Parachucla formation (p. 466), and Parachucla series (p. 327), is reintroduced herein as the lowest and oldest described formation of the Hawthorne Group in Georgia. The Parachucla of Sloan (1908) is expanded and revised here to include both the Combahee phase (in Georgia) of Sloan (1908, p. 274, 465-466) and the Parachucla marl and shale. The reasons for combining the Georgia Combahee and Parachucla into one formation are that (1) they are closely related lithologically, genetically, and temporally, and (2), they are lithologically more similar to each other than they are to the other overlying formations of the Hawthorne Group. The Parachucla of Sloan (1908) was never adopted by other workers, but was abandoned immediately after the name was proposed. Therefore, the Parachucla of Sloan (1908) can not be considered to ever have been an accepted or "formal" stratigraphic unit. Because Sloan (1908) appears to have used the name Parachucla more in a lithostratigraphic sense (marl, shale, and formation), because the name Combahee as Sloan (1908) applied it in Georgia is lithostratigraphically inconsistent with the Combahee that he described elsewhere from the type area in South Carolina, and because the deposits that comprise the Combahee and Parachucla of Sloan (1908) in Georgia constitute a lithostratigraphic unit of formation rank, the expansion of the name Parachucla to encompass both the Combahee and Parachucla of Sloan (1908) is justified. Moreover, in recognition and in honor of Earle Sloan's contributions to the Miocene of Georgia, I wish to retain the lithostratigraphic ranking of his name Parachucla as he apparently intended it.

Veatch and Stephenson (1911, p. 343) abandoned the names Parachucla and Combahee in Georgia because they considered these units to be "stratigraphic representatives of the Alum Bluff formation." However, Veatch and Stephenson (1911) were not consistent in their transferral of the Parachucla to the Alum Bluff in the type area of the Parachucla. At Sloan's main reference locality for the Parachucla at Porters Landing on the Savannah River, Veatch and Stephenson (1911, p. 371-372) transferred only the Parachucla marl of Sloan (1908, 273-274) to the Alum Bluff Formation. They included the overlying Parachucla shale in the Marks Head Formation. Cooke (1936, 1943) abandoned both the names Alum Bluff and Marks Head and replaced them with the name Hawthorne.

Elsewhere in Georgia, deposits included in the Parachucla Formation of the present report have been referred to as Tampa (Fortson and Navarre, 1959; Counts and Donsky, 1963; Herrick, 1961, p. 17-20; also see Furlow, 1969), Hawthorne Formation (MacNeil, 1947a, 1947b; Georgia Geological Survey, 1976; Weaver and Beck, 1977), and Miocene (undifferentiated) (Herrick, 1961).

The Parachucla Formation is divided into two formal members in Georgia: the Tiger Leap Member (= Combahee of Sloan, 1908) and the overlying Porters Landing member (= Parachucla marl and shale of Sloan, 1908).

Type Section

The name Parachucla was taken from the site of a boat landing on the Savannah River in Hampton County, South Carolina, that around the turn of the century was called Parachucla Landing. The name Parachucla has disappeared from local usage, and the current name of the boat landing is Stokes Ferry Landing. Stokes Ferry Landing is approximately 4.5 airline miles (7.3 km) downriver from Porters Landing in Georgia. Because Stokes Ferry Landing is located in the middle of the Savannah River Floodplain, there are no exposures of pre-Quaternary deposits at the landing.

Sloan (1908) did not explicitly designate a type locality for the Parachucla. However, it is clear that he considered the section exposed at Porters Landing the most significant and representative section he knew of: "The important geological relations of this locality were discovered by the writer, May, 1904; subsequently studied in detail in conjunction with Dr. Burns, of the Smithsonian Inst., June, 1904" (Sloan, 1908, p. 273). Because of the importance placed on the locality by Sloan (1908), and its proximity to the old site of Parachucla Landing, I designate Porters Landing on the Savannah River the principal reference locality of the Parachucla Formation (Fig. 14). Porters Landing is located in Effingham County, 2.7 miles (4.3 km) southeast of the Screven-Effingham County line on the Savannah River, and 6.5 miles (10.5 km) east-northeast of the community of Kildare in northern Effingham County (see also Sloan, 1908, p. 273-274; Cooke, 1936, p. 106-107). The Parachucla Formation is exposed in the lower parts of the bluffs at Porters Landing, from river level to approximately 20 feet (6 m) above mean-low-water. These sections, exposed immediately upriver and downriver from the boat landing, are herein designated the lectostratotype (unit-stratotype and principal reference section) and boundary-stratotype for the upper boundary of the formation. The core Effingham 10 (GGS-3108) is herein designated a reference section and locality for the Parachucla Formation (Fig. 3). The core interval from 27 feet to 147 feet is a hypostratotype (reference section) and lower boundary-stratotype for the formation. The site of the Effingham 10 (GGS-3108) core is 3.6 miles (5.8 km) west of Porters Landing on the shoulder of a paved county road 0.4 mile (0.65) south of the Effingham-Screven County line.

Lithology

The Parachucla Formation consists of sand, clay, calcite, and dolomite in varying admixtures. Sand is the primary lithic component of the formation, but limestone or dolostone can locally dominate the lithology of the formation. Clay, although prominent, is not known to dominate the lithology of the formation at any site. Other lithic components of the Parachucla Formation include fossil shells (both calcitic and aragonitic), phosphate, siliceous claystone and chert, mica, feldspar, zeolite, and lignitic flecks. Petrified wood occurs rarely in the type area.

The quartz sand typically is fine- to medium-grained and is well-sorted. In updip sections, however, feldspathic coarse-grained sand with pebbles occurs locally or in scattered beds. These feldspathic coarse-grained sands probably represent lithologies intermediate from Parachucla to Altamaha. Where sand occurs in discrete beds, the sand is never pure but is always argillaceous, calcareous, or dolomitic.

Clay is mostly interstitial in the sand, limestone, or dolostone. The occurrence of clay in discrete beds is characteristic of the Porters Landing Member, but rare in the Tiger Leap Member.

In the type area, the clay mineral fraction of the Parachucla Formation is dominated by montmorillonite whereas illite is commonly present in trace amounts, and palygorskite and sepiolite occur sporadically (see Weaver and Beck, 1977, p. 57, Fig. 20 for clay mineral distribution in the lower part of the Hawthorne section in the Savannah River area; also see Hetrick and Friddell, 1984). Both palygorskite and sepiolite are more prevalent in the clay fraction of the formation in the subsurface of the coastal area and in the central and southern Georgia Coastal Plain. Kaolinite occurs sporadically and only in trace amounts in the Parachucla Formation in the type area.

The Parachucla Formation is the only widespread formation of the Hawthorne Group in Georgia in which carbonate is a consistently occurring major component of the lithology. In the Savannah River area in Georgia, the carbonate occurs in moderate amounts as interstitial calcareous material, as fossil shells and other calcareous biogenic debris, and as limestone. The carbonate content increases both in a seaward direction to the southeast, and into the Southeast Georgia embayment to the south and southwest. In the southern coastal area of Georgia and in the Gulf Trough, limestone and dolostone constitute the greatest proportion of the Parachucla Formation. In general, the carbonate content is highest in the Tiger Leap Member, or, where the formation is undifferentiated, near the base of the formation. In the Savannah River area, calcite is the normal carbonate mineral and dolomite is rare or absent. Farther south, however, in the Southeast Georgia Embayment and in the Gulf Trough, dolomite and dolostone are also significant. In the southern coastal area of Georgia and in the southern part of the Gulf Trough, dolomite and dolostone are typical whereas calcite and limestone are rarely encountered.

Fossil shells, other than molds and casts, are not generally common in the Parachucla Formation in Georgia. However, fossil shells are common and characteristic in the lower part of the formation in a broad band from Savannah River in southern Screven and northern Effingham Counties, southwestward to the vicinity of Jeff Davis and Wheeler Counties. This band of abundant fossil shells continues southwestward to Berrien County as a richly fossiliferous, moldic limestone.

The Parachucla Formation is variably phosphatic, but it is less phosphatic than the overlying formations of the Hawthorne Group in Georgia. Although locally conspicuous, phosphate is absent from specific beds or stratigraphic intervals in the formation. Similarly, the Parachucla Formation contains scattered occurrences of siliceous claystone and chert. However, siliceous sediments are generally rare compared with the sediments of the overlying formations of the Hawthorne Group.

The Parachucla Formation in the Savannah River area is distinguished from the overlying Marks Head Formation in being less phosphatic and siliceous, in being more calcareous, and in having clays of differing physical properties. Except for the uppermost part of the formation, the Parachucla is considerably more calcerous and fossiliferous than

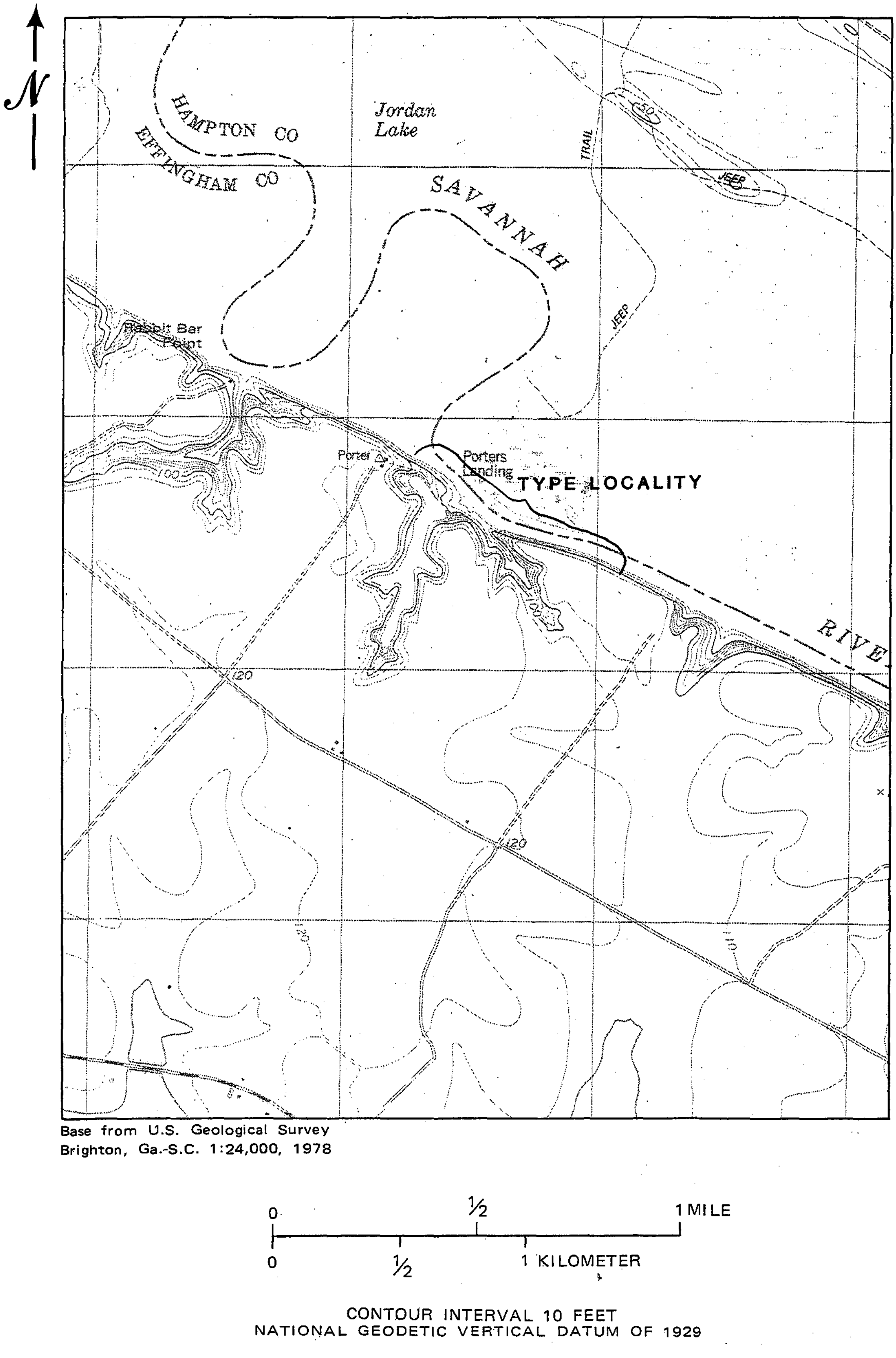


Figure 14. The type locality of the Parachucla Formation and the Porters Landing Member of the Parachucla Formation.

the Marks Head Formation. The Marks Head, on the other hand, is more dolomitic; fossiliferous beds, though present, are rare. The Parachucla clays are generally bluish-gray and are relatively heavy and dense due to their high montmorillonite content. In contrast, Marks Head clays are typically pale greenish-gray and are light-weight due to their high content of palygorskite.

Stratigraphic Relationships

The Parachucla Formation underlies the eastern Coastal Plain of Georgia and extends northward into South Carolina, southward into northeastern Florida, and southwestward in the Gulf Trough (Fig.15). Its northern and western limits are defined by facies change into the lower part of the Altamaha Formation. In the north, this facies change extends from southern Screven County westward across central Emanuel County, and then southwestward into northern Montgomery and Wheeler Counties. There appears to be a broad "embayment" (see Fig. 15) where the updip limit of the Parachucla Formation bends in a more northwesterly direction into Dodge and Pulaski Counties. South of this area, the western limits of the Parachucla Formation trend across Wilcox, Turner, and Worth Counties. The Parachucla Formation grades laterally into the Chattahoochee formation on the flanks of the Gulf Trough in Colquitt County, but appears to extend into Florida within the Gulf Trough (Fig. 13). South of Colquitt County, the western limits of the Parachucla appear to coincide with the central part of the Florida Platform in eastern Brooks County. Limited stratigraphic information from this area suggests that the Parachucla Formation grades laterally westward into the Chattahoochee Formation in Brooks County.

The Parachucla Formation underlies the northern coastal area of Georgia. In the southern part of the coastal area, however, the Parachucla stratigraphic interval is represented by dolomitic clays and argillaceous dolostones that differ lithologically from the Parachucla Formation and which are most lithologically consistent with the Cooper Formation that occurs under the continental shelf of Georgia (Fig. 11).

The Parachucla Formation generally overlies the Suwannee Limestone disconformably in Georgia. However, in Chatham County it also disconformably overlies the Lazaretto Creek Formation (Huddlestun, in press), and in the southern coastal area, in Camden and parts of Glynn and Charlton Counties, it disconformably overlies the Crystal River Formation of the Ocala Group. In the Gulf Trough in Coffee and Berrien Counties, the Parachucla Formation disconformably overlies Suwannee-equivalent limestone.

The Marks Head Formation and stratigraphic equivalents disconformably or paraconformably overlie the Parachucla Formation over most of their area of occurrence in Georgia (Figs. 10, 11). Only in northernmost Effingham and southern Screven Counties is the Parachucla Formation known to be overlain by a younger formation, in this case the upper Pliocene Cypresshead Formation (Pl. 2). In the Gulf Trough, the Parachucla Formation is disconformably overlain by undifferentiated Hawthorne sands and clays that appear to be correlative with the Marks Head Formation.

The Parachucla Formation is distinguished from the stratigraphically equivalent Chattahoochee Formation of southwestern Georgia in consisting of sandy, argillaceous, variably phosphatic limestone and dolostone, or phosphatic, variably calcareous or dolomitic, argillaceous sand or sandy clay whereas the Chattahoochee Formation consists largely of finely sandy, variably argillaceous dolostone. The Parachucla Formation is distinguished from the stratigraphically equivalent upper part of the Cooper Formation, under the continental shelf of Georgia, in consisting of variably sandy and argillaceous, phosphatic limestone or dolostone, or variably calcareous, dolomitic, and phosphatic, argillaceous sand or sandy clay whereas the Cooper Formation consists of argillaceous, microfossiliferous, finely calcarenitic limestone.

The underlying Oligocene carbonates, including the Suwannee Limestone, consist predominantly of relatively pure, variably fossiliferous limestone with minor dolostone. The Oligocene Lazaretto Creek Formation in coastal Georgia is distinguished from the Parachucla in consisting of calcarenitic sand or sandy calcarenitic limestone that is locally phosphatic. Where the Parachucla Formation locally overlies the Crystal River Formation, the Crystal River is distinguished in consisting of relatively pure, bryozoan-rich limestone with variable concentrations of larger foraminifera.

In eastern Georgia, the Parachucla Formation is distinguished from the overlying Marks Head Formation in being less phosphatic, siliceous, and dolomitic, and in being more calcareous and fossiliferous. The Parachucla sands and clays are typically bluish-gray to dark bluish-gray, and the Marks Head sands and clays are typically pale greenish gray. The carbonate content of the Parachula Formation is relatively high and is consistently present within the Parachucla section whereas the carbonate content of the Marks Head Formation is low and carbonate is commonly absent. The characteristic carbonate of the Parachucla Formation is calcite whereas that of the Marks Head Formation is dolomite. However, in southwestern Georgia, dolomite is also characteristic of the Parachucla Formation.

In the Gulf Trough, Marks Head-equivalent deposits are lithologically heterogeneous but are typically lacking in carbonate. The underlying Parachucla Formation, on the other hand, is consistently calcareous or dolomitic, and is variably fossiliferous.

The greatest known thickness of the Parachucla Formation in its type area is 120 feet (37 m) in the reference core Effingham 10 (GGS-3108) in northernmost Effingham County. The Parachucla thins northwestward, up the dip, by facies change into the Altamaha Formation in Screven County. It also thins gradually down the dip from northern

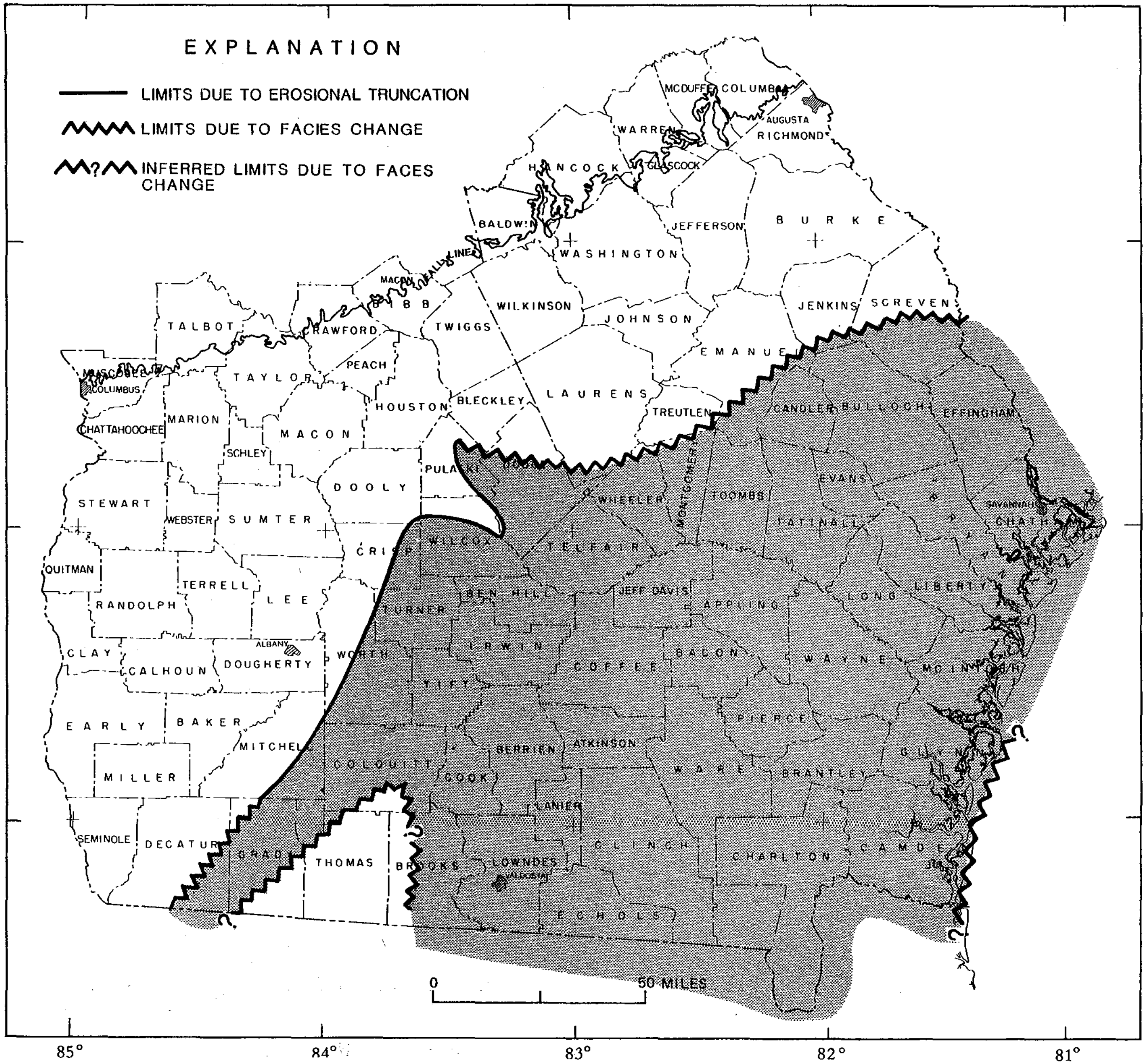


Figure 15. The areal distribution (outcrop and subcrop) of the Parachucla Formation.

Effingham County to southern Effingham County where locally it is absent due to pinchout (Pl. 2). In Chatham and southern Effingham Counties, the Parachucla Formation ranges from 0 to 17 feet (0 to 8 m) thick but averages about 10 feet (3 m) thick. In the subsurface of the coastal area of the Southeast Georgia Embayment, the Parachucla Formation is 177 feet (54 m) thick in the interval 453 feet to approximately 630 feet in the core Wayne 2 (GGS-3512) from Wayne County (Pl. 3). The stratigraphic equivalent of the Parachucla is 114 feet (35 m) thick in the interval 410 feet to 524 feet in the core Cumberland Island 1 (GGS-3426) from Cumberland Island in Camden County. In the Gulf Trough in southern Georgia, the Parachucla Formation is 309 feet (94 m) thick in the interval 258 feet to 567 feet in the core Coffee 4 (GGS-3541) in northern Coffee County; 280 feet (85 m) thick in the interval 324 feet to 604 feet in the core Berrien 10 (GGS-3542) in northern Berrien County; and at least 325 feet (99 m) thick in the interval 380 feet to total depth at 705 feet in the core Colquitt 3 (GGS-3179) in northeastern Colquitt County.

The environment of deposition of the Parachucla Formation was marine, continental shelf, inner to middle neritic.

Age

The age of the Parachucla Formation is early Miocene (Aquitanian). The planktonic foraminiferal assemblages from the Tiger Leap Member and the Porters Landing Member are significantly different in appearance, yet can not be separated by more than one planktonic foraminiferal zone. The Tiger Leap Member is assigned to Zone N4 of Blow (1969), which is the *Globorotalia kugleri* Zone of Bolli (1957) and also of Stainforth and others (1975). This age assignment is based on the occurrence of the following species:

Globorotalia pseudokugleri
Globigerina angulisuturalis
Globigerinoides primordius
Globoquadrina dehiscens
Globigerinita incrusta

Globorotalia pseudokugleri, G. angulisuturalis, and *G. dehiscens* are absent from the planktonic foraminiferal assemblage of the Porters Landing Member. However, the common occurrence and large size of *Globigerinoides primordius* in addition to the absence of species characteristic of younger zones suggests that the Porters Landing Member is possibly as old as late Zone N4, but no younger than Zone N5 (*Catapsydrax dissimilis* Zone of Bolli, 1957, and of Stainforth and others, 1975) (Pl. 1).

TIGER LEAP MEMBER OF THE PARACHUCLA FORMATION (new name)

Definition

The Tiger Leap Member is herein proposed as the lower member of the Parachucla Formation. It corresponds to the Combahee phase of Sloan (1908, p. 274, 465-466) as he described it along the Savannah River in Georgia. The name Combahee is not reintroduced in this report because Sloan described the sediments of the Combahee phase at Broxton Ford and Tobys Bluff on the Salkehatchie River in Hampton County, South Carolina (i.e., the critical reference localities for the Combahee deposits), as shales with fuller's earth and associated glauconite (Sloan, 1908, p. 327-328, 345, 435, 465). This lithology is inconsistent with Tiger Leap lithology as defined in this report. I have visited the approximate locations of Broxton Ford and Tobys Bluff and have not found any exposures along the Salkehatchie River. Therefore, the identity of the Combahee in its type area and the stratigraphic relationship of the type Combahee with the Tiger Leap Member are uncertain at this time.

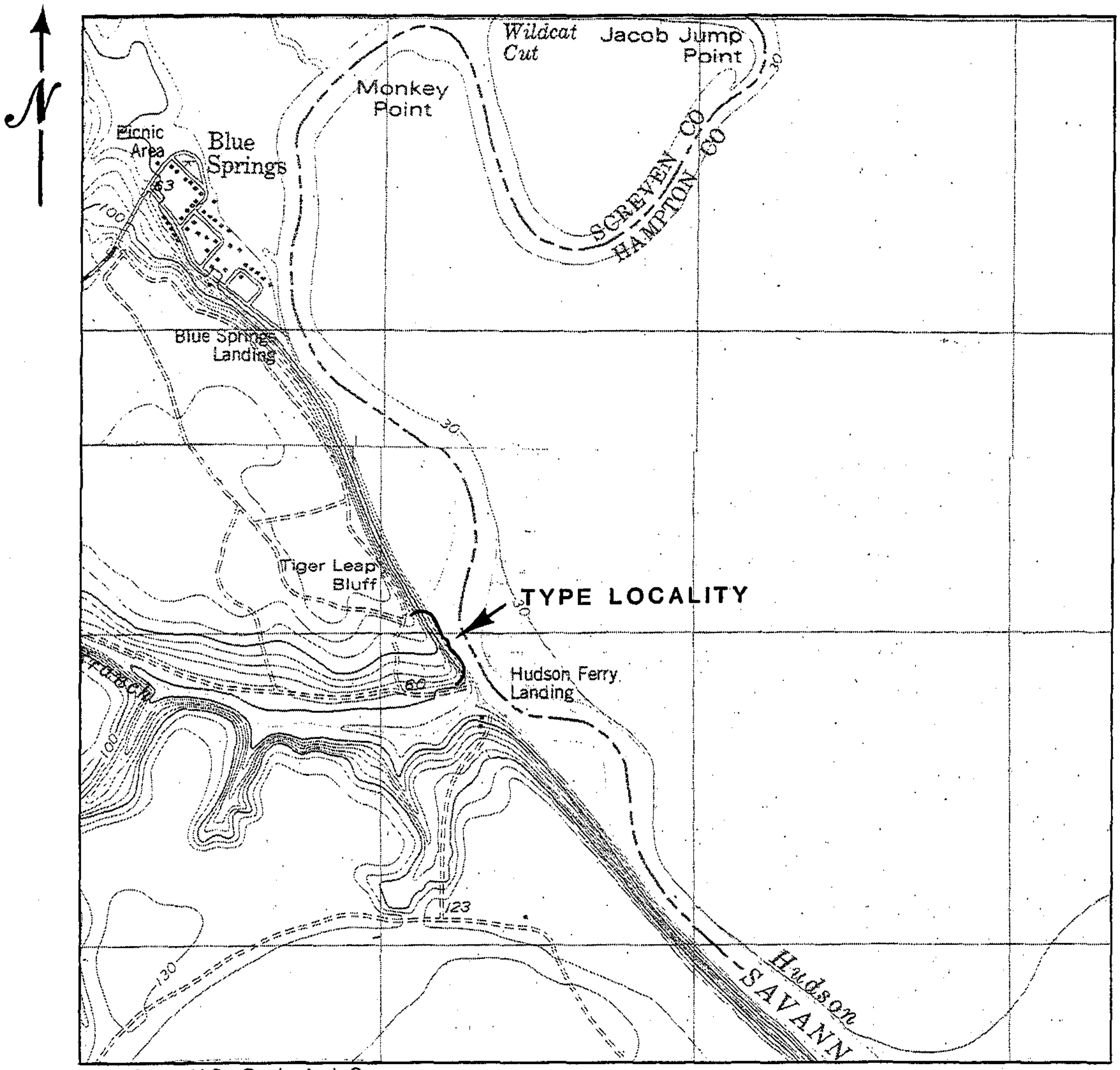
The Tiger Leap Member of the Parachucla Formation corresponds to the lower part of the Alum Bluff Formation of Veatch and Stephenson (1911, p. 361-362, 370, 172) along the Savannah River in Screven and Effingham Counties. Cooke (1936, 1943), however, included the Tiger Leap Member of this report in the Hawthorne Formation.

Type Section

The name Tiger Leap is taken from Tiger Leap Bluff on the Savannah River in southern Screven County, Georgia. The type locality of the Tiger Leap Member is herein designated as the southern end of Tiger Leap Bluff, and the type section, or unit-stratotype (holostratotype) is that section of the Tiger Leap Member exposed at Tiger Leap Bluff (Fig. 16). The unweathered outcrop of the member currently exposed at Tiger Leap Bluff is only about 7 feet (2 m) thick and is the upper, noncalcareous part of the member. To my knowledge, however, this exposure is the best outcropping section of the member. Tiger Leap Bluff is located 0.75 mile (1.2 km) southeast of Blue Springs Landing on the Savannah River, and is 2.25 miles (3.6 km) northwest of the Screven-Effingham county line. A complete section of the Tiger Leap Member is present in the core Effingham 10 (GGS-3108), taken 3.2 miles (5 km) south of Tiger Leap Bluff on the shoulder of a paved county road 0.4 mile (0.65 km) south of the Screven-Effingham county line in Effingham County (Fig. 3). The interval 75 feet to 147 feet in the core Effingham 10 (GGS-3108) is herein designated as a reference section and parastratotype of the Tiger Leap Member. All of the characteristic lithologies of the Tiger Leap Member are present in the Effingham 10 core, and the core recovery of the member is approximately 85%.

Lithology

The Tiger Leap Member is a lithologically heterogeneous unit. However, it is the only stratigraphic unit in the Hawthorne Group in Georgia in which carbonate (calcite and dolomite, limestone and dolostone) consistently constitutes a major or significant part of the lithology. In its type area in southern Screven and northern Effingham Counties, Geor-



Base from U.S. Geological Survey
Kildare, Ga.-S.C. 1:24,000, 1978 and
Blue Springs Landing, Ga.-S.C. 1:24,000, 1978

0 1/2 1 MILE
0 1/2 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 16. The type locality of the Tiger Leap Member of the Parachucla Formation.

gia, the Tiger Leap Member consists of limestone; calcareous shelly sand (shell bed); calcareous, microfossiliferous sand; noncalcareous, argillaceous sand; and noncalcareous, pebbly, prominently bedded, feldspathic sand. In addition to the above, lithologies that have been observed in the Tiger Leap Member elsewhere in the state includes dolostone and phosphatic sand and sandstone. Argillaceous, fine-grained, well-sorted sand that is variably phosphatic, micaceous, calcareous, dolomitic, and fossiliferous is the basic lithology of the Tiger Leap Member. Finely sandy limestone and dolostone that are variably fossiliferous, argillaceous, and phosphatic are other prominent lithology types of the Tiger Leap. Locally, limestone, dolostone, or both are the principal lithologies of the Tiger Leap Member. Subordinate lithic components of the member include clay, shells (both calcitic and aragonitic), phosphate, siliceous claystone, feldspar, mica, zeolite, and lignitic flecks. The clay mineral suite of the Tiger Leap is generally dominated by smectite. Palygorskite and sepiolite are prominent components of the clay mineral suite in the southern part of the Georgia Coastal Plain but occur sporadically and in minor amounts in the type area (Hetrick and Friddell, 1984). Illite is a common trace component of the clay mineral suite.

Stratigraphic Relationships

The Tiger Leap Member of the Parachucla Formation underlies most of the eastern Georgia Coastal Plain except for the coastal area (Fig. 17). In the Savannah River area, its northern limits are in the vicinity of Sylvania in Screven County, and its southern limits are in the vicinity of Clyo in Effingham County. The Tiger Leap Member grades laterally northwestward into the Altamaha Formation in Screven County, resulting in gradual thinning and pinch-out at the base of the Miocene section in northern Screven County (Fig. 11; Pl. 1, 2). In northern Effingham County, the Tiger Leap Member thins and pinches out southeastward either due to nondeposition or erosional truncation. Neither the Tiger Leap Member nor a stratigraphically equivalent unit is present in the Savannah River area southeast of the vicinity of Clyo. The shell bed of the Tiger Leap Member is widespread in the Savannah River area and is unique among Hawthorne lithologies in Georgia. The shell bed can be traced at the base of the Miocene deposits as far north as the vicinity of Sylvania in central Screven County (see Herrick, 1961, p. 346-351). Similarly, it can be traced in well-cuttings from the Savannah River area southwestward into Montgomery, Wheeler, and Jeff Davis Counties (also see Herrick, 1961; Weaver and Beck, 1977). Elsewhere in Georgia, the Tiger Leap Member has been identified in Wayne County in the core Wayne 2 (GGS-3512), in Coffee County in the core Coffee 4 (GGS-3541), in Berrien County in the core Berrien 10 (GGS-3542), and in Colquitt County in the core Colquitt 3 (GGS-3179). The Tiger Leap Member, therefore, probably underlies most of the Southeast Georgia Embayment area and the Gulf Trough. The northern limits of the member, based on current subsurface control, extend from Screven County westward through Emanuel County, northern Montgomery County, and into Dodge County. The eastern limits are known only in the Savannah River area. Farther south, the Tiger Leap Member or its stratigraphic equivalent appears to be absent in the coastal area of Georgia. The southern limits of the member are unknown at this time, but the member appears to be absent in the Suwannee River area of northern Florida (Fig. 17).

The Tiger Leap Member of the Parachucla Formation disconformably overlies the Suwannee Limestone and, in the Gulf Trough, it disconformably overlies Suwannee-equivalent limestone. The Tiger Leap Member is paraconformably overlain by the Porters Landing member of the Parachucla Formation (Fig. 11; Pl. 2). Between the Screven-Effingham county line and the vicinity of the Orangeburg Escarpment, the Tiger Leap Member is disconformably overlain by the upper Pliocene Cypresshead Formation, but north of the vicinity of the Orangeburg Escarpment, the Tiger Leap is overlain conformably and gradationally by the Altamaha Formation (Pl. 2).

The Tiger Leap Member of the Parachucla Formation is distinguished from the overlying Porters Landing Member in being consistently more calcareous or dolomitic, and in generally being less argillaceous. The Porters Landing Member generally contains beds of clay. Clay beds are rare in the Tiger Leap Member and are known to occur only in the lower part of the unit.

In the type area, the greatest thickness of the Tiger Leap Member is approximately 75 feet (23 m) in the reference core Effingham 10 (GGS-3108). The Tiger Leap Member thins northward and is approximately 22 feet (7 m) thick in the core Screven 8 (GGS-3198) in south-central Screven County. (Pl. 2). Southeastward from the core Effingham 10 (GGS-3108), the Tiger Leap thins in the subsurface to 40 feet (12 m) thick in the core Effingham 11 (GGS-3109) near Porters Landing, and to 25 feet (7.5 m) thick in the core Effingham 12 (GGS-3110) 3 miles (5 km) north of Clyo. The Tiger Leap Member is 103 feet (31 m) thick in the interval 527 feet to 630 feet in the core Wayne 2 (GGS-3512) in Wayne County; 147 feet (45 m) thick in the interval 420 feet to 567 feet in the core Coffee 4 (GGS-3541) in Coffee County; 215 feet (66 m) thick in the interval 389 feet to 604 feet in the core Berrien 10 (GGS-3542) in Berrien County; and at least 196 feet (60 m) thick in the interval 509 feet to total depth at 705 feet in the core Colquitt 3 (GGS-3179) in Colquitt County.

The environment of deposition of the Tiger Leap Member of the Parachucla Formation was marine, inner neritic continental shelf, and relatively nearshore.

Age

The age of the Tiger Leap Member of the Parachucla Formation is early Miocene (early Aquitanian) (Pl. 1). The

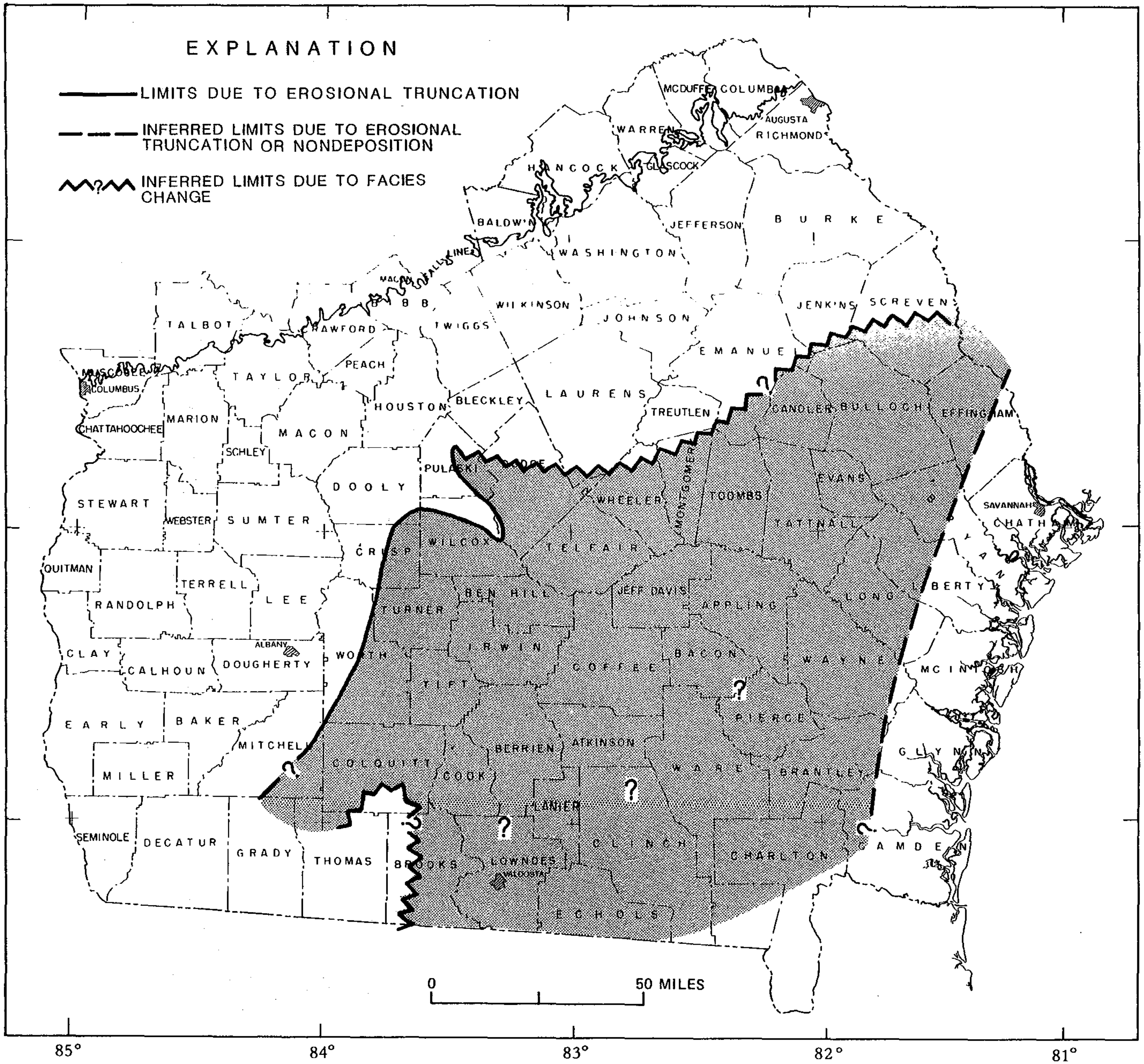


Figure 17. The areal distribution (outcrop and subcrop) of the Tiger Leap Member of the Parachucla Formation.

planktonic foraminifera from the gray, microfossiliferous, fine sand lithofacies of the member indicate that it is contained in the lower part of Zone N4 of Blow (1969) and in the *Globorotalia kugleri* Zone of Bolli (1957) and of Stainforth and others (1975) (Pl. 1). The following planktonic foraminifera have been identified from the microfossiliferous fine sand bed of the Tiger Leap Member in the cores Screven 1 (GGS-1170), Effingham 10 (GGS-3108), Effingham 11 (GGS-3109), and Georgia Power Company cores B3, B21, and B22:

Globorotalia pseudokugleri
G. mayeri
Globigerina angulisuturalis
G. praebulloides
G. ciperoenis
Globigerinoides primordius
Globigerinita juvenelis
G. incrusta
G. bradyi
Globoquadrina altispira globularis
G. dehiscens
Cassigerinella chipolensis

PORTERS LANDING MEMBER OF THE PARACHUCLA FORMATION (new name)

Definition

The Porters Landing Member is herein proposed as the upper member of the Parachucla Formation. The Porters Landing Member is identical to the combined Parachucla marl and Parachucla shale of Sloan (1908, p. 273-274, 466) and represents the original concept of the Parachucla. The name Parachucla was abandoned by Veatch and Stephenson (1911, p. 343) in favor of the name Alum Bluff of Matson and Clapp (1909, p. 91-95) because they believed the Parachucla to be a part of the Alum Bluff Formation. Veatch and Stephenson (1911, p. 371-373) included the "Parachucla marl" (fossiliferous flat-pebble bed) in the vicinity of Porters Landing in the Alum Bluff Formation. However, they included the overlying "Parachucla shale" (clays and sands) with the Marks Head Formation rather than with the Alum Bluff Formation (compare with Sloan, 1908, p. 273-274). Cooke (1936, 1943), on the other hand, abandoned both the names Alum Bluff and Marks Head in Georgia, and referred the entire Miocene section that underlies the Raysor Formation on the Savannah River to the Hawthorne Formation.

In Chatham County, Georgia, calcareous sand-sandy limestone in the subsurface that is provisionally assigned to the Porters Landing Member in this report, was called Tampa Limestone by Counts and Donsky (1963) and Tampa Limestone-equivalent by Furlow (1969).

Type Section

The name Porters Landing is taken from Porters Landing on the Savannah River, a boat landing in northern Effingham County. The type locality of the member is herein designated as the area immediately upriver and downriver from the boat landing, and the type section, or unit-stratotype (holostratotype), of the Porters Landing Member consists of those exposures of the Parachucla Formation in the bluffs at the type locality (Fig. 14). Porters Landing is also the boundary stratotype for the upper boundary of the member.

Porters Landing is located in northern Effingham County, 2.7 miles (4.3 km) southeast of the Screven-Effingham county-line on the Savannah River, and 6.5 miles (10.5 km) east-northeast of the community of Kildare (also see Sloan, 1908, p. 273-274; Veatch and Stephenson, 1911, p. 371-372; Cooke, 1925, p. 106-107). The Porters Landing Member of the Parachucla Formation is exposed in the lower parts of the bluffs at Porters Landing, from river level to approximately 20 feet (6 m) above mean-low-water stage of the river, where it is disconformably overlain by the Marks Head Formation. The unit-stratotype of the Porters Landing member is the same section as the designated unit-stratotype of the Parachucla Formation of this report.

Lithology

The Porters Landing Member of the Parachucla Formation consists predominantly of sand and clay. Other lithic components include calcite, limestone, dolomite, dolostone, mica, phosphate, siliceous claystone, zeolite, shells (only calcitic shells are known), and lignitic flecks and fragments. Characteristically in the type area in northern Effingham County, the Porters Landing Member is a thick-bedded, vaguely stratified to massive, noncalcareous, nonfossiliferous fine-to medium-grained sand and clay. Although quartz sand appears to be the dominant component of the member, clay is the characteristic component that serves to distinguish the member lithologically from the underlying Tiger Leap Member. Clay in the Porters Landing Member occurs both in discrete beds and interstitally in the sand. The bedded clay is typically medium to dark bluish-gray or dark greenish-gray (5 B 5/1 to 5 B 4/1), indistinctly layered and blocky, tough, bioturbated, and massive (as at the type locality), noncalcareous, and finely sandy to silty. In the type area, the clay mineral suite (Hetrick and Friddell, 1984) is strongly dominated by smectite whereas illite and kaolinite are minor but consistently present. Palygorskite and sepiolite are present in the type area, but only sporadically and in minor amounts. Clay occurs interstitially to the quartz sand in all proportions, from slightly argillaceous sand to finely sandy clay.

The quartz sand component of the Porters Landing Member is generally fine- to medium-grained and well-sorted. However, some beds at some sites are gravelly and pebbly, especially near the base and top of the member. The sediments of the pebbly beds, in contrast to the fine- to medium-grained sand beds, are poorly sorted and variably clayey. Sand of relatively high purity is not known to occur in discrete beds; rather, the sand is always argillaceous to some extent.

The basal Porters Landing Member in the type area consists of a discontinuous, poorly sorted, variably pebbly (with flat pebbles), slightly phosphatic, calcareous, macrofossiliferous, variably argillaceous sand that appears to be lenticular in nature. This fossiliferous flat-pebble bed is present at the type locality of the member north of the boat landing and is the "Parachucla marl" of Sloan (1908). It grades laterally downriver into nonfossiliferous, medium- to coarse-grained sand that is exposed at low stages of the river in the section immediately south of the boat landing. The bed also crops out in the bluffs near Marks Head Run and Spring Lake, an oxbow lake in the Savannah River floodplain, approximately 1.5 miles (2.4 km) northwest of Porters Landing. The basal Porters Landing Member is not calcareous and fossiliferous in the cores Effingham 10 and 12 (GGS-3108 and GGS-3110) taken near Porters Landing (Fig. 3).

In the type area, the Porters Landing Member of the Parachucla Formation is variably and weakly phosphatic. Phosphate is present but very inconspicuous in the stratotype, but is more prominent in the cores taken near the type locality. Siliceous claystone is also present in clay beds, but is not common in the member.

The Porters Landing stratigraphic interval in central Effingham County and Chatham County is represented by a massive, very calcareous, argillaceous, mircofossiliferous, well-sorted and fine-grained sand, to argillaceous, finely sandy limestone that is quite distinct lithologically from the typical porters Landing lithology of northern Effingham County. It also differs from typical Porters Landing lithology in that palygorskite is a common component of the clay mineral suite of this lithofacies in Chatham County (Hetrick and Friddell, 1984). This calcareous, fine-grained sand to sandy limestone lithofacies is tentatively assigned to the Porters Landing Member in this report.

In the southern coastal area of Georgia south of Glynn County, the Parachucla stratigraphic interval is occupied by phosphatic, dolomitic clays; dolomitic, argillaceous, fine sands; variably argillaceous dolostone; and minor calcite and limestone. This lithology is intermediate to Parachucla lithology and Cooper lithology. Limited paleontological evidence from Nassau County, Florida, suggests that the entire stratigraphic interval is correlative with the Porters Landing Member. This unit is included by T. Scott (in preparation) in the Penney Farms Formation.

Stratigraphic Relationships

The Porters Landing Member of the Parachucla Formation underlies most of the eastern Georgia Coastal Plain (Fig. 18). In the Savannah River area, the Porters Landing Member pinches out by truncation northwest of Porters Landing in southernmost Screven County, and it is not known to be present at Tiger Leap Bluff (Pl. 2). The Porters Landing Member also thins south (or seaward) of Porters Landing and locally pinches out in southern Effingham County. The calcareous lithofacies of the member reappears in central Chatham County and underlies the coastal area of that county.

The Porters Landing Member has been identified in Wayne County in the core Wayne 2 (GGS-3512), in Coffee County in the core Coffee 4 (GGS-3541), in Berrien County in the core Berrien 10 (GGS-3542), and in Colquitt County in the core Colquitt 3 (GGS-3179). The Porters Landing Member, therefore, probably underlies most of the Southeast Georgia Embayment area and the Gulf Trough. The western limits of the member, based on current subsurface control, extend from southernmost Screven County southwestward through southern Emanuel County, southern Dodge County, and into northern Colquitt County. The Porters Landing Member within the Gulf Trough appears to grade laterally into the Chattahoochee Formation on both flanks of the Gulf Trough in Colquitt County. The southern limits of the member are not known at this time, but the member does occur in outcrop (a parastratotype of the Hawthorne Group) on the upper Suwannee River at White Springs in northeastern Florida. The Porters Landing Member is thin at this site, and is not recognized elsewhere in the Suwannee area (pers. comm., T. Scott, 1985). In the southern coastal area of Georgia south of Glynn County, the Parachucla stratigraphic interval is occupied by phosphatic, dolomitic clays; dolomitic, argillaceous, finegrained sands; variably argillaceous dolostone; and rare occurrences of argillaceous limestone. Limited paleontological evidence from the Florida Bureau of Geology core Cassidy 1 (W-13815) in Nassau County, Florida, suggests that this stratigraphic interval is correlative with the Porters Landing Member.

The Porters Landing Member conformably or paraconformably overlies the Tiger Leap Member (Fig. 11; Pl. 2). It is disconformably overlain by the upper Pliocene Cypresshead Formation in northernmost Effingham County and southernmost Screven County, and disconformably overlain by the Marks Head Formation elsewhere in the Savannah River area. In Chatham County, the Porters Landing Member disconformably overlies the Lazaretto Creek Formation (Huddlestun, in press).

The Porters Landing Member of the Parachucla Formation is distinguished from the underlying Tiger Leap Member in being characteristically more argillaceous than the Tiger Leap and generally containing beds of medium to dark bluish-gray to dark greenish gray clay. In addition, the Tiger Leap Member is consistently more calcareous or dolomitic than the Porters Landing Member and commonly contains fossiliferous beds and beds of limestone or dolostone.

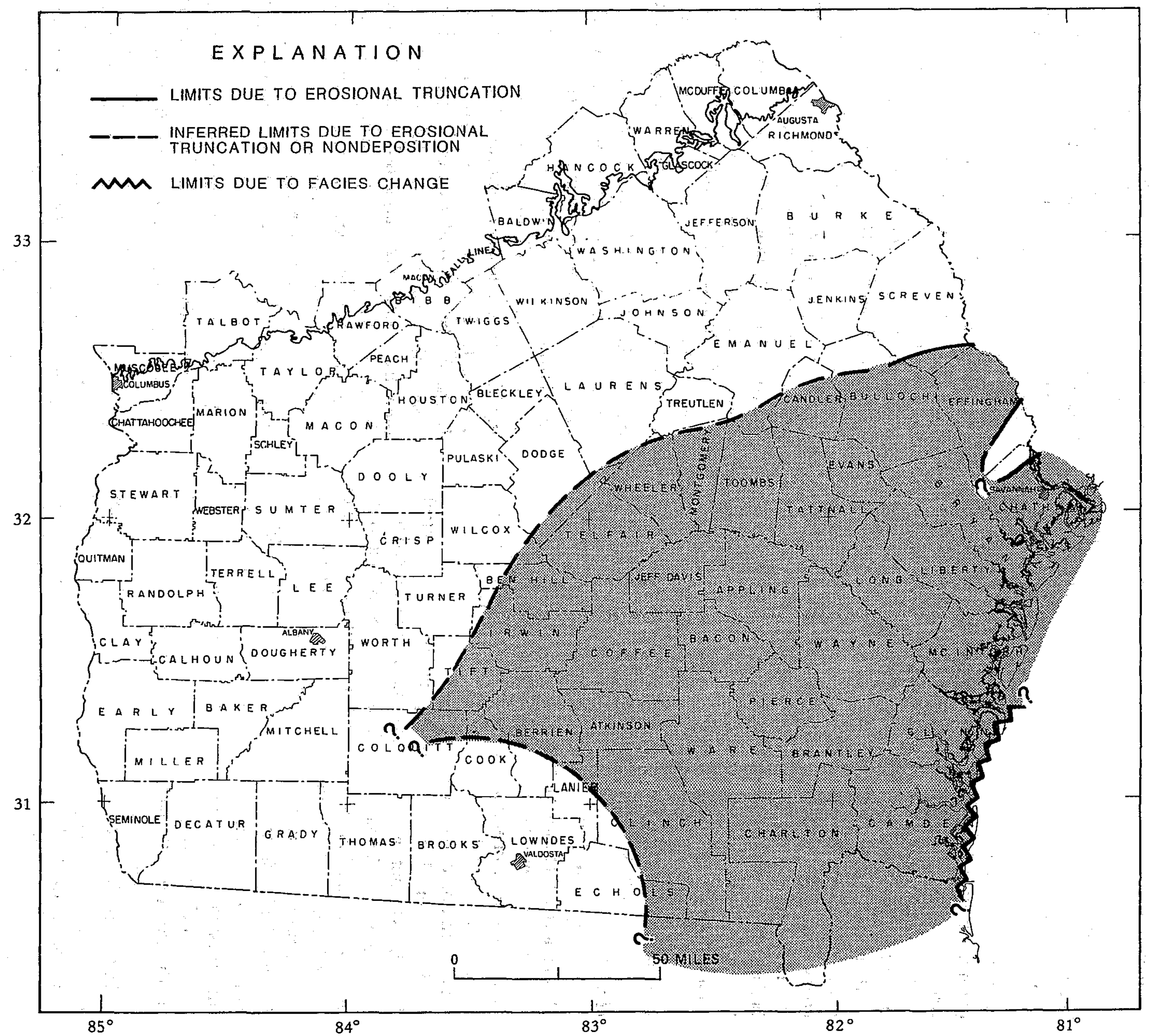


Figure 18. The areal distribution (outcrop and subcrop) of the Porters Landing Member of the Parachucla Formation.

There is evidence that there is substantial relief on the Parachucla Formation in its type area. In the core Effingham 11 (GGS-3109) taken 1.75 miles (2.8 km) southwest of Porters Landing, the Marks Head Formation is unexpectedly thick at 68 feet (21 m) compared with approximately 27 feet (8 m) at Porters Landing. Similarly, the elevation of the Marks Head/Parachucla contact is 37 feet lower in the Effingham 11 (GGS-3109) than it is at Porters Landing, and Porters Landing lithology cannot be positively identified in the core. The difference in the elevations of the Marks Head/Parachucla contact between Porters Landing and the Effingham 11 (GGS-3109) indicates a dip or inclination of approximately 21 feet per mile to the southwest, an unusually steep slope for Coastal Plain Miocene deposits. Therefore, it is suggested that the variation in thickness is more indicative of topographic relief on the Parachucla prior to deposition of the Marks Head Formation than of structural dip as a result of subsidence.

Approximately 20 feet (6 m) of Porters Landing member is exposed at the type locality at Porters Landing. It is not likely that the member is much thicker than this at Porters Landing because the fossiliferous flat-pebble bed exposed at the base of the section at Porters Landing is known to occur only at the base of the member and the bed is not known to be more than a few feet (less than 1 m) thick. In addition, Sloan (1908, p. 274) reported Combahee to be exposed under the "Parachucla marl" (fossiliferous flat-pebble bed) at Porters Landing although I have not seen the base of the flat pebble bed at the site. In the type area, the greatest thickness of sediments assigned to the Porters Landing Member is 48 feet (15 m) in the interval 27 feet to 75 feet in the core Effingham 10 (GGS-3108). The Porters Landing Member thins to 14 feet (4 m) in the interval 120 feet to 134 feet in the core Effingham 12 (GGS-3110). In the calcareous lithofacies of the member at Clyo in central Effingham County, the Porters Landing Member is 24 feet (7 m) thick in the interval 130 feet to 154 feet in the core Georgia Power B40; and it is 39 feet (12 m) thick in the interval 126 feet to 165 feet in the core Effingham 6 (GGS-2179). The Porters Landing Member appears to pinch out in southern Effingham County, but the calcareous lithofacies, which reappears in central Chatham County, ranges from 0 to 17 feet (0 to 8 m) thick, averaging about 10 feet (3 m) thick in Chatham County.

The Porters Landing Member is 74 feet (23 m) thick in the interval 453 feet to 527 feet in the core Wayne 2 (GGS-3512) in Wayne County; 162 feet (49 m) thick in the interval 258 feet to 420 feet in the core Coffee 4 (GGS-3541) in Coffee County; 65 feet (20 m) thick in the interval 324 feet to 289 feet in the core Berrien 10 in Berrien County (GGS-3542); and 229 feet (70 m) thick in the interval 280 feet to 509 feet in the core Colquitt 3 (GGS-3179) in Colquitt County.

The environment of deposition of the Porters Landing Member of the Parachucla Formation was marine, inner to middle neritic continental shelf. The shelf sediments appear to have been considerably more muddy during deposition of the Porters Landing Member than during deposition of the Tiger Leap Member.

Age

The age of the Porters Landing Member of the Parachucla Formation is early Miocene (Aquitanian) (see Pl. 1). The following planktonic foraminifera have been identified from the calcareous lithofacies of the member in the cores Georgia Power B40 and Effingham 6 (GGS-2179) from the vicinity of Clyo, and from the core Chatham 1 (GGS-535) in Chatham County:

Globorotalia mayeri
Globigerina praebulloides
G. ciperoensis
Globigerinoides primordius
Globoquadrina altispira globularis
Cassigerinella chipolensis

The planktonic foraminiferal suite of the Porters Landing Member differs from that of the Tiger Leap member in forming a greater percentage of the total foraminiferal fauna, and in being considerably less diverse. *Globigerina praebulloides* and *G. ciperoensis* constitute the largest part of the fauna, and *Globigerinoides primordius* is both large and well developed, and more numerous than in the older Tiger Leap Member.

Because the Porters Landing Member overlies the Tiger Leap Member, which contains a lower Zone N4 planktonic foraminiferal assemblage, and because the lower Zone N4 species *Globorotalia pseudokugleri* and *Glorigerina angulisuturalis* are not present in the Porters Landing Member whereas *Globigerinoides primordius* is both larger and more abundant, it is suggested here that the age of the Porters Landing Member is either upper Zone N4 (upper *Globorotalia kugleri* Zone) or lower Zone N5 (lower *Catapsydrax dissimilis* Zone). The absence of younger zonal species in the Porters Landing Member, such as *Globigerinoides quadrilobatus quadrilobatus, G. altiapertura, G. subquadratus,* and *Globoquadrina altispira globosa*, suggests that the member is not younger than Zone N5.

Planktonic foraminifera are very rare and consist only of juveniles in the exposed fossiliferous flat-pebble bed at the base of the Porters Landing member in northern Effingham County. Correlation between the typical, exposed Porters Landing Member and the subsurface calcareous lithofacies of the member is based on physical correlation between closely spaced cores (Pl. 2), stratigraphic position, and similarity of benthic foraminiferal assemblages north of the vicinity of Clyo. From Clyo southward, correlation is based on both planktonic and benthic foraminifera.

The benthic foraminifera, *Elphidium rota* and *Florilus struma,* previously considered to be characteristic of the upper Oligocene of the eastern Gulf Coastal Plain, are also characteristic species of the calcareous lithofacies of the Porters Landing Member. *Miogypsina* cf. *M. gunteri*, also thought to be restricted to upper Oligocene deposits in the

Southeast (Cole, 1941; Applin, 1960), was identified from the Porters Landing Member in the Georgia Power Company core B40. These species are not known to occur in the older Tiger Leap Member of the Parachucla Formation.

MARKS HEAD FORMATION OF THE HAWTHORNE GROUP (reintroduced)

Definition

The Marks Head Marl of Sloan (1908, p. 466-470) is herein reintroduced as the Marks Head Formation. In eastern Georgia, it is the middle formation of the Hawthorne Group. As defined herein, the Marks Head Formation is identical to the Marks Head marl of Sloan (1908, p. 273-274) in Georgia, but differs from that of Veatch and Stephenson (1911). The exposures of the Hawthorne Group along the Savannah River in the vicinity of Clyo and Sisters Ferry were mainly referred to as Miocene? (Undifferentiated) or were tentatively referred to the Miocene by Veatch and Stephenson (1911, p. 375). In this report, the outcropping Hawthorne sediments along the Savannah River near Clyo are assigned to the Marks Head Formation. In addition, Veatch and Stephenson (1911, p. 372-373) included the Parachucla shale of Sloan (1908) in the Marks Head Marl, but in this report the Parachucla shale of Sloan (1908) is the upper part of the Parachucla Formation in northern Effingham County, and underlies the Marks Head Formation.

Based on the fossil content of the Marks Head Formation as determined by Gardner (1925), Cooke (1936) abandoned the name Marks Head in favor of Hawthorne Formation, and the name Hawthorne has subsequently been applied to these deposits (Georgia Geological Survey, 1976; Weaver and Beck, 1977). Huddlestun (1973, 1981), however, has applied the name Marks Head informally. The Marks Head Formation of this report is in part the Hawthorne Formation of Counts and Donsky (1963), is largely the Hawthorne Formation of Furlow (1969) and McCollum and Herrick (1964), and appears to be the fuller's earth bearing unit of eastern Georgia of Weaver and Beck (1977, p. 56-63).

Type Section

The name Marks Head was taken from Marks Head Run (Sloan, 1908, p. 274), a deeply incised ravine in the bluffs overlooking the floodplain of the Savannah River (Fig. 19). The type locality of the Marks Head Formation is, by original designation (Sloan, 1908, p. 273), in Marks Head Run, and the type section, or unit-stratotype (holostratotype), of the Marks Head Formation is therefore in Marks Head Run. The type locality, Marks Head Run, is in northern Effingham County, 1.2 miles (1.9 km) northwest of Porters Landing (Fig. 19).

The Marks Head Formation is not well exposed at the type locality, and the lithologies exposed there (calcareous and macrofossiliferous) are not representative of the formation as a whole. The best exposure of the Marks Head Formation is at Porters Landing, 1.2 miles (1.9 km) southeast of the type locality (Fig. 14). This site is a reference locality and parastratotype of the formation (Sloan, 1908, p. 273). In addition, Porters Landing is herein designated the upper and lower boundary stratotype of the Marks Head Formation. At Porters Landing, the Marks Head Formation disconformably overlies the Parachucla Formation, and is disconformably overlain by the Raysor Formation.

Lithology

The Marks Head Formation consists of slightly dolomitic (rarely calcareous), phosphatic, argillaceous sand and sandy clay with scattered beds of dolostone, limestone, and siliceous claystone. In general, quartz sand appears to be the dominant lithic component of the formation, whereas clay is both a major and characteristic component. The sand-clay distribution of the Marks Head Formation reflects the tendency for grain sizes in the formation to become finer in a seaward direction. In outcrop in northern Effingham County, the Marks Head Formation consists predominantly of argillaceous sand, whereas in central Effingham County, the formation consists of interlayered finely sandy clay and argillaceous fine sand. In the subsurface in southern Effingham County and Chatham County, the Marks Head Formation consists predominantly of finely sandy clay with minor argillaceous sand.

Subordinate lithic components include dolomite, dolostone, calcite, limestone, phosphate, mica, zeolite, feldspar, siliceous claystone, shells, and rare, scattered, vertebrate bone debris.

The clay component of the Marks Head Formation occurs in discrete clay beds and interstitially in the quartz sand. The stratified clay occurs in laminae or streaks, thin beds, and thick beds, or as massive, finely sandy clay that constitutes the entire formation. Although the clay may appear to be massive and structureless, it is generally laminated with silt, fine mica, and fine phosphate scattered on the bedding planes. The clay mineral suite of the Marks Head Formation is dominated by palygorskite, with sepiolite and montmorillonite (smectite) as significant accessory clay minerals. Illite occurs in trace amounts in the Marks Head, and kaolinite is very rare (Weaver and Beck, 1977; Hetrick and Friddell, 1984). Thin beds or lenses of fuller's earth are locally scattered throughout the formation in the vicinity of Clyo in Effingham County, but none of them are thick enough to constitute commercial deposits. In the Savannah River area, the light-colored, light-weight, fuller's earth clays of the Marks Head Formation contrast with the dark bluish-gray, more dense clays of the Parachucla Formation, and with the olive-gray clays of the overlying Coosawhatchie Formation.

The quartz sand component of the Marks Head is generally fine-grained and well-sorted, but some beds of fine- to

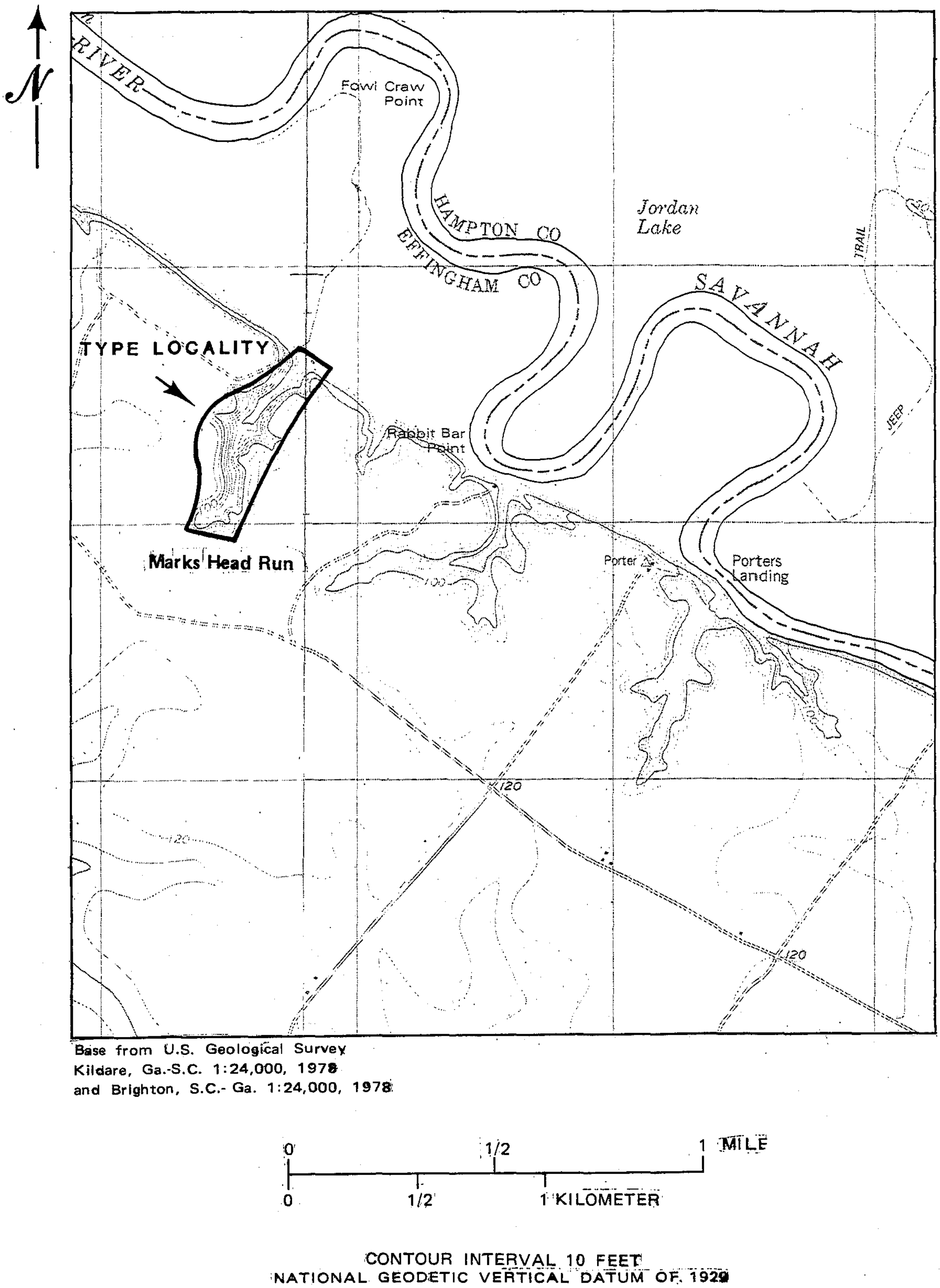


Figure 19. The type locality of the Marks Head Formation of the Hawthorne Group.

medium-grained, moderately sorted sand occur in northern Effingham County. In the Southeast Georgia Embayment, the upper part of the Marks Head Formation consists of coarse, pebbly, poorly sorted sand.

Carbonate is a minor but widely occurring component of the Marks Head Formation. It occurs as intersititial dolomite or calcite, as thin beds or lenses (thick in the Southeast Georgia Embayment) of dolostone or limestone, as calcite concretions, and as shell material in fossiliferous beds. The most common form of carbonate is interstitial dolomite but in most subsurface sections, dolomitic intervals constitute a small proportion of the sections. Most commonly, the sands or clays of the Marks Head are noncalcareous and non-dolomitic. Exceptionally, interstitial dolomite and, more rarely, interstitial calcite occurs throughout the Marks Head section. Scattered thin beds of argillaceous or sandy dolostone or limestone, and stratigraphic horizons with concentrations of concretions, large and small, are characteristic of the formation in northern Effingham County. Limited core information suggests that phosphatic, sandy, argillaceous dolostone beds are thicker in the Southeast Georgia Embayment, but they do not appear to constitute a greater proportion of the section there than elsewhere. Shelly, fossiliferous beds in the Marks Head Formation are known from the vicinity of Clyo north to the vicinity of the type locality. These beds, however, appear to be lenticular in nature and are not traceable over any large distance. The fossiliferous beds appear to be most prominent and thickest in the vicinity of Marks Head Run, and are thin and highly discontinuous in the Marks Head Formation at Porters Landing 1.2 miles (1.9 km) away.

The Marks Head Formation, in spite of its very fossiliferous type locality, is uniformly the least fossiliferous formation of the Hawthorne Group in eastern Georgia. If it were not for the fossiliferous type locality and a small area in the subsurface south of Savannah in Chatham County where the formation is calcareous and microfossiliferous, almost nothing would be known of the formation's fauna, correlation, and precise age.

The Marks Head Formation is characteristically phosphatic and, in the type area, phosphate is conspicuous. The P_2O_5 content, however, is not known to exceed a few percent and is, therefore, not considered commercial. Thin beds or lenses of olive-colored siliceous claystone are common in the type area, but appear to be less common in Chatham County and farther south in the Southeast Georgia Embayment.

In the coastal area, where the Marks Head Formation is disconformably overlain by the Coosawhatchie Formation, a fairly continuous marker bed of dolostone, palygorskite-bearing fuller's earth clay, or dolomitic fuller's earth occurs at the top of the Marks Head (dense, dolomitic limestone stringer of Furlow, 1969, p. 17).

Stratification in the Marks Head Formation is variable. Some intervals of the formation are prominently stratified and the bedding ranges from laminated to thick bedded. Where the sediments have been bioturbated, the sands and clays are generally incompletely mixed and the formation is massive. Less commonly, where bioturbation has been intense, the sands and clays have been completely mixed and the sediment is massive and structureless. Most commonly, the sediments of the Marks Head Formation are stratified with variable disruption of stratification due to bioturbation.

Stratigraphic Relationships

The Marks Head Formation occurs in the Savannah River area from northern Effingham County southeastward to the offshore, inner continental shelf of Georgia, and it underlies the coastal area from Chatham County to Camden County (Fig. 20). It extends some distance southward into northeastern Florida, and it is tentatively recognized in the subsurface as far north as the Coosawhatchie River at Dawsons Landing in Jasper County, South Carolina. The Marks Head thins and pinches out on the continental shelf of Georgia. It underlies the inner continental shelf, but the Marks Head stratigraphic interval is absent in the core AMCOR 6002 on the outer shelf. Its western or landward limits in Georgia south of the Savannah River region are not known at this time due to insufficient core control in the interior of the Southeast Georgia embayment. It is recognized, however, as far west as Wayne County, Georgia, in the embayment, and in Charlton County in the vicinity of Folkston. The Marks Head Formation does not occur as far west as the upper Suwannee River area in northern Florida, nor in the Gulf Trough in Coffee, Berrien, and Colquitt Counties, Georgia.

The Marks Head Formation disconformably overlies the Parachucla Formation in the type area of the two formations, and it disconformably or paraconformably overlies the Parachucla Formation, the calcareous lithofacies of the Porters Landing Member of the Parachucla Formation or the stratigraphic equivalent of the Parachucla Formation, in the southern coastal area of Georgia (Fig. 11). The Marks Head is disconformably overlain by the Cypresshead or Raysor Formations in northern and central Effingham County, and is disconformably overlain by the Coosawhatchie Formation elsewhere in Georgia.

The Marks Head Formation is distinguished from the underlying Parachucla Formation in being more phosphatic, siliceous, and dolomitic, and in being less calcareous and fossiliferous. In the type area, the Marks Head sands and clays are typically pale greenish-gray due to the color of the clay minerals palygorskite and sepiolite, whereas the Parachucla sands and clays are typically darker and bluish- to greenish-gray due to the color of the smectitic clays. Where the sediment is dry, as in cores, the physical properties of clay-rich Marks Head differs significantly from clay-rich Parachucla because of the different physical properties of palygorskite (Marks Head) and smectite (Parachucla).

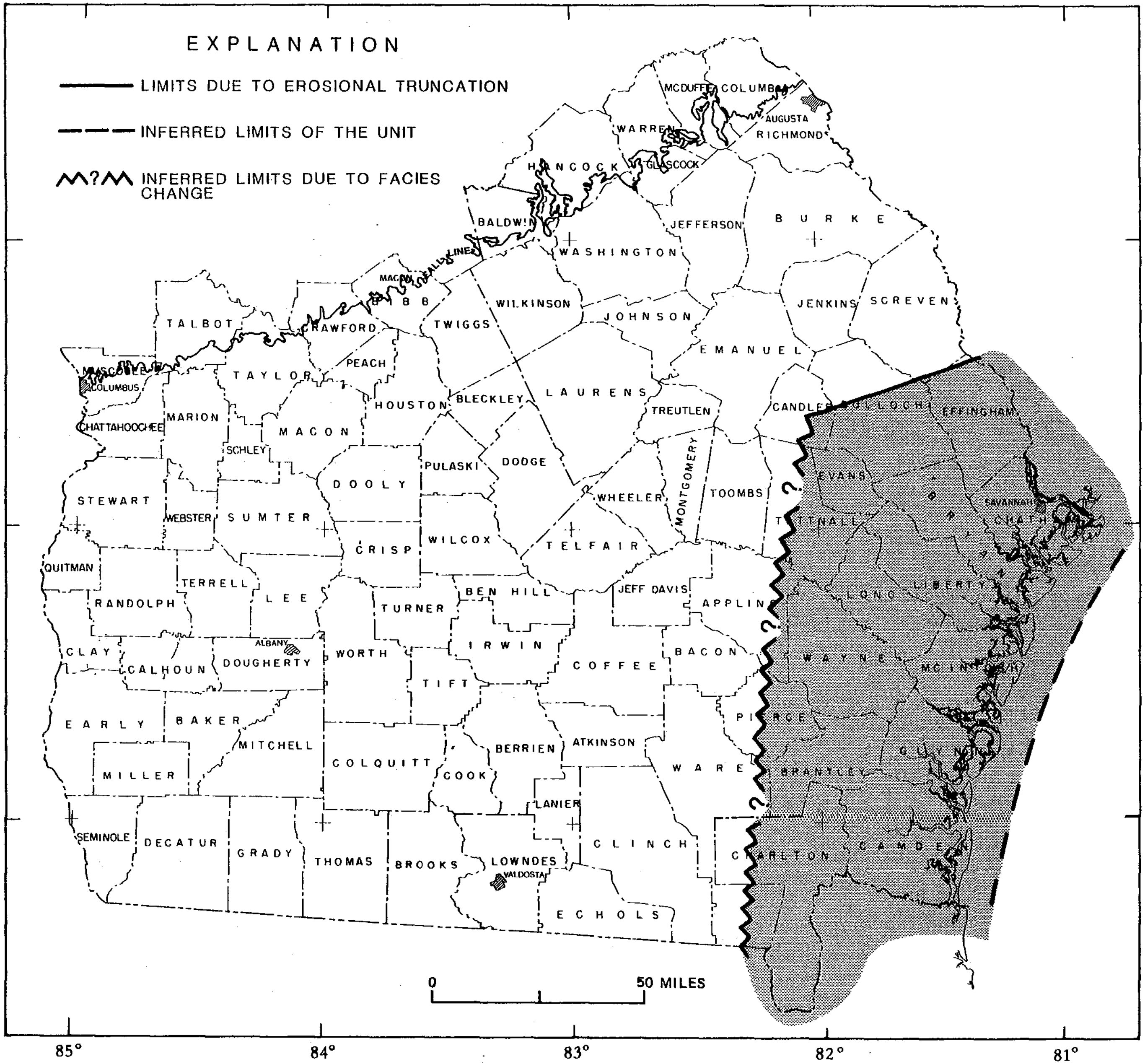


Figure 20. The areal distribution (outcrop and subcrop) of the Marks Head Formation.

The Marks Head Formation in distinguished from the overlying Coosawhatchie Formation in various ways. Where the Berryville Clay Member overlies the Marks Head, the Berryville differs in consisting of phosphatic, light to dark olive-gray smectitic clay. Phosphate and fine, vertebrate debris and fish-scales are commonly concentrated on bedding planes in the Berryville Clay. Also, there is commonly a bed of fuller's earth or dolostone at the top of the Marks Head Formation where it is overlain by the Coosawhatchie Formation. Where the Tybee Phosphorite Member overlies the Marks Head Formation, the Tybee is distinguished in consisting of sandy phosphorite that has the appearance of wet coffee-grounds. The Marks Head Formation in the coastal area, where it is overlain by the Tybee Phosphorite, consists of prominently bioturbated, phosphatic, slightly dolomite (locally calcareous), finely sandy, olive-gray, palygorskitic clay.

The thickness of the Marks Head Formation at the type locality is not readily measurable because the stratotype sections consist of small discontinuous exposures spread over a distance of approximately 500 feet (150 m) along a thickly wooded ravine. Sloan (1908, p. 274), however, reported that at least 15 feet (4.5 m) of section were exposed at the type locality (also see Veatch and Stephenson, 1911, p. 371).

At Porters Landing, the parastratotype and boundary stratotype for the formation, the Marks Head is approximately 27 feet (8 m) thick (Sloan, 1908, p. 273: compare with Veatch and Stephenson, 1911, p. 372-373). The Marks Head thins by truncation to the northwest, or landward, and is absent in the bluffs along Hudson Ferry Reach in northernmost Effingham County where the Cypresshead Formation directly overlies the Parachucla. The Marks Head Formation thickens southeastward, or seaward, in the Savannah River area and is 87 feet (27 m) thick in the interval 43 feet to 130 feet in the core Georgia Power B40, and 84 feet (26 m) thick in the interval 43 feet to 126 feet in the core Effingham 6 (GGS-2179), both near Clyo in central Effingham County (Pl. 2). The Marks Head Formation reaches a maximum thickness in the Savannah River area of 139 feet (42 m) in the core Georgia Power B41 in south-central Effingham County. From there, the formation progressively thins in a seaward direction. It averages about 25 feet (7.5 m) thick in coastal Chatham County (see Furlow, 1969; McCollum and Herrick, 1964). Neither the Marks Head Formation nor a stratigraphic equivalent is present in the core AMCOR 6002 on the outer continental shelf of Georgia (Pls. 2 and 3).

The Marks Head Formation thickens southward in the Southeast Georgia Embayment where it is 150 feet (46 m) thick in the interval 303 feet to 453 feet in the core Wayne 2 (GGS-3512) in Wayne County. It then thins southward to 125 feet (38 m) in the interval 325 feet to 450 feet in the core Charlton 2 (GGS-3185) at Folkston in Charlton County; it is only 36 feet (11 m) thick in the interval 374 feet to 410 feet in the core Cumberland Island 1 (GGS-3426) from Cumberland Island in Camden County, Georgia.

The environment of deposition of the Marks Head Formation was broadly marine, nearshore, inner continental shelf. In the type area of the formation in Effingham County, Georgia, the environment appears to have been brackish marine. At the fossiliferous type locality, the foraminiferal suite consists predominantly of either *Ammonia beccarrii* or *Buliminella elegantissima*, all other species constituting only a small proportion of the assemblage. The paleoenvironment indicated by the foraminiferal assemblage is consistent with the reported molluscan fauna (Veatch and Stephenson, 1911, p. 365; Gardner, 1925). It is also consistent with the abundance of the mussel *Mytilus* sp., a genus that flourishes in brackish water.

The clay mineral suite of the Marks Head Formation is compatible with the paleontological evidence for the paleoenvironment. The clay mineral suite of the formation is dominated by palygorskite (Hetrick and Friddell, 1984) which, according to Weaver and Beck (1977), originated in warm, coastal brackish to schizohaline water where the salinity of the watermass varied from hypersaline to brackish.

In the subsurface of the Savannah area, however, the Marks Head Formation is locally calcareous and contains a moderately diverse, open-marine, inner continental shelf, benthic foraminiferal fauna with a moderate planktonic foraminiferal fauna. Therefore, the offshore environment of the Marks Head Formation in the subsurface of coastal Georgia appears to have been inner continental shelf, relatively shallow water, but open-marine with normal to near normal salinity.

Age

The age of the Marks Head Formation is late early Miocene (Burdigalian) (see Pl. 1). The following planktonic foraminifera have been identified from the core U.S. Geological Survey Test Well 6 from southern Chatham County, and from the cores B13, B25, and B30 taken on Elba Island in the Savannah River in southern Chatham County:

Globorotalia mayeri
G. cf. *minutissima*
Globigerina praebulloides
G. cf. *woodi*
Globigerinoides quadrilobatus quadrilobatus
G. altiapertura
Globoquadrina altispira globosa
G. dehiscens
Globigerinita incrusta
G. juvenilis
G. uvula
Cassigerinella chipolensis

The planktonic foraminiferal assemblage of the Marks Head Formation is significantly different in appearance from that of the Parachucla Formation, and is similar to that of the Chipola Formation of western Florida (Akers, 1972; Huddlestun, 1984). It differs from the underlying Parachucla Formation principally in the typical development and common occurrence of *G. quadrilobatus quadrilobatus, G. altiapertura,* and *G. altispira globosa.* Forms resembling *Catapsydrax stainforthi* but with a very finely perforate test like that of *Globigerinita* and with a relatively high spire, and forms resembling *Turborotalita quinqueloba* are also characteristic and restricted to this stratigraphic interval in the Hawthorne Group. The presence of common and typical *G. quadrilobatus* and *G. altiapertura* indicates that the Marks Head Formation is not older than Zone N6 or N7 of Blow (1969) (= *Catapsydrax stainforthi* Zone and lower part of *Globigerinatella insueta* Zone of Bolli, 1957; and *C. stainforthi* Zone and *G. insueta* Zone of Stainforth and others, 1975; Pl. 1). The common occurrence of *G. altiapertura* in the Marks Head Formation and the absence of typical *G. altiapertura* in the latest Zone N7 Chipola Formation (Akers, 1972; Huddlestun, 1984) suggest that the Marks Head Formation is older than the Chipola Formation. This age is consistent with the correlation of the Marks Head Formation with the Torreya Formation of western Florida and southwestern Georgia, and with the stratigraphic position of the Chipola Formation disconformably overlying the Torreya Formation at Alum Bluff (Banks and Hunter, 1973; Huddlestun, 1984). It appears most probable, then, that the Marks Head Formation is contained in Zone N6 of Blow (1969) (see Pl. 1).

TORREYA FORMATION

Definition

The Torreya Formation was named by Banks and Hunter (1973, p. 355-363) for pre-Chipola, early Miocene age deposits in the eastern Florida panhandle. These deposits previously had been assigned to the Alum Bluff Formation (Matson and Clapp, 1909; Matson, 1915), Chipola Formation (Gardner, 1926; MacNeil, 1947a, 1947b) and Hawthorne Formation (Cooke and Mossom, 1929; Cooke 1943, 1945; Puri and Vernon, 1964; Hendry and Sproul, 1966). The Torreya Formation of this report is expanded to include all of the Hawthorne deposits of the eastern Florida panhandle and of southwesternmost Georgia (Decatur County) up to and including the fuller's earth beds (Dogtown Clay Member) near the top of the formation. The Torreya Formation contains two members: the Dogtown Clay Member in the upper part of the formation, and the Sopchoppy Member in the lower part of the formation.

Type Section

The Torreya Formation was named for Torreya State Park in northern Liberty County, Florida, the type locality being within the confines of the park (Banks and Hunter, 1973). The type locality and type section, or unit stratotype (holostratotype), is at Rock Bluff on the east bank of the Apalachicola River in SW 1/4, Sec. 17, T2N, R7W (Fig. 21; see also Sellards and Gunter, 1909; Mansfield, 1937; and Cooke, 1945, for measured sections and stratigraphic discussion).

Lithology

The Torreya lithology is typically an argillaceous, fine-grained sand/finely sandy clay that is variably calcareous and dolomitic. In outcrop, the carbonate component is generally absent due to leaching, and the physical appearance of the Torreya Formation is that of an indistinctly layered, pale green, clayey, fine-grained sand to sandy clay. The quartz sand, clay, and carbonate are generally present together in varying proportions. Only a few clay beds in the Dogtown Clay Member and a few limestone intervals in the lower part of the formation contain relatively few impurities.

Subordinate lithic components of the Torreya Formation include chert (opal-cristobalite), phosphate, heavy minerals (zircon, tourmaline, rutile, apatite, staurolite, kyanite, sillimanite, and opaques [Weaver and Beck, 1977], mica, K-feldspar, pyrite, wad (hydrated MnO_2), invertebrate macrofossils of various kinds (mostly molds and casts), petrified wood, fossil bone material, and rare calcareous and siliceous microfossils.

Quartz sand is the dominant component of the lithology and is commonly fine-grained and well-sorted. However, the grain-size of the quartz ranges from silt through medium, with a few reports of coarse-grained sand (coarse-grained, pebbly sand is contained in the overlying Miccosukee Formation which Cooke [1945] included in the Hawthorne Formation). I have not observed coarse sand, quartz pebbles, or gravel in the Torreya Formation. In addition, I have not found any poorly sorted quartz sand. Instead, the quartz sand is characteristically very well sorted in the Torreya Formation.

Palygorskite and montmorillonite are the dominant clay minerals of the formation (also see Weaver and Beck, 1977, p. 71-104). Some stratigraphic intervals are strongly dominated by montmorillonite. Subordinate clay minerals include sepiolite, illite, and kaolinite.

Calcite is the dominant carbonate mineral of the formation in the type area. Dolomite is commonly present at any given site, but it is always subordinate to calcite in the section. In outcrop (excluding both large bluffs along major rivers and also deep pits and quarries), the carbonate component of the formation has commonly been leached so that the outcropping lithology typically is lacking in carbonate. In the subsurface, below the leaching zone, however, calcite is an important component of the Torreya lithology. The Torreya Formation is the only formation in the Hawthorne Group of southwestern Georgia and northernmost Florida in which calcite is an important and consistent component of the lithology of the unit. Although subsurface control in southwestern Georgia is very meager, the calcite component of the formation appears to diminish and disappear northeastward from Florida into southwestern Georgia.

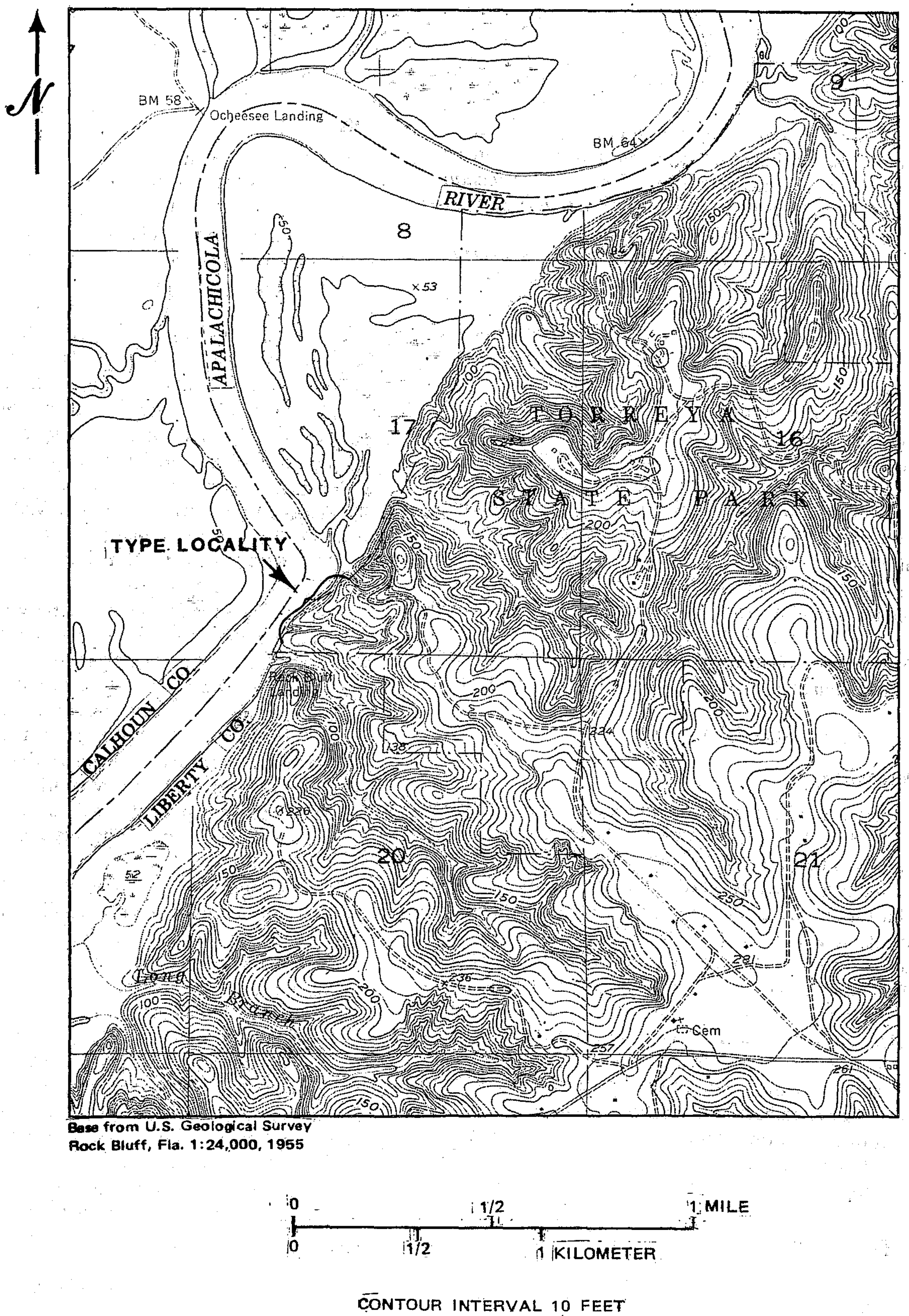


Figure 21. The type locality of the Torreya Formation of the Hawthorne Group.

Stratigraphic Relationships

The Torreya Formation is currently recognized only in the eastern panhandle of Florida east of the Apalachicola River, and in southwesternmost Georgia, in Decatur, Grady, and probably southern Thomas, Brooks, and Lowndes Counties (Fig. 22). The Torreya Formation grades laterally northeastward into variably dolomitic to noncarbonate-bearing clays and fine sands that are neither Torreya nor Marks Head in lithology.

The Torreya Formation disconformably or paraconformably overlies the Chattahoochee Formation in western Florida (Fig. 10), and is paraconformably overlain by the Chipola Formation at Alum Bluff (Banks and Hunter, 1973; Huddlestun, 1984). The contact relationships with the Chattahoochee Formation in Georgia are not established at this time. Where the upper part of the Chattahoochee Formation may be dominated by argillaceous, fine-grained sand, the contact with the overlying Torreya Formation, or its stratigraphic equivalent, may be paraconformable or apparently gradational. Similarly, the upper contact of the Torreya Formation in Georgia is not clearly established at this time. The Meigs Member of the Coosawhatchie Formation, exposed in the vicinity of Meigs in Thomas County, appears to extend into Gadsden County in the Gulf Trough. Where the contact between the Torreya and probable Meigs Member is exposed in the vicinity of Dogtown in Gadsden County, Florida, this contact appears to be conformable, or paraconformable. However, in cores farther south in Gadsden County, Berryville-type clay occurs in the stratigraphic position of the Meigs Member, and the contact between the Torreya and the Meigs Member also appears to be paraconformable. Elsewhere in southwestern Georgia the Torreya Formation is disconformably overlain by the Miccosukee Formation of late Pliocene age.

The Torreya Formation is distinguished from the other formations of the Hawthorne Group in being consistently calcareous (with subordinate dolomite) and consistently but variably fossiliferous in its type area. The deposits that are stratigraphically equivalent to the Torreya Formation farther to the northeast in the Gulf Trough in Georgia lack carbonate and are lithologically heterogeneous. The clay mineral suite of these deposits is variable and locally, or in parts of the sections, dominated by kaolinite, smectite, or palygorskite. Smectite is invariably present but kaolinite and palygorskite may be absent from parts of the sections or at some sites. In the Torreya Formation, on the other hand, the clay mineral suite is dominated by palygorskite and smectite, and either clay mineral may be absent in any part of the sections, or be the only clay mineral present (Weaver and Beck, 1977). The Torreya Formation is distinguished from the stratigraphically equivalent lower Miocene dolostone, clay and sand of the Alapaha and Suwannee Rivers area in that the carbonate of the unnamed formation consists of dolomite and only minor and scattered occurrences of fossiliferous sediments are known. In addition, there are thick beds of massive, unfossiliferous dolostone in the unnamed formation whereas dolostone comprises only a trace of the lithology of the Torreya Formation. The Torreya Formation and the stratigraphically equivalent Marks Head Formation are not known to be contiguous.

The overlying Meigs Member of the Coosawhatchie Formation is not known to contain carbonate and is more siliceous (and diatomaceous) than the Torreya Formation. The Meigs Member characteristically contains very thin bedding to lamination in the clay and fine sand beds whereas the Torreya Formation is generally thickbedded and massive.

The Torreya Formation is thickest in the Apalachicola Embayment where it averages about 200 feet (61 m). The thickest known section of Torreya Formation is 227 feet (69 m) near the axis of the Apalachicola Embayment in the Florida Geological Survey core Suber 1 (W-7539) in Gadsden County, Florida. The Torreya Formation thins abruptly at the eastern edge of the embayment in the vicinity of the Ochlockonee River. To the east of the embayment in Leon, Jefferson, and Madison Counties, Florida, the thickness of the Torreya Formation ranges between 50 and 100 feet (15 and 30 m). There is no thickness information of the Torreya Formation in Georgia.

The environment of deposition of the Torreya Formation was marine, nearshore, brackish to hypersaline. The common occurrence of intraclast beds in the Torreya Formation indicates that the sea bottom was frequently disturbed by periods of high wave or current energy. The low diversity of the benthic foraminifera (planktonic foraminifera are absent) and the occurrence of abundant *Ammonia beccarii* and *Elphidium* spp. (Brooks and others, 1966, p. 64) in the Torreya Formation indicates brackish water conditions. This conclusion is supported by the low diversity of the molluscan fauna and the prominence of oysters and scallops (Brooks and others, 1966, p. 64; Hunter and Huddlestun, 1982, p. 211-223), and by the occurrence of land mammal fossils in the Torreya Formation (Simpson, 1930, 1932; Colbert, 1932; Olsen, 1964a, 1964b; Hunter and Huddlestun, 1982, p. 218-219).

The clay mineral suite of the Torreya Formation is compatible with the paleontological evidence for the paleoenvironment. The clay mineral suite of the formation is dominated by palygorskite and smectite (see Weaver and Beck, 1977, p. 71-104). According to Weaver and Beck (1977), palygorskite originated in warm, coastal brackish to schizohaline water where the salinity of the watermass varied from hypersaline to brackish (schizohaline).

Age

The age of the Torreya Formation is early to middle Burdigalian, approximately in the middle part of the early Miocene (Hunter and Huddlestun, 1982). In Florida, the Torreya Formation contains two Hemingfordian land mammal faunas (Simpson, 1930, 1932; Olsen, 1964; Tedford and Hunter, 1984) that are believed to be between 17 and 19

Figure 22. The areal distribution (outcrop and subcrop) of the Torreya Formation in Georgia.

million years old, indicating equivalency with planktonic foraminiferal Zones N6 or early N7 of Blow (1969) (Pl. 1). This is supported by stratigraphic evidence in that the Chipola Formation, which contains a late N7 planktonic foraminiferal fauna (Akers, 1972; Huddlestun, 1984), overlies the Torreya Formation with discontinuity.

SOPCHOPPY MEMBER OF THE TORREYA FORMATION

The "Sopchoppy limestone", informally introduced by Dall (1892, p. 119-120) and abandoned by Matson and Clapp (1909, p. 102), was informally reintroduced as the Sopchoppy Member of the Torreya Formation by Huddlestun and Hunter (1982, p. 210). The Sopchoppy Member is recognized in this paper as a formal lithostratigraphic unit and a subdivision of the Torreya Formation. The Sopchoppy Member previously has been included in the Chipola Formation (Matson and Clapp, 1909, p. 102, 103; Gardner, 1926) and the Hawthorne Formation (Cooke and Mossom, 1929; Weaver and Beck, 1977).

Type Locality

The name Sopchoppy was taken from the Sopchoppy River in Wakulla County, Florida. The type locality and type section, or unit-stratotype (holostratotype), of the Sopchoppy Member are herein designated as the exposures of fossiliferous, sandy limestone in Mill Creek adjacent to and under the bridge of an unimproved dirt road in the center of Sec. 34, T4S, R3W, approximately 7 miles (11 km) northwest of the village of Sopchoppy. The type locality is less than 0.1 mile (between 100 and 200 m) from the Sopchoppy River.

Lithology

The Sopchoppy Member was originally called a limestone by Dall (1892): It is my observation, however, that the Sopchoppy Member consists of several lithofacies along the Sopchoppy River. The two dominant lithofacies include a sandy, fossiliferous limestone (the original concept of the unit) and a tough, phosphatic, dolomitic sand. The two lithofacies are not completely exclusive.

The limestone lithofacies consists of a moldic, fossiliferous, variably sandy, variably phosphatic limestone. Characteristically the limestone is coarsely fossiliferous and most of the fossils consist of molds and impressions of pelecypods and gastropods. The foraminifera *Sorites* is also conspicuous in the limestone at the type locality. Not only has aragonite been dissolved from the shells but also calcite has been dissolved from pecten shells and foraminiferal tests. The only calcitic fossils that have not been visibly altered are the sand dollars (*Abertella floridana*) and the pelecypod *Carolia floridana.*

A clay component is not readily apparent in the limestone on casual inspection. However, Weaver and Beck (1977, p. 42) reported that the interstitial clay mineral components of the member (the clay sample came from the limestone at the type locality on Mill Creek) include palygorskite and trace amounts of montmorillonite.

The lithology of the phosphatic, dolomitic sand lithofacies appears to be uniform. Fine-grained, well-sorted quartz sand appears to dominate the lithology, but dolomite may occur in equal amounts. Fine- to very fine-grained, black to brown pelletal phosphate is scattered through the sediment. Larger grains, over 2 or 3 millimeters in diameter, are also present but are rare. The sediment is not noticeably argillaceous although it is probable that clay minerals occur intersitially.

The dolomitic fine-grained sand is very resistant to erosion and forms vertical faces along the river and along small tributary stream banks. Incision of the streams into this deposit produces deep, almost vertical-walled ravines that make access difficult. The dolomitic fine-grained sand is massive and shows no layering. It is bioturbated and appears to be incompletely to moderately well mixed. Small impressions of pelecypods are present but rare in this lithofacies, and the sediment is largely nonfossiliferous.

In Gadsden County, Florida, the only part of the Torreya Formation that is lithologically similar to the Sopchoppy Member is a dolomitic, phosphatic sand lithofacies that overlies the lower sandy limestone of the formation and underlies the Dogtown Clay Member. Like the Sopchoppy, the sediments of this lithofacies are characterized by vaguely layered or bioturbated, phosphatic, dolomitic sand with scattered intervals of limestone or dolostone. As a result of the apparent similarity, the dolomitic, phosphatic, sandy lithofacies underlying the Dogtown Clay Member in Gadsden County, Florida, is considered to be the Sopchoppy Member. As thus defined, the Sopchoppy Member probably extends some distance into southwestern Georgia in Decatur and Grady Counties, and underlies the Dogtown Clay Member (see Fig. 10).

Stratigraphic Relationships

The Sopchoppy Member of the Torreya Formation is exposed discontinuously along the Sopchoppy River from the vicinity of the village of Sopchoppy, for about 8 miles (13 km) up the Sopchoppy River and in tributary streams near the river. Outside this area there are no known exposures of the unit. The member appears to be restricted to the Apalachicola Embayment and its flanks, and appears to occur as far north as Gadsden County, Florida, and southern Decatur and Grady Counties, Georgia.

Neither the upper nor lower boundaries of the member are exposed in the type area. However, based on physical correlation with the Torreya Formation in Gadsden County, the Sopchoppy Member appears to be conformably overlain by the Dogtown Clay Member of the Torreya Formation, and is gradationally underlain by the lower fossiliferous, sandy limestones of the Torreya.

The Sopchoppy Member of the Torreya Formation is distinguished from the rest of the Torreya Formation in having a consistent carbonate component. The carbonate of the Sopchoppy Member is dominated by interstitial dolomite with subordinate occurrences of interstitial calcite, calcitic fossils, and limestone beds. Phosphate is also a consistent component of the Sopchoppy Member but appears to be lacking or present only in minor scattered concentrations in the rest of the Torreya Formation.

The greatest exposed thickness of the Sopchoppy Member in the type area is approximately 10 feet (3 m). Approximately 7 feet (2 m) is exposed at the type locality on Mill Creek.

As with the rest of the Torreya Formation, the environment of deposition of the Sopchoppy Member was marine, nearshore, and brackish to hypersaline. The presence of sand dollars (*Abertella floridana*), low diversity molluscan faunas (Gardner, 1926), and low diversity benthic foraminiferal faunas dominated by *Elphidium* spp., in addition to the reported occurrence of palygorskite (Weaver and Beck, 1977, p. 42), are all consistent with the above interpretation.

Age

No age studies of the Sopchoppy Member have been undertaken at this time, and the member is not known to contain any taxa restricted to narrow intervals of time. Therefore, in this report, the Sopchoppy Member of the Torreya Formation is assigned the same age as the rest of the formation, and is believed to be early Miocene (early to middle Burdigalian) (Pl. 1).

DOGTOWN CLAY MEMBER OF THE TORREYA FORMATION

Definition

The Dogtown Clay Member of the Torreya Formation was informally introduced by Huddlestun and Hunter (1982, p. 210) for the clay-rich interval in the upper part of the Torreya Formation in northern Liberty, Gadsden, and Leon Counties, Florida, and southern Decatur County, Georgia. Core and field information indicates that the Dogtown Clay Member is a laterally continuous unit across its area of occurrence (also see Sellards and Gunter, 1909). It grades upward into undifferentiated Torreya Formation and downward probably into the Sopchoppy Member, both the overlying and underlying Torreya being dominantly quartz sand. The commercial fuller's earth of Gadsden County, Florida, and Decatur County, Georgia, occurs within the Dogtown Clay Member, but only a small part of the Dogtown Clay Member contains a commercial-grade fuller's earth. In places where the commercial fuller's earth beds are separated into lower and upper beds, the intervening deposits are mainly sand, calcareous sand, limestone, dolomitic clay, and clayey dolostone.

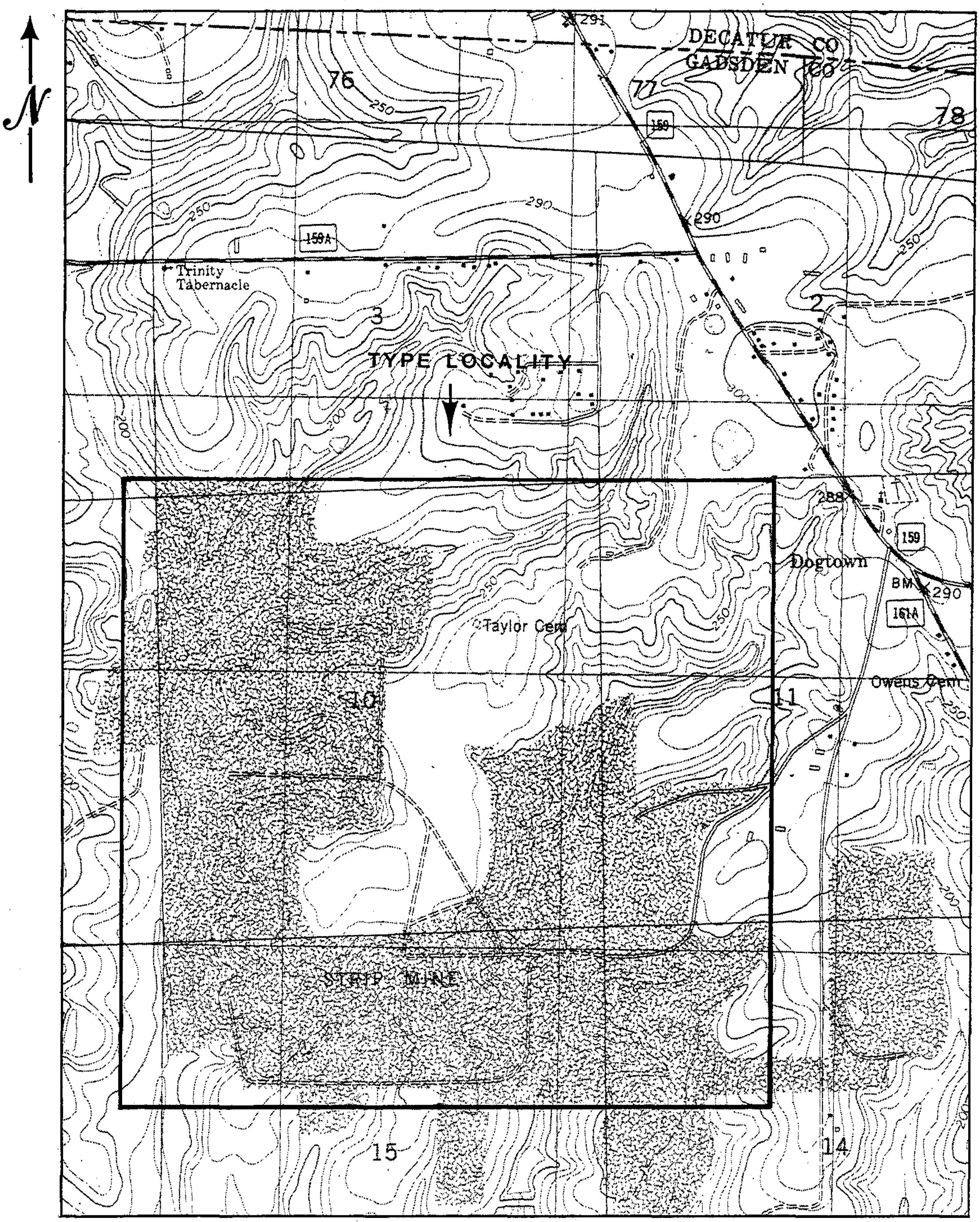
Type Locality

The name Dogtown was taken from the community of Dogtown in Gadsden County, Florida. The type locality of the Dogtown Clay Member of the Torreya Formation is the LaCamellia mine, 1 to 2 miles (1.5 to 3 km) southwest of Dogtown, and located in Sec. 15, T3N, R3W in Gadsden County (Fig. 23). The type section, or unit-stratotype (holostratotype), is that section of the Dogtown Clay Member exposed in the LaCamellia mine. Other reference localities and parastratotypes for the member include the exposures of the fuller's earth beds in the Gunn Farm mine of the Milwhite Company on the Florida-Georgia state line, 0.3 mile (0.5 km) west of highway Fla. 65 (Ga. 241), 9 miles (14 km) north of Quincy, Florida (also see Olson, 1966, p. 31-34, p. 58-65; Weaver and Beck, 1977, p. 100); and the exposure in the Midway mine, approximately 0.5 mile (0.8 km) northeast of the community of Midway in NE 1/4, Sec. 8, and SE 1/4, Sec. 5, T1N, R2W in Gadsden County, Florida (also see Weaver and Beck, 1977, p. 98-100).

Lithology

The lithology of the Dogtown Clay Member of the Torreya Formation is primarily clay (see Weaver and Beck, 1977, p. 71-97 for a thorough description and discussion of the member at its type locality). Palygorskite is the characteristic clay mineral of the member, but in specific beds montmorillonite may dominate the clay mineral suite. Sepiolite and illite are subordinate clay mineral components. In addition, the relative portions of the clay minerals fluctuate from bed to bed (Weaver and Beck, 1977, p. 73-104; Olson and others, 1966, p. 69-70). Other subordinate lithic components include quartz sand, calcite, dolomite, phosphate, mica, K-feldspar, pyrite, heavy minerals, rare fossil bones, and rare and scattered petrified wood. Locally, quartz sand, limestone or dolostone are the dominant lithologies present in specific beds. Clay beds, especially in the upper fuller's earth bed, may grade laterally into sandy clay or argillaceous sand (Weaver and Beck, 1977, p. 92-97).

The purity of the clay in the Dogtown Clay Member is variable. Relatively pure, palygorskite-rich fuller's earth is not present everywhere, however, and even minor amounts of quartz sand or carbonate render it noncommercial. The bedding characteristics of the clay vary from blocky, massive, and structureless; through massive, burrowed, and biologically disrupted (bioturbated); to thinly layered, laminated, and fissile. Where the clay is shaley, there is commonly a powdering of silt or very fine sand along the bedding planes or in lenses or patches. The purest grade fuller's earth clays are generally thin layered and laminated (Weaver and Beck, 1977, p. 71-104). In places the clay shows desiccation cracks, and intraclast zones are locally conspicuous.



Base from U.S. Geological Survey
Dogtown, Ga.-Fla. 1:24,000, 1982

0 1/2 1 MILE
0 1/2 1 KILOMETER

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 23. The type locality of the Dogtown Clay Member of the Torreya Formation.

Stratigraphic Relationships

The Dogtown Clay Member of the Torreya Formation appears to be restricted to the interior of the Apalachicola Embayment in Florida, and the southern part of the Gulf Trough and flanks in Georgia (Fig. 24). The member is present in northern Liberty County, Gadsden County, and Leon County, Florida, and southern Decatur and Grady Counties, Georgia. The northern limit of the Dogtown Clay Member in Georgia is not established at this time because of insufficient core control. The fuller's earth deposits in northern Thomas County are not included in the Dogtown Clay Member but are a part of the Miegs Member of the Coosawhatchie Formation.

Within the Apalachicola Embayment in Florida, the Dogtown Clay Member occurs within the Torreya Formation. It gradationally overlies sediments tentatively assigned to the Sopchoppy Member, and is conformably overlain by fossiliferous, calcareous sediments of undifferentiated Torreya Formation. On the flanks of the Apalachicola Embayment in Leon County, Florida, however, the Dogtown Clay Member is disconformably overlain by either the Miccosukee Formation or the Jackson Bluff Formation.

The Dogtown Clay Member is a mappable clay body that occurs at or near the top of the Torreya Formation. It is distinguishable from the rest of the Torreya, which consists of variably calcareous or dolomitic, argillaceous, fine-grained sand with subordinate limestone, in consisting principally of clay with minor, local occurrences of sand and limestone.

The thickness of the Dogtown Clay Member is variable. Part of the variation in thickness must be due to lateral gradation of Dogtown clay lithology into sand beds adjacent to the top and bottom of the member. The Dogtown Clay Member is approximately 27 feet (8 m) thick at the type locality. The greatest known thickness of the member is 40.5 feet (12 m) in the Florida Geologic Survey core Suber 1 (W-7539) near the axis of the Apalachicola Embayment in Gadsden County. The known thickness range of the Dogtown Clay Member in Gadsden County is 15.5 feet (4.7 m) to 40.5 feet (12 m), and the average thickness is approximately 27 feet (8 m).

The environment of deposition of the Dogtown Clay Member of the Torreya Formation was marine, very near shore, and brackish to hypersaline. The presence of land mammal fossils (Simpson, 1930, 1932; Hunter and Huddlestun, 1982, p. 218) associated with the Dogtown Clay Member indicates close proximity to land.

Age

The Dogtown Clay Member of the Torreya Formation is locally fossiliferous and is included in the *Carolia floridana* zone of Hunter and Huddlestun (1982, p. 215-216). The commercial fuller's earth beds are not normally fossiliferous, but the sands, limestones, and dolostones that occur between the fuller's earth beds commonly are. In addition, Weaver and Beck (1977) reported that the upper fuller's earth bed locally grades laterally into fossiliferous sediments. The principal fossils found in the Dogtown Clay Member are mollusks, most of which occur as molds and casts. *Carolia floridana*, oysters, and *Chlamys* sp. near *C. acanikos*, however, are generally well preserved. Weaver and Beck (1977) reported sponge spicules and diatoms from the fuller's earth beds in the Attapulgus area in Decatur County, Georgia. Hemingfordian land mammal faunas have been reported and described by Simpson (1932) from the deposits defined here as the Dogtown Clay Member, and are now known as the Midway Fauna (Tedford and Hunter, 1984). The stratigraphic interval discussed by Simpson (1932) includes the sandy beds between the two fuller's earth beds as well as the overlying sands and limestones of the *Chlamys nematopleura* zone (Hunter and Huddlestun, 1982, p. 216-217) of the Torreya Formation.

The Dogtown Clay Member of the Torreya Formation is assumed here to be the same age as the rest of the Torreya Formation; that is, early Miocene (early to middle Burdigalian), equivalent to Zone N6 of Blow (1969) (see Pl. 1).

UNNAMED DOLOSTONE, CLAY, AND SAND OF THE HAWTHORNE GROUP

(Echols County)

Definition

This unnamed formation consists variably of dolostone, clay, and sand. It crops out along the lower Alapaha and Alapahoochee Rivers in the vicinity of Jennings in Hamilton County, Florida. It is not known to crop out in Georgia, but is believed to dip northeastward into the Southeast Georgia Embayment and to underlie the Statenville Formation in Echols County (Figs. 10 and 25, Pl. 1).

The deposits assigned to the unnamed dolostone, clay, and sand formation in this report were included in the Glendon Limestone (Mossom, 1925, p. 138-139), Tampa Limestone (Cooke and Mosson, 1929, p. 91) and Hawthorne Formation (Cooke, 1945, p. 149-150, 152-153; Olson, 1966, p. 80-83) in the past.

Reference Localities

In outcrop, the unnamed dolostone, clay, and sand formation is best exposed near the confluence of the Alapaha and Alapahoochee Rivers in Sec. 1, T2N, R12E, 1.5 miles (2.4 km) east of Jennings in Hamilton County, Florida, 1.25 miles (2 km) south of the Georgia-Florida state line. The formation is exposed for some distance along both rivers above their junction, and discontinuously for at least 2 miles (3.2 km) down the Alapaha River. The unnamed formation is also present in the interval 87 feet to 155 feet in the Florida Geological Survey core Betty 1 (W-15121), taken in NE 1/4, NW 1/4, Sec. 3, T2N, R12E at Jennings. The unnamed dolostone, clay, and sand formation crops out along the

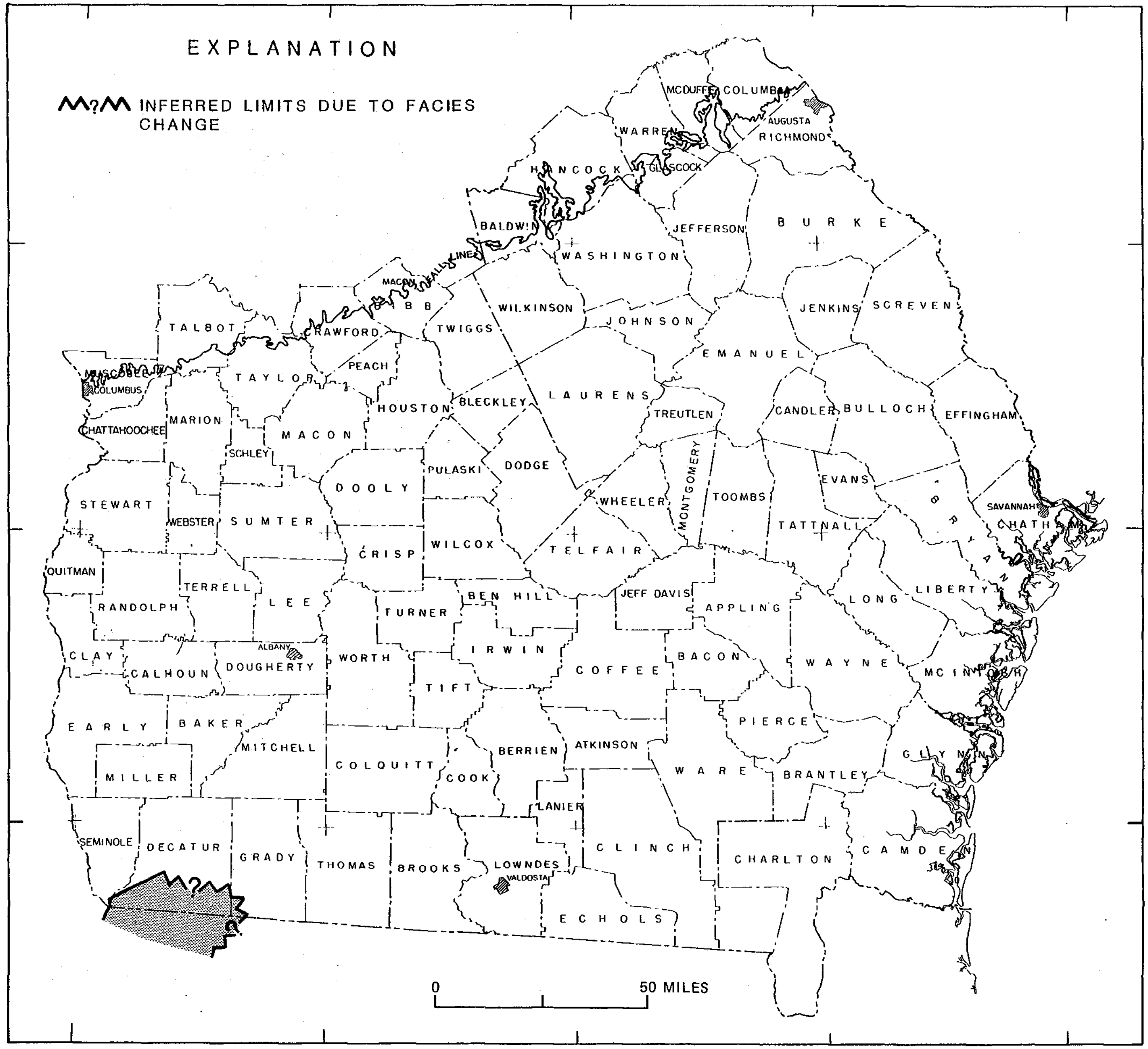


Figure 24. The areal distribution (outcrop and subcrop) of the Dogtown Clay Member of the Torreya Formation in Georgia.

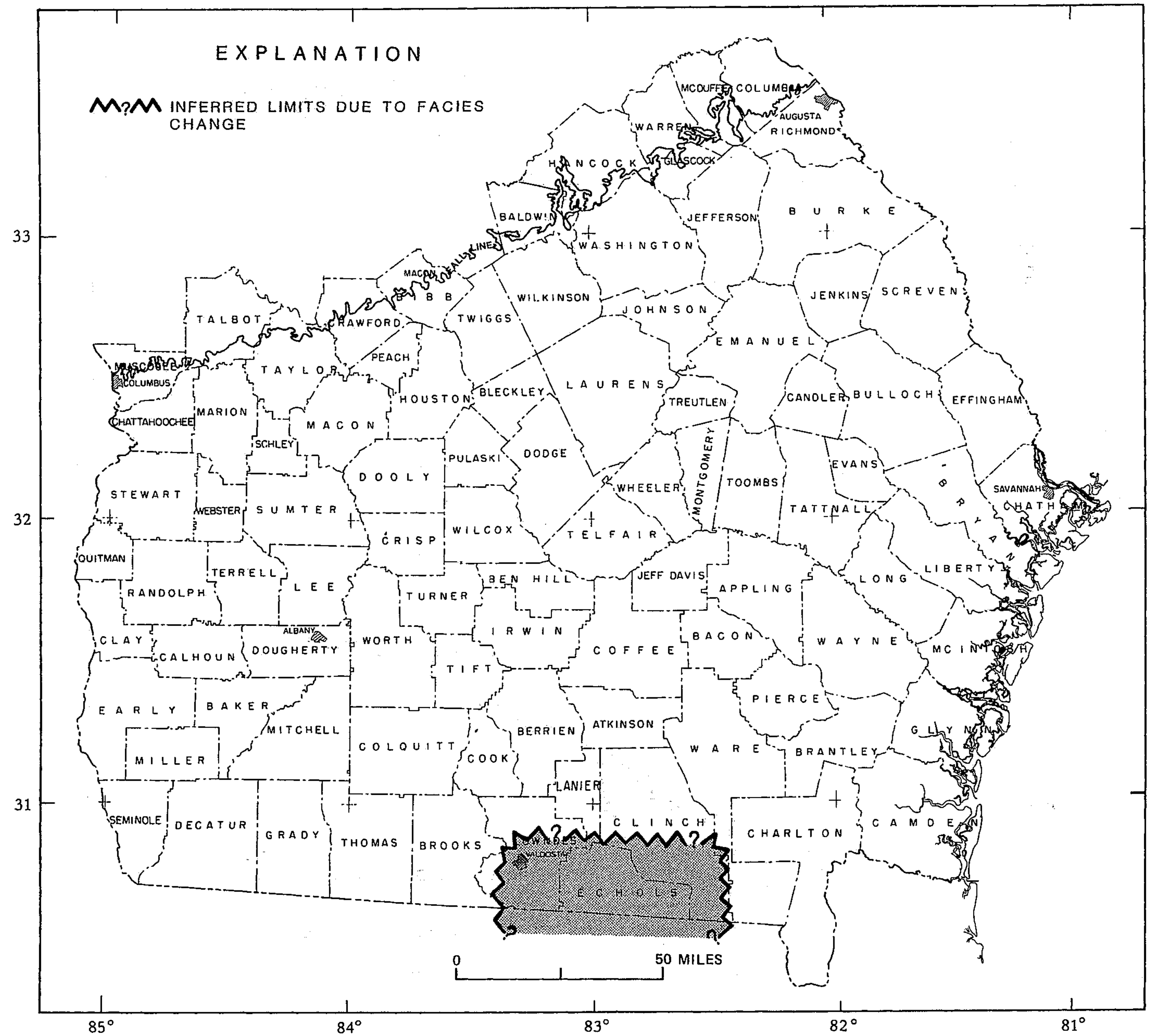


Figure 25. The inferred areal distribution (subcrop) of the unnamed lower Miocene dolostone, clay and sand of the Hawthorne Group in Georgia.

upper Suwannee River from the vicinity of the US 41 bridge east of White Springs, and extends for an unspecified distance upriver.

Lithology

In outcrop in Hamilton County, Florida, the unnamed dolostone, clay, and sand formation consists of thick-bedded, massive, tan to buff, saccharoidal dolostone with interbeds of argillaceous fine-grained sand and finely sandy clay. The massive dolostone is the most conspicuous and characteristic component of the formation. In general, the dolostone is thick-bedded, with some beds as much as 10 feet (3 m) thick. Intraformational, dolomite-cemented dolostone rubble or intraclast zones are locally conspicuous. Well-sorted, fine-grained sand and finely sandy clay are thinly and vaguely bedded. Farther down the Alapaha River in Sec. 7, T2N, R31E, there are some moldic, fossiliferous intervals in the dolostone with silica-replaced calcitic shells, and oyster (*Crassostrea normalis*) bioherms with silica-replaced shell material.

In the core Betty 1 (W-15121), approximately 2 miles (3.2 km) west of the Alapaha River outcrops, the ratio of dolostone to clay and sand is approximately 50/50. The dolostone beds range in thickness from less than 1 foot (0.3 m) to 15 feet (4.6 m), and the clay and sand beds range in thickness from approximately 1 foot (0.3 m) to 16 feet (4.9 m). The dolostone is massive and structureless with some intraclast zones and intervals of argillaceous dolostone. The clay is massive, variably dolomitic and intraclastic, and is largely sand-free. Quartz sand is a minor component of the formation in this core and is well-sorted and fine-grained. The beds of sand are massive, dolomitic, and argillaceous. The sediments are almost nonfossiliferous, and phosphate appears to be absent, in contrast to the overlying Statenville Formation.

There is some evidence that elsewhere this unnamed formation is much less dolomitic and more sandy and argillaceous. A core log presented by Olson (1966, p. 81-83) from Hamilton County, Florida, includes the stratigraphic interval of this formation. However, dolomite and dolostone are not included in the lithologic descriptions, but sand and palygorskite-bearing clay are prominent. Similarly, dolostone, although present and conspicuous, is not so prominent along the Suwannee River east of White Springs (compare with Cooke, 1945, p. 149-150; Brooks, 1966, p. 91).

In general, it appears that the lithology of this unnamed formation is variable, consisting dominantly of dolostone, clay, and sand; furthermore, in any given section or area, the proportions may vary widely. Subordinate lithic components include phosphate, chert, silicified shells, mica, and calcite. Palygorskite has been reported from sediments assigned to this unnamed formation (see Olson, 1966, p. 82).

Stratigraphic Relationships

At this time, the unnamed dolostone, clay, and sand formation is known to occur in Hamilton and Columbia Counties, Florida (Fig. 25). It is present in outcrop immediately south of the Georgia-Florida state line in Hamilton County, north of which it is suspected that the unnamed formation dips into the subsurface of Echols County. The northern limits of this formation are not yet known. The eastern limits must occur in eastern Columbia or western Baker Counties, Florida, because the Marks Head Formation occurs in the same stratigraphic position in the St. Marys River area in Florida and Georgia. The western limits of the unnamed formation appear to be the eastern part of the Florida Platform in Lowndes County, Georgia, and Hamilton County, Florida.

The unnamed dolostone, clay, and sand formation overlies the Parachucla Formation at White Springs on the Suwannee River in Columbia County, Florida, and a variably fossiliferous, sandy limestone in Hamilton County that appears to be assignable to the Parachucla Formation. The unnamed formation is overlain with sharp contact by the Statenville Formation in the core Betty 1 (W-15121), also in Hamilton County.

The unnamed dolostone, clay and sand formation is distinguished from the underlying Parachucla Formation in consisting of argillaceous fine sand with thick beds of massive dolostone that are rarely fossiliferous, and locally consists of sandy fossiliferous limestone. It is distinguishable from the stratigraphically equivalent Marks Head Formation in containing thick beds of massive dolostone and in being relatively nonphosphatic. Much of the dolomite in the Marks Head Formation is interstitial and thick beds of dolostone are not known to occur in the formation. The Marks Head Formation is consistently phosphatic. The unnamed dolostone, clay and sand is distinguishable from the stratigraphically equivalent Torreya Formation in being dolomitic rather than calcareous, in containing beds of nonfossiliferous dolostone rather than limestone, and in being generally nonfossiliferous rather than variably fossiliferous.

Approximately 10 to 15 feet (3 to 4.5 m) of the unnamed dolostone, clay, and sand are present in outcrop near the confluence of the Alapaha and Alapahoochee Rivers in Hamilton County, but neither contact is exposed there. The formation is 68 feet (21 m) thick in the core Betty 1 (W-15121). No other thickness information is available at this time.

The unnamed dolostone, clay and sand formation is distinguishable from the overlying Statenville Formation in being generally thick-bedded and massive, in containing little phosphate, and containing only fine-grained sand whereas the Statenville is prominently bedded and cross-bedded in the lower part, consistently phosphatic and locally abundantly phosphatic, and more coarsely sandy with scattered occurrences of quartz pebbles. The upper part of the Statenville Formation is more argillaceous than the unnamed dolostone, clay and sand and contains no carbonate.

Age

No paleontological criteria are available on which to base an age assessment of this formation at the present time. Stratigraphic position and lithological similarity, however, suggest a close stratigraphic relationship with the Torreya Formation on the western side of the Florida Platform, and with the Marks Head Formation of the Southeast Georgia Embayment. On this basis, it is suggested that the unnamed dolostone, clay, and sand formation is early Miocene (early to middle Burdigalian), and stratigraphically equivalent to the Torreya and Marks Head Formation (Fig. 10 and Pl. 1).

COOSAWHATCHIE FORMATION OF THE HAWTHORNE GROUP (formalized)

Definition

The Coosawhatchie Formation is herein formalized and raised in rank to that of formation. The Coosawhatchie Formation of this report is predominantly a phosphatic clay, sandy clay, argillaceous sand, and phosphorite that originally was called the Coosawhatchie clay member of the Hawthorne Formation (Heron, Robinson, and Johnson, 1965, p. 24). The Coosawhatchie was informally named for a distinctive clay deposit exposed in a railroad cut and at Dawsons Landing near the community of Coosawhatchie in Jasper County, South Carolina (Heron, Robinson, and Johnson, 1965, p. 24). The informal name has subsequently been adopted and extended into Georgia (Abbott, 1974; Ernissee, Abbott, and Huddlestun, 1977; Abbott and Andrews, 1979; Abbott and Huddlestun, 1980; Huddlestun, 1981). The Coosawhatchie is formally recognized as a formation in this report because of its lithologic distinctiveness and its widespread occurrence in southern South Carolina, Georgia, and northeastern Florida.

Previously, along the Savannah River in Effingham County, Georgia, the Coosawhatchie Formation of this report was included in undifferentiated Miocene by Veatch and Stephenson (1911, p. 375) and in the Hawthorne Formation (Cooke, 1936, p. 109; Georgia Geological Survey, 1976). Along the Altamaha River in Georgia, at and downstream from Bugs Bluff in Wayne County, the unit referred to here as Coosawhatchie Formation was variously included in the Alum Bluff Formation, Alum Bluff Formation?, and "Miocene or Oligocene?" by Veatch and Stephenson (1911, p. 360, 376, 377, 412-413), and in the Hawthorne Formation by Cooke (1943, p. 95, 100).

The stratotype of the Coosawhatchie Formation at Dawson's Landing on the Coosawhatchie River, South Carolina, was referred to the Parachucla Formation by Sloan (1908, p. 346).

The Coosawhatchie Formation is divided into five formal members: the Tybee Phosphorite Member (new name), the Berryville Clay Member (new name), the Ebenezer Member (new name), the Meigs Member (new name), and the Charlton Member. These members will be discussed separately.

Type Section

The name Coosawhatchie is derived from the community of Coosawhatchie in Jasper County, South Carolina (Heron, Robinson, and Johnson, 1965, p. 24). Heron, Robinson, and Johnson (1965) listed two localities where the Coosawhatchie clay was known to crop out, "exposures in the Atlantic Coast Line cut south of Coosawhatchie" and "Dawson's Landing on Coosawhatchie River." Although they indicated that their main reference locality was the railroad cut, Dawsons Landing is herein designated the type locality of the Coosawhatchie Formation because the formation there is better exposed, better preserved, more accessible than in the railroad cut, and has been used more as a reference locality than the railroad cut (Abbott, 1974; Ernissee, Abbott, and Huddlestun, 1977; Abbott and Andrews, 1979). The unit-stratotype (holostratotype), of the Coosawhatchie Formation is that section of the formation exposed in the low bluff at Dawsons Landing, located on the Coosawhatchie River 2.5 miles (4 km) south of the community of Coosawhatchie in Jasper County, South Carolina (Fig. 26; also see Abbott and Andrews, 1979, p. 226-227, Fig. 1). In addition to the exposure at the type locality, the interval 3 feet to 30 feet in the Dawsons Landing core taken by the South Carolina Geological Survey is herein designated a parastratotype of the formation. The core site is approximately 300 feet (91 m) from the bluff at the landing.

The unit-stratotype of the Coosawhatchie Formation exposes only 13 feet (4 m) of the formation (Abbott and Andrews, 1979, p. 227), and only the Berryville Clay Member of the Coosawhatchie Formation is present at the type locality. Although discontinuous, the section of the Coosawhatchie Formation is much more complete along the Savannah River in southern Effingham County, Georgia, than it is anywhere else in outcrop. Therefore, the series of exposures in the low bluffs along the Savannah River from Frying Pan Landing downriver to the vicinity of Old Wood Landing is herein designated a reference locality and composite parastratotype of the formation (Fig. 3).

Lithology

The Coosawhatchie is a lithologically heterogeneous formation that consists dominantly of clay and sand. Clay appears to be the dominant and characteristic lithic component of the formation, but sand is also important and locally dominates the lithology. Significant minor lithic components include phosphate, phosphorite, dolostone, limestone, and calcite. Other subordinate lithic components include dolomite, mica, siliceous claystone and chert, siliceous microfossils, zeolite, and scattered vertebrate debris.

Clay (Berryville Clay Member) predominates in the relatively more offshore area, under the present coast and continental shelf. The clay grades laterally landward, or west-

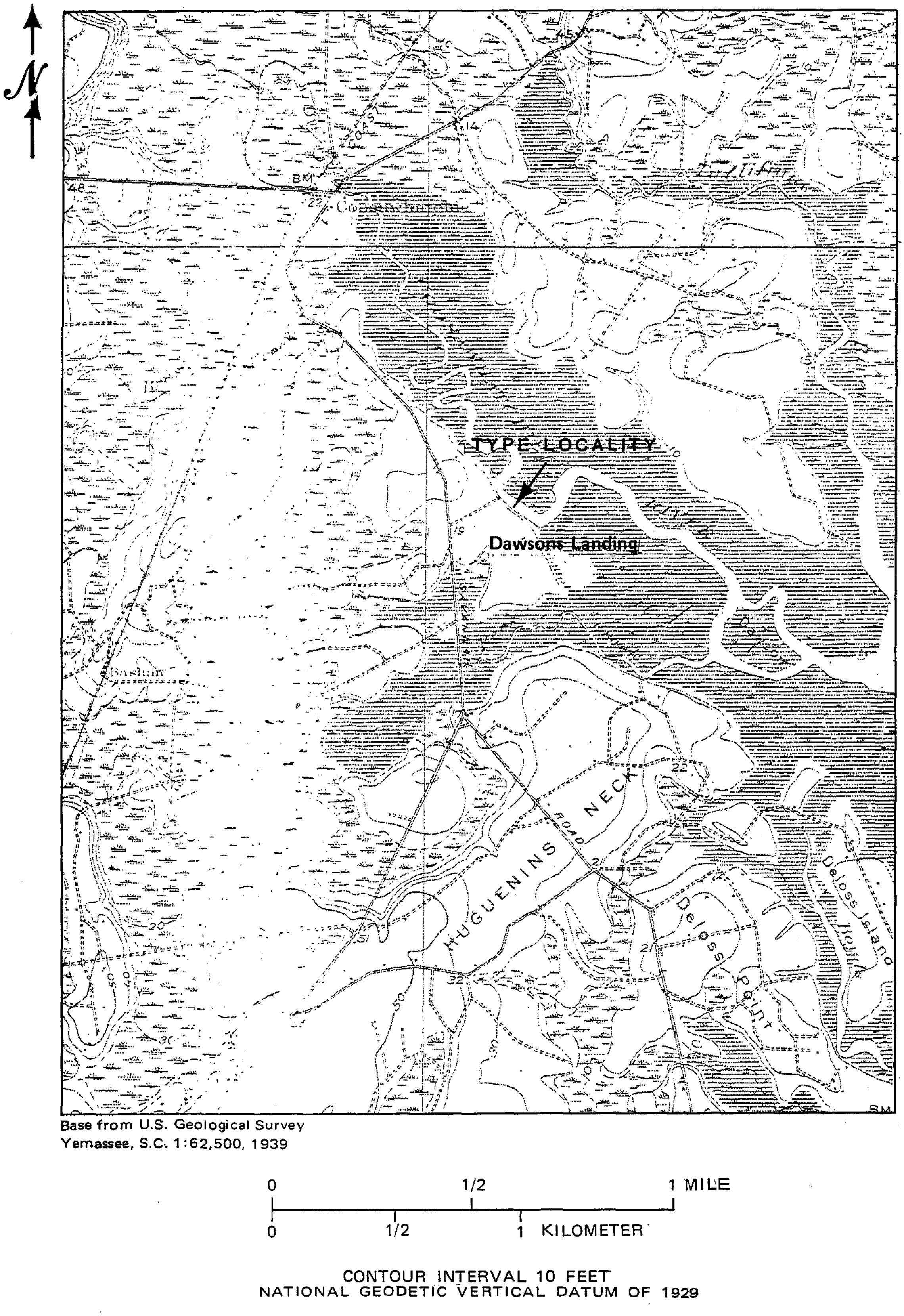


Figure 26. The type locality of the Coosawhatchie Formation of the Hawthorne Group.

ward, into more sandy, inner continental shelf, marine deposits where clay is less conspicuous (Ebenezer Member). Farther south in the Southeast Georgia Embayment, the upper part of the inner shelf sands (Ebenezer Member) grade laterally into estuarine or fluvial sandy clays, argillaceous sands and argillaceous sandstones in which the clay mineral suite is dominated by kaolinite (Altamaha Formation) (see Huddlestun, 1985).

The clay minerals of the Coosawhatchie Formation in the type area in South Carolina and along the Savannah River are dominated by smectite whereas illite, kaolinite, palygorskite, and sepiolite are all minor constituents (Heron, Robinson, and Johnson, 1965, p. 24, 26; Hetrick and Friddell, 1984; also see Weaver and Beck, 1977). Limited information indicates that the palygorskite and sepiolite content increases to the south in eastern Georgia (Hetrick and Friddell, 1984).

The carbonate content of the Coosawhatchie Formation is variable. North of the Altamaha River in Georgia, calcite and dolomite are very minor or lacking. However, the Berryville Clay Member is locally calcareous in the Savannah River area, and is generally calcareous offshore. South of the vicinity of the Altamaha River, the Coosawhatchie is slightly dolomitic with some scattered beds of dolostone. The Charlton Member in southeastern Georgia, however, is characteristically calcareous and dolomitic, and dolomite and dolostone become prevalent in the Coosawhatchie Formation in northeastern Florida.

The Coosawhatchie Formation is phosphoritic on the flanks or crests of structural highs, such as the Beaufort Arch in the northern coastal area of Georgia. Elsewhere, phosphate content of the Coosawhatchie Formation is moderate to minor.

Stratigraphic Relationships

The Coosawhatchie Formation is known to occur from southern South Carolina southward into northeastern Florida (Fig. 27). In the Savannah River area of Georgia, the western limit of the Coosawhatchie Formation is controlled by erosional truncation, and the formation extends updip only to the central part of Effingham County. Farther south in the Southeast Georgia Embayment area, the Coosawhatchie occurs as far west as the Ohoopee River area, where the Meigs Member crops out. The lower part of the Coosawhatchie Formation grades laterally westward into the Meigs Member and the upper part grades into the Altamaha Formation in the vicinity of the Orangeburg Escarpment. Farther south, the Coosawhatchie Formation underlies the St. Marys River area in Georgia and Florida, and appears to grade laterally westward into the Statenville Formation of the upper Suwannee River area (Fig. 11, Pl. 4). The Coosawhatchie Formation underlies most of the continental shelf of Georgia.

The Coosawhatchie Formation disconformably or paraconformably overlies the Marks Head Formation in Georgia, and paraconformably overlies the Cooper Formation on the outer continental shelf in the core AMCOR 6002 (Figs. 10 and 11; Pls. 2 and 3). The Coosawhatchie is generally overlain disconformably by the Cypresshead Formation in Georgia but is locally overlain disconformably by the Raysor Formation, unnamed Pliocene shelly sand, Wabasso beds, or Satilla Formation. In the core AMCOR 6002 on the outer continental shelf of Georgia, the Coosawhatchie Formation is overlain by undifferentiated upper Miocene sands of the Hawthorne Group (Pls. 2 and 3).

The Coosawhatchie Formation is distinguished from the underlying Marks Head Formation in consisting of olive-gray, phosphatic clays or brown phosphorite in the lower part and micaceous, slightly phosphatic, argillaceous, fine-grained sand in the upper part. In contrast, the Marks Head Formation consists of lighter colored phosphatic, slightly dolomitic, argillaceous sand to finely sandy clay. The clays of the Coosawhatchie differ in physical properties from that of the Marks Head because the clay mineral suite of the Coosawhatchie Formation is dominated by smectite with minor sepiolite and illite whereas the clay mineral suite of the Marks Head Formation is dominated by palygorskite and smectite. Generally there is a bed of fuller's earth or dolostone at the top of the Marks Head Formation in eastern Georgia which contrasts with the overlying dark, phosphatic clay or phosphorite. In the vicinity of the Gulf Trough in the central and southwestern Coastal Plain, the Coosawhatchie Formation (Meigs Member) is distinguished from the underlying undifferentiated lower Miocene Hawthorne deposits in containing laminated to thinly bedded, siliceous, diatomaceous clay whereas the underlying deposits are lithologically heterogeneous and typically thick-bedded and massive.

The Coosawhatchie Formation (Meigs Member) is distinguished from the overlying Altamaha Formation in containing laminated to thin-bedded, finely sandy, diatomaceous, smectitic clays with sporadic occurrences of phosphate, whereas the Altamaha Formation consists typically of thick-bedded and massive, feldspathic, nonphosphatic, kaolinitic clays and very poorly sorted to well-sorted sand and sandstone. The Coosawhatchie Formation (Ebenezer Member) is distinguished from the overlying Cypresshead in eastern Georgia in being thick-bedded and massive, commonly bioturbated throughout, slightly but consistently phosphatic, slightly to very micaceous, argillaceous (with clay mainly occurring interstitially); the sand-size is consistently fine-grained and well-sorted. In contrast, the Cypresshead Formation is only locally bioturbated and is commonly bedded (thin- to thick-bedded), nonphosphatic, nonmicaceous, and of widely varying sand-size (fine- to pebble-size). In addition, the clay within the Cypresshead Formation is more commonly distributed in laminae to thin beds, rarely to thick beds, and the interstitial clay fraction of the formation is minor.

In the Savannah River area of Georgia, in southern Effingham and northern Chatham Counties, the Coosaw-

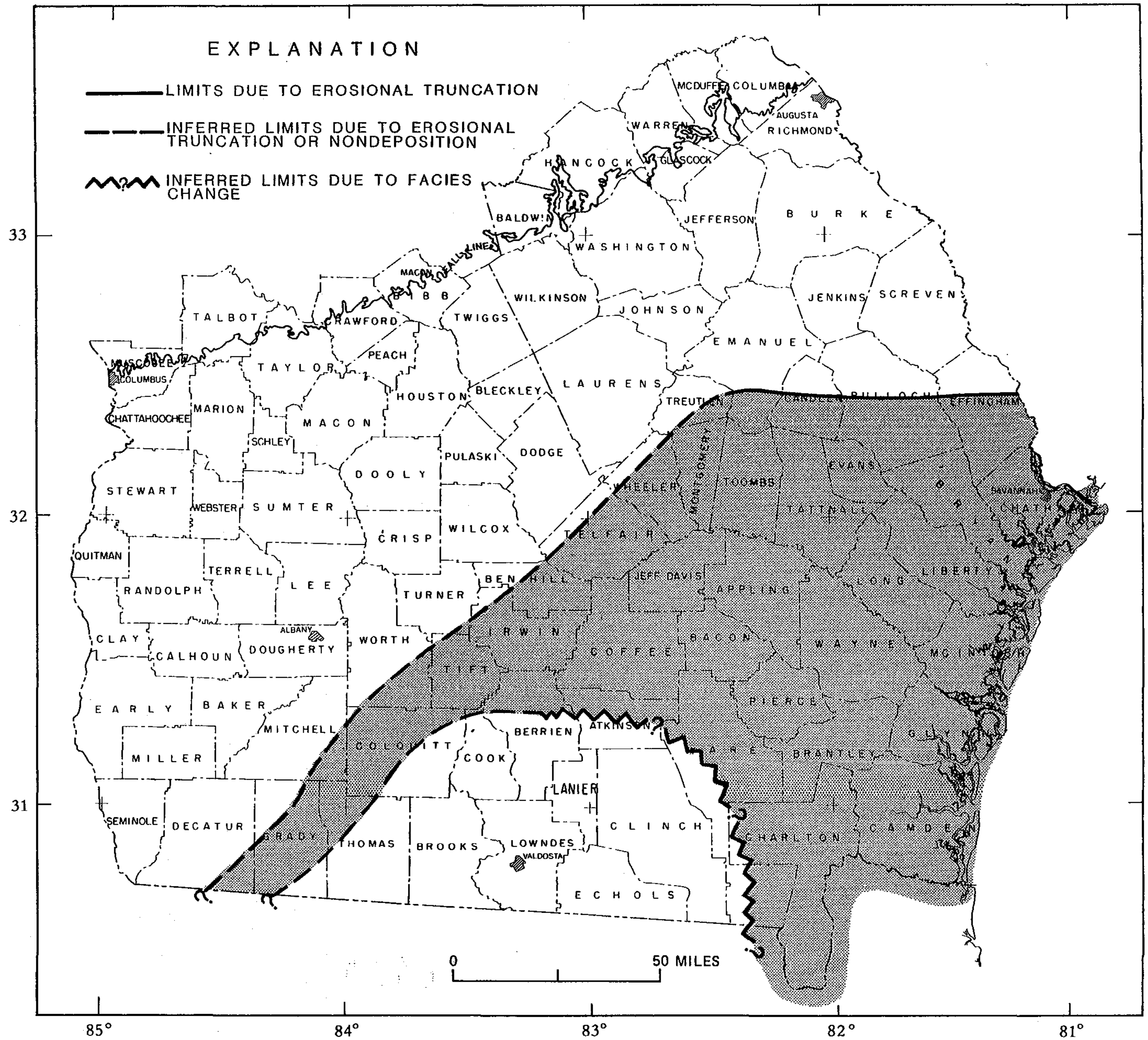


Figure 27. The areal distribution (outcrop and subcrop) of the Coosawhatchie Formation in Georgia.

hatchie Formation averages between 100 and 120 feet (30 and 37 m) thick. It is 27 feet (8 m) thick in the Dawson Landing core taken at the type locality in Jasper County, South Carolina. The Coosawhatchie Formation thickens southward and reaches its greatest known thickness in the Southeast Georgia Embayment where it is 284 feet (87 m) thick in the interval 90 feet to 374 feet in the core Cumberland Island 1 (GGS-3426) in Camden County; 275 feet (84 m) thick in the interval 51 feet to 325 feet in the core Charlton 2 (GGS-3185) at Folkston in Charlton County; 244 feet (74 m) thick in the interval 59 feet to 303 feet in the core Wayne 2 (GGS-3512) in Wayne County; and 175 feet (53 m) thick in the interval of approximately 57 feet to 232 feet in the core AMCOR 6002 on the continental shelf (Pl. 3).

Age

The Coosawhatchie Formation is middle Miocene (early Serravallian) in age (Pl. 1), based on the occurrence of the planktonic foraminifera *Globorotalia peripheroacuta* and *G. fohsi praefohsi.* The presence of these two species requires assignment to Zones N10 or N11 of Blow and Banner (1966, p. 286-302) and Blow (1969) (Pl. 1). The age of the formation will be covered more fully in the discussion of the age of the Berryville Clay Member.

BERRYVILLE CLAY MEMBER OF THE COOSAWHATCHIE FORMATION (new name)

Definition

The Berryville Clay Member is a new name, proposed herein for a clay subdivision of the Coosawhatchie Formation. Offshore, on the continental shelf, the Berryville Clay Member constitutes the entire Coosawhatchie Formation. The Berryville Clay, however, grades laterally westward (shoreward) into the Ebenezer Member and extends farthest inland at the base of the formation (Figs. 10, 11; Pl. 3). Only the Berryville Clay Member is present at the type locality of the Coosawhatchie Formation.

On the Savannah River, the Berryville Clay Member is exposed in outcrop only at Frying Pan Landing and in the low bluffs in the vicinity of Berry Landing. The section exposed at Frying Pan Landing has been included in undifferentiated Miocene by Veatch and Stephenson (1911, p. 375) and in the Hawthorne Formation (Cooke, 1936, p. 109; Georgia Geological Survey, 1976). The section exposed in the low bluff near Berry Landing has been referred to the Coosawhatchie Clay Member of the Hawthorne Formation by Ernissee, Abbott, and Huddlestun (1977) and Abbott and Andrews (1979).

Type Section

The name Berryville is taken from the small community of Berryville in eastern Effingham County, Georgia. The low bluff on the west side of the Savannah River in the vicinity of Berry Landing is herein designated the type locality of the Berryville Clay Member of the Coosawhatchie Formation (Fig. 28). The entire section exposed in the bluffs consists of Berryville Clay, and this is the type section, or unit stratotype (holostratotype), of the member. Nine feet (2.7 m) of Berryville Clay Member is exposed at the type locality, but neither the lower nor upper boundary of the member is exposed. The type locality is approximately 3 miles (5 km) east of Berryville.

The interval 116 feet to 163 feet in the core Effingham 14 (GGS-3155) is herein designated a parastratoytpe and lower and upper boundary stratotype of the Berryville Clay Member. In this core, the Berryville Clay is overlain conformably and gradationally by the Ebenezer Member at 116 feet, and is underlain disconformably or paraconformably by the Marks Head Formation at 163 feet. The core site of Effingham 14 (GGS-3155) is on the south shoulder of Ga. 275, approximately 2.75 miles (4.4 km) southwest of Ebenezer Landing, and approximately 4.8 miles (7.7 km) south of the type locality (Fig. 3).

Lithology

The Berryvillle Clay Member of the Coosawhatchie Formation consists principally of yellowish gray (5 Y 7/2) to light olive gray (5 Y 5/2), silty, phosphatic, calcareous in some areas, variably siliceous clay. Clay is the dominant lithic component of the member, whereas minor components of the lithology include quartz sand and silt, mica, phosphate, calcite, limestone, dolomite, lignitic flecks, scattered fine vertebrate debris, siliceous claystone and opaline cristobolite, traces of feldspar, zeolite, calcareous and siliceous microfossils, and rare shelly material in the type area (especially barnacle scutes). On casual inspection, the Berryville Clay appears to be massive, very thick bedded, and blocky. However, on close inspection, the clay is commonly thin-bedded to laminated, with dustings of silt, mica, phosphate, and fine vertebrate debris (especially fossil fish scales) along partings or bedding planes.

The clay mineral suite of the Berryville Clay Member is dominated by smectite in the type area. Subordinate clay minerals include illite with minor sepiolite, kaolinite, and palygorskite. Palygorskite is a more common component of the clay mineral suite in the offshore area of Georgia, and to the south in southern Georgia and northeastern Florida (Hetrick and Friddell, 1984).

The lower part of the member is commonly diatomaceous, and less commonly calcareous. Microfossils known to occur in the diatomaceous and calcareous phases of the member include diatoms, radiolarians, silicoflagellates, foraminifera, calcareous nannofossils, and ostracodes (also see Ernissee, Abbott, and Huddlestun, 1977). Where siliceous, the Berryville is generally a diatomaceous clay. Only rarely does it approach an argillaceous diatomite in lithology. Thin lenses

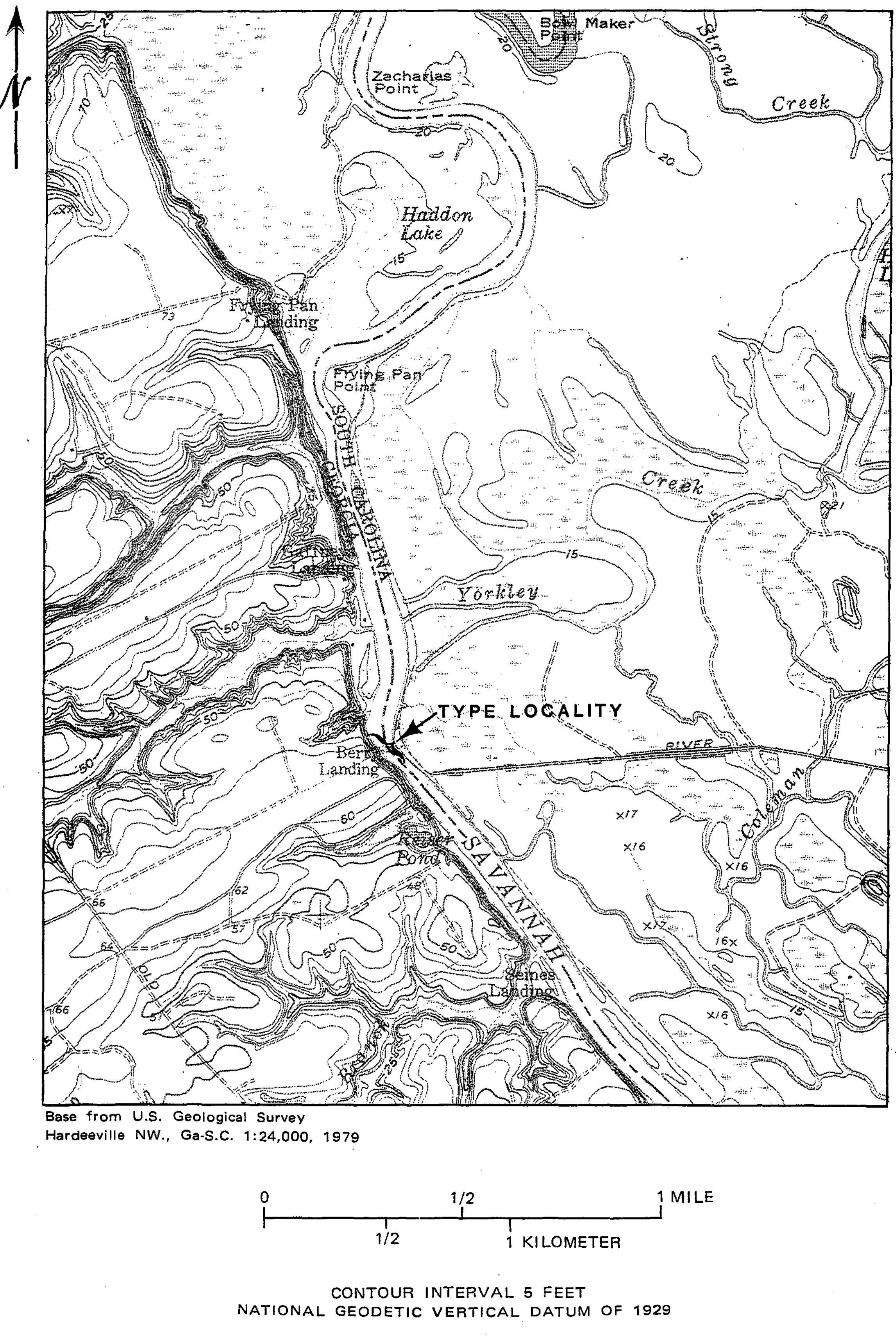


Figure 28. The type locality of the Berryville Clay Member of the Coosawhatchie Formation.

or layers of siliceous claystone are commonly present in the siliceous phases of the member whereas layers of dense, fine-grained limestone or lines of calcareous concretions occur in the calcareous phases. All of the known calcareous Berryville Clay is also diatomaceous, but much of the diatomaceous Berryville is noncalcareous. The known occurrence of calcareous material in the Berryville Clay Member is restricted to the Savannah River area and continental shelf area of Georgia.

Stratigraphic Relationships

The Berryville Clay Member of the Coosawhatchie Formation underlies the coastal area and the continental shelf of Georgia (Fig. 29). It extends from the vicinity of Coosawhatchie in Jasper County, South Carolina in the north, to northeastern Florida in the south. It progressively thins westward by facies change into the Ebenezer Member of the Coosawhatchie Formation (Figs. 10 and 11; Pl. 3) and is known to occur as a thin tongue at the base of the Coosawhatchie Formation as far west as the cores Wayne 2 (GGS-3512) in Wayne County in the Altamaha River area, and Charlton 2 (GGS-3185) at Folkston in Charlton County. In the Savannah River area, the updip limit of the member is defined by erosional truncation and not facies change. The Berryville Clay Member is not believed to occur west of the line defined by the above two cores and outcrop limits on the Savannah River.

The Berryville Clay Member of the Coosawhatchie Formation disconformably or paraconformably overlies the Marks Head Formation in Georgia, but paraconformably overlies the Cooper Formation on the continental shelf in the core AMCOR 6002 (Figs. 10 and 11; Pls. 2 and 3). Generally, the Berryville Clay is conformably and gradationally overlain by the Ebenezer Member of the Coosawhatchie Formation, but in the core AMCOR 6002, it is overlain by undifferentiated upper Miocene sands of the Hawthorne Group.

The Berryville Clay Member of the Coosawhatchie Formation is distinguished from the underlying Marks Head Formation in consisting of olive-gray, phosphatic, silty clay that is calcareous in some areas and commonly diatomaceous in the lower part. In contrast, the Marks Head Formation consists of lighter colored, phosphatic, slightly dolomitic, argillaceous sand to finely sandy clay. The Berryville clays differ in physical properties from the clays of the Marks Head because the clay mineral suite of the Berryville Clay is dominated by smectite and illite with minor sepiolite, whereas the clay mineral suite of the Marks Head is dominated by palygorskite and smectite. Generally, at the top of the Marks Head Formation, there is a bed of fuller's earth (palygorskite-rich) or dolostone, in contrast with the overlying dark phosphatic clay of the Berryville Clay Member. In the coastal area of Georgia, the underlying Tybee Phosphorite is distinguished from the Berryville Clay in consisting of massive and structureless, commonly bioturbated, brown, arenitic, sandy phosphorite that has the appearance of wet coffee-grounds.

The overlying Ebenezer Member of the Coosawhatchie Formation differs from the Berryville Clay Member in consisting of thick-bedded and massive, micaceous, slightly phosphatic, bioturbated, argillaceous, fine-grained, well-sorted sand. The Berryville Clay generally appears massive and structureless in outcrop or cores (when freshly cored and moist), but on closer inspection is seen to be very thinly layered to laminated and, upon drying, is generally fissile and shaley with well-defined bedding planes. In the type area, the clay mineral suite does not appear to differ between the Berryville Clay Member and the Ebenezer Member (compare with Hetrick and Friddell, 1984).

The Berryville Clay Member is at least 9 feet (2.7 m) thick at the type locality, but neither the upper nor lower boundary is exposed there. In cores in the type area, the thickness of the member averages about 50 feet (15 m) with the thickest known section being 54 feet (16.5 m) in the core Chatham 14 (GGS-3139). The Berryville Clay Member thickens in the coastal area southward toward the center of the Southeast Georgia Embayment, but core control in that area is inadequate to delineate its thickness distribution there. In coastal Bryan County, the Berryville Clay Member is 67 feet (20.5 m) thick, and its greatest known thickness onshore is 85 feet (26 m) in the core Cumberland Island 1 (GGS-3426) on Cumberland Island in Camden County. Offshore, where the Berryville Clay constitutes the entire Coosawhatchie Formation, it is 175 feet (53 m) thick in the core AMCOR 6002.

The environment of deposition of the Berryville Clay Member was marine, continental shelf, inner to probably middle neritic. The salinity of the associated water-mass was probably close to normal, based on the microfossil assemblages that occur locally (Ernissee, Abbott, Huddlestun, 1977; Abbott and Andrews, 1979; Abbott, 1980). This is consistent with the typical, but not total, absence of palygorskite in the Berryville Clay member which, according to Weaver and Beck (1977), requires a warm, shallow, coastal brackish to schizohaline environment. Abbott and Andrews (1979) and Abbott (1980) presented evidence for a cool water environment for deposition of the Berryville Clay Member. However, the planktonic foraminifera are strictly subtropical, suggesting either a mixing of different water-masses on the continental shelf or seasonal plankton blooms during the deposition of the Berryville Clay.

The olive-gray to olive-black color of the Berryville Clay, the common occurrence or abundance of small and delicate vertebrate bone debris and fish-scales along bedding planes, the characteristic thin bedding and lamination rather than bioturbation or homogenization of the sediments (due to an infauna), and the local occurrence of sulphosalts on outcrops of the clay are all indicative of an anaerobic, stagnant environment inimical to a bottom dwelling fauna (also see Abbott and Andrews, 1979). Locally, as at the type locality, some bioturbation is evident and the sediments are cal-

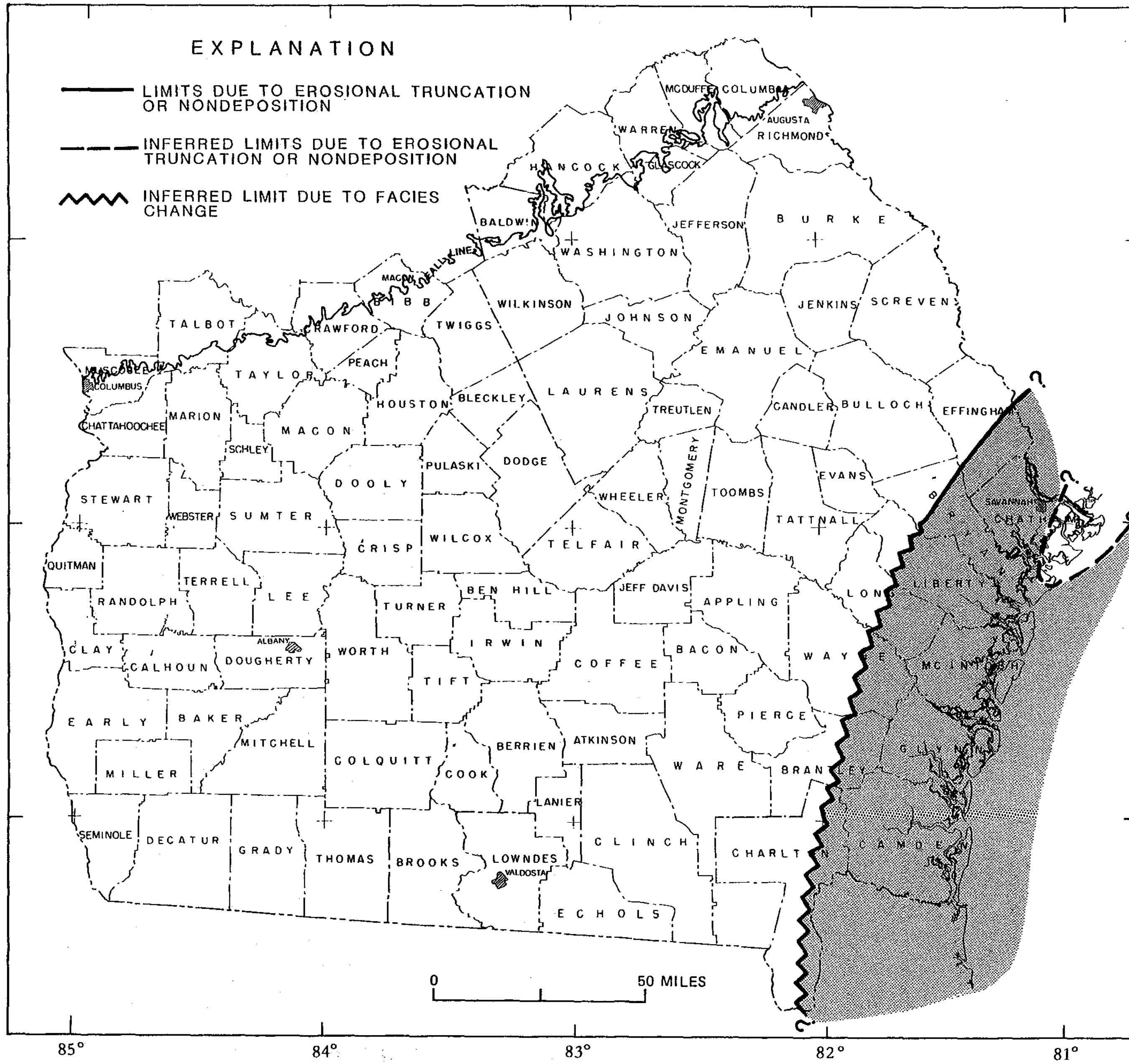


Figure 29. The areal distribution (outcrop and subcrop) of the Berryville Clay Member of the Coosawhatchie Formation in Georgia.

careous with a low diversity benthic fauna, indicating shallow-water, aerobic conditions.

Age

The age of the Berryville Clay Member of the Coosawhatchie Formation (Coosawhatchie clay member of the Hawthorne Formation of Heron, Robinson and Johnson, 1965; Abbott, 1974, 1978; Ernissee, Abbott, and Huddlestun, 1980) has been extensively discussed (Abbott, 1978; Ernissee, Abbott, and Huddlestun, 1977). The age of the member is middle Miocene (early Serravallian) (Pl. 1). The following planktonic foraminifera have been identified by the author from the stratotype section of the Berryville Clay Member near Berry Landing:

Globorotalia peripheroacuta
Globigerina praebulloides
G. druryi
Globerinoides quadrilobatus quadrilobatus
G. quadrilobatus sacculiferus
G. subquadratus
Globoquadrina altispira
Globigerinita juvenilis
Orbulina suturalis

The following planktonic foraminifera have been identified from the Berryville Clay in the cores Effingham 3 (GGS-2175), Effingham 13 (GGS-3140), and Effingham 14 (GGS-3155):

Globorotalia peripheroacuta
G. mayeri
Globigerina praebulloides
G. druryi
G. eamesi
Globigerinoides quadrilobatus quadrilobatus
G. quadrilobatus sacculiferus
G. subquadratus
G. c.f. *obliquus*
Globoquadrina altispira
Glorigerinita juvenilis
Sphaeroidinellopsis seminulina
Orbulina suturalis

The following planktonic foraminifera have been identified from the Berryville Clay in the core AMCOR 6002 from sample 7-2 (30-40 cm) on the continental shelf:

Globorotalia fohsi praefohsi (primitive)
G. peripheroacuta
G. mayeri
Globigerinita juvenilis
G. incrusta
Globoquadrina altispira
Sphaeroidinellopsis seminulina
Orbulina suturalis

The above associations are characteristic of planktonic foraminiferal Zone N10 or early N11 of Blow and Banner (1966) and Blow (1969) (lower part of *Globorotalia fohsi fohsi* Zone of Bolli, 1957; and Stainforth and others, 1975). The presence of well-developed *G. peripheroacuta* at the type locality and advanced *G. peripheroacuta* at 162 feet in the core Effingham 13 (GGS-3140) indicates that the type Berryville Clay is in Zone N10 or possibly earliest Zone N11 (Pl. 1). The presence of primitive *Globorotalia fohsi praefohsi* in sample 7-2, 30-40 cm from AMCOR 6002 indicates earliest Zone N11 in that core on the continental shelf.

Ernissee, Abbott, and Huddlestun (1977) suggested correlation of the Coosawhatchie Clay near Berry Landing on the Savannah River (holostratotype of the Berryville Clay Member of the Coosawhatchie Formation of this report) to upper Zone N11 to lower Zone N12 of Blow (1969). This zonal assignment was based on the identification of one foraminifer that is transitional from *Globorotalia peripheroacuta* and *G. fohsi praefohsi*. Re-examination of the microfossil slides indicates that the individual in question should more prudently be considered a morphologically advanced *G. peripheroacuta*. The evolutionary state of the *Globorotalia fohsi* lineage, and the presence only of *G. peripheroacuta* with very rare, primitive *G. fohsi praefohsi* render the Zone N12 assignment unlikely. Typical *G. peripheroacuta* is not present in shallow-water assemblages of Zone N12, such as is present in the Shoal River Formation of western Florida (Huddlestun, 1984). The White Creek beds of the Shoal River Formation contain a planktonic foraminiferal assemblage identical to that of the Berryville Clay Member, and with the same level of evolutionary development of the *Globorotalia fohsi* lineage (Huddlestun, 1984, p. 81-83). The overlying undifferentiated Shoal River Formation of western Florida, however, contains a typical Zone N12 planktonic foraminiferal suite with *G. fohsi fohsi*, *G. fohsi lobata*, and very rare *G. fohsi robusta* (Huddlestun, 1984, p. 67-72). The Zone N12 planktonic foraminifera of the Shoal River Formation, and especially the stage of evolutionary development of the *Globoratalia fohsi* population, are incompatible with the planktonic foraminiferal suite of the Berryville Clay Member of the Coosawhatchie Formation. Therefore, it is my conclusion that the Berryville Clay Member is in planktonic foraminiferal Zone N10 or earliest N11, but not Zone N12 as suggested by Abbott, Ernissee, and Huddlestun (1977), Abbott (1978), and Abbott and Andrews (1979).

EBENEZER MEMBER OF THE COOSAWHATCHIE FORMATION (new name)

The Ebenezer Member is a new name, proposed herein for the updip, argillaceous sand subdivision of the Coosawhatchie Formation. North of the Altamaha River, and elsewhere if the Charlton Member is locally absent, the Ebenezer Member constitutes the upper part of the Coosawhatchie Formation in eastern Georgia (Fig. 11; Pls. 2 and 3).

South of the Altamaha River, where both the Berryville Clay and Charlton Members are present, the Ebenezer is the middle member of the formation. Farther inland where neither the Berryville Clay nor Charlton Members are present, the Ebenezer Member constitutes the entire Coosawhatchie Formation (Figs. 10, 11; Pl. 1). The Ebenezer grades laterally eastward (seaward) into the Berryville Clay Member and extends farthest east in the coastal area at the top of the formation. Its eastern limits appear to be the Sea Island Escarpment or western flanks of the Beaufort Arch. The upper part of the Ebenezer Member appears to grade westward (shoreward) into the Altamaha Formation, and the lower part of the Ebenezer Member appears to grade westward into the Meigs Member of the Coosawhatchie Formation (Figs. 10, 11; Pl. 3).

The Ebenezer Member at Ebenezer Landing on the Savannah River, the type locality, was tentatively included in the Miocene by Veatch and Stephenson (1911, p. 375). Veatch and Stephenson (1911, p. 360, 375, 377, 412-413) included the deposits along the Altamaha River, both at and also downstream from Bugs Bluff in Wayne County, in the Alum Bluff Formation?, or "Miocene or Oligocene?". Cooke (1936, p. 109; 1943, p. 95, 100) and Georgia Geological Survey (1976) included these deposits in the Hawthorne Formation.

Type Section

The name Ebenezer is taken from Ebenezer Landing on the Savannah River in Effingham County, Georgia, and from Ebenezer Creek, which joins the Savannah River at Ebenezer Landing. Ebenezer Landing on the Savannah River is located at the end of Ga. 275, 7.5 miles (12 km) east of Springfield, Effingham County. The type locality of the Ebenezer Member of the Coosawhatchie Formation is the line of low bluffs immediately downriver from the boat landing (Fig. 30). The type section, or unit stratotype (holostratotype), of the Ebenezer Member is the section exposed in the bluffs at the type locality. Neither the lower nor the upper boundary of the member is exposed in the type section, and the Ebenezer Member constitutes the entire exposed 7 feet (2 m) of section in the bluffs.

The core Effingham 14 (GGS-3155) is herein designated a reference locality, parastratotype, and lower and upper boundary stratotype of the Ebenezer Member. In this core, the Ebenezer Member is overlain disconformably by the Cypresshead Formation at a depth of 59 feet, and is underlain comformably and gradationally by the Berryville Clay Member at 116 feet. The core site of the Effingham 14 (GGS-3155) is on the south shoulder of Ga. 275, approximately 2.75 (4.4 km) southwest of Ebenezer Landing in Effingham County (Fig. 3; Pl. 2). This core is chosen as a reference section for the member because the entire Ebenezer Member with both lower and upper boundaries is present in the core, and the core site is near (2.75 miles [4.4 km]) the type locality.

The core Wayne 2 (GGS-3512) in Wayne County is herein designated a reference locality and parastratotype of the Ebenezer Member in the central part of the Southeast Georgia Embayment (Fig. 2; Pl. 2). In this core, the Ebenezer Member is overlain disconformably by the Cypresshead Formation at 59 feet, and is underlain by the Berryville Clay Member at 270 feet. This core is chosen as a reference section for the Ebenezer Member because it contains the coarse sand lithofacies of the member that is characteristic of the Southeast Georgia Embayment.

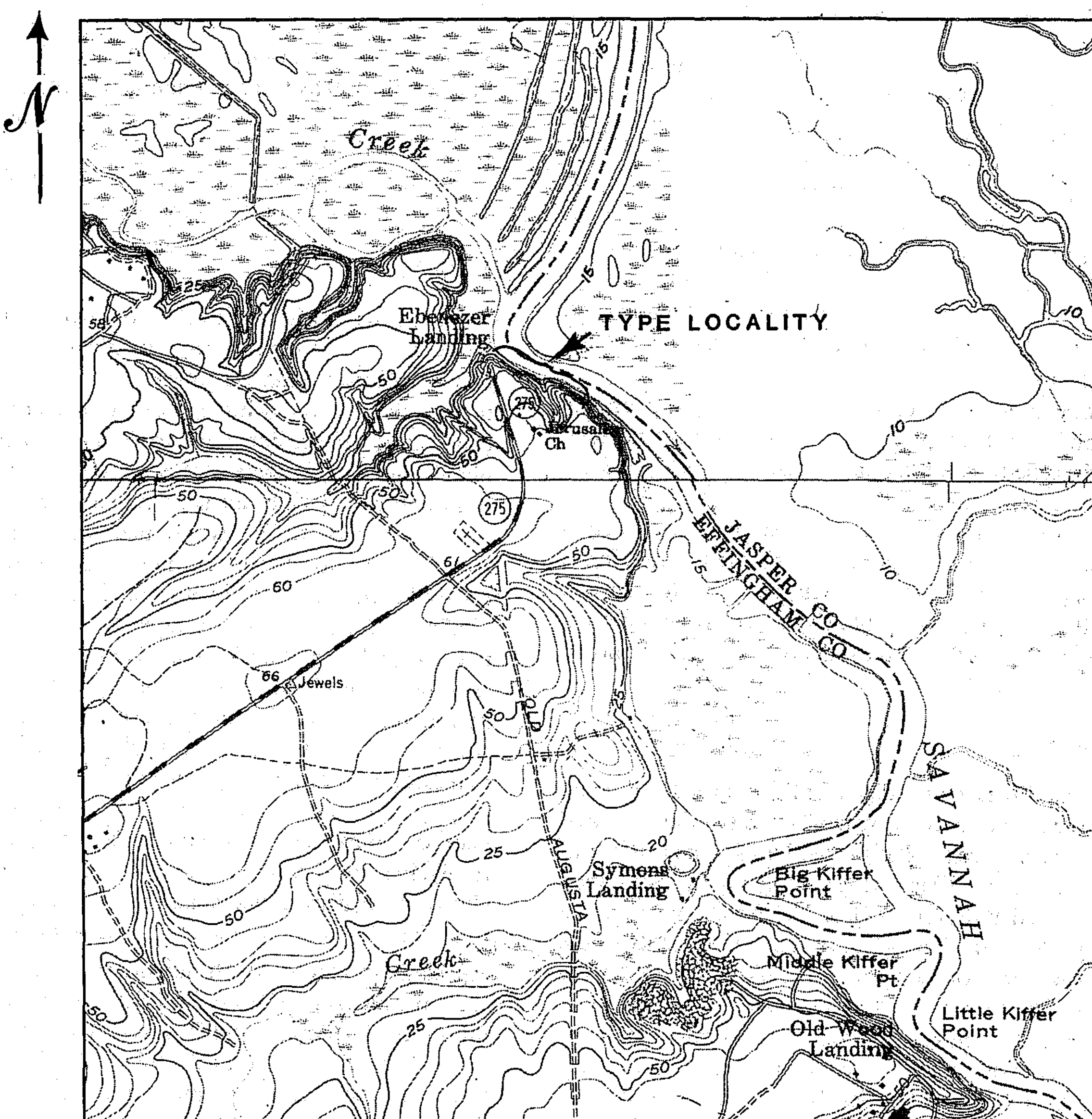
Lithology

The Ebenezer Member of the Coosawhatchie Formation is typically a gray to olive-gray, slightly phosphatic, micaceous, argillaceous sand. Sand is the dominant lithic component of the member, whereas subordinate components are clay, mica, calcite, limestone, dolomite, dolostone, phosphate, siliceous claystone, feldspar, zeolite, and fine vertebrate debris. Typically, the sand is fine- to medium-grained, rarely medium- to coarse-grained; moderately to well-sorted, rarely poorly sorted; thinly and distinctly to indistinctly bedded rarely to bioturbated or structureless; and argillaceous. In the coarser grained lithofacies in the central part of the Southeast Georgia Embayment, the Ebenezer Member is more commonly medium- to coarse-grained, moderately to poorly sorted, thick- to medium-bedded, commonly massive and structureless, pebbly, feldspathic, and not conspicuously argillaceous.

Clay occurrence in the Ebenezer is mainly interstitial, but beds of sandy clay or siliceous claystone occur, though rarely, in some sections. More commonly, discrete layers of clay occur as discontinuous laminae (partings) 2 mm or less thick. The Ebenezer Member in the Savannah River area is especially argillaceous with thin interlayerings of micaceous fine sand and clay laminae. The clay content of the member diminishes southward and is minor and entirely interstitial in the Altamaha River area. In the southern part of the Southeast Georgia Embayment in Charlton and Camden Counties, the Ebenezer Member commonly is fine-grained, similar to the lithology in the type area, but is less argillaceous and more dolomitic.

The clay mineral suite of the Ebenezer Member, like that of the underlying Berryville Clay Member, is dominated by montmorillonite. Illite is a significant secondary clay mineral whereas palygorskite, sepiolite, and kaolinite are minor (compare with Hetrick and Friddell, 1984). However, in the southern part of the Southeast Georgia Embayment in southeasternmost Georgia and northeastern Florida, palygorskite and sepiolite are significant minor components of the clay mineral suite.

In the type area, dolomite and calcite are irregularly occurring minor lithic components of the Ebenezer Member. Interstitial calcite and thin beds of fine-grained, dense limestone or dolostone occur in the lower part of the member that is lithologically transitional with the Berryville Clay.



Hardeeville NW, Ga.-S.C. 1:24,000, 1979
and Rincon, Ga.-S.C. 1:24,000, 1962

0 1/2 1 MILE
0 1/2 1 KILOMETER

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 30. The type locality of the Ebenezer Member of the Coosawhatchie Formation.

Minor interstitial dolomite is rare higher in the section, and most of the Ebenezer Member in the type area is devoid of carbonate. Dolomite content increases to the south, however, and scattered beds of dolostone and dolomitic sand are common in the member in the Altamaha River area. The Ebenezer Member is generally dolomitic in the southern part of the Southeast Georgia Embayment in Georgia and northeastern Florida.

South of the Altamaha River, the upper part of the Ebenezer Member grades laterally into a dolostone, limestone, and clay lithofacies that is referred to in this report as the Charlton Member of the Coosawhatchie Formation, but was earlier referred to as the Charlton Formation (Veatch and Stephenson, 1911; Cooke, 1943, 1945). The Charlton Member is a laterally continuous unit in the St. Marys River area. North of Camden and Charlton Counties, however, it appears to be laterally discontinuous. Within this area in Brantley, Wayne, and Glynn Counties, the lithologies of the upper part of the Coosawhatchie Formation range from typical Ebenezer Member through transitional lithologies (see section on the Charlton member) to typical Charlton Member.

The phosphate content of the Ebenezer Member is variable. The coarse, feldspathic lithofacies in the Altamaha River area is largely nonphosphatic (lithologically transitional to Altamaha Formation), whereas typical Ebenezer lithology is moderately to poorly phosphatic.

The Ebenezer Member is generally nonfossiliferous in Georgia. In the vicinity of its type locality, however, the member contains molds and casts of deposit-feeding pelecypods, similar to the underlying Berryville Clay Member. Also, subsurface dolostone beds in the Ebenezer Member in the Altamaha River area locally contain abundant molds and casts of mollusks. Macro- and microfossils with calcareous shells, however, are not known to occur in the member.

Stratigraphic Relationships

The Ebenezer Member is known to occur from the vicinity of the Savannah River in Georgia southward into northeastern Florida (Fig. 31). The eastern limit of the member in the Savannah River area is the western flank of the Beaufort Arch in central Chatham County (Pl.2). Farther south it appears to trend obliquely offshore and coincides with the Sea Island Escarpment. The western limit of the Ebenezer Member is not clearly defined at this time, but the member is known to occur in the Altamaha River area as far west as the vicinity of Jesup in Wayne county (Pl. 3), and in the core Charlton 2 (GGS-3185) at Folkston, Charlton County. West of the Orangeburg Escarpment, in the Altamaha River area, the Altamaha Formation occurs in the stratigraphic position of the Ebenezer Member. It appears, therefore, that the Ebenezer Member grades laterally westward into the upper part of the Altamaha Formation. Farther south, the western limits of the Ebenezer Member occur between the St. Marys River in the east and the upper Suwannee River in the west. The Ebenezer Member underlies the St. Marys River area but the Ebenezer stratigraphic position is occupied by the Statenville Formation on the upper Suwannee River.

The Ebenezer Member conformably and gradationally overlies the Berryville Clay Member (see Figs. 10 and 11; Pls. 2 and 3). If it occurs west of the pinchout of the Berryville Clay, it would disconformably or paraconformably overlie the Marks Head Formation in that area. The Ebenezer Member is generally overlain disconformably by the Cypresshead Formation in Georgia but is overlain by the Raysor Formation in the coastal area. In the St. Marys River area, the Ebenezer is conformably overlain by the Charlton Member.

The Ebenezer Member of the Coosawhatchie Formation is distinguished from the underlying Berryville Clay Member in consisting of thick-bedded and massive, micaceous, slightly phosphatic, bioturbated, argillaceous, fine-grained, well-sorted sand. In contrast, the Berryville Clay consists of olive-gray to dark olive gray, phosphatic silty clay that is generally thinly bedded to laminated, fissile to shaley. The stratigraphically equivalent Meigs Member of the Coosawhatchie Formation differs from the Ebenezer Member in containing beds of thinly layered to laminated, siliceous, diatomaceous, silty clay that is rarely phosphatic. The stratigraphically equivalent and overlying Charlton Member of the Coosawhatchie Formation is distinguished from the Ebenezer Member in containing thick to very thick beds of variably fossiliferous limestone, dolostone, and clay, and in typically containing little quartz sand or phosphate. The stratigraphically equivalent Statenville Formation is distinguished from the Ebenezer Member in containing prominently horizontal and crossbedded, variably phosphatic, fine- to coarse-grained, well-sorted to poorly sorted sand with thin to medium beds of fine-grained dolostone.

The overlying Cypresshead Formation is distinguished from the Ebenezer Member in being prominently bedded in many places (laminated to thin-bedded to thick-bedded), nonmicaceous, nonphosphatic, only locally bioturbated, and of widely varying sand grain size and sorting. In addition, the clay within the Cypresshead Formation is more commonly distributed in laminae and thin beds, and rarely in thick beds. Unlike the Ebenezer Member, where clay occurs mainly interstitially, the interstitial clay fraction of the Cypresshead Formation is minor.

Only 7 feet (2 m) of the Ebenezer Member of the Coosawhatchie Formation is exposed in the low bluffs on the Savannah River at the type locality. However, the Ebenezer Member is 62 feet (19 m) thick in the reference core Effingham 14 (GGS-3155) 2.75 miles (4.4 km) from the type locality, and the average thickness of the member in the type area is approximately 60 feet (18 m). The Ebenezer Member thins southeastward in the Savannah River area, probably due to post-Coosawhatchie, Miocene truncation, and is

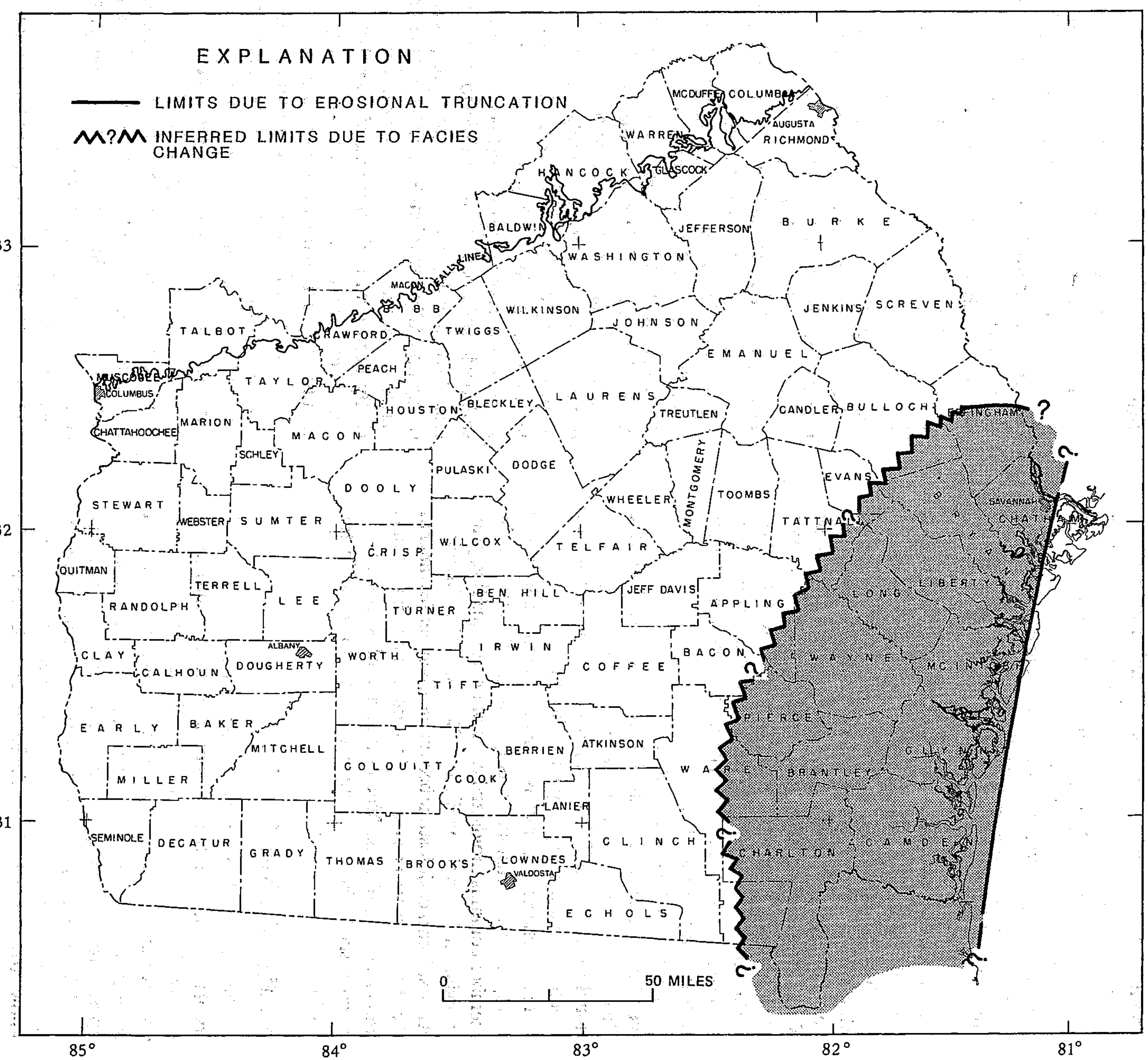


Figure 31. The areal distribution (outcrop and subcrop) of the Ebenezer Member of the Coosawhatchie Formation.

absent over the Beaufort Arch in Chatham County (Pl. 2). The member thickens southward in the Southeast Georgia Embayment and is 211 feet (64 m) thick in the reference core Wayne 2 (GGS-3512) and 234 feet (71 m) thick in the interval 60 feet to 294 feet in the core Wayne 4, both in Wayne County, Georgia. The Ebenezer Member thins south of the Altamaha River area and is 199 feet (61 m) thick in the interval 90 feet to 289 feet in the core Cumberland Island 1 (GGS-3426), and 169 feet (52) at Folkston in the interval 130 feet to 299 feet in the core Charlton 2 (GGS-3185). The thinning of the Ebenezer Member in the Charlton 2 (GGS-3185) is due to the upper part of the Coosawhatchie Formation being occupied by Charlton lithlology and not Ebenezer lithology. In the Charlton 2, the Ebenezer plus Charlton stratigraphic interval is 248 feet (76 m) thick.

The environment of deposition of the Ebenezer Member of the Coosawhatchie Formation was marine, continental shelf, inner neritic. The fine grain size of the sand and the large amount of interstitial clay together with the local presence of deposit-feeding pelecypods indicate that the substrate at the time of deposition was muddy and soft. The Ebenezer Member is interpreted here as being a relatively nearshore facies, intermediate to that of the offshore Berryville Clay Member and that of the coastal Meigs Member. Like the clay mineral suite of the underlying Berryville Clay, smectite and illite are the dominant clay minerals of the Ebenezer Member and palygorskite is either absent or a minor component. This suite is consistent with the interpretation of a relatively cool-water, nearshore (but not coastal) depositional environment for the Ebenezer Member.

Age

Other than scattered fine vertebrate debris, the only known fossils in the Ebenezer Member are molds and casts of mollusks in the argillaceous sands in the type area and in dolostone beds in the central part of the Southeast Georgia embayment. Because the Ebenezer Member is gradational with the Berryville Clay Member, both downsection and laterally, it is assumed here that the Ebenezer is the same age as the Berryville Clay. If that assumption is correct, the Ebenezer Member is middle Miocene (early Serravallian). It is equivalent to Zone N10 or early N11 of Blow and Banner (1966) and Blow (1969) (Pl. 1).

TYBEE PHOSPHORITE MEMBER OF THE COOSAWHATCHIE FORMATION (new name)

Definition

The Tybee Phosphorite Member of the Coosawhatchie Formation is a new name, herein proposed for the subsurface, basal phosporitic beds of the Coosawhatchie Formation in the coastal area of Georgia. The Tybee Phosphorite Member contains the commercial-grade phosphorite in coastal Chatham County (Furlow, 1969) and was referred to the Duplin Formation by Counts and Donsky (1963), McCollum and Herrick (1964), and Furlow (1969). The Tybee Phosphorite Member is recognized as a member of the Coosawhatchie Formation because it interfingers in a landward (northwestward) direction with, and grades upsection into, the Berryville Clay.

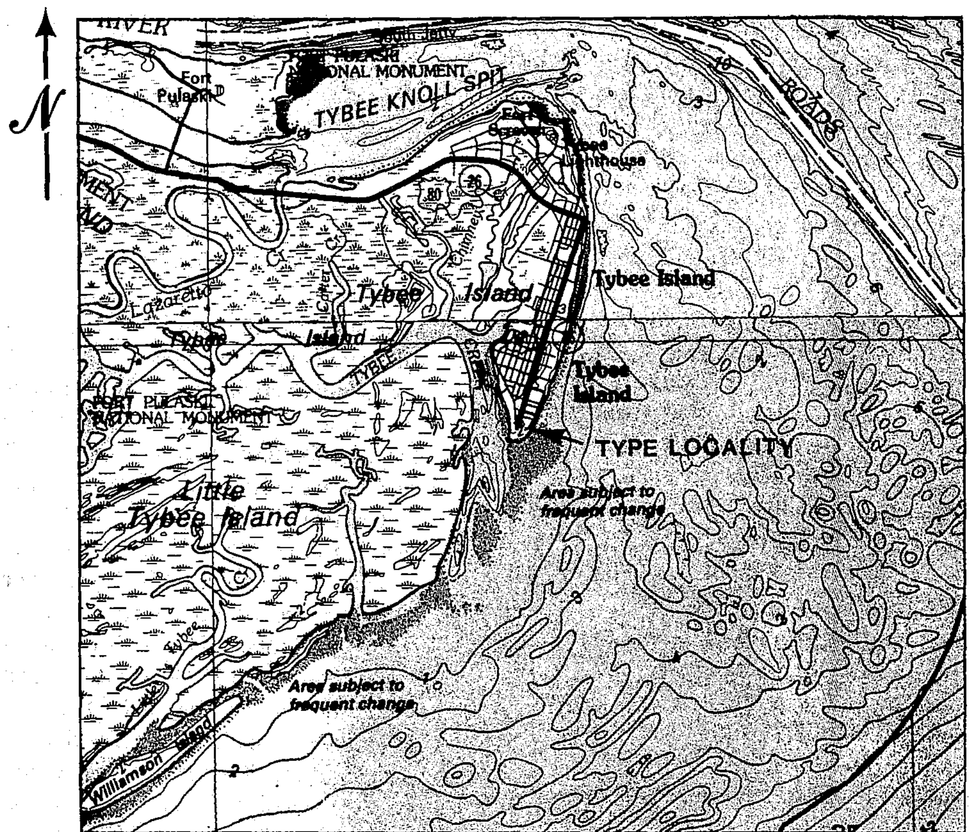
Type Section

The name Tybee is taken from Tybee Island, the northernmost Sea Island of Georgia. The core Chatham 10 (GGS-1394) is herein designated the type locality of the Tybee Phosphorite Member of the Coosawhatchie Formation (Fig. 32). The type section, or unit-stratotype (holostratotype), of the member is the interval 75 feet to 94 feet in the type core. The Tybee Phosphorite Member is disconformably overlain by the Satilla Formation at 75 feet and paraconformably underlain by the Marks Head Formation at 94 feet in the core Chatham 10 (GGS-1394). The core site of Chatham 10 (GGS-1394) is near the southern end of Tybee Island, approximately 100 feet (30 m) south of the termination of US 80 (Fig. 32; also see Furlow, 1969, Fig. 1).

The core Chatham 3 (GGS-1341) is herein designated a reference section and parastratotype of the Tybee Phosphorite Member. The Tybee Phosphorite occurs in the interval 85 feet to 117 feet in the core and is overlain conformably and gradationally by the Berryville Clay Member, and paraconformably overlies the Marks Head Formation. The Chatham 3 is designated a parastratotype because the core recovery is 100% in the Coosawhatchie Formation, and the stratigraphic relationship between the Tybee Phosphorite and Berryville Clay members can be observed in the core. The core site of the Chatham 3 (GGS-1341) is on Wilmington Island near highway U.S. 80, approximately 0.5 mile (0.7 km) south of the U.S. 80 bridge over Bull River (Fig. 3).

Lithology

The Tybee Phosphorite Member of the Coosawhatchie Formation principally consists of quartz sand and phosphate with minor clay and dolomite. The phosphate, which commonly is the dominant lithic component, typically consists of round to irregularly rounded, black to brown to amber-colored grains of apatite that range in size from about 1 mm to less than 0.1 mm. The phosphate is generally associated with abundant fine vertebrate debris (fish teeth, miscellaneous small bones, vertebrae, fish scales, etc.). Subordinate lithic components include quartz sand, clay, dolomite, dolostone, and mica. Scattered small quartz pebbles occur locally in the basal phosphorite, and scattered thin layers of sand, clay, or dolostone occur locally within the member. The dolostone layers in places contain molds and impressions of mollusks. The clay mineral suite consists of palygorskite and smectite, in approximately equal proportions, with some illite and minor sepiolite and kaolinite (Hetrick and Friddell, 1984).



Base from U.S. Geological Survey
Wassaw Sound, Ga. 1:100,000, 1980
and Beaufort, S.C.-Ga. 1:100,000, 1981

0 1 2 3 MILES

0 1 2 3 KILOMETERS

CONTOUR INTERVAL 2 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 32. The type locality of the Tybee Phosphorite Member of the Coosawhatchie Formation.

In cores, the lithology of the Tybee Phosphorite Member resembles a mixture of wet coffee-grounds and sandy, muddy sediment. The member generally is massive, structureless and uniform, or bioturbated and marbled. The color contrast, which highlights the bioturbation structures, results from the variation in concentration of light-colored quartz sand and dark-colored phosphate.

Stratigraphic Relationships

The Tybee Phosphorite Member caps the crest of the Beaufort Arch in Chatham County. The position of the eastern limit is unknown, but it occurs on the continental shelf off the coast of Georgia (Fig. 33). Its western limit in Chatham County is the western flank of the Beaufort Arch where the member separates into two thin tongues and grades laterally into the Berryville Clay Member (Pl. 2). The southern limit of the member is not clearly defined at this time, but several feet of Tybee Phosphorite occur below the base of the Berryville Clay Member in a core in coastal Bryan County and in the core Cumberland Island 1 (GGS-3426) on Cumberland Island in Camden County. This suggests that the Tybee Phosphorite Member may generally be present under the coast and inner continental shelf off Georgia.

The Tybee Phosphorite Member of the Coosawhatchie Formation disconformably or paraconformably overlies the Marks Head Formation in Georgia (Fig. 11; Pl. 2). It is conformably and gradationally overlain by the Berryville, Clay Member (Fig. 11; Pl. 2), but locally is disconformably overlain by the Wabasso beds of the Hawthorne Group or by the Satilla Formation.

The Tybee Phosphorite Member of the Coosawhatchie Formation is distinguished from the underlying Marks Head Formation in consisting of dark olive gray to olive-black, sandy phosphorite whereas the Marks Head consists of lighter colored, bioturbated, phosphatic, slightly dolomitic, finely sandy clay to very argillaceous fine-grained sand. Generally there is a bed of palygorskite-rich fuller's earth or dolostone at the top of the Marks Head Formation. The overlying and stratigraphically equivalent Berryville Clay Member differs from the Tybee Phosphorite in consisting of thinly bedded to laminated, silty, phosphatic clay. Where the Wabasso beds may directly overlie the Tybee Phosphorite, the Wabasso beds consist of phosphatic, calcareous, slightly argillaceous, silty fine-grained sand.

The Tybee Phosphorite Member is 19 feet (6 m) thick at the type locality in the core Chatham 10 (GGS-1394). The member averages about 20 feet (6 m) thick in coastal Chatham County, the type area, but is 33 feet (10 m) thick under southern Tybee Island in the core Petit Chou 1 (Fig. 2) (also see Furlow, 1969). The member thins northwestward in central Chatham County and splits into two thin tongues at the base of the Berryville Clay Member (Pl. 2). The upper tongue extends only a few miles inland from the present marsh, but the lower tongue extends into northern Chatham County as a thin basal bed (about 1 or 2 feet [0.3 or 0.6 m] thick) below the Berryville Clay Member. The Tybee Phosphorite is 7.5 feet (2 m) thick in coastal Bryan County, and 9 feet (2.75 m) thick in the core Cumberland Island 1 (GGS-3426).

The environment of deposition of the Tybee Phosphorite Member of the Coosawhatchie Formation was marine, probably shallow-water but far-offshore, continental shelf. The bioturbation to complete homogenization of the sediments indicates an active infauna during sedimentation. Scattered thin dolostone beds with molluscan molds also indicate the local presence of a meager fauna living upon the substrate. As a result, it is concluded that the environment of deposition of the Tybee Phosphorite was not anaerobic and stagnant as the adjacent Berryville Clay. However, the abundance of small vertebrate (presumably fish), fossil bone debris indicates that the overlying water-mass must have been highly productive in terms of marine life, and the abundance of the debris would suggest that the bottom environment could have been locally or periodically stagnant with putrifying material. It is also noted that the Tybee Phosphorite in Chatham County, Georgia, is found only on the Beaufort Arch, and it is possible that the arch was a topographic high on the continental shelf during the deposition of the Coosawhatchie Formation.

Age

No datable fossils are known to occur in the Tybee Phosphorite Member. However, diatomaceous Berryville Clay is known to occur between the two thin tongues of the Tybee Phosphorite in a core in coastal Bryan County. According to Dr. W.H. Abbott (personal communication, 1978), the diatom flora is typical of that of the Coosawhatchie Formation (Berryville Clay Member). Therefore, the age of the Tybee Phosphorite Member is inferred to be middle Miocene, early Serravallian (See Pl. 1), and equivalent to planktonic foraminiferal Zones N10 or early N11 (Blow and Banner, 1966; Blow, 1969).

CHARLTON MEMBER OF THE COOSAWHATCHIE FORMATION (revised and redefined)

Definition

The Charlton Formation of Veatch and Stephenson (1911, p. 392-400) is herein revised, redefined, and reduced in lithostratigraphic rank from a formation to a member. Previously, the Charlton was considered to be a formation younger than, and overlying, the Hawthorne (Cooke, 1943, 1945). Core information has shown, however, that the Charlton is a lateral lithofacies of the upper part of the Ebenezer member of the Coosawhatchie Formation. It is, therefore, a minor subdivision of the Hawthorne Group. The Charlton is recognized as a formal member of the

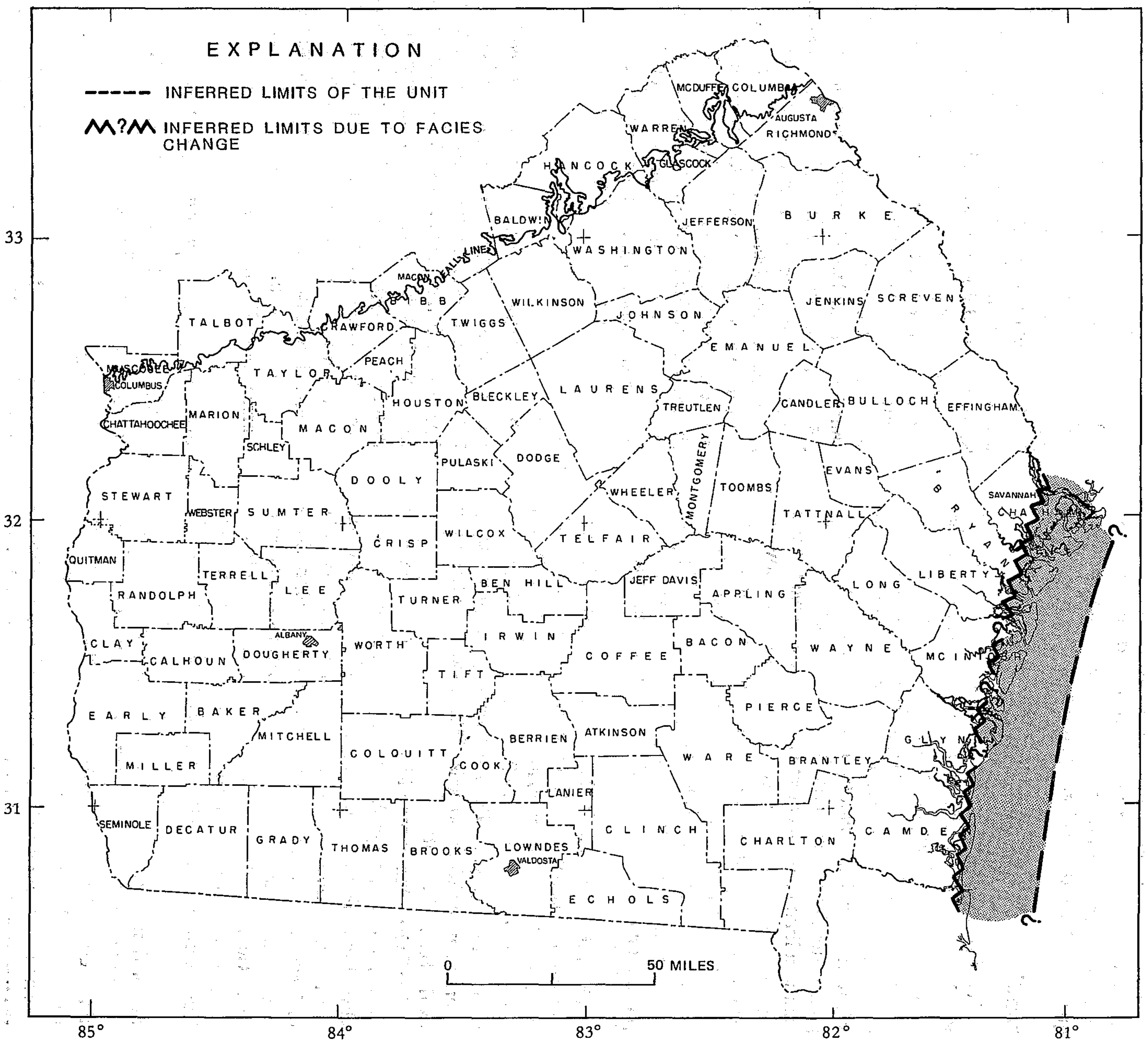


Figure 33. The areal distribution (subcrop) of the Tybee Phosphorite Member of the Coosawhatchie Formation in Georgia.

Coosawatchie Formation in this report because it grades both laterally and downsection into more typical Coosawhatchie sediments (Ebenezer Member) (Figs. 10, 11 and 58; Pl. 1); because the typical Charlton is lithologically distinctive; and because typical Charlton is restricted as a continuous and mappable unit only to the southeastern corner of Georgia in Camden, Charlton, and perhaps Brantley Counties, and in the northeastern corner of Florida in Nassau, Duval, and northern Clay and St. Johns Counties. North, west, and south of this area, Charlton lithofacies appears to occur discontinuously in the upper part of the Ebenezer Member. Also supporting the Charlton as a subdivision of the Hawthorne is the presence of palygorskite, a magnesium-rich clay mineral characteristic of the Hawthorne Group deposits. Palygorskite is one of the dominant clay minerals of the Charlton and is not known to occur in post-Hawthorne deposits, except as trace detrital components.

The Jacksonville limestone of Dall (1892, p. 124; also see Matson and Clapp, 1909, 108-114) at Jacksonville, Duval County, Florida, is part of the Charlton Member. Other calcareous deposits attributed by Dall (1892, p. 124-125) to the Jacksonville limestone, however, are not part of the Charlton Member but are included in various other units.

Type Section

The name Charlton was taken from Charlton County, Georgia. Veatch and Stephenson (1911, p. 392) applied the name Charlton "to an argillaceous limestone and clay formation exposed in the banks and bluffs of St. Marys River, from Stokes Ferry, 11 miles south of St. George, Charlton County, Georgia, to Orange Bluff, near Kings Ferry, Florida." The type locality of the Charlton as described by Veatch and Stephenson (1911) is, therefore, the stretch of St. Marys River from Stokes Ferry (now Stokes Bridge) to Orange Bluff (Figs. 2 and 4). Veatch and Stephenson (1911, p. 393-400) included 12 described sections in the type locality. They did not designate any particular section as the type section, and all of the sections appear to have been given equal weight as examples of the unit. The sections described by Veatch and Stephenson (1911), therefore, are interpreted here to constitute a composite stratotype.

To facilitate field and stratigraphic studies, the section of the Charlton Member exposed in the low bluff on the east side of the St. Marys River at Stokes Bridge (Stokes Ferry of Veatch and Stephenson, 1911) is herein designated the lectostratotype (unit-stratotype and principal reference section) of the Charlton Member of the Coosawhatchie Formation (Fig. 34). The lithology of the Charlton Member at Stokes Bridge is typical of the unit in the type area, and the site is currently the most accessible of Veatch and Stephenson's described Charlton sections. Only Charlton Member is currently exposed in the bluff, although Veatch and Stephenson (1911) briefly described the contact between the Charlton and the overlying formation which they assigned to the Satilla Formation. The residuum of this overlying formation is exposed in the roadcut in the eastern valley wall above Stokes Bridge. The residuum appears to be assignable to either the Cypresshead Formation or the Nashua Formation. The Satilla Formation does not occur as far west as the upper St. Marys River (Fig. 58). The site of Stokes Bridge is in NE 1/4, Sec. 30, T1S, R23E in Nassau County, Florida (also see Connell, 1968).

The core Charlton 2 (GGS-3185) is herein designated a reference locality and hypostratotype of the Charlton Member of the Coosawhatchie Formation. The Charlton Member occurs in the interval 51 feet to 130 feet and is overlain by the Cypresshead Formation and underlain by the Ebenezer Member of the Coosawhatchie Formation. The core site of the Charlton 2 (GGS-3185) (Fig. 2) is on the southwestern village limits of Folkston in Charlton County, 1 mile (1.6 km) from the center of town on the highway right-of-way of Ga. 23-121, and 2 miles (3.2 km) from the St. Marys River. This core is chosen as a hypostratotype because the entire member is present in the core (the core recovery in Charlton interval was approximately 58%), because both overlying and underlying units are present, and because the core site is near the type locality of the Charlton.

Lithology

Typical Charlton Member consists of clay, dolostone, and limestone. Clay appears to be the dominant lithic component. However, dolostone and limestone are more conspicuous in outcrop, probably because they are more resistant to erosion and persist longer in outcrop. Also, the clay, dolomite, and calcite commonly occur in varying combinations. Other subordinate lithic components of the Charlton Member include quartz sand, phosphate, and shells.

The clay component, more conspicuous in cores than in outcrop, generally is a dense, blocky, gray clay that is typically massive and structureless but in places is thinly stratified. The clay, where unweathered and unleached in cores, commonly contains varying proportions of dolomite or calcite. The clay mineral suite appears to vary widely from sample to sample (Hetrick and Friddell, 1984). In any given sample, the suite can be dominated by smectite, palygorskite, or illite. Kaolinite is unusually prominent for a subdivision of the Hawthorne Group in the coastal area. Sepiolite, however, is not known to occur in the Charlton.

Dolomite appears to be the more common carbonate of the Charlton Member, but locally, as in the reference core Charlton 2 (GGS-3185), calcite is the dominant carbonate. Dolostone is commonly of the tan, saccharoidal variety and generally contains abundant molds and impressions of a few species of small pelecypods. Fine-grained, layered, gray dolostone, similar to the fine-grained dolostone of the equivalent Statenville Formation, is also locally present, as at Limerock on the Satilla River in Brantley County. The dolostone and limestone beds of the Charlton range from thin-bedded to thick-bedded. Internally the dolostone or

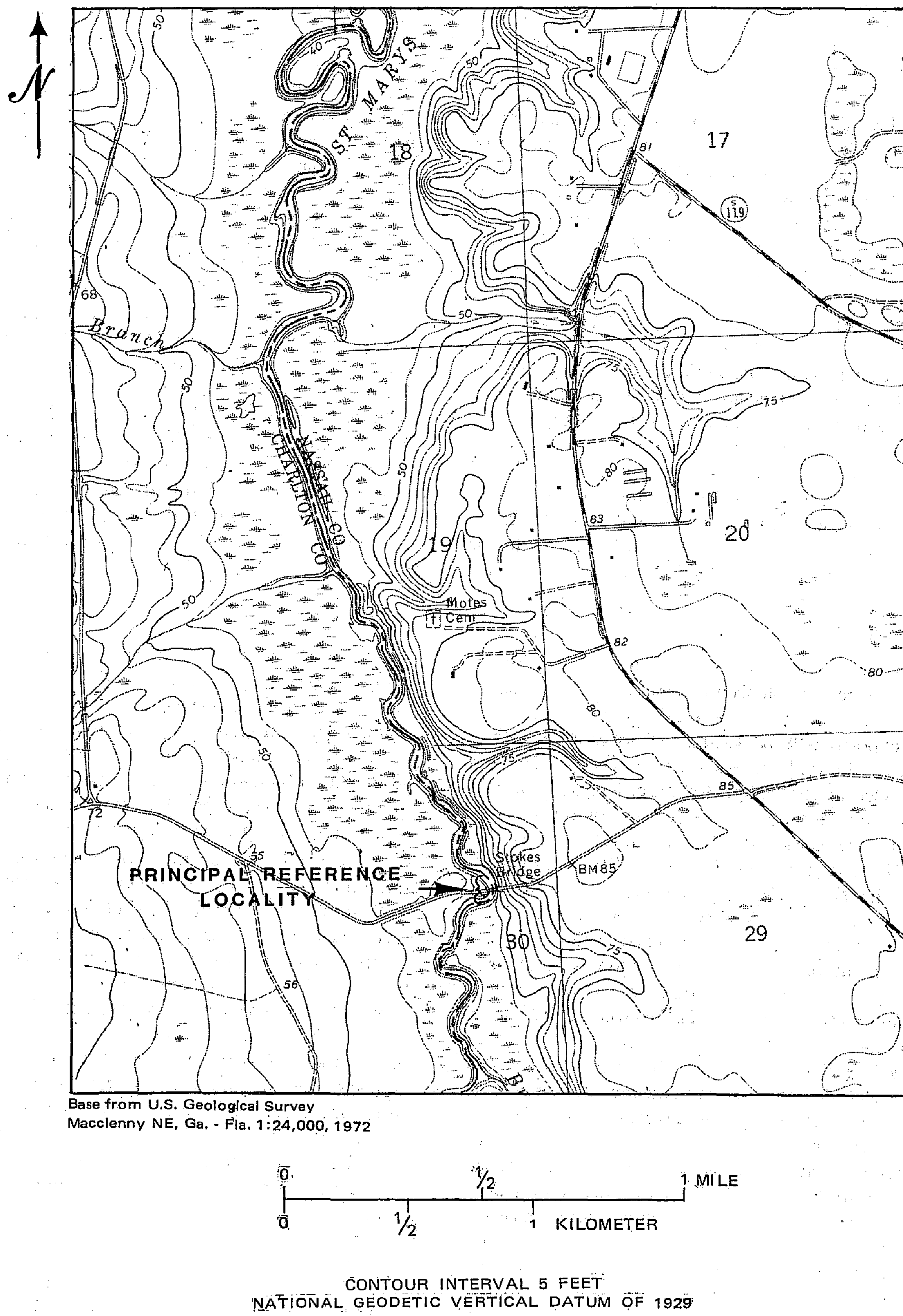


Figure 34. The principal reference locality of the Charlton Member of the Coosawhatchie Formation.

limestone generally is massive and structureless, but locally is stratified, ranging from laminated to thin-bedded.

The Charlton is exceptionally fossiliferous for a unit of the Hawthorne Group. The dolostones and limestones of the member are commonly, but not invariably, moldic and coquinoid, consisting of molds and impressions of small pelecypods. Some beds of the dolostone or limestone, such as those at the principal reference locality at Stokes Bridge, consist of a moldic ostracode coquina. The fossil assemblages of the Charlton, however, lack diversity, and commonly consist of only a few species. The only foraminifera the author has seen in the Charlton Member are the benthic species *Ammonia beccarii* and *Elphidium* spp., which indicate a brackish environment.

Typical Charlton lithology is sand- and phosphate-poor. Sand and phosphate are almost absent in the sections described by Veatch and Stephenson (1911) and from the core Charlton 2 (GGS-3185). Therefore, the low sand and phosphorite content, the high clay and carbonate (calcite, limestone, dolomite, dolostone) content, and the local abundance of fossils are the qualities that serve to distinguish the Charlton Member from the rest of the Coosawhatchie Formation, and from the rest of the Hawthorne Group in Georgia. Lithologies intermediate between typical Charlton Member and Ebenezer Member (e.g., in the core Cumberland Island 1 [GGS-3426] between the depths of 90 and 160 feet), range from phosphatic, sandy dolostone to phosphatic, dolomitic sand and sandstone. This lithology does not clearly fit either Charlton Member or Ebenezer Member, but is arbitrarily included in the Ebenezer Member in this report because of the presence of sand and phosphate.

Stratigraphic Relationships

As a continuous mappable unit, the Charlton Member of the Coosawhatchie Formation is restricted to parts of Camden, Charlton, and Brantley Counties, Georgia, and to parts of Nassau, Duval, Baker, Bradford, and Clay Counties, Florida (Fig. 35). North of this area, to perhaps the vicinity of the Altamaha River, and some distance south of this area in northeastern Florida, the Charlton lithofacies occurs discontinuously in the upper part of the Ebenezer Member.

The Charlton Member is disconformably overlain by the Satilla Formation under the Pamlico terrace, and by the Cypresshead Formation elsewhere in Georgia. The Charlton Member appears to be present under the eastern part of the Okefenokee Swamp, and in that area may be directly overlain by swamp deposits. Scattered remnants of the unnamed Rayser-equivalent shelly sand disconformably overlie the Charlton Member at some sites in the coastal area. The Charlton Member conformably and gradationally overlies the Ebenezer Member of the Coosawhatchie Formation.

At present, there is insufficient data to describe the thickness distribution of the Charlton Member. Veatch and Stephenson (1911, p. 394) reported about 6 feet (2 m) of Charlton at Stokes Bridge. The other sections of the Charlton that Veatch and Stephenson (1911, p. 394-400) measured on the St. Marys River range in thickness from 4 feet (1.2 m) to more than 15 feet (4.6 m). In the reference core Charlton 2 (GGS-3185) at Folkston, the Charlton Member is 79 feet (24 m) thick. It is 32 feet (10 m) thick in the Florida Geological Survey core Trail Ridge 3 (W-10473) in northern Baker County, Florida, and 49 feet (15 m) thick in the Florida Geological Survey core National Lead 1 (W-12360) in Bradford County, Florida (Fig. 4). In Wayne County, Georgia, where the Charlton lithofacies is discontinuous, it is 13 feet (4 m) thick in the core Wayne 3 (Fig. 2).

The environment of deposition of the Charlton Member of the Coosawhatchie Formation was brackish, coastal marine. The foraminiferal fauna of the Charlton consists of the brackish water foraminifer *Ammonia beccarii* with minor amounts of *Elphidium* spp. The low diversity of mollusk and ostracode faunas are consistent with the paleoenvironmental implications of the foraminifera (i.e., brackish water environment).

The variability of the clay mineral suite in addition to the unusual prominence of illite, strong presence of kaolinite, and the scattered dominance of palygorskite is compatible with the paleontological evidence for the environment of deposition. The strong presence of both illite and kaolinite are indicative of the proximity of a large river that drained the Piedmont (Dr. J.H. Hetrick, pers. com., 1986). The presence of palygorskite indicates local brackish to hypersaline water conditions. The characteristic low concentration or absence of quartz sand in the Charlton Member also indicates that the area of deposition of the Charlton was cut off from the direct supply of clastics from the river source. The characteristic occurrence of clay interlayered with dolostone and limestone in the Charlton suggests that the clay fraction of the river sediment load was periodically introduced into a relatively clastic-free coastal environment. In addition, the characteristic absence of phosphate in typical Charlton sediments suggests that the Charlton depositional environment was cut off from direct access to the normal marine, continental shelf watermass.

The environment model most consistent with the above constraints is a depositional environment analagous to that of the present Lake Ponchetrain in the Mississippi delta. The Charlton depositional environment is envisaged to be a large, brackish sound or a coastal semi-enclosed body of water, perhaps cut off from the river source by natural levees along a bird foot delta, and partially isolated from the normal shelf water by the presence of barrier islands or other possible obstacles (e.g., shoals).

Age

Veatch and Stephenson (1911, p. 392-400) provisionally placed the Charlton in the Pliocene on the basis of a few

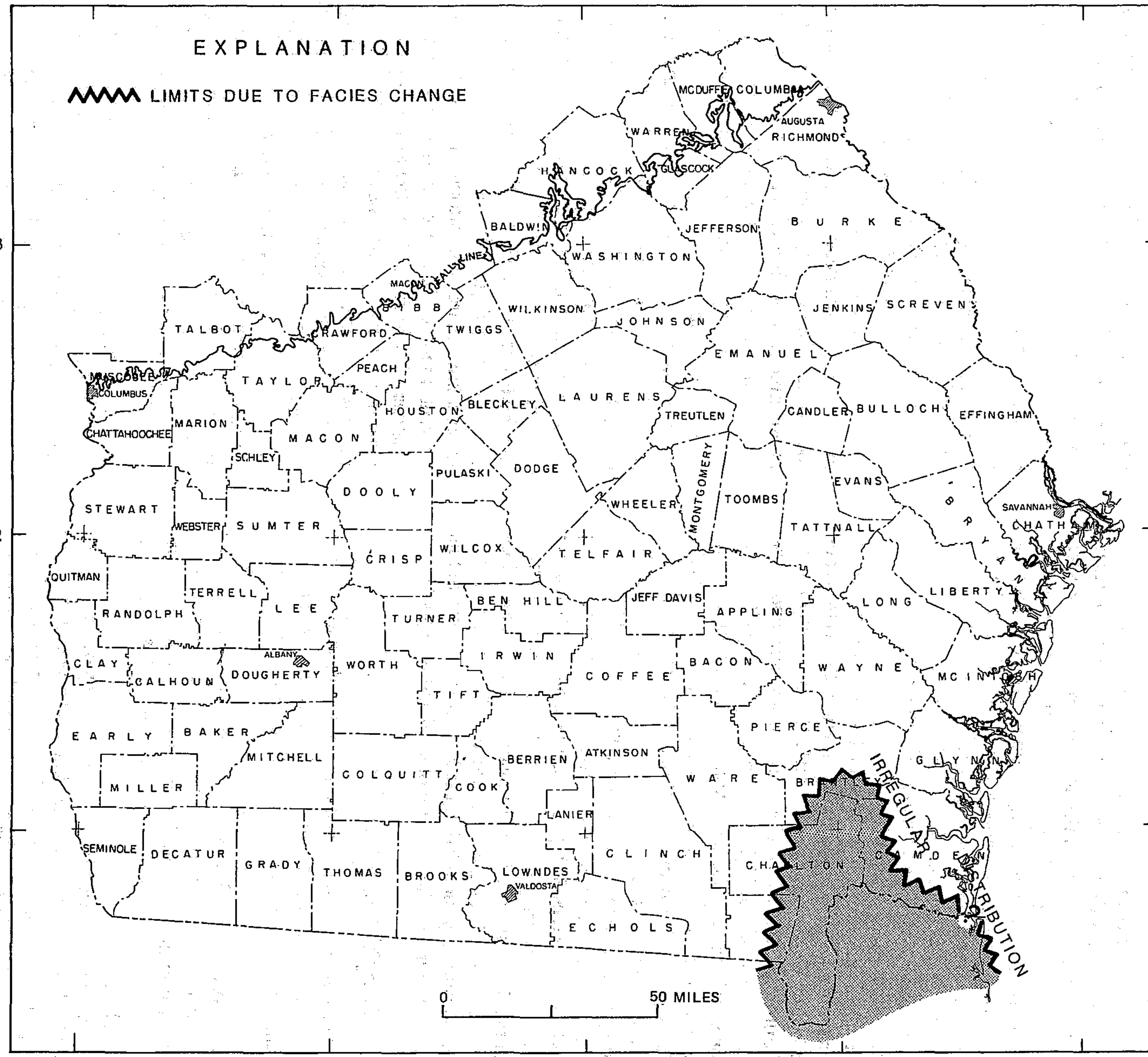


Figure 35. The areal distribution (outcrop and subcrop) of the Charlton Member of the Coosawhatchie Formation in Georgia.

molluscan and ostracode species. Cooke (1943, 1945) concurred with this appraisal. The fossils that would have indicated a Pliocene age for Charlton include *Pecten gibbus, Rangia cuneata, Chione cancellata,* and *Mulinia lateralis*. The fossil then identified as *P. gibbus*, a Pleistocene and Holocene species, was subsequently renamed *P. charltonius* by Mansfield (1936) and transferred to *Argopecten charltonius* by Waller (1969). The only known geographic occurrence of *A. charltonius* is within the Charlton Member and *A. charltonius* is, therefore, of little value in biostratigraphic correlation. Waller (1969), however, suggested that the Charlton is late Miocene based on the general similarity between *A. charltonius* and *A. choctawhatcheensis* of the *Arca* Zone of the upper Miocene Choctawhatchee Formation of western Florida. Supporting Waller's (1969) suggestion of an older age for the Charlton Member, I recently examined the fossil collections from the Charlton in the U.S. National Museum in Washington, D.C., and could find no Pleistocene or Pliocene species as described by Veatch and Stephenson (1911) and by Cooke (1943, 1945) (i.e., *Rangia cuneata, Chione cancellata,* and *Mulinia lateralis*). I have also not found these species in the Charlton, either in outcrops or cores. Therefore, there is no existing paleontological evidence, known to this author, for a post-Miocene age for the Charlton Member.

Because the physical stratigraphic relationships indicate that the Charlton is a lithofacies of the upper part of the Coosawhatchie Formation, the Charlton Member is here provisionally assigned the same age as the rest of the Coosawhatchie, (i.e., middle Miocene, early Serravallian [Pl. 1]). This report does not exclude a late Miocene age for the Charlton Member, as suggested by Waller (1969). Other than the similarity between *Argopecten charltonius* and *A. choctawhatcheensis* noted by Waller, however, no paleontological or physical evidence exists to suggest or support a late Miocene age for the Charlton member. On the other hand, no evidence, other than the appearance of gradational contacts between the Charlton and Ebenezer Members, exists to deny a younger Miocene or late Miocene age for the Charlton or Ebenezer Members.

MEIGS MEMBER OF THE COOSAWHATCHIE FORMATION (new name)

Definition

The Meigs Member of the Coosawhatchie Formation is a new name proposed herein for argillaceous, well-sorted, fine-grained sand and thinly bedded to laminated, variably siliceous and diatomaceous clay. At this time, the Meigs member has been recognized only along the trend of the Gulf Trough from northwestern Thomas County, where it is mined for fuller's earth at Meigs, through northern Coffee County to northern Toombs and southern Emanuel Counties, where it crops out in the lower Ohoopee River area.

The Meigs Member is included in the Coosawhatchie Formation because its lithology is most similar to that of the Coosawhatchie, and it is correlative with (Andrews and Abbott, 1985) and probably stratigraphically continuous with the Coosawhatchie in eastern Georgia. Like the Coosawhatchie Formation, the Meigs consists of silty clay (fuller's earth) and fine-grained, well-sorted sand. Lithologically, the clay phase of the Meigs Member most nearly resembles the stratigraphically equivalent clay at the type locality of the Coosawhatchie Formation at Dawsons Landing in South Carolina and, like the Berryville Clay Member, the fuller's earth clay in the lower part of the Meigs Member is characeristically diatomaceous.

In the past, the Meigs Member of the Coosawhatchie Formation was included with the Alum Bluff Formation (Veatch and Stephenson, 1911, p. 357-358; Shearer, 1917, p. 287-289) and with the Hawthorne Formation (Gremillion, 1965; Patterson and Buie, 1974; Weaver and Beck, 1977). The Meigs Member was mapped as Hawthorne Formation by Cooke (1939), and as "Chipola Formation and Tampa Limestone" by MacNeil (1947b). Sever (1966b) referred to this unit, in the vicinity of Meigs, as the "Upper Zone of the Alum Bluff Group".

Type Section

The name Meigs is taken from the village of Meigs in Thomas County, Georgia. The type locality of the member is the Singletary pit of the Waverly Mineral Products Company, 4.0 airline miles (6.4 km) southeast of Meigs and 1.75 miles (2.8 km) east of highway US 19, on the north side of Hansell Road, and in the southern valley wall of Oaky Woods Creek (Fig. 36). The entire section exposed in the Singletary pit is Meigs Member, and this is the type section, or unit-stratotype (holostratotype), of the member.

The Meigs Member of the Coosawhatchie Formation can also be seen in the lower parts of bluffs along the Altamaha River in Toombs County, Georgia, and in roadcuts at relatively low elevations (below approximately 150 feet above sea level) in the lower Ohoopee River area in northern Toombs and southern Emanuel Counties, Georgia.

Parastratotypes of the Meigs Member include the interval 77 feet to 110.5 feet in the core Coffee 3 (GGS-3539) and 78 feet to 111 feet in the core Coffee 4 (GGS-3541) in Coffee County, Georgia; the interval 123 feet to 160 feet in the core Berrien 10 (GGS-3542) in Berrien County, Georgia; the interval 125 feet to 214 feet in the core Colquitt 3 (GGS-3179) and 0 to 96 feet in the core Colquitt 9 (GGS-3535) in Colquitt County.

Lithology

Available information indicates that the Meigs Member of the Coosawhatchie Formation is a lithologically heterogeneous unit. Well-sorted, fine-grained sand is the dominant

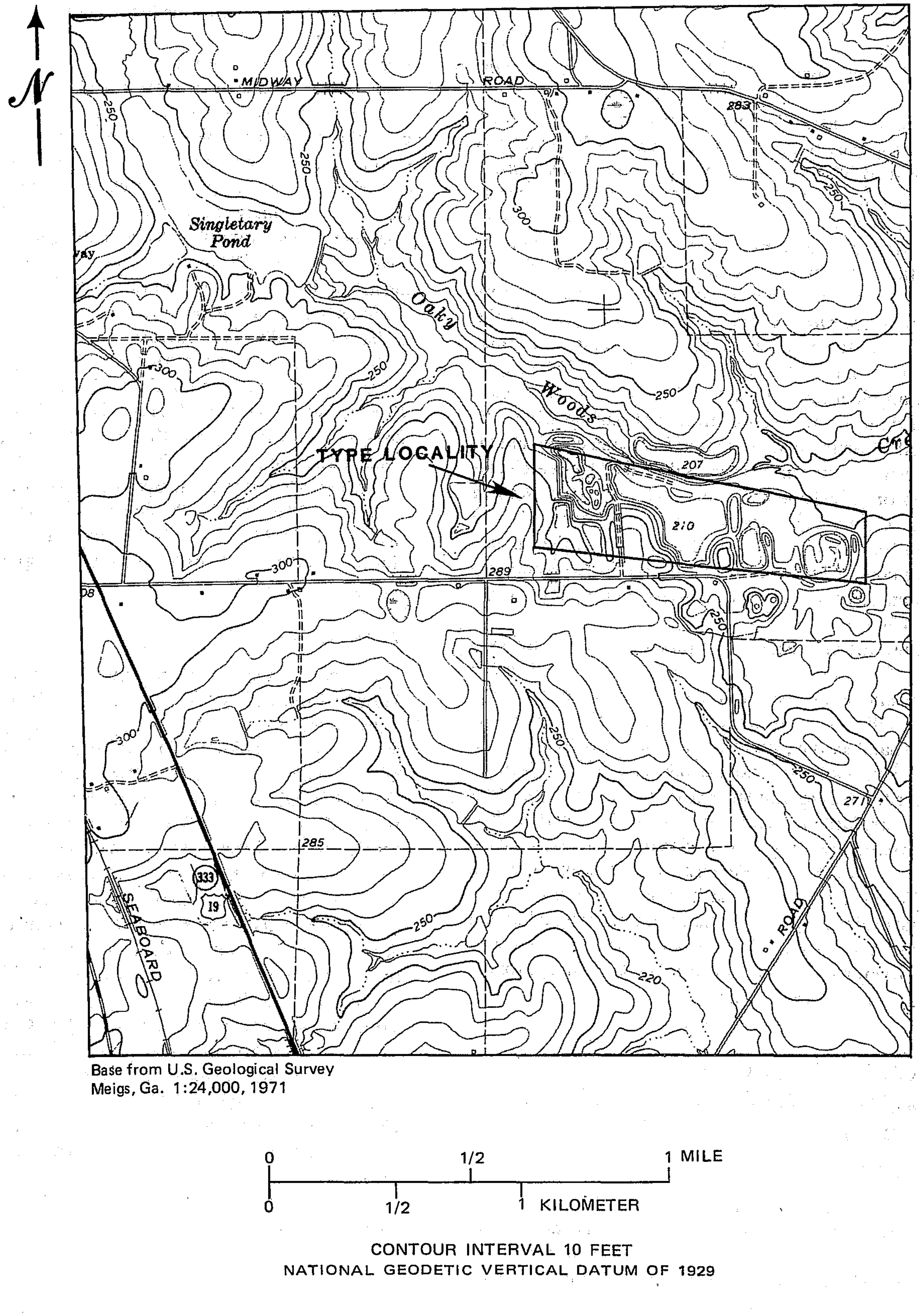


Figure 36. The type locality of the Meigs Member of the Coosawhatchie Formation.

lithic component of the unit, but clay is prominent and is the characteristic lithic component of the unit. Other subordinate lithic components include mica, chert, silica-cemented sandstone, wad (hydrated MnO_2), minor Na- and K-feldspar, heavy minerals, siliceous microfossils, and minor phosphate.

The quartz sand is typically fine-grained and well-sorted, but minor fine- to medium-grained sand has been observed. The sand beds are generally thin to thick, vaguely and rudely bedded to massive and structureless. Scattered small-scale cross-bedding has been observed in fine-grained sand sections. Relatively pure quartz sand is not known in the Meigs Member, and the sand is always argillaceous to some degree with minor to abundant interstitial clay. Where clay occurs in discrete beds, the clay is laminated with scattered fine-grained sand or silt layers, or with silt dustings on bedding planes. The laminated clay commonly is siliceous to a minor degree, and siliceous microfossils (diatoms, ebridians, sponge spicules, and probably very rare silicoflagellates) are common locally (Andrews and Abbott, 1985). The laminated clay beds are present in most sections and vary in thickness from a few feet (approximately 1 m) to as much as 48 feet (15 m) (Weaver and Beck, 1977, p. 105-118). The thick clay deposits are mined for fuller's earth in northwestern Thomas County. Montmorillonite generally is the dominant clay mineral component of this unit, but palygorskite may predominate in some beds. Sepiolite, illite, and kaolinite are minor clay mineral components. The occurrence of palygorskite and sepiolite is characteristic of the Meigs member in the southwestern part of its geographic occurrence whereas palygorskite and sepiolite appear to be minor or absent elements in the northeastern areas. Kaolinite is a significant clay mineral only in the upper part of the section (Weaver and Beck, 1977, p. 105-118; Patterson and Buie, 1974, p. 36-37).

Secondary silica is locally conspicuous in the Meigs Member. The silica is typically interstitial and acts as a cementing agent in argillaceous, fine-grained sands, finely sandy clays, and less commonly, in clay. In non-sandy sediments, the silicification is manifested as siliceous claystone or chert. The degree of induration of the siliceous sediments is variable. Some sediments entirely lack evidence of silicification. Most commonly, however, the sediments appear to be only slightly to moderately silicified, with such sediments being tough, moderately resistant, but crumbly and poorly coherent. Silicified sediments have not been seen in natural outcrops, probably due to weathering and leaching of the siliceous cementing agent. The source of the silica may be siliceous microfossils, because unaltered diatom frustules commonly are seen in various states of preservation in the nonsilicified clays. Diatoms or other siliceous microfossils are not apparent in the silicified, indurated sediments.

Burrows and clear evidence of bioturbation have not yet been observed in exposures in the Meigs area or in the various cores. However, both bioturbation and burrows are present in the sandy phase of this unit in northern Toombs County.

Stratigraphic Relationships

At this time, Meigs Member is known to occur only in or adjacent to the Gulf Trough (Fig. 37). Present information indicates that the unit occurs at least as far southwest as northwestern Thomas County, and at least as far northeast as northern Toombs and southern Emanuel Counties, Georgia. The southwestern limits of the Meigs Member are unknown at this time. In Gadsden County, Florida, sediments reminiscent of the Meigs Member occur in the upper part of the Hawthorne Group and overlie the Torreya Formation in fuller's earth pits. These upper Hawthorne Group deposits of Gadsden County also occur in the Florida Geological Survey cores Suber 1 (W-7573), Owenby 1 (W-7472), and Gregory 1 (W-7528) (Fig. 4). The basal clay bed of this unit in the Florida Geological Survey cores is lithologically similar to the Berryville Clay Member of the Coosawhatchie Formation of eastern Georgia. If the upper sands and clays of the Hawthorne Group in Gadsden County, Florida, represent the Meigs Member of this report, the Gadsden County stratigraphic equivalent is devoid of the characteristic thinly bedded to laminated, diatomaceous clay lithofacies.

It is not clear, yet, to what extent the Meigs Member occurs outside of the Gulf Trough. The outcrops of the unit in the vicinity of the Ohoopee River occur on the northern margin of the Gulf Trough (Fig. 37). On the southern flank of the Gulf Trough in Colquitt County, neither the Meigs Member nor a stratigraphically equivalent unit has been identified in the core Colquitt 10 (GGS-3144). However, 96 feet (29 m) of the Meigs Member are present in the Gulf Trough in the core Colquitt 9 (GGS-3535) 9 miles (14 km) northwest of the site of the core Colquitt 10. This presence suggests pinchout or abrupt facies change of the Meigs Member on the southern flank of the trough.

Because of stratigraphic position and biostratigraphic correlation, the Meigs Member is presumed to grade laterally eastward into the lower part of the Coosawhatchie Formation in the northern part of the Southeast Georgia Embayment (Fig. 11; Pl. 1). As yet, the area has no core control to confirm this correlation. In addition, because of an apparent stratigraphic association (mutual occurrence in stratigraphic sections) between the Meigs Member and the overlying Altamaha Formation (there is as yet no such evidence for a similar stratigraphic association between the Ebenezer Member of the Coosawhatchie Formation and the Altamaha Formation), it is suggested that the Meigs Member rather than the Ebenezer Member more likely occurs in the interior of the Southeast Georgia Embayment south of the Gulf Trough (i.e., in Jeff Davis, Appling, Bacon, and northern Ware Counties). In this model, Meigs Member would represent a lithofacies extension of the middle Miocene, inner Southeast Georgia Embayment deposits, southwestward along the Gulf Trough.

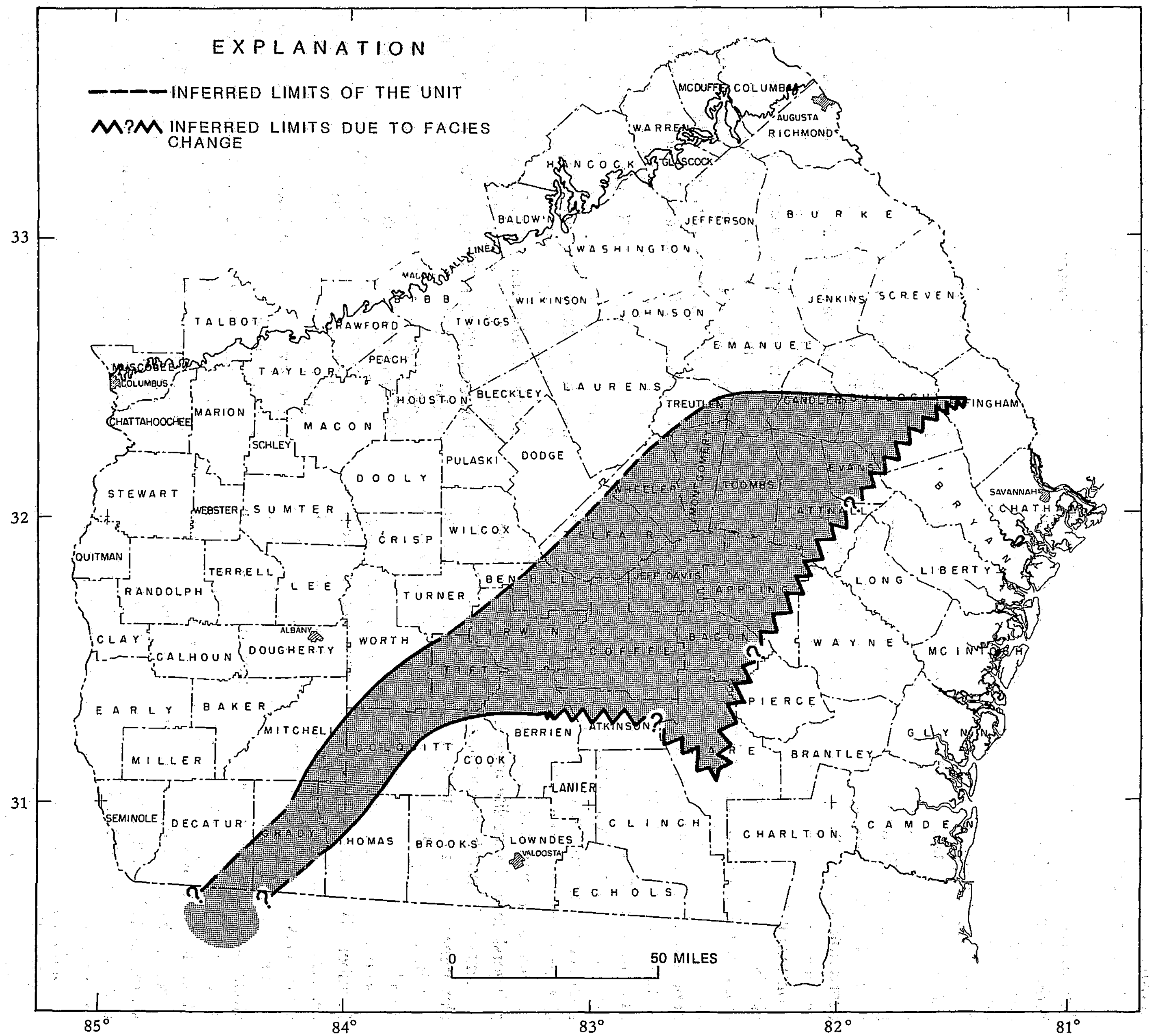


Figure 37. The areal distribution (outcrop and subcrop) of the Meigs Member of the Coosawhatchie Formation in Georgia.

The Meigs Member of the Coosawhatchie Formation overlies, in the Gulf Trough, lithologically heterogeneous Hawthorne Group sand and clay deposits that appear to be stratigraphically equivalent to the Marks Head Formation of eastern Georgia (Pl. 1). The Meigs Member is overlain conformably and gradationally by the Altamaha Formation from northeastern Colquitt County to southern Emanuel County. In central Colquitt County, the Meigs Member occurs to ground level, and in northwestern Thomas County, the Meigs Member is overlain disconformably by the upper Pliocene Miccosukee Formation, or by undifferentiated surficial or alluvial deposits.

The Meigs Member of the Coosawhatchie Formation is distinguished from the other members of the Coosawhatchie Formation in lacking carbonate, in lacking or containing only minor phosphate, and in being more siliceous and diatomaceous. The Meigs Member is distinguished from the underlying undifferentiated Hawthorne deposits by the presence of thinly layered to laminated diatomaceous clay (fuller's earth) near the base of the member. In contrast, the undifferentiated deposits are thick-bedded and massive throughout.

Thickness distribution information on Meigs Member is fragmentary. Available information indicates that the Meigs Member ranges from 47.5 feet (15 m) to 82 feet (25 m) in thickness in northwestern Thomas County (Patterson and Buie, 1974, p. 36-37; Weaver and Beck, 1977, p. 105-118). The maximum thickness of the unit in northwestern Thomas County is probably greater than that cited because the base of the unit has not been identified there. In cores in Colquitt County, the thickness of the Meigs Member is 96 feet (29 m) in the core Coffee 9 (GGS-3535) in the interval 0 to 96 feet, and 89 feet (927 m) in the core Colquitt 3 (GGS-3179) in the interval 125 feet to 212 feet. In northern Berrien County, Meigs Member is 37 feet (11 m) thick in the core Berrien 10 (GGS-3539) in the interval 77 feet to 110.5 feet; and 33 feet (10 m) thick in the core Coffee 4 (GGS-3541) in the interval 78 feet to 111 feet. The known thickness range of the Meigs Member is, therefore, 33 feet (10 m) to 96 feet (29 m), with an apparent systematic increase in thickness southwestward along the Gulf Trough.

The environment of deposition of the Meigs Member was shallow-water, coastal marine. According to Andrews and Abbott (1985) and Abbott, in Huddlestun (1985), the salinity of the water in which the Meigs Member of the Coosawhatchie Formation (Coosawhatchie equivalent of Andrews and Abbott, 1985) was deposited ranged from normal marine with no evidence indicating "any substantial deviation from normal marine salinity" (p. 64), through brackish to mainly fresh-water. In addition, Andrews and Abbott (1985, p. 65) noted that, "The freshwater taxa include forms ranging in preference from acidic to alkaline water . . . ".

Because of lack of sufficient core data south of the Gulf Trough and in the interior of the Southeast Georgia Embayment, it is not clear whether the Meigs Member was deposited only in a narrow strait connecting the Atlantic Ocean and the Gulf of Mexico (Gulf Trough), or whether shallow, water, marine conditions also prevailed south of the Gulf Trough as well.

Age

The age of the Meigs Member of the Coosawhatchie Formation is middle Miocene (Kanaya, *in* Gremillion, 1965, p. 44-45; Abbott, *in* Weaver and Beck, 1977, p. 109-110; Andrews and Abbott, 1985, p. 64; Abbott, *in* Huddlestun, 1985, p. 6-7). According to Andrews and Abbott (1985), the Meigs Member is in the upper part of East Coast Diatom Zone (ECDZ) 4 of Andrews (1978) and in Atlantic Margin Siliceous Microfossil Zone (AMSMZ) IV of Abbott (1978). Andrews (*in* Andrews and Abbott, 1985, p. 64) preferred to correlate ECDZ 4 with the upper part of planktonic foraminiferal Zone N9 of Blow (1969) and with the Langhian Stage, whereas Abbott (*in* Andrews and Abbott, 1985, p. 64) preferred to correlate AMSMZ IV with Zone N10 of Blow (1969) and also with the Langhian Stage.

In eastern Georgia, Ernissee, Abbott, and Huddlestun (1977) suggested correlation of the Coosawhatchie Clay near Berry Landing on the Savannah River (holostratotype of the Berryville Clay Member of this report) to upper Zone N11 or lower Zone N12 of Blow (1969). Abbott and Andrews (1979) later assigned these deposits to AMSMZ VI of Abbott (1978) and ECDZ 6 of Andrews (1978) while maintaining correlation with upper N11 or lower N12. However, *Globorotalia peripheroacuta*, the zonal fossil of N10, is the only member of the *Globorotalia fohsi* lineage[1] present in the type section of the Berryville Clay Member and in nearby cores, and the type Berryville Clay must be, therefore, assigned to Zone N10. Furthermore, the presence of morphologically advanced *G. peripheroacuta* suggests an upper Zone N10 assignment for the type Berryville Clay. It is also possible that, because of the small planktonic foraminiferal faunas in the relatively nearshore area, *G. fohsi praefohsi*, the zonal fossil of N11, may yet be found in the type area of the Berryville clay.

Morphologically primitive *G. fohsi praefohsi* and typical *G. peripheroacuta* are present in the Berryville Clay Member in sample 7-2, 30-40 cm (at a depth of 90 m below sea level) from the core AMCOR 6002 taken on the continental shelf of Georgia. Sample 7-2, 30-40 cm, therefore, is in lower Zone N11 of Blow (1969) and, based on the evolutionary development of the *Globorotalia fohsi* lineage, is slightly younger, or possibly the same age as, the Berryville section near Berry Landing. Abbott (1978, p. 24), however, assigned the interval 80.5 m to 92.5 m below sea level in the AMCOR 6002 to AMSMZ IV whereas he assigned the section near Berry Landing to AMSMZ VI (Abbott and Andrews,

[1]Zones N9 through N12 are based on evolutionary morphological changes in the *Globorotalia fohsi* lineage.

1979). This discrepancy in the correlation and zonal assignment may be the result of AMSMZ IV, V, and VI, and ECDZ 4, 5, and 6 all occurring within Zones N10 and N11 rather than in Zones N9 through N12 as indicated by Abbott and Andrews (1979) and Andrews and Abbott (1985) (W.H. Abbott, pers. com., 1986).

The Meigs Member of the Coosawhatchie Formation contains an AMSMZ IV and ECDZ 4 diatom flora (Andrews and Abbott, 1985; Abbott, *in* Huddlestun, 1985) and, therefore, is equivalent to Zone N10 or lower Zone N11. It seems unlikely to me that the Meigs Member is as old as Zone N9 as suggested by Andrews (*in* Andrews and Abbott, 1985), because I have seen an N9 planktonic foraminiferal assemblage (co-occurrence of *Globorotalia peripheroronda* and *Orbulina suturalis*) at only one site in the Shoal River Formation of western Florida (Huddlestun, 1984, p. 81-83). All of the other lower Shoal River (White Creek beds) and Coosawhatchie planktonic foraminiferal assemblages I have examined are either in Zone N10 or Zone N11. Zones N10 and N11 are in the lower part of the Serravallian Stage (Cita and Blow, 1969; Berggren and van Couvering, 1974; also see Berggren and others, 1985). A Langhian age for the Meigs Member, as proposed by Andrews and Abbott (1985), is not currently supported by correlation of the diatom zonation with the planktonic foraminiferal zonation.

STATENVILLE FORMATION OF THE HAWTHORNE GROUP (new name)

Definition

The Statenville Formation is a new formation proposed herein for prominently planar and trough cross-bedded, argillaceous, dolomitic, phosphatic sand exposed along the Alapaha River at Statenville in Echols County, Georgia. In the past, these deposits have been referred to the Alum Bluff Formation (Veatch and Stephenson, 1911, p. 353-354) and to the Hawthorne Formation (Cooke and Mossom, 1929, p. 125-126; Cooke, 1943, p. 94; 1945, p. 152-153; Puri and Vernon, 1964, p. 153). Brooks (1966, p. 74-78) described the deposits at the type locality at Statenville but did not assign them to any lithostratigraphic unit.

Type Section

The name Statenville is taken from the village of Statenville in Echols County, Georgia. The type locality of the formation is the low bluff on the east bank of the Alapaha River at Statenville (Fig. 38). The type section, or unit stratotype (holostratotype), of the Statenville Formation includes those exposures of the formation in the low bluff along the Alapaha River at Statenville north of the Ga. 94 bridge. Neither the upper nor lower boundaries of the Statenville Formation are exposed at the type locality.

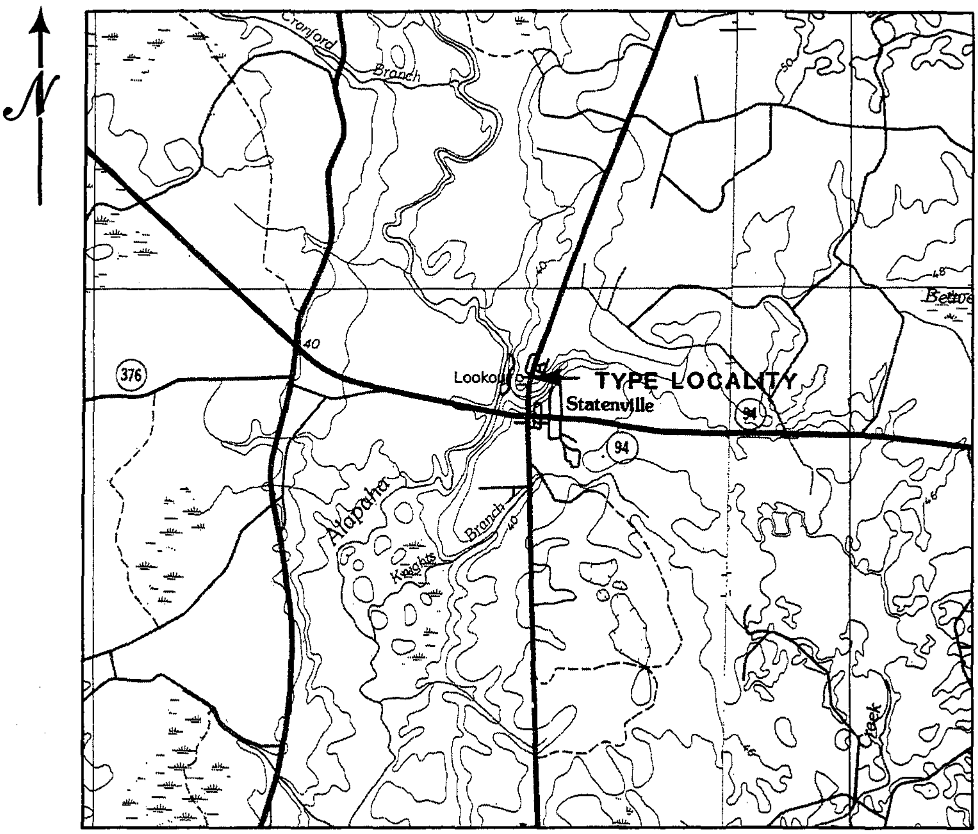
Three additional reference localities and parastratotypes are proposed herein. The interval 11 feet to 87 feet in the Florida Geological Survey core Betty 1 (W-15121) is herein designated a parastratotype and a lower boundary stratotype of the Statenville Formation. The boundary between the Statenville Formation and the underlying unnamed dolostone, clay, and sand occurs at a depth of 87 feet in the core. The core site of the Betty 1 (W-15121) is in NE 1/4, NW 1/4, Sec. 3, T2N, R12E in Jennings, Hamilton County, Florida. The second parastratotype includes those exposures of the Statenville Formation along the Alapahoochee River between the Ga. 135 bridge in southwestern Echols County, and the bridge over the river in NE 1/4, Sec. 224, T2N, R12E in Hamilton County, Florida, approximately 1 1/4 miles (2 km) northeast of Jennings. This stratotype consists of a series of exposures and is, therefore, a composite parastratotype. The third parastratotype is also a composite parastratotype and consists of those exposures along the Suwannee River, approximately 1 mile (1.6 km) above and below the former site of Cones Bridge (currently a boat landing) in Sec. 36, T1N, R16E in Hamilton and Columbia Counties, Florida.

Lithology

The Statenville Formation is a prominently cross-bedded, undulatory-bedded, to horizontal-bedded, dolomitic, phosphatic, argillaceous sand with scattered beds or lenses of clay and dolostone. Quartz sand is the dominant lithic component, whereas clay, dolomite, dolostone, phosphate, and mica are subordinate lithic components. The grain-size of the quartz sand ranges from fine to coarse, and the sorting ranges from well-sorted to poorly sorted. Quartz pebbles occur in the coarser beds or lenses of the formation, and flat pebbles have been observed among the quartz pebbles. The coarser, pebbly sand phases of the formation generally are the more poorly sorted.

Dolomite is characteristically conspicuous in the formation and is present both interstitially and in discrete, thin beds. Dolostone beds may be relatively pure (as in beds at the type locality) or sandy, argillaceous, and phosphatic. The bedded dolostone is typically buff to tan, fine-grained, saccharoidal, hard, and resistant to erosion. In outcrop the dolostone beds produce prominent ledges in contrast to the soft, nonindurated sand layers. Some beds consist of a dolostone conglomerate or breccia cemented by dolomite of similar lithology and appearance.

Phosphate is characteristic of and is commonly conspicuous in the Statenville Formation. The phosphate grains range from the typical small, black, brown, to amber-colored, rounded, sand-size apatite grains or pellets; to irregularly shaped, rounded, black, shiny, sand-size grains or small pebbles; to black, brown, orange, or buff-colored, irregularly shaped pebbles ranging from 1 to 5 cm in diameter. These coarser phosphate pebbles appear to be characteristically found in conglomerate beds cemented with dolomite and are more typical of the Suwannee River section



Base from U.S. Geological Survey
Okefenokee Swamp, Ga.-Fla. 1:100,000, 1980
and Valdosta, Ga.-Fla. 1:100,000, 1981

0 1 2 3 MILES

0 1 2 3 KILOMETERS

CONTOUR INTERVAL 5 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 38. The type locality of the Statenville Formation of the Hawthorne Group.

than the Alapaha River section. The Statenville Formation may be exceptionally rich in phosphate, and thin beds or lenses of phosphatic sediment (or phosphorite) are lithologically identical to the broadly correlative Tybee Phosphorite Member of the Coosawhatchie Formation. These beds have the color and appearance of wet coffee-grounds.

Clay is not conspicuous in the coarse, prominently cross-bedded lithofacies of the Statenville Formation and its occurrence there is mainly interstitial. The upper part of the formation generally is finer grained, however, (e.g., in the interval 11 feet to 53 feet in the core Betty 1 [W-15121]), and clay in this lithofacies occurs in discrete beds of thinly stratified or laminated silty clay. The clay beds range in thickness from less than 1 foot (0.3 m) to more than 8 feet (2.4 m). Massive fuller's earth clay of Shearer (1917, p. 284-287) is referred to the Statenville Formation of this report. The known clay mineral assemblages of the Statenville Formation includes montmorillonite and palygorskite (T. Scott, pers. com., 1983; also compare with Brooks [1966, p. 82]).

Characteristically the Statenville Formation is prominently bedded with the bedding standing out in bold relief. Bedding styles range from horizontal to undulatory to planar and trough cross-bedded with common cut-and-fill structures. Typically the bedding is enhanced or "highlighted", as at the type locality, by thin beds exposed as "sheets" of hard, resistant, fine-grained dolostone that stand out in relief as ledges. The softer, sandy sediment occurs in reentrants between the thin dolostone beds or "sheets". In this lithofacies, most discrete bed-units are less than a few inches (several centimeters) thick, and many are less than 1 inch (2.5 cm) thick.

Based on the core Betty 1 (W-15121) and field observation, the characteristic, prominently cross-bedded Statenville lithology apparently grades upward, and possibly laterally as well, into a less conspicuously bedded, less dolomitic to carbonate-free, variably phosphatic sand with local development of clay beds. This lithofacies is also well-bedded, but the bedding is not enhanced by the presence of resistant, thin dolostone beds. Bedding is marked by the distinction between clay beds and sand beds, or by the distinction between grain-size and sorting within the sand. These upper sands of the Statenville Formation are actively being mined for phosphate by the Occidental Chemical Company in Hamilton County, Florida.

The Statenville Formation is very sparsely fossiliferous. Molds and casts of mollusks occur locally in moderate frequency in the dolomitic beds. Fossils with calcitic shells. such as scallops, oysters, and barnacles are very rare. Voorhis (1974b) reported a meager assemblage of vertebrate fossils from the type locality of the formation. Vertebrate fossil debris, such as small fish teeth and bones, is not rare in the phosphatic beds of the formation, and the trace fossil *Ophiomorpha nodosa* is locally common in sand beds on both the Alapaha and Suwannee Rivers. Most beds and many sections of the Statenville Formation, however, are barren of visible fossils.

Stratigraphic Relationships

The Statenville Formation is known to occur in Echols County, Georgia, and in the upper Suwannee River area in Hamilton and Columbia Counties, Florida, and it probably underlies much of Clinch County, Georgia (Fig. 39). I northern and southern limits are unknown at this time, but its western limit occurs on the eastern part of the Florida Platform in eastern Lowndes County, Georgia, and western Hamilton County, Florida. Its eastern limit occurs in eastern Columbia or western Baker Counties, Florida, and probably southwestern Clinch County, Georgia. The boundary between the Florida Platform and the Southeast Georgia Embayment appears also to make the eastern limit of the Statenville Formation, because the Coosawhatchie Formation occurs in the Statenville stratigraphic position in the St. Marys River area (within the Southeast Georgia Embayment) in Florida and Georgia.

The Statenville Formation overlies the unnamed dolostone, clay, and sand in Hamilton County, Florida, and probably in Echols County, Georgia (Fig. 11). It occurs at the top of the geologic section in most of Echols County where it is overlain only by undifferentiated sands. In northwestern Echols County, the Statenville Formation is disconformably overlain by the Miccosukee Formation.

The Statenville Formation is distinguished from the Coosawhatchie Formation in the prominence of bedding (horizontal-, undulatory-, and cross-bedding), the common occurrence of dolostone, the local coarseness (with pebbles) and poor sorting of the sand, and the lithologic heterogeneity of the member (phosphatic sand beds, clay beds, dolostone beds, and phosphorite beds). The underlying unnamed lower Miocene dolostone, clay, and sand is distinguished from the Statenville Formation in consisting of thick beds of massive dolostone; massive, structureless, finely sandy clay; and massive, structureless, argillaceous sand; in being relatively nonphosphatic, and in the consistently fine grain-size of the sand.

At present there is meager information on the thickness distribution of the Statenville Formation. Brooks (1966, p. 76-78) reported 28.8 feet (9 m) of Miocene sediments (Statenville Formation) at the type locality in Statenville. At the present time, however, only 12 feet (3.5 m) of Statenville Formation is exposed there. Seventy-six feet (23 m) of Statenville Formation is present in the reference core Betty 1 (W-15121).

The environment of deposition of the Statenville Formation is believed to have been shallow water, coastal marine. The Statenville Formation is not known to be calcareous anywhere and, therefore, is not known to contain calcareous fossils. However, a small land mammal fauna has been described from the Statenville (Voorhies, 1947b), indicating

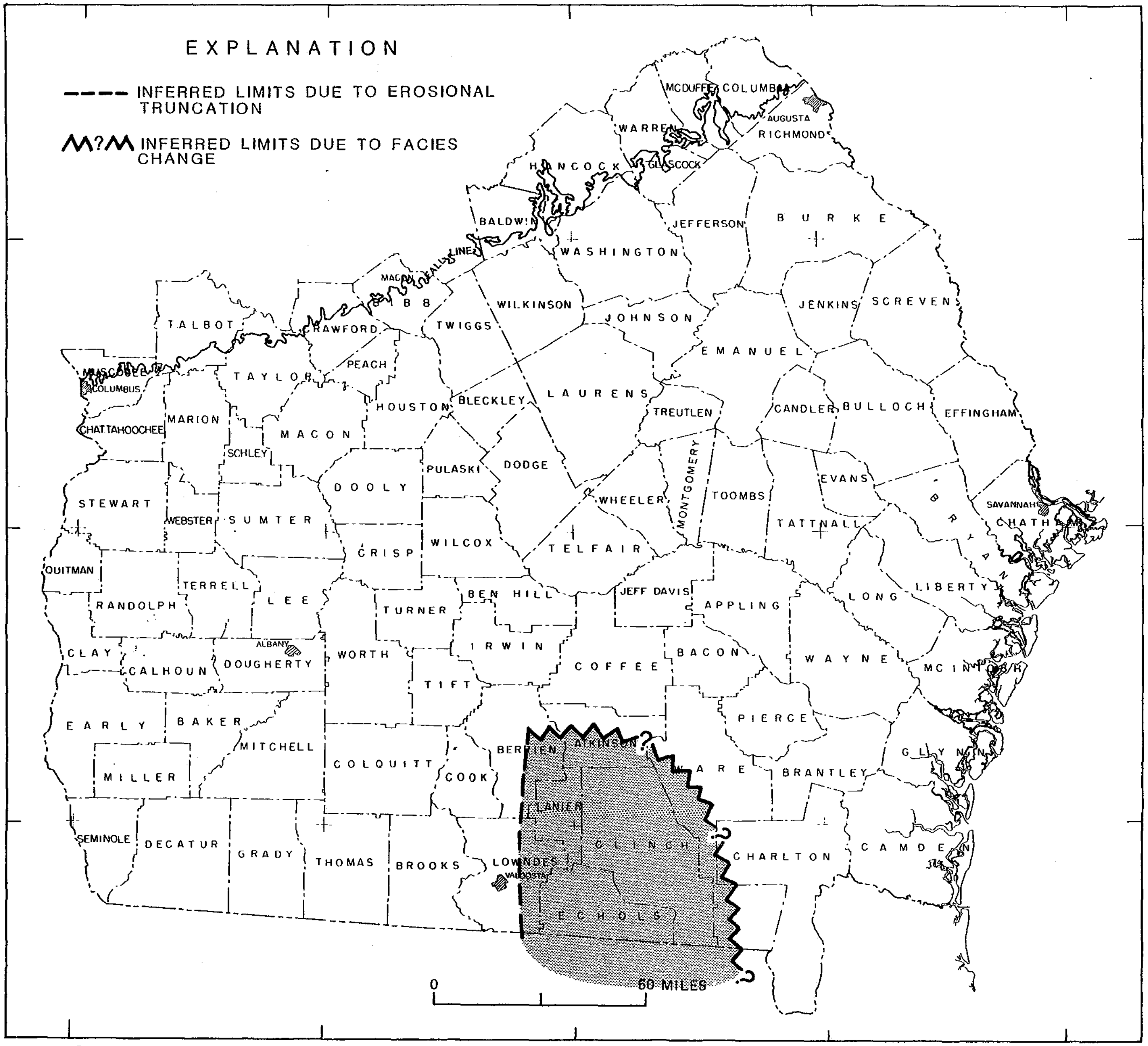


Figure 39. The areal distribution (outcrop and subcrop) of the Statenville Formation in Georgia.

proximity to land. The trace fossil *Ophiomorpha nodosa*, a burrow of the intertidal shrimp *Callianassa major*, is locally common in the Statenville, and is indicative of strand line to subtidal conditions and very shallow water.

The sedimentary structures of the Statenville Formation are compatible with a coastal origin. Large scale cross-bedding requires high energy, which in the marine environment must come from high current energy. In addition, channel cut-and-fill structures are locally conspicuous and these must be of tidal channel origin. The Statenville Formation is, therefore, considered to be a coastal, intertidal to subtidal marine deposit that grades seaward into shallow-water, inner continental shelf deposits (Berryville and Ebenezer Members of the Coosawhatchie Formation). The Charlton Member is considered to have been deposited during the marine regression that terminated Coosawhatchie deposition, and its precise stratigraphic equivalent is probably not represented in the coastal Statenville Formation that was deposited during the maximum extent of the middle Miocene transgression.

Age

The Statenville Formation contains a Barstovian land-mammal fauna (Voorhis, 1947b; Tedford and Hunter, 1984) at its type locality. According to Tedford and Hunter (1984), the Statenville land-mammal assemblage is early late Barstovian and its age is approximately 13 million years. This age determination is also consistent with the age of the Berryville Clay Member of the Coosawhatchie Formation that occurs in the Statenville stratigraphic position in eastern Georgia. The Berryville Clay Member contains a Zone N10 to N11 planktonic foraminiferal assemblage that is approximately 13 to 14 million years old (Berggren and van Couvering, 1974; Berggren and others, 1985; also see Pl. 1). It is concluded, therefore, that the age of the Statenville Formation is early late Barstovian, early Serravallian, middle Miocene.

UNDIFFERENTIATED COQUINA AND SAND OF THE HAWTHORNE GROUP (continental shelf)

Definition

This undifferentiated unit is identified only on the continental shelf in the COST GE-1 well (see Scholle, 1979). The areal extent, the position and nature of contacts, and the lithologic variation are unknown due to meager subsurface control on the continental shelf. This unit is not present in the core AMCOR 6002 (see Hathaway and others, 1976) where its stratigraphic equivalent is the Berryville Clay Member of the Coosawhatchie Formation. This undifferentiated middle Miocene unit does not appear to be present, although the lithologic discussion is inadequate (JOIDES, 1965), in the core JOIDES J-1 on the inner continental shelf off northeastern Florida. The lithology of this unit, however, is distinctive enough and thick enough, and its age and stratigraphic relationships are well enough defined, to warrant recognition of its existence and a brief discussion of the deposit. It is included in the Hawthorne Group with some reservation. The presence of sand, phosphate, dolostone, and chert is indicative of Hawthorne lithology. The presence of glauconite and ooids is exceptional for Hawthorne-type deposits.

Reference Section

This undifferentiated Hawthorne Group deposit is present in the interval 544 feet to 719 feet in the COST GE-1 well (Scholle, 1979) on the continental shelf. The location of the well site is approximately 74 miles (119 km) east of Jacksonville, Florida, at latitude 30° 27′ 07.6892″ north, and longitude 80° 17′ 59.1451″ west at a water depth of 136 feet (41.5 m) (Scholle, 1979, p. 1).

Lithology

The lithology of this deposit is dominated by water-worn, brecciated shell coquina, with oolitic pellets; gray, saccharoidal, hard limestone; olive-gray dolostone; quartz sand with grain-sizes up to small pebbles; some sandstone; chert; glauconite; and phosphate grains and pebbles (Rhodehamel, 1979, p. 24-26).

Stratigraphic Relationships

This lithologically distinctive deposit is known only from the COST GE-1 well which is located east of Nassau County, Florida, and southern Charlton County, Georgia (Fig. 2). The coquina is overlain disconformably or paraconformably by an unnamed upper Pliocene formation, and disconformably or paraconformably overlies undifferentiated Oligocene deposits (Poag and Hall, 1979, p. 49-51). The precise nature of the contacts is uncertain because the unit is known only from well-cuttings. The middle Miocene coquina occurs in the interval 544 feet to 719 feet in the COST GE-1, and is, therefore, 175 feet (53 m) thick.

The onshore stratigraphic equivalent of this undifferentiated coquinoid deposit, in the southern part of the coastal area of Georgia, is the Charlton Member of the Coosawhatchie Formation. There are also coquinoid phases of the Charlton Member, most commonly in the limestone and dolostone lithofacies. Because the Charlton Member is the only subdivision of the Hawthorne Group that displays an abundance of fossils in eastern Georgia, the Charlton Member may possibly grade laterally eastward (offshore) into the undifferentiated coquina and sand.

The presence of water-worn, brecciated shell coquina, oolitic pellets, and quartz pebbles indicates that this unit was deposited in shallow-water, relatively high energy conditions. The presence of planktonic microfossils, on the other hand, indicates near-normal marine salinities. It is not clear whether this unit was deposited in a nearshore, coastal environment, or on a shoal or offshore topographic high.

Age

Poag and Hall (1979, p. 49-50) identified the following planktonic foraminifera from samples referred to here as the undifferentiated middle Miocene coquina and sand:

Globorotalia peripheroronda
G. peripheroacuta (Zone N10-N11)
G. fohsi praefohsi (Zone N11-lower N12)
G. siakensis
Clavatorotella bermudezi (upper Zone N8-lower N10)
Globigerinoides sicanus (Zone N8-lower N9)
Orbulina suturalis

The upper part of this deposit is biostratigraphically equivalent to and correlative with the Coosawhatchie Formation (planktonic foraminiferal Zone N10 and N11 of Blow and Banner, 1966; Blow, 1969). However, the stratigraphic equivalent of the lower part of this unit (i.e., that part which contains Zones N8 and N9) is not known to occur in onshore Hawthorne Group deposits in Georgia. This stratigraphic interval is presumably contained in the hiatus between the Marks Head Formation and the Coosawhatchie Formation.

The age of the undifferentiated coquina and sand of the Hawthorne Group is early middle Miocene (Langhian and Serravallian). It is contained in planktonic foraminiferal Zones N8 or N9 to N11 (Pl.1).

UNDIFFERENTIATED UPPER MIOCENE SAND OF THE HAWTHORNE GROUP (Continental shelf)

Definition

Sediments of this deposit have been recognized at this time only in the core AMCOR 6002 on the outer continental shelf of Georgia (Hathaway and others, 1976). Little can be said of the nature of the deposit because of poor core recovery of the sand. The lithology of this unit is predominantly a sand, and it is, therefore, lithologically distinct from the underlying Berryville Clay. The undifferentiated upper Miocene sand is included in the Hawthorne Group in this report because it is phosphatic and it contains the clay minerals palygorskite and sepiolite (which are characteristic of the Hawthorne Group in Georgia).

Reference Section

This undifferentiated upper Miocene sand of the Hawthorne Group is present in the interval from approximately 138 to 193 feet (string depth) in the core AMCOR 6002 (Hathaway and others, 1976, p. 29-48) on the mid-continental shelf of Georgia. The location of the core site is approximately 46 miles (74 km) east of Brunswick, Georgia, at latitude 31°08.57′ north, and longitude 80°31.05′ west at a water depth of 106 feet (32 m) (Fig. 2). The interval in the core occupied by the unnamed upper Miocene sand is uncertain because core recovery was very poor, only 2 feet of recovery in core runs of 27 feet and 30 feet (3% recovery).

Lithology

This unit consists of sand with apparently minor clay. The recovered sand is variably calcareous, microfossiliferous, argillaceous, phosphatic, and is olive-gray in color. The clay mineral suite is dominated by kaolinite and illite. Smectite and palygorskite are significant but minor components in the unit in the core AMCOR 6002 (Hetrick and Friddell, 1984, p. 36-37).

This undifferentiated deposit differs from other units of the Hawthorne Group in consisting of microfossiliferous, calcareous, argillaceous sand. Of the Hawthorne units in Georgia, it resembles most closely the lower Pliocene Wabasso beds. The environment of deposition of this upper Miocene unit was open-marine, continental shelf.

Stratigraphic Relationships

This upper Miocene deposit is known to occur only in the core AMCOR 6002 on the mid-continental shelf off of Georgia. It is not known to have any correlatives onshore in Georgia, but extensive areas of southern Florida are known to be underlain by upper Miocene, phosphatic, calcareous, microfossiliferous clay and fine sand of similar lithology to this unnamed unit (T. Scott, personal communication, 1984).

The undifferentiated upper Miocene sand of the Hawthorne Group overlies the Berryville Clay Member of the Coosawhatchie Formation in the core AMCOR 6002, and is overlain by Pleistocene sands that are tentatively referred to the Satilla Formation (Pl. 2 and 3; see discussion, p. 281-283). Based on recorded depths of occurrence of this upper Miocene sand in the core AMCOR 6002 (138 feet to 195 feet in Hathaway and others, 1976, p. 33), the undifferentiated unit is no more than 57 feet (17 m) thick.

Age

The following planktonic foraminifera have been identified from samples 3-5, 40-50 cm and 3-4, 15-20 cm from AMCOR 6002:

Globorotalia menardii (sinistral)
Neogloboquadrina acostaensis
Globigerina nepenthes
G. praebulloides
G. apertura
Glorigerinoides quadrilobatus
G. obliquus

G. mitra
Globoquadrina altispira
G. dehiscens
Sphaeroidinellopsis seminulina
Globigerinella siphonifera praesiphonifera
Globigerinita glutinata
Orbulina universa

This assemblages is diagnostically late Miocene (Tortonian) in age, and is probably included in Zone N17 of Blow (1969) (Pl. 1).

WABASSO BEDS OF THE HAWTHORNE GROUP

Definition

The Wabasso beds is an informal name applied here to lower Pliocene, phosphatic, calcareous and microfossiliferous, variably argillaceous, silty, fine-grained to very fine-grained sand in the subsurface of the coastal area of Georgia. They are included in the Hawthorne Group because the Wabasso beds are lithologically similar to the other formations of the Hawthorne Group in eastern Georgia, but are distinguished from the other Hawthorne units in eastern Georgia, and especially the underlying Ebenezer Member of the Coosawhatchie Formation, in being characteristically a calcareous, silty, fine-grained sand, and in containing only minor clay. The Wabasso beds are not considered to be a formal, mappable lithostratigraphic unit at this time because they are known to occur only as erosional remnants and outliers in the shallow subsurface in Georgia, and in southern South Carolina. However, the unit appears to be thick and widespread in eastern and southern Florida and may, with the acquisition of more stratigraphic control in that area, be raised to the rank of formation in the future.

The Wabasso beds were referred to the Duplin Marl by Herrick (1976, p. 124-163) in well BFT 315 in Beaufort County, South Carolina, and wells GS-772 and GGS-381 in Chatham County, Georgia. Herrick (1976) did not, however, differentiate the "Duplin" Wabasso beds from Duplin formation (Raysor Formation of this report) at Doctortown in Wayne County, Georgia. Woolsey (1976, p. 65-66) recognized the discrete unit called Wabasso beds of this report, but referred to them as the Tybee facies of the Duplin formation. Huddlestun and others (1982, p. 184) referred to this unit informally as the Indian River beds.

Reference Section

The name Wabasso is taken from the community of Wabasso in northeastern Indian River County, Florida. The Florida Geological Survey core Phred 1 (W-13958) is suggested as a reference locality for this unit because it is one of the few known cores where the lithology of this unit can be examined and sampled. The Wabasso beds are present in the interval 128.5 feet to 211 feet in the core Phred 1 (W-13958). The core site is in the SW 1/4, SW 1/4, Sec. 16, T32S, R39W, in Indian River County, Florida, approximately 3.5 miles (5.6 km) south of the community of Wabasso (Fig. 3). Two feet of Wabasso beds were recovered in the cored interval 61 feet to 81 feet in the core Chatham 17 (GGS-3554) from Chatham County, Georgia (Fig. 2).

Lithology

Typically, the Wabasso beds consist of silty, fine- to very fine-grained sand that is variably phosphatic, calcareous, microfossiliferous, and argillaceous. Limited information suggests that clay, both interstitially and in discrete beds, is a minor component of the unit. In the core Phred 1 (W-13958) from Indian River County, Florida, the Wabasso beds consist of thinly layered to laminated, well-sorted, phosphatic sand with clay partings. The unit is calcareous in the upper part and weakly to noncalcareous in the lower part. There are some intervals of coarse-grained, well-sorted sand, and a 10-feet-thick bed of dark olive-gray, silty, laminated clay with gypsum bloom on the surface of the core.

The Wabasso beds are not known at this time to be macrofossiliferous, but foraminifera and other calcareous microfossils are present in the calcareous phases of the unit. The unit in the Phred 1 (W-13958) core is variably diatomaceous.

Stratigraphic Relationships

The Wabasso beds occur only in the coastal area of southern South Carolina, Georgia, and eastern Florida (Fig. 40). They are known in the subsurface from the vicinity of Beaufort, Beaufort County, South Carolina, in the north, to Indian River County, Florida, in the south. Based on seismic profiles (Woolsey, 1976) and limited core control, the Wabasso beds appear to be restricted to a relatively narrow belt on the seaward side of the Sea Island Escarpment that is slightly oblique to the present Atlantic coastline. Apparently, then, the Wabasso beds are present onshore in southern South Carolina and Chatham County, Georgia, but trend slightly obliquely to the Georgia coast. The unit occurs under the Georgia barrier islands in the northern coastal area, and would appear to occur a short distance offshore in the southern coastal area (Fig. 37). The eastern limit of the unit are not known, but lower Pliocene deposits of equivalent age have not yet been identified in offshore wells and cores.

The Wabasso beds are discontinuous in Georgia (Fig. 44). They are known only from two wells — one from Fort Pulaski (GGS-772) and one from northern Tybee Island (GGS-381) — from a core taken at House Creek on Petit Chou Island near the site of the Petit Chou Island core (see Furlow, 1969, Fig. 1 for sites of these wells and the Petit Chou Island core), and from the Fort Pulaski (GGS-3554) core. However, six other cores taken in the same area did not encounter the Wabasso beds, although reworked

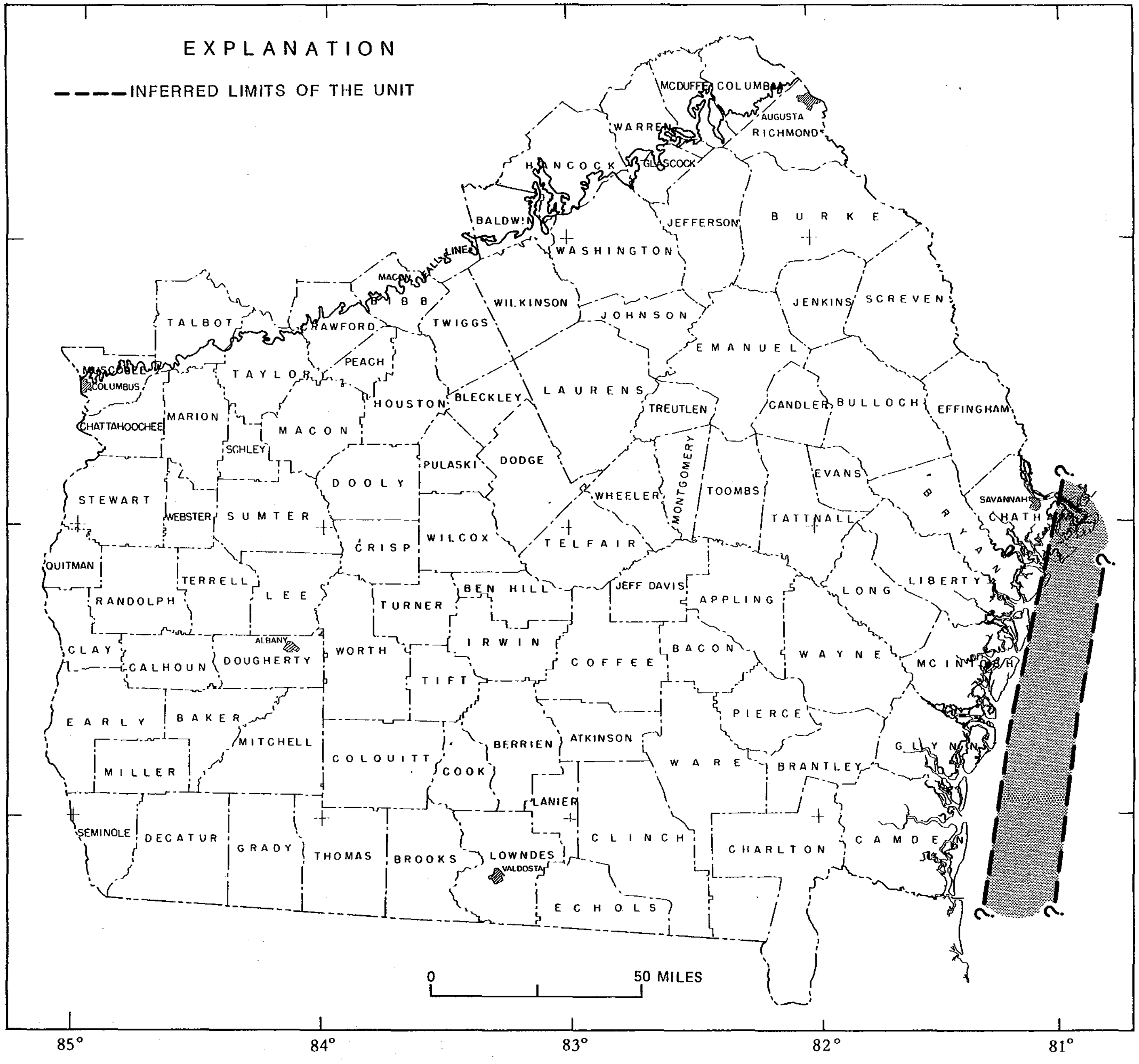


Figure 40. The areal distribution (subcrop) of the Wabasso beds of the Hawthorne Group in Georgia.

Wabasso planktonic foraminifera have been observed by the author from basal Satilla sediments in the core Chatham 13 (GGS-1445) from Chatham County. Therefore, the unit most likely occurs only as erosional outliers in the subsurface of eastern Chatham County. The Wabasso beds have not yet been identified from wells or cores elsewhere in Georgia.

In Chatham County, the Wabasso beds disconformably overlie the Tybee Phosphorite Member of the Coosawhatchie Formation, and are disconformably overlain by the Satilla Formation (Pl. 2). In the core Phred 1 (W-13958) in Indian River County, Florida, the Wabasso beds overlie an undifferentiated massive, phosphatic, calcareous, argillaceous, medium-grained sand of the Hawthorne Group, and are disconformably overlain by the lower Pleistocene Nashua formation.

Very little is known about the thickness of the Wabasso beds. The Wabasso beds that Herrick reported as Duplin Marl (1976, p. 129) are 40 feet (12 m) thick in Beaufort County, South Carolina, and 25 feet (7.5 m) and 28 feet (8.5 m) thick respectively in the wells GGS-772 and GGS-381 in Chatham County, Georgia. In the core Phred 1 (W-13958), the Wabasso beds are approximately 82 feet (25 m) thick.

The environment of deposition of the Wabasso beds in Georgia is open-marine, continental shelf. There is only a small component of brackish water species in the benthic foraminiferal assemblage indicating that the water-mass had near-normal salinities. In addition, the abundance of planktonic foraminifera and the relatively high diversity of the benthic foraminifera indicates that the environment of deposition of the Wabasso beds was the deepest water and most open-marine of all of the Hawthorne deposits of Georgia.

Age

The following planktonic foraminifera have been identified from the Wabasso beds in Georgia and Florida:

Globorotalia menardii (dextral)
G. margaritae margaritae
Neogloboquadrina acostaensis
N. humerosa
Globigerina nepenthes
G. bulloides
G. apertura
G. cf. *rubescans*
Globigerinoides quadrilobatus
G. obliquus obliquus
G. obliquus extremus
G. cf. conglobatus
Globigerinalla siphonifera
Globigerinita glutinata
G. uvula
Globoquadrina altispira
Sphaeriodidinellopsis seminulina
Orbulina universa

The co-occurrence of *Globorotalia margaritae margaritae* and *Globigerina nepenthes* is indicative of Zone PL1 of Berggren (1973). The dextral coiling directions of *Globorotalia menardii, Neogloboquadrina acostaensis,* and *N. humerosa* is characteristic of the upper part of Zone PL1. The Wabasso beds are, therefore, early Pliocene (Zanclean) is age (Pl. 1).

ALTAMAHA FORMATION (reintroduced, redefined, revised)

Definition

The Altamaha grit of Dall and Harris (1892, p. 81-82) and Harper (1906a, 1906b), and the Altamaha Formation of Veatch (1908, p. 71-74; 1909, p. 70-73) and Veatch and Stephenson (1911, p. 400-423), is herein reintroduced as the Altamaha Formation. As defined in this report, the Altamaha Formation is largely the same as the Altamaha grit of Dall and Harris (1892) and Harper (1906a, 1906b), and the Altamaha Formation of Veatch (1908), but it differs in some respects from the Altamaha Formation of Veatch (1909) and Veatch and Stephenson (1911). Veatch (1909) and Veatch and Stephenson (1911) included deposits in their Altamaha Formation that are now assigned to the Miccosukee Formation in southwestern Georgia and to the Cypresshead Formation in eastern Georgia. In other areas, Veatch and Stephenson (1911) assigned deposits to their Alum Bluff Formation that are included in the Altamaha Formation in this report. For example, the section exposed at Berry Hill Bluff on the Oconee River in Treutlen County is considered by this author to be typical Altamaha Formation but was included in the Alum Bluff Formation by Veatch and Stephenson (1911, p. 358).

Stephenson and Veatch (1915, p. 89-94) abandoned the Altamaha Formation in favor of the Alum Bluff Formation of western Florida because "The investigations of recent years have led to the conclusion that the bulk of the deposits included by Harper, Veatch, and Stephenson in the Altamaha Formation are of Oligocene age and are probably contemporaneous with a part of the Alum Bluff formation." The abandonment of the Altamaha Formation, therefore, was based on presumed age and correlation and not on lithologic characteristics or physical distinctions. In addition, replacing the name Altamaha with the name Alum Bluff in Georgia was also contemporaneous with, and probably related to, replacing the name Hawthorne with the name Alum Bluff in Florida (Vaughan and Cooke, 1914). This marks the beginning of the trend, in the southeastern Coastal Plain, in the systematic reduction of stratigraphic units based on lithology, in favor of stratigraphic units based on age and correlation. In accord with Stephenson and Veatch (1915), the name Alum Bluff Formation was applied to deposits that had been included in both the Altamaha and Alum Bluff Formations of Veatch and Stephenson (1911) (Brantly, 1916; Shearer, 1917; Teas, 1921; Prettyman and Cave, 1923). Later, Cooke (1939; 1943, p. 89-98) replaced the name Alum Bluff in Georgia with Hawthorne Formation (also see Cooke and Mossom, 1929; Cooke, 1936), and mapped the Altamaha Formation of this report with the Hawthorne Formation. Subsequent authors (Cooke, 1936, 1939, 1943; MacNeil, 1947a; Cooke and MacNeil, 1952; LeGrand and Furcron, 1956; Siple, 1967; and Herrick and Counts, 1968) referred to these deposits (both Altamaha Formation and Hawthorne Group of this report) under the name Hawthorne Formation. Other names that have been applied to the Altamaha Formation of this report include "Undifferentiated Miocene and Oligocene to Pleistocene inclusive" (Brantly, 1916); Brandywine, Coharie, and Sunderland formations (Cooke, 1939; 1943, p. 106-107); undifferentiated Miocene and Oligocene deposits (LaMoreaux, 1946a); residuum of Oligocene and Miocene formations (LaMoreaux, 1946b); "Duplin marl and Hawthorn formation" (MacNeil, 1947b); Citronelle Formation (Doering, 1960); Miocene (Undifferentiated) (in part) (Herrick, 1961); Recent to Miocene Series (in part) (Herrick and Vorhis, 1963); Ashburn formation (Olson, 1967); Neogene undifferentiated, Miccosukee Formation (in part), and Pleistocene-Pliocene sands and gravels (in part) (Georgia Geological Survey, 1976); and upland fluvial channel deposits (Nystrom and Willoughby, 1982b). The exposure of the Altamaha Formation in the railroad cut 1 mile (1.6 km) east of the railroad station at Barnwell, South Carolina, has been referred to the Barnwell Formation in the past (Cooke, 1936) and has been proposed as the type locality for the Barnwell Formation (Connell, 1968a). The Screven Member of the Altamaha Formation was informally introduced by Huddlestun (1981) as the Screven formation.

The Altamaha Formation is recognized as a formation separate from the Hawthorne and Alum Bluff Groups in this report because of its lithologic distinctiveness. Lithologically the Altamaha Formation is unique among formations in the southeastern Coastal Plain. The only other formations I know that resemble the Altamaha in any way are the "Tuscaloosa" Formation of the Chattahoochee River area, and some phases of the Cape Fear Formation. The Altamaha Formation consists of variably indurated to nonindurated, variably siliceous, kaolin-rich clays and argillaceous, pebbly, feldspathic sands of fluvial origin that are devoid of carbonates, fossils, phosphate, and magnesian clays. The Altamaha Formation is excluded from the Hawthorne Group because Hawthorne deposits generally consist of variably phosphatic, variably dolomitic or calcareous, rarely siliceous, fossiliferous to nonfossiliferous sands and variably magnesium-rich clays of marine, continental shelf origin. The Altamaha Formation is excluded from the Alum Bluff Group because Alum Bluff deposits generally consist of variably calcareous (never dolomitic), typically fossiliferous, nonsiliceous sands and clays (nonmagnesian) of marine, continental shelf origin. The Hawthorne Group is an Atlantic continental shelf deposit, the Alum Bluff Group is an eastern Gulf of Mexico continental shelf deposit, and the Altamaha Formation is a fluvial to upper estuary deposit.

The Altamaha Formation is a multideposit unit; that is, it was deposited during more than one depositional episode. The Altamaha Formation in the inner part of the Coastal Plain and in the Savannah River area is probably early Miocene (Aquitanian) in age, whereas the typical Altamaha Formation of the Altamaha River area is probably middle Miocene (Serravallian) in age. Furthermore, the Altamaha Formation in some regions is divisible into an upper and lower part. The lower part of the Altamaha Formation typically consists of thick bedded, massive sandy clays and argillaceous sands, and claystones and sandstones. The upper part consists of prominently cross-bedded, pebbly to gravelly sands with clay lenses, and appears to be of fluvial channel, cut-and-fill origin. In this report, the upper part of the middle Miocene Altamaha Formation (in the Altamaha and Satilla Rivers area) is named the Screven Member of the Altamaha Formation. The Screven lithofacies occurs locally in the lower Miocene Altamaha Formation, but it is discontinuous and absent over large areas.

Type Section

The name Altamaha was taken from the Altamaha River in southern Georgia. Dall and Harris (1892, p. 82), the authors of the Altamaha lithostratigraphic unit, observed that "Between Rocky Hammock and Doctor Town, all the bluffs (which are mostly on the right bank of the river) are composed of the grit, sometimes extremely hard and flinty and at others more disposed to crumble." They added that "The Altamaha grit is well exposed in these bluffs, ... ". The stretch of river described by Dall and Harris (1892) extends from western Jeff Davis County to central Wayne County, a distance of about 80 miles (128 km). The only reference of Veatch and Stephenson (1911, p. 401) relevant to a type locality or type area of the Altamaha Formation was that "The name 'Altamaha grit' was applied by Dall in 1892, from typical exposures along Altamaha River." Evidently the original authors of the Altamaha Formation and subsequent authors did not conceive of a specific type locality for the formation, only a type area. The type area they thought of is that stretch of the Ocmulgee River and Altamaha River from Jeff Davis County (Rocky Hammock is now in Jeff Davis County, Jeff Davis County having been a part of Coffee County in 1892) to Wayne County.

Because a type section has not been designated for the Altamaha Formation by earlier authors, I am designating as lectostratotype (principal reference section) the exposures of the formation at Upper Sister Bluff on the Altamaha River (also see Veatch and Stephenson [1911, p. 359-360]). Upper Sister Bluff, the principal reference locality of the Altamaha Formation, is located on the south bank of the Altamaha River in Applin County, Georgia, where Georgia highways 121, 144, and 169 cross the river (Fig. 41). The lectostratotype includes the section exposed in the bluff and the series of road cuts along Ga. 121, 144, and 169 to the top of the hill 0.6 miles (1.0 km) south of the bluff. The lower part of the

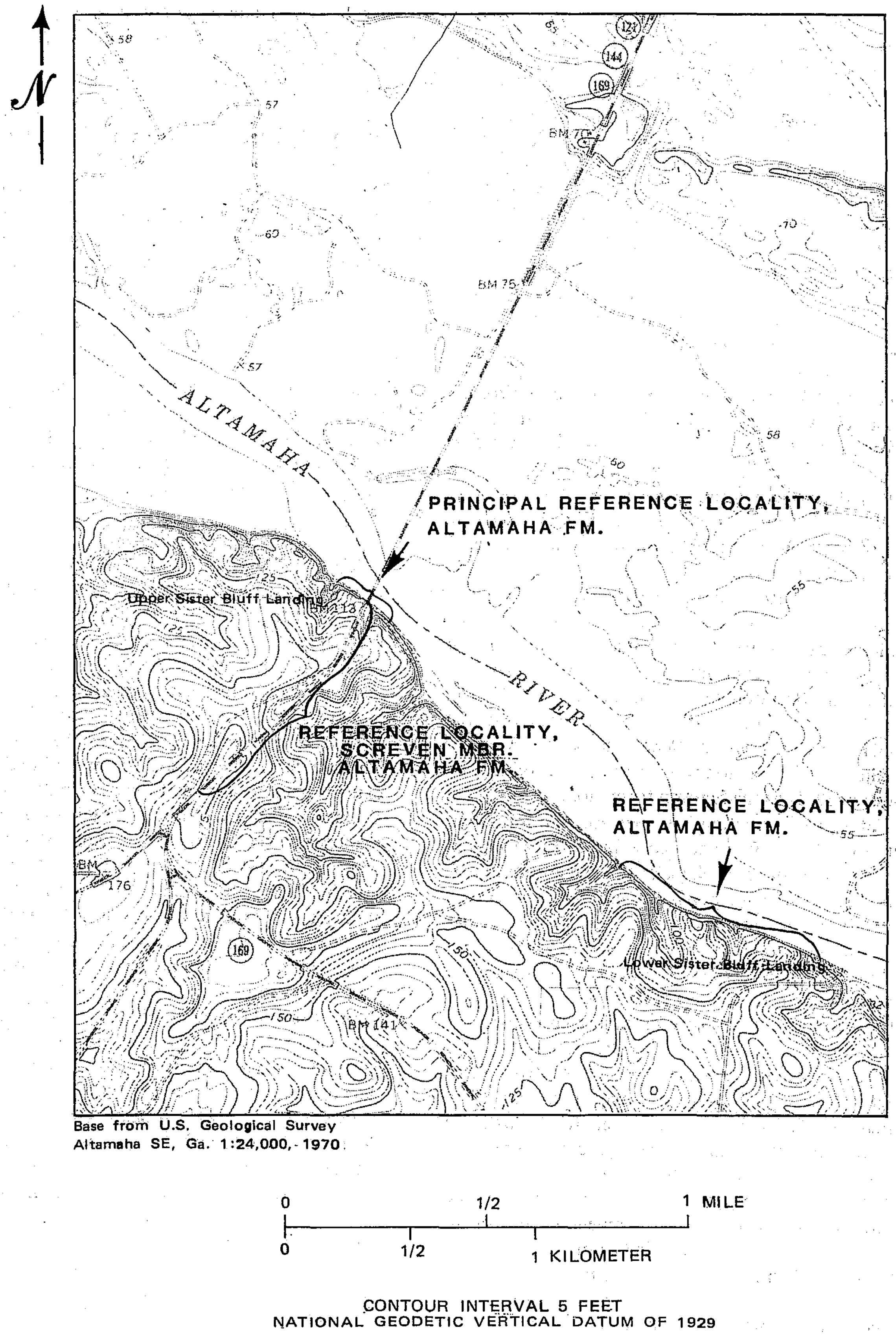


Figure 41. The principal reference locality of the Altamaha Formation.

lectostratotype (exposures in the bluff) extends for several hundred feet (about 100 m) along the face of the bluff under the highway bridge and is currently exposed from approximately 15 feet (4.6 m) above the river at mean-low-water to the top of the bluff at approximately 65 feet (20 m) above the river. The series of road cuts extends from the top of the bluff to the top of the hill at an elevation of approximately 140 feet (43 m) above the river.

Four other sections are herein designated reference localities and hypostratotypes of the Altamaha Formation. Lower Sister Bluff, a reference locality and hypostratotype, is approximately 1 mile (1.6 km) downriver from the lectostratotype at Upper Sister Bluff (Fig. 41; also see Veatch and Stephenson, 1911, p. 359-360, 410-411). This locality is significant because it exposes the best stratigraphic section on the Altamaha River and because the indurated phase of the Altamaha Formation is poorly developed at this site.

Lower Fort James Bluff (see Veatch and Stephenson, 1911, p. 411), herein designated a reference locality and hypostratotype, is located in northern Wayne County (Fig. 2). The Altamaha Formation is exposed at the boat landing and in the roadcut leading down to the landing at the bluff. This section is significant, because it is the easternmost good exposure of the Altamaha Formation, because the Screven lithology in the upper part of the Altamaha Formation is not well-developed at this site, and because the Altamaha Formation is overlain by Cypresshead Formation.

The bluff on the west side of the Oconee River, in a county park at the Georgia highway 46 crossing in northernmost Wheeler County, is herein designated a reference locality and hypostratotype of the Altamaha Formation (Fig. 2). This section shows the close stratigraphic relationship between the sandstone and the poorly sorted, pebbly, clayey sand phases of the formation.

Berryhill Bluff (see Veatch and Stephenson, 1911, p. 358-359) on the Oconee River in Treutlen County is designated herein as a reference locality and hypostratotype (Fig. 2). Berryhill Bluff is significant because it displays the thick, massive sandstone phase of the formation better than any other exposure.

Lithology

The Altamaha Formation consists of thin to thick bedded or crossbedded, well-sorted to very poorly sorted, variably feldspathic, sporadically pebbly or gravelly, argillaceous sand, sandstone, sandy clay, clay, and claystone. Calcite and dolomite, phosphate, the magnesian clays palygorskite and sepiolite are unknown in the formation.

Quartz sand is the dominant lithic component of the Altamaha Formation, but clay is also significant and dominates the lithology of the formation at some sites. The sand ranges in size from fine through very coarse, with coarser quartz ranging from granule to cobble size. The quartz gravel of the Altamaha is subangular to well-rounded, and is characteristically coarser than the gravel in the older Cretaceous and Lower Tertiary deposits in Georgia. Quartz cobbles up to 7 inches (18 cm) in diameter along the major axis have been observed in Washington County, Georgia, and Aiken County, South Carolina. Generally, the finer the upper limit of the sand-size present, the better the sorting; and conversely, the coarser the upper limit of the sand-size present, the poorer the sorting. Poorly sorted, clayey, gravelly sands are characteristic of the Altamaha Formation in the updip areas. Commonly, the coarser beds in the Altamaha are conspicuously feldspathic, and lath-shaped feldspar pebbles within the gravelly beds have been reported by Veatch and Stephenson (1911).

Generally, in the Altamaha Formation, the sand and clay occur in varying states of admixture, with lithologies ranging from argillaceous sand to sandy clay. Beds or lenses of relatively pure sand occur locally but are exceptional. Relatively pure clay or claystone, however, is commonly encountered only in the lower Miocene component of the Altamaha Formation.

The clay mineral suite of the Altamaha Formation is dominated by kaolinite whereas illite and smectite are generally minor constituents (Hetrick, pers. comm., 1986; Hetrick, *in* Huddlestun, 1985). In weathered outcrops, however, kaolinite is generally the only clay mineral present. Both smectite and illite are more significant elements of the clay mineral suite in those sections transitional between typical Altamaha Formation and typical Hawthorne Group.

Secondary silica is locally conspicuous in the Altamaha Formation. Most commonly, the silica occurs as thin veins of siliceous material that has a woodgrain-like texture. In addition, Veatch and Stephenson (1911) speculated that the cementing agent in the indurated phases of the formation is silica.

Bedding style is variable in the Altamaha Formation but typically consists either of rude, thick to very massive bedding or of vague and inconspicuous to very prominent cross-bedding on small to large scales. In the thick-bedded deposits, beds are typically less than 10 feet (3 m) thick, but massive sections of sandstone or clay up to 50 feet (15 m) thick have been observed in outcrops and cores. Generally, the sediments within bedding units are well-mixed and homogeneous. Clays in thick beds, however, are more commonly laminated. Cross-bedding is locally prominent and in the Screven Member cross-bedding is characteristic of the unit. Cross-bedding is generally associated with channel cut-and-fill structures of a wide range of sizes. The cut-and-fill structures generally are either filled with cross-bedded, gravelly, feldspathic sands with clay clasts, or with laminated to massive, blocky clays. The channel cut-and-fill structures are more commonly encountered in the upper part of the middle Miocene component of the Altamaha Formation, but they are also encountered in the lower part of the lower Miocene component of the formation.

The most characteristic lithologies of the Altamaha Formation are the thick-bedded and massive, structureless sandstones and claystones that produce extensive areas of flat rock outcrops and low bluffs (Dall and Harris, 1892, p. 81-82; Veatch and Stephenson, 1911, p. 403-405). Olson (1967) informally called these indurated phases of the Altamaha Formation the Ashburn formation, after exposures of the sandstone cropping out along Interstate 75 north of the town of Ashburn in Turner County, Georgia. The name Ashburn has not been adopted in this report because Ashburn is a junior synonym of the Altamaha Formation, the name has never been formalized, and the indurated phases (Ashburn) are known to be discontinuous in outcrop and cannot be mapped over any large area (also see Georgia Geological Survey, 1976). There is evidence, however, that the lower part of the middle Miocene Altamaha Formation is pervasively indurated in the subsurface, and that the sporadic distribution of outcropping indurated phases of the formation is due to weathering and leaching of the cementing material. At this time, there are few cores that penetrate the entire middle Miocene portion of the Altamaha Formation. In these cores, however (Coffee 3 and 4, GGS-3539, GGS-3541; Berrien 10, GGS-3542; Colquitt 3, GGS-3179; see Fig. 2), the lower part of the Altamaha Formation is consistently indurated. The typical outcropping, middle Miocene Altamaha Formation that occurs in the stratigraphic position of the indurated sediments, consists of weathered, thick-bedded to massive and structureless, sandy clay and argillaceous sand. These weathered sandy clays and argillaceous sands are closely related to the indurated sediments in outcrop. At many outcrop sites, small (as little as 1 x 0.5 foot [30 x 15 cm]) to large (greater than 3 x 1 feet [1 x 0.3 m]) pods of apparently unweathered sandstone are enclosed or surrounded by weathered sands and clays, indicating that the surrounding weathered sediments are weathering products of the indurated sediments (sandstones and claystones). It is likely, therefore, that the typical unweathered, unleached, lower part of the middle Miocene Altamaha Formation consists of argillaceous sandstone and sandy claystone, and that this is the typical unaltered lithology of the lower part of the unit.

A lower, indurated phase is not so readily apparent in the lower Miocene part of the Altamaha Formation. The indurated phases of the lower Miocene do appear to be encountered more in the lower part of the unit or, perhaps more accurately, at lower elevations in the outcrop area. Field studies, in addition to a few cores that penetrate much of the lower Miocene Altamaha Formation (Washington 8, GGS-1179; Washington 10, GGS-1182; Washington 17, GGS-1189; Screven 4, GGS-1007; see Fig. 2), indicate that the indurated phases are not as pervasive as in the middle Miocene, and they tend to be more interstratified with nonindurated sands and clays.

Whereas channel-fill lithologies (cross-bedded sands and gravels) are encountered in the upper part of the middle Miocene Altamaha, channel-fill lithologies occur more randomly throughout the lower Miocene Altamaha. Field observations also indicate that channel-fill lithologies are more closely associated with the indurated phases in the lower Miocene.

The above observations suggest that there are some systematic but subtle differences between the lower Miocene and middle Miocene components of the Altamaha Formation. Particular lithologies are not known to be restricted to either the lower or middle Miocene parts of the Altamaha Formation. However, thick beds of unweathered clay, finely sandy claystone, and claystone that are devoid of sand appear, at this time, to be more characteristic of the lower Miocene Altamaha. Indurated sediments in the middle Miocene Altamaha generally consist of variably argillaceous sandstones or, less commonly, sandy claystones.

The Altamaha Formation is essentially nonfossiliferous. Scattered oyster shell fragments have been reported from the formation at Collins in Tattnall County (Veatch and Stephenson, 1911, p. 406). I have seen evidence of a few burrows in Coffee, Emanuel, and Screven Counties. Small irregular burrows, approximately 1 mm in diameter and constructed of fine-grained sand cemented with siliceous material, are locally abundant in fine-grained sediments of the formation in the Altamaha River area. Presumably these are trace fossils, but they are unlike trace fossils found in other Coastal Plain deposits in Georgia. No other fossils or trace fossils are known from the Altamaha Formation.

Stratigraphic Relationships

The Altamaha Formation is the most widespread outcropping lithostratigraphic unit in Georgia (Fig. 42). Its eastern, or seaward, limit is the Orangeburg Escarpment-Trail Ridge trend in eastern Georgia. The Altamaha Formation grades laterally eastward into the Aquitanian Tiger Leap Member of the Parachucla Formation (Hawthorne Group) in the vicinity of the Orangeburg Escarpment in the Savannah River area (Pl. 2). In the Southeast Georgia Embayment region south of Bulloch County, the Altamaha Formation grades laterally eastward into the middle Miocene Ebenezer Member of the Coosawhatchie Formation of the Hawthorne Group in the vicinity of the Orangeburg Escarpment in the north and Trail Ridge in the south (Fig. 11). The updip limits of the Altamaha Formation in Georgia extend from northern Burke County in the east, westward through Jefferson, Washington, northern Laurens, and southeastern Twiggs Counties. Farther south, the updip limits of the Altamaha Formation are in the vicinity of the Ocmulgee River in the north, and the Pelham Escarpment in the south (Fig. 42). The southern limit of the Altamaha Formation approximates a line (or zone of facies change) that extends from Ware County in the east through Colquitt County in the west. East of the vicinity of Cook and Lowndes Counties, the Altamaha Formation appears to grade laterally southward into the Statenville Formation of the Hawthorne Group. West of the Little River, the Altamaha Formation appears to thin and pinch out in a southward direction in Colquitt County. The Altamaha Forma-

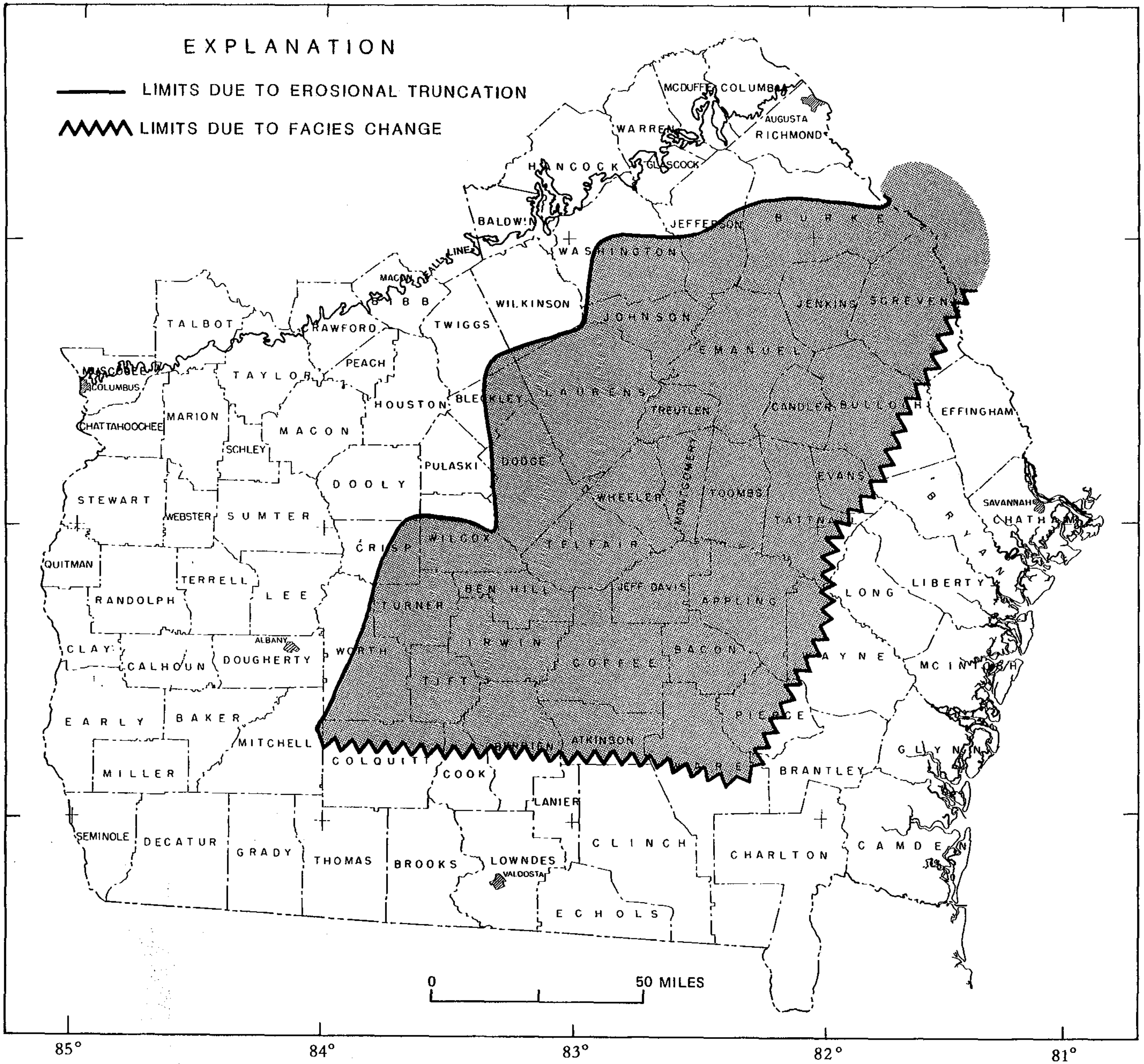


Figure 42. The areal distribution (outcrop and subcrop) of the Altamaha Formation in Georgia.

tion in most places is the only formation that crops out within the geographic confines outlined above.

More stratigraphic information can be gleaned from the Altamaha by recognizing lower and middle Miocene parts of the formation. Recognition of and discrimination between the lower and middle Miocene parts of the Altamaha Formation is based, at this time, mainly on physical correlation with datable marine deposits, and on stratigraphic position. Furthermore, as discussed above, the lower and middle Miocene Altamaha exhibit some lithologic distinctions, but the stratigraphic control is currently insufficient for one to be certain of regional systematic differences. The lower Miocene and middle Miocene components of the Altamaha Formation are not referred to here as lower and upper Altamaha Formation because the two components are not generally present together in the same area or at the same site. Rather, it appears that the lower Miocene Altamaha occurs in the inner part of the Coastal Plain and the middle Miocene Altamaha occurs only in the central and eastern part of the Coastal Plain. The updip limit of the middle Miocene Altamaha Formation, where it thins and pinches out, is in the same area where the underlying lower Miocene Altamaha grades seaward into the calcareous, fossiliferous Parachucla Formation in the subsurface (Fig. 11). As a result, at this time no areas or sections are known with certainty where middle Miocene Altamaha formation directly overlies lower Miocene Altamaha Formation in outcrop or subcrop.

The lower Miocene (Aquitanian) component of the Altamaha Formation can be traced from Screven and Burke Counties in the Savannah River area, westward through Jenkins, northern Emanuel, Jefferson, Washington, Johnson, and Laurens Counties. The stratigraphic position of the outcropping Altamaha Formation in Treutlen County is uncertain but could consist of both lower and middle Miocene components. In addition, the stratigraphic position of the Altamaha Formation southwest of the Ocmulgee River and northwest of the Gulf Trough is uncertain. It is noted, however, that claystone, a prominent lithology of the lower Miocene Altamaha Formation, is widespread in Turner County, Georgia (the type area of the Ashburn formation of Olson, 1967).

The lower Miocene Altamaha Formation grades laterally (or seaward) into calcareous, fossiliferous Parachucla Formation in the subsurface (Fig. 11; Pl. 2). The trend of the Altamaha-Parachucla facies change, in Georgia, extends in the east from southern Screven County westward through central Emanuel County, and thence westward through Treutlen and northwestern Wheeler County (Fig. 15). The Altamaha-Parachucla stratigraphic relationships are uncertain southwest of Wheeler County.

There is no evidence yet of an upper lower Miocene (Burdigalian) component of the Altamaha Formation. That is, the Marks Head Formation, or its stratigraphic equivalent, does not appear to grade updip (or landward) into Altamaha Formation. The absence of Marks Head-equivalent Altamaha Formation may account for a broad east-west belt, extending from Bulloch County westward through south-central Emanuel County, where the typical indurated phases and prominently cross-bedded feldspathic sands and gravels (Screven lithofacies) of the Altamaha Formation are absent, and only deeply weathered sands and clays are poorly exposed. Possibly this belt of poorly developed Altamaha deposits represents the outcrop belt of the Burdigalian, with the lower Miocene (Aquitanian) Altamaha Formation occurring in outcrop north of the belt and the middle Miocene (Serravallian) Altamaha Formation occurring in outcrop south of the belt. This belt does not extend into Treutlen County, suggesting that the updip limit of the Burdigalian deposits (Marks Head-equivalent) is overlapped by the middle Miocene Altamaha Formation and also that the Burdigalian occurs only in the subsurface of the central Georgia Coastal Plain. Moreover, this stratigraphic model suggests that the middle Miocene part of the Altamaha Formation could directly overlie the lower Miocene (Aquitanian) part of the Altamaha Formation in Treutlen County, thus accounting for the unusually thick Altamaha section in Treutlen County.

The updip limits of the middle Miocene part of the Altamaha formation can be traced, approximately, from southwestern Bulloch County in the east, westward through Candler County to southern Emanuel and northern Toombs Counties where the Altamaha Formation overlies the Meigs Member of the Coosawhatchie Formation in outcrop. The middle Miocene Altamaha Formation changes trend in Treutlen County to a more southwesterly direction, passing through Wheeler and Telfair Counties. The updip limits of the middle Miocene Altamaha are uncertain southwest of the Ocmulgee River in Georgia, but the middle Miocene Altamaha is known to occur in the Gulf Trough as far southwest as the vicinity of Norman Park in northeastern Colquitt County.

The Altamaha Formation disconformably overlies various formations in Georgia, including the Tobacco Road Sand of the Barnwell Group, Ocmulgee Formation, and several Oligocene limestone formations. The Altamaha Formation conformably overlies a basal tongue of the Tiger Leap Member of the Parachucla Formation in southern Screven County in the Savannah River area (Pl. 2), and Meigs Member of the Coosawhatchie Formation in the central southwestern Georgia Coastal Plain (Fig. 10).

The Altamaha Formation generally occurs at the top of the local geologic sections in Georgia. Overlying deposits, where present, include colluvium, undifferentiated surficial sands, undifferentiated alluvial deposits, and undifferentiated lacustrine and paludal deposits. In a narrow belt a few miles (a few km) wide west of Trail Ridge in Wayne and Pierce Counties, however, the Altamaha Formation is disconformably overlain by the upper Pliocene Cypresshead Formation (Pl. 3).

The average thickness of the Altamaha Formation in Georgia, based on scattered information, is between 100 and

200 feet (30 and 60 m). The formation is at least 125 feet (38 m) thick at and near the type locality. The Altamaha is approximately 150 feet (46 m) thick in northern Screven County, southern Emanuel, and northern Toombs Counties. It is 77 feet (23 m) thick in the core Coffee 3 (GGS-3539) in northern Coffee County; 112 feet (34 m) thick in the core Berrien 10 (GGS-3542) in northern Berrien County; 125 feet (38 m) thick in the core Colquitt 3 (GGS-3179) in northeastern Colquitt County; at least 123 feet (37 m) thick in the core Screven 4 (GGS-1007) in northwestern Screven County; and 171 feet (52 m) thick in the core Screven 8 (GGS-3198) in southeastern Screven County, where the Altamaha Formation is undergoing facies change into the Tiger Leap Member of the Parachucla Formation (Hawthorne Group) (Pl. 2). The Altamaha Formation is unusually thick in Treutlen County where the formation is exposed from the highest upland elevations (350 feet [107 m]) to bluffs at river level on the Oconee River at elevations of 130 feet (40 m). There is at least, then, 220 feet (67 m) of Altamaha Formation in Treutlen County. If the top of the Oligocene in Treutlen County varies from sea level to +100 feet (30 m) as indicated by Herrick and Vorhis (1963, p. 12), then the thickness of the Altamaha Formation in Treutlen County could be more than 250 feet (76 m). This compares well with the thickness of 283 feet (86 m) of Altamaha Formation (as interpreted in this report) in the well GGS-600 in northern Montgomery County (Herrick, 1961, p. 311-312).

The environment of deposition of the Altamaha Formation is interpreted to be fluvial to upper estuarine. None of the typical marine lithic components (i.e., phosphate, glauconite, calcite, limestone, dolomite, dolostone, magnesium-rich clays) are known to occur in the Altamaha Formation. Consistent with this, the clay mineral suite is dominated by kaolinite, the sands are generally feldspathic, and the sorting of the sediments is characteristically poor (a condition not normally found in deposits of open-marine origin).

No fossils are known with certainty from the Altamaha Formation. The oyster shell fragments reported by Veatch and Stephenson (1911) from Collins could have come from the underlying Meigs Member of the Coosawhatchie Formation. The burrow structures I have seen in the Altamaha in Coffee and Emanuel Counties could be root structures although they appear to be burrows. Only those burrow structures I have seen in Screven County and in exposures along the Altamaha River (e.g., at the principal reference locality) do I consider to be real burrows. However, it is not clear whether the organisms responsible for the burrows lived in a subaerial, fresh water, or brackish marine environment. Perhaps significantly, bioturbation structures which are characteristic of marine sediments, whether of coastal origin or open-marine origin, are also unknown in the Altamaha Formation.

Age

The Altamaha Formation being nonfossiliferous, its age must be inferred from physical correlation and stratigraphic position. In the type area along the Altamaha River, the Altamaha Formation grades laterally eastward into the marine, inner continental shelf, Coosawhatchie Formation (Pl. 3). Therefore, the type Altamaha Formation is roughly time-equivalent to the Coosawhatchie Formation and is probably middle Miocene (Serravallian) in age, equivalent to planktonic foraminiferal Zones N10 or N11 of Blow and Banner (1966) and Blow (1969) (Pl. 1). From northeastern Colquitt County to northern Toombs County, the Altamaha Formation grades downsection into sands and diatomaceous clays of the Meigs Member of the Coosawhatchie Formation. This unit has been dated as middle Miocene (Gremillion, 1965; Andrews and Abbott; 1985) and biostratigraphically equivalent to the Berryville Clay Member of the Coosawhatchie Formation of eastern Georgia (Andrews and Abbott, 1985; Abbott, pers. com., 1984).

In the Savannah River area, however, the Altamaha Formation grades laterally southeastward (seaward) in southern Screven County into the Tiger Leap Member of the Parachucla Formation (Hawthorne Group) of earliest Miocene (Aquitanian) age (Pl. 2). Therefore, in Screven and Burke Counties, the Altamaha Formation is early Aquitanian in age, and equivalent to planktonic foraminiferal Zone N4 of Blow (1969) (see Pl. 1). There may be other chronostratigraphic components of the Altamaha Formation, but their existence is unknown.

SCREVEN MEMBER OF THE ALTAMAHA FORMATION (new name)

Definition

The Screven Member of the Altamaha Formation is a new name proposed herein for prominently cross-bedded, feldspathic, gravelly sands. The Screven Member of this report is restricted to the upper part of the Altamaha Formation (middle Miocene) in the region south of the Altamaha and Ocmulgee Rivers in Georgia. The occurrence of Screven lithologies in the upper part of the middle Miocene Altamaha Formation north of the Altamaha and Ocmulgee Rivers is erratic, discontinuous, and for practical purposes, unmappable. Those Screven lithologies, therefore, are not included in the Screven Member in this report, but are referred to as Screven lithofacies[1]. Screven-type lithofacies

[1]The stratigraphic relationships of the Screven lithofacies to the rest of the Altamaha Formation in Georgia is analogous to the lithofacies relationships of the members of the upper Eocene Dry Branch Formation of the Barnwell Group (Huddlestun and Hetrick, 1979, 1986; Nystrom and Willoughby, 1982a). The Twigs Clay and Irwinton Sand Members of the Dry Branch Formation are mappable lithostratigraphic units in some areas, and are discontinuous, unmappable, but distinctive lithofacies in other areas. Similarly, the Screven Member of the Altamaha Formation is a distinctive, mappable lithostratigraphic unit in one area, and is a discontinuous, unmappable, but distinctive lithofacies in other areas.

also occurs in the lower Miocene component of the Altamaha Formation. Except locally, however, the stratigraphic position of the Screven lithofacies is not consistent in the lower Miocene as it is in the middle Miocene component of the Altamaha Formation, and the regional occurrence of the lithofacies in likewise discontinuous.

Deposits referred to as Screven Member in this report have, in the past, been included with the Altamaha Formation (Veatch and Stephenson, 1911), Hawthorne Formation (Cooke, 1939, 1943; MacNeil, 1947a), Brandywine, Coharie, and Sunderland formations (Cooke, 1939, 1943, p. 106-107), "Duplin marl and Hawthorn formation" (MacNeil, 1947b), Citronelle Formation (Doering, 1960), Neogene undifferentiated and Pleistocene sands and gravels (Georgia Geological Survey, 1976). Although the Screven Member has been included in parts of all of these named units, it is not fully synonymous with any of them. The Screven Member of the Altamaha Formation was informally introduced as Screven formation by Huddlestun (1981).

Type Section

The name Screven is taken from the village of Screven in southwestern Wayne County, Georgia. The designated type locality of the Screven Member is a railroad cut of the Seaboard Coast Line in the eastern valley wall of Little Satilla River, approximately 2.5 miles (4. km) southwest of the village of Screven (Fig. 43). The type section, or unit-stratotype (holostratotype), is the exposure of the Screven Member in the railroad cut at the type locality. Both the Screven Member and the Cypresshead Formation are exposed in the railroad cut. The Screven-Cypresshead contact, the upper boundary stratotype of the Screven Member, is 12 feet (3.5 m) below the top of the land surface at the northeast end of the cut.

The roadcut along US 82, 0.3 mile (0.5 km) northwest of the type locality, is herein designated a reference locality and parastratotype of the Screven Member of the Altamaha Formation (Fig. 43). This locality is significant because it displays both the typical tough, resistant nature of the formation in outcrop, and the intense Leisegang banding that is characteristic of the member.

Upper Sister Bluff and the highway cuts above the bluff to the top of the hill are herein designated a reference locality and parastratotype of the Screven Member (Fig. 41). The Screven Member overlies undifferentiated Altamaha Formation at Upper Sister Bluff. The contact, at 60 feet (18 m) above mean-low-water of the Altamaha River, is designated the lower boundary stratotype of the member. The Screven Member is exposed at the top of the bluff near the level of the highway bridge and in roadcuts and ditches to the top of the hill approximately 0.6 mile (1.0 km) south of the bluff. This site is significant because the entire section characteristic of the upper Altamaha River region is exposed here. The site is also instructive in that the lower part of the Screven Member displays interstratification between typical Screven lithology and Altamaha lithology. This series of exposures is the thickest known section of the Screven Member.

Lithology

The Screven Member of the Altamaha Formation consists of a maze of fluvial channel, cut-and-fill structures, and typical Screven sediments are channel-fill deposits in the cut-and-fill structures. The Screven channel-fill deposits consist of planar and trough cross-bedded, variably micaceous and feldspathic, argillaceous, pebbly to gravelly sands with clay clasts, and scattered lenses of clay channel-fill. The sand phase of the Screven Member is the dominant and characteristic lithofacies of the member. Screven Member sands are typically poorly sorted and coarse-grained. As with the rest of the Altamaha Formation, the sorting of the sand component deteriorates as the upper limit of the sand-size increases. However, it is only in the southeastern-most occurrences of the Screven Member, in Pierce and Ware Counties, Georgia, that I have observed fine-to medium-grained, moderately well sorted sand in the Screven Member.

The sands of the Screven Member are variably pebbly and gravelly. Pebbles are commonly found distributed throughout layers of poorly sorted coarse-grained sand, whereas lenses or stringers of gravel are more scattered and localized in occurence. Feldspar content of the Screven is variable, but is most conspicuous in the coarse-grained, pebbly phases of the member. Most likely, however, the Screven was consistently more feldspathic than is now apparent due to differential weathering of the feldspar. Clay clasts of various sizes are also commonly found in the cross-bedded sands of the Screven Member, but occurrence of clasts and their size-distribution is not systematically related to the coarseness of the sand as are the occurrence and size-distribution of quartz and feldspar pebbles.

Bedding in the Screven Member predominantly consists of planar and trough cross bedding on a wide range of scales. Undulatory bedding is locally present, but I have not yet observed either horizontal, parallel bedding or thick, massive bedding in the sand phase of the Screven Member.

The Screven Member of the Altamaha Formation is typically argillaceous, and the clay occurs both interstitially and in lenses. The sands of the Screven Member are generally argillaceous, and it is the clayey nature of the sands that results in the characteristic toughness and resistance to physical weathering of the member, and in the abundance of Liesegang banding in the member. It is also the clayey nature of the Screven sands that distinguishes it from lithologically similar Pleistocene river terrace deposits, and from the far updip occurrences of the Cypresshead Formation, both of which are typically deficient in interstitial clay. Clay as a discrete lithologic entity occurs only in scattered lenses ranging in thickness from approximately 1 foot (0.3 m) to more than 6 feet (1.8 m). These clay lenses appear to be clay-filled channel structures. The clay within the cut-and-fill structures is generally massive, structureless and blocky,

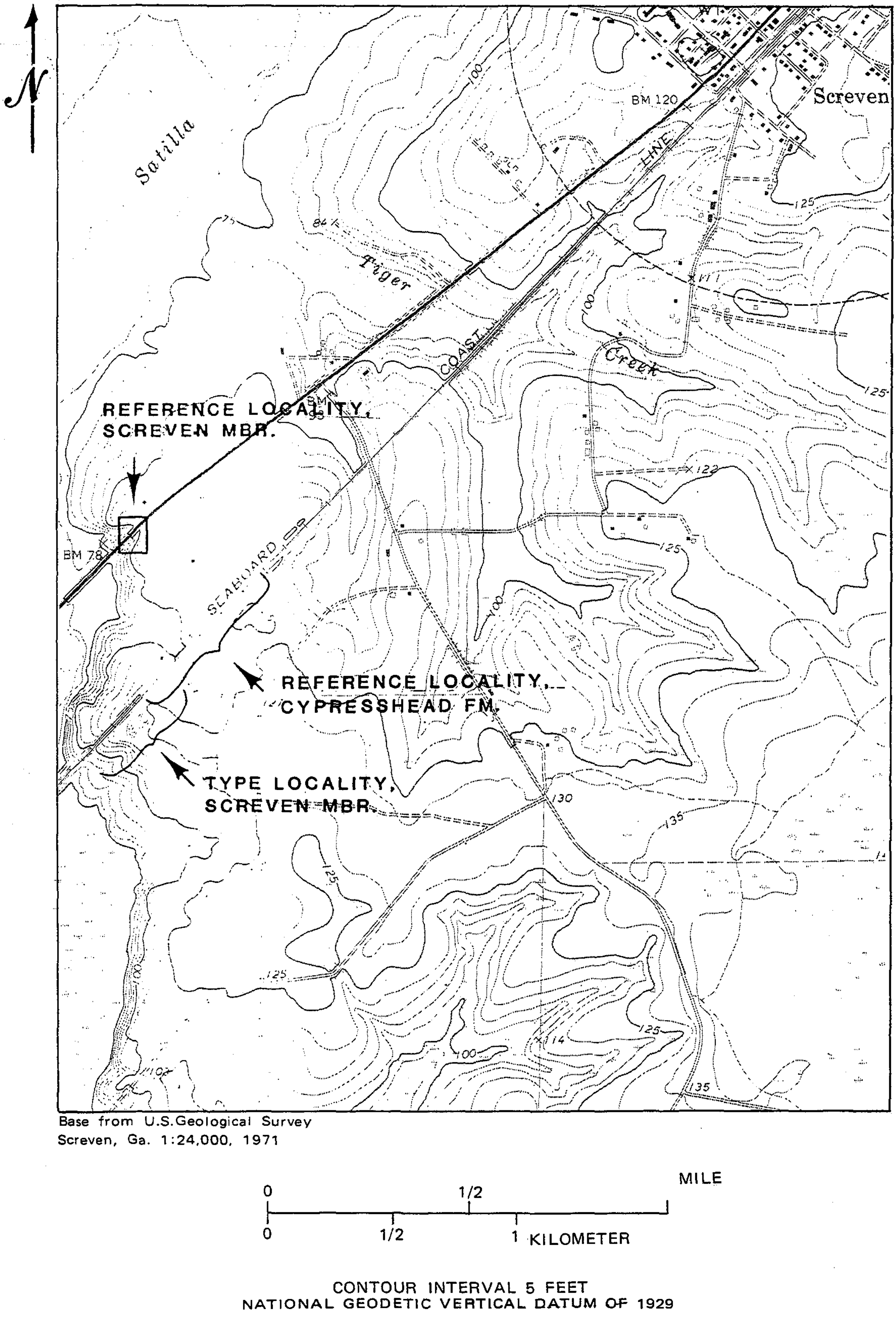


Figure 43. The type locality of the Screven Member of the Altamaha Formation.

color-mottled gray to dark gray and maroon. Scattered clay mineral data indicate that kaolinite is the dominant clay mineral of the Screven Member. Illite and smectite, if present, occur as minor or trace components of the clay mineral suite (Hetrick, pers. com., 1986).

Stratigraphic Relationships

The Screven Member of the Altamaha Formation, as defined in this report, is restricted largely to the region in Georgia south of the Altamaha and Ocmulgee Rivers, and west of Trail Ridge and the southernmost part of the Orangeburg escarpment (Fig. 44). The Screven Member is not known to occur west of the vicinity of the Gulf Trough in southwestern Georgia, and its southern limit approximates an east-west line from Ware County to southern Berrien County. Screven Member occurs north of the Altamaha River in a small area west of the Orangeburg escarpment in eastern Tattnall and eastern Evans Counties, and as far north as the vicinity of Daisy in Evans County. The Screven Member appears to grade laterally eastward into undifferentiated Altamaha Formation, or into the upper part of the Coosawhatchie Formation (Pl. 3). The Screven Member appears to grade southward into the upper part of the Statenville Formation.

Other areas where Screven lithofacies occurs at the top of the Altamaha Formation are southern and western Screven County, Georgia (lower Miocene Altamaha Formation), and northern Treutlen County (middle Miocene? Altamaha Formation). The Screven lithofacies appears to be scattered throughout the Altamaha Formation (lower Miocene) in northern Emanuel County. In Burke County, Georgia, and Aiken, Barnwell, and Allendale Counties, South Carolina, Screven lithofacies occurs only in the lower part or at the base of the Altamaha Formation (lower Miocene).

The Screven Member of the Altamaha Formation typically overlies the undifferentiated Altamaha Formation with sharp, "disconformable" contact (Figs. 10 and 11, Pl. 3). At some sites, however, the undifferentiated Altamaha Formation appears to grade upward into the Screven Member (e.g., at lower Fort James Bluff on the Altamaha River). The typical, sharp, "disconformable" lower contact of the Screven Member is interpreted in this report as the boundary between Altamaha flood plain or estuarine deposits, and the overlying fluvial channel-fill deposits. Because of the effect of channel scour preceding Screven deposition, no significant lapse in time is required to account for the "disconformable" relationships in this stratigraphic model.

The Screven Member generally occurs at the top of the local geologic section, being overlain only by undifferentiated surficial sands, undifferentiated alluvial deposits, or possibly undifferentiated lacustrine and paludal deposits. In a narrow belt west of the Orangeburg escarpment and Trail Ridge in Wayne and Pierce Counties, Georgia, however, the Screven Member of the Altamaha Formation is disconformably overlain by the upper Pliocene Cypresshead Formation.

The Screven Member of the Altamaha Formation is distinguished from the lithologically similar high river-terrace sand deposits in generally containing significantly more interstitial clay. The Screven Member is similarly distinguished from the overlying Cypresshead Formation (in Wayne and Pierce Counties) in containing significantly more interstitial clay. In addition, (1) bedding in the Cypresshead Formation is generally horizontal with only local occurrences of crossbedding, (2) the fine-grained, well-sorted sand with thin beds or laminae of clay so characteristic of the finer grained lithofacies of the Cypresshead Formation is unknown in the Screven Member, and (3) Cypresshead sediments are locally burrowed and bioturbated.

The Screven Member is distinguished from the rest of the Altamaha Formation in being prominently bedded and crossbedded, with channel cut-and-fill structures commonly being evident.

Limited outcrop and core information indicates that the Screven Member of the Altamaha Formation is generally less than 50 feet (15 m) thick. Twenty-four feet (7 m) of the Screven Member is exposed at the type locality and 21 feet (6.5 m) is exposed at the nearby reference locality along US 82. Approximately 41 feet (12.5 m) of the Screven Member is present in the core Coffee 3 (GGS-3539) in Coffee County, and 35 feet (11 m) is present in the core Berrien 10 (GGS-3542) in northern Berrien County. The thickest known occurrence of Screven Member is 78 feet (24 m) at the reference locality at Upper Sister Bluff on the Altamaha River in Appling County.

The environment of deposition of the Screven Member was fluvial. There is no evidence for marine or estuarine conditions in the Screven Member and, exept for one occurrence of small burrows in southern Screven County (near the eastern limit of the facies where it is undergoing facies change into the Parachucla Formation), fossils, trace fossils, and bioturbation structures are unknown in the member. Similarly, lithic components that are of marine origin in the southeastern United States (e.g., phosphate, glauconite, calcite, limestone, dolomite, dolostone, magnesium-rich clays), and even siliceous sediments, are unknown in the member. Channel cut-and-fill structures are characteristic of the Screven Member and locally the deposit appears to consist of a maze of sediment-filled channel structures. Consistent with the interpretation of a fluvial origin for the Screven Member, the unit is generally feldspathic and the sediments are poorly sorted.

Age

The Screven Member of the Altamaha Formation is barren of fossils and trace fossils. Therefore, constraints on the age of the member must be inferred from stratigraphic position and physical correlation. The Screven Member

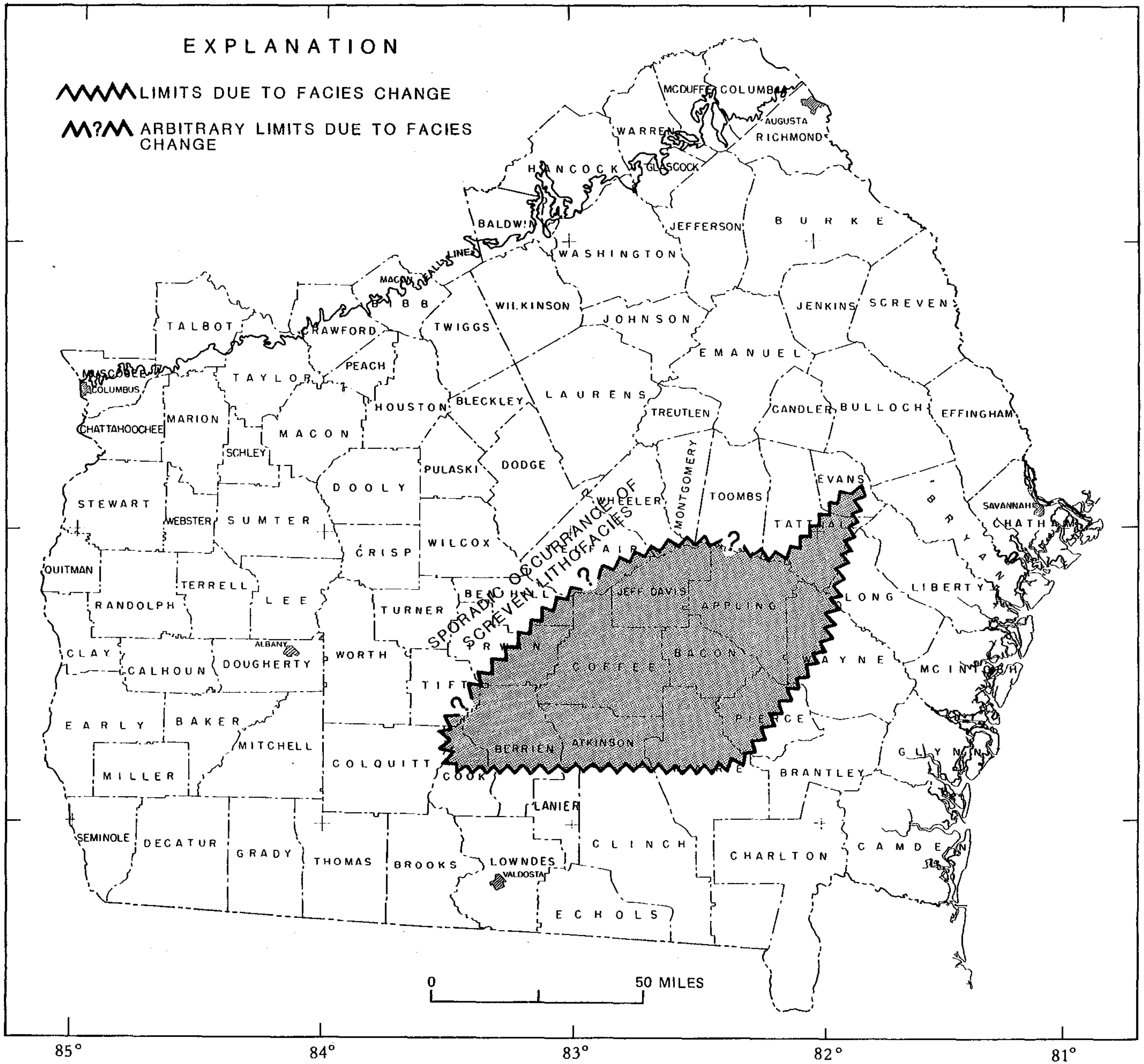


Figure 44. The areal distribution (outcrop and subcrop) of the Screven Member of the Altamaha Formation.

overlies with sharp contact, or gradationally at some sites, nonfossiliferous undifferentiated Altamaha Formation. The undifferentiated Altamaha Formation in turn gradationally overlies Meigs Member of the Coosawhatchie Formation (e.g., from northeastern Colquitt County in the southwest to Toombs County in the northeast). Undifferentiated Altamaha Formation also appears to overlie Coosawhatchie Formation in Pierce and western Wayne Counties (compare with Herrick, 1961, p. 322-324, 438-439; also compare with Pl. 3). Therefore, the Screven Member of the Altamaha Formation overlies fluvial to estuarine? deposits that grade downward into middle Miocene, inner continental shelf deposits. As a result, the Screven Member can be no older than middle Miocene. In its type area, the Screven Member is overlain disconformably by the upper Pliocene Cypresshead Formation, and the Screven Member must be as old as or older than late Pliocene.

In the Altamaha River area, the Screven Member of the Altamaha Formation appears to grade laterally southeastward (seaward) into undifferentiated Altamaha Formaton (see Pl. 3). At Lower Fort James approximately 3.5 miles (5.6 km) north of Madray Springs in Wayne County, Bluff, most of the 70 feet (21 m) of section that occurs between the top of the sandstone phase of the Altamaha Formation and the base of the Cypresshead Formation consists of undifferentiated Altamaha Formation. Only the upper 15 feet (4.6 m) of the Altamaha Formation at Lower Fort James Bluff is assignable to the Screven Member. In addition, no Screven Member has been identified southeast (seaward) of Lower Fort James Bluff in the Altamaha River area. It is, therefore, concluded that in the Altamaha River area, the Screven Member grades laterally southeastward (seaward) into undifferentiated Altamaha Formation, and undifferentiated Altamaha Formation grades southeastward into Coosawhatchie Formation (see Pl. 3). The Screven Member is likely, then, to be stratigraphically correlative with the Coosawhatchie Formation, and the best estimate of the age of the Screven Member is middle Miocene (Serravallian) (see Pl. 1).

In the Savannah River area, the Screven lithofacies in southern and western Screven County overlies Altamaha Formation of probable earliest Miocene (Aquitanian) age (see Pl. 1). Because no Hawthorne Group deposits of middle Miocene age are preserved in northern Effingham or southern Screven Counties (see Pl. 2), there is no evidence that the Screven lithofacies of Screven County once graded laterally into the Coosawhatchie Formation. Therefore, the best current estimate of the age of the Screven lithofacies in Screven County is early Miocene (Aquitanian). Similarly, the Screven lithofacies in the lower part of the Altamaha Formation in South Carolina is provisionally assigned to the lower Miocene (Aquitanian) because all of the Altamaha Formation in the Savannah River area appears to grade downdip (seaward) into the Tiger Leap Member of the Parachucla Formation (Pl. 2).

RAYSOR FORMATION

Definition

The Raysor Formation (Raysor Marl) was named by Cooke (1936, p. 115-117) "for deposits of upper Miocene age older than the Duplin marl in South Carolina." The name Raysor, however, was not generally adopted in South Carolina and, recently, Blackwelder and Ward (1979, p. 38-40) reintroduced the unit on a lithologic basis as the Raysor Formation. In the type area, these deposits consist of soft, variably shelly, slightly argillaceous, finely sandy, finely calcarenitic limestone (also see Sloan, 1908, p. 280-281; Cooke, 1936, p. 116). In Georgia, the Raysor Formation of this report includes deposits in Effingham County along the Savannah River that have been referred to the Edisto marl (Sloan, 1908, p. 273, 174), the Duplin formation (Veatch and Stephenson, 1911; Brantly, 1916; Cooke, 1943; MacNeil, 1947b; Georgia Geological Survey, 1976), and the Porters Landing facies of the Duplin formation (Woolsey, 1976) (part of which is Cypresshead Formation of this report). Raysor Formation along the Altamaha River in Wayne County near Doctortown in the past has been included in the Duplin formation (Veatch and Stephenson, 1911, p. 367-377; Cooke, 1943; MacNeil, 1947b; Herrick, 1976; Georgia Geological Survey, 1976). Those upper Pliocene deposits underlying the coastal area of Georgia that have been included in the Duplin Formation (Darby and Hoyt, 1964; Woolsey, 1976) are referred to, in this report, as unnamed Raysor-equivalent shelly sand. The calcareous upper Pliocene deposits in Effingham and Wayne Counties are assigned to the Raysor Formation because they are lithologically compatible with the Raysor Formation in its type area (an argillaceous, calcareous, variably shelly, finely sandy, finely calcarenitic limestone) (also see Blackwelder and Ward, 1979, p. 38-40) and differ significantly from the lithology of the Duplin deposits in its type area (shelly sand; see Blackwelder and Ward, 1979, p. 36-37).

Type Section

The name Raysor was taken from Raysor's bridge, a bridge that used to span the Edisto River between Dorchester and Colleton Counties, South Carolina (Cooke, 1936, p. 115). Cooke (1936) did not explicitly designate a type locality for the formation, but his comment, "near which the only know outcrops of the formation occur", can be construed as intent to designate a type locality. The exposures, therefore, along the west bank of the Edisto River, approximately 1,200 feet (0.37 km) downriver from the bridge (also see Sloan, 1908, p. 280-281), are interpreted as the type locality of the Raysor Formation, and the type section (unit-stratotype) is that section of the Raysor Formation exposed at the type locality in Colleton County, South Carolina (Fig. 45).

Blackwelder and Ward (1979, p. 39) were unable to locate

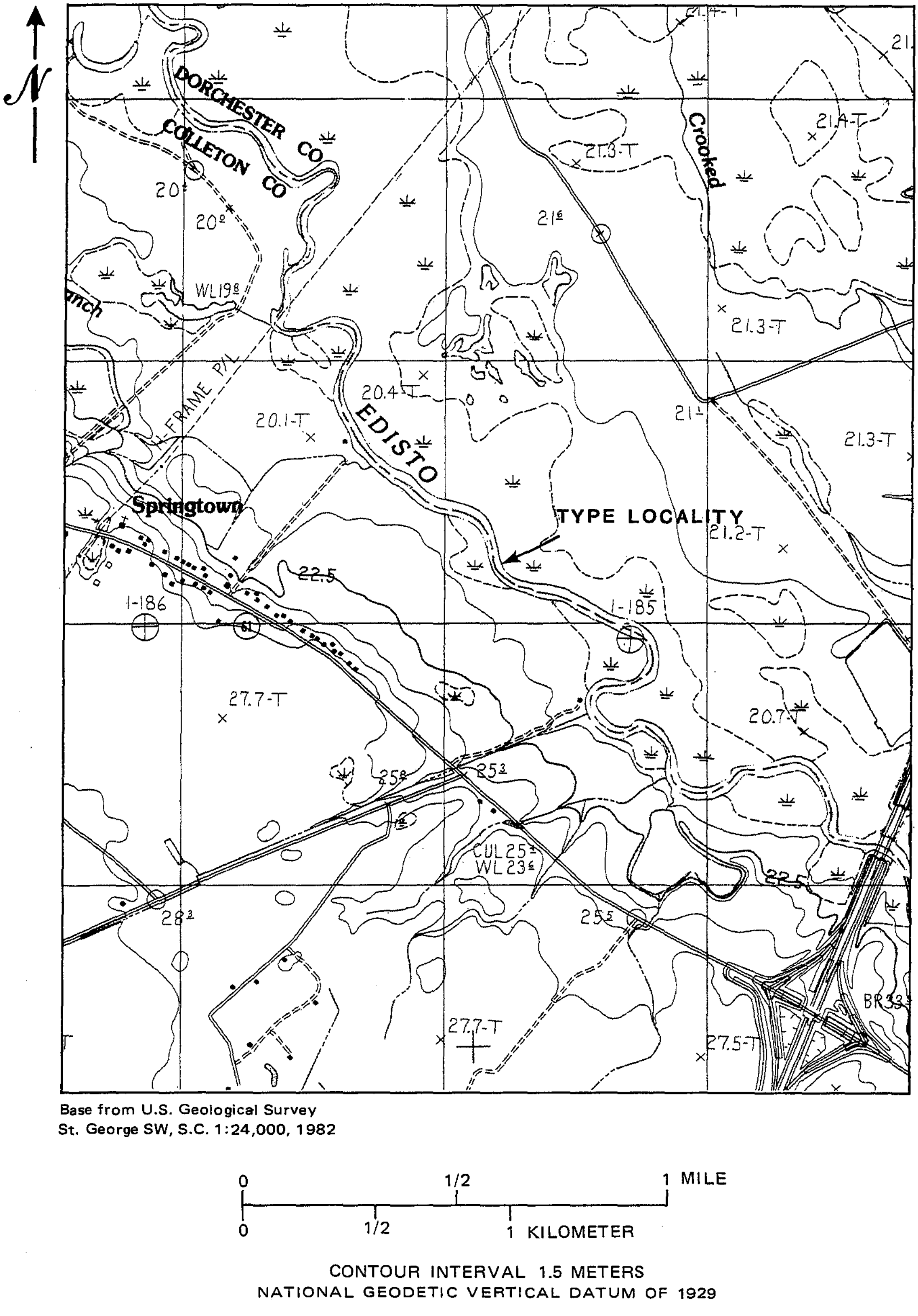


Figure 45. The type locality of the Raysor Formation.

exposures along the Edisto River in the type area of the Raysor Formation and, therefore, concluded that the type locality was overgrown and inaccessible. As a result, they designated a neostratotype for the Raysor Formation near Givhans Ferry State Park on the east bank of the Edisto River, 1.2 airline miles (1.9 km [given as 1.1 km]) upriver from the South Carolina highway 61 bridge, near Muckenfuss Cemetery, in Dorchester County, South Carolina.

Raysor's bridge is no longer standing. However, there is doubt that the exposures cited by Sloan (1908) and Cooke (1936) are in fact near Raysor's bridge. According to Sloan (1908, p. 280) (whose measured section was adopted by Cooke, 1936), Raysor's bridge was located 8 miles S. 25° W. of the town of St. George. This position on the Edisto River is the approximate location of the community of Canadys and the US 15 highway crossing of the Edisto River. According to Cooke (1936, p. 116), however, Raysor's bridge was located 8 miles southwest of St. George (approximately 4 miles [6.4 km] upriver from the site of Raysor's bridge indicated by Sloan [1908]). There are old bridge pilings present in the Edisto River approximately S. 45° W. of St. George and, according to old maps, this is the site of the Raysor's bridge (see quadrangle map, U.S. Geol. Survey, St. George, South Carolina, 1918, 1:62,500). Raysor's bridge, however, may not be the same as the bridge alluded to by Sloan (1908) because the section ¼ mile downriver from the Raysor's bridge of Sloan (1908) exposed 34.25 feet (10.4 m) of sediments. Raysor's bridge is in the river floodplain and there could not have been more than 6 feet (1.8 m) of sediments exposed during low water stages of the river in historic times 1,200 feet downriver from the bridge. According to B.W. Blackwelder (pers. com., 1986), in the area in question there are only two sites along the Edisto River where old bridge pilings can be seen at low water: one is at the location given by Cooke (1936) and the other is at Canadys near the US 15 highway bridge. The location at Canadys is compatible with the location of Sloan (1908) because Canadys is located approximately S. 25° W. of St. George, and there are bluffs 30 feet (9.1 m) high overlooking the Edisto River in the vicinity of Canadys.

Lithology

The dominant lithic components of the Raysor Formation are calcite or calcareous material and quartz sand. In general, it appears that the Raysor Formation in Georgia is less calcareous, more sandy and limestone is less conspicuous than it is in the type area of the formation. Subordinate lithic components of the Raysor Formation include clay minerals, mica, phosphate, feldspar, heavy minerals, shells, rare fossil bones, and scattered carbonaceous material and lignitic flecks. The quartz sand is typically fine-grained and well-sorted. However, Veatch and Stephenson (1911) reported coarse sand in the Raysor Formation, and quartz and feldspar pebbles occur locally in basal sediments of the formation. Clay beds also occur locally in the Raysor Formation but volumetrically are not significant.

In Effingham County, Georgia, the Raysor Formation typically consists of massive, structureless, variably shelly and fossiliferous, argillaceous, generally fine-grained, well-sorted sand that lithologically ranges to a finely sandy, calcarenitic limestone. In the subsurface in Chatham County, there is an outlier of Raysor Formation in the core Chatham 1 (GGS-535) in the interval 49 feet to 52 feet that consists of richly foraminiferal, phosphatic, argillaceous, finely sandy, calcarenitic limestone.

The outcropping Raysor Formation in Wayne County consists of massive, structureless, variably shelly and fossiliferous, calcareous, argillaceous, fine- to medium-grained sand. The Raysor is more argillaceous and sandy in Wayne County, and limestone phases of the formation are not know to be present. In its updip extremities in Wayne County, the Raysor Formation at Bugs Bluff and Linden Bluff on the Altamaha River consists of noncalcareous, nonfossiliferous, massive to thin-bedded, finely sandy to silty (with scattered quartz pebbles), dark gray to black clay. At Buzzards Roost Bluff, 2 miles (3.2 km) above Doctortown, pebbly and shelly Raysor lithology occurs at the base of the black silty clay (Veatch and Stephenson, 1911, p. 376).

Stratigraphic Relationships

The Raysor Formation is known to occur in only two areas in Georgia and in a core in Chatham County (Chatham 1 [GGS-1164]). It is found in scattered outcrops in bluffs along the Savannah River in northern Effingham County, and in a few outcrops in bluffs along the Altamaha River in the vicinity of Doctortown in Wayne County (Figs. 46, 47). Based on limited core information, the deposits of the two areas are not known to be continuous with each other. The Raysor Formation in Effingham and Wayne Counties appears to cover small areas. Despite close core control in Effingham County, the Raysor Formation has not been found as little as 1 mile (1.6 km) from the Savannah River and it is concluded that the Raysor occurs only as outliers or erosional remnants in Georgia.

The western limit of the Raysor Formation in Georgia approximates the Orangeburg Escarpment. In Wayne County, the escarpment appears to approximate the Raysor shoreline.

The Raysor Formation disconformably overlies formations of the Hawthorne Group in Georgia. It overlies the Marks Head Formation in Effingham County, and the Coosawhatchie Formation in Wayne County. The Cypresshead Formation disconformably or paraconformably overlies the Raysor Formation in both Effingham and Wayne Counties.

Being predominantly calcareous and macrofossiliferous, the Raysor Formation is readily distinguished from the underlying characteristically noncalcareous and nonfossiliferous, phosphatic Marks Head Formation, and from the non-calcareous, nonfossiliferous, finely sandy clay and

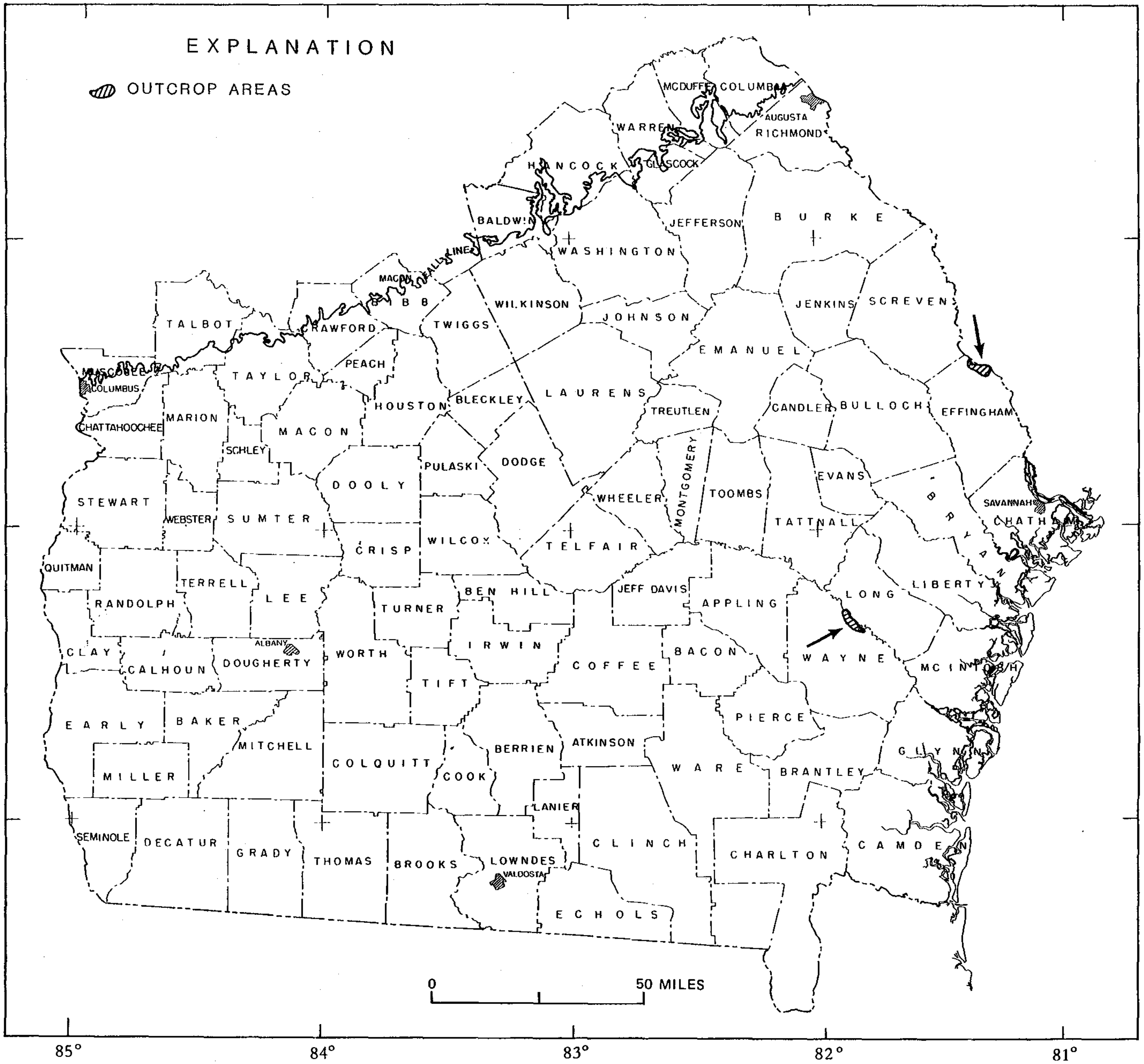


Figure 46. The areal distribution (outcrop and subcrop) of the Raysor Formation in Georgia.

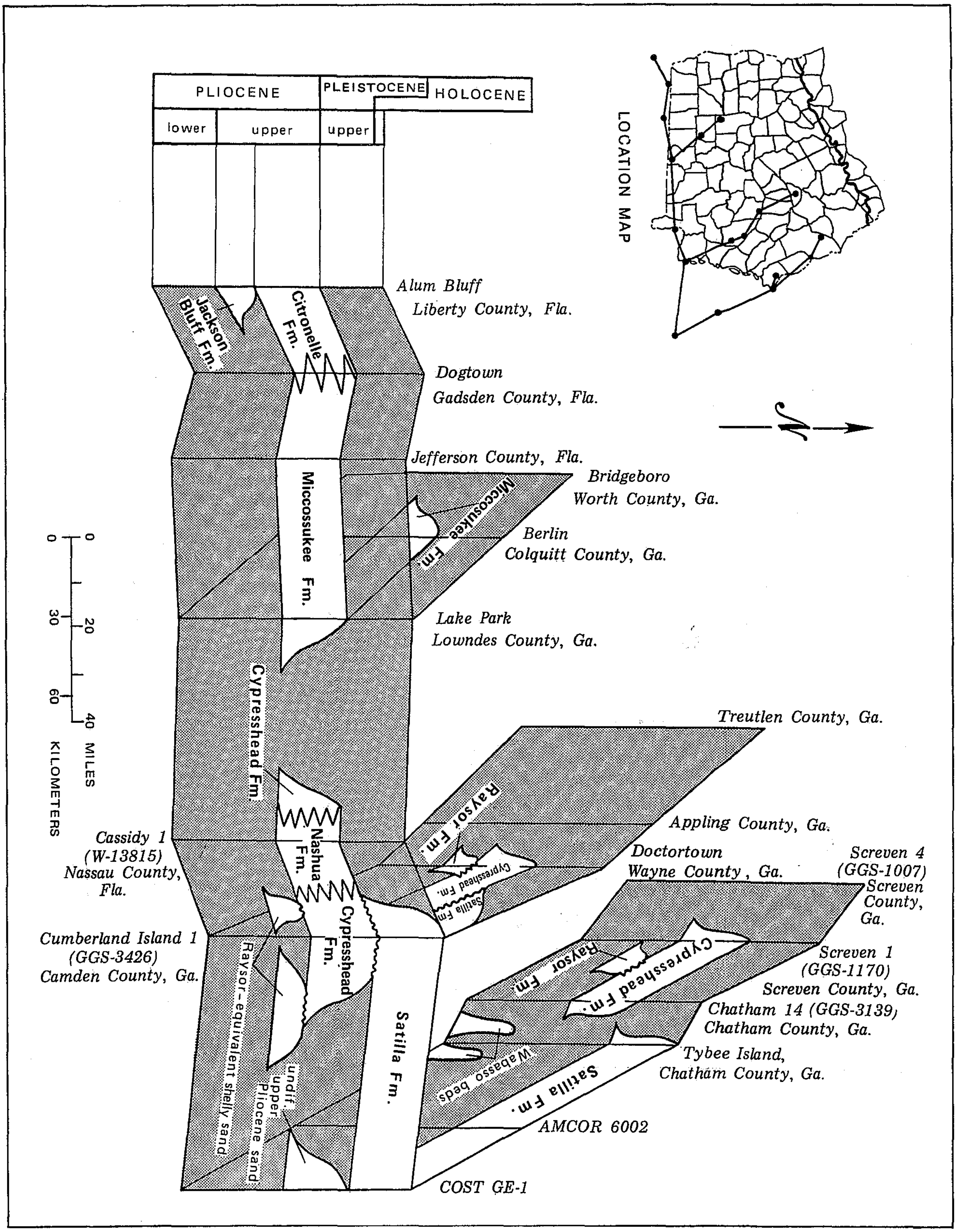


Figure 47. Fence diagram showing stratigraphic relationships of Pliocene, Pleistocene, and Holocene deposits in Georgia.

argillaceous fine sand of the Coosawhatchie Formation. The overlying Cypresshead Formation typically contains prominent horizontal- and crossbedding, and trace fossils including *Ophiomorpha nodosa*. Generally, however, the Cypresshead is noncalcareous, nonfossiliferous, and nonphosphatic. In a few places known where the Cypresshead Formation does contain carbonate based fossils, these deposits consist of channel-fill and are coarsely gravelly, prominently bedded, and the sand is poorly sorted.

In the bluffs along the Savannah River in Effingham County, the Raysor Formation is thin and variable in thickness, ranging from 2 to at least 10 feet (0.6 to 3 m) thick. The Raysor is locally absent, apparently due to solution of the calcium carbonate. In the bluffs along the Altamaha River in Wayne County, the thickness of the Raysor Formation is approximately 10 feet (3 m), although Brantly (1916, p. 32) reported 12 to 15 feet (3.6 to 4.6 m) in the same area.

The environment of deposition of the Raysor Formation in Georgia was open-marine to coastal, inner to possibly middle neritic continental shelf. The relatively high percentage to abundance of planktonic foraminifera in the Raysor Formation suggests shallow upwelling along the edge of the continental shelf and relatively strong currents on the continental shelf.

Age

The following planktonic foraminifera have been identified from the Raysor Formation in Georgia:

Globorotalia menardii (dextral)
G. puncticulata
G. crassula
Neogloboquadrina acostaensis
N. humerosa
Globigerina apertura
G. decoraperta
G. cf. *G. falconesis*
Globigerinoides ruber
G. quadrilobatus quadrilobatus
G. quadrilobatus sacculiferus
G. obliquus
G. conglobatus
G. cf. *G. conglobatus*
Globoquadrina altispira
Sphaeroidinellopsis seminulina
Globigerinella aequilateralis aequilateralis
G. aequilateralis praesiphonifera
Orbulina universa

This association is consistent with Zone PL3 of Berggren (1973) and is roughly equivalent to the concept of Zone N20 of Blow (1969). The Raysor Formation is, therefore, early late Pliocene (early Piacenzian) in age (see Pl. 1).

UNNAMED RAYSOR-EQUIVALENT SHELLY SAND

Definition

The unnamed Raysor-equivalent shelly sand of this report is a subsurface deposit and is restricted to the coastal area of Georgia. In the past, it has been referred to the Duplin formation (Darby and Hoyt, 1964; Woolsey, 1976), to Pliocene, middle Pliocene, or Duplin formation (Woolsey and Henry, 1974; Martinez, 1980; Foley, 1981), and to the Sapelo facies of the Duplin formation (Woolsey, 1976). Although the unnamed Raysor-equivalent shelly sand has largely the same lithology as the Duplin formation in its type area in North Carolina, there is a large gap in the occurrence of deposits of Duplin lithology and age (Zone PL3 of Berggren, 1973) from northern South Carolina to the vicinity of the Ogeechee River in coastal Georgia. The stratigraphically equivalent Raysor Formation is the only formation of that age known to occur in that area. In addition, Blackwelder and Ward (1979, p. 36) proposed the abandonment of the name Duplin in North Carolina and South Carolina, and assigned the shelly sand deposits, previously referred to the Duplin formation, to the Yorktown Formation. As a result, at this time there is question as to the lithostratigraphic validity of the name Duplin formation.

The unnamed Raysor-equivalent shelly sand is a distinctive and mappable lithostratigraphic unit of formational rank. It is not given a formal formation name in this report because there are currently no known outcrops of the unit, and no cores on which to base a type section.

Lithology

Shells, calcareous material, and quartz sand are the characteristic and dominant lithic components of the unnamed Raysor-equivalent shelly sand. Subordinate lithic components include clay, minor phosphate, feldspar, pyrite, mica, heavy minerals, lignitic plant material, and minor scattered limestone (Woolsey, 1976; Martinez, 1980; Foley, 1981). The unnamed Raysor-equivalent sand consists mainly of olive-gray to dark greenish-gray, massive to stratified, slightly argillaceous, variably calcareous and fossiliferous, very well sorted to poorly sorted, fine-to very coarse grained sand that is locally pebbly and gravelly. Dark greenish-gray, to medium to dark gray, to bluish-gray, thinly bedded, variably diatomaceous clay has been reported (Martinez, 1980) (which may be Cypresshead Formation). The unnamed shelly sand is characterized, in seismic profiles, by large-scale, seaward dipping reflectors (Woolsey and Henry, 1974; Woolsey, 1976; Foley, 1981).

Stratigraphic Relationships

The unnamed Raysor-equivalent shelly sand has the geometry of a "double wedge", thinning and pinching out both in landward and seaward directions (Figs. 47, 48). It

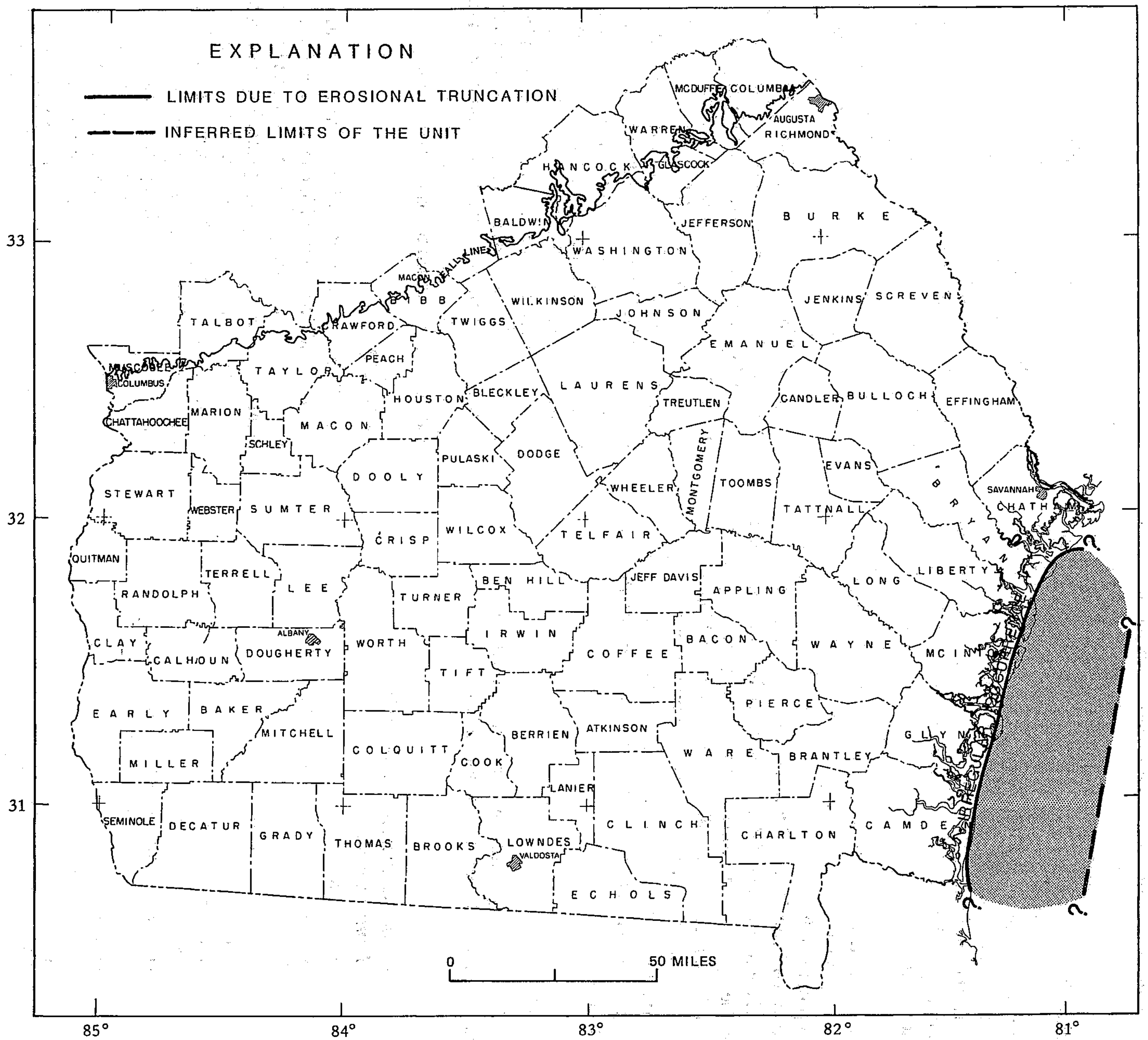


Figure 48. The areal distribution (subcrop) of the unnamed Raysor-equivalent shelly sand in Georgia.

reaches its greatest thickness immediately offshore of the islands, and it is not known to be present on the outer continental shelf of Georgia (compare with Hathaway and others, 1976; Poag and Hall, 1979). The unnamed Raysor-equivalent shelly sand also thins and pinches out in the northern coastal area of Georgia. It is present in coastal Bryan and Chatham Counties in the vicinity of the Ogeechee River only in scattered, thin outliers. Woolsey (1976) recorded the presence of the unnamed Raysor-equivalent sand (Duplin formation of Woolsey, 1976) under Amelia Island in northeastern Florida. The unit, or its stratigraphic equivalent, is not known to occur farther south.

The unnamed Raysor-equivalent shelly sand disconformably overlies the Coosawhatchie Formation of the Hawthorne Group. As yet, no cores have been recovered in which the unnamed Raysor-equivalent sand can be seen to overlie the lower Pliocene Wabasso beds. In the coastal area, the unnamed Raysor-equivalent sand is disconformably or paraconformably overlain by the Cypresshead Formation. Where the Cypresshead locally has been removed by erosion, and under the continental shelf, the unnamed Raysor-equivalent shelly sand is disconformably overlain by the Satilla Formation.

The unnamed Raysor-equivalent shelly sand is distinguished from the underlying Coosawhatchie Formation in consisting of calcareous, shelly, well-sorted to poorly sorted, fine- to very coarse-grained, locally pebbly and gravelly sand that is rarely phosphatic. In contrast, the Coosawhatchie Formation, north of the Atlamaha River, is a noncalcareous and nonfossiliferous, phosphatic, generally well-sorted, fine-grained sand that is locally coarse, pebbly, and poorly sorted only at the top of the formation. South of the Altamaha River, the Coosawhatchie Formation (Charlton Member and sediments lithologically intermediate from Ebenezer Member to Charlton Member) is lithologically heterogeneous and locally consists of phosphatic, well-sorted, fine-grained sand that is variably calcareous or dolomitic, variably phosphatic, sandy limestone, variably phosphatic, sandy dolostone, variably fossiliferous limestone and dolostone, and clay.

The unnamed Raysor-equivalent shelly sand is distinguished from the lower Pliocene Wabasso beds (Tybee facies of Woolsey, 1976) in that the Wabasso beds consist of massive, bioturbated, calcareous, generally nonmacrofossiliferous, phosphatic, well-sorted, fine-grained to silty sand.

What is known of the overlying Cypresshead Formation in the coastal area differs from the unnamed Raysor-equivalent shelly sand in consisting of noncalcareous, nonfossiliferous sand, and noncalcareous, diatomaceous, thinly bedded clay. Except in basal, channel cut-and-fill deposits, the overlying Satilla Formation differs in being lithologically more variable, more argillaceous, having better sorted sand, is more finely sandy, and is generally nonphosphatic.

Woolsey (1976) reported between 2 feet and 31 feet (0.6 to 9.5 m) of unnamed Raysor-equivalent shelly sand (referred to as Sapelo facies of the Duplin formation) from borings and ditch cuttings. However, the thickness distribution of the unnamed Raysor-equivalent sand interpreted from seismic profiles (Woolsey and Henry, 1974, Woolsey, 1976; Foley, 1981) indicates that, in the coastal area and inner continental shelf, it may reach thicknesses approaching 100 feet (31 m).

The environment of deposoition of the unnamed Raysor-equivalent sand was marine, inner to middle continental shelf.

Age

The following planktonic foraminifera have been identified from the unnamed Raysor-equivalent shelly sand in Georgia:

Globorotalia menardii (dextral)
G. puncticulata
G. crassula
Neogloboquadrina acostaensis
N. humerosa
Globigerina apertura
G. quinqueloba
G. cf. *G. falconesis*
Globigerinoides ruber (common)
G. quadrilobatus quadrilobatus
G. quadrilobatus sacculiferus
G. obliquus
G. conglobatus
G. cf. *G. conglobatus*
Globoquadrina altispira
C. cf. *G. venezuelana*
Sphaeroidinellopsis seminulina
Sphaeroidinella dehiscens
Globigerinella aequilateralis aequilateralis
G. aequilateralis praesiphonifera
Orbulina universa

This association is consistent with Zone PL3 or PL4 of Berggren (1973) and is roughly equivalent to the concept of Zone N20 of Blow (1969). The unnamed Raysor-equivalent shelly sand is, therefore, early late Pliocene (early Piacenzian) in age (Pl. 1). The unnamed shelly sand is correlative with the Yorktown and Raysor Formations of the Atlantic Coastal Plain, and with the Jackson Bluff Formation of the eastern Gulf Coastal Plain.

CYPRESSHEAD FORMATION (new name)

Definition

The Cypresshead Formation is named herein for a prominently thin- to thick-bedded and massive, planar- to cross-bedded, variably burrowed and bioturbated, fine-grained to pebbly, coarse-grained sand formation in the terrace region of eastern Georgia (Figs. 47, 56; Pl. 2, 3). It is the uppermost formation in the section between the Orangeburg Escarpment and the Pamlico terrace, and, except along the major streams, it is the only outcropping formation in that region. Its stratigraphic relationships and associations have not been clearly understood in the past. It was included in both the Okefenokee formation and Altamaha Formation by Veatch and Stephenson (1911, p. 427-428, 415-416). Cooke, (1943) and Hails and Hoyt (1969) included the Cypresshead Formation of this report in the Talbot, Penholoway, and Wicomico formations. The Cypresshead of this report was also mapped with parts of the Hawthorne, Sunderland, and Pamlico formations by Cooke (1939). In addition to having been mapped as various shoreline complexes, the Cypresshead was also mapped with both "Pleistocene-Pliocene sands and gravels" and "Neogene undifferentiated" by Georgia Geological Survey (1976). The Cypresshead Formation has been referred to as the Citronelle Formation in northeastern Florida (Cooke and Mossom, 1929); (Cooke, 1945; and Pirkle and others, 1963, 1965).

Although the Cypresshead Formation directly underlies the "Talbot," Penholoway, and "Wicomico" terraces, and portions of the Okefenokee, Waycross, Argyle, and Pamlico terraces, field and core evidence has not shown any direct stratigraphic relationships between the Cypresshead Formation and these terraces. Field and core evidence indicates, on the other hand, that the Cypresshead is an older formation that predates terrace construction. The terraces later were constructed on the Cypresshead Formation.

Type Section

The name Cypresshead is taken from Cypresshead Branch, a small tributary of Goose Creek near the type locality in Wayne County, Georgia. The type locality is a sand-pit in the southern valley wall of Goose Creek, 0.25 mile (0.4 km) southeast of the confluence of Cypresshead Branch and Goose Creek (Fig. 49). The sand-pit is adjacent to a county road, 0.7 mile (1.1 km) north of the intersection of the county road and highway Ga. 169, and 4.6 airline miles (7.5 km) north-northwest of the center of the town of Jesup, Wayne County. There is 39 feet (12 m) of section exposed at the type locality. The upper 23 feet (7 m) is Cypresshead Formation. The lower 16 feet (5 m) of the section is lithologically an intermediate lithofacies between the Altamaha and Coosawhatchie Formations and, in this report, is arbitrarily assigned to the Ebenezer Member of the Coosawhatchie Formation. The section of Cypresshead Formation exposed at the type locality is the type section, or unit-stratotype (holostratotype), of the formation. The disconformable contact between the Cypresshead Formation and the underlying Coosawhatchie Formation, 23 feet (7 m) below the top of the section at the type locality, is the lower boundary stratotype for the Cypresshead.

Four other sections are herein designated reference localities and parastratotypes of the Cypresshead Formation. Linden Bluff on the Altamaha River, a reference locality and parastratotype (Fig. 2), is 2.2 airline miles (3.5 km) northwest of the US-25-82-301 bridge over the Altamaha River in Wayne County (also see Veatch and Stephenson, 1911, p. 412, who referred the Cypresshead Formation at this site to the Altamaha Formation). This locality is significant for two reasons: 1) it represents a more consistently undulatory and cross-bedded, nonburrowed and nonbioturbated sand lithofacies, and 2) the Cypresshead Formation at this site is underlain by a dark-gray, thinly bedded, finely sandy clay that is interpreted in this report as representing the nearshore, updip feather-edge of the Raysor Formation (referred to by Veatch and Stephenson, 1911, p. 412, as Miocene ?).

The railroad cut of the Seaboard Coast Line Railroad (type locality of the Screven Member of the Altamaha Formation), approximately 2.5 miles (4 km) southwest of the village of Screven in Wayne County, is herein designated a reference locality and parastratotype of the Cypresshead Formation (Fig. 43). This locality is significant because typical bioturbated Cypresshead Formation, exposed in the upper 12 feet (3.6 m) of the cut, can be seen disconformably overlying the Screven Member of the Altamaha Formation.

The roadcut on US 301 at Trudie in Brantley County, in the southern valley wall of the Little Satilla River, is herein designated a reference locality and parastratotype of the Cypresshead Formation (Fig. 2). This locality is significant because the thinly interbedded fine-grained sand and clay lithofacies of the Cypresshead Formation is exposed in this cut. The lithology of the Cypresshead at this site is indistinguishable from the typical lithology of the correlative Miccosukee Formation of southwestern Georgia.

The exposure in the Seaboard Coast Line Railroad cut in the southern valley wall of Ebenezer Creek at Birds in Effingham County, Georgia, is herein designated a reference locality and parastratotype of the Cypresshead Formation (Fig. 2). Birds is located at the crossing of the railroad with highway Ga. 275, 0.85 mile (1.4 km) east of the junction of highways Ga. 21 and Ga. 275. The junction of Ga. 21 and Ga. 275 is 3.6 miles (5.8 km) north of Rincon in Effingham County. The railroad cut at Birds is significant because it is the best exposure of the Cypresshead Formation in Effingham County. The exposure is relatively thick, and 35 feet (1.5 m) of the formation is exposed. Most of the lithologic variation present in the formation in central and southern Effingham County can be observed at this site, and the sediments of the lower part of the formation in the cut are exceptionally well-preserved and unweathered. The lower contact of the formation is not exposed at this site, but the top of the Ebenezer Member of the Coosawhatchie Formation is present 1.5 miles (2.4 km) west of Birds in the bed and bank of Ebenezer Creek at an elevation 18 feet lower than the base of the exposure at Birds. The reference locality of the Cypresshead Formation at Birds is 4.4 miles (7 km) southwest of the type locality of the Ebenezer Member of the Coosawhatchie Formation at Ebenezer Landing on the Savannah River.

Lithology

The Cypresshead Formation is dominantly a quartz sand. In some downdip areas, clay beds are prominent or may even dominate the Cypresshead section. Other subordinate

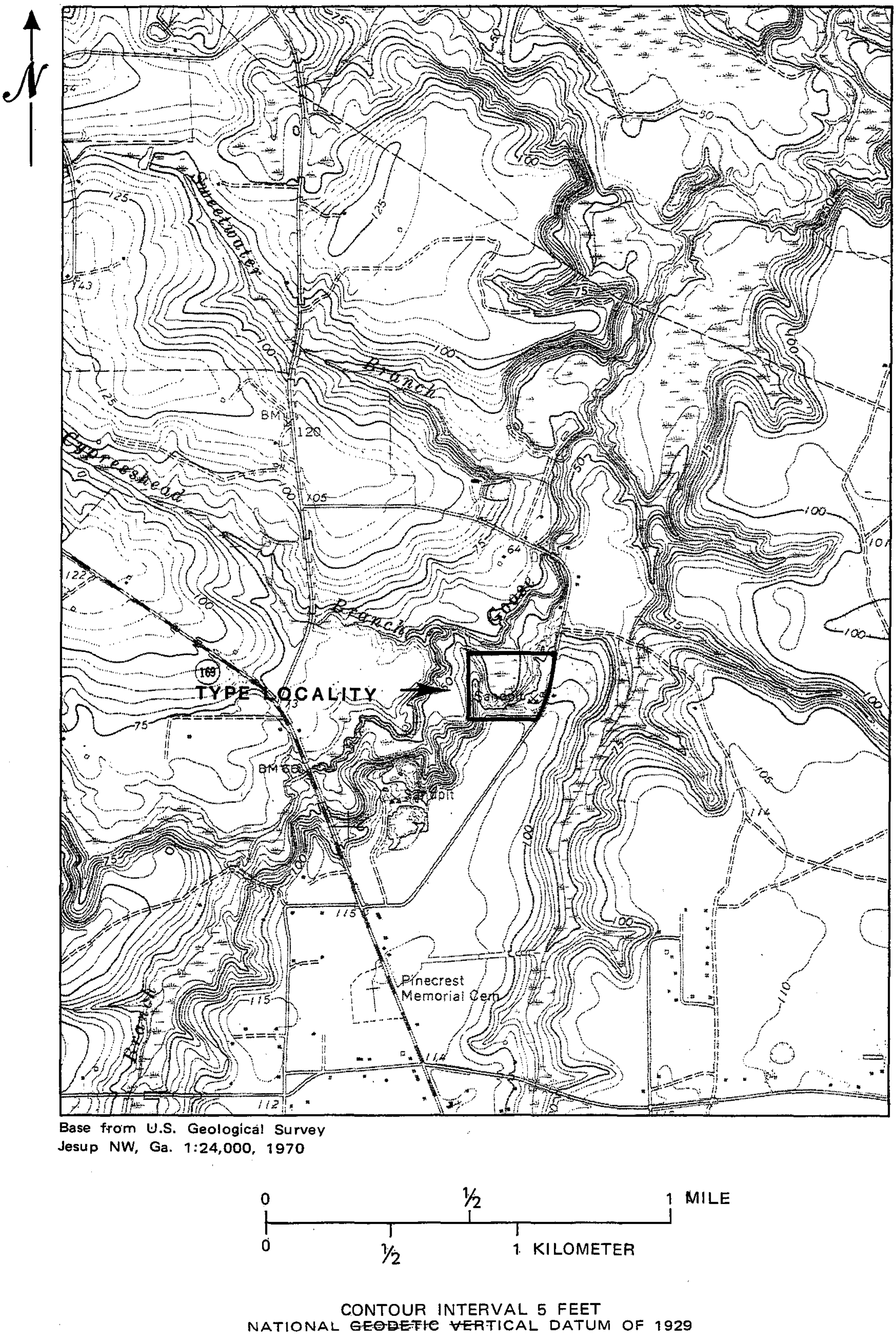


Figure 49. The type locality of the Cypresshead Formation.

lithic components include pebbles and gravel, heavy minerals, mica, trace fossils, and rarely, phosphatic pebbles, calcite, shells, calcareous microfossils, and siliceous microfossils.

The Cypresshead Formation is a coastal, beach/sound-type of deposit and, therefore, is lithologically variable over short distances. However, two gross lithofacies types can be distinguished in the formation in outcrop and in the shallow subsurface: one typically developed in the updip area and near the large rivers (Savannah and Altamaha Rivers), the other typically developed between the large rivers and in downdip areas.

The updip lithofacies is coarse-grained, and the sand-size ranges from fine to coarse and pebbly with scattered gravel stringers. Sorting ranges from well-sorted to poorly sorted in the coarser facies. Bedding is typically prominent with bed thickness ranging from thin to thick, and bedding definition ranging from vague to distinct. Cross-bedding is conspicuous in this lithofacies, and the scale is variable with the largest scale cross-bedding associated with the coarsest and most poorly sorted sands. *Ophiomorpha nodosa*, a trace fossil, is locally common in this lithofacies and is especially characteristic of the massive, structureless, medium to coarse sands. Similarly, there are scattered occurrences of bioturbated and burrowed beds. This coarse-grained sand lithofacies is reminiscent of the time-equivalent Citronelle Formation of western Florida.

The downdip lithofacies of the Cypresshead Formation consists of fine-grained sand and clay. This is the more distinctive lithology of the formation. It is characterized by thinly-bedded, fine-grained, well-sorted sand with thin layers, laminae, or partings of clay dispersed through the sand. The sand is typically weathered to a moderate reddish-brown (10 R 4/6) or orange, and the clay layers and laminae are white, producing a dramatic color contrast that highlights the bedding of the formation. In some scattered areas, the bulk of the formation consists of massive, argillaceous, fine-grained sand that is devoid of any primary sedimentary or biogenic structures. The sediment in this type of deposit is interpreted as being completely mixed and homogenized by burrowing organisms.

Intermediate lithologies consist of bioturbated, poorly mixed sediments. Also characteristic of this intermediate lithofacies is a discontinuous, gray, thinly layered, silty, diatomaceous clay. This gray diatomaceous clay occurs mainly in the subsurface but crops out along the Savannah River in the vicinity of Old Wood Landing, about 1.5 miles (2.4 km) downstream from Ebenezer Landing in Effingham County. The downdip lithofacies of the Cypresshead Formation lithologically resembles the time-equivalent Miccosukee Formation of southwestern Georgia and western Florida.

The Cypresshead Formation is rarely calcareous. Where calcite is present, it is generally, but not invariably, associated with macrofossils. Shell beds have been periodically uncovered in the Cypresshead Formation, but they generally are rare, and only have been seen near the base of the formation.

Stratigraphic Relationships

The Cypresshead Formation occurs at least as far north as the vicinity of Summerville in Dorchester County, South Carolina, and at least as far south as the vicinity of Orlando in Orange County, Florida. North of the Altamaha River in Georgia, the western limit of the Cypresshead Formation occurs at or a few miles west of the Orangeburg Escarpment. South of the Altamaha River, the Cypresshead occurs west of the escarpment in northern Wayne County, and immediately west of Trail Ridge farther south (Figs. 47, 50). The Cypresshead Formation underlies the coastal area of Georgia, except where it is absent on the crest of the Beaufort Arch (Fig. 2). It apparently pinches out offshore, or else grades laterally into an undifferentiated Pliocene sand on the continental shelf (Pls. 2, 3).

Generally the Cypresshead Formation disconformably overlies Coosawhatchie Formation in Georgia (Pls. 2 and 3). In northern Effingham County, however, the Cypresshead Formation disconformably overlies the Marks Head Formation and Parachucla Formation progressively in a northwestward direction (Pl. 2). The Cypresshead Formation overlies the Raysor Formation in only a few places, and with ambiguous contact. The Cypresshead disconformably overlies the Screven Member of the Altamaha Formation west of Trail Ridge and north of the vicinity of Waycross.

The Satilla Formation overlies the Cypresshead Formation in the coastal area of Georgia (Figs. 47, 58; Pls. 2 and 3). Because of poor core recovery in these deposits, the contact relationships between the Cypresshead and Satilla Formations are poorly defined, but the two formations are presumably disconformable. Elsewhere, only surficial sand, Quaternary fluvial deposits, paludal deposits, or residuum overlies the Cypresshead Formation.

The Cypresshead Formation is distinguished from the underlying formations of the Hawthorne Group in being prominently horizontal- and crossbedded, nonphosphatic, in containing little interstitial clay, and commonly containing burrows and bioturbation structures. In contrast, formations of the Hawthorne group are typically thick-bedded and massive, commonly phosphatic (except where they grade into the Altamaha Formation), argillaceous, and locally dolomitic, calcareous, and siliceous. Where the Cypresshead Formation overlies the Screven member of the Altamaha Formation, which is also prominently bedded, the sand of the Cypresshead generally is better sorted, there is little interstitial clay, and the sediments are commonly, but not always, burrowed and bioturbated to some extent. In contrast, the Screven Member has considerable amounts of interstitial clay, typically has poor sorting, Liesegang banding is commonly apparent, and burrows and bioturbation structures are absent. Where the Cypresshead Formation overlies the Raysor Formation, the Raysor is generally thick-bedded and massive, calcareous, and fossiliferous.

The Cypresshead Formation occurs at the top of the

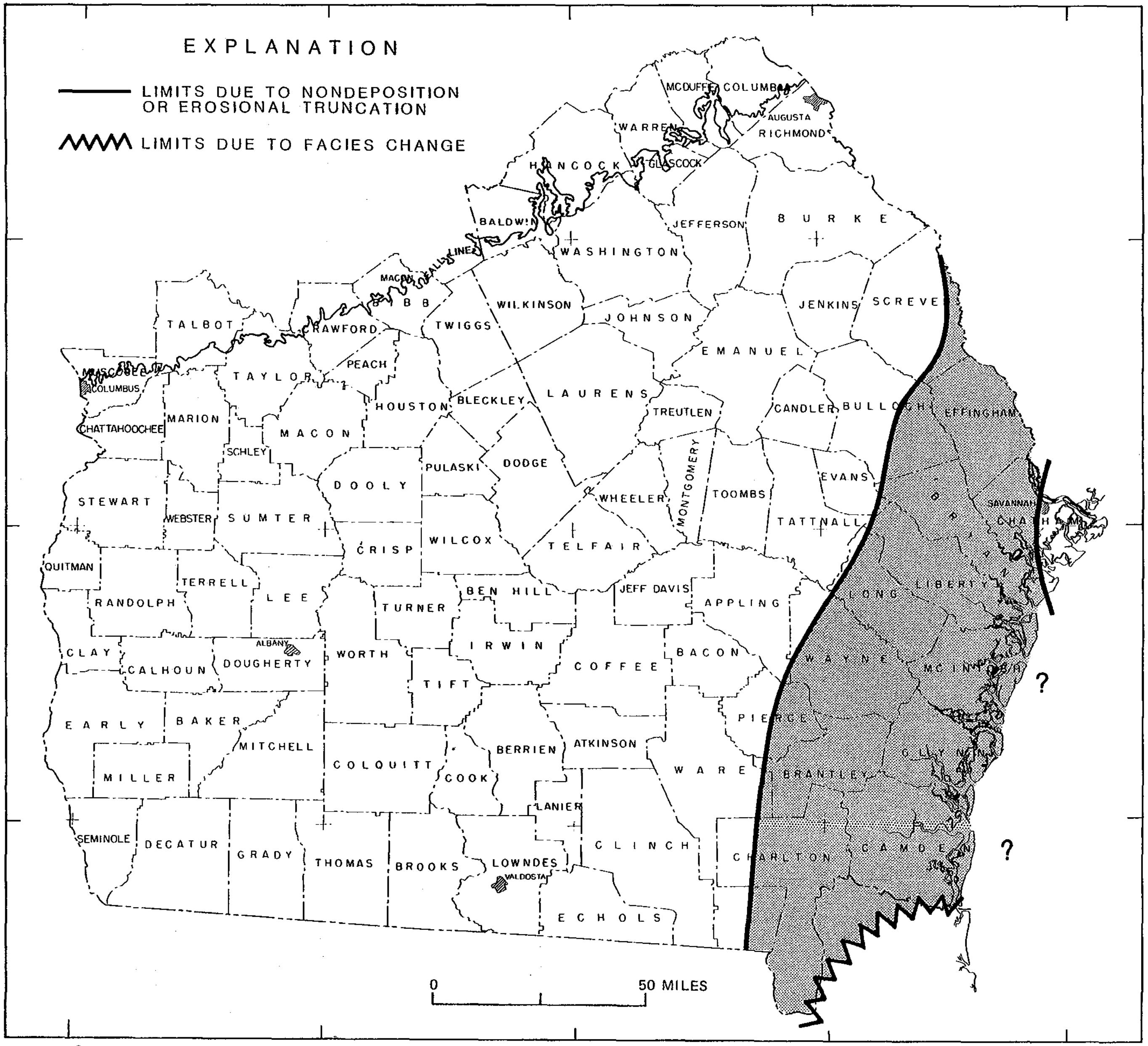


Figure 50. The areal distribution (outcrop and subcrop) of the Cypresshead Formation in Georgia.

stratigraphic section (excluding surficial sand deposits and barrier island sand deposits) west of the Pamlico terrace. However, on the Pamlico and lower terraces, the Satilla Formation overlies the Cypresshead Formation in most places. In this area, the Satilla can be distinguished in its better sorting and finer grain size of the sand, the local occurrence of massive clay beds, in the local presence of calcareous and fossiliferous sediments, and in being generally thick-bedded and massive (except in channel-fill deposits). Where the Satilla Formation locally is prominently bedded and crossbedded, it is distinguished from the Cypresshead Formation by its prevailingly finer grain-size and lack of pebbles, better sorting, and relatively smaller-scale sedimentary structures.

The Cypresshead Formation is 23 feet (7 m) thick at the type locality. The thickness of the formation in cores in the Savannah River area ranges from 25 feet to 62 feet (7.6 m to 19 m). Elsewhere, the maximum thickness of the formation appears to be between 60 and 70 feet (18 and 21 m). In the coastal area, where it is overlain by the Satilla Formation, the Cypresshead may be significantly thinner, even locally absent. As a result of the low topographic relief of the terrain in which the Cypresshead Formation occurs, the Cypresshead outcrop thickness ranges from a few feet (approximately 1 m) to as much as 30 or 40 feet (9 to 12 m) in sand pits, road cuts, railroad cuts, or in bluffs along major rivers.

The environment of deposition of the Cypresshead Formation was coastal marine. It is not clear, however, whether the Cypresshead Formation was deposited in a large sound/lagoon that was partially isolated from the open ocean, or whether it was deposited on the inner continental shelf seaward of the beach. The presence of locally abundant *Ophiomorpha nodosa* indicates that the associated sediments are of very shallow water, near sealevel origin; the presence of abundant *Ammonia beccarii* and *Elphidium* spp. at 61 feet in the core Effingham 13 (GGS-3140), near the base of the Cypresshead Formation, indicates brackish water conditions. On the other hand, the presence of sparse planktonic foraminiferal assemblages in the few scattered occurrences of calcareous, fossiliferous sediments in the Cypresshead suggests that near normal salinities must have prevailed some of the time. The lithology of the Cypresshead Formation, and the nature of the sedimentary structures, is more suggestive to me of deposition in very shallow water in a partially enclosed sound. If this model is correct, then associated barrier islands must have occurred in the present coastal area, or slightly offshore of the present coast. This model would require a very broad sound, at least 50 miles (80 km) wide.

Age

Because the Cypresshead Formation is largely nonfossiliferous, the age of the formation must be inferred from stratigraphic position, from physical correlation with fossiliferous formations, and from limited internal paleontological evidence. On the basis of stratigraphic position, the age of the Cypresshead Formation can be determined within broad limits. The Cypresshead overlies the Raysor Formation of early late Pliocene age along the Altamaha River in Wayne County with ambiguous contact, (either paraconformable or gradational) and it overlies the Raysor Formation along the Savannah River in Effingham County with a weathering contact of high relief. As a consequence, it is not clear whether the Raysor and Cypresshead Formations are disconformable, paraconformable, or conformable and gradational. The Satilla Formation of late Pleistocene age overlies the Cypresshead Formation in the coastal area. In addition, Pirkle and Czel (1983) reported a Pleistocene macrofossil assemblage from Trail Ridge sands in southern Charlton County. These Trail Ridge sands overlie the Cypresshead Formation. The highest marine terrace that the Cypresshead underlies is the Argyle terrace in northern Wayne County. Based on stratigraphic position, therefore, it is concluded that the Cypresshead Formation is no older than early late Pliocene (assuming conformity with the underlying Raysor Formation), is older than the late Pleistocene Satilla Formation, and is older than Trail Ridge and the Argyle terrace (both of which appear to be older than the Satilla Formation).

A small assemblage of planktonic foraminifera consisting only of juveniles was recovered from the interval 53.5 feet to 56 feet in the core Wayne 1 (Mineral Engineering Branch, Engineering Experiment Station, Georgia Institute of Technology and Georgia Department of Mines, Mining, and Geology, 1967, p. 93-95), approximately 5 miles (8 km) south of Jesup (Fig. 2). This assemblage includes the following species:

Globigerina apertura
Globigerina cf. *G. decoraperta*
Globigerina cf. *G. falconesis*
G. bulloides
G. rubescens
Neogloboquadrina cf. *N. dutertrei*
Globigerinoides ruber
G. obliquus

Globigerina apertura and *Globigerinoides obliquus* are not found in deposits younger than the Pliocene. Therefore, the Cypresshead Formation in this core can be no younger than Pliocene.

A small assemblage of benthic foraminifera was recovered from the basal Cypresshead Formation in the core Chatham 14 (GGS-3139) from northern Chatham County, Georgia (Fig. 3). The assemblage from the interval 39 feet to 45 feet includes the following species:

Buccella mansfieldi
Buliminella curta
B. elegantissima
Virgulinella gunteri
Florilus atlantica

The genus *Virgulinella* is not known to occur in deposits younger than the Jackson Bluff Formation (Raysor-equivalent) in western Florida and *Virgulinella* has not been previously reported from the southern Atlantic Coastal Plain Pliocene deposits.

Both the planktonic and benthic foraminifera from the Cypresshead Formation in Wayne and Chatham Counties, Georgia, indicate a Pliocene age for the formation.

In terms of macropaleontological evidence, no published accounts of shell beds can be assigned to the Cypresshead Formation except possibly a "marl" from the Satilla River 4 miles (6.4 km) south of Atkinson in Brantley County, described by Aldrich (1911) and commented on by Richards (1969). Very likely the deposits that contained *Chione cancellata,* along the St. Marys River, and that were assigned by Veatch and Stephenson (1911) and Cooke (1943) to the Charlton Formation, are in fact Cypresshead Formation or Nashua Formation as defined in this paper. This suggestion is based on fieldwork and studies of cores which indicate that the Charlton is a lithofacies of the middle Miocene Coosawhatchie Formation. The deposition of the Coosawhatchie Formation long predates the first occurrence of *C. cancellata*, a late Pliocene to Holocene species.

The Cypresshead Formation grades laterally southward, in the vicinity of the St. Marys River, into the Nashua Formation, a calcareous, shelly sand that underlies much of northeastern Florida east of Trail Ridge. A planktonic foraminiferal assemblage from the Nashua Formation at the depth of 65 feet in the Florida Geological Survey core Cassidy 1 (W-13815) includes the following species restricted to the Pliocene:

Globorotalia menardii miocenica
Globigerina aperatura
Globigerinoides obliquus

The presence of *G. menardii miocenica* is indicative of planktonic foraminiferal Zone PL5 of Berggren (1973) and of the middle part of Zone N21 of Blow (1969). The Nashua Formation in the core Cassidy 1 (W-13815) is, therefore, younger than the Raysor Formation and is time-equivalent to the Bear Bluff Formation of South Carolina.

The age of the Nashua Formation, at the type locality, is early Pleistocene, and the formation is, therefore, a multideposit formation (more than one sedimentational episode involved in the deposition of a formation). This circumstance raises the possibility that the correlative Cypresshead Formation may consequently also be a multideposit unit with a younger, as yet biostratigraphically undifferentiated component.

The best current estimate of the maximum age range of the Cypresshead Formation, based on stratigraphic position, internal paleontology, and physical correlation, is late Pliocene (early Piacenzian; Zone PL3 of Berggren [1973], or approximately Zone N20 of Blow [1969]), to early Pleistocene (Calabrian; Zone N22 of Blow [1969]). The most likely age of the Cypresshead Formation in Georgia is late Pliocene (Piacenzian; Zone PL5 of Berggren [1973], or Zone N21 of Blow [1969], [see Pl. 1]).

MICCOSUKEE FORMATION

Definition

The Miccosukee Formation was named by Hendry and Yon (1967) for a prominently bedded, fine- to coarse-grained sand that overlies the Hawthorne Group in Leon and Jefferson Counties, Florida, and occurs there at the top of the geologic section. The Miccosukee Formation farther north in Georgia is not known to differ in any way from the formation in Florida.

The Miccosukee Formation has been referred to the Lafayette formation (Matson and Clapp, 1909, p. 141-145), Altamaha Formation (Veatch and Stephenson, 1911, p. 421-423), Alum Bluff Formation (Sellards, 1917, p. 104-106), Hawthorne Formation (Cooke and Mossom, 1929, 123-125; Cooke, 1939; 1943, p. 91-92; 1945, p. 151, 153, 157), and Citronelle Formation (Doering, 1960). In addition, it was mapped as "Duplin marl and Hawthorn formation" by MacNeil (1947b). Sellards and Gunter (1909, p. 263-265; 1918, p. 49-51) gave an excellent account of the formation in Gadsden and Leon Counties, Florida, but did not refer it to any named unit.

Type Section

The name Miccosukee was taken from the community of Miccosukee in northeastern Leon County, Florida, and from Lake Miccosukee in eastern Leon and western Jefferson Counties, Florida (Hendry and Yon, 1967). The type locality is a roadcut, now completely overgrown, on highway US 19, approximately 3.1 miles (5 km) south of the Georgia-Florida state line in NW ¼, NW ¼, Sec. 31, T3N, R5E (Fig. 3). The type section (unit-stratotype) is that section of Miccosukee Formation that was exposed at the type locality. The Florida Bureau of Geological Survey core Green 1 (W-6937), taken about 0.75 mile (1.2 km) west of the community of Miccosukee in Leon County (Fig. 3), was designated a reference locality (Hendry and Yon, 1967, p. 253-254). The interval 2.5 feet to 62.5 feet in the core Green 1 (W-6937) (also see Hendry and Sproul, 1966, p. 151-125) is, therefore, a reference section and parastratotype of the Miccosukee Formation.

Lithology

The lithology of the Miccosukee Formation is dominated by sand, although in some areas, and in some parts of the section, clay is a significant or dominant component of the lithology. Other known subordinate lithic components include mica, heavy minerals, feldspar, and rarely, wad or MnO_2 dendrites. Limonite is locally present as a weathering product. The clay mineral components of the lithology consist of montmorillonite, kaolinite, and illite (Hendry and Yon, 1967).

Several lithology types or lithofacies can be identified in the Miccosukee Formation. The most characteristic lithology type is a thinly bedded to laminated, well-sorted, fine-to medium-grained sand with scattered layers or laminae of clay. Where the clay layers are absent, the sand generally remains distinctly and thinly layered, fine- to very fine-grained and well-sorted. Medium- and, rarely, coarse-grained sand beds are associated with the thinly layered, fine-grained sand lithologies. The clay layers typically range in thickness from 1 foot (30 cm) to 1/16 inch (1 mm). Thicker beds of clay are rare. Also associated with the clay beds are thin beds of intraclastic or intraformational clay breccia. Some beds or stratigraphic intervals in this lithofacies are bioturbated with incomplete mixing of the sediments. In outcrop, the Miccosukee Formation is moderately to deeply weathered, and the sands typically are orange to moderate reddish brown. The clay layers or laminae are white, and the resulting color contrast imparts a dramatic and characteristic appearance to the formation (identical to the analagous lithofacies of the equivalent Cypresshead Formation).

Pebbly to gravelly, coarse-grained sand lenses are present locally in the Miccosukee Formation and represent tidal channel scour-and-fill structures. These deposits are conspicuously cross-bedded, and the sorting commonly is poor. Gravel occurs in stringers. Lithologies intermediate to the thinly bedded, fine-grained sand lithofacies and the pebbly, cross-bedded sand also exist, indicating a wide spectrum of energy levels in the paleo-environment.

In some areas, the Miccosukee is dominated by other lithologies, including a massive-bedded, structureless sandy clay to clayey sand (e.g., in a large part of eastern Thomas County, Georgia); massive-bedded, structureless, well-sorted, fine- to coarse-grained sand; or vaguely bedded, well-sorted to moderately well sorted, fine- to coarse-grained sand.

The Miccosukee Formation is characteristically noncalcareous and nonfossiliferous. However, trace fossils such as burrows, bioturbation structures, and *Ophiomorpha nodosa* are locally conspicuous.

Stratigraphic Relationships

In Georgia, the Miccosukee Formation extends from the Pelham escarpment in the west, to the vicinity of the Alapaha River in the east (Fig. 51). The southern limit of the Miccosukee Formation is the Cody Escarpment in Florida (Puri and Vernon, 1964, p. 15, Fig. 5; Hendry and Sproul, 1966; Yon, 1966).

The northern limit of the Miccosukee Formation in Georgia approximates an east-west line trending from the vicinity of Pelham in Mitchell County in the west, through the vicinity of Berlin in Colquitt County, and to northern Lowndes County (Fig. 51). The Miccosukee Formation may exist north of this line but is not recognizable in outcrop because of deep and intense weathering.

The Miccosukee Formation disconformably overlies various formations of the Hawthorne Group: the Torreya Formation, the Meigs Member of the Coosawhatchie Formation in northwestern Thomas County, and the Statenville Formation in Echols County. In western Leon County, Florida, the Miccosukee Formation reportedly overlies the Jackson Bluff Formation (Hendry and Sproul, 1966; Hendry and Yon, 1967). The Miccosukee Formation occurs at the top of the local section in Georgia and Florida (Fig. 47), and is overlain only by various undifferentiated surficial deposits. However, it underlies various marine terraces in Georgia: the Argyle, the Claxton, the Pearson, and the Hazlehurst. Furthermore, it also occurs inland from the marine terrace belt.

The Miccosukee Formation is distinguished from the underlying deposits of the Hawthorne Group in consisting of locally burrowed and bioturbated fine-grained sand with thin beds or laminae of clay and with local occurrences of prominently cross-bedded medium- to coarse-grained, pebbly, channel-fill sands. In contrast, the underlying Hawthorne deposits are typically thick-bedded and massive, variably phosphatic, locally calcareous, dolomitic, and siliceous, and commonly contain magnesium-rich clays. The Miccosukee Formation is always weathered to some degree whereas Hawthorne deposits, due in part of high clay content and occurrence only at topographically low elevations, generally are unweathered to only mildly weathered. Where the Miccosukee Formation has been reported to overlie the Jackson Bluff Formation, the Jackson Bluff consists of a shelly, calcareous sand or, in Gadsden County, Florida, dark gray, sulphurous, finely sandy clay (aluminous clay of Dall and Stanley-Brown, 1894).

The Miccosukee Formation grades laterally westward, in central Gadsden County, Florida, into the Citronelle Formation (Fig. 47). However, the cross-bedded, pebbly and gravelly, coarse-grained sands in the cut-and-fill structures in the Miccosukee Formation represent Citronelle-type lithologies. These lithologies indicate that the west-east facies change from Citronelle Formation into Miccosukee Formation is not uniform and gradual, but irregular and locally discontinuous.

The apparent absence of the Miccosukee Formation east of the Alapaha River in Georgia may be a deception deriving from lack of exposures in the flat, featureless terrain. The alternative explanation is that the absence of the Miccosukee is the result of erosion after deposition. However, the Miccosukee Formation occurs in the same stratigraphic position and is lithologically the same as the Cypresshead Formation of eastern Georgia. The two formations are not continuous across northern Florida in the Suwannee River area, where the Statenville Formation is the uppermost formation in the section. The Miccosukee and Cypresshead Formations are also not known to be continuous across southern Georgia. Possibly, then, the Miccosukee was once continuous with the Cypresshead, and they were at that time one continuous formation. Later, this formation was partly eroded during the period of terrace construction west of the

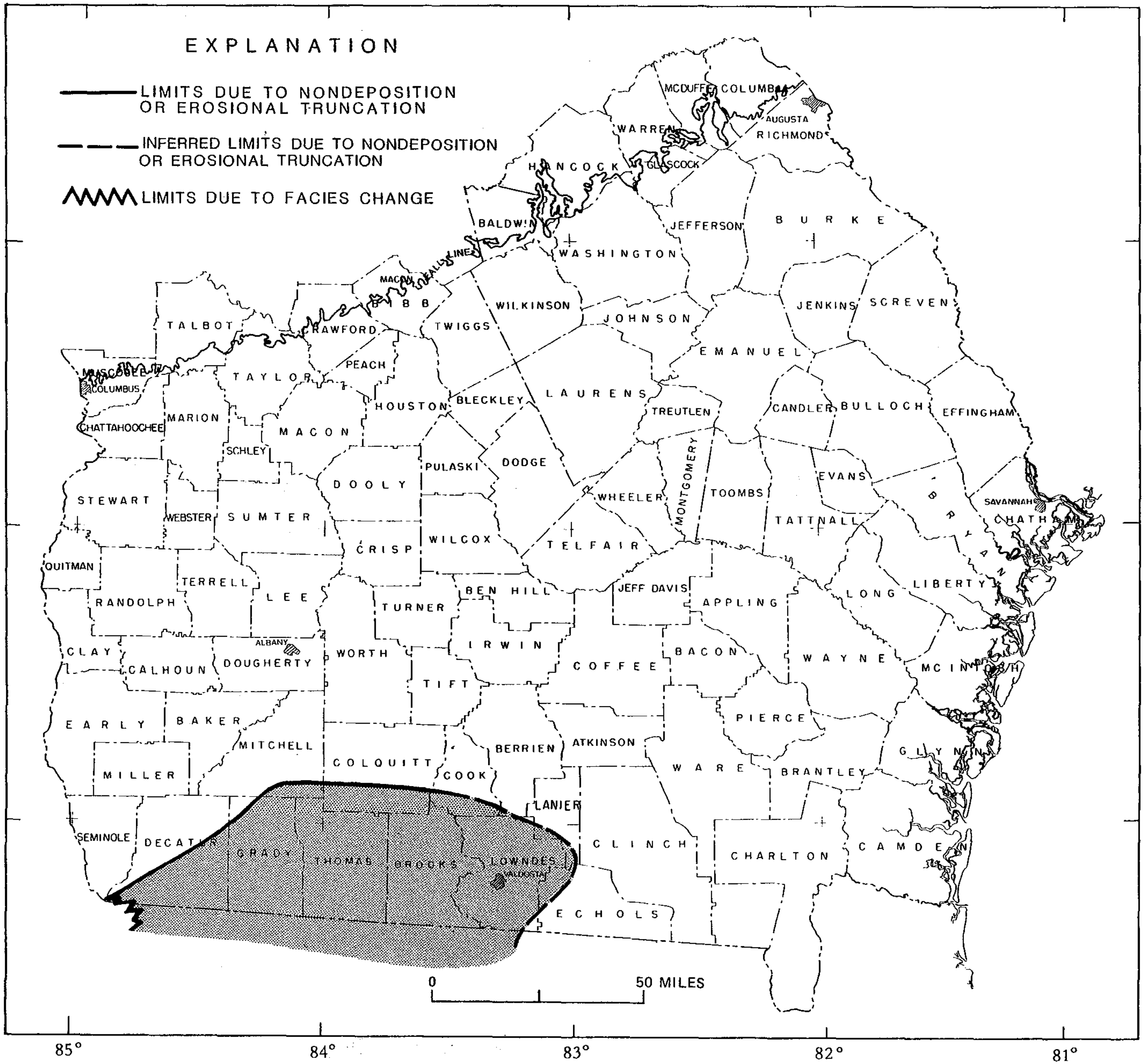


Figure 51. The areal distribution (outcrop and subcrop) of the Miccosukee Formation in Georgia.

Okefenokee Swamp, resulting in the present two formations. The basis for this suggestion is that the lowest elevations of the outcropping Miccosukee Formation in Lowndes County and westward (approximately 150 feet) are higher than the land elevations in the projected Miccosukee subcrop belt east of the Alapaha River. Because of the oblique methods employed to determine the ages of the two formations and, therefore, correlation, this author considers it more prudent to separate the units lithostratigraphically, tying each formation to a local stratotype.

Because of lack of core control in southwestern Georgia, the thickness distribution of the Miccosukee Formation there is not known. In Florida, however, where there is extensive well and core control (Hendry and Sproul, 1966; Yon, 1966), the Miccosukee Formation ranges from 43.5 feet to 83.5 feet (13 m to 25 m) thick. The average thickness of the formation, where it has not been dissected, appears to be between 50 and 60 feet (15 and 18 m).

Based on the scattered occurrences of burrows, bioturbated sediments, and *Ophiomorpha nodosa*, it is concluded that the environment of deposition of the Miccosukee Formation was coastal marine, probably bay-sound. This conclusion is consistent with the interpreted environments of deposition of the stratigraphically better known and lithologically comparable Cypresshead Formation and Tobacco Road Sand (Huddlestun and Hetrick, 1978, 1979, 1986).

Age

Because the Miccosukee Formation is nonfossiliferous, the age of the formation must be extrapolated from its stratigraphic position and physical correlation with adjacent deposits. Stratigraphic position of the Miccosukee Formation in Georgia is of little value in delimiting its age because it occurs at the top of the local stratigraphic section and overlies Hawthorne Group deposits of early and middle Miocene age. However, the Miccosukee Formation is reported to overlie the Jackson Bluff Formation of early late Pliocene age in western Leon County, Florida (Hendry and Sproul, 1966; Hendry and Yon, 1967).

The Miccosukee Formation grades westward, by coarsening of the sediments, into the Citronelle Formation in western Gadsden and Liberty Counties, Florida (also see Cooke and Mossom, 1929, p. 185, Pl. 2). In that area, the Citronelle Formation overlies the Jackson Bluff Formation with ambiguous stratigraphic relationships in the Florida Geological Survey cores Wall 1 and 2 (W-7457 and W-7458), and at Alum Bluff in Liberty County. Therefore, both the Citronelle and Miccosukee Formations are no older than early late Pliocene.

The Citronelle and Miccosukee Formations are overlain by the highest marine terraces, the Claxton, Pearson, and Hazlehurst terraces, and both formations occur inland of the highest marine terrace, the Hazlehurst terrace, in Florida and Georgia. Furthermore, the Miccosukee Formation occurs at elevations between 300 and 350 feet (91 and 107 m) in the vicinity of Pelham, in Mitchell County, Georgia, almost 100 feet (30 m) higher than the Hazlehurst terrace. Therefore, both the Miccosukee Formation and the equivalent Citronelle Formation (also see Carlston, 1950) are older than the highest and, presumably, oldest marine terrace.

The Citronelle Formation has historically been regarded as being of Pliocene age (Matson, 1916; Cooke and Mossom, 1929; Cooke, 1945), but Doering (1960) maintained that the Citronelle is of early Pleistocene (Calabrian) age. There is, however, no known paleontological or local correlation evidence in western Florida or southwestern Georgia to support a Pleistocene age for either the Citronelle or Miccosukee Formations. On the other hand, the stratigraphic evidence does not preclude a Pleistocene age for these formations.

Yon (1966, p. 55-57) identified the vertebrate fossil bed exposed on highway S-146 in northern Jefferson County, Florida (see also Olsen, 1963, p. 308-314; Olson, 1966, p. 19-24) as being Miccosukee Formation. On the basis of molars from the horse *Merychippus* sp. and the rhinoceros *Diceratherium* sp. from this locality, the bed containing the fossil mammal bones and, therefore, the Miccosukee Formation (or "Upper Miocene Clastics" of Yon, 1965) were assigned a late Miocene age (Yon, 1965, 1966; Hendry and Yon, 1967). It is now believed (Tedford and Hunter, 1984, p. 143-144; Fig. 4), however, that the fossils from this Jefferson County vertebrate bed (the Ashville local fauna) are of middle Miocene (late Barstovian) age, and are correlative with those found in the Statenville Formation (Statenville local fauna) at Statenville, Georgia.

Except for a central core of Torreya Formation that is still exposed, this roadcut is now overgrown and the bone-bearing bed can no longer be seen or evaluated in outcrop. However, based on my knowledge of the geology of northern Jefferson County, Florida, the following alternate interpretation of this important locality is offered. In contrast to the interpretation of Yon (1966, p. 103-104) only Torreya Formation is recognized in the upper part of the Florida Geological Survey core Ashville 1 (W-6561) taken at the vertebrate fossil locality. The Miccosukee Formation is, however, exposed at similar elevations in nearby roadcuts, indicating topographic relief on the Hawthorne Group/Miccosukee Formation disconformity. Beds A and B of Yon (1966, p. 60-61) and Olson (1966, p. 46-51) are lithologically consistent with the Torreya Formation that is still exposed. From published descriptions, Beds E and F appear to be Miccosukee Formation which is no longer exposed. The lithologic descriptions of Bed D and the critical bone-bearing Bed C do not clearly suggest either Torreya Formation or Miccosukee Formation. It is not likely that Bed C is Torreya Formation because of the presence of quartz pebbles, which are not known to occur in the Torreya Formation elsewhere. The indication that the vertebrates of Bed C are actually of middle Miocene age and correlative with those from Statenville (Tedford and Hunter, 1984) can not be ignored. This evidence strongly suggests that the coarse, pebbly, bone-bearing Bed C is actually a correlative of the Statenville Formation. The lithology of Bed C and the Statenville is somewhat dissimilar, although the coarse, pebbly sandy is characteristic of both. In addition, there is no known point at which the two units are known to merge, even though the distance now known to separate them is not great. It thus seems indavisable to refer Bed C to the Statenville Formation at this time, but it is here regarded as correlative to the Statenville Formation.

The Miccosukee Formation occurs in the same stratigraphic position, with similar stratigraphic associations, and is lithologically almost identical to the Cypresshead Formation of the Atlantic coastal area. Presumably, therefore, the two formations are precisely time-equivalent and correlative. The Miccosukee Formation is also correlative, at least in part, to the Nashua Formation of northeastern Florida. The type Nashua Formation is early Pleistocene in age and is a multideposit unit. As a consequence, the possibility exists that the Miccosukee Formation is also a multideposit formation, and a part of the formation may be as young as early Pleistocene.

Based on the above discussion, the best current estimate of the age range of the Miccosukee Formation is from early late Pliocene (early Piacenzian; equivalent to Zone PL3 of Berggren [1973]), to early Pleistocene (Calabrian; equivalent to Zone N22 of Blow, [1969]), (see Pl. 1). However, it appears more likely to me that the Miccosukee Formation, like the Cypresshead Formation, is late Pliocene (Piacenzian) in age and is equivalent to Zone PL5 of Berggren (1973).

UNDIFFERENTIATED UPPER PLIOCENE SAND OF THE CONTINENTAL SHELF

Definition

This upper Pliocene deposit underlies the outer continental shelf of Georgia (Fig. 47). Based on paleontological correlation, it appears to be, in part, the offshore equivalent of the Cypresshead Formation. Its precise distribution, facies variations, and thickness distribution are not well-defined at this time due to insufficient core control. However, limited information indicates that the deposit may be widespread on the outer shelf (Poag and Hall, 1979).

Lithology

In the COST GE-1 test well, according to Rhodehamel (1979), the lithology of this deposit consists of loose, water-worn, brecciated shell hash; loose, clear to frosted, angular to subrounded, fine to very coarse to granule-size quartz sand; loose, white to gray oolite pellets; gray oomicrite; biomicrite; sparite; calcareous mud; brown to green glauconite; brown phosphate pellets; and sedimentary and volcanic rock fragments.

In the core AMCOR 6004 taken in approximately 570 feet (174 m) of water on the upper continental slope 63 miles (102 km) southeast of Charleston, South Carolina, and approximately 90 miles (145 km) east of Savannah, the lithology of the correlative deposit consists of massive and structureless, unconsolidated, macrofossiliferous, calcareous, sandy, olive-colored, foraminiferal clay (also see Hathaway and others, 1976).

Thickness

This unit is approximately 124 feet (38 m) thick in the COST GE-1 test well. Poag and Hall (1979, p. 49) noted that the interval is thinner in the wells J-1 and J-2 on the southern rim of the Southeast Georgia Embayment on the continental shelf. This unit is absent in the U.S. Geological Survey core AMCOR 6002 taken on the continental shelf 46 miles (74 km) east of Brunswick. Its correlative is 62 feet (19 m) thick in the core AMCOR 6004 (Hathaway and others, 1976).

Age

This deposit is late Pliocene, Piacenzian in age, and contains planktonic foraminiferal Zone PL5 of Berggren (1973) or Zone N21 of Blow (1969) (Pl. 1). The age assignment is based on the occurrence of the following species of planktonic foraminifera (Poag and Hall, 1979):

Globoratalia menardii miocenica
G. menardii exilis
Globorotaloides planispira
Sphaeroidinella dehiscens
Globigerinoides obliquus
G. conglobatus
Globigerina apertura
G. incisa
G. decoraperta
Neogloboquadrina dutertrei

NASHUA FORMATION (reintroduced)

Definition

The Nashua Marl of Matson and Clapp (1909, p. 128-133) is herein reintroduced as the Nashua Formation. Typically, the Nashua is a variably calcareous, shelly sand and a finely sandy shell coquina that occurs in outcrop in the St. Johns River Valley in northeastern Florida. The Nashua Formation is significant to the understanding of the late Cenozoic stratigraphy of Georgia in that its northern limit is in the vicinity of St. Marys River; therefore, it probably occurs in Georgia (see Fig. 47; Pl. 2). The Nashua Formation is critical for delimiting the age of the correlative Cypresshead Formation in eastern Georgia, and it is useful in defining the age range of the correlative Miccosukee Formation of southwestern Georgia.

The name Nashua Marl was abandoned by Cooke and Mossom (1929) in favor of the name Caloosahatchee marl, a south Florida unit presumably biostratigraphically equivalent to and continuous with the Nashua of northeastern Florida. Because of a lack of stratigraphic investigations in the area, neither the name Nashua nor Caloosahatchee has been applied to any deposit in northeastern Florida in recent years. The name Caloosahatchee is not adopted in this report because it is not clear that the Caloosahatchee marl of former usage is a mappable lithostratigraphic unit of formation rank, nor is there evidence that these shelly, fossiliferous deposits are continuous in the subsurface. The Caloosahatchee (in the strict sense) has always been recognized first on its fossil content and, therefore, its age, and second on its fossiliferous "marl" lithology (Dall, 1892; Matson and Clapp, 1909; Sellards, 1919; Cooke and Mossom, 1929; Cooke, 1945; Dubar, 1958). Because beds have been removed from the upper and lower parts of the Caloosahatchee marl of Dall (1892) on paleontological grounds (i.e., Fort Thompson Formation of Sellards [1919], "unit A" and Pinecrest beds of Olsson and Petit [1964]), the lithostratigraphic ranking of the Caloosahatchie has been rendered ambiguous, and it is questionable whether it is a mappable unit with a lithology that serves to distinguish it from underlying and overlying units. As a result, the Nashua Formation, a lithologically characteristic and mappable formation in northeastern Florida, is reintroduced in this report.

Type Section

The type locality of the Nashua Formation, by original designation (Marson and Clapp, 1909, p. 130), is "one-fourth mile south of Nashua, Putnam County", Florida (Fig. 46). Mansfield (1924 p. 28) noted that the type locality is on the "river bank." There are, however, low bluffs with scattered, poorly exposed outcrops along the St. Johns River for approximately 2 miles (3.2 km) on the east side of the river at Nashua. Cooke and Mossom (1929, p. 160) were unable to find the specific site of the type locality designated by Matson and Clapp (1909); therefore, the precise location of the type locality of the Nashua Formation is not clear. According to the information supplied by the above authors, however, the type locality must be on the east bank of the St. Johns River, in Sec. 28 (possibly Sec. 41), T11S, R26E, approximately 3 miles (4.8 km) southwest of the community of Satsuma, and approximately 10 miles (16 km) south of the town of Palatka, Florida (Fig. 52).

The type section (unit-stratotype) of the Nashua Formation is that section of Nashua exposed at the type locality. The exposures of the Nashua Formation in the bluffs at the type locality are all low. No more than about 3 feet (1 m) of section is currently exposed, and neither lower nor upper contacts can be seen.

Lithology

The Nashua Formation is a variably calcareous, shelly sand to finely sandy coquina. Limited information indicates that all other lithic components are minor. Known subordinate lithic components include calcite, aragonitic and calcitic shells, clay, mica, heavy minerals, and minor phosphate.

Quartz sand is the dominant lithic component of the formation and ranges in grain-size from medium to fine. In its area of facies change with the Cypresshead Formation, quartz sand constitutes the bulk of the formation with only minor occurrences of shells and shell debris. In the type area, the lithology alternates between relatively unfossiliferous sand and sandy coquina (shell marl). The alternation of sand and "shell marl" reported by Matson and Clapp (1909) suggests indistinct organization of the deposit into thick beds. The sediments within the beds are massive and devoid of primary sedimentary or biogenic structures.

Stratigraphic Relationships

The Nashua Formation underlies the St. Johns River area at least as far south as the vicinity of Deland in Volusia County, Florida, and its northern limit is the vicinity of the St. Marys River between Florida and Georgia (Fig. 53). The western limit of the Nashua in northeastern Florida appears to be the vicinity of Trail Ridge. Its eastern limit is unknown at this time. From its stratigraphic position and elevations, and from additional paleontological support, the Nashua Formation apparently grades westward into the Cypresshead Formation in the vicinity of Trail Ridge, and northward into the Cypresshead Formation in the vicinity of the St. Marys River (Fig. 47; Pl. 1).

The Nashua Formation disconformably overlies the Coosawhatchie Formation in northeasternmost Florida. In its area of occurrence, it is the uppermost formation in the geologic section, being overlain only by undifferentiated surficial sand deposits. To the east, in the coastal area, it may be locally overlain by the Satilla Formation.

The Nashua Formation is distinguished from the underlying Coosawhatchie Formation in consisting of buff to cream colored, massive, thick-bedded, variably shelly and calcareous sand whereas the Coosawhatchie Formation is phosphatic, nonfossiliferous and, in northeastern Florida, is locally dolomitic but generally lacks carbonate. Where the Nashua Formation overlies the Charlton Member of the Coosawhatchie Formation, the Charlton Member consists of variably fossiliferous (moldic) dolostone or limestone and clay. Quartz sand in typical Charlton Member occurs in minor amounts but is the principal lithic component in the Nashua. The aragonite and calcite of the fossil shells in the Nashua are generally in a good state of preservation (locally or at some stratigraphic intervals the shells are chalky and poorly preserved) whereas only the calcitic shells in the Charlton are locally well-preserved. The Nashua Formation is not known to overlie the unnamed Raysor-equivalent shelly sand. Because both units are shelly calcareous sand deposits, the Nashua Formation could be mistaken lithologically for the unnamed Raysor-equivalent sand. The un-

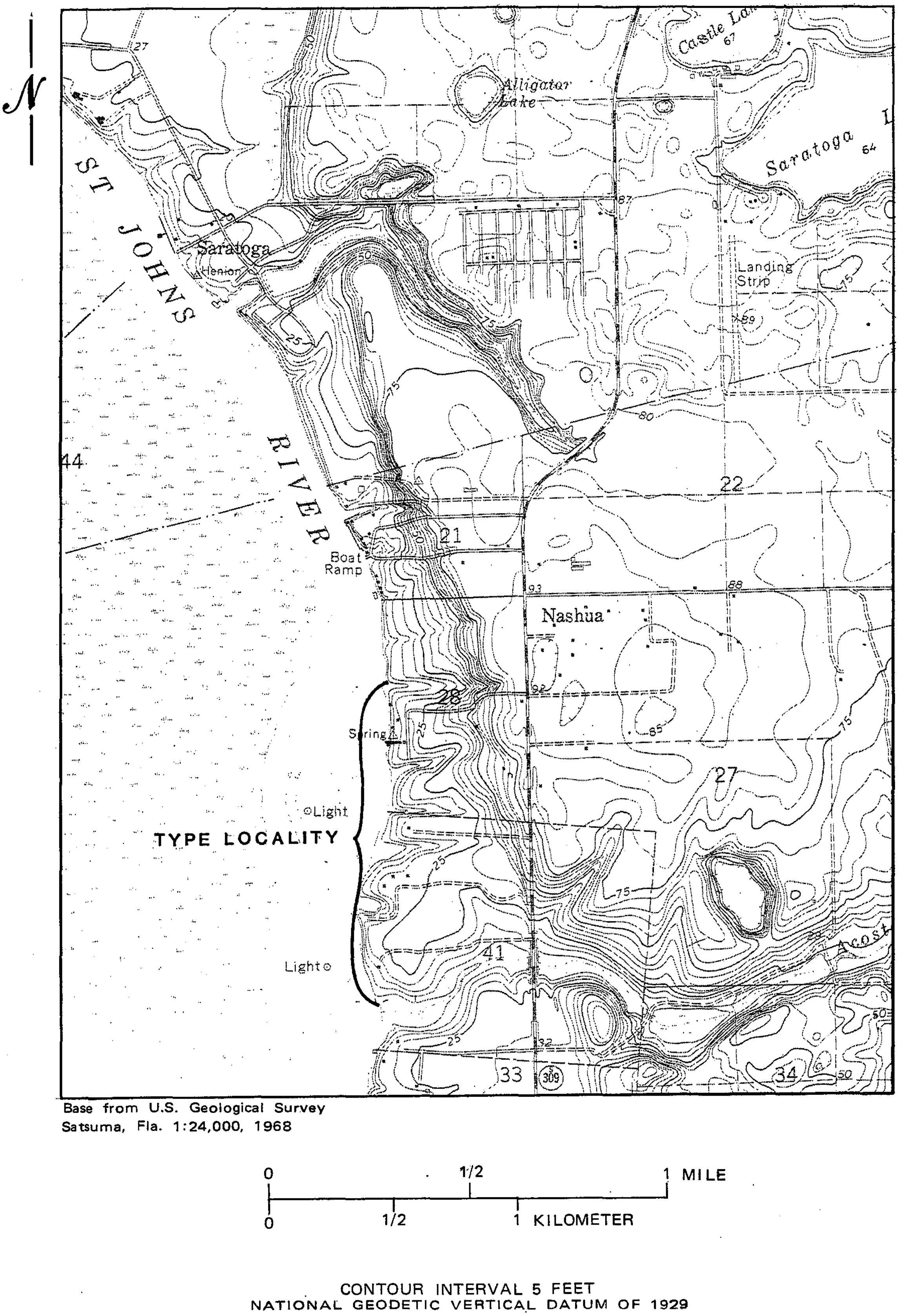


Figure 52. The type locality of the Nashua Formation.

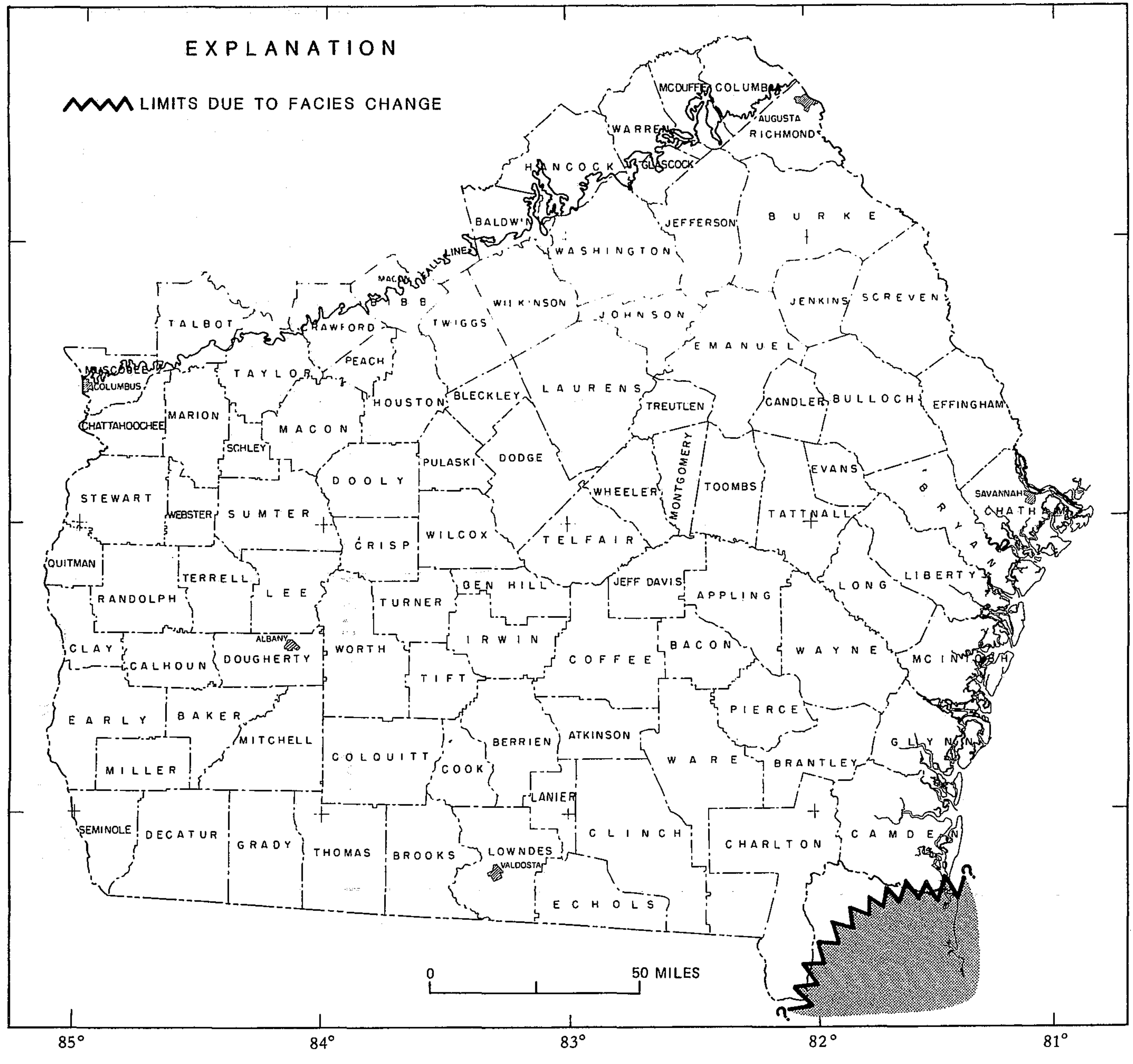


Figure 53. The areal distribution (subcrop) of the Nashua Formation in Georgia.

named Raysor-equivalent sand, however, typically is olive-gray in color, the sand generally more poorly sorted, and it contains a minor amount of phosphate.

The Nashua Formation is distinguished from the stratigraphically equivalent Cypresshead Formation in that the Cypresshead typically is prominently horizontal- and cross-bedded and, in Florida, is not known to be calcareous and fossiliferous.

The Nashua Formation is distinguished from the calcareous, fossiliferous phases of the Satilla Formation in that the Satilla generally is less calcareous and more argillaceous.

There is virtually no information on the thickness distribution of the Nashua Formation. Matson and Clapp (1909) reported 15 feet (4.5 m) of the formation at the type locality, but observed that the formation was seldom more than 6 to 8 feet (1.8 to 2.4 m) thick (presumably in outcrop). The Nashua in a well at Deland was reported to have a thickness of 32 feet (10 m).

Based on similarity in stratigraphic position and elevation to the Cypresshead Formation, total thicknesses ranging from 40 to 60 feet (12 and 18 m) would be expected for the Nashua Formation.

The environment of deposition of the Nashua Formation was open-marine, shallow-water, inner neritic continental shelf. The Nashua Formation is an offshore facies of the coastal marine Cypresshead Formation.

Age

The molluscan fauna of the Nashua Formation and its age implications have been discussed at some length in the literature (Matson and Clapp, 1909, p. 128-133; Mansfield, 1918, p. 111-123; 1924, p. 29-35; Cooke and Mossom, 1929, p. 156-160; Cooke, 1945, p. 225-226). The above authors consistently correlated the Nashua Formation with the Waccamaw Formation of the Carolinas and with the Caloosahatchee marl of southern Florida. Both the Waccamaw Formation and Caloosahatchee marl had been thought to be of Pliocene age. However, Dubar (1958) first assigned a Pleistocene age to the Caloosahatchee, and this age assessment was supported independently by Bender (1973) on helium-uranium dating of corals. Similarly, Akers (1972) assigned a Pleistocene age to the Waccamaw Formation on the evidence of planktonic foraminifera. My identification of both *Globorotalia truncatulinoides* and *G. tosaensis* in samples from the Waccamaw Formation in the vicinity of Myrtle Beach, South Carolina, and Calabash, North Carolina, substantiates the early Pleistocene (Calabrian) age for the Waccamaw Formation.

A sparse suite of planktonic foraminifera has been identified from the Nashua Formation near the type locality at a marina at Nashua in Sec. 21, T11S, R26E. The planktonic foraminifera include the following species:

Globigerina falconensis
G. rubescens
Globigerinoides ruber
G. quadrilobatus
Neogloboquadrina cf. *dutretrei* (juveniles)
Pulleniatina obliquiloculata (juveniles)
Orbulina universa

Pulleniatina obliquiloculata is very rare to absent even in richly microfossiliferous sediments from Coastal Plain deposits of late Pliocene age, but is commonly present even in poorly microfossiliferous sediments of the Waccamaw Formation. The presence of *Globigerina rubescens*, however, is not conspicuous in Coastal Plain deposits of late Pleistocene age. The planktonic foraminiferal suite from the Nashua Formation at Nashua, Florida, is, therefore, consistent with that of the early Pleistocene Waccamaw Formation and is probably early Pleistocene (Calabrian) in age (see Pl. 1).

The following planktonic foraminifera were identified from a sample at 65 feet in the Florida Geological Survey core Cassidy 1 (W-13815) in Nassau County, Florida:

Globorotalia menardii miocenica s.s.
G. puncticulata
Globigerina apertura
G. decoraperta
G. bulloides
G. cf. *falconensis*
Globigerinoides obliquus
G. ruber
G. quadrilobatus
Neogloboquadrina dutertrei
Globigerinella aequilateralis
Sphaeroidinella? (juveniles)

Based on the presence of *G. menardii miocenica, G. apertura*, and *G. obliquus*, none of which occur in the Pleistocene, this assemblage is late Pliocene in age. It is characteristic of Zones PL5 of Berggren (1973) or N21 of Blow (1969) (Pl. 1). The Nashua Formation in this core, which is a shelly, calcareous sand consistent with Nashua lithology, is older than the type Nashua Formation and the Waccamaw Formation of the Carolinas, and is correlative with the Bear Bluff Formation of the Carolinas.

A similar suite was identified from the Nashua Formation in the interval 169 to 171.5 feet in the Florida Geological Survey core Baywood 1 (W-8400) in Putnam County, Florida. These species include the following:

Globigerina decoraperta
G. rubescens
G. falconensis
Globigerinoides obliquus
G. ruber
G. quadrilobatus
Neogloboquadrina dutertrei (juveniles)
Sphaeroidinella? (juveniles)

On the basis of the evidence presented here, the Nashua Formation is probably a multideposit formation (i.e., it was deposited during more than one episode of sedimentation). The evidence in northeastern Florida supports an age range for the Nashua from late Pliocene (Piacenzian; Zone PL5 of Berggren, [1973], or N21 of Blow [1969], to early Pleistocene (Calabrian; Zone N22 of Blow [1969]).

SATILLA FORMATION (reintroduced, redefined, and revised)

Definition

The Satilla Formation of Veatch and Stephenson (1911, p. 434-440) is heren reintroduced as a lithostratigraphic unit of formation rank. The concept of the Satilla Formation of Veatch and Stephenson (1911) consisted of two types of deposits: coastal marine ("coastal terrace") deposits and the presumed equivalent river terrace deposits of Pleistocene age. The reintroduced Satilla Formation is restricted here to include only coastal marine deposits, and it is expanded also to include Holocene coastal marine deposits. The river terrace deposits of the Satilla Formation of Veatch and Stephenson (1911) are excluded from the Satilla Formation of this report because they are lithologically different and distinct from the coastal marine deposits and are not mappable between river valleys. Similarly, the Holocene coastal marine deposits are included in the Satilla Formation of this report because they are lithologically indistinguishable from the late Pleistocene deposits, and the entire suite of deposits constitute a mappable lithostratigraphic unit.

Cooke (1943, p. 111) suppressed the name Satilla Formation in favor of the Pamlico Formation of North Carolina. The present author proposes abandonment of the name Pamlico Formation in Georgia because the name Pamlico is associated with the specific marine terrace as well as with certain Pleistocene deposits in North Carolina (Stephenson, 1912). The use of the name for two widely occurring but different geological phenomena is confusing and is undesirable. Because the formation in question (Satilla) also includes deposits which underlie younger terraces, including the Holocene, the use of the same name for both a formation and a specific terrace is all the more confusing. Because (1) the name Pamlico terrace is deeply entrenched in the literature, (2) the Pamlico Formation has not been in general use in Georgia or in South Carolina in recent years (Georgia Geological Survey, 1976; Dubar, 1971; Dubar and others, 1974), and (3) the lithostratigraphic name Satilla (Veatch and Stephenson, 1911) has priority over the name Pamlico (Stephenson, 1912), I consider it preferable to retain the name Pamlico for the marine terrace and to propose abandonment of that name for the lithostratigraphic unit.

The Satilla Formation is a heterogenous unit that consists of variably fossiliferous, shelly sands and clays of offshore, inner continental shelf origin; prominently bedded to nonbedded barrier island deposits (excluding the undifferentiated soft, incoherent, massive, structureless sands of probably aeolian origin that cap the barrier islands and emergent barrier islands)[1]; and marsh deposits.

The Satilla Formation of this report includes the Pamlico Formation of Cooke (1943); the Pamlico, Princess Anne, and Silver Bluff formations of Hails and Hoyt (1969); and the Pamlico, Princess Anne, Silver Bluff, and Holocene shoreline complexes of Mann (Georgia Geological Survey, 1976).

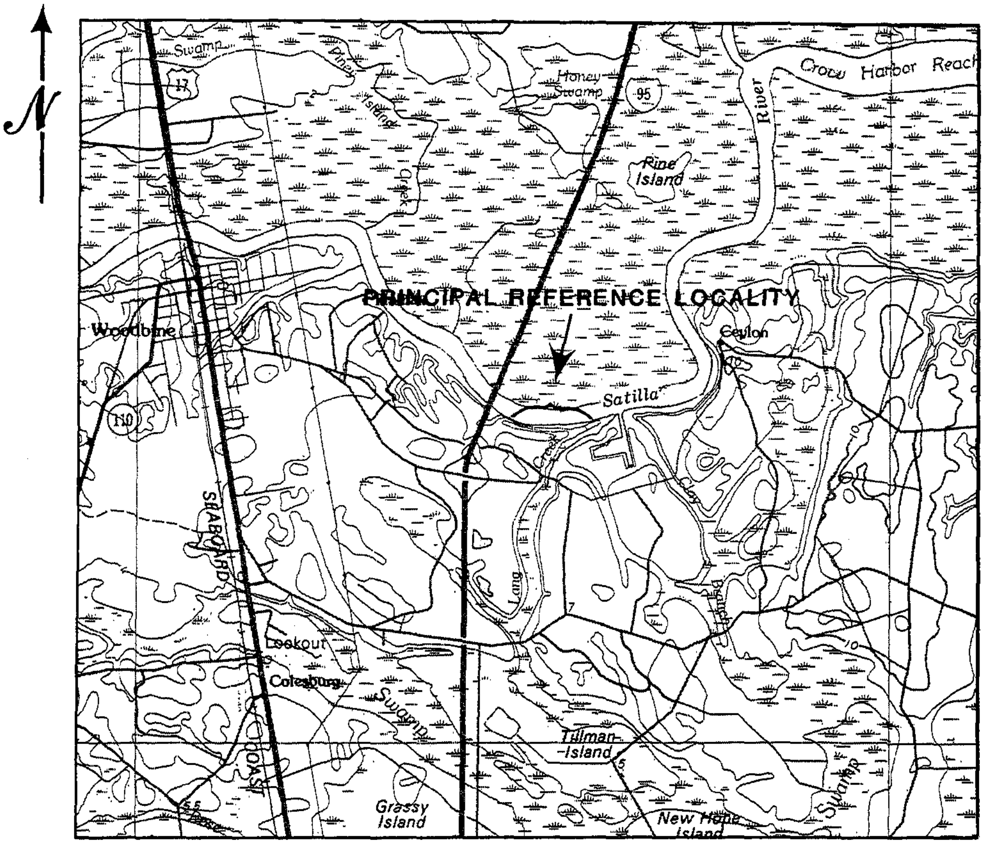
Type Section

Veatch and Stephenson (1911, p. 434) did not specifically designate a type locality for the Satilla Formation. The type locality is inferred from their comment, "These deposits are typically developed along either side of the Satilla River in Camden and Charlton Counties." Most of the exposed deposits along the stretch of the Satilla River in Camden and Charlton Counties consist of undifferentiated Quaternary alluvial deposits that are a part of the original concept of the Satilla Formation of Veatch and Stephenson (1911). The only exposed section of Satilla Formation of this report (coastal marine deposits of Veatch and Stephenson [1911]) on the Satilla River is at Satilla Bluff. Satilla Bluff, therefore, is designated herein the principal reference locality of the Satilla Formation, and the section at Satilla Bluff is the principal reference section (lectostratotype) of the formation. At Satilla Bluff, the Satilla Formation consists of orange to yellow, massive-bedded, structureless, argillaceous, well-sorted, fine- to medium-grained sand. Neither the upper nor lower boundaries of the formation are exposed at Satilla Bluff.

Satilla Bluff is in Camden County, Georgia, approximately 3 miles (5 km) east-southeast (downriver) of the village of Woodbine (Fig. 54). The Interstate-95 bridge over the Satilla River is at the western end of Satilla Bluff.

The best and most instructive exposures of the Satilla Formation in the type area are at Roses and Bells Bluffs along Bells River, a tidal distributary of the St. Marys River, and at Reids Bluff on the lower St. Marys River (Fig. 2). These bluffs are all in Nassau County, Florida, across the St. Marys River from St. Marys, Georgia. Roses and Bells Bluffs, which form one continuous bluff, and Reids Bluff are here designated reference localities of the Satilla Formaation. Roses Bluff and Reids Bluff are parastratotypes of the formation (see Veatch and Stephenson, 1911, p. 436, 440; also see Sellards, 1910; Scott, 1976), and Bells Bluff is designated herein a hypostratotype. Another useful reference locality and hypostratotype in the type area of the formation is Elliots Bluff at Crooked River State Park on

[1]In this report, emergent barrier islands are ancient barrier islands that stand out topographically as ridges due to relative lowering of sea level and withdrawal of the sea.



Base from U.S. Geological Survey
Fernandina Beach, Fla.-Ga. 1:100,000, 1981

0 1 2 3 MILES

0 1 2 3 KILOMETERS

CONTOUR INTERVAL 2 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 54. The principal reference locality of the Satilla Formation.

Crooked River in Camden County, Georgia, 8 miles (13 km) north of St. Marys.

Roses, Bells, and Elliotts Bluffs occur in the cores or centers of Pamlico barrier islands. Reids Bluff occurs near the landward margin of the Pleistocene barrier island whose core is exposed at Roses and Bells Bluffs. Satilla Bluff occurs in the back-barrier tract, immediately behind a Pamlico barrier island. It is expected, therefore, that each of the reference localities would expose sediments of differing character and lithology.

Lithology

The Satilla Formation is a lithologically heterogeneous unit and consists variably of sand and clay. Sand appears to be the dominant lithic component, at least in the barrier island lithofacies, and is most conspicuous at the type locality and reference localities. Other subordinate lithic components include calcite, shells and other fossils, heavy minerals, mica, humate, scattered carbonaceous material, and, locally, fossil vertebrate remains.

The sand generally is fine- to medium-grained and well-sorted. Coarser grained sand, where present, generally is more poorly sorted. Bedding in the dominantly sand lithofacies includes well-stratified sands with well-defined horizontal-bedding and various kinds of cross-bedding; vaguely bedded sands; and massive-bedded sand devoid of primary sedimentary structures. Bioturbated argillaceous sand is present in the more marine, inner shelf phases of the formation. Locally, as at Reids Bluff, channel cut-and-fill structures are conspicuous. Humate-cemented sandstone is also locally prominent, with large boulders of humate sandstone littering the bases of bluffs.

The Satilla Formation exhibits two types of clay deposits: variably bedded, variably calcareous and fossiliferous, silty to sandy clay of inner continental shelf origin; and massive-bedded, blocky to hackly clay of marsh origin with local concentrations of the oyster *Crassostrea virginica*. Based on limited core and outcrop control, it would appear that much of the Pamlico terrace complex is underlain by marsh-type clay in the area south of the Altamaha River (Logan, 1968). Clay containing *Crassostrea virginica* is exposed at Reids Bluff and at Orange Bluff on the St. Marys River in Nassau County, Florida. No stratigraphic information is available for the area north of the Altamaha River.

The Satilla Formation is variably calcareous and fossiliferous. It is least calcareous and fossiliferous in the western or landward part of its belt of occurrence, and in the upper part of the barrier island sequences. It is most commonly calcareous and fossiliferous at low elevations and in the subsurface in the coastal area. Fossiliferous, calcareous, shelly, argillaceous sand and bioturbated, argillaceous sand occur typically at the base of and seaward of the barrier island sequences. As at Roses and Bells Bluffs, sands overlying the bioturbated and shelly sands may be replete with *Ophiomorpha nodosa* (see Scott, 1976).

The Satilla Formation is distinguished from the Cypresshead Formation in the following ways: (1) The sands of the Satilla Formation are finer-grained with little coarse-grained sand and gravel (except in the vicinity of the Altamaha River). The sands of the Cypresshead Formation, on the other hand, are typically coarser, ranging from fine- to coarse-grained and pebbly. (2) Satilla Formation sands are typically well-sorted; poorly sorted sands are more characteristic of the coarser phases of the Cypresshead. (3) The Satilla Formation is consistently calcareous and fossiliferous in the coastal area and more variably calcareous and fossiliferous inland. The Cypresshead Formation is rarely calcareous and fossiliferous. (4) The Satilla Formation contains blocky, massive, locally fossiliferous clays of marsh origin. There are no known massive, blocky clays of marsh origin in the Cypresshead Formation, but there are thick beds of thinly bedded to laminated, conspicuously diatomaceous clay in the Cypresshead. In addition, (5) the thinly bedded, fine-grained sand lithofacies with thin clay partings is characteristic of the Cypresshead Formation and is not known to occur in the Satilla Formation.

Stratigraphic Relationships

The Satilla Formation is restricted to the lower marine terrace region in eastern Georgia and extends northward into South Carolina, and southward into Florida (Fig. 55). The western limit of the formation approximates the landward margin of the Pamlico terrace, and its eastern limit is in the offshore area. Woolsey and Henry (1974), Woolsey (1976), and Foley (1981) indicate that the "Holocene/Pleistocene" deposits of the coastal area of Georgia (Satilla Formation), characterized by prominent cut-and-fill structures and discordant reflectors on seismic cross-sections, are continuous on the inner continental shelf and extend many miles offshore. Similarly, the lithology of sediments on the continental shelf described by Pilkey and others (1981) is consistent with Satilla Formation.

The lower boundary of the Satilla Formation is not known to be exposed in outcrop. In Chatham County, Georgia, the Satilla Formation is known to disconformably overlie the Raysor Formation, and more generally, the Coosawhatchie Formation. In northern Chatham County, the Satilla Formation presumably overlies the Cypresshead Formation locally, but this relationship has not yet been observed in cores. The Satilla Formation disconformably overlies the Charlton Member of the Coosawhatchie Formation at Orange Bluff on the St. Marys River in Nassau County, Florida. In the Altamaha River area, Scott (1976) reported various kinds of deposits to underlie the Satilla Formation of this report: "granular silt and clay" (probably Ebenezer Member of the Coosawhatchie Formation), "arkosic sands" (Cypresshead Formation?), and "limestone and marl" (Charlton Member, Raysor Formation, or Cypresshead Formation?).

The Satilla Formation occurs at the top of the geologic

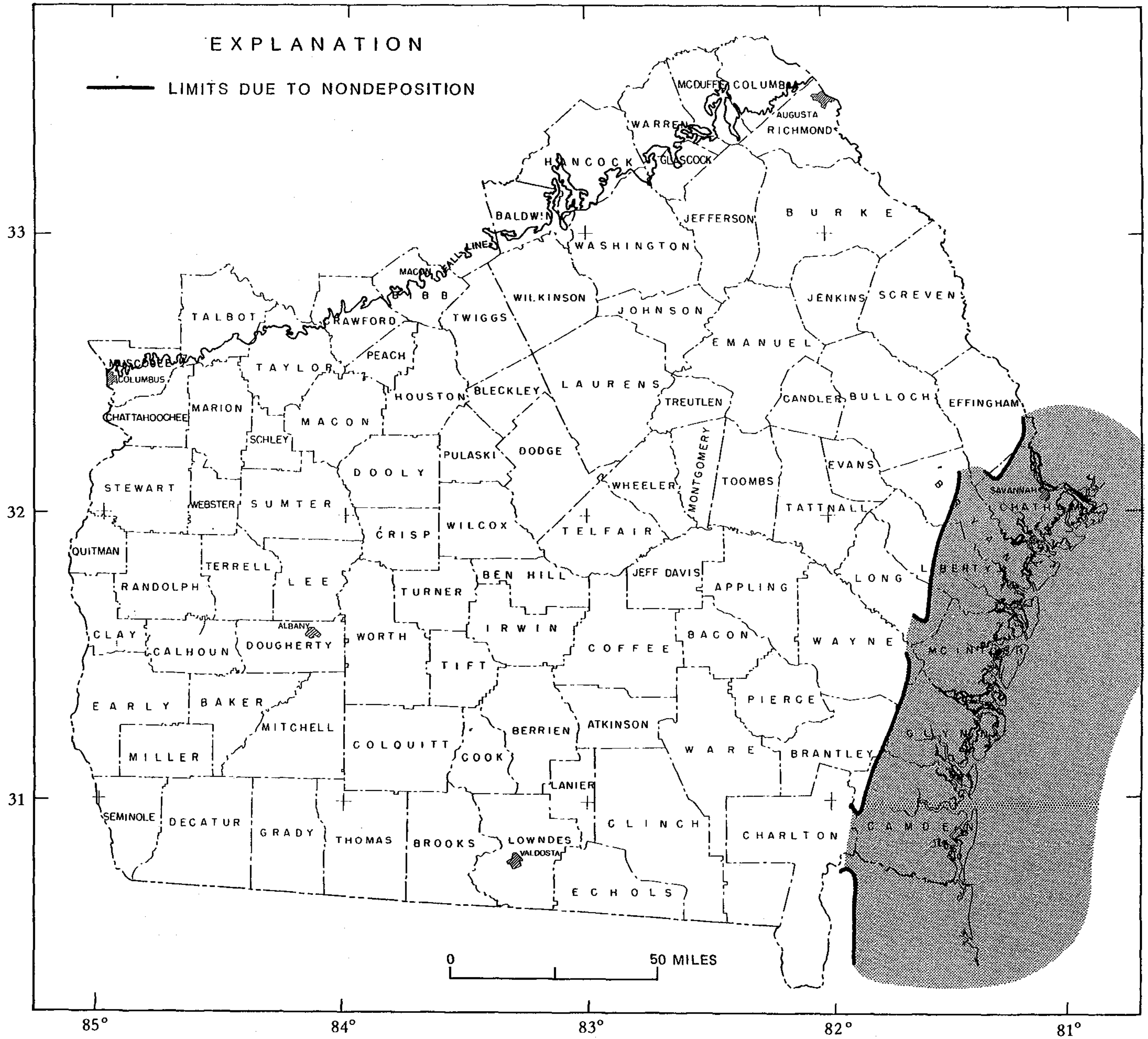


Figure 55. The areal distribution (outcrop and subcrop) of the Satilla Formation in Georgia.

section in the coastal area (Fig. 47) and is overlain only by undifferentiated surficial sand and undifferentiated alluvial deposits.

The Satilla Formation directly underlies the Pamlico and lower (or younger) marine terraces. Because the lithofacies distribution of the Satilla Formation appears to be related to the terrace landforms (i.e., barrier island and back-barrier features), the deposition of the Satilla appears to be related to the construction of the terraces (see Scott, 1976; Hails and Hoyt, 1969). However, based on examination of numerous cores, it appears to me that the lithofacies patterns described by Scott (1976) and Hails and Hoyt (1969) for the successive construction of the terraces is an oversimplification. They do not hold for the "Talbot" and higher terraces where the lithofacies patterns of the Cypresshead Formation show no relationship to the overlying terrace morphology.

The thickness distribution of the Satilla Formation in Georgia can not be established at this time because of inadequate core control. Approximately 10 feet (3 m) of Satilla Formation is exposed at the type locality, and approximately 40 feet (12 m) is exposed at Roses Bluff (also see Veatch and Stephenson, 1911, p. 435). Based on 16 cores taken in Chatham County, the Satilla Formation there ranges in thickness from 0 to 88 feet (0-27 m). The occurrence of the Satilla Formation west of Savannah (i.e., in the Pamlico back-barrier tract) appears to be discontinuous. Veatch and Stephenson (1911, p. 437-438) reported numerous occurrences of Satilla Formation in outcrop and auger holes. However, only Cypresshead Formation is present in the cores Chatham 14 (GGS-3139) and Chatham 15 (GGS-3138) (Fig. 5), indicating that the Satilla Formation in the Pamlico back-barrier tract is thin and discontinuous and that the upper surface of the Cypresshead Formation has considerable topographic relief. The Satilla Formation abruptly thickens eastward east of the Pamlico barrier island at Savannah (Pl. 2). In eastern Chatham County, on the Holocene, Silver Bluff, and Princess Anne terraces, the thickness of the Satilla Formation ranges from 49 feet (15 m) to 88 feet (27 m), and the Cypresshead Formation is absent. The large range in observed thickness (39 feet [12 m]) indicates considerable topographic relief on the pre-Satilla erosion surface.

In Glynn and McIntosh Counties, Georgia, Logan (1968) referred to the Satilla Formation of this report variously as Pamlico, Princess Anne, Silver Bluff, Holocene, and Talbot. As I interpreted the Satilla Formation in that area, it ranges from 17.5 feet (5 m) to 75 feet (23 m), and averages approximately 36 feet (11 m).

The Satilla Formation is a coastal marine unit that consists of marsh and sound deposits, barrier island deposits, and nearshore, continental shelf deposits.

Age

The Satilla Formation is of late Pleistocene and Holocene age. The molluscan faunas that have been reported from the formation (Veatch and Stephenson, 1911, p. 436; Richards, 1936, 1954; Logan, 1968) are not currently differentiabl from the modern living fauna. Therefore, there is no indica tion that any part of the Satilla Formation may be as old a middle or early Pleistocene.

The basal beds of the Satilla Formation in Chathar County contain a small suite of planktonic foraminifera However, there is considerable reworking of older Pliocen foraminifera from the Wabasso beds or Raysor Formatio into the basal Satilla. The clearly reworked older foramini fera include *Globigerina nepenthes* and *Globigerinoide obliquus*. Commonly, but not invariably, there are preserva tion differences that allow discrimination between *in sit* populations and reworked populations. The Pleistocen planktonic foraminifera from the Satilla Formation in Chat ham County include the following species:

Globorotalia menardii (sinistral)
G. inflata
Neogloboquadrina dutertrei
Globigerina falconensis
G. cf. *bulloides*
Globigerinoides ruber
G. quarilobatus
Globigerinella aequilateralis praesiphonifera
Globigerinita glutinata

The planktonic foraminifera are compatible with a Pleisto cene age for the Satilla Formation.

UNDIFFERENTIATED ALLUVIAL DEPOSITS

Definition

The undifferentiated alluvial deposits consist of bot modern flood plain deposits and river terrace deposits These deposits occur throughout the drainage systems of th Coastal Plain, from the largest rivers to small creeks. How ever, the general lithologic composition of the alluvial de posits does not vary significantly between streams of differ ent sizes, from stream valley to stream valley, or betwee river systems. Consequently the lithologies of the alluvia deposits cannot be differentiated from each other. They are however, lithologically distinct from the underlying deposit and locally are mappable.

These deposits have generally been recognized an mapped in the past as undifferentiated river alluvium an terrace deposits (Cooke, 1943; Georgia Geological Survey 1976). Veatch and Stephenson (1911), on the other hand referred these deposits to the Satilla Formation and Okefe nokee formation, distinguishing between coastal marin and alluvial phases of the formations.

Roberts (1958) presented the most modern treatment o the alluvial deposits and river terraces of Georgia. He recog nized four river terraces above the modern flood plain of th Chattahoochee River and found no evidence of warping o tilting of the river terraces in the Coastal Plain.

Lithology

The undifferentiated alluvial deposits of Georgia consist predominantly of sand with minor clay. Other subordinate lithic components include gravel, mica, heavy minerals, and scattered carbonaceous or woody material. My observations on the lithologic distributions of the Quaternary alluvial deposits in the Coastal Plain, and those of Roberts (1958) for the Chattahoochee River in particular, indicate that the modern flood plain deposits are generally fine-grained, and the higher, older terrace deposits are coarser and more gravelly. The modern flood plain deposits typically consist of variably argillaceous fine-grained sand with scattered beds of finely sandy clay. Locally, as in point bars, the sand is clean, loose, and well-sorted, and ranges in size from fine to coarse (also see Teas, 1921). Bedding is seldom apparent in outcrop, and stratification is generally vague. In the smaller streams, lithology is more directly related to the valley configuration and to the immediately surrounding source area. The lithology of these deposits is, therefore, somewhat more variable in sand-size, clay content, and organic content. The basal beds of the modern flood plain deposits are more commonly coarser grained, and locally are gravelly and crossbedded.

According to Roberts (1958, p. 29-30), alluvial deposits of the Chattahoochee River flood plain and the 10- to 20-foot terrace range from clay to sandy clay, to fine-, medium- and coarse-grained sand with pea gravel and coarse gravel. Generally the sorting is poor. He observed (p. 30), that "The sands and clays are poorly cemented, friable masses with various sizes of pebbles disseminated throughout. Layers of quartz gravel are common but are not a dominant constituent."

The lithology of the alluvium of the 30- to 50-foot terrace is similar to that of the lower terraces (Roberts, 1958, p. 30). However, in the higher terraces along the Chattahoochee River, the lithology is coarser and gravel is more prevalent (Roberts, 1958, p. 30, 32). Cross-bedding is more conspicuous in the higher river deposits and the sediments are more poorly sorted.

In the central Georgia Coastal Plain, the high river terrace deposits that are present in the vicinity of the larger streams (i.e., the Ocmulgee, Oconee, and Altamaha Rivers) are lithologically reminiscent of the adjacent Screven lithofacies of the Altamaha Formation, a Miocene unit of similar fluvial origin. The Screven Member and other coarser phases of the Altamaha Formation can be distinguished from the high river terrace deposits of more recent origin in being consistently more argillaceous than the latter. Generally the clay component of the high river terrace deposits occurs in discrete clay lenses or beds, whereas the clay component of the Altamaha Formation is more commonly contained in both discrete lenses or beds, and interstitially between the sand and gravel particles.

Where high river terrace sands and gravels overlie lithologically similar pebbly to gravelly, cross-bedded sands of the lower Claibornian (Tallahatta Formation of some authors), the high terrace deposits can be distinguished in containing much coarser gravel and cobbles. I know of no occurrences in the Georgia Coastal Plain of gravel coarser than approximately 2 inches (5 cm) in diameter from deposits older than the Miocene. Quartz gravel of cobble-size is found only in Miocene or younger deposits in the Georgia Coastal Plain.

Thickness

The thickness distribution of alluvial deposits in Georgia is variable, and, there have been no data published on the thickness of these deposits in most of Georgia. In the Chattahoochee River area, however, Roberts (1958, p. 29) reported thicknesses ranging from 20 to 50 feet (6 to 14 m).

Age

With one exception (Voorhies, 1974a), no fossils have been reported from alluvial and river terrace deposits in the Coastal Plain of Georgia. Therefore the age of the alluvial terrace deposits must be extrapolated mainly from physical relationships (i.e., vertical stacking of the river terraces and relationship of this stacking to that of the marine terraces; direct association of river and marine terraces in the coastal area; and observations on lack of warping or tilting of the river terraces in the Coastal Plain). Veatch and Stephenson (1911) and Roberts (1958) identified a series of river terraces and related them to marine terraces. Veatch and Stephenson (1911) recognized only two terraces, the Okefenokee and Satilla; Roberts (1958) recognized four. Although Roberts (1958) correlated the river terraces with named marine terraces, the correlation of specific river terraces to specific marine terraces is speculative and doubtful at this time.

A significant clue to the age of the river terraces is the observation of Roberts (1958) that none of the river terraces is warped. The gradient on their surfaces appears to be no more than the original constructional gradient of the flood plain at the time of terrace construction. This observation is also compatible with my observations that none of the marine terraces or scarps are warped, a fact which argues for crustal stability in the region since the construction of the river and marine terraces. Because the youngest formations underlying the highest marine terraces (i.e., the Raysor, Jackson Bluff, Miccosukee, and Cypresshead Formations) are warped and tilted, and because these formations are late Pliocene to possibly earliest Pleistocene in age, it would seem that all of the fluvial terraces, up to elevations of 170 to 190 feet (52 to 58 m) above the present flood plain, are Pleistocene in age.

This correlation is inconsistent with the dating of the high terrace of the Flint River at Reynolds in Taylor County, Georgia, by Voorhies (1974a, p. 109-114). Voorhies (1974a) identified worn teeth of the small horse *Nannippus minor* from poorly sorted sand and gravel of the 100- to 130-foot terrace of Carver and Waters (1984). Voorhies (1974, p. 112) suggested an Hemphillian age for this deposit, based on the small size and relatively complex enamel patterns of the teeth. The Hemphillian mammal age extends from 9.0 million years to approximately 4.8 million years before the present (Tedford and Hunter, 1984) and is, therefore, late Miocene to early Pliocene in age. This age is older than any of the marine Plio-Pleistocene formations that underlie the marine terraces, and it is incompatible with warping of these formations and with lack of warping on the marine and fluvial terraces (Roberts, 1958; Carver and Waters, 1984). The question of the ages of the river terraces, and their correlation with marine terraces, is unresolved at this time.

UNDIFFERENTIATED LACUSTRINE AND PALUDAL DEPOSITS

Definition

Undifferentiated lacustrine and paludal deposits consist of lake, sink hole, Carolina bay, and swamp deposits. By nature, these types of deposits are restricted to small and isolated basins of deposition. The lacustrine and paludal deposits are lithologically distinctive and can be distinguished from both the undifferentiated alluvial deposits and the undifferentiated surficial sands. As with these other types of deposits, however, the lithologies of the lacustrine and paludal deposits in any one isolated basin are not systematically distinguishable from those of other basins in the region. Lithologies may vary, however, between specific deposits, depending on the local or regional topography and the nature of the nearby sediment source.

Lithology

In general,the lacustrine and paludal deposits have a significantly higher organic content, a higher clay and silt content, and a lower sand content than the alluvial and surficial sand deposits. In some deposits, the organic content is so high that the deposit is mined as peat (Fortson, 1961).

Thickness

Lacustrine and paludal deposits are typically thin, except possibly for sinkhole-fill. Reported thicknesses of these deposits from various lake and Carolina bay basins (Fortson, 1961) and from the Okefenokee Swamp (Cohen, 1973) indicate that the lacustrine and paludal deposits in Georgia range up to 30 feet (9 m) in lake basins with average thicknesses ranging from 10 to 15 feet (3 to 4.5 m). The greatest thickness of these deposits reported in the Okefenokee Swamp is approximately 12.5 feet (3.8 m) (Cohen, 1973).

Age

Because most of the lakes, swamps, and Carolina bays in Georgia are located on marine or fluvial terraces, all of which are believed to be Pleistocene in age, the age of th overlying lacustrine and paludal deposits must also be Plei tocene or Holocene in age. Similarly, because most of th topographic relief in the Coastal Plain of Georgia is believe to result from incision of the streams during Pleistocer time, most sinkholes must have formed only since the deve opment of the present topography (i.e., during the Plei tocene).

UNDIFFERENTIATED SURFICIAL SAND

Definition

The undifferentiated surficial sand of this report includ loose, generally structureless and massive, pale gray to bu to white sands that mantle the Georgia Coastal Plain i many areas. Sands of this type appear to be dominantly windblown origin and include aeolian drift sand, shee washed sand (also see Newell and others, 1980), barri island and river dune sand, sands that mantle emerge barrier islands and other linear sand ridges in the coast area (including Trail Ridge), and sands of probable ped genic origin in the region of low to nonexistent topograph relief in the lower Coastal Plain. The undifferentiated surf cial sands occur at the top of the local geologic sections, ar underlie, or are a part of, the local soil profiles. The surficial sands do not occur in a consistent stratigraph context due to their heterogeneous origins, and they al occur at various elevations where there is considerab topographic relief. The undifferentiated surficial sands a all lithologically similar and cannot be easily differentiat on casual inspection. However, the fact that they do n occur in a consistent stratigraphic context precludes treati these sands in a formal lithostratigraphic sense. If mappe the undifferentiated surficial sands would more close resemble a soil unit than a lithostratigraphic unit. The surficial sands occur in Georgia from the Chattahooch River to the Savannah River, and from the Fall Line to tl Florida state line.

Lithology

The undifferentiated surficial sand characteristically co sists of massive-bedded and structureless, well- to mode ately well-sorted, soft and incoherent, fine- to mediu grained, and rarely coarse-grained sand. The color of tl sand is typically pale: white, light gray, buff, and less co monly yellow and orange. Humate is a common compone of the undifferentiated surficial sand in the coastal are Where humate is present, the sand may be tan to brown color and partially consolidated. Other known subordina components of the lithology include heavy minerals an rarely, clay.

Stratification can be observed at some sites, althou characteristically it is absent. Where present, stratificati consists of vague, thin to thick bedding, more commor distinguished on the basis of differences in sand-size of the adjacent layers. Within the beds that can be discerned, the sand is massive and structureless.

Thickness

The undifferentiated surficial sand is variable in thickness, ranging from absence, to as much as 50 feet (15 m) on Trail Ridge in Georgia. According to Newell and others (1980), the sand is at least 30 feet (9 m) thick in the Augusta area and mostly consists of colluvium. Sand dunes on the present barrier islands attain an average elevation of between 20 and 30 feet, suggesting a thickness of dune sand of at least 20 to 30 feet (6 and 9 m). Sand dunes on the north end of Cumberland Island reach elevations, and presumably thicknesses of greater than 40 feet (12 m). Elsewhere on the present barrier islands, the undifferentiated surficial sand (mainly aeolian drift sand) ranges from 0 feet to more than 6 feet (2 m) thick.

Because of insufficient exposures, thickness of the surficial sand on the emergent barrier islands is interpreted from topographic relief. Based on measured thicknesses seen in road cuts and small and pits, at least 5 feet (1.5 m) of this undifferentiated surficial sand is present on emergent barrier islands of the Princess Anne, Pamlico, Talbot, and Penholoway terraces. More than 10 feet (3 m) of surifical sand is exposed in a partially excavated Okefenokee Swamp drainage cut on Trail Ridge in Charlton County. Based on topographic relief of the emergent barrier islands and sand ridges (difference between the elevations of the back-barrier tracts and the summit elevations of the ridges), the thicknesses to be expected for the surficial sands range from 0 feet to 25 feet (7.5 m), with an average thickness between 15 and 20 feet (4.5 to 7.5 m). To repeat, however, these thicknesses have not been encountered in the field, nor have they been seen in the few cores taken on the sand ridges. On the same basis, the projected thickness of the Trail Ridge sand deposits range from 0 feet at pinchout, to as much as 50 feet (15 m) in Georgia.

My experience suggests that elsewhere in the Coastal Plain of Georgia, the undifferentiated surficial sand typically ranges in thickness from a few inches (less than 10 cm) to not more than 10 feet (3 m). Thicknesses greater than 10 feet (3 m) are exceptional and local.

Age

The age of the undifferentiated surficial sand cannot be older than the formation or terrace surface that it blankets, nor can it be older than the present topography. Therefore, in the marine terrace region, the surficial sands are all of Pleistocene age, and are probably all late Pleistocene to Holocene due to their prevailing aeolian nature.

Inland of the coastal marine terrace region, the undifferentiated surficial sand cannot be older than the present topography. There is evidence that the topographic relief of the Coastal Plain during the Hazlehurst stand of sea level was substantially less than it is today. Scattered erosional outliers of an earlier, flat to gently undulating terrain are present in the Coastal Plain of Georgia. The upland elevations of these outliers in the Fall Line region of eastern Georgia range around 500 feet (152 m) above present sea level. At the time of the Hazlehurst stand of sea level (approximately 275 feet [84 m] above present sea level), this older surface would have been no more than 225 feet (69 m) above the contemporary sea level, and less than 225 feet (69 m) above local base levels in the vicinity of the Fall Line. Therefore the maximum possible topographic relief in the vicinity of the Fall Line during the Hazlehurst stand of sea level would probably have been less than 200 feet (61 m) compared with the present 300 to 350 feet (91 to 107 m) maximum topographic relief. Consequently, a substantial proportion of the present topographic relief in the Coastal Plain of Georgia must have developed only during the Pleistocene, and most, if not all, of the undifferentiated surficial sand must be Pleistocene in age. Because of the prevailing aeolian nature of the sands, they are periodically rejuvenated or recycled, and are, therefore, probably late Pleistocene to Holocene in age.

MARINE TERRACES

Definition

Marine terraces, which are geomorphic features and not stratigraphic units, are included in this report on the lithostratigraphy of the Georgia Coastal Plain for two reasons: (1) recognition of the terraces offers penetrating insight into the geologic history and stratigraphic processes of the region, and, more important, (2) the concept of the marine terraces has significantly influenced the regional stratigraphic concepts of earlier workers (i.e., the two have traditionally been intimately related). According to the models of Cooke (1930a, 1930b, 1931, 1936, 1943, 1945), Hails and Hoyt (1969a, 1969b), and Georgia Geological Survey (1976), formations or deposits underlying the various terraces have borne the same name as the respective marine terraces. However, to be stratigraphically consistent, one must draw a clear and consistent distinction between the lithostratigraphic framework of the Georgia Coastal Plain, and the Plio-Pleistocene geomorphic framework. In this report, Coastal Plain lithostratigraphy and terrace morphology and sequence are separated.

No unique or discrete lithostratigraphic units are related genetically to any specific terrace surface. Conversely, no single marine terrace contains a discrete, unqiue lithostratigraphic unit that was deposited only during the construction of that particular marine terrace. Therefore, the concepts of the Silver Bluff, Princess Anne, Pamlico, Talbot, Penholoway, Wicomico, Sunderland, Coharie, and Brandywine formations (Cooke, 1943; Hails and Hoyt, 1969a, 1969b) are invalid, and these names should be abandoned in the lithostratigraphic sense.

Convincing evidence exists, however, that the Satilla Formation was deposited during the construction of the Pamlico, Princess Anne, and Silver Bluff-Holocene terraces and that it is, therefore, genetically related to those terrace construction events. The occurrence of back-barrier deposits (marsh clays) and barrier islands deposits within the Satilla Formation shows a direct spatial relationship to the occurrence of Pamlico, Princess Anne, Silver Bluff, and Holocene barrier island/back-barrier geomorphic features. On the other hand, the sediments of Satilla Formation under any one terrace cannot be lithologically discriminated from those Satilla sediments underlying any of the other marine terraces. Therefore, the Satilla Formation appears to be a multi-deposit formation consisting of lithologically undifferentiable components of late Pleistocene to Holocene age. The lower terraces, however, are not invariably underlain by the Satilla Formation. In the Savannah River area, portions of the back-barrier tract of the Pamlico terrace are directly underlain by the older Cypresshead Formation, with no Satilla Formation, apparently, having been deposited.

The higher and, presumably, older terraces present a different situation. The lithostratigraphic unit directly underlying the "Talbot", Penholoway and "Wicomico", and parts of the Okefenokee, Waycross (new name), and Argyle (new name) terraces is the Cypresshead Formation of late Pliocene to possibly early Pleistocene age. Although spatial relationships are evident between the lithofacies of the Satilla Formation and the location of the geomorphic features of the overlying marine terraces, no spatial relationship is discernible between the locations of the various geomorphic features of the "Talbot", Penholoway, "Wicomico", Okefenokee, and Waycross terraces, and the underlying lithologies or lithofacies distributions of the Cypresshead Formation. No evidence has been found to indicate that Cypresshead deposition is related to any of the marine terrace construction events, and the Cypresshead Formation is most likely older than any of the marine terraces (see discussion of age of Cypresshead Formation). The only existing deposits that appear to be directly related to the construction of the "Talbot", Penholoway, "Wicomico", Okefenokee and Waycross terraces are undifferentiated surficial sand deposits that cap the various emergent barrier islands and sand ridges. The surficial sands are thicker on these features but cannot be lithologically differentiated from surficial sand elsewhere in the region.

The terraces and shorelines described by Cooke (1925, 1930a, 1930b, 1931, 1936, 1943, 1945), MacNeil (1950), and Hails and Hoyt (1969a) are adopted here with modifications and a few additions. Twelve marine terraces are recognized and described in this study. In order of increasing elevation, they are the Holocene-Silver Bluff, Princess Anne, Pamlico, "Talbot", Penholoway, "Wicomico", Okefenokee, Waycross, Argyle, Claxton, Pearson (new name), and Hazlehurst (Fig. 56). I have recognized four types of marine terraces in this study: (1) geomorphically simple terraces consisting of gently inclined, featureless, flat surfaces bounded by two low, presumably wave-cut scarps; (2) geomorphically complex terraces — referred to in this report as terrace complexes — consisting of barrier islands or emergent barrier islands, barrier island-like sand ridges, and back-barrier tracts; (3) a few terraces — referred to in this report as composite marine terraces — having distinct and separated components of both simple marine terraces and marine terrace complexes; and (4) massive beach ridge systems lacking any back-barrier tracts.

The scarps that bound the geomorphically simple marine terraces are low, presumably wave-cut scarps that represent changes in elevation of approximately 10 to 15 feet (3 to 4.5 m) over a distance of approximately 1 to 2 miles (1.6 to 3.2 km). The landward bounding scarp of any terrace was presumably formed as a wave-cut coastal feature during the construction of that terrace. For the terrace complexes, however, the bounding scarps are the seaward faces of emergent barrier islands or barrier island-like sand ridges. These are not wave-cut features but constructional features.

The use of the word "shoreline" in describing terraces features is an oversimplification. For terrace complexes with barrier islands, barrier island-like sand ridges, beach ridge systems, back-barrier marshes, sounds, and lagoons, there are also complex and sinuous shorelines. For these terraces, the concept of "shoreline" has little meaning.

Whether the terrace geomorphologies are simple, complex, or composite depends on the adequacy of the sand supply to the coastal paleo-environment. Where the coastal environment was sand-starved, as along the northwestern peninsula of Florida during the Pleiscocene and Holocene, terraces of simple geomorphology were constructed. Where there was an abundance of sand in the coastal environment, beach ridge masses were constructed without sizable back-barrier tracts, as along the coast of eastern Florida. Where there was a moderate supply of sand to the coastal environment, as in eastern Georgia during the construction of the Penholoway and younger terraces, a complex coastal geomorphology was generated with barrier islands, various kinds of sand ridge systems, and back-barrier tracts with marsh, lagoon, or open sound. The type of development on any given terrace, therefore, is regionally variable and varies from area to area. For example, the Pamlico terrace has only simple morphology in northwestern peninsular Florida, has complex morphology in Georgia, and is characterized by sand-choked beach ridge systems in northeastern Florida. In addition, evaluation of the terraces in South Carolina, Georgia, and Florida suggests that both the sources and directions of sand transport have fluctuated in the region throughout the Quaternary, producing an even more complicated marine terrace system. As a result of the variations of the factors controlling coastal construction processes, each of the well preserved marine terraces has a set of characteristics that locally serve to distinguish it geomorphologically from all the other terraces.

Uniform elevations of scarps and terrace surfaces are characteristic of those terraces of simple geomorphology. They have been produced mainly by the eroding capabilities of waves, tides, and currents (destructional processes) at elevations near sea level. In South Carolina, Georgia, and northern Florida, the elevations of all the marine terraces of simple geomorphology do not vary significantly (e.g., the average elevation of the Okefenokee terrace from the Cape Fear River in North Carolina, to northern Florida is invariably between 110 and 120 feet [33 and 37 m] above sea level). As a result, contrary to the conclusions of MacNeil (1950), Hoyt (1969), and Winker and Howard (1977), none of the marine terraces in this region appear to have been tectonically tilted or warped. As a corollary, moreover, this region apparently has been tectonically stable and quiescent during the period of construction of all of the marine terraces.

In contrast to the marine terraces of simple morphology, the elevations on the marine terraces of complex geomorphology are variable. For example, the elevations on the Penholoway terrace in Georgia range from approximately 55 feet (17 m) to 100 feet (30 m) above sea level, a range of roughly 45 feet (14 m). This elevation differential, in light of the apparent tectonic stability, must be a reflection of topographic features formed during the construction of the terrace. Clearly, an investigator must approach the tasks of marine terrace recognition, correlation, and terminology with caution because of the large elevation differentials that are possible. Indeed, the highest elevations on one terrace complex may be higher than the lower elevations of an adjacent, higher, and older terrace complex.

Other factors affect terrace study, and these demand caution on the part of the investigator in recognizing and correlating marine terraces. First, the development of the emergent barrier islands, barrier island-like sand ridges, and back-barrier tracts is variable. The shoreline positions of some barrier islands have clearly been reoccupied during subsequent high stands of sea level (e.g., the shoreline of the present Holocene barrier islands, which were emergent Silver Bluff barrier islands during the Wisconsin low sea level stand, reoccupied the shoreline position of the Silver Bluff barrier islands). Similarly, back-barrier tracts have also been reoccupied during subsequent high stands of sea level (e.g., the Holocene marsh has reoccupied the Silver Bluff marsh, the Princess Ann marsh may have reoccupied the Pamlico marsh and back-barrier tract, and the Okefenokee back-barrier tract [sound?] had reoccupied the Waycross back-barrier tract [sound?]).

Second, in some instances, previously existing terraces have been obliterated by later terrace construction events. For example, the "Wicomico" back-barrier tract north of the Altamaha River has been deeply embayed by the Penholoway back-barrier, and south of the Altamaha River there is no existing "Wicomico" terrace between the vicinity of Jesup in Wayne County, and the vicinity of Folkston in Charlton County.

Third, the development of the back-barrier tracts is extremely variable in Georgia. The average breadth of the Holocene back-barrier (marsh) in Georgia is between 5 and 10 miles (8 and 16 km) whereas the average breadth of the Pamlico back-barrier is between 15 and 20 miles (24 and 32 km). On the other hand, in some instances no back-barrier is developed (e.g., where the "Talbot" barrier islands are constructed against the seaward faces of the Penholoway emergent barrier islands north of the Altamaha River).

There is also the possibility, although the evidence in Georgia is not clear on this point, that some terraces may have been constructed during multiple, closely spaced sea level stands. Given the present average tidal range along the coast of Georgia of approximately 7 feet (2 m), recurring sea level stands within a range of less than 15 feet (4.5 m) would be difficult to recognize, except possibly in the vicinity of large rivers where there is an abundant clastic source with active and rapid outbuilding of the coast.

There are three groups of terraces in Georgia, based on geomorphological distinction. They are referred to in this report as the lower, middle, and upper terraces. The lower terraces consist of the Holocene-Silver Bluff, Princess Anne, and Pamlico terrace complexes (Fig. 56). These terraces are characterized by numerous short, stubby barrier islands; by back-barrier marshes; and by widespread sedimentation associated with coastal construction (Satilla Formation). The lower terraces are the only terraces where active regional sedimentation has occurred during construction.

The middle terraces include the "Talbot," Penholoway, and "Wicomico" terrace complexes, and the Okefenokee and Waycross composite terraces (Fig. 56). These terraces are characterized by strong barrier island development with large, long, prominent barrier islands, barrier island-like ridges, and beach ridge systems in Georgia. The Okefenokee and Waycross terraces are exceptional in that they are the only composite terraces in Georgia. North of the Altamaha River, the Okefenokee and Waycross terraces are morphologically simple. South of the Altamaha River, they consist of a broad back-barrier tract that is morphologically simple, and of extensive sand ridge development (Trail Ridge, Waycross Ridge, and Lake City Ridge). Trail Ridge in Georgia must have been initially constructed during the Waycross terrace construction event, based on the elevation of the ridge and the occurrence of Waycross back-barrier tract west of the ridge in Georgia and Florida. After the withdrawal of the sea following the Waycross terrace construction, the coastal area was reinundated with the Okefenokee sea level stand. Both Trail Ridge and the expansive back-barrier tract between Trail Ridge and the mainland (site of present Okefenokee Swamp) were reoccupied by the sea.

Trail Ridge (Cooke, 1925; MacNeil, 1950; Pirkle, 1972) is the most prominent barrier island-like ridge in the state. Unlike the younger, lower barrier islands and barrier island-like ridges, it progressively becomes higher and more massive to the south, suggesting that the source of sand may

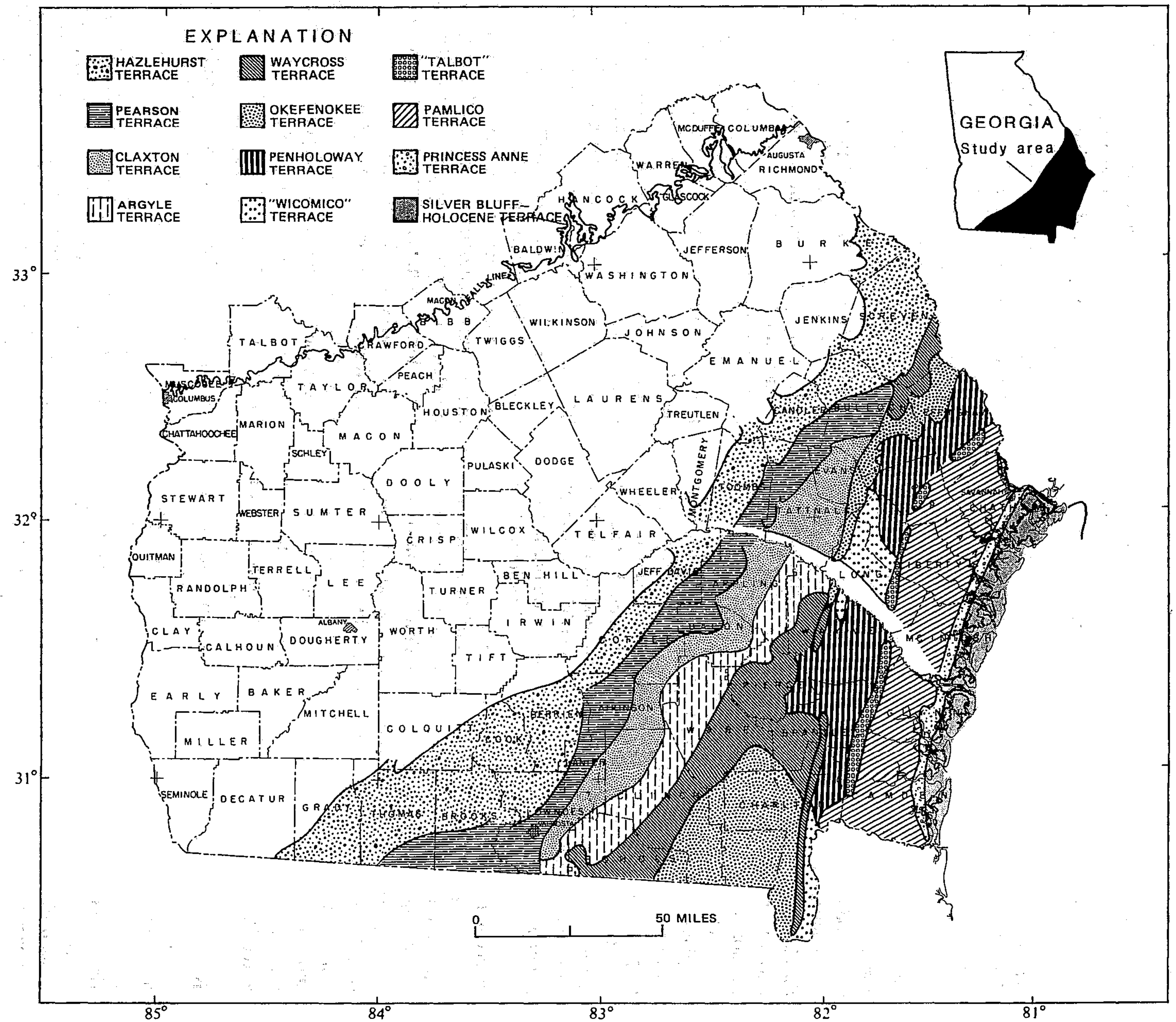


Figure 56. Generalized map of the marine terraces and the dissected marine terrace region of Georgia.

have been from the south. In contrast, all of the lower barrier systems in Georgia are more strongly developed near the major rivers, and become more weakly developed between the major rivers, suggesting that their sources of sand were the major rivers.

The upper terraces consist of the Argyle, Claxton, Pearson, and Hazlehurst (Fig. 56). These marine terraces are characterized, in Georgia, both by the absence of emergent barrier islands, barrier island-like ridges, back-barrier tracts, and associated deposits, and also by the simplicity of their morphology. The Argyle and Claxton terraces have relatively large expanses of undissected terrain, but the Pearson and Hazlehurst terraces are deeply dissected in most areas, with only a few remnants of undissected terrace still preserved.

The major terraces are separated by regular elevation intervals of approximately 25 feet (7.6 m) (i.e., the sea level stands that resulted in the construction of the major terraces were separated by intervals of approximately 25 feet [7.5 m]). In ascending order of age or elevation, these sea level stands and the resulting terraces are the following: Pamlico (25 feet [7.6 m]), "Talbot"(50 feet [15 m]), Penholoway (75 feet [22.5 m]), Okefenokee (125 feet [37.5 m]), Waycross (150 feet [46 m]), Argyle (175 feet [53 m]), Claxton (200 feet [61 m]), Pearson (225 feet [68.5 m]), and Hazlehurst (275 feet [84 m]). The only exceptions to this progression are the "Wicomico" sea level stand at between 90 and 95 feet (27.5 and 29 m), and the absence of evidence for a sea level stand at approximately 250 feet (76 m) above sea level. The Silver Bluff and Princess Anne appear to represent minor sea level stands in that these terraces are poorly developed or absent in marine terrace regions outside of the Sea Island district.

Discussion

Holocene-Silver Bluff terrace complex

The Holocene and the Silver Bluff (Cooke, 1945, p. 248; MacNeil, 1950) represent two different and distinct coastal construction events but are combined in this study because the Silver Bluff terrace was largely reoccupied by the Holocene transgression and its terracing event. The Silver Bluff marsh was reoccupied by the Holocene marsh, and the Holocene barrier islands are merely a continuation of the Silver Bluff barrier islands. The two terrace construction events, therefore, have merged, producing one marine terrace. The Holocene component of the terrace includes the present day barrier islands that have been constructed against the seaward faces of the Silver Bluff barrier islands, except in the vicinity of the Savannah and Altamaha Rivers where the Holocene marsh and barrier islands have been constructed seaward of the Silver Bluff barrier islands. The Holocene barrier islands are characterized by prominent modern dune development, in contrast to the subdued topography on the Silver Bluff barrier islands that are devoid of sand dunes. Only the greater topographic relief on the Holocene, because of continuing dune construction, serves to distinguish the Holocene component from the topographically more subdued Silver Bluff. In addition, the Silver Bluff marsh stands slightly higher than the Holocene marsh and generally is inundated only during the highest tides.

Holocene and Silver Bluff barrier islands are equally developed along the coast of Georgia with little or no distinction in styles of construction between those barrier islands adjacent to the major rivers and those distant from the major rivers.

The summit elevations of the Holocene barrier islands range from near sea level to approximately 45 feet (14 m) at the crests of the highest sand dunes. The average summit elevations of the Holocene islands typically are between 10 and 20 feet (3 to 6 m). The width of the Holocene marsh typically ranges from 3 to 6 miles (5 to 9.5 km). The elevation of the back-barrier tract is sea level to approximately 7 feet (2 m) above sea level.

Sea level during the Silver Bluff construction event stood at approximately 6 feet (1.8 m) above present sea level. The summit elevations of the Silver Bluff barrier islands typically range from 10 to 20 feet (3 to 6 m) with some localized elevations being in excess of 40 feet (12 m). Elevations on the Holocene-Silver Bluff terrace complex range from near sea level to 45 feet (14 m), a relief of more than 45 feet (14 m), including sub-sea level elevations of tidal channels.

The Holocene-Silver Bluff terrace complex is directly underlain by the Satilla Formation.

Princess Anne terrace complex

The Princess Anne (Hails and Hoyt, 1969) terrace complex bears the same relationship to the Pamlico terrace that the Holocene bears to the Silver Bluff (i.e., the Princess Anne marsh largely reoccupied the Pamlico marsh, and Princess Anne barrier islands, in most instances, were constructed against the seaward faces of the older Pamlico barrier islands). Princess Anne back-barrier tracts (marshes), as distinct from those of the reoccupied Pamlico back-barrier tracts, are very poorly developed or lacking in Georgia.

The emergent Princess Anne barrier islands are almost equally developed along the coastal area of Georgia with only slightly more prominent development near the major streams.

Sea level during the Princess Anne terrace construction event stood at approximately 13 feet (4.0 m). The summit elevations of the Princess Anne barrier islands range from approximately 15 to 25 feet (4.5 to 7.6 m) whereas the elevations of the suspected back-barrier tracts, where developed, range from approximately 10 to 20 feet (3 to 6 m) above sea level. Elevations on the Princess Anne terrace complex, therefore, range from approximately 10 to 25 feet (3 to 7.6 m), a range of 15 feet (4.5 m).

The Princess Anne terrace complex is directly underlain by the Satilla Formation.

Pamlico terrace complex

The Pamlico terrace complex of this report, or Pamlico terrace, was originally described as the Pamlico formation and Pamlico terrace in North Carolina (Stephenson, 1912, p. 286-290). Cooke (1930a, 1930b, 1931, 1936, 1943, 1945) applied the name Pamlico both to a marine terrace that was constructed when sea level stood at approximately 25 feet (7.6 m) above present sea level, and to a formation. Pamlico as a marine terrace name is retained in this report because of its widespread acceptance and continued usage in the sense of a marine terrace or shoreline complex (Hails and Hoyt, 1969; Mann, 1974; Georgia Geological Survey, 1976) and because it was originally also described as a terrace (Stephenson, 1912, p. 287).

The Pamlico terrace complex is morphologically similar to the Holocene-Silver Bluff terrace complex (i.e., it is characterized by numerous short, stubby, emergent barrier islands; by well developed back-barrier tracts; and by active sedimentation associated with coastal construction). There are two significant differences, however, between the Pamlico and the Holocene-Silver Bluff in Georgia. The Pamlico emergent barrier islands are prominently developed only adjacent to the major streams (Savannah and Altamaha Rivers) and are very poorly developed or nonexistent as barrier islands in the reaches away from the large rivers. Also, the back-barrier tract is extraordinarily wide compared to the Holocene-Silver Bluff back-barrier. The Pamlico back-barrier tract varies from 10 to 20 miles (16 to 32 km) across, compared with an average of 3 to 6 miles (5 to 9.6 km) for the Holocene-Silver Bluff.

Sea level during the Pamlico terrace construction event stood at approximately 25 feet (7.6 m). The summit elevations of the emergent Pamlico barrier islands range from approximately 25 to 35 feet (7.6 m to 10.5 m), with local summit elevations exceeding 40 feet (12 m). The elevations of the Pamlico back-barrier tract range approximately from 15 to 25 feet (4.5 to 7.6 m). The topographic relief on the Pamlico terrace complex, therefore, is at least 25 feet (7.6 m).

Large expanses of the Pamlico back-barrier tract are at elevations between 15 to 25 feet (4.5 and 7.6 m) above present sea level. In view of the projected Pamlico sea level stand of approximately 25 feet (7.6 m) above present sea level, large expanses of the Pamlico back-barrier were apparently below sea level and may have existed as open sound rather than marsh as maintained by Hails and Hoyt (1969), Mann (1974), and Georgia Geological Survey (1976). However, marsh-type clay deposits are present in the Pamlico back-barrier tract (also see Logan, 1968; Scott, 1976). Consequently, the Pamlico marshes probably existed either as tracts within the sound or as marsh fringing the sound. In appearance, the Pamlico coastal geomorphology in Georgia would have departed significantly from that of the modern Georgia coast.

In most places, the Satilla Formation directly underlies both the Pamlico terrace surface and the undifferentiated surficial sands that mantle the emergent Pamlico barrier islands on the terrace. The Satilla Formation appears to have been deposited during the construction of the terrace. However, in the Savannah River area in northern Chatham County, the Cypresshead Formation directly underlies portions of the Pamlico back-barrier surface and the undifferentiated surficial sands that form the Pamlico sand ridge near the Savannah airport. At least in that area, no appreciable sedimentation appears to have accompanied the construction of the Pamlico terrace.

"Talbot" terrace complex

The "Talbot" terrace of this report was originally described as the Talbot formation in Maryland (Shattuck, 1901, 1906). Cooke (1931, 1930a, 1930b,) also applied the name Talbot to a marine terrace that was believed to have been constructed when sea level stood at 42 feet (12.8 m) above present sea level, but he also referred the deposits underlying the "Talbot" terrace to the Talbot formation (Cooke, 1936, 1943, 1945). Talbot as a terrace name is considered to be inappropriate in this report because the name Talbot was originally applied to a formation. However, because there are no good reference areas on which to base a new terrace name for this particular terrace in Georgia, the name "Talbot" terrace will be retained in this report.

The concept of the "Talbot" terrace (Cooke, 1931) is modified from that of previous usage. Whereas, in the past, the sea level stand during the construction of the "Talbot" terrace was postulated to be near 42 feet (12.8 m) above present sea level (Cooke, 1931, 1936, 1943, 1945; Hails and Hoyt, 1969), there is no definitive evidence in Georgia, northern Florida, or South Carolina for a scarp or sea level stand at that elevation.

In areas where barrier islands are not developed and the marine terraces are of simple morphology, such as along the present coast of the Gulf of Mexico in the northwestern peninsula of Florida, a scarp consistently occurs at the elevation of approximately 50 feet (15 m), and no other scarp occurs between it and the Pamlico scarp at 25 feet (7.6 m). Similarly, only one gently sloping terrace surface occurs between the scarp at 50 feet (15 m) and the Pamlico scarp. This marine terrace surface, between 25 and 50 feet (7.6 and 15 m) above present sea level, incorporates most of the "Talbot" terrace of Cooke (1931). For that reason, the scarp at approximately 50 feet (15 m) is assigned to the "Talbot". The elevations of the emergent "Talbot" barrier islands and "Talbot" back-barrier tract in eastern Georgia are compatible with this higher elevation for the "Talbot" sea level stand. Therefore, as defined in this study, the "Talbot" is that terrace complex, in Georgia, constructed when sea level stood at approximately 50 feet (15 m).

The "Talbot" barrier complex in Georgia is mainly represented by emergent barrier islands and beach ridge complexes (Fig. 56). Generally, the "Talbot" barrier islands were constructed against the seaward faces of the adjacent Penholoway barrier islands, analogous to the Holocene barrier islands constructed against the Silver Bluff barrier islands, and the Princess Anne barrier islands against the Pamlico barrier islands. Only between Brantley County and the St. Marys River are the emergent "Talbot" barrier islands separated from the emergent Penholoway barrier islands by what appears to have been a "Talbot" back-barrier tract (now the valley and flood plain of the Satilla River). The only surviving tract of "Talbot" back-barrier in Georgia occurs in Wayne County.

South of the Altamaha River in Georgia, the "Talbot" barrier islands are prominent and equally developed, showing little if any difference in construction from the vicinity of the Altamaha River to reaches far from the river. On the other hand, north of the Altamaha River, the "Talbot" barrier islands are prominent only near the Savannah, Ogeechee, and Altamaha Rivers.

The summit elevations on the emergent "Talbot" barrier islands in Georgia range from 55 feet to 75 feet (17 m to 23 m), a relief of 20 feet (6 m). The elevation of the "Talbot" back-barrier tract ranges from 45 to 50 feet (13.5 to 15 m). The total relief on the "Talbot" terrace complex in Georgia is approximately 30 feet (9 m).

The Cypresshead Formation directly underlies both the "Talbot" terrace surface and the undifferentiated surficial sands that mantle the emergent "Talbot" barrier islands.

Penholoway terrace complex

The name Penholoway was originally applied to a marine terrace (Cooke, 1925). Subsequently, the deposits underlying the Penholoway terrace were also called the Penholoway formation (Cooke, 1936, 1943, 1945; Connell, 1969). The lithostratigraphic context of the Penholoway is abandoned in this report, however, and the name is used in its original sense as a marine terrace.

The Penholoway terrace complex in Georgia is characterized by prominent emergent barrier islands, sand ridge systems of uncertain origin, and extremely variable development of back-barrier tracts. The morphological variability and complexity of the Penholoway terrace complex in Georgia may have resulted from the terrace's being constructed during more than one marine occupation of the terrace.

In its type area in Wayne and Brantley Counties, the Penholoway terrace complex consists of a narrow but prominent emergent barrier island and a very broad back-barrier tract that is up to 15 miles (24 km) wide. The terrace narrows to the south, and the emergent barrier islands change form to become massive and stubby sand ridges. Some of the ridges have the appearance of intrasound beach ridge systems. The Penholoway back-barrier tract pinches out near Folkston. South of Folkston, in Florida, the Penholoway terrace consists only of an emergent barrier island component that apparently was constructed against the seaward face of a "Wicomico" barrier island.

North of the Altamaha River, the Penholoway barrier islands are strongly developed only near the major rivers. In addition, the back-barrier tracts of the Penholoway deeply embay the back-barrier tracts of the "Wicomico" terrace and the Okefenokee terrace.

Sea level during the Penholoway terrace construction event stood at approximately 70 to 75 feet (21 to 23 m). The summit elevations of the emergent Penholoway barrier islands or sand ridges range from approximately 75 to 95 feet (23 to 29 m), but elevations as high as 100 feet (30 m) occur in the Folkston area. The elevations of the Penholoway back-barrier tracts typically range from 55 to 70 feet (17 to 21 m) but also range upward to elevations as high as 75 to 80 feet (23 ro 24 m) in those areas where the Penholoway embays the "Wicomico". The total relief on the Penholoway terrace complex is approximately 45 feet (14 m).

The Penholoway terrace and the undifferentiated surficial sands that mantle the emergent barrier islands are directly underlain by the Cypresshead Formation.

"Wicomico" terrace

The "Wicomico" terrace of this report was originally described as the Wicomico formation in Maryland (Shattuck, 1901, 1906). Cooke (1930a, 1930b, 1931) later applied the name Wicomico to a marine terrace that was believed to have been constructed when sea level stood at approximately 100 feet (30 m) above present sea level. However, he also referred the deposits underlying the Wicomico terrace to the Wicomico formation (Cooke, 1936, 1943, 1945). Wicomico as a terrace name is considered to be inappropriate in this report because the name Wicomico was originally applied to a formation. However, because there are no good reference areas on which to base a new terrace name for this particular terrace in Georgia, the name "Wicomico" terrace will be retained in this report.

The "Wicomico" terrace is very poorly developed in Georgia and appears to have been largely consumed by erosion prior to or during the construction of the Penholoway terrace complex. As a result, only remnants of the "Wicomico" terrace are preserved in Georgia. These include a back-barrier tract betwen the St. Marys River and Trail Ridge in southern Charlton County, possibly the sand ridge (emergent barrier island?) on which Jesup is built in Wayne County, some deeply embayed back-barrier remnants north of the Altamaha River in Long and Liberty Counties, and possibly a small barrier island/back-barrier set near Springfield in Effingham County. Moreover, some of the Penholoway barrier islands may be, in part, reoccupied "Wicomico" barrier islands.

In contrast to the interpretation of Cooke (1931, 1936, 1943, 1945) and of others (MacNeil [1950]; Hails and Hoyt [1969]), sea level during the "Wicomico" terrace construction event is here postulated to have stood at approximately 90 to 95 feet (27 to 29 m) rather than 100 feet (30 m) above present sea level. This conclusion is consistent with (1) the scattered back-barrier tracts at 80 to 95 feet (24 to 29 m) in Georgia, (2) the elevations of the well-developed "Wicomico" back-barrier tracts of 80 to 90 feet (24 to 27 m) in South Carolina, and (3) the elevation of approximately 90 to 95 feet (27 to 29 m) of a prominent scarp along the Gulf of Mexico in northwestern peninsular Florida.

In South Carolina and perhaps in northeastern Florida, the summit elevations of the "Wicomico" barrier islands range from approximately 95 to 105 feet (29 to 32 m). The elevations of the "Wicomico" back-barrier tracts typically range in elevation from approximately 80 to 95 feet (24 to 29 m). The relief on the "Wicomico" terrace complex, therefore, appears to be approximately 25 feet (7.5 m).

The "Wicomico" terrace in Georgia is directly underlain by the Cypresshead Formation.

Okefenokee terrace (redefined)

The name Okefenokee terrace was first used by Veatch and Stephenson (1911), expanded on by Cooke (1925), and abandoned by Cooke (1931). MacNeil (1950) reintroduced the concept of the Okefenokee in a geomorphologic sense when he recognized an Okefenokee "shoreline" at an elevation of 150 feet (46 m). By implication, the Okefenokee terrace (not referred to as such by MacNeil, 1950) occupied the terrain between the scarp at 150 feet (36 m) and the presumed shoreline at 100 feet (30 m). There is also, however, a low scarp at 125 feet (38 m), not recognized by MacNeil (1950), that bounds the Okefenokee Swamp on the west. As a result, this author proposes a modification of the scheme introduced by MacNeil (1950). The terrain bounded by the scarp at 150 feet (46 m) and by the "Wicomico" terrace (sea level stand at approximately 90 to 95 feet) is divided into two terraces in this report. The upper of the two terraces is herein referred to as the Waycross terrace. It is bounded on the landward (western) side by a low scarp at approximately 150 feet (46 m) (Okefenokee shoreline of MacNeil, 1950). The lower of the two terraces is herein referred to as the Okefenokee terrace because the greater part of that terrace in Georgia is occupied by the Okefenokee Swamp. The Okefenokee terrace is bounded on the landward (western) side by a low scarp at approximately 125 feet (38 m).

The Okefenokee terrace is a composite terrace in Georgia. In the northern area, between the vicinity of Jesup and the Savannah River, it has simple terrace morphology, but in the southern area, in the Okefenokee basin, it has both simple and complex morphology. In the northern area, the Okefenokee terrace is restricted to the region east of the Orangeburg Escarpment (Fig. 56). In the southern area, it is found only west of Trail Ridge and south of the Satilla River. In this southern area, the Okefenokee terrace consists of a very wide back-barrier tract up to 30 miles (50 km) across that is now mainly occupied by the Okefenokee Swamp (Fig. 58). The Okefenokee terrace is bounded on the east by the eastern flanks of Trail Ridge, and on the north by a complex of anomalous sand ridges included in the Waycross Ridge. Trail Ridge and the associated Waycross Ridge are older features that were reoccupied during the Okefenokee stand of sea level. Trail Ridge may have been added to during the construction of the Okefenokee terrace, but the only sand ridges in Georgia that appear to have been constructed during the formation of the Okefenokee terrace are an obscure set of ridges paralleling and immediately south of Waycross Ridge. There is no development of barrier islands or sand ridges in the northern segment of the Okefenokee terrace in Georgia. There is no evidence that the Okefenokee terrace was ever present between the Okefenokee Swamp in Charlton County and the vicinity of Jesup in Wayne County (Fig. 56).

Sea level during the Okefenokee terrace construction event stood at approximately 125 feet (38 m). The typical elevations on the Okefenokee terrace range from 110 feet to 120 feet (33.5 m to 36.5 m). On the obscure associated sand ridges, summit elevations range from 120 to 130 feet (36.5 to 40 m), whereas on Trail Ridge, summit elevations range from approximately 135 feet to 175 feet (41 m to 53 m).

Between the Canoochee and Savannah Rivers, there are some remnants of extremely flat terrain with elevations between 95 and 105 feet (29 and 32 m). In this report, this terrain is included in the Okefenokee terrace because it is continuous in several places with surfaces of typical Okefenokee elevations. The total relief on the Okefenokee terrace complex, therefore, is approximately 80 feet (24 m).

In its northern segments, the Okefenokee terrace in Georgia is directly underlain by the Cypresshead Formation. The eastern part of the southern segment (i.e., the eastern part of the Okefenokee swamp), is directly underlain by swamp deposits or the Cypresshead Formation. The southwestern part of the southern segment is directly underlain by the Statenville Formation of the Hawthorne Group.

Waycross terrace (new name)

The Waycross terrace is a new terrace name proposed herein for that marine terrace that is bounded on the landward side by a low scarp at approximately 150 feet (46 m), and on the seaward side by the scarp at approximately 125 feet 38 m). Typical elevations on the Waycross terrace range from 130 to 140 feet (40 m to 43 m). The name Waycross is taken from the town of Waycross in Ware County, Georgia, that is built on the Waycross terrace.

The Waycross terrace of this report is the upper part of the Okefenokee terrace of Cooke (1925), and the scarp at 150 feet (46 m) is the Okefenokee shoreline of MacNeil (1950).

The Waycross terrace is a composite terrace in Georgia (i.e., it occurs with both simple terrace morphology and complex terrace morphology). Like the Okefenokee terrace, the Waycross terrace occurs in two different areas in Georgia; the southern segment includes Trail Ridge, Waycross

Ridge, and Lake City Ridge and a large expanse west of the Okefenokee terrace (Fig. 56). The northern segment occurs east of the Orangeburg Escarpment in Bulloch, Effingham, and Screven Counties, Georgia. The northern segment and the western part of the southern segment of the Waycross terrace are morphologically simple. However, Trail Ridge marks the eastern limit of the Waycross terrace in Brantley and Wayne Counties. South of Brantley County, Trail Ridge is separated from the rest of the Waycross terrace by the Okefenokee terrace, a large embayment in the Waycross terrace (Fig. 56).

Trail Ridge is the highest and most massive barrier island-like sand ridge in Georgia (also see Cooke, 1925; MacNeil, 1950; Pirkle, 1972). Its summit elevations, in Georgia, range from 135 feet to 175 feet (41 to 53 m). Farther south in Florida, the summit of Trail Ridge reaches elevations of 250 feet (76 m). In the past, Trail Ridge had been placed in the Sunderland terrace (Cooke, 1943; 1945), and in the "Wicomico" terrace (Hails and Hoyt, 1969; Mann, 1974; Georgia Geological Survey, 1976), and associated with the scarp at 150 feet (46 m) (MacNeil, 1950). Trail Ridge is considered to be a part of the Waycross terrace of this report because (1) the summit elevations of Trail Ridge (140 feet to 175 feet [43 m to 53 m]) in Georgia are compatible with elevations expected of the Waycross terrace and (2) Trail Ridge in Brantley and Wayne Counties occurs adjacent to and east (seaward) of the Waycross terrace surface, the standard configuration for a barrier island, back-barrier system (Fig. 56). In addition, the Okefenokee terrace lies east (seaward) of Trail Ridge in northern Wayne County, thus bracketing the terrace relationships of Trail Ridge.

Further evidence that Trail Ridge is not a part of the "Wicomico" terrace is the occurrence of "Wicomico" back-barrier east (seaward) of Trail Ridge in southern Charlton County, between Trail Ridge and the St. Marys River (Fig. 56). In addition, the Waycross Ridge, which must have been constructed during construction of the Waycross terrace because it lies directly on the Waycross surface and shows no geographic relationship to older or younger terraces, is a spur of Trail Ridge and has similar summit elevations (135 to 150 feet [41 to 46 m]). Furthermore, Trail Ridge and its spurs, the Waycross Ridge in Georgia and the Lake City Ridge in Florida, must have been reoccupied at least one time during the Pleistocene sea level fluctuations in the region. Trail Ridge, it appears, was reoccupied during the Okefenokee stand of sea level. Since both "Wicomico" and Penholoway back-barrier tracts abut Trail Ridge on the east, the ridge evidently served locally as a shoreline during construction of these terraces.

Additional evidence that Trail Ridge is part of the Waycross comes from Pirkle and Czel (1983), who reported macrofossils from elevations of 132 feet to 161 feet (41 m to 49 m) above sea level in cores from the southern part of Trail Ridge in Georgia. This finding is largely compatible with a seal level stand at approximately 150 feet (46 m). Fossil occurrences up to 11 feet (3.3 m) above the Waycross sea level stand could be attributed to extreme, but not unusual, tidal ranges or storms. Finally, it is possible, but less likely, that Trail Ridge construction could have been initiated to the south in Florida, where the summit elevations on the ridge reach 250 feet (76 m), during an earlier and higher stand of sea level. If the construction was initiated in Florida, the Trail Ridge was possibly not just reoccupied during successive high stands of sea level, but may also have been constructed through increments during these various high stands of the sea.

The Statenville Formation of the Hawthorne Group directly underlies the Waycross terrace in Georgia near the Florida state line, and the Screven Member of the Altamaha Formation or the Cypresshead Formation directly underlies the terrace surface north of the vicinity of Waycross. Trail Ridge in Georgia is constructed on the Cypresshead Formation. The Cypresshead Formation also directly underlies the Waycross terrace surface (or the undifferentiated surficial sands that mantle its surface) in its northern segment in Bulloch, Effingham, and Screven Counties.

Argyle terrace (new name)

The Argyle terrace is a new terrace name proposed herein for that marine terrace that is bounded on the landward side by the low scarp at approximately 170 to 175 feet (52 to 53 m) above sea level, and on the seaward side by the low scarp at approximately 150 feet (46 m). Typical elevations on the Argyle terrace range from approximately 155 to 165 feet (47 to 50 m). The Argyle terrace and all of the higher terraces in Georgia are morphologically simple (i.e., they are gently inclined surfaces bounded by low, presumably wave-cut scarps, and they do not have associated emergent barrier islands, sand ridges, or back-barrier tracts). The name Argyle is taken from the community of Argyle in northern Clinch County, Georgia, where the Argyle terrace is typically developed and upon which the village of Argyle is located.

The Sunderland terrace of Cooke (1930a, 1930b, 1931) includes the Argyle, Waycross, and Okefenokee terraces of this report, and the Argyle terrace approximates the upper part of the Sunderland terrace. Sunderland as a terrace name is considered to be inappropriate in this report because the name Sunderland was originally applied to the Sunderland formation, a lithostratigraphic unit, in Maryland (Shattuck, 1901, 1906).

The scarp that bounds the Argyle terrace on the west is easily traceable only in the expanse of undissected terrain west of the Okefenokee Swamp in Georgia, between the Alapaha and Satilla Rivers. North of the Satilla River, the Argyle terrace and scarp at 170 to 175 feet (52 to 53 m) are traceable with difficulty due to the dissection of the terrace surface by incision and erosion by the Satilla River system.

The Argyle terrace occurs only as far north as the Altamaha River in Georgia (Fig. 56). Farther north, the Argyle terrace elevations occur only in the face of the Orangeburg

Escarpment (i.e., the terraces in front, or east, of the Orangeburg Escarpment are lower in elevation and younger than the Argyle terrace, and the marine terraces behind, or west or, the Orangeburg Escarpment are higher in elevation and older than the Argyle) (see Fig. 57). The Argyle terrace re-emerges on the east side of the Orangeburg Escarpment farther north in South Carolina.

Near the Florida state line in Echols and Lowndes Counties, the Argyle terrace is directly underlain by the Statenville Formation of the Hawthorne Group, or by the Miccosukee Formation. From the vicinity of the Satilla River to the Altamaha River, the Argyle terrace is directly underlain by the Screven Member of the Altamaha Formation. In northern Wayne County, however, the Argyle terrace is directly underlain by the updip feather-edge of the Cypresshead Formation.

Claxton terrace (reintroduced)

The Claxton terrace of Cooke (1925, p. 29) is reintroduced in this report and is that marine terrace bounded on the shoreward (west) side by the low scarp at approximately 200 feet (61 m) and bounded on the seaward (east) side by the low scarp at approximately 170 to 175 feet (52 to 53 m). Typical elevations on the Claxton terrace range from 180 to 190 feet (55 to 58 m).

The surface of the Claxton terrace is more dissected than that of the lower, younger terraces. South of the Altamaha River, well-preserved and undissected Claxton terrace is still present in eastern Lowndes, Lanier, Clinch, Atkinson, Bacon, and Appling Counties. North of the Altamaha River, it is present in Tattnall and Evans Counties, the type area of the Claxton terrace of Cooke (1925).

The Claxton terrace occurs as a band from Lowndes County in the southwest, to Evans County in the northeast (Fig. 56). The Claxton terrace is not present in Georgia north of the Canoochee River, but it re-emerges on the east side of the Orangeburg Escarpment farther north in South Carolina.

The Claxton terrace is directly underlain by the Miccosukee Formation in Lowndes County, and by the Altamaha Formation north of the vicinity of the Satilla River. No information on the underlying formations is available between Lowndes County and the Satilla River.

Pearson terrace (new name)

The Pearson terrace is a new terrace name proposed herein for that marine terrace that is bounded on the landward side by the low scarp at approximately 225 feet (68 m), and on the seaward side by the low scarp at approximately 200 feet (61 m). Like the other upper terraces, the Pearson is morphologically simple. Typical elevations on the Pearson terrace range from 205 to 220 feet (62.5 to 67 m). The name Pearson is taken from the town of Pearson in Atkinson County, Georgia, which is located on the somewhat dissected seaward scarp bounding the Pearson terrace.

The Coharie terrace of Cooke (1930a,1930b,1931) (also called the Coharie formation [Cooke, 1936, 1943,1945], was postulated to occur between the shorelines at 170 feet and 215 feet. However, with modern 1:24,000-scale map coverage and contour intervals of 5 feet (1.5 m), no scarp at 215 feet (65.5 m) can be recognized. At that elevation, the terrace surface is flat or gently inclined. On the other hand, Stephenson (1912) originally defined the inner edge of the Coharie formation as occurring at elevations between 220 and 235 feet (67 and 71.5 m), a determination that is consistent with my observations for the inner margin of the Pearson terrace in Georgia and South Carolina. As a result of the above modifications, the Coharie terrace of Cooke (1930a, 1930b, 1931) is divided into two parts in this report, a lower Claxton terrace and an upper Pearson terrace. Coharie as a terrace name is considered inappropriate because the name Coharie was originally applied to the Coharie formation, a lithostratigraphic unit, in North Carolina, (Stephenson, 1912, p. 29).

The scarp, at approximately 225 feet (68 m), is considerably more dissected and ambiguous than the lower scarps. Only in northwestern Atkinson County is the low scarp still preserved and well developed. Elsewhere, its earlier existence is inferred from the relatively abrupt and systematic increase in interfluve summit elevations from approximately 200 feet (67 m) to 230-240 feet (70 to 73 m).

Relatively large expanses of undissected Pearson terrace surface still exist only in western Atkinson, northwestern Clinch, and northeastern Lanier Counties, between the Satilla and the Alapaha Rivers. Smaller remnants of the terrace occur in Appling, Tattnall, and Evans Counties. Elsewhere, this terrace is deeply dissected and can be traced only with difficulty by comparing interfluve summit elevations.

The Pearson terrace extends from southeastern Thomas County in the southwest, where it is very deeply dissected, to Bulloch County in the northeast, where it is also very deeply dissected (Fig. 56). The Pearson terrace, like the other upper terraces, occurs only west of the Orangeburg Escarpment, Trail Ridge, and the Okefenokee Swamp in Georgia. It emerges on the east side of the Orangeburg Escarpment in South Carolina.

The Pearson terrace is directly underlain by the Miccosukee Formation in Lowndes, Brooks, and Thomas Counties, and is underlain by the Altamaha Formation north of the Satilla River. No information is available on the underlying formations between Lowndes County and the vicinity of the Satilla River.

Hazlehurst terrace, (reintroduced)

The Hazlehurst terrace of Cooke (1925, p. 29) is reintroduced in this report for that marine terrace bounded on the shoreward side (west) by a generally dissected scarp at approximately 275 feet (84 m), and on the seaward side (east) by the low scarp at approximately 225 feet (68 m). The

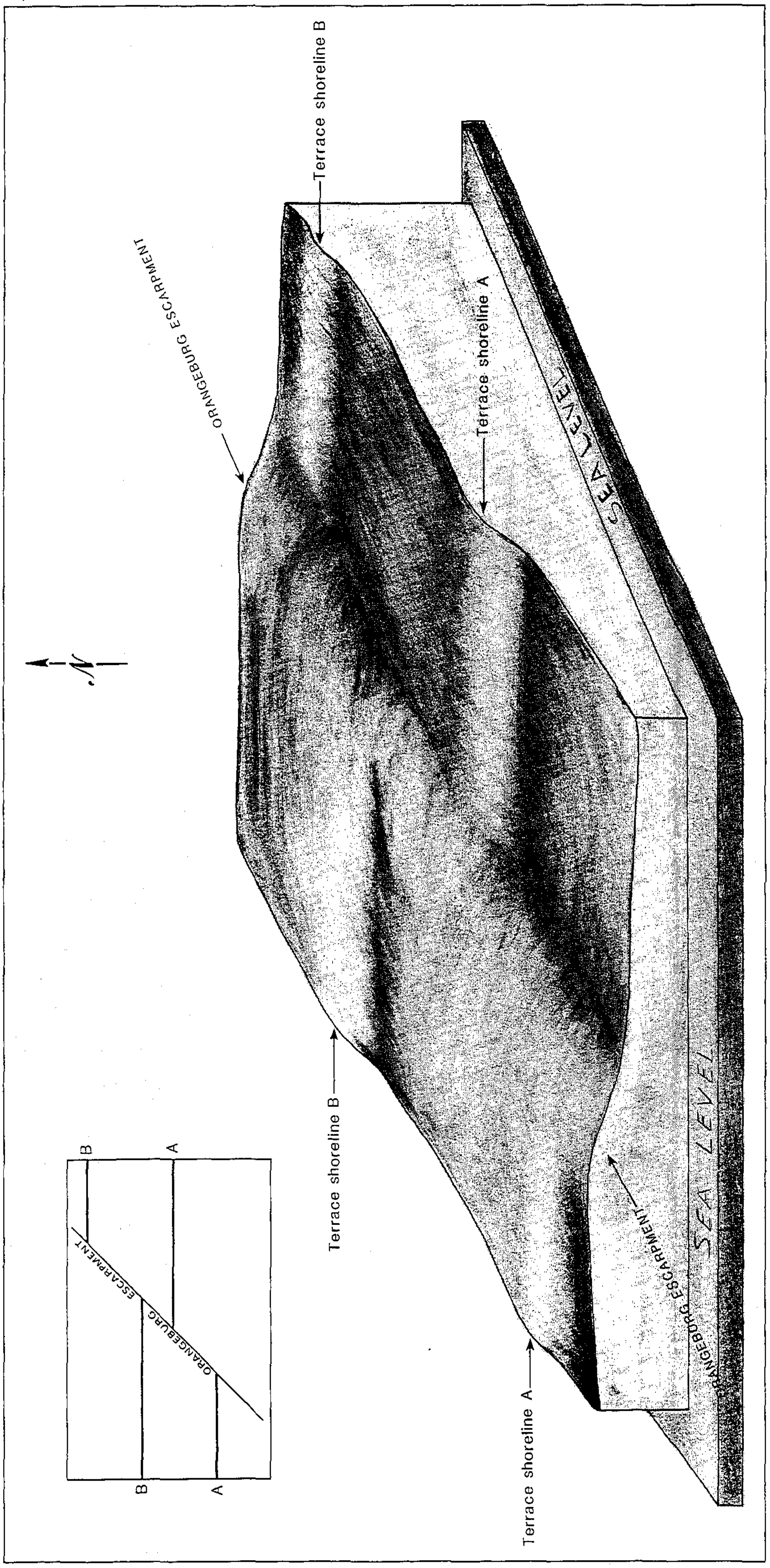


Figure 57. Block diagram showing relationships of marine terraces to the Orangeburg escarpment in Georgia.

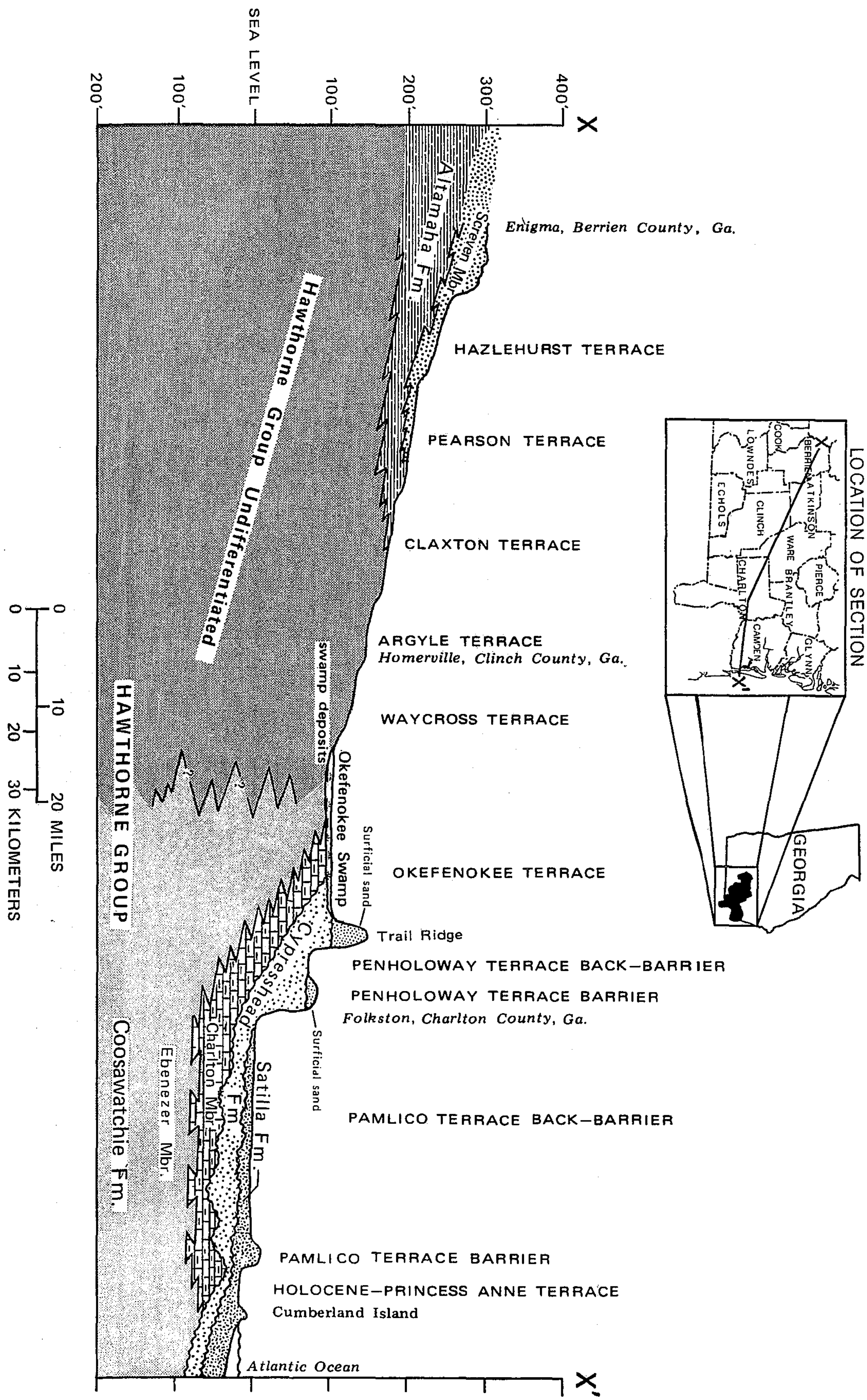


Figure 58. Schematic stratigraphic cross-section of the marine terraces from northern Berrien County to Cumberland Island.

remnants of the Hazlehurst terrace suggests that originally it was morphologically simple. Typical elevations on the Hazlehurst terrace range from 230 feet to 260 feet (70 m to 79 m).

The name Hazlehurst terrace was abandoned by Cooke (1930a, 1930b, 1931) in favor of the name Brandywine terrace. The Brandywine was originally described as a formation (Clark, 1915), and the name Brandywine was applied accordingly in South Carolina, Georgia, and Florida by Cooke (1936, 1943, 1945). The proper use of the name Brandywine, therefore, is as a lithostratigraphic unit and not as a terrace as proposed by Cooke (1930a, 1930b, 1931). The name Brandywine formation is not valid in Georgia because the terrace of that name is underlain by either Miccosukee Formation or by Altamaha Formation. Furthermore, the name Brandywine formation is no longer applied in its type area in Maryland. The name Hazlehurst, on the other hand, was defined as a marine terrace independent of any underlying deposits and is, for that reason, reintroduced herein. The Hazlehurst terrace of this report is largely the same as the Hazlehurst terrace of Cooke (1925, p. 29), with only minor modifications.

The scarp that defines the landward limit of the Hazlehurst terrace can be observed only in northern Berrien County. Elsewhere the former presence of this scarp is inferred from the relatively abrupt increase in interfluve summit elevations from approximately 260 or 270 feet 979 or 82 m), to elevations in excess of 290 feet (88 m).

The Hazlehurst terrace is deeply dissected in most areas of its occurrence, and in many places is virtually unrecognizable as a terrace. Only in northwestern Atkinson, eastern Berrien, western Brooks, southern Emanuel, and northern Tattnall Counties are there existing remnants of the undissected Hazlehurst terrace surface. In other places, the recognition of the former presence of the terrace surface is based on the elevations of the highest interfluve summits.

The Hazlehurst terrace, or deeply dissected remnants of the former terrace surface, extends from southeastern Decatur County in the southwest, northeastward through Jeff Davis County to Burke County (Fig. 51).

The Hazlehurst terrace is directly underlain by the Altamaha Formation from Screven and Burke Counties in the northeast, to Cook County in the southwest. Farther southwest it is underlain by the Miccosukee Formation in southern Colquitt, Lowndes, Brooks, Thomas, Grady, and Decatur Counties, Georgia.

Age of the marine terraces

Marine terraces are geomorphic features. In themselves, they cannot be dated, but the ages of the terraces can be inferred from the ages of associated datable deposits or from the real or interpreted ages of the underlying, unassociated deposits. In addition, I have found that relative ages inferred from regional tilting of the underlying deposits, and absence of tilting or warping of the terraces, are consistent with the age interpretations of the marine terraces based on ages of the underlying deposits.

Only the lowest marine terraces—the Holocene, Silver Bluff, Princess Anne, and Pamlico terraces—can be dated by the age of the associated Satilla Formation. The spatial relationships of the Satilla lithofacies appear to conform to terrace geomorphology (i.e., blocky, massive clays with scattered bioherms of *Crassostrea virginica* [marsh-type deposits] are largely confined to the back-barrier tracts of the terraces, and barrier island-type deposits are largely confined to the barrier island-type sand ridges of the terraces). Consequently, it is assumed that the Satilla Formation was deposited during the associated terrace construction events. The fauna of the Satilla Formation is not known to differ in any way from the modern, living fauna. As a consequence, the ages of the Pamlico, Princess Anne, and Silver Bluff terraces are assumed in this report to be late Pleistocene. The age of the Holocene terrace, which is currently being constructed, is, of course, Holocene.

Pirkle and Czel (1983) reported Pleistocene fossil associations from the Trail Ridge sand deposit in Georgia. The fossils came from elevations of 132 feet (40 m) to 161 feet (49 m) above sea level in cores taken on Trail Ridge. According to Pirkle and Czel (1983, p. 32), this assemblage contained no extinct species and it is, therefore, interpreted in this report as being Pleistocene, and possibly late Pleistocene, in age. The elevations of the fossil associations are consistent with the Trail Ridge being assigned to the Waycross terrace (approximately 125 feet [38 m] to 150 feet [46 m] with a sea level stand at approximately 150 feet [46 m] above sea level). The Waycross terrace, therefore, is interpreted as also being Pleistocene, and possibly late Pleistocene, in age.

No sediments of any kind are known to be associated with the marine terraces above the Waycross terrace in Georgia. However, the Cypresshead Formation, in addition to underlying the "Talbot", Penholoway, "Wicomico", Okefenokee, and Waycross terraces in Georgia, also underlies a small portion of the Argyle terrace in northern Wayne County, Georgia. The Cypresshead Formation is late Pliocene to possibly early Pleistocene in age. Therefore, the Argyle terrace would be no older than late Pliocene to possibly early Pleistocene in Georgia.

In southwestern Georgia, the Argyle, Claxton, Pearson, and Hazlehurst terraces are underlain by the Miccosukee Formation. The dissected scarp (shoreline) that bounds the Hazlehurst terrace on the north and west, is also cut into the Miccosukee Formation (i.e., the Miccosukee Formation both underlies the Hazlehurst terrace and occurs inland from the terrace and at higher elevations) (compare Figs. 51 and 56). The Hazlehurst terrace, which is the highest and oldest currently recognized terrace, is therefore younger than the Miccosukee Formation. The Miccosukee Formation is believed to be late Pliocene to possibly early Pleistocene in age, and the Hazlehurst terrace is interpreted as being no older than that.

The Miccosukee Formation appears to have been structurally tilted since it was deposited. In the vicinity of Pelham, Mitchell County, Georgia, the northernmost known occurrence of the formation, the Miccosukee occurs as high as approximately 350 feet (107 m) above sea level. Based on the known thickness distribution of the Miccosukee Formation, its base is probably not much higher than 300 feet (107 m) above sea level at Pelham. At Tallahassee, Florida, the base of the Miccosukee Formation is approximately 150 feet (46 m) above sea level, and the base of the correlative Citronelle Formation at Alum Bluff in Liberty County, Florida, is approximately at 70 feet (21 m) above sea level. Between Pelham, Georgia, and Alum Bluff in Florida, the elevation range of the base of the Miccosukee Formation-Citronelle Formation is roughly 230 feet (70 m). However, the Miccosukee Formation is interpreted as being of coastal marine origin, and the burrows (*Ophiomorpha nodosa*) of the intertidal shrimp *Callianassa major* are locally abundant in both the Miccosukee and Citronelle Formations. A water depth on the continental shelf of 230 feet (70 m) for deposition of the Miccosukee Formation is out of the question. For these reasons, therefore, the Miccosukee Formation has evidently been structurally tilted since it was deposited.

Similarly, it is concluded that the correlative Cypresshead Formation of eastern Georgia has been structurally tilted since it was deposited. Based on the presence of cross-bedded gravels, bioturbation, local abundance of *Ophiomorpha nodosa*, and rarely occurring fossiliferous beds, the Cypresshead Formation is interpreted as being of coastal marine origin. The base of the Cypresshead Formation occurs at least as high as 100 feet (30 m) above sea level in Screven County in the Savannah River area, and at elevations at least as low as 32 feet (10 m) below sea level in Chatham County, a range of roughly 130 feet (40 m). A water depth on the continental shelf for deposition of the Cypresshead Formation of 130 feet (40 m) is out of the question. For these reasons, the Cypresshead Formation has evidently been structurally tilted since it was deposited.

None of the marine terraces in Georgia and northern Florida have been structurally tilted or warped. Therefore, the tilting event took place after the deposition of the Miccosukee and Cypresshead Formations of late Pliocene to possibly early Pleistocene age, and prior to the construction of the marine terraces. Because the tilting event is likely to have taken some time, all of the marine terraces in Georgia, South Carolina, and northern Florida are interpreted here as being of Pleistocene age.

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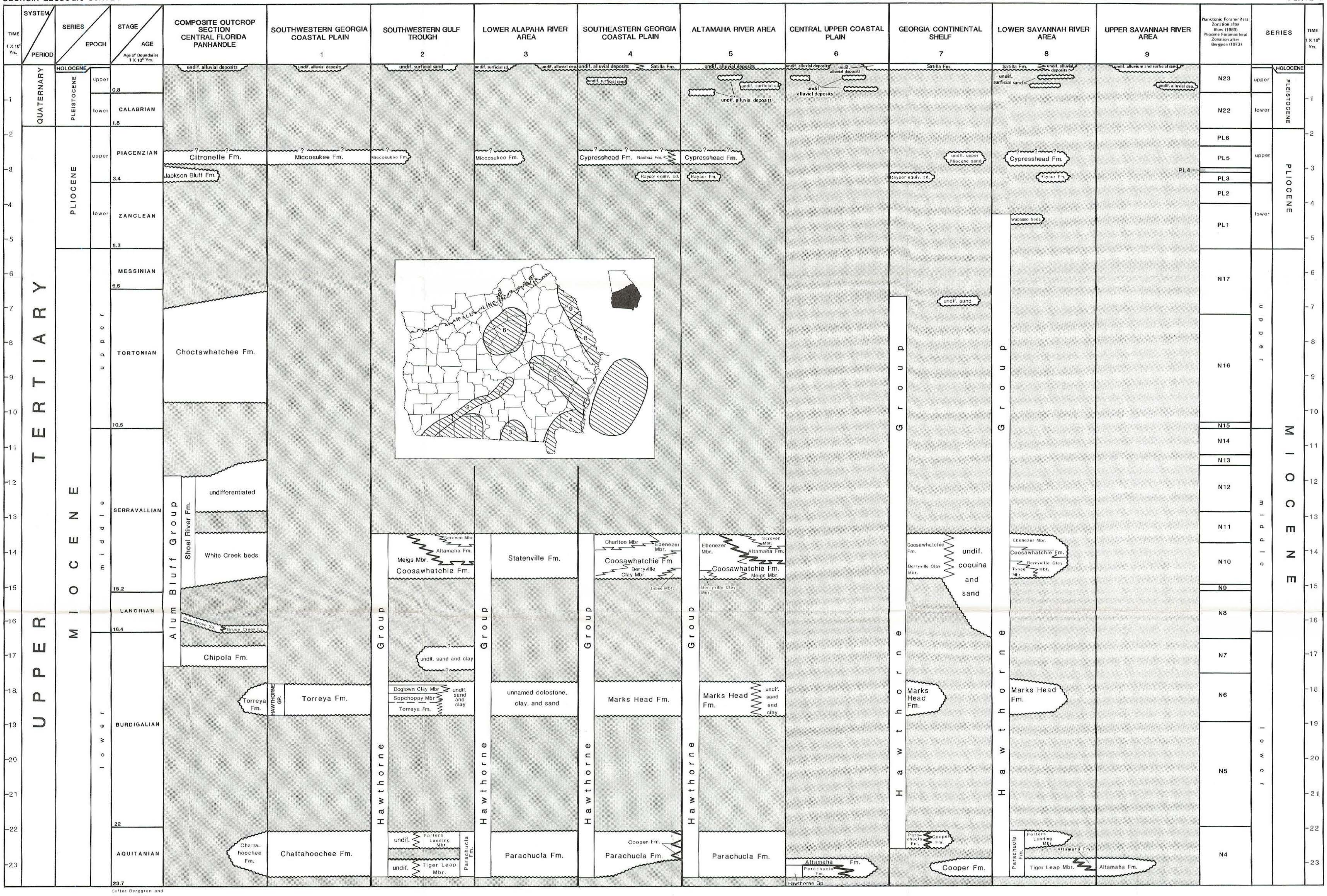


CORRELATION CHART OF MIOCENE TO HOLOCENE STRATIGRAPHIC UNITS OF GEORGIA AND WESTERN FLORIDA

STRATIGRAPHIC CROSS-SECTION NEAR THE SAVANNAH RIVER FROM SCREVEN COUNTY TO AMCOR 6002 ON THE CONTINENTAL SHELF

STRATIGRAPHIC CROSS-SECTION FROM UPPER SISTER BLUFF ON THE ALTAMAHA RIVER TO AMCOR 6002 ON THE CONTINENTAL SHELF

APPENDIX I

SUMMARY TABLE OF WATER LEVELS
DETERMINATION OF SEASONAL HIGH WATER LEVELS (SHWLs)
SITE SUITABILITY ASSESSMENT, BRANTLEY COUNTY, GEORGIA

WELL	WATER LEVEL (ft msl)													
NUMBER	03/15/16	04/08/16	06/28/16	08/19/16	01/30/19	03/12/19	04/16/19	05/24/19	06/28/19	MAX	MIN	DELTA	ADJUST.	SHWL
P-01	62.57	63.17	62.21	64.39	**65.17**	64.72	64.19	61.88	61.84	**65.17**	61.84	3.33	0.00	**65.17**
P-02	69.98	70.11	70.92	70.87	**72.41**	71.79	71.00	69.95	70.16	**72.41**	69.95	2.46	0.00	**72.41**
P-03	69.46	70.07	69.05	69.88	**71.50**	70.92	70.17	68.81	69.03	**71.50**	68.81	2.69	0.00	**71.50**
P-04	70.74	71.55	69.99	70.91	**72.14**	71.47	71.54	70.06	70.13	**72.14**	69.99	2.15	0.00	**72.14**
P-05	67.81	68.01	67.43	68.13	**69.76**	69.05	68.59	67.09	67.17	**69.76**	67.09	2.67	0.00	**69.76**
P-06	69.91	70.80	69.54	70.45	**72.03**	71.54	70.92	69.31	69.33	**72.03**	69.31	2.72	0.00	**72.03**
P-07	67.14	68.70	66.71	67.67	**69.52**	69.20	68.85	66.56	66.98	**69.52**	66.56	2.96	0.00	**69.52**
P-08	65.72	67.77	66.47	66.94	**68.63**	68.30	67.64	65.87	66.15	**68.63**	65.72	2.91	0.00	**68.63**
P-09	67.55	69.00	67.59	68.57	**69.57**	69.04	69.24	67.29	67.22	**69.57**	67.22	2.35	0.00	**69.57**
P-10	67.21	68.10	67.00	67.56	**68.77**	68.60	68.17	66.50	66.56	**68.77**	66.50	2.27	0.00	**68.77**
P-11	59.06	58.90	56.82	57.14	**59.21**	58.96	58.67	56.25	56.32	**59.21**	56.25	2.96	0.00	**59.21**
P-12	65.07	66.74	65.31	66.07	**67.80**	67.18	66.67	65.97	64.95	**67.80**	64.95	2.85	0.00	**67.80**
											AVERAGE =	2.69		
											ROUNDED =	3.00		

WELL	WATER LEVEL (ft msl)													
NUMBER	03/15/16	04/08/16	06/28/16	08/19/16	01/30/19	03/12/19	04/16/19	05/24/19	06/28/19	MAX	MIN	DELTA	ADJUST.	SHWL
P-13	NI	NI	NI	NI	NI	NI	58.69	**57.18**	57.27	58.69	**57.18**	1.51	3.00	**60.18**
P-14	NI	NI	NI	NI	NI	NI	54.22	52.77	**52.54**	54.22	**52.54**	1.68	3.00	**55.54**
P-15	NI	NI	NI	NI	NI	NI	55.83	54.08	**53.51**	55.83	**53.51**	2.32	3.00	**56.51**
P-16	NI	NI	NI	NI	NI	NI	69.72	68.10	**67.21**	69.72	**67.21**	2.51	3.00	**70.21**
P-17	NI	NI	NI	NI	NI	NI	69.24	66.93	**66.79**	69.24	**66.79**	2.45	3.00	**69.79**
P-18	NI	NI	NI	NI	NI	NI	66.13	64.24	**64.20**	66.13	**64.20**	1.93	3.00	**67.20**
P-19	NI	NI	NI	NI	NI	NI	63.21	60.96	**60.67**	63.21	**60.67**	2.54	3.00	**63.67**
P-20	NI	NI	NI	NI	NI	NI	64.72	62.48	**62.46**	64.72	**62.46**	2.26	3.00	**65.46**
P-21	NI	NI	NI	NI	NI	NI	63.08	**60.98**	61.13	63.08	**60.98**	2.10	3.00	**63.98**
P-22	NI	NI	NI	NI	NI	NI	69.98	68.49	**68.48**	69.98	**68.48**	1.50	3.00	**71.48**
P-23	NI	NI	NI	NI	NI	NI	70.58	**68.93**	69.00	70.58	**68.93**	1.65	3.00	**71.93**
P-24	NI	NI	NI	NI	NI	NI	71.32	**70.08**	70.26	71.32	**70.08**	1.24	3.00	**73.08**
											AVERAGE =	1.97		
											ROUNDED =	2.00		

NI = Not Installed   ft msl = feet mean sea level

NOTES:

Seasonal High Water Level's (SHWLs) for piezometers P-01 thru P-12 based upon data measured on January 30, 2019, the date with the highest recorded elevations. Because piezometers P-13 thru P-24 were installed after January 30, 2019, the rounded average groundwater fluctuation of all dates for piezometers P-01 thru P-12 (+3.0 feet) was applied to the lowest water levels recorded to estimate the SHWLs for piezometers P-13 thru P-24.

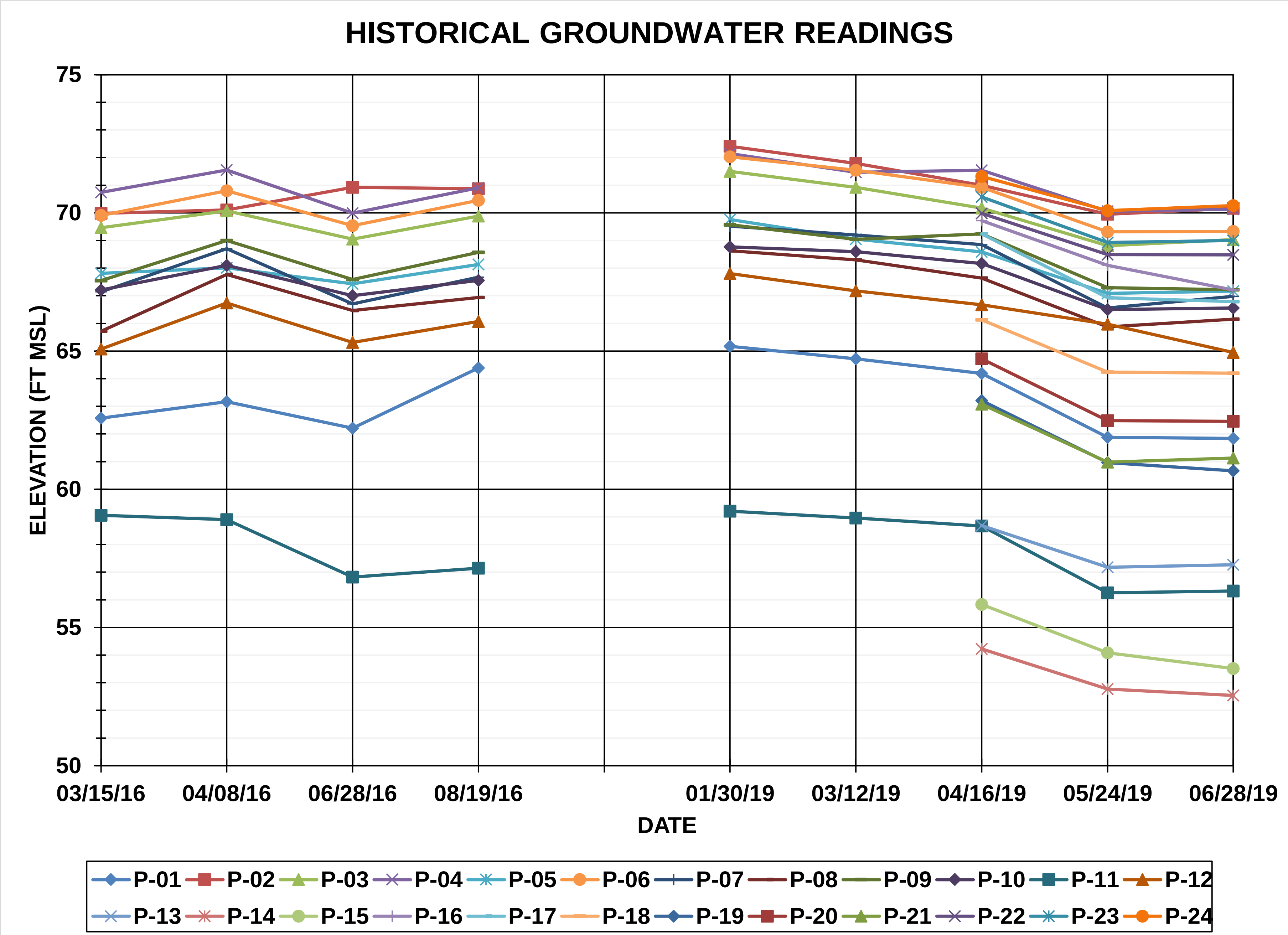

HISTORICAL GROUNDWATER READINGS
75
70
65
60
55
50
ELEVATION (FT MSL)
03/15/16
04/08/16
06/28/16
08/19/16
01/30/19
03/12/19
04/16/19
05/24/19
06/28/19
DATE
P-01 P-02 P-03 P-04 P-05 P-06 P-07 P-08 P-09 P-10 P-11 P-12
P-13 P-14 P-15 P-16 P-17 P-18 P-19 P-20 P-21 P-22 P-23 P-24

TABLE 2-01A
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded 03/15 - 03/17/2016)

WELL NUMBER	TIME	GROUND ELEVATION (msl)	DEPTH TO WATER (bgs)	WATER LEVEL (msl)
P-01	NA	64.97	2.4	62.57
P-02	NA	72.48	2.5	69.98
P-03	NA	71.66	2.2	69.46
P-04	NA	73.94	3.2	70.74
P-05	NA	70.31	2.5	67.81
P-06	NA	72.01	2.1	69.91
P-07	NA	69.24	2.1	67.14
P-08	NA	68.72	3.0	65.72
P-09	NA	70.55	3.0	67.55
P-10	NA	70.21	3.0	67.21
P-11	NA	60.56	1.5	59.06
P-12	NA	67.87	2.8	65.07

btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01B
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 04/08/2016)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	1123	69.96	6.79	63.17
P-02	1134	77.01	6.90	70.11
P-03	1146	76.48	6.41	70.07
P-04	1100	78.91	7.36	71.55
P-05	1055	75.36	7.35	68.01
P-06	1052	77.12	6.32	70.80
P-07	1023	74.66	5.96	68.70
P-08	1049	73.69	5.92	67.77
P-09	1029	75.74	6.74	69.00
P-10	1040	75.01	6.91	68.10
P-11	1044	65.54	6.64	58.90
P-12	1034	71.35	4.61	66.74

btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01C
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 06/28/2016)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	1205	69.96	7.75	62.21
P-02	1142	77.01	6.09	70.92
P-03	1147	76.48	7.43	69.05
P-04	1135	78.91	8.92	69.99
P-05	1127	75.36	7.93	67.43
P-06	1123	77.12	7.58	69.54
P-07	1045	74.66	7.95	66.71
P-08	1120	73.69	7.22	66.47
P-09	1059	75.74	8.15	67.59
P-10	1108	75.01	8.01	67.00
P-11	1113	65.54	8.72	56.82
P-12	1102	71.35	6.04	65.31

btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01D
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 08/19/2016)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	0850	69.96	5.57	64.39
P-02	0839	77.01	6.14	70.87
P-03	0836	76.48	6.60	69.88
P-04	0832	78.91	8.00	70.91
P-05	0827	75.36	7.23	68.13
P-06	0824	77.12	6.67	70.45
P-07	0800	74.66	6.99	67.67
P-08	0822	73.69	6.75	66.94
P-09	0805	75.74	7.17	68.57
P-10	0813	75.01	7.45	67.56
P-11	0816	65.54	8.40	57.14
P-12	0810	71.35	5.28	66.07

btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01E
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 01/30/2019)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	1722	69.96	4.79	65.17
P-02	1507	77.01	4.60	72.41
P-03	1519	76.48	4.98	71.50
P-04	1522	78.68 *	6.54	72.14
P-05	1530	75.36	5.60	69.76
P-06	1533	77.12	5.09	72.03
P-07	1612	74.66	5.14	69.52
P-08	1540	73.69	5.06	68.63
P-09	1608	71.13 *	1.56	69.57
P-10	1605	75.01	6.24	68.77
P-11	1545	63.66 *	4.45	59.21
P-12	1620	71.35	3.55	67.80

* = damaged well casing (estimate only)
btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01F
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 03/12/2019)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	1122	69.96	5.24	64.72
P-02	0956	77.01	5.22	71.79
P-03	1000	76.48	5.56	70.92
P-04	1003	78.68 *	7.21	71.47
P-05	1008	75.36	6.31	69.05
P-06	1006	77.12	5.58	71.54
P-07	1024	74.66	5.46	69.20
P-08	1010	73.69	5.39	68.30
P-09	1018	71.13 *	2.09	69.04
P-10	1016	75.01	6.41	68.60
P-11	1013	63.66 *	4.70	58.96
P-12	1020	71.35	4.17	67.18

* = damaged well casing (estimate only)
btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01H
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 05/24/2019)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	0728	69.96	8.08	61.88
P-02	0818	77.01	7.06	69.95
P-03	0823	76.48	7.67	68.81
P-04	0829	76.52	6.46	70.06
P-05	0846	75.36	8.27	67.09
P-06	0848	77.12	7.81	69.31
P-07	0853	74.66	8.10	66.56
P-08	0926	73.69	7.82	65.87
P-09	0905	74.36	7.07	67.29
P-10	0907	75.01	8.51	66.50
P-11	0910	63.98	7.73	56.25
P-12	0901	71.35	5.38	65.97
P-13	0734	65.40	8.22	57.18
P-14	0739	60.23	7.46	52.77
P-15	0746	62.82	8.74	54.08
P-16	0843	75.22	7.12	68.10
P-17	0904	73.57	6.64	66.93
P-18	0900	72.99	8.75	64.24
P-19	0923	70.76	9.80	60.96
P-20	0913	69.76	7.28	62.48
P-21	0804	68.29	7.31	60.98
P-22	0836	77.60	9.11	68.49
P-23	0850	75.87	6.94	68.93
P-24	0827	76.84	6.76	70.08

btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01G
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 04/16/2019)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	0813	69.96	5.77	64.19
P-02	0858	77.01	6.01	71.00
P-03	0902	76.48	6.31	70.17
P-04	0913	76.52	4.98	71.54
P-05	0936	75.36	6.77	68.59
P-06	0938	77.12	6.20	70.92
P-07	0945	74.66	5.81	68.85
P-08	1018	73.69	6.05	67.64
P-09	0948	74.36	5.12	69.24
P-10	1007	75.01	6.84	68.17
P-11	1012	63.98	5.31	58.67
P-12	0956	71.35	4.68	66.67
P-13	0820	65.40	6.71	58.69
P-14	0832	60.23	6.01	54.22
P-15	0849	62.82	6.99	55.83
P-16	0933	75.22	5.50	69.72
P-17	0951	73.57	4.33	69.24
P-18	1001	72.99	6.86	66.13
P-19	1033	70.76	7.55	63.21
P-20	1014	69.76	5.04	64.72
P-21	0756	68.29	5.21	63.08
P-22	0922	77.60	7.62	69.98
P-23	0942	75.87	5.29	70.58
P-24	0907	76.84	5.52	71.32

btc = Below Top of Casing
msl = Mean Sea Level

TABLE 2-01I
SITE SUITABILITY ASSESSMENT
BRANTLEY COUNTY, GEORGIA
(Measurements Recorded on 06/28/2019)

WELL NUMBER	TIME	TOC ELEVATION (msl)	DEPTH TO WATER (btc)	WATER LEVEL (msl)
P-01	1227	69.96	8.12	61.84
P-02	1311	77.01	6.85	70.16
P-03	1315	76.48	7.45	69.03
P-04	1340	76.52	6.39	70.13
P-05	1401	75.36	8.19	67.17
P-06	1404	77.12	7.79	69.33
P-07	1410	74.66	7.68	66.98
P-08	1459	73.69	7.54	66.15
P-09	1413	74.36	7.14	67.22
P-10	1427	75.01	8.45	66.56
P-11	1432	63.98	7.66	56.32
P-12	1418	71.35	6.40	64.95
P-13	1233	65.40	8.13	57.27
P-14	1238	60.23	7.69	52.54
P-15	1249	62.82	9.31	53.51
P-16	1357	75.22	8.01	67.21
P-17	1415	73.57	6.78	66.79
P-18	1421	72.99	8.79	64.20
P-19	1447	70.76	10.09	60.67
P-20	1429	69.76	7.30	62.46
P-21	1203	68.29	7.16	61.13
P-22	1344	77.60	9.12	68.48
P-23	1407	75.87	6.87	69.00
P-24	1329	76.84	6.58	70.26

btc = Below Top of Casing
msl = Mean Sea Level

Brantley

4/8/16

TIME	Piezometer ~~P-07~~	dtw (TOC)	(TOC to Ground)	
10:23	P-07	5.96	5' 1 1/2"	
10:27	P-09	6.74	4'9"	
10:34	P-12	4.61	3'4"	
10:40	P-10	6.91	5'1½"	
10:44	P-11	6.64	4'11"	
10:49	P-08	5.92	5'1"	
10:52	P-06	6.32	4'10"	58"
10:55	P-05	7.35	5'½"	60½
11:00	P-04	7.36		59½
11:23	P-01	6.79	4'10½	58½
11:34	P-02	6.90	4'7"	55
11:40	P-03	6.41	4'6"	
1:00 PM	P-04	7.37		
1:10 PM	P-06	~~5.33~~ 6.33		
1:36 PM	P-07	6.00		

0/28/2016 Brantley

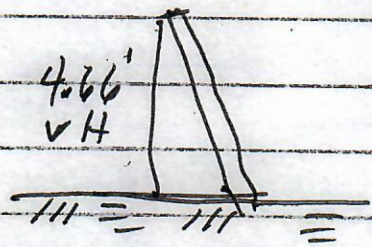
1045	dtw	P-07	7.95
1059	dtw	P-09	8.15
1102	dtw	P-12	6.04
1108	dtw	P-10	8.01
1113	dtw	P-11	8.72
1120	dtw	P-08	7.22
1123	dtw	P-06	7.58
1127	dtw	P-05	7.93
1135	dtw	P-04	8.92
1142	dtw	P-02	6.09
1147	dtw	P-03	7.43
1205	dtw	P-01	7.75

~~1205~~

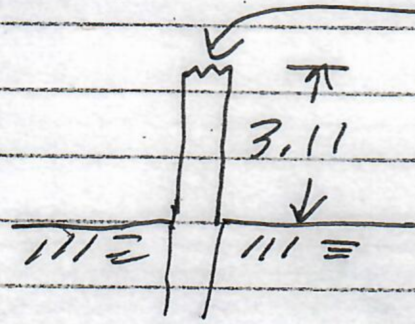
	08/29/2016	Brantley County
0800	P-07	DTW 6.99'
0805	P-09	7.17
0810	P-12	5.28
0813	P-10	7.45
0816	P-11	8.40
0822	P-8	6.75
0824	P-6	6.67
0827	P-5	7.23
0832	P-4	8.00
0836	P-3	6.60
0839	P-2	6.14
0850	P-1	5.57
1245	offsite	35.10 below grade

1/30/19 — Mike Biers — Steve Harbin

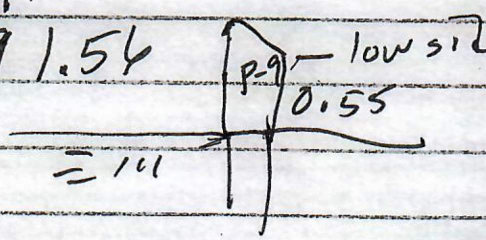
Borehole	Depth to H_2O	Approx. Time	Notes
P-2	4.60	3:07 pm	
P-3	4.98	3:19 pm	
P-4	6.54	3:22 pm	Missing cap Damaged well head



Borehole	Depth to H_2O	Approx. Time	Notes
P-5	5.60	3:30	
P-6	5.09	3:33	
~~P~~		3:46	
P-8	5.06	3:40	Missing cap &
P-11	4.45	3:45	Damaged broken off



Borehole	Depth to H_2O	Approx. Time	Notes
P-10	6.24	4:05	Broken no cap
P-9	1.54	4:08	



Borehole	Depth to H_2O	Approx. Time	Notes
P-7	5.14	4:12	
P-12	3.55	4:20	
P-1	4.79	5:22	

3/12/19

Piezometer No.	Time	Depth to Water	Notes	
2	9:56 am	5.22		
3	10:00 am	5.56		
4	10:03 am	7.21	Vert. Ht. above grn 4.81 bent	no cap
6	10:06 am	5.58		
5	10:08 am	6.31		
8	10:10 am	5.39		
11	10:13 am	4.70	vert Ht. above grn 3.09	Missing cap/broken
10	10:16 am	6.41		cap missing Damaged
9	10:18 am	2.09	vert Ht. above grn 0.61	
12	10:20 am	4.17		
7	10:24 am	5.46		
1	11:22 am	5.24		

4/16/19 Brantley

0756	P-21	dtw	5.21' btoc	
0813	P-01	dtw	5.77	
0820	P-13	dtw	6.71	
0832	P-14	dtw	6.01	
0849	P-15	dtw	6.99	
0858	P-02	dtw	6.01	
0902	P-03	dtw	6.31	
0907	P-24	dtw	5.52	
0913	P-04	dtw	4.98	repair damaged well
0922	P-22	dtw	7.62	
0933	P-16	dtw	5.50	
0936	P-05	dtw	6.77	
0938	P-06	dtw	6.20	
0942	P-23	dtw	5.29'	
0945	P-07	dtw	5.81'	
0948	P-09	dtw	5.12'	repair damaged well
0951	P-17	dtw	4.33'	
0956	P-12	dtw	4.68'	
1001	P-18	dtw	6.86'	
1007	P-10	dtw	6.84'	
1012	P-11	dtw	5.31'	repair damaged well
1014	P-20	dtw	5.04	
1018	P-08	dtw	6.05'	
1033	P-19		7.55'	

05/24/19 Brantley

0728	dtw	P-01	8.08'
0734	dtw	P-13	8.22'
0739	dtw	P-14	7.46'
0746	dtw	P-15	8.74
0804	dtw	P-21	7.31'
0818	dtw	P-02	7.06'
0823	dtw	P-03	7.67'
0827	dtw	P-24	6.76'
0829	dtw	P-04	6.46'
0836	dtw	P-22	9.11'
0843	dtw	P-16	7.12'
0846	dtw	P-05	8.27'
0848	dtw	P-06	7.81'
0850	dtw	P-23	6.94'
0853	dtw	P-07	8.10'
0900	dtw	P-18	8.75
0901	dtw	P-12	5.38'
0904	dtw	P-17	6.64'
0905	dtw	P-09	7.07'
0907	dtw	P-10	8.51'
0910	dtw	P-11	7.73'
0913	dtw	P-20	7.28
0923	dtw	P-19	9.80'
0926	dtw	P-08	7.82'

6/28/19 Brantley

1203	dtw	P-21	dtw 7.16'
1227	dtw	P-01	dtw 8.12'
1233	dtw	P-13	dtw 8.13
1238	dtw	P-14	dtw 7.69'
1249	dtw	P-15	dtw 9.31'
1311	dtw	P-02	dtw 6.85'
1315	dtw	P-03	dtw 7.45'
1329	dtw	P-24	dtw 6.58'
1340	dtw	P-04	dtw 6.39'
1344	dtw	P-22	dtw 9.12'
1357	dtw	P-16	dtw 8.01'
1401	dtw	P-05	dtw 8.19'
1404	dtw	P-06	dtw 7.79'
1407	dtw	P-23	dtw 6.87
1410	dtw	P-07	dtw 7.68'
1413	dtw	P-09	dtw 7.14
1415	dtw	P-17	dtw 6.78'
1418	dtw	P-12	dtw 6.40
1421	dtw	P-18	dtw 8.79
1427	dtw	P-10	dtw 8.45
1429	dtw	P-20	dtw 7.30'
1432	dtw	P-11	dtw 7.60'
1447	dtw	P-19	dtw 10.09'
1459	dtw	P-08	dtw 7.54'

WATER QUALITY SAMPLING FIELD MEASUREMENT FORM

PROJECT NAME:	SITE SUITABILITY ASSESSMENT REPORT	**WELL:**	P-04
PROJECT NO:	1390-011-01	**BY:**	Michael W. Biers
PROJECT LOCATION:	BRANTLEY COUNTY, GEORGIA	**DATE:**	06/28/16

Casing Diameter	2 inches	2" ID wells: c = 0.16	**Total Depth:**	20.47 feet
1 Well Volume:	1.85 gallons	4" ID wells: c = 0.65	**Depth to Water:**	8.92 feet
3 Well Volumes:	5.54 gallons	6.25" ID wells: c = 1.6	**Feet of Water:**	11.55 feet

Time	Gallons Purged	Turbidity (NTU's)	Specific Cond. (X1000) (mS/cm)	pH	Temp (°C)	Dissolved Oxygen (mg/L)	Salinity (ppm)	Oxidation Reduction Potential (mV)	COMMENTS
1240									Begin Purging
1245	5.0	>1000	0.304	4.73	28.46	7.64	0.1	204	cloudy
1248	10.0	>1000	0.091	4.81	27.21	1.21	0.0	182	cloudy
1252	15.0	>1000	0.078	4.47	26.26	0.95	0.0	191	cloudy
1257	20.0	981	0.073	4.16	25.47	1.13	0.0	206	cloudy
1301	25.0	508	0.071	3.99	25.23	6.38	0.0	216	cloudy
1305	30.0	234	0.070	3.90	25.19	1.61	0.0	220	cloudy
1310	35.0	387	0.069	3.49	25.25	3.61	0.0	214	cloudy
1315	40.0	>1000	0.070	4.18	25.08	1.27	0.0	206	cloudy
1320	45.0	>1000	0.068	4.30	24.98	1.30	0.0	197	cloudy
1323	50.0	597	0.067	4.32	25.04	1.37	0.0	198	cloudy
1328	55.0	464	0.067	4.35	24.77	1.38	0.0	196	cloudy
1332	60.0	317	0.065	4.44	25.12	2.76	0.0	193	cloudy
1336	65.0	96.0	0.065	4.42	24.87	1.55	0.0	197	cloudy
1339	70.0	254	0.066	4.39	24.72	1.12	0.0	199	cloudy
1343	75.0	133	0.063	4.45	24.71	2.36	0.0	196	cloudy
1347	80.0	55.8	0.065	4.38	24.89	1.50	0.0	200	cloudy
1352	85.0	110	0.064	4.42	24.53	1.54	0.0	199	cloudy
1356	90.0	33.3	0.063	4.45	24.40	3.08	0.0	198	Sl. cloudy
1400	95.0	16.3	0.064	4.38	24.17	1.14	0.0	201	clear
1403	100.0	12.6	0.063	4.40	24.08	2.00	0.0	202	clear
1407									dtw 9.27'

WATER QUALITY SAMPLING FIELD MEASUREMENT FORM

PROJECT NAME: SITE SUITABILITY ASSESSMENT REPORT **WELL:** P-06
PROJECT NO: 1390-011-01 **BY:** Michael W. Biers
PROJECT LOCATION: BRANTLEY COUNTY, GEORGIA **DATE:** 06/28/16

Casing Diameter 2 inches 2" ID wells: c = 0.16 **Total Depth:** 20.61 feet
1 Well Volume: 2.08 gallons 4" ID wells: c = 0.65 **Depth to Water:** 7.58 feet
3 Well Volumes: 6.25 gallons 6.25" ID wells: c = 1.6 **Feet of Water:** 13.03 feet

Time	Gallons Purged	Turbidity (NTU's)	Specific Cond. (X1000) (mS/cm)	pH	Temp (°C)	Dissolved Oxygen (mg/L)	Salinity (ppm)	Oxidation Reduction Potential (mV)	COMMENTS
1415									Begin Purging
1427	5.0	>1000	0.071	4.87	25.23	7.80	0.0	185	cloudy
1433	10.0	>1000	0.068	4.73	24.46	1.44	0.0	189	cloudy
1437	15.0	661	0.068	4.56	23.94	1.62	0.0	196	cloudy
1442	20.0	235	0.064	4.46	23.98	1.41	0.0	198	cloudy
1447	25.0	180	0.064	4.46	23.75	1.71	0.0	197	cloudy
1451	30.0	36.1	0.063	4.41	23.55	1.75	0.0	198	sl. cloudy
1456	35.0	11.6	0.065	4.47	23.49	1.61	0.0	194	clear
1500	40.0	261	0.062	4.53	23.45	3.05	0.0	191	cloudy
1504	45.0	29.9	0.063	4.40	23.30	1.52	0.0	196	sl. cloudy
1508	50.0	8.0	0.063	4.44	23.05	1.45	0.0	193	clear
1512	55.0	0.0	0.063	4.47	23.78	1.53	0.0	190	clear
1515									dtw 9.38'
1522	60.0	>1000	0.067	4.69	24.00	1.41	0.0	179	cloudy
1526	65.0	>1000	0.064	4.58	23.51	1.28	0.0	184	cloudy
1530	70.0	712	0.064	4.52	23.23	1.35	0.0	185	cloudy
1534	75.0	327	0.064	4.52	23.28	1.46	0.0	184	cloudy
1538	80.0	170	0.064	4.52	23.23	1.58	0.0	185	cloudy
1543	85.0	79.2	0.065	4.54	23.13	1.77	0.0	183	cloudy
1547	90.0	267	0.064	4.55	22.98	5.92	0.0	183	cloudy
1551	95.0	33.7	0.063	4.50	23.09	1.36	0.0	184	sl. cloudy
1555	100.0	26.7	0.062	4.59	23.02	1.64	0.0	185	sl. cloudy/clear
1557									dtw 11.09'
1601									dtw 7.97'

WATER QUALITY SAMPLING FIELD MEASUREMENT FORM

PROJECT NAME: SITE SUITABILITY ASSESSMENT REPORT **WELL:** P-08
PROJECT NO: 1390-011-01 **BY:** Michael W. Biers
PROJECT LOCATION: BRANTLEY COUNTY, GEORGIA **DATE:** 06/28/16

Casing Diameter	2 inches	2" ID wells: c = 0.16	**Total Depth:**	20.47 feet
1 Well Volume:	2.12 gallons	4" ID wells: c = 0.65	**Depth to Water:**	7.22 feet
3 Well Volumes:	6.36 gallons	6.25" ID wells: c = 1.6	**Feet of Water:**	13.25 feet

Time	Gallons Purged	Turbidity (NTU's)	Specific Cond. (X1000) (mS/cm)	pH	Temp (°C)	Dissolved Oxygen (mg/L)	Salinity (ppm)	Oxidation Reduction Potential (mV)	COMMENTS
1608									Begin Purging
1613	5.0	>1000	0.054	4.94	24.08	4.69	0.0	152	cloudy
1618	10.0	>1000	0.053	4.80	24.31	6.41	0.0	160	cloudy
1621	15.0	>1000	0.053	4.66	23.73	1.24	0.0	166	cloudy
1625	20.0	>1000	0.053	4.66	23.69	1.30	0.0	168	cloudy
1628	25.0	>1000	0.053	4.65	24.11	2.27	0.0	168	cloudy
1631	30.0	865	0.053	4.64	24.45	1.26	0.0	168	cloudy
1635	35.0	489	0.053	4.65	23.54	0.96	0.0	168	cloudy
1639	40.0	289	0.053	4.65	23.74	1.20	0.0	169	cloudy
1643	45.0	290	0.052	4.65	23.09	1.71	0.0	169	cloudy
1647	50.0	248	0.051	4.60	23.99	2.82	0.0	173	cloudy
1650	55.0	>1000	0.053	4.62	23.26	1.16	0.0	172	cloudy
1655	60.0	>1000	0.052	4.64	23.66	1.31	0.0	172	cloudy
1658	65.0	>1000	0.057	4.65	23.55	1.35	0.0	172	cloudy
1702	70.0	883	0.051	4.64	23.82	1.37	0.0	173	cloudy
1706	75.0	510	0.051	4.59	23.58	1.50	0.0	176	cloudy
1710	80.0	428	0.051	4.59	23.49	1.33	0.0	177	cloudy
1715	85.0	>1000	0.051	4.65	23.49	1.36	0.0	175	cloudy
1719	90.0	940	0.051	4.59	23.43	1.46	0.0	179	cloudy
1722	95.0	458	0.051	4.60	23.36	1.38	0.0	179	cloudy
1726	100.0	169	0.052	4.55	23.35	1.27	0.0	182	cloudy
1730	105.0	83.9	0.051	4.54	23.21	1.19	0.0	183	cloudy
1733	110.0	42.2	0.050	4.51	23.85	1.17	0.0	185	sl. cloudy
1737	115.0	>1000	0.050	4.56	23.13	1.00	0.0	182	cloudy
1742	120.0	612	0.051	4.52	23.06	1.43	0.0	183	cloudy
1746	125.0	187	0.051	4.54	23.09	1.62	0.0	183	cloudy
1749	130.0	69.3	0.052	4.53	22.80	6.76	0.0	183	sl. cloudy
1753	135.0	41.2	0.051	4.52	23.08	1.33	0.0	185	sl. cloudy
1757	140.0	22.5	0.050	4.51	23.02	1.00	0.0	185	sl. cloudy/clear
1759									dtw 7.52'
1801									dtw 7.35'

WATER QUALITY SAMPLING FIELD MEASUREMENT FORM

PROJECT NAME:	SITE SUITABILITY ASSESSMENT REPORT	**WELL:**	P-02
PROJECT NUMBER:	1390-010-01	**BY:**	M. Biers
PROJECT LOCATION:	BRANTLEY COUNTY, GEORGIA	**DATE:**	05/24/19

Casing Diameter:	2 inches	2" ID wells: c = 0.16	**Total Depth:**	20.48 feet
1 Well Volume:	2.15 gallons	4" ID wells: c = 0.65	**Depth to Water:**	7.06 feet @ 0818
3 Well Volumes:	6.44 gallons	6.25" ID wells: c = 1.6	**Feet of Water:**	13.42 feet

Time	Gallons Purged	Turbidity (NTUs)	Specific Cond. (x1000) (mS/cm)	pH	Temp (²C)	Dissolved Oxygen (mg/L)	Salinity (ppm)	Oxidation Reduction Potential (mV)	COMMENTS four-stage monsoon pump
13:25:30									Begin Purging @ 2.4 setting
13:33:10	5	12.4	0.100	4.04	22.50	7.10	0.0	NA	0.7 gpm
13:37:30	10	7.1	0.069	4.03	21.00	7.62	0.0		1.2
13:41:50	15	3.0	0.060	4.01	20.16	6.41	0.0		1.5
1346:00	20	1.0	0.059	3.81	19.77	7.43	0.0		1.2
1350:20	25	0.6	0.060	3.65	20.20	7.56	0.0		1.5
1354:50	30	0.4	0.060	3.58	19.50	1.54	0.0		1.1
1358:30	35	0.0	0.059	3.48	19.49	1.90	0.0		1.4 begin @ 2.6 setting
1403:10	40	0.6	0.060	3.19	19.23	1.41	0.0		1.1
1406:50	45	0.9	0.059	3.27	18.90	8.00	0.0		1.4
1410:20	50	0.1	0.059	3.15	19.06	7.85	0.0		1.4
1413:30	55	0.0	0.059	3.08	19.02	4.77	0.0		1.7
1417:10	60	1.0	0.060	2.93	18.98	7.97	0.0		1.4
1420:30	65	0.0	0.059	2.96	18.80	7.89	0.0		1.6
1424:00	70	0.0	0.059	3.01	18.80	2.43	0.0		1.4
1427:30	75	0.0	0.059	3.02	18.83	8.05	0.0		1.4 begin setting @ 28
1430:50	80	0.5	0.060	3.02	18.73	1.90	0.0		1.5
1433:30	85	0.0	0.060	3.08	18.67	2.28	0.0		1.9
1436:30	90	0.0	0.059	3.29	18.67	1.73	0.0		1.7
1439:10	95	0.0	0.060	3.56	18.69	1.51	0.0		1.9
1442:10	100	0.0	0.060	3.89	18.49	8.01	0.0		1.7
1445:10	105	1.9	0.060	3.90	18.62	7.90	0.0		1.7
1448:30	110	0.0	0.060	4.06	18.63	7.92	0.0		1.5
1451:10	115	0.0	0.059	4.08	18.58	8.06	0.0		1.9
1454:00	120	0.0	0.059	4.08	18.53	8.06	0.0		1.8
1456:40	125	0.0	0.061	4.11	18.41	8.01	0.0		1.9
1459:30	130	0.0	0.061	3.94	18.65	1.53	0.0		1.8
1508									stabilized WL

WATER QUALITY SAMPLING FIELD MEASUREMENT FORM

PROJECT NAME:	SITE SUITABILITY ASSESSMENT REPORT	**WELL:**	P-10
PROJECT NUMBER:	1390-010-01	**BY:**	M. Biers
PROJECT LOCATION:	BRANTLEY COUNTY, GEORGIA	**DATE:**	05/24/19

Casing Diameter:	2 inches	2" ID wells: c = 0.16	**Total Depth:**	20.45 feet
1 Well Volume:	1.91 gallons	4" ID wells: c = 0.65	**Depth to Water:**	8.51 feet @ 0907
3 Well Volumes:	5.73 gallons	6.25" ID wells: c = 1.6	**Feet of Water:**	11.94 feet

Time	**Gallons Purged**	**Turbidity** (NTUs)	**Specific Cond.** (x1000) (mS/cm)	**pH**	**Temp** (²C)	**Dissolved Oxygen** (mg/L)	**Salinity** (ppm)	**Oxidation Reduction Potential** (mV)	**COMMENTS** four-stage monsoon pump
1015									Begin Purging @ 2.4 setting
1022	5								0.7 gpm 2.9 setting purged dry
1028	10								0.7 restart
1034:29	15	2.7	0.184	4.26	19.81	2.35	0.1	NA	0.9
1041:20	20	3.5	0.077	4.28	19.25	8.98	0.0		0.7 begin @ 2.6 setting
1047:30	25	16.5	0.060	3.96	18.78	7.54	0.0		0.8
1052:30	30	11.5	0.056	3.80	18.38	8.30	0.0		1.0
1056:40	35	9.3	0.055	3.62	18.26	5.98	0.0		1.2
1101:30	40	6.1	0.056	3.48	18.12	8.57	0.6		1.0
1105:50	45	4.8	0.056	3.41	17.85	2.36	0.0		1.2
1110:30	50	4.4	0.056	3.40	17.93	8.75	0.0		1.1 begin @ 2.7 setting
1114:40	55	9.0	0.056	3.36	17.87	8.77	0.0		1.2
1118:40	60	6.3	0.056	3.23	18.10	8.53	0.0		1.3
1123:00	65	4.5	0.055	3.25	17.47	8.40	0.0		1.2
1127:00	70	3.2	0.056	3.31	17.91	8.75	0.0		1.3
1131:00	75	2.3	0.055	3.37	17.84	8.56	0.0		1.3
1135:00	80	1.8	0.056	3.37	17.99	5.71	0.0		1.3
1139:10	85	2.2	0.056	3.43	18.05	4.18	0.0		1.2
1143:40	90	1.8	0.056	3.55	17.92	6.75	0.0		1.4 begin @ 2.8 setting
1147:10	95	4.3	0.056	3.79	17.84	8.47	0.0		1.1
1151:10	100	4.6	0.056	3.87	17.89	8.59	0.0		1.3
1155:00	105	4.0	0.055	3.98	17.78	8.66	0.0		1.3
1158:50	110	2.5	0.054	4.04	17.82	8.39	0.0		1.3
1202:10	115	2.6	0.055	4.13	18.10	7.84	0.0		1.2
1206:30	120	2.0	0.056	4.22	17.98	7.44	0.0		1.5
1210:20	125	1.2	0.055	4.27	17.41	3.44	0.0		1.3
1214:10	130	0.5	0.056	4.20	18.22	8.01	0.0		1.3 shutoff pump
1220									stabilized WL

SITE SUITABILITY ASSESSMENT REPORT
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

SUMMARY TABLES OF
FIELD EVALUATIONS TO CALCULATE GROUNDWATER FLOW VELOCITIES

Table A: Effective Porosity of Undisturbed Soil Samples

Piezo-meter Well No.	Depth Inter-val (ft)	Bulk Density (pcf)	Bulk Density Specific Gravity	Soil Particle Specific Gravity	Effective Porosity (%)
P-08	9-11	114.7	1.84	2.66	31%
P-11	14-16	122.8	1.97	2.66	26%
P-12	20-22	118.4	1.90	2.66	29%
P-13	25-28	110.7	1.77	2.66	33%
P-14	5-8	112.0	1.79	2.66	33%
P-15	5-8	105.7	1.69	2.66	36%
P-23	1-4	110.3	1.77	2.66	34%
				AVERAGE =	**32%**

$$n = 1 - \frac{SG_{BULK\ DENSITY}}{SG_{SOIL\ PARTICLE}}$$

SITE SUITABILITY ASSESSMENT REPORT
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

SUMMARY TABLES OF
FIELD EVALUATIONS TO CALCULATE GROUNDWATER FLOW VELOCITIES

Table B: Horizontal Hydraulic Conductivity Determined From Step-Drawdown Pumping Tests

Piezo-meter Well No.	Step No.	Stabil-ized Draw-down (ft)	Constant Well Yield (gpm)	Aquifer Empiric. Factor	Trans-missivity (gpd/ft)	Static WL Saturat. Screen Length (ft)	Hydraulic Conductivity		
							(gpd/ft^2)	(cm/sec)	(ft/day)
P-04	1	3.61	2.000	1500	831	10.0	83.1	3.92E-03	11.11
P-04	2	4.34	2.143	1500	741	10.0	74.1	3.49E-03	9.90
						AVERAGE P-04 =	**78.6**	**3.71E-03**	**10.51**
P-08	1	0.90	0.500	1500	838	10.0	83.8	3.95E-03	11.20
P-08	2	3.53	1.875	1500	798	10.0	79.8	3.76E-03	10.67
						AVERAGE P-08 =	**81.8**	**3.86E-03**	**10.79**
P-02	1	1.32	0.652	1,500	742	10.0	74.2	3.50E-03	9.92
P-02	2	1.68	1.071	1,500	957	10.0	95.7	4.51E-03	12.79
P-02	3	2.03	1.500	1,500	1,106	10.0	110.6	5.22E-03	14.79
						AVERAGE P-02 =	**93.5**	**4.41E-03**	**12.50**
P-10	1	6.46	0.811	1,500	188	10.0	18.8	8.88E-04	2.52
P-10	2	8.31	1.200	1,500	217	10.0	21.7	1.02E-03	2.90
P-10	3	9.47	1.111	1,500	176	10.0	17.6	8.30E-04	2.35
						AVERAGE P-10 =	**19.4**	**9.13E-04**	**2.59**

Equation (1) from Appendix 16.D (Driscoll's
Groundwater and Wells, Second Edition):

$$T\ (gpd/ft) = 1{,}500\ \frac{Q\ (gpm)}{s\ (ft)} \qquad K = \frac{T}{b}$$

SITE SUITABILITY ASSESSMENT REPORT
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

SUMMARY TABLES OF
FIELD EVALUATIONS TO CALCULATE GROUNDWATER FLOW VELOCITIES

Table C: Groundwater Flow Horizontal Velocity

	Hydraul. Conduct. (ft/day)	Effective Porosity (%)	Hydraul. Gradient (ft/ft)	Flow Velocity (ft/day)
Maximum	14.79	26%	0.010	**0.57**
Average	8.81	26%	0.005	**0.17**

$$V = \frac{K \quad \Delta h}{n \quad \Delta l}$$

APPENDIX 16.D.
Empirical Equations Used to Estimate Specific Capacity and Transmissivity

Two empirical equations have been developed from the modified nonequilibrium (Jacob) equation to estimate the potential specific capacity and transmissivity of a well. These equations are derived by assuming an average well diameter, average duration of pumping, and typical values for the applicable storage coefficient. The equations are useful for quickly checking the accuracy of values obtained for transmissivity and specific capacity during pumping tests.

Recall Jacob's equation (9.6):

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2S}$$

where

s = drawdown in the well, in ft
Q = yield of the well, in gpm
T = transmissivity of the well, in gpd/ft
t = time of pumping, in days
r = radius of the well, in ft
S = storage coefficient of the aquifer

This equation is based on the simplifying assumptions listed on page 218.

By rearranging terms, the specific capacity is:

$$\frac{Q}{s} = \frac{T}{264 \log \frac{0.3Tt}{r^2S}} \qquad (1)$$

If typical values are assumed for the variables in the log function of the equation such as t = 1 day, r = 0.5 ft, T = 30,000 gpd/ft, and $S = 1 \times 10^{-3}$ for a confined aquifer and $S = 7.5 \times 10^{-2}$ for an unconfined aquifer, the specific capacity of the confined aquifer is given by:

$$\frac{Q}{s} = \frac{T}{2000} \qquad (2)$$

The specific capacity for an unconfined aquifer is given by:

$$\frac{Q}{s} = \frac{T}{1500} \qquad (3)$$

These empirical equations can be used to check the transmissivity of wells where the specific capacity is known, or the specific capacity where the transmissivity is known.

It may appear to be presumptuous to use an average transmissivity value or even to assume a transmissivity value at all before one is known. However, because it appears in the log term of Equation 1, its affect on the value of the divisor in either derivation is minimal. For example, if a transmissivity of 120,000 gpd/ft is assumed, the divisor increases from 2,000 to 2,133, a difference of less than 7 percent.

Estimates of Q/s using Equation 3 for unconfined aquifers will nearly always be optimistic because part of the aquifer is dewatered during pumping, resulting in a lower transmissivity as the saturated thickness decreases. Therefore, some estimates for unconfined aquifers may be more accurate if Equation 2 is used.

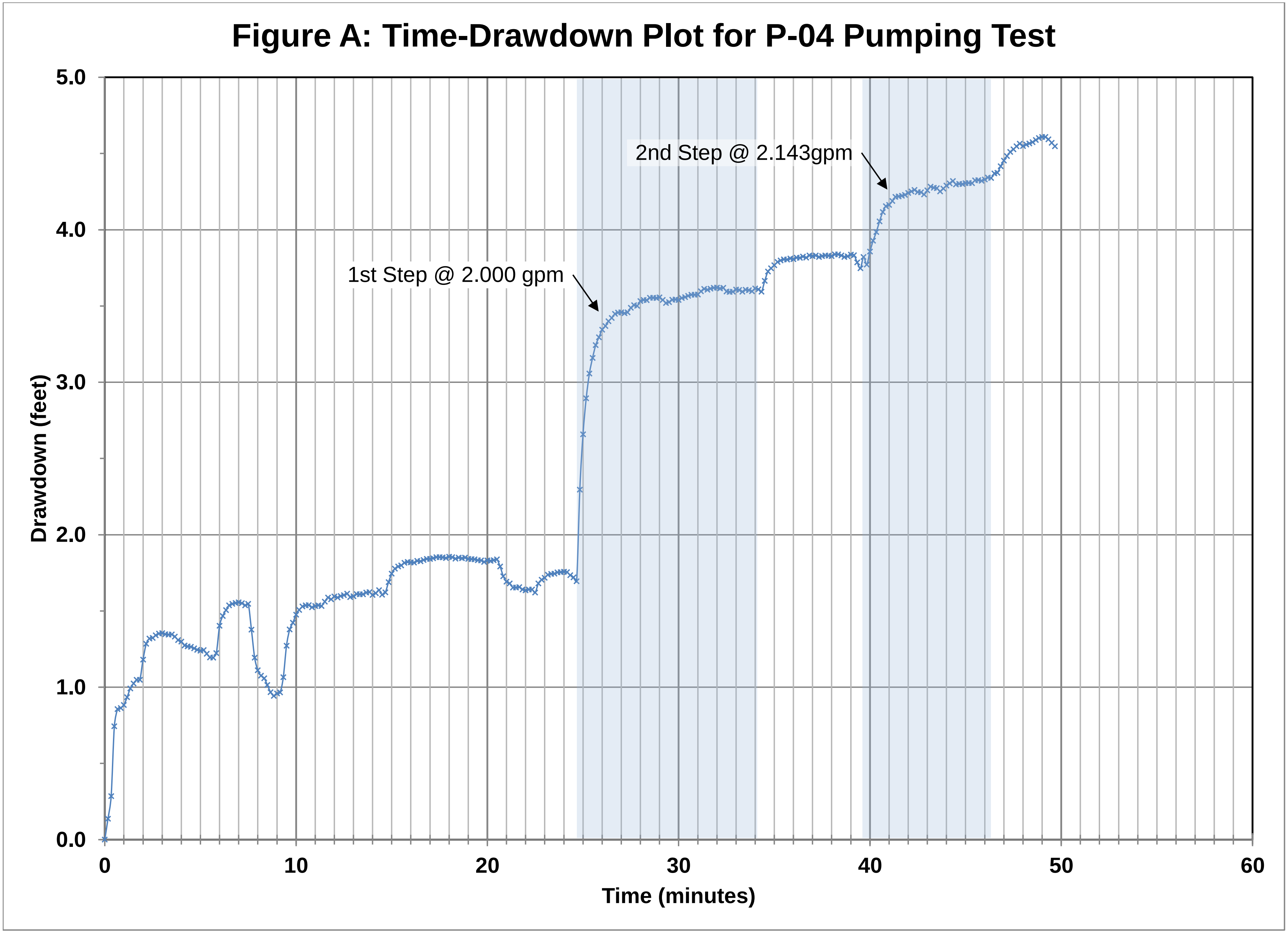


Figure A: Time-Drawdown Plot for P-04 Pumping Test
Drawdown (feet)
Time (minutes)
1st Step @ 2.000 gpm
2nd Step @ 2.143gpm
0.0
1.0
2.0
3.0
4.0
5.0
0
10
20
30
40
50
60

Figure A-1: Log Plot of P-04 Pumping Test Step 1

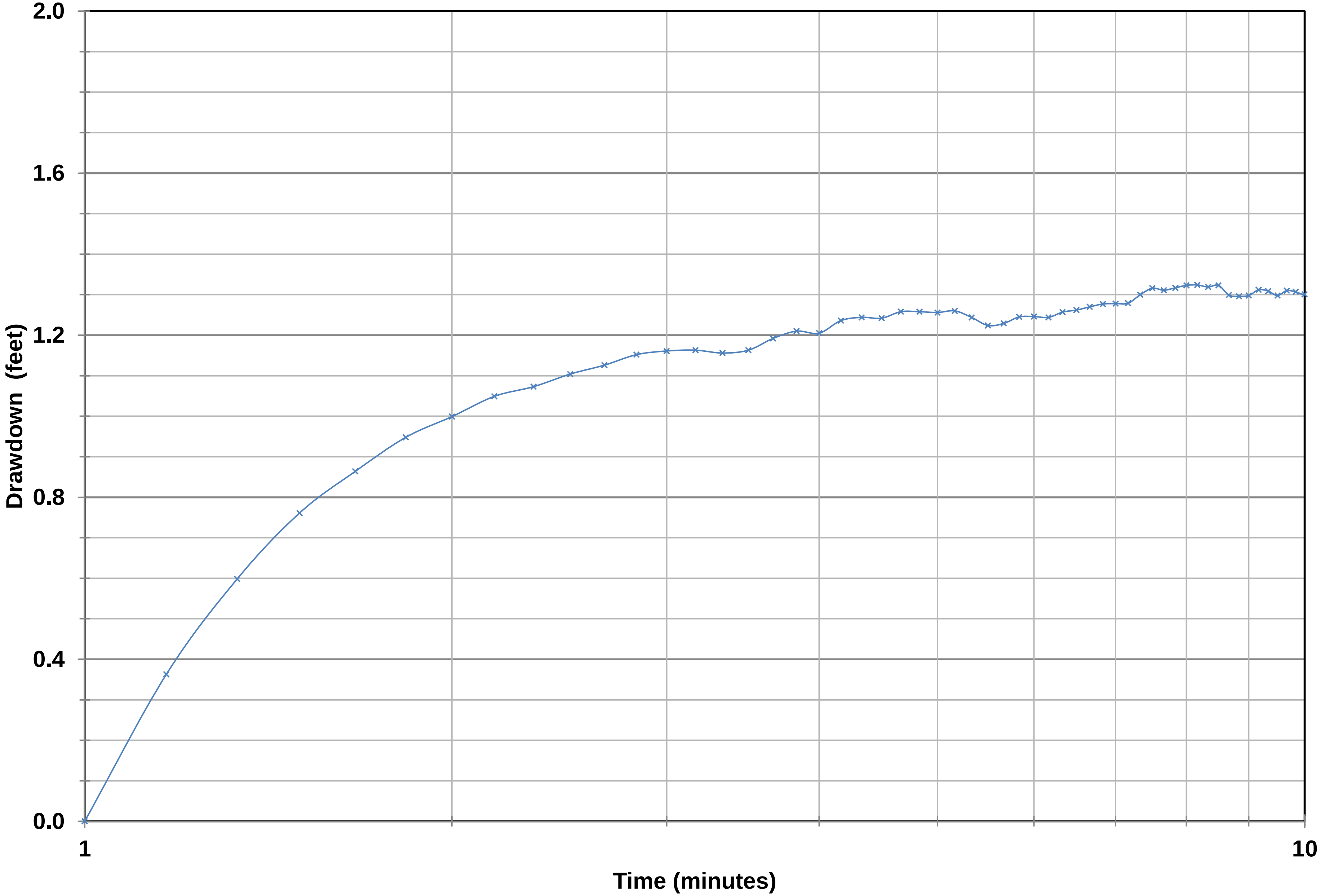
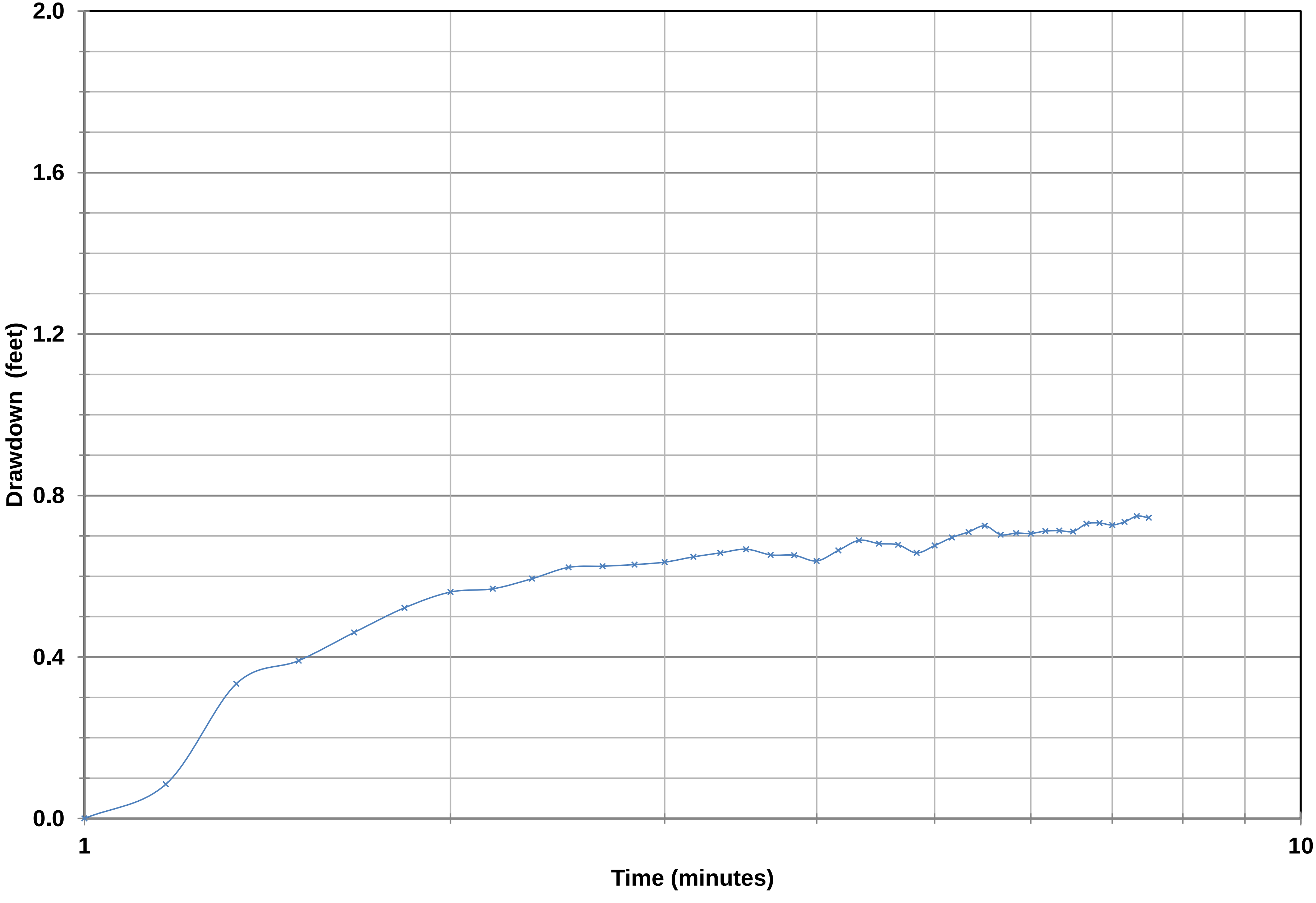


Figure A-2: Log Plot of P-04 Pumping Test Step 2



P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 10:35:06	3011.382	4.681	22.672	0.033		0.00	0.00
08/19/16 10:35:16	3021.382	4.622	22.673	0.170		0.17	0.14
08/19/16 10:35:26	3031.382	4.557	22.669	0.319		0.33	0.29
08/19/16 10:35:36	3041.382	4.359	22.668	0.777		0.50	0.74
08/19/16 10:35:46	3051.382	4.310	22.666	0.889		0.67	0.86
08/19/16 10:35:56	3061.382	4.307	22.664	0.897		0.83	0.86
08/19/16 10:36:06	3071.382	4.299	22.665	0.916		1.00	0.88
08/19/16 10:36:16	3081.382	4.276	22.666	0.967		1.17	0.93
08/19/16 10:36:26	3091.382	4.252	22.667	1.024		1.33	0.99
08/19/16 10:36:36	3101.382	4.237	22.665	1.057		1.50	1.02
08/19/16 10:36:46	3111.382	4.227	22.661	1.081		1.67	1.05
08/19/16 10:36:56	3121.382	4.227	22.658	1.081		1.83	1.05
08/19/16 10:37:06	3131.382	4.170	22.651	1.214	0.682	2.00	1.18
08/19/16 10:37:16	3141.382	4.125	22.646	1.317		2.17	1.28
08/19/16 10:37:26	3151.382	4.110	22.642	1.352		2.33	1.32
08/19/16 10:37:36	3161.382	4.108	22.633	1.356		2.50	1.32
08/19/16 10:37:46	3171.382	4.101	22.625	1.373		2.67	1.34
08/19/16 10:37:56	3181.382	4.095	22.619	1.385		2.83	1.35
08/19/16 10:38:06	3191.382	4.095	22.612	1.387	0.882	3.00	1.35
08/19/16 10:38:16	3201.382	4.098	22.603	1.380		3.17	1.35
08/19/16 10:38:26	3211.382	4.098	22.596	1.378		3.33	1.35
08/19/16 10:38:36	3221.382	4.098	22.583	1.379		3.50	1.35
08/19/16 10:38:46	3231.382	4.104	22.578	1.365		3.67	1.33
08/19/16 10:38:56	3241.382	4.114	22.568	1.342		3.83	1.31
08/19/16 10:39:06	3251.382	4.118	22.561	1.332	0.667	4.00	1.30
08/19/16 10:39:16	3261.382	4.129	22.549	1.307		4.17	1.27
08/19/16 10:39:26	3271.382	4.132	22.543	1.300		4.33	1.27
08/19/16 10:39:36	3281.382	4.133	22.532	1.298		4.50	1.27
08/19/16 10:39:46	3291.382	4.137	22.529	1.288		4.67	1.26
08/19/16 10:39:56	3301.382	4.142	22.519	1.278		4.83	1.25
08/19/16 10:40:06	3311.382	4.144	22.510	1.272		5.00	1.24
08/19/16 10:40:16	3321.382	4.143	22.504	1.276		5.17	1.24
08/19/16 10:40:26	3331.382	4.153	22.493	1.252		5.33	1.22
08/19/16 10:40:36	3341.382	4.163	22.487	1.228		5.50	1.20
08/19/16 10:40:46	3351.382	4.164	22.477	1.227		5.67	1.19
08/19/16 10:40:56	3361.382	4.151	22.474	1.257		5.83	1.22
08/19/16 10:41:06	3371.382	4.074	22.468	1.436		6.00	1.40
08/19/16 10:41:16	3381.382	4.046	22.458	1.500		6.17	1.47
08/19/16 10:41:26	3391.382	4.029	22.455	1.538		6.33	1.51
08/19/16 10:41:36	3401.382	4.016	22.448	1.569		6.50	1.54
08/19/16 10:41:46	3411.382	4.012	22.439	1.579		6.67	1.55
08/19/16 10:41:56	3421.382	4.009	22.432	1.585		6.83	1.55

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 10:42:06	3431.382	4.007	22.427	1.589	0.938	7.00	1.56
08/19/16 10:42:16	3441.382	4.009	22.422	1.584		7.17	1.55
08/19/16 10:42:26	3451.382	4.016	22.415	1.569		7.33	1.54
08/19/16 10:42:36	3461.382	4.011	22.410	1.580		7.50	1.55
08/19/16 10:42:46	3471.382	4.085	22.407	1.410		7.67	1.38
08/19/16 10:42:56	3481.382	4.164	22.404	1.227		7.83	1.19
08/19/16 10:43:06	3491.382	4.200	22.399	1.144		8.00	1.11
08/19/16 10:43:16	3501.382	4.215	22.390	1.109		8.17	1.08
08/19/16 10:43:26	3511.382	4.222	22.386	1.092		8.33	1.06
08/19/16 10:43:36	3521.382	4.242	22.384	1.047		8.50	1.01
08/19/16 10:43:46	3531.382	4.262	22.377	1.000		8.67	0.97
08/19/16 10:43:56	3541.382	4.273	22.374	0.976		8.83	0.94
08/19/16 10:44:06	3551.382	4.265	22.371	0.992		9.00	0.96
08/19/16 10:44:16	3561.382	4.263	22.363	0.999		9.17	0.97
08/19/16 10:44:26	3571.382	4.219	22.363	1.099		9.33	1.07
08/19/16 10:44:36	3581.382	4.130	22.359	1.305		9.50	1.27
08/19/16 10:44:46	3591.382	4.084	22.356	1.411		9.67	1.38
08/19/16 10:44:56	3601.382	4.065	22.353	1.456		9.83	1.42
08/19/16 10:45:06	3611.382	4.042	22.345	1.509	0.938	10.00	1.48
08/19/16 10:45:16	3621.382	4.028	22.342	1.540		10.17	1.51
08/19/16 10:45:26	3631.382	4.019	22.341	1.562		10.33	1.53
08/19/16 10:45:36	3641.382	4.015	22.337	1.570		10.50	1.54
08/19/16 10:45:46	3651.382	4.015	22.334	1.571		10.67	1.54
08/19/16 10:45:56	3661.382	4.021	22.333	1.557		10.83	1.52
08/19/16 10:46:06	3671.382	4.017	22.329	1.566		11.00	1.53
08/19/16 10:46:16	3681.382	4.016	22.325	1.569		11.17	1.54
08/19/16 10:46:26	3691.382	4.017	22.323	1.566		11.33	1.53
08/19/16 10:46:36	3701.382	4.005	22.321	1.594		11.50	1.56
08/19/16 10:46:46	3711.382	3.993	22.317	1.621		11.67	1.59
08/19/16 10:46:56	3721.382	3.998	22.318	1.609		11.83	1.58
08/19/16 10:47:06	3731.382	3.990	22.317	1.628		12.00	1.60
08/19/16 10:47:16	3741.382	3.993	22.313	1.621		12.17	1.59
08/19/16 10:47:26	3751.382	3.989	22.313	1.631		12.33	1.60
08/19/16 10:47:36	3761.382	3.987	22.307	1.636		12.50	1.60
08/19/16 10:47:46	3771.382	3.982	22.307	1.647		12.67	1.61
08/19/16 10:47:56	3781.382	3.992	22.304	1.624		12.83	1.59
08/19/16 10:48:06	3791.382	3.990	22.302	1.629		13.00	1.60
08/19/16 10:48:16	3801.382	3.984	22.298	1.643		13.17	1.61
08/19/16 10:48:26	3811.382	3.984	22.297	1.642		13.33	1.61
08/19/16 10:48:36	3821.382	3.984	22.298	1.642		13.50	1.61
08/19/16 10:48:46	3831.382	3.979	22.296	1.653		13.67	1.62
08/19/16 10:48:56	3841.382	3.978	22.294	1.656		13.83	1.62

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 10:49:06	3851.382	3.986	22.294	1.638		14.00	1.61
08/19/16 10:49:16	3861.382	3.981	22.293	1.650		14.17	1.62
08/19/16 10:49:26	3871.382	3.972	22.292	1.669		14.33	1.64
08/19/16 10:49:36	3881.505	3.985	22.287	1.640		14.50	1.61
08/19/16 10:49:46	3891.382	3.979	22.287	1.655		14.67	1.62
08/19/16 10:49:56	3901.382	3.949	22.287	1.722		14.83	1.69
08/19/16 10:50:06	3911.382	3.925	22.288	1.777		15.00	1.74
08/19/16 10:50:16	3921.382	3.911	22.286	1.810		15.17	1.78
08/19/16 10:50:26	3931.382	3.905	22.283	1.824		15.33	1.79
08/19/16 10:50:36	3941.382	3.902	22.282	1.832		15.50	1.80
08/19/16 10:50:46	3951.382	3.894	22.281	1.849		15.67	1.82
08/19/16 10:50:56	3961.382	3.892	22.278	1.855		15.83	1.82
08/19/16 10:51:06	3971.382	3.893	22.278	1.852		16.00	1.82
08/19/16 10:51:16	3981.382	3.894	22.276	1.850		16.17	1.82
08/19/16 10:51:26	3991.382	3.889	22.273	1.861		16.33	1.83
08/19/16 10:51:36	4001.382	3.890	22.276	1.858		16.50	1.83
08/19/16 10:51:46	4011.382	3.887	22.273	1.867		16.67	1.83
08/19/16 10:51:56	4021.382	3.884	22.276	1.874		16.83	1.84
08/19/16 10:52:06	4031.382	3.884	22.274	1.874		17.00	1.84
08/19/16 10:52:16	4041.382	3.881	22.270	1.879		17.17	1.85
08/19/16 10:52:26	4051.382	3.878	22.268	1.886		17.33	1.85
08/19/16 10:52:36	4061.382	3.878	22.266	1.886		17.50	1.85
08/19/16 10:52:46	4071.382	3.880	22.268	1.884		17.67	1.85
08/19/16 10:52:56	4081.382	3.881	22.265	1.880		17.83	1.85
08/19/16 10:53:06	4091.382	3.877	22.264	1.888		18.00	1.86
08/19/16 10:53:16	4101.382	3.879	22.262	1.886		18.17	1.85
08/19/16 10:53:26	4111.382	3.883	22.266	1.876		18.33	1.84
08/19/16 10:53:36	4121.382	3.880	22.264	1.883		18.50	1.85
08/19/16 10:53:46	4131.382	3.882	22.264	1.878		18.67	1.85
08/19/16 10:53:56	4141.382	3.880	22.263	1.883		18.83	1.85
08/19/16 10:54:06	4151.382	3.883	22.258	1.875		19.00	1.84
08/19/16 10:54:16	4161.382	3.884	22.261	1.873		19.17	1.84
08/19/16 10:54:26	4171.382	3.884	22.257	1.872		19.33	1.84
08/19/16 10:54:36	4181.382	3.887	22.259	1.866		19.50	1.83
08/19/16 10:54:46	4191.382	3.887	22.254	1.865		19.67	1.83
08/19/16 10:54:56	4201.382	3.892	22.256	1.855		19.83	1.82
08/19/16 10:55:06	4211.382	3.888	22.255	1.865		20.00	1.83
08/19/16 10:55:16	4221.382	3.889	22.253	1.862		20.17	1.83
08/19/16 10:55:26	4231.382	3.887	22.254	1.866		20.33	1.83
08/19/16 10:55:36	4241.382	3.885	22.254	1.871		20.50	1.84
08/19/16 10:55:46	4251.382	3.905	22.249	1.824		20.67	1.79
08/19/16 10:55:56	4261.382	3.932	22.251	1.761		20.83	1.73

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 10:56:06	4271.383	3.948	22.247	1.725	0.968	21.00	1.69
08/19/16 10:56:16	4281.382	3.954	22.248	1.713		21.17	1.68
08/19/16 10:56:26	4291.382	3.965	22.246	1.687		21.33	1.65
08/19/16 10:56:36	4301.382	3.965	22.249	1.687		21.50	1.65
08/19/16 10:56:46	4311.382	3.964	22.249	1.689		21.67	1.66
08/19/16 10:56:56	4321.382	3.970	22.247	1.674		21.83	1.64
08/19/16 10:57:06	4331.382	3.973	22.251	1.668		22.00	1.64
08/19/16 10:57:16	4341.382	3.971	22.250	1.673		22.17	1.64
08/19/16 10:57:26	4351.382	3.970	22.248	1.674		22.33	1.64
08/19/16 10:57:36	4361.382	3.979	22.247	1.654		22.50	1.62
08/19/16 10:57:46	4371.382	3.953	22.249	1.714		22.67	1.68
08/19/16 10:57:56	4381.382	3.942	22.246	1.738		22.83	1.71
08/19/16 10:58:06	4391.382	3.937	22.246	1.751		23.00	1.72
08/19/16 10:58:16	4401.382	3.928	22.248	1.771		23.17	1.74
08/19/16 10:58:26	4411.382	3.926	22.247	1.776		23.33	1.74
08/19/16 10:58:36	4421.382	3.926	22.246	1.777		23.50	1.74
08/19/16 10:58:46	4431.382	3.922	22.246	1.786		23.67	1.75
08/19/16 10:58:56	4441.382	3.921	22.242	1.787		23.83	1.75
08/19/16 10:59:06	4451.382	3.920	22.242	1.791		24.00	1.76
08/19/16 10:59:16	4461.382	3.921	22.242	1.788		24.17	1.76
08/19/16 10:59:26	4471.382	3.930	22.241	1.767		24.33	1.73
08/19/16 10:59:36	4481.382	3.936	22.240	1.754		24.50	1.72
08/19/16 10:59:46	4491.382	3.947	22.244	1.727		24.67	1.69
08/19/16 10:59:56	4501.382	3.687	22.240	2.329	2.000	24.83	2.30
08/19/16 11:00:06	4511.382	3.529	22.237	2.692		25.00	2.66
08/19/16 11:00:16	4521.382	3.428	22.237	2.927		25.17	2.89
08/19/16 11:00:26	4531.382	3.357	22.238	3.090		25.33	3.06
08/19/16 11:00:36	4541.382	3.312	22.235	3.193		25.50	3.16
08/19/16 11:00:46	4551.382	3.276	22.235	3.277		25.67	3.24
08/19/16 11:00:56	4561.382	3.254	22.239	3.328		25.83	3.30
08/19/16 11:01:06	4571.382	3.232	22.241	3.378		26.00	3.35
08/19/16 11:01:16	4581.47	3.222	22.239	3.402		26.17	3.37
08/19/16 11:01:26	4591.382	3.208	22.240	3.433		26.33	3.40
08/19/16 11:01:36	4601.382	3.199	22.241	3.455		26.50	3.42
08/19/16 11:01:46	4611.382	3.188	22.243	3.481		26.67	3.45
08/19/16 11:01:56	4621.382	3.184	22.236	3.490		26.83	3.46
08/19/16 11:02:06	4631.382	3.183	22.237	3.492		27.00	3.46
08/19/16 11:02:16	4641.382	3.186	22.234	3.485		27.17	3.45
08/19/16 11:02:26	4651.382	3.183	22.233	3.492		27.33	3.46
08/19/16 11:02:36	4661.382	3.170	22.230	3.521		27.50	3.49
08/19/16 11:02:46	4671.382	3.163	22.231	3.539		27.67	3.51
08/19/16 11:02:56	4681.382	3.165	22.229	3.534		27.83	3.50

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 11:03:06	4691.382	3.151	22.226	3.565		28.00	3.53
08/19/16 11:03:16	4701.382	3.148	22.223	3.573		28.17	3.54
08/19/16 11:03:26	4711.382	3.149	22.221	3.571		28.33	3.54
08/19/16 11:03:36	4721.382	3.142	22.221	3.587		28.50	3.55
08/19/16 11:03:46	4731.382	3.142	22.220	3.587		28.67	3.55
08/19/16 11:03:56	4741.382	3.143	22.217	3.585		28.83	3.55
08/19/16 11:04:06	4751.382	3.141	22.213	3.589		29.00	3.56
08/19/16 11:04:16	4761.382	3.148	22.211	3.573		29.17	3.54
08/19/16 11:04:26	4771.382	3.156	22.207	3.553		29.33	3.52
08/19/16 11:04:36	4781.382	3.154	22.210	3.558		29.50	3.53
08/19/16 11:04:46	4791.382	3.148	22.207	3.574		29.67	3.54
08/19/16 11:04:56	4801.382	3.147	22.204	3.575		29.83	3.54
08/19/16 11:05:06	4811.382	3.148	22.206	3.573		30.00	3.54
08/19/16 11:05:16	4821.382	3.142	22.204	3.586		30.17	3.55
08/19/16 11:05:26	4831.382	3.140	22.201	3.591		30.33	3.56
08/19/16 11:05:36	4841.382	3.137	22.199	3.599		30.50	3.57
08/19/16 11:05:46	4851.382	3.134	22.198	3.606		30.67	3.57
08/19/16 11:05:56	4861.382	3.133	22.198	3.607		30.83	3.57
08/19/16 11:06:06	4871.382	3.133	22.197	3.608		31.00	3.58
08/19/16 11:06:16	4881.382	3.124	22.197	3.629		31.17	3.60
08/19/16 11:06:26	4891.382	3.117	22.193	3.645		31.33	3.61
08/19/16 11:06:36	4901.382	3.119	22.192	3.640		31.50	3.61
08/19/16 11:06:46	4911.382	3.116	22.189	3.646		31.67	3.61
08/19/16 11:06:56	4921.382	3.114	22.189	3.652		31.83	3.62
08/19/16 11:07:06	4931.382	3.113	22.190	3.653		32.00	3.62
08/19/16 11:07:16	4941.382	3.115	22.191	3.648		32.17	3.62
08/19/16 11:07:26	4951.382	3.114	22.188	3.652		32.33	3.62
08/19/16 11:07:36	4961.382	3.124	22.186	3.628		32.50	3.60
08/19/16 11:07:46	4971.382	3.125	22.186	3.625		32.67	3.59
08/19/16 11:07:56	4981.382	3.124	22.185	3.627		32.83	3.59
08/19/16 11:08:06	4991.382	3.118	22.184	3.641		33.00	3.61
08/19/16 11:08:16	5001.382	3.120	22.183	3.638		33.17	3.61
08/19/16 11:08:26	5011.382	3.124	22.182	3.627		33.33	3.59
08/19/16 11:08:36	5021.382	3.119	22.184	3.639		33.50	3.61
08/19/16 11:08:46	5031.382	3.121	22.185	3.636		33.67	3.60
08/19/16 11:08:56	5041.382	3.123	22.184	3.630		33.83	3.60
08/19/16 11:09:06	5051.382	3.115	22.183	3.648		34.00	3.62
08/19/16 11:09:16	5061.382	3.118	22.180	3.642		34.17	3.61
08/19/16 11:09:26	5071.382	3.124	22.180	3.627		34.33	3.59
08/19/16 11:09:36	5081.382	3.094	22.176	3.698		34.50	3.67
08/19/16 11:09:46	5091.382	3.067	22.175	3.759		34.67	3.73
08/19/16 11:09:56	5101.382	3.058	22.178	3.781		34.83	3.75

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 11:10:06	5111.382	3.049	22.176	3.801		35.00	3.77
08/19/16 11:10:16	5121.382	3.040	22.173	3.821		35.17	3.79
08/19/16 11:10:26	5131.382	3.036	22.172	3.831		35.33	3.80
08/19/16 11:10:36	5141.382	3.032	22.169	3.839		35.50	3.81
08/19/16 11:10:46	5151.382	3.033	22.172	3.837		35.67	3.80
08/19/16 11:10:56	5161.382	3.030	22.172	3.844		35.83	3.81
08/19/16 11:11:06	5171.382	3.032	22.170	3.840		36.00	3.81
08/19/16 11:11:16	5181.382	3.028	22.169	3.850		36.17	3.82
08/19/16 11:11:26	5191.382	3.028	22.167	3.849		36.33	3.82
08/19/16 11:11:36	5201.382	3.025	22.167	3.857		36.50	3.82
08/19/16 11:11:46	5211.382	3.028	22.167	3.850		36.67	3.82
08/19/16 11:11:56	5221.382	3.022	22.167	3.864		36.83	3.83
08/19/16 11:12:06	5231.382	3.023	22.164	3.860		37.00	3.83
08/19/16 11:12:16	5241.382	3.022	22.165	3.864		37.17	3.83
08/19/16 11:12:26	5251.382	3.026	22.163	3.854		37.33	3.82
08/19/16 11:12:36	5261.382	3.023	22.158	3.860		37.50	3.83
08/19/16 11:12:46	5271.382	3.021	22.159	3.865		37.67	3.83
08/19/16 11:12:56	5281.382	3.022	22.160	3.863		37.83	3.83
08/19/16 11:13:06	5291.382	3.023	22.157	3.860		38.00	3.83
08/19/16 11:13:16	5301.382	3.019	22.160	3.871		38.17	3.84
08/19/16 11:13:26	5311.382	3.019	22.155	3.871		38.33	3.84
08/19/16 11:13:36	5321.382	3.021	22.155	3.865		38.50	3.83
08/19/16 11:13:46	5331.382	3.026	22.157	3.855		38.67	3.82
08/19/16 11:13:56	5341.382	3.024	22.157	3.859		38.83	3.83
08/19/16 11:14:06	5351.382	3.019	22.155	3.870	2.143	39.00	3.84
08/19/16 11:14:16	5361.382	3.021	22.152	3.866		39.17	3.83
08/19/16 11:14:26	5371.382	3.041	22.152	3.819		39.33	3.79
08/19/16 11:14:36	5381.382	3.058	22.149	3.780		39.50	3.75
08/19/16 11:14:46	5391.382	3.026	22.151	3.855		39.67	3.82
08/19/16 11:14:56	5401.382	3.047	22.150	3.805		39.83	3.77
08/19/16 11:15:06	5411.382	3.011	22.149	3.890		40.00	3.86
08/19/16 11:15:16	5421.382	2.980	22.148	3.961		40.17	3.93
08/19/16 11:15:26	5431.382	2.955	22.145	4.018		40.33	3.99
08/19/16 11:15:36	5441.382	2.925	22.148	4.088		40.50	4.06
08/19/16 11:15:46	5451.382	2.898	22.146	4.149		40.67	4.12
08/19/16 11:15:56	5461.382	2.882	22.142	4.188		40.83	4.16
08/19/16 11:16:06	5471.382	2.878	22.145	4.196	2.143	41.00	4.16
08/19/16 11:16:16	5481.382	2.867	22.141	4.221		41.17	4.19
08/19/16 11:16:26	5491.382	2.855	22.141	4.249		41.33	4.22
08/19/16 11:16:36	5501.382	2.854	22.138	4.252		41.50	4.22
08/19/16 11:16:46	5511.382	2.852	22.136	4.256		41.67	4.22
08/19/16 11:16:56	5521.382	2.849	22.138	4.262		41.83	4.23

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 11:17:06	5531.382	2.844	22.134	4.275	2.400	42.00	4.24
08/19/16 11:17:16	5541.382	2.839	22.138	4.285		42.17	4.25
08/19/16 11:17:26	5551.382	2.836	22.134	4.294		42.33	4.26
08/19/16 11:17:36	5561.382	2.841	22.132	4.280		42.50	4.25
08/19/16 11:17:46	5571.382	2.842	22.134	4.279		42.67	4.25
08/19/16 11:17:56	5581.382	2.848	22.133	4.265		42.83	4.23
08/19/16 11:18:06	5591.382	2.837	22.132	4.291		43.00	4.26
08/19/16 11:18:16	5601.382	2.826	22.130	4.316		43.17	4.28
08/19/16 11:18:26	5611.382	2.830	22.132	4.308		43.33	4.28
08/19/16 11:18:36	5621.382	2.831	22.133	4.305		43.50	4.27
08/19/16 11:18:46	5631.382	2.840	22.133	4.285		43.67	4.25
08/19/16 11:18:56	5641.382	2.832	22.134	4.303		43.83	4.27
08/19/16 11:19:06	5651.385	2.823	22.131	4.323		44.00	4.29
08/19/16 11:19:16	5661.382	2.817	22.131	4.337		44.17	4.30
08/19/16 11:19:26	5671.382	2.810	22.129	4.352		44.33	4.32
08/19/16 11:19:36	5681.382	2.820	22.132	4.330		44.50	4.30
08/19/16 11:19:46	5691.382	2.818	22.131	4.334		44.67	4.30
08/19/16 11:19:56	5701.382	2.819	22.127	4.333		44.83	4.30
08/19/16 11:20:06	5711.382	2.816	22.128	4.339		45.00	4.31
08/19/16 11:20:16	5721.382	2.816	22.126	4.340		45.17	4.31
08/19/16 11:20:26	5731.382	2.817	22.126	4.338		45.33	4.31
08/19/16 11:20:36	5741.382	2.808	22.127	4.357		45.50	4.32
08/19/16 11:20:46	5751.382	2.807	22.126	4.359		45.67	4.33
08/19/16 11:20:56	5761.382	2.809	22.125	4.354		45.83	4.32
08/19/16 11:21:06	5771.382	2.806	22.121	4.362		46.00	4.33
08/19/16 11:21:16	5781.382	2.800	22.121	4.376		46.17	4.34
08/19/16 11:21:26	5791.382	2.802	22.123	4.372		46.33	4.34
08/19/16 11:21:36	5801.382	2.789	22.122	4.402		46.50	4.37
08/19/16 11:21:46	5811.382	2.787	22.120	4.407		46.67	4.37
08/19/16 11:21:56	5821.382	2.768	22.120	4.450		46.83	4.42
08/19/16 11:22:06	5831.382	2.752	22.117	4.487		47.00	4.45
08/19/16 11:22:16	5841.382	2.740	22.118	4.516		47.17	4.48
08/19/16 11:22:26	5851.382	2.727	22.117	4.544		47.33	4.51
08/19/16 11:22:36	5861.382	2.720	22.118	4.560		47.50	4.53
08/19/16 11:22:46	5871.382	2.711	22.117	4.581		47.67	4.55
08/19/16 11:22:56	5881.382	2.705	22.113	4.597		47.83	4.56
08/19/16 11:23:06	5891.382	2.711	22.112	4.582		48.00	4.55
08/19/16 11:23:16	5901.382	2.707	22.112	4.592		48.17	4.56
08/19/16 11:23:26	5911.382	2.703	22.112	4.599		48.33	4.57
08/19/16 11:23:36	5921.382	2.700	22.110	4.607		48.50	4.57
08/19/16 11:23:46	5931.382	2.694	22.111	4.621		48.67	4.59
08/19/16 11:23:56	5941.382	2.688	22.108	4.634		48.83	4.60

P-04	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0832	8.00	78.910	73.940	70.910	58.44	12.47
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 11:24:06	5951.382	2.685	22.105	4.642		49.00	4.61
08/19/16 11:24:16	5961.382	2.685	22.105	4.642		49.17	4.61
08/19/16 11:24:26	5971.382	2.692	22.104	4.626		49.33	4.59
08/19/16 11:24:36	5981.382	2.702	22.104	4.603		49.50	4.57
08/19/16 11:24:46	5991.382	2.711	22.105	4.581		49.67	4.55

Report Date:		8/20/2016 6:38	
Report User Name:	Mike		
Report Computer Name:	Pocket PC		
Application:	WinSituMobile.exe		
Application Version:	5.6.2.0		

Log File Properties				
File Name	P 04 2016-08-19 11.25.00.wsl			
Create Date		8/19/2016 11:24		
Device Properties				
Device	Level TROLL 700			
Site	B County			
Device Name				
Serial Number		349893		
Firmware Version		2.09		
Hardware Version		3		
Device Address		1		
Device Comm Cfg		19200	8 Even	1 (Modbus-RTU)
Used Memory		0		
Used Battery		19		

Log Configuration		
	Log Name	P 04
	Created By	Mike
	Computer Name	Pocket PC
	Application	WinSituMobile.exe
	Application Version	5.6.2.0
	Create Date	8/19/16 9:41:50 AM Eastern Daylight Time
	Log Setup Time Zone	Eastern Daylight Time
	Notes Size(bytes)	4096
	Overwrite when full	Disabled
	Scheduled Start Time	Manual Start
	Scheduled Stop Time	No Stop Time
	Type	Fast Linear
	Interval	Days: 0 hrs: 00 mins: 00 secs: 10
Level Reference Settings At Log Creation		
	Level Measurement Mode	Level Depth To Water
	Specific Gravity	0.999
	Level Reference Mode:	Set new reference
	Level Reference Value:	0 (ft)
	Level Reference Head Pressure	4.69528 (PSI)
Other Log Settings		
	Pressure Offset:	0.0242963 (PSI)

Depth of Probe:	10.8386 (ft)
Head Pressure:	4.69414 (PSI)
Temperature:	23.1488 (C)

Log Notes:

Date and Time	Note
8/19/2016 9:41	Sensor SN: 349893 Factory calibration has expired.: 8/22/14 4:30:38 PM
8/19/2016 9:41	Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 9:44	Manual Start Command
8/19/2016 9:45	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 9:47	Suspend Command
8/19/2016 9:52	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:24	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:26	Resume Command
8/19/2016 10:27	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:30	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:31	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:33	Suspend Command
8/19/2016 10:33	Resume Command
8/19/2016 10:40	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:45	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:49	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 10:56	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 11:01	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 11:08	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 11:18	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike
8/19/2016 11:24	Log Download - Used Battery: 19% Used Memory: 1% User Name: Mike

Log Data:

Record Count	366		
Sensors	1		
	1	349893	Pressure/Temp 15 PSIG (11m/35ft)

Time Zone: Eastern Daylight Time

Date and Time	Elapsed Time Seconds	Sensor: Pres(G) 35ft SN#: 349893 Pressure (PSI)	Sensor: Pres(G) 35ft SN#: 349893 Temperature (C)	Sensor: Pres(G) 35ft SN#: 349893 Level Depth To Water (ft)
8/19/2016 9:44	0	4.696	22.882	-0.003
8/19/2016 9:45	10	4.697	22.878	-0.004
8/19/2016 9:45	20	4.696	22.872	-0.002
8/19/2016 9:45	30	4.696	22.865	-0.002
8/19/2016 9:45	40	4.696	22.862	-0.002
8/19/2016 9:45	50	4.696	22.858	-0.002
8/19/2016 9:45	60	4.695	22.854	0

8/19/2016 9:46	70	4.696	22.848	-0.001
8/19/2016 9:46	80	4.651	22.845	0.101
8/19/2016 9:46	90	4.651	22.841	0.101
8/19/2016 9:46	100	4.652	22.843	0.099
8/19/2016 9:46	110	4.652	22.836	0.1
8/19/2016 9:46	120	4.653	22.834	0.099
8/19/2016 9:47	130	4.653	22.83	0.098
8/19/2016 10:26	2474.253	4.673	22.774	0.051
8/19/2016 10:26	2484.253	4.685	22.774	0.024
8/19/2016 10:26	2494.253	4.684	22.772	0.025
8/19/2016 10:26	2504.253	4.676	22.769	0.044
8/19/2016 10:26	2514.253	4.689	22.764	0.014
8/19/2016 10:26	2524.253	4.686	22.762	0.022
8/19/2016 10:27	2534.253	4.684	22.761	0.026
8/19/2016 10:27	2544.253	4.684	22.756	0.026
8/19/2016 10:27	2554.253	4.685	22.754	0.023
8/19/2016 10:27	2564.253	4.683	22.752	0.028
8/19/2016 10:27	2574.253	4.683	22.752	0.028
8/19/2016 10:27	2584.253	4.683	22.749	0.029
8/19/2016 10:28	2594.253	4.683	22.749	0.027
8/19/2016 10:28	2604.253	4.683	22.746	0.027
8/19/2016 10:28	2614.253	4.683	22.742	0.029
8/19/2016 10:28	2624.253	4.683	22.735	0.029
8/19/2016 10:28	2634.253	4.684	22.733	0.027
8/19/2016 10:28	2644.253	4.683	22.732	0.029
8/19/2016 10:29	2654.253	4.682	22.731	0.031
8/19/2016 10:29	2664.253	4.683	22.729	0.029
8/19/2016 10:29	2674.253	4.683	22.728	0.029
8/19/2016 10:29	2684.253	4.683	22.725	0.029
8/19/2016 10:29	2694.253	4.683	22.723	0.029
8/19/2016 10:29	2704.253	4.682	22.726	0.031
8/19/2016 10:30	2714.253	4.683	22.719	0.028
8/19/2016 10:30	2724.253	4.684	22.717	0.027
8/19/2016 10:30	2734.253	4.683	22.715	0.028
8/19/2016 10:30	2744.253	4.684	22.713	0.027
8/19/2016 10:30	2754.253	4.684	22.711	0.027
8/19/2016 10:30	2764.253	4.683	22.707	0.028
8/19/2016 10:31	2774.253	4.683	22.705	0.029
8/19/2016 10:31	2784.253	4.683	22.703	0.028
8/19/2016 10:31	2794.253	4.683	22.699	0.028
8/19/2016 10:31	2804.253	4.682	22.696	0.03
8/19/2016 10:31	2814.253	4.683	22.698	0.028
8/19/2016 10:31	2824.253	4.683	22.694	0.029
8/19/2016 10:32	2834.253	4.682	22.696	0.031
8/19/2016 10:32	2844.253	4.683	22.695	0.029
8/19/2016 10:32	2854.253	4.683	22.692	0.027
8/19/2016 10:32	2864.253	4.683	22.688	0.027
8/19/2016 10:32	2874.253	4.683	22.689	0.028
8/19/2016 10:32	2884.253	4.681	22.685	0.032
8/19/2016 10:33	2894.253	4.682	22.684	0.031

8/19/2016 10:33	2911.381	4.683	22.684	0.028
8/19/2016 10:33	2921.382	4.68	22.681	0.035
8/19/2016 10:33	2931.382	4.68	22.68	0.036
8/19/2016 10:33	2941.382	4.68	22.68	0.036
8/19/2016 10:34	2951.382	4.68	22.675	0.036
8/19/2016 10:34	2961.382	4.68	22.678	0.036
8/19/2016 10:34	2971.382	4.681	22.675	0.033
8/19/2016 10:34	2981.382	4.68	22.677	0.035
8/19/2016 10:34	2991.382	4.681	22.674	0.032
8/19/2016 10:34	3001.382	4.681	22.676	0.032
8/19/2016 10:35	3011.382	4.681	22.672	0.033
8/19/2016 10:35	3021.382	4.622	22.673	0.17
8/19/2016 10:35	3031.382	4.557	22.669	0.319
8/19/2016 10:35	3041.382	4.359	22.668	0.777
8/19/2016 10:35	3051.382	4.31	22.666	0.889
8/19/2016 10:35	3061.382	4.307	22.664	0.897
8/19/2016 10:36	3071.382	4.299	22.665	0.916
8/19/2016 10:36	3081.382	4.276	22.666	0.967
8/19/2016 10:36	3091.382	4.252	22.667	1.024
8/19/2016 10:36	3101.382	4.237	22.665	1.057
8/19/2016 10:36	3111.382	4.227	22.661	1.081
8/19/2016 10:36	3121.382	4.227	22.658	1.081
8/19/2016 10:37	3131.382	4.17	22.651	1.214
8/19/2016 10:37	3141.382	4.125	22.646	1.317
8/19/2016 10:37	3151.382	4.11	22.642	1.352
8/19/2016 10:37	3161.382	4.108	22.633	1.356
8/19/2016 10:37	3171.382	4.101	22.625	1.373
8/19/2016 10:37	3181.382	4.095	22.619	1.385
8/19/2016 10:38	3191.382	4.095	22.612	1.387
8/19/2016 10:38	3201.382	4.098	22.603	1.38
8/19/2016 10:38	3211.382	4.098	22.596	1.378
8/19/2016 10:38	3221.382	4.098	22.583	1.379
8/19/2016 10:38	3231.382	4.104	22.578	1.365
8/19/2016 10:38	3241.382	4.114	22.568	1.342
8/19/2016 10:39	3251.382	4.118	22.561	1.332
8/19/2016 10:39	3261.382	4.129	22.549	1.307
8/19/2016 10:39	3271.382	4.132	22.543	1.3
8/19/2016 10:39	3281.382	4.133	22.532	1.298
8/19/2016 10:39	3291.382	4.137	22.529	1.288
8/19/2016 10:39	3301.382	4.142	22.519	1.278
8/19/2016 10:40	3311.382	4.144	22.51	1.272
8/19/2016 10:40	3321.382	4.143	22.504	1.276
8/19/2016 10:40	3331.382	4.153	22.493	1.252
8/19/2016 10:40	3341.382	4.163	22.487	1.228
8/19/2016 10:40	3351.382	4.164	22.477	1.227
8/19/2016 10:40	3361.382	4.151	22.474	1.257
8/19/2016 10:41	3371.382	4.074	22.468	1.436
8/19/2016 10:41	3381.382	4.046	22.458	1.5
8/19/2016 10:41	3391.382	4.029	22.455	1.538
8/19/2016 10:41	3401.382	4.016	22.448	1.569

8/19/2016 10:41	3411.382	4.012	22.439	1.579
8/19/2016 10:41	3421.382	4.009	22.432	1.585
8/19/2016 10:42	3431.382	4.007	22.427	1.589
8/19/2016 10:42	3441.382	4.009	22.422	1.584
8/19/2016 10:42	3451.382	4.016	22.415	1.569
8/19/2016 10:42	3461.382	4.011	22.41	1.58
8/19/2016 10:42	3471.382	4.085	22.407	1.41
8/19/2016 10:42	3481.382	4.164	22.404	1.227
8/19/2016 10:43	3491.382	4.2	22.399	1.144
8/19/2016 10:43	3501.382	4.215	22.39	1.109
8/19/2016 10:43	3511.382	4.222	22.386	1.092
8/19/2016 10:43	3521.382	4.242	22.384	1.047
8/19/2016 10:43	3531.382	4.262	22.377	1
8/19/2016 10:43	3541.382	4.273	22.374	0.976
8/19/2016 10:44	3551.382	4.265	22.371	0.992
8/19/2016 10:44	3561.382	4.263	22.363	0.999
8/19/2016 10:44	3571.382	4.219	22.363	1.099
8/19/2016 10:44	3581.382	4.13	22.359	1.305
8/19/2016 10:44	3591.382	4.084	22.356	1.411
8/19/2016 10:44	3601.382	4.065	22.353	1.456
8/19/2016 10:45	3611.382	4.042	22.345	1.509
8/19/2016 10:45	3621.382	4.028	22.342	1.54
8/19/2016 10:45	3631.382	4.019	22.341	1.562
8/19/2016 10:45	3641.382	4.015	22.337	1.57
8/19/2016 10:45	3651.382	4.015	22.334	1.571
8/19/2016 10:45	3661.382	4.021	22.333	1.557
8/19/2016 10:46	3671.382	4.017	22.329	1.566
8/19/2016 10:46	3681.382	4.016	22.325	1.569
8/19/2016 10:46	3691.382	4.017	22.323	1.566
8/19/2016 10:46	3701.382	4.005	22.321	1.594
8/19/2016 10:46	3711.382	3.993	22.317	1.621
8/19/2016 10:46	3721.382	3.998	22.318	1.609
8/19/2016 10:47	3731.382	3.99	22.317	1.628
8/19/2016 10:47	3741.382	3.993	22.313	1.621
8/19/2016 10:47	3751.382	3.989	22.313	1.631
8/19/2016 10:47	3761.382	3.987	22.307	1.636
8/19/2016 10:47	3771.382	3.982	22.307	1.647
8/19/2016 10:47	3781.382	3.992	22.304	1.624
8/19/2016 10:48	3791.382	3.99	22.302	1.629
8/19/2016 10:48	3801.382	3.984	22.298	1.643
8/19/2016 10:48	3811.382	3.984	22.297	1.642
8/19/2016 10:48	3821.382	3.984	22.298	1.642
8/19/2016 10:48	3831.382	3.979	22.296	1.653
8/19/2016 10:48	3841.382	3.978	22.294	1.656
8/19/2016 10:49	3851.382	3.986	22.294	1.638
8/19/2016 10:49	3861.382	3.981	22.293	1.65
8/19/2016 10:49	3871.382	3.972	22.292	1.669
8/19/2016 10:49	3881.505	3.985	22.287	1.64
8/19/2016 10:49	3891.382	3.979	22.287	1.655
8/19/2016 10:49	3901.382	3.949	22.287	1.722

8/19/2016 10:50	3911.382	3.925	22.288	1.777
8/19/2016 10:50	3921.382	3.911	22.286	1.81
8/19/2016 10:50	3931.382	3.905	22.283	1.824
8/19/2016 10:50	3941.382	3.902	22.282	1.832
8/19/2016 10:50	3951.382	3.894	22.281	1.849
8/19/2016 10:50	3961.382	3.892	22.278	1.855
8/19/2016 10:51	3971.382	3.893	22.278	1.852
8/19/2016 10:51	3981.382	3.894	22.276	1.85
8/19/2016 10:51	3991.382	3.889	22.273	1.861
8/19/2016 10:51	4001.382	3.89	22.276	1.858
8/19/2016 10:51	4011.382	3.887	22.273	1.867
8/19/2016 10:51	4021.382	3.884	22.276	1.874
8/19/2016 10:52	4031.382	3.884	22.274	1.874
8/19/2016 10:52	4041.382	3.881	22.27	1.879
8/19/2016 10:52	4051.382	3.878	22.268	1.886
8/19/2016 10:52	4061.382	3.878	22.266	1.886
8/19/2016 10:52	4071.382	3.88	22.268	1.884
8/19/2016 10:52	4081.382	3.881	22.265	1.88
8/19/2016 10:53	4091.382	3.877	22.264	1.888
8/19/2016 10:53	4101.382	3.879	22.262	1.886
8/19/2016 10:53	4111.382	3.883	22.266	1.876
8/19/2016 10:53	4121.382	3.88	22.264	1.883
8/19/2016 10:53	4131.382	3.882	22.264	1.878
8/19/2016 10:53	4141.382	3.88	22.263	1.883
8/19/2016 10:54	4151.382	3.883	22.258	1.875
8/19/2016 10:54	4161.382	3.884	22.261	1.873
8/19/2016 10:54	4171.382	3.884	22.257	1.872
8/19/2016 10:54	4181.382	3.887	22.259	1.866
8/19/2016 10:54	4191.382	3.887	22.254	1.865
8/19/2016 10:54	4201.382	3.892	22.256	1.855
8/19/2016 10:55	4211.382	3.888	22.255	1.865
8/19/2016 10:55	4221.382	3.889	22.253	1.862
8/19/2016 10:55	4231.382	3.887	22.254	1.866
8/19/2016 10:55	4241.382	3.885	22.254	1.871
8/19/2016 10:55	4251.382	3.905	22.249	1.824
8/19/2016 10:55	4261.382	3.932	22.251	1.761
8/19/2016 10:56	4271.383	3.948	22.247	1.725
8/19/2016 10:56	4281.382	3.954	22.248	1.713
8/19/2016 10:56	4291.382	3.965	22.246	1.687
8/19/2016 10:56	4301.382	3.965	22.249	1.687
8/19/2016 10:56	4311.382	3.964	22.249	1.689
8/19/2016 10:56	4321.382	3.97	22.247	1.674
8/19/2016 10:57	4331.382	3.973	22.251	1.668
8/19/2016 10:57	4341.382	3.971	22.25	1.673
8/19/2016 10:57	4351.382	3.97	22.248	1.674
8/19/2016 10:57	4361.382	3.979	22.247	1.654
8/19/2016 10:57	4371.382	3.953	22.249	1.714
8/19/2016 10:57	4381.382	3.942	22.246	1.738
8/19/2016 10:58	4391.382	3.937	22.246	1.751
8/19/2016 10:58	4401.382	3.928	22.248	1.771

8/19/2016 10:58	4411.382	3.926	22.247	1.776
8/19/2016 10:58	4421.382	3.926	22.246	1.777
8/19/2016 10:58	4431.382	3.922	22.246	1.786
8/19/2016 10:58	4441.382	3.921	22.242	1.787
8/19/2016 10:59	4451.382	3.92	22.242	1.791
8/19/2016 10:59	4461.382	3.921	22.242	1.788
8/19/2016 10:59	4471.382	3.93	22.241	1.767
8/19/2016 10:59	4481.382	3.936	22.24	1.754
8/19/2016 10:59	4491.382	3.947	22.244	1.727
8/19/2016 10:59	4501.382	3.687	22.24	2.329
8/19/2016 11:00	4511.382	3.529	22.237	2.692
8/19/2016 11:00	4521.382	3.428	22.237	2.927
8/19/2016 11:00	4531.382	3.357	22.238	3.09
8/19/2016 11:00	4541.382	3.312	22.235	3.193
8/19/2016 11:00	4551.382	3.276	22.235	3.277
8/19/2016 11:00	4561.382	3.254	22.239	3.328
8/19/2016 11:01	4571.382	3.232	22.241	3.378
8/19/2016 11:01	4581.47	3.222	22.239	3.402
8/19/2016 11:01	4591.382	3.208	22.24	3.433
8/19/2016 11:01	4601.382	3.199	22.241	3.455
8/19/2016 11:01	4611.382	3.188	22.243	3.481
8/19/2016 11:01	4621.382	3.184	22.236	3.49
8/19/2016 11:02	4631.382	3.183	22.237	3.492
8/19/2016 11:02	4641.382	3.186	22.234	3.485
8/19/2016 11:02	4651.382	3.183	22.233	3.492
8/19/2016 11:02	4661.382	3.17	22.23	3.521
8/19/2016 11:02	4671.382	3.163	22.231	3.539
8/19/2016 11:02	4681.382	3.165	22.229	3.534
8/19/2016 11:03	4691.382	3.151	22.226	3.565
8/19/2016 11:03	4701.382	3.148	22.223	3.573
8/19/2016 11:03	4711.382	3.149	22.221	3.571
8/19/2016 11:03	4721.382	3.142	22.221	3.587
8/19/2016 11:03	4731.382	3.142	22.22	3.587
8/19/2016 11:03	4741.382	3.143	22.217	3.585
8/19/2016 11:04	4751.382	3.141	22.213	3.589
8/19/2016 11:04	4761.382	3.148	22.211	3.573
8/19/2016 11:04	4771.382	3.156	22.207	3.553
8/19/2016 11:04	4781.382	3.154	22.21	3.558
8/19/2016 11:04	4791.382	3.148	22.207	3.574
8/19/2016 11:04	4801.382	3.147	22.204	3.575
8/19/2016 11:05	4811.382	3.148	22.206	3.573
8/19/2016 11:05	4821.382	3.142	22.204	3.586
8/19/2016 11:05	4831.382	3.14	22.201	3.591
8/19/2016 11:05	4841.382	3.137	22.199	3.599
8/19/2016 11:05	4851.382	3.134	22.198	3.606
8/19/2016 11:05	4861.382	3.133	22.198	3.607
8/19/2016 11:06	4871.382	3.133	22.197	3.608
8/19/2016 11:06	4881.382	3.124	22.197	3.629
8/19/2016 11:06	4891.382	3.117	22.193	3.645
8/19/2016 11:06	4901.382	3.119	22.192	3.64

8/19/2016 11:06	4911.382	3.116	22.189	3.646
8/19/2016 11:06	4921.382	3.114	22.189	3.652
8/19/2016 11:07	4931.382	3.113	22.19	3.653
8/19/2016 11:07	4941.382	3.115	22.191	3.648
8/19/2016 11:07	4951.382	3.114	22.188	3.652
8/19/2016 11:07	4961.382	3.124	22.186	3.628
8/19/2016 11:07	4971.382	3.125	22.186	3.625
8/19/2016 11:07	4981.382	3.124	22.185	3.627
8/19/2016 11:08	4991.382	3.118	22.184	3.641
8/19/2016 11:08	5001.382	3.12	22.183	3.638
8/19/2016 11:08	5011.382	3.124	22.182	3.627
8/19/2016 11:08	5021.382	3.119	22.184	3.639
8/19/2016 11:08	5031.382	3.121	22.185	3.636
8/19/2016 11:08	5041.382	3.123	22.184	3.63
8/19/2016 11:09	5051.382	3.115	22.183	3.648
8/19/2016 11:09	5061.382	3.118	22.18	3.642
8/19/2016 11:09	5071.382	3.124	22.18	3.627
8/19/2016 11:09	5081.382	3.094	22.176	3.698
8/19/2016 11:09	5091.382	3.067	22.175	3.759
8/19/2016 11:09	5101.382	3.058	22.178	3.781
8/19/2016 11:10	5111.382	3.049	22.176	3.801
8/19/2016 11:10	5121.382	3.04	22.173	3.821
8/19/2016 11:10	5131.382	3.036	22.172	3.831
8/19/2016 11:10	5141.382	3.032	22.169	3.839
8/19/2016 11:10	5151.382	3.033	22.172	3.837
8/19/2016 11:10	5161.382	3.03	22.172	3.844
8/19/2016 11:11	5171.382	3.032	22.17	3.84
8/19/2016 11:11	5181.382	3.028	22.169	3.85
8/19/2016 11:11	5191.382	3.028	22.167	3.849
8/19/2016 11:11	5201.382	3.025	22.167	3.857
8/19/2016 11:11	5211.382	3.028	22.167	3.85
8/19/2016 11:11	5221.382	3.022	22.167	3.864
8/19/2016 11:12	5231.382	3.023	22.164	3.86
8/19/2016 11:12	5241.382	3.022	22.165	3.864
8/19/2016 11:12	5251.382	3.026	22.163	3.854
8/19/2016 11:12	5261.382	3.023	22.158	3.86
8/19/2016 11:12	5271.382	3.021	22.159	3.865
8/19/2016 11:12	5281.382	3.022	22.16	3.863
8/19/2016 11:13	5291.382	3.023	22.157	3.86
8/19/2016 11:13	5301.382	3.019	22.16	3.871
8/19/2016 11:13	5311.382	3.019	22.155	3.871
8/19/2016 11:13	5321.382	3.021	22.155	3.865
8/19/2016 11:13	5331.382	3.026	22.157	3.855
8/19/2016 11:13	5341.382	3.024	22.157	3.859
8/19/2016 11:14	5351.382	3.019	22.155	3.87
8/19/2016 11:14	5361.382	3.021	22.152	3.866
8/19/2016 11:14	5371.382	3.041	22.152	3.819
8/19/2016 11:14	5381.382	3.058	22.149	3.78
8/19/2016 11:14	5391.382	3.026	22.151	3.855
8/19/2016 11:14	5401.382	3.047	22.15	3.805

8/19/2016 11:15	5411.382	3.011	22.149	3.89
8/19/2016 11:15	5421.382	2.98	22.148	3.961
8/19/2016 11:15	5431.382	2.955	22.145	4.018
8/19/2016 11:15	5441.382	2.925	22.148	4.088
8/19/2016 11:15	5451.382	2.898	22.146	4.149
8/19/2016 11:15	5461.382	2.882	22.142	4.188
8/19/2016 11:16	5471.382	2.878	22.145	4.196
8/19/2016 11:16	5481.382	2.867	22.141	4.221
8/19/2016 11:16	5491.382	2.855	22.141	4.249
8/19/2016 11:16	5501.382	2.854	22.138	4.252
8/19/2016 11:16	5511.382	2.852	22.136	4.256
8/19/2016 11:16	5521.382	2.849	22.138	4.262
8/19/2016 11:17	5531.382	2.844	22.134	4.275
8/19/2016 11:17	5541.382	2.839	22.138	4.285
8/19/2016 11:17	5551.382	2.836	22.134	4.294
8/19/2016 11:17	5561.382	2.841	22.132	4.28
8/19/2016 11:17	5571.382	2.842	22.134	4.279
8/19/2016 11:17	5581.382	2.848	22.133	4.265
8/19/2016 11:18	5591.382	2.837	22.132	4.291
8/19/2016 11:18	5601.382	2.826	22.13	4.316
8/19/2016 11:18	5611.382	2.83	22.132	4.308
8/19/2016 11:18	5621.382	2.831	22.133	4.305
8/19/2016 11:18	5631.382	2.84	22.133	4.285
8/19/2016 11:18	5641.382	2.832	22.134	4.303
8/19/2016 11:19	5651.385	2.823	22.131	4.323
8/19/2016 11:19	5661.382	2.817	22.131	4.337
8/19/2016 11:19	5671.382	2.81	22.129	4.352
8/19/2016 11:19	5681.382	2.82	22.132	4.33
8/19/2016 11:19	5691.382	2.818	22.131	4.334
8/19/2016 11:19	5701.382	2.819	22.127	4.333
8/19/2016 11:20	5711.382	2.816	22.128	4.339
8/19/2016 11:20	5721.382	2.816	22.126	4.34
8/19/2016 11:20	5731.382	2.817	22.126	4.338
8/19/2016 11:20	5741.382	2.808	22.127	4.357
8/19/2016 11:20	5751.382	2.807	22.126	4.359
8/19/2016 11:20	5761.382	2.809	22.125	4.354
8/19/2016 11:21	5771.382	2.806	22.121	4.362
8/19/2016 11:21	5781.382	2.8	22.121	4.376
8/19/2016 11:21	5791.382	2.802	22.123	4.372
8/19/2016 11:21	5801.382	2.789	22.122	4.402
8/19/2016 11:21	5811.382	2.787	22.12	4.407
8/19/2016 11:21	5821.382	2.768	22.12	4.45
8/19/2016 11:22	5831.382	2.752	22.117	4.487
8/19/2016 11:22	5841.382	2.74	22.118	4.516
8/19/2016 11:22	5851.382	2.727	22.117	4.544
8/19/2016 11:22	5861.382	2.72	22.118	4.56
8/19/2016 11:22	5871.382	2.711	22.117	4.581
8/19/2016 11:22	5881.382	2.705	22.113	4.597
8/19/2016 11:23	5891.382	2.711	22.112	4.582
8/19/2016 11:23	5901.382	2.707	22.112	4.592

8/19/2016 11:23	5911.382	2.703	22.112	4.599
8/19/2016 11:23	5921.382	2.7	22.11	4.607
8/19/2016 11:23	5931.382	2.694	22.111	4.621
8/19/2016 11:23	5941.382	2.688	22.108	4.634
8/19/2016 11:24	5951.382	2.685	22.105	4.642
8/19/2016 11:24	5961.382	2.685	22.105	4.642
8/19/2016 11:24	5971.382	2.692	22.104	4.626
8/19/2016 11:24	5981.382	2.702	22.104	4.603
8/19/2016 11:24	5991.382	2.711	22.105	4.581

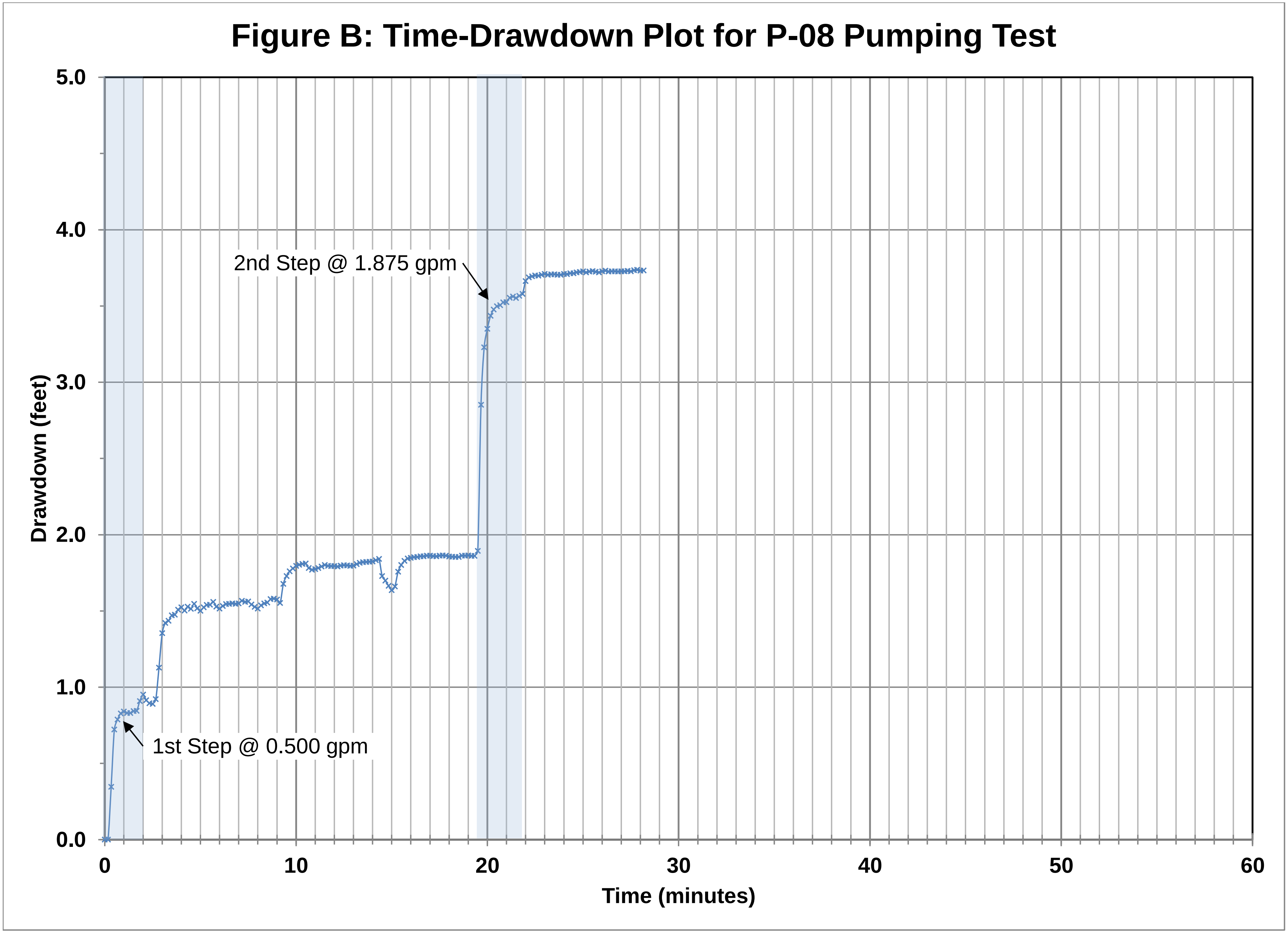


Figure B: Time-Drawdown Plot for P-08 Pumping Test
Drawdown (feet)
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
60
Time (minutes)
2nd Step @ 1.875 gpm
1st Step @ 0.500 gpm

Figure B-1: Log Plot of P-08 Pumping Test Step 1

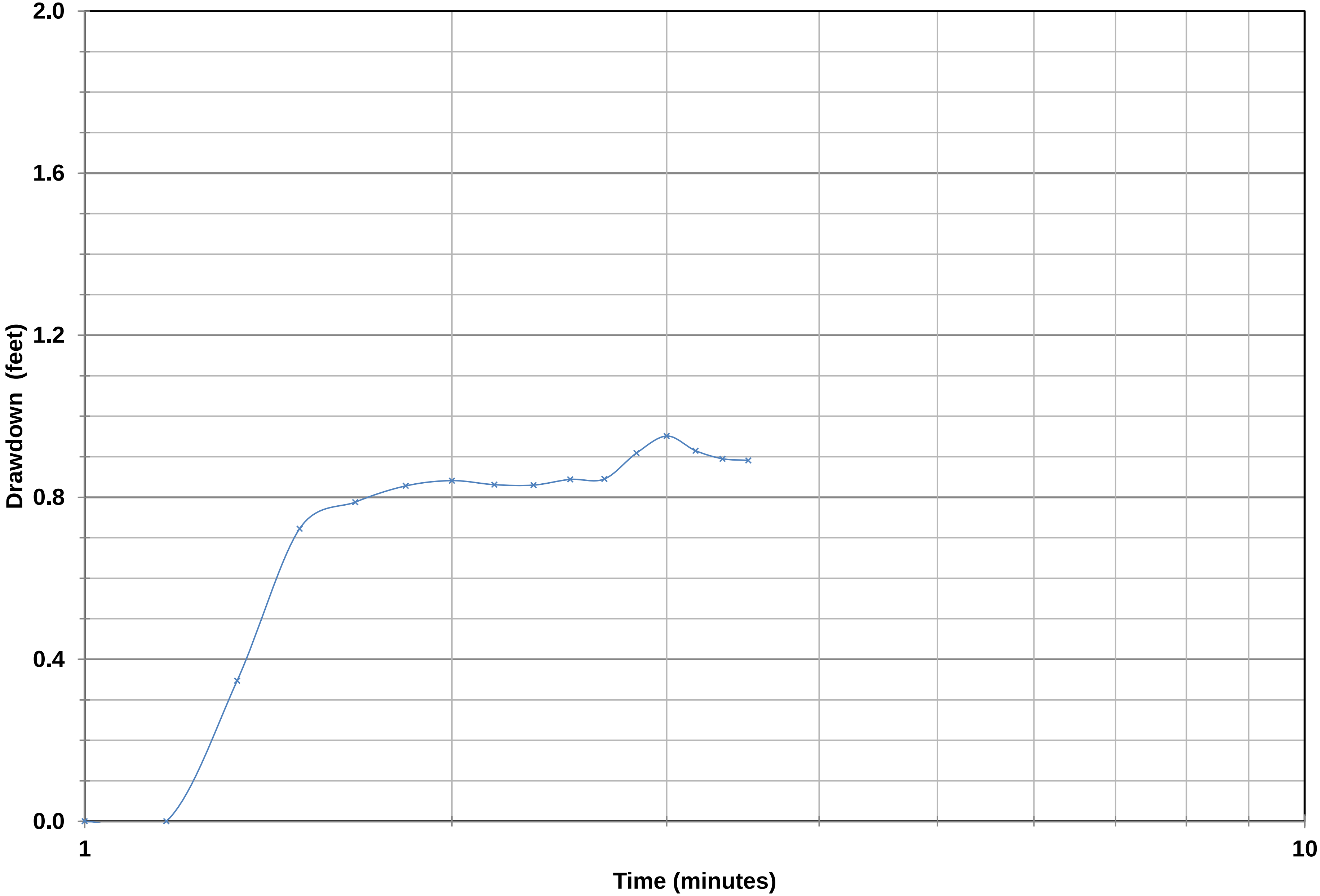
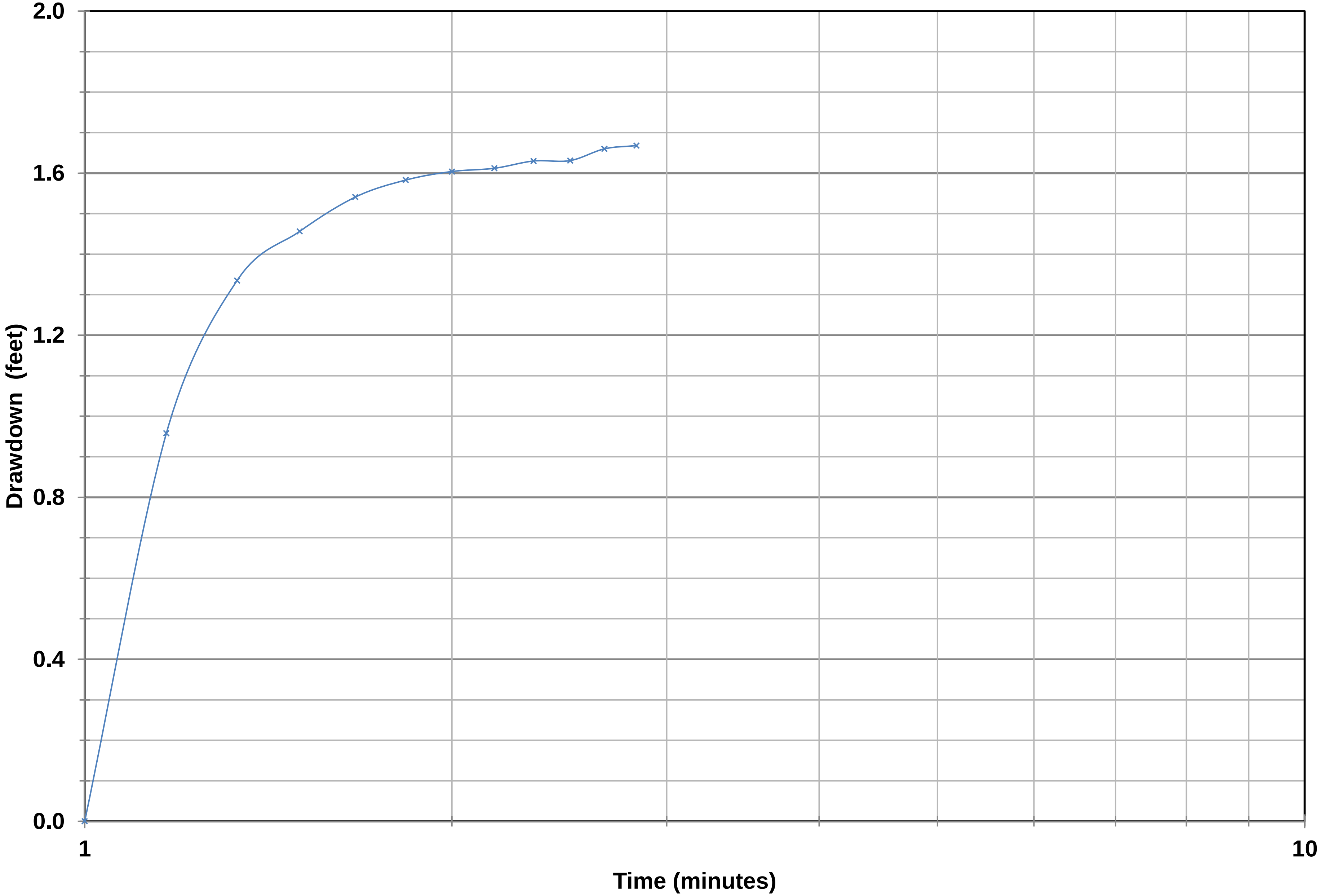


Figure B-2: Log Plot of P-08 Pumping Test Step 2



P-08	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0822	6.75	73.690	68.720	66.940	53.22	13.72
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 11:55:30	1,100.001	5.174	21.349	-11.954		0.00	0.00
08/19/16 11:55:40	1,110.001	5.174	21.347	-11.954		0.17	0.00
08/19/16 11:55:50	1,120.001	5.024	21.342	-11.607		0.33	0.35
08/19/16 11:56:00	1,130.001	4.861	21.341	-11.232		0.50	0.72
08/19/16 11:56:10	1,140.001	4.833	21.337	-11.166		0.67	0.79
08/19/16 11:56:20	1,150.001	4.815	21.330	-11.126		0.83	0.83
08/19/16 11:56:30	1,160.001	4.810	21.322	-11.113		1.00	0.84
08/19/16 11:56:40	1,170.001	4.814	21.310	-11.123		1.17	0.83
08/19/16 11:56:50	1,180.001	4.815	21.302	-11.124		1.33	0.83
08/19/16 11:57:00	1,190.001	4.809	21.286	-11.110	0.500	1.50	0.84
08/19/16 11:57:10	1,200.001	4.808	21.277	-11.109		1.67	0.85
08/19/16 11:57:20	1,210.001	4.780	21.263	-11.045		1.83	0.91
08/19/16 11:57:30	1,220.001	4.762	21.251	-11.003		2.00	0.95
08/19/16 11:57:40	1,230.001	4.778	21.236	-11.039		2.17	0.92
08/19/16 11:57:50	1,240.001	4.786	21.219	-11.059		2.33	0.90
08/19/16 11:58:00	1,250.001	4.788	21.206	-11.063		2.50	0.89
08/19/16 11:58:10	1,260.001	4.775	21.193	-11.032		2.67	0.92
08/19/16 11:58:20	1,270.001	4.686	21.179	-10.826		2.83	1.13
08/19/16 11:58:30	1,280.001	4.588	21.165	-10.600		3.00	1.35
08/19/16 11:58:40	1,290.001	4.559	21.149	-10.533		3.17	1.42
08/19/16 11:58:50	1,300.001	4.552	21.130	-10.518		3.33	1.44
08/19/16 11:59:00	1,310.001	4.537	21.116	-10.483	0.923	3.50	1.47
08/19/16 11:59:10	1,320.001	4.535	21.098	-10.479		3.67	1.48
08/19/16 11:59:20	1,330.001	4.521	21.078	-10.446		3.83	1.51
08/19/16 11:59:30	1,340.001	4.514	21.060	-10.430		4.00	1.52
08/19/16 11:59:40	1,350.001	4.524	21.046	-10.452		4.17	1.50
08/19/16 11:59:50	1,360.001	4.512	21.031	-10.426		4.33	1.53
08/19/16 12:00:00	1,370.001	4.518	21.012	-10.440	0.682	4.50	1.51
08/19/16 12:00:10	1,380.001	4.504	21.000	-10.408		4.67	1.55
08/19/16 12:00:20	1,390.001	4.517	20.985	-10.437		4.83	1.52
08/19/16 12:00:30	1,400.001	4.524	20.968	-10.453		5.00	1.50
08/19/16 12:00:40	1,410.001	4.514	20.953	-10.430		5.17	1.52
08/19/16 12:00:50	1,420.001	4.508	20.941	-10.415		5.33	1.54
08/19/16 12:01:00	1,430.001	4.507	20.928	-10.413	0.882	5.50	1.54
08/19/16 12:01:10	1,440.001	4.498	20.917	-10.394		5.67	1.56
08/19/16 12:01:20	1,450.001	4.513	20.903	-10.426		5.83	1.53
08/19/16 12:01:30	1,460.001	4.518	20.891	-10.439		6.00	1.52
08/19/16 12:01:40	1,470.001	4.511	20.876	-10.422		6.17	1.53
08/19/16 12:01:50	1,480.001	4.505	20.871	-10.409		6.33	1.55
08/19/16 12:02:00	1,490.001	4.505	20.858	-10.408	0.882	6.50	1.55
08/19/16 12:02:10	1,500.001	4.503	20.846	-10.404		6.67	1.55
08/19/16 12:02:20	1,510.001	4.504	20.836	-10.408		6.83	1.55

P-08	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0822	6.75	73.690	68.720	66.940	53.22	13.72
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 12:02:30	1,520.001	4.503	20.824	-10.404		7.00	1.55
08/19/16 12:02:40	1,530.001	4.496	20.820	-10.388		7.17	1.57
08/19/16 12:02:50	1,540.001	4.498	20.810	-10.394		7.33	1.56
08/19/16 12:03:00	1,550.001	4.497	20.804	-10.392		7.50	1.56
08/19/16 12:03:10	1,560.001	4.506	20.794	-10.412		7.67	1.54
08/19/16 12:03:20	1,570.001	4.513	20.785	-10.428		7.83	1.53
08/19/16 12:03:30	1,580.001	4.517	20.775	-10.438		8.00	1.52
08/19/16 12:03:40	1,590.001	4.509	20.769	-10.418		8.17	1.54
08/19/16 12:03:50	1,600.001	4.503	20.762	-10.404		8.33	1.55
08/19/16 12:04:00	1,610.001	4.501	20.755	-10.399		8.50	1.56
08/19/16 12:04:10	1,620.001	4.491	20.748	-10.376		8.67	1.58
08/19/16 12:04:20	1,630.001	4.489	20.745	-10.373		8.83	1.58
08/19/16 12:04:30	1,640.001	4.492	20.737	-10.379		9.00	1.58
08/19/16 12:04:40	1,650.001	4.502	20.729	-10.402		9.17	1.55
08/19/16 12:04:50	1,660.001	4.448	20.721	-10.277		9.33	1.68
08/19/16 12:05:00	1,670.001	4.425	20.715	-10.225		9.50	1.73
08/19/16 12:05:10	1,680.001	4.412	20.708	-10.194		9.67	1.76
08/19/16 12:05:20	1,690.001	4.404	20.704	-10.175		9.83	1.78
08/19/16 12:05:30	1,700.001	4.396	20.698	-10.158		10.00	1.80
08/19/16 12:05:40	1,710.001	4.393	20.691	-10.151		10.17	1.80
08/19/16 12:05:50	1,720.001	4.390	20.687	-10.145		10.33	1.81
08/19/16 12:06:00	1,730.001	4.390	20.679	-10.143		10.50	1.81
08/19/16 12:06:10	1,740.001	4.403	20.677	-10.173		10.67	1.78
08/19/16 12:06:20	1,750.001	4.408	20.673	-10.184		10.83	1.77
08/19/16 12:06:30	1,760.001	4.406	20.668	-10.179		11.00	1.78
08/19/16 12:06:40	1,770.001	4.402	20.664	-10.172		11.17	1.78
08/19/16 12:06:50	1,780.001	4.398	20.660	-10.163		11.33	1.79
08/19/16 12:07:00	1,790.001	4.394	20.654	-10.153		11.50	1.80
08/19/16 12:07:10	1,800.001	4.396	20.651	-10.158		11.67	1.80
08/19/16 12:07:20	1,810.001	4.397	20.647	-10.160		11.83	1.79
08/19/16 12:07:30	1,820.001	4.397	20.642	-10.160		12.00	1.79
08/19/16 12:07:40	1,830.001	4.398	20.638	-10.163		12.17	1.79
08/19/16 12:07:50	1,840.001	4.396	20.633	-10.157		12.33	1.80
08/19/16 12:08:00	1,850.001	4.394	20.632	-10.154		12.50	1.80
08/19/16 12:08:10	1,860.001	4.395	20.626	-10.156		12.67	1.80
08/19/16 12:08:20	1,870.001	4.396	20.623	-10.158		12.83	1.80
08/19/16 12:08:30	1,880.001	4.396	20.619	-10.157		13.00	1.80
08/19/16 12:08:40	1,890.001	4.391	20.615	-10.147		13.17	1.81
08/19/16 12:08:50	1,900.001	4.387	20.609	-10.138		13.33	1.82
08/19/16 12:09:00	1,910.001	4.386	20.606	-10.134		13.50	1.82
08/19/16 12:09:10	1,920.001	4.385	20.604	-10.133		13.67	1.82
08/19/16 12:09:20	1,930.001	4.385	20.599	-10.131		13.83	1.82

P-08	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0822	6.75	73.690	68.720	66.940	53.22	13.72
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 12:09:30	1,940.001	4.384	20.596	-10.130		14.00	1.82
08/19/16 12:09:40	1,950.001	4.380	20.594	-10.121		14.17	1.83
08/19/16 12:09:50	1,960.001	4.377	20.592	-10.113		14.33	1.84
08/19/16 12:10:00	1,970.001	4.425	20.587	-10.225	0.909	14.50	1.73
08/19/16 12:10:10	1,980.001	4.438	20.585	-10.255		14.67	1.70
08/19/16 12:10:20	1,990.001	4.453	20.578	-10.289		14.83	1.67
08/19/16 12:10:30	2,000.001	4.466	20.579	-10.318		15.00	1.64
08/19/16 12:10:40	2,010.001	4.455	20.581	-10.293		15.17	1.66
08/19/16 12:10:50	2,020.001	4.413	20.576	-10.196		15.33	1.76
08/19/16 12:11:00	2,030.001	4.394	20.575	-10.152		15.50	1.80
08/19/16 12:11:10	2,040.001	4.382	20.573	-10.125		15.67	1.83
08/19/16 12:11:20	2,050.001	4.376	20.569	-10.110		15.83	1.84
08/19/16 12:11:30	2,060.001	4.374	20.568	-10.106		16.00	1.85
08/19/16 12:11:40	2,070.001	4.372	20.565	-10.102		16.17	1.85
08/19/16 12:11:50	2,080.001	4.371	20.562	-10.100		16.33	1.85
08/19/16 12:12:00	2,090.001	4.369	20.561	-10.095		16.50	1.86
08/19/16 12:12:10	2,100.001	4.369	20.560	-10.095		16.67	1.86
08/19/16 12:12:20	2,110.001	4.368	20.555	-10.092		16.83	1.86
08/19/16 12:12:30	2,120.001	4.368	20.554	-10.092		17.00	1.86
08/19/16 12:12:40	2,130.001	4.369	20.554	-10.094		17.17	1.86
08/19/16 12:12:50	2,140.001	4.369	20.554	-10.096		17.33	1.86
08/19/16 12:13:00	2,150.001	4.368	20.549	-10.092		17.50	1.86
08/19/16 12:13:10	2,160.001	4.367	20.547	-10.090		17.67	1.86
08/19/16 12:13:20	2,170.001	4.368	20.547	-10.092		17.83	1.86
08/19/16 12:13:30	2,180.001	4.370	20.542	-10.097		18.00	1.86
08/19/16 12:13:40	2,190.001	4.370	20.542	-10.098		18.17	1.86
08/19/16 12:13:50	2,200.001	4.371	20.540	-10.100		18.33	1.85
08/19/16 12:14:00	2,210.001	4.371	20.540	-10.100		18.50	1.85
08/19/16 12:14:10	2,220.001	4.367	20.541	-10.091		18.67	1.86
08/19/16 12:14:20	2,230.001	4.368	20.536	-10.092		18.83	1.86
08/19/16 12:14:30	2,240.001	4.367	20.537	-10.090		19.00	1.86
08/19/16 12:14:40	2,250.001	4.368	20.533	-10.093		19.17	1.86
08/19/16 12:14:50	2,260.001	4.368	20.534	-10.093		19.33	1.86
08/19/16 12:15:00	2,270.001	4.354	20.534	-10.060		19.50	1.89
08/19/16 12:15:10	2,280.001	3.939	20.531	-9.102	1.875	19.67	2.85
08/19/16 12:15:20	2,290.001	3.776	20.528	-8.725		19.83	3.23
08/19/16 12:15:30	2,300.001	3.723	20.535	-8.604		20.00	3.35
08/19/16 12:15:40	2,310.001	3.687	20.538	-8.519		20.17	3.44
08/19/16 12:15:50	2,320.001	3.668	20.543	-8.477		20.33	3.48
08/19/16 12:16:00	2,330.001	3.659	20.543	-8.456	2.000	20.50	3.50
08/19/16 12:16:10	2,340.001	3.656	20.546	-8.448		20.67	3.51
08/19/16 12:16:20	2,350.001	3.648	20.548	-8.430		20.83	3.52

P-08	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0822	6.75	73.690	68.720	66.940	53.22	13.72
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 12:16:30	2,360.001	3.647	20.550	-8.429		21.00	3.53
08/19/16 12:16:40	2,370.001	3.635	20.557	-8.400		21.17	3.55
08/19/16 12:16:50	2,380.001	3.632	20.563	-8.392		21.33	3.56
08/19/16 12:17:00	2,390.001	3.636	20.566	-8.402		21.50	3.55
08/19/16 12:17:10	2,400.001	3.630	20.570	-8.388		21.67	3.57
08/19/16 12:17:20	2,410.001	3.624	20.575	-8.375		21.83	3.58
08/19/16 12:17:30	2,420.001	3.588	20.578	-8.291		22.00	3.66
08/19/16 12:17:40	2,430.001	3.577	20.582	-8.267		22.17	3.69
08/19/16 12:17:50	2,440.001	3.574	20.583	-8.260		22.33	3.69
08/19/16 12:18:00	2,450.001	3.572	20.587	-8.254		22.50	3.70
08/19/16 12:18:10	2,460.001	3.572	20.591	-8.255		22.67	3.70
08/19/16 12:18:20	2,470.001	3.570	20.594	-8.250		22.83	3.70
08/19/16 12:18:30	2,480.001	3.567	20.594	-8.244		23.00	3.71
08/19/16 12:18:40	2,490.001	3.570	20.597	-8.250		23.17	3.70
08/19/16 12:18:50	2,500.001	3.568	20.597	-8.246		23.33	3.71
08/19/16 12:19:00	2,510.001	3.568	20.599	-8.246		23.50	3.71
08/19/16 12:19:10	2,520.001	3.570	20.599	-8.250		23.67	3.70
08/19/16 12:19:20	2,530.001	3.569	20.598	-8.249		23.83	3.71
08/19/16 12:19:30	2,540.001	3.567	20.598	-8.244		24.00	3.71
08/19/16 12:19:40	2,550.001	3.568	20.600	-8.245		24.17	3.71
08/19/16 12:19:50	2,560.001	3.565	20.598	-8.239		24.33	3.72
08/19/16 12:20:00	2,570.001	3.565	20.595	-8.239		24.50	3.72
08/19/16 12:20:10	2,580.001	3.563	20.594	-8.234		24.67	3.72
08/19/16 12:20:20	2,590.001	3.562	20.599	-8.231		24.83	3.72
08/19/16 12:20:30	2,600.001	3.560	20.598	-8.226		25.00	3.73
08/19/16 12:20:40	2,610.001	3.562	20.595	-8.233		25.17	3.72
08/19/16 12:20:50	2,620.001	3.560	20.592	-8.228		25.33	3.73
08/19/16 12:21:00	2,630.001	3.559	20.592	-8.225		25.50	3.73
08/19/16 12:21:10	2,640.001	3.561	20.596	-8.229		25.67	3.73
08/19/16 12:21:20	2,650.001	3.563	20.592	-8.233		25.83	3.72
08/19/16 12:21:30	2,660.001	3.560	20.591	-8.227		26.00	3.73
08/19/16 12:21:40	2,670.001	3.558	20.589	-8.222		26.17	3.73
08/19/16 12:21:50	2,680.001	3.560	20.586	-8.228		26.33	3.73
08/19/16 12:22:00	2,690.001	3.559	20.588	-8.226		26.50	3.73
08/19/16 12:22:10	2,700.001	3.560	20.589	-8.226		26.67	3.73
08/19/16 12:22:20	2,710.001	3.560	20.585	-8.228		26.83	3.73
08/19/16 12:22:30	2,720.001	3.559	20.586	-8.226		27.00	3.73
08/19/16 12:22:40	2,730.001	3.560	20.585	-8.227		27.17	3.73
08/19/16 12:22:50	2,740.001	3.558	20.585	-8.223		27.33	3.73
08/19/16 12:23:00	2,750.001	3.560	20.583	-8.226		27.50	3.73
08/19/16 12:23:10	2,760.001	3.557	20.582	-8.220		27.67	3.73
08/19/16 12:23:20	2,770.001	3.555	20.578	-8.216		27.83	3.74

P-08	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0822	6.75	73.690	68.720	66.940	53.22	13.72
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
08/19/16 12:23:30	2,780.001	3.558	20.581	-8.222		28.00	3.73
08/19/16 12:23:40	2,790.084	3.558	20.581	-8.221		28.17	3.73
08/19/16 12:23:50	2,800.001	3.600	20.577	-8.320		28.33	3.63
08/19/16 12:24:00	2,810.001	3.609	20.582	-8.341		28.50	3.61
08/19/16 12:24:10	2,820.001	3.606	20.585	-8.332		28.67	3.62
08/19/16 12:24:20	2,830.001	3.568	20.583	-8.246		28.83	3.71
08/19/16 12:24:30	2,840.001	3.551	20.583	-8.207		29.00	3.75
08/19/16 12:24:40	2,850.001	4.298	20.582	-9.931		29.17	2.02
08/19/16 12:24:50	2,860.001	4.838	20.578	-11.178		29.33	0.78
08/19/16 12:25:00	2,870.001	4.937	20.581	-11.406		29.50	0.55
08/19/16 12:25:10	2,880.001	4.974	20.580	-11.493		29.67	0.46
08/19/16 12:25:20	2,890.001	5.038	20.582	-11.639		29.83	0.32
08/19/16 12:25:30	2,900.001	5.065	20.575	-11.701		30.00	0.25
08/19/16 12:25:40	2,910.001	5.082	20.574	-11.741		30.17	0.21
08/19/16 12:25:50	2,920.001	5.096	20.575	-11.774		30.33	0.18
08/19/16 12:26:00	2,930.001	4.764	20.576	-11.007		30.50	0.95
08/19/16 12:26:10	2,940.001	4.945	20.574	-11.425		30.67	0.53
08/19/16 12:26:20	2,950.001	5.022	20.572	-11.602		30.83	0.35

Report Date:		8/20/2016 6:38		
Report User Name:	Mike			
Report Computer Name:	Pocket PC			
Application:	WinSituMobile.exe			
Application Version:	5.6.2.0			
Log File Properties				
File Name	P 08 2016-08-19 12.26.54.wsl			
Create Date		8/19/2016 12:26		
Device Properties				
Device	Level TROLL 700			
Site	B County			
Device Name				
Serial Number		349893		
Firmware Version		2.09		
Hardware Version		3		
Device Address		1		
Device Comm Cfg		19200	8 Even	1 (Modbus-RTU)
Used Memory		1		
Used Battery		19		
Log Configuration				
	Log Name	P 08		
	Created By	Mike		
	Computer Name	Pocket PC		
	Application	WinSituMobile.exe		
	Application Version	5.6.2.0		
	Create Date	8/19/16 11:36:46 AM Eastern Daylight Time		
	Log Setup Time Zone	Eastern Daylight Time		
	Notes Size(bytes)	4096		
	Overwrite when full	Disabled		
	Scheduled Start Time	Manual Start		
	Scheduled Stop Time	No Stop Time		
	Type	Fast Linear		
	Interval	Days: 0 hrs: 00 mins: 00 secs: 10		
Level Reference Settings At Log Creation				
	Level Measurement Mode	Level Depth To Water		
	Specific Gravity	0.999		
	Level Reference Mode:	Set new reference		
	Level Reference Value:	0 (ft)		
	Level Reference Head Pressure	-0.00310755 (PSI)		
Other Log Settings				
	Pressure Offset:	0.0242963 (PSI)		
	Depth of Probe:	-0.00558208 (ft)		

Head Pressure:	-0.00241756 (PSI)
Temperature:	27.8967 (C)

Log Notes:

Date and Time	Note
8/19/2016 11:36	Sensor SN: 349893 Factory calibration has expired.: 8/22/14 4:30:38 PM
8/19/2016 11:36	Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 11:37	Manual Start Command
8/19/2016 11:43	Log Download - Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 11:50	Log Download - Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 12:02	Log Download - Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 12:10	Log Download - Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 12:23	Log Download - Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 12:26	Used Battery: 19% Used Memory: 3% User Name: Mike
8/19/2016 12:26	Manual Stop Command

Log Data:

Record Count	296		
Sensors	1		
	1	349893	Pressure/Temp 15 PSIG (11m/35ft)

Time Zone: Eastern Daylight Time

Date and Time	Elapsed Time Seconds	Sensor: Pres(G) 35ft SN#: 349893 Pressure (PSI)	Sensor: Pres(G) 35ft SN#: 349893 Temperature (C)	Sensor: Pres(G) 35ft SN#: 349893 Level Depth To Water (ft)
8/19/2016 11:37	0	0	27.861	-0.008
8/19/2016 11:37	10.001	0	27.878	-0.007
8/19/2016 11:37	20.001	1.852	27.895	-4.284
8/19/2016 11:37	30.001	5.238	27.719	-12.102
8/19/2016 11:37	40.001	5.215	27.381	-12.048
8/19/2016 11:38	50.001	5.202	27.042	-12.017
8/19/2016 11:38	60.001	5.198	26.714	-12.009
8/19/2016 11:38	70.001	5.185	26.4	-11.979
8/19/2016 11:38	80.001	5.178	26.097	-11.964
8/19/2016 11:38	90.001	5.572	25.81	-12.872
8/19/2016 11:38	100.001	5.286	25.53	-12.212
8/19/2016 11:39	110.001	5.232	25.267	-12.087
8/19/2016 11:39	120.001	5.059	25.023	-11.689
8/19/2016 11:39	130.001	4.306	24.796	-9.949
8/19/2016 11:39	140.001	4.881	24.596	-11.278
8/19/2016 11:39	150.001	5.555	24.415	-12.834
8/19/2016 11:39	160.001	5.233	24.226	-12.089
8/19/2016 11:40	170.001	5.209	24.046	-12.035
8/19/2016 11:40	180.001	5.201	23.883	-12.017
8/19/2016 11:40	190.001	5.194	23.73	-11.999

8/19/2016 11:40	200.001	5.191	23.588	-11.994
8/19/2016 11:40	210.001	5.19	23.454	-11.99
8/19/2016 11:40	220.001	5.187	23.325	-11.984
8/19/2016 11:41	230.001	5.185	23.205	-11.98
8/19/2016 11:41	240.001	5.185	23.095	-11.978
8/19/2016 11:41	250.001	5.184	22.993	-11.978
8/19/2016 11:41	260.001	5.185	22.897	-11.979
8/19/2016 11:41	270.001	5.183	22.809	-11.976
8/19/2016 11:41	280.001	5.183	22.726	-11.974
8/19/2016 11:42	290.001	5.182	22.653	-11.973
8/19/2016 11:42	300.001	5.182	22.585	-11.971
8/19/2016 11:42	310.001	5.182	22.522	-11.972
8/19/2016 11:42	320.001	5.181	22.459	-11.97
8/19/2016 11:42	330.001	5.181	22.401	-11.971
8/19/2016 11:42	340.001	5.181	22.345	-11.969
8/19/2016 11:43	350.001	5.181	22.295	-11.969
8/19/2016 11:43	360.001	5.181	22.253	-11.969
8/19/2016 11:43	370.001	5.18	22.207	-11.968
8/19/2016 11:43	380.001	5.18	22.164	-11.968
8/19/2016 11:43	390.001	5.181	22.124	-11.969
8/19/2016 11:43	400.001	5.18	22.092	-11.968
8/19/2016 11:44	410.001	5.18	22.058	-11.967
8/19/2016 11:44	420.001	5.18	22.027	-11.968
8/19/2016 11:44	430.001	5.179	21.995	-11.966
8/19/2016 11:44	440.001	5.18	21.968	-11.967
8/19/2016 11:44	450.001	5.18	21.94	-11.968
8/19/2016 11:44	460.001	5.18	21.915	-11.969
8/19/2016 11:45	470.001	5.18	21.892	-11.968
8/19/2016 11:45	480.001	5.179	21.866	-11.966
8/19/2016 11:45	490.001	5.18	21.847	-11.967
8/19/2016 11:45	500.001	5.18	21.82	-11.968
8/19/2016 11:45	510.001	5.18	21.802	-11.968
8/19/2016 11:45	520.001	5.18	21.779	-11.968
8/19/2016 11:46	530.001	5.18	21.759	-11.967
8/19/2016 11:46	540.001	5.18	21.739	-11.967
8/19/2016 11:46	550.001	5.18	21.721	-11.967
8/19/2016 11:46	560.001	5.179	21.706	-11.966
8/19/2016 11:46	570.001	5.179	21.685	-11.966
8/19/2016 11:46	580.001	5.179	21.671	-11.965
8/19/2016 11:47	590.001	5.18	21.654	-11.966
8/19/2016 11:47	600.001	5.179	21.641	-11.966
8/19/2016 11:47	610.001	5.179	21.63	-11.965
8/19/2016 11:47	620.001	5.178	21.615	-11.963
8/19/2016 11:47	630.001	5.179	21.604	-11.965
8/19/2016 11:47	640.001	5.178	21.59	-11.963
8/19/2016 11:48	650.001	5.178	21.582	-11.963
8/19/2016 11:48	660.001	5.177	21.569	-11.961
8/19/2016 11:48	670.001	5.178	21.558	-11.963
8/19/2016 11:48	680.001	5.178	21.547	-11.964
8/19/2016 11:48	690.001	5.178	21.539	-11.964
8/19/2016 11:48	700.001	5.178	21.527	-11.962

8/19/2016 11:49	710.001	5.178	21.52	-11.963
8/19/2016 11:49	720.001	5.178	21.514	-11.964
8/19/2016 11:49	730.001	5.177	21.504	-11.961
8/19/2016 11:49	740.001	5.177	21.496	-11.96
8/19/2016 11:49	750.001	5.178	21.49	-11.963
8/19/2016 11:49	760.001	5.177	21.483	-11.96
8/19/2016 11:50	770.001	5.177	21.474	-11.961
8/19/2016 11:50	780.001	5.176	21.469	-11.959
8/19/2016 11:50	790.001	5.177	21.464	-11.96
8/19/2016 11:50	800.001	5.176	21.456	-11.958
8/19/2016 11:50	810.001	5.176	21.451	-11.959
8/19/2016 11:50	820.001	5.176	21.448	-11.959
8/19/2016 11:51	830.001	5.175	21.444	-11.956
8/19/2016 11:51	840.001	5.175	21.438	-11.957
8/19/2016 11:51	850.001	5.176	21.432	-11.958
8/19/2016 11:51	860.001	5.175	21.43	-11.957
8/19/2016 11:51	870.001	5.176	21.424	-11.958
8/19/2016 11:51	880.001	5.176	21.421	-11.959
8/19/2016 11:52	890.001	5.175	21.419	-11.956
8/19/2016 11:52	900.001	5.175	21.414	-11.957
8/19/2016 11:52	910.001	5.175	21.409	-11.956
8/19/2016 11:52	920.001	5.175	21.404	-11.956
8/19/2016 11:52	930.001	5.175	21.405	-11.955
8/19/2016 11:52	940.001	5.174	21.398	-11.955
8/19/2016 11:53	950.001	5.175	21.394	-11.955
8/19/2016 11:53	960.001	5.175	21.392	-11.956
8/19/2016 11:53	970.001	5.174	21.389	-11.955
8/19/2016 11:53	980.001	5.175	21.384	-11.955
8/19/2016 11:53	990.001	5.175	21.382	-11.957
8/19/2016 11:53	1000.001	5.175	21.38	-11.955
8/19/2016 11:54	1010.001	5.175	21.372	-11.956
8/19/2016 11:54	1020.001	5.175	21.371	-11.956
8/19/2016 11:54	1030.001	5.175	21.367	-11.956
8/19/2016 11:54	1040.001	5.174	21.366	-11.954
8/19/2016 11:54	1050.001	5.174	21.364	-11.954
8/19/2016 11:54	1060.001	5.175	21.359	-11.955
8/19/2016 11:55	1070.001	5.174	21.354	-11.953
8/19/2016 11:55	1080.001	5.174	21.349	-11.955
8/19/2016 11:55	1090.001	5.174	21.349	-11.955
8/19/2016 11:55	1100.001	5.174	21.349	-11.954
8/19/2016 11:55	1110.001	5.174	21.347	-11.954
8/19/2016 11:55	1120.001	5.024	21.342	-11.607
8/19/2016 11:56	1130.001	4.861	21.341	-11.232
8/19/2016 11:56	1140.001	4.833	21.337	-11.166
8/19/2016 11:56	1150.001	4.815	21.33	-11.126
8/19/2016 11:56	1160.001	4.81	21.322	-11.113
8/19/2016 11:56	1170.001	4.814	21.31	-11.123
8/19/2016 11:56	1180.001	4.815	21.302	-11.124
8/19/2016 11:57	1190.001	4.809	21.286	-11.11
8/19/2016 11:57	1200.001	4.808	21.277	-11.109
8/19/2016 11:57	1210.001	4.78	21.263	-11.045

8/19/2016 11:57	1220.001	4.762	21.251	-11.003
8/19/2016 11:57	1230.001	4.778	21.236	-11.039
8/19/2016 11:57	1240.001	4.786	21.219	-11.059
8/19/2016 11:58	1250.001	4.788	21.206	-11.063
8/19/2016 11:58	1260.001	4.775	21.193	-11.032
8/19/2016 11:58	1270.001	4.686	21.179	-10.826
8/19/2016 11:58	1280.001	4.588	21.165	-10.6
8/19/2016 11:58	1290.001	4.559	21.149	-10.533
8/19/2016 11:58	1300.001	4.552	21.13	-10.518
8/19/2016 11:59	1310.001	4.537	21.116	-10.483
8/19/2016 11:59	1320.001	4.535	21.098	-10.479
8/19/2016 11:59	1330.001	4.521	21.078	-10.446
8/19/2016 11:59	1340.001	4.514	21.06	-10.43
8/19/2016 11:59	1350.001	4.524	21.046	-10.452
8/19/2016 11:59	1360.001	4.512	21.031	-10.426
8/19/2016 12:00	1370.001	4.518	21.012	-10.44
8/19/2016 12:00	1380.001	4.504	21	-10.408
8/19/2016 12:00	1390.001	4.517	20.985	-10.437
8/19/2016 12:00	1400.001	4.524	20.968	-10.453
8/19/2016 12:00	1410.001	4.514	20.953	-10.43
8/19/2016 12:00	1420.001	4.508	20.941	-10.415
8/19/2016 12:01	1430.001	4.507	20.928	-10.413
8/19/2016 12:01	1440.001	4.498	20.917	-10.394
8/19/2016 12:01	1450.001	4.513	20.903	-10.426
8/19/2016 12:01	1460.001	4.518	20.891	-10.439
8/19/2016 12:01	1470.001	4.511	20.876	-10.422
8/19/2016 12:01	1480.001	4.505	20.871	-10.409
8/19/2016 12:02	1490.001	4.505	20.858	-10.408
8/19/2016 12:02	1500.001	4.503	20.846	-10.404
8/19/2016 12:02	1510.001	4.504	20.836	-10.408
8/19/2016 12:02	1520.001	4.503	20.824	-10.404
8/19/2016 12:02	1530.001	4.496	20.82	-10.388
8/19/2016 12:02	1540.001	4.498	20.81	-10.394
8/19/2016 12:03	1550.001	4.497	20.804	-10.392
8/19/2016 12:03	1560.001	4.506	20.794	-10.412
8/19/2016 12:03	1570.001	4.513	20.785	-10.428
8/19/2016 12:03	1580.001	4.517	20.775	-10.438
8/19/2016 12:03	1590.001	4.509	20.769	-10.418
8/19/2016 12:03	1600.001	4.503	20.762	-10.404
8/19/2016 12:04	1610.001	4.501	20.755	-10.399
8/19/2016 12:04	1620.001	4.491	20.748	-10.376
8/19/2016 12:04	1630.001	4.489	20.745	-10.373
8/19/2016 12:04	1640.001	4.492	20.737	-10.379
8/19/2016 12:04	1650.001	4.502	20.729	-10.402
8/19/2016 12:04	1660.001	4.448	20.721	-10.277
8/19/2016 12:05	1670.001	4.425	20.715	-10.225
8/19/2016 12:05	1680.001	4.412	20.708	-10.194
8/19/2016 12:05	1690.001	4.404	20.704	-10.175
8/19/2016 12:05	1700.001	4.396	20.698	-10.158
8/19/2016 12:05	1710.001	4.393	20.691	-10.151
8/19/2016 12:05	1720.001	4.39	20.687	-10.145

8/19/2016 12:06	1730.001	4.39	20.679	-10.143
8/19/2016 12:06	1740.001	4.403	20.677	-10.173
8/19/2016 12:06	1750.001	4.408	20.673	-10.184
8/19/2016 12:06	1760.001	4.406	20.668	-10.179
8/19/2016 12:06	1770.001	4.402	20.664	-10.172
8/19/2016 12:06	1780.001	4.398	20.66	-10.163
8/19/2016 12:07	1790.001	4.394	20.654	-10.153
8/19/2016 12:07	1800.001	4.396	20.651	-10.158
8/19/2016 12:07	1810.001	4.397	20.647	-10.16
8/19/2016 12:07	1820.001	4.397	20.642	-10.16
8/19/2016 12:07	1830.001	4.398	20.638	-10.163
8/19/2016 12:07	1840.001	4.396	20.633	-10.157
8/19/2016 12:08	1850.001	4.394	20.632	-10.154
8/19/2016 12:08	1860.001	4.395	20.626	-10.156
8/19/2016 12:08	1870.001	4.396	20.623	-10.158
8/19/2016 12:08	1880.001	4.396	20.619	-10.157
8/19/2016 12:08	1890.001	4.391	20.615	-10.147
8/19/2016 12:08	1900.001	4.387	20.609	-10.138
8/19/2016 12:09	1910.001	4.386	20.606	-10.134
8/19/2016 12:09	1920.001	4.385	20.604	-10.133
8/19/2016 12:09	1930.001	4.385	20.599	-10.131
8/19/2016 12:09	1940.001	4.384	20.596	-10.13
8/19/2016 12:09	1950.001	4.38	20.594	-10.121
8/19/2016 12:09	1960.001	4.377	20.592	-10.113
8/19/2016 12:10	1970.001	4.425	20.587	-10.225
8/19/2016 12:10	1980.001	4.438	20.585	-10.255
8/19/2016 12:10	1990.001	4.453	20.578	-10.289
8/19/2016 12:10	2000.001	4.466	20.579	-10.318
8/19/2016 12:10	2010.001	4.455	20.581	-10.293
8/19/2016 12:10	2020.001	4.413	20.576	-10.196
8/19/2016 12:11	2030.001	4.394	20.575	-10.152
8/19/2016 12:11	2040.001	4.382	20.573	-10.125
8/19/2016 12:11	2050.001	4.376	20.569	-10.11
8/19/2016 12:11	2060.001	4.374	20.568	-10.106
8/19/2016 12:11	2070.001	4.372	20.565	-10.102
8/19/2016 12:11	2080.001	4.371	20.562	-10.1
8/19/2016 12:12	2090.001	4.369	20.561	-10.095
8/19/2016 12:12	2100.001	4.369	20.56	-10.095
8/19/2016 12:12	2110.001	4.368	20.555	-10.092
8/19/2016 12:12	2120.001	4.368	20.554	-10.092
8/19/2016 12:12	2130.001	4.369	20.554	-10.094
8/19/2016 12:12	2140.001	4.369	20.554	-10.096
8/19/2016 12:13	2150.001	4.368	20.549	-10.092
8/19/2016 12:13	2160.001	4.367	20.547	-10.09
8/19/2016 12:13	2170.001	4.368	20.547	-10.092
8/19/2016 12:13	2180.001	4.37	20.542	-10.097
8/19/2016 12:13	2190.001	4.37	20.542	-10.098
8/19/2016 12:13	2200.001	4.371	20.54	-10.1
8/19/2016 12:14	2210.001	4.371	20.54	-10.1
8/19/2016 12:14	2220.001	4.367	20.541	-10.091
8/19/2016 12:14	2230.001	4.368	20.536	-10.092

8/19/2016 12:14	2240.001	4.367	20.537	-10.09
8/19/2016 12:14	2250.001	4.368	20.533	-10.093
8/19/2016 12:14	2260.001	4.368	20.534	-10.093
8/19/2016 12:15	2270.001	4.354	20.534	-10.06
8/19/2016 12:15	2280.001	3.939	20.531	-9.102
8/19/2016 12:15	2290.001	3.776	20.528	-8.725
8/19/2016 12:15	2300.001	3.723	20.535	-8.604
8/19/2016 12:15	2310.001	3.687	20.538	-8.519
8/19/2016 12:15	2320.001	3.668	20.543	-8.477
8/19/2016 12:16	2330.001	3.659	20.543	-8.456
8/19/2016 12:16	2340.001	3.656	20.546	-8.448
8/19/2016 12:16	2350.001	3.648	20.548	-8.43
8/19/2016 12:16	2360.001	3.647	20.55	-8.429
8/19/2016 12:16	2370.001	3.635	20.557	-8.4
8/19/2016 12:16	2380.001	3.632	20.563	-8.392
8/19/2016 12:17	2390.001	3.636	20.566	-8.402
8/19/2016 12:17	2400.001	3.63	20.57	-8.388
8/19/2016 12:17	2410.001	3.624	20.575	-8.375
8/19/2016 12:17	2420.001	3.588	20.578	-8.291
8/19/2016 12:17	2430.001	3.577	20.582	-8.267
8/19/2016 12:17	2440.001	3.574	20.583	-8.26
8/19/2016 12:18	2450.001	3.572	20.587	-8.254
8/19/2016 12:18	2460.001	3.572	20.591	-8.255
8/19/2016 12:18	2470.001	3.57	20.594	-8.25
8/19/2016 12:18	2480.001	3.567	20.594	-8.244
8/19/2016 12:18	2490.001	3.57	20.597	-8.25
8/19/2016 12:18	2500.001	3.568	20.597	-8.246
8/19/2016 12:19	2510.001	3.568	20.599	-8.246
8/19/2016 12:19	2520.001	3.57	20.599	-8.25
8/19/2016 12:19	2530.001	3.569	20.598	-8.249
8/19/2016 12:19	2540.001	3.567	20.598	-8.244
8/19/2016 12:19	2550.001	3.568	20.6	-8.245
8/19/2016 12:19	2560.001	3.565	20.598	-8.239
8/19/2016 12:20	2570.001	3.565	20.595	-8.239
8/19/2016 12:20	2580.001	3.563	20.594	-8.234
8/19/2016 12:20	2590.001	3.562	20.599	-8.231
8/19/2016 12:20	2600.001	3.56	20.598	-8.226
8/19/2016 12:20	2610.001	3.562	20.595	-8.233
8/19/2016 12:20	2620.001	3.56	20.592	-8.228
8/19/2016 12:21	2630.001	3.559	20.592	-8.225
8/19/2016 12:21	2640.001	3.561	20.596	-8.229
8/19/2016 12:21	2650.001	3.563	20.592	-8.233
8/19/2016 12:21	2660.001	3.56	20.591	-8.227
8/19/2016 12:21	2670.001	3.558	20.589	-8.222
8/19/2016 12:21	2680.001	3.56	20.586	-8.228
8/19/2016 12:22	2690.001	3.559	20.588	-8.226
8/19/2016 12:22	2700.001	3.56	20.589	-8.226
8/19/2016 12:22	2710.001	3.56	20.585	-8.228
8/19/2016 12:22	2720.001	3.559	20.586	-8.226
8/19/2016 12:22	2730.001	3.56	20.585	-8.227
8/19/2016 12:22	2740.001	3.558	20.585	-8.223

8/19/2016 12:23	2750.001	3.56	20.583	-8.226
8/19/2016 12:23	2760.001	3.557	20.582	-8.22
8/19/2016 12:23	2770.001	3.555	20.578	-8.216
8/19/2016 12:23	2780.001	3.558	20.581	-8.222
8/19/2016 12:23	2790.084	3.558	20.581	-8.221
8/19/2016 12:23	2800.001	3.6	20.577	-8.32
8/19/2016 12:24	2810.001	3.609	20.582	-8.341
8/19/2016 12:24	2820.001	3.606	20.585	-8.332
8/19/2016 12:24	2830.001	3.568	20.583	-8.246
8/19/2016 12:24	2840.001	3.551	20.583	-8.207
8/19/2016 12:24	2850.001	4.298	20.582	-9.931
8/19/2016 12:24	2860.001	4.838	20.578	-11.178
8/19/2016 12:25	2870.001	4.937	20.581	-11.406
8/19/2016 12:25	2880.001	4.974	20.58	-11.493
8/19/2016 12:25	2890.001	5.038	20.582	-11.639
8/19/2016 12:25	2900.001	5.065	20.575	-11.701
8/19/2016 12:25	2910.001	5.082	20.574	-11.741
8/19/2016 12:25	2920.001	5.096	20.575	-11.774
8/19/2016 12:26	2930.001	4.764	20.576	-11.007
8/19/2016 12:26	2940.001	4.945	20.574	-11.425
8/19/2016 12:26	2950.001	5.022	20.572	-11.602

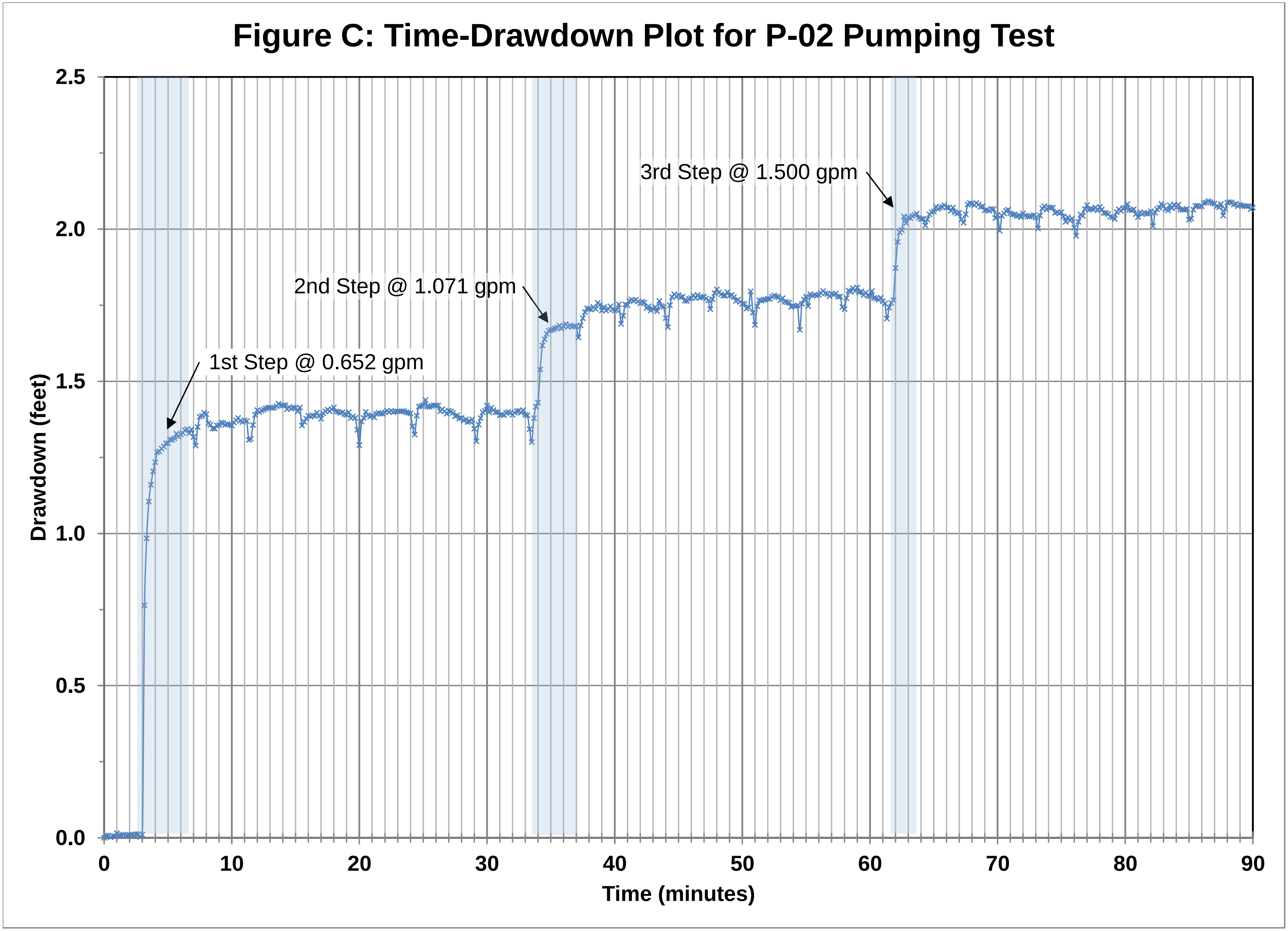


Figure C: Time-Drawdown Plot for P-02 Pumping Test
1st Step @ 0.652 gpm
2nd Step @ 1.071 gpm
3rd Step @ 1.500 gpm
Drawdown (feet)
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
Time (minutes)

Figure C-1: Log Plot of P-02 Pumping Test Step 1

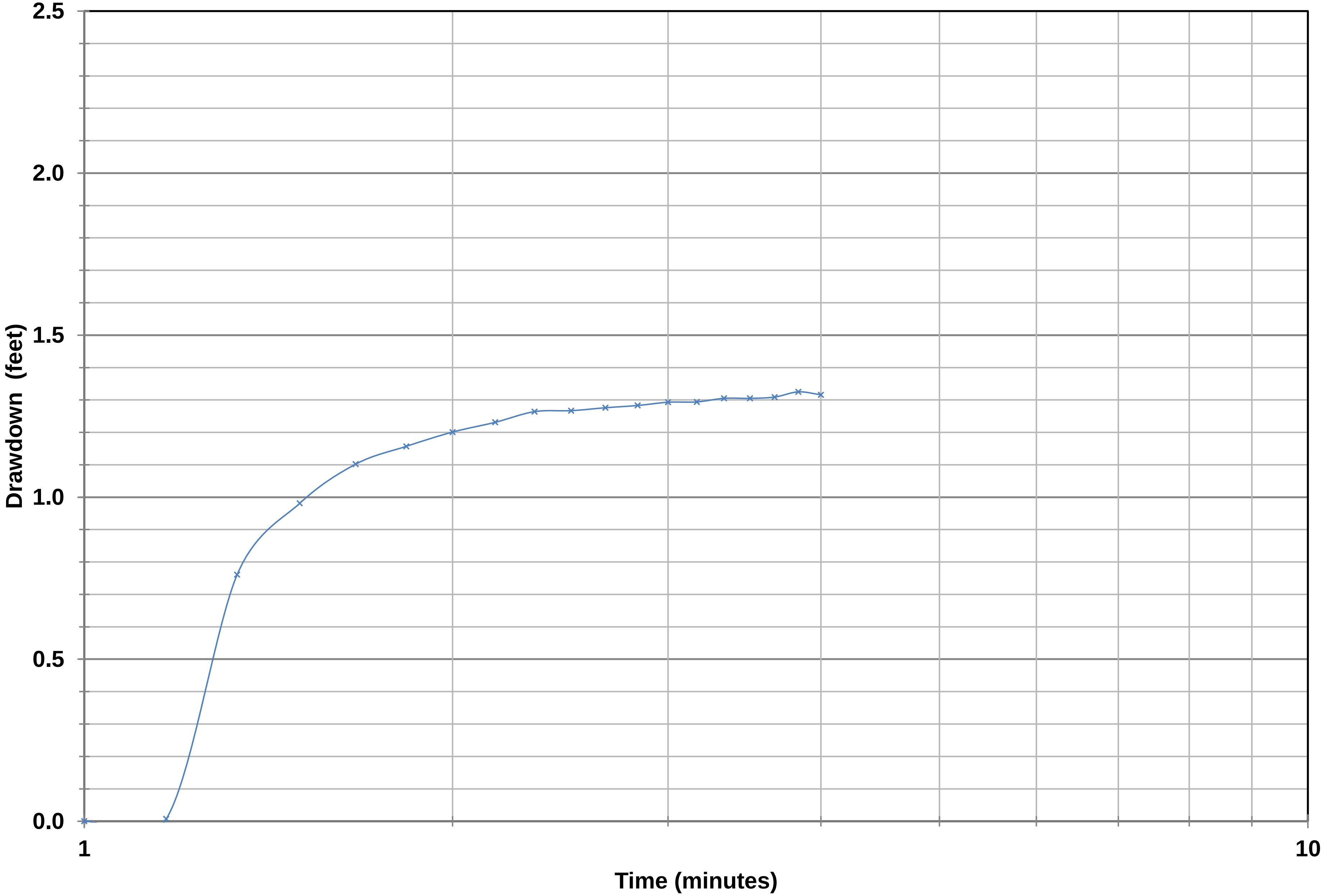


Figure C-2: Log Plot of P-02 Pumping Test Step 2

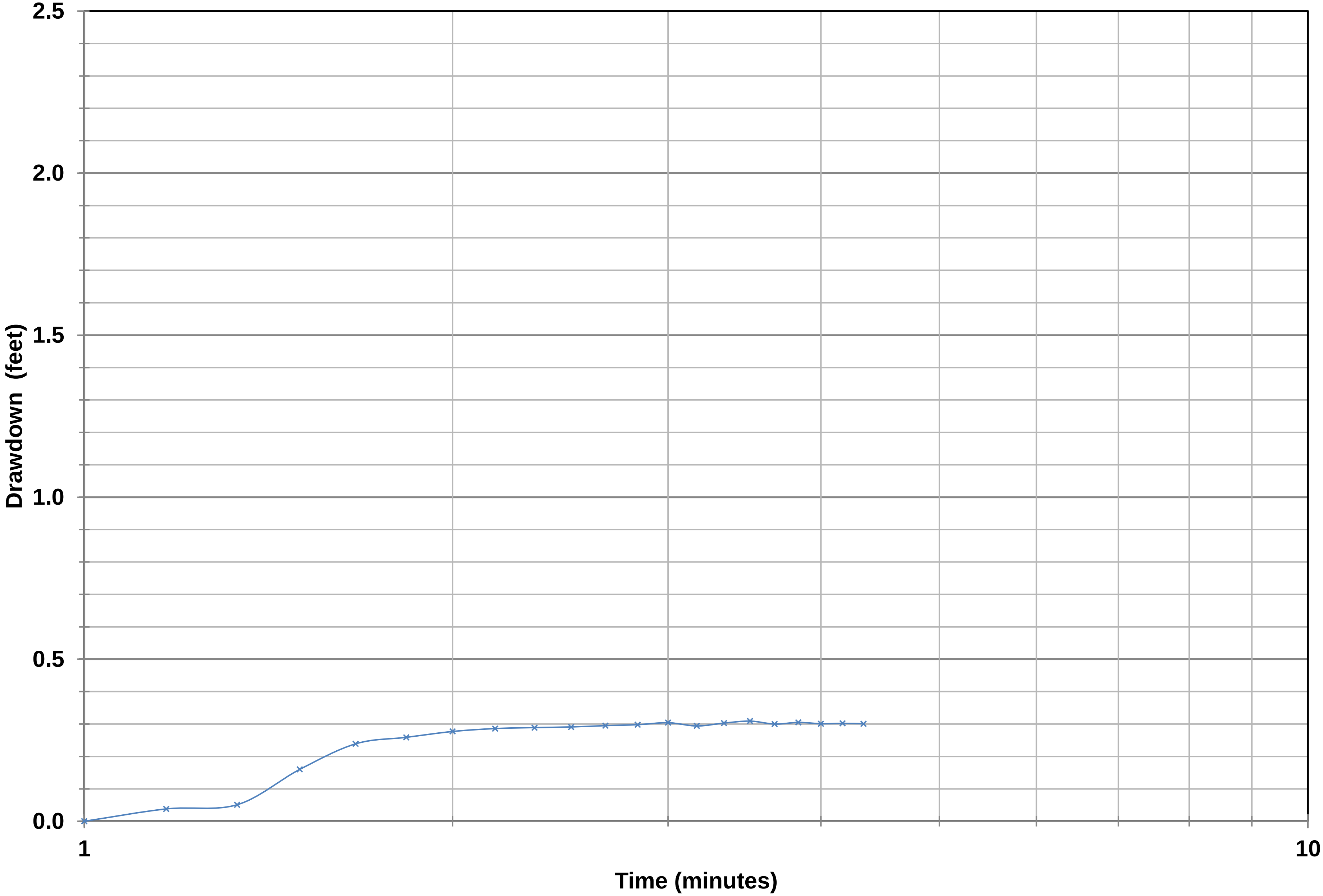
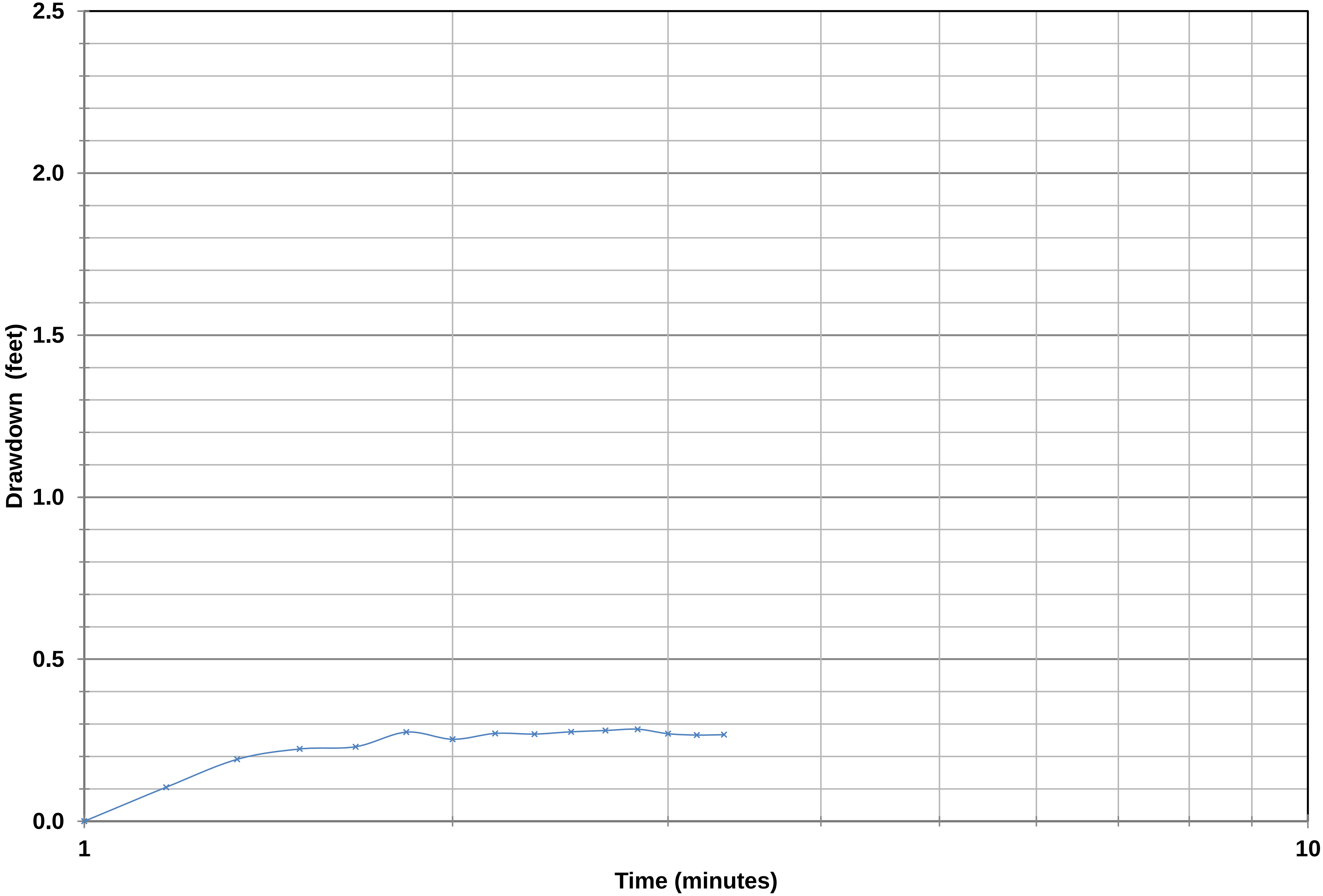


Figure C-3: Log Plot of P-02 Pumping Test Step 3



P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 13:24:23	0	5.758	28.027	-1.288		0.00	0.00
05/24/19 13:24:33	10.001	5.755	27.506	-1.281		0.17	0.01
05/24/19 13:24:43	20.001	5.755	27.002	-1.281		0.33	0.01
05/24/19 13:24:53	30.001	5.757	26.574	-1.286		0.50	0.00
05/24/19 13:25:03	40.001	5.756	26.105	-1.283		0.67	0.01
05/24/19 13:25:13	50.001	5.756	25.729	-1.283		0.83	0.01
05/24/19 13:25:23	60.001	5.751	25.316	-1.273		1.00	0.02
05/24/19 13:25:33	70.001	5.755	25.014	-1.281		1.17	0.01
05/24/19 13:25:43	80.001	5.754	24.690	-1.279		1.33	0.01
05/24/19 13:25:53	90.001	5.753	24.393	-1.277		1.50	0.01
05/24/19 13:27:26	182.926	5.754	22.430	-1.281		1.67	0.01
05/24/19 13:27:36	192.939	5.754	22.299	-1.280		1.83	0.01
05/24/19 13:27:46	202.926	5.753	22.211	-1.278		2.00	0.01
05/24/19 13:27:56	212.926	5.753	22.069	-1.277		2.17	0.01
05/24/19 13:28:06	222.926	5.754	21.971	-1.279		2.33	0.01
05/24/19 13:28:16	232.926	5.752	21.850	-1.276		2.50	0.01
05/24/19 13:28:26	242.926	5.753	21.740	-1.276		2.67	0.01
05/24/19 13:28:36	252.926	5.757	21.668	-1.285		2.83	0.00
05/24/19 13:28:46	262.926	5.753	21.569	-1.278		3.00	0.01
05/24/19 13:28:56	272.926	5.427	21.469	-0.524		3.17	0.76
05/24/19 13:29:06	282.926	5.332	21.381	-0.304		3.33	0.98
05/24/19 13:29:16	292.926	5.279	21.321	-0.183		3.50	1.11
05/24/19 13:29:26	302.926	5.255	21.280	-0.128		3.67	1.16
05/24/19 13:29:36	312.926	5.236	21.186	-0.084		3.83	1.20
05/24/19 13:29:46	322.926	5.223	21.125	-0.054		4.00	1.23
05/24/19 13:29:56	332.926	5.209	21.042	-0.021		4.17	1.27
05/24/19 13:30:06	342.926	5.208	21.003	-0.018		4.33	1.27
05/24/19 13:30:16	352.926	5.204	20.925	-0.009		4.50	1.28
05/24/19 13:30:26	362.926	5.201	20.896	-0.002		4.67	1.29
05/24/19 13:30:36	372.926	5.196	20.882	0.008		4.83	1.30
05/24/19 13:30:46	382.926	5.196	20.806	0.009		5.00	1.30
05/24/19 13:30:56	392.927	5.191	20.785	0.020		5.17	1.31
05/24/19 13:31:06	402.927	5.191	20.746	0.020		5.33	1.31
05/24/19 13:31:16	412.926	5.189	20.723	0.024		5.50	1.31
05/24/19 13:31:26	422.926	5.182	20.697	0.040		5.67	1.33
05/24/19 13:31:36	432.926	5.187	20.674	0.031		5.83	1.32
05/24/19 13:31:46	442.926	5.183	20.639	0.038		6.00	1.33
05/24/19 13:31:56	452.926	5.181	20.638	0.043		6.17	1.33
05/24/19 13:32:06	462.926	5.178	20.585	0.051		6.33	1.34
05/24/19 13:32:16	472.926	5.176	20.579	0.055		6.50	1.34
05/24/19 13:32:26	482.926	5.182	20.551	0.041		6.67	1.33
05/24/19 13:32:36	492.926	5.177	20.528	0.054		6.83	1.34

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 13:32:46	502.926	5.187	20.502	0.029		7.00	1.32
05/24/19 13:32:56	512.926	5.200	20.516	0.001		7.17	1.29
05/24/19 13:33:06	522.926	5.173	20.478	0.062		7.33	1.35
05/24/19 13:33:16	532.926	5.159	20.476	0.095	0.652	7.50	1.38
05/24/19 13:33:26	542.926	5.157	20.473	0.098		7.67	1.39
05/24/19 13:33:36	552.926	5.152	20.434	0.109		7.83	1.40
05/24/19 13:33:46	562.926	5.155	20.448	0.104		8.00	1.39
05/24/19 13:33:56	572.926	5.168	20.441	0.074		8.17	1.36
05/24/19 13:34:06	582.926	5.170	20.415	0.069		8.33	1.36
05/24/19 13:34:16	592.926	5.175	20.415	0.057		8.50	1.35
05/24/19 13:34:26	602.926	5.176	20.419	0.056		8.67	1.34
05/24/19 13:34:36	612.926	5.171	20.376	0.067		8.83	1.36
05/24/19 13:34:46	622.926	5.170	20.348	0.068		9.00	1.36
05/24/19 13:34:56	632.926	5.167	20.354	0.076		9.17	1.36
05/24/19 13:35:06	642.926	5.167	20.387	0.075		9.33	1.36
05/24/19 13:35:16	652.926	5.170	20.364	0.069		9.50	1.36
05/24/19 13:35:26	662.926	5.169	20.335	0.071		9.67	1.36
05/24/19 13:35:36	672.926	5.170	20.329	0.070		9.83	1.36
05/24/19 13:35:46	682.926	5.171	20.368	0.067		10.00	1.36
05/24/19 13:35:56	692.926	5.167	20.323	0.077		10.17	1.37
05/24/19 13:36:06	702.926	5.163	20.331	0.084		10.33	1.37
05/24/19 13:36:16	712.926	5.160	20.322	0.092		10.50	1.38
05/24/19 13:36:26	722.926	5.164	20.290	0.082		10.67	1.37
05/24/19 13:36:36	732.926	5.166	20.320	0.078		10.83	1.37
05/24/19 13:36:46	742.926	5.163	20.302	0.084		11.00	1.37
05/24/19 13:36:56	752.926	5.165	20.299	0.081		11.17	1.37
05/24/19 13:37:06	762.926	5.192	20.305	0.019		11.33	1.31
05/24/19 13:37:16	772.926	5.190	20.306	0.023		11.50	1.31
05/24/19 13:37:26	782.926	5.170	20.283	0.068		11.67	1.36
05/24/19 13:37:36	792.926	5.156	20.290	0.102	1.154	11.83	1.39
05/24/19 13:37:46	802.926	5.149	20.291	0.117		12.00	1.41
05/24/19 13:37:56	812.926	5.152	20.282	0.111		12.17	1.40
05/24/19 13:38:06	822.926	5.150	20.273	0.116		12.33	1.40
05/24/19 13:38:16	832.926	5.149	20.288	0.119		12.50	1.41
05/24/19 13:38:26	842.926	5.147	20.253	0.123		12.67	1.41
05/24/19 13:38:36	852.926	5.146	20.271	0.125		12.83	1.41
05/24/19 13:38:46	862.926	5.145	20.234	0.126		13.00	1.41
05/24/19 13:38:56	872.926	5.146	20.258	0.124		13.17	1.41
05/24/19 13:39:06	882.926	5.145	20.275	0.126		13.33	1.41
05/24/19 13:39:16	892.926	5.144	20.230	0.130		13.50	1.42
05/24/19 13:39:26	902.926	5.140	20.244	0.138		13.67	1.43
05/24/19 13:39:36	912.927	5.142	20.189	0.133		13.83	1.42

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 13:39:46	922.927	5.142	20.242	0.132		14.00	1.42
05/24/19 13:39:56	932.927	5.142	20.230	0.134		14.17	1.42
05/24/19 13:40:06	942.926	5.148	20.205	0.120		14.33	1.41
05/24/19 13:40:16	952.926	5.145	20.240	0.127		14.50	1.42
05/24/19 13:40:26	962.927	5.147	20.252	0.122		14.67	1.41
05/24/19 13:40:36	972.927	5.146	20.210	0.125		14.83	1.41
05/24/19 13:40:46	982.927	5.146	20.213	0.125		15.00	1.41
05/24/19 13:40:56	992.926	5.151	20.228	0.113		15.17	1.40
05/24/19 13:41:06	1002.926	5.145	20.223	0.126		15.33	1.41
05/24/19 13:41:16	1012.926	5.171	20.202	0.067		15.50	1.36
05/24/19 13:41:26	1022.927	5.166	20.240	0.079		15.67	1.37
05/24/19 13:41:36	1032.927	5.161	20.216	0.090		15.83	1.38
05/24/19 13:41:46	1042.927	5.157	20.226	0.099	1.154	16.00	1.39
05/24/19 13:41:56	1052.927	5.158	20.214	0.096		16.17	1.38
05/24/19 13:42:06	1062.927	5.157	20.214	0.100		16.33	1.39
05/24/19 13:42:16	1072.926	5.158	20.213	0.098		16.50	1.39
05/24/19 13:42:26	1082.927	5.153	20.214	0.109		16.67	1.40
05/24/19 13:42:36	1092.927	5.157	20.187	0.099		16.83	1.39
05/24/19 13:42:46	1102.927	5.161	20.218	0.089		17.00	1.38
05/24/19 13:42:56	1112.926	5.154	20.197	0.107		17.17	1.40
05/24/19 13:43:06	1122.927	5.151	20.210	0.113		17.33	1.40
05/24/19 13:43:16	1132.926	5.148	20.179	0.119		17.50	1.41
05/24/19 13:43:26	1142.93	5.150	20.166	0.114		17.67	1.40
05/24/19 13:43:36	1152.927	5.147	20.200	0.121		17.83	1.41
05/24/19 13:43:46	1162.927	5.145	20.171	0.126		18.00	1.41
05/24/19 13:43:56	1172.926	5.151	20.213	0.113		18.17	1.40
05/24/19 13:44:06	1182.926	5.151	20.171	0.112		18.33	1.40
05/24/19 13:44:16	1192.926	5.153	20.202	0.108		18.50	1.40
05/24/19 13:44:26	1202.926	5.152	20.193	0.110		18.67	1.40
05/24/19 13:44:36	1212.927	5.155	20.202	0.104		18.83	1.39
05/24/19 13:44:46	1222.927	5.156	20.178	0.102		19.00	1.39
05/24/19 13:44:56	1232.926	5.152	20.194	0.110		19.17	1.40
05/24/19 13:45:06	1242.927	5.160	20.218	0.091		19.33	1.38
05/24/19 13:45:16	1252.927	5.158	20.203	0.097		19.50	1.39
05/24/19 13:45:26	1262.926	5.160	20.178	0.092		19.67	1.38
05/24/19 13:45:36	1272.927	5.177	20.216	0.053		19.83	1.34
05/24/19 13:45:46	1282.927	5.199	20.173	0.002		20.00	1.29
05/24/19 13:45:56	1292.926	5.165	20.174	0.080	1.200	20.17	1.37
05/24/19 13:46:06	1302.926	5.160	20.198	0.092		20.33	1.38
05/24/19 13:46:16	1312.926	5.151	20.168	0.112		20.50	1.40
05/24/19 13:46:26	1322.926	5.156	20.182	0.101		20.67	1.39
05/24/19 13:46:36	1332.926	5.158	20.203	0.097		20.83	1.39

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 13:46:46	1342.926	5.157	20.196	0.099		21.00	1.39
05/24/19 13:46:56	1352.926	5.159	20.201	0.093		21.17	1.38
05/24/19 13:47:06	1362.926	5.154	20.178	0.105		21.33	1.39
05/24/19 13:47:16	1372.926	5.153	20.186	0.108		21.50	1.40
05/24/19 13:47:26	1382.926	5.154	20.214	0.106		21.67	1.39
05/24/19 13:47:36	1392.926	5.154	20.189	0.105		21.83	1.39
05/24/19 13:47:46	1402.926	5.152	20.195	0.110		22.00	1.40
05/24/19 13:47:56	1412.926	5.150	20.190	0.115		22.17	1.40
05/24/19 13:48:06	1422.926	5.152	20.179	0.111		22.33	1.40
05/24/19 13:48:16	1432.926	5.150	20.207	0.115		22.50	1.40
05/24/19 13:48:26	1442.926	5.152	20.180	0.110		22.67	1.40
05/24/19 13:48:36	1452.926	5.151	20.193	0.113		22.83	1.40
05/24/19 13:48:46	1462.926	5.151	20.198	0.113		23.00	1.40
05/24/19 13:48:56	1472.926	5.151	20.199	0.113		23.17	1.40
05/24/19 13:49:06	1482.926	5.150	20.189	0.114		23.33	1.40
05/24/19 13:49:16	1492.926	5.150	20.163	0.114		23.50	1.40
05/24/19 13:49:26	1502.927	5.152	20.181	0.110		23.67	1.40
05/24/19 13:49:36	1512.927	5.153	20.200	0.108		23.83	1.40
05/24/19 13:49:46	1522.926	5.153	20.189	0.107		24.00	1.40
05/24/19 13:49:56	1532.927	5.172	20.167	0.064		24.17	1.35
05/24/19 13:50:06	1542.927	5.184	20.194	0.037		24.33	1.33
05/24/19 13:50:16	1552.926	5.157	20.188	0.099	1.154	24.50	1.39
05/24/19 13:50:26	1562.926	5.144	20.183	0.129		24.67	1.42
05/24/19 13:50:36	1572.926	5.143	20.139	0.131		24.83	1.42
05/24/19 13:50:46	1582.926	5.142	20.184	0.134		25.00	1.42
05/24/19 13:50:56	1592.926	5.135	20.175	0.151		25.17	1.44
05/24/19 13:51:06	1602.926	5.144	20.157	0.129		25.33	1.42
05/24/19 13:51:16	1612.926	5.145	20.168	0.128		25.50	1.42
05/24/19 13:51:26	1622.926	5.143	20.202	0.131		25.67	1.42
05/24/19 13:51:36	1632.926	5.142	20.154	0.134		25.83	1.42
05/24/19 13:51:46	1642.926	5.142	20.202	0.133		26.00	1.42
05/24/19 13:51:56	1652.926	5.143	20.140	0.132		26.17	1.42
05/24/19 13:52:06	1662.926	5.151	20.186	0.114		26.33	1.40
05/24/19 13:52:16	1672.926	5.148	20.177	0.120		26.50	1.41
05/24/19 13:52:26	1682.926	5.151	20.155	0.113		26.67	1.40
05/24/19 13:52:36	1692.927	5.154	20.171	0.105		26.83	1.39
05/24/19 13:52:46	1702.927	5.150	20.148	0.116		27.00	1.40
05/24/19 13:52:56	1712.927	5.151	20.176	0.113		27.17	1.40
05/24/19 13:53:06	1722.927	5.153	20.182	0.108		27.33	1.40
05/24/19 13:53:16	1732.927	5.158	20.156	0.097		27.50	1.39
05/24/19 13:53:26	1742.927	5.156	20.171	0.100		27.67	1.39
05/24/19 13:53:36	1752.927	5.161	20.179	0.090		27.83	1.38

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 13:53:46	1762.927	5.160	20.181	0.092		28.00	1.38
05/24/19 13:53:56	1772.927	5.164	20.150	0.083		28.17	1.37
05/24/19 13:54:06	1782.927	5.162	20.184	0.087		28.33	1.38
05/24/19 13:54:16	1792.927	5.166	20.179	0.078		28.50	1.37
05/24/19 13:54:26	1802.927	5.165	20.202	0.080		28.67	1.37
05/24/19 13:54:36	1812.926	5.162	20.173	0.087		28.83	1.38
05/24/19 13:54:46	1822.926	5.176	20.155	0.056	1.111	29.00	1.34
05/24/19 13:54:56	1832.927	5.193	20.174	0.015		29.17	1.30
05/24/19 13:55:06	1842.927	5.170	20.160	0.070		29.33	1.36
05/24/19 13:55:16	1852.927	5.160	20.196	0.091		29.50	1.38
05/24/19 13:55:26	1862.927	5.152	20.146	0.110		29.67	1.40
05/24/19 13:55:36	1872.927	5.150	20.152	0.115		29.83	1.40
05/24/19 13:55:46	1882.926	5.143	20.170	0.132		30.00	1.42
05/24/19 13:55:56	1892.927	5.152	20.154	0.110		30.17	1.40
05/24/19 13:56:06	1902.927	5.146	20.174	0.125		30.33	1.41
05/24/19 13:56:16	1912.927	5.149	20.140	0.117		30.50	1.41
05/24/19 13:56:26	1922.926	5.152	20.189	0.110		30.67	1.40
05/24/19 13:56:36	1932.926	5.152	20.160	0.111		30.83	1.40
05/24/19 13:56:46	1942.926	5.157	20.174	0.100		31.00	1.39
05/24/19 13:56:56	1952.927	5.155	20.177	0.103		31.17	1.39
05/24/19 13:57:06	1962.927	5.156	20.189	0.101		31.33	1.39
05/24/19 13:57:16	1972.927	5.153	20.135	0.108		31.50	1.40
05/24/19 13:57:26	1982.926	5.152	20.195	0.111		31.67	1.40
05/24/19 13:57:36	1992.927	5.153	20.184	0.108		31.83	1.40
05/24/19 13:57:46	2002.927	5.156	20.156	0.102		32.00	1.39
05/24/19 13:57:56	2012.926	5.153	20.169	0.109		32.17	1.40
05/24/19 13:58:06	2022.926	5.151	20.157	0.114		32.33	1.40
05/24/19 13:58:16	2032.926	5.150	20.150	0.115		32.50	1.40
05/24/19 13:58:26	2042.926	5.153	20.167	0.109	1.364	32.67	1.40
05/24/19 13:58:36	2052.926	5.149	20.157	0.117		32.83	1.41
05/24/19 13:58:46	2062.926	5.156	20.181	0.102		33.00	1.39
05/24/19 13:58:56	2072.926	5.157	20.174	0.100		33.17	1.39
05/24/19 13:59:06	2082.926	5.176	20.205	0.055		33.33	1.34
05/24/19 13:59:16	2092.926	5.195	20.192	0.012		33.50	1.30
05/24/19 13:59:26	2102.926	5.160	20.170	0.091		33.67	1.38
05/24/19 13:59:36	2112.926	5.144	20.158	0.129		33.83	1.42
05/24/19 13:59:46	2122.926	5.139	20.153	0.142		34.00	1.43
05/24/19 13:59:56	2132.926	5.091	20.142	0.251		34.17	1.54
05/24/19 14:00:06	2142.926	5.057	20.165	0.330		34.33	1.62
05/24/19 14:00:16	2152.926	5.048	20.192	0.350		34.50	1.64
05/24/19 14:00:26	2162.926	5.041	20.176	0.368		34.67	1.66
05/24/19 14:00:36	2172.926	5.037	20.164	0.377		34.83	1.67

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:00:46	2182.926	5.035	20.178	0.380		35.00	1.67
05/24/19 14:00:56	2192.927	5.034	20.169	0.382		35.17	1.67
05/24/19 14:01:06	2202.926	5.033	20.181	0.386		35.33	1.67
05/24/19 14:01:16	2212.926	5.031	20.162	0.389		35.50	1.68
05/24/19 14:01:26	2222.927	5.029	20.181	0.395		35.67	1.68
05/24/19 14:01:36	2232.927	5.033	20.161	0.385		35.83	1.67
05/24/19 14:01:46	2242.926	5.029	20.173	0.394		36.00	1.68
05/24/19 14:01:56	2252.927	5.027	20.173	0.400		36.17	1.69
05/24/19 14:02:06	2262.927	5.031	20.174	0.391		36.33	1.68
05/24/19 14:02:16	2272.927	5.028	20.170	0.396		36.50	1.68
05/24/19 14:02:26	2282.926	5.030	20.168	0.392		36.67	1.68
05/24/19 14:02:36	2292.926	5.030	20.151	0.393		36.83	1.68
05/24/19 14:02:46	2302.927	5.030	20.207	0.392		37.00	1.68
05/24/19 14:02:56	2312.927	5.046	20.168	0.356		37.17	1.64
05/24/19 14:03:06	2322.926	5.028	20.176	0.396	1.071	37.33	1.68
05/24/19 14:03:16	2332.926	5.018	20.187	0.419		37.50	1.71
05/24/19 14:03:26	2342.927	5.010	20.208	0.439		37.67	1.73
05/24/19 14:03:36	2352.927	5.004	20.179	0.452		37.83	1.74
05/24/19 14:03:46	2362.927	5.005	20.182	0.450		38.00	1.74
05/24/19 14:03:56	2372.926	5.006	20.170	0.448		38.17	1.74
05/24/19 14:04:06	2382.926	5.002	20.189	0.456		38.33	1.74
05/24/19 14:04:16	2392.927	5.005	20.186	0.450		38.50	1.74
05/24/19 14:04:26	2402.927	4.997	20.188	0.470		38.67	1.76
05/24/19 14:04:36	2412.927	5.000	20.188	0.463		38.83	1.75
05/24/19 14:04:46	2422.926	5.007	20.178	0.445		39.00	1.73
05/24/19 14:04:56	2432.926	5.002	20.171	0.456		39.17	1.74
05/24/19 14:05:06	2442.926	5.007	20.197	0.444		39.33	1.73
05/24/19 14:05:16	2452.926	5.005	20.189	0.450		39.50	1.74
05/24/19 14:05:26	2462.927	5.001	20.171	0.458		39.67	1.75
05/24/19 14:05:36	2472.927	5.006	20.189	0.448		39.83	1.74
05/24/19 14:05:46	2482.927	5.007	20.194	0.445		40.00	1.73
05/24/19 14:05:56	2492.926	5.006	20.194	0.447		40.17	1.74
05/24/19 14:06:06	2502.926	4.999	20.194	0.465		40.33	1.75
05/24/19 14:06:16	2512.927	5.026	20.181	0.401		40.50	1.69
05/24/19 14:06:26	2522.927	5.015	20.168	0.428		40.67	1.72
05/24/19 14:06:36	2532.927	4.999	20.194	0.465		40.83	1.75
05/24/19 14:06:46	2542.926	5.000	20.181	0.462	1.364	41.00	1.75
05/24/19 14:06:56	2552.926	4.994	20.184	0.476		41.17	1.76
05/24/19 14:07:06	2562.927	4.992	20.159	0.480		41.33	1.77
05/24/19 14:07:16	2572.927	4.993	20.189	0.477		41.50	1.77
05/24/19 14:07:26	2582.927	4.992	20.187	0.480		41.67	1.77
05/24/19 14:07:36	2592.926	4.995	20.163	0.474		41.83	1.76

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:07:46	2602.926	4.997	20.216	0.468		42.00	1.76
05/24/19 14:07:56	2612.927	4.995	20.192	0.473		42.17	1.76
05/24/19 14:08:06	2622.927	4.996	20.187	0.471		42.33	1.76
05/24/19 14:08:16	2632.927	5.004	20.181	0.453		42.50	1.74
05/24/19 14:08:26	2642.926	5.001	20.182	0.458		42.67	1.75
05/24/19 14:08:36	2652.926	5.007	20.178	0.445		42.83	1.73
05/24/19 14:08:46	2662.927	5.005	20.184	0.450		43.00	1.74
05/24/19 14:08:56	2672.927	5.002	20.181	0.456		43.17	1.74
05/24/19 14:09:06	2682.927	5.009	20.184	0.442		43.33	1.73
05/24/19 14:09:16	2692.927	4.994	20.172	0.476		43.50	1.76
05/24/19 14:09:26	2702.927	5.001	20.179	0.459		43.67	1.75
05/24/19 14:09:36	2712.927	5.002	20.187	0.457		43.83	1.75
05/24/19 14:09:46	2722.927	5.018	20.135	0.420		44.00	1.71
05/24/19 14:09:56	2732.927	5.031	20.169	0.390		44.17	1.68
05/24/19 14:10:06	2742.927	5.000	20.156	0.462		44.33	1.75
05/24/19 14:10:16	2752.927	4.988	20.194	0.489	1.429	44.50	1.78
05/24/19 14:10:26	2762.927	4.984	20.162	0.498		44.67	1.79
05/24/19 14:10:36	2772.927	4.988	20.208	0.490		44.83	1.78
05/24/19 14:10:46	2782.926	4.986	20.171	0.495		45.00	1.78
05/24/19 14:10:56	2792.926	4.988	20.179	0.488		45.17	1.78
05/24/19 14:11:06	2802.927	4.988	20.201	0.490		45.33	1.78
05/24/19 14:11:16	2812.927	4.993	20.207	0.477		45.50	1.77
05/24/19 14:11:26	2822.927	4.994	20.160	0.476		45.67	1.76
05/24/19 14:11:36	2832.926	4.991	20.180	0.483		45.83	1.77
05/24/19 14:11:46	2842.926	4.990	20.172	0.485		46.00	1.77
05/24/19 14:11:56	2852.927	4.986	20.176	0.494		46.17	1.78
05/24/19 14:12:06	2862.927	4.990	20.173	0.485		46.33	1.77
05/24/19 14:12:16	2872.927	4.985	20.158	0.496		46.50	1.78
05/24/19 14:12:26	2882.926	4.989	20.213	0.487		46.67	1.78
05/24/19 14:12:36	2892.926	4.988	20.202	0.489		46.83	1.78
05/24/19 14:12:46	2902.927	4.988	20.197	0.490		47.00	1.78
05/24/19 14:12:56	2912.927	4.990	20.179	0.484		47.17	1.77
05/24/19 14:13:06	2922.927	4.993	20.176	0.478		47.33	1.77
05/24/19 14:13:16	2932.926	5.005	20.202	0.449		47.50	1.74
05/24/19 14:13:26	2942.927	4.991	20.175	0.482	1.667	47.67	1.77
05/24/19 14:13:36	2952.927	4.983	20.192	0.502		47.83	1.79
05/24/19 14:13:46	2962.927	4.977	20.191	0.514		48.00	1.80
05/24/19 14:13:56	2972.926	4.982	20.194	0.504		48.17	1.79
05/24/19 14:14:06	2982.927	4.984	20.189	0.498		48.33	1.79
05/24/19 14:14:16	2992.927	4.986	20.187	0.494		48.50	1.78
05/24/19 14:14:26	3002.926	4.986	20.187	0.493		48.67	1.78
05/24/19 14:14:36	3012.926	4.981	20.193	0.505		48.83	1.79

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:14:46	3022.926	4.986	20.201	0.493		49.00	1.78
05/24/19 14:14:56	3032.927	4.985	20.216	0.496		49.17	1.78
05/24/19 14:15:06	3042.927	4.988	20.176	0.489		49.33	1.78
05/24/19 14:15:16	3052.926	4.994	20.197	0.476		49.50	1.76
05/24/19 14:15:26	3062.926	4.992	20.228	0.480		49.67	1.77
05/24/19 14:15:36	3072.926	4.995	20.173	0.473		49.83	1.76
05/24/19 14:15:46	3082.927	4.998	20.205	0.467		50.00	1.76
05/24/19 14:15:56	3092.927	4.998	20.169	0.466		50.17	1.75
05/24/19 14:16:06	3102.926	5.004	20.187	0.451		50.33	1.74
05/24/19 14:16:16	3112.926	5.003	20.201	0.455		50.50	1.74
05/24/19 14:16:26	3122.926	4.980	20.186	0.507		50.67	1.80
05/24/19 14:16:36	3132.927	5.010	20.190	0.438		50.83	1.73
05/24/19 14:16:46	3142.927	5.028	20.200	0.397		51.00	1.69
05/24/19 14:16:56	3152.927	5.001	20.223	0.459		51.17	1.75
05/24/19 14:17:06	3162.927	4.993	20.215	0.478	1.364	51.33	1.77
05/24/19 14:17:16	3172.926	4.993	20.166	0.477		51.50	1.77
05/24/19 14:17:26	3182.927	4.992	20.189	0.480		51.67	1.77
05/24/19 14:17:36	3192.927	4.992	20.181	0.480		51.83	1.77
05/24/19 14:17:46	3202.926	4.991	20.186	0.483		52.00	1.77
05/24/19 14:17:56	3212.927	4.991	20.189	0.483		52.17	1.77
05/24/19 14:18:06	3222.927	4.988	20.201	0.490		52.33	1.78
05/24/19 14:18:16	3232.927	4.986	20.207	0.494		52.50	1.78
05/24/19 14:18:26	3242.927	4.987	20.203	0.490		52.67	1.78
05/24/19 14:18:36	3252.926	4.988	20.194	0.489		52.83	1.78
05/24/19 14:18:46	3262.927	4.992	20.202	0.479		53.00	1.77
05/24/19 14:18:56	3272.927	4.990	20.202	0.485		53.17	1.77
05/24/19 14:19:06	3282.927	4.995	20.159	0.473		53.33	1.76
05/24/19 14:19:16	3292.927	4.996	20.182	0.472		53.50	1.76
05/24/19 14:19:26	3302.926	4.996	20.207	0.470		53.67	1.76
05/24/19 14:19:36	3312.927	5.002	20.189	0.456		53.83	1.74
05/24/19 14:19:46	3322.927	5.001	20.205	0.460		54.00	1.75
05/24/19 14:19:56	3332.926	5.001	20.192	0.458		54.17	1.75
05/24/19 14:20:06	3342.926	5.000	20.187	0.461		54.33	1.75
05/24/19 14:20:16	3352.927	5.035	20.179	0.381		54.50	1.67
05/24/19 14:20:26	3362.927	4.998	20.194	0.467	1.579	54.67	1.76
05/24/19 14:20:36	3372.926	4.992	20.184	0.480		54.83	1.77
05/24/19 14:20:46	3382.926	4.988	20.200	0.490		55.00	1.78
05/24/19 14:20:56	3392.926	5.001	20.179	0.459		55.17	1.75
05/24/19 14:21:06	3402.926	4.984	20.183	0.498		55.33	1.79
05/24/19 14:21:16	3412.926	4.986	20.160	0.493		55.50	1.78
05/24/19 14:21:26	3422.926	4.985	20.178	0.496		55.67	1.78
05/24/19 14:21:36	3432.926	4.986	20.176	0.494		55.83	1.78

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:21:46	3442.926	4.984	20.202	0.497		56.00	1.79
05/24/19 14:21:56	3452.926	4.982	20.189	0.502		56.17	1.79
05/24/19 14:22:06	3462.926	4.980	20.207	0.509		56.33	1.80
05/24/19 14:22:16	3472.926	4.983	20.211	0.501		56.50	1.79
05/24/19 14:22:26	3482.926	4.984	20.197	0.499		56.67	1.79
05/24/19 14:22:36	3492.926	4.987	20.205	0.492		56.83	1.78
05/24/19 14:22:46	3502.926	4.983	20.190	0.500		57.00	1.79
05/24/19 14:22:56	3512.926	4.985	20.181	0.497		57.17	1.79
05/24/19 14:23:06	3522.926	4.983	20.208	0.500		57.33	1.79
05/24/19 14:23:16	3532.926	4.988	20.174	0.490		57.50	1.78
05/24/19 14:23:26	3542.926	4.988	20.198	0.490		57.67	1.78
05/24/19 14:23:36	3552.927	5.002	20.203	0.456		57.83	1.74
05/24/19 14:23:46	3562.927	5.005	20.173	0.449		58.00	1.74
05/24/19 14:23:56	3572.927	4.990	20.176	0.485	1.429	58.17	1.77
05/24/19 14:24:06	3582.927	4.979	20.221	0.510		58.33	1.80
05/24/19 14:24:16	3592.926	4.981	20.193	0.506		58.50	1.79
05/24/19 14:24:26	3602.926	4.976	20.210	0.518		58.67	1.81
05/24/19 14:24:36	3612.926	4.979	20.205	0.509		58.83	1.80
05/24/19 14:24:46	3622.927	4.975	20.202	0.520		59.00	1.81
05/24/19 14:24:56	3632.927	4.982	20.165	0.504		59.17	1.79
05/24/19 14:25:06	3642.927	4.980	20.163	0.507		59.33	1.80
05/24/19 14:25:16	3652.926	4.985	20.211	0.495		59.50	1.78
05/24/19 14:25:26	3662.926	4.982	20.158	0.503		59.67	1.79
05/24/19 14:25:36	3672.927	4.986	20.179	0.493		59.83	1.78
05/24/19 14:25:46	3682.927	4.987	20.175	0.492		60.00	1.78
05/24/19 14:25:56	3692.927	4.980	20.201	0.508		60.17	1.80
05/24/19 14:26:06	3702.926	4.989	20.197	0.486		60.33	1.77
05/24/19 14:26:16	3712.926	4.990	20.200	0.484		60.50	1.77
05/24/19 14:26:26	3722.927	4.992	20.207	0.480		60.67	1.77
05/24/19 14:26:36	3732.927	4.989	20.213	0.487		60.83	1.78
05/24/19 14:26:46	3742.927	4.994	20.185	0.475		61.00	1.76
05/24/19 14:26:56	3752.926	4.997	20.214	0.468		61.17	1.76
05/24/19 14:27:06	3762.927	5.019	20.188	0.418		61.33	1.71
05/24/19 14:27:16	3772.926	5.003	20.166	0.454		61.50	1.74
05/24/19 14:27:26	3782.926	4.996	20.189	0.470	1.429	61.67	1.76
05/24/19 14:27:36	3792.926	4.993	20.189	0.479		61.83	1.77
05/24/19 14:27:46	3802.926	4.947	20.189	0.584		62.00	1.87
05/24/19 14:27:56	3812.926	4.910	20.187	0.670		62.17	1.96
05/24/19 14:28:06	3822.926	4.896	20.208	0.702		62.33	1.99
05/24/19 14:28:16	3832.926	4.893	20.139	0.709		62.50	2.00
05/24/19 14:28:26	3842.926	4.873	20.153	0.754		62.67	2.04
05/24/19 14:28:36	3852.926	4.883	20.198	0.732		62.83	2.02

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:28:46	3862.926	4.875	20.233	0.750		63.00	2.04
05/24/19 14:28:56	3872.926	4.876	20.178	0.748		63.17	2.04
05/24/19 14:29:06	3882.926	4.873	20.188	0.755		63.33	2.04
05/24/19 14:29:16	3892.926	4.871	20.176	0.759		63.50	2.05
05/24/19 14:29:26	3902.926	4.869	20.195	0.763		63.67	2.05
05/24/19 14:29:36	3912.926	4.876	20.174	0.749		63.83	2.04
05/24/19 14:29:46	3922.926	4.877	20.216	0.745		64.00	2.03
05/24/19 14:29:56	3932.926	4.877	20.209	0.746		64.17	2.03
05/24/19 14:30:06	3942.926	4.886	20.215	0.724		64.33	2.01
05/24/19 14:30:16	3952.926	4.878	20.171	0.744		64.50	2.03
05/24/19 14:30:26	3962.927	4.870	20.176	0.761		64.67	2.05
05/24/19 14:30:36	3972.927	4.868	20.179	0.767		64.83	2.06
05/24/19 14:30:46	3982.926	4.867	20.197	0.770	1.500	65.00	2.06
05/24/19 14:30:56	3992.926	4.859	20.197	0.786		65.17	2.07
05/24/19 14:31:06	4002.926	4.863	20.203	0.778		65.33	2.07
05/24/19 14:31:16	4012.926	4.861	20.189	0.783		65.50	2.07
05/24/19 14:31:26	4022.926	4.860	20.184	0.785		65.67	2.07
05/24/19 14:31:36	4032.926	4.857	20.185	0.791		65.83	2.08
05/24/19 14:31:46	4042.926	4.861	20.192	0.783		66.00	2.07
05/24/19 14:31:56	4052.926	4.861	20.177	0.783		66.17	2.07
05/24/19 14:32:06	4062.926	4.865	20.176	0.772		66.33	2.06
05/24/19 14:32:16	4072.926	4.861	20.177	0.783		66.50	2.07
05/24/19 14:32:26	4082.926	4.868	20.174	0.767		66.67	2.06
05/24/19 14:32:36	4092.926	4.869	20.168	0.763		66.83	2.05
05/24/19 14:32:46	4102.926	4.868	20.190	0.766		67.00	2.05
05/24/19 14:32:56	4112.926	4.877	20.193	0.744		67.17	2.03
05/24/19 14:33:06	4122.926	4.883	20.178	0.733		67.33	2.02
05/24/19 14:33:16	4132.926	4.870	20.193	0.761		67.50	2.05
05/24/19 14:33:26	4142.926	4.857	20.187	0.793	1.875	67.67	2.08
05/24/19 14:33:36	4152.926	4.854	20.208	0.798		67.83	2.09
05/24/19 14:33:46	4162.926	4.855	20.174	0.796		68.00	2.08
05/24/19 14:33:56	4172.926	4.857	20.186	0.791		68.17	2.08
05/24/19 14:34:06	4182.926	4.854	20.223	0.798		68.33	2.09
05/24/19 14:34:16	4192.926	4.857	20.192	0.793		68.50	2.08
05/24/19 14:34:26	4202.926	4.860	20.157	0.785		68.67	2.07
05/24/19 14:34:36	4212.926	4.859	20.184	0.787		68.83	2.08
05/24/19 14:34:46	4222.926	4.865	20.188	0.774		69.00	2.06
05/24/19 14:34:56	4232.926	4.864	20.215	0.775		69.17	2.06
05/24/19 14:35:06	4242.926	4.866	20.226	0.772		69.33	2.06
05/24/19 14:35:16	4252.926	4.863	20.209	0.779		69.50	2.07
05/24/19 14:35:26	4262.926	4.864	20.192	0.777		69.67	2.07
05/24/19 14:35:36	4272.926	4.876	20.215	0.748		69.83	2.04

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:35:46	4282.926	4.871	20.200	0.759		70.00	2.05
05/24/19 14:35:56	4292.926	4.894	20.199	0.707		70.17	2.00
05/24/19 14:36:06	4302.926	4.872	20.193	0.756		70.33	2.04
05/24/19 14:36:16	4312.926	4.869	20.189	0.764		70.50	2.05
05/24/19 14:36:26	4322.926	4.865	20.227	0.772	1.667	70.67	2.06
05/24/19 14:36:36	4332.926	4.864	20.203	0.776		70.83	2.06
05/24/19 14:36:46	4342.926	4.869	20.187	0.764		71.00	2.05
05/24/19 14:36:56	4352.926	4.871	20.214	0.760		71.17	2.05
05/24/19 14:37:06	4362.926	4.871	20.168	0.760		71.33	2.05
05/24/19 14:37:16	4373.109	4.873	20.187	0.755		71.50	2.04
05/24/19 14:37:26	4383.11	4.872	20.193	0.757		71.67	2.05
05/24/19 14:37:36	4393.109	4.875	20.197	0.751		71.83	2.04
05/24/19 14:37:46	4402.926	4.869	20.197	0.764		72.00	2.05
05/24/19 14:37:56	4412.926	4.872	20.213	0.757		72.17	2.05
05/24/19 14:38:06	4422.927	4.873	20.176	0.754		72.33	2.04
05/24/19 14:38:16	4432.927	4.874	20.202	0.753		72.50	2.04
05/24/19 14:38:26	4442.927	4.873	20.201	0.755		72.67	2.04
05/24/19 14:38:36	4452.927	4.872	20.178	0.758		72.83	2.05
05/24/19 14:38:46	4462.927	4.875	20.165	0.750		73.00	2.04
05/24/19 14:38:56	4472.927	4.891	20.203	0.714		73.17	2.00
05/24/19 14:39:06	4482.927	4.872	20.198	0.757	1.875	73.33	2.05
05/24/19 14:39:16	4492.926	4.862	20.194	0.780		73.50	2.07
05/24/19 14:39:26	4502.926	4.859	20.167	0.787		73.67	2.08
05/24/19 14:39:36	4512.926	4.864	20.186	0.776		73.83	2.06
05/24/19 14:39:46	4522.927	4.860	20.195	0.784		74.00	2.07
05/24/19 14:39:56	4532.927	4.861	20.200	0.783		74.17	2.07
05/24/19 14:40:06	4542.926	4.861	20.162	0.782		74.33	2.07
05/24/19 14:40:16	4552.926	4.869	20.186	0.765		74.50	2.05
05/24/19 14:40:26	4562.926	4.867	20.223	0.768		74.67	2.06
05/24/19 14:40:36	4572.926	4.869	20.193	0.764		74.83	2.05
05/24/19 14:40:46	4582.926	4.868	20.212	0.767		75.00	2.06
05/24/19 14:40:56	4592.926	4.873	20.194	0.754		75.17	2.04
05/24/19 14:41:06	4602.926	4.881	20.184	0.736		75.33	2.02
05/24/19 14:41:16	4612.926	4.875	20.187	0.751		75.50	2.04
05/24/19 14:41:26	4622.926	4.879	20.187	0.740		75.67	2.03
05/24/19 14:41:36	4632.926	4.876	20.192	0.747		75.83	2.04
05/24/19 14:41:46	4642.926	4.889	20.193	0.717		76.00	2.01
05/24/19 14:41:56	4652.926	4.901	20.195	0.690		76.17	1.98
05/24/19 14:42:06	4662.926	4.881	20.192	0.736	1.667	76.33	2.02
05/24/19 14:42:16	4672.927	4.871	20.186	0.760		76.50	2.05
05/24/19 14:42:26	4682.927	4.873	20.171	0.755		76.67	2.04
05/24/19 14:42:36	4692.927	4.863	20.179	0.778		76.83	2.07

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:42:46	4702.926	4.857	20.200	0.791		77.00	2.08
05/24/19 14:42:56	4712.926	4.864	20.160	0.775		77.17	2.06
05/24/19 14:43:06	4722.926	4.862	20.197	0.779		77.33	2.07
05/24/19 14:43:16	4732.927	4.863	20.171	0.778		77.50	2.07
05/24/19 14:43:26	4742.927	4.861	20.203	0.783		77.67	2.07
05/24/19 14:43:36	4752.927	4.865	20.187	0.774		77.83	2.06
05/24/19 14:43:46	4762.926	4.860	20.189	0.785		78.00	2.07
05/24/19 14:43:56	4772.926	4.864	20.230	0.776		78.17	2.06
05/24/19 14:44:06	4782.926	4.869	20.170	0.765		78.33	2.05
05/24/19 14:44:16	4792.927	4.869	20.171	0.765		78.50	2.05
05/24/19 14:44:26	4802.927	4.870	20.194	0.762		78.67	2.05
05/24/19 14:44:36	4812.927	4.874	20.191	0.753		78.83	2.04
05/24/19 14:44:46	4822.926	4.875	20.182	0.751		79.00	2.04
05/24/19 14:44:56	4832.926	4.877	20.187	0.745		79.17	2.03
05/24/19 14:45:06	4842.926	4.867	20.163	0.768	1.667	79.33	2.06
05/24/19 14:45:16	4852.927	4.863	20.191	0.777		79.50	2.07
05/24/19 14:45:26	4862.926	4.866	20.180	0.772		79.67	2.06
05/24/19 14:45:36	4872.926	4.862	20.161	0.781		79.83	2.07
05/24/19 14:45:46	4882.926	4.861	20.176	0.782		80.00	2.07
05/24/19 14:45:56	4892.926	4.856	20.179	0.794		80.17	2.08
05/24/19 14:46:06	4902.926	4.864	20.176	0.775		80.33	2.06
05/24/19 14:46:16	4912.926	4.865	20.179	0.774		80.50	2.06
05/24/19 14:46:26	4922.926	4.863	20.197	0.777		80.67	2.07
05/24/19 14:46:36	4932.926	4.870	20.188	0.762		80.83	2.05
05/24/19 14:46:46	4942.926	4.874	20.168	0.752		81.00	2.04
05/24/19 14:46:56	4952.926	4.868	20.172	0.767		81.17	2.06
05/24/19 14:47:06	4962.926	4.870	20.191	0.761		81.33	2.05
05/24/19 14:47:16	4972.926	4.868	20.182	0.766		81.50	2.05
05/24/19 14:47:26	4982.926	4.869	20.203	0.763		81.67	2.05
05/24/19 14:47:36	4992.926	4.869	20.176	0.763		81.83	2.05
05/24/19 14:47:46	5002.926	4.866	20.166	0.771		82.00	2.06
05/24/19 14:47:56	5012.926	4.887	20.188	0.722		82.17	2.01
05/24/19 14:48:06	5022.927	4.868	20.191	0.766		82.33	2.05
05/24/19 14:48:16	5032.927	4.864	20.161	0.777		82.50	2.07
05/24/19 14:48:26	5042.926	4.861	20.176	0.782	1.500	82.67	2.07
05/24/19 14:48:36	5052.927	4.855	20.202	0.795		82.83	2.08
05/24/19 14:48:46	5062.927	4.858	20.175	0.789		83.00	2.08
05/24/19 14:48:56	5072.927	4.863	20.155	0.778		83.17	2.07
05/24/19 14:49:06	5082.927	4.865	20.197	0.774		83.33	2.06
05/24/19 14:49:16	5092.927	4.858	20.180	0.790		83.50	2.08
05/24/19 14:49:26	5102.927	4.862	20.210	0.781		83.67	2.07
05/24/19 14:49:36	5112.927	4.857	20.190	0.793		83.83	2.08

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:49:46	5122.927	4.860	20.168	0.784		84.00	2.07
05/24/19 14:49:56	5132.927	4.857	20.168	0.792		84.17	2.08
05/24/19 14:50:06	5142.931	4.864	20.174	0.776		84.33	2.06
05/24/19 14:50:16	5152.927	4.864	20.170	0.776		84.50	2.06
05/24/19 14:50:26	5162.927	4.864	20.178	0.776		84.67	2.06
05/24/19 14:50:36	5172.926	4.862	20.184	0.779		84.83	2.07
05/24/19 14:50:46	5182.926	4.878	20.184	0.743		85.00	2.03
05/24/19 14:50:56	5192.926	4.876	20.179	0.747		85.17	2.04
05/24/19 14:51:06	5202.927	4.864	20.176	0.776	1.875	85.33	2.06
05/24/19 14:51:16	5212.927	4.858	20.188	0.789		85.50	2.08
05/24/19 14:51:26	5222.927	4.858	20.210	0.789		85.67	2.08
05/24/19 14:51:36	5232.926	4.860	20.165	0.785		85.83	2.07
05/24/19 14:51:46	5242.926	4.859	20.180	0.787		86.00	2.08
05/24/19 14:51:56	5252.926	4.854	20.193	0.798		86.17	2.09
05/24/19 14:52:06	5262.927	4.854	20.181	0.799		86.33	2.09
05/24/19 14:52:16	5272.927	4.852	20.179	0.804		86.50	2.09
05/24/19 14:52:26	5282.927	4.853	20.174	0.801		86.67	2.09
05/24/19 14:52:36	5292.926	4.855	20.202	0.797		86.83	2.09
05/24/19 14:52:46	5302.926	4.855	20.181	0.796		87.00	2.08
05/24/19 14:52:56	5312.926	4.859	20.178	0.787		87.17	2.08
05/24/19 14:53:06	5322.927	4.860	20.179	0.784		87.33	2.07
05/24/19 14:53:16	5332.927	4.856	20.161	0.794		87.50	2.08
05/24/19 14:53:26	5342.927	4.872	20.196	0.757		87.67	2.05
05/24/19 14:53:36	5352.927	4.863	20.186	0.778		87.83	2.07
05/24/19 14:53:46	5362.927	4.854	20.166	0.799		88.00	2.09
05/24/19 14:53:56	5372.927	4.853	20.176	0.801	1.765	88.17	2.09
05/24/19 14:54:06	5382.926	4.853	20.196	0.800		88.33	2.09
05/24/19 14:54:16	5392.926	4.856	20.202	0.793		88.50	2.08
05/24/19 14:54:26	5402.926	4.856	20.172	0.795		88.67	2.08
05/24/19 14:54:36	5412.926	4.859	20.202	0.787		88.83	2.08
05/24/19 14:54:46	5422.926	4.857	20.184	0.792		89.00	2.08
05/24/19 14:54:56	5432.926	4.858	20.161	0.789		89.17	2.08
05/24/19 14:55:06	5442.926	4.858	20.183	0.788		89.33	2.08
05/24/19 14:55:16	5452.926	4.859	20.170	0.787		89.50	2.08
05/24/19 14:55:26	5462.926	4.859	20.171	0.788		89.67	2.08
05/24/19 14:55:36	5472.926	4.863	20.184	0.777		89.83	2.07
05/24/19 14:55:46	5482.926	4.861	20.157	0.783		90.00	2.07
05/24/19 14:55:56	5492.926	4.861	20.166	0.784		90.17	2.07
05/24/19 14:56:06	5502.926	4.863	20.206	0.777		90.33	2.07
05/24/19 14:56:16	5512.926	4.878	20.209	0.744		90.50	2.03
05/24/19 14:56:26	5522.926	4.870	20.223	0.761		90.67	2.05
05/24/19 14:56:36	5532.926	4.861	20.174	0.781	1.875	90.83	2.07

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 14:56:46	5542.926	4.853	20.185	0.801		91.00	2.09
05/24/19 14:56:56	5552.926	4.857	20.228	0.792		91.17	2.08
05/24/19 14:57:06	5562.927	4.855	20.177	0.795		91.33	2.08
05/24/19 14:57:16	5572.927	4.858	20.169	0.789		91.50	2.08
05/24/19 14:57:26	5582.927	4.854	20.200	0.798		91.67	2.09
05/24/19 14:57:36	5592.927	4.856	20.192	0.793		91.83	2.08
05/24/19 14:57:46	5602.927	4.861	20.184	0.782		92.00	2.07
05/24/19 14:57:56	5612.927	4.856	20.188	0.793		92.17	2.08
05/24/19 14:58:06	5622.927	4.864	20.185	0.776		92.33	2.06
05/24/19 14:58:16	5632.927	4.865	20.200	0.773		92.50	2.06
05/24/19 14:58:26	5642.927	4.860	20.181	0.786		92.67	2.07
05/24/19 14:58:36	5652.927	4.860	20.176	0.784		92.83	2.07
05/24/19 14:58:46	5662.927	4.867	20.172	0.768		93.00	2.06
05/24/19 14:58:56	5672.927	4.868	20.148	0.767		93.17	2.06
05/24/19 14:59:06	5682.927	4.867	20.169	0.768		93.33	2.06
05/24/19 14:59:16	5692.927	4.880	20.176	0.739		93.50	2.03
05/24/19 14:59:26	5702.927	4.877	20.173	0.746	1.765	93.67	2.03
05/24/19 14:59:36	5712.927	4.863	20.166	0.779		93.83	2.07
05/24/19 14:59:46	5722.926	4.859	20.169	0.788		94.00	2.08
05/24/19 14:59:56	5732.927	4.941	20.174	0.597		94.17	1.89
05/24/19 15:00:06	5742.927	5.446	20.206	-0.568		94.33	0.72
05/24/19 15:00:16	5752.927	5.519	20.165	-0.738		94.50	0.55
05/24/19 15:00:26	5762.926	5.564	20.174	-0.840		94.67	0.45
05/24/19 15:00:36	5772.926	5.594	20.163	-0.911		94.83	0.38
05/24/19 15:00:46	5782.926	5.619	20.183	-0.968		95.00	0.32
05/24/19 15:00:56	5792.927	5.635	20.167	-1.004		95.17	0.28
05/24/19 15:01:06	5802.927	5.647	20.161	-1.033		95.33	0.26
05/24/19 15:01:16	5812.927	5.656	20.170	-1.053		95.50	0.24
05/24/19 15:01:26	5822.926	5.665	20.160	-1.073		95.67	0.22
05/24/19 15:01:36	5832.926	5.672	20.176	-1.090		95.83	0.20
05/24/19 15:01:46	5842.926	5.677	20.175	-1.103		96.00	0.19
05/24/19 15:01:56	5852.927	5.685	20.187	-1.121		96.17	0.17
05/24/19 15:02:06	5862.927	5.690	20.152	-1.131		96.33	0.16
05/24/19 15:02:16	5872.927	5.693	20.187	-1.139		96.50	0.15
05/24/19 15:02:26	5882.926	5.699	20.187	-1.153		96.67	0.14
05/24/19 15:02:36	5892.926	5.704	20.185	-1.163		96.83	0.13
05/24/19 15:02:46	5902.927	5.706	20.173	-1.169		97.00	0.12
05/24/19 15:02:56	5912.927	5.710	20.147	-1.177		97.17	0.11
05/24/19 15:03:06	5923.204	5.713	20.194	-1.184		97.33	0.10
05/24/19 15:03:16	5932.926	5.714	20.161	-1.188		97.50	0.10
05/24/19 15:03:26	5942.926	5.719	20.171	-1.199		97.67	0.09
05/24/19 15:03:36	5952.926	5.722	20.189	-1.206		97.83	0.08

P-02	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0818	7.06	77.01	72.48	69.95	56.53	13.42
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 15:03:46	5963.172	5.723	20.194	-1.208		98.00	0.08
05/24/19 15:03:56	5973.171	5.724	20.163	-1.210		98.17	0.08
05/24/19 15:04:06	5983.237	5.726	20.196	-1.215		98.33	0.07
05/24/19 15:04:16	5992.926	5.726	20.160	-1.214		98.50	0.07
05/24/19 15:04:26	6002.926	5.730	20.184	-1.223		98.67	0.06
05/24/19 15:04:36	6012.926	5.732	20.184	-1.230		98.83	0.06
05/24/19 15:04:46	6023.204	5.735	20.173	-1.235		99.00	0.05
05/24/19 15:04:56	6033.205	5.734	20.190	-1.233		99.17	0.05
05/24/19 15:05:06	6042.926	5.739	20.164	-1.245		99.33	0.04
05/24/19 15:05:16	6052.926	5.737	20.144	-1.241		99.50	0.05
05/24/19 15:05:26	6062.926	5.737	20.152	-1.240		99.67	0.05
05/24/19 15:05:36	6072.926	5.742	20.169	-1.252		99.83	0.04
05/24/19 15:05:46	6083.242	5.743	20.162	-1.255		100.00	0.03
05/24/19 15:05:56	6093.243	5.741	20.181	-1.250		100.17	0.04
05/24/19 15:06:06	6102.927	5.742	20.137	-1.253		100.33	0.04
05/24/19 15:06:16	6112.927	5.742	20.139	-1.251		100.50	0.04
05/24/19 15:06:26	6122.927	5.743	20.129	-1.254		100.67	0.03
05/24/19 15:06:36	6132.927	5.746	20.142	-1.262		100.83	0.03
05/24/19 15:06:46	6142.926	5.743	20.169	-1.255		101.00	0.03
05/24/19 15:06:56	6152.926	5.748	20.155	-1.265		101.17	0.02
05/24/19 15:07:06	6162.926	5.747	20.162	-1.262		101.33	0.03
05/24/19 15:07:16	6172.926	5.753	20.167	-1.276		101.50	0.01
05/24/19 15:07:26	6182.926	5.753	20.140	-1.276		101.67	0.01
05/24/19 15:07:36	6192.926	5.751	20.145	-1.273		101.83	0.02
05/24/19 15:07:46	6202.926	5.754	20.137	-1.279		102.00	0.01
05/24/19 15:07:56	6212.926	5.753	20.115	-1.278		102.17	0.01
05/24/19 15:08:06	6222.926	5.752	20.122	-1.275		102.33	0.01
05/24/19 15:08:16	6232.926	5.753	20.111	-1.278		102.50	0.01
05/24/19 15:08:26	6242.926	5.756	20.125	-1.284		102.67	0.00
05/24/19 15:08:36	6252.926	5.755	20.143	-1.281		102.83	0.01
05/24/19 15:08:46	6262.926	5.756	20.171	-1.284		103.00	0.00
05/24/19 15:08:56	6272.926	5.755	20.119	-1.281		103.17	0.01
05/24/19 15:09:06	6282.926	5.759	20.132	-1.291		103.33	0.00
05/24/19 15:09:16	6292.926	5.757	20.129	-1.286		103.50	0.00
05/24/19 15:09:26	6302.926	5.758	20.101	-1.288		103.67	0.00

Report Date:	5/25/2019 22:05		
Report User Name:	Harbin		
Report Computer Name:	HE-MBIERS		
Application:	WinSitu.exe		
Application Version:	5.6.28.6		

Log File Properties			
File Name	P-02_2019-05-25_22-01-21-433.wsl		
Create Date	5/25/2019 22:01		

Device Properties			
Device	Level TROLL 700		
Site	BCDP		
Device Name			
Serial Number	405895		
Firmware Version	3.06		
Hardware Version	4		
Device Address	1		
Device Comm Cfg	19200	8 Even	1 (Modbus-RTU)
Used Memory	3		
Used Battery	30		

Log Configuration		
	Log Name	P-02
	Created By	Unknown
	Computer Name	Pocket PC
	Application	WinSituMobile.exe
	Application Version	5.6.0.10
	Create Date	5/24/2019 12:24:32 PM Eastern Daylight Time
	Log Setup Time Zone	Eastern Daylight Time
	Notes Size(bytes)	4096
	Overwrite when full	Disabled
	Scheduled Start Time	Manual Start
	Scheduled Stop Time	No Stop Time
	Type	Fast Linear
	Interval	Days: 0 hrs: 00 mins: 00 secs: 10

Level Reference Settings At Log Creation		
	Level Measurement Mode	Level Depth To Water
	Specific Gravity	0.999
	Level Reference Mode:	Set new reference
	Level Reference Value:	0 (ft)
	Level Reference Head Pressure	5.19988 (PSI)

Other Log Settings

	Pressure Offset:	0.374898 (PSI)
	Depth of Probe:	12.0055 (ft)
	Head Pressure:	5.1995 (PSI)
	Temperature:	19.8242 (C)

Log Notes:

Date and Time	Note
5/24/2019 12:23	Sensor SN: 405895 Factory calibration has expired.: 3/25/2016 7:43:58 AM
5/24/2019 12:23	Used Battery: 30% Used Memory: 4% User Name: Unknown
5/24/2019 13:24	Manual Start Command
5/24/2019 13:25	Suspend Command
5/24/2019 13:27	Resume Command
5/24/2019 15:09	Used Battery: 30% Used Memory: 4% User Name: Unknown
5/24/2019 15:09	Manual Stop Command

Log Data:

Record Count	623		
Sensors	1		
	1	405895	Pressure/Temp 15 PSIG (11m/35ft)

Time Zone: Eastern Daylight Time

Date and Time	Elapsed Time Seconds	Sensor: Pres(G) 35ft SN#: 405895 Pressure (PSI)	Sensor: Pres(G) 35ft SN#: 405895 Temperature (C)	Sensor: Pres(G) 35ft SN#: 405895 Level Depth To Water (ft)
5/24/2019 13:24	0	5.758	28.027	-1.288
5/24/2019 13:24	10.001	5.755	27.506	-1.281
5/24/2019 13:24	20.001	5.755	27.002	-1.281
5/24/2019 13:24	30.001	5.757	26.574	-1.286
5/24/2019 13:25	40.001	5.756	26.105	-1.283
5/24/2019 13:25	50.001	5.756	25.729	-1.283
5/24/2019 13:25	60.001	5.751	25.316	-1.273
5/24/2019 13:25	70.001	5.755	25.014	-1.281
5/24/2019 13:25	80.001	5.754	24.69	-1.279
5/24/2019 13:25	90.001	5.753	24.393	-1.277
5/24/2019 13:27	182.926	5.754	22.43	-1.281
5/24/2019 13:27	192.939	5.754	22.299	-1.28
5/24/2019 13:27	202.926	5.753	22.211	-1.278
5/24/2019 13:27	212.926	5.753	22.069	-1.277
5/24/2019 13:28	222.926	5.754	21.971	-1.279
5/24/2019 13:28	232.926	5.752	21.85	-1.276
5/24/2019 13:28	242.926	5.753	21.74	-1.276

5/24/2019 13:28	252.926	5.757	21.668	-1.285
5/24/2019 13:28	262.926	5.753	21.569	-1.278
5/24/2019 13:28	272.926	5.427	21.469	-0.524
5/24/2019 13:29	282.926	5.332	21.381	-0.304
5/24/2019 13:29	292.926	5.279	21.321	-0.183
5/24/2019 13:29	302.926	5.255	21.28	-0.128
5/24/2019 13:29	312.926	5.236	21.186	-0.084
5/24/2019 13:29	322.926	5.223	21.125	-0.054
5/24/2019 13:29	332.926	5.209	21.042	-0.021
5/24/2019 13:30	342.926	5.208	21.003	-0.018
5/24/2019 13:30	352.926	5.204	20.925	-0.009
5/24/2019 13:30	362.926	5.201	20.896	-0.002
5/24/2019 13:30	372.926	5.196	20.882	0.008
5/24/2019 13:30	382.926	5.196	20.806	0.009
5/24/2019 13:30	392.927	5.191	20.785	0.02
5/24/2019 13:31	402.927	5.191	20.746	0.02
5/24/2019 13:31	412.926	5.189	20.723	0.024
5/24/2019 13:31	422.926	5.182	20.697	0.04
5/24/2019 13:31	432.926	5.187	20.674	0.031
5/24/2019 13:31	442.926	5.183	20.639	0.038
5/24/2019 13:31	452.926	5.181	20.638	0.043
5/24/2019 13:32	462.926	5.178	20.585	0.051
5/24/2019 13:32	472.926	5.176	20.579	0.055
5/24/2019 13:32	482.926	5.182	20.551	0.041
5/24/2019 13:32	492.926	5.177	20.528	0.054
5/24/2019 13:32	502.926	5.187	20.502	0.029
5/24/2019 13:32	512.926	5.2	20.516	0.001
5/24/2019 13:33	522.926	5.173	20.478	0.062
5/24/2019 13:33	532.926	5.159	20.476	0.095
5/24/2019 13:33	542.926	5.157	20.473	0.098
5/24/2019 13:33	552.926	5.152	20.434	0.109
5/24/2019 13:33	562.926	5.155	20.448	0.104
5/24/2019 13:33	572.926	5.168	20.441	0.074
5/24/2019 13:34	582.926	5.17	20.415	0.069
5/24/2019 13:34	592.926	5.175	20.415	0.057
5/24/2019 13:34	602.926	5.176	20.419	0.056
5/24/2019 13:34	612.926	5.171	20.376	0.067
5/24/2019 13:34	622.926	5.17	20.348	0.068
5/24/2019 13:34	632.926	5.167	20.354	0.076
5/24/2019 13:35	642.926	5.167	20.387	0.075
5/24/2019 13:35	652.926	5.17	20.364	0.069
5/24/2019 13:35	662.926	5.169	20.335	0.071
5/24/2019 13:35	672.926	5.17	20.329	0.07
5/24/2019 13:35	682.926	5.171	20.368	0.067
5/24/2019 13:35	692.926	5.167	20.323	0.077
5/24/2019 13:36	702.926	5.163	20.331	0.084
5/24/2019 13:36	712.926	5.16	20.322	0.092
5/24/2019 13:36	722.926	5.164	20.29	0.082

5/24/2019 13:36	732.926	5.166	20.32	0.078
5/24/2019 13:36	742.926	5.163	20.302	0.084
5/24/2019 13:36	752.926	5.165	20.299	0.081
5/24/2019 13:37	762.926	5.192	20.305	0.019
5/24/2019 13:37	772.926	5.19	20.306	0.023
5/24/2019 13:37	782.926	5.17	20.283	0.068
5/24/2019 13:37	792.926	5.156	20.29	0.102
5/24/2019 13:37	802.926	5.149	20.291	0.117
5/24/2019 13:37	812.926	5.152	20.282	0.111
5/24/2019 13:38	822.926	5.15	20.273	0.116
5/24/2019 13:38	832.926	5.149	20.288	0.119
5/24/2019 13:38	842.926	5.147	20.253	0.123
5/24/2019 13:38	852.926	5.146	20.271	0.125
5/24/2019 13:38	862.926	5.145	20.234	0.126
5/24/2019 13:38	872.926	5.146	20.258	0.124
5/24/2019 13:39	882.926	5.145	20.275	0.126
5/24/2019 13:39	892.926	5.144	20.23	0.13
5/24/2019 13:39	902.926	5.14	20.244	0.138
5/24/2019 13:39	912.927	5.142	20.189	0.133
5/24/2019 13:39	922.927	5.142	20.242	0.132
5/24/2019 13:39	932.927	5.142	20.23	0.134
5/24/2019 13:40	942.926	5.148	20.205	0.12
5/24/2019 13:40	952.926	5.145	20.24	0.127
5/24/2019 13:40	962.927	5.147	20.252	0.122
5/24/2019 13:40	972.927	5.146	20.21	0.125
5/24/2019 13:40	982.927	5.146	20.213	0.125
5/24/2019 13:40	992.926	5.151	20.228	0.113
5/24/2019 13:41	1002.926	5.145	20.223	0.126
5/24/2019 13:41	1012.926	5.171	20.202	0.067
5/24/2019 13:41	1022.927	5.166	20.24	0.079
5/24/2019 13:41	1032.927	5.161	20.216	0.09
5/24/2019 13:41	1042.927	5.157	20.226	0.099
5/24/2019 13:41	1052.927	5.158	20.214	0.096
5/24/2019 13:42	1062.927	5.157	20.214	0.1
5/24/2019 13:42	1072.926	5.158	20.213	0.098
5/24/2019 13:42	1082.927	5.153	20.214	0.109
5/24/2019 13:42	1092.927	5.157	20.187	0.099
5/24/2019 13:42	1102.927	5.161	20.218	0.089
5/24/2019 13:42	1112.926	5.154	20.197	0.107
5/24/2019 13:43	1122.927	5.151	20.21	0.113
5/24/2019 13:43	1132.926	5.148	20.179	0.119
5/24/2019 13:43	1142.93	5.15	20.166	0.114
5/24/2019 13:43	1152.927	5.147	20.2	0.121
5/24/2019 13:43	1162.927	5.145	20.171	0.126
5/24/2019 13:43	1172.926	5.151	20.213	0.113
5/24/2019 13:44	1182.926	5.151	20.171	0.112
5/24/2019 13:44	1192.926	5.153	20.202	0.108
5/24/2019 13:44	1202.926	5.152	20.193	0.11

5/24/2019 13:44	1212.927	5.155	20.202	0.104
5/24/2019 13:44	1222.927	5.156	20.178	0.102
5/24/2019 13:44	1232.926	5.152	20.194	0.11
5/24/2019 13:45	1242.927	5.16	20.218	0.091
5/24/2019 13:45	1252.927	5.158	20.203	0.097
5/24/2019 13:45	1262.926	5.16	20.178	0.092
5/24/2019 13:45	1272.927	5.177	20.216	0.053
5/24/2019 13:45	1282.927	5.199	20.173	0.002
5/24/2019 13:45	1292.926	5.165	20.174	0.08
5/24/2019 13:46	1302.926	5.16	20.198	0.092
5/24/2019 13:46	1312.926	5.151	20.168	0.112
5/24/2019 13:46	1322.926	5.156	20.182	0.101
5/24/2019 13:46	1332.926	5.158	20.203	0.097
5/24/2019 13:46	1342.926	5.157	20.196	0.099
5/24/2019 13:46	1352.926	5.159	20.201	0.093
5/24/2019 13:47	1362.926	5.154	20.178	0.105
5/24/2019 13:47	1372.926	5.153	20.186	0.108
5/24/2019 13:47	1382.926	5.154	20.214	0.106
5/24/2019 13:47	1392.926	5.154	20.189	0.105
5/24/2019 13:47	1402.926	5.152	20.195	0.11
5/24/2019 13:47	1412.926	5.15	20.19	0.115
5/24/2019 13:48	1422.926	5.152	20.179	0.111
5/24/2019 13:48	1432.926	5.15	20.207	0.115
5/24/2019 13:48	1442.926	5.152	20.18	0.11
5/24/2019 13:48	1452.926	5.151	20.193	0.113
5/24/2019 13:48	1462.926	5.151	20.198	0.113
5/24/2019 13:48	1472.926	5.151	20.199	0.113
5/24/2019 13:49	1482.926	5.15	20.189	0.114
5/24/2019 13:49	1492.926	5.15	20.163	0.114
5/24/2019 13:49	1502.927	5.152	20.181	0.11
5/24/2019 13:49	1512.927	5.153	20.2	0.108
5/24/2019 13:49	1522.926	5.153	20.189	0.107
5/24/2019 13:49	1532.927	5.172	20.167	0.064
5/24/2019 13:50	1542.927	5.184	20.194	0.037
5/24/2019 13:50	1552.926	5.157	20.188	0.099
5/24/2019 13:50	1562.926	5.144	20.183	0.129
5/24/2019 13:50	1572.926	5.143	20.139	0.131
5/24/2019 13:50	1582.926	5.142	20.184	0.134
5/24/2019 13:50	1592.926	5.135	20.175	0.151
5/24/2019 13:51	1602.926	5.144	20.157	0.129
5/24/2019 13:51	1612.926	5.145	20.168	0.128
5/24/2019 13:51	1622.926	5.143	20.202	0.131
5/24/2019 13:51	1632.926	5.142	20.154	0.134
5/24/2019 13:51	1642.926	5.142	20.202	0.133
5/24/2019 13:51	1652.926	5.143	20.14	0.132
5/24/2019 13:52	1662.926	5.151	20.186	0.114
5/24/2019 13:52	1672.926	5.148	20.177	0.12
5/24/2019 13:52	1682.926	5.151	20.155	0.113

5/24/2019 13:52	1692.927	5.154	20.171	0.105
5/24/2019 13:52	1702.927	5.15	20.148	0.116
5/24/2019 13:52	1712.927	5.151	20.176	0.113
5/24/2019 13:53	1722.927	5.153	20.182	0.108
5/24/2019 13:53	1732.927	5.158	20.156	0.097
5/24/2019 13:53	1742.927	5.156	20.171	0.1
5/24/2019 13:53	1752.927	5.161	20.179	0.09
5/24/2019 13:53	1762.927	5.16	20.181	0.092
5/24/2019 13:53	1772.927	5.164	20.15	0.083
5/24/2019 13:54	1782.927	5.162	20.184	0.087
5/24/2019 13:54	1792.927	5.166	20.179	0.078
5/24/2019 13:54	1802.927	5.165	20.202	0.08
5/24/2019 13:54	1812.926	5.162	20.173	0.087
5/24/2019 13:54	1822.926	5.176	20.155	0.056
5/24/2019 13:54	1832.927	5.193	20.174	0.015
5/24/2019 13:55	1842.927	5.17	20.16	0.07
5/24/2019 13:55	1852.927	5.16	20.196	0.091
5/24/2019 13:55	1862.927	5.152	20.146	0.11
5/24/2019 13:55	1872.927	5.15	20.152	0.115
5/24/2019 13:55	1882.926	5.143	20.17	0.132
5/24/2019 13:55	1892.927	5.152	20.154	0.11
5/24/2019 13:56	1902.927	5.146	20.174	0.125
5/24/2019 13:56	1912.927	5.149	20.14	0.117
5/24/2019 13:56	1922.926	5.152	20.189	0.11
5/24/2019 13:56	1932.926	5.152	20.16	0.111
5/24/2019 13:56	1942.926	5.157	20.174	0.1
5/24/2019 13:56	1952.927	5.155	20.177	0.103
5/24/2019 13:57	1962.927	5.156	20.189	0.101
5/24/2019 13:57	1972.927	5.153	20.135	0.108
5/24/2019 13:57	1982.926	5.152	20.195	0.111
5/24/2019 13:57	1992.927	5.153	20.184	0.108
5/24/2019 13:57	2002.927	5.156	20.156	0.102
5/24/2019 13:57	2012.926	5.153	20.169	0.109
5/24/2019 13:58	2022.926	5.151	20.157	0.114
5/24/2019 13:58	2032.926	5.15	20.15	0.115
5/24/2019 13:58	2042.926	5.153	20.167	0.109
5/24/2019 13:58	2052.926	5.149	20.157	0.117
5/24/2019 13:58	2062.926	5.156	20.181	0.102
5/24/2019 13:58	2072.926	5.157	20.174	0.1
5/24/2019 13:59	2082.926	5.176	20.205	0.055
5/24/2019 13:59	2092.926	5.195	20.192	0.012
5/24/2019 13:59	2102.926	5.16	20.17	0.091
5/24/2019 13:59	2112.926	5.144	20.158	0.129
5/24/2019 13:59	2122.926	5.139	20.153	0.142
5/24/2019 13:59	2132.926	5.091	20.142	0.251
5/24/2019 14:00	2142.926	5.057	20.165	0.33
5/24/2019 14:00	2152.926	5.048	20.192	0.35
5/24/2019 14:00	2162.926	5.041	20.176	0.368

5/24/2019 14:00	2172.926	5.037	20.164	0.377
5/24/2019 14:00	2182.926	5.035	20.178	0.38
5/24/2019 14:00	2192.927	5.034	20.169	0.382
5/24/2019 14:01	2202.926	5.033	20.181	0.386
5/24/2019 14:01	2212.926	5.031	20.162	0.389
5/24/2019 14:01	2222.927	5.029	20.181	0.395
5/24/2019 14:01	2232.927	5.033	20.161	0.385
5/24/2019 14:01	2242.926	5.029	20.173	0.394
5/24/2019 14:01	2252.927	5.027	20.173	0.4
5/24/2019 14:02	2262.927	5.031	20.174	0.391
5/24/2019 14:02	2272.927	5.028	20.17	0.396
5/24/2019 14:02	2282.926	5.03	20.168	0.392
5/24/2019 14:02	2292.926	5.03	20.151	0.393
5/24/2019 14:02	2302.927	5.03	20.207	0.392
5/24/2019 14:02	2312.927	5.046	20.168	0.356
5/24/2019 14:03	2322.926	5.028	20.176	0.396
5/24/2019 14:03	2332.926	5.018	20.187	0.419
5/24/2019 14:03	2342.927	5.01	20.208	0.439
5/24/2019 14:03	2352.927	5.004	20.179	0.452
5/24/2019 14:03	2362.927	5.005	20.182	0.45
5/24/2019 14:03	2372.926	5.006	20.17	0.448
5/24/2019 14:04	2382.926	5.002	20.189	0.456
5/24/2019 14:04	2392.927	5.005	20.186	0.45
5/24/2019 14:04	2402.927	4.997	20.188	0.47
5/24/2019 14:04	2412.927	5	20.188	0.463
5/24/2019 14:04	2422.926	5.007	20.178	0.445
5/24/2019 14:04	2432.926	5.002	20.171	0.456
5/24/2019 14:05	2442.926	5.007	20.197	0.444
5/24/2019 14:05	2452.926	5.005	20.189	0.45
5/24/2019 14:05	2462.927	5.001	20.171	0.458
5/24/2019 14:05	2472.927	5.006	20.189	0.448
5/24/2019 14:05	2482.927	5.007	20.194	0.445
5/24/2019 14:05	2492.926	5.006	20.194	0.447
5/24/2019 14:06	2502.926	4.999	20.194	0.465
5/24/2019 14:06	2512.927	5.026	20.181	0.401
5/24/2019 14:06	2522.927	5.015	20.168	0.428
5/24/2019 14:06	2532.927	4.999	20.194	0.465
5/24/2019 14:06	2542.926	5	20.181	0.462
5/24/2019 14:06	2552.926	4.994	20.184	0.476
5/24/2019 14:07	2562.927	4.992	20.159	0.48
5/24/2019 14:07	2572.927	4.993	20.189	0.477
5/24/2019 14:07	2582.927	4.992	20.187	0.48
5/24/2019 14:07	2592.926	4.995	20.163	0.474
5/24/2019 14:07	2602.926	4.997	20.216	0.468
5/24/2019 14:07	2612.927	4.995	20.192	0.473
5/24/2019 14:08	2622.927	4.996	20.187	0.471
5/24/2019 14:08	2632.927	5.004	20.181	0.453
5/24/2019 14:08	2642.926	5.001	20.182	0.458

5/24/2019 14:08	2652.926	5.007	20.178	0.445
5/24/2019 14:08	2662.927	5.005	20.184	0.45
5/24/2019 14:08	2672.927	5.002	20.181	0.456
5/24/2019 14:09	2682.927	5.009	20.184	0.442
5/24/2019 14:09	2692.927	4.994	20.172	0.476
5/24/2019 14:09	2702.927	5.001	20.179	0.459
5/24/2019 14:09	2712.927	5.002	20.187	0.457
5/24/2019 14:09	2722.927	5.018	20.135	0.42
5/24/2019 14:09	2732.927	5.031	20.169	0.39
5/24/2019 14:10	2742.927	5	20.156	0.462
5/24/2019 14:10	2752.927	4.988	20.194	0.489
5/24/2019 14:10	2762.927	4.984	20.162	0.498
5/24/2019 14:10	2772.927	4.988	20.208	0.49
5/24/2019 14:10	2782.926	4.986	20.171	0.495
5/24/2019 14:10	2792.926	4.988	20.179	0.488
5/24/2019 14:11	2802.927	4.988	20.201	0.49
5/24/2019 14:11	2812.927	4.993	20.207	0.477
5/24/2019 14:11	2822.927	4.994	20.16	0.476
5/24/2019 14:11	2832.926	4.991	20.18	0.483
5/24/2019 14:11	2842.926	4.99	20.172	0.485
5/24/2019 14:11	2852.927	4.986	20.176	0.494
5/24/2019 14:12	2862.927	4.99	20.173	0.485
5/24/2019 14:12	2872.927	4.985	20.158	0.496
5/24/2019 14:12	2882.926	4.989	20.213	0.487
5/24/2019 14:12	2892.926	4.988	20.202	0.489
5/24/2019 14:12	2902.927	4.988	20.197	0.49
5/24/2019 14:12	2912.927	4.99	20.179	0.484
5/24/2019 14:13	2922.927	4.993	20.176	0.478
5/24/2019 14:13	2932.926	5.005	20.202	0.449
5/24/2019 14:13	2942.927	4.991	20.175	0.482
5/24/2019 14:13	2952.927	4.983	20.192	0.502
5/24/2019 14:13	2962.927	4.977	20.191	0.514
5/24/2019 14:13	2972.926	4.982	20.194	0.504
5/24/2019 14:14	2982.927	4.984	20.189	0.498
5/24/2019 14:14	2992.927	4.986	20.187	0.494
5/24/2019 14:14	3002.926	4.986	20.187	0.493
5/24/2019 14:14	3012.926	4.981	20.193	0.505
5/24/2019 14:14	3022.926	4.986	20.201	0.493
5/24/2019 14:14	3032.927	4.985	20.216	0.496
5/24/2019 14:15	3042.927	4.988	20.176	0.489
5/24/2019 14:15	3052.926	4.994	20.197	0.476
5/24/2019 14:15	3062.926	4.992	20.228	0.48
5/24/2019 14:15	3072.926	4.995	20.173	0.473
5/24/2019 14:15	3082.927	4.998	20.205	0.467
5/24/2019 14:15	3092.927	4.998	20.169	0.466
5/24/2019 14:16	3102.926	5.004	20.187	0.451
5/24/2019 14:16	3112.926	5.003	20.201	0.455
5/24/2019 14:16	3122.926	4.98	20.186	0.507

5/24/2019 14:16	3132.927	5.01	20.19	0.438
5/24/2019 14:16	3142.927	5.028	20.2	0.397
5/24/2019 14:16	3152.927	5.001	20.223	0.459
5/24/2019 14:17	3162.927	4.993	20.215	0.478
5/24/2019 14:17	3172.926	4.993	20.166	0.477
5/24/2019 14:17	3182.927	4.992	20.189	0.48
5/24/2019 14:17	3192.927	4.992	20.181	0.48
5/24/2019 14:17	3202.926	4.991	20.186	0.483
5/24/2019 14:17	3212.927	4.991	20.189	0.483
5/24/2019 14:18	3222.927	4.988	20.201	0.49
5/24/2019 14:18	3232.927	4.986	20.207	0.494
5/24/2019 14:18	3242.927	4.987	20.203	0.49
5/24/2019 14:18	3252.926	4.988	20.194	0.489
5/24/2019 14:18	3262.927	4.992	20.202	0.479
5/24/2019 14:18	3272.927	4.99	20.202	0.485
5/24/2019 14:19	3282.927	4.995	20.159	0.473
5/24/2019 14:19	3292.927	4.996	20.182	0.472
5/24/2019 14:19	3302.926	4.996	20.207	0.47
5/24/2019 14:19	3312.927	5.002	20.189	0.456
5/24/2019 14:19	3322.927	5.001	20.205	0.46
5/24/2019 14:19	3332.926	5.001	20.192	0.458
5/24/2019 14:20	3342.926	5	20.187	0.461
5/24/2019 14:20	3352.927	5.035	20.179	0.381
5/24/2019 14:20	3362.927	4.998	20.194	0.467
5/24/2019 14:20	3372.926	4.992	20.184	0.48
5/24/2019 14:20	3382.926	4.988	20.2	0.49
5/24/2019 14:20	3392.926	5.001	20.179	0.459
5/24/2019 14:21	3402.926	4.984	20.183	0.498
5/24/2019 14:21	3412.926	4.986	20.16	0.493
5/24/2019 14:21	3422.926	4.985	20.178	0.496
5/24/2019 14:21	3432.926	4.986	20.176	0.494
5/24/2019 14:21	3442.926	4.984	20.202	0.497
5/24/2019 14:21	3452.926	4.982	20.189	0.502
5/24/2019 14:22	3462.926	4.98	20.207	0.509
5/24/2019 14:22	3472.926	4.983	20.211	0.501
5/24/2019 14:22	3482.926	4.984	20.197	0.499
5/24/2019 14:22	3492.926	4.987	20.205	0.492
5/24/2019 14:22	3502.926	4.983	20.19	0.5
5/24/2019 14:22	3512.926	4.985	20.181	0.497
5/24/2019 14:23	3522.926	4.983	20.208	0.5
5/24/2019 14:23	3532.926	4.988	20.174	0.49
5/24/2019 14:23	3542.926	4.988	20.198	0.49
5/24/2019 14:23	3552.927	5.002	20.203	0.456
5/24/2019 14:23	3562.927	5.005	20.173	0.449
5/24/2019 14:23	3572.927	4.99	20.176	0.485
5/24/2019 14:24	3582.927	4.979	20.221	0.51
5/24/2019 14:24	3592.926	4.981	20.193	0.506
5/24/2019 14:24	3602.926	4.976	20.21	0.518

5/24/2019 14:24	3612.926	4.979	20.205	0.509
5/24/2019 14:24	3622.927	4.975	20.202	0.52
5/24/2019 14:24	3632.927	4.982	20.165	0.504
5/24/2019 14:25	3642.927	4.98	20.163	0.507
5/24/2019 14:25	3652.926	4.985	20.211	0.495
5/24/2019 14:25	3662.926	4.982	20.158	0.503
5/24/2019 14:25	3672.927	4.986	20.179	0.493
5/24/2019 14:25	3682.927	4.987	20.175	0.492
5/24/2019 14:25	3692.927	4.98	20.201	0.508
5/24/2019 14:26	3702.926	4.989	20.197	0.486
5/24/2019 14:26	3712.926	4.99	20.2	0.484
5/24/2019 14:26	3722.927	4.992	20.207	0.48
5/24/2019 14:26	3732.927	4.989	20.213	0.487
5/24/2019 14:26	3742.927	4.994	20.185	0.475
5/24/2019 14:26	3752.926	4.997	20.214	0.468
5/24/2019 14:27	3762.927	5.019	20.188	0.418
5/24/2019 14:27	3772.926	5.003	20.166	0.454
5/24/2019 14:27	3782.926	4.996	20.189	0.47
5/24/2019 14:27	3792.926	4.993	20.189	0.479
5/24/2019 14:27	3802.926	4.947	20.189	0.584
5/24/2019 14:27	3812.926	4.91	20.187	0.67
5/24/2019 14:28	3822.926	4.896	20.208	0.702
5/24/2019 14:28	3832.926	4.893	20.139	0.709
5/24/2019 14:28	3842.926	4.873	20.153	0.754
5/24/2019 14:28	3852.926	4.883	20.198	0.732
5/24/2019 14:28	3862.926	4.875	20.233	0.75
5/24/2019 14:28	3872.926	4.876	20.178	0.748
5/24/2019 14:29	3882.926	4.873	20.188	0.755
5/24/2019 14:29	3892.926	4.871	20.176	0.759
5/24/2019 14:29	3902.926	4.869	20.195	0.763
5/24/2019 14:29	3912.926	4.876	20.174	0.749
5/24/2019 14:29	3922.926	4.877	20.216	0.745
5/24/2019 14:29	3932.926	4.877	20.209	0.746
5/24/2019 14:30	3942.926	4.886	20.215	0.724
5/24/2019 14:30	3952.926	4.878	20.171	0.744
5/24/2019 14:30	3962.927	4.87	20.176	0.761
5/24/2019 14:30	3972.927	4.868	20.179	0.767
5/24/2019 14:30	3982.926	4.867	20.197	0.77
5/24/2019 14:30	3992.926	4.859	20.197	0.786
5/24/2019 14:31	4002.926	4.863	20.203	0.778
5/24/2019 14:31	4012.926	4.861	20.189	0.783
5/24/2019 14:31	4022.926	4.86	20.184	0.785
5/24/2019 14:31	4032.926	4.857	20.185	0.791
5/24/2019 14:31	4042.926	4.861	20.192	0.783
5/24/2019 14:31	4052.926	4.861	20.177	0.783
5/24/2019 14:32	4062.926	4.865	20.176	0.772
5/24/2019 14:32	4072.926	4.861	20.177	0.783
5/24/2019 14:32	4082.926	4.868	20.174	0.767

5/24/2019 14:32	4092.926	4.869	20.168	0.763
5/24/2019 14:32	4102.926	4.868	20.19	0.766
5/24/2019 14:32	4112.926	4.877	20.193	0.744
5/24/2019 14:33	4122.926	4.883	20.178	0.733
5/24/2019 14:33	4132.926	4.87	20.193	0.761
5/24/2019 14:33	4142.926	4.857	20.187	0.793
5/24/2019 14:33	4152.926	4.854	20.208	0.798
5/24/2019 14:33	4162.926	4.855	20.174	0.796
5/24/2019 14:33	4172.926	4.857	20.186	0.791
5/24/2019 14:34	4182.926	4.854	20.223	0.798
5/24/2019 14:34	4192.926	4.857	20.192	0.793
5/24/2019 14:34	4202.926	4.86	20.157	0.785
5/24/2019 14:34	4212.926	4.859	20.184	0.787
5/24/2019 14:34	4222.926	4.865	20.188	0.774
5/24/2019 14:34	4232.926	4.864	20.215	0.775
5/24/2019 14:35	4242.926	4.866	20.226	0.772
5/24/2019 14:35	4252.926	4.863	20.209	0.779
5/24/2019 14:35	4262.926	4.864	20.192	0.777
5/24/2019 14:35	4272.926	4.876	20.215	0.748
5/24/2019 14:35	4282.926	4.871	20.2	0.759
5/24/2019 14:35	4292.926	4.894	20.199	0.707
5/24/2019 14:36	4302.926	4.872	20.193	0.756
5/24/2019 14:36	4312.926	4.869	20.189	0.764
5/24/2019 14:36	4322.926	4.865	20.227	0.772
5/24/2019 14:36	4332.926	4.864	20.203	0.776
5/24/2019 14:36	4342.926	4.869	20.187	0.764
5/24/2019 14:36	4352.926	4.871	20.214	0.76
5/24/2019 14:37	4362.926	4.871	20.168	0.76
5/24/2019 14:37	4373.109	4.873	20.187	0.755
5/24/2019 14:37	4383.11	4.872	20.193	0.757
5/24/2019 14:37	4393.109	4.875	20.197	0.751
5/24/2019 14:37	4402.926	4.869	20.197	0.764
5/24/2019 14:37	4412.926	4.872	20.213	0.757
5/24/2019 14:38	4422.927	4.873	20.176	0.754
5/24/2019 14:38	4432.927	4.874	20.202	0.753
5/24/2019 14:38	4442.927	4.873	20.201	0.755
5/24/2019 14:38	4452.927	4.872	20.178	0.758
5/24/2019 14:38	4462.927	4.875	20.165	0.75
5/24/2019 14:38	4472.927	4.891	20.203	0.714
5/24/2019 14:39	4482.927	4.872	20.198	0.757
5/24/2019 14:39	4492.926	4.862	20.194	0.78
5/24/2019 14:39	4502.926	4.859	20.167	0.787
5/24/2019 14:39	4512.926	4.864	20.186	0.776
5/24/2019 14:39	4522.927	4.86	20.195	0.784
5/24/2019 14:39	4532.927	4.861	20.2	0.783
5/24/2019 14:40	4542.926	4.861	20.162	0.782
5/24/2019 14:40	4552.926	4.869	20.186	0.765
5/24/2019 14:40	4562.926	4.867	20.223	0.768

5/24/2019 14:40	4572.926	4.869	20.193	0.764
5/24/2019 14:40	4582.926	4.868	20.212	0.767
5/24/2019 14:40	4592.926	4.873	20.194	0.754
5/24/2019 14:41	4602.926	4.881	20.184	0.736
5/24/2019 14:41	4612.926	4.875	20.187	0.751
5/24/2019 14:41	4622.926	4.879	20.187	0.74
5/24/2019 14:41	4632.926	4.876	20.192	0.747
5/24/2019 14:41	4642.926	4.889	20.193	0.717
5/24/2019 14:41	4652.926	4.901	20.195	0.69
5/24/2019 14:42	4662.926	4.881	20.192	0.736
5/24/2019 14:42	4672.927	4.871	20.186	0.76
5/24/2019 14:42	4682.927	4.873	20.171	0.755
5/24/2019 14:42	4692.927	4.863	20.179	0.778
5/24/2019 14:42	4702.926	4.857	20.2	0.791
5/24/2019 14:42	4712.926	4.864	20.16	0.775
5/24/2019 14:43	4722.926	4.862	20.197	0.779
5/24/2019 14:43	4732.927	4.863	20.171	0.778
5/24/2019 14:43	4742.927	4.861	20.203	0.783
5/24/2019 14:43	4752.927	4.865	20.187	0.774
5/24/2019 14:43	4762.926	4.86	20.189	0.785
5/24/2019 14:43	4772.926	4.864	20.23	0.776
5/24/2019 14:44	4782.926	4.869	20.17	0.765
5/24/2019 14:44	4792.927	4.869	20.171	0.765
5/24/2019 14:44	4802.927	4.87	20.194	0.762
5/24/2019 14:44	4812.927	4.874	20.191	0.753
5/24/2019 14:44	4822.926	4.875	20.182	0.751
5/24/2019 14:44	4832.926	4.877	20.187	0.745
5/24/2019 14:45	4842.926	4.867	20.163	0.768
5/24/2019 14:45	4852.927	4.863	20.191	0.777
5/24/2019 14:45	4862.926	4.866	20.18	0.772
5/24/2019 14:45	4872.926	4.862	20.161	0.781
5/24/2019 14:45	4882.926	4.861	20.176	0.782
5/24/2019 14:45	4892.926	4.856	20.179	0.794
5/24/2019 14:46	4902.926	4.864	20.176	0.775
5/24/2019 14:46	4912.926	4.865	20.179	0.774
5/24/2019 14:46	4922.926	4.863	20.197	0.777
5/24/2019 14:46	4932.926	4.87	20.188	0.762
5/24/2019 14:46	4942.926	4.874	20.168	0.752
5/24/2019 14:46	4952.926	4.868	20.172	0.767
5/24/2019 14:47	4962.926	4.87	20.191	0.761
5/24/2019 14:47	4972.926	4.868	20.182	0.766
5/24/2019 14:47	4982.926	4.869	20.203	0.763
5/24/2019 14:47	4992.926	4.869	20.176	0.763
5/24/2019 14:47	5002.926	4.866	20.166	0.771
5/24/2019 14:47	5012.926	4.887	20.188	0.722
5/24/2019 14:48	5022.927	4.868	20.191	0.766
5/24/2019 14:48	5032.927	4.864	20.161	0.777
5/24/2019 14:48	5042.926	4.861	20.176	0.782

5/24/2019 14:48	5052.927	4.855	20.202	0.795
5/24/2019 14:48	5062.927	4.858	20.175	0.789
5/24/2019 14:48	5072.927	4.863	20.155	0.778
5/24/2019 14:49	5082.927	4.865	20.197	0.774
5/24/2019 14:49	5092.927	4.858	20.18	0.79
5/24/2019 14:49	5102.927	4.862	20.21	0.781
5/24/2019 14:49	5112.927	4.857	20.19	0.793
5/24/2019 14:49	5122.927	4.86	20.168	0.784
5/24/2019 14:49	5132.927	4.857	20.168	0.792
5/24/2019 14:50	5142.931	4.864	20.174	0.776
5/24/2019 14:50	5152.927	4.864	20.17	0.776
5/24/2019 14:50	5162.927	4.864	20.178	0.776
5/24/2019 14:50	5172.926	4.862	20.184	0.779
5/24/2019 14:50	5182.926	4.878	20.184	0.743
5/24/2019 14:50	5192.926	4.876	20.179	0.747
5/24/2019 14:51	5202.927	4.864	20.176	0.776
5/24/2019 14:51	5212.927	4.858	20.188	0.789
5/24/2019 14:51	5222.927	4.858	20.21	0.789
5/24/2019 14:51	5232.926	4.86	20.165	0.785
5/24/2019 14:51	5242.926	4.859	20.18	0.787
5/24/2019 14:51	5252.926	4.854	20.193	0.798
5/24/2019 14:52	5262.927	4.854	20.181	0.799
5/24/2019 14:52	5272.927	4.852	20.179	0.804
5/24/2019 14:52	5282.927	4.853	20.174	0.801
5/24/2019 14:52	5292.926	4.855	20.202	0.797
5/24/2019 14:52	5302.926	4.855	20.181	0.796
5/24/2019 14:52	5312.926	4.859	20.178	0.787
5/24/2019 14:53	5322.927	4.86	20.179	0.784
5/24/2019 14:53	5332.927	4.856	20.161	0.794
5/24/2019 14:53	5342.927	4.872	20.196	0.757
5/24/2019 14:53	5352.927	4.863	20.186	0.778
5/24/2019 14:53	5362.927	4.854	20.166	0.799
5/24/2019 14:53	5372.927	4.853	20.176	0.801
5/24/2019 14:54	5382.926	4.853	20.196	0.8
5/24/2019 14:54	5392.926	4.856	20.202	0.793
5/24/2019 14:54	5402.926	4.856	20.172	0.795
5/24/2019 14:54	5412.926	4.859	20.202	0.787
5/24/2019 14:54	5422.926	4.857	20.184	0.792
5/24/2019 14:54	5432.926	4.858	20.161	0.789
5/24/2019 14:55	5442.926	4.858	20.183	0.788
5/24/2019 14:55	5452.926	4.859	20.17	0.787
5/24/2019 14:55	5462.926	4.859	20.171	0.788
5/24/2019 14:55	5472.926	4.863	20.184	0.777
5/24/2019 14:55	5482.926	4.861	20.157	0.783
5/24/2019 14:55	5492.926	4.861	20.166	0.784
5/24/2019 14:56	5502.926	4.863	20.206	0.777
5/24/2019 14:56	5512.926	4.878	20.209	0.744
5/24/2019 14:56	5522.926	4.87	20.223	0.761

5/24/2019 14:56	5532.926	4.861	20.174	0.781
5/24/2019 14:56	5542.926	4.853	20.185	0.801
5/24/2019 14:56	5552.926	4.857	20.228	0.792
5/24/2019 14:57	5562.927	4.855	20.177	0.795
5/24/2019 14:57	5572.927	4.858	20.169	0.789
5/24/2019 14:57	5582.927	4.854	20.2	0.798
5/24/2019 14:57	5592.927	4.856	20.192	0.793
5/24/2019 14:57	5602.927	4.861	20.184	0.782
5/24/2019 14:57	5612.927	4.856	20.188	0.793
5/24/2019 14:58	5622.927	4.864	20.185	0.776
5/24/2019 14:58	5632.927	4.865	20.2	0.773
5/24/2019 14:58	5642.927	4.86	20.181	0.786
5/24/2019 14:58	5652.927	4.86	20.176	0.784
5/24/2019 14:58	5662.927	4.867	20.172	0.768
5/24/2019 14:58	5672.927	4.868	20.148	0.767
5/24/2019 14:59	5682.927	4.867	20.169	0.768
5/24/2019 14:59	5692.927	4.88	20.176	0.739
5/24/2019 14:59	5702.927	4.877	20.173	0.746
5/24/2019 14:59	5712.927	4.863	20.166	0.779
5/24/2019 14:59	5722.926	4.859	20.169	0.788
5/24/2019 14:59	5732.927	4.941	20.174	0.597
5/24/2019 15:00	5742.927	5.446	20.206	-0.568
5/24/2019 15:00	5752.927	5.519	20.165	-0.738
5/24/2019 15:00	5762.926	5.564	20.174	-0.84
5/24/2019 15:00	5772.926	5.594	20.163	-0.911
5/24/2019 15:00	5782.926	5.619	20.183	-0.968
5/24/2019 15:00	5792.927	5.635	20.167	-1.004
5/24/2019 15:01	5802.927	5.647	20.161	-1.033
5/24/2019 15:01	5812.927	5.656	20.17	-1.053
5/24/2019 15:01	5822.926	5.665	20.16	-1.073
5/24/2019 15:01	5832.926	5.672	20.176	-1.09
5/24/2019 15:01	5842.926	5.677	20.175	-1.103
5/24/2019 15:01	5852.927	5.685	20.187	-1.121
5/24/2019 15:02	5862.927	5.69	20.152	-1.131
5/24/2019 15:02	5872.927	5.693	20.187	-1.139
5/24/2019 15:02	5882.926	5.699	20.187	-1.153
5/24/2019 15:02	5892.926	5.704	20.185	-1.163
5/24/2019 15:02	5902.927	5.706	20.173	-1.169
5/24/2019 15:02	5912.927	5.71	20.147	-1.177
5/24/2019 15:03	5923.204	5.713	20.194	-1.184
5/24/2019 15:03	5932.926	5.714	20.161	-1.188
5/24/2019 15:03	5942.926	5.719	20.171	-1.199
5/24/2019 15:03	5952.926	5.722	20.189	-1.206
5/24/2019 15:03	5963.172	5.723	20.194	-1.208
5/24/2019 15:03	5973.171	5.724	20.163	-1.21
5/24/2019 15:04	5983.237	5.726	20.196	-1.215
5/24/2019 15:04	5992.926	5.726	20.16	-1.214
5/24/2019 15:04	6002.926	5.73	20.184	-1.223

5/24/2019 15:04	6012.926	5.732	20.184	-1.23
5/24/2019 15:04	6023.204	5.735	20.173	-1.235
5/24/2019 15:04	6033.205	5.734	20.19	-1.233
5/24/2019 15:05	6042.926	5.739	20.164	-1.245
5/24/2019 15:05	6052.926	5.737	20.144	-1.241
5/24/2019 15:05	6062.926	5.737	20.152	-1.24
5/24/2019 15:05	6072.926	5.742	20.169	-1.252
5/24/2019 15:05	6083.242	5.743	20.162	-1.255
5/24/2019 15:05	6093.243	5.741	20.181	-1.25
5/24/2019 15:06	6102.927	5.742	20.137	-1.253
5/24/2019 15:06	6112.927	5.742	20.139	-1.251
5/24/2019 15:06	6122.927	5.743	20.129	-1.254
5/24/2019 15:06	6132.927	5.746	20.142	-1.262
5/24/2019 15:06	6142.926	5.743	20.169	-1.255
5/24/2019 15:06	6152.926	5.748	20.155	-1.265
5/24/2019 15:07	6162.926	5.747	20.162	-1.262
5/24/2019 15:07	6172.926	5.753	20.167	-1.276
5/24/2019 15:07	6182.926	5.753	20.14	-1.276
5/24/2019 15:07	6192.926	5.751	20.145	-1.273
5/24/2019 15:07	6202.926	5.754	20.137	-1.279
5/24/2019 15:07	6212.926	5.753	20.115	-1.278
5/24/2019 15:08	6222.926	5.752	20.122	-1.275
5/24/2019 15:08	6232.926	5.753	20.111	-1.278
5/24/2019 15:08	6242.926	5.756	20.125	-1.284
5/24/2019 15:08	6252.926	5.755	20.143	-1.281
5/24/2019 15:08	6262.926	5.756	20.171	-1.284
5/24/2019 15:08	6272.926	5.755	20.119	-1.281
5/24/2019 15:09	6282.926	5.759	20.132	-1.291
5/24/2019 15:09	6292.926	5.757	20.129	-1.286
5/24/2019 15:09	6302.926	5.758	20.101	-1.288

Figure D: Time-Drawdown Plot for P-10 Pumping Test

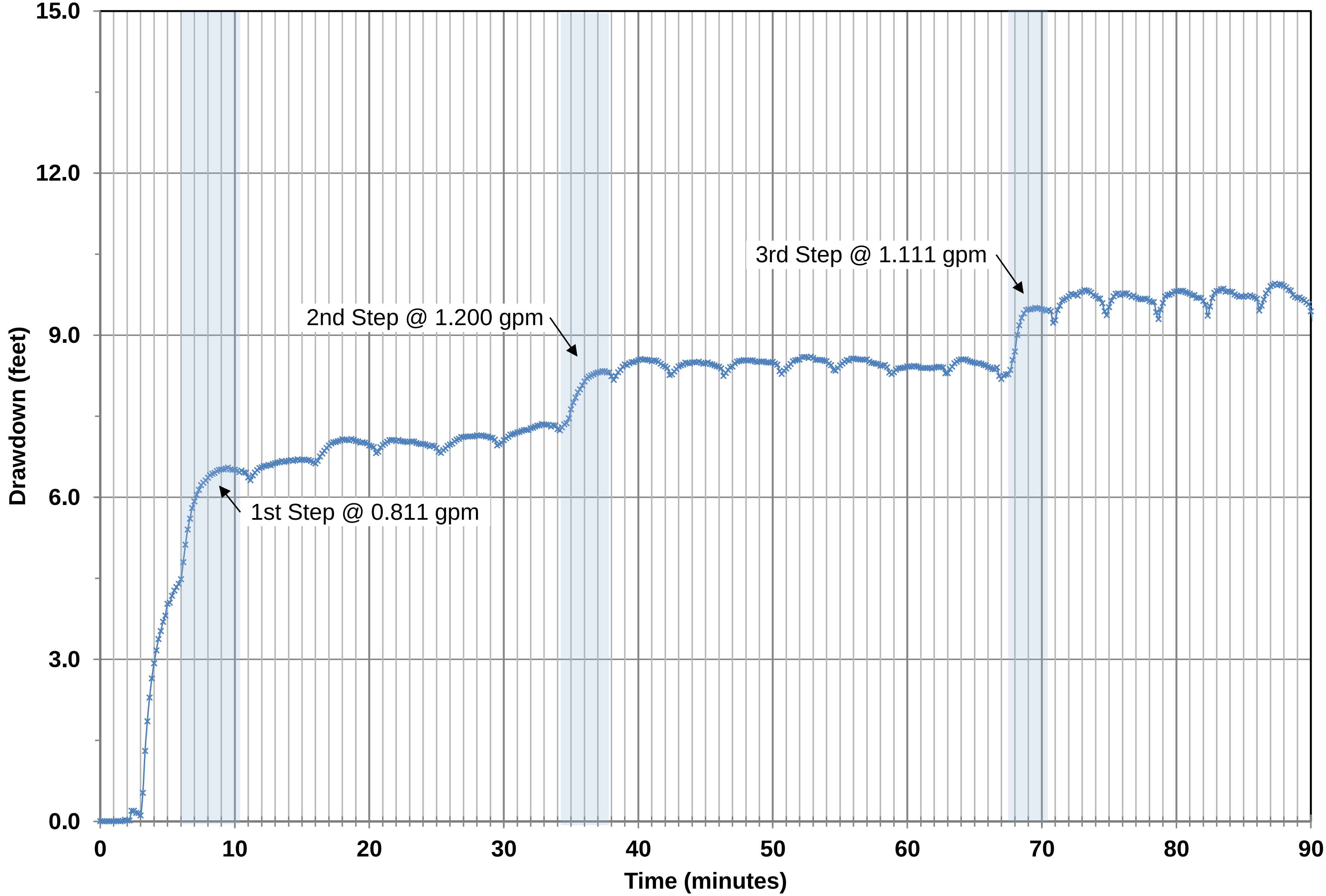


Figure D-1: Log Plot of P-10 Pumping Test Step 1

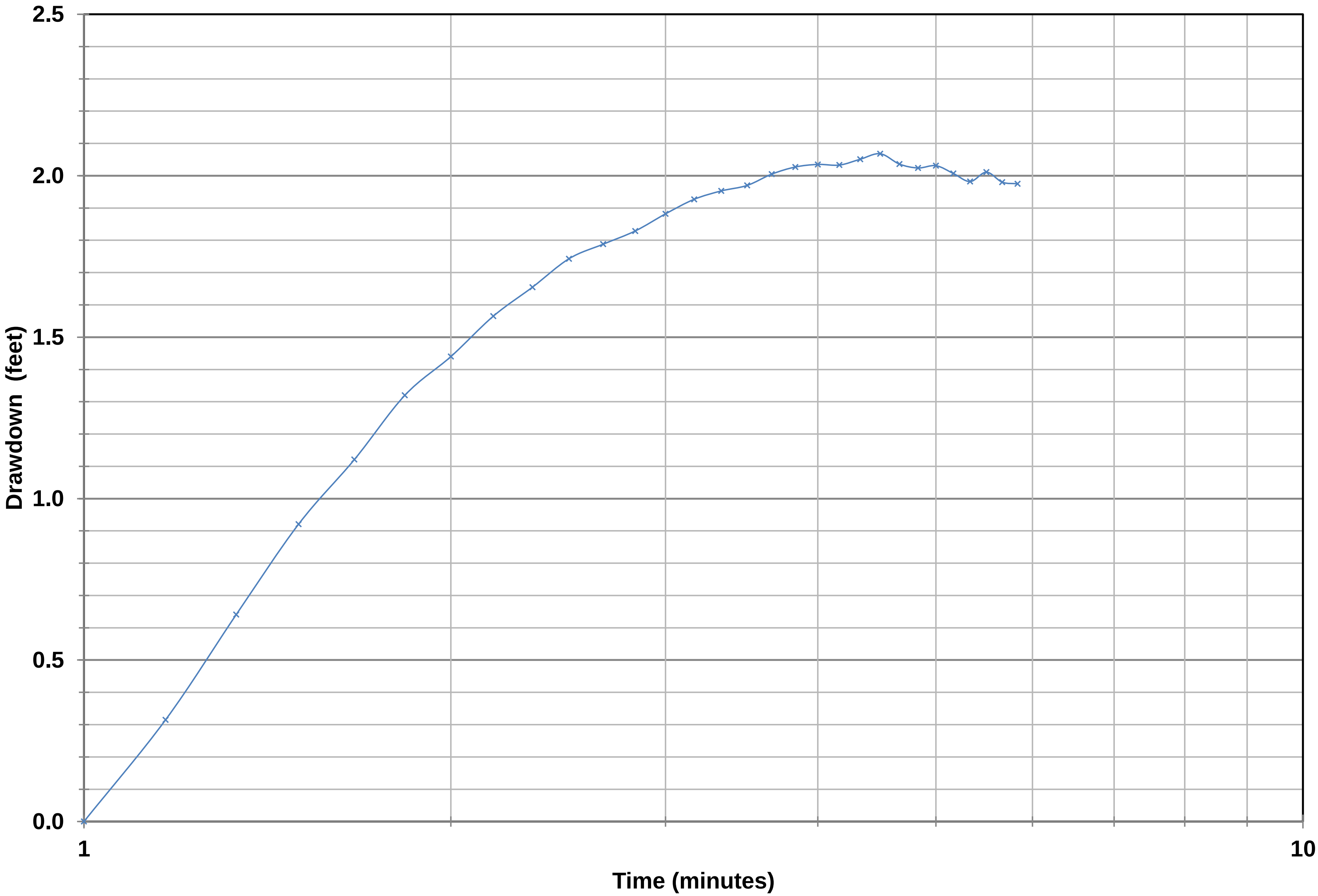


Figure D-2: Log Plot of P-10 Pumping Test Step 2

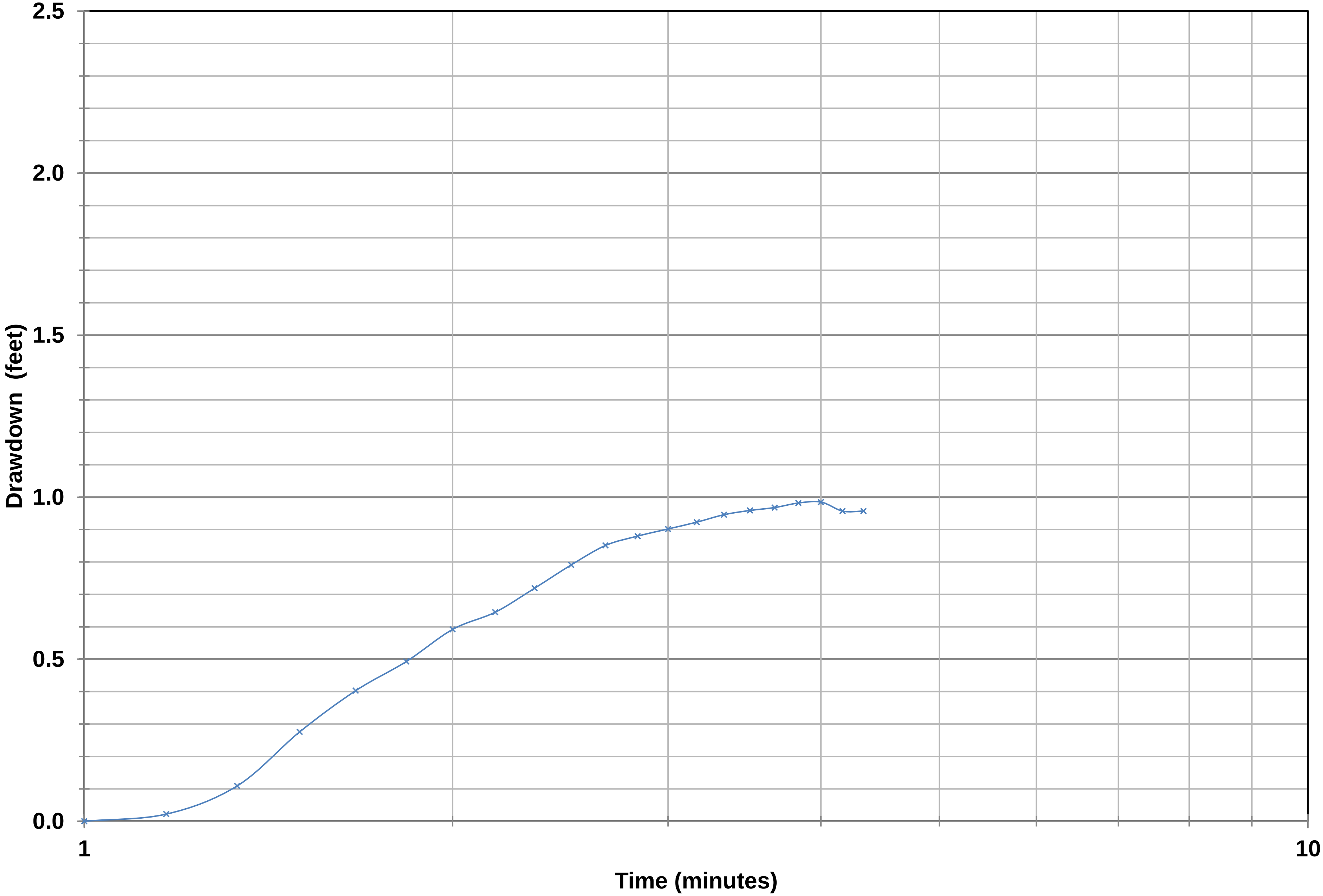
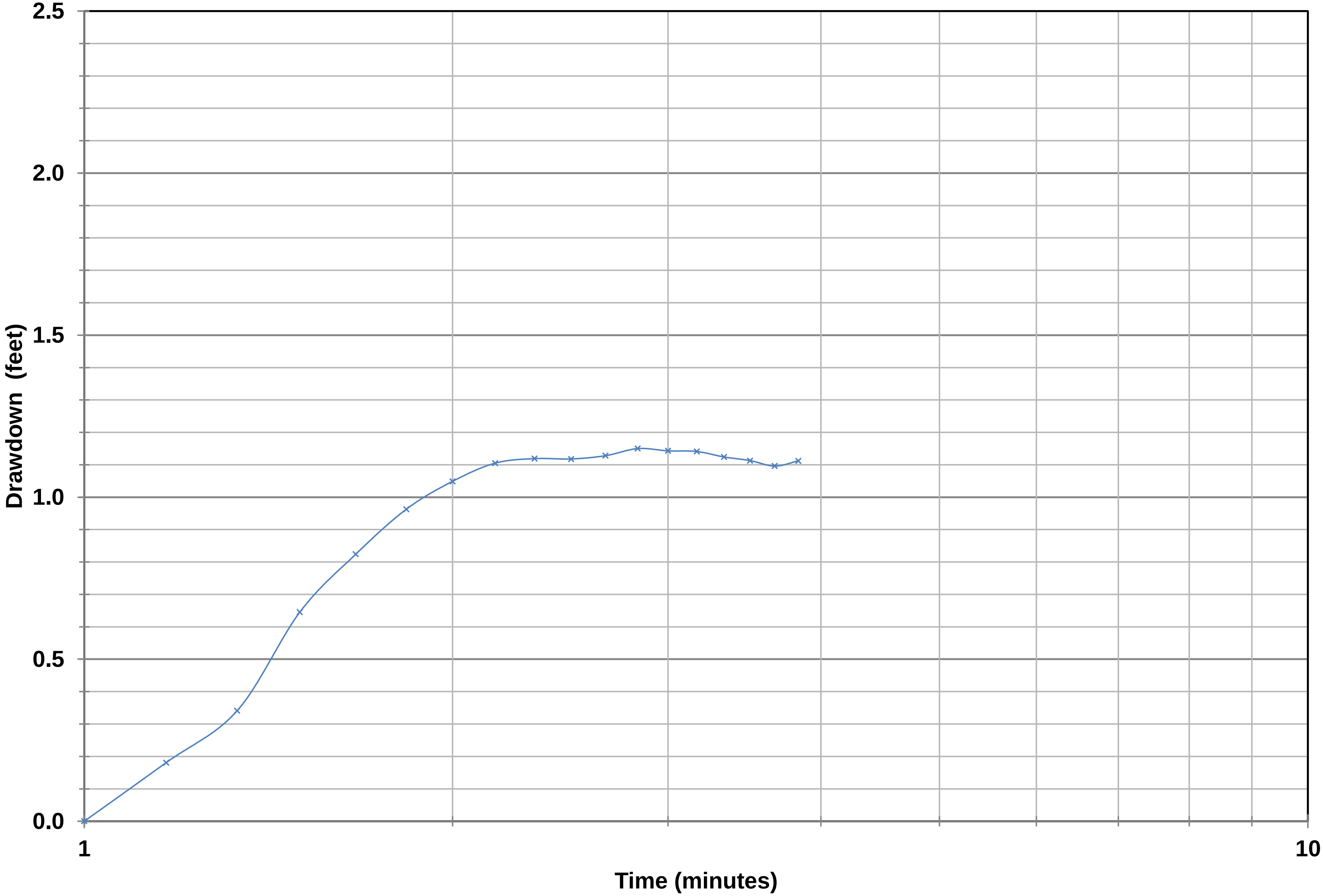


Figure D-3: Log Plot of P-10 Pumping Test Step 3



P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 10:07:23	0.000	5.159	19.694	0.007		0.00	0.01
05/24/19 10:07:33	10.001	5.160	19.648	0.004		0.17	0.00
05/24/19 10:07:43	20.001	5.162	19.652	0.000		0.33	0.00
05/24/19 10:07:53	30.001	5.160	19.640	0.004		0.50	0.00
05/24/19 10:08:03	40.001	5.159	19.679	0.007		0.67	0.01
05/24/19 10:08:13	50.001	5.159	19.650	0.006		0.83	0.01
05/24/19 10:08:23	60.001	5.162	19.668	0.001		1.00	0.00
05/24/19 10:08:33	70.001	5.158	19.632	0.009		1.17	0.01
05/24/19 10:08:43	80.001	5.158	19.648	0.010		1.33	0.01
05/24/19 10:08:53	90.001	5.161	19.675	0.002		1.50	0.00
05/24/19 10:09:03	100.001	5.158	19.640	0.009		1.67	0.01
05/24/19 10:09:13	110.001	5.149	19.633	0.030		1.83	0.03
05/24/19 10:09:23	120.001	5.153	19.652	0.020		2.00	0.02
05/24/19 10:09:33	130.001	5.154	19.637	0.017		2.17	0.02
05/24/19 10:09:43	140.001	5.078	19.655	0.195		2.33	0.20
05/24/19 10:09:53	150.001	5.078	19.645	0.195		2.50	0.20
05/24/19 10:10:03	160.001	5.093	19.609	0.159		2.67	0.16
05/24/19 10:10:13	170.001	5.095	19.609	0.155		2.83	0.16
05/24/19 10:10:23	180.001	5.114	19.635	0.111		3.00	0.11
05/24/19 10:10:33	190.001	4.933	19.635	0.529		3.17	0.53
05/24/19 10:10:43	200.001	4.598	19.592	1.303		3.33	1.30
05/24/19 10:10:53	210.001	4.358	19.635	1.856		3.50	1.86
05/24/19 10:11:03	220.001	4.169	19.645	2.293		3.67	2.29
05/24/19 10:11:13	230.001	4.015	19.652	2.649		3.83	2.65
05/24/19 10:11:23	240.001	3.893	19.607	2.929		4.00	2.93
05/24/19 10:11:33	250.001	3.791	19.605	3.167		4.17	3.17
05/24/19 10:11:43	260.001	3.699	19.607	3.377		4.33	3.38
05/24/19 10:11:53	270.001	3.634	19.596	3.527		4.50	3.53
05/24/19 10:12:03	280.001	3.562	19.614	3.695		4.67	3.70
05/24/19 10:12:13	290.001	3.511	19.578	3.812		4.83	3.81
05/24/19 10:12:23	300.001	3.418	19.614	4.027		5.00	4.03
05/24/19 10:41:14	2,030.201	3.409	19.473	4.047	0.732	5.17	4.05
05/24/19 10:41:24	2,040.200	3.353	19.507	4.177		5.33	4.18
05/24/19 10:41:34	2,050.200	3.311	19.520	4.274		5.50	4.27
05/24/19 10:41:44	2,060.200	3.284	19.507	4.337		5.67	4.34
05/24/19 10:41:53	2,070.001	3.257	19.478	4.399		5.83	4.40
05/24/19 10:42:04	2,080.199	3.221	19.503	4.482		6.00	4.48
05/24/19 10:42:14	2,090.201	3.084	19.509	4.797		6.17	4.80
05/24/19 10:42:23	2,100.001	2.943	19.456	5.123		6.33	5.12
05/24/19 10:42:33	2,110.001	2.822	19.465	5.403		6.50	5.40
05/24/19 10:42:43	2,120.001	2.736	19.459	5.603		6.67	5.60
05/24/19 10:42:53	2,130.001	2.649	19.488	5.802		6.83	5.80

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 10:43:03	2,140.001	2.597	19.463	5.922		7.00	5.92
05/24/19 10:43:13	2,150.001	2.543	19.459	6.047		7.17	6.05
05/24/19 10:43:23	2,160.001	2.504	19.494	6.137		7.33	6.14
05/24/19 10:43:33	2,170.001	2.466	19.467	6.225		7.50	6.23
05/24/19 10:43:43	2,180.001	2.446	19.454	6.270		7.67	6.27
05/24/19 10:43:53	2,190.001	2.429	19.459	6.311		7.83	6.31
05/24/19 10:44:03	2,200.001	2.406	19.451	6.364		8.00	6.36
05/24/19 10:44:13	2,210.001	2.386	19.476	6.409		8.17	6.41
05/24/19 10:44:23	2,220.001	2.375	19.475	6.435		8.33	6.44
05/24/19 10:44:33	2,230.001	2.368	19.449	6.452		8.50	6.45
05/24/19 10:44:43	2,240.001	2.353	19.470	6.487		8.67	6.49
05/24/19 10:44:53	2,250.001	2.343	19.457	6.509		8.83	6.51
05/24/19 10:45:03	2,260.001	2.339	19.465	6.517		9.00	6.52
05/24/19 10:45:13	2,270.001	2.341	19.466	6.515		9.17	6.52
05/24/19 10:45:23	2,280.001	2.333	19.468	6.533		9.33	6.53
05/24/19 10:45:33	2,290.001	2.325	19.477	6.550		9.50	6.55
05/24/19 10:45:43	2,300.001	2.339	19.476	6.518		9.67	6.52
05/24/19 10:45:53	2,310.001	2.344	19.459	6.506		9.83	6.51
05/24/19 10:46:03	2,320.001	2.341	19.467	6.513		10.00	6.51
05/24/19 10:46:13	2,330.001	2.352	19.459	6.489		10.17	6.49
05/24/19 10:46:23	2,340.001	2.363	19.481	6.464		10.33	6.46
05/24/19 10:46:33	2,350.001	2.350	19.462	6.493		10.50	6.49
05/24/19 10:46:43	2,360.001	2.363	19.433	6.462		10.67	6.46
05/24/19 10:46:53	2,370.001	2.366	19.451	6.457		10.83	6.46
05/24/19 10:47:03	2,380.001	2.404	19.478	6.369		11.00	6.37
05/24/19 10:47:13	2,390.001	2.427	19.479	6.315		11.17	6.32
05/24/19 10:47:23	2,400.001	2.387	19.480	6.407	0.811	11.33	6.41
05/24/19 10:47:33	2,410.001	2.365	19.473	6.458		11.50	6.46
05/24/19 10:47:43	2,420.001	2.346	19.436	6.503		11.67	6.50
05/24/19 10:47:53	2,430.001	2.329	19.478	6.541		11.83	6.54
05/24/19 10:48:03	2,440.001	2.323	19.478	6.554		12.00	6.55
05/24/19 10:48:13	2,450.001	2.313	19.446	6.579		12.17	6.58
05/24/19 10:48:23	2,460.001	2.312	19.479	6.580		12.33	6.58
05/24/19 10:48:33	2,470.001	2.304	19.474	6.599		12.50	6.60
05/24/19 10:48:43	2,480.001	2.306	19.479	6.595		12.67	6.60
05/24/19 10:48:53	2,490.001	2.295	19.472	6.620		12.83	6.62
05/24/19 10:49:03	2,500.001	2.289	19.499	6.633		13.00	6.63
05/24/19 10:49:13	2,510.001	2.284	19.488	6.645		13.17	6.65
05/24/19 10:49:23	2,520.001	2.282	19.462	6.650		13.33	6.65
05/24/19 10:49:33	2,530.001	2.273	19.477	6.672		13.50	6.67
05/24/19 10:49:43	2,540.001	2.279	19.459	6.656		13.67	6.66
05/24/19 10:49:53	2,550.001	2.276	19.473	6.663		13.83	6.66

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	**Elapsed Time (seconds)**	**Pressure (psi)**	**Temp (°C)**	**Level Depth To Water (feet)**	**Est. Flow Rate (gpm)**	**Total Adjusted Time (minutes)**	**Total Draw-down (feet)**
05/24/19 10:50:03	2,560.001	2.270	19.475	6.677		14.00	6.68
05/24/19 10:50:13	2,570.001	2.265	19.451	6.689		14.17	6.69
05/24/19 10:50:23	2,580.001	2.271	19.470	6.676		14.33	6.68
05/24/19 10:50:33	2,590.001	2.267	19.462	6.685		14.50	6.69
05/24/19 10:50:43	2,600.001	2.259	19.423	6.703		14.67	6.70
05/24/19 10:50:53	2,610.001	2.266	19.469	6.686		14.83	6.69
05/24/19 10:51:03	2,620.001	2.262	19.479	6.695		15.00	6.70
05/24/19 10:51:13	2,630.001	2.260	19.497	6.700		15.17	6.70
05/24/19 10:51:23	2,640.001	2.266	19.467	6.686		15.33	6.69
05/24/19 10:51:33	2,650.001	2.263	19.484	6.693		15.50	6.69
05/24/19 10:51:43	2,660.001	2.272	19.466	6.673		15.67	6.67
05/24/19 10:51:53	2,670.001	2.283	19.475	6.648		15.83	6.65
05/24/19 10:52:03	2,680.001	2.292	19.493	6.626		16.00	6.63
05/24/19 10:52:13	2,690.001	2.272	19.448	6.673		16.17	6.67
05/24/19 10:52:23	2,700.001	2.236	19.458	6.755	1.000	16.33	6.76
05/24/19 10:52:33	2,710.001	2.213	19.478	6.809		16.50	6.81
05/24/19 10:52:43	2,720.001	2.190	19.449	6.863		16.67	6.86
05/24/19 10:52:53	2,730.001	2.168	19.479	6.913		16.83	6.91
05/24/19 10:53:03	2,740.001	2.148	19.475	6.960		17.00	6.96
05/24/19 10:53:13	2,750.001	2.132	19.464	6.996		17.17	7.00
05/24/19 10:53:23	2,760.001	2.121	19.474	7.021		17.33	7.02
05/24/19 10:53:33	2,770.001	2.120	19.446	7.023		17.50	7.02
05/24/19 10:53:43	2,780.001	2.112	19.454	7.042		17.67	7.04
05/24/19 10:53:53	2,790.001	2.109	19.482	7.049		17.83	7.05
05/24/19 10:54:03	2,800.001	2.098	19.472	7.074		18.00	7.07
05/24/19 10:54:13	2,810.001	2.102	19.449	7.066		18.17	7.07
05/24/19 10:54:23	2,820.001	2.103	19.467	7.062		18.33	7.06
05/24/19 10:54:33	2,830.001	2.107	19.434	7.053		18.50	7.05
05/24/19 10:54:43	2,840.001	2.097	19.479	7.077		18.67	7.08
05/24/19 10:54:53	2,850.001	2.102	19.488	7.066		18.83	7.07
05/24/19 10:55:03	2,860.001	2.113	19.448	7.039		19.00	7.04
05/24/19 10:55:13	2,870.001	2.115	19.457	7.037		19.17	7.04
05/24/19 10:55:23	2,880.001	2.125	19.447	7.011		19.33	7.01
05/24/19 10:55:33	2,890.001	2.123	19.474	7.017		19.50	7.02
05/24/19 10:55:43	2,900.001	2.125	19.467	7.012		19.67	7.01
05/24/19 10:55:53	2,910.001	2.132	19.451	6.996		19.83	7.00
05/24/19 10:56:03	2,920.001	2.148	19.467	6.958		20.00	6.96
05/24/19 10:56:13	2,930.001	2.153	19.474	6.948		20.17	6.95
05/24/19 10:56:23	2,940.001	2.161	19.456	6.929		20.33	6.93
05/24/19 10:56:33	2,950.001	2.209	19.467	6.818	1.200	20.50	6.82
05/24/19 10:56:43	2,960.001	2.198	19.456	6.844		20.67	6.84
05/24/19 10:56:53	2,970.001	2.163	19.449	6.924		20.83	6.92

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 10:57:03	2,980.001	2.145	19.478	6.967		21.00	6.97
05/24/19 10:57:13	2,990.001	2.131	19.444	6.999		21.17	7.00
05/24/19 10:57:23	3,000.001	2.118	19.448	7.028		21.33	7.03
05/24/19 10:57:33	3,010.001	2.106	19.469	7.056		21.50	7.06
05/24/19 10:57:43	3,020.001	2.105	19.467	7.060		21.67	7.06
05/24/19 10:57:53	3,030.001	2.104	19.428	7.060		21.83	7.06
05/24/19 10:58:03	3,040.001	2.113	19.465	7.040		22.00	7.04
05/24/19 10:58:14	3,050.092	2.103	19.486	7.063		22.17	7.06
05/24/19 10:58:24	3,060.089	2.114	19.462	7.039		22.33	7.04
05/24/19 10:58:33	3,070.001	2.116	19.460	7.034		22.50	7.03
05/24/19 10:58:44	3,080.087	2.118	19.483	7.029		22.67	7.03
05/24/19 10:58:54	3,090.089	2.122	19.446	7.020		22.83	7.02
05/24/19 10:59:04	3,100.088	2.117	19.478	7.030		23.00	7.03
05/24/19 10:59:13	3,110.001	2.115	19.462	7.035		23.17	7.04
05/24/19 10:59:24	3,120.088	2.116	19.480	7.033		23.33	7.03
05/24/19 10:59:34	3,130.088	2.127	19.472	7.008		23.50	7.01
05/24/19 10:59:44	3,140.088	2.133	19.465	6.995		23.67	7.00
05/24/19 10:59:53	3,150.001	2.136	19.487	6.987		23.83	6.99
05/24/19 11:00:04	3,160.087	2.134	19.479	6.991		24.00	6.99
05/24/19 11:00:14	3,170.088	2.139	19.485	6.980		24.17	6.98
05/24/19 11:00:24	3,180.086	2.146	19.463	6.963		24.33	6.96
05/24/19 11:00:33	3,190.001	2.155	19.462	6.943		24.50	6.94
05/24/19 11:00:44	3,200.086	2.148	19.459	6.958		24.67	6.96
05/24/19 11:00:54	3,210.088	2.152	19.467	6.950		24.83	6.95
05/24/19 11:01:04	3,220.086	2.168	19.449	6.914		25.00	6.91
05/24/19 11:01:13	3,230.001	2.197	19.475	6.846		25.17	6.85
05/24/19 11:01:24	3,240.086	2.207	19.478	6.823	1.034	25.33	6.82
05/24/19 11:01:34	3,250.087	2.184	19.499	6.875		25.50	6.88
05/24/19 11:01:43	3,260.085	2.171	19.491	6.906		25.67	6.91
05/24/19 11:01:53	3,270.001	2.152	19.480	6.949		25.83	6.95
05/24/19 11:02:03	3,280.001	2.140	19.467	6.977		26.00	6.98
05/24/19 11:02:13	3,290.001	2.133	19.472	6.993		26.17	6.99
05/24/19 11:02:23	3,300.001	2.115	19.436	7.034		26.33	7.03
05/24/19 11:02:33	3,310.001	2.101	19.490	7.068		26.50	7.07
05/24/19 11:02:43	3,320.001	2.094	19.425	7.083		26.67	7.08
05/24/19 11:02:53	3,330.001	2.080	19.426	7.116		26.83	7.12
05/24/19 11:03:03	3,340.001	2.082	19.420	7.113		27.00	7.11
05/24/19 11:03:13	3,350.001	2.076	19.424	7.126		27.17	7.13
05/24/19 11:03:23	3,360.001	2.075	19.448	7.127		27.33	7.13
05/24/19 11:03:33	3,370.001	2.074	19.449	7.131		27.50	7.13
05/24/19 11:03:43	3,380.001	2.075	19.455	7.127		27.67	7.13
05/24/19 11:03:53	3,390.001	2.074	19.443	7.130		27.83	7.13

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:04:03	3,400.001	2.068	19.437	7.145		28.00	7.15
05/24/19 11:04:13	3,410.001	2.071	19.456	7.138		28.17	7.14
05/24/19 11:04:23	3,420.001	2.066	19.438	7.148		28.33	7.15
05/24/19 11:04:33	3,430.001	2.071	19.446	7.137		28.50	7.14
05/24/19 11:04:43	3,440.001	2.076	19.458	7.127		28.67	7.13
05/24/19 11:04:53	3,450.001	2.076	19.457	7.125		28.83	7.13
05/24/19 11:05:03	3,460.001	2.085	19.465	7.106		29.00	7.11
05/24/19 11:05:13	3,470.001	2.088	19.498	7.098		29.17	7.10
05/24/19 11:05:23	3,480.001	2.101	19.455	7.067		29.33	7.07
05/24/19 11:05:33	3,490.001	2.147	19.462	6.961		29.50	6.96
05/24/19 11:05:43	3,500.001	2.137	19.457	6.983	1.154	29.67	6.98
05/24/19 11:05:53	3,510.001	2.126	19.435	7.009		29.83	7.01
05/24/19 11:06:03	3,520.001	2.105	19.436	7.059		30.00	7.06
05/24/19 11:06:13	3,530.001	2.090	19.462	7.093		30.17	7.09
05/24/19 11:06:23	3,540.001	2.077	19.457	7.122		30.33	7.12
05/24/19 11:06:33	3,550.001	2.061	19.466	7.161		30.50	7.16
05/24/19 11:06:43	3,560.001	2.058	19.449	7.167		30.67	7.17
05/24/19 11:06:53	3,570.001	2.051	19.472	7.182		30.83	7.18
05/24/19 11:07:03	3,580.001	2.043	19.462	7.202		31.00	7.20
05/24/19 11:07:13	3,590.001	2.038	19.465	7.212		31.17	7.21
05/24/19 11:07:23	3,600.001	2.031	19.459	7.229		31.33	7.23
05/24/19 11:07:33	3,610.001	2.025	19.467	7.244		31.50	7.24
05/24/19 11:07:43	3,620.001	2.023	19.467	7.249		31.67	7.25
05/24/19 11:07:53	3,630.001	2.025	19.435	7.243		31.83	7.24
05/24/19 11:08:03	3,640.001	2.010	19.446	7.278		32.00	7.28
05/24/19 11:08:13	3,650.001	2.005	19.440	7.289		32.17	7.29
05/24/19 11:08:23	3,660.001	1.997	19.459	7.309		32.33	7.31
05/24/19 11:08:33	3,670.001	1.990	19.430	7.325		32.50	7.33
05/24/19 11:08:43	3,680.001	1.987	19.463	7.332		32.67	7.33
05/24/19 11:08:53	3,690.052	1.977	19.493	7.355		32.83	7.36
05/24/19 11:09:04	3,700.141	1.979	19.472	7.349		33.00	7.35
05/24/19 11:09:13	3,710.001	1.981	19.469	7.344		33.17	7.34
05/24/19 11:09:23	3,720.001	1.981	19.441	7.345		33.33	7.35
05/24/19 11:09:33	3,730.001	1.997	19.465	7.308		33.50	7.31
05/24/19 11:09:43	3,740.001	1.985	19.426	7.335		33.67	7.34
05/24/19 11:09:53	3,750.001	1.987	19.450	7.332		33.83	7.33
05/24/19 11:10:03	3,760.028	2.016	19.471	7.263		34.00	7.26
05/24/19 11:10:13	3,770.001	2.027	19.469	7.240		34.17	7.24
05/24/19 11:10:23	3,780.001	2.001	19.464	7.298	1.071	34.33	7.30
05/24/19 11:10:33	3,790.001	1.978	19.441	7.352		34.50	7.35
05/24/19 11:10:43	3,800.001	1.968	19.446	7.374		34.67	7.37
05/24/19 11:10:53	3,810.030	1.931	19.452	7.461		34.83	7.46

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:11:03	3,820.001	1.858	19.463	7.628		35.00	7.63
05/24/19 11:11:13	3,830.001	1.803	19.446	7.755		35.17	7.76
05/24/19 11:11:23	3,840.001	1.764	19.470	7.845		35.33	7.85
05/24/19 11:11:33	3,850.001	1.721	19.432	7.944		35.50	7.94
05/24/19 11:11:43	3,860.031	1.698	19.446	7.997		35.67	8.00
05/24/19 11:11:53	3,870.001	1.667	19.448	8.071		35.83	8.07
05/24/19 11:12:03	3,880.001	1.635	19.463	8.143		36.00	8.14
05/24/19 11:12:13	3,890.001	1.609	19.462	8.203		36.17	8.20
05/24/19 11:12:23	3,900.001	1.597	19.458	8.232		36.33	8.23
05/24/19 11:12:33	3,910.001	1.587	19.468	8.254		36.50	8.25
05/24/19 11:12:43	3,920.001	1.578	19.483	8.275		36.67	8.28
05/24/19 11:12:53	3,930.001	1.568	19.440	8.298		36.83	8.30
05/24/19 11:13:03	3,940.001	1.563	19.421	8.311		37.00	8.31
05/24/19 11:13:13	3,950.001	1.558	19.473	8.320		37.17	8.32
05/24/19 11:13:23	3,960.001	1.553	19.462	8.334		37.33	8.33
05/24/19 11:13:33	3,970.001	1.551	19.465	8.337		37.50	8.34
05/24/19 11:13:43	3,980.001	1.563	19.450	8.309		37.67	8.31
05/24/19 11:13:53	3,990.001	1.563	19.427	8.309		37.83	8.31
05/24/19 11:14:03	4,000.001	1.592	19.436	8.243		38.00	8.24
05/24/19 11:14:13	4,010.001	1.621	19.449	8.175		38.17	8.18
05/24/19 11:14:23	4,020.001	1.590	19.470	8.248		38.33	8.25
05/24/19 11:14:33	4,030.001	1.560	19.429	8.316	1.200	38.50	8.32
05/24/19 11:14:43	4,040.001	1.544	19.457	8.355		38.67	8.36
05/24/19 11:14:53	4,050.001	1.518	19.441	8.415		38.83	8.42
05/24/19 11:15:03	4,060.001	1.498	19.444	8.460		39.00	8.46
05/24/19 11:15:13	4,070.001	1.504	19.475	8.445		39.17	8.45
05/24/19 11:15:23	4,080.001	1.490	19.444	8.480		39.33	8.48
05/24/19 11:15:33	4,090.001	1.480	19.467	8.501		39.50	8.50
05/24/19 11:15:43	4,100.001	1.479	19.451	8.503		39.67	8.50
05/24/19 11:15:53	4,110.001	1.472	19.422	8.521		39.83	8.52
05/24/19 11:16:04	4,120.217	1.464	19.447	8.539		40.00	8.54
05/24/19 11:16:13	4,130.001	1.454	19.467	8.561		40.17	8.56
05/24/19 11:16:23	4,140.001	1.460	19.496	8.549		40.33	8.55
05/24/19 11:16:33	4,150.001	1.459	19.451	8.550		40.50	8.55
05/24/19 11:16:43	4,160.001	1.461	19.439	8.546		40.67	8.55
05/24/19 11:16:53	4,170.001	1.463	19.442	8.541		40.83	8.54
05/24/19 11:17:04	4,180.305	1.472	19.479	8.520		41.00	8.52
05/24/19 11:17:13	4,190.001	1.465	19.454	8.536		41.17	8.54
05/24/19 11:17:23	4,200.001	1.466	19.444	8.533		41.33	8.53
05/24/19 11:17:33	4,210.001	1.477	19.465	8.508		41.50	8.51
05/24/19 11:17:43	4,220.001	1.494	19.436	8.470		41.67	8.47
05/24/19 11:17:54	4,230.308	1.507	19.452	8.440		41.83	8.44

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:18:03	4,240.001	1.514	19.444	8.423		42.00	8.42
05/24/19 11:18:13	4,250.001	1.528	19.441	8.390		42.17	8.39
05/24/19 11:18:23	4,260.001	1.583	19.435	8.264		42.33	8.26
05/24/19 11:18:33	4,270.001	1.579	19.451	8.274	1.250	42.50	8.27
05/24/19 11:18:44	4,280.308	1.555	19.498	8.328		42.67	8.33
05/24/19 11:18:53	4,290.001	1.536	19.439	8.373		42.83	8.37
05/24/19 11:19:03	4,300.001	1.514	19.438	8.422		43.00	8.42
05/24/19 11:19:13	4,310.001	1.506	19.464	8.443		43.17	8.44
05/24/19 11:19:23	4,320.001	1.500	19.449	8.455		43.33	8.46
05/24/19 11:19:34	4,330.308	1.483	19.453	8.494		43.50	8.49
05/24/19 11:19:43	4,340.001	1.488	19.423	8.484		43.67	8.48
05/24/19 11:19:53	4,350.001	1.491	19.432	8.476		43.83	8.48
05/24/19 11:20:03	4,360.001	1.481	19.460	8.499		44.00	8.50
05/24/19 11:20:13	4,370.001	1.480	19.453	8.502		44.17	8.50
05/24/19 11:20:23	4,380.001	1.481	19.452	8.499		44.33	8.50
05/24/19 11:20:33	4,390.001	1.476	19.439	8.511		44.50	8.51
05/24/19 11:20:43	4,400.001	1.486	19.433	8.488		44.67	8.49
05/24/19 11:20:53	4,410.001	1.493	19.443	8.472		44.83	8.47
05/24/19 11:21:03	4,420.001	1.489	19.469	8.480		45.00	8.48
05/24/19 11:21:13	4,430.001	1.482	19.470	8.498		45.17	8.50
05/24/19 11:21:23	4,440.001	1.495	19.468	8.468		45.33	8.47
05/24/19 11:21:33	4,450.001	1.499	19.404	8.458		45.50	8.46
05/24/19 11:21:43	4,460.001	1.505	19.466	8.444		45.67	8.44
05/24/19 11:21:53	4,470.001	1.513	19.453	8.425		45.83	8.43
05/24/19 11:22:03	4,480.001	1.516	19.444	8.418		46.00	8.42
05/24/19 11:22:13	4,490.001	1.531	19.436	8.385		46.17	8.39
05/24/19 11:22:23	4,500.001	1.590	19.412	8.248		46.33	8.25
05/24/19 11:22:33	4,510.001	1.567	19.445	8.301		46.50	8.30
05/24/19 11:22:43	4,520.001	1.542	19.459	8.359		46.67	8.36
05/24/19 11:22:53	4,530.001	1.521	19.441	8.408	1.154	46.83	8.41
05/24/19 11:23:03	4,540.001	1.515	19.432	8.420		47.00	8.42
05/24/19 11:23:13	4,550.001	1.489	19.463	8.480		47.17	8.48
05/24/19 11:23:23	4,560.001	1.476	19.436	8.510		47.33	8.51
05/24/19 11:23:33	4,570.001	1.470	19.455	8.524		47.50	8.52
05/24/19 11:23:43	4,580.001	1.469	19.475	8.527		47.67	8.53
05/24/19 11:23:53	4,590.001	1.463	19.467	8.540		47.83	8.54
05/24/19 11:24:03	4,600.001	1.466	19.430	8.535		48.00	8.54
05/24/19 11:24:13	4,610.001	1.470	19.433	8.526		48.17	8.53
05/24/19 11:24:23	4,620.001	1.464	19.455	8.537		48.33	8.54
05/24/19 11:24:33	4,630.001	1.466	19.456	8.534		48.50	8.53
05/24/19 11:24:43	4,640.001	1.474	19.451	8.516		48.67	8.52
05/24/19 11:24:53	4,650.001	1.479	19.466	8.504		48.83	8.50

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:25:03	4,660.001	1.476	19.434	8.511		49.00	8.51
05/24/19 11:25:13	4,670.001	1.475	19.480	8.513		49.17	8.51
05/24/19 11:25:23	4,680.001	1.475	19.476	8.514		49.33	8.51
05/24/19 11:25:33	4,690.001	1.481	19.469	8.499		49.50	8.50
05/24/19 11:25:43	4,700.001	1.483	19.463	8.494		49.67	8.49
05/24/19 11:25:53	4,710.001	1.483	19.464	8.494		49.83	8.49
05/24/19 11:26:03	4,720.001	1.478	19.437	8.506		50.00	8.51
05/24/19 11:26:13	4,730.001	1.492	19.464	8.475		50.17	8.48
05/24/19 11:26:23	4,740.001	1.500	19.451	8.455		50.33	8.46
05/24/19 11:26:33	4,750.001	1.551	19.464	8.337		50.50	8.34
05/24/19 11:26:43	4,760.001	1.573	19.455	8.286		50.67	8.29
05/24/19 11:26:53	4,770.001	1.549	19.476	8.343	1.250	50.83	8.34
05/24/19 11:27:03	4,780.001	1.531	19.428	8.383		51.00	8.38
05/24/19 11:27:13	4,790.001	1.516	19.440	8.420		51.17	8.42
05/24/19 11:27:23	4,800.001	1.494	19.497	8.469		51.33	8.47
05/24/19 11:27:33	4,810.001	1.472	19.462	8.520		51.50	8.52
05/24/19 11:27:43	4,820.001	1.464	19.469	8.538		51.67	8.54
05/24/19 11:27:53	4,830.001	1.462	19.440	8.544		51.83	8.54
05/24/19 11:28:03	4,840.001	1.460	19.444	8.547		52.00	8.55
05/24/19 11:28:13	4,850.001	1.439	19.429	8.597		52.17	8.60
05/24/19 11:28:23	4,860.001	1.437	19.470	8.600		52.33	8.60
05/24/19 11:28:33	4,870.001	1.439	19.469	8.597		52.50	8.60
05/24/19 11:28:43	4,880.001	1.447	19.472	8.577		52.67	8.58
05/24/19 11:28:53	4,890.001	1.435	19.486	8.605		52.83	8.61
05/24/19 11:29:03	4,900.001	1.446	19.493	8.580		53.00	8.58
05/24/19 11:29:13	4,910.001	1.461	19.449	8.545		53.17	8.55
05/24/19 11:29:23	4,920.001	1.462	19.451	8.543		53.33	8.54
05/24/19 11:29:33	4,930.001	1.461	19.481	8.545		53.50	8.55
05/24/19 11:29:43	4,940.001	1.464	19.469	8.539		53.67	8.54
05/24/19 11:29:53	4,950.001	1.469	19.442	8.528		53.83	8.53
05/24/19 11:30:03	4,960.001	1.473	19.468	8.518		54.00	8.52
05/24/19 11:30:13	4,970.001	1.492	19.457	8.473		54.17	8.47
05/24/19 11:30:23	4,980.001	1.504	19.476	8.447		54.33	8.45
05/24/19 11:30:33	4,990.001	1.542	19.473	8.359		54.50	8.36
05/24/19 11:30:43	5,000.001	1.549	19.461	8.343		54.67	8.34
05/24/19 11:30:53	5,010.001	1.526	19.444	8.395	1.250	54.83	8.40
05/24/19 11:31:03	5,020.001	1.506	19.464	8.442		55.00	8.44
05/24/19 11:31:13	5,030.001	1.490	19.451	8.478		55.17	8.48
05/24/19 11:31:23	5,040.001	1.476	19.446	8.511		55.33	8.51
05/24/19 11:31:33	5,050.001	1.464	19.476	8.539		55.50	8.54
05/24/19 11:31:43	5,060.001	1.468	19.415	8.530		55.67	8.53
05/24/19 11:31:53	5,070.001	1.453	19.441	8.564		55.83	8.56

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:32:03	5,080.001	1.449	19.453	8.572		56.00	8.57
05/24/19 11:32:13	5,090.001	1.454	19.420	8.562		56.17	8.56
05/24/19 11:32:23	5,100.001	1.458	19.423	8.553		56.33	8.55
05/24/19 11:32:33	5,110.001	1.460	19.452	8.548		56.50	8.55
05/24/19 11:32:43	5,120.001	1.460	19.430	8.548		56.67	8.55
05/24/19 11:32:53	5,130.001	1.462	19.434	8.543		56.83	8.54
05/24/19 11:33:03	5,140.001	1.458	19.480	8.551		57.00	8.55
05/24/19 11:33:13	5,150.001	1.474	19.430	8.515		57.17	8.52
05/24/19 11:33:23	5,160.001	1.485	19.456	8.490		57.33	8.49
05/24/19 11:33:33	5,170.001	1.488	19.460	8.483		57.50	8.48
05/24/19 11:33:43	5,180.001	1.493	19.472	8.472		57.67	8.47
05/24/19 11:33:53	5,190.001	1.495	19.472	8.466		57.83	8.47
05/24/19 11:34:03	5,200.001	1.510	19.462	8.433		58.00	8.43
05/24/19 11:34:13	5,210.001	1.508	19.459	8.437		58.17	8.44
05/24/19 11:34:23	5,220.001	1.503	19.465	8.449		58.33	8.45
05/24/19 11:34:33	5,230.001	1.520	19.454	8.410		58.50	8.41
05/24/19 11:34:43	5,240.001	1.563	19.432	8.310		58.67	8.31
05/24/19 11:34:53	5,250.001	1.576	19.449	8.280	1.250	58.83	8.28
05/24/19 11:35:03	5,260.001	1.561	19.440	8.315		59.00	8.32
05/24/19 11:35:13	5,270.001	1.542	19.454	8.360		59.17	8.36
05/24/19 11:35:23	5,280.001	1.531	19.454	8.385		59.33	8.39
05/24/19 11:35:33	5,290.001	1.528	19.457	8.391		59.50	8.39
05/24/19 11:35:43	5,300.001	1.526	19.438	8.396		59.67	8.40
05/24/19 11:35:53	5,310.001	1.522	19.431	8.404		59.83	8.40
05/24/19 11:36:03	5,320.001	1.513	19.483	8.426		60.00	8.43
05/24/19 11:36:13	5,330.001	1.517	19.447	8.416		60.17	8.42
05/24/19 11:36:23	5,340.001	1.517	19.463	8.416		60.33	8.42
05/24/19 11:36:33	5,350.001	1.510	19.490	8.432		60.50	8.43
05/24/19 11:36:43	5,360.001	1.514	19.449	8.424		60.67	8.42
05/24/19 11:36:53	5,370.001	1.517	19.446	8.416		60.83	8.42
05/24/19 11:37:03	5,380.001	1.525	19.443	8.397		61.00	8.40
05/24/19 11:37:13	5,390.001	1.527	19.444	8.393		61.17	8.39
05/24/19 11:37:23	5,400.001	1.526	19.444	8.396		61.33	8.40
05/24/19 11:37:33	5,410.001	1.525	19.420	8.397		61.50	8.40
05/24/19 11:37:43	5,420.001	1.526	19.481	8.396		61.67	8.40
05/24/19 11:37:53	5,430.001	1.532	19.449	8.381		61.83	8.38
05/24/19 11:38:03	5,440.001	1.524	19.438	8.401		62.00	8.40
05/24/19 11:38:13	5,450.001	1.519	19.461	8.412		62.17	8.41
05/24/19 11:38:23	5,460.001	1.517	19.465	8.417		62.33	8.42
05/24/19 11:38:33	5,470.001	1.520	19.444	8.409		62.50	8.41
05/24/19 11:38:43	5,480.001	1.522	19.444	8.404		62.67	8.40
05/24/19 11:38:53	5,490.001	1.569	19.452	8.296		62.83	8.30

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:39:03	5,500.001	1.569	19.438	8.296	1.200	63.00	8.30
05/24/19 11:39:13	5,510.001	1.536	19.449	8.372		63.17	8.37
05/24/19 11:39:23	5,520.001	1.517	19.460	8.416		63.33	8.42
05/24/19 11:39:33	5,530.001	1.490	19.439	8.479		63.50	8.48
05/24/19 11:39:43	5,540.001	1.475	19.446	8.512		63.67	8.51
05/24/19 11:39:53	5,550.001	1.463	19.463	8.541		63.83	8.54
05/24/19 11:40:03	5,560.001	1.457	19.448	8.554		64.00	8.55
05/24/19 11:40:13	5,570.001	1.457	19.462	8.554		64.17	8.55
05/24/19 11:40:23	5,580.001	1.459	19.421	8.551		64.33	8.55
05/24/19 11:40:33	5,590.001	1.467	19.465	8.531		64.50	8.53
05/24/19 11:40:43	5,600.001	1.474	19.480	8.515		64.67	8.52
05/24/19 11:40:53	5,610.001	1.479	19.462	8.504		64.83	8.50
05/24/19 11:41:03	5,620.001	1.484	19.459	8.493		65.00	8.49
05/24/19 11:41:13	5,630.001	1.491	19.470	8.477		65.17	8.48
05/24/19 11:41:23	5,640.001	1.487	19.453	8.486		65.33	8.49
05/24/19 11:41:33	5,650.001	1.493	19.478	8.472		65.50	8.47
05/24/19 11:41:43	5,660.001	1.502	19.477	8.450		65.67	8.45
05/24/19 11:41:53	5,670.001	1.506	19.467	8.441		65.83	8.44
05/24/19 11:42:03	5,680.001	1.519	19.457	8.413		66.00	8.41
05/24/19 11:42:13	5,690.001	1.525	19.446	8.399		66.17	8.40
05/24/19 11:42:23	5,700.001	1.536	19.460	8.372		66.33	8.37
05/24/19 11:42:33	5,710.001	1.538	19.453	8.368	1.429	66.50	8.37
05/24/19 11:42:43	5,720.001	1.522	19.461	8.405		66.67	8.41
05/24/19 11:42:53	5,730.001	1.591	19.453	8.246		66.83	8.25
05/24/19 11:43:03	5,740.001	1.614	19.470	8.192		67.00	8.19
05/24/19 11:43:13	5,750.001	1.588	19.422	8.253		67.17	8.25
05/24/19 11:43:23	5,760.001	1.578	19.463	8.275		67.33	8.28
05/24/19 11:43:33	5,770.001	1.575	19.432	8.281		67.50	8.28
05/24/19 11:43:43	5,780.001	1.542	19.481	8.358		67.67	8.36
05/24/19 11:43:53	5,790.001	1.464	19.451	8.539		67.83	8.54
05/24/19 11:44:03	5,800.001	1.394	19.464	8.699		68.00	8.70
05/24/19 11:44:13	5,810.001	1.263	19.463	9.003		68.17	9.00
05/24/19 11:44:23	5,820.001	1.185	19.449	9.182		68.33	9.18
05/24/19 11:44:33	5,830.001	1.125	19.429	9.321		68.50	9.32
05/24/19 11:44:43	5,840.001	1.088	19.449	9.407		68.67	9.41
05/24/19 11:44:53	5,850.001	1.064	19.472	9.463		68.83	9.46
05/24/19 11:45:03	5,860.001	1.058	19.446	9.477		69.00	9.48
05/24/19 11:45:13	5,870.001	1.058	19.459	9.476		69.17	9.48
05/24/19 11:45:23	5,880.001	1.054	19.441	9.486		69.33	9.49
05/24/19 11:45:33	5,890.001	1.044	19.451	9.508		69.50	9.51
05/24/19 11:45:43	5,900.001	1.047	19.446	9.501		69.67	9.50
05/24/19 11:45:53	5,910.001	1.048	19.480	9.499		69.83	9.50

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:46:03	5,920.001	1.056	19.455	9.482		70.00	9.48
05/24/19 11:46:13	5,930.001	1.060	19.451	9.471		70.17	9.47
05/24/19 11:46:23	5,940.001	1.067	19.432	9.454		70.33	9.45
05/24/19 11:46:33	5,950.001	1.061	19.471	9.470		70.50	9.47
05/24/19 11:46:43	5,960.001	1.072	19.445	9.444		70.67	9.44
05/24/19 11:46:53	5,970.001	1.164	19.472	9.232		70.83	9.23
05/24/19 11:47:03	5,980.001	1.143	19.452	9.279	1.111	71.00	9.28
05/24/19 11:47:13	5,990.001	1.064	19.483	9.463		71.17	9.46
05/24/19 11:47:23	6,000.001	1.028	19.454	9.545		71.33	9.55
05/24/19 11:47:33	6,010.001	0.986	19.447	9.643		71.50	9.64
05/24/19 11:47:43	6,020.001	0.979	19.435	9.659		71.67	9.66
05/24/19 11:47:53	6,030.001	0.967	19.448	9.686		71.83	9.69
05/24/19 11:48:03	6,040.001	0.952	19.412	9.721		72.00	9.72
05/24/19 11:48:13	6,050.001	0.932	19.462	9.768		72.17	9.77
05/24/19 11:48:23	6,060.001	0.940	19.441	9.749		72.33	9.75
05/24/19 11:48:33	6,070.001	0.935	19.461	9.759		72.50	9.76
05/24/19 11:48:43	6,080.001	0.947	19.430	9.732		72.67	9.73
05/24/19 11:48:53	6,090.013	0.923	19.460	9.788		72.83	9.79
05/24/19 11:49:03	6,100.001	0.915	19.420	9.807		73.00	9.81
05/24/19 11:49:13	6,110.001	0.903	19.450	9.834		73.17	9.83
05/24/19 11:49:23	6,120.001	0.906	19.438	9.827		73.33	9.83
05/24/19 11:49:33	6,130.001	0.911	19.438	9.815		73.50	9.82
05/24/19 11:49:43	6,140.001	0.923	19.460	9.787		73.67	9.79
05/24/19 11:49:53	6,150.001	0.943	19.447	9.741		73.83	9.74
05/24/19 11:50:03	6,160.001	0.949	19.451	9.727		74.00	9.73
05/24/19 11:50:13	6,170.001	0.969	19.465	9.683		74.17	9.68
05/24/19 11:50:23	6,180.001	0.971	19.462	9.677		74.33	9.68
05/24/19 11:50:33	6,190.001	1.007	19.483	9.594		74.50	9.59
05/24/19 11:50:43	6,200.001	1.073	19.419	9.442		74.67	9.44
05/24/19 11:50:53	6,210.001	1.103	19.486	9.373		74.83	9.37
05/24/19 11:51:03	6,220.001	1.039	19.459	9.520	1.250	75.00	9.52
05/24/19 11:51:13	6,230.001	0.988	19.445	9.639		75.17	9.64
05/24/19 11:51:23	6,240.001	0.952	19.465	9.722		75.33	9.72
05/24/19 11:51:33	6,250.001	0.932	19.475	9.768		75.50	9.77
05/24/19 11:51:43	6,260.001	0.928	19.462	9.775		75.67	9.78
05/24/19 11:51:53	6,270.001	0.944	19.467	9.740		75.83	9.74
05/24/19 11:52:03	6,280.001	0.934	19.472	9.761		76.00	9.76
05/24/19 11:52:13	6,290.001	0.928	19.464	9.776		76.17	9.78
05/24/19 11:52:23	6,300.001	0.928	19.462	9.777		76.33	9.78
05/24/19 11:52:33	6,310.001	0.942	19.452	9.743		76.50	9.74
05/24/19 11:52:43	6,320.001	0.955	19.465	9.714		76.67	9.71
05/24/19 11:52:53	6,330.001	0.946	19.464	9.734		76.83	9.73

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 11:53:03	6,340.001	0.961	19.449	9.701		77.00	9.70
05/24/19 11:53:13	6,350.001	0.970	19.457	9.680		77.17	9.68
05/24/19 11:53:23	6,360.001	0.975	19.457	9.667		77.33	9.67
05/24/19 11:53:33	6,370.001	0.976	19.444	9.666		77.50	9.67
05/24/19 11:53:43	6,380.001	0.970	19.439	9.679		77.67	9.68
05/24/19 11:53:53	6,390.001	0.972	19.451	9.675		77.83	9.68
05/24/19 11:54:03	6,400.001	0.989	19.459	9.635		78.00	9.64
05/24/19 11:54:13	6,410.001	0.999	19.474	9.613		78.17	9.61
05/24/19 11:54:23	6,420.001	0.997	19.429	9.616		78.33	9.62
05/24/19 11:54:33	6,430.001	1.079	19.455	9.428		78.50	9.43
05/24/19 11:54:43	6,440.001	1.134	19.433	9.300		78.67	9.30
05/24/19 11:54:53	6,450.001	1.059	19.475	9.475	1.304	78.83	9.48
05/24/19 11:55:03	6,460.001	1.005	19.467	9.598		79.00	9.60
05/24/19 11:55:13	6,470.001	0.952	19.447	9.722		79.17	9.72
05/24/19 11:55:23	6,480.001	0.941	19.439	9.746		79.33	9.75
05/24/19 11:55:33	6,490.001	0.939	19.457	9.751		79.50	9.75
05/24/19 11:55:43	6,500.001	0.930	19.458	9.772		79.67	9.77
05/24/19 11:55:53	6,510.001	0.915	19.434	9.807		79.83	9.81
05/24/19 11:56:03	6,520.001	0.911	19.470	9.815		80.00	9.82
05/24/19 11:56:13	6,530.001	0.914	19.430	9.809		80.17	9.81
05/24/19 11:56:23	6,540.001	0.907	19.465	9.825		80.33	9.83
05/24/19 11:56:33	6,550.001	0.907	19.446	9.824		80.50	9.82
05/24/19 11:56:43	6,560.001	0.919	19.436	9.798		80.67	9.80
05/24/19 11:56:53	6,570.001	0.924	19.437	9.784		80.83	9.78
05/24/19 11:57:03	6,580.001	0.932	19.451	9.767		81.00	9.77
05/24/19 11:57:13	6,590.001	0.945	19.440	9.738		81.17	9.74
05/24/19 11:57:23	6,600.001	0.943	19.461	9.742		81.33	9.74
05/24/19 11:57:33	6,610.001	0.966	19.461	9.689		81.50	9.69
05/24/19 11:57:43	6,620.001	0.964	19.478	9.694		81.67	9.69
05/24/19 11:57:53	6,630.001	0.965	19.462	9.691		81.83	9.69
05/24/19 11:58:03	6,640.001	0.989	19.447	9.636		82.00	9.64
05/24/19 11:58:13	6,650.001	1.021	19.467	9.562		82.17	9.56
05/24/19 11:58:23	6,660.001	1.107	19.458	9.362		82.33	9.36
05/24/19 11:58:33	6,670.001	1.032	19.443	9.535		82.50	9.54
05/24/19 11:58:43	6,680.001	0.967	19.467	9.685	1.304	82.67	9.69
05/24/19 11:58:53	6,690.001	0.925	19.459	9.784		82.83	9.78
05/24/19 11:59:03	6,700.001	0.910	19.457	9.817		83.00	9.82
05/24/19 11:59:13	6,710.001	0.907	19.474	9.824		83.17	9.82
05/24/19 11:59:23	6,720.001	0.895	19.454	9.852		83.33	9.85
05/24/19 11:59:33	6,730.001	0.892	19.472	9.860		83.50	9.86
05/24/19 11:59:43	6,740.001	0.915	19.477	9.806		83.67	9.81
05/24/19 11:59:53	6,750.001	0.910	19.472	9.818		83.83	9.82

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 12:00:03	6,760.001	0.917	19.486	9.801		84.00	9.80
05/24/19 12:00:13	6,770.001	0.917	19.464	9.802		84.17	9.80
05/24/19 12:00:23	6,780.001	0.937	19.446	9.755		84.33	9.76
05/24/19 12:00:33	6,790.001	0.947	19.471	9.732		84.50	9.73
05/24/19 12:00:44	6,800.204	0.956	19.465	9.712		84.67	9.71
05/24/19 12:00:54	6,810.261	0.951	19.472	9.722		84.83	9.72
05/24/19 12:01:03	6,820.001	0.955	19.467	9.714		85.00	9.71
05/24/19 12:01:13	6,830.001	0.947	19.453	9.732		85.17	9.73
05/24/19 12:01:23	6,840.001	0.955	19.454	9.713		85.33	9.71
05/24/19 12:01:33	6,850.001	0.945	19.447	9.736		85.50	9.74
05/24/19 12:01:44	6,860.285	0.953	19.467	9.718		85.67	9.72
05/24/19 12:01:53	6,870.001	0.962	19.465	9.699		85.83	9.70
05/24/19 12:02:04	6,880.286	0.972	19.475	9.675		86.00	9.68
05/24/19 12:02:14	6,890.285	1.067	19.464	9.455		86.17	9.46
05/24/19 12:02:24	6,900.289	1.026	19.447	9.550		86.33	9.55
05/24/19 12:02:33	6,910.001	0.977	19.451	9.663		86.50	9.66
05/24/19 12:02:44	6,920.289	0.929	19.470	9.774		86.67	9.77
05/24/19 12:02:53	6,930.001	0.906	19.438	9.828		86.83	9.83
05/24/19 12:03:03	6,940.001	0.871	19.454	9.908	1.154	87.00	9.91
05/24/19 12:03:13	6,950.001	0.860	19.415	9.933		87.17	9.93
05/24/19 12:03:23	6,960.001	0.850	19.423	9.955		87.33	9.96
05/24/19 12:03:33	6,970.001	0.863	19.445	9.926		87.50	9.93
05/24/19 12:03:43	6,980.001	0.856	19.447	9.943		87.67	9.94
05/24/19 12:03:53	6,990.001	0.857	19.466	9.941		87.83	9.94
05/24/19 12:04:03	7,000.001	0.869	19.442	9.912		88.00	9.91
05/24/19 12:04:13	7,010.001	0.881	19.456	9.885		88.17	9.89
05/24/19 12:04:23	7,020.001	0.901	19.462	9.838		88.33	9.84
05/24/19 12:04:33	7,030.001	0.907	19.455	9.826		88.50	9.83
05/24/19 12:04:43	7,040.001	0.942	19.422	9.744		88.67	9.74
05/24/19 12:04:53	7,050.001	0.958	19.458	9.706		88.83	9.71
05/24/19 12:05:03	7,060.001	0.964	19.438	9.692		89.00	9.69
05/24/19 12:05:13	7,070.001	0.961	19.407	9.700		89.17	9.70
05/24/19 12:05:23	7,080.001	0.976	19.417	9.665		89.33	9.67
05/24/19 12:05:33	7,090.001	0.983	19.448	9.648		89.50	9.65
05/24/19 12:05:43	7,100.001	0.999	19.463	9.611		89.67	9.61
05/24/19 12:05:53	7,110.001	1.014	19.435	9.577		89.83	9.58
05/24/19 12:06:03	7,120.001	1.072	19.437	9.444		90.00	9.44
05/24/19 12:06:13	7,130.001	1.154	19.449	9.255		90.17	9.26
05/24/19 12:06:23	7,140.001	1.082	19.418	9.421	1.500	90.33	9.42
05/24/19 12:06:33	7,150.001	1.034	19.424	9.531		90.50	9.53
05/24/19 12:06:43	7,160.001	1.022	19.416	9.558		90.67	9.56
05/24/19 12:06:53	7,170.001	0.980	19.427	9.656		90.83	9.66

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 12:07:03	7,180.001	0.946	19.452	9.735		91.00	9.74
05/24/19 12:07:13	7,190.001	0.921	19.465	9.792		91.17	9.79
05/24/19 12:07:23	7,200.001	0.914	19.428	9.809		91.33	9.81
05/24/19 12:07:33	7,210.001	0.900	19.422	9.841		91.50	9.84
05/24/19 12:07:43	7,220.001	0.894	19.440	9.855		91.67	9.86
05/24/19 12:07:53	7,230.001	0.901	19.438	9.840		91.83	9.84
05/24/19 12:08:03	7,240.001	0.905	19.459	9.829		92.00	9.83
05/24/19 12:08:13	7,250.001	0.916	19.464	9.805		92.17	9.81
05/24/19 12:08:23	7,260.001	0.919	19.428	9.796		92.33	9.80
05/24/19 12:08:33	7,270.001	0.929	19.462	9.773		92.50	9.77
05/24/19 12:08:43	7,280.001	0.932	19.441	9.768		92.67	9.77
05/24/19 12:08:53	7,290.001	0.928	19.437	9.776		92.83	9.78
05/24/19 12:09:03	7,300.001	0.915	19.438	9.807		93.00	9.81
05/24/19 12:09:13	7,310.001	0.911	19.454	9.816		93.17	9.82
05/24/19 12:09:23	7,320.001	0.921	19.447	9.791		93.33	9.79
05/24/19 12:09:33	7,330.001	0.920	19.446	9.796		93.50	9.80
05/24/19 12:09:43	7,340.001	0.920	19.473	9.795		93.67	9.80
05/24/19 12:09:53	7,350.001	0.940	19.423	9.748		93.83	9.75
05/24/19 12:10:03	7,360.001	1.043	19.430	9.511		94.00	9.51
05/24/19 12:10:13	7,370.001	0.954	19.462	9.717	1.304	94.17	9.72
05/24/19 12:10:23	7,380.001	0.906	19.452	9.827		94.33	9.83
05/24/19 12:10:33	7,390.001	0.864	19.446	9.925		94.50	9.93
05/24/19 12:10:43	7,400.001	0.841	19.454	9.976		94.67	9.98
05/24/19 12:10:53	7,410.001	0.842	19.454	9.974		94.83	9.97
05/24/19 12:11:03	7,420.001	0.815	19.451	10.036		95.00	10.04
05/24/19 12:11:13	7,430.001	0.819	19.445	10.028		95.17	10.03
05/24/19 12:11:23	7,440.001	0.810	19.456	10.048		95.33	10.05
05/24/19 12:11:33	7,450.001	0.826	19.468	10.011		95.50	10.01
05/24/19 12:11:43	7,460.001	0.830	19.436	10.003		95.67	10.00
05/24/19 12:11:53	7,470.001	0.830	19.451	10.003		95.83	10.00
05/24/19 12:12:03	7,480.001	0.838	19.450	9.983		96.00	9.98
05/24/19 12:12:13	7,490.001	0.850	19.464	9.955		96.17	9.96
05/24/19 12:12:23	7,500.001	0.865	19.424	9.922		96.33	9.92
05/24/19 12:12:33	7,510.001	0.865	19.438	9.921		96.50	9.92
05/24/19 12:12:43	7,520.001	0.878	19.470	9.891		96.67	9.89
05/24/19 12:12:53	7,530.001	0.891	19.470	9.862		96.83	9.86
05/24/19 12:13:03	7,540.001	0.897	19.467	9.849		97.00	9.85
05/24/19 12:13:13	7,550.001	0.895	19.451	9.852		97.17	9.85
05/24/19 12:13:23	7,560.001	0.899	19.436	9.843		97.33	9.84
05/24/19 12:13:33	7,570.001	0.904	19.454	9.832		97.50	9.83
05/24/19 12:13:43	7,580.001	0.948	19.474	9.729		97.67	9.73
05/24/19 12:13:53	7,590.001	1.057	19.451	9.479		97.83	9.48

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	Elapsed Time (seconds)	Pressure (psi)	Temp (°C)	Level Depth To Water (feet)	Est. Flow Rate (gpm)	Total Adjusted Time (minutes)	Total Draw-down (feet)
05/24/19 12:14:03	7,600.001	0.988	19.457	9.637	1.304	98.00	9.64
05/24/19 12:14:13	7,610.001	0.942	19.439	9.744		98.17	9.74
05/24/19 12:14:23	7,620.001	0.906	19.429	9.827		98.33	9.83
05/24/19 12:14:33	7,630.001	1.469	19.423	8.527		98.50	8.53
05/24/19 12:14:43	7,640.001	2.706	19.429	5.671		98.67	5.67
05/24/19 12:14:53	7,650.001	3.652	19.462	3.486		98.83	3.49
05/24/19 12:15:03	7,660.001	4.342	19.475	1.894		99.00	1.89
05/24/19 12:15:13	7,670.001	4.823	19.434	0.782		99.17	0.78
05/24/19 12:15:23	7,680.001	4.949	19.469	0.492		99.33	0.49
05/24/19 12:15:33	7,690.001	4.886	19.462	0.637		99.50	0.64
05/24/19 12:15:43	7,700.001	4.489	19.487	1.554		99.67	1.55
05/24/19 12:15:53	7,710.001	4.681	19.444	1.110		99.83	1.11
05/24/19 12:16:03	7,720.001	4.789	19.478	0.861		100.00	0.86
05/24/19 12:16:13	7,730.001	4.853	19.462	0.713		100.17	0.71
05/24/19 12:16:23	7,740.001	4.904	19.480	0.596		100.33	0.60
05/24/19 12:16:33	7,750.001	4.947	19.451	0.497		100.50	0.50
05/24/19 12:16:43	7,760.001	4.980	19.475	0.421		100.67	0.42
05/24/19 12:16:53	7,770.001	5.008	19.472	0.355		100.83	0.36
05/24/19 12:17:03	7,780.001	5.035	19.457	0.294		101.00	0.29
05/24/19 12:17:13	7,790.001	5.051	19.479	0.256		101.17	0.26
05/24/19 12:17:23	7,800.001	5.070	19.493	0.212		101.33	0.21
05/24/19 12:17:33	7,810.001	5.085	19.537	0.178		101.50	0.18
05/24/19 12:17:43	7,820.001	5.097	19.500	0.149		101.67	0.15
05/24/19 12:17:53	7,830.001	5.105	19.552	0.131		101.83	0.13
05/24/19 12:18:03	7,840.001	5.115	19.564	0.108		102.00	0.11
05/24/19 12:18:13	7,850.001	5.121	19.609	0.095		102.17	0.10
05/24/19 12:18:23	7,860.001	5.129	19.576	0.075		102.33	0.08
05/24/19 12:18:33	7,870.001	5.136	19.650	0.059		102.50	0.06
05/24/19 12:18:43	7,880.001	5.143	19.643	0.044		102.67	0.04
05/24/19 12:18:53	7,890.001	5.150	19.661	0.027		102.83	0.03
05/24/19 12:19:03	7,900.001	5.150	19.656	0.028		103.00	0.03
05/24/19 12:19:13	7,910.001	5.156	19.677	0.013		103.17	0.01
05/24/19 12:19:23	7,920.001	5.162	19.716	0.000		103.33	0.00
05/24/19 12:19:33	7,930.001	5.164	19.709	-0.004		103.50	0.00
05/24/19 12:19:43	7,940.001	5.169	19.720	-0.016		103.67	-0.02
05/24/19 12:19:53	7,950.002	5.167	19.717	-0.012		103.83	-0.01
05/24/19 12:20:03	7,960.001	5.174	19.730	-0.027		104.00	-0.03
05/24/19 12:20:13	7,970.001	5.173	19.747	-0.026		104.17	-0.03
05/24/19 12:20:23	7,980.001	5.179	19.728	-0.039		104.33	-0.04
05/24/19 12:20:33	7,990.001	5.178	19.742	-0.037		104.50	-0.04
05/24/19 12:20:43	8,000.001	5.182	19.751	-0.045		104.67	-0.05
05/24/19 12:20:53	8,010.001	5.182	19.773	-0.045		104.83	-0.05

P-10	TIME	DTW (ft)	TOC ELEV	GS ELEV	GW ELEV	BW ELEV	HEAD
	0907	8.51	75.01	70.21	66.50	54.56	11.94
Date and Time	**Elapsed Time (seconds)**	**Pressure (psi)**	**Temp (°C)**	**Level Depth To Water (feet)**	**Est. Flow Rate (gpm)**	**Total Adjusted Time (minutes)**	**Total Draw-down (feet)**
05/24/19 12:21:03	8,020.001	5.187	19.751	-0.058		105.00	-0.06
05/24/19 12:21:13	8,030.001	5.187	19.775	-0.059		105.17	-0.06
05/24/19 12:21:23	8,040.001	5.188	19.775	-0.060		105.33	-0.06
05/24/19 12:21:33	8,050.001	5.187	19.767	-0.058		105.50	-0.06
05/24/19 12:21:43	8,060.001	5.192	19.787	-0.070		105.67	-0.07
05/24/19 12:21:53	8,070.001	5.192	19.758	-0.070		105.83	-0.07
05/24/19 12:22:03	8,080.001	5.193	19.803	-0.072		106.00	-0.07

Report Date:	5/25/2019 22:06		
Report User Name:	Harbin		
Report Computer Name:	HE-MBIERS		
Application:	WinSitu.exe		
Application Version:	5.6.28.6		

Log File Properties			
File Name	P-10_2019-05-25_22-05-05-486.wsl		
Create Date	5/25/2019 22:04		

Device Properties			
Device	Level TROLL 700		
Site	BCDP		
Device Name			
Serial Number	405895		
Firmware Version	3.06		
Hardware Version	4		
Device Address	1		
Device Comm Cfg	19200	8 Even	1 (Modbus-RTU)
Used Memory	3		
Used Battery	29		

Log Configuration		
	Log Name	P-10
	Created By	Unknown
	Computer Name	Pocket PC
	Application	WinSituMobile.exe
	Application Version	5.6.0.10
	Create Date	5/24/2019 10:08:18 AM Eastern Daylight Time
	Log Setup Time Zone	Eastern Daylight Time
	Notes Size(bytes)	4096
	Overwrite when full	Disabled
	Scheduled Start Time	Manual Start
	Scheduled Stop Time	No Stop Time
	Type	Fast Linear
	Interval	Days: 0 hrs: 00 mins: 00 secs: 10

Level Reference Settings At Log Creation		
	Level Measurement Mode	Level Depth To Water
	Specific Gravity	0.999
	Level Reference Mode:	Set new reference
	Level Reference Value:	0 (ft)
	Level Reference Head Pressure	5.16201 (PSI)

Other Log Settings

	Pressure Offset:	0.374898 (PSI)
	Depth of Probe:	11.9171 (ft)
	Head Pressure:	5.16122 (PSI)
	Temperature:	19.7019 (C)

Log Notes:

Date and Time	Note
5/24/2019 10:07	Sensor SN: 405895 Factory calibration has expired.: 3/25/2016 7:43:58 AM
5/24/2019 10:07	Used Battery: 29% Used Memory: 3% User Name: Unknown
5/24/2019 10:07	Manual Start Command
5/24/2019 12:22	Used Battery: 30% Used Memory: 3% User Name: Unknown
5/24/2019 12:22	Manual Stop Command

Log Data:

Record Count	809		
Sensors	1		
	1	405895	Pressure/Temp 15 PSIG (11m/35ft)

Time Zone: Eastern Daylight Time

Date and Time	Elapsed Time Seconds	Sensor: Pres(G) 35ft SN#: 405895 Pressure (PSI)	Sensor: Pres(G) 35ft SN#: 405895 Temperature (C)	Sensor: Pres(G) 35ft SN#: 405895 Level Depth To Water (ft)
5/24/2019 10:07	0	5.159	19.694	0.007
5/24/2019 10:07	10.001	5.16	19.648	0.004
5/24/2019 10:07	20.001	5.162	19.652	0
5/24/2019 10:07	30.001	5.16	19.64	0.004
5/24/2019 10:08	40.001	5.159	19.679	0.007
5/24/2019 10:08	50.001	5.159	19.65	0.006
5/24/2019 10:08	60.001	5.162	19.668	0.001
5/24/2019 10:08	70.001	5.158	19.632	0.009
5/24/2019 10:08	80.001	5.158	19.648	0.01
5/24/2019 10:08	90.001	5.161	19.675	0.002
5/24/2019 10:09	100.001	5.158	19.64	0.009
5/24/2019 10:09	110.001	5.149	19.633	0.03
5/24/2019 10:09	120.001	5.153	19.652	0.02
5/24/2019 10:09	130.001	5.154	19.637	0.017
5/24/2019 10:09	140.001	5.078	19.655	0.195
5/24/2019 10:09	150.001	5.078	19.645	0.195
5/24/2019 10:10	160.001	5.093	19.609	0.159
5/24/2019 10:10	170.001	5.095	19.609	0.155
5/24/2019 10:10	180.001	5.114	19.635	0.111

5/24/2019 10:10	190.001	4.933	19.635	0.529
5/24/2019 10:10	200.001	4.598	19.592	1.303
5/24/2019 10:10	210.001	4.358	19.635	1.856
5/24/2019 10:11	220.001	4.169	19.645	2.293
5/24/2019 10:11	230.001	4.015	19.652	2.649
5/24/2019 10:11	240.001	3.893	19.607	2.929
5/24/2019 10:11	250.001	3.791	19.605	3.167
5/24/2019 10:11	260.001	3.699	19.607	3.377
5/24/2019 10:11	270.001	3.634	19.596	3.527
5/24/2019 10:12	280.001	3.562	19.614	3.695
5/24/2019 10:12	290.001	3.511	19.578	3.812
5/24/2019 10:12	300.001	3.418	19.614	4.027
5/24/2019 10:12	310.001	3.23	19.601	4.461
5/24/2019 10:12	320.001	3.077	19.616	4.814
5/24/2019 10:12	330.001	2.952	19.594	5.103
5/24/2019 10:13	340.001	2.7	19.599	5.686
5/24/2019 10:13	350.001	2.469	19.577	6.218
5/24/2019 10:13	360.001	2.277	19.559	6.662
5/24/2019 10:13	370.001	2.112	19.583	7.043
5/24/2019 10:13	380.001	1.946	19.559	7.426
5/24/2019 10:13	390.001	1.785	19.546	7.797
5/24/2019 10:14	400.001	1.666	19.568	8.072
5/24/2019 10:14	410.001	1.546	19.569	8.35
5/24/2019 10:14	420.001	1.448	19.561	8.576
5/24/2019 10:14	430.001	1.243	19.58	9.048
5/24/2019 10:14	440.001	1.056	19.548	9.481
5/24/2019 10:14	450.001	0.936	19.554	9.758
5/24/2019 10:15	460.001	0.857	19.545	9.94
5/24/2019 10:15	470.001	1.467	19.543	8.533
5/24/2019 10:15	480.001	2.236	19.551	6.756
5/24/2019 10:15	490.001	2.612	19.546	5.888
5/24/2019 10:15	500.001	2.771	19.533	5.52
5/24/2019 10:15	510.001	2.875	19.55	5.28
5/24/2019 10:16	520.001	2.958	19.515	5.089
5/24/2019 10:16	530.001	3.032	19.548	4.919
5/24/2019 10:16	540.001	3.102	19.529	4.757
5/24/2019 10:16	550.001	3.152	19.546	4.642
5/24/2019 10:16	560.001	3.188	19.524	4.557
5/24/2019 10:16	570.001	3.211	19.541	4.504
5/24/2019 10:17	580.001	3.228	19.53	4.465
5/24/2019 10:17	590.001	3.23	19.548	4.46
5/24/2019 10:17	600.001	3.241	19.527	4.435
5/24/2019 10:17	610.001	3.245	19.508	4.426
5/24/2019 10:17	620.041	3.253	19.548	4.408
5/24/2019 10:17	630.001	3.25	19.503	4.414
5/24/2019 10:18	640.001	3.245	19.538	4.426
5/24/2019 10:18	650.001	3.25	19.527	4.416
5/24/2019 10:18	660.001	3.253	19.533	4.408

5/24/2019 10:18	670.001	3.257	19.53	4.4
5/24/2019 10:18	680.001	3.259	19.532	4.395
5/24/2019 10:18	690.001	3.265	19.508	4.38
5/24/2019 10:19	700.001	3.269	19.52	4.37
5/24/2019 10:19	710.001	3.28	19.514	4.346
5/24/2019 10:19	720.001	3.287	19.514	4.33
5/24/2019 10:19	730.001	3.285	19.506	4.333
5/24/2019 10:19	740.001	3.282	19.506	4.341
5/24/2019 10:19	750.001	3.286	19.535	4.332
5/24/2019 10:20	760.001	3.29	19.507	4.323
5/24/2019 10:20	770.001	3.302	19.515	4.295
5/24/2019 10:20	780.001	3.294	19.541	4.312
5/24/2019 10:20	790.001	3.296	19.528	4.31
5/24/2019 10:20	800.001	3.296	19.537	4.309
5/24/2019 10:20	810.001	3.289	19.52	4.324
5/24/2019 10:21	820.072	3.288	19.522	4.328
5/24/2019 10:21	830.072	3.286	19.496	4.332
5/24/2019 10:21	840.001	3.291	19.508	4.321
5/24/2019 10:21	850.073	3.292	19.534	4.318
5/24/2019 10:21	860.073	3.284	19.524	4.337
5/24/2019 10:21	870.073	3.288	19.554	4.327
5/24/2019 10:22	880.074	3.282	19.533	4.34
5/24/2019 10:22	890.001	3.265	19.504	4.379
5/24/2019 10:22	900.073	3.245	19.518	4.427
5/24/2019 10:22	910.073	3.226	19.539	4.47
5/24/2019 10:22	920.073	3.22	19.515	4.483
5/24/2019 10:22	930.073	3.221	19.505	4.482
5/24/2019 10:23	940.001	3.211	19.528	4.505
5/24/2019 10:23	950.079	3.206	19.506	4.517
5/24/2019 10:23	960.073	3.204	19.506	4.521
5/24/2019 10:23	970.072	3.2	19.512	4.53
5/24/2019 10:23	980.072	3.207	19.518	4.514
5/24/2019 10:23	990.001	3.208	19.533	4.511
5/24/2019 10:24	1000.001	3.211	19.49	4.504
5/24/2019 10:24	1010.001	3.204	19.499	4.521
5/24/2019 10:24	1020.001	3.201	19.528	4.528
5/24/2019 10:24	1030.001	3.206	19.535	4.517
5/24/2019 10:24	1040.001	3.207	19.52	4.514
5/24/2019 10:24	1050.001	3.203	19.491	4.523
5/24/2019 10:25	1060.001	3.206	19.504	4.516
5/24/2019 10:25	1070.001	3.215	19.506	4.497
5/24/2019 10:25	1080.001	3.213	19.515	4.5
5/24/2019 10:25	1090.001	3.22	19.533	4.483
5/24/2019 10:25	1100.001	3.23	19.511	4.46
5/24/2019 10:25	1110.001	3.237	19.499	4.444
5/24/2019 10:26	1120.001	3.245	19.475	4.426
5/24/2019 10:26	1130.001	3.256	19.512	4.401
5/24/2019 10:26	1140.001	3.249	19.509	4.416

5/24/2019 10:26	1150.001	3.246	19.504	4.424
5/24/2019 10:26	1160.001	3.256	19.522	4.401
5/24/2019 10:26	1170.001	3.255	19.535	4.402
5/24/2019 10:27	1180.001	3.257	19.509	4.398
5/24/2019 10:27	1190.001	3.262	19.489	4.387
5/24/2019 10:27	1200.001	3.265	19.517	4.381
5/24/2019 10:27	1210.001	3.274	19.494	4.359
5/24/2019 10:27	1220.001	3.283	19.493	4.338
5/24/2019 10:27	1230.001	3.299	19.514	4.301
5/24/2019 10:28	1240.001	3.309	19.498	4.278
5/24/2019 10:28	1250.001	3.323	19.503	4.247
5/24/2019 10:28	1260.001	3.311	19.49	4.273
5/24/2019 10:28	1270.001	3.29	19.53	4.322
5/24/2019 10:28	1280.001	3.273	19.517	4.363
5/24/2019 10:28	1290.001	3.252	19.517	4.411
5/24/2019 10:29	1300.002	3.245	19.548	4.425
5/24/2019 10:29	1310.001	3.236	19.51	4.446
5/24/2019 10:29	1320.001	3.23	19.507	4.461
5/24/2019 10:29	1330.001	3.219	19.506	4.487
5/24/2019 10:29	1340.001	3.215	19.49	4.495
5/24/2019 10:29	1350.001	3.211	19.509	4.505
5/24/2019 10:30	1360.001	3.199	19.506	4.532
5/24/2019 10:30	1370.001	3.191	19.486	4.551
5/24/2019 10:30	1380.001	3.192	19.504	4.55
5/24/2019 10:30	1390.001	3.194	19.491	4.545
5/24/2019 10:30	1400.001	3.187	19.488	4.56
5/24/2019 10:30	1410.001	3.188	19.459	4.558
5/24/2019 10:31	1420.001	3.192	19.48	4.55
5/24/2019 10:31	1430.001	3.21	19.479	4.508
5/24/2019 10:31	1440.001	3.221	19.483	4.483
5/24/2019 10:31	1450.001	3.228	19.528	4.466
5/24/2019 10:31	1460.001	3.239	19.496	4.441
5/24/2019 10:31	1470.001	3.246	19.492	4.423
5/24/2019 10:32	1480.001	3.25	19.487	4.414
5/24/2019 10:32	1490.001	3.267	19.454	4.375
5/24/2019 10:32	1500.001	3.27	19.481	4.369
5/24/2019 10:32	1510.114	3.271	19.483	4.367
5/24/2019 10:32	1520.057	3.29	19.492	4.322
5/24/2019 10:32	1530.054	3.295	19.505	4.311
5/24/2019 10:33	1540.055	3.299	19.522	4.303
5/24/2019 10:33	1550.055	3.297	19.472	4.306
5/24/2019 10:33	1560.001	3.293	19.504	4.315
5/24/2019 10:33	1570.055	3.286	19.504	4.332
5/24/2019 10:33	1580.057	3.284	19.485	4.337
5/24/2019 10:33	1590.054	3.298	19.48	4.305
5/24/2019 10:34	1600.057	3.307	19.483	4.282
5/24/2019 10:34	1610.001	3.317	19.48	4.26
5/24/2019 10:34	1620.057	3.334	19.504	4.22

5/24/2019 10:34	1630.055	3.374	19.514	4.129
5/24/2019 10:34	1640.056	3.412	19.492	4.041
5/24/2019 10:34	1650.054	3.369	19.478	4.14
5/24/2019 10:35	1660.001	3.328	19.514	4.235
5/24/2019 10:35	1670.055	3.303	19.497	4.292
5/24/2019 10:35	1680.056	3.277	19.493	4.352
5/24/2019 10:35	1690.055	3.264	19.545	4.383
5/24/2019 10:35	1700.056	3.244	19.514	4.429
5/24/2019 10:35	1710.001	3.243	19.47	4.431
5/24/2019 10:36	1720.057	3.236	19.496	4.448
5/24/2019 10:36	1730.055	3.225	19.512	4.471
5/24/2019 10:36	1740.056	3.233	19.5	4.454
5/24/2019 10:36	1750.055	3.226	19.509	4.47
5/24/2019 10:36	1760.001	3.229	19.482	4.462
5/24/2019 10:36	1770.054	3.231	19.472	4.459
5/24/2019 10:37	1780.055	3.224	19.497	4.475
5/24/2019 10:37	1790.055	3.228	19.492	4.465
5/24/2019 10:37	1800.055	3.232	19.507	4.456
5/24/2019 10:37	1810.001	3.232	19.474	4.457
5/24/2019 10:37	1820.001	3.239	19.507	4.44
5/24/2019 10:37	1830.001	3.246	19.441	4.425
5/24/2019 10:38	1840.19	3.242	19.488	4.434
5/24/2019 10:38	1850.189	3.227	19.52	4.467
5/24/2019 10:38	1860.001	3.231	19.466	4.458
5/24/2019 10:38	1870.189	3.247	19.514	4.423
5/24/2019 10:38	1880.187	3.258	19.498	4.396
5/24/2019 10:38	1890.188	3.259	19.478	4.395
5/24/2019 10:39	1900.001	3.259	19.504	4.394
5/24/2019 10:39	1910.188	3.258	19.462	4.397
5/24/2019 10:39	1920.194	3.261	19.484	4.389
5/24/2019 10:39	1930.188	3.259	19.517	4.395
5/24/2019 10:39	1940.189	3.267	19.457	4.375
5/24/2019 10:39	1950.001	3.264	19.502	4.383
5/24/2019 10:40	1960.189	3.267	19.515	4.375
5/24/2019 10:40	1970.189	3.276	19.486	4.356
5/24/2019 10:40	1980.188	3.297	19.468	4.306
5/24/2019 10:40	1990.199	3.309	19.506	4.278
5/24/2019 10:40	2000.189	3.312	19.494	4.272
5/24/2019 10:40	2010.001	3.336	19.475	4.215
5/24/2019 10:41	2020.2	3.38	19.465	4.115
5/24/2019 10:41	2030.201	3.409	19.473	4.047
5/24/2019 10:41	2040.2	3.353	19.507	4.177
5/24/2019 10:41	2050.2	3.311	19.52	4.274
5/24/2019 10:41	2060.2	3.284	19.507	4.337
5/24/2019 10:41	2070.001	3.257	19.478	4.399
5/24/2019 10:42	2080.199	3.221	19.503	4.482
5/24/2019 10:42	2090.201	3.084	19.509	4.797
5/24/2019 10:42	2100.001	2.943	19.456	5.123

5/24/2019 10:42	2110.001	2.822	19.465	5.403
5/24/2019 10:42	2120.001	2.736	19.459	5.603
5/24/2019 10:42	2130.001	2.649	19.488	5.802
5/24/2019 10:43	2140.001	2.597	19.463	5.922
5/24/2019 10:43	2150.001	2.543	19.459	6.047
5/24/2019 10:43	2160.001	2.504	19.494	6.137
5/24/2019 10:43	2170.001	2.466	19.467	6.225
5/24/2019 10:43	2180.001	2.446	19.454	6.27
5/24/2019 10:43	2190.001	2.429	19.459	6.311
5/24/2019 10:44	2200.001	2.406	19.451	6.364
5/24/2019 10:44	2210.001	2.386	19.476	6.409
5/24/2019 10:44	2220.001	2.375	19.475	6.435
5/24/2019 10:44	2230.001	2.368	19.449	6.452
5/24/2019 10:44	2240.001	2.353	19.47	6.487
5/24/2019 10:44	2250.001	2.343	19.457	6.509
5/24/2019 10:45	2260.001	2.339	19.465	6.517
5/24/2019 10:45	2270.001	2.341	19.466	6.515
5/24/2019 10:45	2280.001	2.333	19.468	6.533
5/24/2019 10:45	2290.001	2.325	19.477	6.55
5/24/2019 10:45	2300.001	2.339	19.476	6.518
5/24/2019 10:45	2310.001	2.344	19.459	6.506
5/24/2019 10:46	2320.001	2.341	19.467	6.513
5/24/2019 10:46	2330.001	2.352	19.459	6.489
5/24/2019 10:46	2340.001	2.363	19.481	6.464
5/24/2019 10:46	2350.001	2.35	19.462	6.493
5/24/2019 10:46	2360.001	2.363	19.433	6.462
5/24/2019 10:46	2370.001	2.366	19.451	6.457
5/24/2019 10:47	2380.001	2.404	19.478	6.369
5/24/2019 10:47	2390.001	2.427	19.479	6.315
5/24/2019 10:47	2400.001	2.387	19.48	6.407
5/24/2019 10:47	2410.001	2.365	19.473	6.458
5/24/2019 10:47	2420.001	2.346	19.436	6.503
5/24/2019 10:47	2430.001	2.329	19.478	6.541
5/24/2019 10:48	2440.001	2.323	19.478	6.554
5/24/2019 10:48	2450.001	2.313	19.446	6.579
5/24/2019 10:48	2460.001	2.312	19.479	6.58
5/24/2019 10:48	2470.001	2.304	19.474	6.599
5/24/2019 10:48	2480.001	2.306	19.479	6.595
5/24/2019 10:48	2490.001	2.295	19.472	6.62
5/24/2019 10:49	2500.001	2.289	19.499	6.633
5/24/2019 10:49	2510.001	2.284	19.488	6.645
5/24/2019 10:49	2520.001	2.282	19.462	6.65
5/24/2019 10:49	2530.001	2.273	19.477	6.672
5/24/2019 10:49	2540.001	2.279	19.459	6.656
5/24/2019 10:49	2550.001	2.276	19.473	6.663
5/24/2019 10:50	2560.001	2.27	19.475	6.677
5/24/2019 10:50	2570.001	2.265	19.451	6.689
5/24/2019 10:50	2580.001	2.271	19.47	6.676

5/24/2019 10:50	2590.001	2.267	19.462	6.685
5/24/2019 10:50	2600.001	2.259	19.423	6.703
5/24/2019 10:50	2610.001	2.266	19.469	6.686
5/24/2019 10:51	2620.001	2.262	19.479	6.695
5/24/2019 10:51	2630.001	2.26	19.497	6.7
5/24/2019 10:51	2640.001	2.266	19.467	6.686
5/24/2019 10:51	2650.001	2.263	19.484	6.693
5/24/2019 10:51	2660.001	2.272	19.466	6.673
5/24/2019 10:51	2670.001	2.283	19.475	6.648
5/24/2019 10:52	2680.001	2.292	19.493	6.626
5/24/2019 10:52	2690.001	2.272	19.448	6.673
5/24/2019 10:52	2700.001	2.236	19.458	6.755
5/24/2019 10:52	2710.001	2.213	19.478	6.809
5/24/2019 10:52	2720.001	2.19	19.449	6.863
5/24/2019 10:52	2730.001	2.168	19.479	6.913
5/24/2019 10:53	2740.001	2.148	19.475	6.96
5/24/2019 10:53	2750.001	2.132	19.464	6.996
5/24/2019 10:53	2760.001	2.121	19.474	7.021
5/24/2019 10:53	2770.001	2.12	19.446	7.023
5/24/2019 10:53	2780.001	2.112	19.454	7.042
5/24/2019 10:53	2790.001	2.109	19.482	7.049
5/24/2019 10:54	2800.001	2.098	19.472	7.074
5/24/2019 10:54	2810.001	2.102	19.449	7.066
5/24/2019 10:54	2820.001	2.103	19.467	7.062
5/24/2019 10:54	2830.001	2.107	19.434	7.053
5/24/2019 10:54	2840.001	2.097	19.479	7.077
5/24/2019 10:54	2850.001	2.102	19.488	7.066
5/24/2019 10:55	2860.001	2.113	19.448	7.039
5/24/2019 10:55	2870.001	2.115	19.457	7.037
5/24/2019 10:55	2880.001	2.125	19.447	7.011
5/24/2019 10:55	2890.001	2.123	19.474	7.017
5/24/2019 10:55	2900.001	2.125	19.467	7.012
5/24/2019 10:55	2910.001	2.132	19.451	6.996
5/24/2019 10:56	2920.001	2.148	19.467	6.958
5/24/2019 10:56	2930.001	2.153	19.474	6.948
5/24/2019 10:56	2940.001	2.161	19.456	6.929
5/24/2019 10:56	2950.001	2.209	19.467	6.818
5/24/2019 10:56	2960.001	2.198	19.456	6.844
5/24/2019 10:56	2970.001	2.163	19.449	6.924
5/24/2019 10:57	2980.001	2.145	19.478	6.967
5/24/2019 10:57	2990.001	2.131	19.444	6.999
5/24/2019 10:57	3000.001	2.118	19.448	7.028
5/24/2019 10:57	3010.001	2.106	19.469	7.056
5/24/2019 10:57	3020.001	2.105	19.467	7.06
5/24/2019 10:57	3030.001	2.104	19.428	7.06
5/24/2019 10:58	3040.001	2.113	19.465	7.04
5/24/2019 10:58	3050.092	2.103	19.486	7.063
5/24/2019 10:58	3060.089	2.114	19.462	7.039

5/24/2019 10:58	3070.001	2.116	19.46	7.034
5/24/2019 10:58	3080.087	2.118	19.483	7.029
5/24/2019 10:58	3090.089	2.122	19.446	7.02
5/24/2019 10:59	3100.088	2.117	19.478	7.03
5/24/2019 10:59	3110.001	2.115	19.462	7.035
5/24/2019 10:59	3120.088	2.116	19.48	7.033
5/24/2019 10:59	3130.088	2.127	19.472	7.008
5/24/2019 10:59	3140.088	2.133	19.465	6.995
5/24/2019 10:59	3150.001	2.136	19.487	6.987
5/24/2019 11:00	3160.087	2.134	19.479	6.991
5/24/2019 11:00	3170.088	2.139	19.485	6.98
5/24/2019 11:00	3180.086	2.146	19.463	6.963
5/24/2019 11:00	3190.001	2.155	19.462	6.943
5/24/2019 11:00	3200.086	2.148	19.459	6.958
5/24/2019 11:00	3210.088	2.152	19.467	6.95
5/24/2019 11:01	3220.086	2.168	19.449	6.914
5/24/2019 11:01	3230.001	2.197	19.475	6.846
5/24/2019 11:01	3240.086	2.207	19.478	6.823
5/24/2019 11:01	3250.087	2.184	19.499	6.875
5/24/2019 11:01	3260.085	2.171	19.491	6.906
5/24/2019 11:01	3270.001	2.152	19.48	6.949
5/24/2019 11:02	3280.001	2.14	19.467	6.977
5/24/2019 11:02	3290.001	2.133	19.472	6.993
5/24/2019 11:02	3300.001	2.115	19.436	7.034
5/24/2019 11:02	3310.001	2.101	19.49	7.068
5/24/2019 11:02	3320.001	2.094	19.425	7.083
5/24/2019 11:02	3330.001	2.08	19.426	7.116
5/24/2019 11:03	3340.001	2.082	19.42	7.113
5/24/2019 11:03	3350.001	2.076	19.424	7.126
5/24/2019 11:03	3360.001	2.075	19.448	7.127
5/24/2019 11:03	3370.001	2.074	19.449	7.131
5/24/2019 11:03	3380.001	2.075	19.455	7.127
5/24/2019 11:03	3390.001	2.074	19.443	7.13
5/24/2019 11:04	3400.001	2.068	19.437	7.145
5/24/2019 11:04	3410.001	2.071	19.456	7.138
5/24/2019 11:04	3420.001	2.066	19.438	7.148
5/24/2019 11:04	3430.001	2.071	19.446	7.137
5/24/2019 11:04	3440.001	2.076	19.458	7.127
5/24/2019 11:04	3450.001	2.076	19.457	7.125
5/24/2019 11:05	3460.001	2.085	19.465	7.106
5/24/2019 11:05	3470.001	2.088	19.498	7.098
5/24/2019 11:05	3480.001	2.101	19.455	7.067
5/24/2019 11:05	3490.001	2.147	19.462	6.961
5/24/2019 11:05	3500.001	2.137	19.457	6.983
5/24/2019 11:05	3510.001	2.126	19.435	7.009
5/24/2019 11:06	3520.001	2.105	19.436	7.059
5/24/2019 11:06	3530.001	2.09	19.462	7.093
5/24/2019 11:06	3540.001	2.077	19.457	7.122

5/24/2019 11:06	3550.001	2.061	19.466	7.161
5/24/2019 11:06	3560.001	2.058	19.449	7.167
5/24/2019 11:06	3570.001	2.051	19.472	7.182
5/24/2019 11:07	3580.001	2.043	19.462	7.202
5/24/2019 11:07	3590.001	2.038	19.465	7.212
5/24/2019 11:07	3600.001	2.031	19.459	7.229
5/24/2019 11:07	3610.001	2.025	19.467	7.244
5/24/2019 11:07	3620.001	2.023	19.467	7.249
5/24/2019 11:07	3630.001	2.025	19.435	7.243
5/24/2019 11:08	3640.001	2.01	19.446	7.278
5/24/2019 11:08	3650.001	2.005	19.44	7.289
5/24/2019 11:08	3660.001	1.997	19.459	7.309
5/24/2019 11:08	3670.001	1.99	19.43	7.325
5/24/2019 11:08	3680.001	1.987	19.463	7.332
5/24/2019 11:08	3690.052	1.977	19.493	7.355
5/24/2019 11:09	3700.141	1.979	19.472	7.349
5/24/2019 11:09	3710.001	1.981	19.469	7.344
5/24/2019 11:09	3720.001	1.981	19.441	7.345
5/24/2019 11:09	3730.001	1.997	19.465	7.308
5/24/2019 11:09	3740.001	1.985	19.426	7.335
5/24/2019 11:09	3750.001	1.987	19.45	7.332
5/24/2019 11:10	3760.028	2.016	19.471	7.263
5/24/2019 11:10	3770.001	2.027	19.469	7.24
5/24/2019 11:10	3780.001	2.001	19.464	7.298
5/24/2019 11:10	3790.001	1.978	19.441	7.352
5/24/2019 11:10	3800.001	1.968	19.446	7.374
5/24/2019 11:10	3810.03	1.931	19.452	7.461
5/24/2019 11:11	3820.001	1.858	19.463	7.628
5/24/2019 11:11	3830.001	1.803	19.446	7.755
5/24/2019 11:11	3840.001	1.764	19.47	7.845
5/24/2019 11:11	3850.001	1.721	19.432	7.944
5/24/2019 11:11	3860.031	1.698	19.446	7.997
5/24/2019 11:11	3870.001	1.667	19.448	8.071
5/24/2019 11:12	3880.001	1.635	19.463	8.143
5/24/2019 11:12	3890.001	1.609	19.462	8.203
5/24/2019 11:12	3900.001	1.597	19.458	8.232
5/24/2019 11:12	3910.001	1.587	19.468	8.254
5/24/2019 11:12	3920.001	1.578	19.483	8.275
5/24/2019 11:12	3930.001	1.568	19.44	8.298
5/24/2019 11:13	3940.001	1.563	19.421	8.311
5/24/2019 11:13	3950.001	1.558	19.473	8.32
5/24/2019 11:13	3960.001	1.553	19.462	8.334
5/24/2019 11:13	3970.001	1.551	19.465	8.337
5/24/2019 11:13	3980.001	1.563	19.45	8.309
5/24/2019 11:13	3990.001	1.563	19.427	8.309
5/24/2019 11:14	4000.001	1.592	19.436	8.243
5/24/2019 11:14	4010.001	1.621	19.449	8.175
5/24/2019 11:14	4020.001	1.59	19.47	8.248

5/24/2019 11:14	4030.001	1.56	19.429	8.316
5/24/2019 11:14	4040.001	1.544	19.457	8.355
5/24/2019 11:14	4050.001	1.518	19.441	8.415
5/24/2019 11:15	4060.001	1.498	19.444	8.46
5/24/2019 11:15	4070.001	1.504	19.475	8.445
5/24/2019 11:15	4080.001	1.49	19.444	8.48
5/24/2019 11:15	4090.001	1.48	19.467	8.501
5/24/2019 11:15	4100.001	1.479	19.451	8.503
5/24/2019 11:15	4110.001	1.472	19.422	8.521
5/24/2019 11:16	4120.217	1.464	19.447	8.539
5/24/2019 11:16	4130.001	1.454	19.467	8.561
5/24/2019 11:16	4140.001	1.46	19.496	8.549
5/24/2019 11:16	4150.001	1.459	19.451	8.55
5/24/2019 11:16	4160.001	1.461	19.439	8.546
5/24/2019 11:16	4170.001	1.463	19.442	8.541
5/24/2019 11:17	4180.305	1.472	19.479	8.52
5/24/2019 11:17	4190.001	1.465	19.454	8.536
5/24/2019 11:17	4200.001	1.466	19.444	8.533
5/24/2019 11:17	4210.001	1.477	19.465	8.508
5/24/2019 11:17	4220.001	1.494	19.436	8.47
5/24/2019 11:17	4230.308	1.507	19.452	8.44
5/24/2019 11:18	4240.001	1.514	19.444	8.423
5/24/2019 11:18	4250.001	1.528	19.441	8.39
5/24/2019 11:18	4260.001	1.583	19.435	8.264
5/24/2019 11:18	4270.001	1.579	19.451	8.274
5/24/2019 11:18	4280.308	1.555	19.498	8.328
5/24/2019 11:18	4290.001	1.536	19.439	8.373
5/24/2019 11:19	4300.001	1.514	19.438	8.422
5/24/2019 11:19	4310.001	1.506	19.464	8.443
5/24/2019 11:19	4320.001	1.5	19.449	8.455
5/24/2019 11:19	4330.308	1.483	19.453	8.494
5/24/2019 11:19	4340.001	1.488	19.423	8.484
5/24/2019 11:19	4350.001	1.491	19.432	8.476
5/24/2019 11:20	4360.001	1.481	19.46	8.499
5/24/2019 11:20	4370.001	1.48	19.453	8.502
5/24/2019 11:20	4380.001	1.481	19.452	8.499
5/24/2019 11:20	4390.001	1.476	19.439	8.511
5/24/2019 11:20	4400.001	1.486	19.433	8.488
5/24/2019 11:20	4410.001	1.493	19.443	8.472
5/24/2019 11:21	4420.001	1.489	19.469	8.48
5/24/2019 11:21	4430.001	1.482	19.47	8.498
5/24/2019 11:21	4440.001	1.495	19.468	8.468
5/24/2019 11:21	4450.001	1.499	19.404	8.458
5/24/2019 11:21	4460.001	1.505	19.466	8.444
5/24/2019 11:21	4470.001	1.513	19.453	8.425
5/24/2019 11:22	4480.001	1.516	19.444	8.418
5/24/2019 11:22	4490.001	1.531	19.436	8.385
5/24/2019 11:22	4500.001	1.59	19.412	8.248

5/24/2019 11:22	4510.001	1.567	19.445	8.301
5/24/2019 11:22	4520.001	1.542	19.459	8.359
5/24/2019 11:22	4530.001	1.521	19.441	8.408
5/24/2019 11:23	4540.001	1.515	19.432	8.42
5/24/2019 11:23	4550.001	1.489	19.463	8.48
5/24/2019 11:23	4560.001	1.476	19.436	8.51
5/24/2019 11:23	4570.001	1.47	19.455	8.524
5/24/2019 11:23	4580.001	1.469	19.475	8.527
5/24/2019 11:23	4590.001	1.463	19.467	8.54
5/24/2019 11:24	4600.001	1.466	19.43	8.535
5/24/2019 11:24	4610.001	1.47	19.433	8.526
5/24/2019 11:24	4620.001	1.464	19.455	8.537
5/24/2019 11:24	4630.001	1.466	19.456	8.534
5/24/2019 11:24	4640.001	1.474	19.451	8.516
5/24/2019 11:24	4650.001	1.479	19.466	8.504
5/24/2019 11:25	4660.001	1.476	19.434	8.511
5/24/2019 11:25	4670.001	1.475	19.48	8.513
5/24/2019 11:25	4680.001	1.475	19.476	8.514
5/24/2019 11:25	4690.001	1.481	19.469	8.499
5/24/2019 11:25	4700.001	1.483	19.463	8.494
5/24/2019 11:25	4710.001	1.483	19.464	8.494
5/24/2019 11:26	4720.001	1.478	19.437	8.506
5/24/2019 11:26	4730.001	1.492	19.464	8.475
5/24/2019 11:26	4740.001	1.5	19.451	8.455
5/24/2019 11:26	4750.001	1.551	19.464	8.337
5/24/2019 11:26	4760.001	1.573	19.455	8.286
5/24/2019 11:26	4770.001	1.549	19.476	8.343
5/24/2019 11:27	4780.001	1.531	19.428	8.383
5/24/2019 11:27	4790.001	1.516	19.44	8.42
5/24/2019 11:27	4800.001	1.494	19.497	8.469
5/24/2019 11:27	4810.001	1.472	19.462	8.52
5/24/2019 11:27	4820.001	1.464	19.469	8.538
5/24/2019 11:27	4830.001	1.462	19.44	8.544
5/24/2019 11:28	4840.001	1.46	19.444	8.547
5/24/2019 11:28	4850.001	1.439	19.429	8.597
5/24/2019 11:28	4860.001	1.437	19.47	8.6
5/24/2019 11:28	4870.001	1.439	19.469	8.597
5/24/2019 11:28	4880.001	1.447	19.472	8.577
5/24/2019 11:28	4890.001	1.435	19.486	8.605
5/24/2019 11:29	4900.001	1.446	19.493	8.58
5/24/2019 11:29	4910.001	1.461	19.449	8.545
5/24/2019 11:29	4920.001	1.462	19.451	8.543
5/24/2019 11:29	4930.001	1.461	19.481	8.545
5/24/2019 11:29	4940.001	1.464	19.469	8.539
5/24/2019 11:29	4950.001	1.469	19.442	8.528
5/24/2019 11:30	4960.001	1.473	19.468	8.518
5/24/2019 11:30	4970.001	1.492	19.457	8.473
5/24/2019 11:30	4980.001	1.504	19.476	8.447

5/24/2019 11:30	4990.001	1.542	19.473	8.359
5/24/2019 11:30	5000.001	1.549	19.461	8.343
5/24/2019 11:30	5010.001	1.526	19.444	8.395
5/24/2019 11:31	5020.001	1.506	19.464	8.442
5/24/2019 11:31	5030.001	1.49	19.451	8.478
5/24/2019 11:31	5040.001	1.476	19.446	8.511
5/24/2019 11:31	5050.001	1.464	19.476	8.539
5/24/2019 11:31	5060.001	1.468	19.415	8.53
5/24/2019 11:31	5070.001	1.453	19.441	8.564
5/24/2019 11:32	5080.001	1.449	19.453	8.572
5/24/2019 11:32	5090.001	1.454	19.42	8.562
5/24/2019 11:32	5100.001	1.458	19.423	8.553
5/24/2019 11:32	5110.001	1.46	19.452	8.548
5/24/2019 11:32	5120.001	1.46	19.43	8.548
5/24/2019 11:32	5130.001	1.462	19.434	8.543
5/24/2019 11:33	5140.001	1.458	19.48	8.551
5/24/2019 11:33	5150.001	1.474	19.43	8.515
5/24/2019 11:33	5160.001	1.485	19.456	8.49
5/24/2019 11:33	5170.001	1.488	19.46	8.483
5/24/2019 11:33	5180.001	1.493	19.472	8.472
5/24/2019 11:33	5190.001	1.495	19.472	8.466
5/24/2019 11:34	5200.001	1.51	19.462	8.433
5/24/2019 11:34	5210.001	1.508	19.459	8.437
5/24/2019 11:34	5220.001	1.503	19.465	8.449
5/24/2019 11:34	5230.001	1.52	19.454	8.41
5/24/2019 11:34	5240.001	1.563	19.432	8.31
5/24/2019 11:34	5250.001	1.576	19.449	8.28
5/24/2019 11:35	5260.001	1.561	19.44	8.315
5/24/2019 11:35	5270.001	1.542	19.454	8.36
5/24/2019 11:35	5280.001	1.531	19.454	8.385
5/24/2019 11:35	5290.001	1.528	19.457	8.391
5/24/2019 11:35	5300.001	1.526	19.438	8.396
5/24/2019 11:35	5310.001	1.522	19.431	8.404
5/24/2019 11:36	5320.001	1.513	19.483	8.426
5/24/2019 11:36	5330.001	1.517	19.447	8.416
5/24/2019 11:36	5340.001	1.517	19.463	8.416
5/24/2019 11:36	5350.001	1.51	19.49	8.432
5/24/2019 11:36	5360.001	1.514	19.449	8.424
5/24/2019 11:36	5370.001	1.517	19.446	8.416
5/24/2019 11:37	5380.001	1.525	19.443	8.397
5/24/2019 11:37	5390.001	1.527	19.444	8.393
5/24/2019 11:37	5400.001	1.526	19.444	8.396
5/24/2019 11:37	5410.001	1.525	19.42	8.397
5/24/2019 11:37	5420.001	1.526	19.481	8.396
5/24/2019 11:37	5430.001	1.532	19.449	8.381
5/24/2019 11:38	5440.001	1.524	19.438	8.401
5/24/2019 11:38	5450.001	1.519	19.461	8.412
5/24/2019 11:38	5460.001	1.517	19.465	8.417

5/24/2019 11:38	5470.001	1.52	19.444	8.409
5/24/2019 11:38	5480.001	1.522	19.444	8.404
5/24/2019 11:38	5490.001	1.569	19.452	8.296
5/24/2019 11:39	5500.001	1.569	19.438	8.296
5/24/2019 11:39	5510.001	1.536	19.449	8.372
5/24/2019 11:39	5520.001	1.517	19.46	8.416
5/24/2019 11:39	5530.001	1.49	19.439	8.479
5/24/2019 11:39	5540.001	1.475	19.446	8.512
5/24/2019 11:39	5550.001	1.463	19.463	8.541
5/24/2019 11:40	5560.001	1.457	19.448	8.554
5/24/2019 11:40	5570.001	1.457	19.462	8.554
5/24/2019 11:40	5580.001	1.459	19.421	8.551
5/24/2019 11:40	5590.001	1.467	19.465	8.531
5/24/2019 11:40	5600.001	1.474	19.48	8.515
5/24/2019 11:40	5610.001	1.479	19.462	8.504
5/24/2019 11:41	5620.001	1.484	19.459	8.493
5/24/2019 11:41	5630.001	1.491	19.47	8.477
5/24/2019 11:41	5640.001	1.487	19.453	8.486
5/24/2019 11:41	5650.001	1.493	19.478	8.472
5/24/2019 11:41	5660.001	1.502	19.477	8.45
5/24/2019 11:41	5670.001	1.506	19.467	8.441
5/24/2019 11:42	5680.001	1.519	19.457	8.413
5/24/2019 11:42	5690.001	1.525	19.446	8.399
5/24/2019 11:42	5700.001	1.536	19.46	8.372
5/24/2019 11:42	5710.001	1.538	19.453	8.368
5/24/2019 11:42	5720.001	1.522	19.461	8.405
5/24/2019 11:42	5730.001	1.591	19.453	8.246
5/24/2019 11:43	5740.001	1.614	19.47	8.192
5/24/2019 11:43	5750.001	1.588	19.422	8.253
5/24/2019 11:43	5760.001	1.578	19.463	8.275
5/24/2019 11:43	5770.001	1.575	19.432	8.281
5/24/2019 11:43	5780.001	1.542	19.481	8.358
5/24/2019 11:43	5790.001	1.464	19.451	8.539
5/24/2019 11:44	5800.001	1.394	19.464	8.699
5/24/2019 11:44	5810.001	1.263	19.463	9.003
5/24/2019 11:44	5820.001	1.185	19.449	9.182
5/24/2019 11:44	5830.001	1.125	19.429	9.321
5/24/2019 11:44	5840.001	1.088	19.449	9.407
5/24/2019 11:44	5850.001	1.064	19.472	9.463
5/24/2019 11:45	5860.001	1.058	19.446	9.477
5/24/2019 11:45	5870.001	1.058	19.459	9.476
5/24/2019 11:45	5880.001	1.054	19.441	9.486
5/24/2019 11:45	5890.001	1.044	19.451	9.508
5/24/2019 11:45	5900.001	1.047	19.446	9.501
5/24/2019 11:45	5910.001	1.048	19.48	9.499
5/24/2019 11:46	5920.001	1.056	19.455	9.482
5/24/2019 11:46	5930.001	1.06	19.451	9.471
5/24/2019 11:46	5940.001	1.067	19.432	9.454

5/24/2019 11:46	5950.001	1.061	19.471	9.47
5/24/2019 11:46	5960.001	1.072	19.445	9.444
5/24/2019 11:46	5970.001	1.164	19.472	9.232
5/24/2019 11:47	5980.001	1.143	19.452	9.279
5/24/2019 11:47	5990.001	1.064	19.483	9.463
5/24/2019 11:47	6000.001	1.028	19.454	9.545
5/24/2019 11:47	6010.001	0.986	19.447	9.643
5/24/2019 11:47	6020.001	0.979	19.435	9.659
5/24/2019 11:47	6030.001	0.967	19.448	9.686
5/24/2019 11:48	6040.001	0.952	19.412	9.721
5/24/2019 11:48	6050.001	0.932	19.462	9.768
5/24/2019 11:48	6060.001	0.94	19.441	9.749
5/24/2019 11:48	6070.001	0.935	19.461	9.759
5/24/2019 11:48	6080.001	0.947	19.43	9.732
5/24/2019 11:48	6090.013	0.923	19.46	9.788
5/24/2019 11:49	6100.001	0.915	19.42	9.807
5/24/2019 11:49	6110.001	0.903	19.45	9.834
5/24/2019 11:49	6120.001	0.906	19.438	9.827
5/24/2019 11:49	6130.001	0.911	19.438	9.815
5/24/2019 11:49	6140.001	0.923	19.46	9.787
5/24/2019 11:49	6150.001	0.943	19.447	9.741
5/24/2019 11:50	6160.001	0.949	19.451	9.727
5/24/2019 11:50	6170.001	0.969	19.465	9.683
5/24/2019 11:50	6180.001	0.971	19.462	9.677
5/24/2019 11:50	6190.001	1.007	19.483	9.594
5/24/2019 11:50	6200.001	1.073	19.419	9.442
5/24/2019 11:50	6210.001	1.103	19.486	9.373
5/24/2019 11:51	6220.001	1.039	19.459	9.52
5/24/2019 11:51	6230.001	0.988	19.445	9.639
5/24/2019 11:51	6240.001	0.952	19.465	9.722
5/24/2019 11:51	6250.001	0.932	19.475	9.768
5/24/2019 11:51	6260.001	0.928	19.462	9.775
5/24/2019 11:51	6270.001	0.944	19.467	9.74
5/24/2019 11:52	6280.001	0.934	19.472	9.761
5/24/2019 11:52	6290.001	0.928	19.464	9.776
5/24/2019 11:52	6300.001	0.928	19.462	9.777
5/24/2019 11:52	6310.001	0.942	19.452	9.743
5/24/2019 11:52	6320.001	0.955	19.465	9.714
5/24/2019 11:52	6330.001	0.946	19.464	9.734
5/24/2019 11:53	6340.001	0.961	19.449	9.701
5/24/2019 11:53	6350.001	0.97	19.457	9.68
5/24/2019 11:53	6360.001	0.975	19.457	9.667
5/24/2019 11:53	6370.001	0.976	19.444	9.666
5/24/2019 11:53	6380.001	0.97	19.439	9.679
5/24/2019 11:53	6390.001	0.972	19.451	9.675
5/24/2019 11:54	6400.001	0.989	19.459	9.635
5/24/2019 11:54	6410.001	0.999	19.474	9.613
5/24/2019 11:54	6420.001	0.997	19.429	9.616

5/24/2019 11:54	6430.001	1.079	19.455	9.428
5/24/2019 11:54	6440.001	1.134	19.433	9.3
5/24/2019 11:54	6450.001	1.059	19.475	9.475
5/24/2019 11:55	6460.001	1.005	19.467	9.598
5/24/2019 11:55	6470.001	0.952	19.447	9.722
5/24/2019 11:55	6480.001	0.941	19.439	9.746
5/24/2019 11:55	6490.001	0.939	19.457	9.751
5/24/2019 11:55	6500.001	0.93	19.458	9.772
5/24/2019 11:55	6510.001	0.915	19.434	9.807
5/24/2019 11:56	6520.001	0.911	19.47	9.815
5/24/2019 11:56	6530.001	0.914	19.43	9.809
5/24/2019 11:56	6540.001	0.907	19.465	9.825
5/24/2019 11:56	6550.001	0.907	19.446	9.824
5/24/2019 11:56	6560.001	0.919	19.436	9.798
5/24/2019 11:56	6570.001	0.924	19.437	9.784
5/24/2019 11:57	6580.001	0.932	19.451	9.767
5/24/2019 11:57	6590.001	0.945	19.44	9.738
5/24/2019 11:57	6600.001	0.943	19.461	9.742
5/24/2019 11:57	6610.001	0.966	19.461	9.689
5/24/2019 11:57	6620.001	0.964	19.478	9.694
5/24/2019 11:57	6630.001	0.965	19.462	9.691
5/24/2019 11:58	6640.001	0.989	19.447	9.636
5/24/2019 11:58	6650.001	1.021	19.467	9.562
5/24/2019 11:58	6660.001	1.107	19.458	9.362
5/24/2019 11:58	6670.001	1.032	19.443	9.535
5/24/2019 11:58	6680.001	0.967	19.467	9.685
5/24/2019 11:58	6690.001	0.925	19.459	9.784
5/24/2019 11:59	6700.001	0.91	19.457	9.817
5/24/2019 11:59	6710.001	0.907	19.474	9.824
5/24/2019 11:59	6720.001	0.895	19.454	9.852
5/24/2019 11:59	6730.001	0.892	19.472	9.86
5/24/2019 11:59	6740.001	0.915	19.477	9.806
5/24/2019 11:59	6750.001	0.91	19.472	9.818
5/24/2019 12:00	6760.001	0.917	19.486	9.801
5/24/2019 12:00	6770.001	0.917	19.464	9.802
5/24/2019 12:00	6780.001	0.937	19.446	9.755
5/24/2019 12:00	6790.001	0.947	19.471	9.732
5/24/2019 12:00	6800.204	0.956	19.465	9.712
5/24/2019 12:00	6810.261	0.951	19.472	9.722
5/24/2019 12:01	6820.001	0.955	19.467	9.714
5/24/2019 12:01	6830.001	0.947	19.453	9.732
5/24/2019 12:01	6840.001	0.955	19.454	9.713
5/24/2019 12:01	6850.001	0.945	19.447	9.736
5/24/2019 12:01	6860.285	0.953	19.467	9.718
5/24/2019 12:01	6870.001	0.962	19.465	9.699
5/24/2019 12:02	6880.286	0.972	19.475	9.675
5/24/2019 12:02	6890.285	1.067	19.464	9.455
5/24/2019 12:02	6900.289	1.026	19.447	9.55

5/24/2019 12:02	6910.001	0.977	19.451	9.663
5/24/2019 12:02	6920.289	0.929	19.47	9.774
5/24/2019 12:02	6930.001	0.906	19.438	9.828
5/24/2019 12:03	6940.001	0.871	19.454	9.908
5/24/2019 12:03	6950.001	0.86	19.415	9.933
5/24/2019 12:03	6960.001	0.85	19.423	9.955
5/24/2019 12:03	6970.001	0.863	19.445	9.926
5/24/2019 12:03	6980.001	0.856	19.447	9.943
5/24/2019 12:03	6990.001	0.857	19.466	9.941
5/24/2019 12:04	7000.001	0.869	19.442	9.912
5/24/2019 12:04	7010.001	0.881	19.456	9.885
5/24/2019 12:04	7020.001	0.901	19.462	9.838
5/24/2019 12:04	7030.001	0.907	19.455	9.826
5/24/2019 12:04	7040.001	0.942	19.422	9.744
5/24/2019 12:04	7050.001	0.958	19.458	9.706
5/24/2019 12:05	7060.001	0.964	19.438	9.692
5/24/2019 12:05	7070.001	0.961	19.407	9.7
5/24/2019 12:05	7080.001	0.976	19.417	9.665
5/24/2019 12:05	7090.001	0.983	19.448	9.648
5/24/2019 12:05	7100.001	0.999	19.463	9.611
5/24/2019 12:05	7110.001	1.014	19.435	9.577
5/24/2019 12:06	7120.001	1.072	19.437	9.444
5/24/2019 12:06	7130.001	1.154	19.449	9.255
5/24/2019 12:06	7140.001	1.082	19.418	9.421
5/24/2019 12:06	7150.001	1.034	19.424	9.531
5/24/2019 12:06	7160.001	1.022	19.416	9.558
5/24/2019 12:06	7170.001	0.98	19.427	9.656
5/24/2019 12:07	7180.001	0.946	19.452	9.735
5/24/2019 12:07	7190.001	0.921	19.465	9.792
5/24/2019 12:07	7200.001	0.914	19.428	9.809
5/24/2019 12:07	7210.001	0.9	19.422	9.841
5/24/2019 12:07	7220.001	0.894	19.44	9.855
5/24/2019 12:07	7230.001	0.901	19.438	9.84
5/24/2019 12:08	7240.001	0.905	19.459	9.829
5/24/2019 12:08	7250.001	0.916	19.464	9.805
5/24/2019 12:08	7260.001	0.919	19.428	9.796
5/24/2019 12:08	7270.001	0.929	19.462	9.773
5/24/2019 12:08	7280.001	0.932	19.441	9.768
5/24/2019 12:08	7290.001	0.928	19.437	9.776
5/24/2019 12:09	7300.001	0.915	19.438	9.807
5/24/2019 12:09	7310.001	0.911	19.454	9.816
5/24/2019 12:09	7320.001	0.921	19.447	9.791
5/24/2019 12:09	7330.001	0.92	19.446	9.796
5/24/2019 12:09	7340.001	0.92	19.473	9.795
5/24/2019 12:09	7350.001	0.94	19.423	9.748
5/24/2019 12:10	7360.001	1.043	19.43	9.511
5/24/2019 12:10	7370.001	0.954	19.462	9.717
5/24/2019 12:10	7380.001	0.906	19.452	9.827

5/24/2019 12:10	7390.001	0.864	19.446	9.925
5/24/2019 12:10	7400.001	0.841	19.454	9.976
5/24/2019 12:10	7410.001	0.842	19.454	9.974
5/24/2019 12:11	7420.001	0.815	19.451	10.036
5/24/2019 12:11	7430.001	0.819	19.445	10.028
5/24/2019 12:11	7440.001	0.81	19.456	10.048
5/24/2019 12:11	7450.001	0.826	19.468	10.011
5/24/2019 12:11	7460.001	0.83	19.436	10.003
5/24/2019 12:11	7470.001	0.83	19.451	10.003
5/24/2019 12:12	7480.001	0.838	19.45	9.983
5/24/2019 12:12	7490.001	0.85	19.464	9.955
5/24/2019 12:12	7500.001	0.865	19.424	9.922
5/24/2019 12:12	7510.001	0.865	19.438	9.921
5/24/2019 12:12	7520.001	0.878	19.47	9.891
5/24/2019 12:12	7530.001	0.891	19.47	9.862
5/24/2019 12:13	7540.001	0.897	19.467	9.849
5/24/2019 12:13	7550.001	0.895	19.451	9.852
5/24/2019 12:13	7560.001	0.899	19.436	9.843
5/24/2019 12:13	7570.001	0.904	19.454	9.832
5/24/2019 12:13	7580.001	0.948	19.474	9.729
5/24/2019 12:13	7590.001	1.057	19.451	9.479
5/24/2019 12:14	7600.001	0.988	19.457	9.637
5/24/2019 12:14	7610.001	0.942	19.439	9.744
5/24/2019 12:14	7620.001	0.906	19.429	9.827
5/24/2019 12:14	7630.001	1.469	19.423	8.527
5/24/2019 12:14	7640.001	2.706	19.429	5.671
5/24/2019 12:14	7650.001	3.652	19.462	3.486
5/24/2019 12:15	7660.001	4.342	19.475	1.894
5/24/2019 12:15	7670.001	4.823	19.434	0.782
5/24/2019 12:15	7680.001	4.949	19.469	0.492
5/24/2019 12:15	7690.001	4.886	19.462	0.637
5/24/2019 12:15	7700.001	4.489	19.487	1.554
5/24/2019 12:15	7710.001	4.681	19.444	1.11
5/24/2019 12:16	7720.001	4.789	19.478	0.861
5/24/2019 12:16	7730.001	4.853	19.462	0.713
5/24/2019 12:16	7740.001	4.904	19.48	0.596
5/24/2019 12:16	7750.001	4.947	19.451	0.497
5/24/2019 12:16	7760.001	4.98	19.475	0.421
5/24/2019 12:16	7770.001	5.008	19.472	0.355
5/24/2019 12:17	7780.001	5.035	19.457	0.294
5/24/2019 12:17	7790.001	5.051	19.479	0.256
5/24/2019 12:17	7800.001	5.07	19.493	0.212
5/24/2019 12:17	7810.001	5.085	19.537	0.178
5/24/2019 12:17	7820.001	5.097	19.5	0.149
5/24/2019 12:17	7830.001	5.105	19.552	0.131
5/24/2019 12:18	7840.001	5.115	19.564	0.108
5/24/2019 12:18	7850.001	5.121	19.609	0.095
5/24/2019 12:18	7860.001	5.129	19.576	0.075

5/24/2019 12:18	7870.001	5.136	19.65	0.059
5/24/2019 12:18	7880.001	5.143	19.643	0.044
5/24/2019 12:18	7890.001	5.15	19.661	0.027
5/24/2019 12:19	7900.001	5.15	19.656	0.028
5/24/2019 12:19	7910.001	5.156	19.677	0.013
5/24/2019 12:19	7920.001	5.162	19.716	0
5/24/2019 12:19	7930.001	5.164	19.709	-0.004
5/24/2019 12:19	7940.001	5.169	19.72	-0.016
5/24/2019 12:19	7950.002	5.167	19.717	-0.012
5/24/2019 12:20	7960.001	5.174	19.73	-0.027
5/24/2019 12:20	7970.001	5.173	19.747	-0.026
5/24/2019 12:20	7980.001	5.179	19.728	-0.039
5/24/2019 12:20	7990.001	5.178	19.742	-0.037
5/24/2019 12:20	8000.001	5.182	19.751	-0.045
5/24/2019 12:20	8010.001	5.182	19.773	-0.045
5/24/2019 12:21	8020.001	5.187	19.751	-0.058
5/24/2019 12:21	8030.001	5.187	19.775	-0.059
5/24/2019 12:21	8040.001	5.188	19.775	-0.06
5/24/2019 12:21	8050.001	5.187	19.767	-0.058
5/24/2019 12:21	8060.001	5.192	19.787	-0.07
5/24/2019 12:21	8070.001	5.192	19.758	-0.07
5/24/2019 12:22	8080.001	5.193	19.803	-0.072

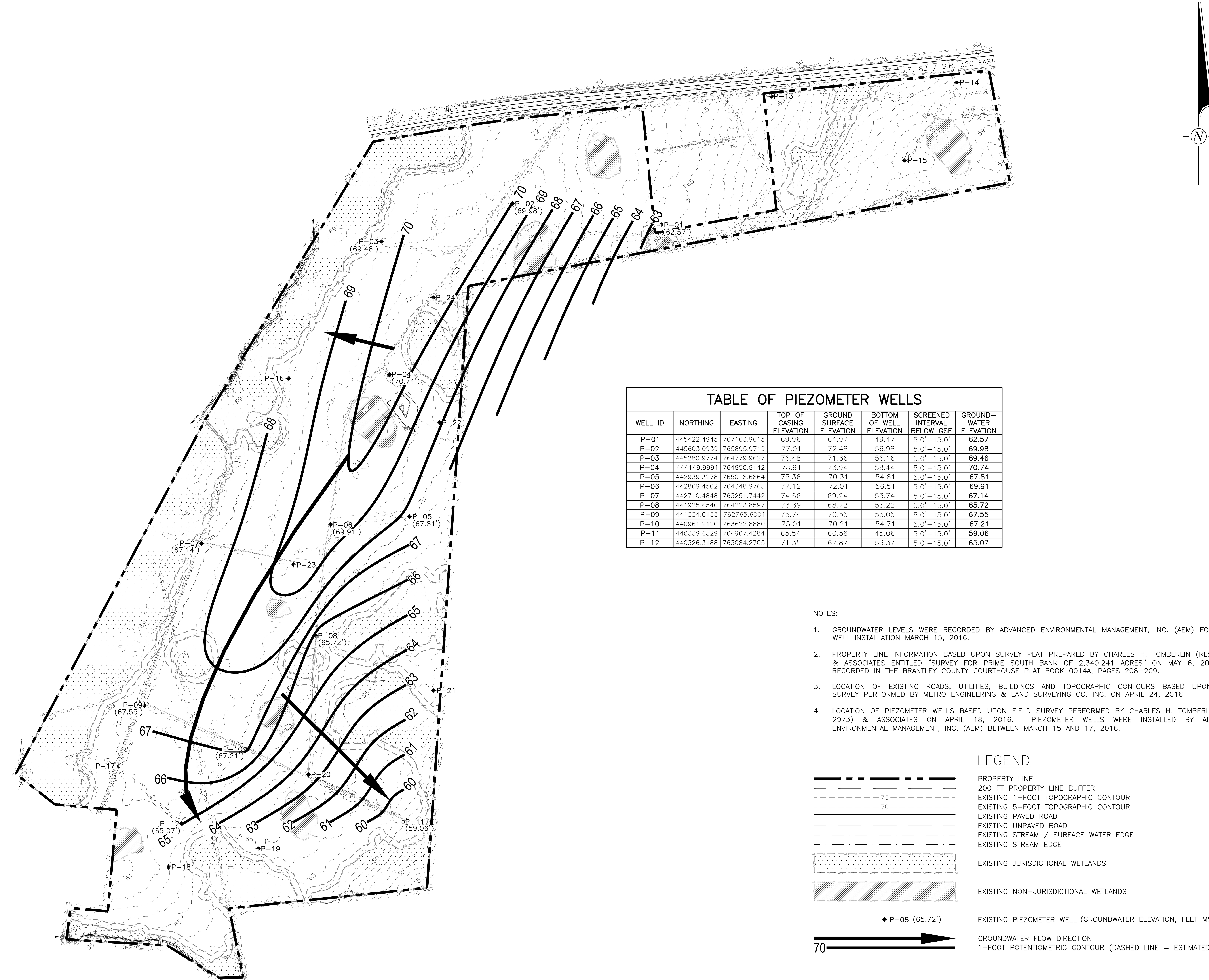


TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**62.57**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**69.98**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**69.46**
P-04	444149.9991	764850.8142	78.91	73.94	58.44	5.0'-15.0'	**70.74**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**67.81**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**69.91**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**67.14**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**65.72**
P-09	441334.0133	762765.6001	75.74	70.55	55.05	5.0'-15.0'	**67.55**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**67.21**
P-11	440339.6329	764967.4284	65.54	60.56	45.06	5.0'-15.0'	**59.06**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**65.07**

NOTES:

1. GROUNDWATER LEVELS WERE RECORDED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) FOLLOWING WELL INSTALLATION MARCH 15, 2016.
2. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.
3. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.

LEGEND

PROPERTY LINE
200 FT PROPERTY LINE BUFFER
73 EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
70 EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
EXISTING NON-JURISDICTIONAL WETLANDS
P-08 (65.72') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
GROUNDWATER FLOW DIRECTION
70 1-FOOT POTENTIOMETRIC CONTOUR (DASHED LINE = ESTIMATED)

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
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Smarr, Georgia 31086
Phone (478) 365-8609

GEORGIA REGISTERED PROFESSIONAL ENGINEER NO. 36066 MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT
POTENTIOMETRIC MAP (03-15-2016)

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
2-01A

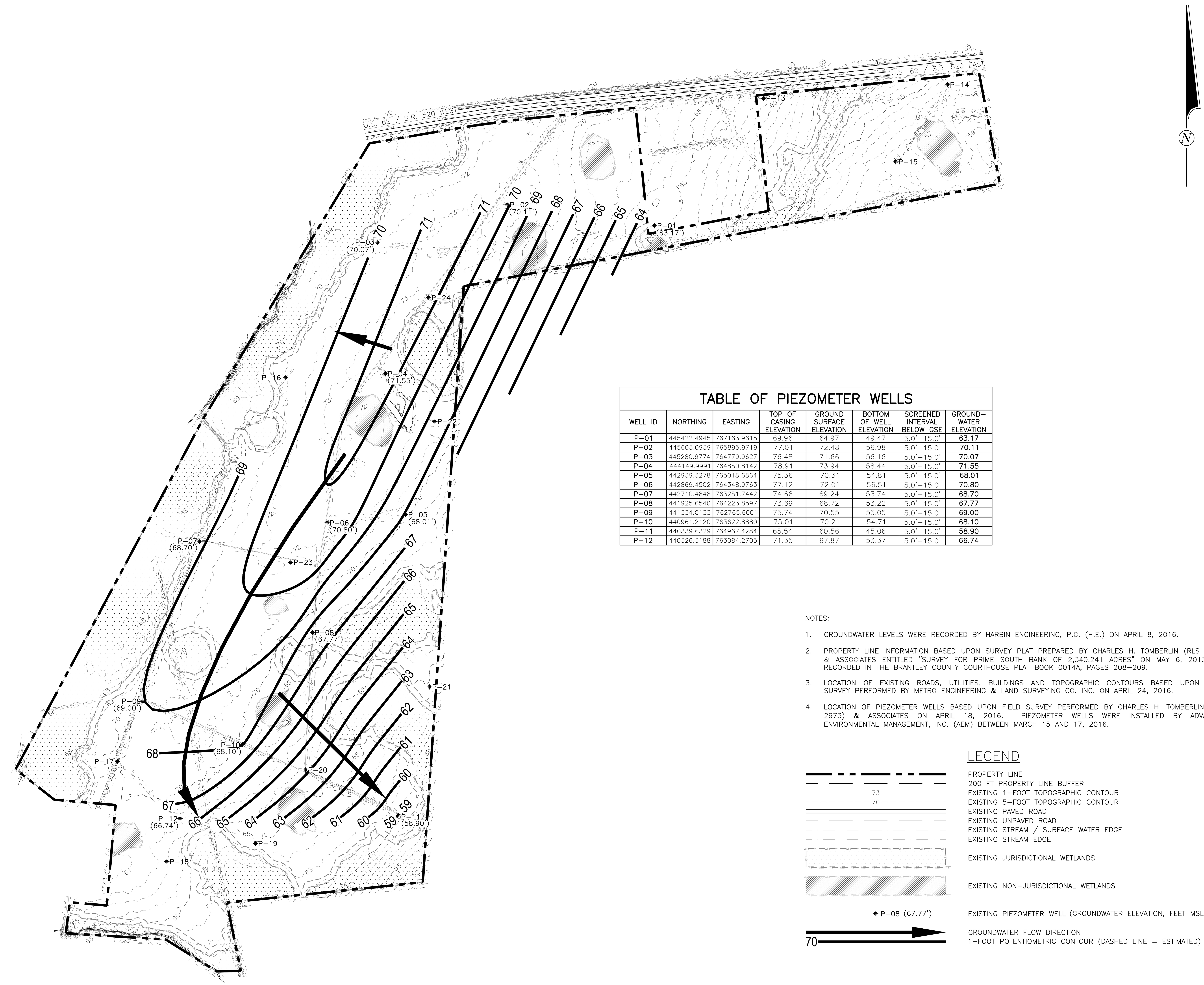


TABLE OF PIEZOMETER WELLS							
WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	63.17
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	70.11
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	70.07
P-04	444149.9991	764850.8142	78.91	73.94	58.44	5.0'-15.0'	71.55
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	68.01
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	70.80
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	68.70
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	67.77
P-09	441334.0133	762765.6001	75.74	70.55	55.05	5.0'-15.0'	69.00
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	68.10
P-11	440339.6329	764967.4284	65.54	60.56	45.06	5.0'-15.0'	58.90
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	66.74

NOTES:

1. GROUNDWATER LEVELS WERE RECORDED BY HARBIN ENGINEERING, P.C. (H.E.) ON APRIL 8, 2016.
2. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.
3. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.

LEGEND

- PROPERTY LINE
- 200 FT PROPERTY LINE BUFFER
- 73 — EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
- 70 — EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM / SURFACE WATER EDGE
- EXISTING STREAM EDGE
- EXISTING JURISDICTIONAL WETLANDS
- EXISTING NON-JURISDICTIONAL WETLANDS
- P-08 (67.77') — EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
- GROUNDWATER FLOW DIRECTION
- 70 — 1-FOOT POTENTIOMETRIC CONTOUR (DASHED LINE = ESTIMATED)

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
CIVIL · ENVIRONMENTAL
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

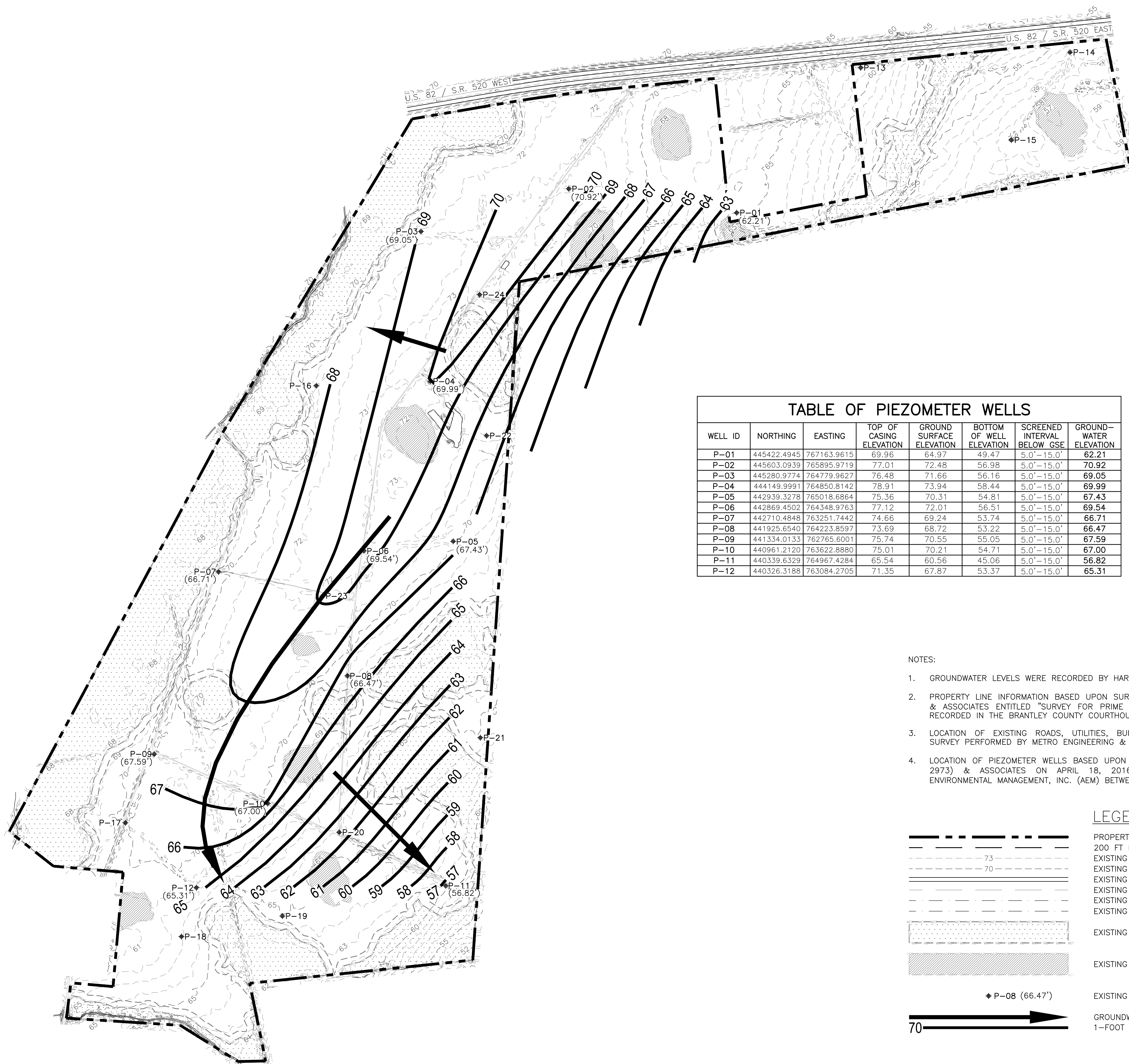
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT
POTENTIOMETRIC MAP (04-08-2016)

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
2-01B



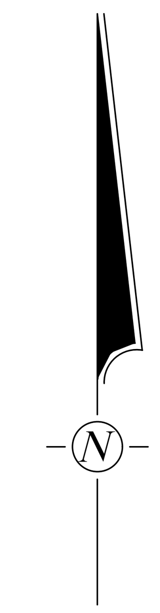


TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**62.21**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**70.92**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**69.05**
P-04	444149.9991	764850.8142	78.91	73.94	58.44	5.0'-15.0'	**69.99**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**67.43**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**69.54**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**66.71**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**66.47**
P-09	441334.0133	762765.6001	75.74	70.55	55.05	5.0'-15.0'	**67.59**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**67.00**
P-11	440339.6329	764967.4284	65.54	60.56	45.06	5.0'-15.0'	**56.82**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**65.31**

NOTES:

1. GROUNDWATER LEVELS WERE RECORDED BY HARBIN ENGINEERING, P.C. (H.E.) ON JUNE 28, 2016.
2. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.
3. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.

LEGEND

- PROPERTY LINE
- 200 FT PROPERTY LINE BUFFER
- 73 EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
- 70 EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM / SURFACE WATER EDGE
- EXISTING STREAM EDGE
- EXISTING JURISDICTIONAL WETLANDS
- EXISTING NON-JURISDICTIONAL WETLANDS
- P-08 (66.47') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
- GROUNDWATER FLOW DIRECTION
- 70 1-FOOT POTENTIOMETRIC CONTOUR (DASHED LINE = ESTIMATED)

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
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GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
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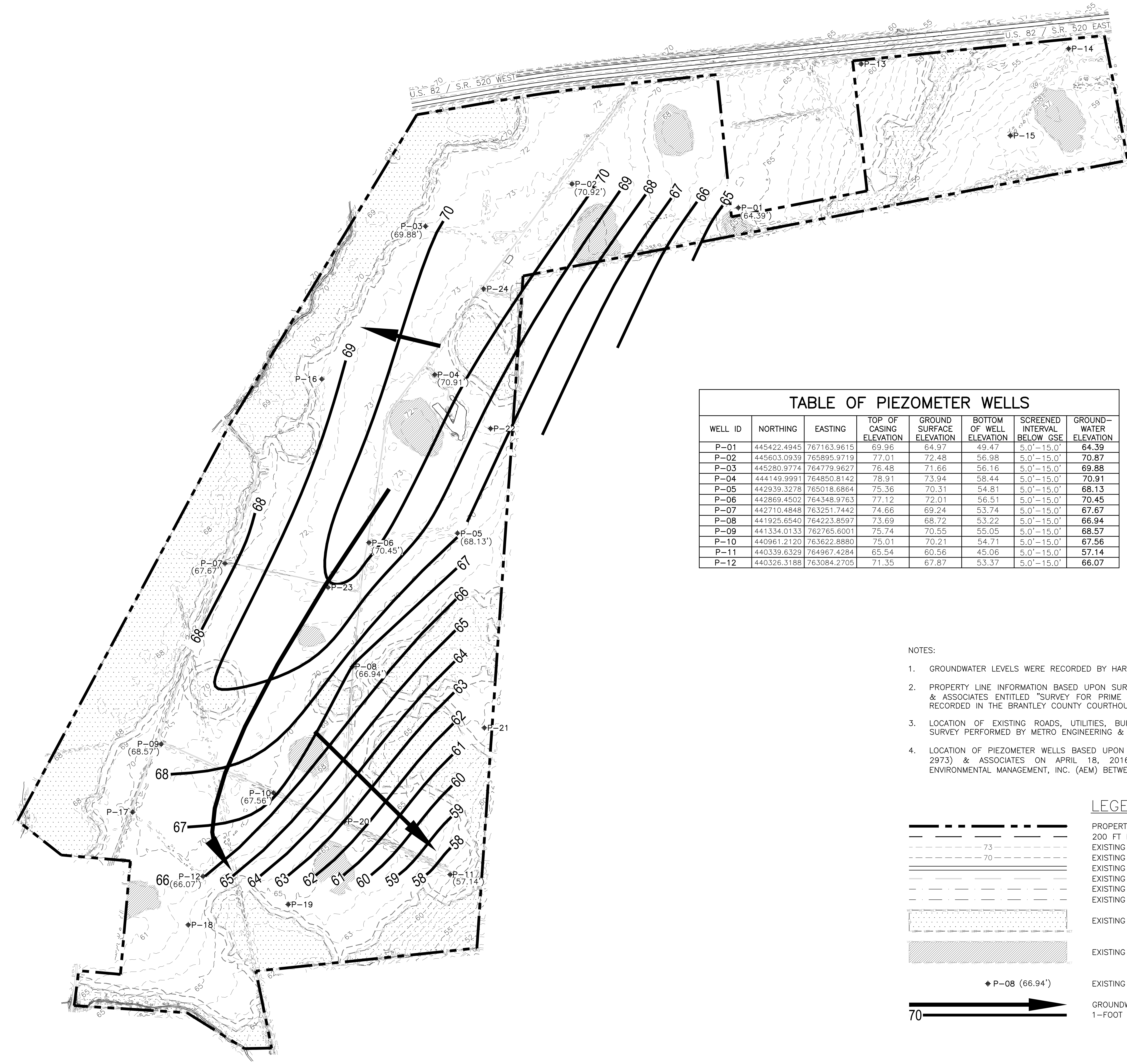
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT
POTENTIOMETRIC MAP (06-28-2016)

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
2-01C



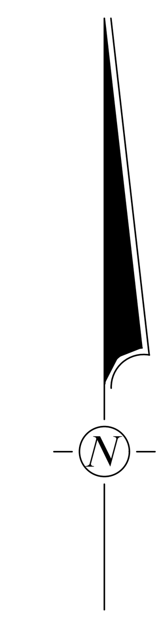


TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**64.39**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**70.87**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**69.88**
P-04	444149.9991	764850.8142	78.91	73.94	58.44	5.0'-15.0'	**70.91**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**68.13**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**70.45**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**67.67**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**66.94**
P-09	441334.0133	762765.6001	75.74	70.55	55.05	5.0'-15.0'	**68.57**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**67.56**
P-11	440339.6329	764967.4284	65.54	60.56	45.06	5.0'-15.0'	**57.14**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**66.07**

NOTES:

1. GROUNDWATER LEVELS WERE RECORDED BY HARBIN ENGINEERING, P.C. (H.E.) ON AUGUST 19, 2016.
2. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.
3. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.

LEGEND

PROPERTY LINE
200 FT PROPERTY LINE BUFFER
73 EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
70 EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
EXISTING NON-JURISDICTIONAL WETLANDS
P-08 (66.94') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
GROUNDWATER FLOW DIRECTION
70 1-FOOT POTENTIOMETRIC CONTOUR (DASHED LINE = ESTIMATED)

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
CIVIL · ENVIRONMENTAL
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE SUITABILITY ASSESSMENT REPORT
POTENTIOMETRIC MAP (08-19-2016)

	REVISION	DATE
0	INITIAL SUBMITTAL	Dec 2016
1	ADDITIONAL FIELD WORK	Aug 2019
2	10-23-19 EPD COMMENTS	Oct 2019
3		
4		
5		
6		

DRAWING: 1390-010 SAR Site Figures Phase 2.dwg
IES PROJECT NO.1390-013-01

FIGURE
2-01D

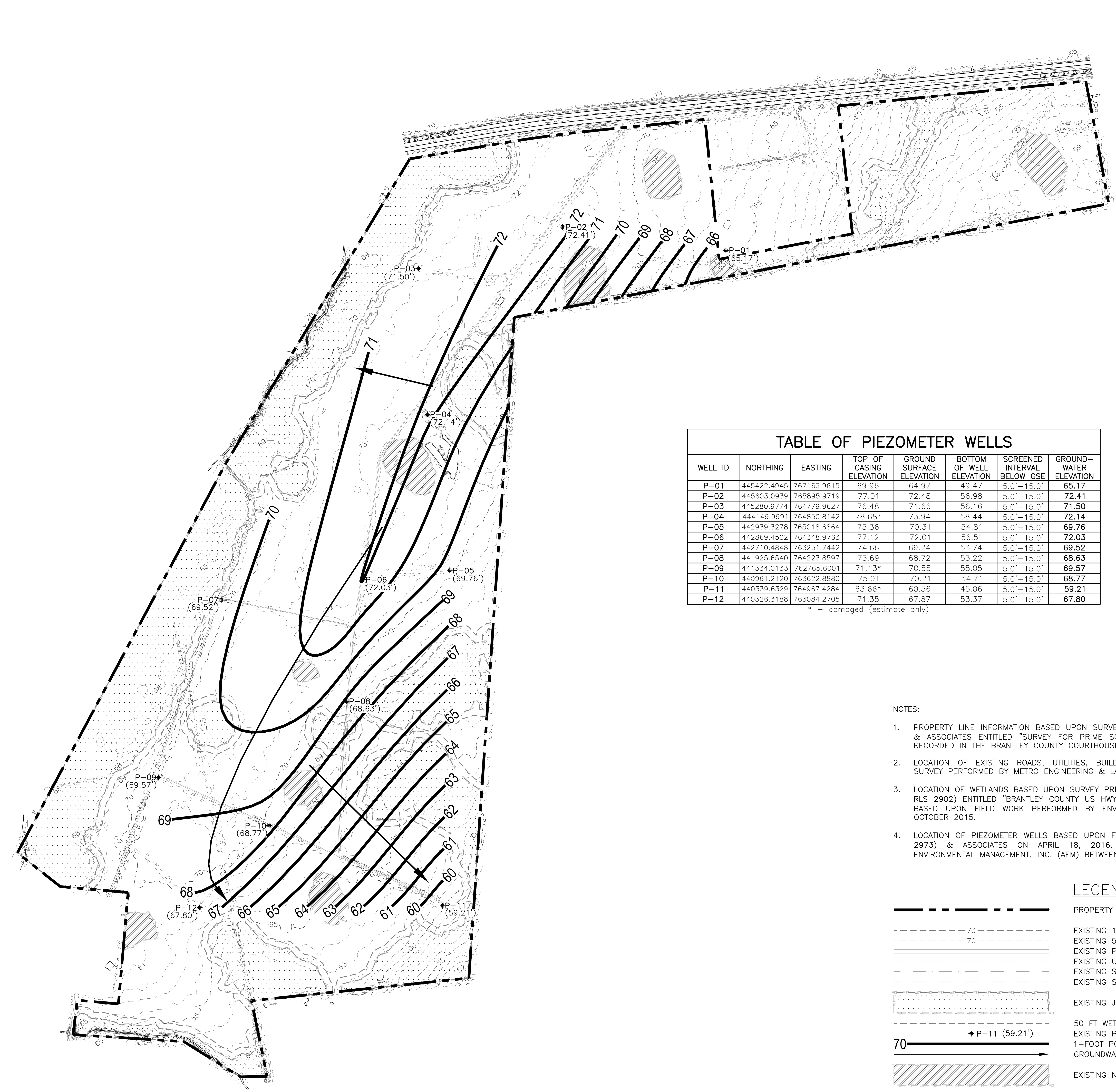


TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**65.17**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**72.41**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**71.50**
P-04	444149.9991	764850.8142	78.68*	73.94	58.44	5.0'-15.0'	**72.14**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**69.76**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**72.03**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**69.52**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**68.63**
P-09	441334.0133	762765.6001	71.13*	70.55	55.05	5.0'-15.0'	**69.57**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**68.77**
P-11	440339.6329	764967.4284	63.66*	60.56	45.06	5.0'-15.0'	**59.21**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**67.80**

* – damaged (estimate only)

NOTES:

1. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208–209.
2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
3. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.

LEGEND

PROPERTY LINE
EXISTING 1–FOOT TOPOGRAPHIC CONTOUR (73)
EXISTING 5–FOOT TOPOGRAPHIC CONTOUR (70)
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
50 FT WETLANDS BUFFER
◆ P–11 (59.21') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
70 1–FOOT POTENTIOMETRIC CONTOUR
GROUNDWATER FLOW DIRECTION
EXISTING NON–JURISDICTIONAL WETLANDS

400 200 0 400 800
GRAPHIC SCALE IN FEET

Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
IES
CIVIL · ENVIRONMENTAL

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE ASSESSMENT REPORT
POTENTIOMETRIC MAP
(Measurements Recorded on 01-30-19)

	REVISION	DATE
0	INITIAL SUBMITTAL	07-09-19
1	10-23-2019 EPD COMMENTS	10-28-19
2		
3		
4		
5		
6		

DRAWING: 1390-010 BCDP_pot-2019-01-30.dwg
IES PROJECT NO.1390-010-01

FIGURE
2-01E

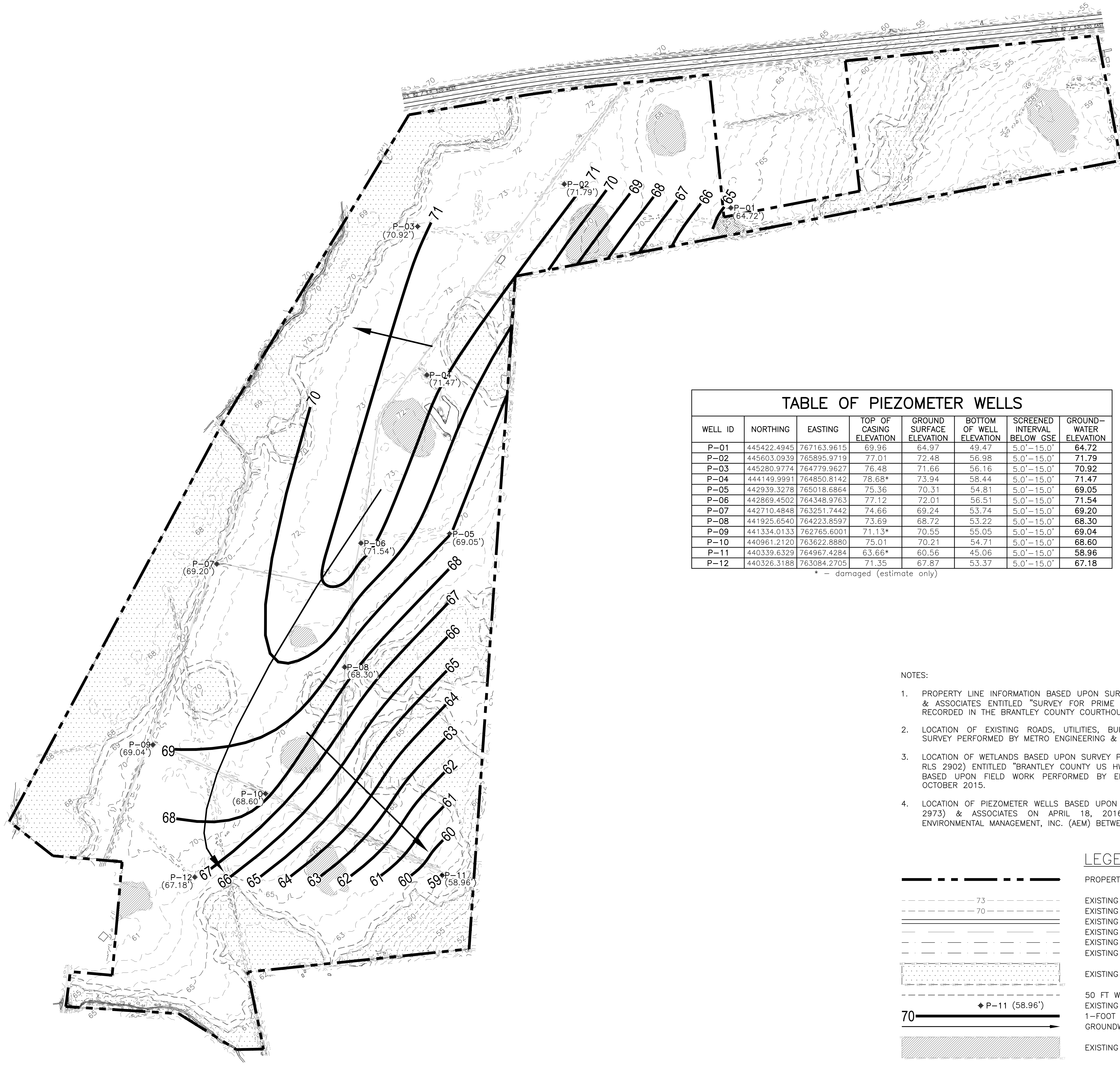


TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**64.72**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**71.79**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**70.92**
P-04	444149.9991	764850.8142	78.68*	73.94	58.44	5.0'-15.0'	**71.47**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**69.05**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**71.54**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**69.20**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**68.30**
P-09	441334.0133	762765.6001	71.13*	70.55	55.05	5.0'-15.0'	**69.04**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**68.60**
P-11	440339.6329	764967.4284	63.66*	60.56	45.06	5.0'-15.0'	**58.96**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**67.18**

* - damaged (estimate only)

NOTES:

1. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.
2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
3. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.
4. LOCATION OF PIEZOMETER WELLS BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016.

LEGEND

PROPERTY LINE
EXISTING 1-FOOT TOPOGRAPHIC CONTOUR (73)
EXISTING 5-FOOT TOPOGRAPHIC CONTOUR (70)
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
50 FT WETLANDS BUFFER
◆ P-11 (58.96') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
70 1-FOOT POTENTIOMETRIC CONTOUR
GROUNDWATER FLOW DIRECTION
EXISTING NON-JURISDICTIONAL WETLANDS

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
CIVIL · ENVIRONMENTAL
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

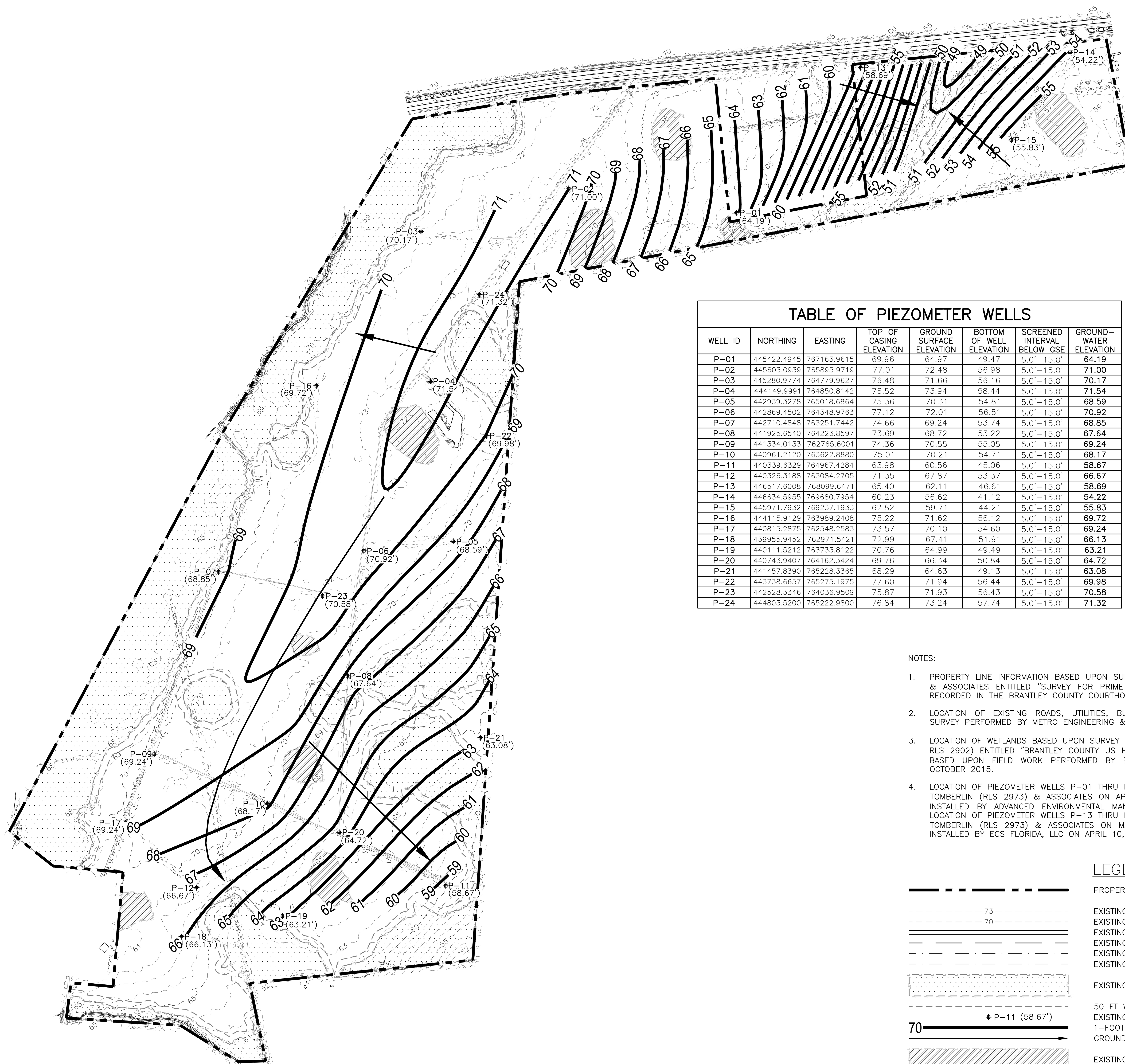
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE ASSESSMENT REPORT
POTENTIOMETRIC MAP
(Measurements Recorded on 03-12-19)

	REVISION	DATE
0	INITIAL SUBMITTAL	07-09-19
1	10-23-19 EPD COMMENTS	10-28-19
2		
3		
4		
5		
6		

DRAWING: 1390-010 BCDP_pot-2019-03-12.dwg
IES PROJECT NO.1390-010-01

FIGURE
2-01F



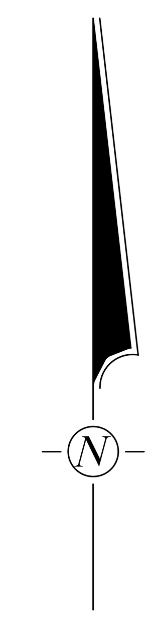


TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**64.19**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**71.00**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**70.17**
P-04	444149.9991	764850.8142	76.52	73.94	58.44	5.0'-15.0'	**71.54**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**68.59**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**70.92**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**68.85**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**67.64**
P-09	441334.0133	762765.6001	74.36	70.55	55.05	5.0'-15.0'	**69.24**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**68.17**
P-11	440339.6329	764967.4284	63.98	60.56	45.06	5.0'-15.0'	**58.67**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**66.67**
P-13	446517.6008	768099.6471	65.40	62.11	46.61	5.0'-15.0'	**58.69**
P-14	446634.5955	769680.7954	60.23	56.62	41.12	5.0'-15.0'	**54.22**
P-15	445971.7932	769237.1933	62.82	59.71	44.21	5.0'-15.0'	**55.83**
P-16	444115.9129	763989.2408	75.22	71.62	56.12	5.0'-15.0'	**69.72**
P-17	440815.2875	762548.2583	73.57	70.10	54.60	5.0'-15.0'	**69.24**
P-18	439955.9452	762971.5421	72.99	67.41	51.91	5.0'-15.0'	**66.13**
P-19	440111.5212	763733.8122	70.76	64.99	49.49	5.0'-15.0'	**63.21**
P-20	440743.9407	764162.3424	69.76	66.34	50.84	5.0'-15.0'	**64.72**
P-21	441457.8390	765228.3365	68.29	64.63	49.13	5.0'-15.0'	**63.08**
P-22	443738.6657	765275.1975	77.60	71.94	56.44	5.0'-15.0'	**69.98**
P-23	442528.3346	764036.9509	75.87	71.93	56.43	5.0'-15.0'	**70.58**
P-24	444803.5200	765222.9800	76.84	73.24	57.74	5.0'-15.0'	**71.32**

NOTES:

1. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208–209.

2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.

3. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.

4. LOCATION OF PIEZOMETER WELLS P–01 THRU P–12 BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS P–01 THRU P–12 WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016. LOCATION OF PIEZOMETER WELLS P–13 THRU P–24 BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON MAY 12, 2019. PIEZOMETER WELLS P–13 THRU P–24 WERE INSTALLED BY ECS FLORIDA, LLC ON APRIL 10, 11, 12 AND 15, 2019.

LEGEND

	PROPERTY LINE
73	EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
70	EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
	EXISTING PAVED ROAD
	EXISTING UNPAVED ROAD
	EXISTING STREAM / SURFACE WATER EDGE
	EXISTING STREAM EDGE
	EXISTING JURISDICTIONAL WETLANDS
	50 FT WETLANDS BUFFER
◆P-11 (58.67')	EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
70	1-FOOT POTENTIOMETRIC CONTOUR
	GROUNDWATER FLOW DIRECTION
	EXISTING NON-JURISDICTIONAL WETLANDS

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
CIVIL · ENVIRONMENTAL
Innovative Engineering Strategies, LLC
P.O. Box 560
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Phone (478) 365-8609

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC

U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE ASSESSMENT REPORT

POTENTIOMETRIC MAP
(Measurements Recorded on 04-16-19)

	REVISION	DATE
0	INITIAL SUBMITTAL	07-09-19
1	10-23-19 EPD COMMENTS	10-28-19
2		
3		
4		
5		
6		

DRAWING: 1390-010 BCDP_pot-2019-04-16.dwg
IES PROJECT NO.1390-010-01

FIGURE
2-01G

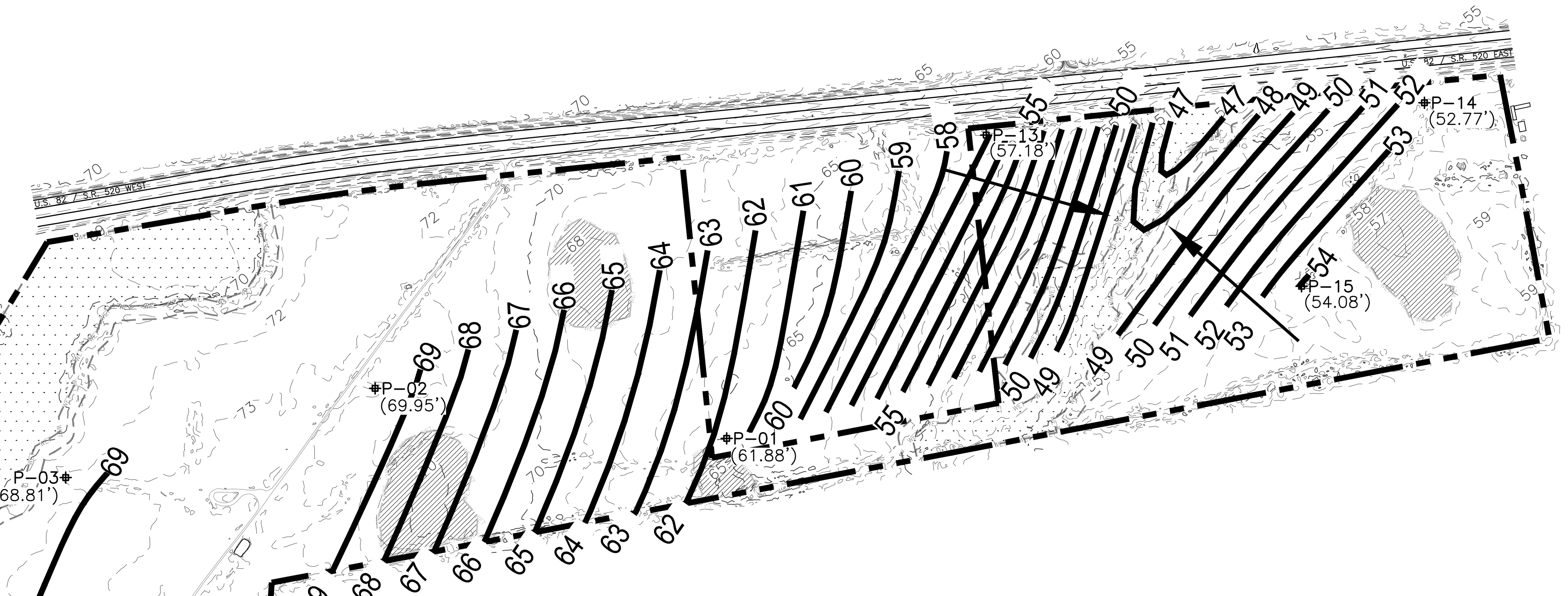
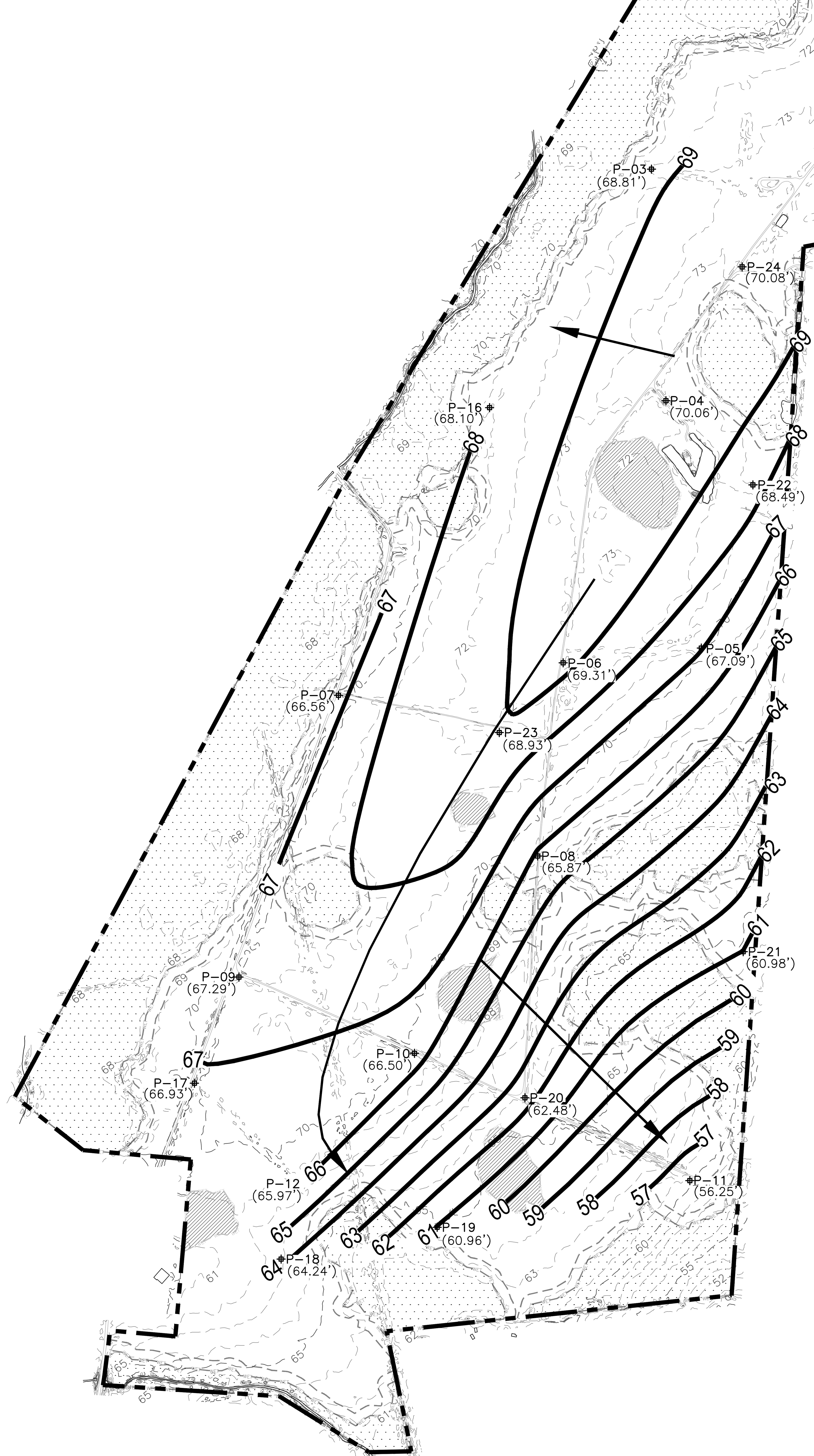

TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**61.88**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**69.95**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**68.81**
P-04	444149.9991	764850.8142	76.52	73.94	58.44	5.0'-15.0'	**70.06**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**67.09**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**69.31**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**66.56**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**65.87**
P-09	441334.0133	762765.6001	74.36	70.55	55.05	5.0'-15.0'	**67.29**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**66.50**
P-11	440339.6329	764967.4284	63.98	60.56	45.06	5.0'-15.0'	**56.25**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**65.97**
P-13	446517.6008	768099.6471	65.40	62.11	46.61	5.0'-15.0'	**57.18**
P-14	446634.5955	769680.7954	60.23	56.62	41.12	5.0'-15.0'	**52.77**
P-15	445971.7932	769237.1933	62.82	59.71	44.21	5.0'-15.0'	**54.08**
P-16	444115.9129	763989.2408	75.22	71.62	56.12	5.0'-15.0'	**68.10**
P-17	440815.2875	762548.2583	73.57	70.10	54.60	5.0'-15.0'	**66.93**
P-18	439955.9452	762971.5421	72.99	67.41	51.91	5.0'-15.0'	**64.24**
P-19	440111.5212	763733.8122	70.76	64.99	49.49	5.0'-15.0'	**60.98**
P-20	440743.9407	764162.3424	69.76	66.34	50.84	5.0'-15.0'	**62.48**
P-21	441457.8390	765228.3365	68.29	64.63	49.13	5.0'-15.0'	**60.98**
P-22	443738.6657	765275.1975	77.60	71.94	56.44	5.0'-15.0'	**68.49**
P-23	442528.3346	764036.9509	75.87	71.93	56.43	5.0'-15.0'	**68.93**
P-24	444803.5200	765222.9800	76.84	73.24	57.74	5.0'-15.0'	**70.08**

NOTES:

1. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.
2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.
3. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.
4. LOCATION OF PIEZOMETER WELLS P-01 THRU P-12 BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON APRIL 18, 2016. PIEZOMETER WELLS P-01 THRU P-12 WERE INSTALLED BY ADVANCED ENVIRONMENTAL MANAGEMENT, INC. (AEM) BETWEEN MARCH 15 AND 17, 2016. LOCATION OF PIEZOMETER WELLS P-13 THRU P-24 BASED UPON FIELD SURVEY PERFORMED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ON MAY 12, 2019. PIEZOMETER WELLS P-13 THRU P-24 WERE INSTALLED BY ECS FLORIDA, LLC ON APRIL 10, 11, 12 AND 15, 2019.

LEGEND

PROPERTY LINE
EXISTING 1-FOOT TOPOGRAPHIC CONTOUR (73)
EXISTING 5-FOOT TOPOGRAPHIC CONTOUR (70)
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
EXISTING STREAM / SURFACE WATER EDGE
EXISTING STREAM EDGE
EXISTING JURISDICTIONAL WETLANDS
50 FT WETLANDS BUFFER
◆P-11 (56.25') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
70 1-FOOT POTENTIOMETRIC CONTOUR
GROUNDWATER FLOW DIRECTION
EXISTING NON-JURISDICTIONAL WETLANDS

400 200 0 400 800
GRAPHIC SCALE IN FEET

IES
CIVIL · ENVIRONMENTAL
Innovative Engineering Strategies, LLC
P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE ASSESSMENT REPORT
POTENTIOMETRIC MAP
(Measurements Recorded on 05-24-19)

	REVISION	DATE
0	INITIAL SUBMITTAL	07-09-19
1	10-23-19 EPD COMMENTS	10-28-19
2		
3		
4		
5		
6		

DRAWING: 1390-010 BCDP_pot-2019-05-24.dwg
IES PROJECT NO.1390-010-01

FIGURE
2-01H

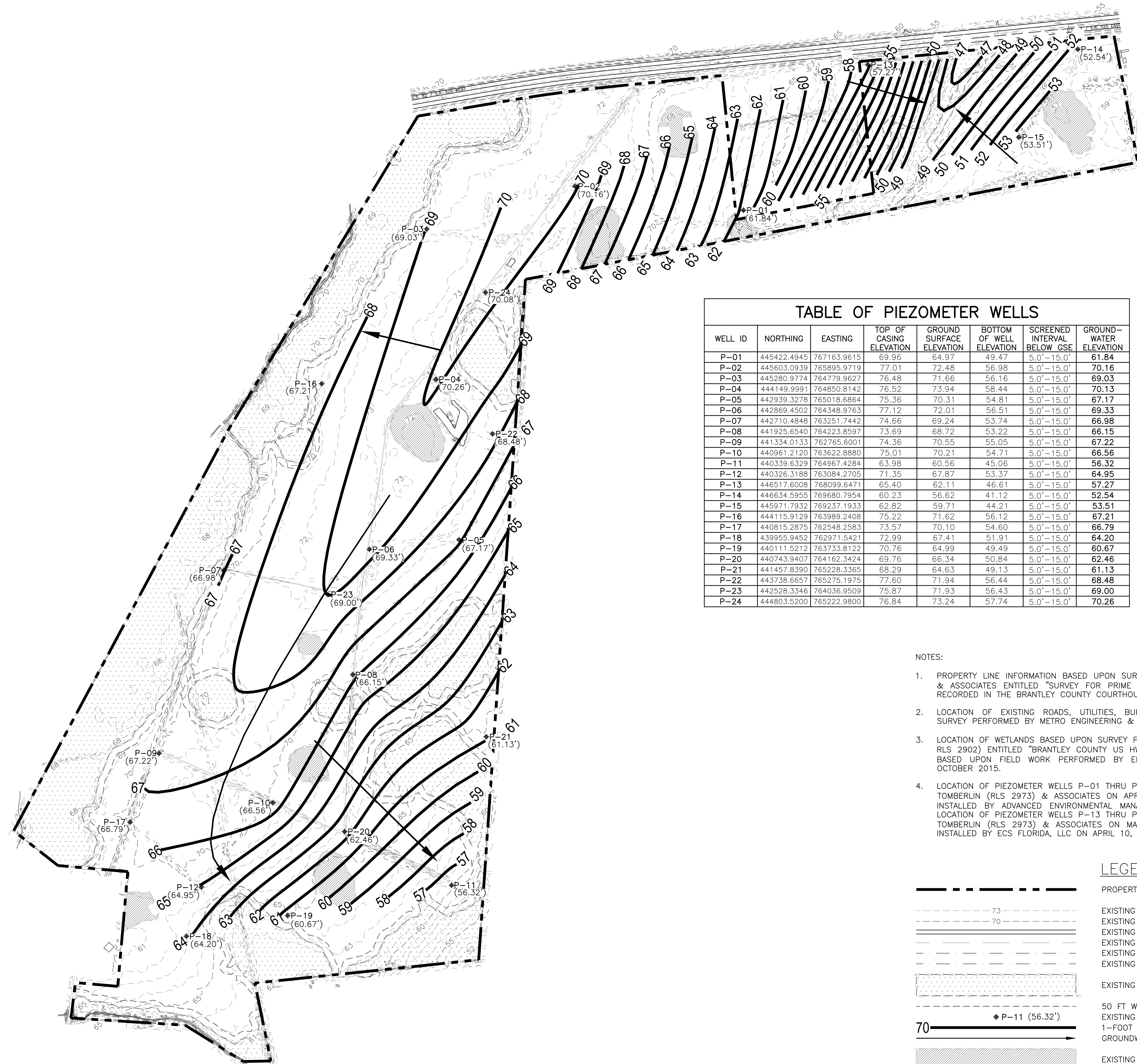

TABLE OF PIEZOMETER WELLS

WELL ID	NORTHING	EASTING	TOP OF CASING ELEVATION	GROUND SURFACE ELEVATION	BOTTOM OF WELL ELEVATION	SCREENED INTERVAL BELOW GSE	GROUND-WATER ELEVATION
P-01	445422.4945	767163.9615	69.96	64.97	49.47	5.0'-15.0'	**61.84**
P-02	445603.0939	765895.9719	77.01	72.48	56.98	5.0'-15.0'	**70.16**
P-03	445280.9774	764779.9627	76.48	71.66	56.16	5.0'-15.0'	**69.03**
P-04	444149.9991	764850.8142	76.52	73.94	58.44	5.0'-15.0'	**70.13**
P-05	442939.3278	765018.6864	75.36	70.31	54.81	5.0'-15.0'	**67.17**
P-06	442869.4502	764348.9763	77.12	72.01	56.51	5.0'-15.0'	**69.33**
P-07	442710.4848	763251.7442	74.66	69.24	53.74	5.0'-15.0'	**66.98**
P-08	441925.6540	764223.8597	73.69	68.72	53.22	5.0'-15.0'	**66.15**
P-09	441334.0133	762765.6001	74.36	70.55	55.05	5.0'-15.0'	**67.22**
P-10	440961.2120	763622.8880	75.01	70.21	54.71	5.0'-15.0'	**66.56**
P-11	440339.6329	764967.4284	63.98	60.56	45.06	5.0'-15.0'	**56.32**
P-12	440326.3188	763084.2705	71.35	67.87	53.37	5.0'-15.0'	**64.95**
P-13	446517.6008	768099.6471	65.40	62.11	46.61	5.0'-15.0'	**57.27**
P-14	446634.5955	769680.7954	60.23	56.62	41.12	5.0'-15.0'	**52.54**
P-15	445971.7932	769237.1933	62.82	59.71	44.21	5.0'-15.0'	**53.51**
P-16	444115.9129	763989.2408	75.22	71.62	56.12	5.0'-15.0'	**67.21**
P-17	440815.2875	762548.2583	73.57	70.10	54.60	5.0'-15.0'	**66.79**
P-18	439955.9452	762971.5421	72.99	67.41	51.91	5.0'-15.0'	**64.20**
P-19	440111.5212	763733.8122	70.76	64.99	49.49	5.0'-15.0'	**60.67**
P-20	440743.9407	764162.3424	69.76	66.34	50.84	5.0'-15.0'	**62.46**
P-21	441457.8390	765228.3365	68.29	64.63	49.13	5.0'-15.0'	**61.13**
P-22	443738.6657	765275.1975	77.60	71.94	56.44	5.0'-15.0'	**68.48**
P-23	442528.3346	764036.9509	75.87	71.93	56.43	5.0'-15.0'	**69.00**
P-24	444803.5200	765222.9800	76.84	73.24	57.74	5.0'-15.0'	**70.26**

NOTES:

1. PROPERTY LINE INFORMATION BASED UPON SURVEY PLAT PREPARED BY CHARLES H. TOMBERLIN (RLS 2973) & ASSOCIATES ENTITLED "SURVEY FOR PRIME SOUTH BANK OF 2,340.241 ACRES" ON MAY 6, 2013 AND RECORDED IN THE BRANTLEY COUNTY COURTHOUSE PLAT BOOK 0014A, PAGES 208-209.

2. LOCATION OF EXISTING ROADS, UTILITIES, BUILDINGS AND TOPOGRAPHIC CONTOURS BASED UPON LIDAR SURVEY PERFORMED BY METRO ENGINEERING & LAND SURVEYING CO. INC. ON APRIL 24, 2016.

3. LOCATION OF WETLANDS BASED UPON SURVEY PREPARED BY JORDAN ENGINEERING, INC. (ROBERT O. JORDAN, RLS 2902) ENTITLED "BRANTLEY COUNTY US HWY 82 WETLANDS MAPPING" DATED DECEMBER 23, 2015 AND BASED UPON FIELD WORK PERFORMED BY ENVIRONMENTAL SERVICES, INC. (ESI) BETWEEN AUGUST AND OCTOBER 2015.

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LEGEND

- PROPERTY LINE
- 73 EXISTING 1-FOOT TOPOGRAPHIC CONTOUR
- 70 EXISTING 5-FOOT TOPOGRAPHIC CONTOUR
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING STREAM / SURFACE WATER EDGE
- EXISTING STREAM EDGE
- EXISTING JURISDICTIONAL WETLANDS
- 50 FT WETLANDS BUFFER
- P-11 (56.32') EXISTING PIEZOMETER WELL (GROUNDWATER ELEVATION, FEET MSL)
- 70 1-FOOT POTENTIOMETRIC CONTOUR
- GROUNDWATER FLOW DIRECTION
- EXISTING NON-JURISDICTIONAL WETLANDS

400 200 0 400 800
GRAPHIC SCALE IN FEET

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P.O. Box 560
Smarr, Georgia 31086
Phone (478) 365-8609
IES
CIVIL · ENVIRONMENTAL

GEORGIA REGISTERED NO. 36066 PROFESSIONAL ENGINEER MICHAEL W. BIERS

BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC
U.S. HIGHWAY 82
BRANTLEY COUNTY, GEORGIA

SITE ASSESSMENT REPORT

POTENTIOMETRIC MAP
(Measurements Recorded on 06-28-19)

	REVISION	DATE
0	INITIAL SUBMITTAL	07-09-19
1	10-23-19 EPD COMMENTS	10-28-19
2		
3		
4		
5		
6		

DRAWING: 1390-010 BCDP_pot-2019-06-28.dwg
IES PROJECT NO.1390-010-01

FIGURE
2-01I

APPENDIX J

Groundwater Conditions and Studies in Georgia, 2008–2009

Scientific Investigations Report 2011–5048

U.S. Department of the Interior
U.S. Geological Survey

Preface

This report is published biennially in stop format and presents a summary of groundwater conditions in Georgia, and a description of ongoing groundwater studies. This report is the culmination of a concerted effort by personnel of the U.S. Geological Survey, Georgia Water Science Center who collected, compiled, organized, analyzed, verified and edited and assembled the report. In addition to the authors, who had primary responsibility for ensuring that the information contained herein is accurate and complete, the following individuals contributed substantially to the collection, processing, tabulation, and review of the data:

Gregory S. Cherry
John S. Clarke
Alan M. Cressler
Julia L. Fanning
Debbie Warner Gordon
Anthony J. Gotvald
Jamal A. Grimes
Michael D. Hamrick
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John K. Joiner
Andrew E. Knaak
Stephen J. Lawrence
John J. McCranie
Jonathan W. Musser
Welby L. Stayton
Lynn J. Torak
Lester J. Williams

Cover. (Left) Well 13FF14 located in Lawrenceville, Georgia, being pumped during a 72-hour aquifer test. Water levels and discharge were continuously monitored during the test. The well is 280 feet deep with 23 feet of casing and is completed in the crystalline rock aquifer. Photo by Michael D. Hamrick, USGS.

(Center) A hydrologic technician from the Groundwater Information and Project Support Unit prepares to lower a geophysical logging tool in a well. The well is located at the Albany Water Gas and Light Commission well field, Dougherty County, Georgia. Photo by Debbie Warner Gordon, USGS.

(Right) Test well being drilled at Fort Stewart, Liberty County, Georgia, to assess the water-bearing properties of the surficial aquifer as a potential source of irrigation water for athletic fields. Photo shows the well being developed with a drill rig air-lifting water from the well prior to conducting a 24-hour pumping test. The well was completed to 100 feet with screen set from 50 to 90 feet. Results from the 24-hour pumping test indicated that the well yield ranged from 545 to 550 gallons per minute. Photo by Michael D. Hamrick, USGS.

Groundwater Conditions and Studies in Georgia, 2008–2009

By Michael F. Peck, David C. Leeth, and Jaime A. Painter

Scientific Investigations Report 2011–5048

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2011

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For an overview of USGS information products, including maps, imagery, and publications, visit *http://www.usgs.gov/pubprod*

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Suggested citation:
Peck, M.F., Leeth, D.C., and Painter, J.A., 2011, Groundwater conditions and studies in Georgia, 2008–2009; U.S. Geological Survey Scientific Investigations Report 2011–5048, 83 p.

Contents

Conversion Factors and Datums

Multiply	By	To obtain
	Length	
inch	2.54	centimeter (cm)
inch	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
yard (yd)	0.9144	meter (m)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88). Historical data collected and stored as National Geodetic Vertical Datum of 1929 have been converted to NAVD 88 for use in this publication.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Historical data collected and stored as North American Datum of 1927 (NAD 27) have been converted to NAD 83 for use is in this publication.

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (μS/cm at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (μ/L).

Groundwater Conditions and Studies in Georgia, 2008–2009

by Michael F. Peck, David C. Leeth, and Jaime A. Painter

Abstract

The U.S. Geological Survey collects groundwater data and conducts studies to monitor hydrologic conditions, better define groundwater resources, and address problems related to water supply, water use, and water quality. In Georgia, water levels were monitored continuously at 179 wells during 2008 and 181 wells during 2009. Because of missing data or short periods of record (less than 3 years) for several of these wells, a total of 161 wells are discussed in this report. These wells include 17 in the surficial aquifer system, 19 in the Brunswick aquifer and equivalent sediments, 66 in the Upper Floridan aquifer, 16 in the Lower Floridan aquifer and underlying units, 10 in the Claiborne aquifer, 1 in the Gordon aquifer, 11 in the Clayton aquifer, 12 in the Cretaceous aquifer system, 2 in Paleozoic-rock aquifers, and 7 in crystalline-rock aquifers. Data from the well network indicate that water levels generally rose during the 2008–2009 period, with water levels rising in 135 wells and declining in 26. In contrast, water levels declined over the period of record at 100 wells, increased at 56 wells, and remained relatively constant at 5 wells.

In addition to continuous water-level data, periodic water-level measurements were collected and used to construct potentiometric-surface maps for the Upper Floridan aquifer in Camden, Charlton, and Ware Counties, Georgia, and adjacent counties in Florida during September 2008 and May 2009; in the Brunswick, Georgia area during July 2008 and July–August 2009; and in the City of Albany–Dougherty County, Georgia area during November 2008 and November 2009. In general, water levels in these areas were higher during 2009 than during 2008; however, the configuration of the potentiometric surfaces in each of the areas showed little change.

Groundwater quality in the Floridan aquifer system is monitored in the Albany, Savannah, Brunswick, and Camden County areas of Georgia. In the Albany area, nitrate as nitrogen concentrations in the Upper Floridan aquifer during 2008–2009 generally increased, with concentrations in two wells above the U.S. Environmental Protection Agency (USEPA) 10-milligrams-per-liter (mg/L) drinking-water standard. In the Savannah area, measurement of specific conductance and chloride concentration in water samples from discrete depths in three wells completed in the Upper Floridan aquifer indicate that chloride concentrations in the Upper Floridan aquifer showed little change and remained below the 250 mg/L USEPA secondary drinking-water standard. Chloride concentrations in the Lower Floridan aquifer increased slightly at Tybee Island and Skidaway Island, remaining above the drinking-water standard. In the Brunswick area, maps showing the chloride concentration of water in the Upper Floridan aquifer were constructed using data collected from 28 wells during July 2008 and from 29 wells during July–August 2009, indicate that chloride concentrations remained above the USEPA secondary drinking-water standard in an approximately 2-square-mile area. During 2008–2009, chloride concentrations decreased, with a maximum decrease of 160 mg/L, in a well located in the northern part of the Brunswick area.

In the Camden County area, chloride concentration during 2008–2009 was analyzed in water samples collected from eight wells, six of which were completed in the Upper Floridan aquifer and two in the Lower Floridan aquifer. In most of the wells sampled during this period, chloride concentrations did not appreciably change; however, since the closure of the Durango Paper Company in October 2002, chloride concentrations in the Upper Floridan aquifer near the paper mill decreased from a high of 184 mg/L in May 2002 to 41 mg/L in September 2009.

Groundwater studies conducted in Georgia during 2008–2009 include the following:

- evaluation of groundwater flow, water-quality, and water-level monitoring in the Augusta–Richmond County area;
- evaluation of groundwater flow, water-quality, and water-level monitoring in the City of Albany–Dougherty County area;
- evaluation of saltwater intrusion, water-level, and water-quality monitoring in the City of Brunswick– Glynn County area;
- collection of groundwater data in and adjacent to the State of Georgia;
- assessment of the sustainability of groundwater resources in the City of Lawrenceville area;
- evaluation of alternative groundwater resources, flow, water quality, and water-level monitoring Hunter Army Airfield and Fort Stewart, Georgia; and
- evaluation and quality assurance of agricultural pumpage in Georgia.

Introduction

Reliable and impartial scientific information on the occurrence, quantity, quality, distribution, and movement of water is essential to resource managers, planners, and others throughout the Nation. The U.S. Geological Survey (USGS), in cooperation with numerous local, State, and Federal agencies, collects hydrologic data and conducts studies to monitor hydrologic conditions and better define the water resources of Georgia and other States and territories.

Groundwater-level and quality data are essential for water-resources assessment and management. Water-level measurements from observation wells are the principal source of information about the hydrologic stresses on aquifers and how these stresses affect groundwater recharge, storage, and discharge. Long-term, systematic measurement of water levels provides essential data needed to evaluate changes in the resource over time, develop groundwater models and forecast trends, and design, implement, and monitor the effectiveness of groundwater management and protection programs (Taylor and Alley, 2001). Groundwater-quality data are necessary for the protection of groundwater resources because deterioration of groundwater quality may be virtually irreversible, and treatment of contaminated groundwater can be expensive (Alley, 1993). Reliable water-use data are important to many organizations and individuals in support of research and policy decisions and are essential in understanding the effects of humans on the hydrologic system (Hutson and others, 2004).

Purpose and Scope

This report presents an overview of groundwater conditions, permitted water use, and hydrologic studies conducted during 2008–2009 by the USGS in Georgia. Summaries are presented for selected groundwater studies along with objectives and progress. These summaries include the following;

- evaluation of groundwater flow, water-quality, and water-level monitoring in the Augusta–Richmond County area;
- evaluation of groundwater flow, water-quality, and water-level monitoring in the City of Albany–Dougherty County area;
- evaluation of saltwater intrusion, water-level, and water-quality monitoring in the City of Brunswick–Glynn County area;
- collection of groundwater data in and adjacent to the State of Georgia;
- assessment of the sustainability of groundwater resources in the City of Lawrenceville area;
- evaluation of alternative groundwater resources, at Hunter Army Airfield and Fort Stewart, Georgia;
- evaluation and quality assurance of agricultural pumpage in Georgia; and
- publication of reports on groundwater conditions in Georgia (listed on page 4).

Permitted water-use data compiled for 2005–2009 and reported herein are based on State-mandated reporting requirements for water users withdrawing more than 100,000 gallons per day (gal/d). State-mandated reporting includes data for public supply, industrial and commercial, and thermoelectric-power water use; however, reporting of information on irrigation water use is not mandated and, therefore, not discussed in this report.

Continuous water-level measurements were obtained from 179 wells during 2008 and 181 wells during 2009; however, data from 161 wells are summarized herein. Of the 181 wells equipped with continuous water-level recorders during 2009, 151 wells had electronic data recorders that recorded water levels at 60-minute intervals, and the data generally were retrieved bimonthly. Thirty wells had real-time satellite telemetry that recorded water levels at 60-minute intervals. Three of the real-time sites were equipped to monitor water levels and specific conductance, and at another site only specific conductance was monitored. Real-time satellite telemetry data are transmitted every 1 to 4 hours (based on equipment) for display on the USGS Georgia Water Science Center Web site at *http://waterdata.usgs.gov/ga/nwis/current?type=gw/*.

Groundwater levels in major aquifers are presented as hydrographs for selected wells throughout Georgia. Estimated annual water-level change is reported for the period of record and for 2008–2009. Additional well information can be obtained from the USGS National Water Information System (NWIS) at *http://waterdata.usgs.gov/ga/nwis/gw/*.

In addition to continuous water-level recording, periodic water-level measurements were collected to complete potentiometric surface maps for the Upper Floridan aquifer. In southwestern Georgia near Albany, measurements were collected in 81 wells during November 2008 and in 64 wells during November 2009. In the southern coastal area of Georgia, including Camden, Charlton, and Ware Counties and adjacent counties in Florida, water-level measurements were collected during September 2008 and May 2009 (Kinnaman and Dixon, 2009a, b).

The quality of groundwater in the Floridan aquifer system is being monitored in the Albany–Dougherty County area and in several areas along the Georgia coast. In the Albany area, nitrate as nitrogen concentrations in the Upper Floridan aquifer were determined in water from 25 wells during November 2008 and from 13 wells during November 2009. In the coastal area, groundwater quality of the Upper and Lower Floridan aquifers was determined in the Savannah, Brunswick, and St. Marys areas. In the Savannah area, groundwater quality was assessed in four wells by using a combination of borehole fluid-resistivity logs and grab samples collected at discrete depths.

Long-term chloride concentrations in the Brunswick area are presented by using composite-sample data from five wells for the periods 1960–2009 and 1965–2009 together with maps showing chloride concentrations in the Brunswick area during July 2008 (26 wells) and July–August 2009 (26 wells). Data are presented from a network of three continuous, specific-conductance monitoring sites (used as surrogate data for chloride concentration) surrounding the chloride plume at Brunswick. In the St. Marys area of Camden County, chloride-concentration data from 8 wells are presented for the period 1984–2009.

Methods of Analysis, Sources of Data, and Data Accuracy

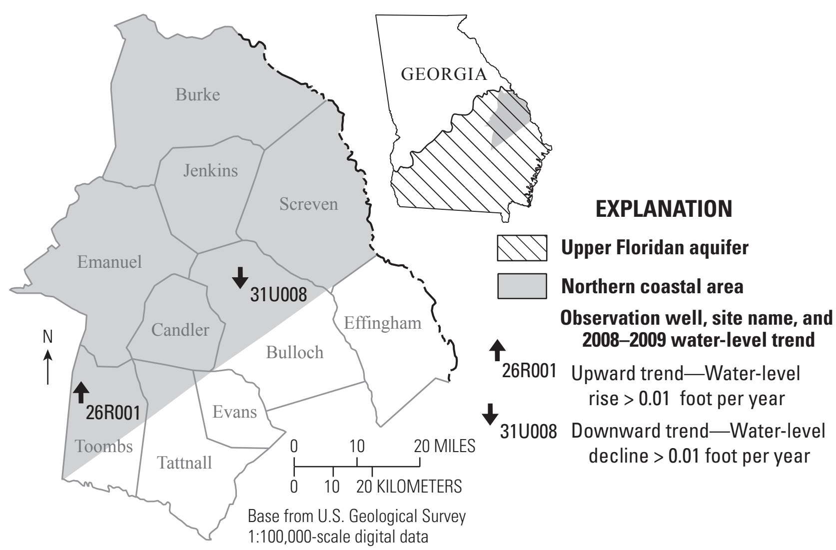
To illustrate long-term (period of record) and more recent (2008–2009) water-level changes, hydrographs showing monthly mean water levels are presented together with maps showing water-level trends during 2008–2009. To estimate water-level trends, the Levenberg–Marquardt (LMA) method for minimization of a weighted least-squares merit function (Janert, 2010) was used to determine a straight-line fit to both recent and period-of-record monthly-mean groundwater levels (see example graph below). Estimated water levels from these straight-line fits were used to compute an annual rate of change (yearly slope) for the period of record and for 2008–2009. A more thorough discussion of the LMA method is presented at the end of this report along with associated summary statistics for each well and for straight-line fits (appendix).

Water-level trends are presented on tables, hydrographs, and maps for each aquifer and sub-area in the groundwater level section of this report. Trends for 2008–2009 are presented on maps either by an upward arrow for a positive rate of change of 0.01 foot per year (ft/yr) or greater, or a downward arrow for a negative rate of change of 0.01 ft/yr or greater. A circle represents no water-level change on the map when the change was less than ± 0.01 ft/yr. Additional well information can be obtained from the USGS NWIS at *http://waterdata.usgs.gov/ga/nwis/gw/*.

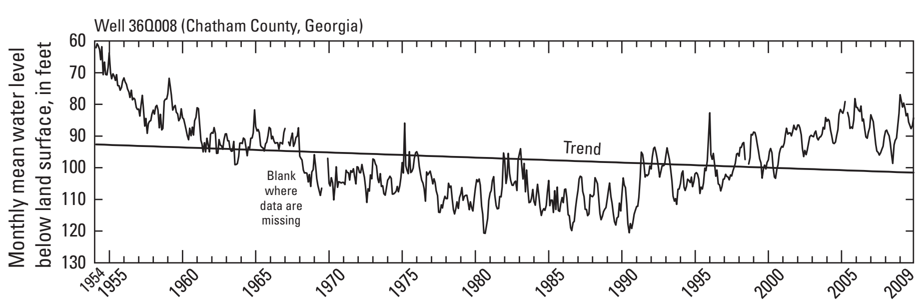
Water samples were analyzed for nitrate as nitrogen at the USGS laboratory in Denver, Colorado. Chloride analyses were conducted at the St. Johns River Water Management District in Palatka, Florida (for Camden County), and at TestAmerica Laboratory, Savannah, Georgia. Additional water-quality data for Georgia can be obtained from the USGS NWIS at *http://waterdata.usgs.gov/ga/nwis/qw/*.

Permitted water-use data for 2008–2009 were compiled from the Georgia Water-Use Data System (GWUDS). The GWUDS contains permitted water-use information on public supplies, industrial and commercial supplies, and thermoelectric-power and hydroelectric-power uses for 1980–2009. These data are limited to permitted water withdrawals of 100,000 gal/d or greater, in compliance with Georgia water law that requires withdrawal permits for all public-supply, industrial, and other water users who withdraw more than 100,000 gal/d (*http://rules.sos.state.ga.us/docs/391/3/2/03.pdf*).

Water-level trends for 2008–2009 are presented on maps either by an upward arrow for a positive rate of change of 0.01 foot per year or greater, or a downward arrow for a negative rate of change of 0.01 foot per year or greater. A circle represents no water-level change.



Example hydrograph showing monthly mean water levels in well 36Q008 for the period 1954–2009, and period-of-record trend.



Previously published U.S. Geological Survey reports on groundwater conditions in Georgia.

[OFR, Open-File Report; WRIR, Water-Resources Investigations Report; SIR, Scientific Investigations Report]

Year of data collection	USGS report series and number	Author(s)	Year of publication
1977	OFR 79–213	U.S. Geological Survey	1978
1978	OFR 79–1290	Clarke, J.S., Hester, W.G., and O'Byrne, M.P.	1979
1979	OFR 80–501	Mathews, S.E., Hester, W.G., and O'Byrne, M.P.	1980
1980	OFR 81–1068	Mathews, S.E., Hester, W.G., and O'Byrne, M.P.	1981
1981	OFR 82–904	Mathews, S.E., Hester, W.G., and McFadden, K.W.	1982
1982	OFR 83–678	Stiles, H.R., and Mathews, S.E.	1983
1983	OFR 84–605	Clarke, J.S., Peck, M.F., Longsworth, S.A., and McFadden, K.W.	1984
1984	OFR 85–331	Clarke, J.S., Longsworth, S.A., McFadden, K.W., and Peck, M.F.	1985
1985	OFR 86–304	Clarke, J.S., Joiner, C.N., Longsworth, S.A., McFadden, K.W., and Peck, M.F.	1986
1986	OFR 87–376	Clarke, J.S., Longsworth, S.A., Joiner, C.N., Peck, M.F., McFadden, K.W., and Milby, B.J.	1987
1987	OFR 88–323	Joiner, C.N., Reynolds, M.S., Stayton, W.L., and Boucher, F.G.	1988
1988	OFR 89–408	Joiner, C.N., Peck, M.F., Reynolds, M.S., and Stayton, W.L.	1989
1989	OFR 90–706	Peck, M.F., Joiner, C.N., Clarke, J.S., and Cressler, A.M.	1990
1990	OFR 91–486	Milby, B.J., Joiner, C.N., Cressler, A.M., and West, C.T.	1991
1991	OFR 92–470	Peck, M.F., Joiner, C.N., and Cressler, A.M.	1992
1992	OFR 93–358	Peck, M.F., and Cressler, A.M.	1993
1993	OFR 94–118	Joiner, C.N., and Cressler, A.M.	1994
1994	OFR 95–302	Cressler, A.M., Jones, L.E., and Joiner, C.N.	1995
1995	OFR 96–200	Cressler, A.M.	1996
1996	OFR 97–192	Cressler, A.M.	1997
1997	OFR 98–172	Cressler, A.M.	1998
1998	OFR 99–204	Cressler, A.M.	1999
1999	OFR 00–151	Cressler, A.M.	2000
2000	OFR 01–220	Cressler, A.M., Blackburn, D.K., and McSwain, K.B.	2001
2001	WRIR 03–4032	Leeth, D.C., Clarke, J.S., and Craigg, S.D., and Wipperfurth, C.J.	2003
2002–2003	SIR 2005–5065	Leeth, D.C., Clarke, J.S., Wipperfurth, C.J., and Craigg, S.D.	2005
2004–2005	SIR 2007–5017	Leeth, D.C., Peck, M.F., and Painter, J.A.	2007
2006–2007	SIR 2009–5070	Peck, M.F., Painter, J.A. and Leeth, D.C.	2009

Georgia Well-Identification System

Wells described in this report are identified according to a system based on the index of USGS 7.5-minute topographic maps of Georgia. Each map in Georgia has been assigned a two- to three-digit number and letter designation (for example, 07H) beginning at the southwestern corner of the State. Numbers increase sequentially eastward, and letters advance alphabetically northward. Quadrangles in the northern part of the State are designated by double letters: AA follows Z, and so forth. The letters I, O, II, and OO are not used in the well-identification system. Wells inventoried in each quadrangle are numbered consecutively, beginning with 001. Thus, the fourth well inventoried in the 11A quadrangle is designated 11A004. In the USGS NWIS database, this information is stored in the "Station Name" field; in NWIS Web, it is labeled "Site Name."

Cooperating Organizations and Agencies

Groundwater monitoring and hydrologic studies in Georgia are conducted in cooperation with numerous local organizations and State and Federal agencies. Cooperating organizations and agencies include;

- Department of Defense, U.S. Army
- Georgia Department of Agriculture
- Georgia Department of Natural Resources, Environmental Protection Division
- St. Johns Water Management District (Florida)
- Jekyll Island Authority
- Flint River Water Planning and Policy Center
- Albany Water, Gas, and Light Commission
- Camden County
- Glynn County
- Lee County
- City of Brunswick/Glynn County
- City of Lawrenceville
- City of Augusta/Richmond County

With the exception of the Federal agencies, all of these organizations participate in the USGS Cooperative Water Program, an ongoing partnership between the USGS and State and local agencies. The program enables joint planning and funding for systematic studies of water quantity, quality, and use. Data obtained from these studies are used to guide water-resources management and planning activities and provide indications of emerging water problems. For a more complete description of the Cooperative Water Program, see Brooks (2001)

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Kinnaman, S.L., and Dixon, J.F., 2009b, Potentiometric surface of the Upper Floridan aquifer in the St. Johns River Water Management District and vicinity, Florida, May 2009: U.S. Geological Survey Scientific Investigations Map 3091, 1 sheet; available online at *http://pubs.usgs.gov/sim/3091/*.

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Groundwater Resources

Contrasting geologic features and landforms of the physiographic provinces of Georgia (see map on p. 7 and table on p. 8–9) affect the quantity and quality of groundwater throughout the State. The surficial aquifer system is present in each of the physiographic provinces. In the Coastal Plain Physiographic Province, the surficial aquifer system consists of layered sand, clay, and limestone. The surficial aquifer system usually is under water-table (unconfined) conditions and provides water for domestic and livestock use. The surficial aquifer system is semiconfined to confined locally in the coastal area. In the Piedmont, Blue Ridge, and Valley and Ridge Physiographic Provinces, the surficial aquifer system consists of soil, saprolite, stream alluvium, colluvium, and other surficial deposits.

The most productive aquifers in Georgia are in the Coastal Plain Physiographic Province in the southern half of the State. The Coastal Plain is underlain by alternating layers of sand, clay, dolomite, and limestone that dip and thicken to the southeast. Coastal Plain aquifers generally are confined, except near their northern limits where they crop out or are near land surface. Aquifers in the Coastal Plain include the surficial aquifer system, Brunswick aquifer system, Upper and Lower Floridan aquifers, Gordon aquifer system, Claiborne aquifer, Clayton aquifer, and Cretaceous aquifer system.

In the Valley and Ridge Physiographic Province, groundwater is transmitted through primary and secondary openings in folded and faulted sedimentary and metasedimentary rocks of Paleozoic age, herein referred to as "Paleozoic-rock aquifers."

In the Piedmont and Blue Ridge Physiographic Provinces, the geology is complex and consists of structurally deformed metamorphic and igneous rocks. Groundwater is transmitted through secondary openings along fractures, foliation, joints, contacts, or other features in the crystalline bedrock. In these provinces, aquifers are referred to as "crystalline-rock aquifers." For a more complete discussion of the State's groundwater resources, see Clarke and Pierce (1985).

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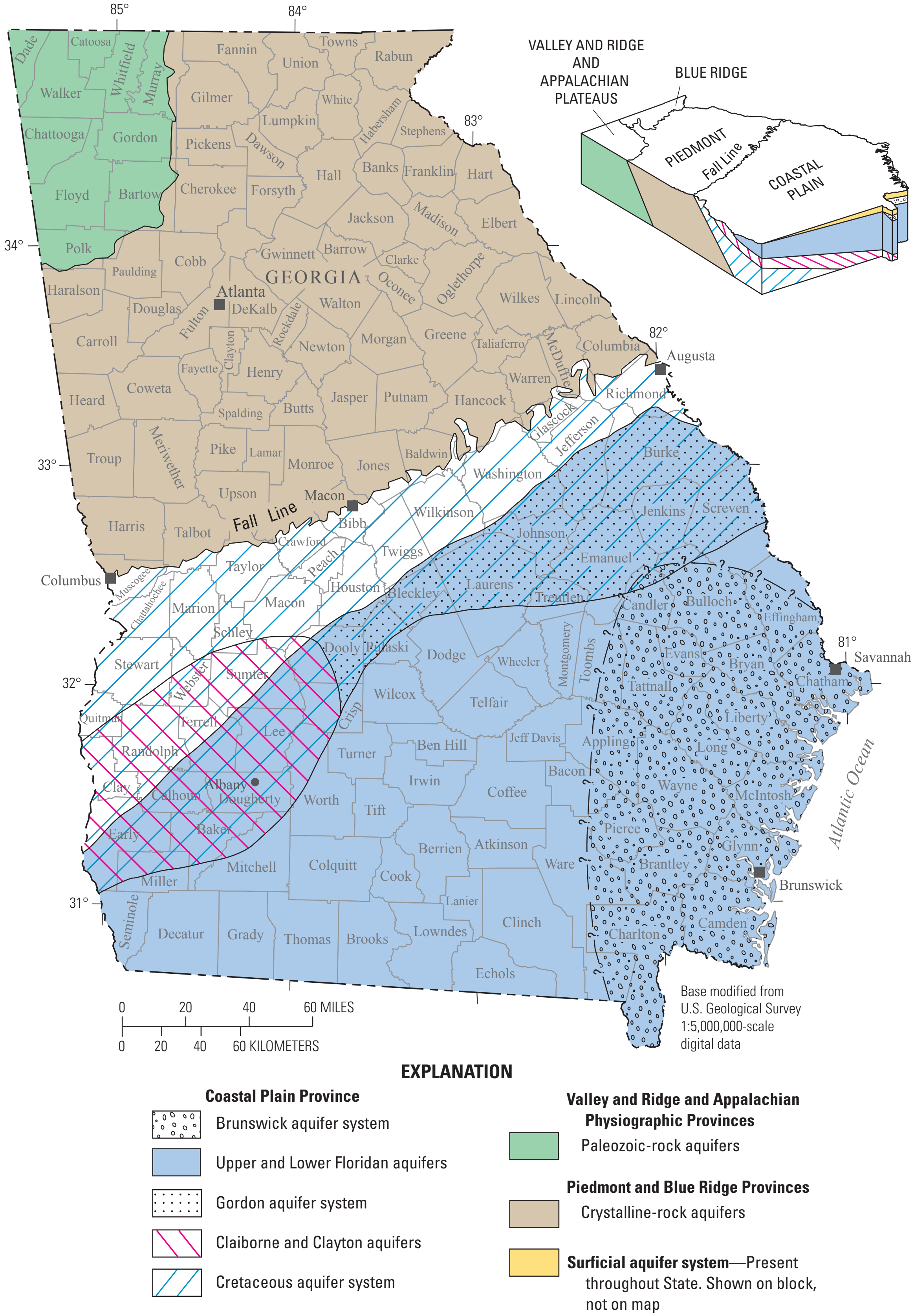


Areas of use of major aquifers in Georgia (modified from Clarke and Pierce, 1985).

Groundwater Resources

Aquifer and well characteristics in Georgia [modified from Clarke and Pierce, 1985; Peck and others, 1992; ft, foot; gal/min, gallon per minute]

Aquifer name	Aquifer description	Well characteristics		
		Depth (ft)	Yield (gal/min)	
		Typical range	Typical range	May exceed
Surficial aquifer system	Unconsolidated sediments and residuum; generally unconfined. However, in the coastal area of the Coastal Plain, at least two semiconfined aquifers have been identified	11–300	2–25	75
Brunswick aquifer system, including upper and lower Brunswick aquifers	Phosphatic and dolomitic quartz sand; generally confined	85–390	10–30	180
Upper and Lower Floridan aquifers	Limestone, dolomite, and calcareous sand; generally confined	40–900	1,000–5,000	11,000
Gordon aquifer system	Sand and sandy limestone; generally confined	270–530	87–1,200	1,800
Claiborne aquifer	Sand and sandy limestone; generally confined	20–450	150–600	1,500
Clayton aquifer	Limestone and sand; generally confined	40–800	250–600	2,150
Cretaceous aquifer system	Sand and gravel; generally confined	30–750	50–1,200	3,300
Paleozoic-rock aquifers	Sandstone, limestone and dolomite; generally confined	15–2,100	1–50	3,500
Crystalline-rock aquifers	Granite, gneiss, schist, and quartzite; confined and unconfined	40–600	1–25	500

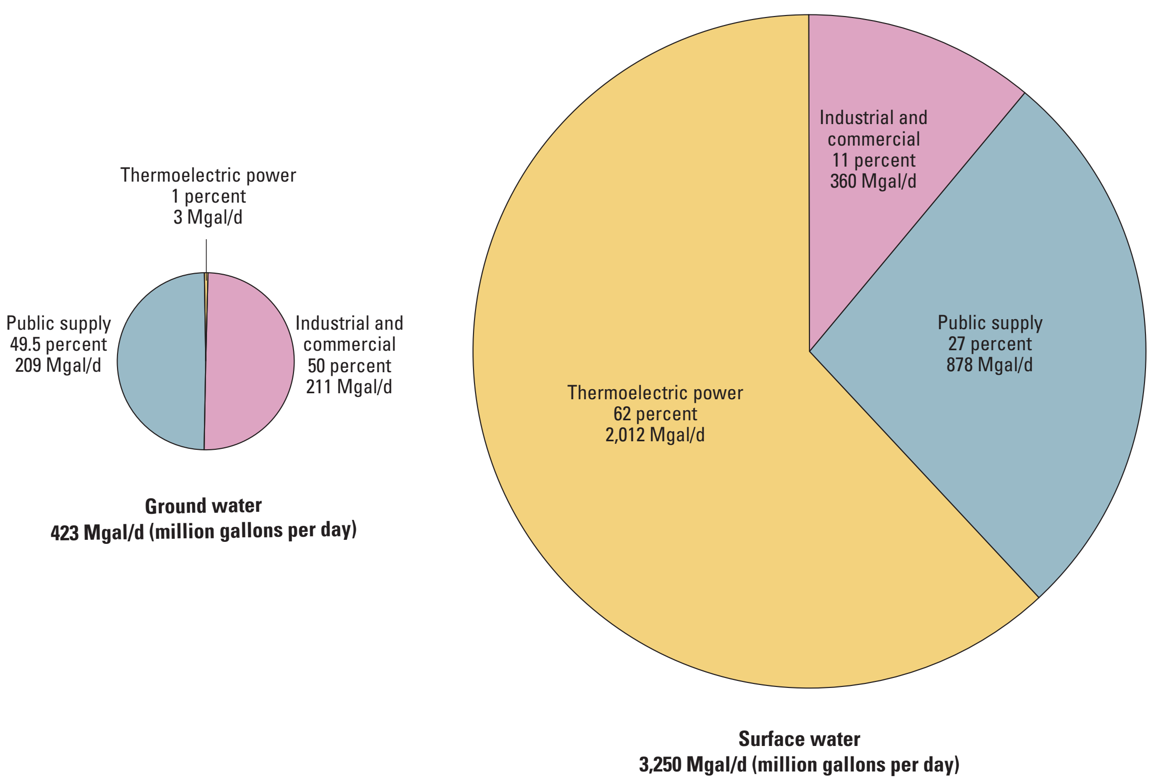
Hydrologic response	Remarks
Water-level fluctuations are caused mainly by variations in precipitation, evapotranspiration, and natural drainage or discharge. In addition, water levels in the City of Brunswick area are influenced by nearby pumping, precipitation, and tidal fluctuations (Clarke and others, 1990). Water levels generally rise rapidly during wet periods and decline slowly during dry periods. Prolonged droughts may cause water levels to decline below pump intakes in shallow wells, particularly those located on hilltops and steep slopes, resulting in temporary well failures. Usually, well yields are restored by precipitation (Clarke, 2003).	Primary source of water for domestic and livestock supply in rural areas. Supplemental source of water for irrigation supply in coastal Georgia.
In the coastal area, the aquifers may respond to pumping from the Upper Floridan aquifer as a result of the hydraulic connection between the aquifers. Elsewhere, the water level mainly responds to seasonal variations in recharge and discharge. In Bulloch County, unnamed aquifers equivalent to the upper and lower Brunswick aquifers are unconfined to semiconfined and are influenced by variations in recharge from precipitation and by pumping from the Upper Floridan aquifer; in the Wayne and Glynn County area, the aquifers are confined and respond to nearby pumping (Clarke and others, 1990; Clarke, 2003).	Not a major source of water in coastal Georgia, but considered a supplemental water supply to the Upper Floridan aquifer.
In and near outcrop areas, the aquifers are semiconfined, and water levels in wells tapping the aquifers fluctuate seasonally in response to variations in recharge rate and pumping. Near the coast, where the aquifers are confined, water levels primarily respond to pumping, and fluctuations related to recharge are less pronounced (Clarke and others, 1990).	Supplies about 50 percent of groundwater in Georgia. The aquifer system is divided into the Upper and Lower Floridan aquifers. In the Brunswick area, the Upper Floridan aquifer includes two freshwater-bearing zones—the upper water-bearing zone and the lower water-bearing zone. In the Brunswick area and in southeastern Georgia, the Lower Floridan aquifer includes the brackish-water zone, the deep freshwater zone, and the Fernandina permeable zone (Krause and Randolph, 1989). The Lower Floridan aquifer extends to more than 2,700 ft in depth and yields high-chloride water below 2,300 ft (Jones and Maslia, 1994).
Water levels are influenced by seasonal fluctuations in recharge from precipitation, discharge to streams, and evapotranspiration (Clarke and others, 1985).	Major source of water for irrigation, industrial, and public-supply use in east-central Georgia.
Water levels are mainly affected by precipitation and by local and regional pumping (Hicks and others, 1981). The water level is generally highest following the winter and spring rainy seasons, and lowest in the fall following the summer irrigation season.	Major source of water for irrigation, industrial, and public-supply use in southwestern Georgia.
Water levels are affected by seasonal variations in local and regional pumping (Hicks and others, 1981).	Major source of water for irrigation, industrial, and public-supply use in southwestern Georgia.
Water levels are influenced by variations in precipitation and pumping (Clarke and others, 1983, 1985).	Major source of water in east-central Georgia. Supplies water for kaolin mining and processing; includes the Providence aquifer in southwestern Georgia, and the Dublin, Midville, and Dublin–Midville aquifer systems in east-central Georgia.
Water levels are affected mainly by precipitation and local pumping (Cressler, 1964).	Not laterally extensive. Limestone and dolomite aquifers are the most productive. Storage is in regolith, primary openings, and secondary fractures and solution openings in rock. Springs in limestone and dolomite aquifers discharge at rates of as much as 5,000 gal/min. Sinkholes may form in areas of intensive pumping.
Water levels are affected mainly by precipitation and evapotranspiration, and locally by pumping (Cressler and others, 1983). Precipitation can cause a rapid rise in water levels in wells tapping aquifers overlain by thin regolith.	Storage is in regolith and fractures in rock.

Permitted Water-Use Data for Georgia during 2009 and Groundwater-Use Trends for 2005–2009

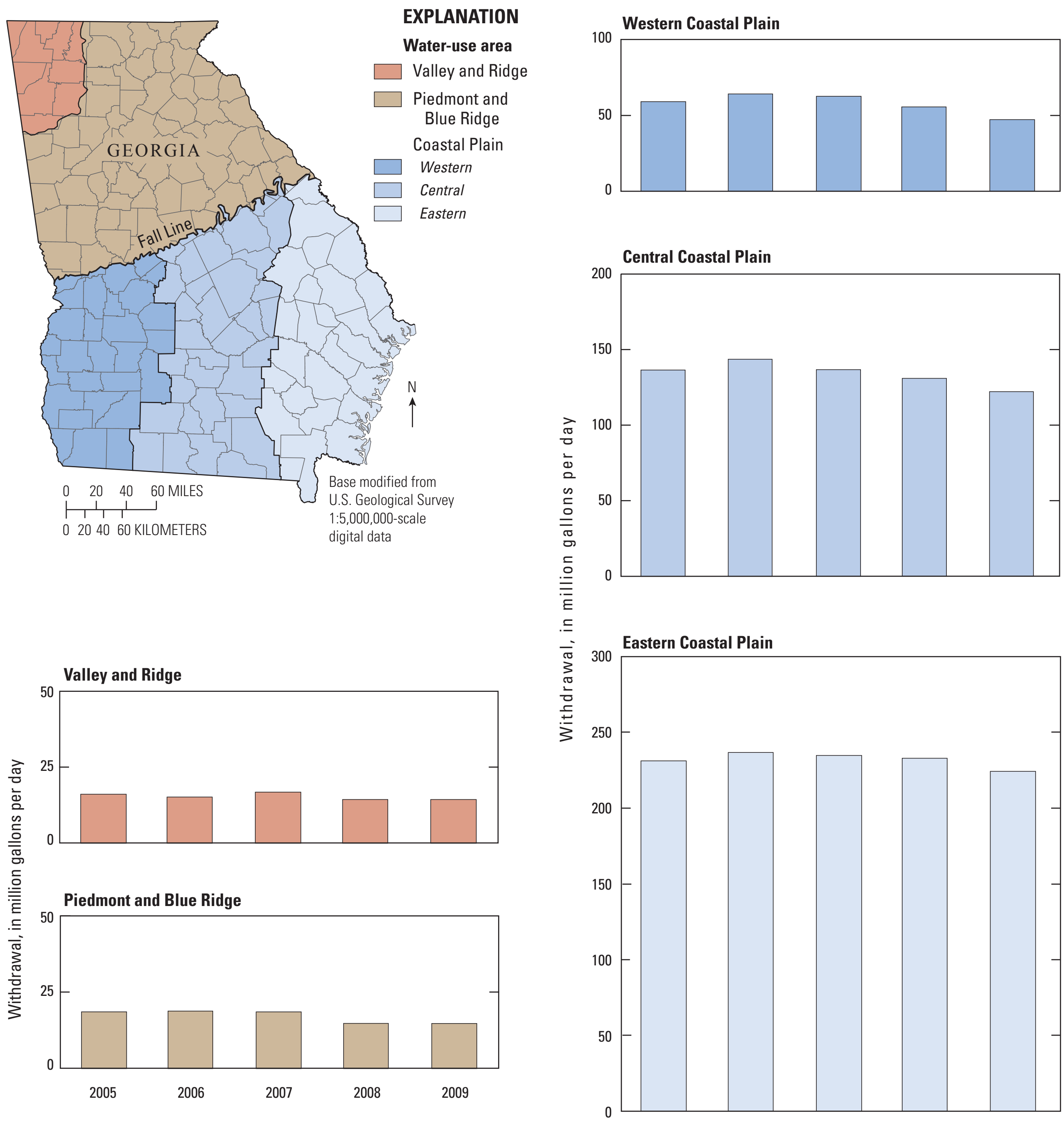
Permitted water-use data can be used to assess potential effects of groundwater withdrawal on groundwater systems. Only water-use data from permitted public supply, industrial and commercial, and thermoelectric systems are included in this report. Estimates for irrigation, livestock, and domestic use are omitted. During 2009, permitted water withdrawal in Georgia totaled 3,672 million gallons per day (Mgal/d) of which about 88 percent (3,250 Mgal/d) was from surface-water sources and 12 percent (423 Mgal/d) was from groundwater sources. Permitted withdrawal by public-supply systems totaled about 1,087 Mgal/d, about 81 percent of which was from surface-water sources and 19 percent was from groundwater sources (see pie charts below). Eighteen thermoelectric plants, the largest water users in Georgia, withdrew about 2,015 Mgal/d during 2009, mostly from surface-water sources. Permitted withdrawals by industrial and commercial users totaled about 571 Mgal/d, with 63 percent was from surface-water sources and 37 percent from groundwater sources. The major industrial users in Georgia include paper, textiles, chemicals, stone and clay, and mining.

Compared to 2007, total withdrawals for 2009 decreased by 975 Mgal/d. Thermoelectric power withdrawals saw the largest decrease during 2007–2009 (793 Mgal/d), mostly from surface-water sources. The largest decrease for groundwater-supplied users was for industrial and commercial systems, which decreased from 242 Mgal/d in 2007 to 211 Mgal/d in 2009. Public-supply withdrawals from groundwater sources also decreased during this period from 221 Mgal/d in 2007 to 209 Mgal/d in 2009.

To understand the areal distribution and trends of permitted groundwater withdrawal in the State, data from 2005 to 2009 were grouped into five areas as depicted in the map and graphs (facing page). Permitted groundwater withdrawal in each of the five areas decreased during 2005–2009. This decrease largely is a result of continued conservation efforts made by industrial and municipal users. In the Coastal Plain, groundwater use decreased from 14.4 to 6.97 Mgal/d, mostly because of a reduction in industrial withdrawals. In the northern one-half of the State, groundwater use also decreased 1.74 Mgal/d in the Valley and Ridge area and 3.85 Mgal/d in the Piedmont and Blue Ridge area. These decreases were largely due to conservation efforts by public-supply and industrial systems during the most recent drought.



Percentages of permitted water use in Georgia by category and source, 2009.



Groundwater withdrawals in Georgia by water-use area, 2005–2009.

Groundwater Conditions

Groundwater Levels

Maps and tables in this section provide an overview of groundwater levels in major aquifers in Georgia during 2008–2009. Hydrographs of selected wells are presented to demonstrate period-of-record and 2008–2009 water-level trends. Discussion of each aquifer is subdivided into areas where wells likely would have similar water-level fluctuations and trends if they were unaffected by pumping. The map on the facing page shows the locations of selected wells that were continuously monitored by the U.S. Geological Survey during the 2009 calendar year, including 30 wells that were monitored in real time.

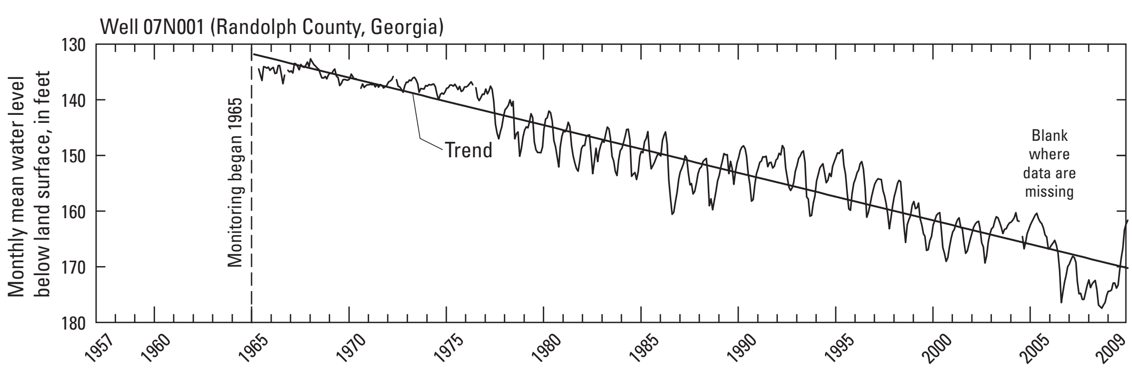
Changes in aquifer storage cause changes in groundwater levels in wells. Taylor and Alley (2001) described many factors that affect groundwater storage; these factors are discussed briefly here. When recharge to an aquifer exceeds discharge, groundwater levels rise; when discharge from an aquifer exceeds recharge, groundwater levels decline. Recharge varies in response to precipitation and surface-water infiltration to an aquifer. Discharge occurs as natural flow from an aquifer to streams and springs, as evapotranspiration, and as withdrawal from wells. Hydraulic responses and controls on groundwater levels in major aquifers in Georgia are summarized on pages 8 and 9.

Water levels in aquifers in Georgia typically follow a cyclical pattern of seasonal fluctuation. Water levels rise during winter and spring because of increased recharge from precipitation and decline during summer and fall because of decreased recharge, greater evapotranspiration, and pumping. The magnitude of fluctuations can vary greatly from season to season and from year to year in response to changing climatic conditions.

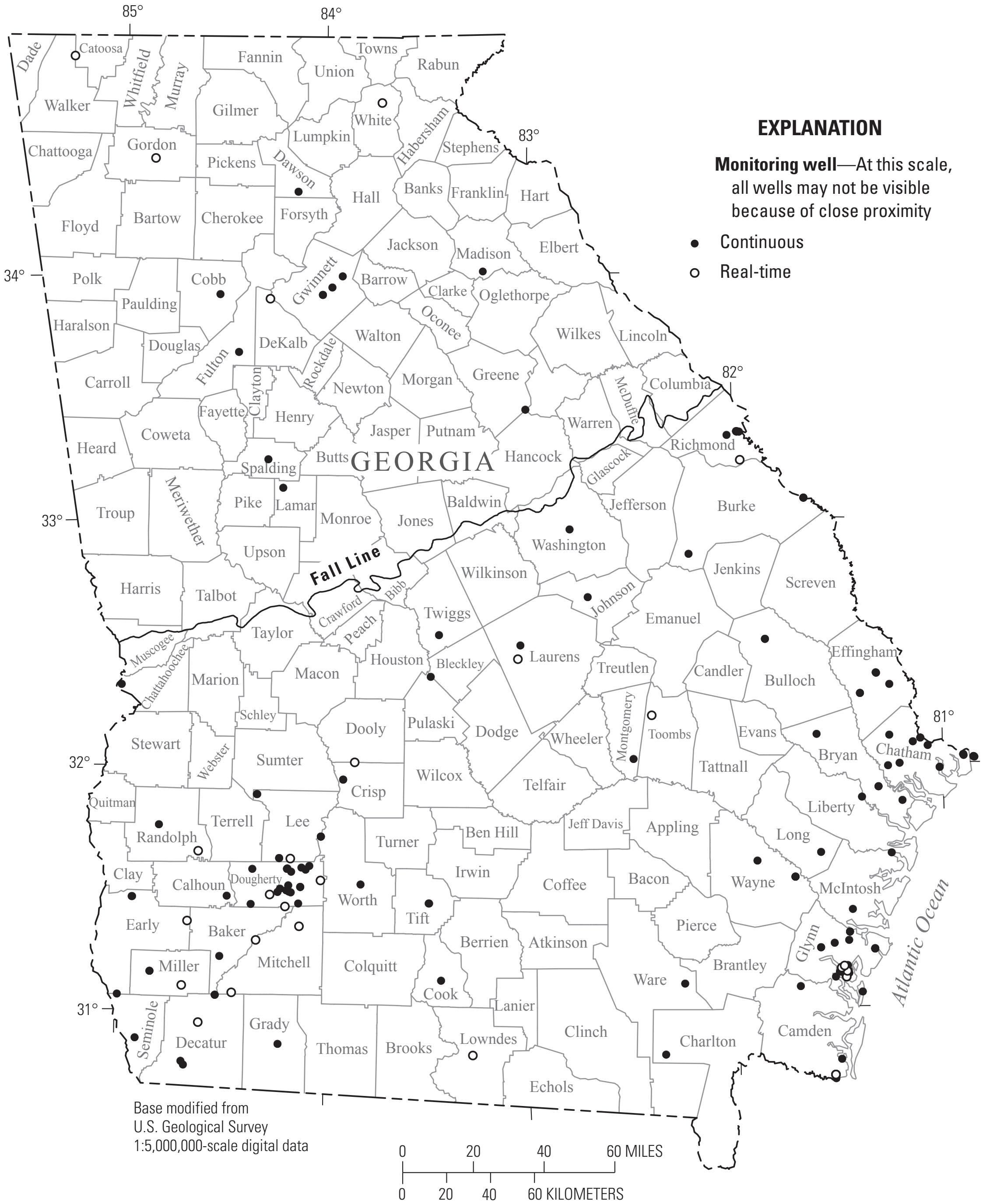
Groundwater pumping is the most important human activity that affects the amount of groundwater in storage and the rate of discharge from an aquifer (Taylor and Alley, 2001). As groundwater storage is depleted within the radius of influence of pumping, water levels in the aquifer decline forming a cone of depression around the well. In areas having a high density of pumped wells, multiple cones of depression can form and combine to produce water-level declines across a large area. These declines may alter groundwater-flow directions, reduce flow to streams, capture water from a stream or adjacent aquifer, or alter groundwater quality. The effects of sustained pumping can be seen in the hydrograph of well 07N001 completed in the Clayton aquifer in Randolph County (below).

Reference

Taylor, C.J., and Alley, W.M., 2001, Ground-water-level monitoring and the importance of long-term water-level data: U.S. Geological Survey Circular 1217, 68 p.



Example hydrograph showing monthly mean water levels and trend line for well 07N001 for the period 1965–2009, Randolph County, Georgia.



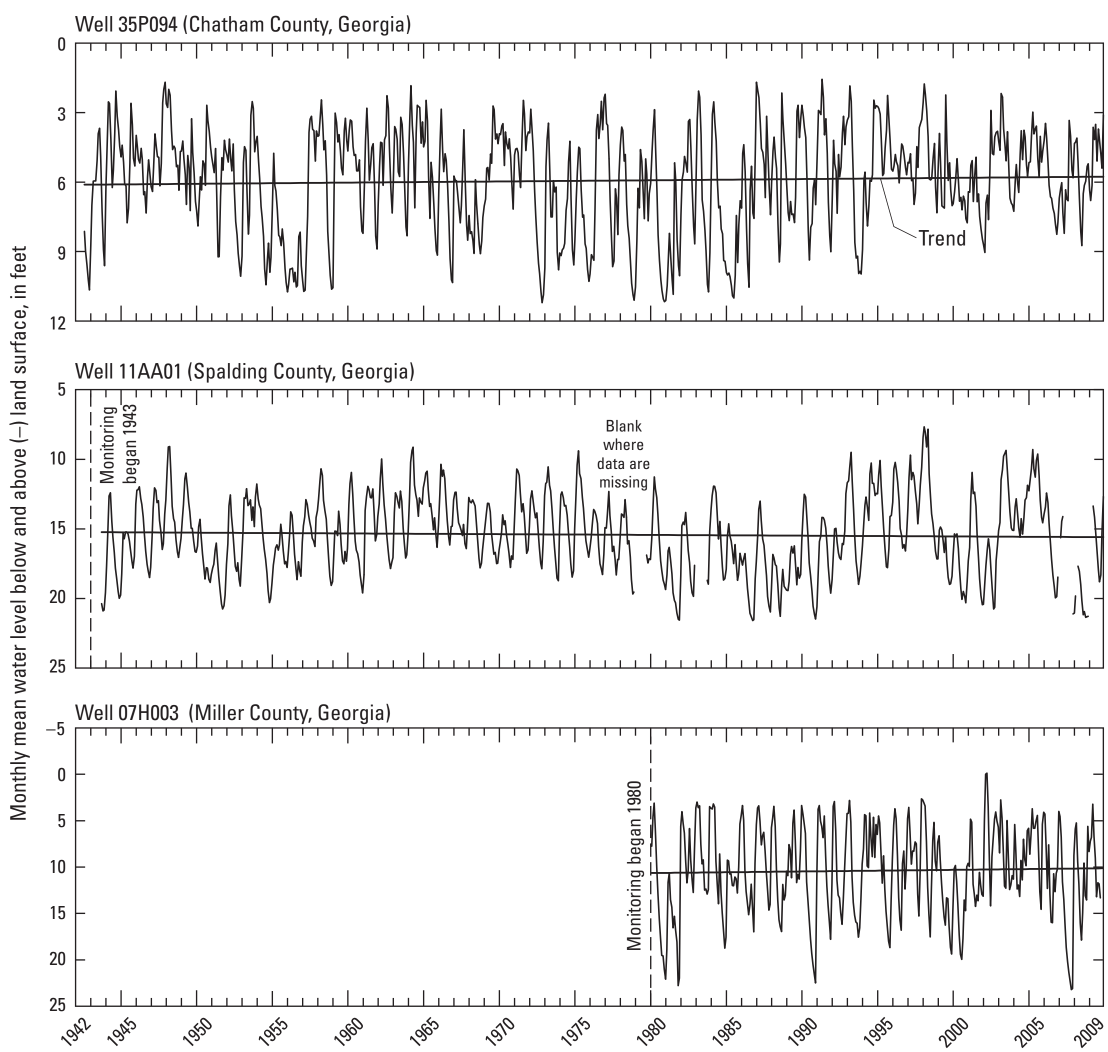
Locations of monitoring wells used to collect long-term water-level data in Georgia during 2008–2009.

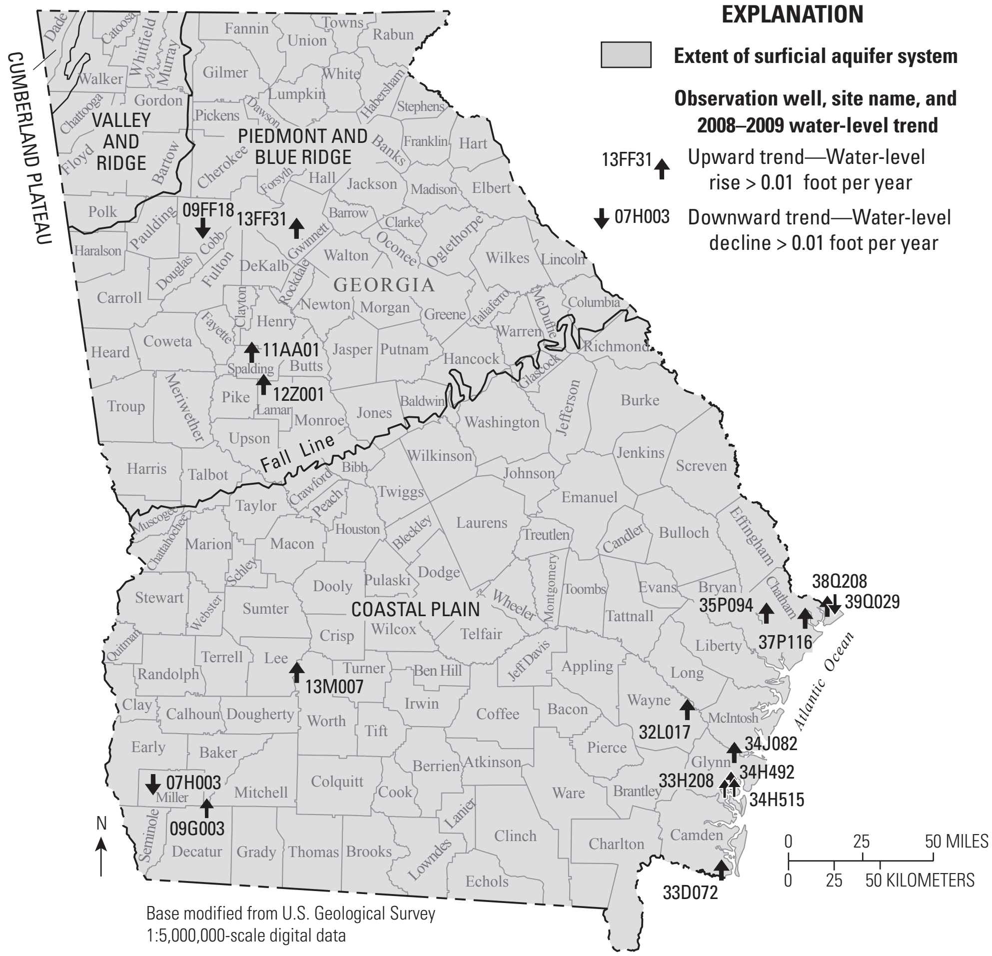
Groundwater Levels

Surficial Aquifer System

Water levels measured in 17 wells were used to define conditions in the surficial aquifer system during 2008–2009 (map and table, facing page). Groundwater in the surficial aquifer system typically is in contact with the atmosphere (referred to as an unconfined or water-table aquifer), but locally (especially in coastal Georgia) may be under pressure exerted by overlying sediments or rocks (referred to as a confined aquifer). Where unconfined, water levels change quickly in response to recharge and discharge. Consequently, hydrographs from these wells show a strong relation to climatic fluctuations. Water-level hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show mostly seasonal variations, with periodic upward or downward trends that respectively reflect surplus or deficits in rainfall. These periodic trends tend to be level over the long term.

Water levels in the surficial aquifer have shown little change in long-term trend during the period of record with rates of change less than ±0.01 foot per year (ft/yr) in three of the wells, declines of 0.01 to 0.33 ft/yr in nine wells, and rises of 0.02 to 0.41 ft/yr in five wells. During 2008–2009, water levels in all but two of the wells rose from 0.12 to 2.85 ft/yr corresponding to an increase in precipitation at the end of a 2-year drought in 2008. Well 09FF18 in Cobb County had a decline of 0.38 ft/yr during 2008–2009, continuing a downward trend since 2001. The reason for this downward trend is unknown but may be related to nearby pumping.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
33D072	Camden	1998	0.41	0.88
35P094	Chatham	1942	<.01	0.94
37P116	Chatham	1984	<.01	0.12
38Q208	Chatham	1998	–0.01	0.65
39Q029	Chatham	1998	–0.01	0.79
09FF18	Cobb	2001	–0.10	–0.38
09G003	Decatur	1980	–0.04	1.27
33H208	Glynn	1985	0.15	1.05
34H492	Glynn	1999	0.08	0.88
34H515	Glynn	2005	0.03	0.24
34J082	Glynn	2002	–0.08	0.40
13FF31	Gwinnett	2003	–0.33	1.21
12Z001	Lamar	1967	–0.07	1.23
07H003	Miller	1980	0.02	–0.08
11AA01	Spalding	1943	–0.01	2.85
32L017	Wayne	1983	–0.15	0.39
13M007	Worth	1980	<.01	0.39

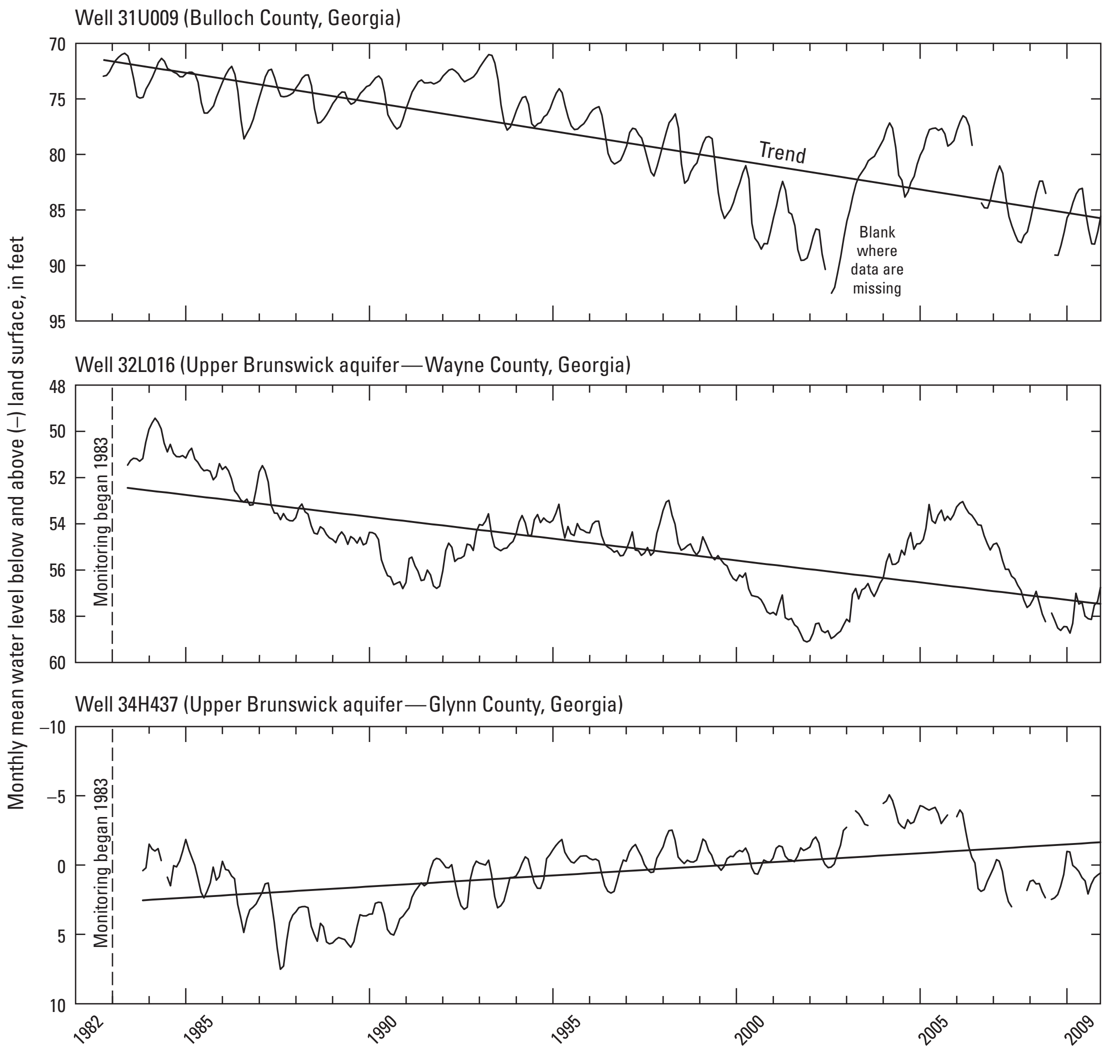
[1]See appendix for summary statistics.

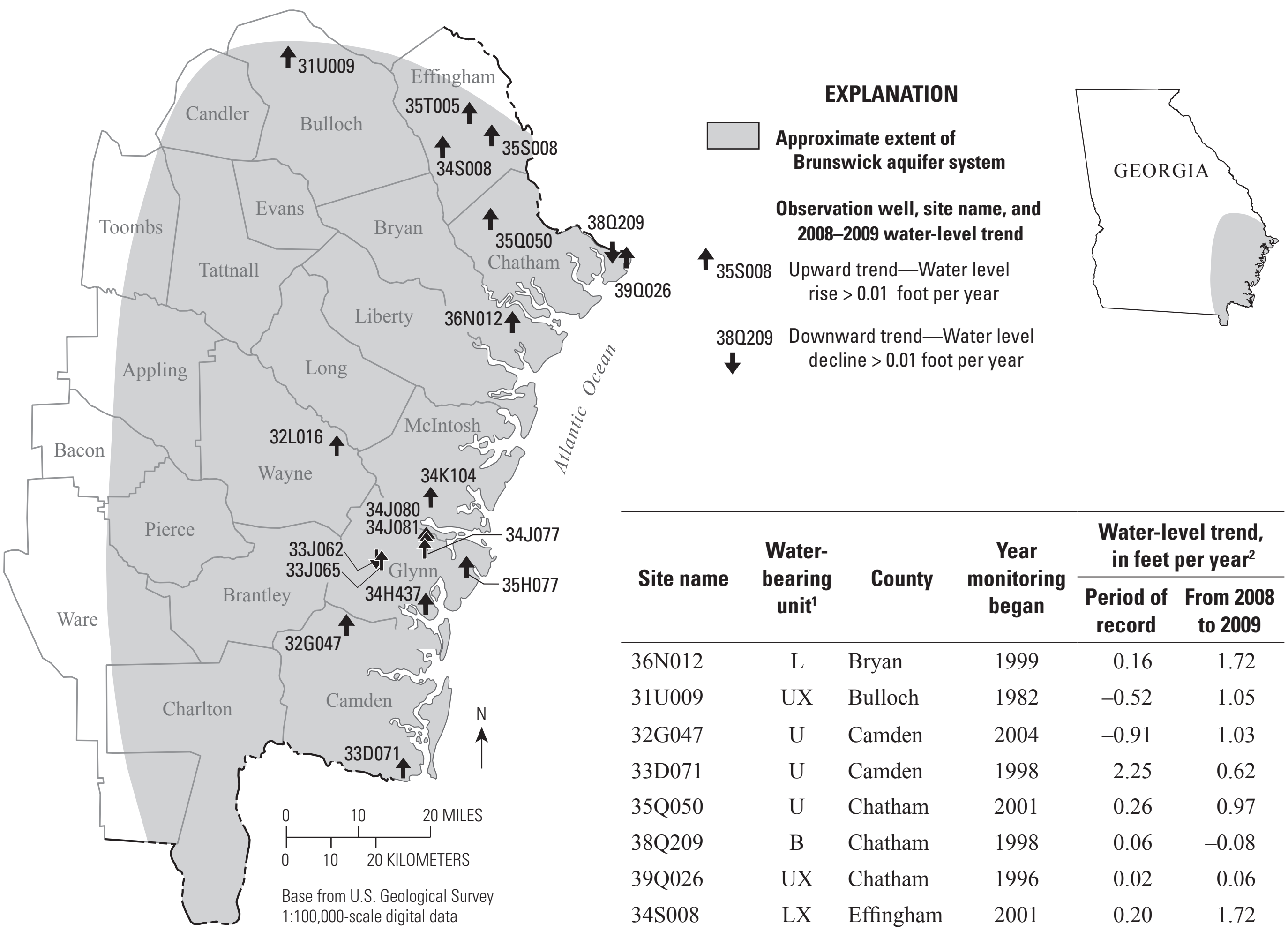
Groundwater Levels

Brunswick Aquifer System

Water levels in 19 wells were used to define conditions during 2008–2009 in the Brunswick aquifer system. The aquifer system consists of the upper and lower Brunswick aquifers and equivalent low-permeability sediments to the north and west in southeastern Georgia, which are confined throughout the known area of extent (map and table, facing page). Water-level fluctuations reflect changes in local pumping, interaquifer-leakage effects, and recharge. Water-level hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect surplus or deficits in rainfall, respectively, and changes in pumping.

During the period of record, water levels in 11 of the 19 wells have remained the same or have been rising at rates of 0.02 to 2.25 feet per year (ft/yr). Water levels in eight wells declined at rates of 0.06 to 0.94 ft/yr during the period of record. During 2008–2009, water levels in 17 wells rose at rates of 0.05 to 2.30 ft/yr, which reflects recovery from the drought that ended in late 2008. Water levels in two wells declined from 0.08 to 0.37 ft/yr. The reason for the declining levels in these two wells is unknown but may be related to local variations in pumping





Site name	Water-bearing unit[1]	County	Year monitoring began	Water-level trend, in feet per year[2]	
				Period of record	From 2008 to 2009
36N012	L	Bryan	1999	0.16	1.72
31U009	UX	Bulloch	1982	–0.52	1.05
32G047	U	Camden	2004	–0.91	1.03
33D071	U	Camden	1998	2.25	0.62
35Q050	U	Chatham	2001	0.26	0.97
38Q209	B	Chatham	1998	0.06	–0.08
39Q026	UX	Chatham	1996	0.02	0.06
34S008	LX	Effingham	2001	0.20	1.72
35S008	LX	Effingham	2000	0.27	1.02
35T005	UX	Effingham	2000	0.23	1.11
33J062	L	Glynn	2001	<.01	–0.37
33J065	U	Glynn	2001	<.01	0.32
34H437	U	Glynn	1983	0.16	0.52
34J077	U	Glynn	1998	–0.94	2.30
34J080	L	Glynn	2002	–0.52	1.46
34J081	U	Glynn	2002	–0.16	1.30
35H077	L	Glynn	2005	–0.06	1.59
34K104	L	McIntosh	2005	–0.40	1.06
32L016	U	Wayne	1983	–0.19	0.05

[1]L, lower Brunswick aquifer; UX, undifferentiated, low-permeability equivalent to the upper Brunswick aquifer; U, upper Brunswick aquifer; B, Brunswick aquifer system; LX, undifferentiated, low-permeability equivalent to the lower Brunswick aquifer.

[2]See appendix for summary statistics.

Groundwater Levels

Upper Floridan Aquifer

The Upper Floridan aquifer underlies most of the Coastal Plain of Georgia, southern South Carolina, extreme southeastern Alabama, and all of Florida (Miller, 1986). The aquifer is one of the most productive in the United States and a major source of water in the region. During 2005, about 658 million gallons per day (Mgal/d) were withdrawn from the Upper and Lower Floridan aquifers in Georgia, primarily for industrial and irrigation uses (Fanning and Trent, 2009).

The Upper Floridan aquifer predominately consists of Eocene to Oligocene limestone, dolomite, and calcareous sand. The aquifer is thinnest along its northern limit (map, facing page) and thickens to the southeast, where the maximum thickness is about 1,700 feet (ft) in Ware County, Georgia (Miller, 1986). The aquifer is confined throughout most of its extent, except where it crops out or is near land surface along the northern limit, and in karst areas in parts of southwestern and south-central Georgia.

The Coastal Plain of Georgia has been divided informally into four hydrologic areas for discussion of water levels (map, facing page)—the southwestern, south-central, east-central, and coastal areas. This subdivision is a modification of that used by Peck and others (1999) and is similar to that used by Clarke (1987).

Southwestern area. All or parts of 16 counties constitute the southwestern area. In this area, the Upper Floridan aquifer ranges in thickness from about 50 ft in the northwest to about 475 ft in the southeast (Hicks and others, 1987). The aquifer is overlain by sandy clay residuum, which is hydraulically connected to streams. Since the introduction of center-pivot irrigation systems around 1975, the Upper Floridan aquifer has been widely used as the primary water source for irrigation in southwestern Georgia (Hicks and others, 1987). According to Fanning and Trent (2009), about 314 Mgal/d of water was withdrawn from the Upper Floridan aquifer in the southwestern area during 2005, and 80 percent of this amount was used for irrigation.

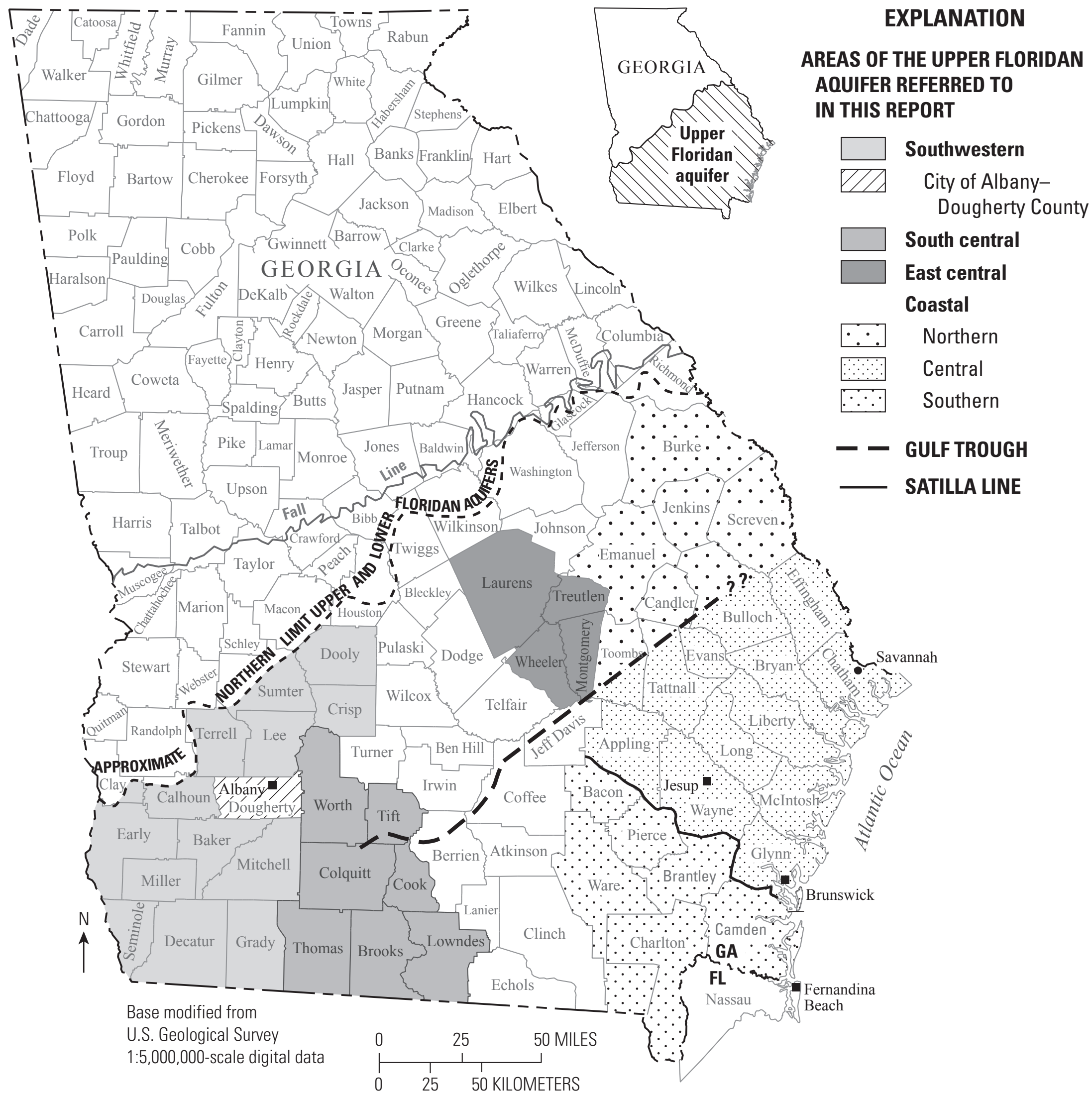
The City of Albany–Dougherty County lies in the southwestern area of Georgia. During 2005, most of the water withdrawn from the Upper Floridan aquifer in this area was used for public-supply (about 14 Mgal/d) and industry (14 Mgal/d; Fanning and Trent, 2009).

South-central area. Six counties constitute the south-central area. In this area, the Upper Floridan aquifer ranges in thickness from about 300 to 700 ft (Miller, 1986). Lowndes County is a karst region with abundant sinkholes and sinkhole lakes that have formed where the aquifer crops out and the overlying confining unit has been removed by erosion (Krause, 1979). Direct recharge from rivers to the Upper Floridan aquifer occurs through these sinkholes at a rate of about 70 Mgal/d (Krause, 1979). In the south-central area, groundwater use totaled about 91 Mgal/d in 2005, and most of this withdrawal was used for irrigation (Fanning and Trent, 2009).

East-central area. Four counties constitute the east-central area. In this area, the Upper Floridan aquifer can be as thick as 650 ft in the southeast or absent in the north. In the east-central area, groundwater withdrawal totaled about 15 Mgal/d during 2005 and was used predominantly for irrigation (Fanning and Trent, 2009).

Coastal area. The Georgia Environmental Protection Division (GaEPD) defines the coastal area of Georgia as a 24-county area that includes 6 coastal counties and the adjacent 18 counties—an area of about 12,240 square miles. In the coastal area, the Upper Floridan aquifer may be thin or absent in the north (Burke County) to about 1,700 ft thick in the south (Ware County; Miller, 1986). Excluding withdrawals for thermoelectric-power generation, nearly 70 percent of all withdrawals in the area are from groundwater, primarily for industrial purposes. During 2005, about 308 Mgal/d of water was withdrawn from the Upper Floridan aquifer in the coastal area (Fanning and Trent, 2009).

The coastal area of Georgia has been subdivided by GaEPD into three subareas—the northern, central, and southern—to facilitate implementation of the State's water-management policies. The central subarea includes the largest concentration of pumpage in the coastal area of the Savannah, Brunswick, and Jesup pumping centers. The northern subarea is northwest of the Gulf Trough (Herrick and Vorhis, 1963), a prominent geologic feature that is characterized by a zone of low permeability in the Upper Floridan aquifer that inhibits flow between the central and northern subareas. In these two subareas, pumping from the aquifer primarily is for agricultural use, and no large pumping centers are located in the area. The southern subarea is separated from the central subarea by the Satilla line, a postulated hydrologic boundary (W.H. McLemore, Georgia Environmental Protection Division, Geologic Survey Branch, oral commun., 2000). In this area, the largest pumping center is at Fernandina Beach, Nassau County, Florida.



Areas of the Upper Floridan aquifer referred to in this report.

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Clarke, J.S., 1987, Potentiometric surface of the Upper Floridan aquifer in Georgia, May 1985, and water-level trends, 1980–85: Georgia Geologic Survey Hydrologic Atlas 16, scale 1:1,000,000, 1 sheet.

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Miller, J.A., 1986, Hydrogeologic framework of the Floridan aquifer system in Florida and parts of Georgia, Alabama, and South Carolina: U.S. Geological Survey Professional Paper 1403-B, 91 p.

Peck, M.F., Clarke, J.S., Ransom, III, Camille, and Richards, C.J., 1999, Potentiometric surface of the Upper Floridan aquifer in Georgia and adjacent parts of Alabama, Florida and South Carolina, May 1998, and water-level trends in Georgia, 1990–98: Georgia Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, Hydrologic Atlas 22, 1 pl.

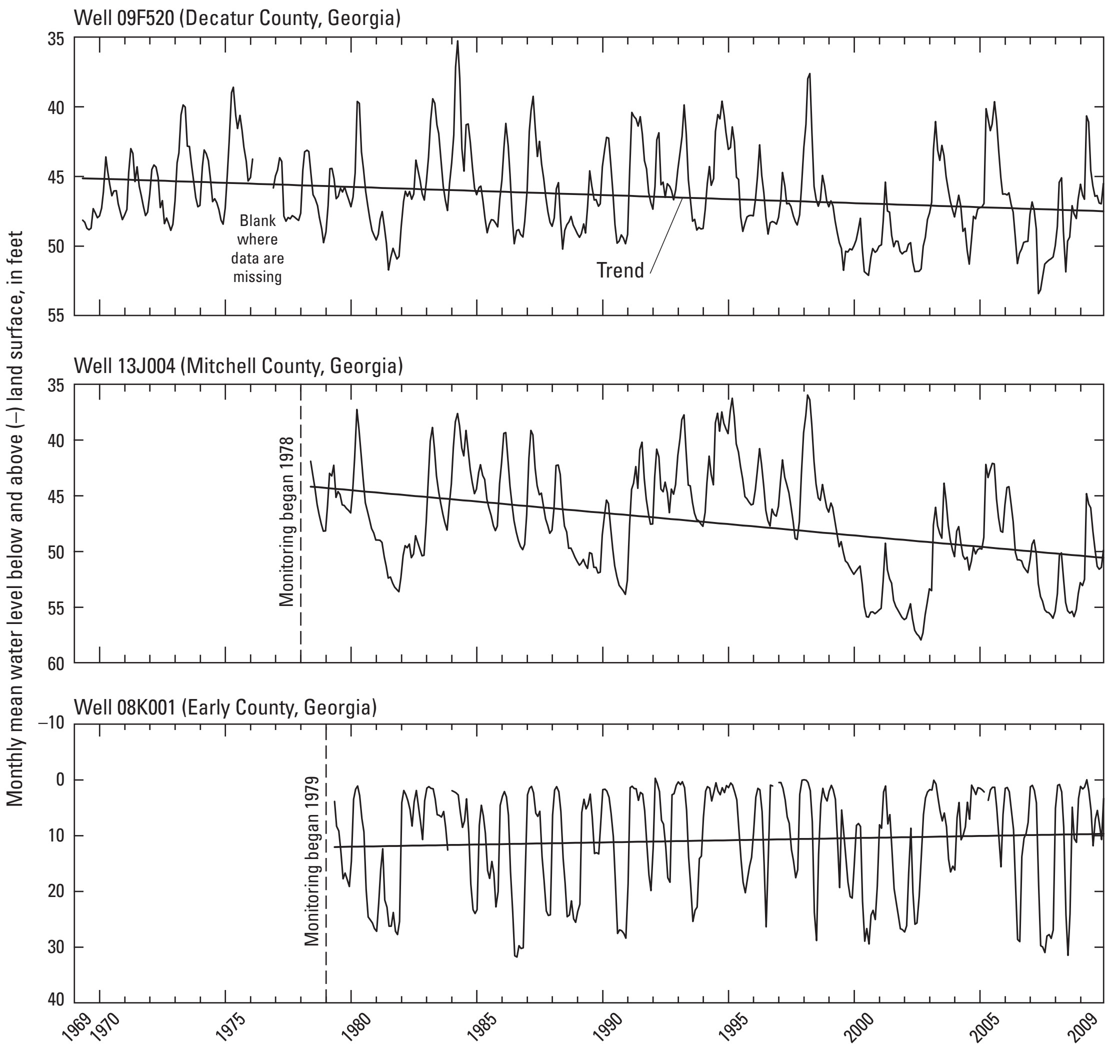
Groundwater Levels

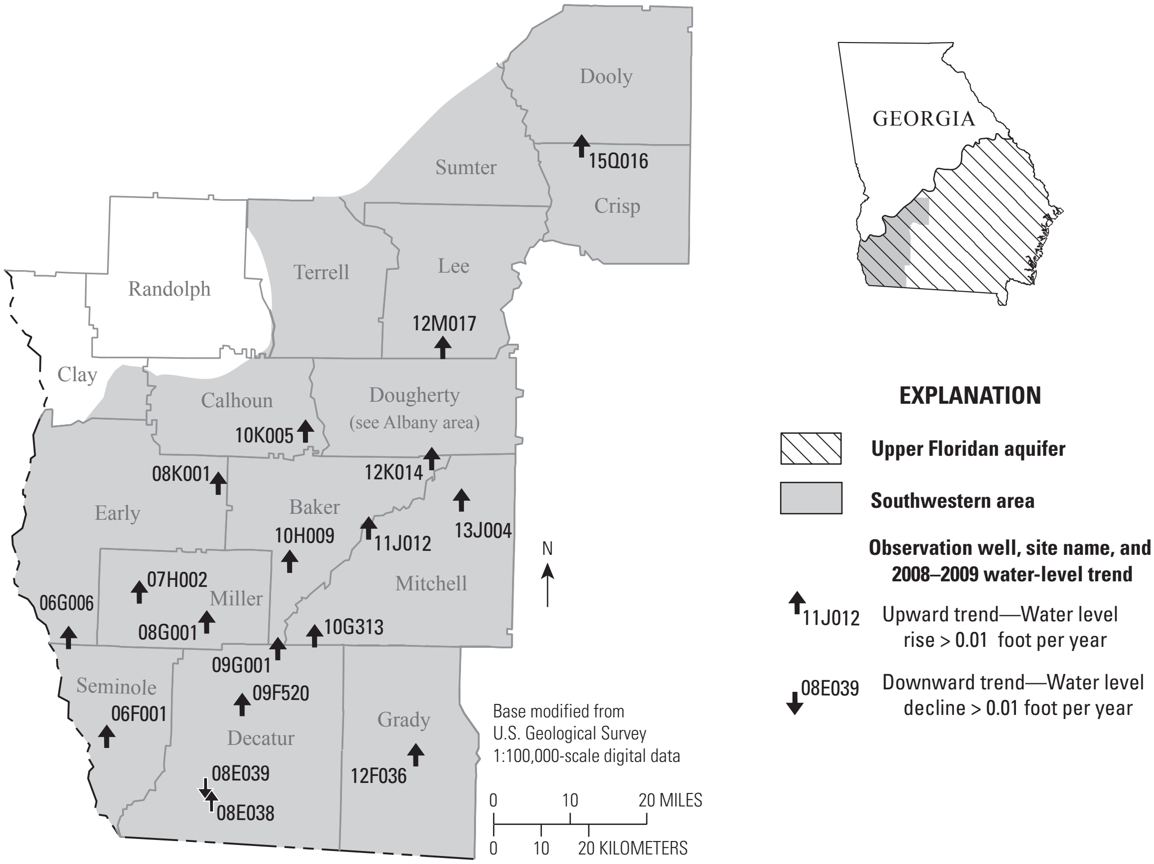
Upper Floridan Aquifer

Southwestern Area

Water levels in 18 wells were used to define groundwater conditions in the Upper Floridan aquifer in southwestern Georgia during 2008–2009 (map and table, facing page). In this area, water in the Upper Floridan aquifer typically is confined; however, in areas where no sediments overlie the aquifer (typically to the north and west), water is unconfined. Water levels in this area are affected by changes in precipitation and pumping. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect surplus or deficits in rainfall, respectively, and changes in pumping.

During the period of record, water levels in 11 wells had declining trends of 0.05 to 0.73 foot per year (ft/yr), and 7 wells had rising trends of 0.01 to 0.38 ft/yr. During 2008–2009, water levels in 17 of the wells rose 0.37 to 6.02 ft/yr, which reflect recovery from the drought that ended in late 2008. One well (08E039), however, had a declining trend of 0.48 ft/yr.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
10H009	Baker	1998	0.33	4.53
12K014	Baker	1982	–0.09	2.03
10K005	Calhoun	1983	–0.09	1.19
15Q016	Crisp	2002	–0.73	1.78
08E038	Decatur	2001	0.12	0.37
08E039	Decatur	2002	0.01	–0.48
09F520	Decatur	1972	–0.06	2.03
09G001	Decatur	1980	–0.07	2.04
06G006	Early	1982	–0.05	5.06
08K001	Early	1982	0.08	2.22
12F036	Grady	1971	0.26	2.30
12M017	Lee	1982	0.06	0.86
07H002	Miller	1980	0.38	3.29
08G001	Miller	1977	–0.11	6.02
10G313	Mitchell	1976	–0.08	2.91
11J012	Mitchell	1981	–0.06	1.95
13J004	Mitchell	1978	–0.20	2.82
06F001	Seminole	1979	–0.10	4.41

[1]See appendix for summary statistics.

Groundwater Levels

Upper Floridan Aquifer

City of Albany–Dougherty County Area

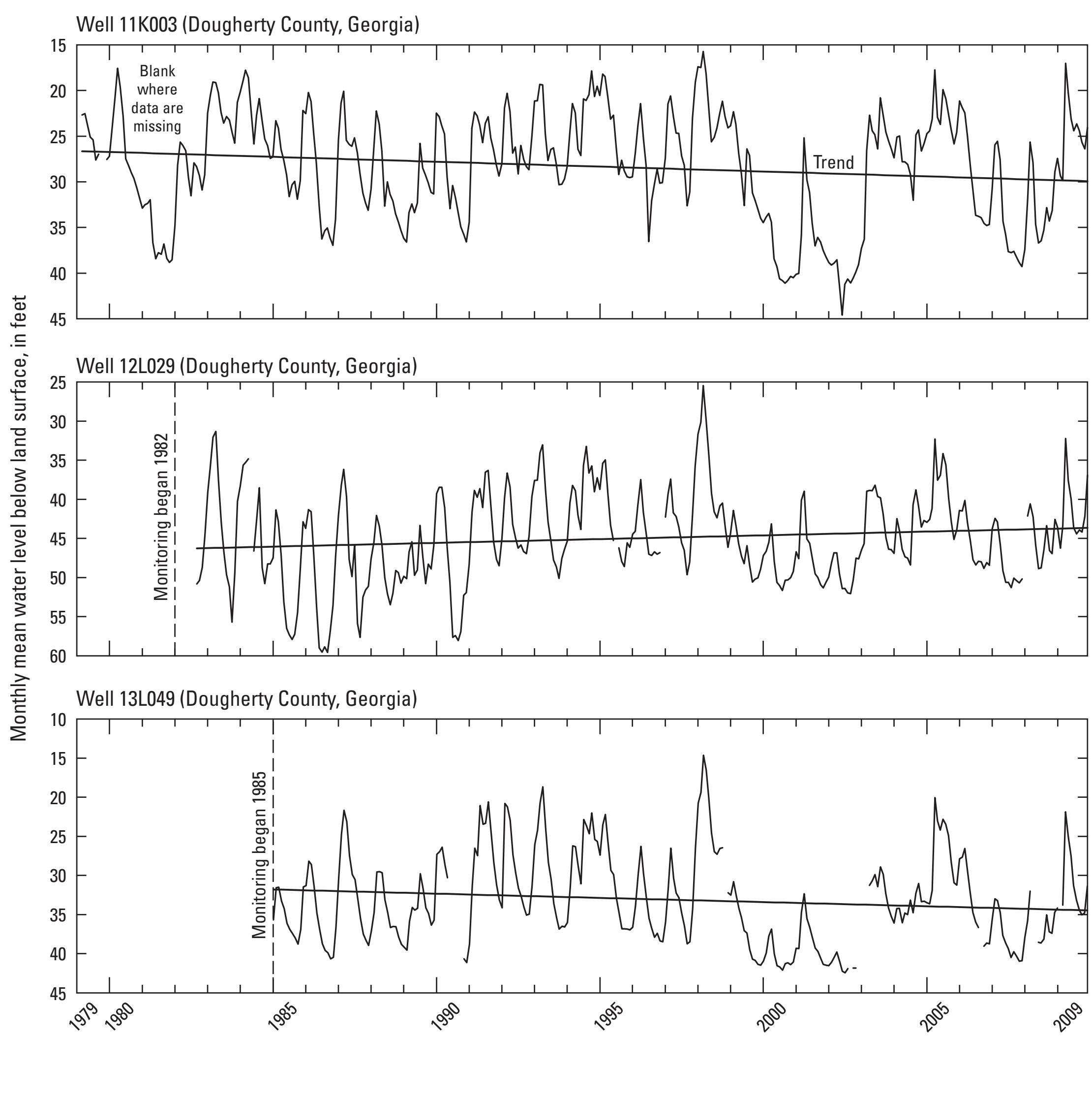
Water levels in 12 wells were used to define groundwater conditions in the Upper Floridan aquifer near Albany, Georgia, during 2008–2009 (Dougherty County map and table, facing page). Water levels in this area are affected by changes in precipitation and pumping. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect surplus or deficits in rainfall, respectively, and changes in pumping.

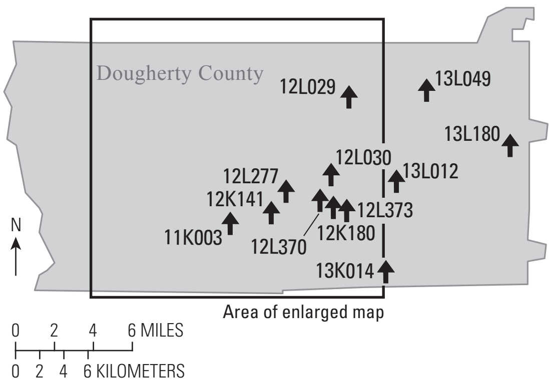
During the period of record, water levels in 9 of the 12 wells had declining trends of 0.03 to 0.36 foot per year (ft/yr); the remaining 3 wells had rising trends of 0.07 to 0.10 ft/yr. During 2008–2009, water levels in all of the wells rose from 1.86 to 7.33 ft/yr, which reflect recovery from the drought that ended in late 2008.

In addition to continuous water-level monitoring, synoptic water-level measurements are made periodically in wells southwest of Albany. Water-level measurements from 81 wells during November 2008 and 64 wells during November 2009 were used to construct maps showing the potentiometric surface of the Upper Floridan aquifer. Although water levels in 2009 generally were higher than in 2008, the configuration of the potentiometric surface maps (facing page) was similar. The potentiometric-surface maps show that water generally flows from northwest to southeast toward the Flint River. In the southeastern part of the mapped area, flow was away from the river toward the southwest.

Reference

Gordon, D.W., 2009, Groundwater conditions and studies in the Albany area of Dougherty County, Georgia, 2008: U.S. Geological Survey Open-File Report 2009–1244, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1244/*.





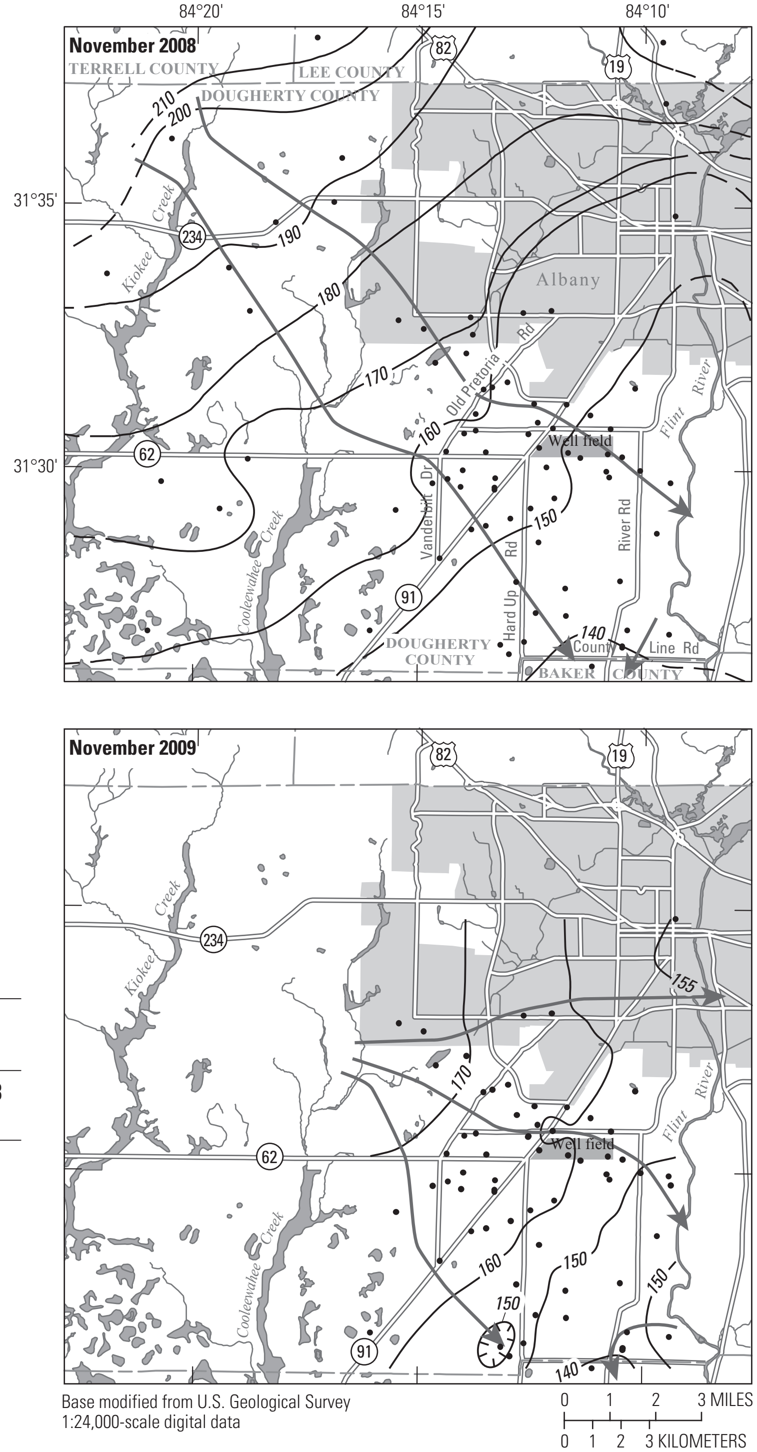
EXPLANATION

Upper Floridan aquifer

City of Albany–Dougherty County area

Observation well, site name, and 2008–2009 water-level trend

11K003 ↑ Upward trend—Water level rise > 0.01 foot per year



EXPLANATION

— *150* — **Potentiometric contour**—Shows altitude at which water level would have stood in tightly cased wells. Dashed where approximately located. Hachures indicate depression. Contour interval 10 feet. Datum is National Geodetic Vertical Datum 1929 (November 2008 map modified from Gordon, 2009)

Direction of groundwater flow

• **Well data point**

Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
11K003	Dougherty	1982	–0.11	6.39
12K141	Dougherty	1996	–0.36	7.33
12K180	Dougherty	2002	–0.15	2.78
12L029	Dougherty	1982	0.10	2.39
12L030	Dougherty	1985	–0.06	3.81
12L277	Dougherty	2000	0.07	6.43
12L370	Dougherty	2000	0.07	3.32
12L373	Dougherty	2002	–0.16	3.27
13K014	Dougherty	1982	–0.11	1.86
13L012	Dougherty	1978	–0.04	2.14
13L049	Dougherty	1985	–0.11	3.35
13L180	Dougherty	1996	–0.03	2.83

[1]See appendix for summary statistics.

Groundwater Levels

Upper Floridan Aquifer

South-Central Area

Water levels in five wells were used to define groundwater conditions in the Upper Floridan aquifer in south-central Georgia during 2008–2009 (map and table below). In this area, water in the Upper Floridan aquifer generally is confined but locally is unconfined in karst areas in Lowndes County. Water levels in this area are affected by changes in pumping and by precipitation, with climatic effects more pronounced in areas where the aquifer is close to land surface, such as the karst area in Lowndes County and near the Flint River in the northwestern part of Worth County.

Hydrographs for selected wells (facing page) illustrate monthly mean water levels for the period of record. In Lowndes County, water-level fluctuations in well 19E009 show a pronounced response to climatic effects because the well is in a karst area. Climatic effects are less pronounced in the other three wells, and water levels primarily are influenced by pumping. The hydrographs show periodic upward or downward trends that reflect surplus or deficits in rainfall, respectively, and changes in pumping.

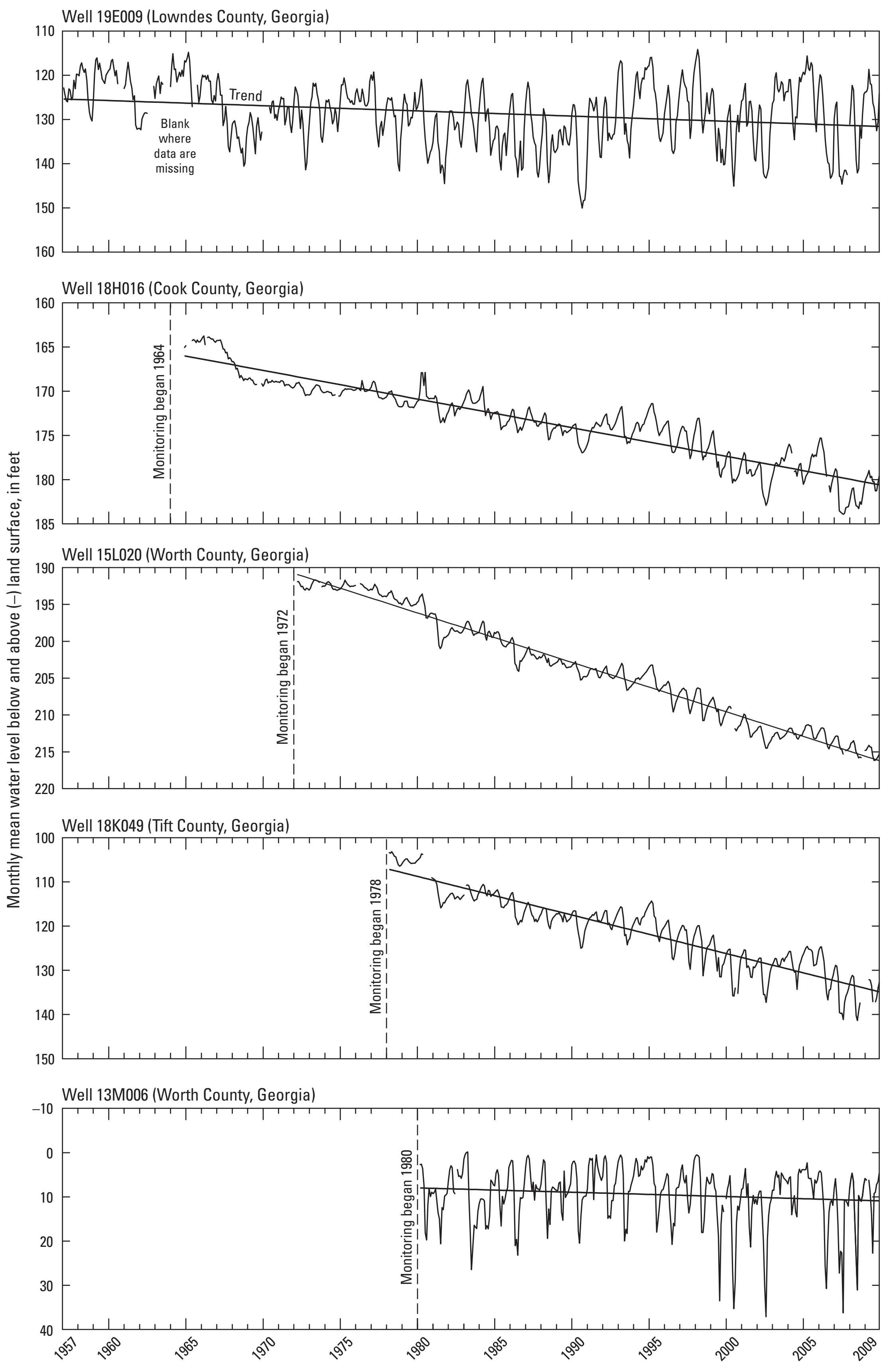
During the period of record, water levels in all five of the wells monitored in the south-central area declined 0.10 to 0.87 foot per year (ft/yr). The greatest declines were in Tift, Cook, and Worth Counties in the northern and eastern part of the area, where recharge is limited by low permeability overburden and irrigation pumping is high (Torak and others, 2010). The rate of decline was lower in wells located near areas of recharge in Lowndes County (well 19E009) and near the Flint River in northwestern Worth County (well 13M006). During 2008–2009, water levels in three of the five wells rose at rates ranging from 1.37 to 2.83 ft/yr, which reflect recovery from the drought that ended in late 2008. Despite the end of the drought, however, water levels in wells 15L020 and 18K049 continued to decline at rates of 0.76 and 0.03 ft/yr, respectively, which reflect the restricted recharge and influence of continued pumping in the area.

Reference

Torak, L.J., Painter, J.A., and Peck, M.F., 2010, Geohydrology of the Aucilla–Suwannee–Ochlockonee River basin, south-central Georgia and adjacent parts of Florida: U.S. Geological Survey Scientific Investigations Report 2010–5072, available online at *http://pubs.usgs.gov/sir/2010/5072/*.

Site name	County	Year monitoring began	Water-level trend, in feet, per year[1] Period of record	From 2008 to 2009
18H016	Cook	1971	–0.32	1.37
19E009	Lowndes	1957	–0.12	2.83
18K049	Tift	1978	–0.87	–0.03
13M006	Worth	1980	–0.10	1.62
15L020	Worth	1972	–0.67	–0.76

[1]See appendix for summary statistics.



Well 19E009 (Lowndes County, Georgia)
Trend
Blank where data are missing
Well 18H016 (Cook County, Georgia)
Monitoring began 1964
Well 15L020 (Worth County, Georgia)
Monitoring began 1972
Well 18K049 (Tift County, Georgia)
Monitoring began 1978
Well 13M006 (Worth County, Georgia)
Monitoring began 1980
Monthly mean water level below and above (–) land surface, in feet
1957
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2009

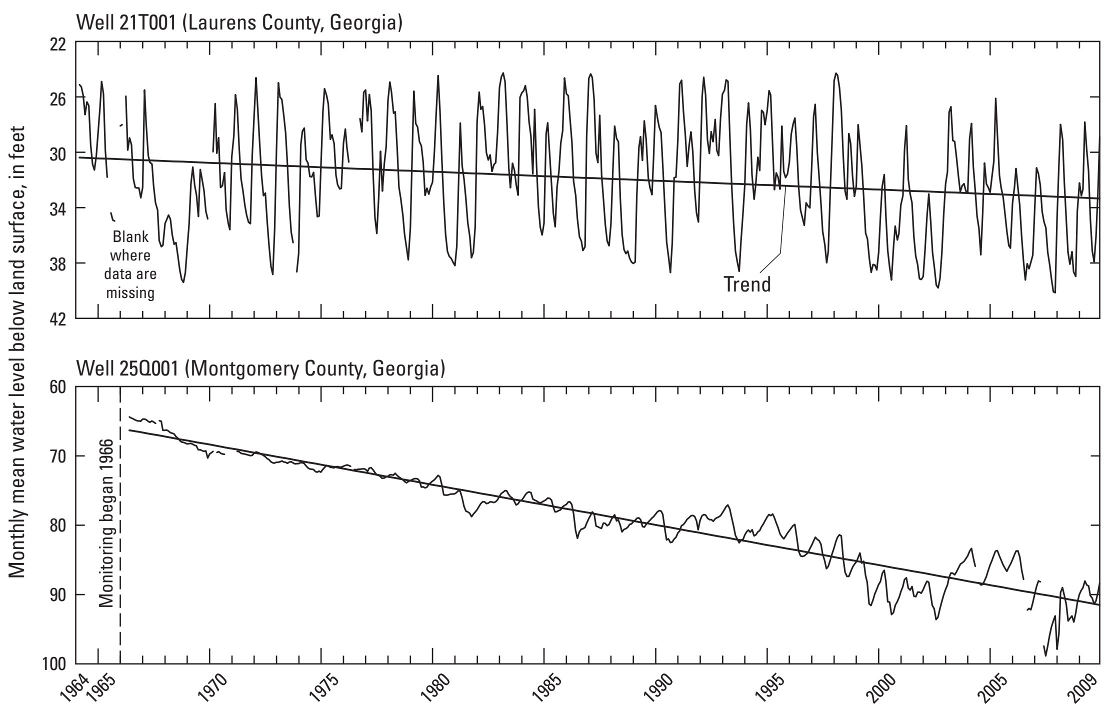
Groundwater Levels

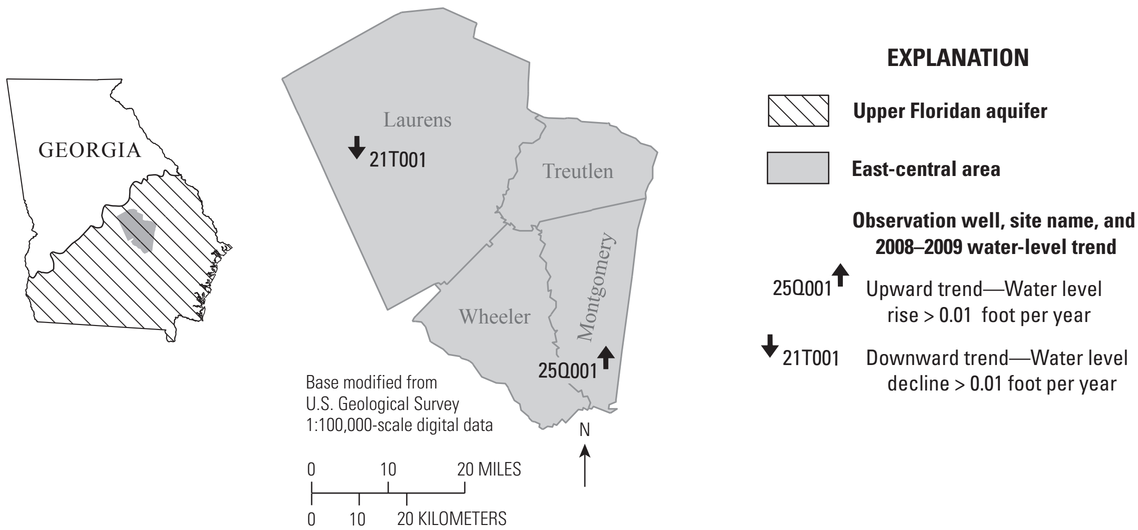
Upper Floridan Aquifer

East-Central Area

Water levels in two wells were used to define groundwater conditions in the Upper Floridan aquifer in east-central Georgia during 2008–2009 (map and table, facing page). In this area, water in the Upper Floridan aquifer is confined in the southeast and is semiconfined in the northwest, and water levels are influenced by climatic effects and agricultural pumping in these areas. Hydrographs for the two wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect surplus or deficits in rainfall, respectively, and changes in pumping.

During the period of record, water levels in both wells showed a long-term decline, ranging from 0.06 foot per year (ft/yr) in well 21T001 to 0.58 ft/yr in well 25Q001. During 2008–2009, water levels in well 21T001 continued to show a slight decline (0.18 ft/yr), whereas water levels in well 25Q001 rose 2.39 ft/yr. These variations in water-level response may be related to differences in proximity to available recharge and to local pumping changes. Well 21T001 in Laurens County is in the northwestern part of the area where the aquifer is semiconfined and close to the area of recharge. Well 25Q001 in Montgomery County is in an area where the aquifer is deeply buried and confined and is more isolated from recharge sources. Local and regional pumping have a more pronounced effect on water levels in well 21T001, which may account for the larger rate of change observed during the period of record and 2008–2009.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
21T001	Laurens	1964	–0.06	–0.18
25Q001	Montgomery	1966	–0.58	2.39

[1]See appendix for summary statistics.

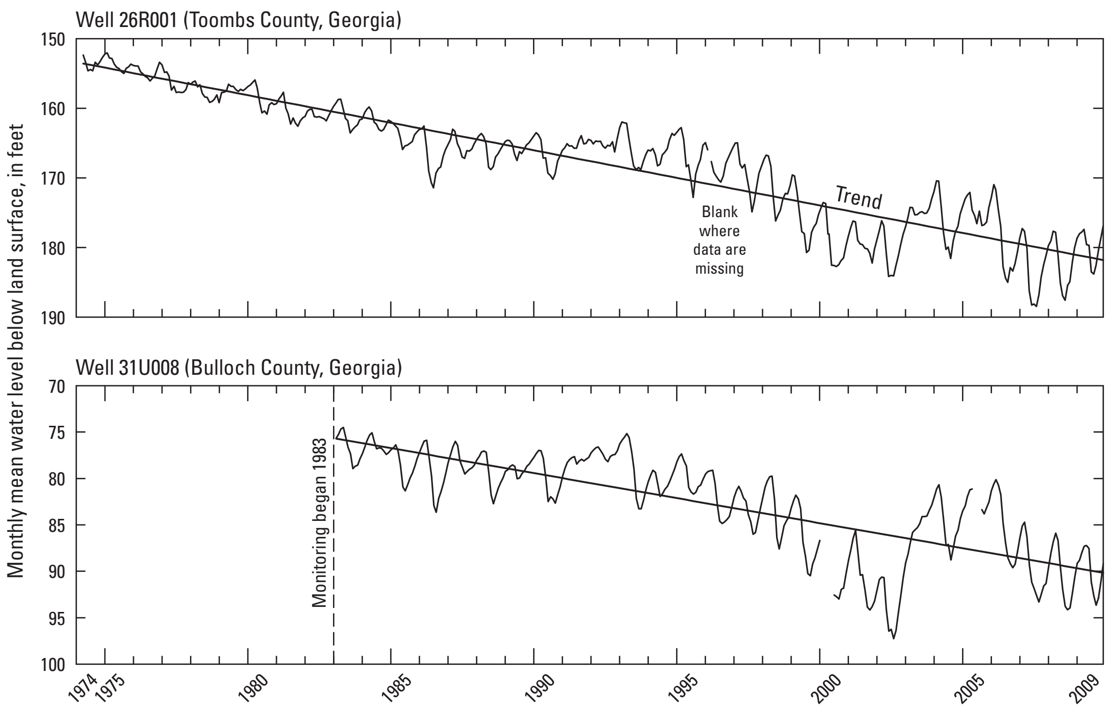
Groundwater Levels

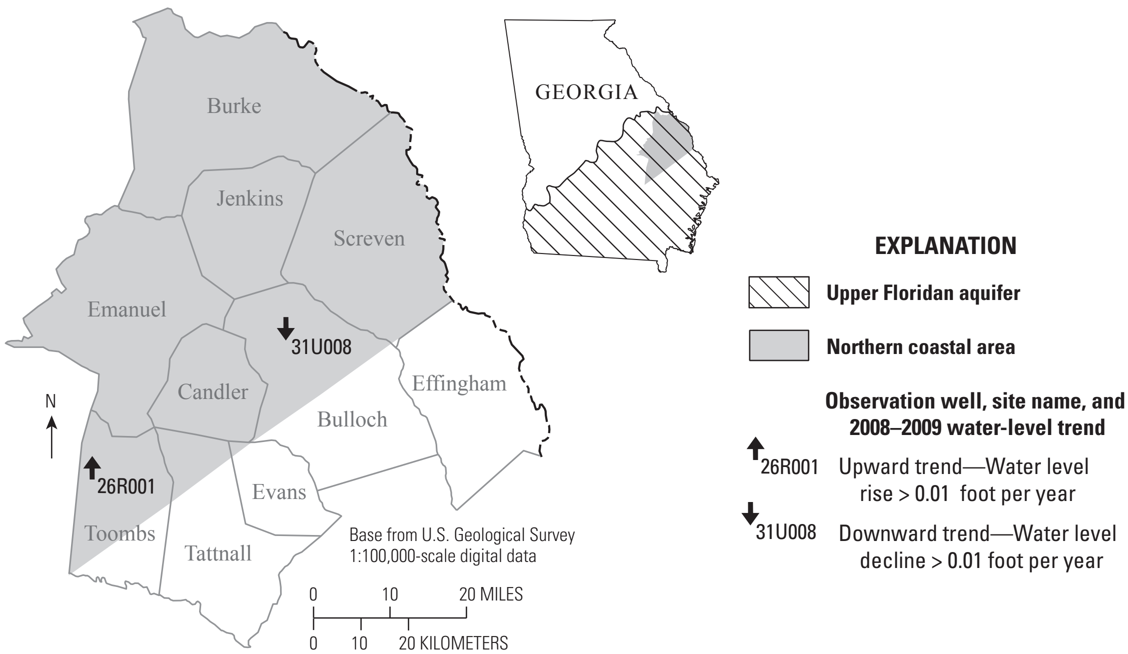
Upper Floridan Aquifer

Northern Coastal Area

Water levels in two wells were used to define groundwater conditions in the Upper Floridan aquifer in the northern coastal area during 2008–2009 (map and table, facing page). In this area, water in the Upper Floridan aquifer is confined to the southeast and is semiconfined to the northwest, and water levels are influenced by climatic effects and agricultural pumping in these areas. Hydrographs for the two wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect surplus or deficits in rainfall, respectively, and changes in pumping.

During the period of record, water levels declined at rates of 0.54 foot per year (ft/yr) in well 31U008 and 0.79 ft/yr in well 26R001. During 2008–2009, water levels declined at an accelerated rate of 1.13 ft/yr in well 31U008, whereas water levels in well 26R001 rose at a rate of 0.92 ft/yr. These variations likely resulted from changes in nearby pumping.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
31U008	Bulloch	1983	–0.54	–1.13
26R001	Toombs	1974	–0.79	0.92

[1]See appendix for summary statistics.

Groundwater Levels

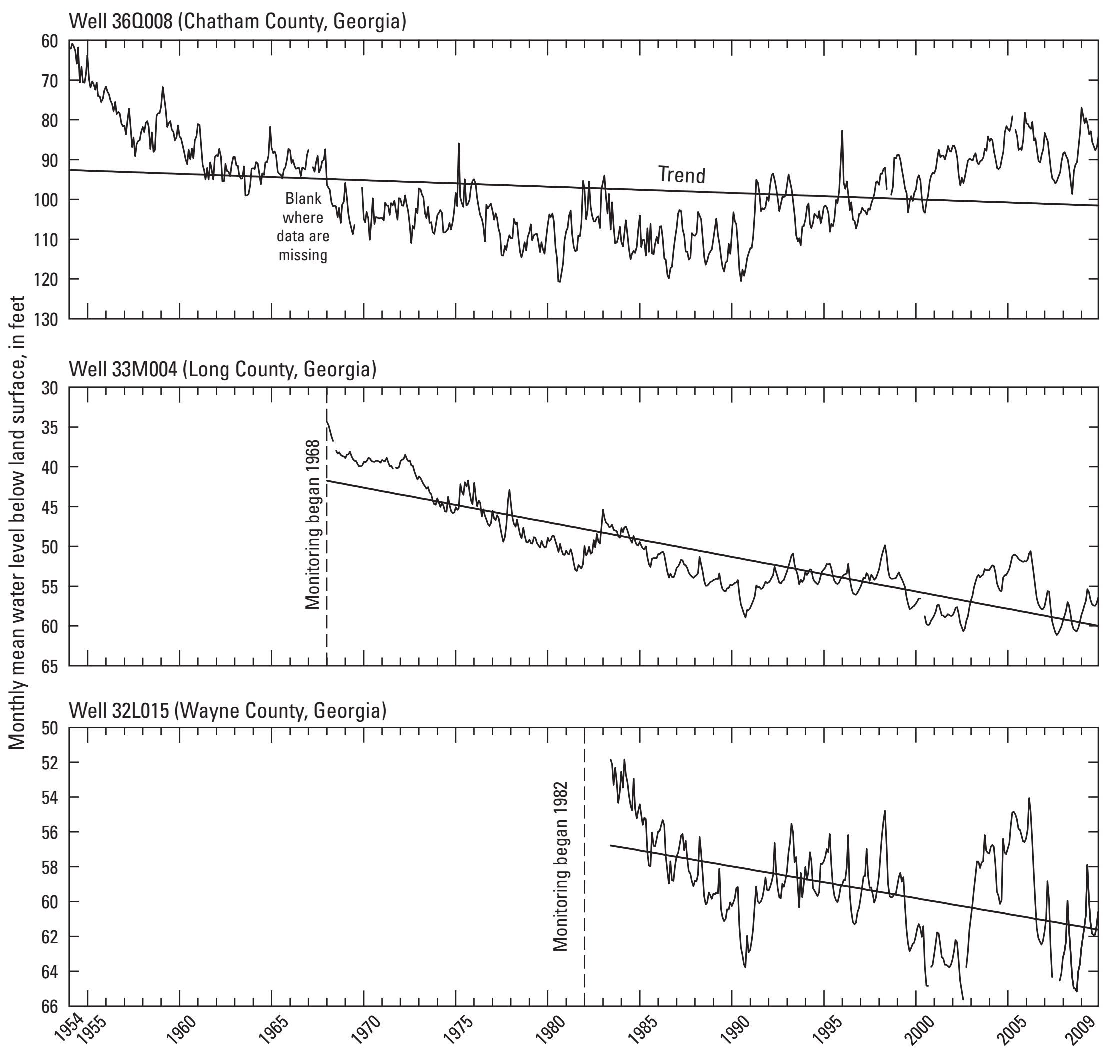
Upper Floridan Aquifer

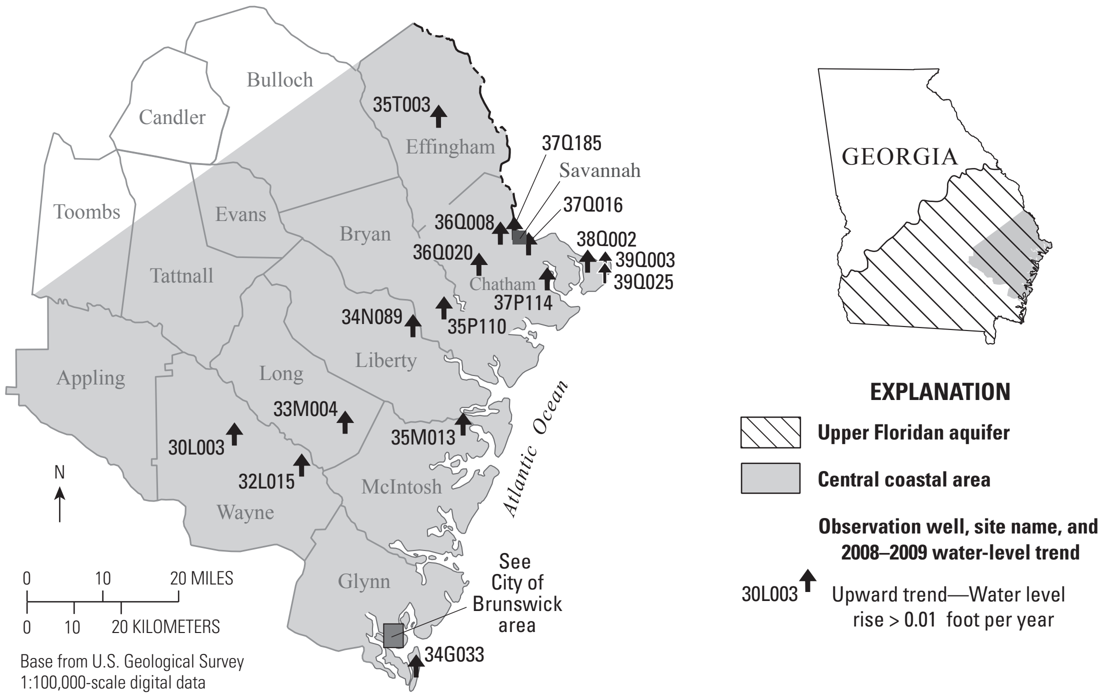
Central Coastal Area

Water levels in 16 wells were used to define groundwater conditions in the Upper Floridan aquifer in the central coastal area of Georgia (excluding the Brunswick area of Glynn County) during 2008–2009 (map and table below). In this area, water in the Upper Floridan aquifer is confined and primarily influenced by pumping. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect changes primarily in pumping.

During the period of record, water levels in 11 of the 16 wells declined 0.04 to 1.49 feet per year (ft/yr). Water levels in the remaining five wells rose at rates of 0.05 to 1.5 ft/yr. During 2008–2009, water levels in all 16 wells rose at rates ranging from 0.72 to 5.88 ft/yr, which reflect reduced water use in the coastal area as the result of conservation practices and recovery from the drought that ended in late 2008.

The hydrograph for well 36Q008 near Savannah in Chatham County shows an overall downward trend of 0.16 ft/yr in water levels for the period of record. Since 1991, however, water levels have been rising in the well, largely as the result of decreased water use due to conservation practices in the area (J.L. Fanning, U.S. Geological Survey, oral commun., 2008). This rising trend continued during 2008–2009 when water levels in well 36Q008 rose 4.72 ft/yr.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
35P110	Bryan	2000	0.05	2.20
36Q008	Chatham	1954	–0.16	4.72
36Q020	Chatham	1958	–0.54	2.75
37P114	Chatham	1984	0.22	3.04
37Q016	Chatham	1955	–0.04	4.40
37Q185	Chatham	1985	1.50	5.88
38Q002	Chatham	1956	–0.27	1.48
39Q003	Chatham	1962	–0.26	0.72
39Q025	Chatham	1996	0.18	1.10
34G033	Glynn	2004	–1.49	1.38
35T003	Effingham	2000	0.23	1.11
34N089	Liberty	1967	–0.49	1.96
33M004	Long	1968	–0.43	1.41
35M013	McIntosh	1966	–0.42	1.68
30L003[2]	Wayne	1964	–0.46	2.43
32L015	Wayne	1983	–0.18	1.31

[1]See appendix for summary statistics.

[2]Well is completed in the Upper and Lower Brunswick aquifers and the Upper Floridan aquifer.

Groundwater Levels

Upper Floridan Aquifer

City of Brunswick Area

Water levels in seven wells were used to define groundwater conditions in the Upper Floridan aquifer near the City of Brunswick in the central coastal area of Georgia during 2008–2009 (maps and table, facing page). In this area, water in the Upper Floridan aquifer is confined, and groundwater flow paths are influenced primarily by pumping for industrial and public supply.

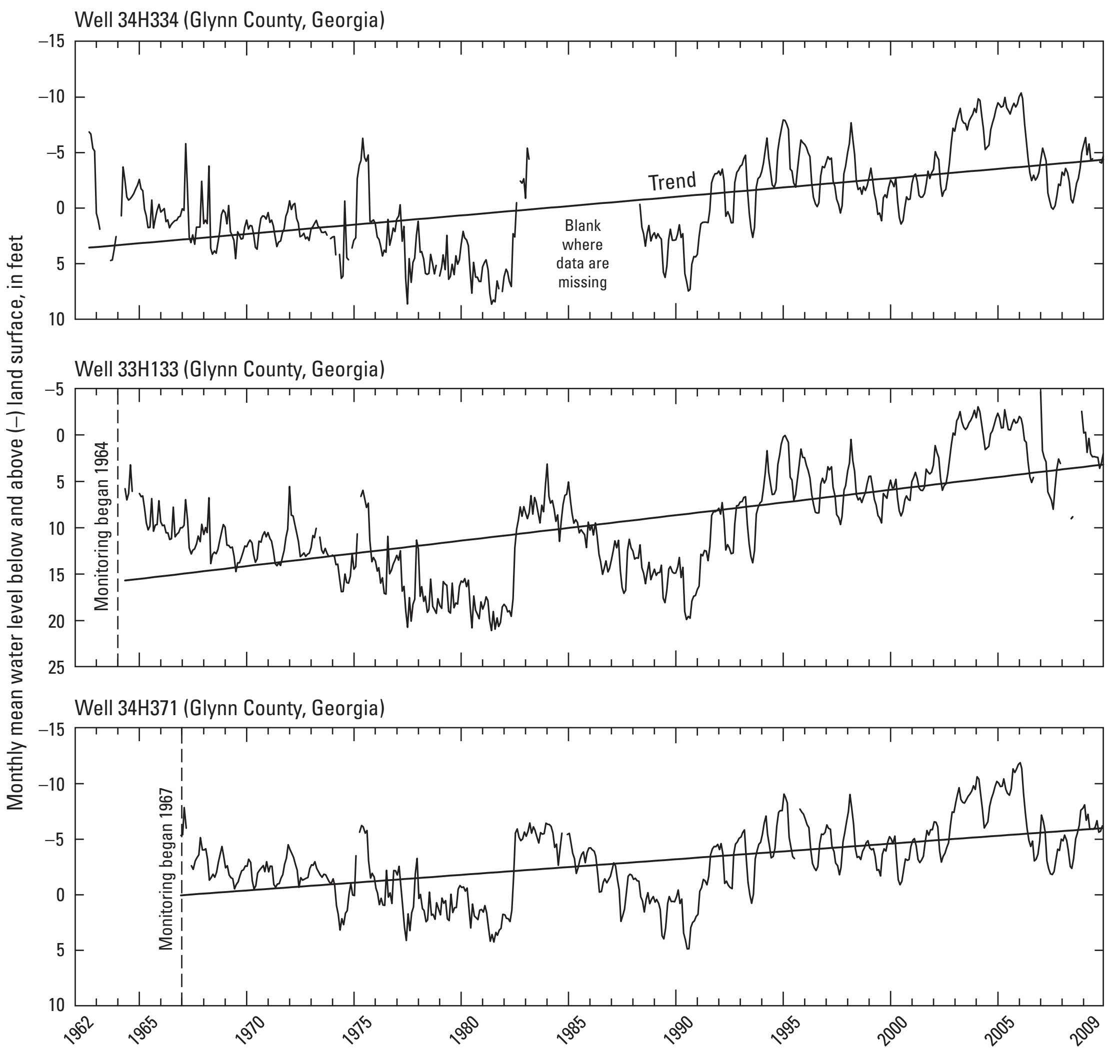
During the period of record, water levels in all of the wells had rising trends with rates of change that ranged from 0.05 to 4.26 feet per year (ft/yr). Hydrographs for three wells in the Upper Floridan aquifer in the Brunswick area (below) illustrate monthly mean water levels for the period of record. During 2008–2009, water levels in the seven wells rose at rates ranging from 0.89 to 7.58 ft/yr.

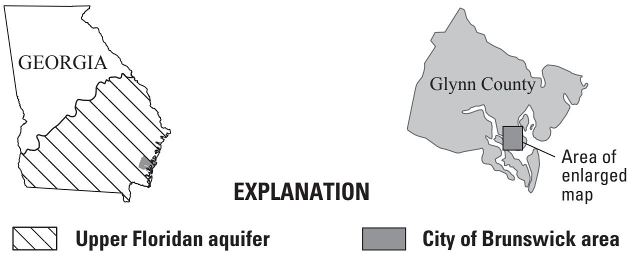
In addition to continuous water-level monitoring, synoptic water-level measurements are made periodically in wells in the Brunswick area. Water-level measurements from 20 wells were collected during July 2008 and from 22 wells during July–August 2009, which subsequently were used to construct potentiometric-surface maps of the Upper Floridan aquifer. The maps on the facing page show that groundwater generally flows from the south, where water-level altitudes are greater than 15 ft, toward industrial pumping centers in northern Brunswick, where water-level altitude is less than 0 ft.

References

Cherry, G.S., Peck, M.F., Painter, J.A., and Stayton, W.L., 2010, Groundwater conditions and studies in the Brunswick–Glynn County area, Georgia, 2008: U.S. Geological Survey Open-File Report 2009–1275, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1275/*.

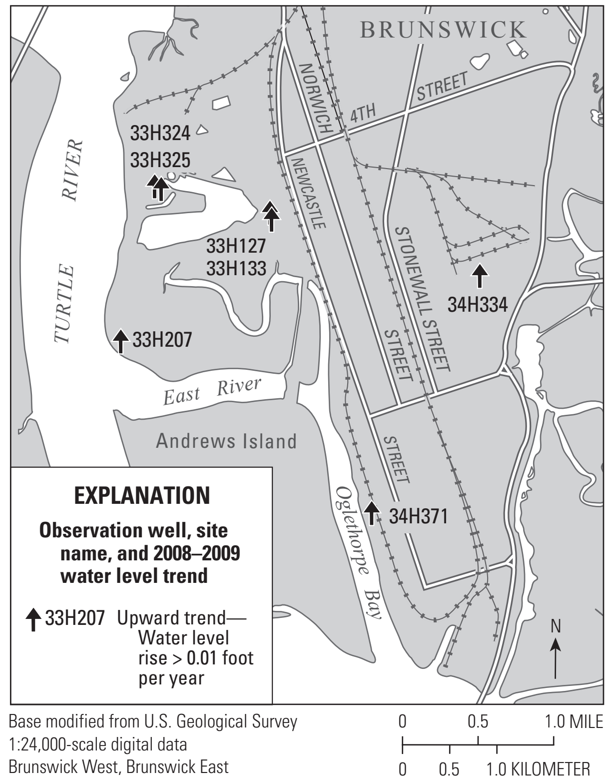
Peck, M.F., Painter, J.A., and Leeth, D.C., 2009, Groundwater conditions and studies in Georgia, 2006–2007: U.S. Geological Survey Scientific Investigations Report 2009–5070, 86 p.; available online at *http://pubs.usgs.gov/sir/2009/5070/*.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
33H127	Glynn	1962	0.05	2.07
33H133	Glynn	1964	0.27	2.43
33H207	Glynn	1986	0.47	0.89
33H324	Glynn	2007	1.73	2.24
33H325	Glynn	2007	4.26	7.58
34H334	Glynn	1985	0.17	1.54
34H371	Glynn	1986	0.14	1.28

[1]See appendix for summary statistics.



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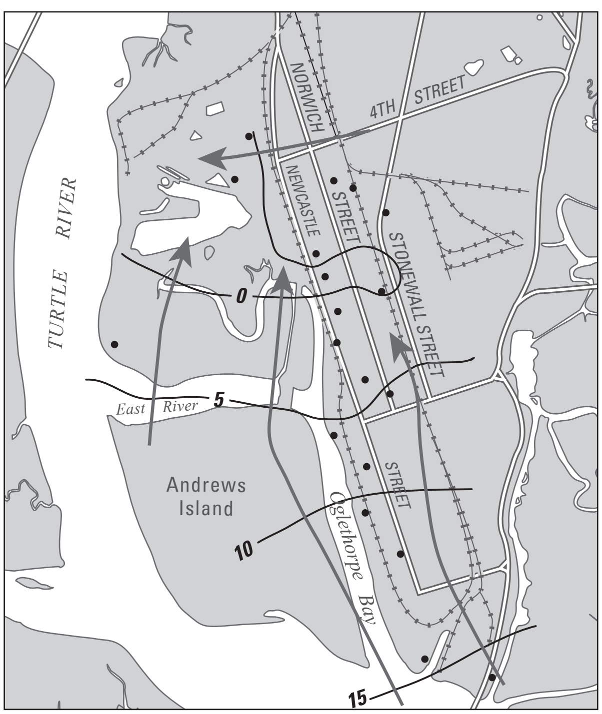
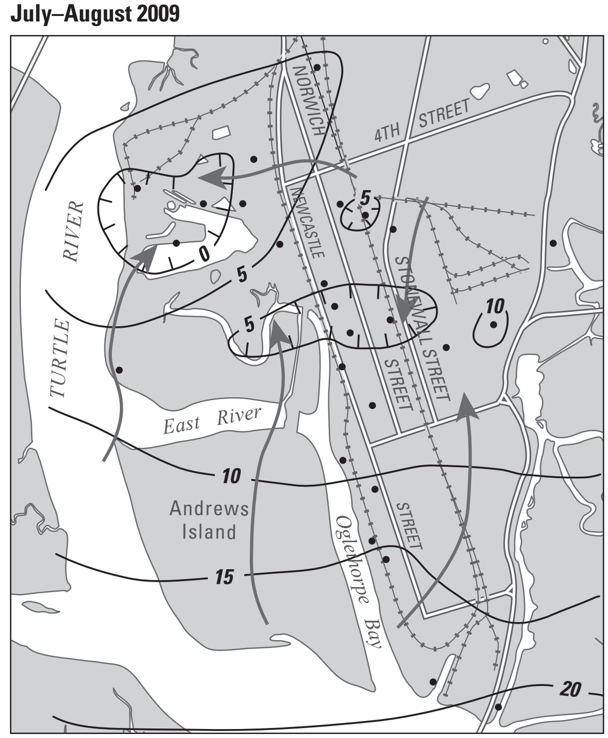


(Modified from Cherry and others, 2010)

July–August 2009



EXPLANATION

— 15 — **Potentiometric contour**—Shows altitude at which water level would have stood in tightly cased wells in the Upper Floridan aquifer. Contour interval 5 feet. Hachures indicate depression. Datum is North American Vertical Datum of 1988

General direction of groundwater flow

• **Observation well**

Groundwater Levels

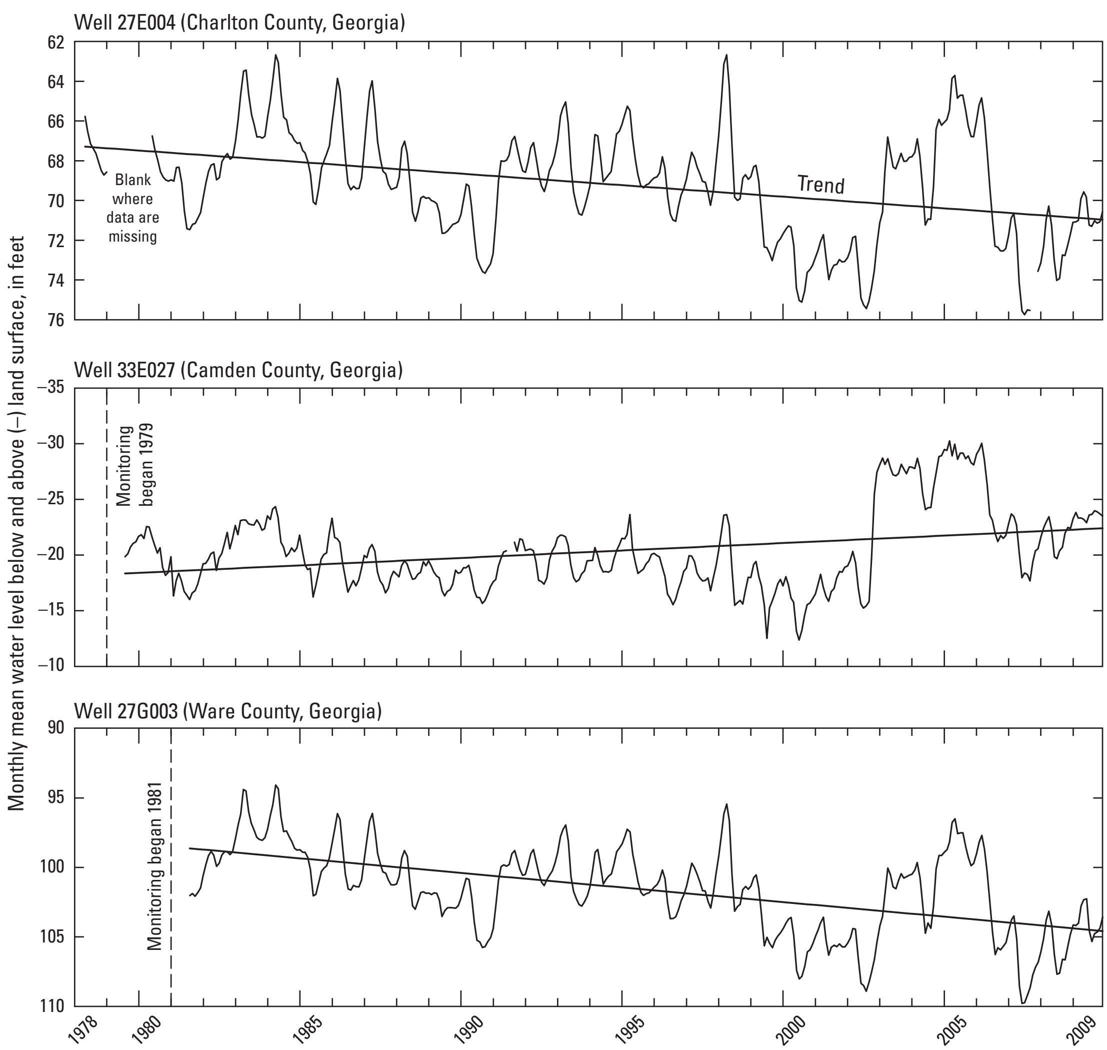
Upper Floridan Aquifer

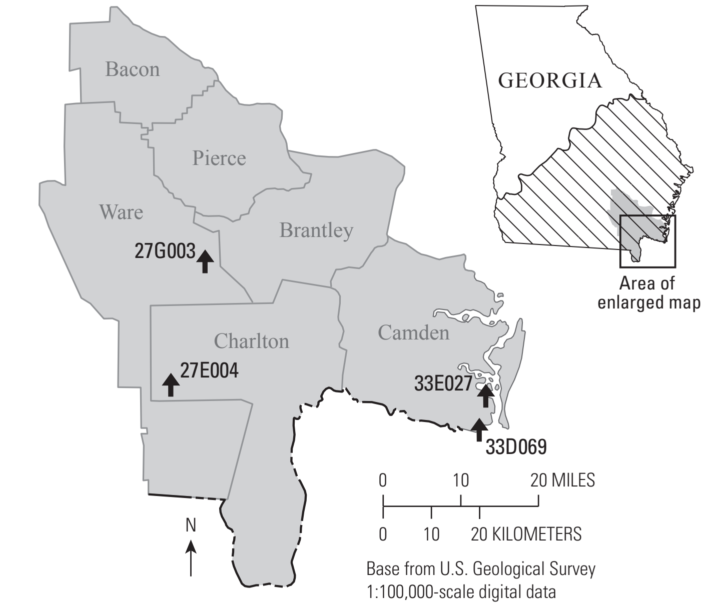
Southern Coastal Area

Water levels in four wells were used to define groundwater conditions in the Upper Floridan aquifer in the southern coastal area of Georgia during 2008–2009 (map and table, facing page). In this area, water in the Upper Floridan aquifer is confined and influenced mostly by pumping to the south in the Fernandina Beach area, Florida, and by climatic effects and pumping to the west. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that primarily reflect changes in pumping. The sharp rise in water levels in late 2002 on each of the hydrographs is the result of a 35 million gallons per day decrease in pumpage at a nearby industry in St. Marys (Peck and others, 2005).

Water-level changes during the period of record varied across the southern coastal area. In the western part of the area, water levels declined at rates of 0.12 to 0.21 foot per year (ft/yr). In the eastern part of the area, water levels rose at rates of 0.13 to 1.74 ft/yr. The larger water-level rises in the eastern part of the area result from the discontinuation of pumping at nearby St. Marys in 2002 (see hydrograph for well 33E027). During 2008–2009, water levels in all of the wells rose at rates ranging from 0.92 to 1.34 ft/yr, which corresponds to the end of a 2-year drought in 2008.

In addition to continuous water-level monitoring, synoptic water-level measurements are made periodically, in cooperation with the St. Johns River Water Management District, in wells in and around the southern coastal area of Georgia and adjacent parts of Florida. During September 2008 and May 2009, water levels measured in this area were used to construct potentiometric-surface maps of the aquifer (Kinnaman and Dixon 2009a, b). The maps for 2008 and 2009 (insets, facing page) show that water generally flowed from west to east toward the Atlantic Ocean and toward pumping centers at Fernandina Beach and Jacksonville, Florida.





EXPLANATION

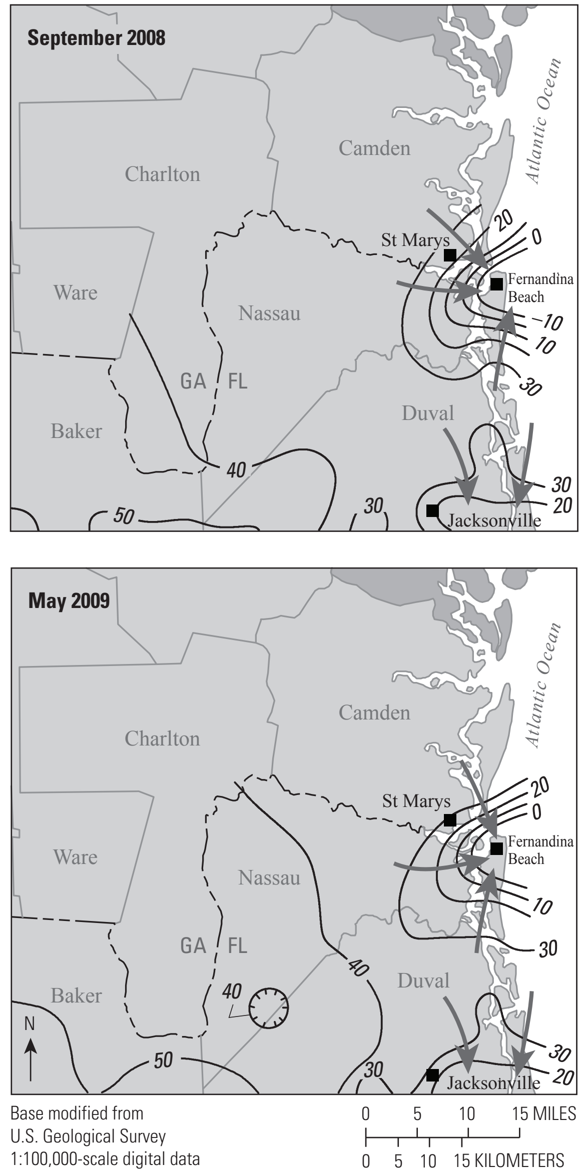
Upper Floridan aquifer   Southern coastal area

Observation well, site name, and 2008–2009 water-level trend

27E004 Upward trend—Water level rise > 0.01 foot per year

Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
33D069	Camden	1994	1.74	0.92
33E027	Camden	1979	0.13	1.34
27E004	Charlton	1986	–0.12	1.09
27G003	Ware	1984	–0.21	0.98

[1]See appendix for summary statistics.



EXPLANATION

— 40 — **Potentiometric contour**—Shows altitude at which water level would have stood in tightly cased wells. Hachures indicate depressions. Contour interval 10 feet. Datum is North American Vertical Datum of 1988 (modified from Kinnaman and Dixon, 2009a, b)

Direction of ground-water flow

References

Kinnaman, S.L., and Dixon, J.F., 2009a, Potentiometric surface of the Upper Floridan aquifer in the St. Johns River Water Management District and vicinity, Florida, September 2008: U.S. Geological Survey Scientific Investigations Map 3070, 1 sheet; available online at *http://pubs.usgs.gov/sim/3070/*.

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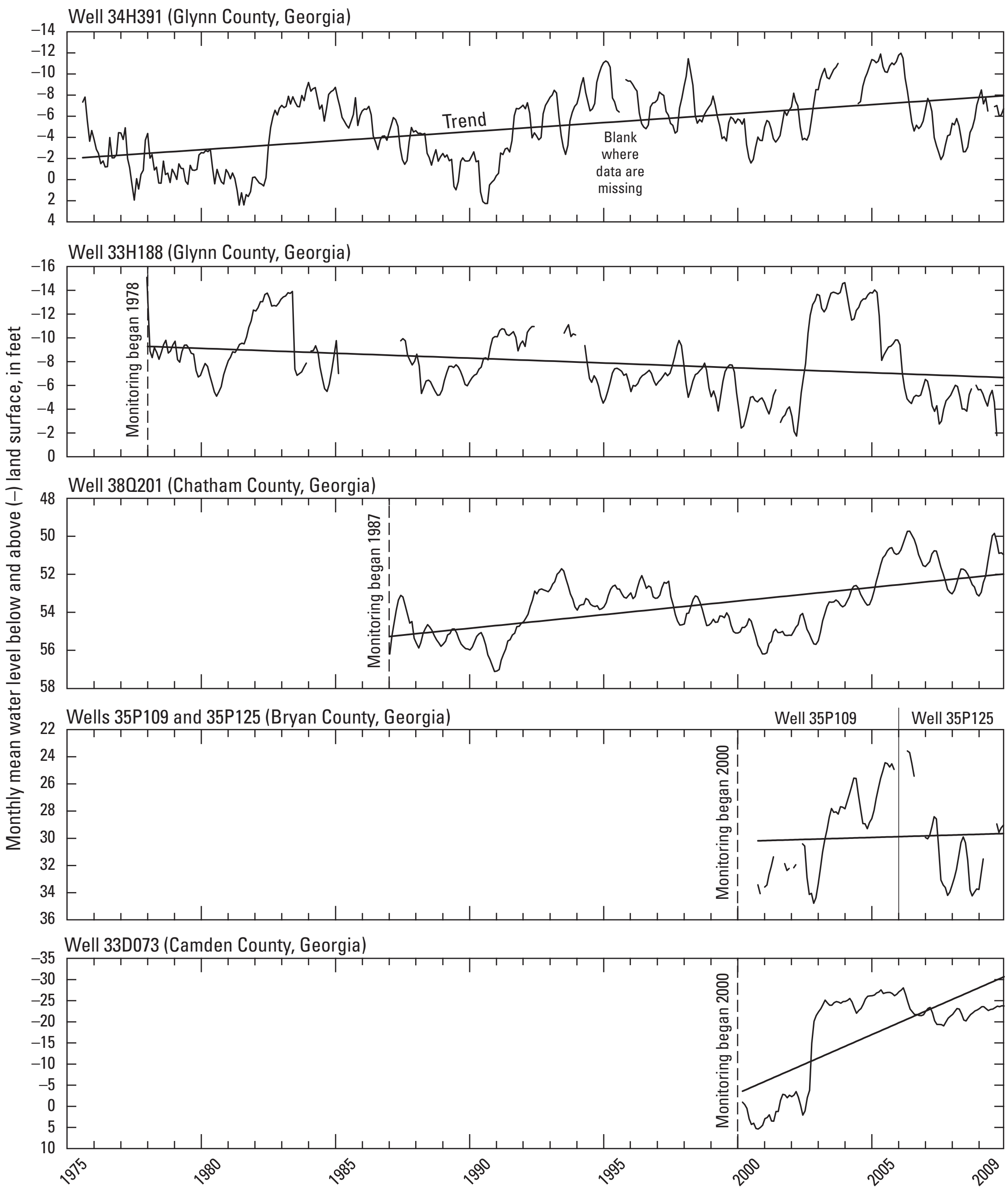
Groundwater Levels

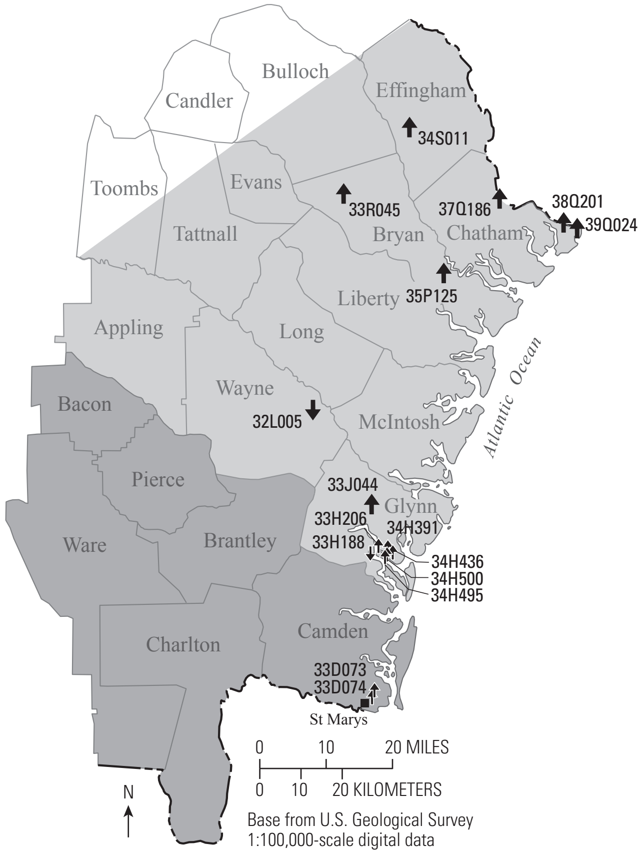
Lower Floridan Aquifer and Underlying Units in Coastal Georgia

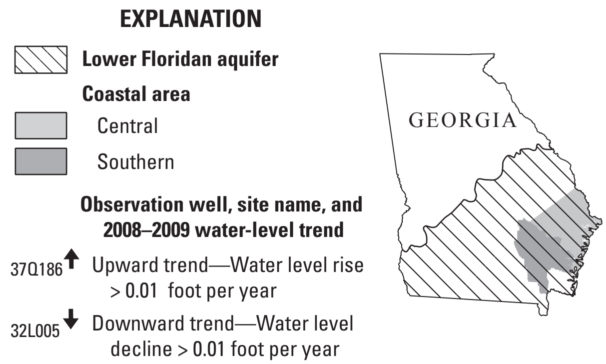
Water levels in 16 wells in central and southern coastal Georgia were used to define groundwater conditions in the Lower Floridan aquifer and underlying units during 2008–2009 (map and table, facing page). In this area, water in the Lower Floridan aquifer is confined and influenced mostly by pumping. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that primarily reflect changes in pumping.

During the period of record, water levels in 10 of the wells rose 0.05 to 2.77 feet per year (ft/yr), and declined in 6 wells from 0.06 to 0.46 ft/yr. The largest rise occurred in well 33D073 near St. Marys, Camden County, in response to the shutdown of an industry in 2002 (Peck and others, 2005).

During 2008–2009, water levels in 14 of the 16 wells rose at rates ranging from 1.10 to 2.33 ft/yr, which reflects reduced water use in the coastal area as the result of conservation practices and recovery from the drought that ended in late 2008. Despite this recovery, water levels in well 32L005 and 33H188 declined at rates of 0.42 and 0.83 ft/yr, respectively.







Reference

Peck, M.F., McFadden, K.W., and Leeth, D.C., 2005, Effects of decreased ground-water withdrawal on ground-water levels and chloride concentrations in Camden County, Georgia, and ground-water levels in Nassau County, Florida, from September 2001 to May 2003: U.S. Geological Survey Scientific Investigations Report 2004–5295; 36 p.; available online at *http://pubs.usgs.gov/sir/2004/5295/*.

Site name	Water-bearing unit[1]	County	Year monitoring began	Water-level trend, in feet, per year[2]	
				Period of record	From 2008 to 2009
33R045	LF	Bryan	2002	–0.46	1.44
35P109/35P125[3]	LF	Bryan	2000	0.05	1.52
33D073	LF	Camden	2000	2.77	1.11
33D074	LF	Camden	2003	–0.46	1.10
37Q186	P	Chatham	1985	0.67	2.33
38Q201	P	Chatham	1987	0.14	1.14
39Q024	LF	Chatham	1996	0.17	1.18
34S011	LF	Effingham	2002	–0.34	1.14
33H188	F	Glynn	1985	–0.08	–0.83
33H206	LF	Glynn	1986	0.25	1.54
33J044	LF	Glynn	1979	0.09	1.98
34H391	LF	Glynn	1984	0.17	1.57
34H436	LF	Glynn	1983	0.18	1.46
34H495	LF	Glynn	2001	1.22	1.63
34H500	LF	Glynn	2001	–0.06	1.90
32L005	LF	Wayne	1980	–0.31	–0.42

[1]LF, Lower Floridan aquifer; P, Paleocene unit of low permeability; F, Fernandina permeable zone.

[2]See appendix for summary statistics.

[3]Record from 2000–2006 is from well 35P109 that has now been replaced by 35P125.

Groundwater Levels

Claiborne and Gordon Aquifers

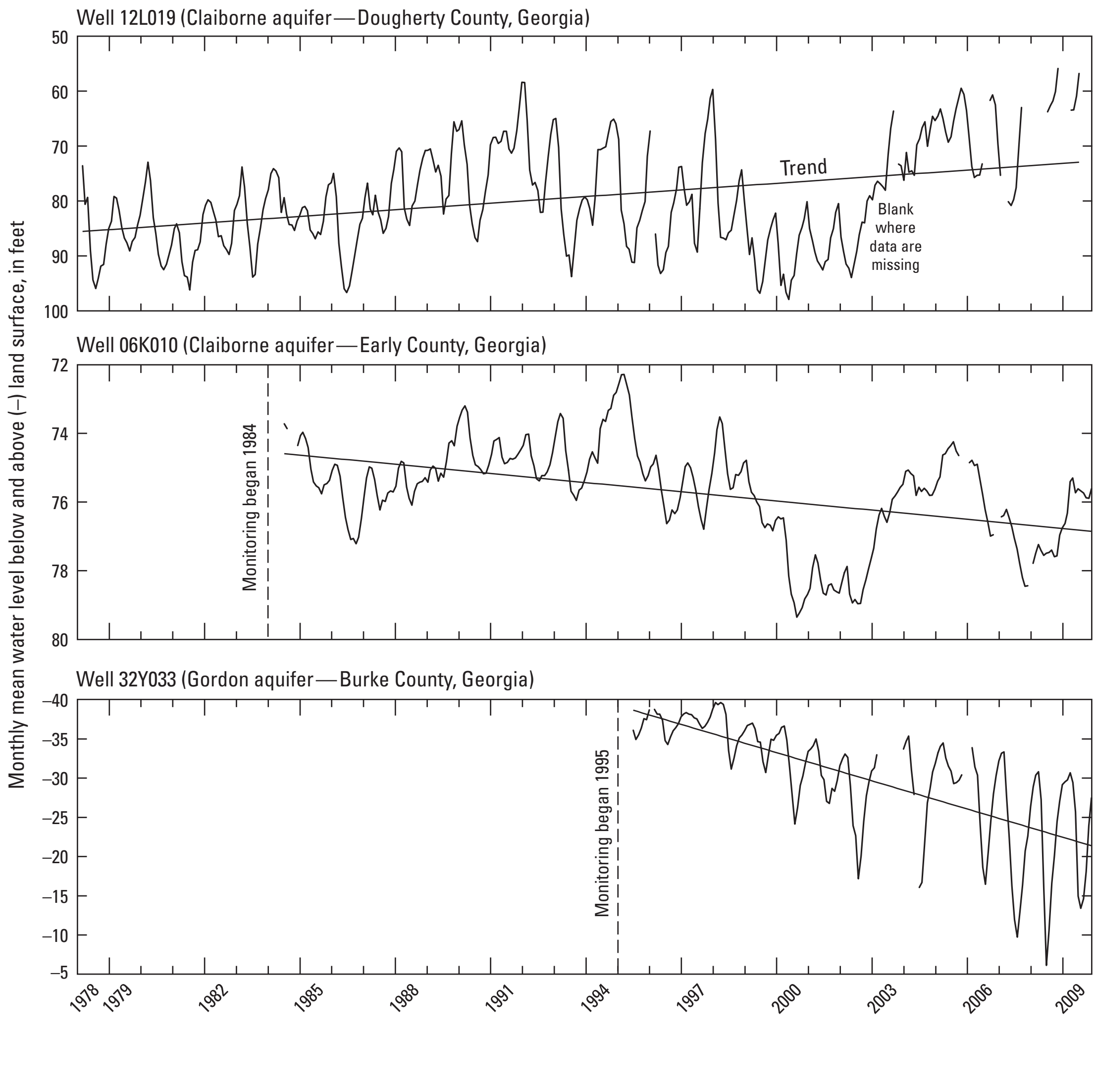
Water levels in 10 Claiborne aquifer wells and 1 Gordon aquifer well were used to define groundwater conditions in southwestern and east-central Georgia during 2008–2009 (map and table, facing page). Water in the Claiborne and Gordon aquifers can be confined or unconfined. Hydrographs showing water levels in two wells in the Claiborne aquifer and one well in the Gordon aquifer (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect changes in precipitation and pumping.

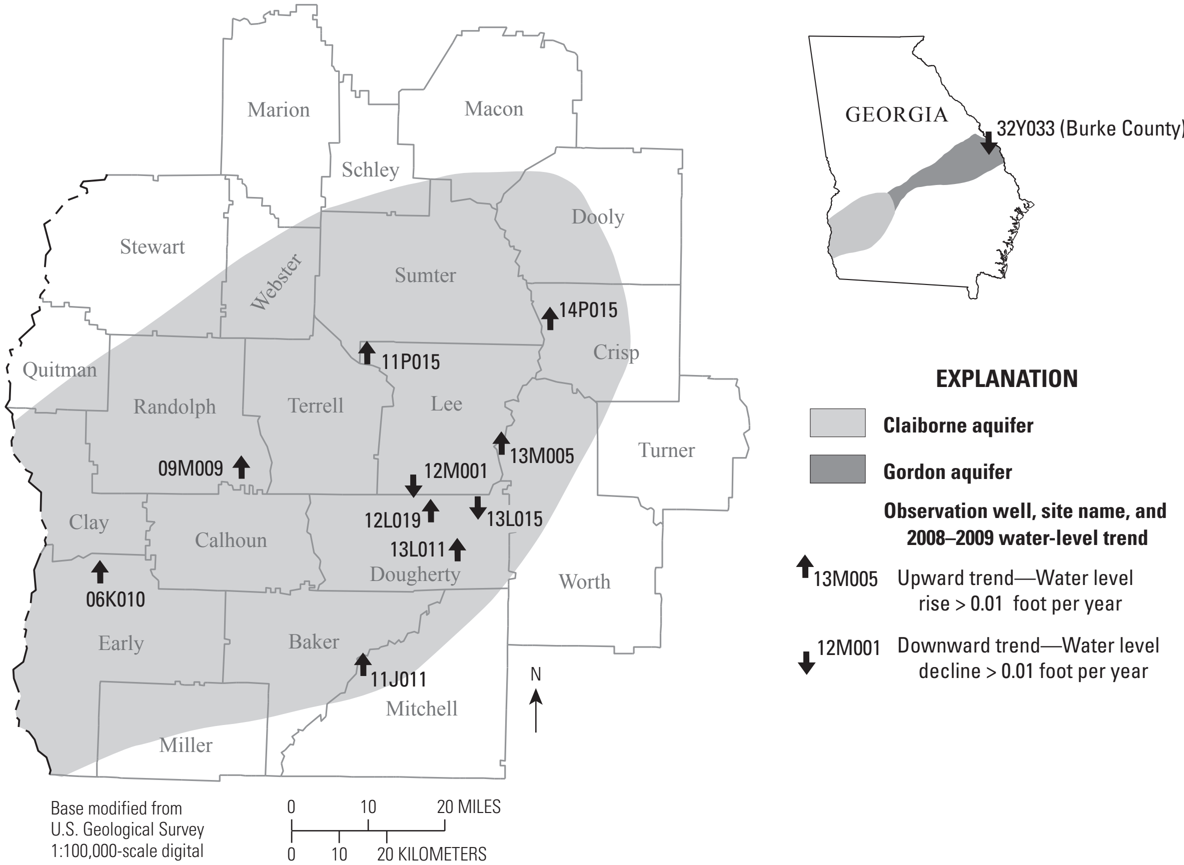
During the period of record, water levels in the Claiborne aquifer declined at rates of 0.04 to 1.10 feet per year (ft/yr) in 7 of the 10 wells monitored. The greatest decline (5.07 ft/yr) in well 12M001 in southern Lee County probably is related to increases in local pumping. During 2008–2009, water levels in 8 of the 10 Claiborne aquifer wells rose from 0.39 to 4.83 ft/yr, which corresponds to the end of a 2-year drought in 2008. Despite this overall recovery, however, water levels in wells 13L015 and 12M001 in the Claiborne aquifer continued to decline at rates of 0.92 and 5.07 ft/yr, respectively.

In the Gordon aquifer, water levels in well 32Y033 declined at a rate of 1.19 ft/yr for the period of record. During 2008–2009, water-levels continued to decline at a rate of 1.35 ft/yr. These declines correspond to increased agricultural use in east-central Georgia (Cherry, 2006).

Reference

Cherry, G.S., 2006, Simulation and particle-tracking analysis of ground-water flow near the Savannah River Site, Georgia and South Carolina, 2002, and for selected water-management scenarios, 2002 and 2020: U.S. Geological Survey Scientific Investigations Report 2006–5195, 156 p.; available online at *http://pubs.usgs.gov/sir/2006/5195/*.





Site name	Water-bearing unit[1]	County	Year monitoring began	Water-level trend, in feet, per year[2]	
				Period of record	From 2008 to 2009
14P015	C	Crisp	1984	–0.31	4.83
12L019	C	Dougherty	1978	0.04	3.79
13L011	C	Dougherty	1977	0.12	2.63
13L015	C	Dougherty	1979	–0.51	–0.92
06K010	C	Early	1986	–0.09	1.38
11P015	C	Lee	1984	–0.04	1.14
12M001	C	Lee	1978	–1.10	–5.07
11J011	C	Mitchell	1981	–0.15	3.58
09M009	C	Randolph	1984	0.01	1.56
13M005	C	Worth	1980	–0.23	0.39
32Y033	G	Burke	1995	–1.19	–1.35

[1]C, Claiborne aquifer; G, Gordon aquifer.

[2]See appendix for summary statistics.

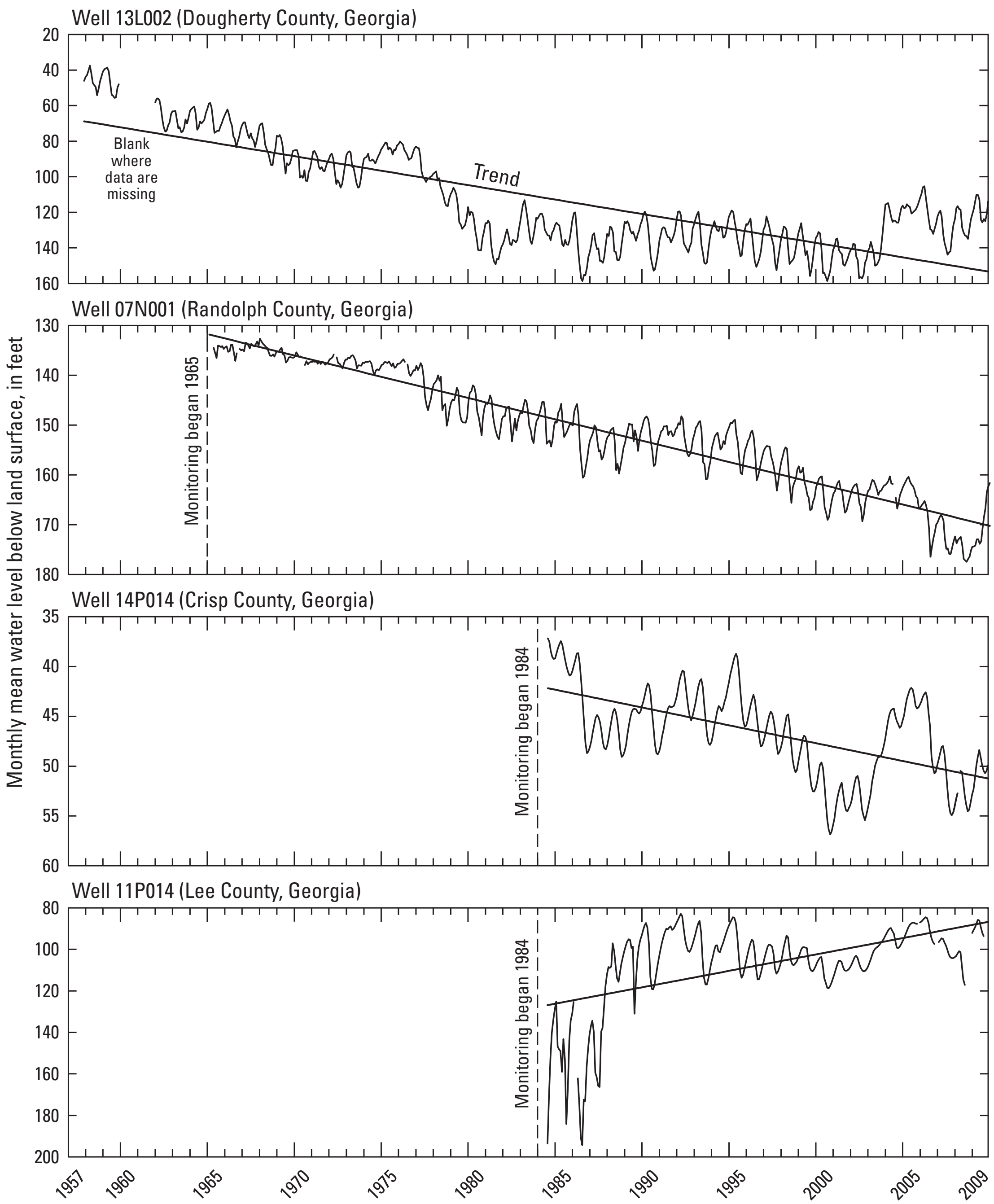
Groundwater Levels

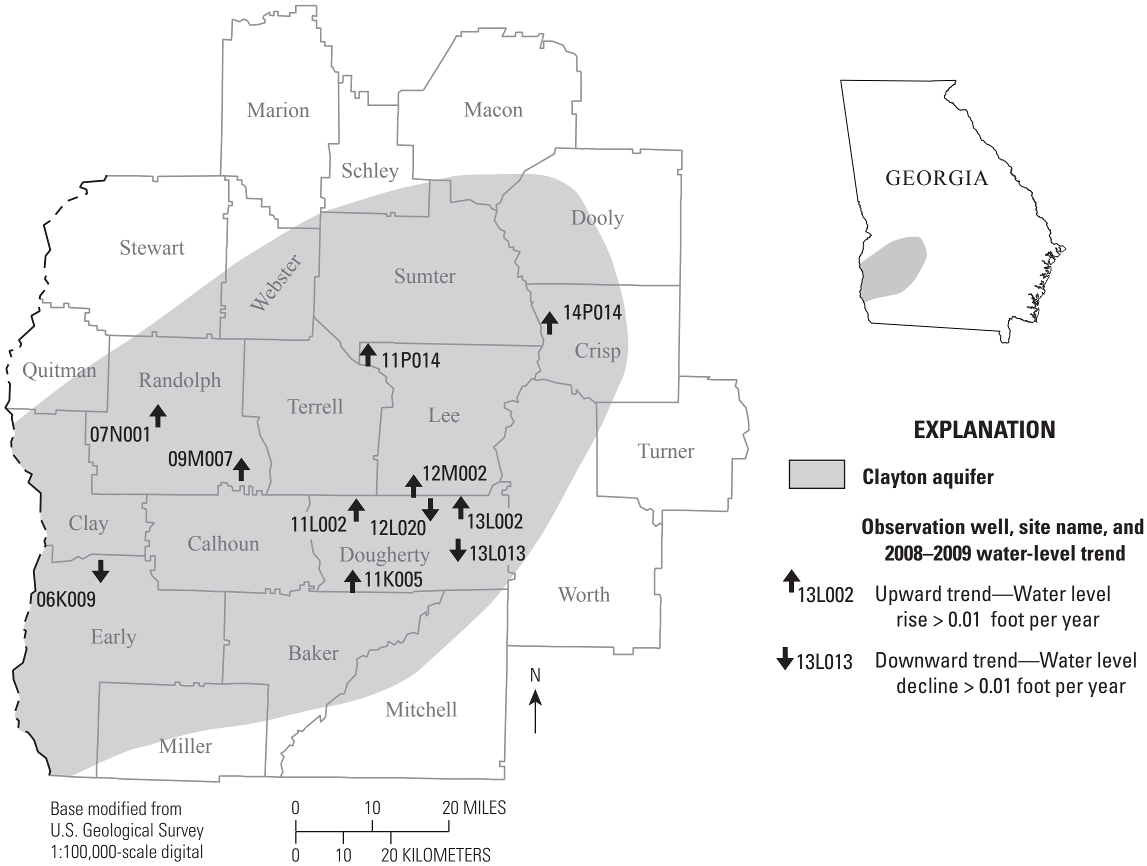
Clayton Aquifer

Water levels in 11 wells were used to define groundwater conditions in the Clayton aquifer in southwestern Georgia during 2008–2009 (map and table, facing page). In this area, water in the Clayton aquifer is confined and influenced mostly by pumping. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect changes in pumping.

During the period of record, water levels in 8 of the 11 wells declined at rates of 0.36 to 1.85 feet per year (ft/yr). Water levels rose in three wells at rates from 0.07 to 1.58 ft/yr during the period of record. These changes reflect variations in local and regional pumping.

During 2008–2009, water levels in eight of the wells rose from 0.32 to 12.48 ft/yr, which corresponds to the end of a 2-year drought and the resulting decrease in irrigation in 2008. The largest rise occurred in well 11P014 in northern Lee County and likely results from a decrease in nearby pumping. Despite regional recovery from the drought, water levels in three of the wells declined from 0.10 to 4.01 ft/yr.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
14P014	Crisp	1986	–0.36	2.01
11K005	Dougherty	1979	–1.64	0.32
11L002	Dougherty	1973	–1.79	5.25
12L020	Dougherty	1980	0.32	–1.98
13L002	Dougherty	1957	–1.62	2.92
13L013	Dougherty	1978	0.07	–4.01
06K009	Early	1986	–1.42	0.10
11P014	Lee	1984	1.58	12.48
12M002	Lee	1978	–0.73	3.71
07N001	Randolph	1965	–0.85	5.54
09M007	Randolph	1984	–1.85	4.16

[1]See appendix for summary statistics.

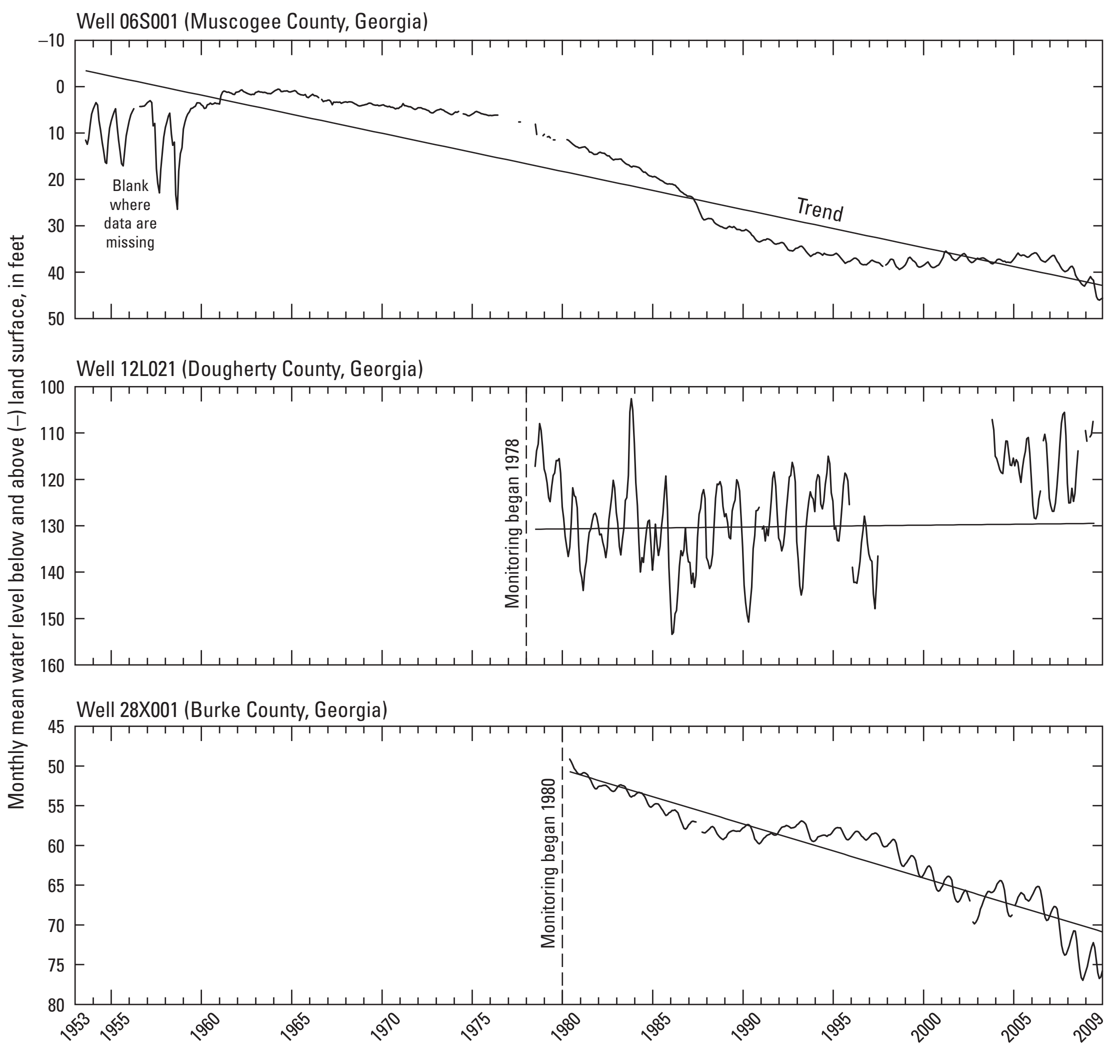
Groundwater Levels

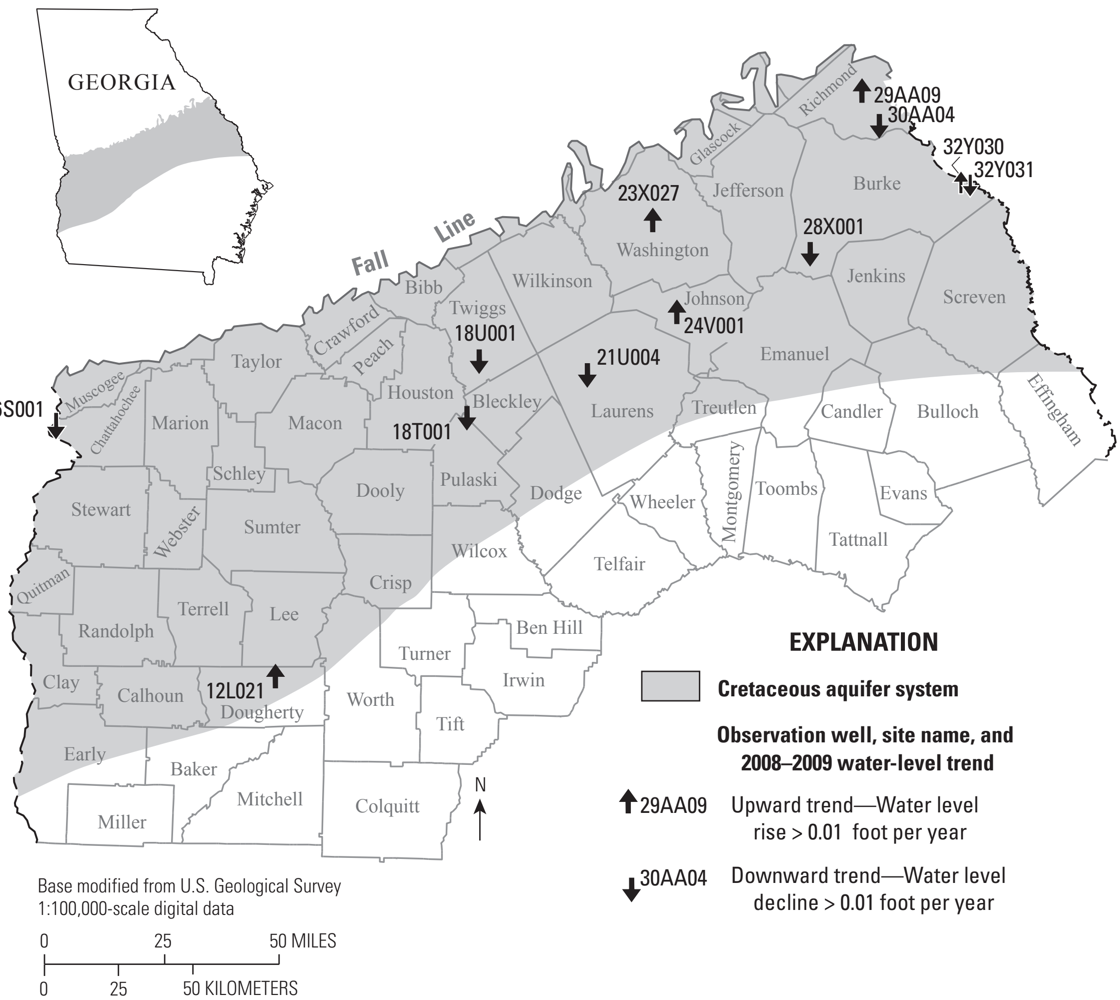
Cretaceous Aquifer System

Water levels in 12 wells in the Cretaceous aquifer system were used to define groundwater conditions throughout central and southwestern Georgia during 2008–2009 (map and table, facing page). In this area, water in the Cretaceous aquifer system mostly is confined but can be unconfined in stream valleys. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that largely reflect changes in pumping. Water levels in wells 06S001 and 28X001 both show a long term downward trend related to groundwater pumping. The hydrograph for well 12L021 shows a sharp water level rise in 2003 when pumping was discontinued from a nearby public-supply well.

During the period of record, water levels in 11 of the 12 wells declined from 0.12 to 0.89 foot per year (ft/yr). The only well showing a water level rise (0.04 ft/yr) during the period of record was well 12L021 at Albany because of decreased pumping for public supply.

During 2008–2009, water levels in seven of the wells declined at rates of 0.16 to 3.40 ft/yr and rose in five wells at rates of 0.28 to 8.74 ft/yr. The variation in water-level response during 2008–2009 probably is related to changes in pumping across the area.





Site name	Water-bearing unit[1]	County	Year monitoring began	Water-level trend, in feet, per year[2]	
				Period of record	From 2008 to 2009
28X001	M	Burke	1980	–0.68	–1.87
32Y030	LM	Burke	1995	–0.44	0.28
32Y031	LD	Burke	1995	–0.51	–0.16
12L021	P	Dougherty	1978	0.04	1.57
24V001	M	Johnson	1980	–0.60	0.31
21U004	M	Laurens	1982	–0.32	–0.23
06S001	T	Muscogee	1953	–0.82	–3.40
18T001	M	Pulaski	1981	–0.23	–0.70
29AA09	UM	Richmond	1990	–0.23	0.51
30AA04	DM	Richmond	1979	–0.33	–0.19
18U001	D	Twiggs	1975	–0.12	–0.36
23X027	DM	Washington	1985	–0.89	8.74

[1]M, Midville aquifer system; LM, lower Midville aquifer; LD, lower Dublin aquifer; T, Tuscaloosa Formation; P, Providence aquifer; UM, upper Midville aquifer; DM, Dublin–Midville aquifer system; D, Dublin aquifer system.

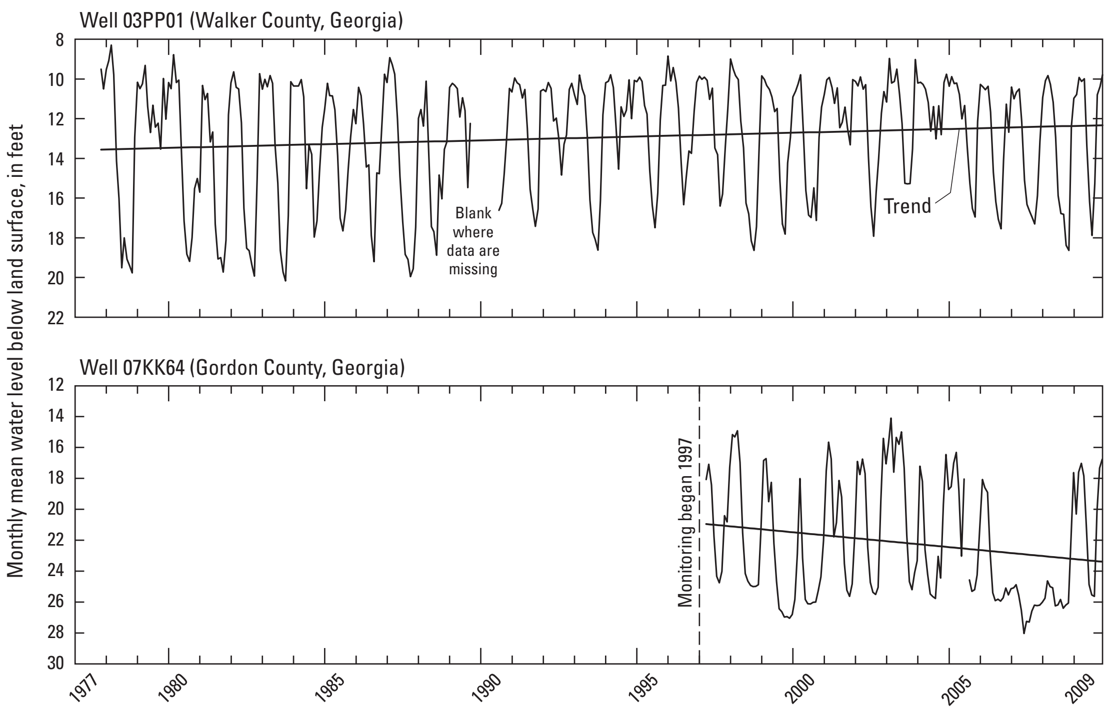
[2]See appendix for summary statistics.

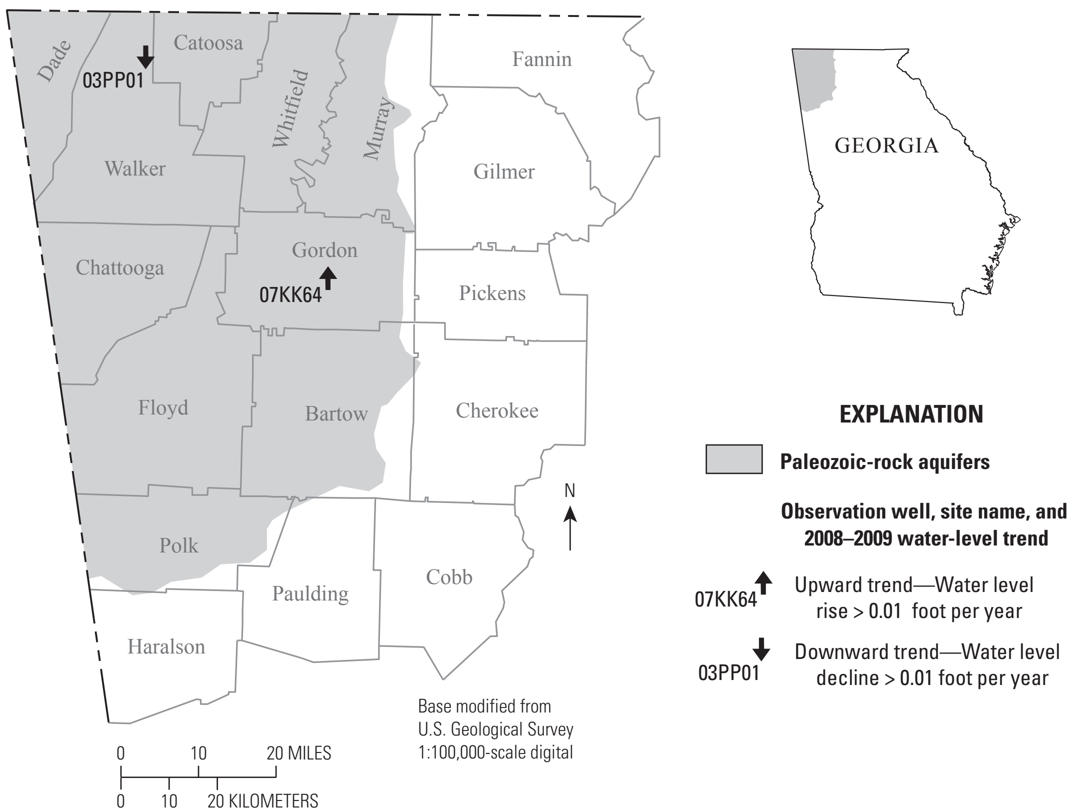
Groundwater Levels

Paleozoic-Rock Aquifers

Water levels were measured in two wells in the Paleozoic-rock aquifers of northwestern Georgia during 2008–2009 (map and table, facing page). In this area, the Paleozoic-rock aquifers are unconfined and show a pronounced response to precipitation. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect changes in precipitation and pumping. Overall trends during the period of record and during 2008–2009 are described below.

During the period of record, the water level in well 07KK64 declined 0.19 foot per year (ft/yr) due to pumping from a nearby public-supply well. Conversely, the water level in well 03PP01 rose 0.04 ft/yr during the period of record. During 2008–2009, the water level in well 07KK64 rose 3.80 ft/yr and declined 0.12 ft/yr in well 03PP01. These differences relate to variations in local pumping and climatic conditions.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
07KK64	Gordon	1997	–0.19	3.80
03PP01	Walker	1977	0.04	–0.12

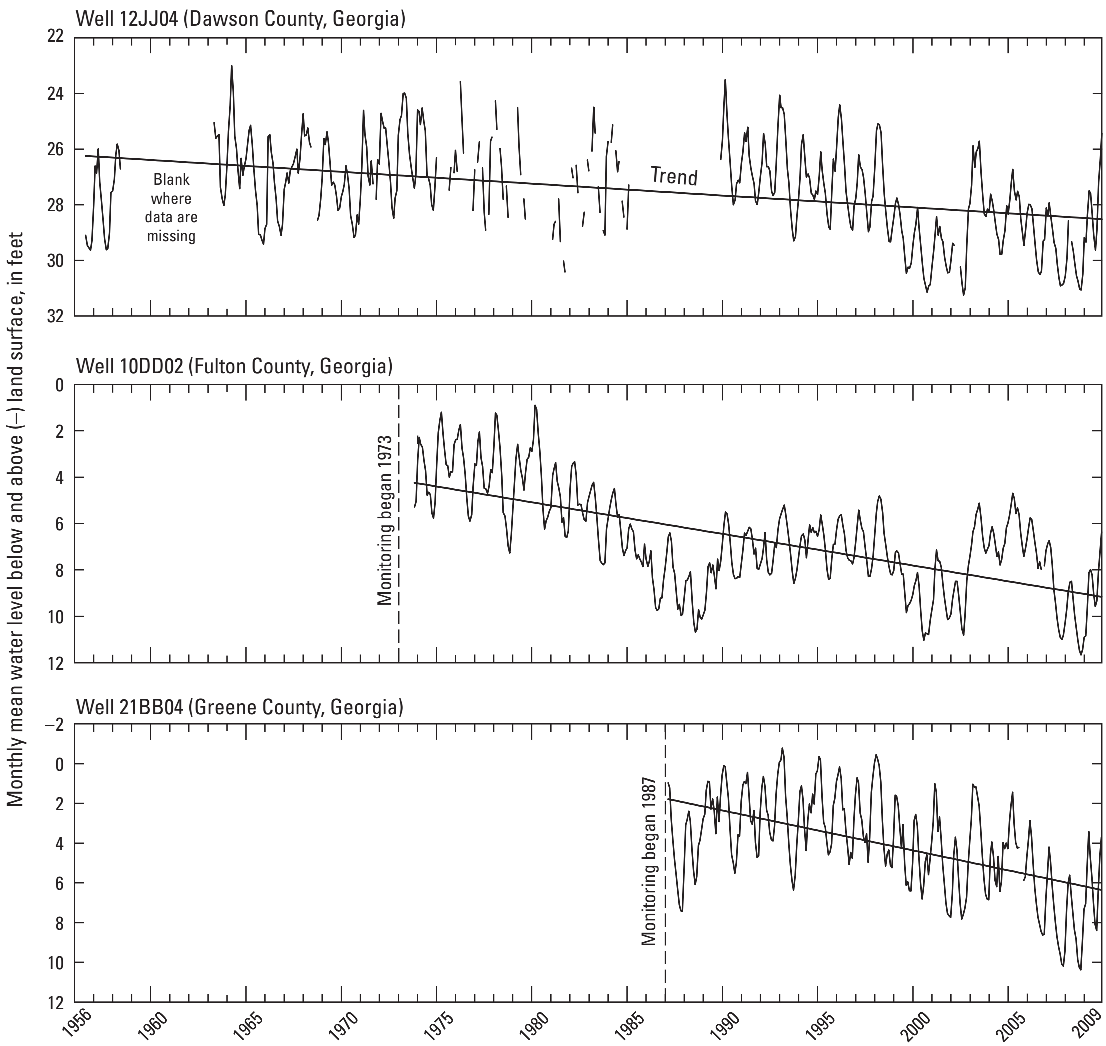
[1]See appendix for summary statistics.

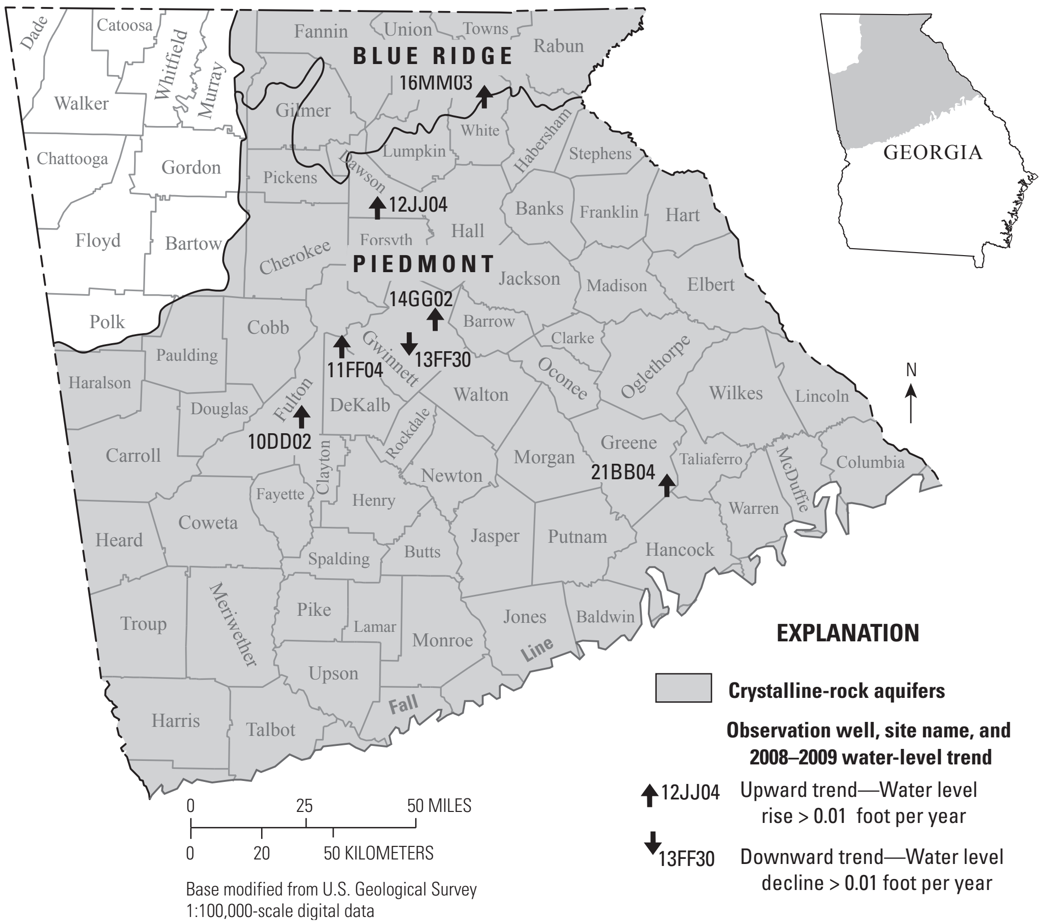
Groundwater Levels

Crystalline-Rock Aquifers

Water levels in seven wells were measured in crystalline-rock aquifers in the Piedmont and Blue Ridge Physiographic Provinces of Georgia during 2008–2009 (map and table, facing page). In this area, water is present in discontinuous joints and fractures and may be confined or unconfined. In general, crystalline-rock aquifers have local extent and can be greatly affected by localized water use and climate. Hydrographs for selected wells (below) illustrate monthly mean water levels for the period of record. The hydrographs show periodic upward or downward trends that reflect changes in precipitation and pumping.

During the period of record, water levels in all seven of the wells declined from 0.04 to 0.53 foot per year (ft/yr). During 2008–2009, water levels in six of the wells rose at rates of change ranging from 0.44 to 1.74 ft/yr, which corresponds to the end of a 2-year drought in 2008. Water levels in one well (13FF30) declined at a rate of 0.22 ft/yr.





Site name	County	Year monitoring began	Water-level trend, in feet, per year[1]	
			Period of record	From 2008 to 2009
12JJ04	Dawson	1956	–0.04	1.74
11FF04	DeKalb	1980	–0.05	0.44
10DD02	Fulton	1973	–0.14	1.07
21BB04	Greene	1987	–0.20	1.39
13FF30	Gwinnett	2003	–0.50	–0.22
14GG02	Gwinnett	2003	–0.53	0.73
16MM03	White	1988	–0.04	0.48

[1]See appendix for summary statistics.

Groundwater Quality in the Upper and Lower Floridan Aquifers

The quality of water from the Upper and Lower Floridan aquifers is monitored in the Albany and coastal areas. In the south-central part of Dougherty County near Albany, wells are monitored annually for nitrate as nitrogen concentrations. In coastal Georgia, chloride concentration in water from the Upper and Lower Floridan aquifers has been monitored in the Savannah and Brunswick areas since the 1950s and in the Camden County area since the early 1990s.

Groundwater Quality in the Upper and Lower Floridan Aquifers

City of Albany Area

The Upper Floridan aquifer is shallow in southwestern Georgia where agricultural land use is prevalent, which increases the susceptibility of groundwater to contamination from nitrates and other chemicals. Nitrate as nitrogen (N) levels greater than 10 milligrams per liter (mg/L), the maximum contaminant level (MCL) for nitrate as N set by the U.S. Environmental Protection Agency (2000), have been measured in wells southwest of Albany.

Nitrate plus nitrite as N concentrations have been measured in the southwestern Albany area at least annually since September 1998. Because nitrite typically represents a small fraction of the total concentration, the reported values are presented and discussed as nitrate. During November 2008 and November 2009, samples were collected from selected wells and at one site on the Flint River and analyzed for major cations and anions and selected nutrients. The graph below shows the nitrate trend in selected wells and the Flint River.

Of the 25 wells sampled in November 2008, 14 are located in the well-field area where samples have been collected annually for the past 10 years. A sample from well 12L061, completed in the Upper Floridan aquifer, had a nitrate concentration of 12.5 mg/L, greater than the 10-mg/L MCL. Water from well 12L376, completed in the surficial aquifer, had a nitrate concentration of 10.1 mg/L.

Samples were collected from 13 wells and the Flint River during November 2009. Nitrate levels increased at most of the wells from November 2008 to November 2009, which is a typical response during wet years. Nitrate levels dropped slightly at well 12L348 during this period, with a larger decrease at well 12L350.

To assess nitrate concentrations in an area believed to provide recharge to the Upper Floridan aquifer, samples were collected from eight additional wells in 2008 northwest of the well field (*A*, facing page). The recharge area was delineated by preliminary simulations from a groundwater-flow model of the Upper Floridan aquifer (Gordon, 2009). Nitrate concentrations in all eight wells were below 2 mg/L (Gordon, 2009), similar to concentrations measured in five of the wells in July 1993 (Stewart and others, 1999).

Samples collected during November 2008 and November 2009 were plotted on trilinear diagrams (*B*, facing page), which show that the groundwater samples are chemically distinct from the surface-water sample. The groundwater samples had lower sodium, potassium, and magnesium content and higher carbonate and bicarbonate content than the surface-water sample.

A hazardous-waste site, the T.H. Agriculture & Nutrition (THAN) Company Superfund Site (*http://www.clu-in.org/products/costperf/THRMDESP/Thagr.htm*, accessed January 31, 2011), is located in the northern part of Albany (*A*, facing page). The USGS collected and analyzed water samples for pesticides from two wells closest to the Superfund Site in November 2008 (wells 12L010 and 12L018). The sample from well 12L010 contained no detectable pesticides, and the sample from well 12L018 had a very low concentration of p,p'-methoxychlor (0.0014 microgram per liter (µg/L)), which is below the reporting limit and nearly 2 orders of magnitude below the MCL of 0.04 mg/L (U.S. Environmental Protection Agency, 2000). Although such a low concentration is not a cause for concern, continued monitoring could enable tracking of any increasing trend. Well 12L018 was sampled again in November 2009, and pesticides were not detected in that water sample.

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Gordon, D.W., 2009, Groundwater conditions and studies in the Albany area of Dougherty County, Georgia, 2008: U.S. Geological Survey Open-File Report 2009–1244, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1244/*.

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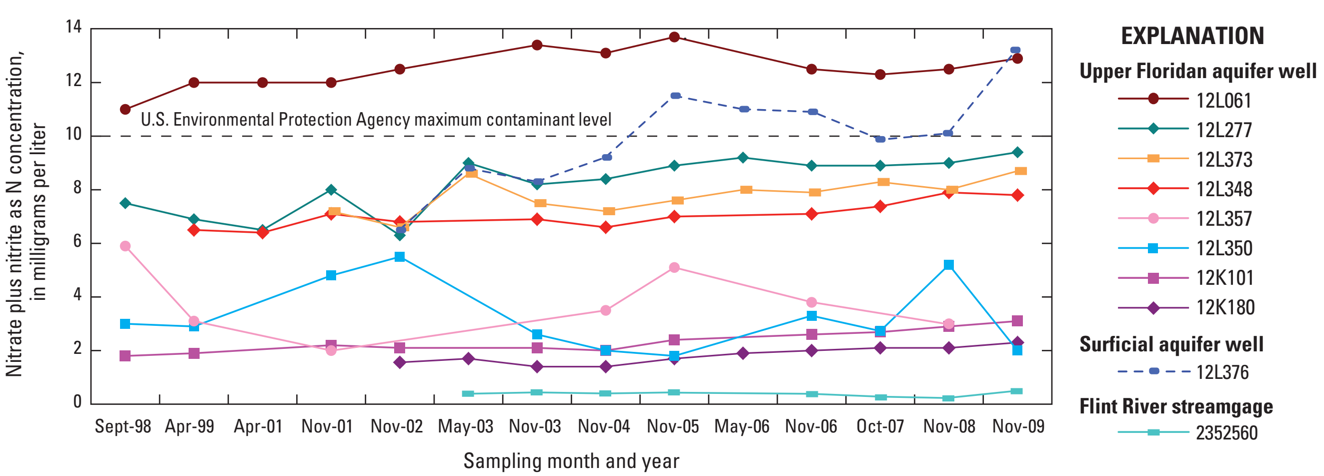
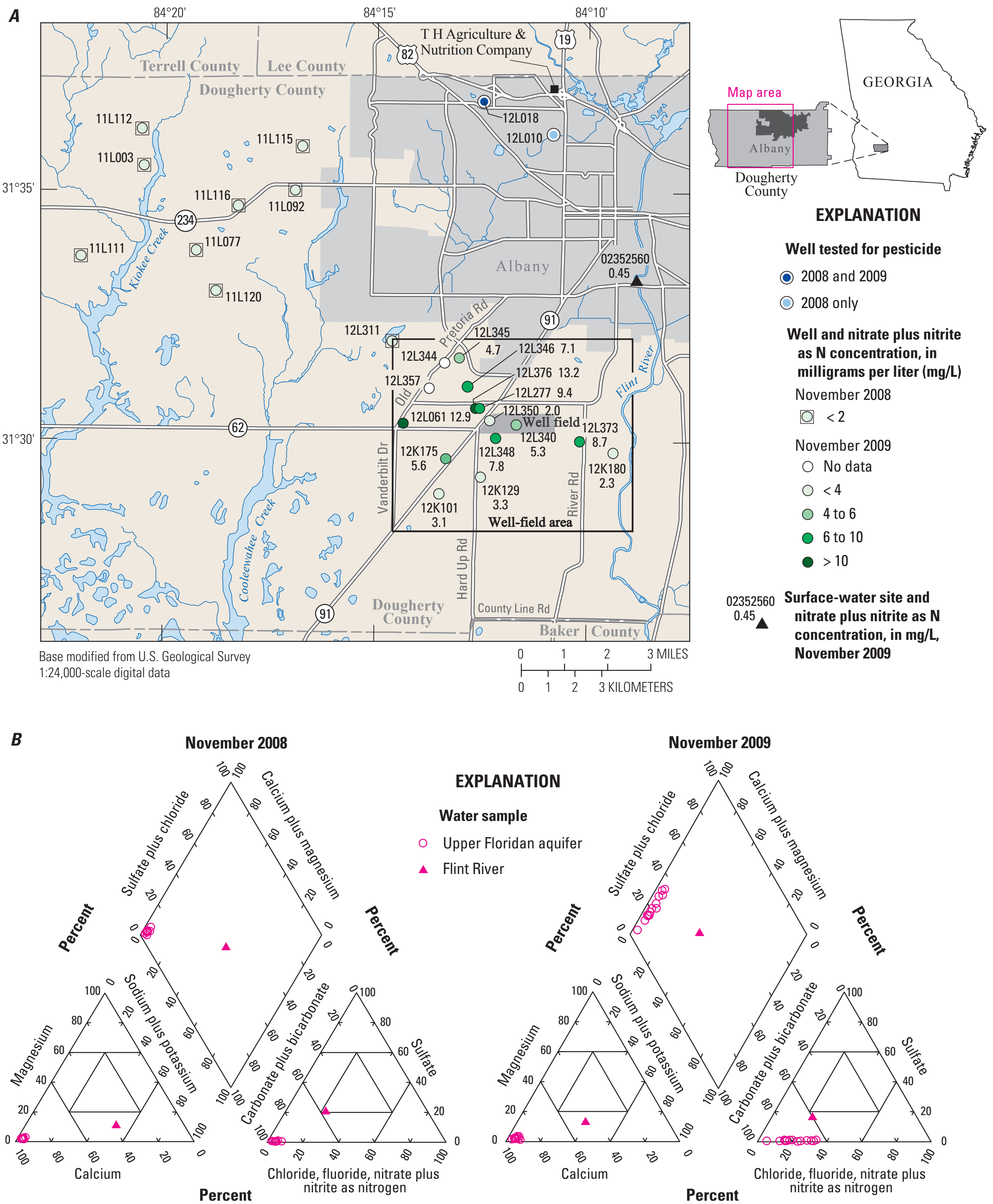
U.S. Environmental Protection Agency, 2000, Maximum contaminant levels (Part 143, National Secondary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100–149, rev. as of July 1, 2000, p. 612–614.





(A) Map of southwestern Albany area showing nitrate plus nitrite as nitrogen (N) concentrations in the well-field area, November 2009; and northeast of the well-field area, November 2008; and *(B)* piper plots of major cation and anion compositions of water samples from the Upper Floridan aquifer and the Flint River, November 2008 and November 2009.

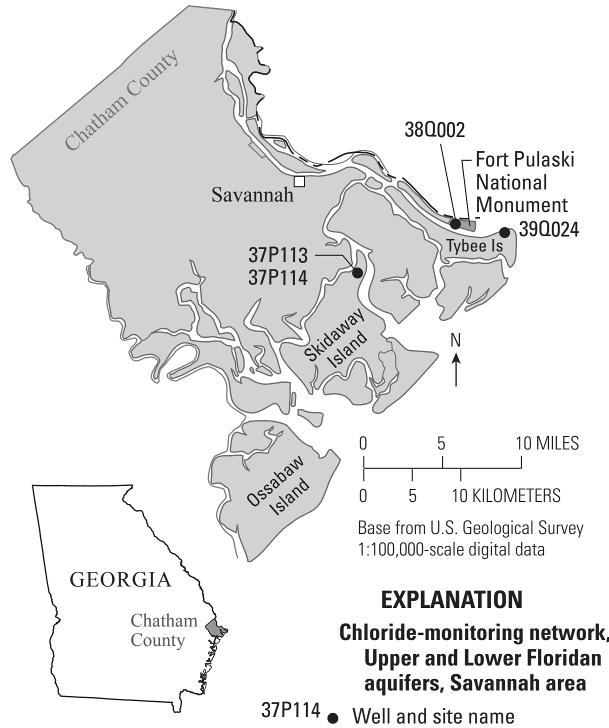
Groundwater Quality in the Upper and Lower Floridan Aquifers

City of Savannah Area

During December 2008 and December 2009, borehole geophysical logs and discrete water samples were collected from open intervals in wells completed in the Upper and Lower Floridan aquifers to assess changes in chloride concentration in the Savannah area, continuation of a program that began in 2003. Borehole geophysical logs include fluid resistivity—an indicator of dissolved-solids concentration—and fluid temperature—an indicator of possible breaches in the well casing that might compromise the reliability of water-quality measurements. Water samples were collected at specific depth intervals in each well to reflect the range of fluid resistivity observed in the well during logging. The chloride concentrations in water samples are summarized in a table and shown graphically on the facing page.

At Fort Pulaski, fluid resistivity logs and water samples were collected from well 38Q002 completed in the Upper Floridan aquifer (facing page). The fluid resistivity logs collected during 2008–2009 indicated no changes or breaches in the well casing. During 2008 and 2009, chloride concentrations in all samples collected at depths of 200 and 320 feet (ft) were at or below 12 milligrams per liter (mg/L).

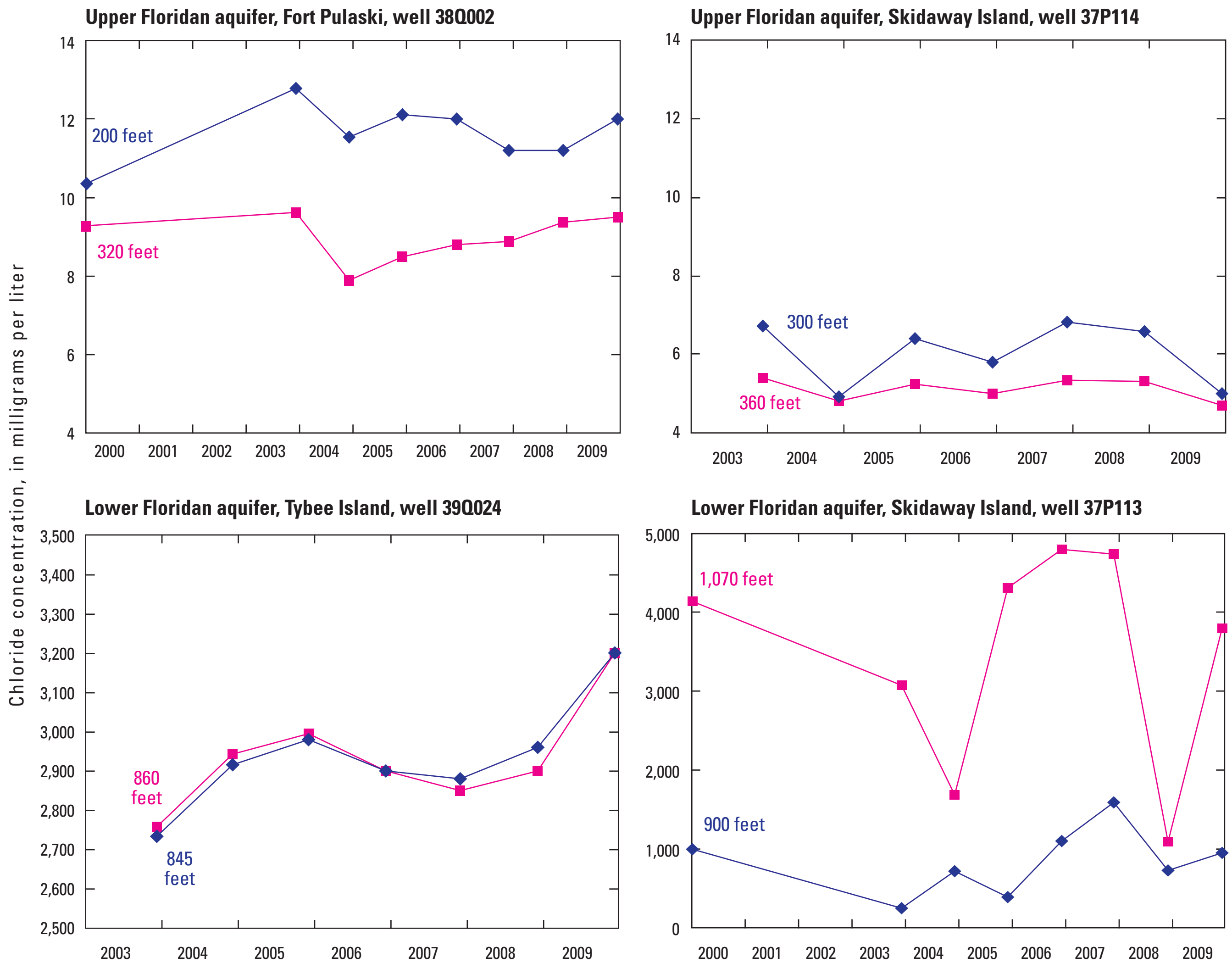
At Skidaway Island, fluid-resistivity logs and water samples were collected from well 37P114 completed in the Upper Floridan aquifer and from well 37P113 completed in the Lower Floridan aquifer. Water in the Upper Floridan aquifer is fresh (chloride concentrations less than 7 mg/L) at the Skidaway Island site and chloride concentrations of samples from well 37P114 did not appreciably change during 2008–2009. The fluid-resistivity logs collected indicated no changes or breaches in the well casing. During 2008 and 2009, chloride concentrations in samples collected at depths of 300 and 360 ft were less than 10 mg/L. In well 37P113, the fluid-resistivity logs collected during 2008–2009 indicated no changes or breaches in the well casing. The chloride concentrations were higher in samples collected at a depth of 1,070 ft and had greater variability than in the samples collected from the 900-ft interval. Chloride concentrations varied from 4,740 mg/L in 2007 to 1,090 in 2008 and 3,800 mg/L in 2009. Concentrations in samples collected from a depth of 900 ft during the same period ranged from 950 to 1,590 mg/L.



At Tybee Island, fluid-resistivity logs and water samples were collected from well 39Q024 completed in the Lower Floridan aquifer. The fluid-resistivity logs collected during 2008–2009 indicated no changes or breaches in the well casing. Chloride concentrations in samples collected at two depths in well 39Q024 increased during 2008–2009, a continuation of an upward trend that began in 2007 (Peck and others, 2009; facing page). Concentrations in samples from the 845-ft interval rose from 2,960 to 3,200 mg/L. Similarly, concentrations in samples from the 860-ft interval rose from 2,700 to 3,200 mg/L.

Reference

Peck, M.F., Painter, J.A., and Leeth, D.C., 2009, Ground-water conditions and studies in Georgia, 2006–07: U.S. Geological Survey Scientific Investigations Report 2009–5070, 86 p. available online at *http://pubs.usgs.gov/sir/2009/5070/*.



Chloride concentration in groundwater from wells in the Upper and Lower Floridan aquifers in the Savannah area, Georgia, 2000–2009.

Site name	Other identifier	Open interval (feet below land surface)	Water-bearing unit[1]	Water sample depth (feet below land surface)	Chloride concentration (milligrams per liter)	Water sample depth (feet below land surface)	Chloride concentration (milligrams per liter)
				December 2008		December 2009	
38Q002	U.S. National Park Service, Fort Pulaski Pilot House	110–348	U	200	11.2	200	12.0
				320	9.3	320	9.5
37P113	Skidaway Institute test well 1	700–1,100	L	900	727	900	950
				1,070	1,090	1,070	3,800
37P114	Skidaway Institute test well 2	262–400	U	300	6.5	300	5.0
				360	5.3	360	4.7
39Q024	Georgia Geologic Survey, Tybee Island, test well 1	840–880	L	845	2,960	845	3,200
				860	2,900	860	3,200

[1] L, Lower Floridan aquifer; U, Upper Floridan aquifer.

Groundwater Quality in the Upper and Lower Floridan Aquifers

City of Brunswick Area

Chloride concentrations have been monitored in the Brunswick area since the late 1950s when saltwater was first detected in wells completed in the Upper Floridan aquifer at the southern part of the area (Wait, 1965). By the 1960s, a plume of saltwater had migrated northward toward two major industrial pumping centers.

Since 1965, chloride concentrations have increased markedly in wells completed in the Upper Floridan aquifer in the northern Brunswick area. During 2008 and 2009, the chloride concentration was above the 250-milligrams per liter (mg/L) State and Federal secondary drinking-water standards (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000) in a 2-square-mile area and exceeded 2,250 mg/L in part of the area.

Graphs of chloride concentrations in water samples from wells in the upper and lower water-bearing zones of the Upper Floridan aquifer are shown below for wells in the southern Brunswick area (wells 34H393 and 34H403) and northern Brunswick area (wells 33H127 and 33H133). Chloride concentration in water from the Lower Floridan aquifer is shown for well 34H391 (graph below) in the southern Brunswick area. More information on monitoring groundwater quality in the Brunswick area is available at *http://ga.water.usgs.gov/projects/brunswick/*.

Dissolved chloride concentrations in the upper water-bearing zone of the Upper Floridan aquifer at Brunswick were mapped for July 2008 using data from 29 wells and for July–August 2009 using data from 28 wells (facing page). The 2008 and 2009 maps are similar to previously published maps for 2006 and 2007 (Peck and others, 2009) and show that areas of highest chloride concentrations are near the two industrial pumping centers in the northern part of the city, and the original area of contamination in the southern part of the city.

During 2008–2009, chloride concentrations within the plume area decreased in 18 of 28 wells sampled. The greatest decrease in concentration was 160 mg/L at well 33H130 in the northern part of the plume. Chloride concentrations in 10 wells increased from 0.1 to 80 mg/L during 2008–2009; the largest increase occurred in well 33H133 in the northern part of the plume. These changes probably reflect shifts in local pumping patterns.

References

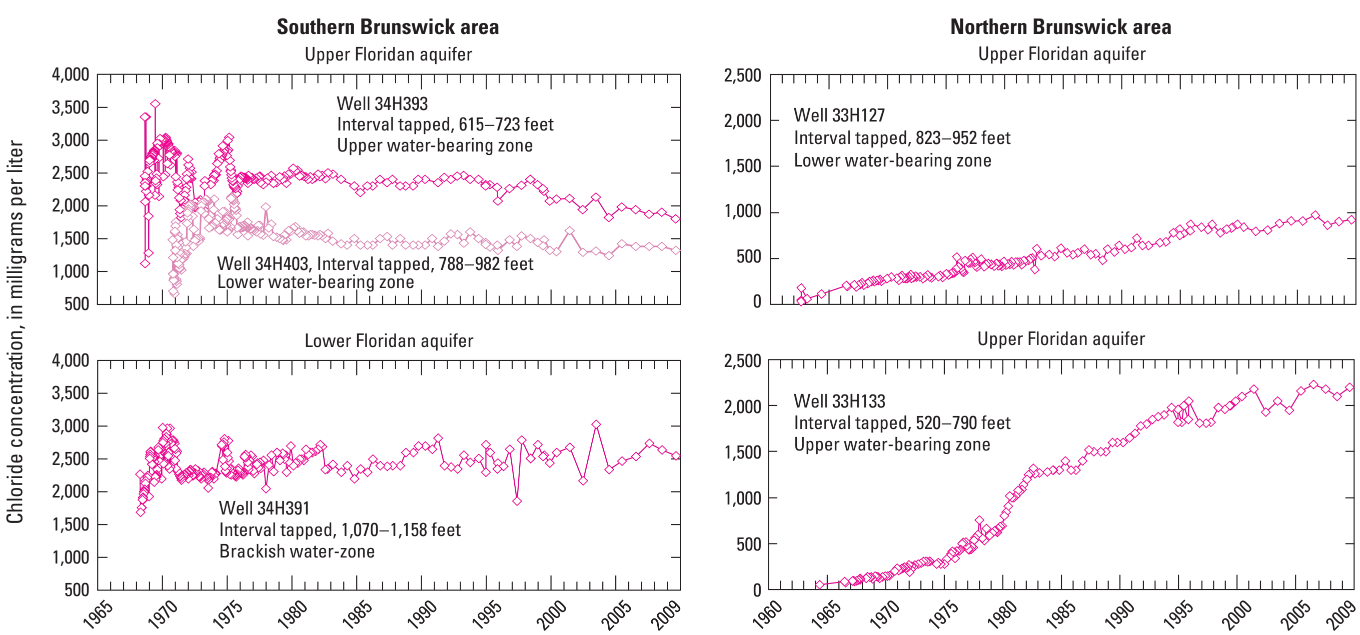
Cherry, G.S., Peck, M.F., Painter, J.A., and Stayton, W.L., 2010, Groundwater conditions and studies in the Brunswick–Glynn County area, Georgia, 2008: U.S. Geological Survey Open-File Report 2009–1275, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1275/*.

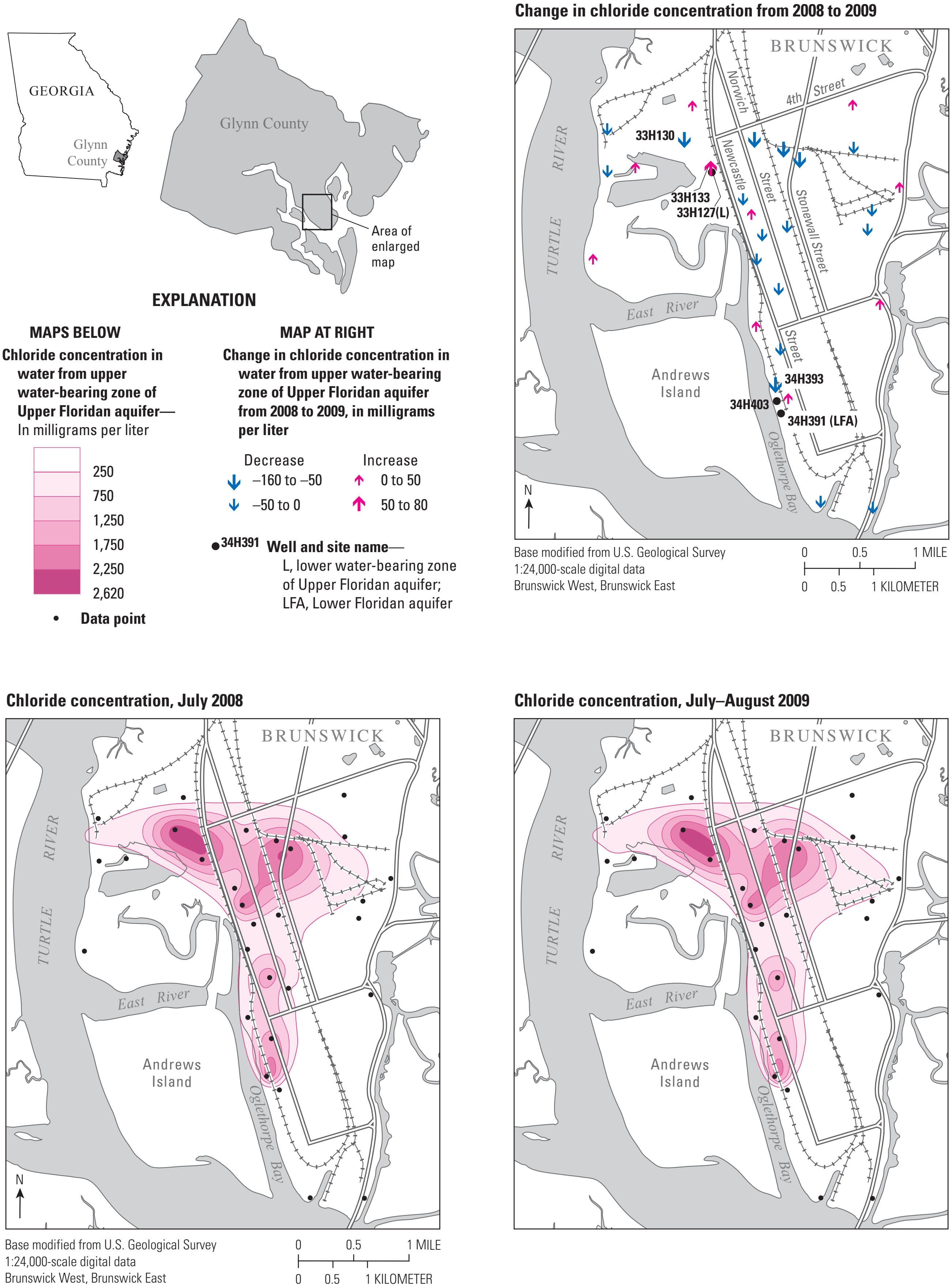
Georgia Environmental Protection Division, 1997, Secondary maximum contaminant levels for drinking water: Environmental Rule 391-3-5-19, revised October 1997: Official Code of Georgia Annotated Statutes, Statute 12-5-170 (Georgia Safe Drinking Water Act), variously paginated.

Peck, M.F., Painter, J.A., and Leeth, D.C., 2009, Ground-water conditions and studies in Georgia, 2006–2007: U.S. Geological Survey Scientific Investigations Report 2009–5070, 86 p.; available online at *http://pubs.usgs.gov/sir/2009/5070/*.

U.S. Environmental Protection Agency, 2000, Maximum contaminant levels (Part 143, National Secondary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100–149, rev. July 1, 2000, p. 612–614.

Wait, R.L., 1965, Geology and occurrence of fresh and brackish ground water in Glynn County, Georgia: U.S. Geological Survey Water-Supply Paper 1613-E , 94 p.

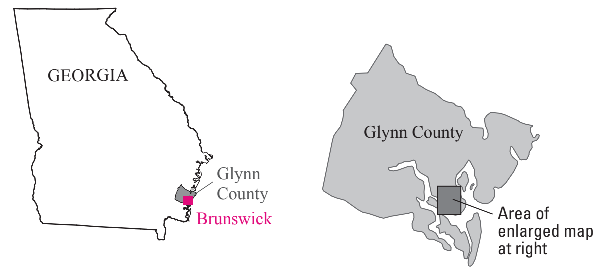




GEORGIA
Glynn County
Glynn County
Area of enlarged map
EXPLANATION
MAPS BELOW
Chloride concentration in water from upper water-bearing zone of Upper Floridan aquifer—In milligrams per liter
250
750
1,250
1,750
2,250
2,620
Data point
MAP AT RIGHT
Change in chloride concentration in water from upper water-bearing zone of Upper Floridan aquifer from 2008 to 2009, in milligrams per liter
Decrease
–160 to –50
–50 to 0
Increase
0 to 50
50 to 80
34H391 Well and site name—L, lower water-bearing zone of Upper Floridan aquifer; LFA, Lower Floridan aquifer
Change in chloride concentration from 2008 to 2009
BRUNSWICK
Norwich
4th Street
Newcastle Street
Stonewall Street
TURTLE RIVER
East River
Andrews Island
Oglethorpe Bay
33H130
33H133
33H127(L)
34H393
34H403
34H391 (LFA)
N
Base modified from U.S. Geological Survey 1:24,000-scale digital data Brunswick West, Brunswick East
0 0.5 1 MILE
0 0.5 1 KILOMETER
Chloride concentration, July 2008
BRUNSWICK
TURTLE RIVER
East River
Andrews Island
Oglethorpe Bay
N
Base modified from U.S. Geological Survey 1:24,000-scale digital data Brunswick West, Brunswick East
0 0.5 1 MILE
0 0.5 1 KILOMETER
Chloride concentration, July–August 2009
BRUNSWICK
TURTLE RIVER
East River
Andrews Island
Oglethorpe Bay

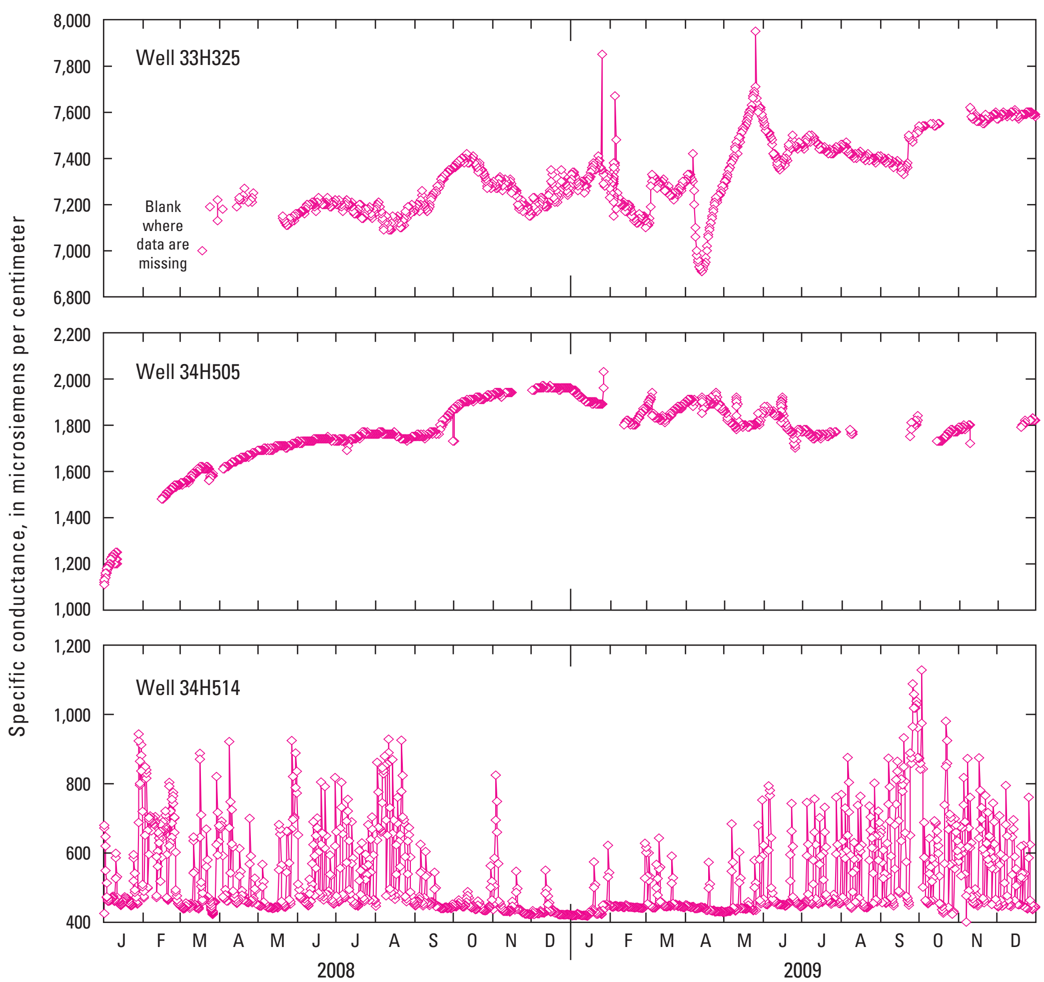
Groundwater Quality in the Upper and Lower Floridan Aquifer

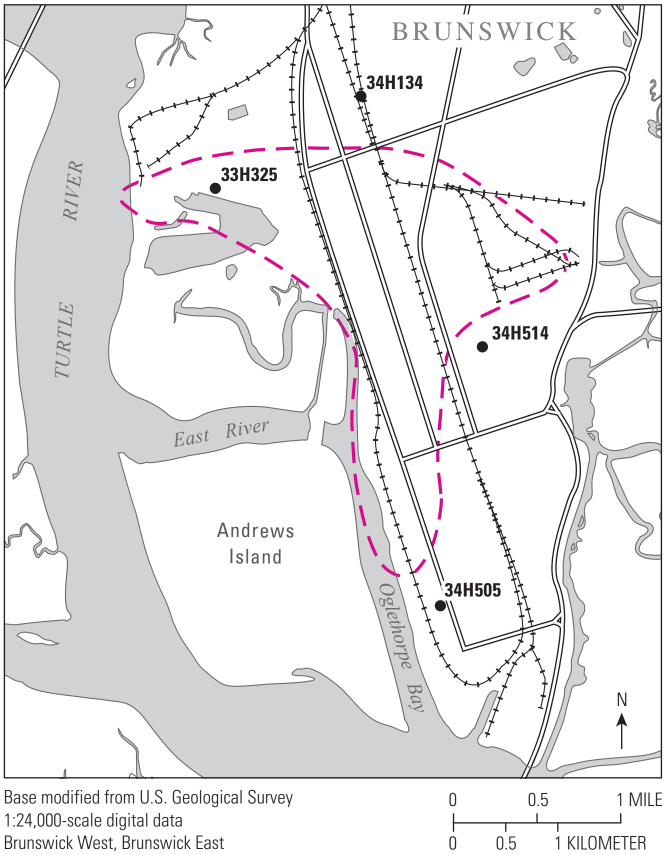
Real-Time Specific Conductance Monitoring in Brunswick Area



Beginning in 2007, a network of wells with real-time, satellite-telemetry was established at Brunswick to monitor changes in specific conductance in the upper and lower water-bearing zones of the Upper Floridan aquifer (specific conductance is a surrogate for changes in chloride concentration). Three of the wells are located immediately outside of the chloride plume, and one is located inside the plume area (see map, facing page). Of these four wells currently monitored in real time, three are monitored for daily specific conductance and hourly water levels and one is monitored for specific conductance only. Specific conductance is monitored in wells 33H325, 34H505, and 34H514 by pumping once a day from rigid, small-diameter tubing installed at predetermined depths (see table, facing page) to the water-bearing zone of interest (Walls and others, 2009). In supply well 34H134, specific conductance is recorded directly in the well-discharge pipe every 15 minutes. Data are transmitted every 1 to 4 hours, based on equipment, and can be viewed on the Web at *http://water.usgs.gov/ga/nwis/current?type=gw/*.

A correlation between specific conductance and chloride concentration presented by Cherry and others (2010) for the Brunswick area was used to determine the possible range of chloride concentration in these wells during 2008–2009 (see table, facing page). Estimated chloride concentration in wells 34H514 and 34H134 were at or below the 250-mg/L secondary drinking-water standard (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000). The estimated chloride concentration in wells 34H505 and 33H325 likely exceeded the secondary drinking-water standard.





Specific conductance, Upper Floridan aquifer, 2008–2009

[µS/cm, microsiemens per centimeter at 25º Celsius; mg/L, milligram per liter; LWBZ, lower water-bearing zone; UWBZ, upper water-bearing zone; ULWBZ, upper and lower water-bearing zones; modified from Cherry and others, 2010]

Site name	Water-bearing zone	Sampling interval (feet)	Specific conductance (µS/cm)	Estimated chloride concentration (mg/L)
34H514	UWBZ	605	401–1,130	15–250
34H134	ULWBZ	518–942	452–583	15–45
33H325	LWBZ	900	6,910–7,950	1,800–2,200
34H505	LWBZ	960	1,110–2,030	250–550

EXPLANATION

Approximate boundary of 2009 chloride plume— Chloride concentrations at least 250 milligrams per liter in the upper water-bearing zone of the Upper Floridan aquifer

34H505 **Real time specific conductance and water-level monitoring well**

Location of real-time specific conductance monitoring network and estimated chloride concentration in the upper water-bearing zone of the Upper Floridan aquifer in the Brunswick–Glynn County area, Georgia, July and August 2009.

References

Cherry, G.S., Peck, M.F., Painter, J.A, and Stayton, W.L., 2010, Groundwater conditions and studies in the Brunswick–Glynn County area, Georgia, 2009: U.S. Geological Survey Open-File Report 2009–1275, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1275/*.

Georgia Environmental protection Division, 1997, Secondary maximum contaminant levels for drinking water: Environmental Rule 391-3-5-19, revised October 1997: Official Code of Georgia Annotated Statutes, Statute 12-5-170 (Georgia Safe Drinking Water Act), variously paginated.

U.S. Environmental Protection Agency, 2000, Maximum contaminant levels (Part 143, National Secondary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100-149, rev. July 1, 2000, p. 612–614.

Walls, C.B., Cressler, A.M., and Stayton, W.L., 2009, Real-time water-level and specific conductance monitoring of saltwater contamination in the Upper Floridan aquifer, Brunswick, Georgia, *in* Rasmussen, Todd, Carroll, D.G., and Georgakakos, Aris, eds., Proceedings of the 2009 Georgia Water Resources Conference, held April 27–29, 2009, at the University of Georgia, Athens, Institute of Ecology, The University of Georgia, accessed July 2, 2009, at *http://www.gwri.gatech.edu/conferences/previous-gwrc-conferences/gwrc-2009/*.

Groundwater Quality in the Upper and Lower Floridan Aquifers

Camden County Area

In the Camden County area, chloride concentrations have been monitored periodically in the Upper Floridan aquifer from 1959 to 1993 and annually to semiannually from 1994 to the present. In the Lower Floridan aquifer, chloride concentrations have been monitored from 2001 to the present. During 2008–2009, the U.S. Geological Survey collected a total of 32 water samples from eight wells; six wells were completed in the Upper Floridan aquifer, and two wells were completed in the Lower Floridan aquifer. These wells (table, below) are part of a monitoring network maintained for the St. Johns Water Management District in Florida.

During 2008–2009, chloride concentrations in the Upper and Lower Floridan aquifers were relatively constant. Chloride concentrations in the Upper Floridan aquifer ranged from 30.2 to 44.8 milligrams per liter (mg/L), which are similar to the 20 to 40 mg/L background level for the area (Peck and others, 2005) and below the 250-mg/L drinking-water standard (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000). Chloride concentrations in the Lower Floridan aquifer remained below the 250-mg/L drinking-water standard, ranging from 27.5 to 30.3 mg/L in well 33D073, completed in the upper section of the Lower Floridan aquifer, and from 93.5 to 102 mg/L in well 33D074, completed in the lower section of the Lower Floridan aquifer (table, below).

References

Georgia Environmental Protection Division, 1997, Secondary maximum contaminant levels for drinking water: Environmental Rule 391-3-5-19, revised October 1997: Official Code of Georgia Annotated Statutes, Statute 12-5-170 (Georgia Safe Drinking Water Act), variously paginated.

Peck, M.F., McFadden, K.W., and Leeth, D.C., 2005, Effects of decreased ground-water withdrawal on ground-water levels and chloride concentrations in Camden County, Georgia, and ground-water levels in Nassau County, Florida, from September 2001 to May 2003: U.S. Geological Survey Scientific Investigations Report 2004–5295, 31 p.; available online at *http://pubs.usgs.gov/sir/2004/5295/.*

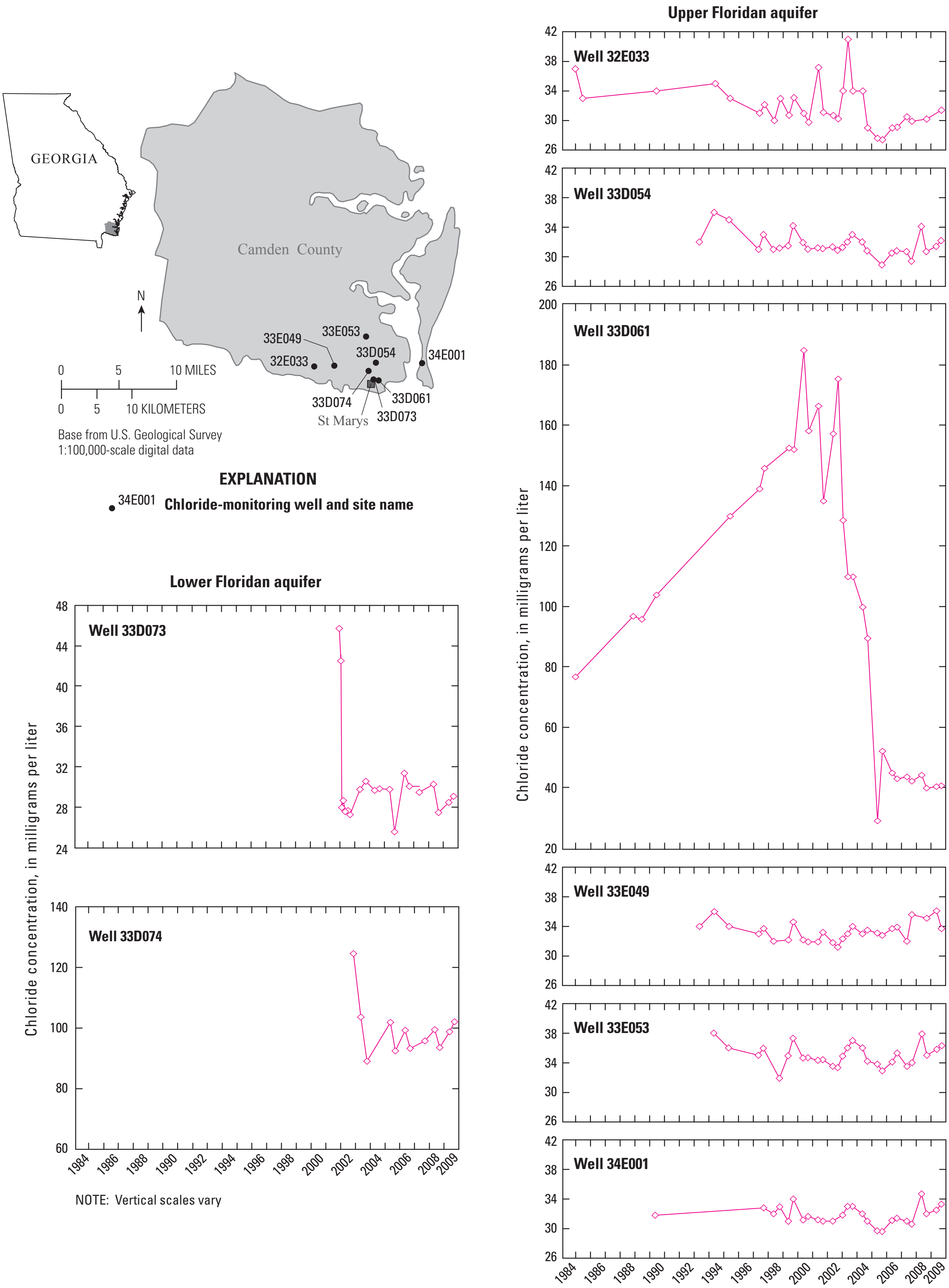
U.S. Environmental Protection Agency, 2000, Maximum contaminant levels (Part 143, National Secondary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100–149, rev. July 1, 2000, p. 612–614.

Chloride-monitoring network in the Floridan aquifer system, Camden County, Georgia

[UF, Upper Floridan aquifer; LF, Lower Floridan aquifer; —, no data]

Site name	Aquifer	Open interval (feet below land surface)	Chloride concentration (milligrams per liter)			
			May 2008	September 2008	May 2009	September 2009
32E033	UF	420–600	—	130.2	—	131.4
33D054	UF	563–1,000	[1]34.1	130.7	131.4	132.2
33D061	UF	550–1,090	[1]44.6	140.3	144.8	141.1
33E049	UF	522–840	—	135.1	136.1	133.7
33E053	UF	570–900	[1]37.9	135.0	135.8	136.3
34E001	UF	540–640	[1]34.7	132.0	132.5	133.3
33D073	LF	1,360–1,500	30.3	27.5	28.5	29.1
33D074	LF	1,840–2,004	99.4	93.5	98.7	102.0

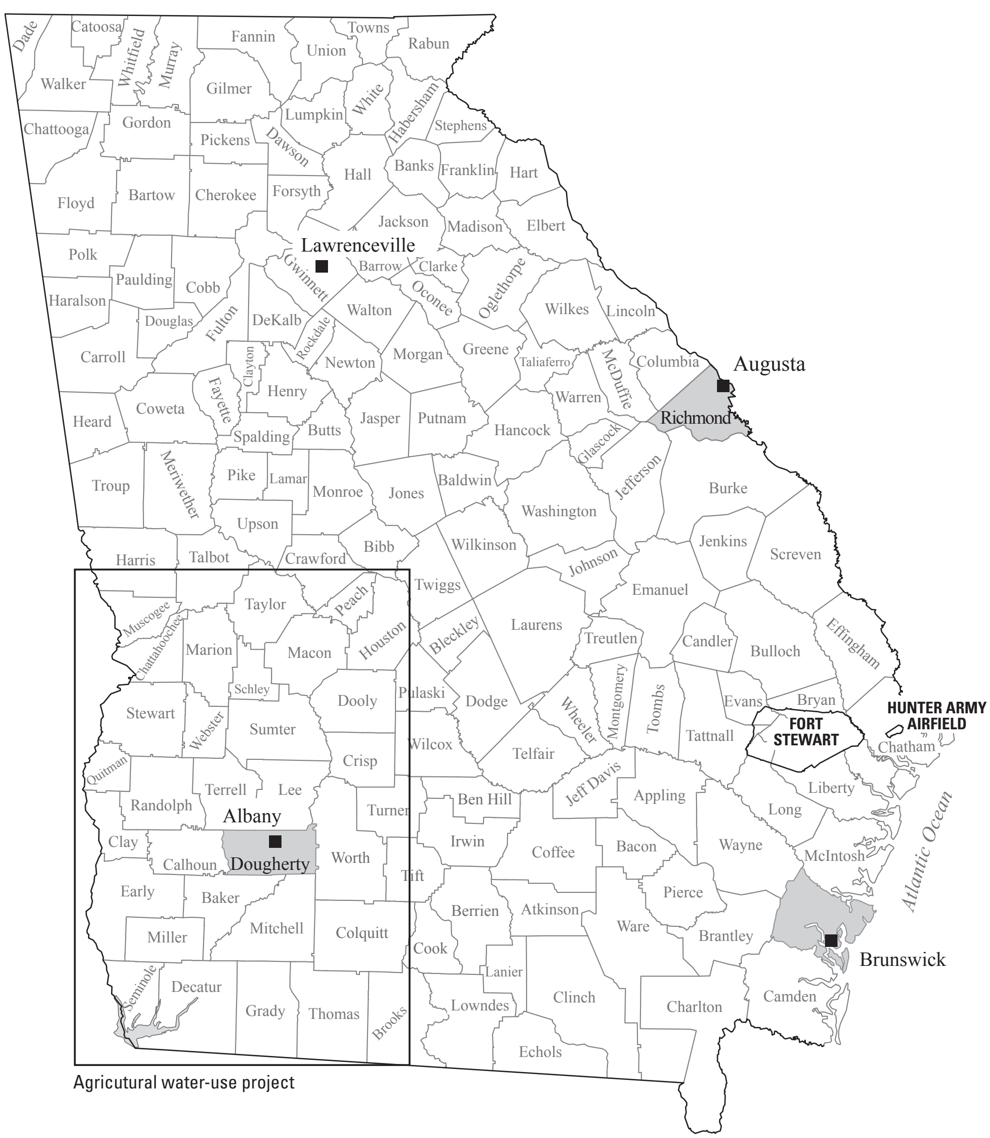
[1]Brian McGurk, St. Johns River Water Management District, written commun., February 2010.


GEORGIA
Camden County
N
0 5 10 MILES
0 5 10 KILOMETERS
Base from U.S. Geological Survey
1:100,000-scale digital data
33E049
33E053
33D054
32E033
34E001
33D074
33D061
33D073
St Marys
EXPLANATION
34E001 Chloride-monitoring well and site name
Lower Floridan aquifer
Well 33D073
Well 33D074
Chloride concentration, in milligrams per liter
NOTE: Vertical scales vary
Upper Floridan aquifer
Well 32E033
Well 33D054
Well 33D061
Well 33E049
Well 33E053
Well 34E001
1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2009

Selected Groundwater Studies in Georgia, 2008–2009

The U.S. Geological Survey (USGS), in cooperation with local, State, and other Federal agencies, conducted several studies in Georgia and adjacent States during 2008–2009 to better define the quantity and quality of groundwater and to monitor hydrologic conditions. Summaries of current USGS studies in Georgia are provided in the following sections and include information regarding

- Study title
- Study area location
- Study chief
- Cooperating agency or agencies
- Year study began
- Problem
- Objectives
- Progress and significant results

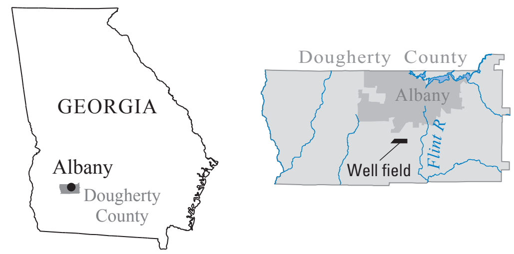


City of Albany Cooperative Water Program

Study Chief Debbie Warner Gordon

Cooperator Albany Water, Gas, and Light Commission

Year Started 1977



Problem

Long-term heavy pumping from the Claiborne and Clayton aquifers and the Cretaceous aquifer system (includes the Providence aquifer), which underlie the Upper Floridan aquifer, has resulted in substantial water-level declines in these deep aquifers in the Albany area. To provide additional water supply and reduce the demand on the deep aquifers, the Albany Water, Gas, and Light Commission (WGL) developed a large well field southwest of Albany with wells completed in the Upper Floridan aquifer, a karstic unit that is the uppermost reliable source of water in the area. Because of local recharge to the aquifer, water quality may be affected by land-use practices. Concentrations of nitrate plus nitrite as nitrogen exceeding the 10-milligrams per liter (mg/L) maximum contaminant level (U.S. Environmental Protection Agency, 2000) have been detected in some wells upgradient from the well field.

Objectives

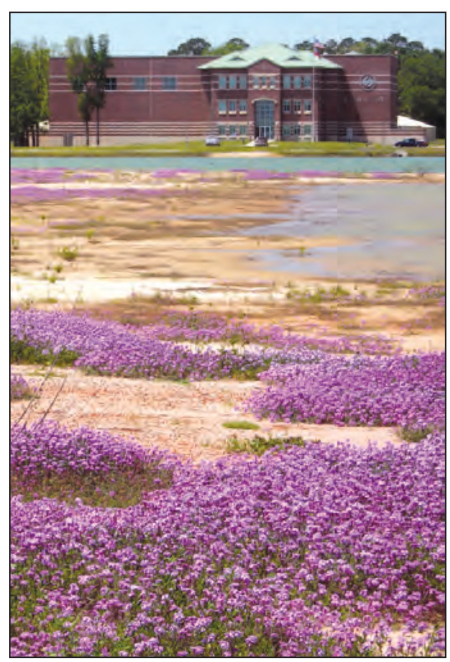
- Monitor water-level fluctuations in the five aquifers in the Albany area and relate water-level trends to changes in climatic conditions and pumping patterns.
- Describe the groundwater flow and water quality of the Upper Floridan aquifer near the new well field in the south-western Albany area.

Progress and Significant Results, 2008–2009

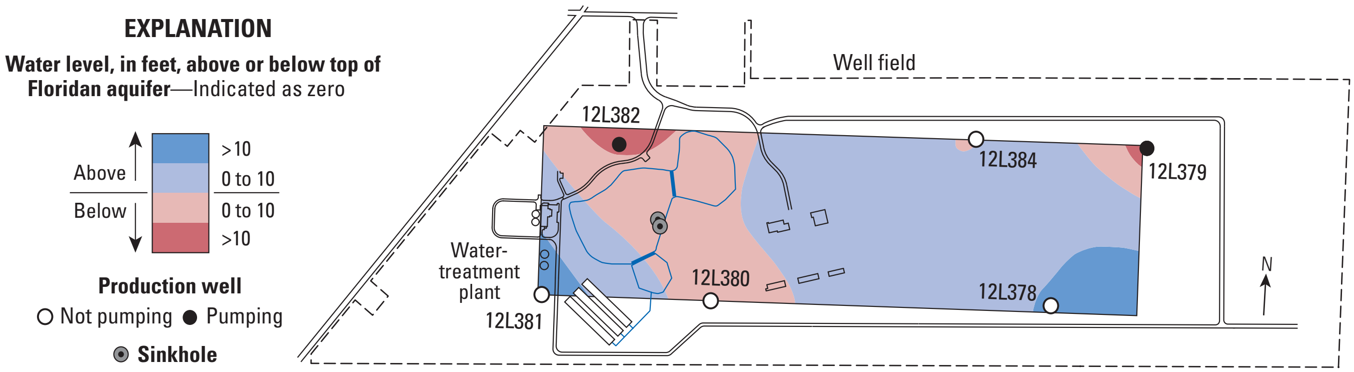
- Continued operation of the 14-well continuous groundwater-level monitoring network in the surficial, Upper Floridan, Claiborne, Clayton, and Providence aquifers.
- Continued groundwater-quality monitoring program. Water samples were collected and analyzed for major cations and anions, and selected nutrients during November 2008 (25 wells), and November, 2009 (17 wells). The USGS sampled wells 12L010 and 12L018 (map facing page), two of WGL's municipal supply wells, for pesticides in November 2008 and well 12L018 for pesticides in 2009.
- Constructed potentiometric-surface maps for the Upper Floridan aquifer near the well field based on measurements from 81 wells during November 2008, and 64 wells during November 2009. Both maps indicate that water generally flows from northwest to southeast near the well field. Water levels were higher during 2009 than during 2008. The well-field pumping did not result in the formation of a cone of depression surrounding the well field.
- Continued to map sinkholes at the well field. No new sinkholes formed during 2008; however, during 2009, six new sinkholes developed, two on January 12, 2009, two on April 26, 2009, and two on July 6, 2009.
- Began to study the reasons for sinkhole formation at the well field with regard to precipitation and water-level changes within the Upper Floridan aquifer.
- Continued development of a groundwater model to simulate flow in the vicinity of the Albany well-field area.

Reference

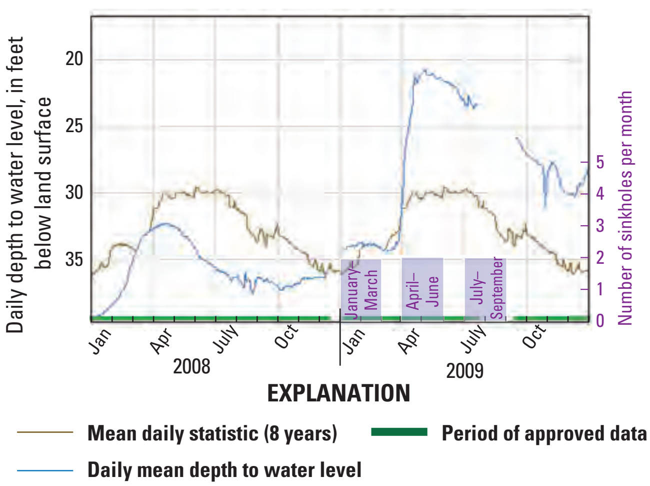
U.S. Environmental Protection Agency, 2000, Maximum contaminant levels (Part 143, National Secondary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100–149, rev. as of July 1, 2000, p. 612–614.



Albany Water, Gas, and Light Commission well field, Albany, Georgia, April 21, 2009. Photo by Debbie Warner Gordon, USGS.

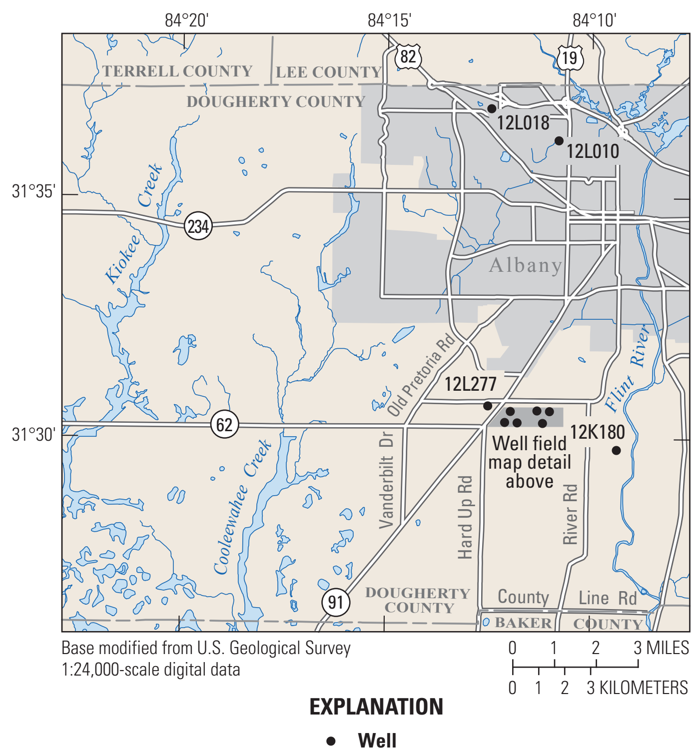


Water levels relative to the top of the Upper Floridan aquifer at the Albany well field during January 12, 2009. Water levels were below the top of the aquifer in much of the western part of the well field and in the northeast corner. Two production wells in the field were pumping during the period when two sinkholes formed.



Water level in well 12L277 (see map on right for location). No sinkholes formed in the well field during 2008, but six sinkholes formed in the well field during 2009.

Well 12K180 located on Victory Street, Albany, Georgia, April 21, 2009, following more than 15 inches of rain during March and April 2009. Photo by Debbie Warner Gordon, USGS.



Site map and well locations, Albany area.

Groundwater Monitoring Program for the Augusta–Richmond County Area

Study Chief John S. Clarke

Cooperator Augusta Utilities Department

Year Started 2006

Problem

Water supply in the Augusta–Richmond County area is provided in part by three well fields that withdraw water from the Dublin–Midville aquifer system—a Late Cretaceous sand aquifer. Low levels of the volatile organic compounds (VOCs) tetrachloroethene and trichloroethene have been detected in a supply well at the northernmost extent of well field number 2. To ensure that groundwater pumping does not adversely affect water levels in adjacent areas and to monitor groundwater quality, the U.S. Geological Survey operates a groundwater monitoring program for the Augusta–Richmond County area. Data from this network provide information to support water-management decisions and serve as a basis for future ground-water-modeling efforts while adding to improved regional characterization of groundwater conditions.

Objectives

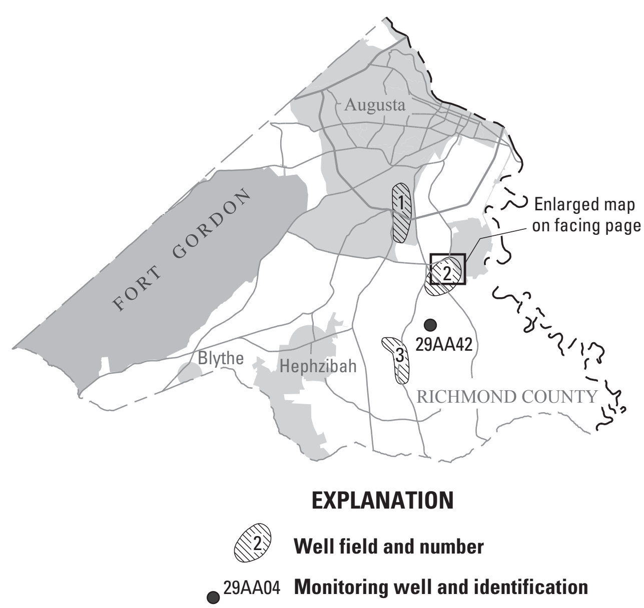
- Determine current groundwater levels, flow directions, and water quality of the Dublin–Midville aquifer system in the Augusta–Richmond County area.
- Monitor groundwater fluctuations and trends by operating a continuous water-level recorder network.
- Monitor groundwater quality in the vicinity of well field number 2 and assess the source of low-level volatile organic compounds.

Progress and Significant Results, 2008–2009

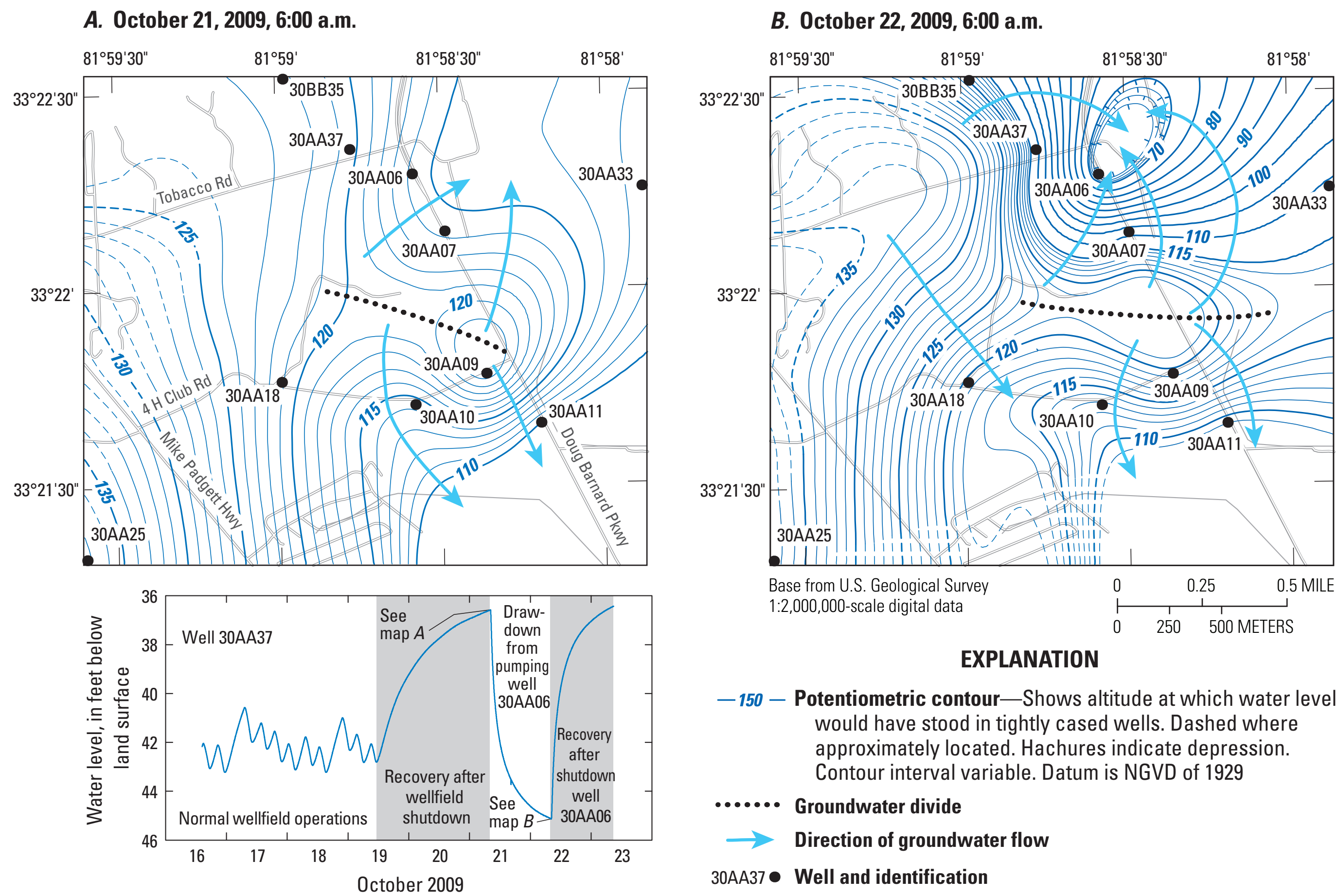
- Operated continuous water-level recorder network in wells 30AA06, 30AA33, and 30AA35 near well field number 2.
- Constructed three new test wells at two sites—one two-well site upgradient of well field number 2 (wells 30AA37 and 30AA38), and one single-well site located northwest of well field number 3 (well 29AA42).
- Obtained water-level measurements during June 2008 and September 2009 and constructed potentiometric-surface maps for the Dublin–Midville aquifer system.
- Conducted aquifer test at well field number 2 during October 19–24, 2009, to assess hydraulic properties of water-bearing units and to evaluate changes in groundwater levels and flow directions when various combinations of wells are pumped.
- Collected water samples during June–July 2008 and September 2009 and analyzed for VOCs near well field number 2.
- Collected water samples from selected wells in September 2009 for analysis of stable isotopes to provide an indication of the source(s) of low-level contaminants and age of water.
- Conducted borehole geophysical logging and flowmeter testing, and collected a grab water sample from well 30BB35 upgradient of well field number 2. Results indicate that borehole flow is downward from shallow to deep zones. VOCs were not detected in two water-quality samples collected from the well in September 2009.

Reference

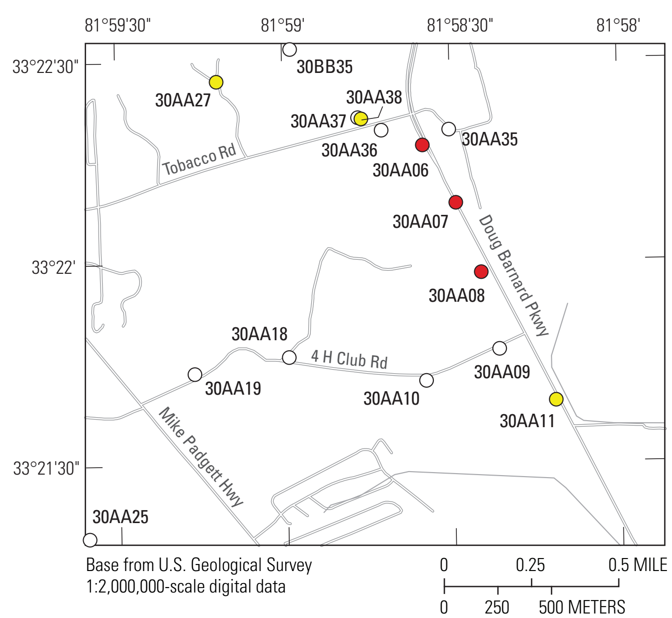
Williams, L.J., 2007, Hydrogeology and potentiometric surface of the Dublin and Midville aquifer systems in Richmond County, Georgia, January 2007: U.S. Geological Survey Scientific Investigations Map 2982, 1 sheet; available online at *http://pubs.usgs.gov/sim/2007/2982/*.



General area of the groundwater monitoring study showing the three municipal well fields and recorder well in the Augusta–Richmond County area of Georgia.



Graph and maps showing water levels in the Midville aquifer system near well field number 2 during aquifer test conducted in October 2009. Water levels shown on the graph are from well 30AA37, located upgradient of the well field. Map *A* shows water levels about 45 hours following shutdown of well field. Map *B* shows water levels 24 hours following initiation of pumping in well 30AA06. Note a groundwater divide has formed between wells in the southern part of the well field (not pumping) and the pumping well 30AA06. Groundwater north of this line flows toward well 30AA06, whereas south of the line water flows southeastward.



EXPLANATION

Well and identification with—

- 30AA25 Undetectable volatile organic compound levels
- 30AA08 Detectable volatile organic compound levels
- 30AA11 Detectable levels of chlorine disinfection byproducts

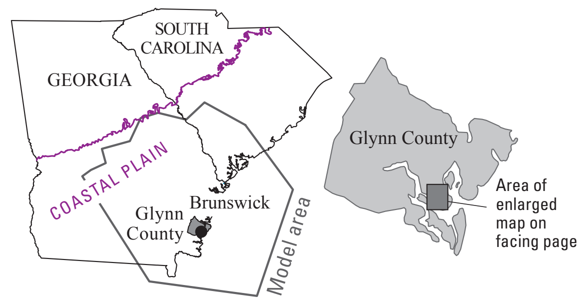
Results of water-quality monitoring near well field number two during 2008 and 2009 indicate presence of low-level concentrations of volatile organic compounds in some wells. Long-term water-quality monitoring provides information on water-quality trends to help assess contaminant migration. Analysis of groundwater age provides an indication of potential source areas of groundwater withdrawn at the well field. The apparent year of groundwater recharge in shallow well 30AA38, completed at a depth of 120 feet was 1991; whereas deeper wells at the well field (depths typically greater than 250 feet) were recharged between 1980 and 1984.

City of Brunswick and Glynn County Cooperative Water Program

Study Chief Gregory S. Cherry

Cooperator City of Brunswick, Glynn County
Jekyll Island Authority

Year Started 1959



Problem

In the Brunswick area, saltwater has contaminated the Upper Floridan aquifer for more than 50 years. Currently within an area of 2 square miles in downtown Brunswick, the aquifer yields water with a chloride concentration greater than 2,000 milligrams per liter (mg/L), markedly higher than the State and Federal secondary drinking-water standard of 250 mg/L (Georgia Environmental Protection Division, 1997; U.S. Environmental Protection Agency, 2000). This chloride contamination has constrained further development of the Upper Floridan aquifer in the Brunswick area and stimulated interest in the development of alternative sources of water, primarily from the shallower surficial and Brunswick aquifer systems.

Objectives

- Define and simulate mechanisms of groundwater flow and the occurrence and movement of saltwater in the Floridan aquifer system.
- Assess alternative sources of water supply from the surficial and Brunswick aquifer systems and the Lower Floridan aquifer.
- Monitor long-term groundwater levels and quality including real-time monitoring of the spatial extent of chloride contamination in the Upper Floridan aquifer.
- Develop and maintain a comprehensive groundwater database.

Progress and Significant Results, 2008–2009

A network of 32 continuous groundwater-level monitoring wells was operated—12 wells in the Upper Floridan aquifer, 8 wells in the Lower Floridan aquifer, 7 wells in the Brunswick aquifer system, and 5 wells in the surficial aquifer system (*C,* facing page). Of these 32 wells, 20 are funded by the Georgia Environmental Protection Division through the Coastal Georgia Sound Science Initiative.

Potentiometric surfaces of the Upper Floridan aquifer were mapped as follows:

- July 2008—mapping was based on water-level measurements made in 35 wells (Brunswick area only).
- August 2009—mapping was based on water-level measurements made in 52 wells (all of Glynn County).
- Chloride concentration of the Upper Floridan aquifer was mapped as follows:
- July 2008—mapping was based on analyses of samples collected from 67 wells.
- July–August 2009—mapping was based on analyses of samples collected from 60 wells.

A regional MODFLOW model of coastal Georgia and adjacent parts of Florida and South Carolina (Payne and others, 2005) was refined with higher resolution near the area of chloride contamination at Brunswick. The revised model is being used to assess the effects of pumping on hydraulic gradients along the outer margin of the contaminated area.

Real-time monitoring systems were installed in wells completed in the upper and lower water-bearing zones of the Upper Floridan aquifer that surround the area of chloride contamination. The following continuous data were collected:

- Water levels at Southside Baptist Church (wells 34H504 and 34H505), Perry Park (well 34H514), and Georgia–Pacific Cellulose (wells 33H324 and 33H325).
- Specific conductance at Southside Baptist Church (well 34H505), Perry Park (well 34H514; hydrograph, facing page), Georgia–Pacific Cellulose (well 33H325), and Brunswick Villa (well 34H134).

Information from the real-time groundwater-monitoring sites can be accessed at *http://waterdata.usgs.gov/ga/nwis/current/?type=quality&group%20Key=basin%20cd* and *http://waterdata.usgs.gov/ga/nwis/current/?type=gw&group_key=county_cd*.

References

Cherry, G.S., Peck, M.F., Painter, J.A, and Stayton, W.L., 2010, Groundwater conditions and studies in the Brunswick–Glynn County area, Georgia, 2008: U.S. Geological Survey Open-File Report 2009–1275, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1275/*.

Georgia Environmental Protection Division, 1997, Secondary maximum contaminant levels for drinking water: Environmental Rule 391-3-5-19, revised October 1997: Official Code of Georgia Annotated Statutes, Statute 12-5-170 (Georgia Safe Drinking Water Act), variously paginated.

Payne, D.F., Rumman M.A., and Clarke J.S., 2005, Simulation of groundwater flow in coastal Georgia and adjacent parts of South Carolina and Floridan Predevelopment, 1980, and 2000: U.S. Geological Survey Scientific Investigations Report 2005–5089, 91 p.; available online at *http://pubs.usgs.gov/sir/2005/5089/*.

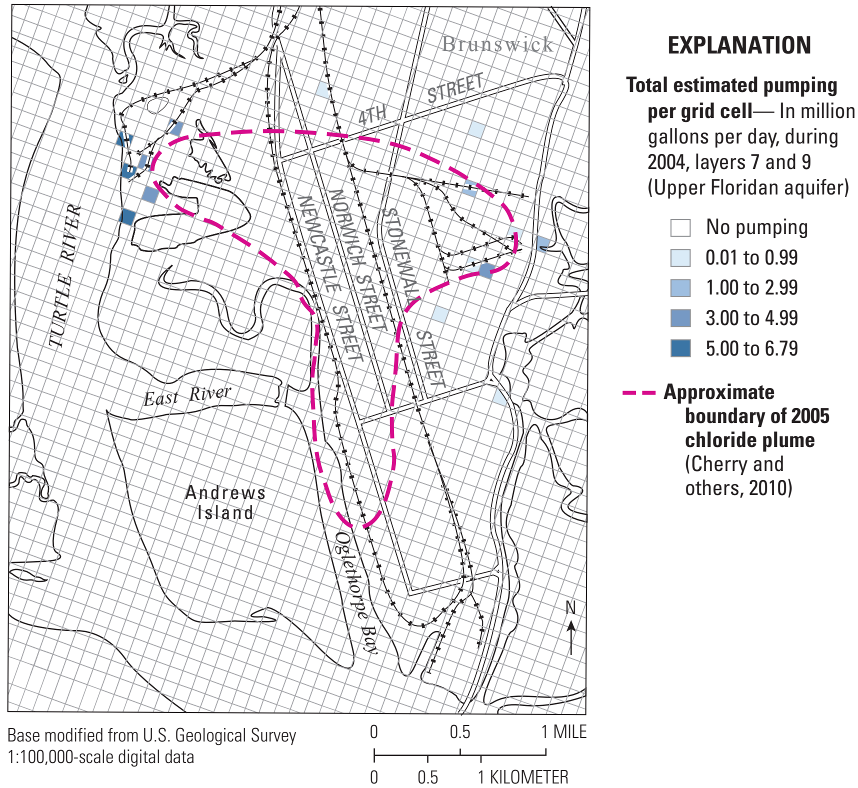
U.S. Environmental Protection Agency, 2000, Maximum contaminant levels (Part 143, National Secondary Drinking Water Regulations): U.S. Code of Federal Regulations, Title 40, Parts 100–149, rev. July 1, 2000, p. 612–614.

A. **Hydrogeologic units and model layers**

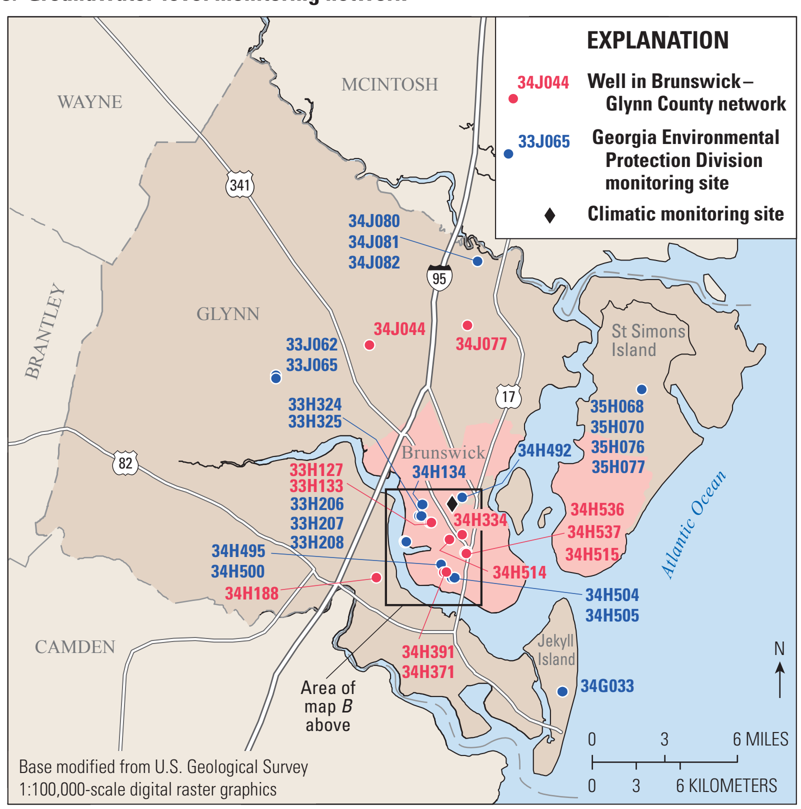
Hydrogeologic unit: Savannah	Hydrogeologic unit: Brunswick	Aquifer system	Model layer: Payne and others, 2005	Model layer: Revised model
Water-table zone		SURFICIAL AQUIFER SYSTEM	GHB (not modeled)	GHB (not modeled)
Confining unit	Upper water-bearing zone		1	1
	Lower water-bearing zone			
Confining unit		BRUNSWICK AQUIFER SYSTEM	2	2
	Upper Brunswick aquifer		3	3
				4
	Lower Brunswick aquifer			5
Upper Floridan confining unit			4	6
Upper Floridan aquifer	Upper water-bearing zone	FLORIDAN AQUIFER SYSTEM	5	7
	Upper Floridan semi-confining unit			8
	Lower water-bearing zone			9
Lower Floridan confining unit			6	10
Lower Floridan aquifer	Confining unit		7	11
	Fernandina permeable zone			
Confining unit			Not modeled	Not modeled

[GHB, general-head boundary]

B. **Hydrogeologic units and model layers**



C. **Groundwater-level monitoring network**



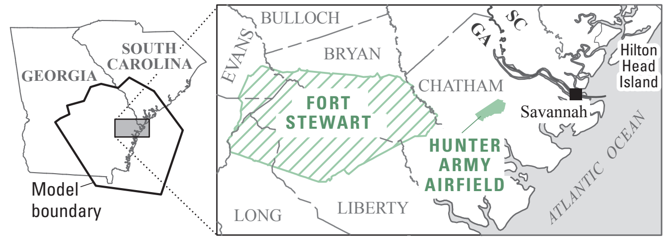
A digital model is being developed to simulate groundwater flow in the vicinity of the chloride plume at Brunswick. The model is based on a regional model developed by Payne and others (2005) as part of the Coastal Sound Science Initiative. A greater number of model layers *(A)* and finer grid resolution *(B)* are being applied to enable more detailed simulations in the vicinity of the chloride plume, including assessment of the effects of pumping on the hydraulic gradients near the plume. A groundwater-level monitoring network *(C)* helps assess current hydrologic conditions and the effectiveness of water-management practices.

Fort Stewart–Hunter Army Airfield Alternative Water Resources

Study Chief John S. Clarke

Cooperator U.S. Department of the Army

Year Started 2009



Problem

The U.S. Department of the Army Fort Stewart and Hunter Army Airfield (HAAF), Georgia, are home of the 3rd Infantry Division. These two sites are located in coastal Georgia near Savannah, where concern over saltwater intrusion at Hilton Head Island, South Carolina, has resulted in increased restrictions on groundwater withdrawals from the Upper Floridan aquifer by the Georgia Environmental Protection Division (GaEPD). To meet the growing water demand in Georgia's coastal area, the GaEPD has encouraged use of alternative water sources to the Upper Floridan, including streams, ponds, and wells completed in the Lower Floridan aquifer and shallower surficial and Brunswick aquifer systems.

To assess the water-resource potential of these various sources for potable supply and irrigation, the U.S. Geological Survey, in cooperation with the Department of the Army, is conducting detailed field investigations at HAAF and Fort Stewart.

Objectives

- Analysis of shallow alternative aquifers (surficial and Brunswick aquifer systems)—Conduct detailed site investigations in new and existing wells, including borehole geophysical logging and flowmeter testing, depth-integrated water sampling and analysis, and aquifer-performance testing to determine the drawdown and water-bearing capacity of the aquifer.

- Analysis of Lower Floridan aquifer—Conduct detailed site investigations, including borehole geophysical logging and flowmeter testing, depth-integrated water sampling and analysis, and aquifer-performance testing to determine the drawdown and water-bearing capacity of the Lower Floridan aquifer and interconnection (leakage) with the overlying Upper Floridan aquifer. Perform groundwater model analyses to further assess the effects of pumping on leakage between the Upper and Lower Floridan aquifers.

- Analysis of ponds—Conduct detailed site investigations of selected ponds to assess water-supply potential, including describing the local site setting and pond bathymetry, estimating the volume of water stored in the ponds over a range of stages, estimating net groundwater seepage derived from water-budget analyses and pond-discharge tests, and determining the suitability of pond water quality for irrigation purposes.

Progress and Significant Results, 2008–2009

- Completed construction and field testing of new production well at HAAF completed in the Lower Floridan aquifer. Field testing included collection of drill cuttings, core, borehole geophysical logs and flowmeter data, conducting aquifer-performance tests in the Upper and Lower Floridan aquifers, collection and analysis of water samples from a variety of depths, conducting packer slug tests in the Lower Floridan confining unit, and laboratory analysis of core samples for determination of vertical hydraulic conductivity. Data were synthesized into an existing groundwater-flow model modified to assess interaquifer leakage between the Upper and Lower Floridan aquifers.

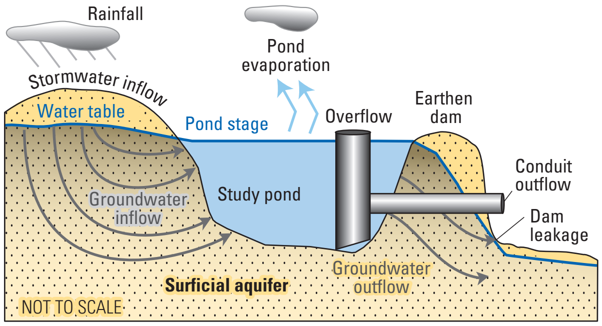
- Conducted evaluation of the hydrology, water-quality, and water-supply potential of four ponds at HAAF. This included determination of the volume of water stored in the ponds under a range of stage conditions; measurement of streamflow discharging from one of the ponds and development of a stage-discharge relation to determine flow rates over a range of climatic conditions; estimating net groundwater seepage by developing hydrologic budgets; and sampling and analysis to determine pond water quality. Results of the investigation are documented in a final report (Clarke and Painter, 2010).

References

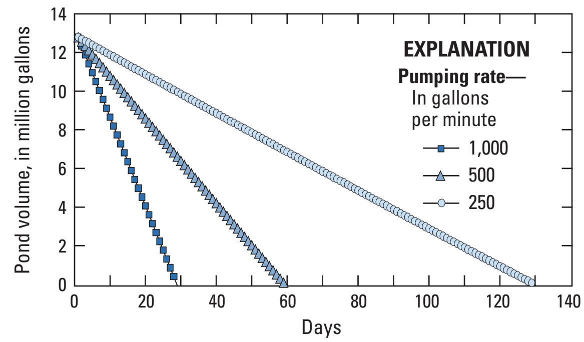
Clarke, J.S., and Painter, J.A., 2010, Hydrology, water quality, and water-supply potential of ponds at Hunter Army Airfield, Chatham County, Georgia, November 2008–July 2009: U.S. Geological Survey Scientific Investigations Report 2009–5265, 34 p.; available online at *http://pubs.usgs.gov/sir/2009/5265/*.

U.S. Environmental Protection Agency, 2009, Drinking water contaminants, accessed February 3, 2011, available online at *http://water.epa.gov/drink/contaminants/index.cfm*.

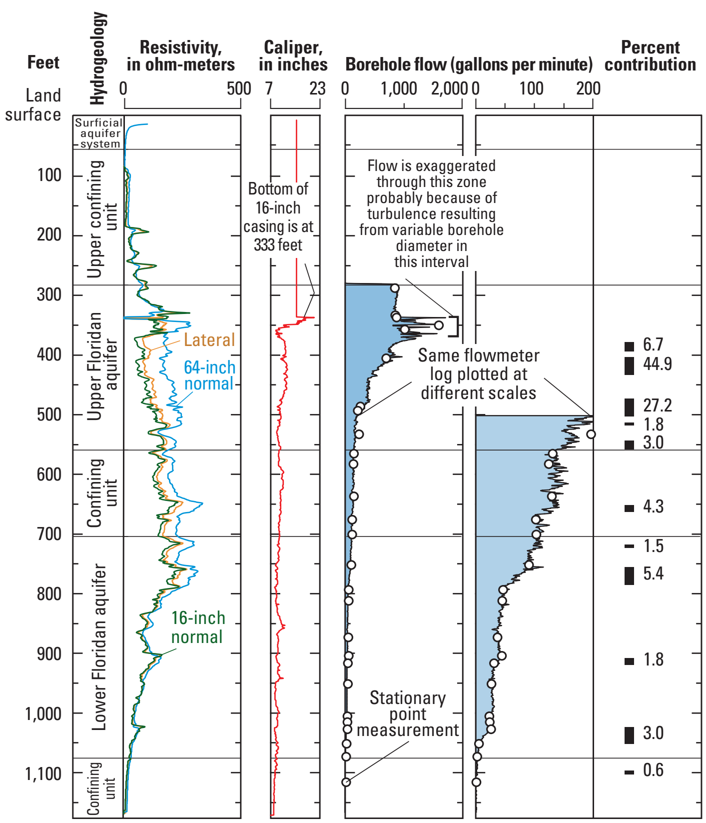
Williams, L.J., 2010, Summary of hydrologic testing of the Floridan aquifer system at Hunter Army Airfield, Chatham County, Georgia: U.S. Geological Survey Open-File Report 2010–1066, 30 p.; available online at *http://pubs.usgs.gov/of/2010/1066/*.



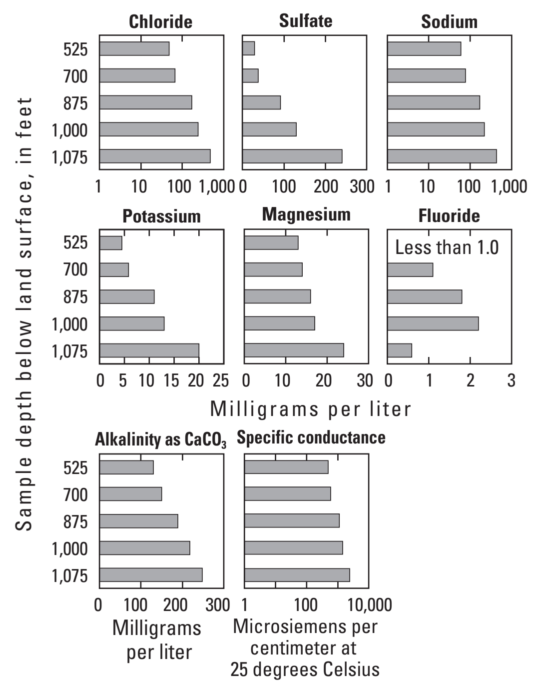
Conceptual model of pond-aquifer flow for a typical coastal area pond. Water supply from ponds is derived from the amount of available storage in the pond replenished by groundwater inflow and surface runoff. Evaporation, groundwater outflow, and leakage through earthen dams accounts for losses to pond storage. Field data including precipitation, evaporation, pond stage, and pond bathymetry were used to develop a hydrologic budget for three ponds at Hunter Army Airfield (HAAF) and assess their potential as sources of irrigation water supply (modified from Clarke and Painter, 2010).



At one of the ponds at HAAF, the total available volume was 12.8 million gallons and the average rate of net groundwater flow was 19 gallons per minute (gal/min). Assuming long-term average climatic conditions for July and an 8-hour-per-day pumping period, total depletion of pond volume would occur after 29 days at a pumping rate of 1,000 gal/min, after 60 days at a pumping rate of 500 gal/min, and after 130 days at a pumping rate of 250 gal/min. (modified from Clarke and Painter, 2010).



Geophysical logs and flowmeter data collected from a test boring open to both the Upper and Lower Floridan aquifers at HAAF were used to determine the relative flow contribution from water-bearing zones and to delineate the top and bottom of the Upper and Lower Floridan aquifers. While pumping at a rate of 847 gallons per minute (gal/min), flowmeter data indicated that the Upper Floridan aquifer, as a whole, produced 83.5 percent of the total flow with the remaining 16.5 percent derived from the underlying confining unit and the Lower Floridan aquifer. Two intervals in the Upper Floridan aquifer, 405–435 feet (ft) and 475–505 ft, produced the highest percentage of accumulated flow with an estimated 610 gal/min or 72 percent of the total pumping rate (modified from Williams, 2010).



Discrete water samples collected from the Upper and Lower Floridan aquifers indicate that constituent concentrations generally increase with depth and are within drinking-water standards, with the exception of the deepest sample at 1,075 feet (ft). Water from the 1,075-ft interval had a chloride concentration of 480 milligrams per liter (mg/L), which exceeds the U.S. Environmental Protection Agency (USEPA) Secondary Maximum Contaminant Level (SMCL) of 250 mg/L (U.S. Environmental Protection Agency, 2009). The sulfate concentration of water from the same interval (240 mg/L) is slightly below the USEPA SMCL of 250 mg/L (U.S. Environmental Protection Agency, 2009). Flowmeter testing in the completed Lower Floridan aquifer well indicates that water from the 1,075-ft zone contributes less than 2 percent of the total flow to the well, and therefore the relatively higher concentrations of chloride and sulfate do not adversely affect the overall water quality from the well.

Monitoring of Groundwater and Surface-Water Resources in the City of Lawrenceville Area

Study Chief John S. Clarke

Cooperator City of Lawrenceville, Georgia

Year Started 2002

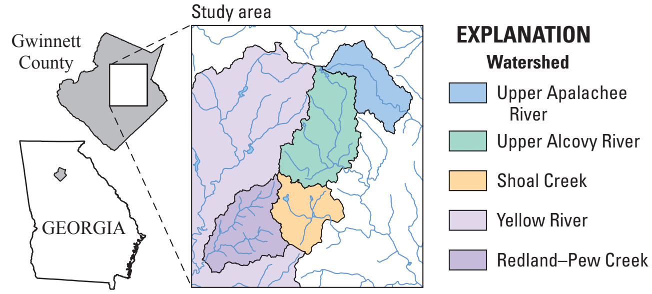
Problem

To meet Lawrenceville's growing need for water, the city is expanding development of its groundwater supply. During 1995–2007, Lawrenceville obtained 4–7 percent of its drinking water from groundwater (from a single well); the remainder of the drinking water was obtained from surface-water sources. In addition to a well near the center of town, the city plans additional groundwater withdrawal in the Redland–Pew Creek and upper Alcovy River watersheds. To enable informed decisions, city managers want to be able to quantify the effects (if any) of groundwater pumping on the surface-water resources as development increases. In addition to understanding groundwater resources, successful watershed management requires an understanding of how stream water quality is affected by watershed characteristics.

To support long-term management goals, the City of Lawrenceville, in cooperation with the U.S. Geological Survey (USGS), established a hydrologic monitoring network. The network consists of groundwater (regolith and bedrock wells) and surface-water (streamgages) sites in the two newly developed watersheds and in a background watershed (upper Apalachee River watershed) that is not influenced by the main pumping centers. In addition, sites in the Yellow River watershed are monitored to provide an indication of changes along the northern boundary of the Redland–Pew Creek watershed. An additional streamgage was installed in the adjacent Shoal Creek watershed. The data and information collected during the study can be used by local resource managers to develop a sustainable groundwater supply while minimizing the effects on surface-water resources. The data also will help in understanding changes in surface-water quality over time.

Objectives

A cooperative water program (CWP) between the USGS and the City of Lawrenceville has been in place since 1994. The initial purpose of the CWP was to provide a better understanding of the geologic controls on groundwater availability in fractured crystalline rock. In 2002, the program was modified to incorporate groundwater and stream monitoring to assess the effects of groundwater development. Stream water-quality monitoring was added to the program in 2005.

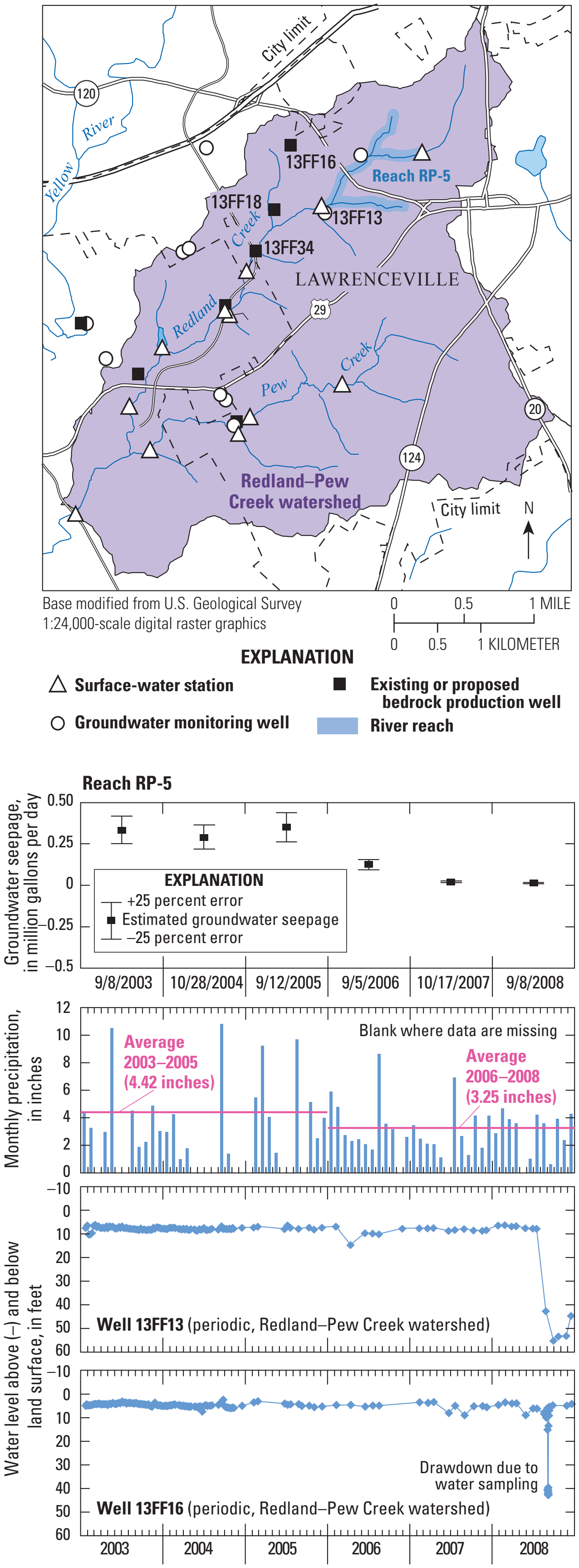


Progress and Significant Results, 2008–2009

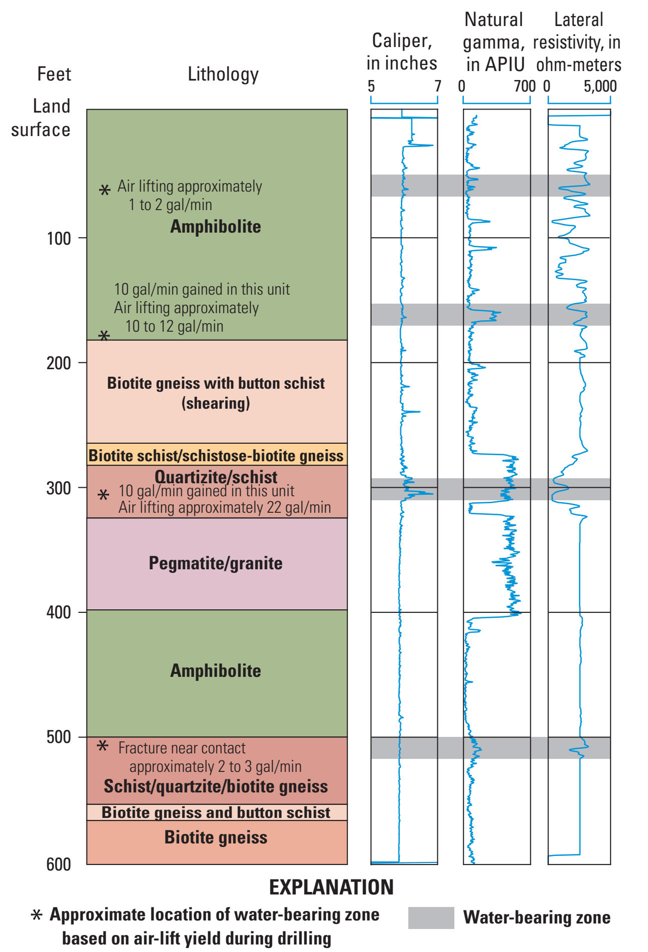
- Monitored groundwater levels in 26 wells, 3 of which recorded continuously, 21 wells were measured periodically, and 2 wells were continuously monitored during part of the year and measured periodically during the remainder of the year.
- Monitored streamflow and precipitation continuously at three sites, two of which included continuous water-quality monitoring of water temperature, specific conductance, and turbidity. In addition to these three continuously monitored surface-water sites, the network included periodic streamflow measurements at 22 other sites (the number of locations measured in a given year varied over the reporting period).
- Collected synoptic stream base-flow measurements in September 2008 to locate and quantify gains or losses to streamflow resulting from groundwater interaction (groundwater seepage). Measurements were not collected during the fall of 2009 because of above-normal precipitation and high streamflows.
- Collected borehole geophysical logs in well 13FF34, a 605-foot-deep test well drilled by the City of Lawrenceville in June 2008 to explore additional water resources in the Redland–Pew Creek watershed.
- Published study results in USGS Scientific Investigations Report 2010–5032, "Hydrologic conditions, stream-water quality, and selected groundwater studies conducted in the Lawrenceville area, Georgia, 2003–2008."
- Updated the project Web site, which can be accessed at *http://ga.water.usgs.gov/projects/lawrenceville/*.

Reference

Clarke, J.S., and Williams, L.J., 2010, Hydrologic conditions, stream-water quality, and selected groundwater studies conducted in the Lawrenceville area, Georgia, 2003–2008: U.S. Geological Survey Scientific Investigations Report 2010–5032, 55 p.; available online at *http://pubs.usgs.gov/sir/2010/5032/*.



Groundwater level and streamflow monitoring data are used to evaluate effects of groundwater pumping in the Lawrenceville area. In the Redland–Pew Creek watershed during 2003–2007, groundwater levels in wells 13FF13 and 13FF16 showed a similar, slightly downward trend in response to decreased precipitation. In 2008, water levels in well 13FF16 showed little change, whereas well 13FF13 showed a sharp decline of nearly 37 ft. This sharp decline was in response to the initiation of pumping in well 13FF18, located about 0.3 mile west of well 13FF13. In reach RP-5 along Redland Creek, streamflow gain was indicated throughout 2003–2008, with a decrease related to low precipitation during the drought period of 2006–2008. There was no appreciable difference in streamflow gain since the initiation of pumping in well 13FF18 (modified from Clarke and Williams, 2010).



Well 13FF34 is a 605-ft-deep test well drilled by the City of Lawrenceville in June 2008 to explore additional water resources in the Redland–Pew Creek watershed. Borehole geophysical logs and examination of drill cuttings indicate the rocks penetrated by this well include an upper and lower amphibolite unit, biotite gneiss and button schist unit, a quartzite/schist unit and a pegmatite/granite unit. Four water-bearing zones provide water to this well: (1) within the upper amphibolite unit, (2) near the contact of the upper amphibolite unit and the biotite gneiss and button schist unit, (3) within the quartzite/schist unit, (4) near the basal contact of the lower amphibolite unit. The final air-lift yield was measured at about 22 gal/min (gallon per minute; APIU, American Petroleum Institute Units; modified from Clarke and Williams, 2010).

Georgia Agricultural Water-Use Project

Study Chief Lynn J. Torak

Cooperator Georgia Soil and Water Conservation Commission

Year started 2008

Area maps *A* and *B* facing page

Introduction

By the end of 2009, agricultural water withdrawals in south Georgia were being monitored from a network of 6,985 annually read flow meters and 148 daily reporting, satellite-transmitted, telemetry sites (see map *A*, facing page). The monitoring is a result of the enactment of House Bill 579 by the Georgia General Assembly on June 4, 2003, which granted jurisdiction to the Georgia Soil and Water Conservation Commission (Commission) to "[implement] a program of measuring farm uses of water in order to obtain clear and accurate information on the patterns and amounts of such use, which information is essential to proper management of water resources by the state and useful to farms for improving the efficiency and effectiveness of their use of water, …, and [for] improving water conservation" (Georgia General Assembly, 2003).

Since November 2008, the U.S. Geological Survey, in cooperation with the Commission, has been researching methods for estimating agricultural water use and growing-season pumping rates through the analysis of water-meter data. A geographic information system (GIS) has been used for geospatial analyses of the data and has yielded promising results for identifying seasonal pumping patterns.

Objectives

Objectives of the analysis were to (1) develop a quality-assurance program to ensure completeness and internal consistency of water-meter data, (2) calculate descriptive statistics of aggregated water-use data, (3) evaluate the potential to relate daily water-use telemetry to annually reported water use through a descriptive statistical model, and (4) identify spatial and temporal distributions of agricultural-irrigation pumpage

Progress and Significant Results

A GIS-compatible relational database was developed consisting of all annually reported and satellite-transmitted telemetry of agricultural water use for aggregated statistical evaluation and comparison by source (groundwater, surface-water, and well-to-pond irrigation systems). Quality-assurance checks indicated water-meter "rollback" or "roll forward" during periods of non-irrigation, and zero water use at some meter sites since the inception of the metering program in 2003; zero water use significantly affected calculations of mean annual water use. On average, irrigation volume supplied by groundwater exceeded the volume supplied by surface water by about one-third. Comparison of mean irrigation volumes by source indicated that groundwater and surface-water use represent two distinct data populations that require independent statistical analyses.

Analyses of 81 telemetered and 4,357 annually reported water-use sites, which constitute the metering program in the Chattahoochee–Flint River basin, were conducted to evaluate the randomness of the two datasets (groundwater and surface water)—a prerequisite for subsequent geospatial analyses—and to assess the spatial distribution of meter locations. The analyses indicated

- Possible outliers or "hot spots" (clusters of high or low water-use values) that may relate to variations in aquifer yield, streamflow availability, soil type, crop patterns, rainfall and topography, requiring further identification and study. Separate hot-spot analyses for surface water (map *B*) and groundwater (map *C*) indicated geographic bands trending northwest to southeast of low-to-high agricultural water-use volume.
- Concentrated distributions (clustering) of telemetry sites in areas containing low-irrigation volumes, which resulted in underestimating annually reported mean water use with the telemetry network.
- A wide range of applied irrigation volumes among meter sites, which required data conversion to per-acre application rates by dividing irrigation volume by field acres

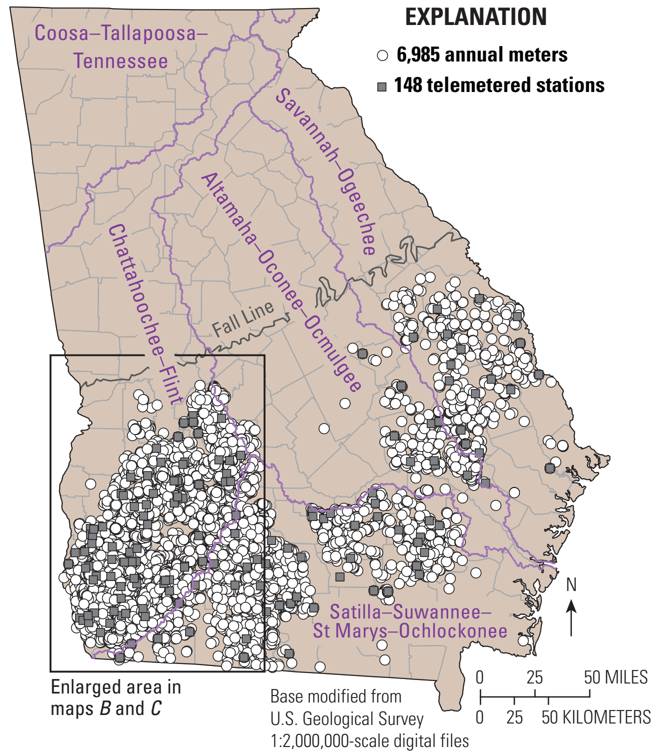
Reference

Environmental Systems Research Institute, Inc., 2009, How hot spot analysis: Getis-Ord Gi* (Spatial Statistics) works: Environmental Systems Research Institute, Inc., release 9.2, accessed March 24, 2010, at *http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=How%20Hot%20Spot%20Analysis:%20Getis-Ord%20Gi*%20(Spatial%20Statistics)%20works*.

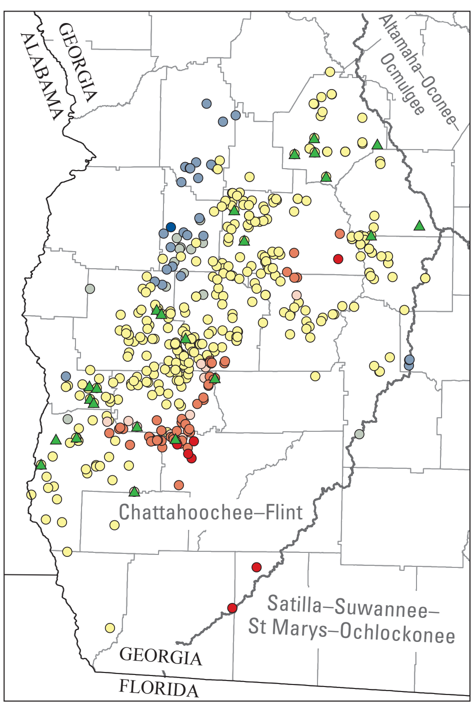
Georgia General Assembly, 2003, HB 579—Water resources; farm uses; water-measuring device: Georgia General Assembly, accessed March 23, 2010, at *http://www.legis.state.ga.us/legis/2003_04/search/hb579.htm*.

Locations of agricultural water metering program sites in south Georgia, 2009, including *(A)* 6,985 annually read and 148 daily satellite-transmitted data sites, with pattern of statistic (Gi* Z scores, Environmental Systems Research Institute, Inc., 2009) indicating geographic clustering of low-to-high annual irrigation volumes (“hot spots”) applied to *(B)* surface-water and *(C)* groundwater metered sites in the Chattahoochee–Flint River basin. The Gi* statistic defines a normal Z score (or standard score), which assesses the distribution of the annually reported water-use values about the mean. Statistically significant Z scores (less than –1.64 or greater than 1.65 standard deviations) of the Gi* statistic occur in areas containing clusters of either high (positive Z scores) or low (negative Z scores) irrigation water-use volume.

***A.* Georgia agricultural water metering program, 2009**



***B.* Surface-water metered sites, 2009**



EXPLANATION

Annual hotspot Gi* Z score—
Standard deviation

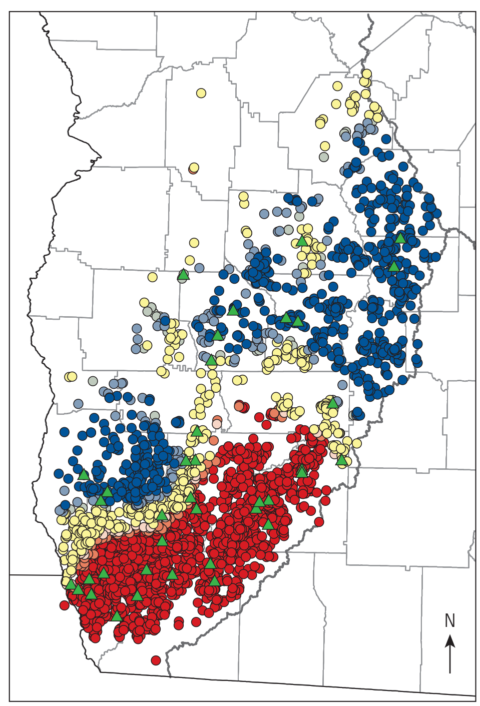
- < –2.57
- –2.57 to –1.96
- –1.95 to –1.66
- –1.65 to 1.65
- 1.66 to 1.96
- 1.97 to 2.58
- > 2.58

Telemetry

0 10 20 MILES
0 10 20 KILOMETERS

Base modified from
U.S. Geological Survey
1:100,000-scale digital data

***C.* Groundwater metered sites, 2009**

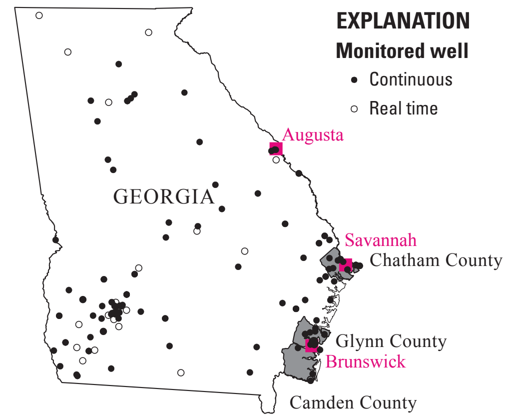


Groundwater Information and Project Support

Study Chief Michael F. Peck

Cooperator Georgia Department of Natural Resources Environmental Protection Division
St. Johns River Water Management District, Florida

Year Started 1938



Problem

Groundwater supplies about 22 percent of freshwater withdrawals in Georgia—more than 1.2 billion gallons per day during 2005. More than 1.9 million people are served by groundwater supplies, and 752 million gallons per day are withdrawn for irrigation (Fanning and Trent, 2009). The distribution and quality of groundwater are highly variable and directly related to geology and natural and human stresses. Monitoring groundwater levels and groundwater quality is essential for the management and development of this resource.

Objectives

- Collect groundwater-level and groundwater-quality data to assess the quantity, quality, and distribution of groundwater.
- Provide data to address water-management needs and evaluate the effects of national and local management and conservation programs.
- Contribute data to national databases that will be used to advance the understanding of regional and temporal variations in hydrologic conditions..

Progress and Significant Results, 2008–2009

- Continuous water-level recorders were operated in 179 wells during 2008 and in 181 wells during 2009. Of the 181 wells, 30 are instrumented with real-time transmission (satellite relay) of continuous water-level records. During 2009 an additional well was instrumented with real-time equipment in the coastal area to monitor specific conductance, which brought the total to four wells being monitored for water quality. The data from these wells can be accessed through the National Water Information System (NWIS) database on the Web at *http://waterdata.usgs.gov/ga/nwis/current/?type=gw*.
- Periodic water-level measurements were made in more than 3,700 wells to define potentiometric surfaces and to assess long-term trends.
- Water samples for chloride analyses were collected from 66 wells during 2008 and 60 wells during 2009 in the Brunswick area, and from 4 wells in the Savannah area and 7 wells in Camden County during 2008–2009.
- During 2008–2009, borehole geophysical logs were collected in 11 wells in northern Georgia and in 22 wells in southern Georgia (map and table, facing page).
- Well-inventory, water-level, and geologic data were verified for entry into the NWIS database. Field inventories of well sites were conducted to assist projects, and 1,030 sites were added to the NWIS Groundwater Site Inventory to improve groundwater data coverage in the State. The NWIS database can be accessed on the Web at *http://waterdata.usgs.gov/ga/nwis/inventory/*.

References

Fanning, J.L., and Trent, V.P., 2009, Water Use in Georgia by county for 2005; and water-use trends, 1980–2005: U.S. Geological Survey Scientific Investigations Report 2009–5002, 186 p.; available online at *http://pubs.usgs.gov/sir/2009/5002/.*

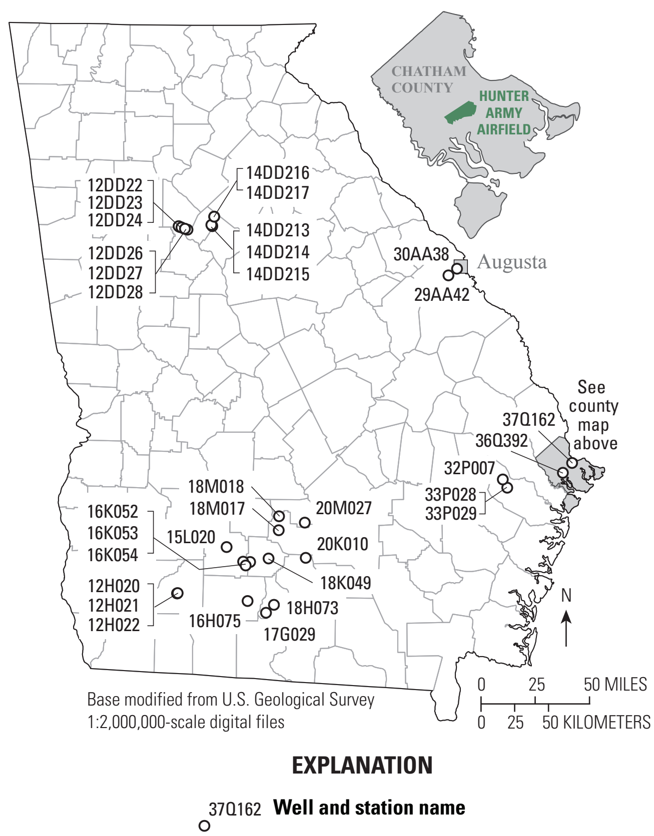
Peck, M.F., Painter, J.A., and Leeth, D.C., 2009, Ground-water conditions and studies in Georgia, 2006–2007: U.S. Geological Survey Scientific Investigations Report 2009–5070, 86 p.; available at *http://pubs.usgs.gov/sir/2009/5070/*.

Wells where geophysical logs were collected, 2008–2009

County name	Station name	Well depth, in feet, below land surface
Ben Hill	18M018	265.0
Ben Hill	20M027	304.0
Berrien	20K010	485.0
Chatham	36Q392	1,168.0
Chatham	37Q162	903.0
Colquitt	16H075	342.0
Cook	17G029	306.0
Cook	18H073	210.0
DeKalb	12DD22	228.0
DeKalb	12DD23	183.0
DeKalb	12DD24	165.0
DeKalb	12DD26	183.5
DeKalb	12DD27	206.6
DeKalb	12DD28	172.6
Liberty	32P007	505.0
Liberty	33P028	1,300.0
Liberty	33P029	560.0
Mitchell	12H020	133.0
Mitchell	12H021	76.0
Mitchell	12H022	200.0
Richmond	29AA42	509.0
Richmond	30AA38	122.0
Rockdale	14DD213	622.0
Rockdale	14DD214	622.0
Rockdale	14DD215	725.0
Rockdale	14DD216	305.0
Rockdale	14DD217	305.0
Tift	16K053	244.0
Tift	18K049	622.0
Tift	18M017	230.0
Worth	15L020	738.0
Worth	16K052	725.0
Worth	16K054	520.0

A hydrologic technician from the Groundwater Information and Project Support unit is recording the discharge from a well at Augusta, Georgia, during a 24-hour aquifer test. The well is completed in the Dublin–Midville aquifer system. Photo by Michael D. Hamrick, USGS.

Hydrologic technicians set up a data logger and pressure transducer to monitor the stage at Hunter Army Airfield in Chatham County, Georgia. A tipping bucket rain gage has also been installed to record precipitation during the test period. Data were used to develop a hydrologic budget for the pond to help assess water-bearing potential as a source of irrigation supply. Photo by John S. Clarke, USGS.



Well locations where geophysical logs were collected during 2008–2009.

Selected Groundwater Publications, Conferences, and Outreach, 2008–2009

Many reports, conference proceedings papers, and abstracts were published during 2008 and 2009 presenting results of U.S. Geological Survey (USGS) groundwater investigations in Georgia. Oral and poster presentations were given at various technical conferences and outreach events throughout the State. These publications and presentations provide results of investigations conducted in cooperation with State, Federal, and local agencies including the Georgia Department of Natural Resources (primarily the Environmental Protection Division); U.S. Department of Defense, City of Brunswick and Glynn County; Albany Water, Gas, and Light Commission; City of Lawrenceville; and Rockdale County. Most of the publications are available on the Web only and can be viewed and downloaded at *http://ga.water.usgs.gov/publications/*.

Georgia Water Resources Conference for 2009

The biennial Georgia Water Resources Conference is co-sponsored by the USGS, and the results of several USGS investigations are highlighted. The 11th biennial conference was held at The University of Georgia in Athens during April 2009. Twenty-eight USGS papers and posters, 14 of which addressed groundwater investigations, were published in the conference proceedings (see bibliographic listing below).

Other Conferences and Outreach Events

During 2008–2009, USGS groundwater scientists participated in a variety of conferences and outreach events, including the following:

- Georgia Association of Water Professionals Spring Conference and Expo, April 2009
- Carl E. Kindsvader Symposium, April 2008
- Geological Society of America, October 2008 and October 2009
- Sunbelt Agricultural Exposition, October 2008 and October 2009
- Georgia CoastFest, October 2008 and October 2009
- Georgia Groundwater Association, various
- Future Farmers of America, 2009
- Environmental Flows: Water for People and Nature in the Southeast, 2008
- Lake Seminole Workshop, 2008
- U.S. Geological Survey–U.S. Army Corps of Engineers (USGS–USACE) Annual Program Meeting, 2009
- American Society of Civil Engineers, Environmental and Water Resources Meetings and Georgia Section Meetings, 2009
- Managing Georgia's groundwater—A monitoring and modeling approach: Georgia Association of Environmental Professionals meeting, February 2009

Selected U.S. Geological Survey Reports and Conference Proceedings Articles

U.S. Geological Survey Reports

Calhoun, D.L., Gregory, M.B., and Wyers, H.S., 2008, Algal and invertebrate community composition along agricultural gradients—A comparative study from two regions of the Eastern United States: U.S. Geological Survey Scientific Investigations Report 2008–5046, 33 p.; also available online at *http://pubs.usgs.gov/sir/2008/5046/*.

Cherry, G.S., and Clarke, J.S., 2008, Ground-water conditions and studies in the Brunswick–Glynn County area, Georgia, 2007: U.S. Geological Survey Open-File Report 2008–1297, 42 p.; available online at *http://pubs.usgs.gov/of/2008/1297/*.

Dalton, M.S., Stewart, L.M., Ip, H.S., 2009, Occurrence of viable avian influenza viruses in water and bed sediments from selected water bodies along the Atlantic Flyway, February and May 2006 and January 2007: U.S. Geological Survey Open-File Report 2009–1161, 12 p.; available online at *http://pubs.usgs.gov/of/2009/1161/*.

Fanning, J.L. and Trent, V.P.; 2009a, Water use in Georgia by county for 2005; and water-use trends, 1980–2005: U.S. Geological Survey Scientific Investigations Report 2009–5002, 186 p.; available online at *http://pubs.usgs.gov/sir/2009/5002/*.

Fanning, J.L., and Trent, V.P, 2009b, Water use in Georgia by county for 2005; and water-use trends, 1980–2005: U.S. Geological Survey Fact Sheet 2009–3034, 4 p.; available online at *http://pubs.usgs.gov/fs/2009/3034/*.

Gordon, D.W., 2008, Ground-water conditions and studies in the Albany area of Dougherty County, Georgia, 2007: U.S. Geological Survey Open-File Report 2008–1328, 49 p.; available online at *http://pubs.usgs.gov/of/2008/1328/*.

Gordon, D.W., 2009, Groundwater conditions and studies in the Albany area of Dougherty County, Georgia, 2008: U.S. Geological Survey Open-File Report 2009–1244, 54 p.; available online at *http://pubs.usgs.gov/of/2009/1244/*.

Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and frequency of rural floods in the southeastern United States, 2006—Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009–5043, 120 p., available online at *http://pubs.usgs.gov/sir/2009/5043/*.

Gotvald, A.J., and Oberg, K.A., 2008, Acoustic Doppler current profiler applications used in rivers and estuaries by the U.S. Geological Survey: U.S. Geological Survey Fact Sheet 2008–3096, 4 p.; available online at *http://pubs.usgs.gov/fs/2008/3096/*.

Holloway, O.G., and Waddell, J.P.; 2008, Design and operation of a borehole straddle packer for ground-water sampling and hydraulic testing of discrete intervals at U.S. Air Force Plant 6, Marietta, Georgia: U.S. Geological Survey Open-File Report 2008–1349, 24 p.; available online at *http://pubs.usgs.gov/of/2008/1349/*.

Knaak, A.E., and Joiner, J.K., 2008, Hydrologic streamflow conditions for Georgia, 2007: U.S. Geological Survey Fact Sheet 2008–3099, 4 p.; available online at *http://pubs.usgs.gov/fs/2008/3099/*.

Knaak, A. E., Joiner, J. K., and Peck, M. F., 2009, Summary of hydrologic conditions in Georgia, 2008: U.S. Geological Survey Fact Sheet 2009–3109, 6 p.; also available online at *http://pubs.usgs.gov/fs/2009/3109/*.

Landers, M.N., and Ankcorn, P.D., 2008, Methods to evaluate influence of onsite septic wastewater-treatment systems on base flow in selected watersheds in Gwinnett County, Georgia, October 2007: U.S. Geological Survey Scientific Investigations Report 2008–5220, 12 p.; available online at *http://pubs.usgs.gov/sir/2008/5220/*.

McCallum, B.E., Gotvald, A.J., and Landers, M.N., 2009, Historic flooding in South Georgia, March 27–April 3, 2009: U.S. Geological Survey Fact Sheet 2009–3079, 2 p.; available online at *http://pubs.usgs.gov/fs/2009/3079/*.

Musser, J.W., 2008, Evaluation of floodplain modifications to reduce the effect of floods using a two-dimensional hydrodynamic model of the Flint River at Albany, Georgia: U.S. Geological Survey Scientific Investigations Report 2008–5223, 12 p.; available online at *http://pubs.usgs.gov/sir/2008/5223/*.

Peck, M.F., Leeth, D.C., and Hamrick, M.D., 2008, Well inventory and geophysical logging of selected wells in Troup County, Georgia, 2007–2008: U.S. Geological Survey Scientific Investigations Map 3058, 1 sheet; available online at *http://pubs.usgs.gov/sim/3058/*.

Peck, M.F., Painter, J.A., and Leeth, D.C., 2009, Ground-water conditions and studies in Georgia, 2006–2007: U.S. Geological Survey Scientific Investigations Report 2009–5070, 86 p.; available online at *http://pubs.usgs.gov/sir/2009/5070/*.

Riley, J.W., and Jacobson, R.B., 2009, Long-term stage, stage-residual, and width data for streams in the Piedmont physiographic region, Georgia: U.S. Geological Survey Open-File Report 2009–1205, 46 p.; available online at *http://pubs.usgs.gov/of/2009/1205/*.

U.S. Geological Survey, 2008, Georgia's ground-water resources and monitoring network, 2008: U.S. Geological Survey Fact Sheet 2008–3072, 2 p.; available at *http://pubs.usgs.gov/fs/2008/3072/*.

U.S. Geological Survey, 2008, Borehole geophysical logging of water-supply wells in the Piedmont, Blue Ridge, and Valley and Ridge, Georgia: U.S. Geological Survey Fact Sheet 2007–3048, 4 p.; available online at *http://pubs.usgs.gov/fs/2007/3048/*.

2009 Georgia Water Resources Conference Proceedings Papers

The following USGS papers were published *in* Rasmussen, Todd, Carroll, D.G., and Georgakakos, Aris, eds., 2009, Proceedings of the 2009 Georgia Water Resources Conference, April 27–29, 2009: Athens, Georgia, The University of Georgia, CD–ROM. All USGS papers also are available online at *http://www.gwri.gatech.edu/conferences/previous-gwrc-conferences/gwrc-2009/*.

Buell, G.R., Calhoun, D.L., and Wehmeyer, L.L., 2009, Hydrologic and land-use/land-cover metrics used in ecological assessments of six U.S. Fish and Wildlife Service National Wildlife Refuges in the southeastern USA, 8 p.

Cherry, G.C., 2009, Ground-water modeling and monitoring to manage chloride plume expansion in the Upper Floridan aquifer near Brunswick, Georgia, 2 p.

Clarke, J.S., 2009a, Assessment of hydrogeology and effects of pumping on water-bearing zones within and overlying the Upper Floridan aquifer, south-central Georgia, 3 p.

Clarke, J.S., 2009b, The Israeli red line—A possible way to manage ground-water conditions in Georgia?, 4 p.

Fanning, J.L., 2009, Effectiveness of water-management actions during droughts in the Chattahoochee River Basin, Metropolitan Atlanta area, poster.

Gonthier, G.J., 2009, Conceptual model of ground-water flow in fractured-crystalline rock—A case study based on constant-discharge tests at U.S. Air Force Plant 6, Marietta, Georgia, 2003, 6 p.

Gotvald, A.J., Weaver, J.C., and Feaster. T.D., 2009, Magnitude and frequency of floods in rural basins of Georgia, South Carolina, and North Carolina, 1 p.

Hall, M.E., and Holloway, O.G, 2009, Impact of declining water levels on domestic wells in south-central Georgia, 1 p.

Horowitz, A.J., 2009, An update on sediment studies associated with the City of Atlanta long-term monitoring program, 6 p.

Hughes, W.B., and Moon, C., 2009, Assessment of pesticides in urbanized watersheds of the Atlanta Metropolitan area, Georgia, 4 p.

Joiner, J.K., 2009, Comparison of automated hydrograph separation methods in a Metropolitan Atlanta, Georgia, watershed, 2 p.

Jones, L.E., 2009, Temporal and spatial variation of simulated effects on base flow of increased ground-water pumping in the Lower Apalachicola–Chattahoochee–Flint River Basin, 1 p.

Knaak, A.E., 2009, U.S. Geological Survey Georgia Water Science Center streamflow gaging network in Cobb County, Georgia, poster.

Knaak, A. E., and Joiner, J.K., 2009, Hydrologic streamflow conditions for Georgia, 2007, 2 p.

LaFontaine, J., 2009, Hydrologic characteristics of watersheds in Metropolitan Atlanta, Georgia, 2003–2007, 3 p.

Landers, M.N., and Ankcorn, P.D., 2009, Influence of septic wastewater-treatment systems on base flow in southeastern Gwinnett County, Georgia, October 2007, 6 p.

Lawrence, S.J., 2009, Occurrence of organic wastewater-indicator compounds in the urban streams of Atlanta, Georgia, 2003–2006, 6 p.

Leeth, D.C., 2009, Using the World Wide Web to assess current ground-water conditions in Georgia, 2 p.

Musser, J.W., 2009, Evaluation of floodplain modifications to reduce the effect of floods using a two-dimensional hydrodynamic model of the Flint River in Albany, Georgia, poster.

Payne, D.F., 2009, Simulated effects of sea-level rise on saltwater intrusion in the Upper Floridan aquifer at Hilton Head Island, South Carolina, 2 p.

Peck, M.F., Leeth, D.C., Hamrick, M.D., 2009, Well inventory and geophysical logging of selected wells in Troup County, Georgia, poster.

Peters, N.E., and Aulenbach, B.T., 2009, Hydrologic pathway contributions to stream fluxes of weathering products at Panola Mountain Research Watershed, Georgia, 8 p.

Riley, J.W., 2009, Assessing channel change using USGS stream gaging data. 2 p.

Torak, L.J., 2009, Effects of climate and pumpage on the ground-water level of the Upper Floridan aquifer in the Aucilla–Suwannee–Ochlockonee River Basin, south-central Georgia, 8 p.

Torak, L.J., and Sanders, J.H., 2009, New evidence of leakage from Lake Seminole into karst limestone and the Apalachicola River near Chattahoochee, Florida, 6 p.

Walls, C.B., Cressler, A.M., and Stayton, W.L., 2009, Real-time water-level and specific conductance monitoring of saltwater contamination in the Upper Floridan aquifer, Brunswick, Georgia, poster.

Williams, L.J., 2009, Revised hydrostratigraphy of the Upper Floridan aquifer in South-Central Georgia—Insights gained through flowmeter logging, 4 p.

Williams, L.J., and Gonthier, G.J., 2009, Movement and discharge of trichloroethene to streams near U.S. Air Force Plant 6, Marietta, Georgia, 6 p.

Appendix. Regression Statistics

Water-level trends in this report were estimated by applying the Levenberg–Marquardt Algorithm (LMA; Moré, 1978) to monthly mean water-level data for the period of record and during 2008–2009. Although the LMA typically is used for nonlinear fitting, it also can be used for deriving linear fits very near values derived using ordinary least squares fitting. In concept, LMA works by optimizing a mathematical function (called a merit function by statisticians) that measures how well the function represents the data. In this report, the merit function is the weighted sum of the squares of the differences (informally known as chi-squared and represented in equations and tables as χ^2).

In this report, the steps involved in minimizing this merit function are as follows:

1. Estimate a value for the slope and intercept, and calculate a line based on this estimate.

2. Calculate how far this line lies from the data (using the χ^2). Adjust the line so that it lies closer to the center of the data.

3. Repeat this until adjustments no longer affect the χ^2 value.

Each step is completed through manipulations of algebraic matrices, that are beyond the scope of this report, but are fully explained in Moré, (1978).

Summary statistics for the straight line (linear) fits of water-level trends described in the main body of the report are provided here as an indicator of goodness of fit (Janert, 2010), and so that readers can make decisions based on their tolerance for risk. These include:

- The degrees of freedom representing the number of data points minus the variables used. For this evaluation, two variables are used—slope (m) and intercept (b). A general rule of thumb is that the residuals and the χ^2 should be in the same order of magnitude, for the fit to be reasonable (with some exceptions).

- The root mean square error (RMSE) of the residuals is the square root of the average squared distance of a data point from the fitted line. RMSE units are in the same units as the quantity being estimated (in this report, feet).

- The chi-squared is the sum of squared residuals (differences) between the monthly mean water level and the values computed by the algorithm after the final iteration. Thus, the term "least-squares" fitting. The χ^2 from the fit along with χ^2 distribution tables may be used to estimate confidence intervals.

- The standard error (SE) of a variable (m or b in this report), expressed as a percentage, is a measure of how well m or b has been estimated and affects the location of the regression line. The greater the standard error, the greater the scatter around the regression line. In other words, standard error is a measure of dispersion.

References

Janert, P.K., 2010, Gnuplot in action—Understanding data with graphs: Greenwich, Connecticut, Manning Publications Co., 360 p.

Moré, J., 1978, The Levenberg-Marquardt Algorithm—Implementation and theory, *in* Watson, G.A., ed., Numerical analysis, v. 630: Berlin, Springer-Verlag, p. 105.

Table A–1. Regression statistics.

[%, percent]

Well name	Period of record summary statistics					2008–2009 summary statistics				
	Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m %)	Standard error of intercept (SE_b %)	Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m %)	Standard error of intercept (SE_b %)
03PP01	375	3.01	9.08	43.36	1.45	22	3.22	10.37	969.70	86.35
06F001	351	7.47	55.79	45.81	1.74	17	6.43	41.33	73.18	44.35
06G006	193	8.80	77.38	110.80	1.29	19	7.35	54.01	52.93	24.87
06K009	293	7.61	57.85	4.24	0.27	22	5.06	25.65	1,851.00	8.68
06K010	294	1.30	1.69	11.71	0.11	21	0.41	0.17	11.29	1.58
06S001	641	6.09	37.05	1.76	1.00	22	1.11	1.24	11.55	30.39
07H002	346	7.62	58.13	12.78	3.69	18	4.42	19.57	58.63	42.58
07H003	355	4.91	24.14	175.10	2.93	20	3.97	15.73	1,918.00	151.30
07KK64	150	3.81	14.54	43.60	2.00	22	3.00	8.99	27.88	16.74
07N001	530	3.44	11.82	1.35	0.13	22	3.26	10.60	20.75	4.66
08E038	89	0.79	0.62	29.50	0.91	19	0.40	0.16	39.67	5.13
08E039	91	1.27	1.62	771.10	2.76	22	1.07	1.15	79.38	37.54
08G001	393	8.47	71.73	42.42	1.64	22	6.84	46.80	40.09	25.11
08K001	362	9.32	86.84	71.45	5.48	22	8.29	68.64	131.90	95.31
09F520	477	3.00	8.99	20.08	0.39	22	2.25	5.08	39.18	11.02
09FF18	89	0.56	0.31	23.01	0.66	11	0.45	0.21	48.70	9.42
09G001	351	3.43	11.75	29.71	0.41	21	2.59	6.71	47.88	12.47
09G003	336	2.30	5.29	45.13	0.39	20	0.97	0.94	30.73	6.99
09M007	295	23.05	531.26	9.89	0.83	21	24.20	585.75	219.10	36.08
09M009	300	1.48	2.20	103.50	0.33	22	0.84	0.70	19.00	6.53
10DD02	431	1.69	2.86	5.72	1.32	22	1.29	1.66	42.54	21.49
10G313	463	5.35	28.67	23.65	0.61	21	3.47	12.02	44.39	14.96
10H009	136	5.68	32.31	44.52	1.97	22	6.03	36.42	47.04	24.63
10K005	306	1.80	3.24	15.93	0.51	19	2.93	8.61	89.23	28.05
11AA01	763	2.80	7.85	98.73	1.04	18	2.27	5.16	29.49	17.28
11FF04	355	0.38	0.15	4.89	0.32	22	0.42	0.18	33.37	11.48
11J011	345	3.69	13.61	15.24	0.55	22	2.22	4.92	21.86	9.48
11J012	342	3.61	13.05	42.04	0.48	22	3.54	12.53	64.15	17.77
11K003	139	1.05	1.11	223.20	1.39	22	4.14	17.16	22.88	15.27
11K005	362	4.29	18.39	1.54	0.39	22	0.91	0.84	101.70	3.53
11L002	452	15.58	242.67	4.05	0.79	17	13.52	182.83	122.60	32.11
11P014	291	17.52	306.80	9.07	1.09	15	6.82	46.52	23.67	12.61
11P015	296	1.69	2.84	30.88	0.28	18	0.97	0.95	30.51	6.37
12F036	520	5.87	34.44	7.60	0.26	17	1.39	1.93	24.71	3.11
12JJ04	464	1.52	2.31	10.50	0.34	21	1.13	1.29	23.82	8.36
12K014	330	3.95	15.58	31.37	0.56	21	3.67	13.45	64.68	19.48
12K141	161	6.81	46.31	36.82	2.04	22	3.67	13.47	17.67	11.50
12K180	84	3.96	15.65	126.80	5.51	20	4.12	16.95	56.17	28.84
12L019	362	8.70	75.67	12.96	0.74	10	3.39	11.46	42.63	15.22
12L020	357	14.43	208.33	26.28	0.69	14	10.04	100.74	213.30	39.42

Table A–1. Regression statistics.—Continued

[%, percent]

Well name	Period of record summary statistics					2008–2009 summary statistics				
	Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m%)	Standard error of intercept (SE_b%)	Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m%)	Standard error of intercept (SE_b%)
12L021	359	11.73	137.61	173.70	0.57	16	7.18	51.50	185.80	20.09
12L029	322	5.84	34.09	42.92	0.80	21	3.71	13.79	58.36	19.51
12L030	287	4.49	20.20	64.36	1.22	22	2.89	8.34	26.77	15.89
12L277	130	6.02	36.24	209.20	2.72	21	3.92	15.39	21.91	14.16
12L370	107	4.23	17.88	207.10	2.18	21	3.82	14.59	40.72	17.84
12L373	88	4.24	17.94	127.00	3.74	22	4.09	16.73	44.15	19.56
12M001	341	11.64	135.49	6.14	0.65	17	8.81	77.54	70.88	55.64
12M002	345	13.88	192.67	11.26	0.58	15	8.57	73.41	104.30	20.16
12M017	326	4.77	22.73	58.41	0.94	22	2.43	5.91	99.80	20.60
12Z001	483	2.07	4.30	11.84	1.09	17	1.41	1.99	40.80	19.53
13FF30	67	1.07	1.15	14.92	2.22	17	1.20	1.44	193.00	14.94
13FF31	66	1.04	1.08	20.77	2.33	22	0.81	0.65	23.46	7.34
13J004	377	4.49	20.18	12.48	0.56	22	2.85	8.14	35.76	11.75
13K014	323	4.64	21.53	30.17	0.88	19	4.39	19.24	84.12	28.54
13L002	599	17.20	295.76	2.96	0.74	22	7.25	52.63	87.87	15.55
13L011	382	6.54	42.72	28.73	0.54	18	1.67	2.78	27.59	6.89
13L012	388	3.69	13.60	50.84	0.53	22	3.57	12.77	58.98	18.40
13L013	367	8.91	79.31	71.72	0.52	18	0.48	0.23	5.27	2.75
13L015	358	9.18	84.36	10.89	0.60	21	3.52	12.39	136.30	13.43
13L049	284	5.85	34.20	44.80	1.11	19	4.04	16.34	45.41	21.55
13L180	137	5.11	26.11	344.90	1.15	22	2.42	5.86	30.15	9.77
13M005	352	5.10	26.03	13.58	2.18	20	4.17	17.39	385.10	71.30
13M006	353	6.51	42.35	41.32	4.02	21	6.76	45.75	147.40	85.60
13M007	351	2.10	4.40	234.10	1.55	21	1.52	2.30	137.60	41.78
14GG02	70	1.02	1.05	12.22	0.54	16	0.91	0.84	47.03	3.39
14P014	302	3.59	12.89	7.85	0.46	21	1.49	2.23	27.11	7.06
14P015	299	9.29	86.26	23.42	2.47	19	10.08	101.56	80.86	52.98
15L020	442	1.19	1.42	0.78	0.04	20	0.72	0.52	33.46	1.10
15Q016	76	8.02	64.37	66.34	5.95	22	7.43	55.25	147.30	31.04
16MM03	258	0.64	0.41	17.84	0.93	22	0.51	0.26	37.28	18.18
18H016	527	1.56	2.44	1.63	0.05	22	1.04	1.07	26.63	1.70
18K049	367	3.22	10.38	2.14	0.16	15	3.33	11.10	4,515.00	8.10
18T001	335	1.35	1.82	3.82	0.14	21	1.00	1.00	50.22	5.48
18U001	406	1.10	1.21	4.80	0.04	17	0.90	0.81	101.60	1.95
19E009	613	6.83	46.66	15.54	0.31	22	6.15	37.84	76.71	12.71
21BB04	270	2.07	4.30	9.51	2.95	22	1.86	3.44	47.11	30.05
21T001	536	3.88	15.08	19.76	0.71	22	3.58	12.83	713.80	35.42
21U004	333	0.70	0.49	1.47	0.10	22	0.49	0.24	75.02	3.61
23X027	291	4.26	18.11	3.92	0.10	21	2.62	6.85	10.63	2.53
24V001	338	1.00	1.01	1.10	0.05	15	0.84	0.71	124.10	2.38

Table A–1. Regression statistics.—Continued

[%, percent]

Well name	Period of record summary statistics					2008–2009 summary statistics				
	Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m%)	Standard error of intercept (SE_b%)	Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m%)	Standard error of intercept (SE_b%)
25Q001	510	2.16	4.68	1.33	0.15	22	2.08	4.32	30.71	5.87
26R001	426	3.20	10.21	1.89	0.11	22	3.26	10.65	125.10	5.48
27E004	361	2.52	6.33	12.90	0.22	22	1.07	1.14	34.57	4.16
27G003	339	2.63	6.93	8.27	0.16	22	1.42	2.02	51.45	3.98
28X001	348	2.07	4.28	1.90	0.20	22	1.76	3.09	33.17	9.73
29AA09	152	1.36	1.84	8.46	0.17	22	0.44	0.19	30.74	1.85
30AA04	353	2.26	5.09	4.08	0.11	22	0.71	0.51	130.90	1.75
30L003	425	3.43	11.74	3.14	0.24	18	1.66	2.77	49.36	5.33
31U008	313	3.39	11.48	4.54	0.25	22	2.59	6.73	81.28	10.38
31U009	320	3.18	10.12	4.32	0.25	20	2.11	4.45	72.52	9.08
32G047	65	1.43	2.05	11.42	7.03	22	0.43	0.18	14.70	21.25
32L005	133	1.02	1.05	2.85	0.16	22	0.30	0.09	25.52	1.72
32L015	312	2.53	6.41	10.25	0.26	22	1.64	2.69	44.07	7.04
32L016	316	1.55	2.37	5.97	0.17	21	0.59	0.34	452.40	3.25
32L017	309	1.54	2.37	7.35	0.23	22	0.81	0.65	73.58	5.45
32Y030	148	0.99	0.98	4.61	0.10	13	0.56	0.32	115.20	3.39
32Y031	164	1.42	2.01	5.06	0.17	22	0.95	0.90	213.20	4.21
32Y033	158	5.04	25.45	7.74	1.41	22	7.46	55.70	195.40	67.56
33D069	183	6.46	41.79	5.91	9.28	20	1.18	1.40	45.62	35.58
33D071	134	4.77	22.79	5.30	7.69	22	0.28	0.08	16.20	38.04
33D072	138	1.44	2.06	8.64	3.24	19	0.46	0.21	22.38	16.51
33D073	116	7.64	58.41	8.92	46.01	22	0.80	0.64	25.40	20.13
33D074	77	1.62	2.64	20.82	1.78	22	0.72	0.52	23.09	9.78
33E027	361	3.40	11.55	15.17	0.98	22	1.04	1.09	27.54	31.22
33H127	537	4.34	18.81	29.57	27.96	16	1.80	3.25	35.67	36.86
33H133	528	4.54	20.60	5.58	4.77	13	2.94	8.67	71.39	64.43
33H188	325	2.87	8.23	20.45	2.42	19	0.98	0.97	46.30	28.02
33H206	306	3.30	10.86	9.80	3.70	22	1.38	1.91	31.58	55.24
33H207	303	3.81	14.51	5.99	48.12	21	1.46	2.14	58.34	60.90
33H208	303	1.38	1.91	6.66	2.32	22	0.61	0.37	20.40	15.91
33H324	33	1.95	3.79	22.56	12.41	22	1.80	3.23	28.35	18.15
33H325	33	7.15	51.12	33.63	13.84	22	6.88	47.37	32.03	18.42
33J044	363	2.64	6.96	17.52	26.36	21	1.05	1.11	18.82	18.10
33J062	107	2.74	7.49	24.07	4.13	22	0.65	0.42	61.75	15.33
33J065	97	1.18	1.38	9,726.00	285.30	17	0.11	0.01	12.49	9.79
33M004	498	2.93	8.56	2.49	0.32	22	1.31	1.72	32.86	5.88
33R045	90	3.43	11.75	34.71	1.70	22	1.66	2.75	40.56	6.58
34G033	59	2.21	4.87	12.28	4.68	21	1.08	1.16	28.73	87.47
34H334	492	3.43	11.78	6.48	7.86	19	1.37	1.88	34.48	46.85
34H371	507	2.87	8.23	7.30	3.79	22	1.31	1.70	36.01	70.07

Table A–1. Regression statistics.—Continued

[%, percent]

Well name	Period of record summary statistics: Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m %)	Standard error of intercept (SE_b %)	2008–2009 summary statistics: Degrees of freedom	Root mean square error of residuals (RMSE)	Variance of residuals (χ^2)	Standard error of slope (SE_m %)	Standard error of intercept (SE_b %)
34H391	399	2.82	7.94	8.34	2.84	20	1.39	1.92	32.36	55.03
34H436	310	2.92	8.55	11.86	2.01	22	1.21	1.45	29.14	96.02
34H437	298	2.09	4.39	10.12	286.80	21	0.92	0.84	63.33	51.45
34H492	119	1.06	1.13	38.80	4.59	22	0.75	0.57	30.10	20.78
34H495	88	2.85	8.13	9.29	7.15	21	0.94	0.88	21.66	85.01
34H500	102	3.52	12.38	218.40	6.61	20	1.14	1.31	21.30	58.57
34H515	48	0.52	0.27	200.70	14.44	17	0.42	0.18	64.39	28.20
34J077	136	3.77	14.18	10.15	2.99	22	2.58	6.65	39.52	18.35
34J080	90	2.33	5.42	21.19	92.57	22	1.19	1.42	28.74	20.11
34J081	88	1.60	2.57	47.25	3.70	22	1.27	1.62	34.50	14.93
34J082	90	0.89	0.80	49.25	4.10	22	0.50	0.25	43.80	14.19
34K104	52	2.44	5.94	54.27	6.13	22	0.71	0.51	23.84	5.59
34N089	508	3.00	9.03	2.18	0.70	22	1.33	1.78	24.04	9.17
34S008	98	1.22	1.49	25.17	1.02	22	0.46	0.21	9.48	3.29
34S011	90	3.14	9.89	43.63	1.35	22	1.46	2.14	45.38	5.40
35H077	52	4.45	19.81	747.70	19.21	22	4.17	17.41	92.90	40.12
35M013	506	2.52	6.34	2.13	0.65	22	0.91	0.83	19.16	7.02
35P094	807	2.23	4.96	78.57	2.12	22	1.36	1.86	51.04	31.44
35P110	111	3.10	9.60	223.30	2.10	22	1.62	2.26	26.05	10.16
35P109/125	108	3.08	9.46	62.41	2.00	19	1.64	2.70	27.90	10.58
35Q050	47	2.16	4.65	24.19	3.81	21	0.68	0.46	24.77	8.31
35S008	115	1.39	1.94	16.49	0.50	22	0.53	0.29	18.59	2.82
35T003	112	3.38	11.40	48.79	1.64	22	2.02	4.09	64.41	12.71
35T005	107	2.24	5.02	5,375.00	1.72	22	1.27	1.61	56.87	10.91
36N012	121	2.40	5.75	43.04	0.91	22	1.33	1.77	27.26	7.32
36Q008	660	11.29	127.38	17.03	0.66	22	4.71	22.19	35.26	11.59
36Q020	603	4.47	19.99	2.28	0.52	20	2.49	6.22	36.50	12.11
37P114	307	2.93	8.58	10.25	0.35	22	2.52	6.36	29.30	10.56
37P116	304	0.30	0.09	26.04	0.22	21	0.36	0.13	104.10	12.15
37Q016	647	8.29	68.69	56.25	0.58	22	4.45	19.79	35.65	12.73
37Q185	247	5.51	30.38	3.40	0.36	17	7.53	56.75	52.32	19.33
37Q186	67	1.89	3.56	15.43	2.68	21	0.87	0.76	14.08	3.47
38Q002	641	3.01	9.07	2.77	0.51	22	1.66	2.75	39.63	11.59
38Q201	274	1.31	1.72	8.31	0.15	22	0.76	0.58	23.52	3.89
38Q208	137	0.40	0.16	85.67	0.85	22	0.42	0.18	23.13	11.29
38Q209	141	0.32	0.11	14.14	0.46	22	0.36	0.13	152.90	14.53
39Q003	543	2.51	6.32	3.08	0.50	20	1.47	2.16	77.36	13.89
39Q024	159	1.30	1.68	15.13	0.34	22	1.02	1.05	30.71	6.74
39Q025	158	1.60	2.58	18.42	0.46	22	1.44	2.08	46.19	10.25
39Q026	152	0.50	0.25	62.52	0.46	21	0.48	0.23	284.50	12.91
39Q029	139	1.05	1.11	223.20	1.39	21	0.87	0.76	40.06	17.33

Manuscript approved for publication, March 21, 2011

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USGS

Peck, M.F., Leeth, D.C, and Painter, J.A.—**Groundwater Conditions and Studies in Georgia, 2008–2009**—Scientific Investigations Report 2011–5048

APPENDIX K

THE SURFICIAL AND BRUNSWICK AQUIFER SYSTEMS—ALTERNATIVE GROUND-WATER RESOURCES FOR COASTAL GEORGIA

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REFERENCE: *Proceedings of the 2003 Georgia Water Resources Conference*, held April 23–24, 2003, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. The surficial and Brunswick aquifer systems may provide a supplemental water source in coastal Georgia. The surficial aquifer system consists of two to three water-bearing zones—the water-table zone and the confined upper and lower water-bearing zones. The Brunswick aquifer system is comprised of the upper and lower Brunswick aquifers. Productivity of the aquifer systems is greatest in the vicinity of the southeast Georgia embayment and is highly variable along the outer margins of this structural feature. In the southeast Georgia embayment, transmissivity of the lower Brunswick aquifer ranges from 2,000 to 4,700 feet squared per day (ft^2/d). Outside of the embayment, permeable sediments are thin or absent and the productivity is low—reported transmissivity of the Brunswick aquifer system ranges from 5 to 500 ft^2/d.

Withdrawal from the Brunswick aquifer system increased from about 1.5 million gallons per day (Mgal/d) during 1990 to 3.7 Mgal/d during 2000. At one site in Glynn County, average withdrawal of 0.6 Mgal/d or less since early 1999 resulted in water-level declines of about 12 feet (ft) in the upper Brunswick aquifer and about 5 ft in the lower Brunswick aquifer. This difference may reflect differences in the amount of leakage from adjacent units, the connection of the aquifer to recharge areas, or the aquifer's hydraulic properties.

INTRODUCTION

Coastal Georgia is experiencing increasing demands on limited freshwater resources. To alleviate saltwater intrusion, the Georgia Environmental Protection Division (GaEPD) has restricted further development of the Upper Floridan aquifer (the principal source of water) in parts of the coastal area. In recent studies, three aquifers—the surficial aquifer and the upper and lower Brunswick aquifers—were assessed to determine if they might be viable, supplemental sources of ground water. Information on the geologic, water-quality, and water-bearing characteristics of the aquifers is needed to assess their potential as a source of water supply. Water-level monitoring is needed to assess the effect of development as the aquifers become increasingly utilized for water supply.

Purpose and Scope

This paper provides an overview of current understanding of the geologic and hydraulic characteristics of the surficial aquifer and upper and lower Brunswick aquifers, proposes a revised hydrogeologic nomenclature for coastal Georgia, and describes the effects of development on ground-water levels in coastal Georgia. Data and information were derived from previous studies and from ongoing technical investigations being conducted as part of the Coastal Sound Science Initiative (CSSI), a series of scientific and feasibility studies being conducted to support development of the GaEPD's final strategy to protect the Upper Floridan aquifer from saltwater intrusion.

GaEPD defined the coastal area of Georgia to include the 6 coastal counties and adjacent 18 counties (Fig. 1), an area of about 12,240 square miles (mi^2). Topographic relief ranges from flat in the coastal counties, to steep in northwestern parts of the area. Altitudes range from sea level along the coast to as high as 300 ft in the northwestern part of the area.

Previous Studies

Clarke and others (1990) defined the surficial and upper and lower Brunswick aquifers and described their water-bearing characteristics. Steele and McDowell (1998) mapped the permeable zones of the upper and lower Brunswick aquifers. Leeth (1999) described the hydrogeology of the surficial aquifer at Naval Submarine Base Kings Bay in Camden County. Hodges (1998, 1999) described results of aquifer tests in Toombs and Evans Counties. More recent investigations include Gill (2001) who described the development potential of the upper and lower Brunswick aquifers in Glynn and Bryan Counties; Radtke and others (2001) who described results of an engineering assessment of the "Miocene" aquifer system in coastal Georgia; and Weems and Edwards (2001) who described the geology of Oligocene and younger deposits in coastal Georgia.

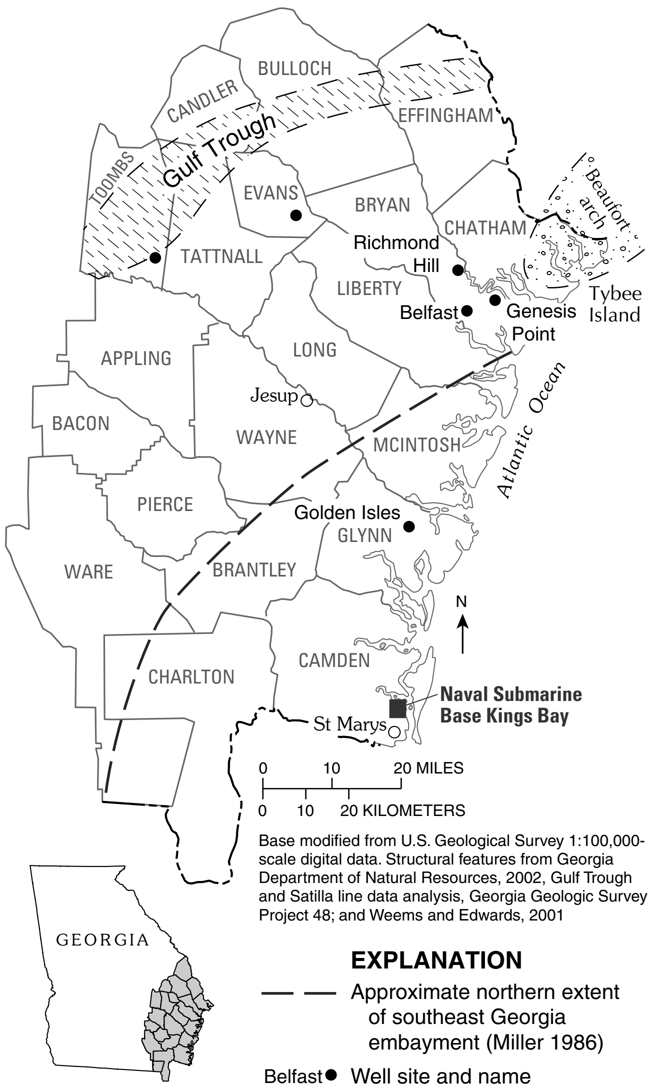


Figure 1. Structural features and selected well sites in coastal Georgia.

Geologic Setting

Coastal Plain strata consist of unconsolidated layers of sand and clay and semiconsolidated to consolidated layers of limestone and dolomite of Late Cretaceous to Holocene age. The Coastal Plain units strike southwest-northeast and dip and thicken to the southeast; maximum thickness is about 5,500 ft in Camden County.

Major structural features that affect the geology and hydrogeology of coastal Georgia include the southeast Georgia embayment, the Beaufort arch, and the Gulf Trough (Fig. 1). The southeast Georgia embayment (Miller, 1986) is an east-northeast-plunging synclinal feature, which extends from northeastern Florida into southeastern Georgia and offshore. Within this embayment, thick deposits of Coastal Plain sediments comprise thicker and more abundant aquifer layers compared to elsewhere in the coastal area. The Beaufort arch is an area of geologic uplift in which Coastal Plain sediments are thin and near land surface; hence, aquifers are thinner and less abundant than in the area of the southeast Georgia embayment. The Gulf Trough (Herrick and Vorhis, 1963), which could be of either structural or depositional origin, is an area of increased clay content and decreased permeability in Coastal Plain sediments.

AQUIFER SYSTEMS

An aquifer system is a body of intercalated permeable and poorly permeable material that acts as a water-yielding hydrologic unit of regional extent. The concept of an aquifer system is useful because it provides a framework for grouping local aquifer and confining units into a regional hydrologic unit. Previous studies (Clarke and others, 1990) have defined several separate aquifers in Miocene and younger deposits in coastal Georgia that are largely of local extent. Two aquifer systems are proposed for coastal Georgia—the surficial aquifer system (comprised of two to three water-bearing zones) and the Brunswick aquifer system (comprised of the upper and lower Brunswick aquifers) (Fig. 2).

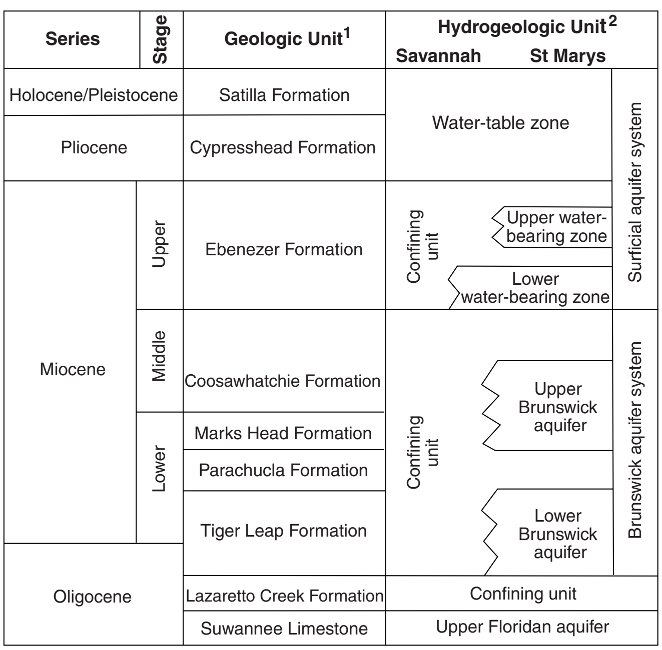
The surficial and Brunswick aquifer systems are thickest in the vicinity of the southeast Georgia embayment, which is deepest in the southern part of the coastal area (Fig. 1), and become progressively thinner to the north and west. Along the northern margins of the embayment, and in the vicinity of the Beaufort arch, the aquifer systems thin and are dissected by ancient channels. Weems and Edwards (2001) reported an ancient alluvial channel that breached the confining unit between the upper and lower Brunswick aquifers in a corehole at Evans County, and presented maps showing the discontinuity of Miocene deposits in Evans, Chatham, and Effingham Counties. In these areas, sediments comprising the aquifer system are discontinuous or absent, and the two aquifer systems may be interconnected to varying degrees.

Surficial Aquifer System

The surficial aquifer system consists of interlayered sand, clay, and thin limestone beds of Miocene and younger age (Fig. 2), which were formerly called the surficial aquifer (Clarke and others, 1990). The aquifer system designation proposed herein is based on Leeth (1999), who subdivided the aquifer into three zones—the water-table zone and the confined upper and lower water-bearing zones. Weems and Edwards (2001) assigned the confined zones to the Ebenezer Formation and the water-table zone to the Satilla and Cypresshead

Formations. The areal extent of the confined units of the surficial aquifer system is currently unknown. Leeth (1999) reported two confined water-bearing zones in Camden County; and Clarke and others (1990) reported one confined water-bearing zone at Brunswick, Glynn County, and one at Skidaway Island, Chatham County. Multiple confined water-bearing zones are believed to occur mostly in areas where deposits are thick, such as in the southeast Georgia embayment.

For the water-table zone, Clarke and others (1990) and Leeth (1999) reported well yields ranging from 2 to 140 gallons per minute (gal/min) and transmissivity ranging from 14 to 6,700 ft^2/d in Glynn and Camden Counties. For the confined water-bearing zones, Clarke and others (1990) reported well yields ranging from 40 to 180 gal/min and transmissivity ranging from 150 to 6,000 ft^2/d. Leeth (1999) reported well yields from 15 to 100 gal/min and a transmissivity of 180 ft^2/d at Camden County. Industrial supply wells near Jesup, Wayne County, formerly yielded about 250 gal/min from the confined water-bearing zones, with a total withdrawal of about 0.86 Mgal/d during 1986 (Clarke and others, 1990).



[1] Weems and Edwards, 2001 [2] Clarke and others, 1990; Leeth, 1999

Figure 2. Geologic and hydrogeologic units of Oligocene and younger age, coastal Georgia.

Brunswick Aquifer System

The upper and lower Brunswick aquifers comprise the Brunswick aquifer system, which consists of poorly sorted, fine to coarse, slightly phosphatic and calcareous or dolomitic quartz sand of Miocene age (Fig. 2). The upper Brunswick aquifer includes the Coosawhatchie and Marks Head Formations, and the lower Brunswick aquifer is within the Tiger Leap Formation (Weems and Edwards, 2001). The upper Brunswick aquifer is separated from the overlying surficial aquifer system by a confining unit comprised of clay from the Coosawhatchie Formation. The upper and lower Brunswick aquifers are separated from one another by clay of the Parachucla Formation. Recent investigations have provided better definition of the areal extent and water-bearing properties of the Brunswick aquifer system (Weems and Edwards, 2001; Gill, 2001; Radtke and others, 2001).

Within the southeast Georgia embayment (Fig. 1), transmissivity and yield of the Brunswick aquifer system is the highest observed in coastal Georgia. In Glynn County, reported transmissivities of the lower Brunswick range from 2,000 to 4,700 ft^2/d, and reported well yields range from 340 to 750 gal/min (Clarke and others, 1990; Gill, 2001; Radtke and others, 2001). In general, the upper Brunswick aquifer has lower transmissivity than the lower Brunswick aquifer. Reported transmissivities of the upper Brunswick aquifer range from about 20 to 3,500 ft^2/d, with a maximum reported well yield of 750 gal/min in Glynn County (Gill, 2001; Radtke and others, 2001).

Outside the area of the southeast Georgia embayment, permeable sediments are thin or absent. In Toombs County, in the area of the Gulf Trough, combined transmissivity of the Brunswick aquifer system is about 500 ft^2/d with a test yield of 35 gal/min (Hodges, 1998). South of the Gulf Trough in Evans County, the lower Brunswick aquifer has a transmissivity of about 25 ft^2/d with a test yield of 5 gal/min (Hodges, 1999). In Chatham and Effingham Counties, transmissivity of the upper Brunswick aquifer is generally less than 15 ft^2/d, and reported test yields are 5 gal/min (Gill, 2001; Radtke and others, 2001). At Richmond Hill and on Tybee Island in Chatham County, core and geophysical logs indicate that the aquifer system consists of very fine sand, silt, and clay of low permeability.

Along the outer margins of the southeast Georgia embayment, hydraulic properties of the Brunswick aquifer system are highly variable. For example, in Bryan County, reported transmissivities for wells at Belfast and Genesis Point (Fig. 1), only 8 miles apart, are 90 and 2,300 ft/d, respectively (Gill, 2001; Radtke and others, 2001). Because the Miocene sediments comprising the

Brunswick aquifer system were deposited in a marine-shelf environment (Weems and Edwards, 2001), they should be relatively homogeneous—variations in hydraulic properties are probably related to discontinuous deposition and erosion rather than changes in lithofacies.

EFFECTS OF DEVELOPMENT

Because of restrictions on water withdrawal from the Upper Floridan aquifer, numerous wells are being completed in the Brunswick aquifer system—withdrawal increased from about 1.5 Mgal/d during 1990 to 3.7 Mgal/d during 2000 (Da'Vette Taylor, U.S. Geological Survey, written commun., 2002). At the Golden Isles development in Glynn County, the Brunswick aquifer system is being used as a source for public supply, with an average withdrawal of 0.6 Mgal/d or less since early 1999. The water level in an upper Brunswick aquifer well at the site declined about 12 ft; whereas the water level in a lower Brunswick well declined only 5 ft during the same period (Fig. 3).

This difference may reflect differences in the amount of leakage from adjacent units, the connection of the aquifer to recharge areas, or the aquifer's hydraulic properties. A possible leakage response between the lower Brunswick aquifer and Upper Floridan aquifer is indicated by similar water-level fluctuations (Fig. 3).

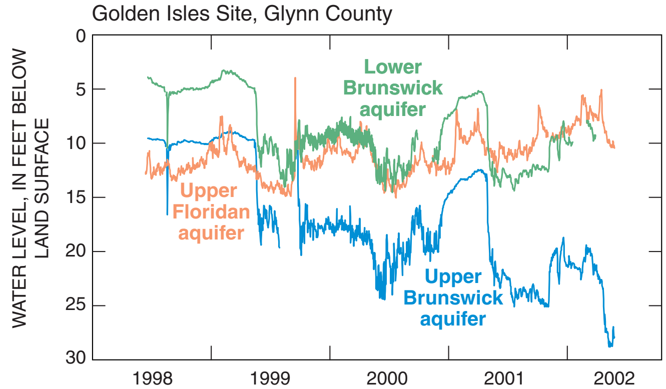


Figure 3. Ground-water levels in the upper and lower Brunswick and Upper Floridan aquifers at the Golden Isles site, Glynn County, Georgia, 1998–2002.

ONGOING RESEARCH

In addition to the CSSI study, the surficial and Brunswick aquifer systems are being evaluated as part of the USGS cooperative water-resources program. These studies, being conducted in Camden, Glynn, Liberty, Long, and McIntosh Counties, include completing test wells, conducting aquifer tests, determining water quality, and assessing interaquifer leakage. Results are being synthesized into a regional hydrogeologic characterization of these aquifer systems.

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APPENDIX L

WATER RESOURCES MANAGEMENT BRANCH WELL DATA SHEET
Georgia Department of Natural Resources
Environmental Protection Division
(Form To Be completed By Licensed Water Well Contractor)

Water System Name: HAWKS LANDING
County: BRANTLEY
System ID. No. 0250028 System Permit No. ______ System Well No. 1
System Type: community: X non-commu non-transient: ______ non-public: ______

Owner*: W&D INVESTMENTS, INC.
Address*: 4774 NEW JESUP HWY
City/State/Zip*: BRUNSWICK, GA. 31520
Phone No*: (912) 265-2603

Driller*: Woodrow Sapp Well Drilling, Inc.
Address*: 4774 New Jesup Highway
City/State/Zip*: Brunswick, GA 31520
Phone No*: (912) 265-2603

Well Location: ______
Ground Elevation: ______ ft. MSL., Longitude: W ______, Latitude: N

WELL DESCRIPTION

Date Drilled*: 12/11/2007
Total Depth*: 720
Static Water Level (SWL) 30FT
Date SWL Measured 12/11/2007

DRILLING METHOD
Rotary: X Percussion: ___ Other: ___

HOLE DIAMETER*
Size: 14 From: 0 feet, To: 600 feet
Size: 8 in., From: 600 feet, To: 720 feet
Size: ___ in., From: ___ feet, To: ___ feet

CASING RECORD*
Type Material: PVC WELL CASING
Wall Thickness 0.41 SDR: 21
Weight/Foot: 6.9
Size: 8 in., From: 0 feet, To: 600 feet
Size: ___ in., From: ___ feet, To: ___ feet
Size: ___ in., From: ___ feet, To: ___ feet
(use additional sheets if necessary)

WELL SCREEN*
Type of Material: N/A
Size: ___ in., From: ___ feet, To: ___ feet
Size: ___ in., From: ___ feet, To: ___ feet
Size: ___ in., From: ___ feet, To: ___ feet

GROUTING*
Type Grout: Cement
Applied by pressure: Yes X No: ___
From: 0 feet, To: 600 feet
From: ___ feet, To: ___ feet

PUMPING TEST DATA

Date Tested: 12/11/2007
Test Pump Rated: 400 gpm, 20 hp
Total Continuous Hrs. Tested: 8 HR
Water Level Stabilized: Yes: X No: ___
Hrs. Before Stabilization: 1 HR
Sustained Well Yield: 300 gpm
Static Water Level: 30
Total Drawdown: 10 feet
Specific Capacity: 150 gpm/ft
Pumping Water Level: 40 feet
No. Minutes to Recover: 5 MIN
Developed Well: Yes: X No: ___
Deisinfected Well: Yes: X No: ___
(Attach Time and Drawdown Measurements)

PERMANENT PUMP DATA

(Completed by Contractor or Owner)
Pump Type: Submersible
Diameter: 6 in., Outlet size: 3 in.
Motor hp*: 15 Motor rpm: 3450
Pump Capacity*: 200 gpm
Total Dynamic Head: 175 feet
Pump Set At*: 84 feet
Pump Disinfected: Yes: x No: ___
Deep Well Air Line Length: n/a feet
Access Port Diameter: 1-Jan in.
Casing Vent Installed: Yes: x No: ___
Sample Tap Installed: Yes: x No: ___
Meter installed: Yes: x No: ___
Meter Size: 3 in. 300 gpm

SEND FORM TO: Drinking Water Program, 205 Butler ST., S.E., Rm. 1066, Atlanta, Ga. 30334

This well was drilled and constructed (and plugged, if applicable) in accordance with the Georgia Department of Natural Resources' Regulations for Groundwater Use, Chapter 391-3-2. I certify that the information on both sides of this form (Page 1 and 2) is correct and true to the best of my knowledge

Well Contractor's Signature*: Woodrow Sapp
License No.*: 95
Well Contractor's Name*: Woodrow Sapp
Date*: 12/18/07

PLEASE COMPLETE **DRILLER'S WELL LOG** ON PAGE 2

EPD-ws1.1 (1989)

WELL COMPLETION DATA FORM

DRILLERS WELL LOG

FROM (feet)	TO (feet)	TYPE MATERIAL ENCOUNTERED	REMARKS	WATER BEARING?
0	20	FINE SAND/ MUD		
20	60	FINE SAND/ MUD		
60	80	ROCK		
80	160	MUD		
160	180	ROCK		
180	220	MEDIUM GRAVEL		
220	300	GREEN MUD		
300	340	MEDIUM GRAVEL		
340	400	MUD/FINE SAND		
400	460	MUD		
460	560	SAND LIMEROCK		
560	580	BROWN MUD		
580	590	WHITE CLAY		
590	700	LIME ROCK		

(If more space is required, use additional sheets)

After completing this information, please return a copy of this form along with a copy of your concurrence letter, your previously proposed agricultural witdrawal application and a county map with your well location clearly marked to the address below. Only after we receive this material can your required Agricultural Groundwater Use Permit be processed.

RETURN THIS FORM TO:

Georgia EPD, Water Resources
Suite 1058 East Tower
2 Martin Luther King Jr. Dr.
Atlanta, Georgia 30034

WATER RESOURCES MANAGEMENT BRANCH WELL DATA SHEET
Georgia Department of Natural Resources
Environmental Protection Division
(Form To Be completed By Licensed Water Well Contractor)

Water System Name: SATILLA PLANTATION ________ County: BRANTLEY
System ID. No. 0250026 System Permit No. ________ System Well No. ________
System Type: community: X non-commu non-transient: ________ non-public: ________

Owner*: W&D INVESTMENTS, INC.
Address*: 4774 NEW JESUP HWY.
City/State/Zip*: BRUNSWICK, GA. 31520
Phone No*: (912) 265-2603

Driller*: Woodrow Sapp Well Drilling, Inc.
Address*: 4774 New Jesup Highway
City/State/Zip*: Brunswick, GA 31520
Phone No*: (912) 265-2603

Well Location: ________
Ground Elevation: ________ ft. MSL., Longitude: W ________ , Latitude: N

WELL DESCRIPTION

Date Drilled*: 9/18/2007
Total Depth*: 720
Static Water Level (SWL) 25 FT.
Date SWL Measured 9/20/2007

DRILLING METHOD
Rotary: X Percussion: ____ Other: ____

HOLE DIAMETER*
Size: 14 in., From: 0 feet, To: 600 feet
Size: 8 in., From: 600 feet, To: 720 feet
Size: ____ From: ____ feet, To: ____ feet

CASING RECORD*
Type Material: BLK STEEL
Wall Thickness 0.322 SDR: 40
Weight/Foot: 28.55
Size: 8 in., From: 0 feet, To: 600 feet
Size: ____ in., From: 0 feet, To: ____ feet
Size: ____ in., From: ____ feet, To: ____ feet
(use additional sheets if necessary)

WELL SCREEN*
Type of Material: N/A
Size: ____ in., From: ____ feet, To: ____ feet
Size: ____ in., From: ____ feet, To: ____ feet
Size: ____ in., From: ____ feet, To: ____ feet

GROUTING*
Type Grout: CEMENT
Applied by pressure: Yes X No: ____
From: 0 feet, To: 600 feet
From: ____ feet, To: ____ feet

PUMPING TEST DATA
Date Tested: 9/21/2007
Test Pump Rated: 250 gpm, 15 hp
Total Continuous Hrs. Tested: 8 HR
Water Level Stabilized: Yes: X No: ____
Hrs. Before Stabilization: 1 HR.
Sustained Well Yield: 250 gpm
Static Water Level: 25
Total Drawdown: 5 feet
Specific Capacity: 250/170 gpm/ft
Pumping Water Level: 30 feet
No. Minutes to Recover: 2 MIN.
Developed Well: Yes: X No: ____
Deisinfected Well: Yes: X No: ____
(Attach Time and Drawdown Measurements)

PERMANENT PUMP DATA
(Completed by Contractor or Owner)
Pump Type: SUBMERISBLE
Diameter: 6 in., Outlet size: 3 in.
Motor hp*: 15 Motor rpm: 3450
Pump Capacity*: 250 gpm
Total Dynamic Head: 170 feet
Pump Set At*: 84 feet
Pump Disinfected: Yes: X No: ____
Deep Well Air Line Length: N/A feet
Access Port Diameter: 1-Jan in.
Casing Vent Installed: Yes: X No: ____
Sample Tap Installed: Yes: X No: ____
Meter installed: Yes: x No: ____
Meter Size: 4 in. 500 gpm

SEND FORM TO: Drinking Water Program, 205 Butler ST., S.E., Rm. 1066, Atlanta, Ga. 30334

This well was drilled and constructed (and plugged, if applicable) in accordance with the Georgia Department of Natural Resources' Regulations for Groundwater Use, Chapter 391-3-2. I certify that the information on both sides of this form (Page 1 and 2) is correct and true to the best of my knowledge

Well Contractor's Signature*: [signature] License No.*: 95
Well Contractor's Name*: Woodrow Sapp Date*: 9/21/2007

PLEASE COMPLETE **DRILLER'S WELL LOG** ON PAGE 2

EPD-ws1.1 (1989)

WELL COMPLETION DATA FORM

DRILLERS WELL LOG

FROM (feet)	TO (feet)	TYPE MATERIAL ENCOUNTERED	REMARKS	WATER BEARING?
0	20	FINE SAND/ MUD		
20	60	FINE SAND/ MUD		
60	80	ROCK		
80	160	MUD		
160	180	ROCK		
180	220	MEDIUM GRAVEL		
220	300	GREEN MUD		
300	340	MEDIUM GRAVEL		
340	400	MUD/FINE SAND		
400	460	MUD		
460	560	SAND LIMEROCK		
560	580	BROWN MUD		
580	590	WHITE CLAY		
590	700	LIME ROCK		

(If more space is required, use additional sheets)

After completing this information, please return a copy of this form along with a copy of your concurrence letter, your previously proposed agricultural witdrawal application and a county map with your well location clearly marked to the address below. Only after we receive this material can your required Agricultural Groundwater Use Permit be processed.

RETURN THIS FORM TO:

Georgia EPD, Water Resources
Suite 1058 East Tower
2 Martin Luther King Jr. Dr.
Atlanta, Georgia 30034

Georgia Department of Natural Resources
Environmental Protection Division
(Form To Be Completed By Licensed Water Well Contractor)

Water System Name: WAYNESVILLE AREA ELEMENTARY SCHOOL County: Brantley
System ID. No.____ System Permit No.____ System Well No.____
System Type: community:___ non-community:___ non-community non-transient:___ non-public:___

Owner: BRANTLEY COUNTY BOARD OF EDUCATION
Address:
City/State/Zip: Nahunta, Georgia
Phone No: ( )

Driller: WOODROW SAPP WATER WEL CONTRACTOR, INC.
Address: 4774 New Jesup Highway
City/State/Zip: Brunswick, Georgia 31520
Phone No: ( )

Well Location
Ground Elevation:___ ft. MSL., Longitude: W___, Latitude: N___

WELL DESCRIPTION

Date Drilled: 05/21/99
Total Depth: 730 ft.
Static Water Level (SWL): 30 ft.
Date SWL Measured: 05/21/99

DRILLING METHOD (Indicate)
Rotary: X Percussion:___ Other:___

HOLE DIAMETER
Size: 16 in., From: 0 ft., To: 623 ft.
Size: 10 in., From: 623 ft., To: 730 ft.
Size:___ in., From:___ ft., To:___ ft.

CASING RECORD
Type Material: Blk Steel
Wall Thickness: .365 SDR: 40
Weight/Foot: 40.48
Size: 10 in., From: 0 ft., To: 623 ft.
Size:___ in., From:___ ft., To:___ ft.
Size:___ in., From:___ ft., To:___ ft.
(Use Additional Sheets If Necessary)

WELL SCREEN
Type Of Material: N/A
Size:___ in., From:___ ft., To:___ ft.
Size:___ in., From:___ ft., To:___ ft.
Size:___ in., From:___ ft., To:___ ft.
Size:___ in., From:___ ft., To:___ ft.
Thickness Of Gravel Packing:___

GROUTING
Type Grout: Cement
Applied By Pressure: Yes: X No:___
From: 0 ft., To: 623 ft.
From:___ ft., To:___ ft.

PUMPING TEST DATA
Date Tested: 05/24/99
Test Pump Rated: 600 gpm, 50 hp
Total Continuous Hrs. Tested: 24
Water Level Stabilized: YES: X NO:___
Hrs. Before Stabilization: Less than 1 hour
Sustained Well Yield: 600 gpm
Static Water Level : 30 ft.
Total Drawdown: 8 ft.
Specific Capacity: 500 gpm/ft.
Pumping Water Level: 38 ft.
No. Minutes Well To Recover: 60 minutes
Developed Well: Yes: X No:___
Disinfected Well: Yes: X No:___
(Attach Time And Drawdown Measurements)

PERMANENT PUMP DATA
(Completed By Contractor Or Owner)
Pump Type: Turbine
Diameter: 9 1/2in., Outlet Size: 6 in.
Motor hp: 40 Motor rpm: 1800
Pump Capacity: 500 gpm
Total Dynamic Head: 195 ft.
Pump Set At: 80 ft.
Pump Disinfected: Yes: X No:___
Deep Well Air Line Length:___ ft.
Access Port Diameter: 3/4 in.
Casing Vent Installed: Yes: X No:___
Sample Tap Installed: Yes: X No:___
Meter Installed: Yes: X No:___
Meter Size: 6 in. ___ gpm

SEND FORM TO : Drinking Water Program, 205 Butler St., S.E., Rm. 1066, Atlanta, Ga. 30334

This well was drilled and constructed in accordance with the Georgia Department of Natural Resources' Rules for Safe Drinking Water, Chapter 391-3-5, and/or the Rules and Regulations for Groundwater Use, Chapter 391-3-2. I certify that the information on both sides of this form is correct and true to the best of my knowledge.

Well Contractor's Signature: Woodrow Sapp License No.: 305

Well Contractor's Name: Woodrow Sapp Date: 8/13/99

EPD-WS1.1(1990) **COMPLETE WELL LOG ON THE REVERSE SIDE**

From Feet	To Feet	Type Material Encountered	Remarks	Water Bearing
0	2	Red Clay		
2	9	Sand		
9	20	Green Moral & Sand		
20	25	Hard Green Moral		
25	38	Small Shells & Sand		
38	46	Green Moral & Shells		
46	50	Hard Dark Blue Moral		
50	53	Medium-Hard Gray Rock		
53	75	Green Moral & Sand		
75	79	Medium-Hard Rock		
79	151	Green Marl & Sand		
151	152	Soft Rock		
152	156	Green Moral & Sand		
156	180	Coarse Sand & Green Moral		
180	186	Soft Rock		
186	220	Coarse Sand and Green Moral		
220	223	Hard Rock		
223	230	Green Moral		
230	260	Hard Gray Moral		
260	265	Green Moral & Sand		
265	292	Coarse Sand & Green Moral		
292	293	Soft Rock		
293	296	Green Moral & Sand		
296	297	Soft Rock		
297	302	Green Moral & Sand		
302	304	Soft Rock		
304	326	Green Moral & Sand		
326	328	Hard Rock		
328	397	Hard Green Moral & Sand		
397	399	Rock		
399	426	Green Moral & Sand		
426	427	Rock		
427	437	Green & White Clay & Sand		
437	438	Rock		
438	442	Sandy White Clay		
442	446	Rock		
446	471	Green Moral & Coarse Sand		
471	477	Hard Brown Rock		
477	487	Green Moral & Sand		
487	509	Soft Sandy White Limestone		
509	585	Hard Green Moral & Sand		
585	617	Soft Brown & Gray Limestone		
617	635	Tan Limestone		
635	730	Soft White Porous Limestone		

(If More Space Is Required, Use Additional Sheets)

DEPARTMENT USE ONLY

Microbiological Analysis Results:__________
Inorganic Analysis Results:__________
Pesticides Analysis Results:__________
VOC Analysis Results:__________
SOC Analysis Results:__________
Organic Analysis Results:__________

RADIOLOGICAL ANALYSIS RESULTS

WS#________ Gross Alpha:________
Ra226:________ Ra228:________ U238:________
Radon:________ Composite:________

HARBIN ENGINEERING, P.C. CIVIL & ENVIRONMENTAL CONSULTANTS

Michael Biers <mbiers@harbinengineering.com>

FW: Brantley County Well Coordinates & Well Data Info

Diane Sapp <DSapp@woodrowsapp.com> Fri, Feb 26, 2016 at 3:07 PM
To: "mbiers@harbinengineering.com" <mbiers@harbinengineering.com>

Mike,

As requested, hope this info is helpful. Thanks, Diane

Diane M. Sapp

WOODROW SAPP

W & D UTILITIES

4774 New Jesup Highway

Brunswick, Georgia 31520

912/265-2603

912/262-0423 (Fax)

From: Jeff Carter
Sent: Friday, February 26, 2016 2:51 PM
To: Diane Sapp
Subject: Brantley County Well Coordinates

Satilla Plantation: 31°11'44.02"N, 81°50'9.47"W

https://www.google.com/maps/place/31%C2%B011'44.0%22N+81%C2%B050'09.5%22W/@31.1955657,-81.8381526,975m/data=!3m1!1e3!4m2!3m1!1s0x0:0x0

Hawks Landing: 31°13'29.62"N, 81°47'49.61"W

https://www.google.com/maps/place/31%C2%B013'29.6%22N+81%C2%B047'49.6%22W/@31.224899,-81.7993026,974m/data=!3m2!1e3!4b1!4m2!3m1!1s0x0:0x0

Waynesville Elementary School: 31°13'34.71"N, 81°47'26.56"W https://www.google.com/maps/place/31%C2%B013'34.7%22N+81%C2%B047'26.6%22W/@31.2263129,-81.7928998,974m/data=!3m2!1e3!4b1!4m2!3m1!1s0x0:0x0

Thank you,

Jeff Carter

Woodrow Sapp

Well Drilling & Water Management

4774 New Jesup Hwy

Brunswick, GA 31520

P 912-265-2603

jcarter@woodrowsapp.com

---

3 attachments

WAYNESVILLE ELEMENTARY SCHOOL WELL DATA SHEET.PDF
153K

SATILLA PLANTATION WELL DATA SHEET.PDF
432K

HAWKS LANDING WELL DATA SHEET.PDF
422K

HARBIN ENGINEERING, P.C.
CIVIL & ENVIRONMENTAL CONSULTANTS

Michael Biers <mbiers@harbinengineering.com>

FW: Brantley County Well Coordinates & Well Data Info

Michael Biers <mbiers@harbinengineering.com> Wed, Jul 13, 2016 at 5:14 PM
To: Diane Sapp <DSapp@woodrowsapp.com>

Ms. Sapp,

I have a few more questions now that I've had time to look through this and am curious if you may answer them:

1. Do you happen to have information or know the typical depth of well screen and screened intervals for wells such as these? The information listed on these sheets is listed as an "N/A" when it comes to the screen information

The reason why I ask is I want to know which aquifer is actually being used for water withdrawal for these "public drinking water wells."

2. Is it the the Upper Floridan Aquifer at the well depths indicated (720-730 feet below ground)?

3. Are typical private/domestic drinking water wells in the Waynesville/Atkinson communities of Brantley County installed at these depths and withdrawing groundwater from the same aquifers?

4. Are any withdrawing groundwater from the surficial, unconfined aquifer?

I am very grateful for any help you may provide. Please call me at (478) 365-8609 if you have any questions, etc./

Sincerely,

Michael W. Biers, P.E.

HARBIN ENGINEERING, P.C.
41 West Johnston Street
Forsyth, Georgia 31029
(478) 365-8609 cell
(478) 992-9122 office
(478) 994-0439 fax
www.harbinengineering.com

On Fri, Feb 26, 2016 at 3:07 PM, Diane Sapp <DSapp@woodrowsapp.com> wrote:
[Quoted text hidden]

HARBIN ENGINEERING, P.C.
CIVIL & ENVIRONMENTAL CONSULTANTS

Michael Biers <mbiers@harbinengineering.com>

FW: Brantley County Well Coordinates & Well Data Info

Diane Sapp <DSapp@woodrowsapp.com> Sat, Jul 16, 2016 at 6:19 PM
To: Michael Biers <mbiers@harbinengineering.com>

There are no screens, that is why it indicates not applicable.

Water is coming from upper Floridian aquifer. All public water systems, including municipal wells, do come from UFA.

Most private home wells are approx 260 feet in Brantley County; not utilizing the UFA.

Thanks, DS

Diane M. Sapp

WOODROW SAPP

W & D UTILITIES

4774 New Jesup Highway

Brunswick, Georgia 31520

912/265-2603

912/262-0423 (Fax)

From: Michael Biers [mailto:mbiers@harbinengineering.com]
Sent: Wednesday, July 13, 2016 5:15 PM
To: Diane Sapp
Subject: Re: FW: Brantley County Well Coordinates & Well Data Info

[Quoted text hidden]

HARBIN ENGINEERING, P.C.
CIVIL & ENVIRONMENTAL CONSULTANTS

Michael Biers <mbiers@harbinengineering.com>

FW: Brantley County Well Coordinates & Well Data Info

Michael Biers <mbiers@harbinengineering.com> Mon, Jul 18, 2016 at 8:21 AM
To: Diane Sapp <DSapp@woodrowsapp.com>

Thank you for the clarification....

For the private home wells in BC, are they typically screened? If so, what are the typical intervals? Are they withdrawing from the Brunswick aquifer system, the surficial, or both?

Again, thanks.

Sincerely,

Michael W. Biers, P.E.

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41 West Johnston Street
Forsyth, Georgia 31029
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> Diane M. Sapp
>
> **WOODROW SAPP**
>
> **W & D UTILITIES**
>
> 4774 New Jesup Highway
>
> Brunswick, Georgia 31520

912/265-2603

912/262-0423 (Fax)

From: Michael Biers [mailto:mbiers@harbinengineering.com]
Sent: Wednesday, July 13, 2016 5:15 PM
To: Diane Sapp
Subject: Re: FW: Brantley County Well Coordinates & Well Data Info

Ms. Sapp,

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1. Do you happen to have information or know the typical depth of well screen and screened intervals for wells such as these? The information listed on these sheets is listed as an "N/A" when it comes to the screen information

The reason why I ask is I want to know which aquifer is actually being used for water withdrawal for these "public drinking water wells."

2. Is it the the Upper Floridan Aquifer at the well depths indicated (720-730 feet below ground)?

3. Are typical private/domestic drinking water wells in the Waynesville/Atkinson communities of Brantley County installed at these depths and withdrawing groundwater from the same aquifers?

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Mike,

As requested, hope this info is helpful. Thanks, Diane

Diane M. Sapp

WOODROW SAPP

W & D UTILITIES

4774 New Jesup Highway

Brunswick, Georgia 31520

912/265-2603

912/262-0423 (Fax)

From: Jeff Carter
Sent: Friday, February 26, 2016 2:51 PM
To: Diane Sapp
Subject: Brantley County Well Coordinates

Satilla Plantation: 31°11'44.02"N, 81°50'9.47"W

https://www.google.com/maps/place/31%C2%B011'44.0%22N+81%C2%B050'09.5%22W/@31.1955657,-81.8381526,975m/data=!3m1!1e3!4m2!3m1!1s0x0:0x0

Hawks Landing: 31°13'29.62"N, 81°47'49.61"W

https://www.google.com/maps/place/31%C2%B013'29.6%22N+81%C2%B047'49.6%22W/@31.224899,-81.7993026,974m/data=!3m2!1e3!4b1!4m2!3m1!1s0x0:0x0

Waynesville Elementary School: 31°13'34.71"N, 81°47'26.56"W

https://www.google.com/maps/place/31%C2%B013'34.7%22N+81%C2%B047'26.6%22W/@31.2263129,-81.7928998,974m/data=!3m2!1e3!4b1!4m2!3m1!1s0x0:0x0

Thank you,

Jeff Carter

Woodrow Sapp

Well Drilling & Water Management

4774 New Jesup Hwy

Brunswick, GA 31520

P 912-265-2603

jcarter@woodrowsapp.com

HARBIN ENGINEERING, P.C.
CIVIL & ENVIRONMENTAL CONSULTANTS

Michael Biers <mbiers@harbinengineering.com>

FW: Brantley County Well Coordinates & Well Data Info

Diane Sapp <DSapp@woodrowsapp.com> Mon, Jul 18, 2016 at 9:33 AM
To: Michael Biers <mbiers@harbinengineering.com>

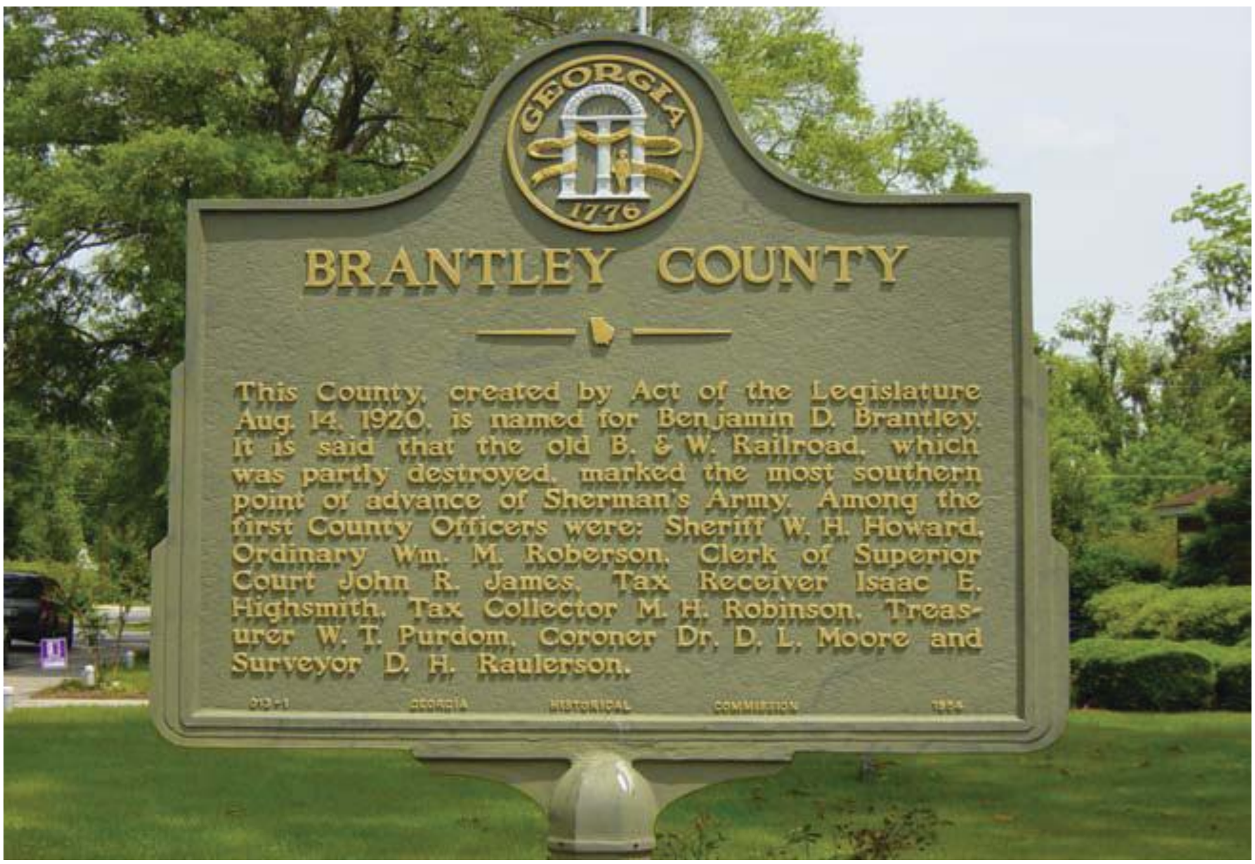
No screen on them either.

Diane M. Sapp
WOODROW SAPP
W & D UTILITIES
4774 New Jesup Highway
Brunswick, Georgia
912/265-2603
912/262-0423 (fax)
[Quoted text hidden]

APPENDIX M

Comprehensive Plan
for
Brantley County
and the Cities of
Hoboken and Nahunta

Adopted June 10, 2016



Prepared by the

Southern Georgia Regional Commission

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TABLE OF CONTENTS

I. Chapter 110-12-1 Minimum Standards and Procedures for Local Comprehensive Planning

1. Introduction

The 2016 Joint Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update was prepared in accordance with the Rules of the Georgia Department of Community Affairs Chapter 110-12-1, Minimum Standards and Procedures for Local Comprehensive Planning.

As required by the Local Comprehensive Planning Standards, the 2016 Brantley County and the Cities of Hoboken and Nahunta Comprehensive Plan Update consists of the following elements:

- Community Goals
- Needs and Opportunities
- Community Work Program
- Economic Development Element (As a community included in the Georgia Job Tax Credit Tier 1 category)
    - Although a separate summarized economic development element is included in this Comprehensive Plan, which by reference adopts the current regional Comprehensive Economic Development Strategy (CEDS), any economic development goals, policies, needs, opportunities, and objectives pertaining to Brantley County and the Cities of Hoboken and Nahunta have also been integrated directly into their parallel components in this Comprehensive Plan.
- Land Use Element

2. Community Involvement

All of the required elements have been developed with extensive opportunity for involvement and input from stakeholders throughout the county and cities. The following steps were taken to ensure that this plan reflected the full range of needs and opportunities from the many stakeholders and residents in the county:

a) Stakeholders were identified. These included the Brantley County Board of Commissioners; The City of Hoboken and Nahunta City Councils; the Brantley County Board of Education; the Brantley County Emergency Management Agency; the County Sheriff's Department; local nonprofit organizations; local businesses and industries; and the general public.
b) Participation techniques were identified. Techniques used included a kick-off public information meeting, printed public information in local newspapers, and information on the Southern Georgia Regional Commission's website and social media page as well as local government websites. A steering committee was formed to oversee and participate in planned development, including members of the local governing authorities (Brantley County Board of Commissioners and the municipal governments of the Cities of Hoboken and Nahunta) and representatives from the Brantley County Planning Commission; the Brantley County Emergency Management Agency; the Satilla Riverkeeper; local economic development practitioners; local businesses and nonprofit organizations; and the general public.
c) A participation program was conducted. Identified stakeholders were invited and attended, yielding specific input in plan content. The steering committee held regular meetings to provide input and feedback.

The public hearing kicking off the comprehensive planning process was held on Dec. 1, 2015 at the County Commission office. It was held for the purpose of making any potential stakeholders and residents aware that the comprehensive plan update and review was now under way, explaining the purpose of the update, and encouraging residents and other stakeholders to actively participate in the plan update.

3. Identification of Stakeholders

A comprehensive list of potential stakeholders was put together with input from the County and Cities' governments, Development Authority, Emergency Management Agency, elected officials, local business leaders, and residents. Copies of each meeting's sign-up sheet are included in this plan in the Appendix**.**

4. Identification of Participation Techniques

The following participation techniques were utilized during the update process:

- Three Public Hearings:
  - Kick-off
  - Transmittal
  - Adoption
- Four Workshops:
  - Goals, issues, and opportunities
  - Policies, Report of Accomplishments, and Community Work Program
  - Economic Development and Land Use
  - Additional workshop for the City of Nahunta
- Extensive e-mail correspondence with stakeholders (notices of meetings, e-mail requests for comments, distribution of revised drafts and final documents)
- Regular updates on SGRC website and social media page as well as County and Cities' Websites
- Dissemination of Information in the newspaper (public notices, advertisements)

5. Participation Program

A foundational principle utilized by the Southern Georgia Regional Commission in all of its planning projects is public and stakeholder participation from and coordination with multiple and diverse interest groups. In order to ensure the broadest buy-in and diversity of input into the comprehensive plan update, all participants were included in the stakeholder group. Outreach to the public, local governments, economic development authorities, local businesses and nonprofits, and other stakeholders and interested parties was accomplished by e-mail correspondence, direct communication, social media postings, SGRC and local government websites, and updates provided at workshops and other group meetings. Opportunity for public comment was provided at public hearings and city and county commission meetings.

In addition to the three required public hearings, SGRC held a series of four workshops to discuss several elements of the plan. The first workshop was used to review the existing goals, issues, and opportunities. In a process consisting of a review and open discussion of the existing goals, issues, and opportunities from the prior adopted Comprehensive Plan, participants updated these items to meet current needs. Input from the workshops was then incorporated into the draft Plan Update by SGRC staff. Copies of the sign-in sheets are provided in the appendix along with public hearing notices.

In the second workshop, the Community Policies were reviewed and the Report of Accomplishments was developed, along with the draft of the updated Community Work Program. The Community Work Program was developed by the participants to include specific action items and projects that would be feasible for the County and the individual communities to implement, should funding be available.

The third workshop was utilized to update the Economic Development Element and the Land Use Element and Maps as desired by the local governments. Information from community participation was gathered from open discussion during the three workshops through notes taken by SGRC staff and then incorporated into the plan from those notes. In addition, some information from community participation was received via mail, e-mail, and directly at meetings; this is included in the Appendix of the plan.

A fourth workshop was held in the City of Nahunta in order to update the Nahunta City Council members regarding the development of the Comprehensive Plan Update and to provide a further opportunity for community input.

6. Consideration of Regional Water Plan and Environmental Planning Criteria

During the preparation of the Comprehensive Plan Update, the local governments must review both the Regional Water Plan covering its area and the GDNR Rules for Environmental Planning Criteria as laid out in Chapter 391-3-16 to determine whether any local implementation practices or development regulations need to be adapted to be consistent with both.

Suwannee-Satilla Regional Water Plan

Brantley County and the Cities of Nahunta and Hoboken lie within the area of the Suwannee-Satilla Regional Water Plan, which was adopted in September 2011.

The Suwannee-Satilla Regional Water Plan had identified 13 goals, listed below, to implement its vision of managing water resources in a sustainable manner under Georgia's regulated riparian and reasonable use laws to support the state's and regions' economy, to protect public health and natural resources, and to enhance the quality of life for all citizens; while preserving the private property rights of Georgia's landowners, and in consideration of the need to enhance resource augmentation and efficiency opportunities.

Source: CDM Suwannee-Satilla Regional Water Plan

Goals:

1. Manage and develop water resources to sustainably and reliably meet domestic, commercial, and industrial water needs, including all agricultural sectors (including agro-forestry).

2. Manage ground and surface water to encourage sustainable economic and population growth in the region.

3. Manage the Region's and State's water resources in a manner that preserves and protects private property rights.

4. Ensure an adequate water supply of suitable quality to meet current and future human needs, while protecting environmental resources.

5. Identify opportunities to optimize existing and future supplies, and water and wastewater infrastructure.

6. Promote efficient use and management of surface and groundwater resources to allow for sufficient supplies for current and future generations.

7. Protect and manage surface and groundwater recharge areas to ensure sufficient long-term water supplies for the region.

8. Protect, maintain, and where appropriate and practicable, identify opportunities to enhance water quality and river base flows.

9. Protect and maintain regional water-dependent recreational opportunities.

10. Identify opportunities to manage stormwater to improve water quality and quantity.

11. Identify and implement cost-effective water management strategies.

12. Seek to provide economically affordable power and water resource service to all citizens in the region.

13. Identify and implement actions to better measure and share water use data and information.

In addition, the Regional Water Plan has adopted several Short-Term Water Quantity and Water Quality Management Practices, which the local comprehensive plan should include in order to manage water resources in a sustainable manner through the planning period and beyond:

The most significant issues in the Suwannee-Satilla Region are surface water availability gaps driven by agricultural usage. As such, the majority of water supply management practices are intended to address agricultural surface water use.

Short Term Water Quantity Management Practices (0-10 Years)

1. Utilize surface water and groundwater sources within the available resource capacities
2. Water conservation
3. Data Collection and research to confirm the frequency, duration, severity, and drivers of surface water gaps
4. Evaluate and ensure that current and future surface water permit conditions do not contribute to 7Q10 low flow concerns (1 in 10 year 7 day low flow condition)
5. Encourage sustainable groundwater use as a preferred supply in regions with surface water 7Q10 low flow concerns and adequate groundwater supply
6. Identify incentives and a process to sustainably replace a portion of existing agricultural surface water use with groundwater use to address 7Q10 low flow concerns
8. Evaluate the potential to use existing storage to address 7Q10 low flow concerns
9. Education to reduce surficial aquifer groundwater use impacts to 7Q10 low flow concerns

Short-Term Water Quality Management Practices (0 – 10 Years):

1. Point Sources:
- Support and fund current permitting and waste load allocation process to improve treatment of wastewater and increase treatment capacity
- Data collection and research to confirm discharge volumes and waste concentrations as well as receiving stream flows and chemistry

2. Non-Point Sources:
- Data collection to confirm source of pollutants and causes; encourage storm water ordinances, septic system maintenance, and coordinated planning
- Ensure funding and support for Best Management Practices Programs by local and state programs, including urban/suburban, rural, forestry, and agricultural Best Management Practices

3. Non-point Source Existing Impairments:
- Total maximum daily load listed streams: Improve data on source of pollutant and length of impairment; Identify opportunities to leverage funds and implement non-point source Best Management Practices

Longer Term (20 – 40 years) water quantity and quality management practices include:

- Improve infiltration and management of wetlands
- Evaluate incentive-based programs to manage, increase, and restore wastewater and stormwater returns
- Identify potential/feasibility of a multi-purpose reservoir
- Identify feasibility of regional inter-basin transfer
- Continue wastewater and storm water master planning

Chapter 391-3-16, Rules for Environmental Planning Criteria

The Environmental Planning Criteria that are part of the Minimum Planning Standards deal specifically with the protection of water supply watersheds, groundwater recharge areas, wetlands, river corridors, and mountains, the last of these not being applicable in this region. These criteria were developed by the Department of Natural Resources (DNR) as mandated in Part V of the Georgia Planning Act and in the Mountains and River Corridor Protection Act.

The criteria require that local governments shall identify existing and future water supply watersheds and adopt a water supply watershed protection plan for their jurisdiction.

Some uses may be grandfathered, such as land uses existing prior to the adoption of a watershed plan, mining activities permitted by DNR, certain utilities placements, special forestry, or agricultural services.

The Environmental guidelines also spell out criteria for the delineation of small and large water supply watersheds, for the protection of groundwater recharge areas, for the protection of wetlands, and for the protection of river corridors which shall be incorporated into this comprehensive plan and addressed specifically and in more detail through local ordinances and land development code regulations.

II. PLAN ELEMENTS

1. Community Goals and Vision

The purpose of the Community Goals Element is to lay out a road map for Brantley County and the Cities of Hoboken and Nahunta; to generate local buy-in to the plan; and to ensure that the plan is implemented. The Goals as listed below were developed in the 2006 Comprehensive Plan and the 2011 Major Amendment through several community workshops. The goals are listed by category and are not listed in order of priority. These Goals were reviewed individually for continued relevance during the first workshop of this 2016 comprehensive plan update.

Vision

By the year 2025, Brantley County and the Cities of Hoboken and Nahunta will be a thriving and vibrant community. The County and Cities will endeavor to supply quality education for all citizens, offer diverse housing options, create a thriving economy through the recruitment of diverse employers, seek creative ways to promote and capitalize upon the strategic location and unique natural resources, and pursue options to preserve and promote future economic growth from their unique natural and cultural heritage.

Goal 1: Minimize impacts of development on natural and cultural resources.

Goal 2: Consider the impacts of development on the local economy, particularly the agricultural industry.

Goal 3: Consider the suitability of soils for septic systems and proposed development.

Goal 4: Consider the impact of development to the functionality of the floodplain, and ensure that new development is protected from flooding.

Goal 5: Understand and manage our expectation for growth.

Goal 6: Ensure that future development is coordinated appropriately with water and sanitary sewer service areas.

Goal 7: Consider the impact of development to the transportation system as well as local transportation plans and projects.

Goal 8: Increase educational and recreational opportunities.

2. Issues and Opportunities

The initial Needs and Opportunities were developed and identified in the 2006 Update for Brantley County and the Cities of Hoboken and Nahunta. For the 2016 Comprehensive Plan update, the issues and opportunities were reviewed in the first of three workshops. Each of the previously identified issues and opportunities was reviewed and discussed by the participants, and then either deleted, amended, or retained as deemed applicable to Brantley County and the Cities of Hoboken and Nahunta. This was done utilizing a strengths, weaknesses, opportunities, and threats (SWOT) analysis, analysis of statistical data and information, and review and revision as applicable of the issues and opportunities with stakeholders and residents. Each of the following Issues and Opportunities is addressed by corresponding implementation measures in the Community Work Program for Brantley County and the Cities of Hoboken and Nahunta.

Cultural Resources

Issues

1. Lack of specific ordinance/policy to preserve historic homes and other historic sites.

Opportunities

1. Develop a list of the historic sites in the community.

Economic Development

Issues

1. Lack of employers/businesses.
2. Lack of name recognition; Brantley County and the Cities of Hoboken and Nahunta need to become better known outside of the local area in order to attract businesses and tourism.

Opportunities

1. Promote local eco-tourism (especially the Satilla River Water Trail for canoeing, boating, fishing, and educational opportunities) and historic-based tourism with marketing, festivals, and events.
2. The local economy could be stimulated through downtown revitalization and infill development in the Cities of Hoboken and Nahunta.
3. Partner with local community colleges and technical colleges to provide satellite classes and courses for community residents.
4. Improve communication and inclusion between government, agencies, authorities, business, and citizens in planning and implementing economic development plans.
5. The Brantley County Development Authority is a good resource for businesses.
6. Natural gas service will make the county more marketable to businesses.
7. Capitalize on proximity to major ports (the Ports of Brunswick, Jacksonville, and Savannah), and on proximity to I-95 and other major highways such as US-1, US-82, and US-301.
8. The community should be marketed on major transportation corridors in the region, for example by exit signage on I-95.

Housing

Issues

1. Lack of special needs housing (for the elderly, handicapped, etc.).

Opportunities

1. Create mixed-use neighborhoods by locating small stores, such as local markets, within easy walking distance of residences.
2. Create rehabilitation programs and incentive programs for affordable infill housing, and offer readily available homebuyer education programs.

Natural Resources

Issues

1. Lack of preservation of open spaces.

Opportunities

1. The County and Cities can work together to preserve prime agricultural land and existing open space.
2. Identify the county's natural resources and develop ways to protect and market them.
3. Develop natural resource conservation and protection education for citizens, local officials, and developers.
4. Incorporate walking trails, bike trails, and riding trails in greenspace.

Land Use

Issues

1. Rapid population growth is expected in the next 20 years, which will present several issues for Brantley County's services, environment, infrastructure, and quality of life.
2. Lack of conservation of resources and lack of organized efforts to minimize waste, such as a recycling program.
3. Lack of safe pedestrian environment.
4. Land development regulations, zoning, and/or design guidelines are needed in order to avoid conflicts between land uses and ensure development appropriate to the context of the area.

Opportunities

1. The County and the Cities of Hoboken and Nahunta have the opportunity to develop land development regulations.
2. Preserve open space to be used as parks and greenspace.
3. Create a checklist for permitting, fee schedules, and design review. The checklist will ensure that the design complements and protects Brantley County and the Cities of Hoboken and Nahunta.
4. Encourage traditional neighborhood development.
5. Create greenways and pedestrians trails, as well as providing more sidewalks within the cities and requiring developers to pave streets and provide sidewalks within new developments.

Community Facilities and Services

Issues

1. The County and Cities are limited in their ability to meet the future demands of growing population.
2. The County needs improvements in storm water management due to the great deal of flooding that occurs with heavy rains.
3. The City of Nahunta water system is not adequate to meet future needs.
4. There is a need for a community meeting facility that will also double as an Emergency Operations Center (EOP) and Joint Training Facility.
5. The community needs a Critical Care Facility for stabilizing patients.
6. The community does not have a Subtitle D Solid Waste Facility for economic development and emergency management. The location of such a facility is, however, generating a lot of discussion within the County.
7. Lack of educational and recreational opportunities.
8. Some dirt roads still lack adequate drainage because of problems created by erosion, sedimentation, and storm water runoff.

Opportunities

1. Determine the extent of Nahunta's water lines and service provided to city residents.
2. Vacant buildings in downtown Nahunta could be redeveloped.

Intergovernmental Coordination

Issues

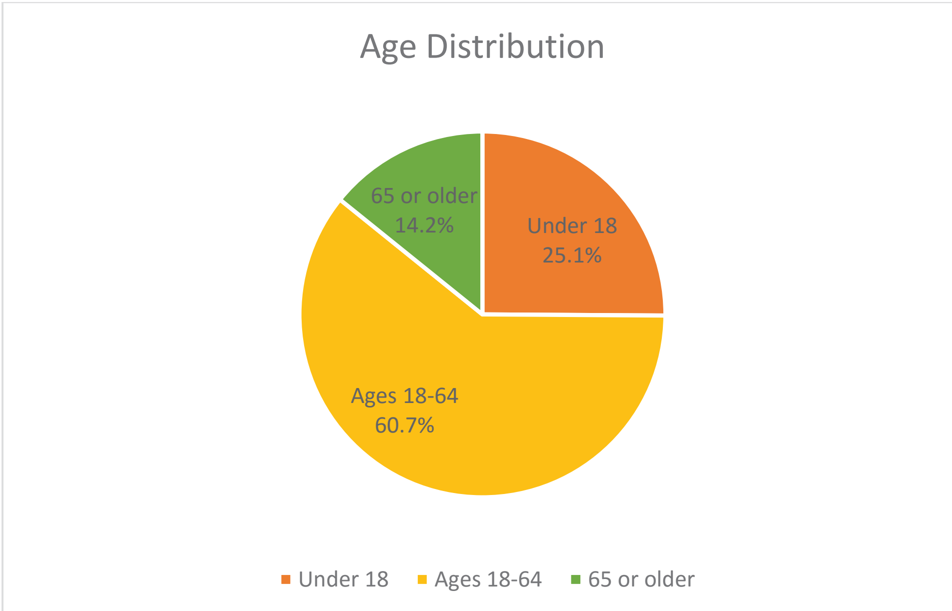
1. Lack of coordination between local governments.
2. No process is in place to ensure consistency between land use regulations.

Opportunities

1. The County and Cities could coordinate in meeting land use regulations.

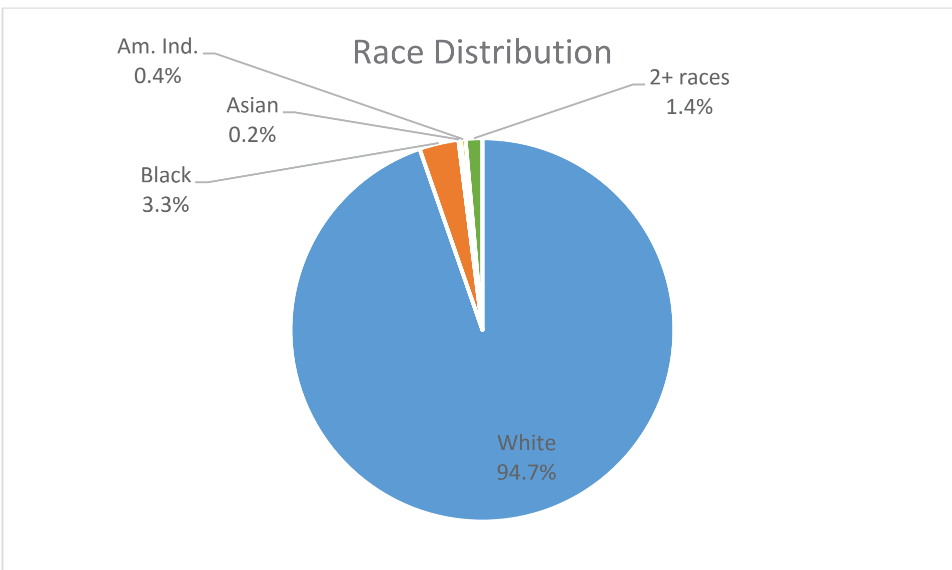
3. Analysis of Data and Information

Brantley County



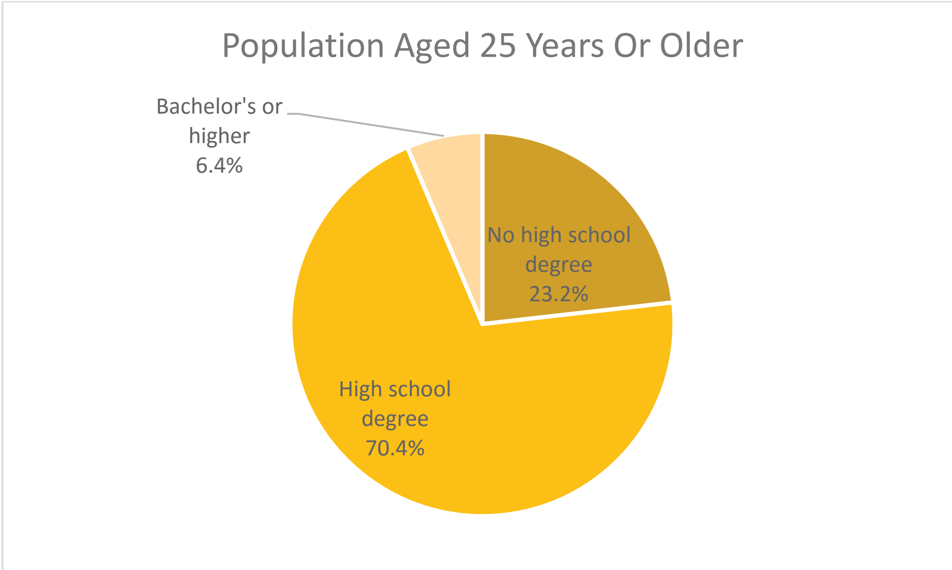
Data source: U.S. Census Bureau, American Community Survey, 2014 1-year estimates.

The 2014 population of Brantley County is 18,417. Since the 2010 Census, the population has increased by 4.2 percent. As of the U.S. Census Bureau's 2013 estimate, 25.1 percent of the population are under age 18, 60.7 percent are between 18 and 64, and 14.2 percent are aged 65 or older. The population is 50.5 percent female and 49.5 percent male.



Data source: U.S. Census Bureau, American Community Survey, 2013 1-year estimates.

As of 2013, Brantley County's population is 94.6 percent White, 3.3 percent Black or African American, 0.4 percent American Indian and Alaska Native, 0.2 percent Asian, and 1.4 percent of two or more races. 2.0 percent of the population are of Hispanic/Latino ethnicity (regardless of race). 0.7 percent of the population are foreign-born and 1.7 percent of people aged 5 or older speak a language other than English at home.

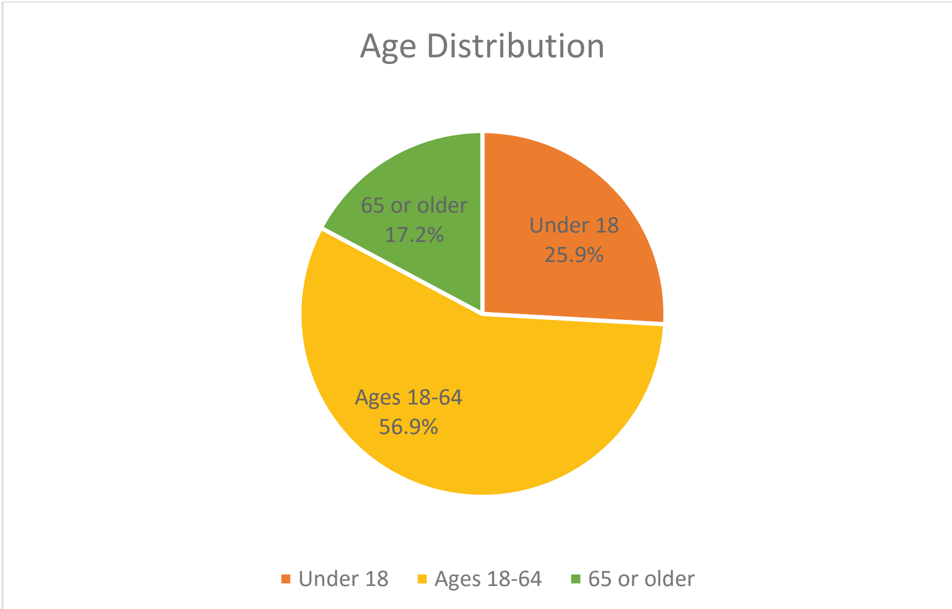


Data source: U.S. Census Bureau, American Community Survey, 2009-2013 5-year estimates.

According to 2009-2013 five-year Census Bureau estimates, 76.8 percent of the population aged 25 or older have at least a high school degree. 6.4 percent have a bachelor's or higher degree. 23.2 percent of those 25 or older do not have a high school degree.

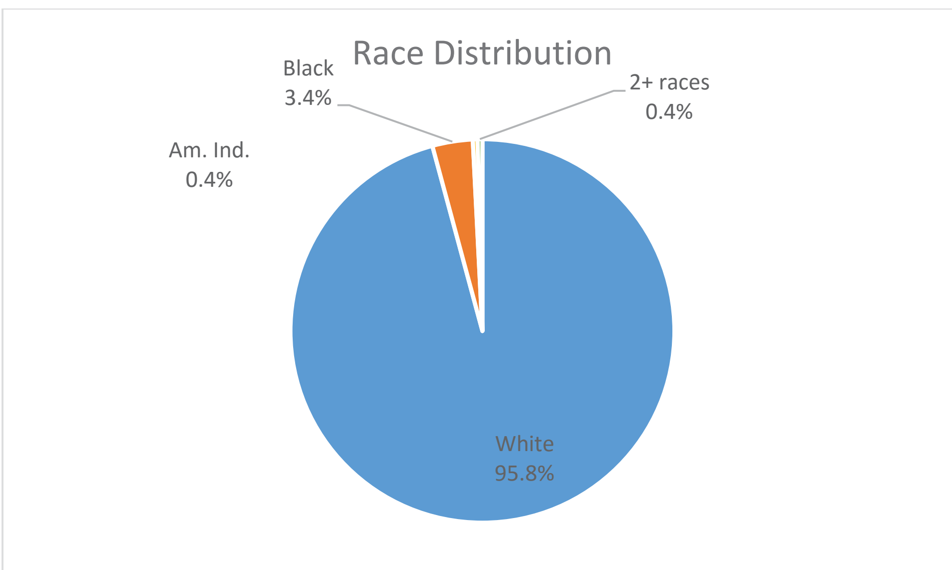
There are 6,550 households in Brantley County, with an average of 2.79 persons per household. The homeownership rate is 80.4 percent, and the median owner-occupied home value is $68,500. The median household income is $36,070 and the per capita income is $16,938, measured in 2013 dollars. 21.9 percent of the population lives below the poverty level.

Hoboken



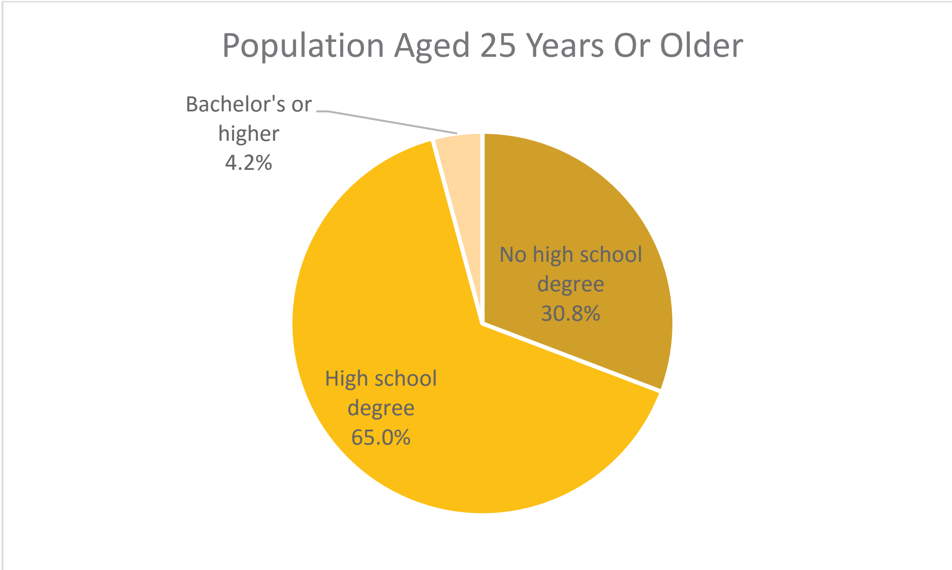
Data source: U.S. Census Bureau, American Community Survey, 2013 1-year estimates.

The 2013 Census population estimate of the City of Hoboken is 525. As of the U.S. Census Bureau's 2013 estimate, 25.9 percent of the population are under age 18, 56.9 percent are between 18 and 64, and 17.2 percent are aged 65 or older. The population is 50.9 percent female and 49.1 percent male.



Data source: U.S. Census Bureau, 2010 Census, Summary File 1.

As of 2010, Hoboken's population is 95.8 percent White, 3.4 percent Black or African American, 0.4 percent American Indian and Alaska Native, and 0.4 percent of two or more races. 0.4 percent of the population are of Hispanic/Latino ethnicity (regardless of race).

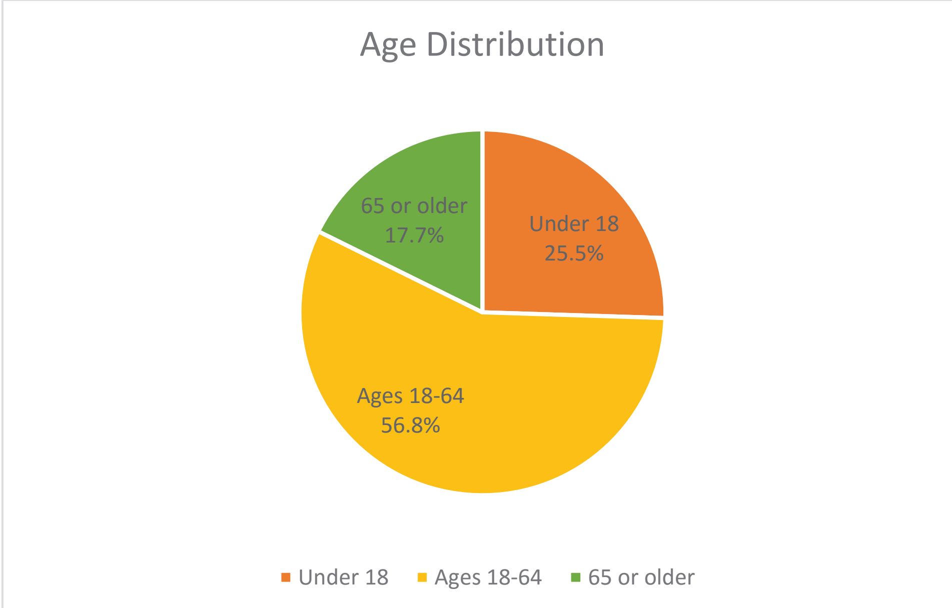


Data source: U.S. Census Bureau, American Community Survey, 2009-2013 5-year estimates.

According to 2009-2013 five-year Census Bureau estimates, 69.2 percent of the population aged 25 or older have at least a high school degree. 4.2 percent have a bachelor's or higher degree. 30.8 percent of those 25 or older do not have a high school degree.

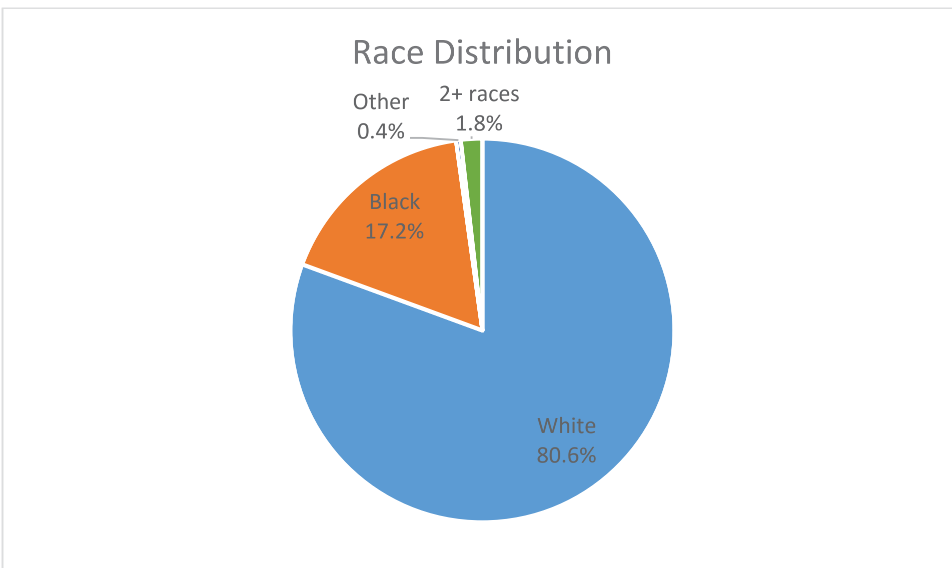
There are 206 households in Hoboken, with an average of 2.56 persons per household. The homeownership rate is 88.8 percent. The median household income is $35,735 and the per capita income is $17,508. 17.4 percent of the population lives below the poverty level.

Nahunta



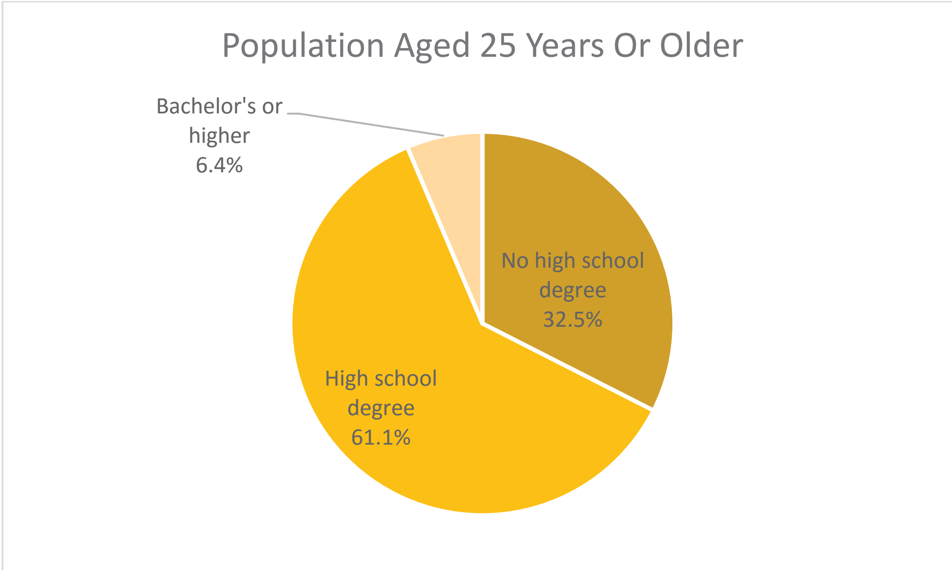
Data source: U.S. Census Bureau, American Community Survey, 2013 1-year estimates.

The 2013 Census population estimate of the City of Nahunta is 1,051. As of the U.S. Census Bureau's 2013 estimate, 25.5 percent of the population are under age 18, 56.8 percent are between 18 and 64, and 17.7 percent are aged 65 or older. The population is 55.4 percent female and 44.6 percent male.



Data source: U.S. Census Bureau, 2010 Census, Summary File 1.

As of 2010, Nahunta's population is 80.6 percent White, 17.2 percent Black or African American, 0.4 percent of some other race, and 1.8 percent of two or more races. 2.1 percent of the population are of Hispanic/Latino ethnicity (regardless of race).



Data source: U.S. Census Bureau, American Community Survey, 2009-2013 5-year estimates.

According to 2009-2013 five-year Census Bureau estimates, 67.5 percent of the population aged 25 or older have at least a high school degree. 6.4 percent have a bachelor's or higher degree. 32.5 percent of those 25 or older do not have a high school degree.

There are 400 households in Nahunta, with an average of 2.48 persons per household. The homeownership rate is 52.8 percent. The median household income is $24,821 and the per capita income is $13,028. 25.1 percent of the population lives below the poverty level.

4. Consideration of DCA Quality Community Objectives

DCA Quality Community Objectives and Best Practices:

1. Economic Prosperity

Encourage development or expansion of businesses and industries that are suitable for the community. Factors to consider when determining suitability include job skills required; long-term sustainability; linkages to other economic activities in the region; impact on the resources of the area; or prospects for creating job opportunities that meet the needs of a diverse local workforce.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- Research and create a source book to identify technical and financial assistance available for local businesses from regional, state and federal sources and make it available to local businesses.
- Track business needs of existing businesses to help with business retention.
- Tailor training programs to provide workforce skills needed by local businesses.

2. Resource Management

Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- ***Conservation Easements:*** Encourage owners of key properties (such as those in environmentally sensitive areas, included in the local greenspace plan, or designated for agricultural use in the comprehensive plan) to utilize conservation easements or sale of development rights to preserve their land from future development. Conservation easements allow private landowners to donate the development rights of their property to a qualified conservation organization or government agency, in exchange for tax savings. Sale of development rights is an arrangement whereby private landowners sell the development rights of their property to a qualified conservation organization or government agency. In both cases above, giving up the development rights permanently protects a property from development and thereby ensures that it remains as green space or farmland.
- ***Riparian Buffers:*** Adopt a riparian buffer ordinance, with a minimum buffer of 25', to protect the banks of streams and rivers from development. These buffers help protect water quality by slowing and filtering stormwater runoff as it flows toward the stream.

3. Efficient Land Use

Maximize the use of existing infrastructure and minimize the costly conversion of undeveloped land at the periphery of the community. This may be achieved by encouraging development or redevelopment of sites closer to the traditional core of the community; designing new development to minimize the amount of land consumed; carefully planning expansion of public infrastructure; or maintaining open space in agricultural, forestry, or conservation uses.

Best Practices recommended for Brantley County and Hoboken and Nahunta

- Create some regulatory tools like a zoning code to encourage owners to maintain property or utilize vacant or unused properties and structures.
- Consider adopting a rehabilitation code in addition to a new construction code to help keep costs down, thereby encouraging rehabilitation of properties.

4. Local Preparedness

Identify and put in place the prerequisites for the type of future the community seeks to achieve. These prerequisites might include infrastructure (roads, water, and sewer) to support or direct new growth; ordinances and regulations to manage growth as desired; leadership and staff capable of responding to opportunities and managing new challenges; or undertaking an all-hazards approach to disaster preparedness and response.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- ***Capital Improvement Program:*** Develop an infrastructure investment plan that clearly spells out what public services and infrastructure your community will provide where, and when, so that your community grows in a rational and organized manner. This should accompany the comprehensive plan and indicate to developers and citizens where the community desires new development to be located. A capital improvement program brings predictability to the location and extent of future public facility expansions, so that residents and developers can plan their investments accordingly.
- ***Grants for Financing Infrastructure Improvements:*** There are many federal and state grants available to local governments that need help in funding public infrastructure projects. Such projects may include water, sewer, roads, broadband, power, solid waste, and various other infrastructural elements.
- Continue implementation of a Service Delivery Strategy.

5. Sense of Place

Protect and enhance the community's unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- ***Aesthetic Overlay:*** Enact special measures to preserve and enhance physical attractiveness of particular districts of the community, particularly gateway corridors or similar areas important to the image of the community. These special measure may include signage controls, special landscaping requirements, building design guidelines, or screening requirements for obtrusive uses like cell towers, utilities, and energy generating infrastructure. These special requirements are typically adopted as an overlay district, a mapped area where additional regulations apply as a supplement to existing zoning and subdivision regulations.
- ***Historic Preservation Program:*** Begin by Identifying and mapping the visual, cultural, and historical assets your community most values Then adopt a local historic preservation/protection ordinance to protect and enhance the places, districts, sites, buildings, structures, and works of art identified in the inventory of assets. This ordinance should be adopted under the auspices of Georgia Historic Preservation Act, which establishes a local Historic Preservation Commission to provide oversight on administration of the local ordinance and provide guidance on aesthetic changes to historic structures within locally designated districts.
- Adopt manufactured home regulations to ensure compatibility of manufactured homes with surrounding single family residences and to regulate appearance, layout and location of manufactured homes.

6. Regional Cooperation

Cooperate with neighboring jurisdictions to address shared needs. This may be achieved by actively participating in regional organizations; identifying joint projects that will result in greater efficiency and less cost to the taxpayer; or developing collaborative solutions for regional issues such as protection of shared natural resources, development of the transportation network, or creation of a tourism plan.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- Meet regularly with SGRC staff to discuss local priorities and projects and explore opportunities for assistance and coordination with regional efforts.

7. Housing Options

Promote an adequate range of safe, affordable, inclusive, and resource efficient housing in the community. This may be achieved by encouraging development of a variety of housing types, sizes, costs, and densities in each neighborhood; promoting programs to provide housing for residents of all socioeconomic backgrounds, including affordable mortgage finance options; instituting programs to address homelessness issues in the community; or coordinating with local economic development programs to ensure availability of adequate workforce housing in the community.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- Consider creating an ordinance to allow cottage zoning to allow very small single family homes to fill the need for affordable housing, utilize vacant properties and keep cost down for construction and so eliminate the need for manufactured homes.
- Provide education on home loan assistance to foster rehabilitation and revitalization.
- ***Density Districts:*** Identify and establish, by ordinance, districts of your community where higher density housing is appropriate and permitted, such as downtown and walkable neighborhoods near commercial districts.

8. Transportation Options

Address the transportation needs, challenges and opportunities of all community residents. This may be achieved by fostering alternatives to transportation by automobile, including walking, cycling, and transit; employing traffic calming measures throughout the community; requiring adequate connectivity between adjoining developments; or coordinating transportation and land use decision-making within the community.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- Create a continuous, well maintained sidewalk network, especially around schools.
- Ensure safe, adequate and well-designed facilities for bicyclists.

9. Educational Opportunities

Make educational and training opportunities readily available to enable all community residents to improve their job skills, adapt to technological advances, manage their finances, or pursue life ambitions. This can be achieved by expanding and improving local educational institutions or programs; providing access to other institutions in the region; instituting programs to improve local graduation rates; expanding vocational education programs; or coordinating with local economic development programs to ensure an adequately trained and skilled workforce.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- Ensure that all schools and libraries have adequate and efficient access to the internet to provide sufficient opportunities for on-line education and certification opportunities.
- ***Public Internet Access:*** Ensure that your community provides public access to internet connected computers at locations such as libraries. This provides students access to online courses and training, such as Georgia's E-Core or the variety of online degree and certification opportunities available from the University System of Georgia.
- ***Experience Works Program:*** Help older workers gain employment by partnering with Experience Works, a national community-based organization that helps older adults find good jobs in their communities.

10. Community Health

Ensure that all community residents, regardless of age, ability, or income, have access to critical goods and services, safe and clean neighborhoods, and good work opportunities. This may be achieved by providing services to support the basic needs of disadvantaged residents, including the disabled; instituting programs to improve public safety; promoting programs that foster better health and fitness; or otherwise providing all residents the opportunity to improve their circumstances in life and to fully participate in the community.

Best Practices recommended for Brantley County and Hoboken and Nahunta:

- Develop a comprehensive listing of health services and assistance resources for local citizens.

5. Goals, Issues and Policies

Cultural Resources

Goal 1: Minimize impacts of development on natural and cultural resources.

Issues & Policies

Issue 1: **Lack of specific ordinance/policy to preserve historic homes and other historic sites.**

Policy 1.1: Pursue opportunities to fund a countywide survey that will identify and record historic resources.

Policy 1.2: Encourage the development of a Historic Preservation Ordinance for the protection of locally designated historic properties.

Economic Development

Goal 2: Consider the impacts of development on the local economy, particularly the agricultural industry.

Issues & Policies

Issue 1: **Lack of employers/businesses.**

Policy 2.1: Encourage economic development and redevelopment, to include the acquisition and development of land.

Policy 2.2: Encourage the development of the downtowns of the two Cities as vibrant centers for culture, government, dining, residential use, and retail diversity.

Policy 2.3: Encourage adoption of landscaping guidelines to create a unified and pleasing visual environment.

Policy 2.4: Support programs for retention, expansion and creation of businesses that enhance the community's economic well-being.

Policy 2.5: Establish an atmosphere in which entrepreneurial enterprise is nurtured in the community.

Policy 2.6: Support and work with the Development Authority to attract new business and industry to the community.

Issue 2: **Lack of name recognition; Brantley County and the Cities of Hoboken and Nahunta need to become better known outside of the local area in order to attract businesses and tourism.**

Policy 2.7: Pursue a marketing campaign to increase name recognition of the community.

Policy 2.8: Encourage niche marketing of local artists and craftsmen.

Policy 2.9: Encourage promotion of sustainable local eco-tourism, canoeing (including the Satilla River Water Trail), hiking, nature trails, bird watching, hunting, fishing, swimming, and environmental education as viable economic opportunities

Policy 2.10: Participate in the 301 Association to promote US 301 as a scenic and economic development highway

Policy 2.11: Promote the Christmas Parade, Satilla Celebration, and Sacred Harp Singing Festival to generate tourism dollars

Housing

Goal 3: Consider the suitability of soils for septic systems and proposed development.

Issues & Policies

Issue 1: Lack of special needs housing (for the elderly, handicapped, etc.).

Policy 3.1: Accommodate the community's diverse population by encouraging a harmonious mixture of housing types and uses.

Policy 3.2: Encourage developers to include affordable homes when building a particular number of market rate homes.

Policy 3.3: Promote availability of vacant and developable land available for multifamily housing.

Policy 3.4: Encourage housing policies, choices and patterns that move people upward on the housing ladder from dependence to independence.

Policy 3.5: Encourage creation of affordable housing opportunities to ensure that all those who work in the community have a viable choice or option to live in the community.

Natural Resources

Goal 4: Consider the impact of development to the functionality of the floodplain, and ensure that new development is protected from flooding.

Issues & Policies

Issue 1: Lack of preservation of open spaces.

Policy 4.1: Encourage new development in suitable locations in order to protect natural resources.

Policy 4.2: Encourage more compact and efficient urban development and preservation of open spaces.

Policy 4.3: Ensure that the protection and conservation of the community's resources plays an important role in the decision-making process.

Policy 4.4: Pursue the establishment of bikeways and trails in and around the Satilla River area.

Policy 4.5: Encourage conservation easements to keep productive farmland in agricultural use.

Land Use

Goal 5: Understand and manage our expectation for growth.

Issues & Policies

Issue 1: **Rapid population growth is expected in the next 20 years, which will present several issues for Brantley County's services, environment, infrastructure, and quality of life.**

Policy 5.1: Review population projections on a regular basis to ensure community leaders are aware of what levels of growth are expected.

Policy 5.2: Ensure that the necessary services are provided concurrent with growth and are planned for in keeping with future growth.

Policy 5.3: Continually analyze the financial impact of new subdivision growth in Brantley County.

Policy 5.4: Petition FEMA to produce revised flood maps.

Issue 2: **Lack of conservation of resources and lack of organized efforts to minimize waste, such as a recycling program.**

Policy 5.5: Encourage new development in suitable locations in order to protect natural resources.

Policy 5.6: Pursue the development of a recycling program.

Policy 5.7: Continue fiscally responsible operation of solid waste collection and disposal.

Policy 5.8: Encourage participation in annual Satilla River cleanup events.

Issue 3: **Lack of safe pedestrian environment.**

Policy 5.9: Promote safe, walkable neighborhoods.

Issue 4: **Land development regulations, zoning, and/or design guidelines are needed in order to avoid conflicts between land uses and ensure development appropriate to the context of the area.**

Policy 5.10: Consider adopting land use development regulations and/or zoning.

Policy 5.11: Consider conducting a Smart Growth Audit to identify impediments to achieving livable, mixed-use, and walkable communities.

Community Facilities and Services

Goal 6: Ensure that future development is coordinated appropriately with water and sanitary sewer service areas.

Goal 8: Increase educational and recreational opportunities.

Issues & Policies

Issue 1: **The County and Cities are limited in their ability to meet the future demands of growing population.**

Policy 6.1: Promote strategies to ensure that new development does not cause a decline in locally adopted level of service for and that capital improvements or other strategies needed to accommodate the impacts of development are made or provided for concurrent with new development.

Policy 6.2: Develop regulations for shared/combined septic and water systems for new residential, commercial, and industrial developments.

Issue 2: The County needs improvements in storm water management due to the great deal of flooding that occurs with heavy rains.

Policy 6.3: Pursue opportunities to conduct a sedimentation, erosion and storm water runoff survey and pursue the creation of a plan to address those issues.

Issue 3: The City of Nahunta water system is not adequate to meet future needs.

Policy 6.4: Apply for grants, such as CDBG, to expand the current water system to accommodate future population growth.

Issue 4: There is a need for a community meeting facility that will also double as an Emergency Operations Center (EOP) and Joint Training Facility.

Policy 6.5: Pursue funding to construct a community meeting facility adequate to serve the community's needs.

Issue 5: The community needs a Critical Care Facility for stabilizing patients.

Policy 6.6: Encourage development of health care services that meet the current and future needs of the community.

Issue 6: The community does not have a Subtitle D Solid Waste Facility for economic development and emergency management. The location of such a facility is, however, generating a lot of discussion within the County.

Policy 6.7: Investigate feasibility and potential funding sources for constructing an expanded solid waste facility.

Issue 7: Lack of educational and recreational opportunities.

Policy 6.8: Encourage parks and community facilities to be located as focal points in neighborhoods.

Policy 6.9: Encourage neighborhoods to develop as interactive communities where people have easy access to schools, parks, residences and businesses through walkways, bike paths, roads and public transportation.

Policy 6.10: Pursue expansion of educational opportunities.

Policy 6.11: Encourage increased investment in existing neighborhoods.

Policy 6.12: Pursue partnerships with local community colleges and technical colleges to provide satellite classes and courses for community residents.

Policy 6.13: Continue to develop existing and new recreational facilities and community centers throughout the County and Cities.

Issue 8: Some dirt roads still lack adequate drainage because of problems created by erosion, sedimentation, and storm water runoff.

Policy 6.14: Strive to limit the number of miles of dirt roads accepted by the County and require new developments to include paving of roads.

Policy 6.15: Continue to encourage paving or grading/stabilizing and best management practices for existing dirt roads.

Policy 6.16: Continue implementing the plan to address sedimentation, erosion and storm water runoff issues.

Intergovernmental Coordination

Goal 7: Consider the impact of development to the transportation system as well as local transportation plans and projects.

Issues & Policies

Issue 1: Lack of coordination between local governments.

Policy 7.1: Encourage coordination between the County and Cities with regard to land use regulations.

Policy 7.2: Pursue joint processes for collaborative planning and decision-making.

Issue 2: No process is in place to ensure consistency between land use regulations.

Policy 7.1: Encourage coordination between the County and Cities with regard to land use regulations.

Policy 7.3: Ensure consistency between the Service Delivery Strategy and the Comprehensive Plan.

Policy 7.4: Establish coordination mechanisms with adjacent local governments to provide for exchange of information.

Policy 7.5: Encourage development of building codes for the Cities of Hoboken and Nahunta.

Policy 7.6: Encourage coordination, collaboration, and cooperation between departments and organizations that have similar interests, for example the Parks & Recreation department and the Development Authority.

6. Community Work Program

Report Of Accomplishments: Joint Brantley County and Cities of Hoboken and Nahunta 5-Year Short-Term Work Program
(2011 - 2016)

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	REPORT OF ACCOMPLISHMENTS	FY 12	FY 13	FY 14	FY 15	FY 16
CULTURAL RESOURCES									
Develop a historic preservation ordinance for protection of locally designated historic properties	Staff Time	Brantley County Zoning commission	Brantley County Planning/Zoning commission	Ongoing	*				
Conduct a countywide survey to identify and record historic resources	Unknown	Brantley County	Brantley County and available grants	Complete	*	*	*	*	*
ECONOMIC DEVELOPMENT									
Perform an annual review of the STWP	staff time	Brantley County, City of Hoboken, City of Nahunta	County/City	Complete	*	*	*	*	*
Promote niche marketing using local artists and artisans, highlighting the uniqueness and historical value of Brantley County	staff time	County/City	County/City	Complete (moved to Policy 2.8)	*	*	*	*	*
Participate in the 301 Association to promote US 301 as a scenic and economic development highway	staff time	Brantley County, City of Nahunta	County/City of Nahunta	Complete (moved to Policy 2.10)	*	*	*	*	*
Continue to improve the entrance of the industrial park	20,000	Brantley County, Development Authority	Brantley County	Complete	*	*	*	*	*
Promote sustainable eco-tourism, canoeing, hiking, nature trails, bird watching, hunting, fishing, swimming, environmental education as viable economic opportunities	50,000	Brantley County	Brantley County, CIG, LDF, ETC	Complete (moved to Policy 2.9)	*	*	*	*	*
Promote Christmas Parade, Satilla Celebration, and Sacred Harp Singing Festival to generate tourism dollars	10,000	Brantley County	Brantley County, Chamber of Commerce, CIG, LDF and other grants	Complete (moved to Policy 2.11)	*	*	*	*	*

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	REPORT OF ACCOMPLISHMENTS	FY 12	FY 13	FY 14	FY 15	FY 16
Investment in 500 – 1,000 acres of river accessible land for future construction of a Satilla Center and Park	250,000	Brantley County	Brantley County, Development Authority, Other Agencies	Ongoing (reworded in the new Work Program to clarify that it is an Industrial Park; "river accessible" removed; acreage changed)	*	*	*	*	*
Support and work with the Development Authority to attract new business and industry to our community	400,000	Brantley County	Brantley County, Development Authority, Other Agencies	Complete (moved to Policy 2.6)	*	*	*	*	*
HOUSING									
Continue to develop an aggressive program to pursue grants for housing rehabilitation/renewal for low to moderate income families inhabiting the unincorporated areas of Brantley County	$75,000	Brantley County, Housing Authority	DCA, USDA, HUD, etc.	Complete	*	*	*	*	*
Analyze financial impact of new subdivision growth in the county	Staff Time	Brantley County Planning commission	Brantley County	Complete	*	*	*	*	*
NATURAL RESOURCES									
Natural Resource Conservation education for citizens, developers and local officials	25,000	Brantley County, Satilla River Keeper, State Workshops	County, CIG Grants, Volunteers	Ongoing	*	*	*	*	*
Develop a conservation subdivision ordinance requiring developers of new subdivisions to set aside up to 30 percent of their gross area as greenspace	unknown	Brantley County	County	Complete	*	*	*	*	*
Enforce the Part V Ordinances that are in place in Brantley County. Preserve scenic areas and corridors within the conservation area	10,000	Brantley County Code Enforcement	County and available grants	Complete	*	*	*	*	*
Develop plan for preserving and marketing resources for eco-tourism	Staff Time	Historical Society, Development Authority, Citizens	Development Authority	Ongoing	*				
Enhance the three existing public boat ramps along the Satilla River	50,000	Brantley County	Brantley County and available grants	Ongoing (1 ramp has been completed and 3 remain)	*	*	*	*	*
Encourage conservation easements to keep productive farmland in agricultural use	Staff Time	Brantley County, State of Georgia	Brantley County	Complete (moved to Policy 4.5)	*				

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	REPORT OF ACCOMPLISHMENTS	FY 12	FY 13	FY 14	FY 15	FY 16
Establish bikeways and trails in and around the Satilla River area	Staff time/grants	Brantley County, City of Hoboken, City of Nahunta	Brantley County and available grants	Ongoing as a County project, so carried over to County work program only	*	*	*	*	*
LAND USE									
Pass an ordinance requiring new subdivisions to pave roads and put in sidewalks	Staff time	Brantley County Planning Commission	Brantley County	Complete	*				
Develop land use development codes and/or zoning codes for county and cities	Staff Time	Brantley County Planning Commission	Brantley County	Ongoing	*				
COMMUNITY FACILITIES & SERVICES									
Upgrade fire departments in Hoboken, Nahunta, and throughout the county	$500,000	Brantley County	Brantley County	Ongoing (listed as specific projects in the County's new Work Program)	*	*	*	*	*
Renovate the Brantley County courthouse for improved accessibility and additional parking, as well as retrofit other existing public buildings to comply with the Americans with Disabilities Act	$75,000	Brantley County	Brantley County	Ongoing	*				
Expand and improve recreation facilities at the Nahunta and Schlatterville Recreation Park	$1,200,000	Brantley County	Brantley County and available grants	Ongoing	*	*	*	*	*
Improve county airport by resurfacing runway, extending runway, and improvements to hangars and building	$400,000	Brantley County / Airport Authority	Brantley County	Complete	*	*	*	*	*
Replace windows in historic courthouse	$75,000	Brantley County	Brantley County	Complete		*			
Continue to encourage resident participation in recycling and waste reduction	Staff time	Brantley County	Brantley County	Complete (moved to Policy 5.4)	*	*	*	*	*
Continue fiscally responsible operation of solid waste collection and disposal	Staff time	Brantley County	Brantley County	Complete (moved to Policy 5.5)	*	*	*	*	*
Construct add-on to the courthouse instead of a separate annex	$1,500,000	Brantley County	Brantley County and available grants	Complete	*	*	*	*	*
Continue to develop and implement enhanced 911 services, contacting with private company to perform services	$100,000	Brantley County	Brantley County and available grants	Complete	*	*	*	*	*

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	REPORT OF ACCOMPLISHMENTS	FY 12	FY 13	FY 14	FY 15	FY 16
City of Nahunta will need to expand its water system to meet the projected influx of future population	$400,000	City of Nahunta	City of Nahunta and available grants	Ongoing		*			
INTERGOVERNMENTAL COORDINATION									
None identified.									

6. Community Work Program

Brantley County 5-Year Community Work Program Update
(2017 - 2021)

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	GOAL	FY 17	FY 18	FY 19	FY 20	FY 21
CULTURAL RESOURCES									
Develop a historic preservation ordinance for protection of locally designated historic properties	Staff Time	Brantley County	Brantley County	1				X	
ECONOMIC DEVELOPMENT									
Acquire 200 – 300 acres of land for future construction of an Industrial Park	$750,000	Brantley County	Brantley County, Development Authority, Grants	2, 5	X	X			
HOUSING									
None identified									
NATURAL RESOURCES									
Conduct a Natural Resource Conservation education program for citizens, developers and local officials	$25,000	Brantley County, Satilla Riverkeeper, State Agencies	Brantley County, Grants, Volunteers	1		X	X		
Develop a plan for preserving and marketing resources for eco-tourism	Staff Time	Historical Society, Development Authority, Citizens	Brantley County, Development Authority	1, 8		X	X		
Purchase and improve land for Satilla River Recreational Facilities, including public restrooms, beach, and campsite	$1 million	Brantley County	Brantley County, grants	8			X	X	X
Enhance three existing public boat ramps along the Satilla River, with concrete repairs, picnic tables, and other improvements	$50,000	Brantley County, Satilla Riverkeeper	Brantley County, grants	8	X	X			
Construct 2 – 3 miles of bikeways and trails in and around the Satilla River area	$300,000	Brantley County, Satilla Riverkeeper	Brantley County, grants	8			X	X	X

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	GOAL	FY 17	FY 18	FY 19	FY 20	FY 21
Install signage, kiosk, and make maps available along the Satilla River Water Trail	$3,000	Satilla Riverkeeper	Satilla Riverkeeper, Grants	1, 8	X				
LAND USE									
Develop land use development codes and/or zoning codes for the County and Cities	Staff Time	Brantley County, City of Hoboken, City of Nahunta	Brantley County, City of Hoboken, City of Nahunta	1, 2, 3, 4, 5, 6, 7	X	X	X		
COMMUNITY FACILITIES & SERVICES									
Expand and improve recreation facilities at the Nahunta, Schlatterville, and Waynesville parks, including 4 ballfields, gymnasium, walking track, playground equipment, dock, public restrooms, lighting, and paved driveways	$1,200,000	Brantley County	Brantley County, grants	8	X	X	X	X	X
Construct a 1-mile walking trail at the Recreation Park	$125,000	Brantley County	Brantley County, grants	8			X	X	
Pave approximately 22 miles of dirt roads, including CR 163, CR 63, CR 90, CR 92, CR 528, and CR 42	$4.4 million	Brantley County, GDOT	Brantley County, GDOT, grants	7	X	X	X	X	X
Resurface approximately 15 miles of roads, including Caney Bay Rd., Riverside Rd., West Raybon Rd., Hwy 259, and Cumberland Rd.	$2.4 million	Brantley County, GDOT	Brantley County, GDOT, grants	7	X	X	X	X	X
Replace Humpback Bridge	$200,000	Brantley County, GDOT	Brantley County, GDOT, grants	7		X			
Purchase 5 dump trucks, 1 track hoe, 1 bulldozer, 6 motor graders, and fueling system upgrade	$2.5 million	Brantley County	Brantley County, grants	5, 7	X	X	X	X	X
Purchase 3 new ambulances, 3 stretchers, and 3 cardio units	$585,000	Brantley County	Brantley County, grants	5	X	X	X		
Construct 3 new fire stations	$1 million	Brantley County	Brantley County, grants	5		X	X	X	
Purchase 80 SCBA units for firefighters	$400,000	Brantley County	Brantley County, grants	5	X	X	X	X	X
Purchase 80 air tanks for firefighters	$88,000	Brantley County	Brantley County, grants	5	X	X	X	X	X
Purchase 80 turnout gear sets for firefighters	$160,000	Brantley County	Brantley County, grants	5	X	X	X	X	X

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	GOAL	FY 17	FY 18	FY 19	FY 20	FY 21
Purchase 50-foot fire hose	$250	Brantley County	Brantley County, grants	5	X				
Purchase 2 cascade systems	$100,000	Brantley County	Brantley County, grants	5		X	X		
Purchase 1 brush truck for fire dept.	$90,000	Brantley County	Brantley County, grants	5	X				
Purchase 1 tanker/pumper for fire dept.	$250,000	Brantley County	Brantley County, grants	5		X			
Purchase 1 rescue truck for fire dept.	$200,000	Brantley County	Brantley County, grants	5			X		
Purchase 1 air truck/compressor	$200,000	Brantley County	Brantley County, grants	5				X	
Construct firefighter training facility	$500,000	Brantley County	Brantley County, grants	5			X	X	
Purchase 20 new police cars	$750,000	Brantley County	Brantley County, grants	5	X	X	X	X	X
Renovate the Brantley County courthouse for improved accessibility and additional parking, and retrofit other existing public buildings to comply with the Americans with Disabilities Act	$75,000	Brantley County	Brantley County, grants	5			X		
Renovate existing building to house the County Commissioners, County Tax Assessor, and Tax Commissioner offices	$400,000	Brantley County	Brantley County, grants	5		X	X		
Install taxiways, fueling system, and restroom/terminal facilities at the County Airport	$700,000	Brantley County, Airport Authority	Brantley County, Airport Authority, grants	2, 7			X	X	
Construct new hangars at the County Airport	$400,000	Brantley County, Airport Authority	Brantley County, Airport Authority, grants	2, 7		X	X	X	
INTERGOVERNMENTAL COORDINATION									
None identified									

City of Hoboken 5-Year Community Work Program Update
(2017 - 2021)

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	GOAL	FY 17	FY 18	FY 19	FY 20	FY 21
CULTURAL RESOURCES									
None identified									
HOUSING									
Renovate approximately 10 homes of low-income residents	$300,000	City of Hoboken	City of Hoboken, Grants	5		X	X	X	X
COMMUNITY FACILITIES & SERVICES									
Develop the Recreation Park with facilities including picnic area, shelters, walking track, educational materials, etc.	$150,000	City of Hoboken	City of Hoboken, Grants	8		X	X		
Construct new City Hall	$250,000	City of Hoboken	City of Hoboken, Grants	5			X	X	
Pave approximately 2 miles of dirt roads	$200,000	City of Hoboken	City of Hoboken, Grants, SPLOST	7	X	X	X	X	X
Resurface approximately 2 miles of roads	$70,000	City of Hoboken	City of Hoboken, Grants, SPLOST	7	X	X	X	X	X
Construct approximately ½ mile of sidewalks along US 82	$50,000	GDOT, City of Hoboken	GDOT, City of Hoboken, Grants	7	X	X			
Repair approximately ¼ mile of sidewalks leading to the Elementary School	$25,000	City of Hoboken	City of Hoboken, Grants	7	X	X			
Extend water lines and install hydrants along Palmetto and Maple Streets	$100,000	City of Hoboken	City of Hoboken, Grants	6		X	X	X	
Purchase Christmas decorations and entry signs for the City	$30,000	City of Hoboken	City of Hoboken, Grants	1		X	X		
NATURAL RESOURCES									
None identified									
LAND USE									
None identified									
INTERGOVERNMENTAL COORDINATION									
None identified									

City of Nahunta 5-Year Community Work Program Update
(2017 - 2021)

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	GOAL	FY 17	FY 18	FY 19	FY 20	FY 21
ECONOMIC DEVELOPMENT									
Acquire and develop land for a potential factory site	$500,000	City of Nahunta	City of Nahunta, Grants	2		X			
HOUSING									
Acquire land and construct approximately 25 affordable housing units	$1.3 million	City of Nahunta	City of Nahunta, Grants	5		X	X	X	
COMMUNITY FACILITIES & SERVICES									
Expand City of Nahunta water system to meet the projected influx of future population	$400,000	City of Nahunta	City of Nahunta, Grants	6	X	X	X	X	
Replace water lines citywide	$1 million	City of Nahunta	City of Nahunta, Grants	6		X	X	X	
Loop water lines citywide	$50,000	City of Nahunta	City of Nahunta, Grants	6	X	X			
Renovate water tower	$250,000	City of Nahunta	City of Nahunta, Grants	6		X			
Extend sewer lines to the north end of the City	$200,000	City of Nahunta	City of Nahunta, Grants	6	X	X			
Expand sewer pond with more land and spray field	$1 million	City of Nahunta	City of Nahunta, Grants	6		X	X		
Purchase sewer jetter	$50,000	City of Nahunta	City of Nahunta, Grants	6	X				
Replace culvert pipes and upgrade other drainage citywide	$1 million	City of Nahunta	City of Nahunta, Grants	4, 6		X	X	X	
Purchase limb truck	$100,000	City of Nahunta	City of Nahunta, Grants	1	X				
Construct new City Hall and adapt an existing building to serve as the Community Center	$1 million	City of Nahunta	City of Nahunta, Grants	5			X	X	
Pave approximately 10 miles of dirt roads	$1 million	City of Nahunta	City of Nahunta, Grants, SPLOST	7	X	X	X	X	X
Resurface approximately 15 miles of roads	$500,000	City of Nahunta	City of Nahunta, Grants, SPLOST	7	X	X	X	X	X
Repair approximately 5 miles of sidewalks	$500,000	City of Nahunta	City of Nahunta, Grants	7	X	X	X	X	X
Construct approximately 3 miles of new sidewalks	$500,000	City of Nahunta	City of Nahunta, Grants	7	X	X	X	X	X
Construct brick sidewalks, planters, benches, and other streetscaping on Main Street	$100,000	City of Nahunta	City of Nahunta, Grants	1, 5		X	X		

PROJECTS	ESTIMATED COST	RESPONSIBLE PARTY	FUNDING SOURCE	GOAL	FY 17	FY 18	FY 19	FY 20	FY 21
Purchase land and develop facilities for a City Park	$1 million	City of Nahunta	City of Nahunta, Grants	8			X	X	
Purchase 2 police vehicles	$100,000	City of Nahunta	City of Nahunta, Grants	5	X			X	
Purchase Christmas decorations and lights for Downtown	$25,000	City of Nahunta	City of Nahunta, Grants	1	X				
Purchase banners for light poles	$25,000	City of Nahunta	City of Nahunta, Grants	1				X	X
NATURAL RESOURCES									
None identified									
LAND USE									
None identified									
INTERGOVERNMENTAL COORDINATION									
None identified									

7. Economic Development Element

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The September 2012 Comprehensive Economic Development Strategy (CEDS), as developed by the Southern Georgia Regional Commission under a grant from the US Department of Commerce Economic Development Administration, is hereby incorporated by reference into this Comprehensive Plan to serve as the Economic Development Element for Brantley County and The Cities of Hoboken and Nahunta.

The Southern Georgia Regional Commission's (SGRC) Comprehensive Economic Development Strategy (CEDS) was designed to bring together the public and private sectors in the creation of an economic roadmap to diversify and strengthen the regional economy. The SGRC CEDS analyzed the regional economy and serves as a guide for establishing regional goals and objectives, a regional plan of action, and investment priorities and funding sources.

As a performance-based plan, this CEDS plays a critical role in adapting to global economic conditions by fully utilizing the region's unique advantages to maximize economic opportunity for its residents by attracting private investment that creates jobs. The SGRC CEDS is a regionally-owned strategy that is the result of a continuing economic development planning process developed with regional public- and private-sector participation. This plan sets forth the goals and objectives necessary to solve the economic development problems of the Southern Georgia region and clearly defines the measures of success.

The Southern Georgia CEDS gives an overview of the region, briefly describing geography, population, economy, labor and workforce development and use, education, transportation access, environment, and regional resources. It reviews the state of the regional economy and provides a list of achievable Goals and Objectives for the region, a Plan of Action to ensure success, and Performance Measures used to evaluate the Southern Georgia Regional Commission's successful development and implementation of the 2013-2018 CEDS. Implementation of the goals identified in this plan is significant to the economic future of the SGRC District.

Policies, issues and opportunities, and Short-term Work Program implementation strategies located in the current Comprehensive Plans for each jurisdiction in our 18-county region were used extensively to develop the CEDS Goals and Objectives, Vital Projects, and Problems and Opportunities.

Included below are goals and objectives from the CEDS which are aligned with the current economic development goals of Brantley County and The Cities of Hoboken and Nahunta.

Goal:
Coordinate economic development initiatives with a variety of economic development entities.

> **Objective:**
> *Promote coordination among all economic development entities in the region.* (Consistent with Policy 2.6.)

Goal:
Public services and facilities adequate to accommodate existing and future growth.

> **Objective:**
> *Industrial Parks/properties with all necessary infrastructure and transportation links, to attract new and expanding businesses and industries to the region.* (Consistent with Community Work Program project: Continue to improve the entrance of the industrial park.)

Goal:
Promote the enactment of land development regulations at the local level.

> **Objective**:
> *Encourage the region's governments to adopt local development regulations.* (Consistent with Policies 5.7, 7.1, and 7.5.)

Goal:
Promote the creation and updating of local level future land use maps and plans.

> **Objective:**
> *Encourage local governments to prepare and update future land use maps and plans.* (The present Comprehensive Plan Update includes Character Area maps, which provide guidance for future land development.)

Goal:
Ensure that the region's transportation systems are intact to facilitate growth.

> **Objective:**
> *Encourage local governments to implement the Southern Georgia Regional Bicycle and Pedestrian plan.* (Consistent with Policy 5.6.)

Goal:
Promote the region's natural resources as opportunities for tourism and recreation. (Consistent with Policy 5.6.)

> **Objective:**
> *Create more opportunities for natural resource related recreation such as bike trails, access to waterways, fishing, hunting, and ecotourism, walking and hiking trails.* (Consistent with Policy 2.9.)

Goal:
Implement a regional historic and cultural resource inventory for the region.

> **Objective:**
> *Encourage local governments to inventory their historic and cultural resources for their area.* (A historic resources survey is listed as a project in the Community Work Program in the present Comprehensive Plan Update.)

8. Land Use Element

- Agriculture / Forestry – Land that is actively being used for farming, forestry, logging, etc.

- Commercial – Land used for businesses such as retail and service establishments, restaurants, offices, entertainment, etc.

- Parks / Recreation / Conservation – Land used for both active and passive recreation. Includes County parks as well as permanently protected greenspace.

- Industrial – Land used for warehousing, manufacturing, transportation, utilities, plants, factories, wholesale trade facilities, solid waste facilities, etc.

- Public / Institutional – Local, state, and federal buildings and worship facilities. Includes municipal buildings, schools, police and fire stations, and churches.

- Residential – Land or parcels used for permanent living conditions. This includes single-family houses, multi-family houses, duplex, town houses, modular homes, apartments, etc.

- Transportation / Communication / Utilities – Land used by transportation (roads, railroads), communication or utility facilities; such as airports, cell towers, sewer plants, water towers, water treatment facilities, etc.

- Undeveloped / Other – Includes all vacant and undeveloped land that does not fit the definition of the other land use classification.

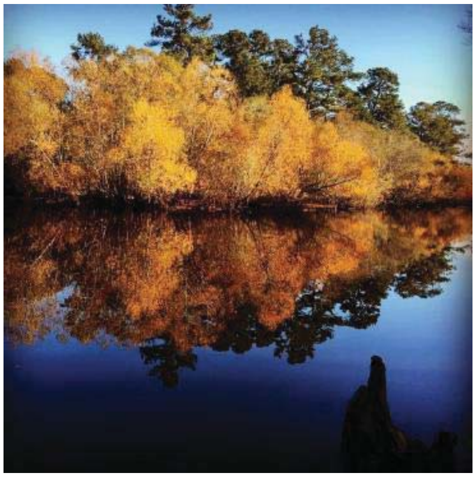
The primary land uses in the County are agriculture, parks, and residential. Collectively, these land uses account for roughly 96% of the total land area in the County. It should be noted that the agriculture category contains a number of instances where residential structures are located on the same parcel as an active agricultural use. These parcels were classified under the agriculture land use category based on the size and intensity of the agricultural use. There is also an additional 4,000-5,000 acres of land that have been platted for new residential development. These sites remain in the agriculture or undeveloped category because they are currently vacant due to downturns in the economy and development markets. The high percentage of parks / recreation / conservation is attributed to the areas immediately adjacent to the Satilla and the Little Satilla Rivers where land was classified as conservation. The table below shows the current distribution of land uses.

Land Use	Percentage
Agriculture / Forestry	67.8%
Commercial	0.1%
Parks / Recreation / Conservation	23.6%
Residential	0.4%
Transportation / Communication / Utilities	1.1%
Undeveloped / Unused	7.0%

Specific projects and programs to further the vision of Brantley County and the Cities of Hoboken and Nahunta are outlined within the 5-year Community Work Program.

CHARACTER AREAS

Satilla River Character Area



Vision

The Satilla River offers Brantley County an opportunity to encourage economic growth through the preservation of natural resources, developing eco-tourism and recreation. Brantley County lies in the Satilla Watershed with a major portion of the county consisting of wetlands (16%) and lowlands with poorly drained soils, 5 significant groundwater recharge areas, and approximately 90 miles of river corridor. The Satilla River was nominated in 1992 as a Regionally Important Resource. Brantley County contains two Wildlife Management Areas. Science, natural disasters, and increasing demand for water have shown us that these valuable resources are vital to the community's wellbeing and must be conserved, restored, and increased in future planning. At this time, Brantley County has not adopted zoning or designated land uses. Currently this area is being impacted by residential development encroaching from Glynn County. Sustainable eco-tourism, canoeing, hiking, nature trails, bird watching, hunting, fishing, swimming, and environmental education are viable economic opportunities.

Land uses: Conservation

Implementation Strategies:

Resource Management
Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

- Brantley County has identified Defining Natural Resources and has Part V Ordinances in place, but needs to limit development within the River Corridor to help protect the water quality.

Sense of Place
Protect and enhance the community's unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

- Much of Brantley County has traditionally been rural with forest cover. Preserving rural forested areas will help the county maintain its traditional character.

- Protecting the Satilla River from pollution and overdevelopment will allow Brantley County to preserve its unique traditional character.

Residents of Brantley County donating their time to help keep the Satilla River pristine for all to enjoy.

Regional Cooperation

Cooperate with neighboring jurisdictions to address shared needs. This may be achieved by actively participating in regional organizations; identifying joint projects that will result in greater efficiency and less cost to the taxpayer; or developing collaborative solutions for regional issues such as protection of shared natural resources, development of the transportation network, or creation of a tourism plan.

Agriculture and Forestry Character Area

Vision
The Agricultural and Forestry Area will emphasize the rural lifestyle and offer an economic boost through the promotion of agri-tourism. The prime use of this land category is forestry, with some farmland.

Prime agricultural and forestland are located between the convergence of the Satilla and the Little Satilla Rivers, along the southern side of the Satilla River border with Pierce County, north and southeast of Hickox, and running parallel to the Satilla River at Lulaton. Part of the Waycross State Forest is located along the east-southeast border of Ware and Brantley Counties at Schlatterville. Most of this area is surrounded by timberland, although there is some residential development along the fringe areas of the forest. Until the timber companies recently began to divest their holdings, it was almost impossible to buy land in Brantley County because the timber companies and family holdings comprised most of the landowners. Sandy, poorly drained soils are well suited for timber, but the land has suffered from ditching, monoculture, pesticides, and loss of native hardwood trees.

On one hand, the community is greatly concerned with the ways in which new owners of smaller parcels will manage and use their land. On the other hand, the current growth presents an unprecedented opportunity to utilize State Quality Growth Planning and create a Statewide and even Federal model for sustainable environment that is also economically viable. Again, with no zoning or designated land use, Brantley County runs the risk of the rural lifestyle vanishing as subdivisions encroach into farm and forestry lands.

Land uses: Agriculture, Forestry

Implementation Strategies:

Resource Management
Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

- Brantley County has a local land conservation program, and works with state and national land conservation programs to preserve environmentally important areas in the community.

Sense of Place
Protect and enhance the community's unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is

compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

- The community is connected to the surrounding region for economic livelihood through businesses that process local agricultural products.

Conservation Character Area

Vision

The Conservation Character Area is intended to identify those areas in Brantley County which exhibit unique or special environmental characteristics. These areas may be held either publicly or privately. The vision for the future of this character area is to protect natural habitats and other significant natural resources, such as pristine wetland habitat and wildlife, while utilizing the natural resources' attraction to visitors to build a sustainable economy based on eco-tourism.

Land uses: Conservation

Implementation Strategies:

Resource Management
Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

Efficient Land Use
Maximize the use of existing infrastructure and minimize the costly conversion of undeveloped land at the periphery of the community. This may be achieved by encouraging development or redevelopment of sites closer to the traditional core of the community; designing new development to minimize the amount of land consumed; carefully planning expansion of public infrastructure; or maintaining open space in agricultural, forestry, or conservation uses.

<u>Residential Character Area</u>

Vision

This character area contains the established residential areas of Brantley County and the Cities of Hoboken and Nahunta. These residential areas typically include single-family residential, with the density ranging from low to medium. The vision of the future of this character area is to preserve the rural and small-town character and lifestyle of residential areas while reinforcing the stability of neighborhoods, encouraging higher rates of homeownership, and encouraging a mix of uses that is mostly residential with some limited neighborhood amenities.

Land uses: Residential; limited neighborhood-scale commercial in select areas to serve residents

Implementation Strategies:

3. Efficient Land Use
Maximize the use of existing infrastructure and minimize the costly conversion of undeveloped land at the periphery of the community. This may be achieved by encouraging development or redevelopment of sites closer to the traditional core of the community; designing new development to minimize the amount of land consumed; carefully planning expansion of public infrastructure; or maintaining open space in agricultural, forestry, or conservation uses.

- Continuing to reinforce established residential areas will help to preserve the rural character of the community.

5. Sense of Place
Protect and enhance the community's unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development;

protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

- The County has delineated the areas that are important for history and heritage, and steps have been taken to protect those areas.

7. Housing Options

Promote an adequate range of safe, affordable, inclusive, and resource efficient housing in the community. This may be achieved by encouraging development of a variety of housing types, sizes, costs, and densities in each neighborhood; promoting programs to provide housing for residents of all socioeconomic backgrounds, including affordable mortgage finance options; instituting programs to address homelessness issues in the community; or coordinating with local economic development programs to ensure availability of adequate workforce housing in the community.

- The County has a sufficient diversity of housing stock for all income levels.

Developing Subdivisions in East Brantley County Character Area

Vision

Due to the rapid development of numerous subdivisions in East Brantley County, this area has an opportunity to contribute to the economy of the County. Local business owners and entrepreneurs have the opportunity to locate specialty locally-owned restaurants and entertainment in this area. This will encourage homeowners and residents to spend money within Brantley County instead of neighboring cities. Since Brantley County has no codes, ordinances or zoning, there are major areas of rural blight. Substandard and unfit living conditions, health problems, and safety issues—the plight of the rural poor—will need to be addressed. In 2005, Brantley County took the first step in passing an ordinance that requires any mobile home moved into the county to pass a minimum inspection. Having no development code or zoning to govern the rapid growth, Brantley County and its residents are left without protection from the steady stream of developers entering their community. Protection of natural resources and impact fees for the use of existing infrastructure are very limited. This in turn will lead to lack of funding for schools, roads, sewers, and health and safety services. Brantley County has been designated as one of Georgia's fast-growing Coastal Counties. Unless measures are taken to control development, more residences will be built wherever developers buy land rather than being planned in a rational way. The County hopes to address this problem with development codes, ordinances, and planning strategies.

Land uses: Residential

Implementation Strategies:

Sense of Place
Protect and enhance the community's unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

- The County has delineated the areas of the community that are important for history and heritage. Steps have been taken to protect those areas.

Housing Options
Promote an adequate range of safe, affordable, inclusive, and resource efficient housing in the community. This may be achieved by encouraging development of a variety of housing types, sizes, costs, and densities in each neighborhood; promoting programs to provide housing for residents of all socioeconomic backgrounds, including affordable mortgage finance options; instituting programs to address homelessness issues in the community; or coordinating with local economic development programs to ensure availability of adequate workforce housing in the community.

- Brantley County has sufficient housing for all income levels, meaning that people who work in Brantley County can afford to live there, too.

- Vacant and developable land is available for multifamily housing.

Resource Management
Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

Major Highway Corridor Character Area


Vision

US Highways 82 and 301 intersect Brantley County. Development such as local specialty shops and restaurants along these major highways will encourage travelers to contribute to the local economy. In addition, the expansion of the airport, which is located along Highway 82, will allow potential employers, visitors, and future residents to fly directly into the county.

Highway 82 runs the width of the county, as does the railroad. Buffers should be maintained on either side of the highway for wildlife, aesthetics, fly zones, safety, and erosion control. CSX Transportation operates an east-west railroad line parallel to US 82 that bisects the County and the Cities of Hoboken and Nahunta, as well as the communities of Lulaton, Atkinson, and Waynesville. CSX also operates a north-south railroad line parallel to US 301, which runs through the City of Nahunta and the Hortense and Hickox communities. Currently, there are mixed residential, commercial, and industrial uses along Highways 82 and 301.

Land uses: Commercial, Industrial, Residential

Implementation Strategies:

Sense of Place
Protect and enhance the community’s unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

- The County is working to create a land development code
- Brantley County does not have ordinances to regulate the aesthetics of development in highly visible areas.
- Brantley County does not have ordinances to regulate signage.

Transportation Options
Address the transportation needs, challenges and opportunities of all community residents. This may be achieved by fostering alternatives to transportation by automobile, including walking, cycling, and transit; employing traffic calming measures throughout the community; requiring adequate connectivity between adjoining developments; or coordinating transportation and land use decision-making within the community.

Resource Management

Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

Local Preparedness

Identify and put in place the prerequisites for the type of future the community seeks to achieve. These prerequisites might include infrastructure (roads, water, and sewer) to support or direct new growth; ordinances and regulations to manage growth as desired; leadership and staff capable of responding to opportunities and managing new challenges; or undertaking an all-hazards approach to disaster preparedness and response.

Brantley County Courthouse Character Area

Vision

This character area consists of the Brantley County Courthouse and the area directly surrounding it. The vision for the future is for this area to be used for the governmental functions of the County, while continuing to provide a convenient downtown location for residents to access governmental services.

Land uses: Public/Institutional

Implementation Strategies:

Local Preparedness
Identify and put in place the prerequisites for the type of future the community seeks to achieve. These prerequisites might include infrastructure (roads, water, and sewer) to support or direct new growth; ordinances and regulations to manage growth as desired; leadership and staff capable of responding to opportunities and managing new challenges; or undertaking an all-hazards approach to disaster preparedness and response.

- Capital Improvements Program that supports current and future growth are needed in Brantley County.

- The County will need to evaluate various financing methods of financing for new and improvements to infrastructure.

Sense of Place
Protect and enhance the community's unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

- The County and Cities must ensure that the physical appearance of new development or improvements to existing properties is compatible with the existing and/or historic character, as is the case with the courthouse.

Hoboken and Nahunta Downtown Character Area

Vision

Downtown Hoboken and Nahunta have vacant buildings, such as a convenience store in Hoboken and the Hotel Knox in Nahunta. These buildings could be converted for uses such as local specialty shops, bed and breakfasts, or office space. Such properties represent an opportunity not only for local entrepreneurs, but also for those relocating from outside the County. Both Downtown areas, being located on Highway 82, have the potential to bring in large volumes of potential customers. Currently the downtown areas consist of commercial, retail, and scattered residential. There are no zoning codes or land use development regulations to guide growth.

Land uses: Commercial, Residential

Implementation Strategies:

Sense of Place
Protect and enhance the community’s unique qualities. This may be achieved by maintaining the downtown as focal point of the community; fostering compact, walkable, mixed-use development; protecting and revitalizing historic areas of the community; encouraging new development that is compatible with the traditional features of the community; or protecting scenic and natural features that are important to defining the community's character.

Efficient Land Use
Maximize the use of existing infrastructure and minimize the costly conversion of undeveloped land at the periphery of the community. This may be achieved by encouraging development or redevelopment of sites closer to the traditional core of the community; designing new development

to minimize the amount of land consumed; carefully planning expansion of public infrastructure; or maintaining open space in agricultural, forestry, or conservation uses.

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Address the transportation needs, challenges and opportunities of all community residents. This may be achieved by fostering alternatives to transportation by automobile, including walking, cycling, and transit; employing traffic calming measures throughout the community; requiring adequate connectivity between adjoining developments; or coordinating transportation and land use decision-making within the community.

Resource Management
Promote the efficient use of natural resources and identify and protect environmentally sensitive areas of the community. This may be achieved by promoting energy efficiency and renewable energy generation; encouraging green building construction and renovation; utilizing appropriate waste management techniques; fostering water conservation and reuse; or setting environmentally sensitive areas aside as green space or conservation reserves.

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Brantley County Industrial Park Character Area

Vision

The location and availability of land in the Brantley County Industrial Park offers the community a chance to recruit diverse industry. These industries will provide jobs to local citizens and will stimulate the local economy.

The Brantley County Industrial Park has access to the CSX rail line and is fronted by US 82. The Industrial Park is 1 mile east of US 301 and less than 2 miles from the County Airport. With its close proximity to major highways, access to a railway, and location within 25 miles of Interstate 95, future development should be attractive to many industries looking for sites.

Land uses: Industrial

Implementation Strategies:

Economic Prosperity
Encourage development or expansion of businesses and industries that are suitable for the community. Factors to consider when determining suitability include job skills required; long-term sustainability; linkages to other economic activities in the region; impact on the resources of the area; or prospects for creating job opportunities that meet the needs of a diverse local workforce.

- Brantley County does not have a diverse jobs base; one major employer leaving could possibly cripple the community financially and economically.

- The Brantley Development Authority will need to create a business development strategy based on the community's strengths, assets, and weaknesses.

Educational Opportunities
Make educational and training opportunities readily available to enable all community residents to improve their job skills, adapt to technological advances, manage their finances, or pursue life ambitions. This can be achieved by expanding and improving local educational institutions or programs; providing access to other institutions in the region; instituting programs to improve local graduation rates; expanding vocational education programs; or coordinating with local economic development programs to ensure an adequately trained and skilled workforce.

- Brantley provides work-force training options and programs to provide residents with skills for jobs that are currently available in the community. Higher education opportunities area available in nearby counties.

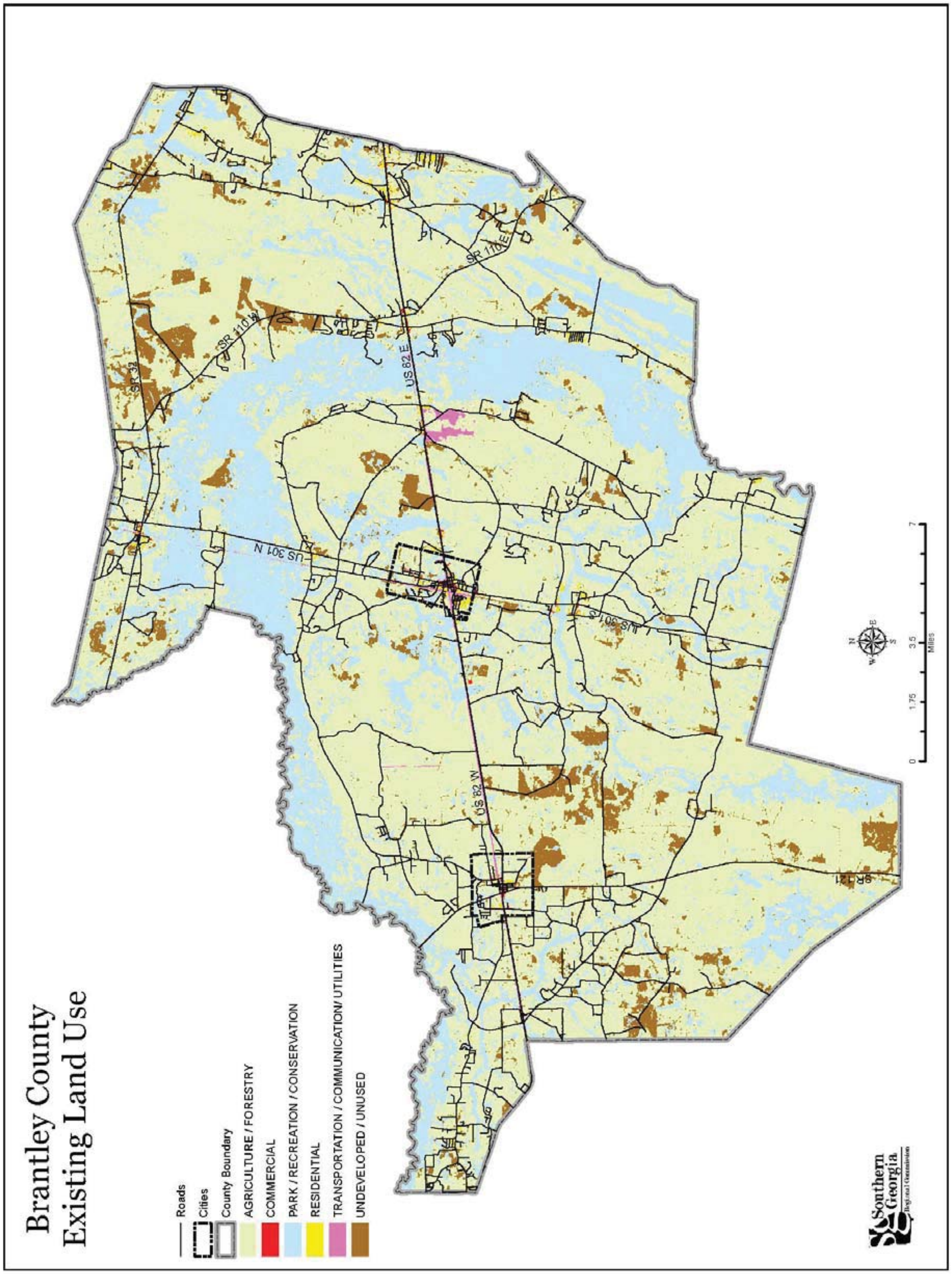
Local Preparedness

Identify and put in place the prerequisites for the type of future the community seeks to achieve. These prerequisites might include infrastructure (roads, water, and sewer) to support or direct new growth; ordinances and regulations to manage growth as desired; leadership and staff capable of responding to opportunities and managing new challenges; or undertaking an all-hazards approach to disaster preparedness and response.

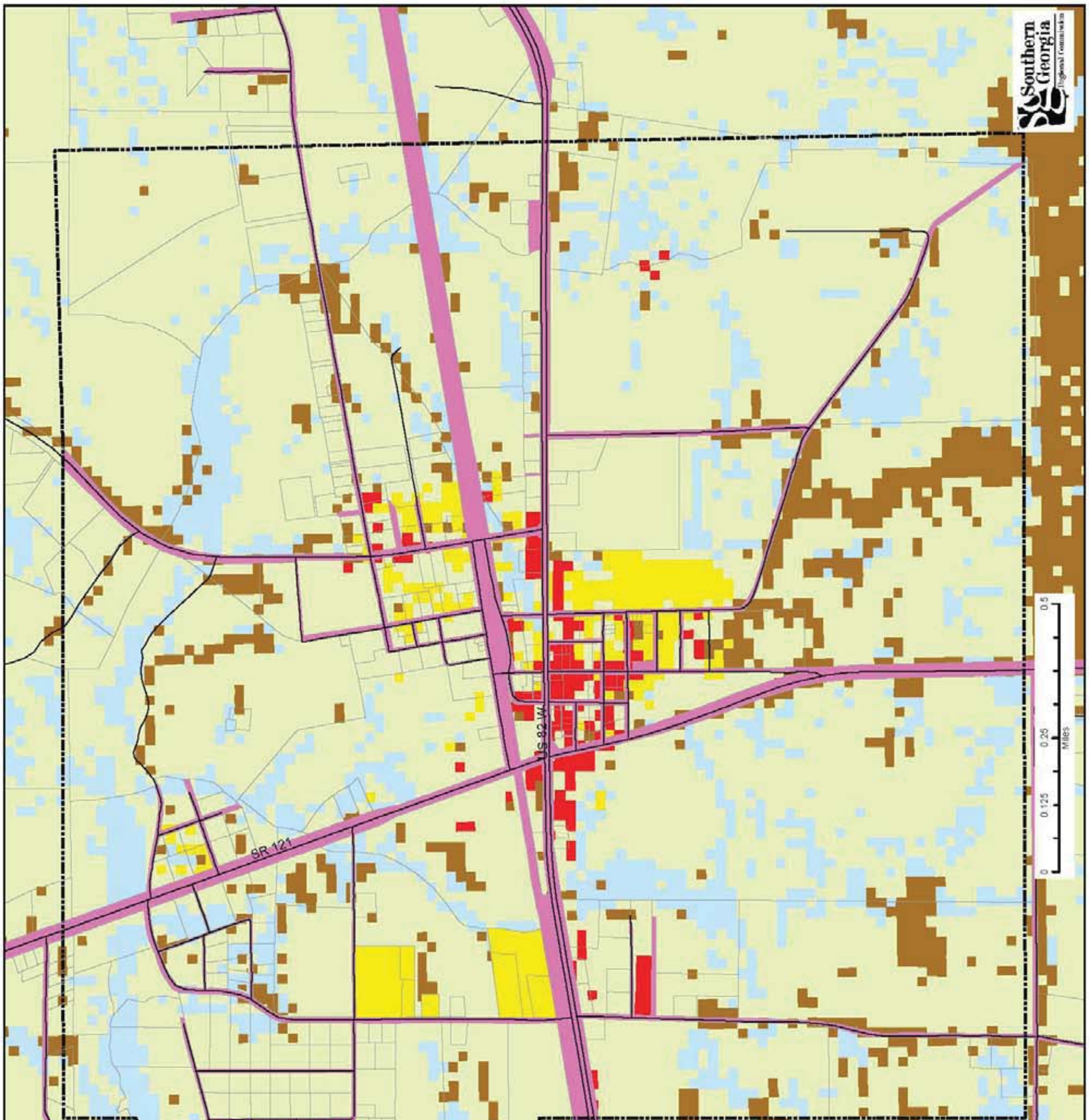
Regional Cooperation

Cooperate with neighboring jurisdictions to address shared needs. This may be achieved by actively participating in regional organizations; identifying joint projects that will result in greater efficiency and less cost to the taxpayer; or developing collaborative solutions for regional issues such as protection of shared natural resources, development of the transportation network, or creation of a tourism plan.

Existing Land Use Maps



Brantley County
Existing Land Use
Roads
Cities
County Boundary
AGRICULTURE / FORESTRY
COMMERCIAL
PARK / RECREATION / CONSERVATION
RESIDENTIAL
TRANSPORTATION / COMMUNICATION/ UTILITIES
UNDEVELOPED / UNUSED
SR 32
SR 110 W
US 82 E
SR 110 E
US 301 N
US 301 S
US 82 W
SR 121
0
1.75
3.5
7
Miles
Southern Georgia
Regional Commission



Hoboken
Existing Land Use
SR 121
US 82 W
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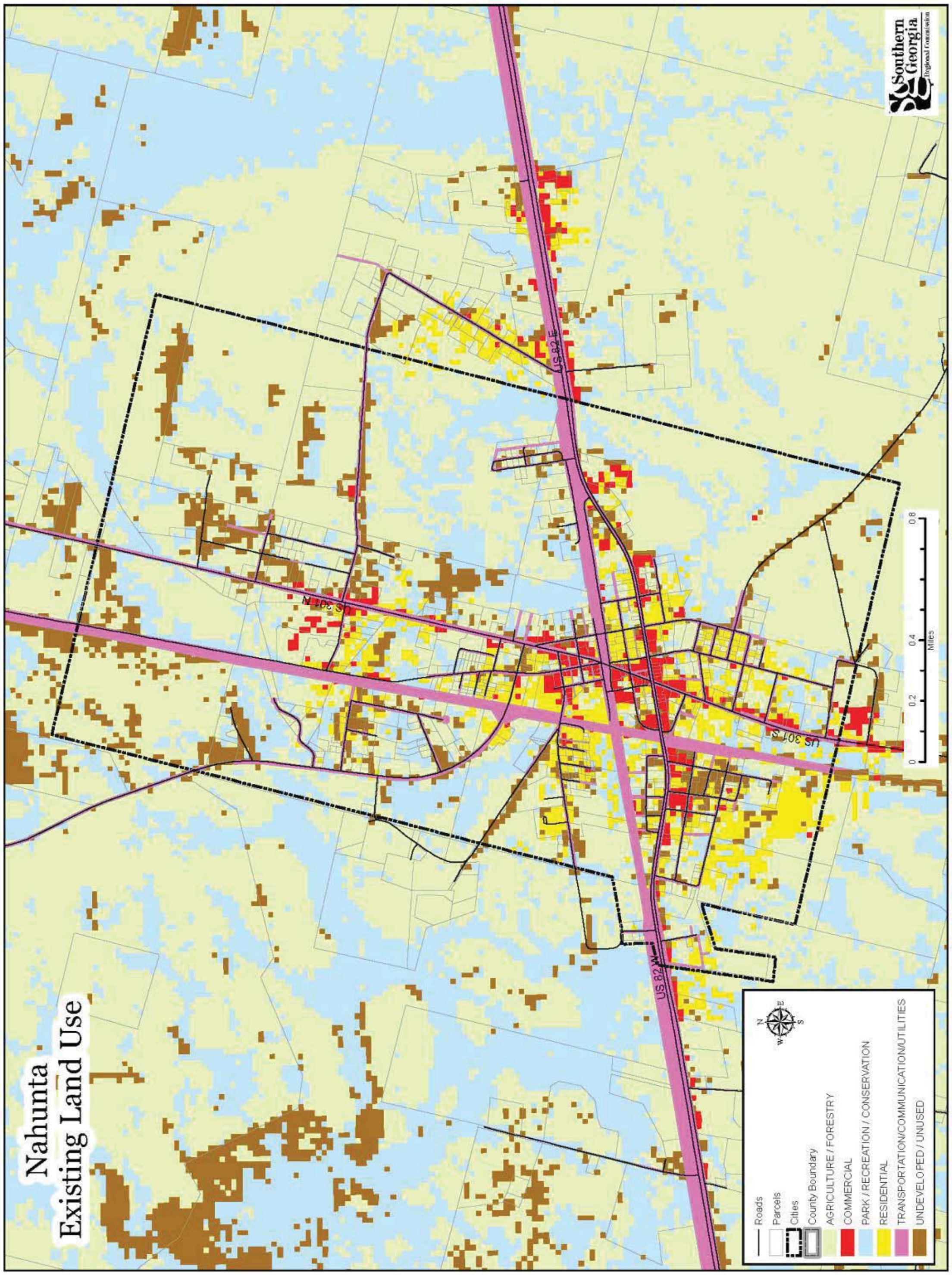
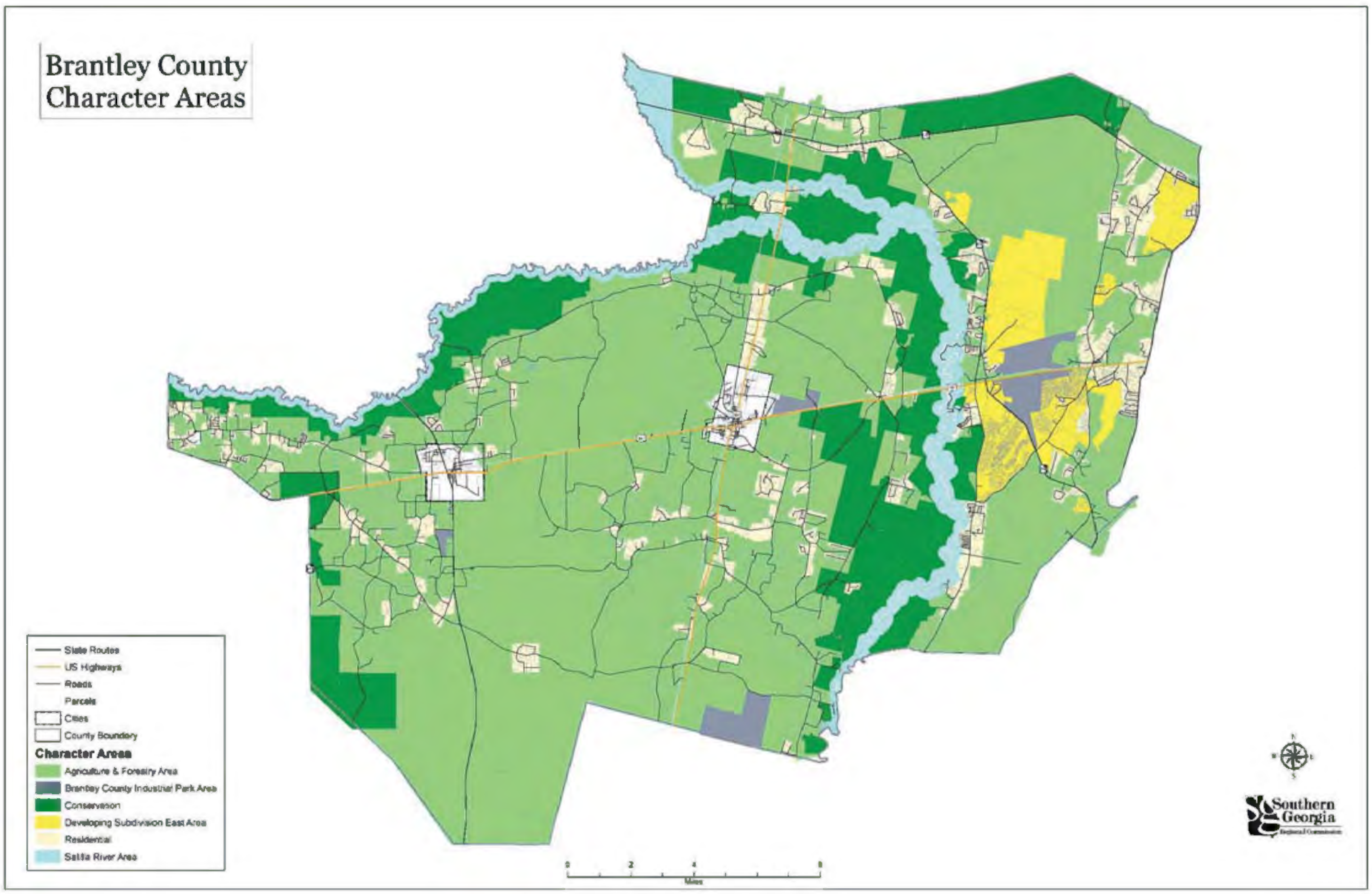
0.125
0.25
0.5
Miles
Roads
Parcels
Cities
County Boundary
AGRICULTURE / FORESTRY
COMMERCIAL
PARK / RECREATION / CONSERVATION
RESIDENTIAL
TRANSPORTATION/COMMUNICATION/UTILITIES
UNDEVELOPED / UNUSED
Southern Georgia


Nahunta
Existing Land Use
Roads
Parcels
Cities
County Boundary
AGRICULTURE / FORESTRY
COMMERCIAL
PARK / RECREATION / CONSERVATION
RESIDENTIAL
TRANSPORTATION/COMMUNICATION/UTILITIES
UNDEVELOPED / UNUSED
US 82 E
US 82 W
US 301 N
US 301 S
0
0.2
0.4
0.8
Miles
Southern Georgia

Character Area Maps


Brantley County
Character Areas
State Routes
US Highways
Roads
Parcels
Cities
County Boundary
Character Areas
Agriculture & Forestry Area
Brantley County Industrial Park Area
Conservation
Developing Subdivision East Area
Residential
Satilla River Area
0
2
4
8
Miles
Southern
Georgia


Hoboken
Character Areas
State Routes
US Highways
Roads
Parcels
Cities
Character Areas
Agriculture & Forestry Area
Brantley County Industrial Park Area
Hoboken Downtown Area
Major Highway Corridor
Residential
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0.25
0.5
Miles
Southern
Georgia
Regional Commission

Nahunta
Character Areas
State Routes
US Highways
Roads
Parcels
Cities
Character Areas
Agriculture & Forestry Area
Brantley County Courthouse Area
Major Highway Corridor
Nahunta Downtown Area
Residential
County Boundary
0
0.125
0.25
0.5
Miles
Southern
Georgia
Regional Commission

Appendix

NEWSPAPER ADS
SIGN-IN SHEETS

Kick Off – Joint Public Hearing
2016 Comprehensive Plan Update

December 1, 2015

SIGN IN

Name	Organization
Ariel Godwin	Southern GA Regional Commission
Kathleen Harris	Resident
Cathy Jacobs	Brantley Co Health Dept
[illegible]	Brantley Comm [illegible]
Rene' Henri	BOC
Jesse Mobley	Brantley BOC
James Spradley	BOC
Mike Edgy	
Carl Bowland	BoC
Dean [illegible]	Boc atty
Jimmy E Smith	
[illegible]	

Kick Off – Joint Public Hearing
2016 Comprehensive Plan Update

December 1, 2015

SIGN IN

Name	Organization
Linda Henderson	City of Hoboken
Cherry Jacobs	Brantley Co Health Dept
Rick Head	The Brantley Beacon

Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan Workshop
Date: 1/12/2016

Name	Organization	Phone	Email
Paul Bowers	BC Planning Commission	286-5969	pbb47@btconLine.net
G. David Butler	BC Planning Commission	266-4343	GDBUTLER@dbsystems.com
Mike Edgy	Commissioner	209-0283	Timberjk@btconline.net
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Carl Rowland	Brantley County	614-8917	bccm@btconline.net
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Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan Workshop
Date: 1/12/2016

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Ariel Godwin	SGRC	229 333 5277	agodwin @ sgrc.us

Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan Workshop
Date: 2/1/2016

Name	Organization	Phone	Email
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Jesse Mobley	Commission	912-217-9553	jessemobley.bc@gmail.com
Charles H. Lee	Mayor	912-458-2171	
Linda Henderson	City Clerk	912-458-2171	lhenderson1948@hotmail.com
Mary E. Freund	Mary E. Freund	912-510-9500	mary@satillariverkeeper.org

Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan Workshop
Date: 2/1/2016

Name	Organization	Phone	Email
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Henry Edwards	BC Firefighters Association	912-571-5534	henrynitae@gmail.com
Ariel Godwin	SGRC	229 333 5277	agodwin@sgrc.us

Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan and Plan Implementation Assessment Meeting
Date: 3/7/2016

Name	Organization	Phone	Email
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Betty Smiter			
Mary E. Freund	Satilla Riverkeeper	912-510-9500	mary@satillariverkeeper.org
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Michelle Lee	Brantley EMA	282 7853	brantleyema@btconline.net
G. David Butler	BCPC	266-4343	GDBUTLER@dbsystems.com
Carl Rowland	BOC	462-5256	bccm@btconline.net

Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan Workshop – City of Nahunta
Date: 4/12/2016

Name	Organization	Phone	Email
Kathleen Harris	Resident	912 276 2413	Kathleen_harris 200077@yahoo.com
Tom Wirth	City of Nahunta	912-614-7693	Citymanager @ btc online.net
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DAN Smith	Nahunta City	462 6383	
Diane Morgan	Nahunta, Ga.	462-6834	
Crystal Johns	City of Nahunta	614-1803	crystaljohns@hotmail.com
Richard Johns	city of nahunta	614-4475	
[illegible]	City of Nahunta	462-5103	
Betty Smith	Individual	912-4626322	PO Box 475 Nahunta, GA

Southern Georgia Regional Commission
Brantley County and the Cities of Hoboken and Nahunta
Comprehensive Plan Workshop – City of Nahunta
Date: 4/12/2016

Name	Organization	Phone	Email
Mike Edgy	Brantley Commissioner	269-0283	
Kelli Edgy	Educator		
Carl Rowland	BOF Commissioner	462-5256	
Angela Wirth	Resident	614-7693	angie-wirth@yahoo.com
Michelle Mitchell	Resident	462-5568	michelle.11.mitchell@gmail.com
Irene Rountree	"	462.5568	tree@btconline.net
Daniel S. Cohen		778-4312	
Bessie R. Cohen		996-6219	
Rick Head	Brantley Beacon	462-2326	beacon@btconline.NET

Kick Off – Joint Public Hearing

For Brantley County and the Cities of Hoboken and Nahunta
2016 Comprehensive Plan Update

A public meeting will be held at 5:30 p.m. on Tuesday, December. 1, 2015, at the Commissioner's Office at 33 Allen Road, Nahunta, GA, to announce the beginning of the 2016 Joint Comprehensive Plan Update for Brantley County and the Cities of Hoboken and Nahunta. The purpose of this hearing is to brief the community on the process to be used to develop the Comprehensive Plan, announce opportunities for public participation in development of the plan, and obtain input on the proposed planning process.

Persons with special needs relating to disability access or foreign language should contact the Brantley County Commission Office at 912-462-5256. Persons with hearing disabilities may consider using the Georgia Relay Service, at 1-800-255-0135.

All persons are invited to attend the public hearing. If you would like more information, please contact Ariel Godwin at the Southern Georgia Regional Commission, (229) 333-5277.

PUBLIC NOTICE

A public hearing to review and transmit the Joint 2016 Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update to the Southern Georgia Regional Commission and the Georgia Department of Community Affairs for review will be held at 6:00 p.m. on Tuesday, April 19, 2016 at the Board of Commissioners Office, 33 Allen Road, Nahunta. Residents are invited to attend and participate in the planning effort. Copies of the Plan Update are available for public review at the County Commission office and at the Cities of Hoboken and Nahunta, and for download at the SGRC website: www.sgrc.us.

Persons with special needs relating to disability access or foreign language should contact Brantley County at (912) 462-5256. Persons with hearing disabilities may consider using the Georgia Relay Service, at (Voice) 1-800-255-0135.

All persons are invited to attend the public hearing. If you would like more information, please contact Ariel Godwin, SGRC Planner, at (229) 333-5277. 30/5

throughout the session as we passed numerous bills that would improve the quality of education in our state. A bill which I sponsored, Senate Bill 355, passed through the House last week securing its transmission to the Governor's desk. Also known as the "Student Protection Act," this bill provides that students would not be required to take state mandated standardized tests if they are suffering from a serious health condition, which is documented by a physician or licensed therapist. Additionally, the State School Superintendent shall develop alternative policies for students who don't participate in standardized tests that local school boards can adopt. The State Board of Education and local school districts may also provide requires student growth to count for 40 percent of the evaluations. Senate Bill 275, which also passed, ensures that governmental entities, including boards of education, cannot adopt ethics policies that interfere with a board member's freedom of speech. Two other education measures that I worked on, Senate Bill 357 and Senate Bill 310, instead of passing as stand-alone legislation, were added, in part, to other bills which did pass. SB 357, similar to SB 275, addresses board of education policies, and SB 310 requires more transparency from the state in how education grants will affect long-term education policies and finances. All of these changes will benefit Georgia's board of education members, principals, teachers, and students

to receive a vote in the Senate. The widely publicized bills that would legalize casino gambling and allow the in-state cultivation of medical marijuana failed to gain enough traction this session and were therefore defeated. I am pleased that we were able to beat back both of these ill-advised efforts, but we will have to be ready again next year to again play defense in the Senate. Sometimes, success means just stopping bad legislation from becoming law. After three years of effort and finally making a breakthrough with the House of Representatives this year on addressing religious liberty protections, it was a sad moment to see Governor Nathan Deal decide to veto House Bill 757, the Free

Continued On Page18

Brantley County Express MARCH 30, 2016

PUBLIC NOTICE

A public hearing to review and transmit the Joint 2016 Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update to the Southern Georgia Regional Commission and the Georgia Department of Community Affairs for review will be held at 6:00 p.m. on Tuesday, April 19, 2016 at the Board of Commissioners Office, 33 Allen Road, Nahunta. Residents are invited to attend and participate in the planning effort. Copies of the Plan Update are available for public review at the County Commission office and at the Cities of Hoboken and Nahunta, and for download at the SGRC website: www.sgrc.us.

Persons with special needs relating to disability access or foreign language should contact Brantley County at (912) 462-5256. Persons with hearing disabilities may consider using the Georgia Relay Service, at (Voice) 1-800-255-0135.

All persons are invited to attend the public hearing. If you would like more information, please contact Ariel Godwin, SGRC Planner, at (229) 333-5277. 30/5

BRANTLEY COUNTY

RESOLUTION TO ADOPT
2016 JOINT BRANTLEY COUNTY
AND CITIES OF HOBOKEN AND NAHUNTA
COMPREHENSIVE PLAN UPDATE

WHEREAS, Brantley County has completed the 2016 Joint Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update;

WHEREAS, this document was prepared according to the Standards and Procedures for Local Comprehensive Planning as established by the Georgia Planning Act of 1989;

BE IT THEREFORE RESOLVED, that Brantley County does hereby adopt the 2016 Joint Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update.

Adopted this 9th day of June, 2016.

ATTEST:

René T. Herrin

René T. Herrin, County Clerk

Brian Hendrix, Vice-Chairman
Brantley County Commission

CITY OF HOBOKEN

**RESOLUTION TO ADOPT
2016 JOINT BRANTLEY COUNTY
AND CITIES OF HOBOKEN AND NAHUNTA
COMPREHENSIVE PLAN UPDATE**

WHEREAS, the City of Hoboken has completed the 2016 Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update;

WHEREAS, this document was prepared according to the Standards and Procedures for Local Comprehensive Planning as established by the Georgia Planning Act of 1989;

BE IT THEREFORE RESOLVED, that the City of Hoboken does hereby adopt the 2016 Joint Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update.

Adopted this 7th day of June, 2016.

Charles H. Lee
Charles H. Lee, Mayor
City of Hoboken

Linda Henderson
ATTEST: Linda Henderson, City Clerk

CITY OF NAHUNTA

RESOLUTION TO ADOPT
2016 JOINT BRANTLEY COUNTY
AND CITIES OF HOBOKEN AND NAHUNTA
COMPREHENSIVE PLAN UPDATE

WHEREAS, the City of Nahunta has completed the 2016 Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update;

WHEREAS, this document was prepared according to the Standards and Procedures for Local Comprehensive Planning as established by the Georgia Planning Act of 1989;

BE IT THEREFORE RESOLVED, that the City of Nahunta does hereby adopt the 2016 Joint Brantley County and Cities of Hoboken and Nahunta Comprehensive Plan Update.

Adopted this 6th day of June, 2016.

Ronnie Jacobs
Ronnie Jacobs, Mayor
City of Nahunta

Suzanne Manning
ATTEST: [NAME], City Clerk

BRANTLEY COUNTY BOARD OF COMMISSIONERS

Post Office Box 398
33 Allen Road
Nahunta, Georgia 31553
(912) 462-5256
FAX (912) 462-5538
Email: bcbc@btconline.net

Charles D. Summerlin, Jr., Chairman
Mike Edgy, Commissioner
James A. Spradley, Commissioner
Brian Hendrix, Commissioner
Jesse Mobley, Commissioner

Carl L. Rowland, County Manager
Dale J. Halligan, County Clerk
René T. Herrin, Accounting Coordinator
Bobbie Trosper, Administrative Clerk

4/19/2016

To: Southern Georgia Regional Commission
327 West Savannah Avenue
Valdosta, Georgia 31601

RE: Comprehensive Plan Update Submittal

Brantley County has completed an update of its Comprehensive Plan and is submitting it with this letter for review by the Southern Georgia Regional Commission and the Department of Community Affairs.

I certify that we have held the required public hearings and have involved the public in development of the plan in a manner appropriate to our community's dynamics and resources. Evidence of this has been included with our submittal.

I certify that appropriate staff and decision-makers have reviewed both the Regional Water Plan(s) covering our area and the Rules for Environmental Planning Criteria (O.C.G.A. 12-2-8) and taken them into consideration in formulating our plan.

If you have any questions concerning our submittal, please contact Carl Rowland, County Manager, at (912) 462-5256 or bccm@btconline.net

Sincerely,

Brian Hendrix, Vice Chairman
Brantley County Board of Commissioners

"A Progressive County Government for Progressive People"

CITY OF HOBOKEN

P.O. Box 345
Hoboken, Georgia 31542
(912) 458-2171 • Fax: (912) 458-3552

CHARLES H. LEE
Mayor

LINDA HENDERSON
Clerk

5/3/2016

To: Southern Georgia Regional Commission
327 West Savannah Avenue
Valdosta, Georgia 31601

RE: Comprehensive Plan Update Submittal

The City of Hoboken has completed an update of its comprehensive plan and is submitting it with this letter for review by the Southern Georgia Regional Commission and the Department of Community Affairs.

I certify that we have held the required public hearings and have involved the public in development of the plan in a manner appropriate to our community's dynamics and resources. Evidence of this has been included with our submittal.

I certify that appropriate staff and decision-makers have reviewed both the Regional Water Plan(s) covering our area and the Rules for Environmental Planning Criteria (O.C.G.A. 12-2-8) and taken them into consideration in formulating our plan.

If you have any questions concerning our submittal, please contact Linda Henderson, City Clerk, at (912) 458-2171 or lhenderson1948@hotmail.com.

Sincerely,

Charles H. Lee

Charles H. Lee, Mayor
City of Hoboken

CITY OF NAHUNTA
INCORPORATED
1925
BRANTLEY COUNTY, GEORGIA

City of Nahunta

Post Office Box 156 • Nahunta, Georgia 31553 • Phone: 912-462-5631

5/2/2016

To: Southern Georgia Regional Commission
327 West Savannah Avenue
Valdosta, Georgia 31601

RE: Comprehensive Plan Update Submittal

The City of Nahunta has completed an update of its comprehensive plan and is submitting it with this letter for review by the Southern Georgia Regional Commission and the Department of Community Affairs.

I certify that we have held the required public hearings and have involved the public in development of the plan in a manner appropriate to our community's dynamics and resources. Evidence of this has been included with our submittal.

I certify that appropriate staff and decision-makers have reviewed both the Regional Water Plan(s) covering our area and the Rules for Environmental Planning Criteria (O.C.G.A. 12-2-8) and taken them into consideration in formulating our plan.

If you have any questions concerning our submittal, please contact Thomas Wirth, City Manager, at (912) 462-5631 or citymanager@btconline.net.

Sincerely,

Ronnie Jacobs

Ronnie Jacobs, Mayor
City of Nahunta

APPENDIX N

LOCATION LEON FL+AL GA MD MS NC SC VA

Established Series
Rev. AGH, GWH, DL, JNS; GRB
03/2014

LEON SERIES

The Leon series consists of very deep, very poorly and poorly drained, moderately rapid to moderately slowly permeable soils on upland flats, depressions, stream terraces and tidal areas. They formed in sandy marine sediments of the Eastern Gulf Coast Flatwoods (MLRA 152A), the Atlantic Coast Flatwoods (MLRA 153A) and to a lesser extent in the Southern Coastal Plain (MLRA 133A) and the North-Central Florida Ridge (MLRA 138). Near the type location, the mean annual temperature is about 68 degrees F., and the mean annual precipitation is about 65 inches. Slopes range from 0 to 5 percent.

TAXONOMIC CLASS: Sandy, siliceous, thermic Aeric Alaquods

TYPICAL PEDON: Leon sand, in a forested area (Colors are for moist soil).

A--0 to 4 inches; 70 percent black (10YR 2/1) and 30 percent light gray (10YR 7/1) sand; weak fine granular structure; very friable; many fine, medium, and large roots; many clean sand grains give a salt-and-pepper appearance; very strongly acid; clear smooth boundary. (2 to 9 inches thick)

Eg1--4 to 10 inches; gray (10YR 6/1) sand; common medium faint very dark gray (10YR 3/1) streaks and splotches of organic matter accumulations deposited in former root channels and krotovinas, ranging from about 20 percent in upper part to 0 percent in lower part; single grain; loose; many fine, medium, and large roots; very strongly acid; clear wavy boundary.

Eg2--10 to 15 inches; gray (10YR 6/1) sand; 20 percent faint light gray (10YR 7/1) oval splotches of organic matter depletions; single grain; loose; few fine and medium roots; very strongly acid; abrupt smooth boundary. (Combined thickness of the Eg horizons range from 2 to 22 inches)

Bh1--15 to 18 inches; 50 percent dark brown (7.5YR 3/3) and 50 percent black (7.5YR 2.5/1) sand; weak medium and coarse subangular blocky structure; firm; common fine and medium roots; many fine and medium pores; more than 95 percent of sand grains have organic coatings; extremely acid; clear smooth boundary.

Bh2--18 to 22 inches; dark brown (7.5YR 3/4) sand; weak medium and coarse subangular blocky structure; firm; few fine and medium roots; common fine and medium pores; more than 95 percent of sand grains have organic coatings; extremely acid; clear wavy boundary. (Combined thickness of the Bh horizons ranges from 4 to 50 inches)

Bw and Bh--22 to 25 inches; 80 percent (Bw) dark yellowish brown (10YR 4/4) and 20 percent (Bh) dark brown (10YR 3/3) sand; very weak medium and coarse subangular blocky structure; very friable; common fine and medium pores; very strongly acid; clear wavy boundary. (0 to 15 inches thick)

Eg and Bh--25 to 30 inches; 95 percent (Eg) weak red (2.5YR 5/2) and 5 percent (Bh) dark brown (7.5YR 3/3) sand; single grain; loose; common fine and medium pores; very strongly acid; diffuse irregular boundary. (0 to 10 inches thick)

E'g--30 to 42 inches; pinkish gray (7.5YR 7/2) sand; single grain; loose; very strongly acid; clear wavy boundary. (0 to 36 inches thick)

B'h--42 to 77 inches; 50 percent very dark brown (10YR 2/2) and 50 percent dark yellowish brown (10YR 3/4) sand; weak medium and coarse subangular blocky structure; friable; common fine and medium pores; very strongly acid; clear wavy boundary. (0 to 50 inches thick)

B'w and B'h--77 to 108 inches; 60 percent (Bw) brown (10YR 4/3), 40 percent Bh of very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) sand; very weak medium and coarse subangular blocky structure; very friable; common fine and medium pores; very strongly acid.

TYPE LOCATION: Bay County, Florida. USGS Panama City Beach topographic quadrangle. Approximately 1.2 miles north of U.S. Highway 98, about 2.7 miles south of West Bay in Panama City Beach, Florida. SW 1/4, Sec. 20; T. 3 S., R. 15 W. 30 degrees 12.0 minutes 19.9 seconds N.; 85 degrees 46.0 minutes 20.4 seconds W.

RANGE IN CHARACTERISTICS: The Bh horizon is within 30 inches of the soil surface. Reaction ranges from extremely acid to slightly acid throughout. In tidal areas, the soil reaction ranges from very strongly acid to moderately alkaline throughout.

The A or Ap horizon has hue of 7.5YR or 10YR, value of 2 to 4, and chroma of 1 or 2; or is neutral with value of 2 to 4. When dry, this horizon has a salt-and-pepper appearance due to mixing of organic matter and sand grains. A thin O horizon of muck is present in some pedons. Texture is sand, fine sand, mucky fine sand, or mucky sand.

The E horizon, where present, has hue of 7.5YR to 2.5Y, value of 4 to 8, and chroma of 3 to 4; or is neutral with value of 5 to 8. Streaks and splotches of organically enriched material in shades of black to gray range from common to many. Texture is sand or fine sand.

The Eg or E'g horizons, where present, have hue of 7.5YR to 2.5Y, value of 4 to 8, and chroma of 1 to 3. Redoximorphic features of oval faint splotches (depletions) range from none to many. Streaks and masses of organic matter accumulation (Bh material) in shades of black to brown range from none to common. Texture is sand or fine sand.

A transitional horizon may be present between the lower E horizon and the Bh1 horizon. Where present, it has hue of 10YR or 2.5Y, value of 2 to 5, and chroma of 1 to 4. Thickness ranges from 0.5 to 7.0 inches. Texture is sand or fine sand.

The Bh horizon has hue of 5YR to 10YR, value of 2 to 6, and chroma of 1 to 4; or is neutral with value of 2 to 4. This horizon burns white on ignition. Texture is sand, fine sand, loamy sand or loamy fine sand.

The Bw horizon, where present, has hue of 5YR to 10YR, value of 2 to 6, and chroma of 1 to 4; or is neutral with value of 1 to 5. Streaks and masses of organic matter accumulation (Bh material) in shades of black to brown range from none to common. Texture is sand or fine sand.

B'h, B"h. B'"h horizons, where present, have similar colors and textures as the Bh horizon but occurs below the BE, E', E" and E'" horizons.

The C horizon, where present, has hue of 7.5YR to 2.5Y, value of 4 to 8, and chroma of 1 to 6. Texture is sand or fine sand.

COMPETING SERIES: The [Talquin] and [Witherbee] series are the only known series in the same family. They are on similar to slightly higher positions. In addition, Talquin soils have a spodic horizon less than 6 inches in thickness and the somewhat poorly drained Witherbee soils have less than 0.06 organic carbon in the upper 12 inches of the spodic horizon.

GEOGRAPHIC SETTING: Leon soils are on upland flats, depressions, stream terraces and tidal marshes of the lower Atlantic and Gulf Coastal Plain. They formed in thick beds of acid sandy marine sediments. The climate is humid subtropical. Slopes range from 0 to 5 percent. The average annual temperature ranges from 66 to 70 degrees F., and the average annual precipitation ranges from 61 to 69 inches at the sample location.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Allanton, Chaires, Chipley, Croatan, Dorovan, Foxworth, Hurricane, Kershaw, Kureb, Lakeland, Lynn Haven, Mandarin, Mascotte, Olustee, Ortega, Osier, Pactolus, Pamlico, Pantego, Pickney, Plummer, Portsmouth, Pottsburg, Resota, Ridgeland, Ridgewood, Rutlege, Sapelo, Scranton, Surrency and Wesconnett series. Allanton, Hurricane and Pottsburg soils have a spodic horizon at depths greater than 50 inches. In addition, Allanton soils are on lower positions and have umbric epipedons, Hurricane soils are somewhat poorly drained and on higher positions and Pottsburg soils are somewhat poorly to poorly drained and on similar to slightly higher positions. Chaires, Mascotte, Olustee and Sapelo soils are on similar positions but are underlain by argillic horizons under the Bh horizon. Chipley, Foxworth, Kershaw, Lakeland, Ortega and Ridgewood soils are on higher positions and lack spodic horizons. In addition, Chipley and Ridgewood soils are somewhat poorly drained, Foxworth soils are moderately well drained to excessively drained, Kershaw, Kureb and Lakeland soils are excessively drained and Ortega soils are moderately well drained. The very poorly drained Croatan, Dorovan and Pamlico soils are on lower positions and are organic. Lynn Haven soils are on similar positions but have an umbric epipedon. The somewhat poorly drained Mandarin soils are on higher positions. Osier soils are on flood plains and lack spodic horizons. The somewhat poorly to moderately well drained Pactolus soils are on higher positions and lack spodic horizons. The very poorly drained Pantego, Pickney, Portsmouth, Rutlege and Surrency soils are on lower positions and lack spodic horizons. In addition, Pantego, Pickney, Rutlege and Surrency soils have umbric epipedons. Plummer soils are on similar to lower positions and are grossarenic. Ridgeland and Wesconnett soils and lack E horizons between the A and Bh horizons. In addition, Ridgeland soils are on slightly higher positions and are somewhat poorly drained while Wesconnett soils are in lower depressional areas and are very poorly drained. The moderately well drained Resota soils are in higher positions and have weakly expressed spodic horizons. The poorly drained Scranton soils are on similar to slighter higher positions and lack spodic horizons.

DRAINAGE AND PERMEABILITY: Poorly drained and very poorly drained; moderate to moderately rapid permeability in the A and E horizons, moderate to moderately slow permeability in the Bh horizons, and rapidly permeable in the other layers.

USE AND VEGETATION: Most areas of Leon soils are used for forestry, rangeland and pasture. Areas with adequate water control are used for cropland and vegetables. The natural vegetation consists of longleaf pine, slash pine, water oak, myrtle, with a thick undergrowth of sawpalmetto, running oak, fetterbush and other lyionia, inkberry (gallberry), wax myrtle, goldenrod, ligustrina, dog fennel, chalky bluestem, lowbush blueberry, creeping bluestem and pineland threeawn (wiregrass). In depressions, the vegetation is dominated by brackenfern, smooth sumac and swamp cyrilla are common. Vegetation in the tidal marshes includes bushy seaoxeye, marshhay cordgrass, seashore saltgrass, batis, and smooth cordgrass.

DISTRIBUTION AND EXTENT: The Atlantic and Gulf Coastal Plain from Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia and Maryland. The series is of large extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Auburn, Alabama.

SERIES ESTABLISHED: Leon County, Florida; 1905.

REMARKS: Diagnostic horizons and features recognized in this pedon:

Ochric epipedon - the zone from 0 to 15 inches (A, E and Eg horizons).

Albic horizons - the zones from 4 to 15 inches (E and Eg horizons) and from 30 to 42 inches (E'g horizon).

Spodic horizon within 30 inches - the zones from 15 to 22 inches (Bh1 and Bh2 horizons) and from 42 inches to 77 inches (B'h horizon).

Aquic conditions - endosaturation throughout.

The water table is at depths of 6 to 18 inches for 1 to 4 months during most years. In low flats or sloughs it is at a depth of 0 to 6 for periods of more than 3 weeks during most years. It is between depths of 18 and 36 inches for 2 to 10 months during most years. It is below 60 inches during the dry periods of most years. Depressional areas are covered with standing water for periods of 6 months or more in most years.

Leon soils are in MLRAs 133A, 138, 152A and 153A.

ADDITIONAL DATA: IFAS Soil Characterization Data: S2-1-(1-9), S2-2-(1-8), S3-3-(1-5), S4-8-(1-9), S10-12-(1-7) S12-17-(1-7), S16-9-(1-7), S19-6-(1-5), S33-24-(1-7), S37-28-(1-8), S45-27-(1-7), S46-2-(1-6), S57-46-(1-6), S66-24-(1-8); samples by IFAS, University of Florida, Gainesville, FL.

NSSL Soil Characterization Data: S08FL-005-1 (1-10); sample by NSSL, Lincoln, NE.

Soil Name Slope Airtemp FrFr/Seas Precip Elevation
LEON 0-5% 65-70F 230-310 60-69 in 8-135 ft

FloodL FloodH Water table Kind Months Bedrock
Fl0051 NONE 0.5-1.5 APPARENT MAR-SEP 60-60
FL0093 NONE 0 - 0.5 APPARENT FEB-SEP 60-60
FL0406 RARE COMMON 0 - 1.0 APPARENT MAR-SEP 60-60
FL0501 NONE - APPARENT - 60-60
FL0508 FREQ 0 - 0.5 APPARENT JAN-DEC 60-60

Depth Texture 3-Inch No-10 Clay% -CEC-
FL0051 0- 3 S FS 0- 0 100-100 1- 5 2 - 12
FL0051 3-15 S FS 0- 0 100-100 0- 3 .3- 1
FL0051 15-30 S FS LS 0- 0 100-100 2- 8 8 - 30
FL0051 30-66 S FS 0- 0 100-100 1- 4 .5- 3
FL0051 66-80 0- 0 100-100 2- 8 8 - 30

FL0093 0- 4 MK-S MK-FS 0- 0 100-100 1- 6 12 - 30
FL0093 0- 4 S FS 0- 0 100-100 1- 5 2 - 12
FL0093 4-16 S FS 0- 0 100-100 0- 3 .3- 1
FL0093 16-25 S FS LS 0- 0 100-100 2- 8 8 - 30
FL0093 25-80 S FS 0- 0 100-100 1- 4 .5- 3

FL0406 0- 3 FS S 0- 0 100-100 1- 5 2 - 12
FL0406 0- 3 MK-FS MK-S 0- 0 100-100 1- 6 12 - 30
FL0406 3-15 FS S 0- 0 100-100 0- 3 .3-1
FL0406 15-23 FS S LS 0- 0 100-100 2- 8 8 - 30
FL0406 23-80 FS S 0- 0 100-100 1- 4 .5-3
Depth Texture 3-Inch No-10 Clay% CEC

FL0501 0- 3 MUCK 0- 0 90-200 --- ---
FL0501 3-17 S FS 0- 0 100-100 0- 3 .3- 2
FL0501 17-80 S FS LFS 0- 0 100-100 2- 8 8.0- 30

FL0508 0-26 S FS 0- 0 100-100 1- 3 1.0- 12
FL0508 26-40 S FS 0- 0 100-100 2- 8 12 - 30

FL0508 40-80 S FS 0- 0 100-100 2-10 .5- 3

SOI-5 Depth pH O.M. Salin Permeab Shnk-Swll
FL0051 0- 3 3.6- 6.5 0.5-4.0 0- 2 6.0-20 LOW
FL0051 3-15 3.6- 6.5 0.0-0.5 0- 2 6.0-20 LOW
FL0051 15-30 3.6- 6.5 2.0-4.0 0- 2 0.6- 6.0 LOW
FL0051 30-66 3.6- 6.5 0.0-0.5 0- 2 2.0-20 LOW
FL0051 66-80 3.6- 6.5 1.0-3.0 0- 2 0.2- 2.0 LOW

FL0093 0- 4 3.6- 6.5 10-20 0- 2 6.0- 20 LOW
FL0093 0- 4 3.6- 6.5 2.-5. 0- 2 6.0- 20 LOW
FL0093 4-16 3.6- 6.5 0.- .5 0- 2 6.0- 20 LOW
FL0093 16-25 3.6- 6.5 1.-4. 0- 2 0.6- 6.0 LOW
FL0093 25-80 3.6- 6.5 0.- .5 0- 2 2.0- 20 LOW

FL0406 0- 3 3.6- 5.5 0.5-4. 0- 2 6.0- 20 LOW
FL0406 0- 3 3.6- 5.5 10-20 0- 2 6.0- 20 LOW
FL0406 3-15 3.6- 5.5 0.- .5 0- 2 6.0- 20 LOW
FL0406 15-23 3.6- 5.5 1.-4. 0- 2 0.6- 6.0 LOW
FL0406 23-80 3.6- 5.5 0.- .5 0- 2 0.6- 20 LOW

FL0501 0- 3 3.6- 5.5 20-80 0- 2 6.0- 20 LOW
FL0501 3-17 3.6- 5.5 0.-.5 0- 2 6.0- 20 LOW
FL0501 17-80 3.6- 5.5 1.-4. 0- 2 0.6- 6.0 LOW

FL0508 0-26 4.5- 8.4 1.-3. 8-16 2.0- 6.0 LOW
FL0508 26-40 4.5- 8.4 1.-4. 8-16 0.6- 6.0 LOW
FL0508 40-80 4.5- 8.4 0.-.5 2- 8 0.6- 6.0 LOW

National Cooperative Soil Survey
U.S.A.

LOCATION POTTSBURG FL+NC

Established Series
Rev. AGH
05/2003

POTTSBURG SERIES

MLRA(s): 153A, 153B
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina
Depth Class: very deep
Drainage Class (Agricultural): somewhat poorly and poorly drained
Internal Free Water Occurrence: very shallow to shallow, persistent
Index Surface Runoff: negligible to very low
Permeability: moderate
Landscape: lower coastal plain
Landform: flats
Geomorphic Component: talfs
Parent Material: marine sediments
Slope: 0 to 2 percent
Elevation (type location):
Mean Annual Air Temperature (type location): 65 degrees F.
Mean Annual Precipitation (type location): 45 inches

TAXONOMIC CLASS: Sandy, siliceous, thermic Grossarenic Alaquods

TYPICAL PEDON: Pottsburg fine sand on a 0.5 percent slope in range. (Colors are for moist soil.)

A--0 to 3 inches; gray (10YR 5/1) fine sand; weak fine granular structure; very friable; very strongly acid; gradual smooth boundary. (3 to 8 inches thick)

E1--3 to 10 inches; brown (10YR 5/3) fine sand; common fine faint light gray (10YR 7/2) bodies; weak fine granular structure; very friable; moderately acid; gradual wavy boundary.

E2--10 to 34 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; common coarse faint pale brown (10YR 6/3) iron depletions and few fine faint yellowish brown (10YR 5/4) soft masses of iron accumulation; moderately acid; gradual smooth boundary.

E3--34 to 57 inches; light gray (10YR 7/1) fine sand; few medium faint very pale brown (10YR 8/2) bodies; single grained; loose; slightly acid; gradual smooth boundary. (Combined thickness of E horizon is 47 to 70 inches)

Bh--57 to 80 inches; dark reddish brown (5YR 2/2) fine sand; common fine faint black (5YR 2.5/1) bodies; weak fine subangular blocky structure; very friable; weakly cemented in parts; sand grains well coated with organic matter; strongly acid.

TYPE LOCATION: Duval County, Florida; about 0.2 mile east of U. S. 1, 0.3 mile south of Greenland Road in NW1/4SE1/4SW1/4, Sec. 7, T. 4 S., R. 28 E.

RANGE IN CHARACTERISTICS:
Depth to Bedrock: Greater than 60 inches
Depth to Seasonal High Water Table: 0 to 24 inches, February to September or December to May. On typical

flatwoods sites the water table is a depth of 6 to 12 inches for 1 to 4 months and at a depth of 12 to 40 inches for 4 months or longer during most years. On higher flatwoods sites, the water table is at 12 to 24 inches for 1 to 4 months and at a depth of 24 to 40 inches for 3 months or longer during most years.
Soil Reaction: extremely acid to slightly acid in the A horizon and E horizon and from extremely acid to moderately acid in the Bh horizon

RANGE OF INDIVIDUAL HORIZONS:

A horizon:
Color--hue of 10YR, value of 2 to 5, and chroma of 1 or 2; or it is neutral (N) with value of 2 to 5
Texture (fine-earth fraction)-- sand or fine sand

E horizon (upper part):
Color--hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 to 3
Texture (fine-earth fraction)-- sand or fine sand

E horizon (lower part):
Color--hue of 7.5YR, 10YR or 2.5Y, value of 4 to 8, and chroma of 1 to 2
Texture (fine-earth fraction)-- sand or fine sand
Redoximorphic features (if they occur)-none to common iron masses in shade of red, yellow, or brown and iron depletions in shades of brown, yellow, olive, or gray

EB, BE, E/B horizon (if it occurs):
Color--hue of 5YR, 7.5YR, 10YR or 2.5Y, value of 2 to 8, and chroma of 1 to 4 or is neutral (N) with value of 2
Texture (fine-earth fraction)-- sand, fine sand, loamy sand, or loamy fine sand
Redoximorphic features (if they occur)-none to common iron masses in shade of red, yellow, or brown and iron depletions in shades of brown, yellow, olive, or gray
Other features-- Discontinuous lenses or spodic bodies, thinly to moderately coated with colloidal organic matter are in some pedons

Bh horizon:
Color--hue of 5YR, value of 2 to 4, and chroma of 1 to 4, hue of 7.5YR, value of 3 or 5, and chroma of 1 to 4; and hue of 10YR, value of 2 to 5, and chroma of 1 to 4, or is neutral (N) with value of 2
Texture (fine-earth fraction)-- sand, fine sand, loamy sand, or loamy fine sand
Other features-- Sand grains are well coated with organic matter and are weakly cemented in parts. It is massive or has blocky or subangular blocky structure.

COMPETING SERIES:
Allanton soils -- have an umbric epipedon

GEOGRAPHIC SETTING:
Landscape: Coastal Plain
Landform: upland
Geomorphic Component: talfs, rises
Parent Material: marine sediments
Elevation: 8 to 150 feet
Mean Annual Air Temperature: 59 to 70 degrees
Mean Annual Precipitation: 38 to 60 inches
Frost Free Period: 190 to 285 days

GEOGRAPHICALLY ASSOCIATED SOILS:
Kershaw soils-- do not have a Bh horizon and are better drained
Leon soils-- have Bh horizons at depths less than 30 inches
Lynn Haven soils-- have Bh horizons at depths less than 30 inches
Mandarin soils-- have Bh horizons at depths less than 30 inches

Mascotte soils-- have Bt horizons beneath the Bh horizons
Ortega soils-- do not have a Bh horizon and are better drained
Ridgeland soils -- do not have E horizons and the upper boundary of the Bh horizon is commonly at depths of less than 10 inches

DRAINAGE AND PERMEABILITY:
Drainage Class (Agricultural): somewhat poorly and poorly drained
Internal Free Water Occurrence: very shallow to shallow, persistent
Index Surface Runoff: negligible to very low, some areas are subject to flooding.
Permeability: moderate

USE AND VEGETATION:
Major Uses: timber and pulpwood production, community development
Dominant Vegetation: second growth slash and longleaf pine with an understory of sawpalmetto, gallberry, pineland threeawn, broomsedge bluestem, lopsided indiangrass, chalky bluestem, wild grape, and other perennial grasses

DISTRIBUTION AND EXTENT:
Distribution: Northern Peninsular Florida and Georgia, and possibly North Carolina, and South Carolina
Extent: moderate

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: Duval County, Florida; 1977.

REMARKS: This revision changes the series classification to recognize the amendments to Soil Taxonomy that introduces changes in classification of Spodosols.

Diagnostic horizons and features recognized in the typifying pedon include:
Ochric epipedon - the zone extending from the surface to a depth of 57 inches (A, E1, E2, and E3 horizons).
Albic horizon - the zone extending from 10 to 57 inches (E2, and E3 horizons).
Spodic horizon - the zone extending from 57 to 80 inches (Bh horizon).
Aquic condition - endosaturation throughout in most pedons.

ADDITIONAL DATA: Soil Characterization Lab., IFAS, UOF S1-90-(1-6), S3-10-(1-8), S4-10-(1-7), S10-13-(1-5), S16-11-(1-6), S55-7-(1-6)

TABULAR SERIES DATA:

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SOI-5  Soil Name   Slope  Airtemp FrFr/Seas Precip  Elevation
FL0098 POTTSBURG   0-  2   59- 70  190-285  38- 60    8- 135
FL0186 POTTSBURG   0-  2   59- 70  190-285  38- 60   20- 150
FL0557 POTTSBURG   0-  3   59- 70  190-285  38- 60   75- 150


SOI-5  FloodL FloodH Watertable Kind    Months   Bedrock Hardness
FL0098 NONE   OCCAS    0-0.5  APPARENT FEB-SEP  60-60
FL0186 NONE   OCCAS  0.5-1.0  APPARENT MAR-SEP  60-60
FL0557 NONE          1.0-2.0  APPARENT MAR-AUG  60-60


SOI-5  Depth  Texture                3-Inch  No-10  Clay%   -CEC-
FL0098  0- 3  S FS                    0-  0 100-100  1- 4   3- 10
FL0098  3-57  S FS                    0-  0 100-100  0- 4  .3-  5
FL0098 57-80  S FS LS                 0-  0 100-100  1- 6   3- 15
FL0186  0- 3  S FS                    0-  0 100-100  1- 4   3- 10
FL0186  3-57  S FS                    0-  0 100-100  0- 4  .3-  5
FL0186 57-80  S FS LS                 0-  0 100-100  1- 6   3- 15
FL0557  0- 4  S FS                    0-  0 100-100  0- 4   3- 10
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FL0557  4-52  S FS                      0-  0 100-100  0- 5  .3-  5
FL0557 52-80  S FS                      0-  0 100-100  1- 6   3- 12


SOI-5  Depth    -pH-     O.M.  Salin  Permeab   Shnk-Swll
FL0098  0- 3  3.6- 6.5  .5-3.  0- 2   6.0-  20  LOW
FL0098  3-57  3.6- 6.5  0.-.5  0- 2   6.0-  20  LOW
FL0098 57-80  3.6- 6.0  1.-4.  0- 2   0.6- 2.0  LOW
FL0186  0- 3  3.6- 6.5  .5-3.  0- 2   6.0-  20  LOW
FL0186  3-57  3.6- 6.5  0.-.5  0- 2   6.0-  20  LOW
FL0186 57-80  3.6- 6.0  1.-4.  0- 2   0.6- 2.0  LOW
FL0557  0- 4  3.6- 6.5  .5-3.  0- 2   6.0-  20  LOW
FL0557  4-52  3.6- 6.5  0.-1.  0- 2   6.0-  20  LOW
FL0557 52-80  3.6- 6.0  1.-4.  0- 2   0.6- 2.0  LOW
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National Cooperative Soil Survey
U.S.A.

LOCATION MANDARIN FL+GA NC

Established Series
AGH, Rev MHC
11/2008

MANDARIN SERIES

MLRA(s): 153A
MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina
Depth Class: Very deep
Drainage Class (Agricultural): Somewhat poorly drained
Internal Free Water Occurrence: Moderate deep, common
Permeability: Moderate
Landscape: Lower coastal plain
Landform: Marine terrace
Geomorphic Component: Talf
Parent Material: Marine sediments
Slope: 0 to 3 percent
Elevation (type location):
Mean Annual Air Temperature (type location): 67 degrees F.
Mean Annual Precipitation (type location): 55 inches

TAXONOMIC CLASS: Sandy, siliceous, thermic Oxyaquic Alorthods

TYPICAL PEDON: Mandarin fine sand, on a smooth convex 0.5 percent slope, in forest. (Colors are for moist soil.)

A--0 to 4 inches; dark gray (10YR 4/1) fine sand; weak fine granular structure; very friable; extremely acid; clear wavy boundary. (2 to 8 inches thick)

E1--4 to 8 inches; light brownish gray (10YR 6/2) fine sand; single grained; loose; extremely acid; clear wavy boundary.

E2--8 to 26 inches; light gray (10YR 7/1) fine sand; single grained; loose; strongly acid; abrupt wavy boundary. (Combined thickness of the E horizon is 3 to 24 inches)

Bh1--26 to 30 inches; very dark grayish brown (10YR 3/2) fine sand; weak fine subangular blocky structure; friable; in places sand grains well coated with organic matter; very strongly acid; gradual wavy boundary.

Bh2--30 to 35 inches; very dark brown (10YR 2/2) fine sand; weak fine subangular blocky structure; friable; in places sand grains well coated with organic matter; few medium faint dark brown (10YR 3/3) soft masses of iron accumulation; very strongly acid; clear wavy boundary.

Bh3--35 to 40 inches; black (5YR 2/1) fine sand; moderate medium subangular blocky structure; friable; in places sand grains well coated with organic matter; few fine prominent yellowish brown (10YR 5/4) soft masses of iron accumulation; very strongly acid; gradual wavy boundary.

BE--40 to 46 inches; brown (10YR 5/3) fine sand; single grained; loose; moderately acid; gradual smooth boundary.

E'1--46 to 56 inches; light gray (10YR 7/2) fine sand; single grained; loose; slightly acid; gradual wavy boundary.

E'2--56 to 62 inches; white (10YR 8/1) fine sand; single grained; loose; few medium faint very pale brown (10YR 7/3) soft masses of iron accumulation; neutral; gradual wavy boundary.

E'3--62 to 73 inches; grayish brown (10YR 5/2) fine sand; single grained; loose; neutral; gradual wavy boundary.

B'h--73 to 80 inches; black (10YR 2/1) fine sand; few fine distinct white (10YR 8/1) bodies; weak fine subangular blocky structure; friable; in places sand grains coated with organic matter; moderately acid.

TYPE LOCATION: Duval County, Florida; 3,000 feet north of Atlantic Boulevard, 0.7 mile west of Girvin Road in NE1/4NW1/4, Sec. 22, T. 2 S., R. 28 E.

RANGE IN CHARACTERISTICS:
Depth to the top of the Spodic: less than 30 inches
Depth to Bedrock: Greater than 60 inches
Depth to Seasonal High Water Table: 18 to 42 inches, June to December or November to April
Soil Reaction: extremely acid to moderately acid in the A, E, and Bh horizons and from extremely acid to neutral in the BE, E', and B'h horizons
Other Features: All horizons are sand, fine sand, loamy sand, or loamy fine sand
Other Features: Some pedons do not have a bisequum of E and Bh horizons, and are underlain by a C horizon

RANGE OF INDIVIDUAL HORIZONS:

A horizon:
Color--hue of 10YR, value of 2 to 7, and chroma of 1 or 2; or is neutral with value of 3 to 5

E horizon:
Color--hue of 10YR, value of 4 to 8, and chroma of 1 to 8

Bh and B'h horizon:
Color--hue of 2.5YR, value of 2 or 3, and chroma of 2 to 4; hue of 5YR, value of 2 or 3, and chroma of 1 to 4; hue of 7.5YR, value of 2.5 to 5, and chroma of 1 or 2; or hue of 10YR, value of 2, and chroma of 1 or 2; or hue 10YR, value of 3, and chroma of 1.
Other features--Some pedons are weakly cemented (less than 50 percent) and sand grains are coated with organic matter. It is massive or has blocky or subangular blocky structure.

BE or BC horizon (where present):
Color--hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4; hue of 7.5YR, value of 4, and chroma of 2 to 4, and value of 5, chroma of 4

E' horizon:
Color--hue of 10YR or 2.5Y, value of 4 to 8, and chroma of 2 to 8; hue of 7.5YR, value of 6 to 8, and chroma of 2 to 8

Eg horizon (where present):
Color--hue of 10YR or 2.5Y, value of 4 to 8, and chroma of 1 or 2; hue of 7.5YR, value of 6 to 8, and chroma of 1 or 2

C horizon (where present):
Color--hue of 7.5YR to 2.5Y, value of 6 to 8, and chroma of 3 or 4

Cg horizon (where present):
Color--hue of 7.5YR to 2.5Y, value of 6 to 8, and chroma of 1 or 2

COMPETING SERIES:
Echaw soils--have a spodic horizon between depths of 30 and 50 inches
Hurricane soils--have a spodic horizon below a depth of 50 inches
Melvina soils--have an argillic horizon and are underlain by limestone bedrock at 60 to 80 inches or more
Ridgeland soils--do not have an E horizon more than 2 inches thick between the A and Bh horizon
Rigdon soils--have an argillic horizon at 24 to 40 inches

GEOGRAPHIC SETTING:
Landscape: Lower coastal plain
Landform: Marine terrace
Geomorphic Component: Talf
Parent Material: Marine sediments
Elevation:
Mean Annual Air Temperature: 65 to 70 degrees
Mean Annual Precipitation: 50 to 60 inches

GEOGRAPHICALLY ASSOCIATED SOILS:
Cainhoy soils--do not have a spodic horizon and are better drained
Hurricane soils--have a spodic horizon below a depth of 50
Leon soils--have a water table within 18 inches of the surface for some period in most years
Mascotte soils--have a water table within 18 inches of the surface for some period in most years, and have a Bt horizon below the spodic horizon
Pottsburg soils--have a spodic horizon at depths of 50 inches or more
Ortega soils--do not have a spodic horizon and are better drained
Rutlege soils--do not have a spodic horizon and are very poorly drained
Sapelo soils--have a water table within 18 inches of the surface for some period in most years, and have a Bt horizon below the spodic horizon

DRAINAGE AND PERMEABILITY:
Drainage class (Agricultural): Somewhat poorly
Internal Free Water Occurrence: Moderately deep, common
Permeability: Moderate

USE AND VEGETATION:
Major Uses: Natural areas, some community development
Dominant Vegetation: Where natural--scattered second growth slash and longleaf pine, and scrub oak with an understory of greenbriar, sawpalmetto, pineland threeawn, creeping bluestem, paspalum, panicum, and lopsided Indiangrass.

DISTRIBUTION AND EXTENT: Northern peninsular Florida, Georgia, North Carolina.
The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Raleigh, North Carolina

SERIES ESTABLISHED: Duval County, Florida; 1977.

REMARKS: Mandarin soils were formerly mapped as a thermic variant of the Cassia series. Based on a 2-year soil temperature study, the mean annual soil temperature range for this soil in Duval County, Florida is about 69.2 to 71.5 degrees F.

Diagnostic horizons and soil characteristics recognized in this pedon are:
Ochric epipedon--the zone from 0 to 4 inches (A horizon)
Albic horizon--the zone from 4 to 26 inches (E horizon)
Spodic horizon--the zone from 30 to 40 inches and 73 to 80 or more inches (Bh2, Bh3 and Bh horizons)
Aquic conditions--the soil has redox depletions and concentrations within 18 to 42 inches of the surface, with

periodic saturation and reduction at some time during the year
Series control section--the zone from 0 to 60 inches

ADDITIONAL DATA: Pedon 5lb-13-(1-11) in soil survey of city of Jacksonville, Duval County, Florida. Pedon (S79FL-005-006) soil survey of Bay County, Florida Pedon (S80FL-131-033) soil survey of Walton County, Florida

TABULAR SERIES DATA:

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SOI-5  Soil Name   Slope  Airtemp FrFr/Seas Precip  Elevation
FL0188 MANDARIN    0-  2     -        -       -         -
FL0506 MANDARIN    0-  2     -        -       -         -


SOI-5  FloodL FloodH Watertable Kind    Months    Bedrock Hardness
FL0188 NONE          1.5-3.5  APPARENT  JUN-DEC   >60
FL0506 OCCAS         1.5-3.5  APPARENT  JUN-DEC   >60


SOI-5  Depth  Texture                3-Inch  No-10  Clay%   -CEC-
FL0188  0-26  FS S                    0-  0 100-100  0- 3    -
FL0188 26-40  FS S LFS                0-  0 100-100  2- 9    -
FL0188 40-73  FS S                    0-  0 100-100  0- 3    -
FL0188 73-80  FS S LFS                0-  0 100-100  2- 9    -
FL0506  0-10  FS S                    0-  0 100-100  0- 3    -
FL0506 10-20  FS S                    0-  0 100-100  2- 9    -
FL0506 20-80  FS S                    0-  0 100-100  0- 3    -


SOI-5  Depth    -pH-     O.M.  Salin  Permeab   Shnk-Swll
FL0188  0-26  3.6- 6.0  .5-3.  0- 0   6.0-  20  LOW
FL0188 26-40  3.6- 6.0    -    0- 0   0.6- 2.0  LOW
FL0188 40-73  3.6- 7.3    -    0- 0   6.0-  20  LOW
FL0188 73-80  3.6- 7.3    -    0- 0   0.6- 2.0  LOW
FL0506  0-10  3.6- 6.0  .5-3.  0- 0   6.0-  20  LOW
FL0506 10-20  3.6- 6.0    -    0- 0   0.6- 2.0  LOW
FL0506 20-80  4.5- 7.3    -    0- 0   6.0-  20  LOW
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National Cooperative Soil Survey
U.S.A.

LOCATION ALLANTON FL+GA

Established Series
EMD-TEC/Rev. JAK
09/2008

ALLANTON SERIES

The Allanton series consists of very deep, poorly drained and very poorly drained soils that formed in sandy marine deposits. These soils occur on broad flats, slight depressions, and along poorly defined drainageways on the Lower Coastal Plain. Slopes range from 0 to 2 percent.

TAXONOMIC CLASS: Sandy, siliceous, thermic Arenic Umbric Alaquods

TYPICAL PEDON: Allanton sand on a nearly level, 0.5 percent slope in cut-over woodlands. (Colors are for moist soil.)

A1--0 to 10 inches; black (10YR 2/1) sand; weak fine granular structure; very friable; many fine and medium roots; many uncoated sand grains; very strongly acid; clear smooth boundary. (10 to 22 inches thick)

A2--10 to 18 inches; very dark gray (10YR 3/1) sand; single grain; loose; common uncoated sand grains; common fine and medium roots; very strongly acid; clear wavy boundary. (6 to 12 inches thick)

E1--18 to 27 inches; dark gray (10YR 4/1) sand with streaks and splotches of gray (10YR 5/1); single grain; loose; few medium roots; common uncoated sand grains; very strongly acid; gradual wavy boundary. (6 to 12 inches thick)

E2--27 to 52 inches; light gray (10YR 7/1) sand; single grain; loose; few fine roots; very strongly acid; clear smooth boundary. (5 to 33 inches thick)

Bh1--52 to 56 inches; very dark gray (10YR 3/1) sand; single grain; loose; about 50 percent of sand grains coated with organic matter; very strongly acid; clear wavy boundary. (0 to 10 inches thick)

Bh2--56 to 80 inches; black (N 2/0) sand; massive, crushing to weak fine granular structure; very friable; sand grains coated with organic matter; extremely acid.

TYPE LOCATION: Bay County, Florida. Cut-over woodlands in the flatwoods about 2.8 miles west of Fountain, Florida, west of U.S. Highway 231; NW1/4SW1/4,Sec. 20, T. 1. N., R. 12 W.

RANGE IN CHARACTERISTICS: Solum thickness exceeds 80 inches. Reaction is extremely acid to strongly acid throughout the profile. Depth to the spodic horizon is 50 to 80 inches. Thickness of the umbric epipedon is 16 to 30 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 2 or less or it is neutral. Texture is sand, fine sand, loamy sand, or loamy fine sand. Some pedons have mucky texture modifiers.

The E or Eg horizon has hue of 10YR or 2.5Y, value of 4 to 7 and chroma of 2 or less or it is neutral. Texture is sand or fine sand. Redoximorphic features, where present, consists of masses of oxidized iron in shades of red, brown, or yellow and iron depletions in shades of white, gray or olive.

The upper Bh horizon has hue of 7.5YR or 10YR, value of 2 to 5, and chroma of 2 or less. Texture is sand, fine sand, loamy sand, or loamy fine sand. Redoximorphic features, where present, consists of masses of oxidized iron in shades of red, brown, or yellow and iron depletions in shades of white, gray or olive.

The lower Bh horizon has hue of 5YR to l0YR, value of 2 or 3, and chroma 2 or less or it is neutral. Texture is sand, fine sand, loamy sand, or loamy fine sand. Most sand grains are coated with organic matter. Redoximorphic features, where present, consists of masses of oxidized iron in shades of red, brown, or yellow and iron depletions in shades of white, gray or olive.

COMPETING SERIES: This is the Pottsburg series in the same family and Centenary, Hurricane, Leon, and Mandarin series in similar families. None of these soils have an umbric epipedon. In addition, Centenary and Hurricane soils are better drained. Leon and Mandarin soils have a spodic horizon that occurs within 30 inches of the surface.

GEOGRAPHIC SETTING: Allanton soils are on broad flats, slight depressional areas, and along poorly defined drainageways of the flatwoods of the lower Coastal Plain in northwest Florida. Slopes are 0 to 2 percent. Annual precipitation is about 50 to 60 inches and mean annual temperature is about 65 to 70 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Chipley, Dorovan, Foxworth, Osier, Pamlico, Pickney, Plummer, and Rutlege series. None of these associated soils have spodic horizons within 80 inches of the surface. Chipley and Foxworth soils are on upland and side slopes and are better drained. Dorovan and Pamlico soils have organic surfaces. Osier soils have an ochric or albic surface horizon. Pickney soils have an umbric epipedon more than 24 inches thick. Plummer soils have an argillic horizon at depths of 40 to 60 inches.

DRAINAGE AND PERMEABILITY: Allanton soils are poorly or very poorly drained. Runoff is very slow. Permeability is moderately rapid throughout but is impeded by a high water table. A water table is within 6 inches of the surface for 3 to 5 months during most years. It is at or on the surface for periods of 1 to 3 months in some years. It is within depths of 24 inches for 6 to 9 months in most years. In the lower lying areas water may stand for 2 to 4 months in most years.

USE AND VEGETATION: Most of the areas of these soils remain in native vegetation or cut over areas of woodland. Natural vegetation consists of sweet bay, blackgum, sweetgum, red maple and some slash pine. The understory consists of buckwheattree (titi), waxmyrtle, hammock sweet azalea, gallberry, and similar species and pineland threeawn. A few areas are drained, cleared, and in tame pastures.

DISTRIBUTION AND EXTENT: Lower Coastal Plain flatwoods in northwest Florida. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Auburn, Alabama

SERIES ESTABLISHED: Bay County, Florida; 1982.

REMARKS: This revision changes the series classification to recognize the 1992 amendments to Soil Taxonomy that introduces changes in classification of Spodosols.
09/2008. The OSD was reclassified from Grossarenic Alaquods to Arenic Umbric Alaquods. These soils have both the Grossarenic and Umbric soil features; however, classify as Arenic Umbric Alaquods by virtue of the order of the Alaquod subgroups in the 10th edition of the Keys to Soil Taxonomy. These soils would classify as Grossarenic Umbric Alaquods if such existed in the Soil Taxonomy.

Diagnostic horizons and features recognized in this pedon are:
Umbric epipedon-zone from the surface to a depth of 18 inches (A1, A2).
Albic horizon-zone from 18 to 52 inches (E1, E2).
Spodic horizon-zone from 52 to 80 inches (Bh).
Aquic condition-endosaturation throughout soil.

ADDITIONAL DATA: Soil Characterization Lab., IFAS, UOF
S3-14-(1-8), S4-5-(1-7)

TABULAR SERIES DATA:

SOI-5	Soil Name	Slope	Airtemp	FrFr/Seas	Precip	Elevation
FL0295	ALLANTON	0- 2	65- 70	230-310	50- 60	20- 150
FL0397	ALLANTON	0- 2	65- 70	230-310	50- 60	20- 150
FL0489	ALLANTON	0- 2	65- 70	230-310	50- 60	20- 150

SOI-5	FloodL	FloodH	Watertable	Kind	Months	Bedrock	Hardness
FL0295	NONE		0-0.5	APPARENT	FEB-SEP	60-60	
FL0397	COMMON		0-0.5	APPARENT	DEC-MAY	60-60	
FL0489	NONE		-	APPARENT	-	60-60	

SOI-5	Depth	Texture	3-Inch	No-10	Clay%	-CEC-
FL0295	0-18	LS LFS	0- 0	100-100	8-12	10- 25
FL0295	0-18	S FS	0- 0	100-100	3- 8	4- 8
FL0295	18-56	S FS LS	0- 0	100-100	3-12	1- 8
FL0295	56-80	S FS LS	0- 0	100-100	3-12	10- 30
FL0397	0-18	S FS	0- 0	100-100	3- 8	4- 8
FL0397	0-18	LS LFS	0- 0	100-100	8-12	10- 25
FL0397	18-52	S FS LS	0- 0	100-100	3-12	1- 8
FL0397	52-80	S FS LS	0- 0	100-100	3-12	10- 30
FL0489	0-18	MK-S MK-FS MK-LFS	0- 0	100-100	3-12	15- 30
FL0489	18-56	S FS	0- 0	100-100	1- 8	1- 8
FL0489	56-80	S FS LS	0- 0	100-100	3-12	10- 30

SOI-5	Depth	-pH-	O.M.	Salin	Permeab	Shnk-Swll
FL0295	0-18	3.5- 5.5	2.-7.	0- 2	2.0- 6.0	LOW
FL0295	0-18	3.5- 5.5	2.-5.	0- 2	2.0- 6.0	LOW
FL0295	18-56	3.5- 5.5	0.-.5	0- 2	6.0- 20	LOW
FL0295	56-80	3.5- 5.5	2.-4.	0- 2	0.6- 6.0	LOW
FL0397	0-18	3.5- 5.5	2.-5.	0- 0	2.0- 6.0	LOW
FL0397	0-18	3.5- 5.5	2.-7.	0- 2	2.0- 6.0	LOW
FL0397	18-52	3.5- 5.5	0.-.5	0- 0	6.0- 20	LOW
FL0397	52-80	3.5- 5.5	2.-4.	0- 0	0.6- 6.0	LOW
FL0489	0-18	3.5- 5.5	10-20	0- 2	2.0- 6.0	LOW
FL0489	18-56	3.5- 5.5	0.-1.	0- 2	2.0- 6.0	LOW
FL0489	56-80	3.5- 5.5	2.-4.	0- 2	0.6- 6.0	LOW

National Cooperative Soil Survey
U.S.A.

LOCATION LYNN HAVEN FL+GA NC SC

Established Series
Rev. GRB
03/2009

LYNN HAVEN SERIES

The Lynn Haven series consists of very deep, poorly and very poorly drained, moderate or moderately rapid permeable soils in low areas and depressions the Gulf Coast and Atlantic Flatwoods. They formed in thick deposits of sandy marine sediments. Near the type location, the mean annual temperature is about 68 degrees F., and the mean annual precipitation is about 55 inches. Slopes range from 0 to 5 percent.

TAXONOMIC CLASS: Sandy, siliceous, thermic Typic Alaquods

TYPICAL PEDON: Lynn Haven fine sand--range. (Colors are for moist soil)

A--0 to 12 inches; black (10YR 2/1) fine sand; weak fine granular structure; friable; many fine and medium roots; strongly acid; clear wavy boundary. (8 to 20 inches thick)

Eg--12 to 16 inches; gray (N 6/0) fine sand; single grain; loose; common fine and medium roots; many uncoated sand grains; very strongly acid; abrupt wavy boundary. (2 to 18 inches thick)

Bh1--16 to 22 inches; dark reddish brown (5YR 3/2) fine sand; weak fine granular structure; friable; many fine and medium roots; few fine and medium pores; sand grains coated with organic matter; very strongly acid; gradual wavy boundary.

Bh2--22 to 30 inches; dark brown (7.5YR 3/2) fine sand; weak fine granular structure; friable; few fine roots; few fine pores; most sand grains are coated with organic matter; few small pockets of uncoated sand grains; very strongly acid; gradual wavy boundary. (Combined thickness of the Bh horizons is from 6 to more than 50 inches thick.)

Cg--30 to 75 inches; gray (5Y 6/1) fine sand; single grain; loose; common medium distinct brown (10YR 5/3) and light yellowish brown (10YR 6/4) masses of iron accumulation; very strongly acid.

TYPE LOCATION: Bay County, Florida. Approximately 1 mile south of intersection of U. S. Highway 98 and State Highway 392 and about 50 feet east of Highway 392 in Sec. 4, T. 4 S., R. 15 W.

RANGE IN CHARACTERISTICS: Reaction ranges from extremely acid to strongly acid throughout the profile.

The Oa, horizon, where present, is less than 7 inches thick. It has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. Texture is muck.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2; or is neutral with value of 2 or 3. When dry, this horizon has a salt-and-pepper appearance due to mixing of organic matter and white sand grains. Texture is sand, fine sand or mucky fine sand.

The Eg or E horizon, where present, has hue of 10YR or 2.5YR, value of 4 to 7, and chroma of 1 or 2; or is neutral with value of 5 to 7. Redoximorphic features in shades of yellow and brown range from none to common. Texture is sand or fine sand.

The Bh horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 4. Sand grains are coated with organic matter. Vertical or horizontal tongues or pockets of grayish sand occur in the Bh horizon in some pedons. Texture is sand, fine sand, loamy sand or loamy fine sand.

Some pedons have a C/B horizon with hue of 10YR to 5YR, value of 3 to 5, and chroma of 3 or 4 with redoximorphic features in shades of gray, brown, or yellow. Texture is sand, fine sand, loamy sand or loamy fine sand.

Some pedons have a bisequum of E'g and B'h. Colors and textures are similar to the Eg and Bh horizons.

The Cg horizon has hue of 7.5YR to 5Y, value of 4 to 7, and chroma of 1 to 3. Redoximorphic features in shades of brown, yellow, or red range from few to many. Texture is sand, fine sand, loamy sand or loamy fine sand.

COMPETING SERIES: These include Boulogne and the very poorly drained Wesconnett series. Boulogne and Wesconnett soils do not have E horizons immediately below the A horizon.

GEOGRAPHIC SETTING: Lynn Haven soils are on low areas and in depressions of the Gulf Coast and Atlantic Flatwoods. They formed in thick beds of marine sand. The climate is warm and humid. Slopes range from 0 to 5 percent. The average annual air temperature ranges from 65 to 70 degrees F., and the average annual precipitation ranges from 50 to 60 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Allanton, Baymeade, Blanton, Evergreen, Hurricane, Kershaw, Kingsferry, Kureb, Lakeland, Leon, Mandarin, Murville, Olustee, Osier, Plummer, Pottsburg, Rutlege, Scranton, and Seagate series. Allanton, Hurricane and Pottsburg soils have a Bh horizon at depths greater than 50 inches. The Baymeade, Blanton, Kershaw, Kureb, Lakeland, Osier, Plummer, Rutlege, and Scranton soils do not have Bh horizons. Evergreen soils have a histic epipedon. Kingsferry soils have a Bh horizon between a depth of 30 and 50 inches. Leon soils lack an umbric epipedon. Olustee soils have Bt horizons below the Bh horizon. Murville soils do not have E horizons immediately below the A horizon. Seagate soils are better drained and have argillic horizons beneath the Bh horizons.

DRAINAGE AND PERMEABILITY: poorly or very poorly drained; moderately rapid or moderate permeability.

USE AND VEGETATION: Most areas of Lynn Haven soils remain in their natural state. A few small areas are used for truck crops and pasture land. The native vegetation consists of slash pine, longleaf pine, or cypress and bay trees with an undergrowth of sawpalmetto, gallberry, fedderbush, huckleberry, and pineland threeawn. In depressions, cypress and bay trees are denser along with blackgum, red maple, and Ogeechee lime. The shrubs include fetterbush, Virginia willow, buttonbush, and waxmyrtle. Common herbaceous plants and vines include muscadine grape, greenbriars, and poison-ivy, along with maidencane grass, cinnamon fern and sphagnum.

DISTRIBUTION AND EXTENT: Florida, Georgia, North Carolina and South Carolina. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Auburn, Alabama.

SERIES ESTABLISHED: Florence and Sumter Counties, South Carolina; 1969.

REMARKS: The water table is at 0 to 6 inches for periods of 2 to 6 months annually and within a depth of 40 inches for more than 6 months during most years; during extended dry periods it is below 40 inches. Depressional areas are ponded for long duration in most years.

Diagnostic horizons and features recognized in this pedon:

Umbric epipedon - The zone extending from the surface to a depth of 12 inches. (A horizon).

Albic horizon - The zone between 12 and 16 inches. (E horizon).

Spodic horizon - The zone between 16 and 30 inches. (Bh1 and Bh2 horizons).

National Cooperative Soil Survey
U.S.A.

APPENDIX O

GENERAL NOTE

DASHED CONTOURS AND SHADED AREAS ARE AREAS OBSCURED BY DENSE FOLIAGE OR SHADOWS, AND SHOULD BE FIELD VERIFIED FOR ANY DESIGN AND/OR CONSTRUCTION.

NOTES:

1. Ninety (90) percent of the elevations determined from the solid line contours of this topographic map have an accuracy with respect to true elevation of one-half (1/2) contour interval or better and the remaining ten (10) percent of such elevations are not in error of more than one contour interval.

2. This map was compiled by Metro Engineering & Surveying Co., Inc. using LiDAR & Digital Softcopy photogrammetric methods. Planimetrics were compiled with Digital Stereo Imagery and/or from high resolution Orthorectified Mosaics taken with a Metric 60 megapixel digital camera.

3. LiDAR data was captured using a Trimble Harrier 68-i Planned Pulse Density for this project was 4-5 pulses per square meter. This data was filtered to produce a Bare Earth DEM which was used to create breaklines along features such as draws, wet weather drains, etc. The Bare Earth DEM, Breaklines and Compiled Hydro features and Planimetrics were merged to create a DTM of the site. This DTM Surface was used to produce the Hydro Enforced 1' Interval LiDAR Technical Contours shown.

4. Contours portrayed as dashed lines should be considered approximate. This map has not been field verified. Prior to use as a basis for design and or construction, it should be field verified.

GRAPHIC SCALE

300 0 300 600 1200

(IN FEET)
1 inch = 300 ft.
CONTOUR INTERVAL 1'

LEGEND

FENCE LINE	BUILDING	MANHOLE
WATER COURSE	HEADWALL/CULVERT	POWER POLE
TREE LINE	CATCH BASIN	LIGHT POLE
SINGLE TREES	DROP INLET	STREET LAMP
TRAIL	530 INDEX CONTOUR	GUY WIRE
PAVED ROAD W/O CURB	INTERMEDIATE CONTOUR	TRANSFORMER
UNPAVED ROAD	900.9 SPOT ELEVATION	SIGNS 1 & 2 POST
WALL	BV2305 G.P.S. SURVEY MONUMENT	HYDRANT
GUARD RAIL	RAILROAD	UNKNOWN OBJECTS

NORTH

Metro Engineering & Surveying Co., Inc.
Engineers • Surveyors • Photogrammetrist
"QUALITY SERVICE SINCE 1967"
1469 Hwy 20 West • McDonough, GA 30253
Phone: (770)-707-0777 | 1-800-594-8988
www.metro-engineering.com
mapping@metro-engineering.com

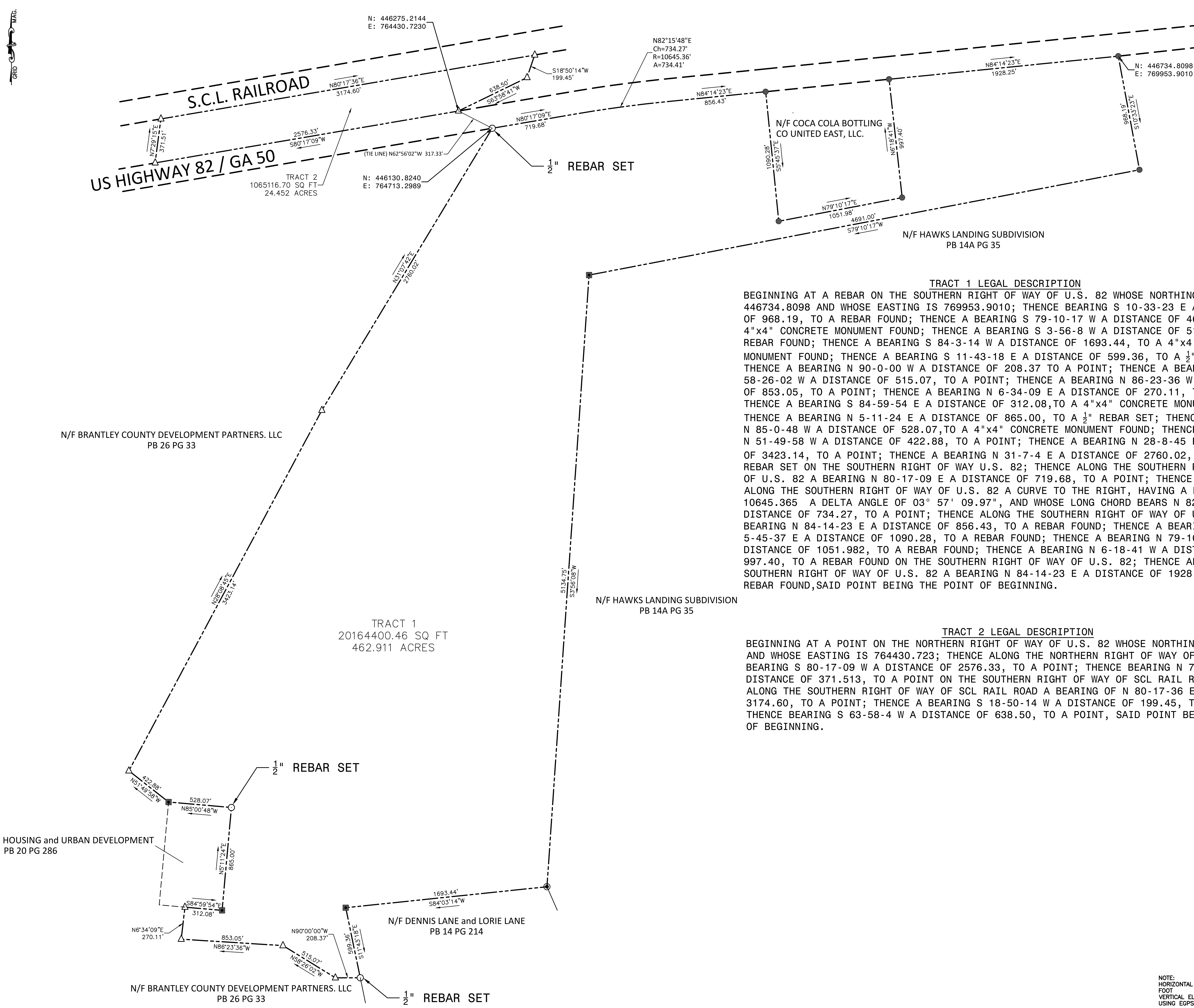
TOPOGRAPHIC MAP PREPARED FOR

HARBIN ENGINEERING

BRANTLEY CO. SITE

DATE OF CAPTURE: 04-24-2016

PROJECT NO: 13837
06-06-2016



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GEORGIA REGISTERED LAND SURVEYOR 2973 CHARLES H. TOMBERLIN

BOUNDARY SURVEY FOR
BRANTLEY COUNTY DEVELOPMENT PARTNERS, LLC.
TRACT 1 462.911 ACRES
TRACT 2 24.452 ACRES

LOCATED IN G.M.D. 1493
BRANTLEY COUNTY. GA
SCALE 1"=400'
DATE 05/12/2019

TRACT 1 LEGAL DESCRIPTION

BEGINNING AT A REBAR ON THE SOUTHERN RIGHT OF WAY OF U.S. 82 WHOSE NORTHING IS 446734.8098 AND WHOSE EASTING IS 769953.9010; THENCE BEARING S 10-33-23 E A DISTANCE OF 968.19, TO A REBAR FOUND; THENCE A BEARING S 79-10-17 W A DISTANCE OF 4691.00, TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING S 3-56-8 W A DISTANCE OF 5134.75, TO A REBAR FOUND; THENCE A BEARING S 84-3-14 W A DISTANCE OF 1693.44, TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING S 11-43-18 E A DISTANCE OF 599.36, TO A ½" REBAR SET; THENCE A BEARING N 90-0-00 W A DISTANCE OF 208.37 TO A POINT; THENCE A BEARING N 58-26-02 W A DISTANCE OF 515.07, TO A POINT; THENCE A BEARING N 86-23-36 W A DISTANCE OF 853.05, TO A POINT; THENCE A BEARING N 6-34-09 E A DISTANCE OF 270.11, TO A POINT; THENCE A BEARING S 84-59-54 E A DISTANCE OF 312.08,TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING N 5-11-24 E A DISTANCE OF 865.00, TO A ½" REBAR SET; THENCE A BEARING N 85-0-48 W A DISTANCE OF 528.07,TO A 4"x4" CONCRETE MONUMENT FOUND; THENCE A BEARING N 51-49-58 W A DISTANCE OF 422.88, TO A POINT; THENCE A BEARING N 28-8-45 E A DISTANCE OF 3423.14, TO A POINT; THENCE A BEARING N 31-7-4 E A DISTANCE OF 2760.02, TO A ½" REBAR SET ON THE SOUTHERN RIGHT OF WAY U.S. 82; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A BEARING N 80-17-09 E A DISTANCE OF 719.68, TO A POINT; THENCE CONTINUING ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A CURVE TO THE RIGHT, HAVING A RADIUS OF 10645.365 A DELTA ANGLE OF 03° 57' 09.97", AND WHOSE LONG CHORD BEARS N 82-15-48 E A DISTANCE OF 734.27, TO A POINT; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 BEARING N 84-14-23 E A DISTANCE OF 856.43, TO A REBAR FOUND; THENCE A BEARING S 5-45-37 E A DISTANCE OF 1090.28, TO A REBAR FOUND; THENCE A BEARING N 79-10-17 E A DISTANCE OF 1051.982, TO A REBAR FOUND; THENCE A BEARING N 6-18-41 W A DISTANCE OF 997.40, TO A REBAR FOUND ON THE SOUTHERN RIGHT OF WAY OF U.S. 82; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF U.S. 82 A BEARING N 84-14-23 E A DISTANCE OF 1928.25 TO A REBAR FOUND,SAID POINT BEING THE POINT OF BEGINNING.

TRACT 2 LEGAL DESCRIPTION

BEGINNING AT A POINT ON THE NORTHERN RIGHT OF WAY OF U.S. 82 WHOSE NORTHING IS 446275.214 AND WHOSE EASTING IS 764430.723; THENCE ALONG THE NORTHERN RIGHT OF WAY OF U.S. 82 A BEARING S 80-17-09 W A DISTANCE OF 2576.33, TO A POINT; THENCE BEARING N 7-29-15 E A DISTANCE OF 371.513, TO A POINT ON THE SOUTHERN RIGHT OF WAY OF SCL RAIL ROAD; THENCE ALONG THE SOUTHERN RIGHT OF WAY OF SCL RAIL ROAD A BEARING OF N 80-17-36 E A DISTANCE OF 3174.60, TO A POINT; THENCE A BEARING S 18-50-14 W A DISTANCE OF 199.45, TO A POINT; THENCE BEARING S 63-58-4 W A DISTANCE OF 638.50, TO A POINT, SAID POINT BEING THE POINT OF BEGINNING.

Such approvals or affirmations should be confirmed with the appropriate governmental bodies by any purchaser as to intended use of any parcel. The Registered Land Surveyor further certifies that this map, plat, or plan complies with the minimum standards and specifications of the State Board of Registration for Professional Engineers and Land Surveyors and the Georgia Superior Court Clerks' Cooperative Authority.

References:
Survey plat recorded in Plat Book 1 page 174
Deed recorded in Deed Book 588 pg 235 public records of BRANTLEY county.

Closure Statement:
The field data upon which this plat is based has a closure of one foot in 25,000 feet and an angular error of 03 seconds per angle and was adjusted using the compass rule. This plat has been calculated for closure and found to be accurate to 1 foot in 3062282 feet.

Notes:
1) The field data was collected using a Sokkia srx total station, topcon hiper v.
2) The bearings are true bearings, distances shown hereon are ground distances expressed in U.S. feet and decimal parts thereof.
3) This survey has been preformed without the benefit of a formal title review.
4) Charles H. Tomberlin, the land Surveyor, whose seal is affixed hereto does not guarantee that all easements which may affect this property are shown.

FLOOD INSURANCE NOTE: By graphics plotting only, this property is in ZONE X of the Flood Insurance Rate Map 13025C0230C EFFECTIVE DATE: 9/25/2009

1. The certification, as shown hereon, is purely a statement of professional opinion based on knowledge, information and belief, and based on existing field evidence and documentary evidence available. The certification is not an expressed or implied warranty or guarantee. 2. This Survey complies with both the rules of the Georgia Board of Registration for Professional Engineers and Land Surveyors and the Official Code of Georgia Annotated (OCGA) 15-6-67 as amended by HB1004 (2016), in that where a conflict exists between those two sets of specifications, the requirements of law prevail.

NOTE:
HORIZONTAL COORDINATES BASED ON GEORGIA EAST ZONE, US FOOT
VERTICAL ELEVATIONS BASED ON NAVD88. ESTABLISHED BY GPS USING EGPS SOLUTIONS NETWORK.

0 400 800 Feet
SCALE: 1"=400'

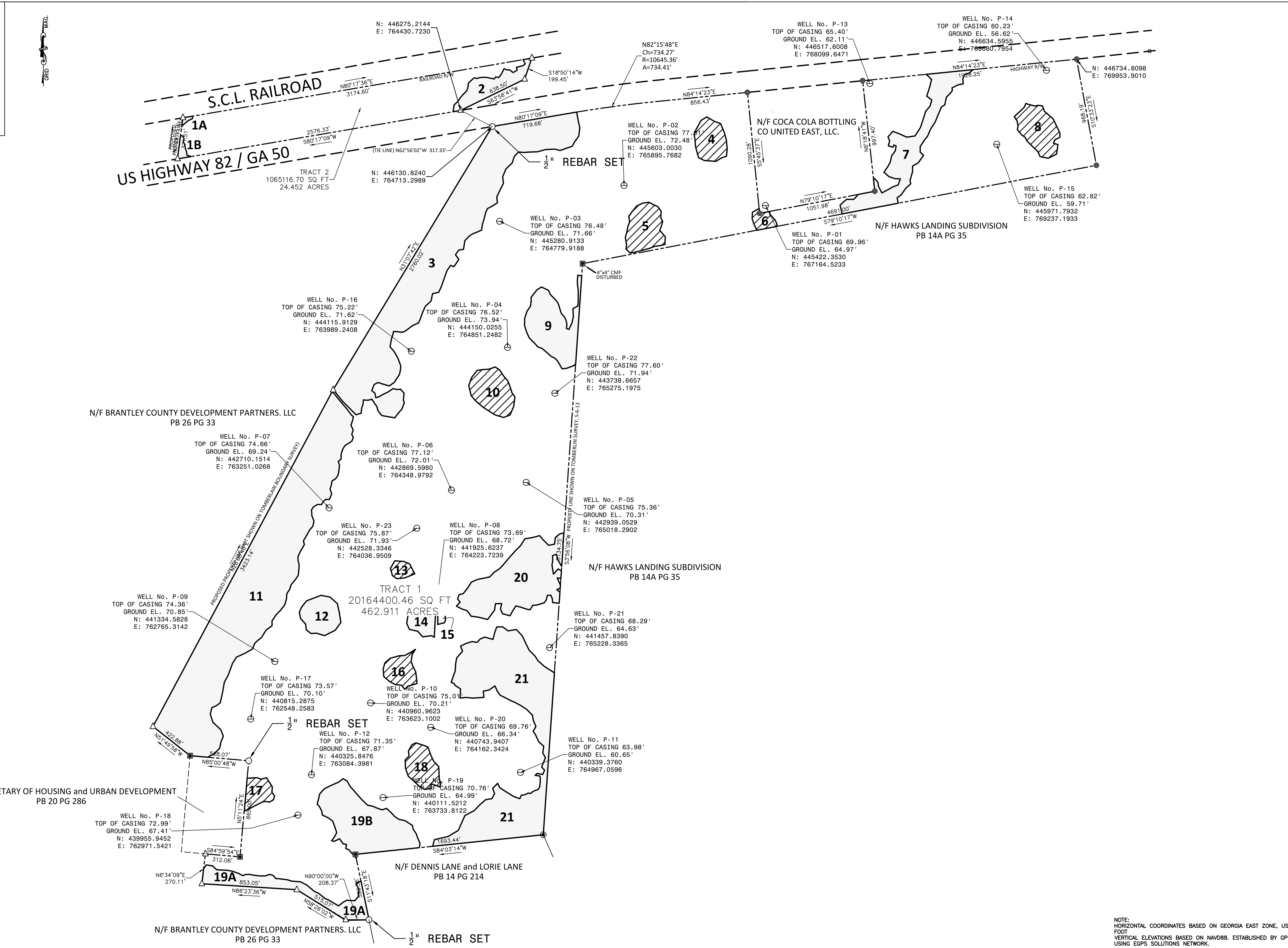
FIELD WORK: CT-BT-DT
Survey Date: 05-12-2019
PLAT BY: CHT
Plat Date: 05-12-2019
Checked By: CHT
REF. FILE :BOUNDARY

LEGEND

THESE STANDARD SYMBOLS WILL BE FOUND IN THE DRAWING.

- ■ CONCRETE MONUMENT FOUND
- ● 1/2" REBAR FOUND
- ○ 1/2" REBAR SET
- ▲ NO CORNER SET/FOUND

This plat is a retracement of an existing parcel or parcels of land and does not subdivide or create a new parcel or make any changes to any real property boundaries. The recording information of the documents, maps, plats, or other instruments which created the parcel or parcels are stated hereon. RECORDATION OF THIS PLAT DOES NOT IMPLY APPROVAL OF ANY LOCAL JURISDICTION, AVAILABILITY OF PERMITS, COMPLIANCE WITH LOCAL REGULATIONS OR REQUIREMENTS, OR SUITABILITY FOR ANY USE OR PURPOSE OF THE LAND. Furthermore, the undersigned land surveyor certifies that this plat complies with the minimum technical standards for property surveys in Georgia as set forth in the rules and regulations of the Georgia Board of Registration for Professional Engineers and Land Surveyors and as set forth in O.C.G.A. Section 15-6-67.



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0 400 800 Feet
SCALE: #######

FIELD WORK: CT-BT-DT
Survey Date: 05-12-2019
PLAT BY: CHT
Plat Date: 05-12-2019
Checked By: CHT
REF. FILE : WELL LOCATION

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- ○ 1/2" REBAR SET
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