OPERATIONS PLAN

PLANT BOWEN
COAL COMBUSTION RESIDUALS
(CCR) LANDFILL
BARTOW COUNTY, GEORGIA

FOR

Georgia Power

AUGUST 2022

REVISED JANUARY 2024

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
Approved
Solid Waste Management Program
Approved By: Rima Naji Digitally signed by Rima Naji Date: 2024.03.21 12:33:11 -04'00'

GEORGIA REGISTERED NO. 27185 PROFESSIONAL ENGINEER R. BRANT LANE

1/24/24

HHNT
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
Consulting Engineers

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1. GENERAL SITE INFORMATION

This Operations Plan was developed to meet the requirements set forth in Rule 391-3-4-.10 (5)(a) of the Georgia Solid Waste Rules & Regulations (CCR Rules) which address the Operation Criteria of Coal Combustion Residuals (CCR) Landfills.

A. Volumes and Estimated Life

The total area of the Plant Bowen Coal Combustion Landfill (CCR) is 504.1 acres (within permit boundary). The waste disposal area occupies 139.3 acres and is divided in ten (10) cells as follows:

Cell	Excavation (cy)	Earthfill (cy)	CCR volume (cy)	Life (yrs)(1)	24" Clay Liner(2)	24" Liner Prot. Cover(2)	18" Cap Infiltration layer (cy)	18" Cap Prot. Cover Soil (cy)	6" Topsoil (cy)
1&2	-	-	1,704,592	3.4	N/A(2)	N/A	69,196	69,196	23,065
3-8	-	-	7,202,869	14.4	170,415	170,415	196,729	196,729	65,576
9&10	-	-	1,936,003	3.9	N/A	N/A	67,639	67,639	22,546
Total	**485,787(3)**	**501,696(3)**	**10,843,464**	**21.7**	**170,415**	**170,415**	**333,564**	**333,564**	**111,187**

Note:
(1) The disposal life of the facility is based on a projected annual disposal rate of 500,000 tons/yr. The estimated life of all parcels is based on 1 ton per cubic yard.
(2) Cells 1 through 4 and Cells 9&10 are existing.
(3) Excavation and earthfill quantities represent the total volume of excavation and earthfill for the remaining proposed cells to be constructed (Cells 5-8).

The actual site life may differ depending on the amount of gypsum and other CCR produced by the plant and the amount removed from the site for beneficial re-use.

B. Description of Waste

The facility will receive solid waste produced from the generation of electricity from coal as defined in Rule 391-3-4-.01, and materials containing CCR or used to contain or absorb CCR (truck liners, truck wash sediments containing ash, etc.) generated by Georgia Power Company. Allowable wastes include:

(i) CCR (fly ash, bottom ash, flue gas desulfurization materials, and boiler slag).

(ii) Materials in contact with or that contain CCR, or used to collect or absorb CCR, that were generated by Georgia Power Company.

(iii) Other waste generated from milling coal in preparation for the combustion process.

(iv) Coal combustion water treatment residuals (as described below and in Section 2.K and 2.L of this Operations Plan).

a. Coal combustion water treatment residuals are generated primarily from processes that support the combustion of coal or other fossil fuels that are co-disposed with fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste. The residuals result from the treatment of the following wastewaters: coal pile run-off, boiler cleaning solutions, boiler blowdown, process water treatment and demineralizer regeneration wastes, cooling tower blowdown, air heater and precipitator washes, and effluents from floor and yard drains and sumps.

(v) Wastewater treatment residuals from the treatment of water generated during ash pond dewatering activities.

As required by the Rules, CCRs do not include putrescible or hazardous materials regulated under Subtitle C of the Resource Conservation Recovery Act (RCRA).

C. Zoning

The site received confirmation of compliance with zoning approval from the Bartow County Board of Commissioners in a letter dated February 20, 2018. This letter is included in Section 3 of this permit application package.

D. Buffers

The CCR landfill permitted site boundary is shown on drawing H-15062 and corner markers consisting of 1/2-inch diameter rebars and 4x4 inch marker posts are installed to delineate this boundary. A permanent survey control monument is established at the location indicated on drawing H-15062 for vertical and horizontal control. During filling, standard survey practices will be used to establish vertical and horizontal control of the filling operations.

A minimum 200-foot undisturbed buffer exists inside the permitted site boundary as indicated on permit drawings H-15063. A minimum 500-foot undisturbed buffer exists between the CCR disposal boundary and any adjacent residences and/or water supply wells.

A minimum 25-foot buffer exists between the CCR disposal boundary and any on-site springs and surface waters (perennial or intermittent). All erosion control measures and/or diversion ditches conform to the Erosion and Sedimentation Control Act and are protective of all streams in the landfill watershed and any associated perennial or intermittent tributaries.

Disturbance of wetland areas is prohibited, except as permitted by the United States Army Corps of Engineers. A statement certifying that wetlands will not be impacted as a result of construction activities at the site will be submitted to EPD, signed and stamped by the professional engineer responsible for construction.

E. Site Survey Control

The permitted site boundary is shown on drawing H-15063 included in Section 10 of the permit application. Corner markers consisting of 1/2-inch diameter rebars with GPC Red Cap have been installed to delineate this boundary. A permanent survey control monument is maintained at the location indicated on drawing H-15063 for vertical and horizontal control.

F. Limited Access

This CCR landfill is for exclusive use by Georgia Power Company for CCR disposal and is located entirely within the Plant Bowen property boundary. Only authorized personnel are allowed on the plant property. Access to the landfill is further restricted by the Etowah River and a chain link security fence and gated access from the Plant Bowen generating site, as well as the railroad and transmission line to the south of the site.

G. Posted Information

The CCR landfill is for exclusive use by Georgia Power Company for CCR disposal, and is not open to, or accessible by the public. Signage indicating the specific waste that can be placed in the CCR landfill is posted at the entrance. Also, signage denoting the limits of the buffer zone and the location of groundwater and surface water monitoring points is in place. Reference drawing H-15097 for details.

H. Communication

Communications are by cell phone or two-way radio with Plant Bowen. Telephone communications are maintained at the plant.

I. First Aid

First aid supplies are available at the plant.

J. Employee Facilities

Employee restroom facilities are available at Plant Bowen, as well as portable toilets in select locations around the landfill.

2. OPERATIONAL PROCEDURES

A. Supervision

The CCR landfill is under the supervision of an operator who is present at all times during operation and who is properly trained in the operation of landfills and the implementation of the CCR landfill's permit.

The CCR landfill may operate twenty-four (24) hours a day. Personnel trained in landfill operations will be present at all times. Supervision is provided by Georgia Power Company trained personnel.

Training in the operation of CCR landfills and the implementation of the approved permit is provided by Georgia Power Company with documentation of training maintained in the facility's operating records.

B. Exclusion of Prohibited Wastes

No hazardous, putrescible wastes or other non-approved wastes will be deposited at this site. To ensure the exclusion of prohibited wastes, the supervisor and/or operator regularly performs random inspections of the CCR material placement operation (generally referred to as "stacking operations"). The results of each inspection are recorded and maintained as part of the facility's operating record. Facility personnel receive training to recognize prohibited wastes.

If prohibited wastes are detected at any time, Georgia Power will remove such waste and ensure it is transported to a properly permitted solid waste handling facility. Any incident of prohibited waste will be described in a report and placed in the facility's operating record.

C. Prohibited Acts

The CCR landfill is operated and maintained in a manner described herein, to prevent open burning, scavenging, and the open dumping of waste.

D. Erosion and Sediment Control

All necessary erosion and sediment control measures will be constructed or installed in accordance with Best Management Practices (BMPs) that meet the requirements of the latest version of the Manual for Erosion and Sediment Control in Georgia (E&S Manual). Any required diversion berms, ditches and other stormwater management structures will be constructed in accordance with the E&S Manual.

E. Access Roads

Temporary access roads, covered with bottom ash, gravel, or a graded aggregate base will be provided for ease of access to the working area of each cell, including during inclement weather. All temporary access roads, covered with bottom ash, will only be constructed within the limits of the lined areas. Final access roads are designed to provide continued access for maintenance and inspection. Reference permit drawing H-15097 for details of permanent access roads.

Additionally, access roads may be paved at Georgia Power's discretion to enhance all-weather performance.

F. Fire Protection

Fly ash, bottom ash and boiler slag are by-products of the coal combustion process and consist of non-combustible coal minerals. Synthetic gypsum is a by-product of the flue gas desulfurization process in which flue gas is forced through a fluidized bed of calcium carbonate (limestone). The oxidation process produces calcium sulfate (gypsum) and water, neither one is a combustible material. Coal combustion water treatment residuals and other wastes generated from milling coal are also not fire hazards. Litter and other putrescible wastes are not permitted for disposal at this landfill and as a result, the occurrence of fire related to CCRs disposal is not possible, and therefore no soil fire protection is required. Fly ash and gypsum are available for fire control if needed.

G. Site Equipment

The following is a list of typical equipment that is used during operation of this CCR Landfill:

- CAT D5H-5S dozer or equivalent,
- Excavators,
- Drum Rollers,
- Water truck with spray attachment,
- Off-road trucks,
- Backup and/or specialized equipment will be leased or subcontracted on an as-needed basis, and
- Other equipment, as needed.

H. Recovered Materials Processing Operations

CCRs may be recovered (removed) from the CCR landfill for beneficial re-use in construction, manufacturing, agriculture and other industries. During recovery operations, personnel will leave two (2) feet minimum depth of in-place CCR material over the protective soil cover on the bottom of the cells.

When recovered materials are removed by truck, the truck tires will be cleaned to avoid tracking of recovered materials offsite.

Georgia Power will maintain a record of the volume of CCR material that is recovered for beneficial re-use and will report it to EPD in accordance with Rule 391-3-4-.17(5). See Section 4.C. of this Operations Plan. On-going recovery of CCR material will cause the site life to vary.

I. Controlled Unloading of Waste

CCRs will be hauled to the disposal cells in dump trucks and unloaded at the working face. See Section 2.L. of this plan for spreading, compaction, and stability procedures and Section 2.P. for dust control procedures.

Georgia Power will maintain a record of the volume of CCR that is placed in the CCR landfill and will report it to EPD in accordance with Rule 391-3-4-.17(5). See Section 4.C of this Operations Plan.

J. Solid Waste Processing Operations

No on-site waste processing is performed at this CCR landfill.

K. Waste Requiring Special Handling

This section will be updated prior to receipt of any new waste streams or changes in wastewater treatment processes that require special handling.

L. Spreading, Compaction and Stability

Initial Fill

For the initial fill operations of Cells 5-6, temporary rain flap berms constructed of protective cover sand will be installed upgradient of the initial working area. The 24 inches of sand drainage and protective layer for the LCRS upgradient of the rain flap berms will be covered with a sacrificial HDPE rain cover to prevent excessive stormwater from entering the LCRS and prevent erosion of the protective layer. The stormwater trapped by the rain cover berms will be pumped to the perimeter drainage ditch and routed to the sediment basins. Sandbags placed generally on a 10 ft. by 10 ft. grid will be used to prevent wind uplift of the rain tarp. As the CCR is placed over the initial working area, the upgradient rain flap berm and rain tarp will be removed to create a larger working area for CCR placement.

For the initial fill operations of Cells 7-10, a temporary containment berm will be constructed no farther than 100 ft. down gradient from edge of CCR placement, defining the initial working area. The 24 inches of sand drainage and protective layer for the LCRS down gradient of the temporary containment berm will be covered with a sacrificial 40mil HDPE geomembrane (rain cover), or approved equivalent material, to prevent excessive storm-water run-off from entering the LCRS and prevention of erosion of the protective layer. Sandbags placed generally on a 10 ft. by 10 ft. grid will be used to prevent wind uplift of the rain cover. As the working face and working area are advanced, the berm and rain flap will be removed and constructed farther down-gradient to define the new working area.

The initial fill will consist of 2 to 3 ft. of compacted ash covering the working area defined by the containment berm. The compacted ash will be compacted with smooth drum roller to create a smooth surface minimizing infiltration of storm water and facilitating run-off. The leachate collected by the LCRS will be routed to the leachate pond or leachate sump. The storm water run-off will be routed through the constructed BMPs (sedimentation basin and clear pool) to a permitted discharge location.

On-Going Operations

CCRs including coal combustion water treatment residuals will be uniformly spread in approximately 6 to 8-inch lifts (nominal loose thickness) and compacted to achieve a minimum 92% of its maximum dry density as determined by ASTM D698. Proper placement of CCR includes stabilization of wet materials by mixing with dry materials or by drying, no downhill pushing and/or compaction of CCR, and benching lifts of CCR material when placing against existing CCR slopes.

The surface of the compacted material will be rolled with a smooth drum roller to seal the surface to reduce infiltration and graded to prevent ponding of precipitation. Efforts will be made to achieve conditioning at a moisture content suitable for ease of handling, transporting, placement, compaction and testing.

Moisture Conditioning

Georgia Power will utilize an irrigation type system or other forms of moisture conditioning, such as the use of water trucks, at the Plant Bowen CCR Landfill. The irrigation system will be installed in phases as CCR waste is placed in the constructed cells. If needed, the system may also be extended to the surface of each additional lift of CCR disposed. Water for the system will be pumped from one of the landfill clear pools or sediment ponds. All water from the system will be sprayed over lined areas and all runoff will be contained within the lined waste footprint or lined containment ditches. Water will be applied at a rate that minimizes runoff and does not over-saturate the waste. Any potential runoff will be directed to one of the landfill's lined sediment or clear pool ponds. Spray nozzles and pipe sizes will be sized and adjusted by the landfill operator as necessary to meet operational requirements and minimize runoff. Pipe material for the irrigation system will be HDPE but may be modified at the operator's discretion.

Coal Combustion water treatment residuals received at the facility may require moisture conditioning and/or mixing with fly ash to achieve the required moisture conditions and shear strength of the waste. If necessary, coal combustion water treatment residuals will be unloaded and spread at the working face of the facility. CCR comprised of fly ash and/or bottom ash, including fines, will be added at appropriate volumes, as determined by prior testing, and mixed using a dozer, excavator, or disc harrow as necessary to achieve the required shear strength and moisture content.

Long-Term Stability Considerations

The long-term stability of the active and future cells (Cells 1 through 10) has been confirmed assuming that the CCR material is placed as discussed in this section of the Operations Plan and has the minimum shear strength discussed in the engineering report calculations. In all Cells, the CCR material shall have a minimum drained shear strength of 30 degrees and undrained shear strength of 18 degrees, or a combination of friction and cohesion equal to or greater than the shear strength envelope represented by 30 degrees for drained conditions and 18 degrees for undrained conditions.

The strength of the CCR materials placed within each cell shall be evaluated at least annually to confirm that the minimum strength required for stability is being achieved. A test pad section constructed using the field methods representative of placement conditions shall be built to obtain representative samples for testing in the laboratory.

CCR materials placement operations should be conducted in a manner to minimize the infiltration of water into the waste. The landfill shall be regularly monitored for standing water, leachate outbreaks, pumping and rutting of CCR materials under traffic loading, or other signs that may indicate that liquids are not draining properly. Additionally, waste placement procedures should not be modified in a manner that may create impermeable zones of waste. If waste permeabilities change or signs of saturated waste conditions are observed, the stability of the landfill slopes shall be re-evaluated based on the new conditions.

Additionally, CCR material will be placed and compacted in uniform and continuous lifts beginning in the bottom of the cell with CCR materials abutting the perimeter berm. If needed, intermediate CCR slopes with a maximum slope inclination of 3H:1V and maximum height of 25 feet can be formed in the bottom of the cell without abutting the exterior berm of the cell to maintain intermediate stability conditions. Intermediate slopes higher than 25 feet must be buttressed by the perimeter berm.

M. Daily and Intermediate Cover

CCRs are predominantly inorganic by-products of the coal combustion process. Synthetic gypsum is a by-product of the flue-gas desulfurization process in which the flue gas is forced through a fluidized bed of calcium carbonate (limestone). Additionally, litter and other putrescible wastes are not allowed to be disposed at this CCR landfill. Therefore, daily and intermediate covers are not necessary for the control of disease vectors, odor, fires, scavenging, and litter.

Additionally, the CCRs will be deposited in a moistened condition thus reducing the possibility of fugitive dust. The possibility of fugitive dust from this CCR landfill will be further controlled by water spray from water trucks or irrigation type systems (See Section 2.P. of this plan).

N. Disease Vector Control

The CCR landfill is used only for the disposal of materials described in Section 1.B. Vector controls are not required at this CCR landfill since no litter or putrescible wastes are disposed.

O. Litter Control

The Plant Bowen CCR Landfill is used exclusively for disposal of CCR materials. These materials do not contain litter or contribute to blowing refuse. Routine inspection of the CCR landfill site is conducted regularly, and any litter and/or waste blown onto the CCR landfill, is removed.

P. Dust Control

The purpose of this fugitive dust control plan is to demonstrate compliance with the fugitive dust requirements in CCR Rule 391-3-4-.10(5)(a).

This fugitive dust control plan identifies and describes the CCR fugitive dust control measures that Georgia Power Plant Bowen uses to minimize CCR from becoming airborne at the facility, including CCR fugitive dust originating from CCR units, roads, and other CCR management and material handling activities.

CCR Rule 391-3-4-.10(2)(a), by reference to 40 CFR 257.53, defines "CCR fugitive dust" as "solid airborne particulate matter that contains or is derived from CCR, emitted from any source other than through a stack, or chimney". Fugitive dust originating from the landfill facility is controlled using water suppression and compaction.

The fugitive dust control measures identified and described in this plan were adopted and implemented based upon an evaluation of site-specific conditions and are determined to be applicable and appropriate for the Bowen CCR Landfill. Evaluation included assessing the effectiveness of the fugitive dust control measures for the facility, taking into consideration various factors such as site conditions, weather conditions, and operating conditions.

CCR that is transported via truck to the landfill facility is conditioned to appropriate moisture content to reduce the potential for fugitive dust.

Water suppression will be used as needed to control fugitive dust on facility roads used to transport CCR and on other CCR management areas.

Speed limits are also utilized to reduce the potential for fugitive dust.

Trucks used to transport CCR are filled to or under capacity to reduce the potential for material spillage.

Plant personnel assess the effectiveness of the control measures by performing visual observations of all CCR units and surrounding areas and implementing appropriate corrective actions for fugitive dust, as necessary. Logs are used to record the utilization of water-spray equipment.

When complaints are received from a citizen regarding a CCR fugitive dust event at the facility, the complaints are documented and investigated. Appropriate steps are taken if needed, including any corrective action.

CCR Annual Fugitive Dust Control Reports for the Plant Bowen CCR Units are published in the Georgia Power website under Environmental Compliance.

Q. Explosive Gas Control (Methane Gas)

Methane gas is not generated in the disposal area because the FGD and the coal combustion processes do not produce waste that generate methane gas. Also, waste that may generate methane gas, such as putrescible wastes and litter, is not allowed at this CCR landfill; thus, a methane gas monitoring system is not required.

R. Run-On/Run-Off Control

CCR is contained within earthen berms to prevent stormwater from the surrounding area from entering the disposal cells (run-on). CCR placement is confined to within this berm. Run-off from active cells, as well as any disturbed areas, is routed into the lined sediment ponds designed to collect and control the flow resulting from a 24-hour, 25-year storm. The details for erosion and sediment control structures are included in the permit drawings.

The Initial Run-On and Run-Off Control Plan that Georgia Power developed in October 2016 to meet the requirements of the Federal CCR Rule is included in Appendix 1. Additionally, the plan has been revised as part of the periodic assessment and also includes calculations for proposed Cells No. 5-8. The most recent Run-On and Run-Off Control Plan, is provided in Appendix 2. The Run-On and Run-Off Control Plan will be reviewed and updated every 5 years. Georgia Power may amend the written run-on and run-off control system plan at any time provided the revised plan is placed in the facility's operating record. Georgia Power must amend the written run-on and run-off control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

S. Surface Water Requirements

Lined sediment ponds, clear pools capture all stormwater run-off from the CCR disposal cells. Ditches constructed in the perimeter berms convey all run-off to these ponds. The only discharge from the site is from the clear pool ponds. The discharge from the clear pools during operation is monitored under a NPDES General Permit for Industrial Activities.

T. Final Grading

The final slopes were designed to remain permanently stable, to control erosion, to allow placement, compaction, and seeding of cover material, to minimize percolation of precipitation into the final cover, and to provide diversion of surface run-off from the disposal area. The final surface slopes are between 3% and 33% (3H:1V). Final grading plans and final cover system details are provided in the permit drawings.

U. Vegetation

All areas of the landfill required to be vegetated, as well as all ponds, will be maintained throughout the life of the CCR landfill. The following schedule indicates the recommended species, planting dates, and fertilization requirements. Reference the latest edition of the Manual for Erosion and Sediment Control in Georgia.

VEGETATION SCHEDULE														
BROADCAST														
SPECIES	**RATES**	**PLANTING DATES**												**COMMENTS**
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	
Wilimington Bahia alone	60 lbs./ac	- -	- -	——	——	- -	- -	- -	- -	- -	- -	- -	- -	Low growing.
Wilimington Bahia w/ other perennials	30 lbs./ac	- -	- -	——	——	- -	- -	- -	- -	- -	- -	- -	- -	Mix with service alespedeza. Low growing.
Tall Fescue alone	50 lbs./ac			——	——				- - ——	——	—— - -			
Tall Fescue w/ other perennials	30 lbs./ac			——	——				- - ——	——	—— - -			Mix with service alespedeza.
Reed Canary alone	50 lbs./ac								- - ——	——	—— - -			
Reed Canary w/ other perennials	30 lbs./ac								- - ——	——	—— - -			
Ambro Virgataor Appalow Lespedeza scarified	60 lbs./ac			- -	——	——	- -							Mix with bahai or tall fescue. Do not mix with service alespedeza.
Ambro Virgataor Appalow Lespedeza unscarified	75 lbs./ac	——	——	- -	- -	- -	- -	- -	- -	——	——	——	——	Mix with bahai or tall fescue. Do not mix with service alespedeza.

Note: Solid lines indicate optimum dates, dotted lines indicate permissible but marginal dates.

FERTILIZATION (Warm Season Grasses)			
YEAR	**N-P-K**	**RATE**	**N TOP DRESSING RATE**
First	6-12-12	1500 lbs./ac	50 - 100 lbs./ac
Second	6-12-12	800 lbs./ac	50 - 100 lbs./ac
Maintenance	10-10-10	400 lbs./ac	30 lbs./ac

V. Continuity of Operation

Access roads and ramps are provided to the active disposal cells. The permanent access road to the CCR landfill is an all-weather road and allows access to the CCR landfill during inclement weather for disposal, inspection, and maintenance or replacement of equipment. The access roads will be maintained at all times during landfill operations.

3. ENVIRONMENTAL PROTECTION

A. Inspections

1. 7-day Inspections

Georgia Power will inspect the CCR landfill at intervals not exceeding seven (7) days. The 7-day inspections will be made by a Qualified Person and include observation and documentation of any appearance of actual or potential structural weakness and other conditions which are disrupting or have the potential to disrupt the operation or safety of the landfill.

Georgia Power will record the results of these inspections on a self-generated form that will be filed in the facility's operating record. If a potential deficiency or release is identified during an inspection, Georgia Power will remedy the deficiency or release as soon as feasible. Georgia Power will prepare documentation detailing the corrective measures taken and place it in the facility's operating record.

2. Annual Inspections

As required by Chapter 391-3-4-.10(5)(a) of the Georgia Solid Waste Rules, a Professional Engineer registered in Georgia will inspect the CCR landfill on an annual basis. The inspection includes, at a minimum:

a. A visual inspection of the CCR landfill to identify signs of distress or malfunction of the CCR landfill.

b. A review of available information regarding the status and condition of the CCR landfill, including, but not limited to, files available in the facility's operating record such as:

   i. The results of the 7-day inspections and the results of previous annual inspections,

   ii. Files available in the operating record and other conditions which have disrupted or have the potential to disrupt the operation or safety of the CCR landfill.

c. If a potential deficiency or release is identified during an inspection, Georgia Power will remedy the deficiency or release as soon as feasible. Georgia Power will prepare documentation detailing the corrective measures taken and place it in the facility's operating record.

B. Annual Reporting

At the completion of each annual inspection, the Professional Engineer who completed the inspection will prepare an annual inspection report that includes the following:

a. Any changes in geometry of the CCR landfill components since the previous annual inspection.

b. The approximate volume of CCR contained in the unit at the time of the inspection.

c. Any appearances of an actual or potential structural weakness of the CCR within the CCR landfill, or any existing conditions that are disrupting or have the potential to disrupt the operation and stability of the CCR landfill.

d. Any other change(s) which may have affected the stability or operation of the CCR landfill since the previous annual inspection.

Annual Inspection Reports for the Plant Bowen CCR landfill, which meet the requirement of Chapter 391-3-4-.10(5) of the Georgia Rules, can be found online at the Georgia Power website under Environmental Compliance.

C. Leachate Management (Cells 3-10)

Leachate will be collected above the composite liner as detailed on the Composite Liner & Leachate Collection & Removal System Detail on Sheet H-15084 of the Permit Drawings. Leachate in Cells 3, 4, 7, and 8 is designed to gravity drain to the leachate pond for each cell where it will be pumped to the leachate storage tank. The leachate force main will consist of dual contained piping as described in the permit drawings. Leachate from Cells 5, 6, 9 and 10 will be pumped to the leachate storage tank directly from the leachate sump and riser system located within the cell. The leachate force main from Cells 5, 6, 9 and 10 will consist of dual contained piping as described on Sheet H15073, H15075, H52268 and H52269.

From the leachate storage tank, leachate may be transferred to the plant for re-use or to a water treatment facility on Plant property or off-site to a privately-owned water treatment system.

Pumps in the leachate ponds may also pump water to water trucks for use inside the cells for dust control. Slope markers indicating water levels will be added to the leachate ponds to help prevent overflow discharges. These markers will be maintained for the life of the facility.

The leachate ponds will operate under varying heads over their lifetime. Georgia Power will maintain permanent pumps in the leak detection sumps and will operate them as needed to maintain liquids in the leak detection system lower than one (1) foot.

D. Groundwater Monitoring Plan

Groundwater monitoring will be performed in accordance with the schedule and requirements indicated in the Plant Bowen CCR Landfill Groundwater Monitoring Plan included in Section 7 of this permit application. The plan meets the requirements of Georgia CCR Rule 391-3-4-.10(6).

4. RECORDKEEPING, NOTIFICATION, AND PUBLICLY ACCESSIBLE INTERNET SITE REQUIREMENTS

The Plant Bowen CCR Landfill complies and will continue to comply with the recordkeeping, notification, and publicly accessible internet site requirements set forth in Georgia CCR Rule 391-3-4-.10(8).

The publicly accessible internet site for the Plant Bowen CCR facilities is found at the Georgia Power website under Environmental Compliance.

A. Recordkeeping

Georgia Power maintains and will continue to maintain the facility's operating record at all times during the life of the CCR landfill including the closure and post closure period. These records are maintained by plant personnel and are located at Plant Bowen. The following records are maintained as part of the facility's operating record:

1. A copy of the permit and any operating conditions including location restrictions.

2. Inspection records, training procedures, and notification procedures required by this Plan and by Rule 391-3-4-.10(5) and (8).

3. Any demonstration, certification, finding, monitoring, testing, or analytical data pertaining to groundwater monitoring and as required by rule 391-3- 4 -.10(6).

4. Closure and post-closure care plans and any monitoring, testing, or analytical data required by those Plans and Rules 391-3-4.10(7).

5. Any cost estimates and financial assurance documentation.

6. A copy of the permit documents for the CCR landfill.

7. A copy of the groundwater monitoring plan for the CCR landfill.

8. A copy of the Construction Quality Assurance Plan, construction certifications, closure certifications, and post-closure certifications.

9. The fugitive dust control plan, and any subsequent amendment of the plan, required by 40 CFR 257.80(b), except that only the most recent control plan must be maintained in the facility's operating record irrespective of the time requirement of 5 years.

10. The annual CCR fugitive dust control report as required by 40 CFR 257.80(c).

11. The initial and periodic run-on and run-off control system plans.

All information contained in the facility's operating record will be furnished to the Georgia EPD or be made available at all reasonable times for inspection by EPD staff.

B. Notification and Internet Posting Requirements.

Unless otherwise specified by the Rules, Georgia Power will provide notifications to EPD within 30 days of placing documents in the facility's operating record. The notifications will be sent before the close of business on or before the day the notification is required to be completed. Notifications to EPD will be postmarked or sent by electronic mail. If a notification deadline falls on a weekend or federal holiday, the notification deadline will be extended to the next business day. Georgia Power will state in the notification to EPD if the relevant information was also placed on the Georgia Power website under Environmental Compliance. Information required to be posted on the Georgia Power website under Environmental Compliance will be available to the Public for at least five (5) years following the date on which the information was first posted.

C. Measuring and Reporting Requirements

In accordance with Rule 391-3-4-.17(5), on July 1 of each year after the first full year that the CCR Landfill solid waste handling permit is issued, Georgia Power will report to EPD the total volume of the CCR waste disposed in the CCR Landfill, and the CCR removed, recovered, or diverted for beneficial re-use. The required data will be submitted to EPD on forms issued by EPD.

5. SITE LIMITATIONS[1]

1. Engineering measures must be included in the design and operational (D&O) plan for this site, as presented in Section II of Addendum 1 referenced below[2].

2. The area considered for suitability includes only that area labeled Surveyed Site Boundary, as shown on Southern Company Services, Inc.'s Plate 2-1: Plant Bowen Composite Geologic Map, Revision 2, dated March 7, 2004.

3. Waste placement shall be limited to the Favorable Areas, and no waste shall be placed within the Unfavorable Areas, as delineated on Plate 2-1.

4. Only two borings were performed in the northern "Favorable Area" (Site B) that were located significantly north of the blue-dashed lineament shown on Plate 2-1. As such, no waste shall be placed north of an imaginary straight line drawn from boring BLFR20 through BLFR53 to the edge of the Surveyed Site Boundary, as shown on Plate 2-1. Modification of this limitation may be considered once additional information from the area is obtained.

5. A minimum 500-foot undisturbed buffer shall be maintained between the waste disposal area and any residential structures and/or water supply wells.

6. A minimum 200-foot undisturbed buffer shall be maintained between the waste disposal area and the Surveyed Site Boundary shown on Plate 2-1.

7. The spring shown along the northeastern edge of the proposed site (Plate 2-1), as well as any other on-site or adjacent springs or seeps, shall be incorporated into the facility's groundwater monitoring plan. Protective measures shall be incorporated into the facility's D&0 plan such that landfill activities will not adversely affect any on-site springs or seeps.

8. Topographic elevations of 670 feet and lower, as shown on Plate 2-1, shall remain undisturbed in areas adjacent to the Etowah River.

9. Bottom of waste elevations shall be kept a minimum of 5 feet above seasonal high groundwater elevations. Since seasonal high groundwater elevations have not been specifically determined for the subject site, the bottom of waste elevations shall be kept a minimum of 15 feet above the water level elevations shown for the date of December 18, 2002 on PELA, Inc.'s Table 3-1: Ground-Water Levels and Top of Unweathered Bedrock, dated January 6, 2004, provided as part of Addendum 1 referenced below[3].

10. All borings/piezometers located in the proposed waste footprint shall be abandoned in accordance with the Water Well Standards Act. The well casing shall be removed, and the borings

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[1] Approved by EPD on December 8, 2004

[2] Southern Company Services, Inc.'s Georgia Power Company, Plant Bowen, Proposed Coal Combustion By-Product Monofill/, Addendum 1, Site Acceptability Report, Hydrogeological Assessment and Demonstration of Engineering Measures, dated July 2004.

[3] Ditto.

shall be overdrilled and filled with a non-- shrinking cement/bentonite mixture via tremie pipe to within 10 feet of the maximum depth of waste. Within 10 feet of the maximum depth of waste, the boring can be filled with bentonite. Above the maximum depth of waste, the annular space can be backfilled with soil. Borings/piezometers located outside of the proposed waste footprint may be abandoned by backfilling with bentonite. The abandonment of all on-site wells shall be supervised by a professional geologist (PG) or professional engineer (PE) registered to practice in the State of Georgia. The supervising PG/PE shall submit a report of the abandonment to EPD and certify that the borings/wells were abandoned in accordance with the Water Well Standards Act.

11. Groundwater and surface water monitoring systems, conforming to EPD's Rules of Solid Waste Management, shall be installed at the site. The applicant must be aware that, due to the unpredictable nature of the karstic subsurface, a more comprehensive groundwater monitoring system will be necessary to adequately monitor the site. Well nests, consisting of shallow and deep (rock) wells, will be necessary. The well nests shall be installed along obvious and inferred lineaments on-site in addition to any other areas of potential leachate migration.

12. As the site is located within a seismic impact zone, all design engineering drawings included in the D&O plan shall stipulate that all structures are engineered to withstand a maximum horizontal acceleration of 0.22g.

13. All erosion control measures and/or diversion ditches shall conform to the Erosion and Sediment Control Act (as amended through 2003) and be protective of the Etowah River and any associated wetlands and perennial or intermittent tributaries.

6. ENGINEERING MEASURES/PREPARATION PROTOCOL

This Section is based on and referenced from Southern Company Services, Inc.'s report entitled "Georgia Power Company, Plant Bowen, Proposed Coal Combustion By-Product Monofill, Addendum I, Site Acceptability Report, Hydrogeologic Assessment and Demonstration of Engineering Measures," dated July 2004. The protocol and engineering measures presented therein, and summarized below, have been designed to prevent the collapse of potential subsurface voids and subsequent ground subsidence beneath the facility's waste footprint.

A. Cell Investigation and Preparation Protocol

The specific Cell Investigation and Preparation Protocol is summarized as follows:

1. Overburden material will be excavated and replaced with a minimum of 15 feet of compacted structural earth fill to the base grade elevations. This activity will verify the absence of voids within the upper 15 feet of the foundation.

2. Once the limits of the excavation grade are established, loaded off-road trucks will be used to proof-roll the entire cell subgrade. This will verify the absence of any appreciably sized void (i.e., typically >1 foot diameter) to a depth of approximately 5 feet below the excavation grade.

3. Any depressions encountered during execution of this Protocol will be photo-documented and reported to EPD. Should these features be encountered below the excavation grade, they will be photo-documented, repaired, and reported to EPD.

4. The model analysis results presented in Section II of Addendum I can be used to demonstrate the absence of any large (i.e., >10 feet diameter) voids to a depth of 15 feet below the excavation grade (i.e., an additional 10 feet below Zone 2).

B. Engineering Measures

The Engineering Measures, incorporated into the design of the disposal facility, are summarized as follows:

1. Excavation and Foundation Preparation

A "void free" interval of soil immediately beneath the cell base grade will be provided by a combination of excavating residual and terrace soils and backfilling with 13 ft. of compacted structural earth fill and 2 ft. of compacted clay liner.

In accordance with the Protocol, an additional 5 ft. interval of overburden soil beneath the proposed excavation limit will be "free of significant voids" as a result of proof-rolling and possibly repairing the excavation subgrade with loaded, off road, construction equipment. These combined activities will result in a 15 ft. thick zone below the final base grade of the cells that is free of voids. This zone will overlie a 5 ft. zone that is free of voids of any engineering significance.

The combined 20 ft. thick zone will be capable of spanning voids up to 10 ft. in diameter that may exist deeper than 20 ft. below the planned bottom of waste elevations.

A minimum of 5 ft. of overburden soils will be excavated in order to investigate the existing foundation conditions.

The compacted earth fill will consist of excavated residual and terrace soils (overburden) generally consisting of fine-grained silty and clayey soils.

An extensive Construction Quality Assurance Plan (CQAP) has been developed and will be executed during excavation, backfill and compaction of the overburden soils to assure that a competent, relatively low permeability, structural earth fill layer is provided.

Proof-rolling of the subgrade will be conducted utilizing pneumatic-tired, off - road trucks (such as a Caterpillar D400E or equivalent type vehicle). The gross machine weight, including a payload of approximately 40 tons of soil, will impart a minimum 7600 psf subgrade loading over a minimum tire width of 2 feet.

2. Sinkhole Repairs

It is explicitly noted that any depressions encountered during execution of this Protocol will be photo-documented and reported to EPD. Should these features be encountered below the excavation grade, they will be photo-documented, repaired, and reported to EPD. The procedures to be followed for repair of any collapse feature are included in the CQAP, Section 3.D.3.

3. Base Grades

The base grades will generally follow existing topography and range from 2.0% to 2.75%.

Upon excavation of the overburden soils to the excavation limits, subgrade proof-rolling, and collapse repairs (if any), 15 feet of cell base material will be placed and compacted to establish the cell base grades.

Specific construction procedures for a structural earth fill are provided in the CQAP. The CQAP will provide placement and compaction criteria for the fill soils.

A maximum permeability of $1x10^{-6}$ cm/sec for the lower 13 feet of the compacted fill will be specified.

Requirements for confirmation testing to ensure that this maximum permeability is achieved are included in Section 3.G. of the CQAP.

The upper 2 ft. (minimum) of the compacted earth fill for the stacking area shall have a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec. Thereby, the compaction requirements for the upper 2 ft. of the compacted structural earth fill will be adjusted, if necessary, in order to provide a minimum 2 ft. compacted layer that meets the above permeability requirement.

4. Storm Water Management

The following storm water controls are incorporated into the design of the Facility:

a. Properly designed and constructed perimeter containment berms for control of storm water run-on and control of run-off from cell operations.

b. Diversion and perimeter conveyance ditches for run-on and run-off control.

c. Perimeter containment berms and conveyance ditches will be constructed of compacted residual and terrace deposit clayey soils.

d. Final base cell grades will be utilized to facilitate run-off from within the active cell. Actual grades vary from 2.0% to 2.5%.

e. Run-off from CCB fill operations and final grades will be routed to sediment basins. The run-off will be directed into a primary sediment basin and then through a secondary basin, or "clear pool," providing optimum opportunity for settling of the suspended solids. Sediment basins will be designed for a 24 hr., 25 yr. storm.

f. The sediment basins will be lined with a composite liner system since storm water will be allowed to pool in these structures.

g. The composite liner system for the sediment basins will consist of a minimum 30 mil flexible membrane liner or a 60 mil high density polyethylene (HDPE) geomembrane overlain by a heavy weight (14 oz to 16 oz) geotextile in turn overlain by 12 inches of #89 stone and 6 inches of #3 stone. The HDPE will overlie the compacted structural earth fill (base grade).

5. CQA Monitoring Activities During Construction

The CQAP developed for the facility includes the specific inspection procedures that will be implemented during cell construction.

6. Inspections and Reporting

Guidelines for inspection and reporting during the operation, closure and post-closure of the Facility are provided below. These guidelines will focus on storm water management and controls to assure that storm water will not be allowed to pond in the cells and conveyance ditches. A notification protocol, which describes the notification procedures to be followed if anomalous conditions are identified during the inspections are included.

The inspections will be performed on a weekly basis by the Qualified Person during the operation and closure of the Facility. Post construction inspections will be performed, at a minimum, on a quarterly basis.

The area shall be thoroughly inspected to delineate, as a minimum, the following:

i) Areas of ponding of surface storm water in the cell or in the CCR fill area.

ii) Formation of concentric cracking that could be an early indication of a foundation Instability and potential collapse.

iii) Newly developed depressions and/or collapse features.

The ponding of any surface storm water within the cell area identified during operation, closure, and post-closure shall be immediately corrected by grading to facilitate run-off.

Any area exhibiting potential foundation instability, potential collapse, newly developed depressions and/or collapse features shall be located by survey. The conditions of the area shall be documented. The location and documentation shall be maintained in the CQA records and operating records of the facility.

If any occurrence and/or reoccurrence of instability is identified during the operation, closure, and post closure periods, the area shall be documented and repaired in accordance the Sinkhole Repair Procedures included in the CQAP.

The surveyed location of any of the above conditions shall be determined and the location depicted on the cell development drawing as a permanent record. The resulting location map shall be maintained in the CQA record for Cell construction and the operating record for the facility.

Upon identification of potential foundation instability, potential collapse, newly developed depressions and/or collapse features, the Notification Procedure outlined in the following Section 7 shall be followed.

a. Surface water body inspections:

   The weekly inspection shall include the existing surface waters of the site, most notably the Etowah River and the existing spring identified as being located in the northern favorable area.

b. Storm water management system inspections:

   Storm water monitoring will be in accordance with the NPDES General Permit for Stand-Alone Construction Activities (Permit No. GAR 100001) During Construction (Construction Storm Water Permit) as well as in accordance with NPDES General Permit for Industrial Activities during operations (Industrial Storm Water Permit, Permit No. GAR 100000).

c. Groundwater monitoring:

Groundwater sampling, testing, and reporting will be in accordance with the Groundwater and Surface Water Monitoring Plan.

7. Notification Protocol

The location and condition of any area exhibiting potential foundation instability, potential collapse, and/or newly developed depressions and/or collapse features detected during the construction and post - construction period, to include the operation, closure, and post-closure periods, shall be immediately communicated to the Plant Manager, Environmental Manager, Land and Remediation, and Owner's Engineer. Upon receipt of this notification, the Environmental Manager, Land and Remediation, shall immediately notify the Georgia EPD.

APPENDIX 1 – INITIAL RUN-ON AND RUN-OFF CONTROL PLAN [40 C.F.R. PART 257.81] PLANT BOWEN PRIVATE INDUSTRY SOLID WASTE DISPOSAL FACILITY (ASH LANDFILL), GEORGIA POWER COMPANY

INITIAL RUN-ON AND RUN-OFF CONTROL PLAN
40 C.F.R. PART 257.81
PLANT BOWEN PRIVATE INDUSTRY SOLID WASTE DISPOSAL FACILITY
(ASH LANDFILL)
GEORGIA POWER COMPANY

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities Final Rule" (40 C.F.R. Part 257 and Part 261), §257.81, requires the owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill to prepare a run-on and run-off control system plan to document how these control systems have been designed and constructed to meet the applicable requirements of this section of the Rule.

The CCR Landfill known as the Plant Bowen Ash Landfill is located in Bartow County, just west of Cartersville, Georgia on Plant Bowen property. Active Cells 1&2 and 9&10 were permitted and constructed with a minimum 2-ft. compacted clay liner with a maximum hydraulic conductivity of 1 x 10^{-7} cm/sec, underlain with a structural fill layer with a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec. Active Cells 3 & 4 were permitted and constructed with a composite liner system consisting of a HDPE geomembrane and a minimum 2-ft. compacted clay layer with a maximum hydraulic conductivity of 1 x 10^{-7} cm/sec. The composite liner is underlain with a structural fill layer with a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec. The structural fill layers varied in thickness from a minimum of 5 ft. to 13 ft. The facility consists of the CCR storage cells, leachate ponds for Cell 3 and 4, and separate sedimentation ponds and clear pools. Future Cells 5-8 will be constructed in the same manner as Cells 3 & 4.

The storm water flows have been calculated using the Natural Resources Conservation Service (NRCS) method (also known as the Soil Conservation Service (SCS) method) using the 25-yr, 24-hr storm event. The storm water detention system has been designed in accordance with the Georgia Soil and Water Conservation Commission requirements and Technical Release 55 (TR-55) as well as other local, city, and government codes. The post developed storm water discharge was designed to be less than the pre-developed storm water discharge in accordance with the requirements of the State of Georgia.

Run-off curve number data was determined using Table 2.1.5-1 from the Georgia Stormwater Management Manual. Run-off coefficient data was determined by utilizing Table 2.1.5-2.The rainfall distribution for Plant Bowen (Type II) was determined from Technical Release 55 (TR-55). NOAA Atlas 14 was used to determine the 24 hour precipitation for the design storm event of 25-yr for Plant Bowen.

The NRCS provides information on soil characteristics and hydrologic groups present at the site. It was determined that the hydrological group "C" for Cells 1&2 and "B" for Cells 3&4 and Cells 9&10 should be used to best reflect the characteristics of the soils on site. This information was placed into Hydraflow Hydrographs 2011 and used to generate appropriate precipitation curves, runoff curve numbers and storm basin run-off values. This methodology will be utilized for future cells within the unit.

The Plant Bowen Ash Landfill Cells are designed and constructed with perimeter berms and drainage ditches around the cells that prevent stormwater run-on during the peak discharge of a 24-hr, 25-yr storm from flowing onto the active portion of the landfill. The leachate from the Cells 3&4 and future Cells 5-8 leachate collection and removal system is routed to the leachate ponds where it is collected and controlled. The ponds are designed to hold the anticipated amount of leachate generated from the leachate collection system over a period of 6 days as well as the quantity of rainfall from a 24-hr, 100-yr storm event that falls directly into the leachate pond. For the purposes of the run-off calculations, the drainage area for the leachate pond is not included. Storm water run-off from Cells 1&2, Cells 9&10, and Cells 3&4, is routed through a system of sedimentation pond designed to handle the run-off from a 24-hr, 25-yr storm. This plan is supported by appropriate engineering calculations which are attached. Future Cells 5 – 8 will be designed and constructed in this same manner.

The facility is operated subject to and in accordance with § 257.3-3 of EPA's regulations.

I hereby certify that the run-on and run-off control system plan meets the requirements of 40 C.F.R. Part 257.81.

10/17/17

James C. Pegues, P.E.
Licensed State of Georgia, PE No. 17419

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JAMES C. PEGUES, JR.

Run-on and Run-off Control System Plan for Landfills:
Calculation Summary

for

Plant Bowen Ash Landfill Cells 1 and 2

Prepared by:

Southern Company Services
Technical Services

Originator: Jeremy Brown 10/6/16
Jeremy K. Brown Date

Reviewer: JW 10/11/16
Jason S. Wilson Date

Approval: 10/12/16
James C. Pegues Date

1.0 Purpose of Calculation

The purpose of this report is to demonstrate the run-on and run-off controls of the Plant Bowen Ash Landfill Cells 1 and 2 in order to prepare a run-on and run-off control system plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (EPA 40 CFR 257).

2.0 Summary of Conclusions

2.1 Site Overview

The Plant Bowen Ash Landfill Cells 1 and 2 are located on Plant Bowen property approximately 1.5 miles east of Euharlee, Georgia and 6 miles southwest of Cartersville, Georgia. The total area occupied by the Ash landfill Cells 1 and 2 is 34.88 acres. Run-off from this area is directed through perimeter ditches that are inside the cells' perimeter dike. Flow from the perimeter ditches discharge into a sedimentation pond via three 36" diameter pipes. The sedimentation pond is connected to a clear pool via two 72" diameter risers and two 48" diameter pipes. Storm water from the clear pool is discharged through a 72" diameter riser and 42" diameter pipe. Discharge from the clear pool goes into a stone lined ditch that flows to the east towards the Etowah River.

An overview of the Plant Bowen Ash Landfill Cells 1 & 2 is provided in Table 1 below.

Table 1 – Ash Landfill Cells 1 and 2 Site Characteristics

Pond Description	Storage Cells	Sedimentation Pond	Clear Pool
Size (Acres)	31.12	2.53	1.23
Outlet Type	Three 36" pipes	Two 72" Risers connected to two 48" pipes	72" Riser connected to a 48" pipe
Outlets To	Sedimentation Pond	Clear Pool	Ditch

2.2 Run-on Control System Plan

There is no stormwater run-on into the facility because it is contained within earthen berms that prevent stormwater from the surrounding area to enter the CCR facility.

2.3 Run-off Control System Plan

A hydrologic and hydraulic model was developed for the Plant Bowen Ash Landfill to determine the hydraulic capacity of Cells 1 and 2. The design storm for the purposes of run-off control system plans is the 24-hour, 25-year rainfall event. The results of routing the design storm event through the landfill are presented in Table 2 below:

Table 2 - Flood Routing Results for Plant Bowen Ash Landfill Cells 1 and 2

Plant Bowen	Normal Pool El (ft)	Top of Embankment El (ft)	Peak Water Surface El (ft)	Freeboard* (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
Cells 1 & 2	691.00	700.00	693.88	6.12	78.47	0.00**

*Freeboard is measured from the top of embankment to the peak water surface elevation

******The peak outflow is negligible because the riser is perforated with 0.5" holes that are covered by filter stone which drains the clear pool slowly. The elevation of the clear pool does not reach the elevation of the primary spillway during the design storm.

3.0 Methodology

3.1 HYDROLOGIC ANALYSES

The design storm for all run-on/run-off analyses is a 24-hour, 25-year rainfall event. A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 3.

Table 3 - Plant Bowen Ash Landfill Cells 1 and 2 Design Storm Distribution

Return Frequency (years)	Storm Duration (hours)	Rainfall Total (Inches)	Rainfall Source	Storm Distribution
25	24	6.07	NOAA Atlas 14	SCS Type II

The drainage area for the Plant Bowen Ash Landfill Cells 1 and 2 was delineated based on LiDAR data acquired for the Plant in 2004. Run-off characteristics were developed based on the Soil Conservation Service (SCS) methodologies as outlined in TR-55. An overall SCS curve number for the drainage area was developed based on methods prescribed in TR-55. Soil types were obtained from the Natural Resources Conservation Service. Land use areas were delineated based on aerial photography. Time of Concentration and Lag Time calculations were also developed based on methodologies prescribed in TR-55.

A table of the pertinent basin characteristics of the landfill is provided below in Table 4.

Table 4 - Landfill Hydrologic Information (Cells 1 & 2)

Drainage Basin Area (acres)	34.88
Hydrologic Curve Number, CN	64
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	20.60
Hydrologic Software	Hydroflow Hydrographs

Run-off values were determined by importing the characteristics developed above into a hydrologic model with the Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2013.

3.2 HYDRAULIC ANALYSES

Storage values for the landfill were determined by developing a stage-storage relationship utilizing contour data. The spillway system at the Plant Bowen Ash Landfill Cells 1 and 2 consists of a primary spillway and an auxiliary spillway which are both located in the clear pool. The primary spillway consists of a sharp crested riser weir of 18.85 foot length which conveys flow to a corrugated metal pipe. The top of the riser weir is at elevation of 694.50 feet. The pipe is 48-inches in diameter and has a length of approximately 128 feet. The auxiliary spillway is a concrete trapezoidal weir that is 8' wide with 6:1 side slopes sloped at 1% with a crest elevation of 696.00. A summary of spillway information is presented below in Table 5.

Table 5 - Spillway Attribute Table

Spillway Component	US Invert El (ft)	DS Invert El (ft)	Dimension (ft)	Slope (ft/ft)	Length (ft)	Spillway Capacity (cfs)
Primary	674.00	673.50	4' Diameter	0.40%	128	52.46
Auxiliary	696.00	695.65	8' span 4' rise	1.00%	35	1,296

Based on the spillway attributes listed above, the data was inserted into Hydraflow Hydrographs to determine the pond performance during the design storm. Results are shown in Table 2.

4.0 SUPPORTING INFORMATION

4.1 CURVE NUMBER

Terrain Type	**Area**	**Curve Number**
Grass	31.17	61
Gravel	2.56	85
HDPE	1.15	98

4.2 STAGE-STORAGE TABLE

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	689.00	15,324	0	0
1.00	690.00	56,131	33,591	33,591
2.00	691.00	60,622	58,356	91,947
3.00	692.00	65,193	62,887	154,835
4.00	693.00	69,840	67,496	222,331
5.00	694.00	74,567	72,183	294,515
6.00	695.00	79,374	76,950	371,465
7.00	696.00	84,257	81,795	453,260

4.3 TIME OF CONCENTRATION

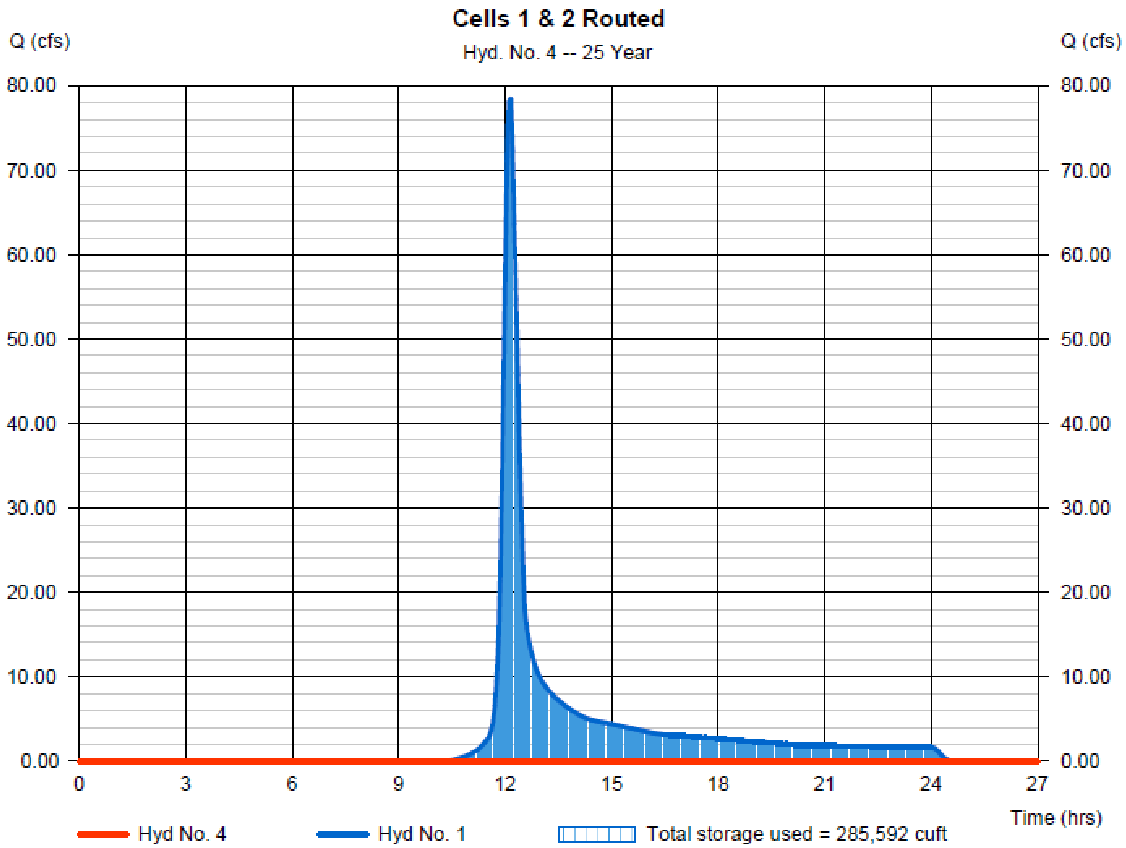
Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.79		0.00		0.00		
Land slope (%)	=	7.50		0.00		0.00		
Travel Time (min)	**=**	**12.78**	**+**	**0.00**	**+**	**0.00**	**=**	**12.78**
Shallow Concentrated Flow								
Flow length (ft)	=	202.00		0.00		0.00		
Watercourse slope (%)	=	18.56		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=6.95			0.00		0.00		
Travel Time (min)	**=**	**0.48**	**+**	**0.00**	**+**	**0.00**	**=**	**0.48**
Channel Flow								
X sectional flow area (sqft)	=	6.00		0.00		0.00		
Wetted perimeter (ft)	=	8.47		0.00		0.00		
Channel slope (%)	=	1.95		0.00		0.00		
Manning's n-value	=	0.030		0.015		0.015		
Velocity (ft/s)	=5.51			0.00		0.00		
Flow length (ft)	({0})2387.0			0.0		0.0		
Travel Time (min)	**=**	**7.23**	**+**	**0.00**	**+**	**0.00**	**=**	**7.23**

Total Travel Time, Tc .... **20.49 min**

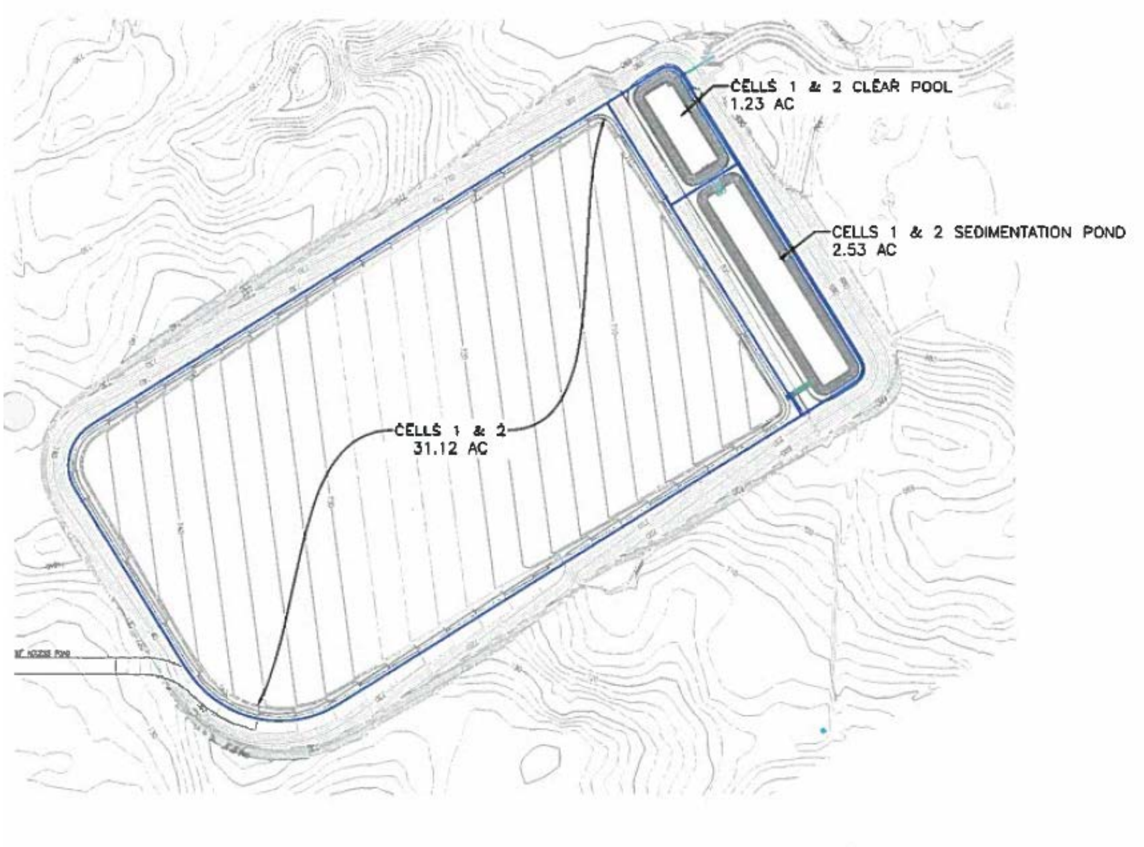
4.4 RESULTS

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	25 yrs	Time to peak	=	n/a
Time interval	=	3 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	1 - Cells 1 & 2	Max. Elevation	=	693.88 ft
Reservoir name	=	Cell 1&2 Sed Pond/Clear Pool	Max. Storage	=	285,592 cuft

Storage Indication method used.



4.5 DRAINAGE BASIN



Run-on and Run-off Control System Plan for Landfills:
Calculation Summary

for

Plant Bowen Ash Landfill Cells 3 and 4

Prepared by:

Southern Company Services
Technical Services

Originator: Jeremy Brown 10/6/16
Jeremy K. Brown Date

Reviewer: JW 10/11/16
Jason S. Wilson Date

Approval: JP 10/12/16
James C. Pegues Date

1.0 Purpose of Calculation

The purpose of this report is to demonstrate the run-on and run-off controls of the Plant Bowen Ash Landfill in order to prepare a run-on and run-off control system plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (EPA 40 CFR 257).

2.0 Summary of Conclusions

2.1 Site Overview

The Plant Bowen Ash Landfill Cells 3 & 4 are located on Plant Bowen property approximately 1.5 miles east of Euharlee, Georgia and 6 miles southwest of Cartersville, Georgia. The total area occupied by the Ash Landfill Cells 3 and 4 is 36.45 acres. The active drainage area for run-off purposes is 35.36 acres which does not include the area for the leachate ponds.

Run-off from Cell 3 is directed through perimeter ditches that are inside the cell's perimeter dike. Flow from the perimeter ditches discharge into a sedimentation pond via a concrete channel. The Cell 3 sedimentation pond is connected to a clear pool via two 48" diameter risers and two 30" diameter pipes. Storm water from the Cell 3 clear pool is discharged through two 54" diameter risers and two 36" diameter pipes. Discharge from the clear pool goes into a ditch that flows to the east into the Etowah River.

Run-off from Cell 4 is directed through perimeter ditches that are inside the cell's perimeter dike. Flow from the perimeter ditches discharge into a sedimentation pond via a concrete channel. The Cell 4 sedimentation pond is connected to a clear pool via two 48" diameter risers and two 30" diameter pipes. Storm water from the Cell 4 clear pool is discharged through a 66" diameter riser and a 42" diameter pipe. Discharge from the clear pool goes into a ditch that flows to the north towards the Etowah River.

An overview of the Bowen Ash Landfill Cells 3 & 4 is provided in Tables 1a and 1b below.

Table 1a – Bowen Ash Landfill Cell 3 Site Characteristics

Pond Description	Storage Cell	Sedimentation Pond	Clear Pool
Size (Acres)	18.81	1.93	0.62
Outlet Type	Concrete channel	Two 48" Risers connected to two 30" pipes	Two 54" Risers connected to two 36" pipes
Outlets To	Sedimentation Pond	Clear Pool	Ditch

Table 1b – Bowen Ash Landfill Cell b Site Characteristics

Pond Description	Storage Cell	Sedimentation Pond	Clear Pool
Size (Acres)	12.65	0.92	0.43
Outlet Type	Concrete channel	Two 48” Risers connected to two 30” pipes	A 66” Riser connected to a 42” pipe
Outlets To	Sedimentation Pond	Clear Pool	Ditch

2.2 Run-on Control System Plan

There is no stormwater run-on into the facility because it is contained within earthen berms that prevent stormwater from the surrounding area to enter the CCR facility.

2.3 Run-off Control System Plan

A hydrologic and hydraulic model was developed for the Plant Bowen Ash Landfill to determine the hydraulic capacity of Cells 3 and 4. The design storm for the purposes of run-off control system plans is the 24-hour, 25-year rainfall event. The results of routing the design storm event through the landfill are presented in Table 2 below:

Table 2 - Flood Routing Results for Plant Bowen Ash Landfill Cells 3 and 4

Plant Bowen	Normal Pool El (ft)	Top of Embankment El (ft)	Peak Water Surface El (ft)	Freeboard* (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
Cell 3	685.50	694.00	689.11	4.89	150.99	3.50
Cell 4	698.50	704.00	701.89	2.11	98.96	70.77

*Freeboard is measured from the top of embankment to the peak water surface elevation

3.0 Methodology

3.1 HYDROLOGIC ANALYSES

The design storm for all run-on/run-off analyses is a 24-hour, 25-year rainfall event. A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 3.

Table 3 - Plant Bowen Ash Landfill Design Storm Distribution

Return Frequency (years)	Storm Duration (hours)	Rainfall Total (Inches)	Rainfall Source	Storm Distribution
25	24	6.07	NOAA Atlas 14	SCS Type II

The drainage area for the Plant Bowen Ash Landfill Cells 3 and 4 was delineated based on LiDAR data acquired for the Plant in 2005. Run-off characteristics were developed based on the Soil Conservation Service (SCS) methodologies as outlined in TR-55. An overall SCS curve number for the drainage area was developed based on methods prescribed in TR-55. Soil types were obtained from the Natural Resources Conservation Service. Land use areas were delineated based on aerial photography. Time of Concentration and Lag Time calculations were also developed based on methodologies prescribed in TR-55.

A table of the pertinent basin characteristics of the landfill is provided below in Tables 4a through 4b.

Table 4a - Landfill Hydrologic Information (Cell 3)

Drainage Basin Area (acres)	21.36
Hydrologic Curve Number, CN	94
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	11.80
Hydrologic Software	Hydroflow Hydrographs

Table 4b - Landfill Hydrologic Information (Cell 4)

Drainage Basin Area (acres)	14.00
Hydrologic Curve Number, CN	94
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	10.40
Hydrologic Software	Hydroflow Hydrographs

Run-off values were determined by importing the characteristics developed above into a hydrologic model with the Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2013.

3.2 HYDRAULIC ANALYSES

Storage values for the landfill were determined by developing a stage-storage relationship utilizing contour data. The spillway systems at the Plant Bowen Cells 3 and 4 consist of a primary spillway and an auxiliary spillway which are located in the clear pools for Cell 3 and Cell 4 respectively. The Cell 3 primary spillway consists of two sharp crested riser weirs of 28.28 foot length which conveys flow to two HDPE pipes. The top of the riser weirs is at elevation of 689.00 feet. The pipes are 36-inches in diameter and have a length of approximately 117 feet each. The Cell 3 auxiliary spillway is a concrete trapezoidal weir that is 20’ wide with 6:1 side slopes and is sloped at 1% with a crest elevation of 690.50. The Cell 4 primary spillway consists of a sharp crested riser weir of 25.13 foot length which conveys flow to an hdpe pipe. The top of the riser weir is at elevation of 701.00 feet. The pipe is 42-inches in diameter and has a length of approximately 113 feet. The Cell 4 auxiliary spillway is a concrete trapezoidal weir that is 18’ wide with 6:1 side slopes and is sloped at 1% with a crest elevation of 702.00.

A summary of spillway information is presented below in Tables 5a through 5b.

Table 5a - Spillway Attribute Table (Cell 3)

Spillway Component	US Invert El (feet)	DS Invert El (feet)	Dimension (ft)	Slope (ft/ft)	Length (ft)	Spillway Capacity (cfs)
Primary	671.00	670.71	3' Diameter	0.20%	117	68.90
Auxiliary	690.50	690.16	20' span 3.5' rise	0%	34.50	1,445

Table 5b - Spillway Attribute Table (Cell 4)

Spillway Component	US Invert El (feet)	DS Invert El (feet)	Dimension (ft)	Slope (ft/ft)	Length (ft)	Spillway Capacity (cfs)
Primary	682.00	680.98	3.5' Diameter	0.90%	113	110.20
Auxiliary	702.00	701.71	18' span 2' rise	1.00%	29	235.5

Based on the spillway attributes listed above, the data was inserted into Hydraflow Hydrographs to determine the pond performance during the design storm. Results are shown in Table 2.

4.0 SUPPORTING INFORMATION

4.1 CURVE NUMBER

4.1.1 CELL 3

Terrain Type	Area	Curve Number
Grass	1.56	61
Gravel	2.22	85
HDPE/Concrete	17.58	98

4.1.2 CELL 4

Terrain Type	Area	Curve Number
Grass	1.14	61
Gravel	1.29	85
HDPE/Concrete	11.57	98

4.2 STAGE-STORAGE TABLE

4.2.1 CELL 3

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	683.00	9,025	0	0
1.00	684.00	53,992	28,361	28,361
2.00	685.00	57,714	55,837	84,198
2.50	685.50	59,604	29,325	113,523
3.00	686.00	61,514	30,275	143,799
4.00	687.00	65,394	63,438	207,236
5.00	688.00	69,352	67,357	274,593
6.00	689.00	73,388	71,353	345,946
7.00	690.00	77,502	75,428	421,374
7.50	690.50	79,590	39,268	460,642

4.2.2 CELL 4

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	697.00	6,653	0	0
1.00	698.00	23,565	14,245	14,245
1.50	698.50	25,207	12,189	26,434
2.00	699.00	26,868	13,015	39,450
3.00	700.00	30,248	28,538	67,988
4.00	701.00	33,707	31,959	99,947
5.00	702.00	37,215	35,443	135,390

4.3 TIME OF CONCENTRATION

4.3.1 CELL 3

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 3.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.79		0.00		0.00		
Land slope (%)	= 0.67		0.00		0.00		
Travel Time (min)	**= 0.84**	**+**	**0.00**	**+**	**0.00**	**=**	**0.84**
Shallow Concentrated Flow							
Flow length (ft)	= 9.00		0.00		0.00		
Watercourse slope (%)	= 38.89		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=10.06		0.00		0.00		
Travel Time (min)	**= 0.01**	**+**	**0.00**	**+**	**0.00**	**=**	**0.01**
Channel Flow							
X sectional flow area (sqft)	= 1.64		20.22		0.00		
Wetted perimeter (ft)	= 5.57		22.52		0.00		
Channel slope (%)	= 1.66		0.50		0.00		
Manning's n-value	= 0.030		0.013		0.015		
Velocity (ft/s)	=2.83		7.54		0.00		
Flow length (ft)	({0})1821.0		77.0		0.0		
Travel Time (min)	**= 10.74**	**+**	**0.17**	**+**	**0.00**	**=**	**10.91**
Total Travel Time, Tc							**11.77 min**

4.3.2 CELL 4

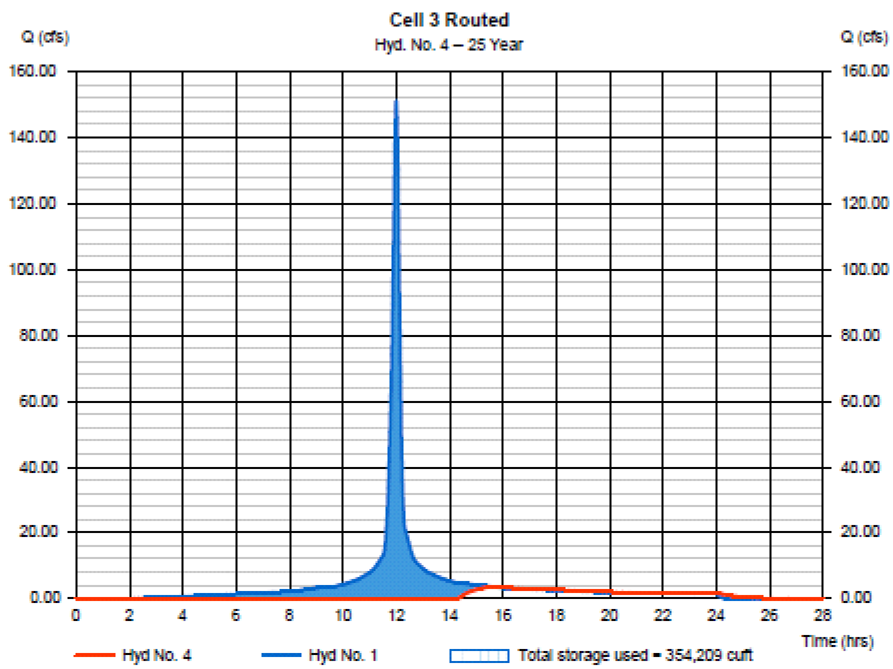
Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 3.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.79		0.00		0.00		
Land slope (%)	= 0.67		0.00		0.00		
Travel Time (min)	**= 0.84**	**+**	**0.00**	**+**	**0.00**	**=**	**0.84**
Shallow Concentrated Flow							
Flow length (ft)	= 9.00		0.00		0.00		
Watercourse slope (%)	= 38.89		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=10.06		0.00		0.00		
Travel Time (min)	**= 0.01**	**+**	**0.00**	**+**	**0.00**	**=**	**0.01**
Channel Flow							
X sectional flow area (sqft)	= 1.49		11.65		0.00		
Wetted perimeter (ft)	= 5.43		17.76		0.00		
Channel slope (%)	= 1.36		0.99		0.00		
Manning's n-value	= 0.030		0.013		0.015		
Velocity (ft/s)	=2.44		8.60		0.00		
Flow length (ft)	({0})1379.0		74.0		0.0		
Travel Time (min)	**= 9.44**	**+**	**0.14**	**+**	**0.00**	**=**	**9.58**
Total Travel Time, Tc							**10.44 min**

4.4 RESULTS

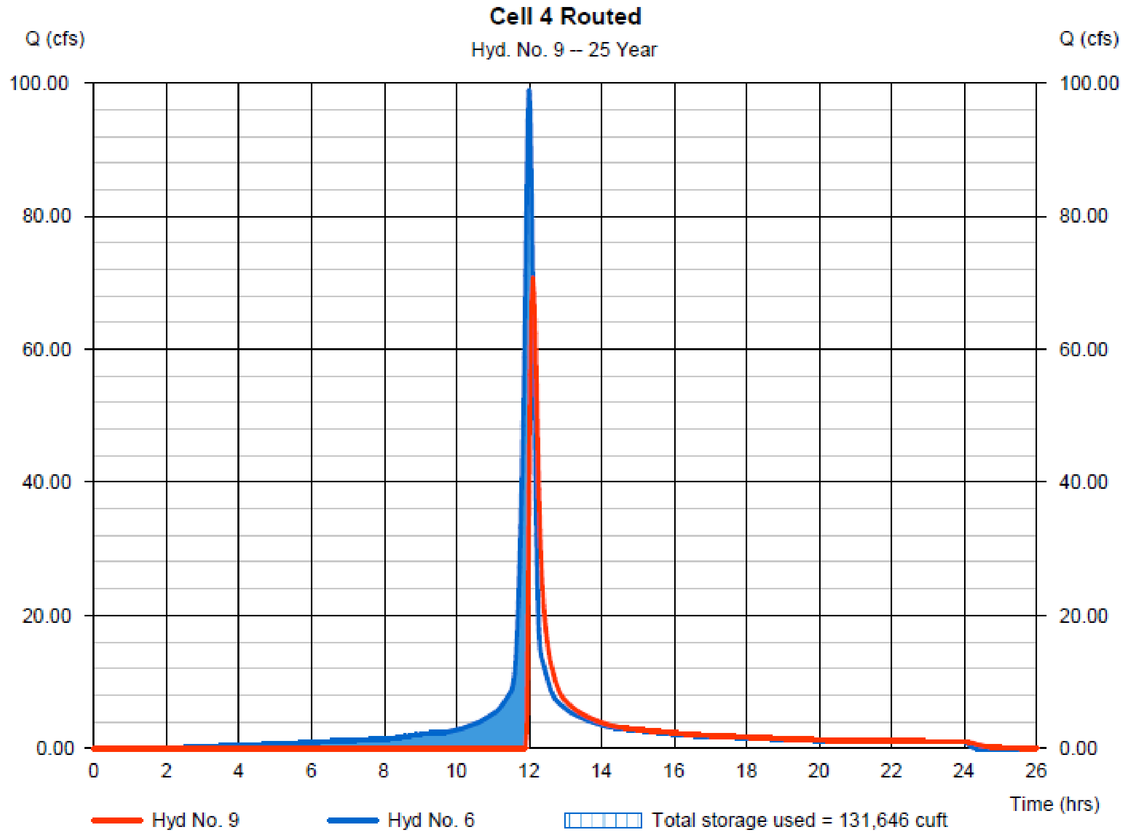
4.4.1 CELL 3

Hydrograph type	= Reservoir	Peak discharge	= 3.496 cfs
Storm frequency	= 25 yrs	Time to peak	= 15.70 hrs
Time interval	= 2 min	Hyd. volume	= 83,112 cuft
Inflow hyd. No.	= 1 - Cell 3	Max. Elevation	= 689.11 ft
Reservoir name	= Cell 3 Sed Pond/Clear Pool	Max. Storage	= 354,209 cuft

Storage Indication method used.



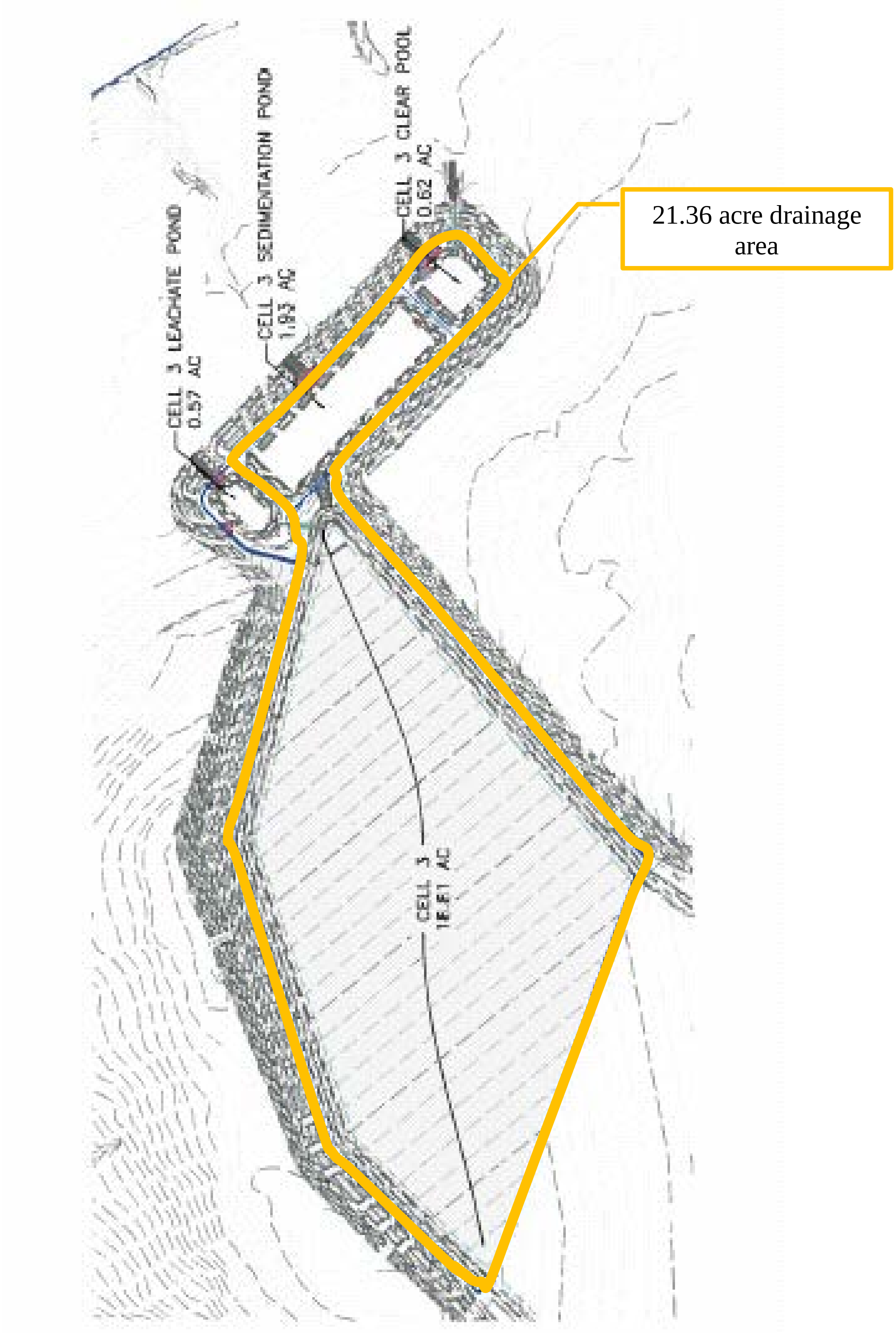
4.4.2 CELL 4



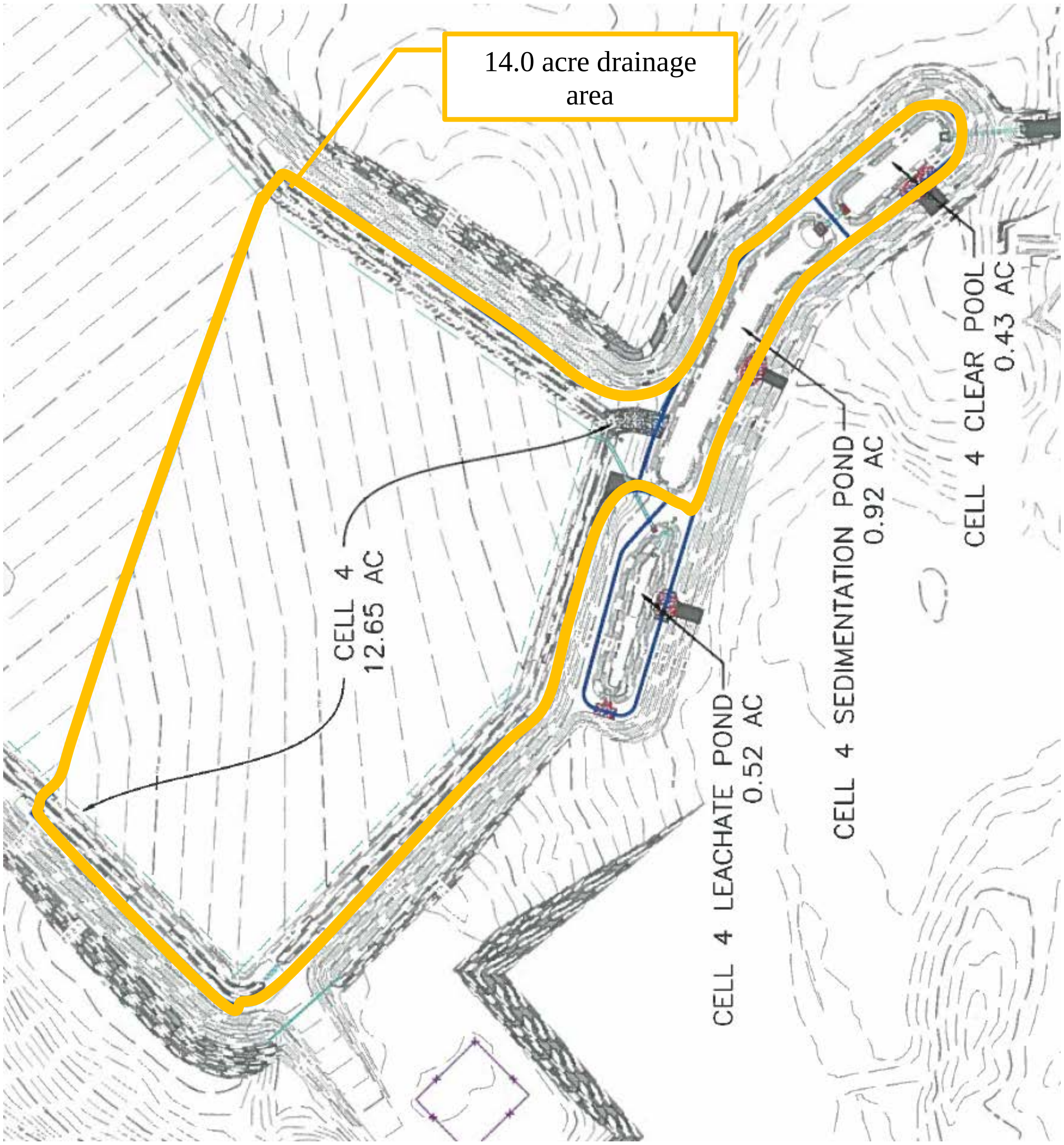
Cell 4 Routed
Hyd. No. 9 -- 25 Year
Q (cfs)
Q (cfs)
100.00
80.00
60.00
40.00
20.00
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Time (hrs)
Hyd No. 9
Hyd No. 6
Total storage used = 131,646 cuft

4.5 DRAINAGE BASIN

4.5.1 CELL 3



4.5.2 CELL 4


14.0 acre drainage area
CELL 4
12.65 AC
CELL 4 LEACHATE POND
0.52 AC
CELL 4 SEDIMENTATION POND
0.92 AC
CELL 4 CLEAR POOL
0.43 AC

Run-on and Run-off Control System Plan for Landfills:
Calculation Summary

for

Plant Bowen Ash Landfill Cells 9 and 10

Prepared by:

Southern Company Services
Technical Services

Originator: Jeremy Brown 10/6/16
Jeremy K. Brown Date

Reviewer: JWilson 10/11/16
Jason S. Wilson Date

Approval: J Pegues 10/12/16
James C. Pegues Date

1.0 Purpose of Calculation

The purpose of this report is to demonstrate the run-on and run-off controls of the subject Plant Bowen Ash Landfill Cells 9 and 10 in order to prepare a run-on and run-off control system plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (EPA 40 CFR 257).

2.0 Summary of Conclusions

2.1 Site Overview

The Plant Bowen Ash Landfill Cells 9 and 10 are located on Plant Bowen property approximately 1.5 miles east of Euharlee, Georgia and 6 miles southwest of Cartersville, Georgia. The total area occupied by the Ash landfill Cells 9 and 10 is 34.71 acres. Run-off from this area is directed through perimeter ditches that are inside the cells' perimeter dike. Flow from the perimeter ditches discharge into a sedimentation pond via four 30" diameter pipes. The sedimentation pond is connected to a clear pool via two 48" diameter risers and two 30" diameter pipes. Storm water from the clear pool is discharged through a 66" diameter riser and 42" diameter pipe. Discharge from the clear pool goes into a stone lined ditch that flows to the east into the Etowah River.

An overview of Cells 9 & 10 is provided in Table 1 below.

Table 1 – Ash Landfill Cells 9 and 10 Site Characteristics

Pond Description	Storage Cells	Sedimentation Pond	Clear Pool
Size (Acres)	31.67	2.12	0.92
Outlet Type	Four 30" pipes	Two 48" Risers connected to two 30" pipes	66" Riser connected to a 42" pipe
Outlets To	Sedimentation Pond	Clear Pool	Ditch

2.2 Run-on Control System Plan

There is no stormwater run-on into the facility because it is contained within earthen berms that prevent stormwater from the surrounding area to enter the Ash Landfill area.

2.3 Run-off Control System Plan

A hydrologic and hydraulic model was developed for the Plant Bowen Ash Landfill to determine the hydraulic capacity of Cells 9 and 10. The design storm for the purposes of run-off control system plans is the 24-hour, 25-year rainfall event. The results of routing the design storm event through the landfill are presented in Table 2 below:

Table 2 - Flood Routing Results for Plant Bowen Ash Landfill Cells 9 and 10

Plant Bowen	Normal Pool El (ft)	Top of Embankment El (ft)	Peak Water Surface El (ft)	Freeboard* (ft)	Peak Inflow (cfs)	Peak Outflow (cfs)
Cells 9 & 10	697.00	706.00	701.50	4.5	65.64	0.00**

*Freeboard is measured from the top of embankment to the peak water surface elevation

******The peak outflow is negligible because the riser is perforated with 0.5" holes that are covered by filter stone which drains the clear pool slowly. The elevation of the clear pool does not reach the elevation of the primary spillway during the design storm.

3.0 Methodology

3.1 HYDROLOGIC ANALYSES

The design storm for all run-on/run-off analyses is a 24-hour, 25-year rainfall event. A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 3.

Table 3 - Plant Bowen Ash Landfill Cells 9 and 10 Design Storm Distribution

Return Frequency (years)	Storm Duration (hours)	Rainfall Total (Inches)	Rainfall Source	Storm Distribution
25	24	6.07	NOAA Atlas 14	SCS Type II

The drainage area for the Plant Bowen Ash Landfill Cells 9 and 10 was delineated based on LiDAR data acquired for the Plant in 2005. Run-off characteristics were developed based on the Soil Conservation Service (SCS) methodologies as outlined in TR-55. An overall SCS curve number for the drainage area was developed based on methods prescribed in TR-55. Soil types were obtained from the Natural Resources Conservation Service. Land use areas were delineated based on aerial photography. Time of Concentration and Lag Time calculations were also developed based on methodologies prescribed in TR-55.

A table of the pertinent basin characteristics of the landfill is provided below in Table 4.

Table 4 - Landfill Hydrologic Information (Cells 9 & 10)

Drainage Basin Area (acres)	34.71
Hydrologic Curve Number, CN	64
Hydrologic Methodology	SCS Method
Time of Concentration (minutes)	31.50
Hydrologic Software	Hydroflow Hydrographs

Run-off values were determined by importing the characteristics developed above into a hydrologic model with the Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2013.

3.2 HYDRAULIC ANALYSES

Storage values for the landfill were determined by developing a stage-storage relationship utilizing contour data. The spillway system at the Plant Bowen Ash Landfill Cells 9 and 10 consists of a primary spillway and an auxiliary spillway which are located in the clear pool. The primary spillway consists of a sharp crested riser weir of 17.28 foot length which conveys flow to an HDPE pipe. The top of the riser weir is at elevation of 701.50 feet. The pipe is 42-inches in diameter and has a length of approximately 200 feet. The auxiliary spillway is a concrete trapezoidal weir that is 24' wide with 6:1 side slopes sloped at 1% with a crest elevation of 703.50. A summary of spillway information is presented below in Table 5.

Table 5 - Spillway Attribute Table

Spillway Component	US Invert El (ft)	DS Invert El (ft)	Dimension (ft)	Slope (ft/ft)	Length (ft)	Spillway Capacity (cfs)
Primary	680.00	679.00	3.5' Diameter	0.50%	200	82.16
Auxiliary	703.50	703.21	24' span 2.5' rise	1.00%	29.5	628.9

Based on the spillway attributes listed above, the data was inserted into Hydraflow Hydrographs to determine the pond performance during the design storm. Results are shown in Table 2.

4.0 SUPPORTING INFORMATION

4.1 CURVE NUMBER

Terrain Type	Area	Curve Number
Grass	31.17	61
Gravel	2.48	85
HDPE	0.76	98

4.2 STAGE-STORAGE TABLE

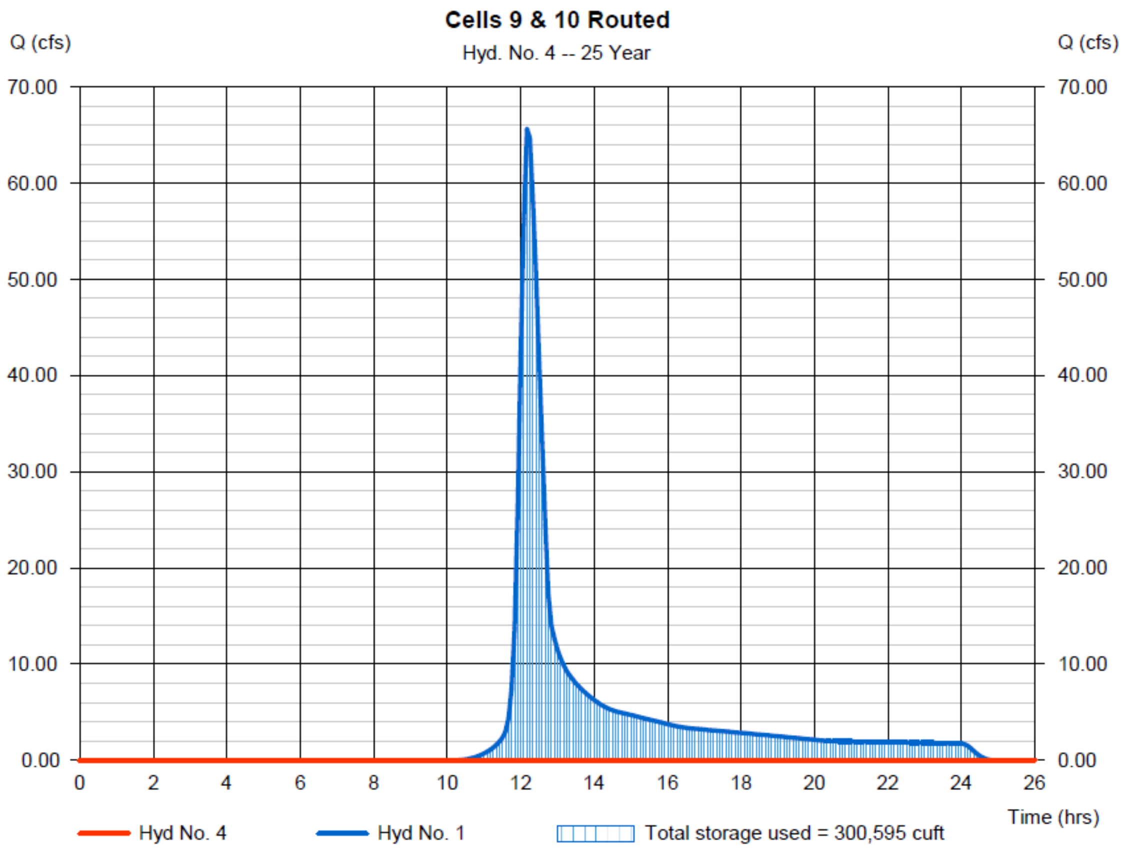
Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	695.00	9,369	0	0
1.00	696.00	40,876	23,269	23,269
2.00	697.00	44,230	42,538	65,807
3.00	698.00	47,663	45,931	111,738
4.00	699.00	51,173	49,403	161,141
5.00	700.00	54,762	52,952	214,093
6.00	701.00	58,431	56,581	270,674
7.00	702.00	62,177	60,288	330,962
8.00	703.00	66,002	64,074	395,036
8.50	703.50	67,945	33,482	428,518

4.3 TIME OF CONCENTRATION

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.79		0.00		0.00		
Land slope (%)	=	2.17		0.00		0.00		
Travel Time (min)	**=**	**20.99**	**+**	**0.00**	**+**	**0.00**	**=**	**20.99**
Shallow Concentrated Flow								
Flow length (ft)	=	353.00		0.00		0.00		
Watercourse slope (%)	=	15.43		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	6.34		0.00		0.00		
Travel Time (min)	**=**	**0.93**	**+**	**0.00**	**+**	**0.00**	**=**	**0.93**
Channel Flow								
X sectional flow area (sqft)	=	6.57		1.79		0.00		
Wetted perimeter (ft)	=	8.79		3.39		0.00		
Channel slope (%)	=	1.45		1.51		0.00		
Manning's n-value	=	0.030		0.013		0.015		
Velocity (ft/s)	=	4.92						
				9.18				
						0.00		
Flow length (ft)		({0})2773.0		102.0		0.0		
Travel Time (min)	**=**	**9.39**	**+**	**0.19**	**+**	**0.00**	**=**	**9.58**

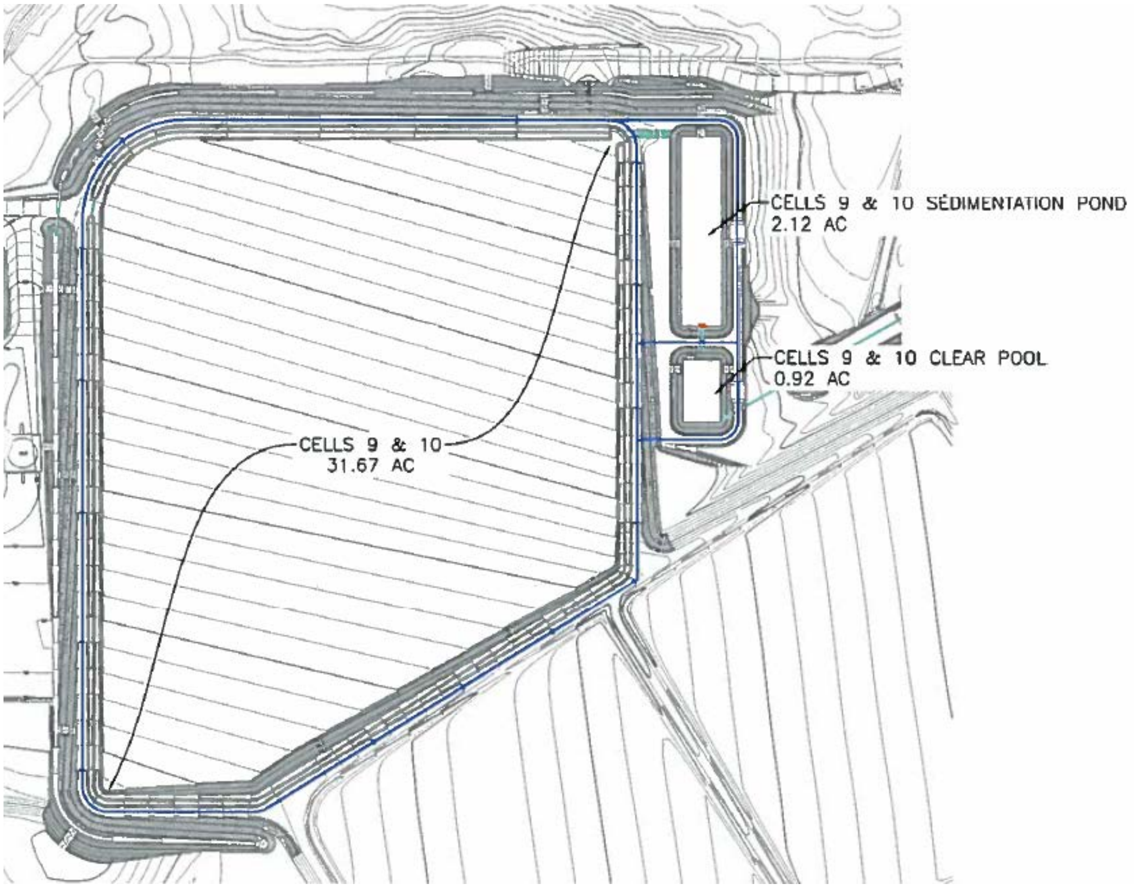
Total Travel Time, Tc .... **31.49 min**

4.4 RESULTS



Cells 9 & 10 Routed
Hyd. No. 4 -- 25 Year
Q (cfs)
Q (cfs)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Time (hrs)
Hyd No. 4
Hyd No. 1
Total storage used = 300,595 cuft

4.5 DRAINAGE BASIN



APPENDIX 2 – PERIODIC RUN-ON AND RUN-OFF CONTROL PLAN REVISION 3 [391-3-4-.10(5) AND 40 C.F.R. PART 257.81] PLANT BOWEN PRIVATE INDUSTRY SOLID WASTE DISPOSAL FACILITY (ASH LANDFILL), GEORGIA POWER COMPANY

PERIODIC RUN-ON AND RUN-OFF CONTROL PLAN REVISION 3
391-3-4-.10(5) and 40 C.F.R. PART 257.81
PLANT BOWEN PRIVATE INDUSTRY SOLID WASTE DISPOSAL FACILITY
(ASH LANDFILL)
GEORGIA POWER COMPANY

The Federal CCR Rule, and, for existing CCR Landfills where applicable, the Georgia CCR Rule (391-3-4-.10) require the owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill to prepare a run-on and run-off control system plan to document how these control systems have been designed and constructed to meet the applicable requirements of this section of the Rule. *See* 40 C.F.R. § 257.81; Ga. Comp. R. & Regs. r. 391.3-4-.10(5)(a). In addition, the Rules require periodic run-on and run-off control system plans every five years. *See* 40 C.F.R. § 257.81(c)(4); Ga. Comp. R. & Regs. r. 391.3-4-.10(5)(a).

The CCR Landfill known as the Plant Bowen CCR Landfill is located in Bartow County, just west of Cartersville, Georgia on Plant Bowen property. Active Cells 1 & 2 and 9 & 10 were permitted and constructed with a minimum 2-ft. compacted clay liner with a maximum hydraulic conductivity of 1 x 10^{-7} cm/sec, underlain with a structural fill layer with a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec. Cells 9 & 10 were subsequently retrofitted with a composite liner and leachate collection system. Active Cells 3 & 4 were permitted and constructed with a composite liner system consisting of a HDPE geomembrane and a minimum 2-ft. compacted clay layer with a maximum hydraulic conductivity of 1 x 10^{-7} cm/sec. The composite liner is underlain with a structural fill layer with a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec. The structural fill layers varied in thickness from 5 ft. (minimum) to 13 ft. The facility consists of the CCR storage cells, leachate ponds for Cell 3 and 4, and separate sedimentation ponds and clear pools. Future Cells 5-8 will be constructed in the same manner as Cells 3 & 4.

The storm water flows have been calculated using the Natural Resources Conservation Service (NRCS) method (also known as the Soil Conservation Service (SCS) method) using the 25-yr, 24-hr storm event. The storm water detention system has been designed in accordance with the Georgia Soil and Water Conservation Commission requirements and Technical Release 55 (TR-55) as well as other local, city, and government codes. The post-developed storm water discharge was designed to be less than the pre-developed storm water discharge in accordance with the requirements of the State of Georgia.

Run-off curve number data was determined using Table 2.1.5-1 from the Georgia Stormwater Management Manual. Run-off coefficient data was determined by utilizing Table 2.1.5-2. The rainfall distribution for Plant Bowen (Type II) was determined from Technical Release 55 (TR-55). National Oceanic and Atmospheric Administration (NOAA) Atlas 14 was used to determine the 24-hr precipitation for the design storm event of 25-yr for Plant Bowen.

The NRCS provides information on soil characteristics and hydrologic groups present at the site. It was determined that the hydrological group “C” for Cells 1 & 2 and “B” for Cells 3 through 8 and Cells 9 & 10 should be used to best reflect the characteristics of the soils on site. This information was placed into Hydraflow Hydrographs 2019 and used to generate appropriate precipitation curves, runoff curve numbers and storm basin run-off values. This methodology has also been utilized for future cells within the unit.

The Plant Bowen CCR Landfill Cells are designed and constructed with perimeter berms and drainage ditches around the cells that prevent stormwater run-on during the peak discharge of a 24-hr, 25-yr storm from flowing onto the active portion of the landfill. The leachate from Cells 3 & 4, future Cells 5 through 8 and Cells 9 & 10 is collected and treated separately from all storm water run-off in the cells. Storm water run-off from Cells 1 & 2, Cells 9 & 10 and Cells 3 through 8, is routed through a system of sedimentation ponds designed to handle the run-off from a 24-hr, 25-yr storm. This plan is supported by appropriate engineering calculations (attached) and was reviewed to reflect current conditions.

The facility is operated subject to and in accordance with § 257.3-3 of EPA's regulations.

I hereby certify that the run-on and run-off control system plan meets the requirements of 40 C.F.R. Part 257.81.

1/24/24

James C. Pegues, P.E.
Licensed State of Georgia, PE No. 17419

Southern Company

Technical and Project Solutions Calculation

Calculation Number: DC-BN-735210-004

Project/Plant: Bowen	Unit(s): 1 - 4	Discipline/Area: Civil
Title/Subject: Run-on and Run-off Study for Bowen Cells 1 & 2		
Purpose/Objective: To determine if the Cell's stormwater management can safely manage and pass the design storm event.		
System or Equipment Tag Numbers: N/A	Originator: Jeremy Brown	

Contents

Revision Record

Rev. No.	Description	Originator Initial / Date	Reviewer Initial / Date	Approver Initial / Date
0	Issued for Review	JKB 2/9/21	AOG 3/1/21	JWM 6/7/21

Notes:

GEORGIA REGISTERED No. PE031968 PROFESSIONAL ENGINEER JIM W. MINOR

J.W. Minor
4/14/22

Design Calculations

Southern Company

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
	Calculation Number DC-BN- 735210-004	Sheet 1 of 23

Purpose of Calculation

The purpose of this calculation is to determine if the existing sedimentation ponds and clear pools can sufficiently handle run-on/run-off during a minimum 25-yr, 24-hr storm event per federal stormwater requirements Title 40 CFR Part 257.81 and the Georgia Environmental Protection Division's (EPD) Georgia CCR Rule (391-3-4-.10).

Summary of Conclusions

Based on our analysis, the detention pond system is adequate to collect and control the volume of water resulting from a 24-hour 25-year storm, as required.

Storage Pond Name	Normal Pool Elevation (feet, NAVD 88)	Maximum 25 year pool elevation (feet, NAVD 88)	Spillway/Top of Dike Elevation (feet, NAVD 88)	Freeboard to Spillway (feet, NAVD 88)
Clear Pool	691.00	693.88	696.00/700.00	2.12/6.12
Sedimentation Pond	691.00	693.88	696.00/700.00	2.12/6.12

Project Narrative

The Plant Bowen CCB Disposal Facility Cells 1 & 2 site is located in Bartow County and is approximately 1.5 miles East of Euharlee, Georgia and 6 miles southwest of Cartersville, Georgia. The plant is bordered on the north and east by the Etowah River and on the south and west by farmland.

Cells 1 & 2 cover 34.88 acres and the two disposal cells are not divided by any means. (See Image 1).

Cells 1 & 2 are comprised of a 31.12 acres storage cell, 2.53 acres sedimentation pond, 1.23 acres clear pool, berms, access roads and ditches. (See Image 2) Cells 1& 2 include a perimeter dike to control surface rainfall run-off. There is no stormwater run-on for these cells. Run-off from this area is directed through interior perimeter ditches and through 3 – 36" diameter HDEP pipes into a sedimentation pond that is connected to a clear pool via two 72" diameter risers and two 48" diameter pipes. Stormwater from the clear pool is discharged through a 72" diameter riser and 48" diameter pipe.

The clear pool has an auxiliary spillway that is a grassed trapezoidal weir. The auxiliary spillway is 8’ wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end. Following pages will show the analysis for Cells 1 & 2.

Methodology

The stormwater flows were calculated using the National Resources Conservation Service method (also known as the Soil Conservation Service (SCS) method) using a 25-yr, 24-hr design storm event.

Storm basin calculation information was gathered from a number of sources to include the Georgia Stormwater Manual and Technical Release 55.

The National Resources Conservation Service (NCRS) provided information on the soil characteristics and hydrologic groups. The soil types found on the site are Urban Land, Wax Silt Loam and Waynesboro Clay Loam. (See Images 3 & 4). Almost the entire site (99.9%) is considered Urban Land because the cells currently have some waste stacked in it. The soils in Cells 9 & 10 that are adjacent to the North and Cells 3 & 4 that are in the vicinity to the Northwest both consist of hydrological group “B”. Therefore, hydrological group “B” should be used to best reflect the characteristics of the soils on site.

Run-off curve number data was determined using Table 2.1.5-1 from the Georgia Stormwater Management Manual. Run-off coefficient data was determined by utilizing Table 2.1.5-2 from the Georgia Stormwater Management Manual and Manning’s n for Channels (Chow, 1959).

Appendix B from the TR-55 was used to determine the rain distribution for Plant Bowen is Type II. (See Image 5)

NOAA Atlas 14 was used to determine the 24-hour precipitation for the design storm event of 25-yr for Plant Bowen is 6.07 in. (See Image 6)

Assumptions/Criteria

- Refer to Title 40 CFR Part 257.81 Hydrologic and hydraulic capacity requirements for the run-on and run-off controls for CCR landfills.
- Other assumptions are listed on attached calculation sheets.

Design Inputs/References

- AutoCad Civil 3D 2019, Autodesk, Inc.
- Hydraflow Hydrographs Extension for AutoCad Civil 3D 2019, Autodesk, Inc.
- Hydraflow Express Extension for AutoCad Civil 3D 2019, Autodesk, Inc.
- NOAA Atlas 14, Volume 9, Version 2 for Taylorsville, GA.
- Georgia Stormwater Manual
- TR-55 – Urban Hydrology for Small Watersheds, Appendix B, National Resources Conservation Service, Conservation Engineering Division, 1986.
- Georgia Power Company – Plant Bowen – CCB Disposal Facility Design and Operation Plans H15061 - H15097, H15296 - H15315 and H52258 - H52260.

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
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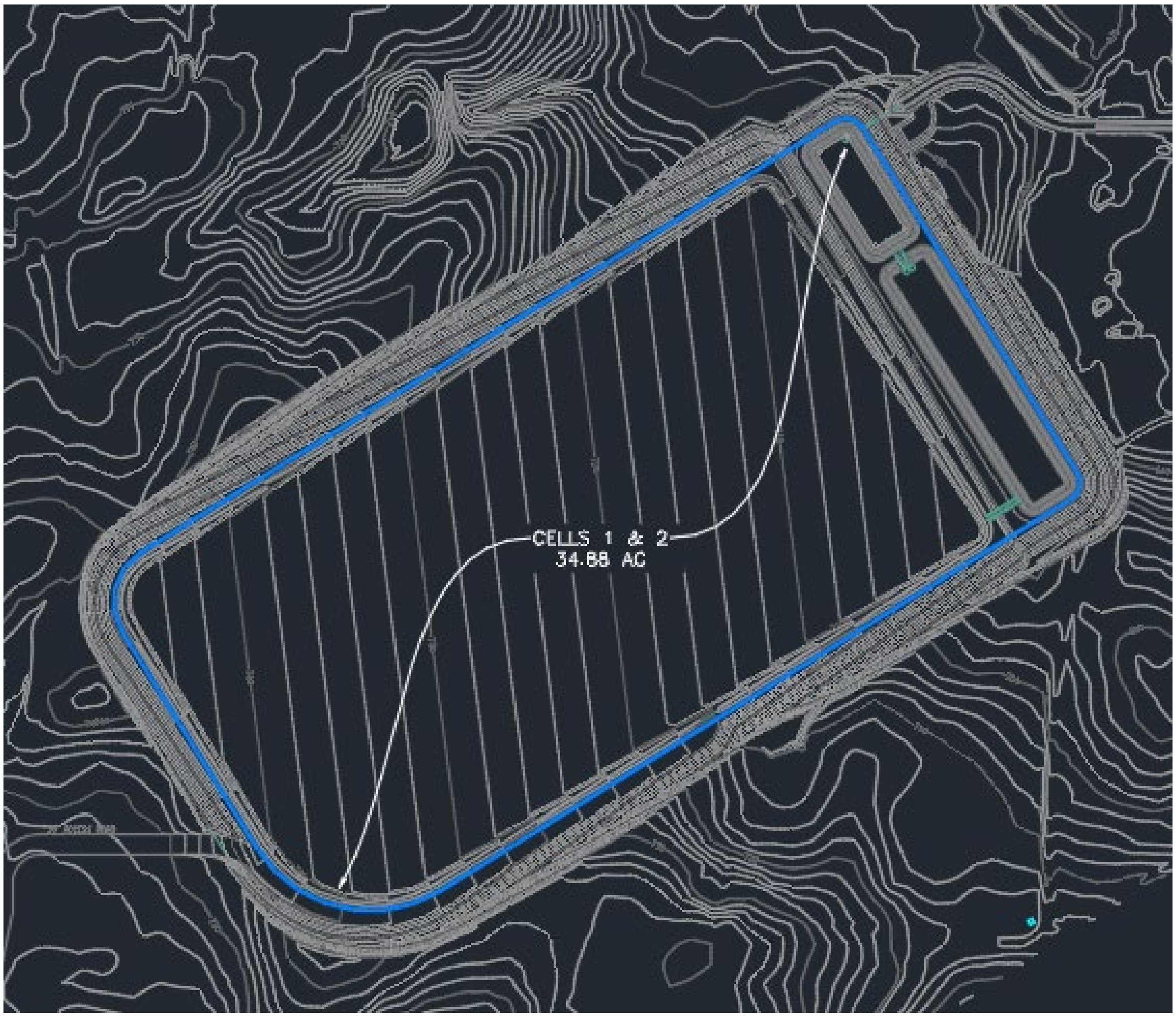

Image 1

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
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Image 2

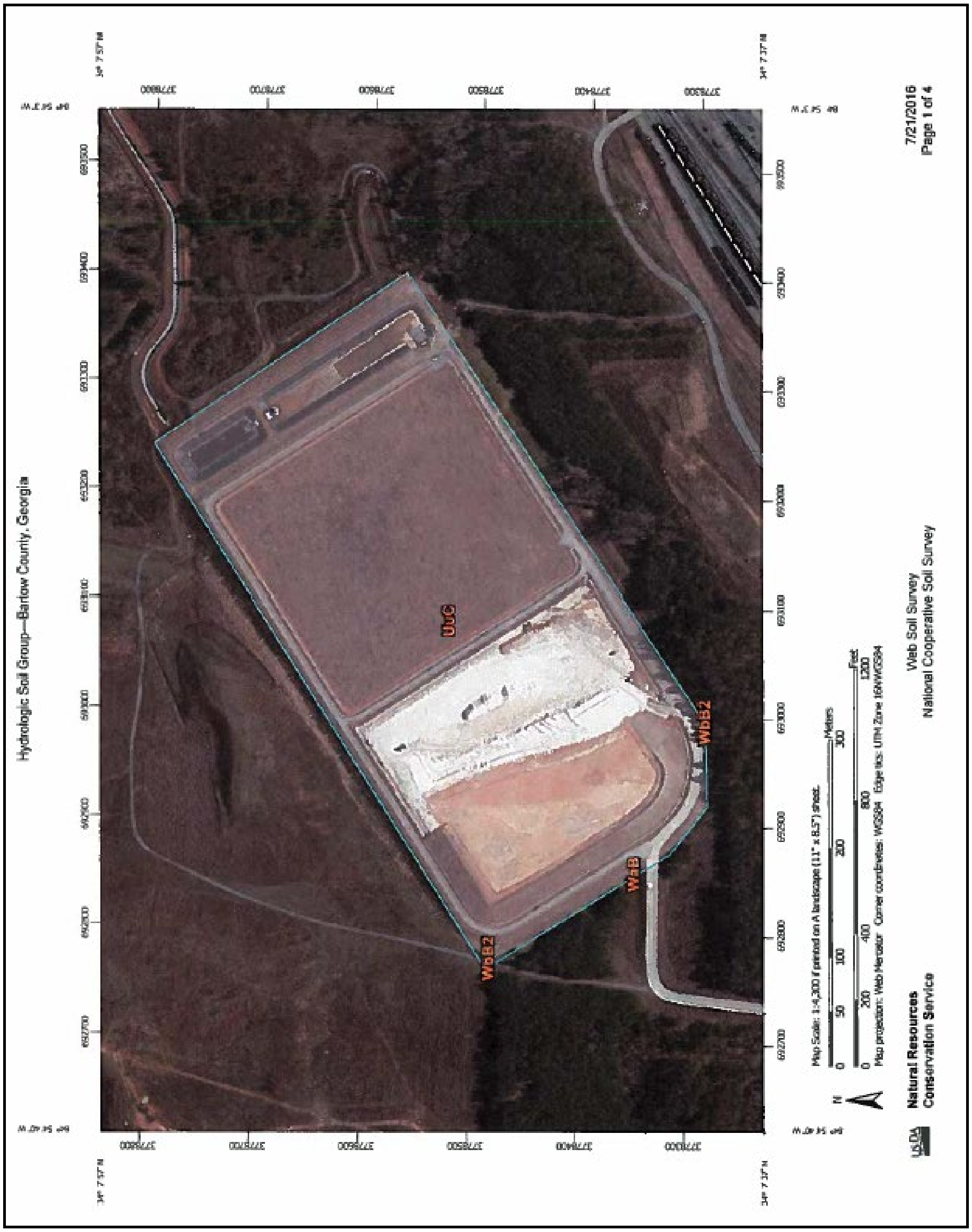

Hydrologic Soil Group—Bartow County, Georgia
UuC
WbB2
WaB
WbB2
7/21/2016
Page 1 of 4
Web Soil Survey
National Cooperative Soil Survey
Natural Resources
Conservation Service
USDA

Image 3

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bartow County, Georgia (GA015)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
UuC	Urban land-Udorthents complex, 0 to 10 percent slopes		40.2	99.9 %
WaB	Wax silt loam, 2 to 6 percent slopes, rarely flooded	D	0.0	0.0 %
WbB2	Waynesboro clay loam, 2 to 6 percent slopes, moderately eroded	B	0.1	0.1 %
Totals for Area of Interest			**40.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Image 4

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
	Calculation Number DC-BN- 735210-004	Sheet 8 of 23

7/13/2016 Rainfall Distribution Types within USA.gif (652×621)

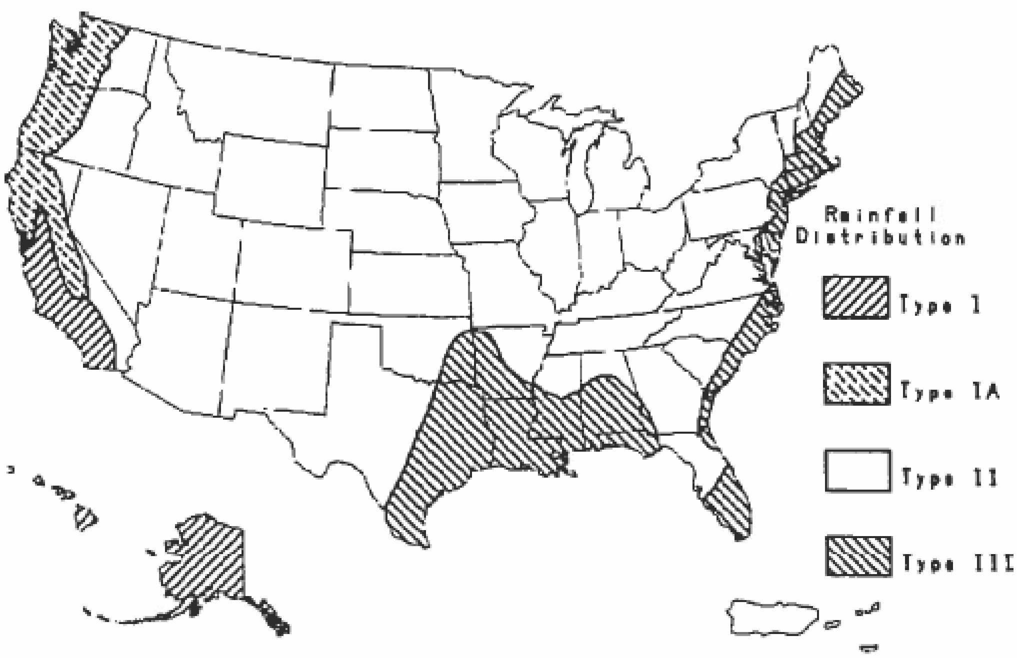


Figure B-2 —Approximate geographic boundaries for SCS rainfall distributions

Image 5

Precipitation Frequency Data Server — Page 1 of 4

NOAA Atlas 14, Volume 9, Version 2
TAYLORSVILLE
Station ID: 09-8600
Location name: Taylorsville, Georgia, US*
Latitude: 34.0861°, Longitude: -84.9828°
Elevation:
Elevation (station metadata): 721 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.406 (0.321-0.518)	0.464 (0.367-0.593)	0.568 (0.448-0.726)	0.662 (0.520-0.849)	0.804 (0.619-1.06)	0.924 (0.695-1.23)	1.05 (0.768-1.42)	1.19 (0.838-1.62)	1.39 (0.943-1.92)	1.55 (1.02-2.14)
10-min	0.594 (0.471-0.759)	0.679 (0.537-0.868)	0.831 (0.655-1.06)	0.969 (0.761-1.24)	1.18 (0.907-1.56)	1.35 (1.02-1.80)	1.54 (1.12-2.07)	1.75 (1.23-2.38)	2.03 (1.38-2.81)	2.27 (1.50-3.14)
15-min	0.725 (0.574-0.926)	0.828 (0.655-1.06)	1.01 (0.799-1.30)	1.18 (0.928-1.52)	1.44 (1.11-1.90)	1.65 (1.24-2.19)	1.88 (1.37-2.53)	2.13 (1.50-2.90)	2.48 (1.68-3.43)	2.77 (1.83-3.83)
30-min	1.02 (0.811-1.31)	1.17 (0.924-1.49)	1.43 (1.13-1.83)	1.66 (1.31-2.13)	2.02 (1.56-2.68)	2.33 (1.75-3.09)	2.65 (1.94-3.57)	3.01 (2.12-4.11)	3.52 (2.39-4.86)	3.93 (2.60-5.44)
60-min	1.33 (1.05-1.70)	1.52 (1.20-1.94)	1.85 (1.46-2.36)	2.15 (1.69-2.76)	2.61 (2.01-3.45)	3.00 (2.25-3.98)	3.41 (2.49-4.58)	3.86 (2.71-5.26)	4.49 (3.05-6.21)	5.01 (3.31-6.93)
2-hr	1.64 (1.31-2.06)	1.86 (1.49-2.35)	2.27 (1.81-2.86)	2.64 (2.10-3.34)	3.20 (2.49-4.17)	3.66 (2.79-4.79)	4.16 (3.08-5.52)	4.70 (3.36-6.33)	5.47 (3.77-7.46)	6.09 (4.09-8.32)
3-hr	1.84 (1.49-2.30)	2.10 (1.69-2.62)	2.55 (2.05-3.19)	2.96 (2.37-3.71)	3.56 (2.80-4.60)	4.07 (3.12-5.28)	4.60 (3.43-6.05)	5.18 (3.73-6.91)	6.00 (4.17-8.12)	6.66 (4.51-9.04)
6-hr	2.27 (1.86-2.79)	2.57 (2.10-3.17)	3.10 (2.53-3.83)	3.57 (2.90-4.41)	4.26 (3.38-5.41)	4.82 (3.75-6.16)	5.42 (4.10-7.02)	6.05 (4.42-7.96)	6.94 (4.90-9.27)	7.65 (5.27-10.3)
12-hr	2.79 (2.32-3.39)	3.15 (2.61-3.83)	3.77 (3.12-4.58)	4.31 (3.54-5.25)	5.08 (4.08-6.34)	5.70 (4.49-7.17)	6.36 (4.87-8.10)	7.04 (5.21-9.11)	7.99 (5.72-10.5)	8.73 (6.11-11.6)
24-hr	3.34 (2.81-3.99)	3.79 (3.18-4.53)	4.54 (3.80-5.44)	5.18 (4.32-6.21)	6.07 (4.93-7.43)	6.77 (5.40-8.36)	7.48 (5.81-9.38)	8.22 (6.17-10.5)	9.21 (6.70-11.9)	9.98 (7.10-13.0)
2-day	3.87 (3.29-4.55)	4.43 (3.77-5.21)	5.34 (4.54-6.30)	6.10 (5.16-7.22)	7.14 (5.88-8.60)	7.95 (6.42-9.65)	8.75 (6.88-10.8)	9.56 (7.27-12.0)	10.6 (7.84-13.6)	11.4 (8.27-14.8)
3-day	4.24 (3.64-4.96)	4.81 (4.13-5.62)	5.76 (4.93-6.73)	6.56 (5.59-7.68)	7.66 (6.37-9.16)	8.53 (6.95-10.3)	9.40 (7.47-11.5)	10.3 (7.92-12.8)	11.5 (8.57-14.5)	12.4 (9.06-15.9)
4-day	4.56 (3.94-5.28)	5.14 (4.43-5.96)	6.10 (5.25-7.08)	6.92 (5.93-8.06)	8.07 (6.76-9.61)	8.98 (7.38-10.8)	9.92 (7.94-12.1)	10.9 (8.43-13.6)	12.2 (9.16-15.4)	13.2 (9.72-16.8)
7-day	5.37 (4.69-6.14)	5.99 (5.22-6.88)	7.04 (6.13-8.07)	7.94 (6.88-9.14)	9.24 (7.84-10.9)	10.3 (8.56-12.2)	11.3 (9.21-13.7)	12.5 (9.80-15.3)	14.0 (10.7-17.5)	15.2 (11.3-19.2)
10-day	6.07 (5.34-6.89)	6.74 (5.92-7.66)	7.88 (6.91-8.97)	8.87 (7.74-10.1)	10.3 (8.79-12.0)	11.4 (9.58-13.5)	12.6 (10.3-15.1)	13.8 (11.0-16.8)	15.5 (11.9-19.3)	16.8 (12.7-21.1)
20-day	8.08 (7.21-9.03)	8.91 (7.95-9.96)	10.3 (9.17-11.5)	11.5 (10.2-12.9)	13.2 (11.5-15.2)	14.6 (12.4-16.9)	16.0 (13.3-18.8)	17.4 (14.0-20.9)	19.4 (15.2-23.7)	21.0 (16.1-25.9)
30-day	9.86 (8.87-10.9)	10.8 (9.75-12.0)	12.5 (11.2-13.8)	13.9 (12.4-15.4)	15.8 (13.8-17.9)	17.3 (14.9-19.8)	18.8 (15.8-22.0)	20.4 (16.6-24.2)	22.5 (17.8-27.3)	24.1 (18.7-29.5)
45-day	12.2 (11.1-13.4)	13.5 (12.2-14.8)	15.4 (14.0-17.0)	17.1 (15.4-18.8)	19.3 (16.9-21.6)	20.9 (18.1-23.7)	22.6 (19.1-26.1)	24.3 (19.9-28.5)	26.4 (21.1-31.7)	28.1 (22.0-34.1)
60-day	14.4 (13.1-15.6)	15.8 (14.4-17.2)	18.1 (16.5-19.6)	19.9 (18.1-21.6)	22.4 (19.8-24.9)	24.2 (21.0-27.2)	25.9 (22.0-29.7)	27.7 (22.8-32.2)	29.8 (23.9-35.5)	31.4 (24.6-37.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

Image 6

Body of Calculation

See detailed calculations and software output.

Drainage Area = 34.88 AC (See Map 1)

Curve Number = 64 (See Attached Table 1)

31.17 AC @ CN 61 (Grass)

2.56 AC @ CN 85 (Gravel)

1.15 AC @ CN 98 (Impervious – Liner in Sediment Pond and Clear Pool)

((31.17*61)+(2.56*85)+(1.15*98))/34.88_ = 63.98 = 64

Time of Concentration = 20.49 Min (See Attached TR55 Worksheet and Map 2)

Sheet Flow

Manning's n-Value = 0.15 (Short Grass) (See Table 2)

Flow Length = 300 LF

Land Slope = (806.50-784.00)/300 = 0.075 = 7.50%

Shallow Concentrated

Flow Length = 202 LF

Watercourse Slope = (784.00-746.50)/202 = 0.1856 = 18.56%

Surface is Unpaved

Channel Flow (See Channel Report 1)

Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 4' Deep

Cross Sectional Area = 6.00 SF

Wetted Perimeter = 8.47 LF

Channel Slope = (746.50-700.01)/2387 = 0.0195 = 1.95%

Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)

Flow Length = 2387 LF

Channel Flow (See Channel Report 2)

3 – 36" Dia. HDPE Pipes @ 2.75%

Cross Section Area = 2.079 SF

Wetted Perimeter = 3.70 LF

Channel Slope = (700.01-698.00)/74 = 0.0272 = 2.72%

Manning's n-Value = 0.013 (HDPE Pipes) (See Table 4)

Flow Length = 74 LF

Time Interval = 3 Min

Tc*0.1333 = 20.49*0.1333 = 2.73 = 3

Storm Distribution = Type II

Q_{25} = 78.47 CFS (See Hydrograph Report 1)

To Evaluate for Storage Capacity, Treat The Sediment Pond and Clear Pool As One Pond Since They Are Interconnected.

Elevation (FT)	Sed. Pond Area (SF)	Clear Pool Area (SF)	Total Area (SF)	Volume (CF)
689	0	15,324	15,324	0*
690	39,353	16,778	56,131	33,591*
691	42,351	18,271	60,622	91,947
692	45,389	19,804	65,193	154,835
693	48,465	21,375	69,840	222,331
694	51,581	22,986	74,567	294,515
695	54,737	24,637	79,374	371,465
696	57,931	26,326	84,257	453,260

Note: Stage storage is based on topographic information from 2020.
*Dead Storage

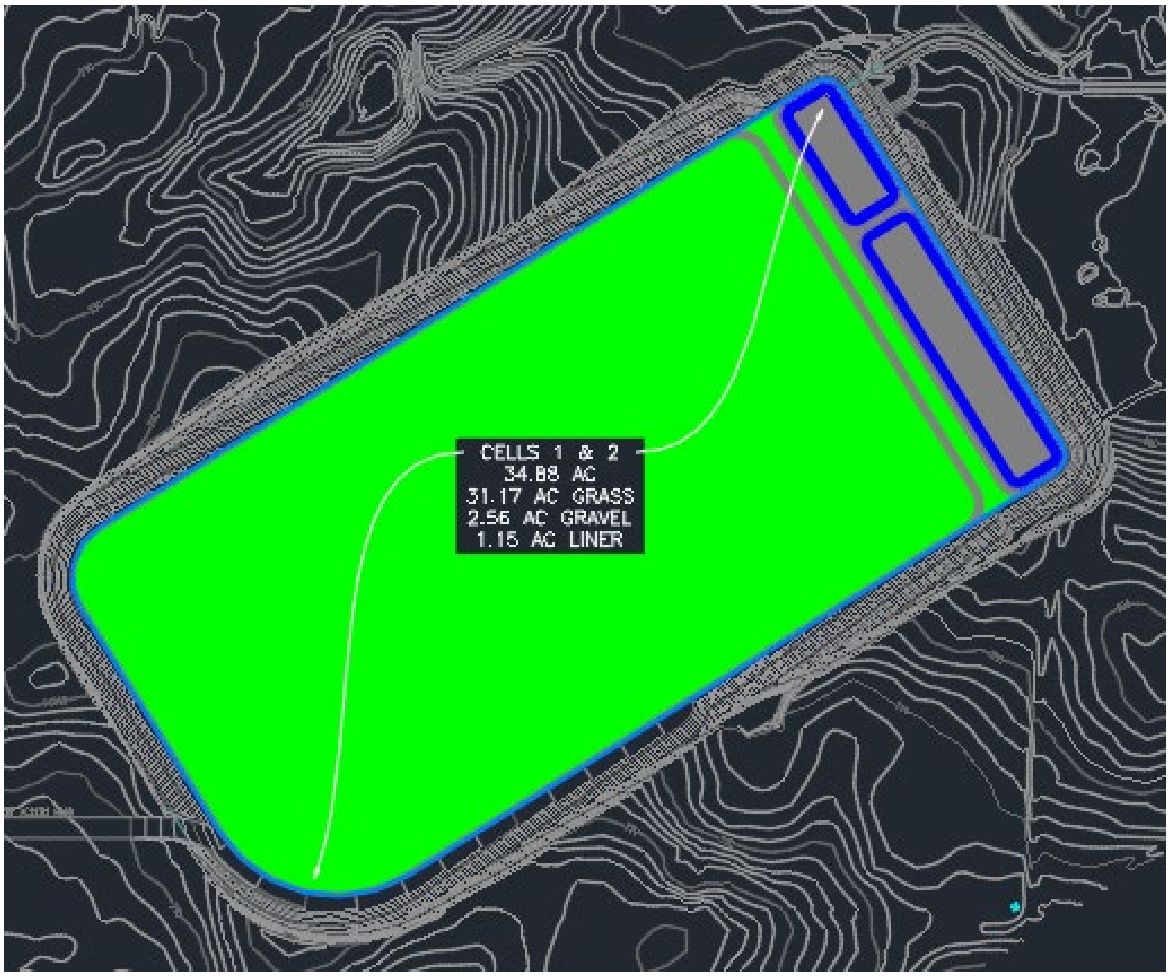
Spillways

- Principal Spillway consists of a 72” Dia. Riser with a 48” Dia. CMP.
- Auxiliary Spillway consist of a grass lined trapezoidal weir that is 8’ wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end.

High Water Elevation is 693.88 (See Pond Reports 1 & 2)

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
	Calculation Number DC-BN- 735210-004	Sheet 12 of 23



Map 1

Table 2.1.5-1 Runoff Curve Numbers[1]

Cover description			Curve numbers for hydrologic soil groups			
Cover type and hydrologic condition		*Average percent impervious area*[2]	A	B	C	D
Cultivated land:	without conservation treatment		72	81	88	91
	with conservation treatment		62	71	78	81
Pasture or range land:	poor condition		68	79	86	89
	good condition		39	61	74	80
Meadow: good condition			30	58	71	78
Wood or forest land:	thin stand, poor cover		45	66	77	83
	good cover		25	55	70	77
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]						
Poor condition (grass cover <50%)			68	79	86	89
Fair condition (grass cover 50% to 75%)			49	69	79	84
Good condition (grass cover > 75%)			39	61	74	80
Impervious areas:						
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)			98	98	98	98
Streets and roads:						
Paved; curbs and storm drains (excluding right-of-way)			98	98	98	98
Paved; open ditches (including right-of-way)			83	89	92	93
Gravel (including right-of-way)			76	85	89	91
Dirt (including right-of-way)			72	82	87	89
Urban districts:						
Commercial and business		85%	89	92	94	95
Industrial		72%	81	88	91	93
Residential districts by average lot size:						
1/8 acre or less (town houses)		65%	77	85	90	92
1/4 acre		38%	61	75	83	87
1/3 acre		30%	57	72	81	86
1/2 acre		25%	54	70	80	85
1 acre		20%	51	68	79	84
2 acres		12%	46	65	77	82
Developing urban areas and Newly graded areas (pervious areas only, no vegetation)			77	86	91	94

[1] Average runoff condition, and $I_a = 0.2S$

[2] The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. If the impervious area is not connected, the SCS method has an adjustment to reduce the effect.

[3] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

Table 1

TR55 Tc Worksheet

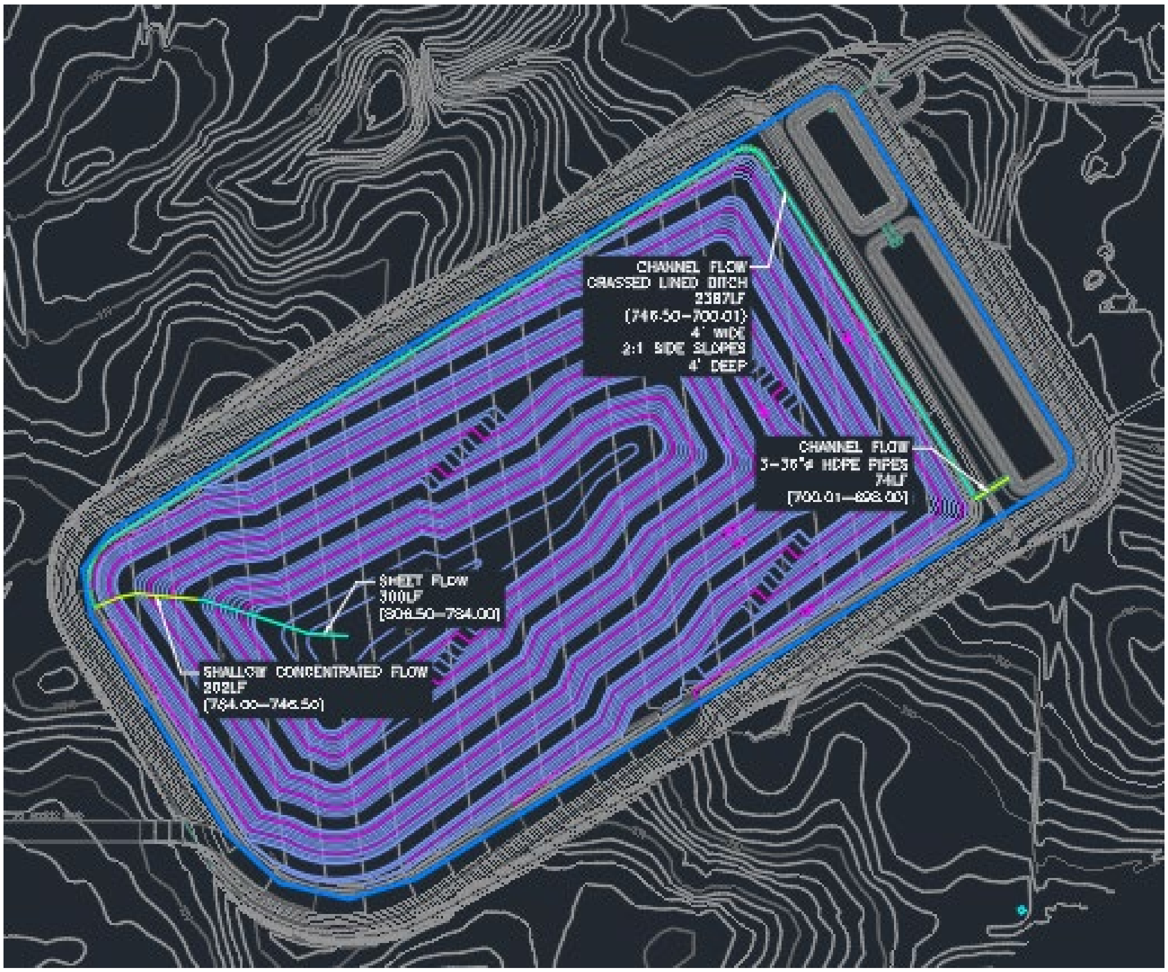
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

Hyd. No. 2

Ditch

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.79		0.00		0.00		
Land slope (%)	=	7.50		0.00		0.00		
Travel Time (min)	=	**12.78**	+	**0.00**	+	**0.00**	=	**12.78**
Shallow Concentrated Flow								
Flow length (ft)	=	202.00		0.00		0.00		
Watercourse slope (%)	=	18.56		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	6.95		0.00		0.00		
Travel Time (min)	=	**0.48**	+	**0.00**	+	**0.00**	=	**0.48**
Channel Flow								
X sectional flow area (sqft)	=	6.00		0.00		0.00		
Wetted perimeter (ft)	=	8.47		0.00		0.00		
Channel slope (%)	=	1.95		0.00		0.00		
Manning's n-value	=	0.030		0.015		0.015		
Velocity (ft/s)	=	5.51						
				0.00				
						0.00		
Flow length (ft)		({0})2387.0		0.0		0.0		
Travel Time (min)	=	**7.23**	+	**0.00**	+	**0.00**	=	**7.23**
Total Travel Time, Tc								**20.49 min**

TR55 Worksheet


CHANNEL FLOW
GRASSED LINED DITCH
2387LF
(746.50–700.01)
4' WIDE
2:1 SIDE SLOPES
4' DEEP
CHANNEL FLOW
3–36"Ø HDPE PIPES
74LF
[700.01–698.00]
SHEET FLOW
300LF
[808.50–784.00]
SHALLOW CONCENTRATED FLOW
202LF
(784.00–746.50)

Map 2

Table 2.1.5-2 Roughness Coefficients (Manning's n) for Sheet Flow[1]

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover < 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information by Engman (1986).

[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Source: SCS, TR-55, Second Edition, June 1986

Table 2

Design Calculations

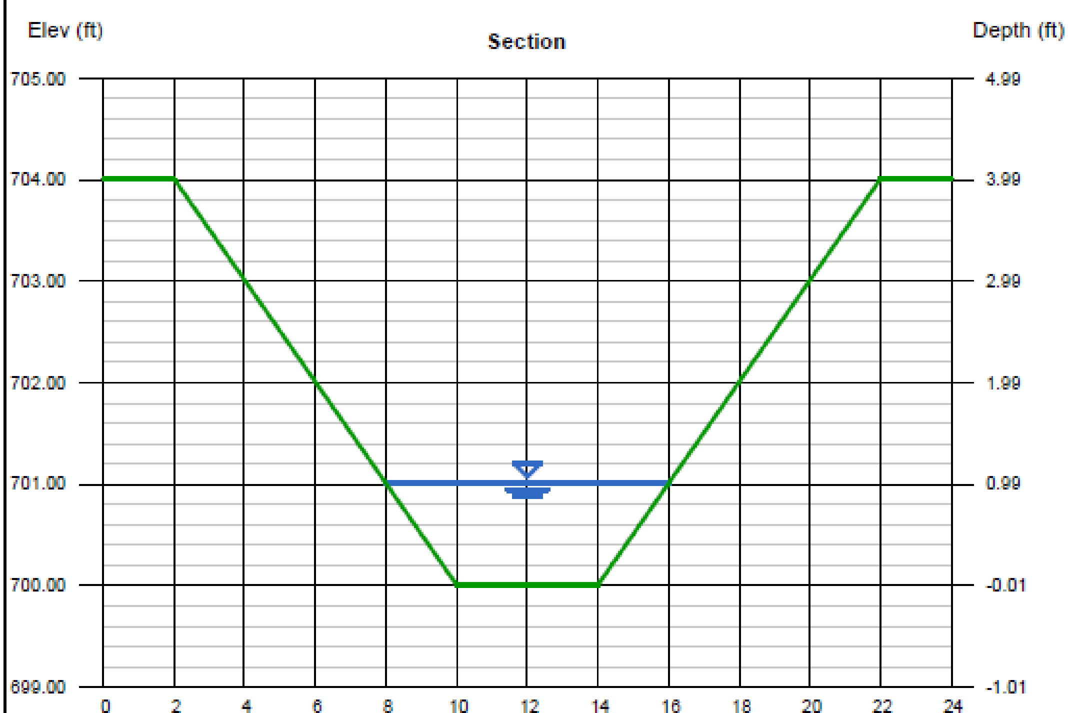
Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
	Calculation Number DC-BN- 735210-004	Sheet 17 of 23

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Feb 4 2021

Cells 1 & 2 Ditch

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 4.00	Depth (ft)	= 1.00
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 32.62
Total Depth (ft)	= 4.00	Area (sqft)	= 6.00
Invert Elev (ft)	= 700.01	Velocity (ft/s)	= 5.44
Slope (%)	= 1.95	Wetted Perim (ft)	= 8.47
N-Value	= 0.030	Crit Depth, Yc (ft)	= 1.06
		Top Width (ft)	= 8.00
Calculations		EGL (ft)	= 1.46
Compute by:	Known Q		
Known Q (cfs)	= 32.62		



Channel Report 1

3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.020	0.025
2. random stone mortar	0.020	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.030
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.030		0.500

Table 3

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
	Calculation Number DC-BN- 735210-004	Sheet 19 of 23

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Feb 4 2021

Cells 1 & 2 Pipe

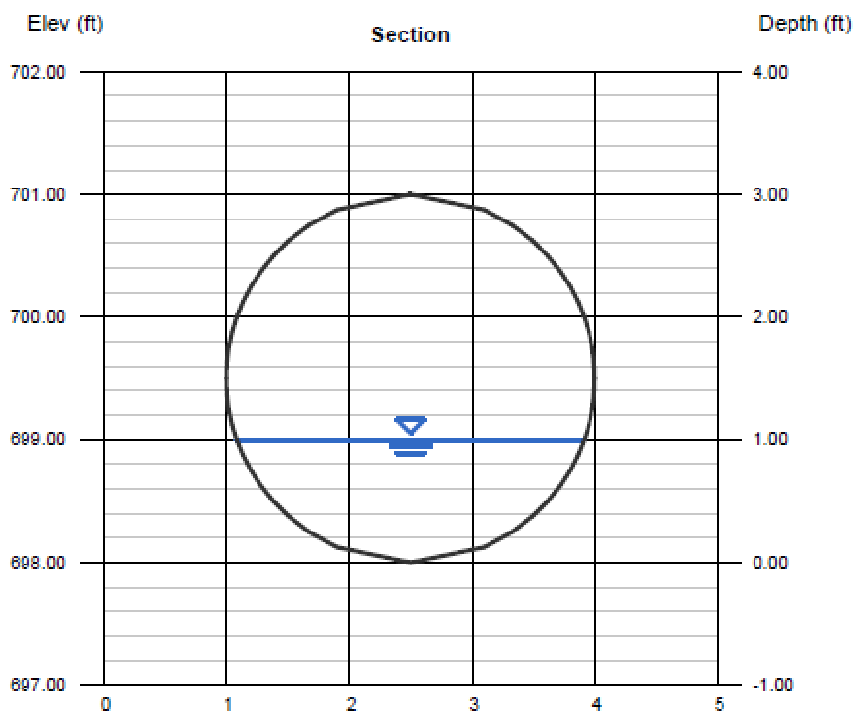
Circular
Diameter (ft) = 3.00

Invert Elev (ft) = 698.00
Slope (%) = 2.72
N-Value = 0.013

Calculations
Compute by: Known Q
Known Q (cfs) = 26.16

Full Flow = 78.47
Pipes = 3
Flow Per Pipe = 78.47/3 = 26.16

Highlighted
Depth (ft) = 1.00
Q (cfs) = 26.16
Area (sqft) = 2.08
Velocity (ft/s) = 12.58
Wetted Perim (ft) = 3.70
Crit Depth, Yc (ft) = 1.65
Top Width (ft) = 2.83
EGL (ft) = 3.46



Channel Report 2

Manning's n Values

Page 4 of 5

7. Concrete:			
Culvert, straight and free of debris	0.010	0.011	0.013
Culvert with bends, connections, and some debris	0.011	0.013	0.014
Finished	0.011	0.012	0.014
Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
Unfinished, steel form	0.012	0.013	0.014
Unfinished, smooth wood form	0.012	0.014	0.016
Unfinished, rough wood form	0.015	0.017	0.020
8. Wood:			
Stave	0.010	0.012	0.014
Laminated, treated	0.015	0.017	0.020
9. Clay:			
Common drainage tile	0.011	0.013	0.017
Vitrified sewer	0.011	0.014	0.017
Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
Vitrified Subdrain with open joint	0.014	0.016	0.018
10. Brickwork:			
Glazed	0.011	0.013	0.015
Lined with cement mortar	0.012	0.015	0.017
Sanitary sewers coated with sewage slime with bends and connections	0.012	0.013	0.016
Paved invert, sewer, smooth bottom	0.016	0.019	0.020
Rubble masonry, cemented	0.018	0.025	0.030

Table 4

Hydrograph Report

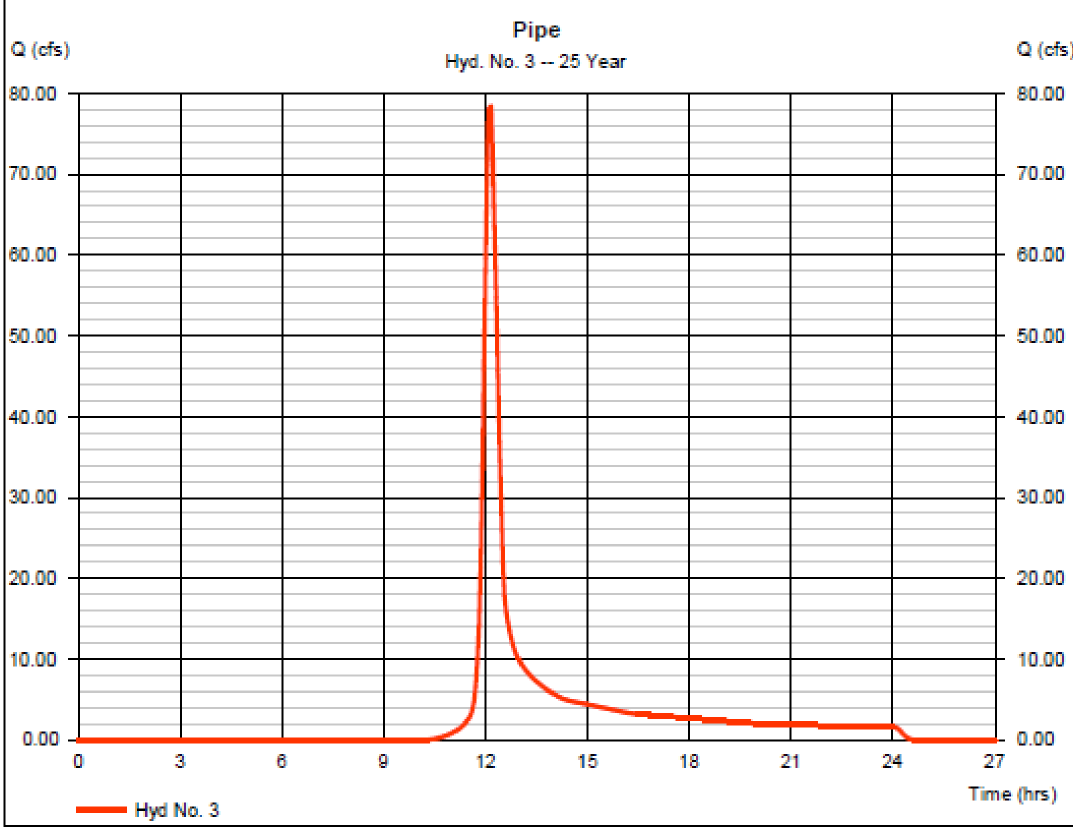
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Thursday, 02 / 4 / 2021

Hyd. No. 3

Pipe

Hydrograph type	= SCS Runoff	Peak discharge	= 78.47 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.15 hrs
Time interval	= 3 min	Hyd. volume	= 285,591 cuft
Drainage area	= 34.880 ac	Curve number	= 64*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.60 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(31.170 x 61) + (2.560 x 85) + (1.150 x 98)] / 34.880



Hydrograph Report 1

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 Friday, 02 / 5 / 2021

Pond No. 1 - Cell 1&2 Sed Pond/Clear Pool

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 689.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	689.00	15,324	0	0
1.00	690.00	56,131	33,591	33,591
2.00	691.00	60,622	58,356	91,947
3.00	692.00	65,193	62,887	154,835
4.00	693.00	69,840	67,496	222,331
5.00	694.00	74,567	72,183	294,515
6.00	695.00	79,374	76,950	371,465
7.00	696.00	84,257	81,795	453,260

Culvert / Orifice Structures

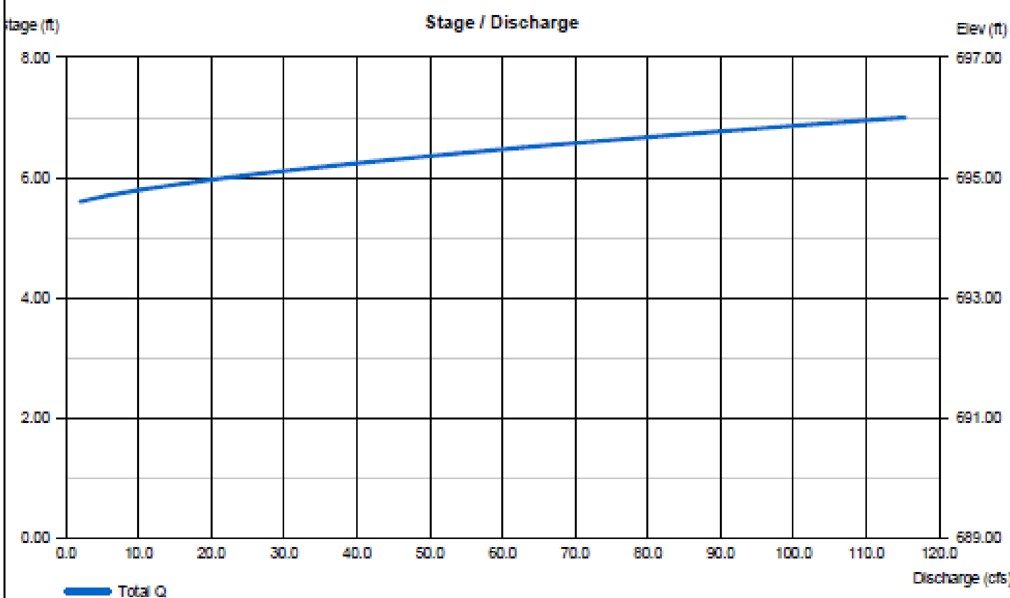
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 48.00	0.00	0.00	0.00
Span (in)	= 48.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 673.50	0.00	0.00	0.00
Length (ft)	= 128.00	0.00	0.00	0.00
Slope (%)	= 0.40	0.00	0.00	n/a
N-Value	= .024	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 18.85	0.00	0.00	0.00
Crest El. (ft)	= 694.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	—	—	—
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

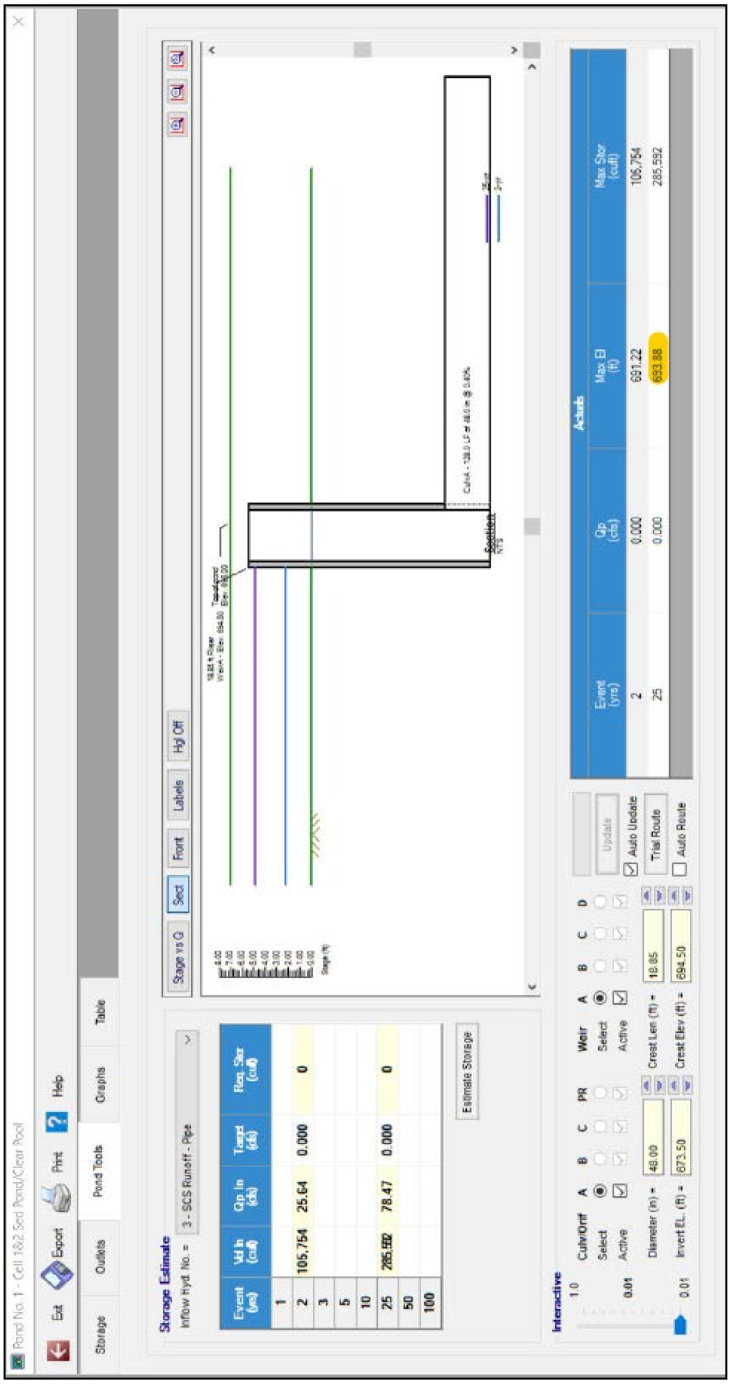


Pond Report 1

Design Calculations

Southern Company

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/9/21
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 1 & 2	Reviewed by Ashley Grissom	Date 3/1/21
	Calculation Number DC-BN- 735210-004	Sheet 23 of 23



Pond Report 2

Southern Company

Technical and Project Solutions Calculation

Calculation Number:
DC-BN-735210-002

Project/Plant:	Unit(s):	Discipline/Area:
Bowen	1 - 4	Civil
Title/Subject: Run-on and Run-off Study for Bowen Cells 3-8		
Purpose/Objective: To determine if the Cell's stormwater management can safely manage and pass the design storm event.		
System or Equipment Tag Numbers: N/A	**Originator:** Jeremy Brown	

Contents

Topic	Page	Attachments (Computer Printouts, Tech. Papers, Sketches, Correspondence)	# of Pages
Purpose of Calculation	1		1
Summary of Conclusions	1		1
Project Narrative	1-3		3
Methodology	3-4		2
Assumptions/Criteria	4		1
Design Inputs/References	5-10		6
Body of Calculation	11-70		59
Total # of pages including cover sheet & attachments:	70		

Revision Record

Rev. No.	Description	Originator Initial / Date	Reviewer Initial / Date	Approver Initial / Date
0	Issued for Review	JKB 3/19/21	AOG 4/1/21	JWM 4/6/21
1	Replace concrete flumes with pipes and changes to leachate system in Cells 5&6.	JKB 9/15/23	AOG 9/21/23	JWM 9/25/23

Notes:

GEORGIA
REGISTERED
No. 031968
PROFESSIONAL
9/27/23
ENGINEER
JIM W. MINOR

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 1 of 70

Purpose of Calculation

The purpose of this calculation is to determine if the existing sedimentation ponds and clear pools can sufficiently handle run-on/run-off during a minimum 25-yr, 24-hr storm event per federal stormwater requirements Title 40 CFR Part 257.81 and the Georgia Environmental Protection Division's (EPD) Georgia CCR Rule (391-3-4-.10).

Summary of Conclusions

Based on our analysis, the detention pond system is adequate to collect and control the volume of water resulting from a 24-hour 25-year storm, as required.

Storage Pond Name	Normal Pool Elevation (feet, NAVD 88)	Maximum 25 year pool elevation (feet, NAVD 88)	Spillway/Top of Dike Elevation (feet, NAVD 88)	Freeboard to Spillway (feet, NAVD 88)
Cells 3, 5 & 7 Clear Pool	685.5	688.37	690.50/694.00	2.13/5.63
Cells 3, 5 & 7 Sediment Pond	685.5	688.37	690.50/694.00	2.13/5.63
Cell 4 Clear Pool	698.50	701.04	702.00/704.00	0.96/2.96
Cell 4 Sediment Pond	698.50	701.04	702.00/704.00	0.96/2.96
Cell 6 Clear Pool	686	688.25	689.50/692.00	1.25/3.75
Cell 6 Sediment Pond	686	688.25	689.50/692.00	1.25/3.75
Cell 8 Clear Pool	686	688.03	689.50/692.00	1.47/3.97
Cell 8 Sediment Pond	686	688.03	689.50/692.00	1.47/3.97

Project Narrative

The Plant Bowen CCB Disposal Facility Cells 3-8 site is located in Bartow County and is approximately 1.5 miles East of Euharlee, Georgia and 6 miles southwest of Cartersville, Georgia. The plant is bordered on the north and east by the Etowah River and on the south and west by farmland.

Since Cells 3-8 share an interconnected cap the storage area information below is based on the drainage area for each cells' sedimentation and clear pool. It should be noted that Cells 3, 5 & 7 share a sedimentation pond and clear pool.

Cells 3, 5 & 7

Cells 3, 5 & 7 cover 41.47 acres and their cap is not divided by any means. (See Image 1).

Cells 3, 5 & 7 are comprised of a 43.27 acres storage cell, 2.25 acres sedimentation pond, 0.73 acres clear pool, berms, access roads and ditches. (See Image 2) Cells 3, 5 & 7 include a perimeter dike to control surface rainfall run-off. There is no stormwater run-on for these cells. Run-off from this area is directed through a down drain system into an interior perimeter ditch and is conveyed by pipe(s) into a sedimentation pond that is connected to a clear pool via two 48” diameter risers and two 30” diameter pipes. Stormwater from the clear pool is discharged through two 54” diameter risers and two 36” diameter pipes.

The sediment pond and clear pool both have an auxiliary spillway that is a concrete trapezoidal weir. The auxiliary spillway is 20’ wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end. Following pages will show the analysis for Cells 3, 5 & 7.

Cell 4

Cell 4 covers 12.83 acres and its cap is not divided by any means. (See Image 1).

Cell 4 is comprised of a 12.24 acres storage cell, 1.27 acres sedimentation pond, 0.45 acres clear pool, berms, access roads and ditches. (See Image 2) Cell 4 includes a perimeter dike to control surface rainfall run-off. There is no stormwater run-on for this cell. Run-off from this area is directed through a down drain system into an interior perimeter ditch and is conveyed by pipes into a sedimentation pond that is connected to a clear pool via two 48” diameter risers and two 30” diameter pipes. Stormwater from the clear pool is discharged through a 66” diameter riser and 42” diameter pipe.

The sediment pond and clear pool both have an auxiliary spillway that is a concrete trapezoidal weir. The auxiliary spillway is 18’ wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end. Following pages will show the analysis for Cell 4.

Cell 6

Cell 6 covers 28.61 acres and its cap is not divided by any means. (See Image 1).

Cell 6 is comprised of a 16.37 acres storage cell, 1.52 acres sedimentation pond, 0.31 acres clear pool, berms, access roads and ditches. (See Image 2) Cell 6 includes a perimeter dike to control surface rainfall run-off. There is no stormwater run-on for these cells. Run-off from this area is directed through a down drain system into an interior perimeter ditch and is conveyed by pipes into a sedimentation pond that is connected to a clear pool via a 36" diameter riser and six 24" diameter pipes. Stormwater from the clear pool is discharged through a 36" diameter riser and two 24" diameter pipes.

The sediment pond and clear pool both have an auxiliary spillway that is a grassed trapezoidal weir. The auxiliary spillway is 8' wide with 3:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end. Following pages will show the analysis for Cell 6.

Cell 8

Cell 8 cover 10.49 acres and its cap is not divided by any means. (See Image 1).

Cell 8 is comprised of a 13.51 acres storage cell, 0.74 acres sedimentation pond, 0.34 acres clear pool, berms, access roads and ditches. (See Image 2) Cell 8 includes a perimeter dike to control surface rainfall run-off. There is no stormwater run-on for this cell. Run-off from this area is directed through a down drain system into an interior perimeter ditch into a sedimentation pond that is connected to a clear pool via a 36" diameter riser and five 24" diameter pipes. Stormwater from the clear pool is discharged through a 36" diameter riser and two 24" diameter pipes.

The sediment pond and clear pool both have an auxiliary spillway that is a grassed trapezoidal weir. The auxiliary spillway is 8' wide with 3:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end. Following pages will show the analysis for Cell 8.

Methodology

The stormwater flows were calculated using the National Resources Conservation Service method (also known as the Soil Conservation Service (SCS) method) using a 25-yr, 24-hr design storm event.

Storm basin calculation information was gathered from a number of sources to include the Georgia Stormwater Manual and Technical Release 55.

The National Resources Conservation Service (NCRS) provided information on the soil characteristics and hydrologic groups. The soil types found on the site are Etowah Loam (17.1%), Waynesboro Clay Loam (81.8%) and Whitwell Silt Loam (1.1%) (See Images 3 & 4). Therefore, hydrological group "B" should be used to best reflect the characteristics of the soils on site.

Run-off curve number data was determined using Table 2.1.5-1 from the Georgia Stormwater Management Manual. Run-off coefficient data was determined by utilizing Table 2.1.5-2 from the Georgia Stormwater Management Manual and Manning's n for Channels (Chow, 1959).

Appendix B from the TR-55 was used to determine the rain distribution for Plant Bowen is Type II. (See Image 5)

NOAA Atlas 14 was used to determine the 24-hour precipitation for the design storm event of 25-yr for Plant Bowen is 6.07 in. (See Image 6)

Assumptions/Criteria

- Refer to Title 40 CFR Part 257.81 Hydrologic and hydraulic capacity requirements for the run-on and run-off controls for CCR landfills.
- Other assumptions are listed on attached calculation sheets.

Design Inputs/References

- AutoCad Civil 3D 2019, Autodesk, Inc.
- Hydraflow Hydrographs Extension for AutoCad Civil 3D 2019, Autodesk, Inc.
- Hydraflow Express Extension for AutoCad Civil 3D 2019, Autodesk, Inc.
- NOAA Atlas 14, Volume 9, Version 2 for Taylorsville, GA.
- TR-55 – Urban Hydrology for Small Watersheds, Appendix B, National Resources Conservation Service, Conservation Engineering Division, 1986.
- Georgia Power Company – Plant Bowen – CCB Disposal Facility Design and Operation Plans H15061 - H15097, H15296 - H15315 and H52258 - H52260.

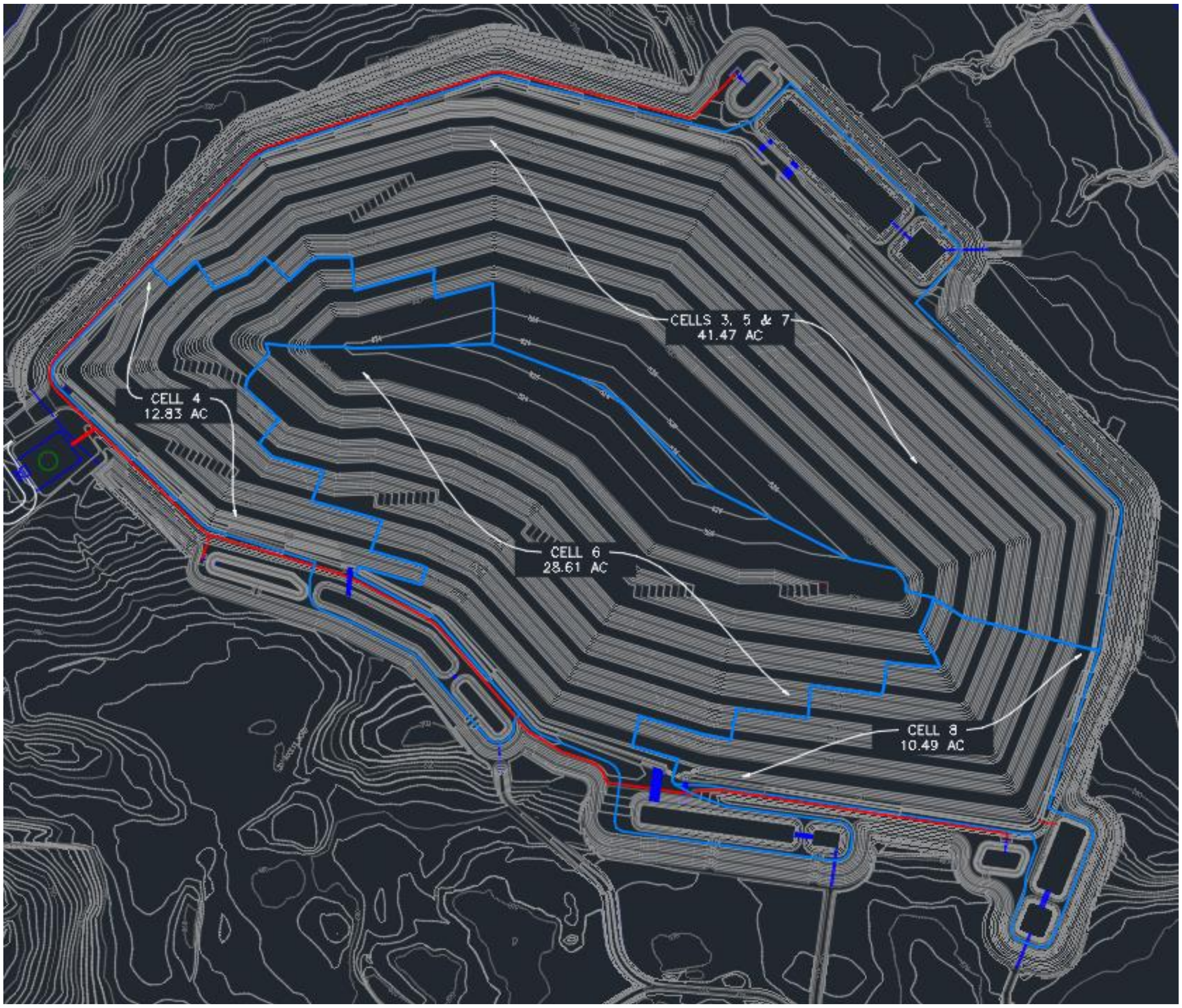


Image 1


CELLS 3, 5 & 7 LEACHATE POND
0.35 AC
HDPE PIPES TO
LEACHATE POND
CELLS 3, 5 & 7
43.27 AC
CELL 4
12.24 AC
CELL 6
16.37 AC
CELL 4 LEACHATE POND
0.39 AC
HDPE PIPES TO
LEACHATE POND
CELL 8
13.51 AC
CELL 8 LEACHATE POND
0.28 AC
HDPE PIPES TO
LEACHATE POND

Image 2

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 7 of 70

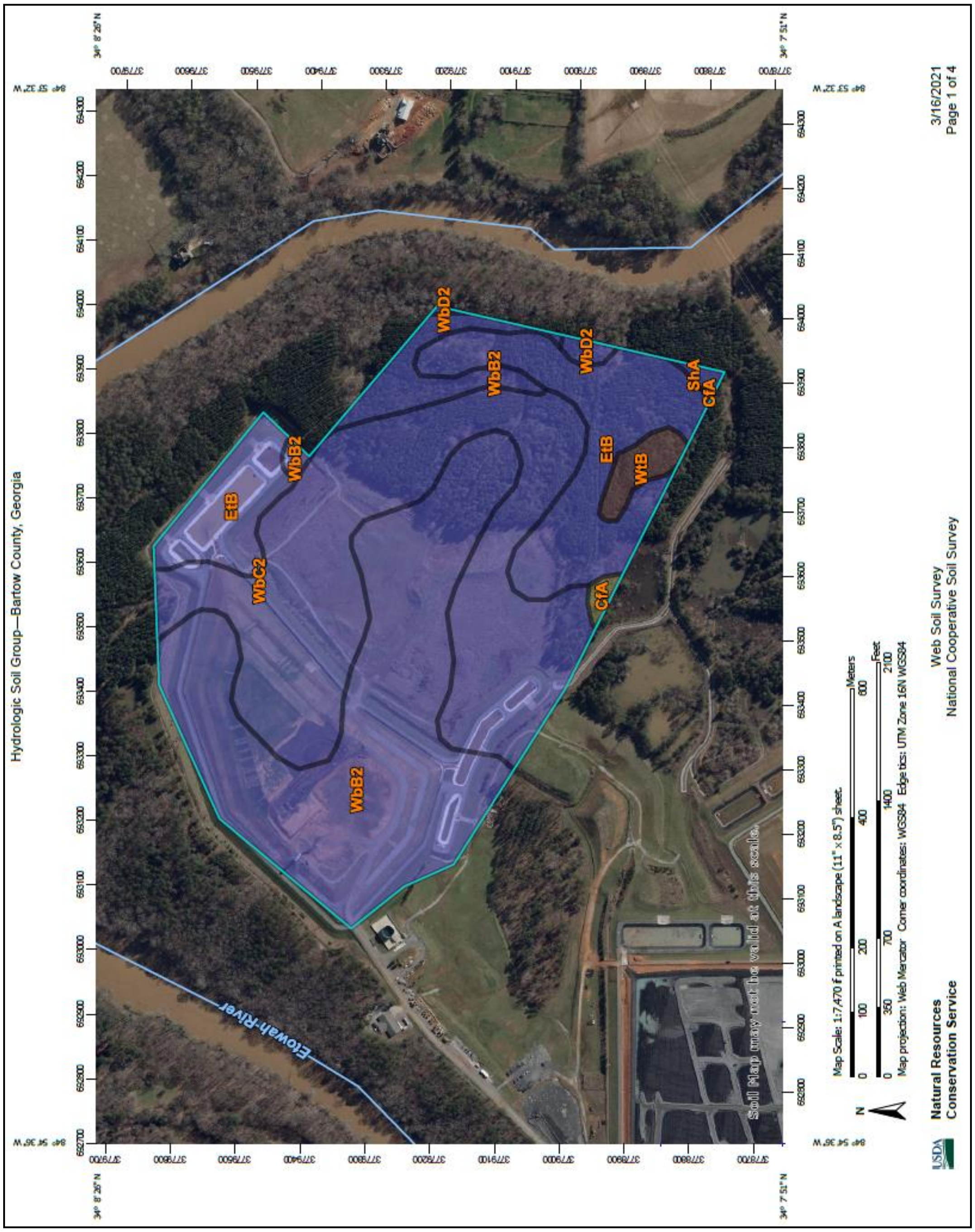


Image 3

Hydrologic Soil Group—Bartow County, Georgia

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CfA	Cedarbluff loam, 0 to 2 percent slopes, occasionally flooded	C/D	0.0	0.0%
EtB	Etowah loam, 2 to 6 percent slopes	B	19.9	17.1%
WbB2	Waynesboro clay loam, 2 to 6 percent slopes, moderately eroded	B	50.0	42.9%
WbC2	Waynesboro clay loam, 6 to 10 percent slopes, moderately eroded	B	45.0	38.6%
WbD2	Waynesboro clay loam, 10 to 15 percent slopes, moderately eroded	B	0.3	0.3%
WtB	Whitwell silt loam, 1 to 5 percent slopes, rarely flooded	B/D	1.3	1.1%
Totals for Area of Interest			**116.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Image 4

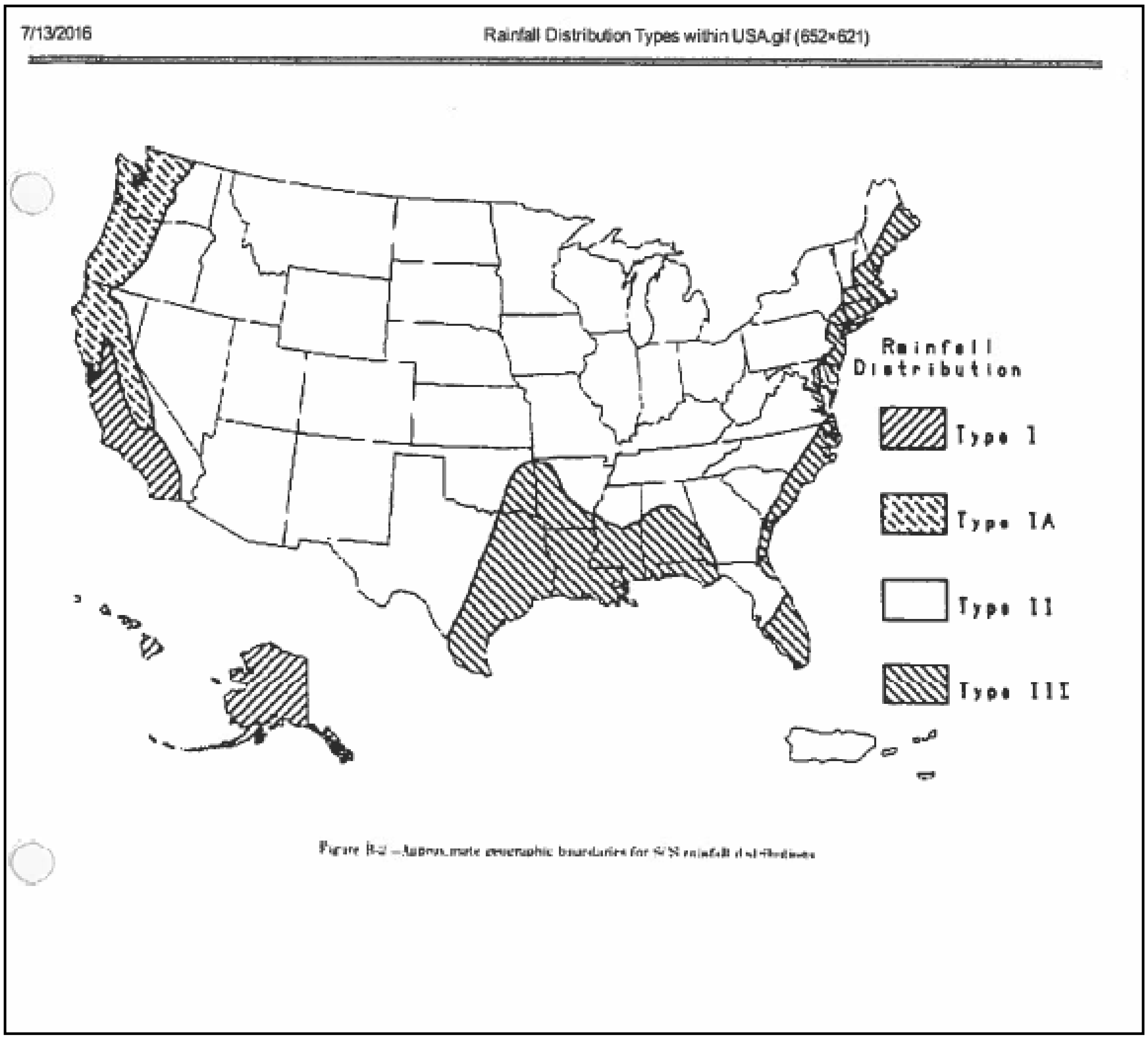

7/13/2016
Rainfall Distribution Types within USA.gif (652×621)
Rainfall Distribution
Type I
Type IA
Type II
Type III

Image 5

Precipitation Frequency Data Server

Page 1 of 4

NOAA Atlas 14, Volume 9, Version 2
TAYLORSVILLE
Station ID: 09-8600
Location name: Taylorsville, Georgia, US*
Latitude: 34.0861°, Longitude: -84.9828°
Elevation:
Elevation (station metadata): 721 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.406 (0.321-0.518)	0.464 (0.367-0.593)	0.568 (0.448-0.726)	0.662 (0.520-0.849)	0.804 (0.619-1.05)	0.924 (0.695-1.23)	1.05 (0.768-1.42)	1.19 (0.838-1.62)	1.39 (0.943-1.92)	1.55 (1.02-2.14)
10-min	0.594 (0.471-0.759)	0.679 (0.537-0.868)	0.831 (0.655-1.06)	0.969 (0.761-1.24)	1.18 (0.907-1.56)	1.35 (1.02-1.80)	1.54 (1.12-2.07)	1.75 (1.23-2.38)	2.03 (1.38-2.81)	2.27 (1.50-3.14)
15-min	0.725 (0.574-0.926)	0.828 (0.655-1.06)	1.01 (0.799-1.30)	1.18 (0.928-1.52)	1.44 (1.11-1.90)	1.65 (1.24-2.19)	1.88 (1.37-2.53)	2.13 (1.50-2.90)	2.48 (1.68-3.43)	2.77 (1.83-3.83)
30-min	1.02 (0.811-1.31)	1.17 (0.924-1.49)	1.43 (1.13-1.83)	1.66 (1.31-2.13)	2.02 (1.56-2.68)	2.33 (1.75-3.09)	2.65 (1.94-3.57)	3.01 (2.12-4.11)	3.52 (2.39-4.86)	3.93 (2.60-5.44)
60-min	1.33 (1.05-1.70)	1.52 (1.20-1.94)	1.85 (1.46-2.36)	2.15 (1.69-2.76)	2.61 (2.01-3.45)	3.00 (2.25-3.98)	3.41 (2.49-4.58)	3.86 (2.71-5.26)	4.49 (3.05-6.21)	5.01 (3.31-6.93)
2-hr	1.64 (1.31-2.06)	1.86 (1.49-2.35)	2.27 (1.81-2.86)	2.64 (2.10-3.34)	3.20 (2.49-4.17)	3.66 (2.79-4.79)	4.16 (3.08-5.52)	4.70 (3.36-6.33)	5.47 (3.77-7.46)	6.09 (4.09-8.32)
3-hr	1.84 (1.49-2.30)	2.10 (1.69-2.62)	2.55 (2.05-3.19)	2.96 (2.37-3.71)	3.56 (2.80-4.60)	4.07 (3.12-5.28)	4.60 (3.43-6.05)	5.18 (3.73-6.91)	6.00 (4.17-8.12)	6.66 (4.51-9.04)
6-hr	2.27 (1.86-2.79)	2.57 (2.10-3.17)	3.10 (2.53-3.83)	3.57 (2.90-4.41)	4.26 (3.38-5.41)	4.82 (3.75-6.16)	5.42 (4.10-7.02)	6.05 (4.42-7.96)	6.94 (4.90-9.27)	7.65 (5.27-10.3)
12-hr	2.79 (2.32-3.39)	3.15 (2.61-3.83)	3.77 (3.12-4.58)	4.31 (3.54-5.25)	5.08 (4.08-6.34)	5.70 (4.49-7.17)	6.36 (4.87-8.10)	7.04 (5.21-9.11)	7.99 (5.72-10.5)	8.73 (6.11-11.6)
24-hr	3.34 (2.81-3.99)	3.79 (3.18-4.53)	4.54 (3.80-5.44)	5.18 (4.32-6.21)	6.07 (4.93-7.43)	6.77 (5.40-8.36)	7.48 (5.81-9.38)	8.22 (6.17-10.5)	9.21 (6.70-11.9)	9.98 (7.10-13.0)
2-day	3.87 (3.29-4.55)	4.43 (3.77-5.21)	5.34 (4.54-6.30)	6.10 (5.16-7.22)	7.14 (5.88-8.60)	7.95 (6.42-9.65)	8.75 (6.89-10.8)	9.56 (7.27-12.0)	10.6 (7.84-13.6)	11.4 (8.27-14.8)
3-day	4.24 (3.64-4.95)	4.81 (4.13-5.62)	5.76 (4.93-6.73)	6.56 (5.59-7.68)	7.66 (6.37-9.16)	8.53 (6.95-10.3)	9.40 (7.47-11.5)	10.3 (7.92-12.8)	11.5 (8.57-14.6)	12.4 (9.06-15.9)
4-day	4.56 (3.94-5.28)	5.14 (4.43-5.96)	6.10 (5.25-7.08)	6.92 (5.93-8.06)	8.07 (6.76-9.61)	8.98 (7.38-10.8)	9.92 (7.94-12.1)	10.9 (8.43-13.5)	12.2 (9.16-15.4)	13.2 (9.72-16.8)
7-day	5.37 (4.69-6.14)	5.99 (5.22-6.86)	7.04 (6.13-8.07)	7.94 (6.88-9.14)	9.24 (7.84-10.9)	10.3 (8.56-12.2)	11.3 (9.21-13.7)	12.5 (9.80-15.3)	14.0 (10.7-17.5)	15.2 (11.3-19.2)
10-day	6.07 (5.34-6.89)	6.74 (5.92-7.66)	7.88 (6.91-8.97)	8.87 (7.74-10.1)	10.3 (8.79-12.0)	11.4 (9.58-13.5)	12.6 (10.3-15.1)	13.8 (11.0-16.8)	15.5 (11.9-19.3)	16.8 (12.7-21.1)
20-day	8.08 (7.21-9.03)	8.91 (7.95-9.96)	10.3 (9.17-11.5)	11.5 (10.2-12.9)	13.2 (11.5-15.2)	14.6 (12.4-16.9)	16.0 (13.3-18.8)	17.4 (14.0-20.9)	19.4 (15.2-23.7)	21.0 (16.1-25.9)
30-day	9.86 (8.87-10.9)	10.8 (9.75-12.0)	12.5 (11.2-13.8)	13.9 (12.4-15.4)	15.8 (13.8-17.9)	17.3 (14.9-19.8)	18.8 (15.8-22.0)	20.4 (16.6-24.2)	22.5 (17.8-27.3)	24.1 (18.7-29.5)
45-day	12.2 (11.1-13.4)	13.5 (12.2-14.8)	15.4 (14.0-17.0)	17.1 (15.4-18.8)	19.3 (16.9-21.6)	20.9 (18.1-23.7)	22.6 (19.1-26.1)	24.3 (19.9-28.5)	26.4 (21.1-31.7)	28.1 (22.0-34.1)
60-day	14.4 (13.1-15.6)	15.8 (14.4-17.2)	18.1 (16.5-19.8)	19.9 (18.1-21.8)	22.4 (19.8-24.9)	24.2 (21.0-27.2)	25.9 (22.0-29.7)	27.7 (22.8-32.2)	29.8 (23.9-35.5)	31.4 (24.8-37.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

Image 6

Body of Calculation

See detailed calculations and software output.

Cells 3, 5 & 7

Cells 3, 5 & 7 is broken down into 3 smaller subbasins (1A, 1B & 1C)

Drainage Area = 11.20 AC (See Map 1A)

Curve Number = 64 (See Table 1)

10.88 AC @ CN 61 (Grass)

0.32 AC @ CN 85 (Gravel)

((10.88*61)+(0.32*85))/10.88 = 63.50 = 64

Time of Concentration = 22.18 Min (See TR55 Worksheet 1A and Map 2A)

Sheet Flow

Manning's n-Value = 0.15 (Short Grass) (See Table 2)

Flow Length = 167 LF

Land Slope = (826.25-821.50)/167 = 0.0284 = 2.84%

Shallow Concentrated

Flow Length = 161 LF

Watercourse Slope = (821.50-820.50)/161 = 0.0062 = 0.62%

Surface is Unpaved

Channel Flow (See Channel Report 1A1)

15" Dia. HDPE Downdrain Pipes

Cross Sectional Area = 0.23 SF

Wetted Perimeter = 1.28 LF

Channel Slope = (820.50-724.00)/1099 = 0.0878 = 8.78%

Manning's n-Value = 0.012 (HDPE Pipe)(See Table 4)

Flow Length = 1099 LF

Channel Flow (See Channel Report 1A2)

Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 4' Deep

Cross Sectional Area = 4.99 SF

Wetted Perimeter = 7.89 LF

Channel Slope = (724.00-694.00)/1847 = 0.0162 = 1.62%

Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)

Flow Length = 1847 LF

Channel Flow (See Channel Report 1A3)

2 – 30” Dia. HDPE Pipes
Cross Sectional Area = 1.00 SF
Wetted Perimeter = 2.66 LF
Channel Slope = (694.00-692.00)/60 = 0.0333 = 3.33%
Manning’s n-Value = 0.012 (HDPE Pipes) (See Table 4)
Flow Length = 60 LF

Time Interval = 3 Min
Tc*0.1333 = 22.18*0.1333 = 2.96 = 3

Storm Distribution = Type II

Q_{25}1A = 23.05 CFS (See Hydrograph Report 1A)

Drainage Area = 27.35 AC (See Map 1B)

Curve Number = 64 (See Table 1)
27.06 AC @ CN 61 (Grass)
0.29 AC @ CN 85 (Gravel)
((27.06*61)+(0.29*85))/27.35 = 61.25 = 61

Time of Concentration = 37.23 Min (See TR55 Worksheet 1B and Map 2B)
Sheet Flow
Manning’s n-Value = 0.15 (Short Grass) (See Table 2)
Flow Length = 300 LF
Land Slope = (828.50-824.95)/300 = 0.0118 = 1.18%
Shallow Concentrated
Flow Length = 92 LF
Watercourse Slope = (824.95-822.00)/92 = 0.0321 = 3.21%
Surface is Unpaved
Channel Flow (See Channel Report 1B1)
15” Dia. HDPE Downdrain Pipes
Cross Sectional Area = 0.65 SF
Wetted Perimeter = 2.02 LF
Channel Slope = (822.00-705.75)/1957 = 0.0594 = 5.94%
Manning’s n-Value = 0.012 (HDPE Pipe)(See Table 4)

Flow Length = 1957 LF

Channel Flow (See Channel Report 1B2)

Grass Lined 4’ Wide Ditch with 2:1 Side Slopes and 4’ Deep

Cross Sectional Area = 8.67 SF

Wetted Perimeter = 9.86 LF

Channel Slope = (705.75-694.67)/1673 = 0.0066 = 0.66%

Manning’s n-Value = 0.030 (Vegetal Lining) (See Table 3)

Flow Length = 1673 LF

Channel Flow (See Channel Report 1B3)

4 – 30” Dia. HDPE Pipes

Cross Sectional Area = 0.70 SF

Wetted Perimeter = 2.32 LF

Channel Slope = (694.67-692.00)/60 = 0.0445 = 4.45%

Manning’s n-Value = 0.012 (HDPE Pipes) (See Table 4)

Flow Length = 60 LF

Time Interval = 5 Min

Tc*0.1333 = 37.23*0.1333 = 4.96 = 5

Storm Distribution = Type II

Q_{25}1B = 32.02 CFS (See Hydrograph Report 1B)

Drainage Area = 2.92 AC (See Map 1C)

Curve Number = 64 (See Table 1)

1.97 AC @ CN 85 (Gravel)

0.95 AC @ CN 98 (Impervious – Liner in Sediment Pond and Clear Pool)

((1.97*85)+(0.95*98))/2.92 = 89.23 = 89

Time of Concentration = 5.00 Min (See TR55 Worksheet 1C)

*Use Tc of 5.00 minutes due to small drainage area and only receiving what stormwater falls directly in the ponds and the small area around them.

Time Interval = 1 Min

Tc*0.1333 = 5.00*0.1333 = 0.67= 1

Storm Distribution = Type II

$Q_{25}1C$ = 24.05 CFS (See Hydrograph Report 1C)

$Q_{25}1Total$ = 57.16 CFS (See Hydrograph Report 1 Total)

To Evaluate for Storage Capacity, Treat The Sediment Pond and Clear Pool As One Pond Since They Are Interconnected.

Elevation (FT)	Sed. Pond Area (SF)	Clear Pool Area (SF)	Total Area (SF)	Volume (CF)
683	0	9,025	9,025	0*
684	43,996	9,996	53,992	28,361*
685	46,707	11,007	57,714	84,198*
685.5	48,077	11,527	59,604	113,523*
686	49,457	12,057	61,514	143,799
687	52,247	13,147	65,394	207,236
688	55,076	14,276	69,352	274,593
689	57,944	15,444	73,388	345,946
690	60,851	16,651	77,502	421,374
690.5	62,320	17,270	79,590	460,642

*Dead Storage

Spillways

- Principal Spillway consists of two 54” Dia. Risers with two 36” Dia. HDPE Pipes.
- Auxiliary Spillway consist of a concrete lined trapezoidal weir that is 20’ wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end.

High Water Elevation is 688.37 (See Pond Reports 1 & 2)

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 15 of 70

Map 1A

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

Hyd. No. 4

Cell 3, 5 & 7 Pipes 1A

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	167.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.79		0.00		0.00		
Land slope (%)	=	2.84		0.00		0.00		
Travel Time (min)	**=**	**11.79**	**+**	**0.00**	**+**	**0.00**	**=**	**11.79**
Shallow Concentrated Flow								
Flow length (ft)	=	161.00		0.00		0.00		
Watercourse slope (%)	=	0.62		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.27		0.00		0.00		
Travel Time (min)	**=**	**2.11**	**+**	**0.00**	**+**	**0.00**	**=**	**2.11**
Channel Flow								
X sectional flow area (sqft)	=	0.23		4.99		1.00		
Wetted perimeter (ft)	=	1.28		7.89		2.66		
Channel slope (%)	=	8.78		1.62		3.33		
Manning's n-value	=	0.012		0.030		0.012		
Velocity (ft/s)	=	11.65		4.65		11.76		
Flow length (ft)		({0})1099.0		1847.0		60.0		
Travel Time (min)	**=**	**1.57**	**+**	**6.62**	**+**	**0.09**	**=**	**8.28**
Total Travel Time, Tc								**22.18 min**

TR55 Worksheet 1A

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
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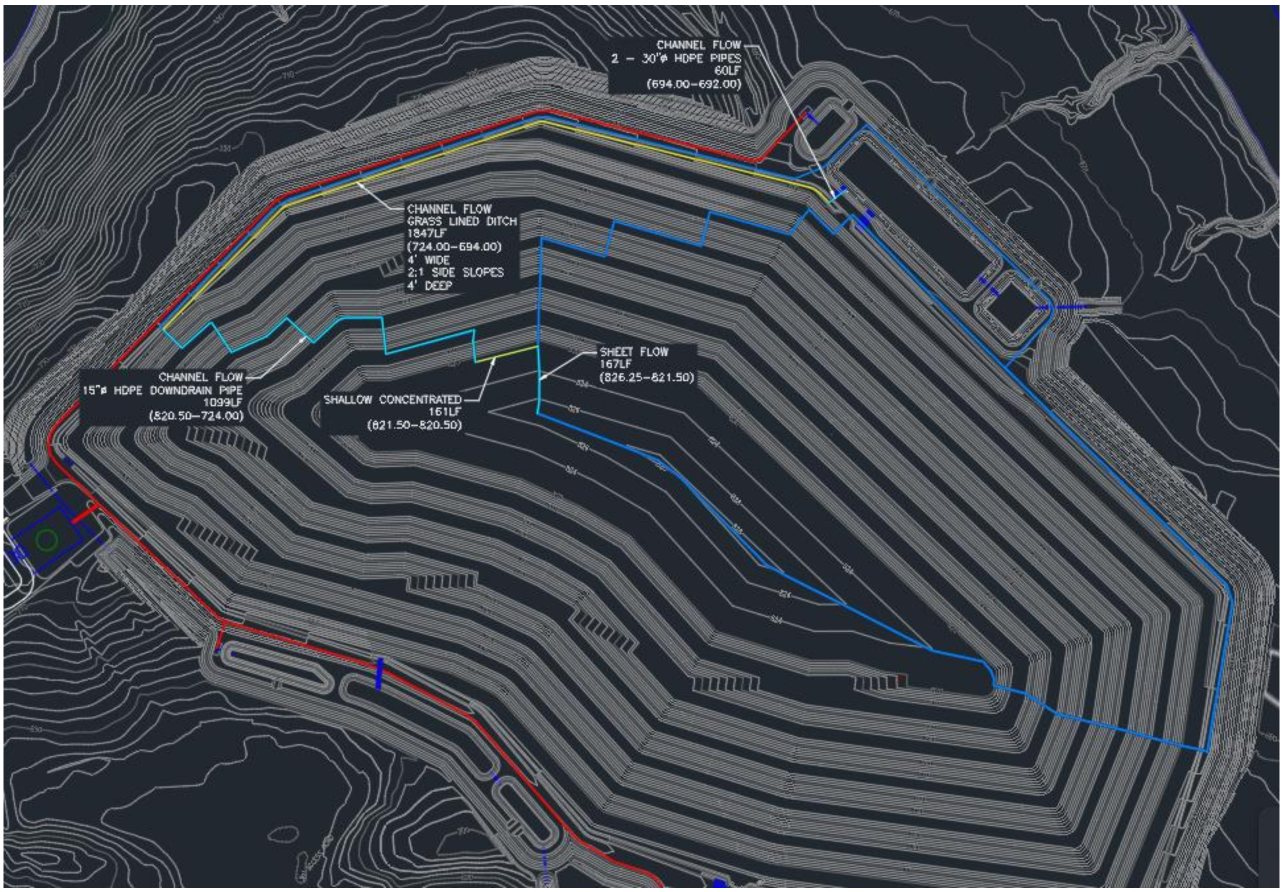


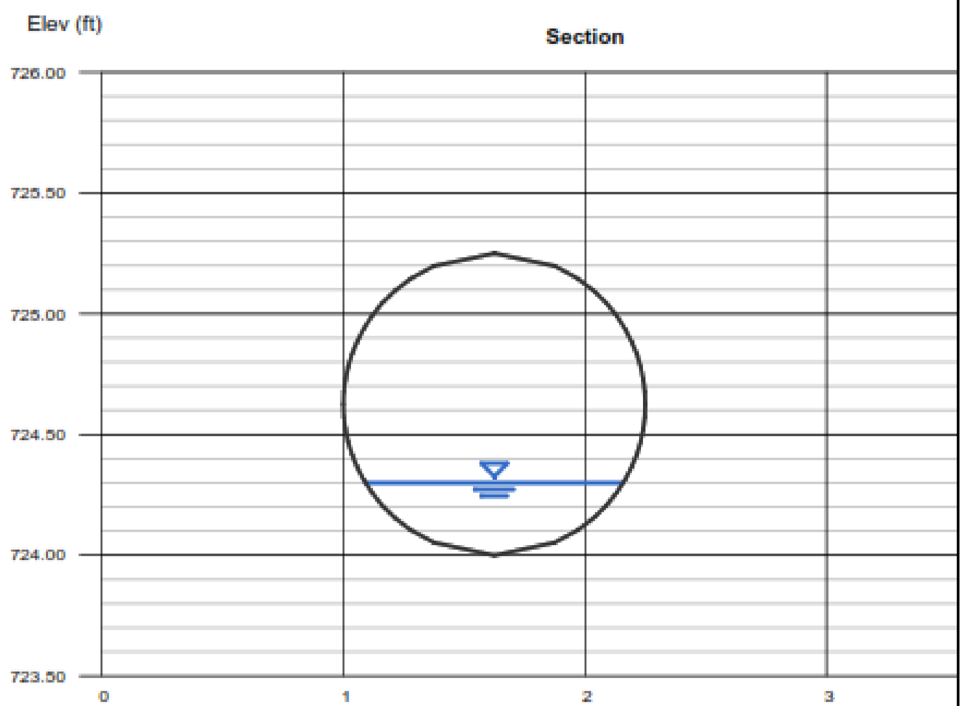
Map 2A

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Sep 7 2023

Cell 357 Downdrain 1A1

Circular		**Highlighted**	
Diameter (ft)	= 1.25	Depth (ft)	= 0.30
		Q (cfs)	= 2.550
		Area (sqft)	= 0.23
Invert Elev (ft)	= 724.00	Velocity (ft/s)	= 11.23
Slope (%)	= 8.78	Wetted Perim (ft)	= 1.28
N-Value	= 0.012	Crit Depth, Yc (ft)	= 0.64
		Top Width (ft)	= 1.07
Calculations		EGL (ft)	= 2.26
Compute by:	Known Q		
Known Q (cfs)	= 2.55		



Channel Report 1A1

Design Calculations

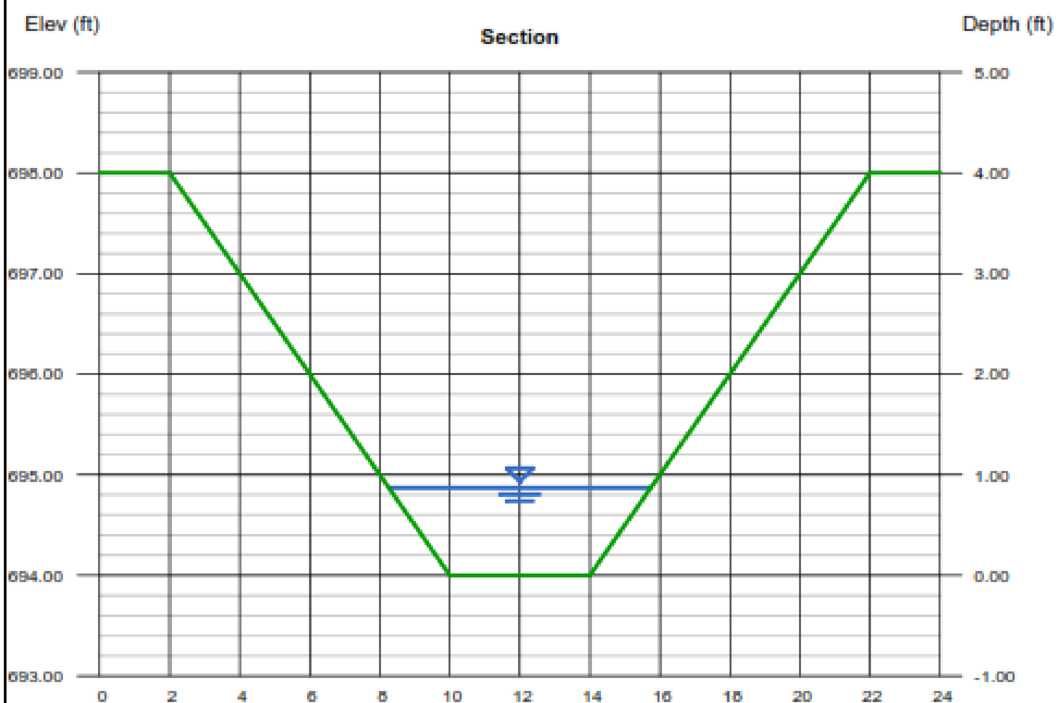
Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 19 of 70

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Aug 18 2023

Cell 357 Ditch 1A

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 4.00	Depth (ft)	= 0.87
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 23.05
Total Depth (ft)	= 4.00	Area (sqft)	= 4.99
Invert Elev (ft)	= 694.00	Velocity (ft/s)	= 4.62
Slope (%)	= 1.62	Wetted Perim (ft)	= 7.89
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.87
		Top Width (ft)	= 7.48
Calculations		EGL (ft)	= 1.20
Compute by:	Known Q		
Known Q (cfs)	= 23.05		



Channel Report 1A2

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Sep 6 2023

Cell357_Pipes1A

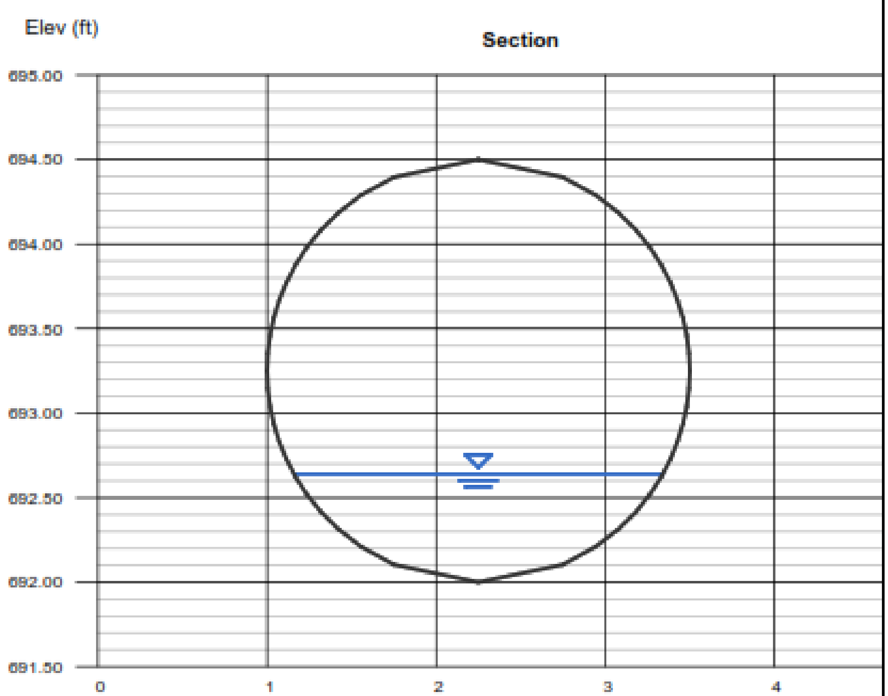
Circular
Diameter (ft) = 2.50

Invert Elev (ft) = 692.00
Slope (%) = 3.33
N-Value = 0.012

Calculations
Compute by: Known Q
Known Q (cfs) = 11.53

Highlighted
Depth (ft) = 0.64
Q (cfs) = 11.53
Area (sqft) = 1.00
Velocity (ft/s) = 11.51
Wetted Perim (ft) = 2.66
Crit Depth, Yc (ft) = 1.14
Top Width (ft) = 2.19
EGL (ft) = 2.70

23.05/2=11.53
Full flow of 23.05 is divided by 2 since there are two pipes.



Channel Report 1A3

Design Calculations

Project **Plant Bowen Run-on Run-off Control**	Prepared by Jeremy Brown	Date 9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 21 of 70

Hydrograph Report

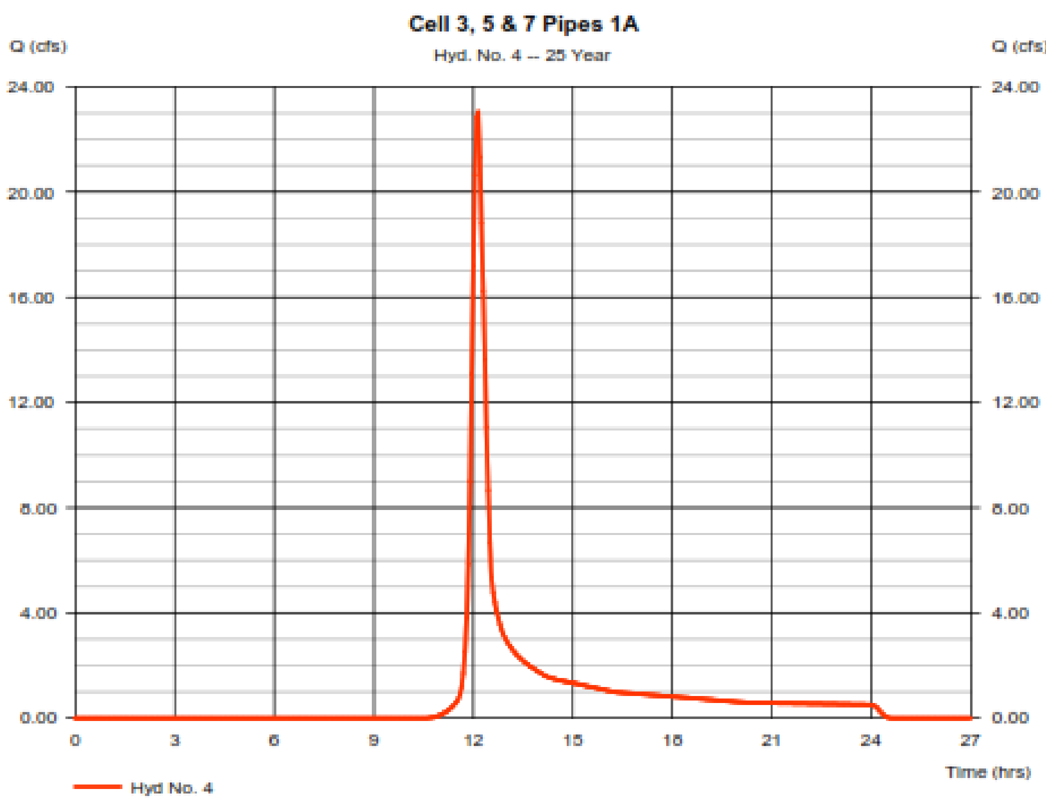
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Thursday, 09 / 7 / 2023

Hyd. No. 4

Cell 3, 5 & 7 Pipes 1A

Hydrograph type	= SCS Runoff	Peak discharge	= 23.05 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.15 hrs
Time interval	= 3 min	Hyd. volume	= 84,769 cuft
Drainage area	= 11.200 ac	Curve number	= 62*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 22.20 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

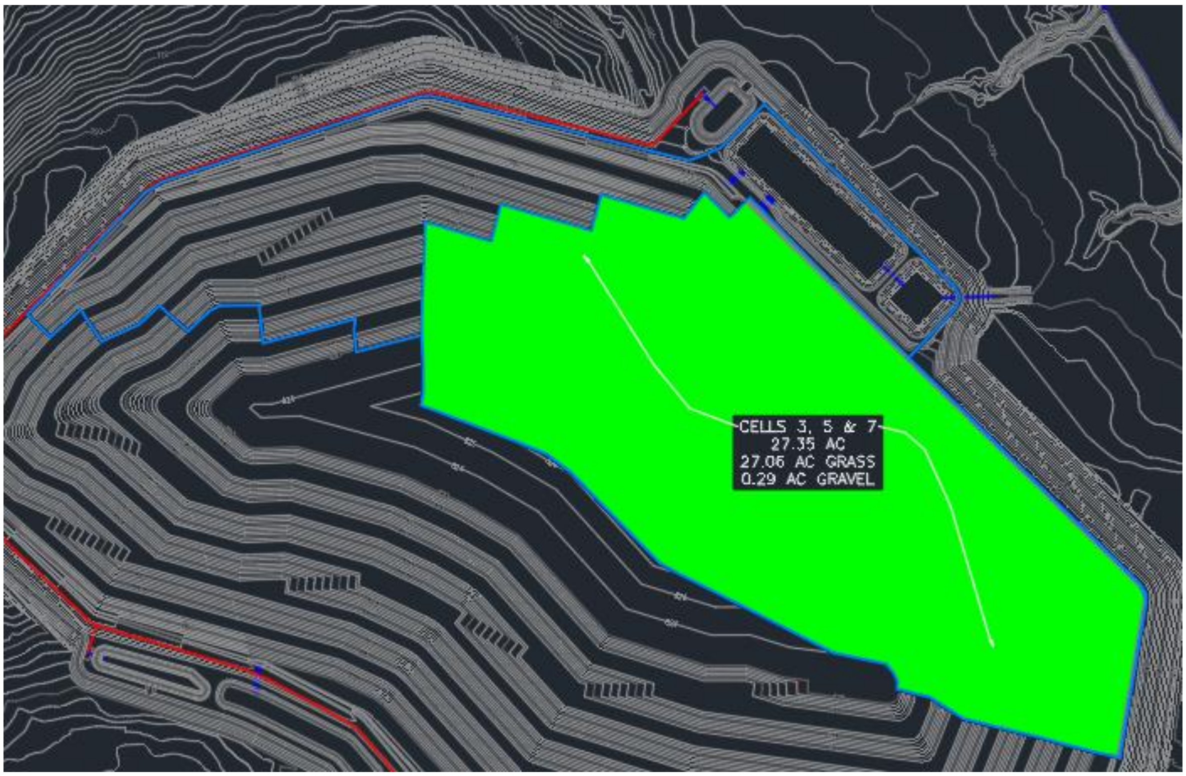
* Composite (Area/CN) = [(10.880 x 61) + (0.320 x 85)] / 11.200



Hydrograph Report 1A

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 22 of 70



Map 1B

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

Hyd. No. 6

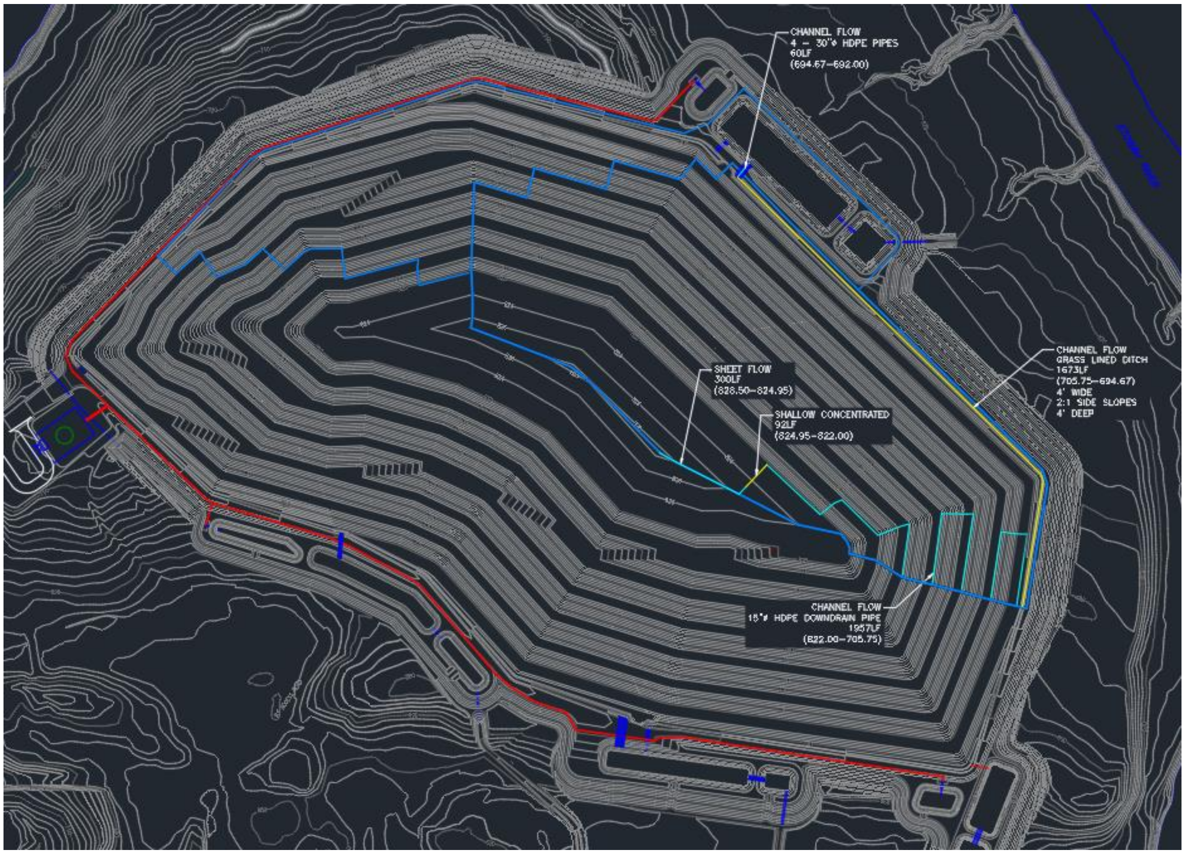
Cell 3, 5 & 7 1B

Description	A	B	C	Totals
Sheet Flow				
Manning's n-value	= 0.150	0.011	0.011	
Flow length (ft)	= 300.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.79	0.00	0.00	
Land slope (%)	= 1.18	0.00	0.00	
Travel Time (min)	**= 26.78 +**	**0.00 +**	**0.00 =**	**26.78**
Shallow Concentrated Flow				
Flow length (ft)	= 92.00	0.00	0.00	
Watercourse slope (%)	= 3.21	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=2.89	0.00	0.00	
Travel Time (min)	**= 0.53 +**	**0.00 +**	**0.00 =**	**0.53**
Channel Flow				
X sectional flow area (sqft)	= 0.65	8.67	0.70	
Wetted perimeter (ft)	= 2.02	9.86	2.32	
Channel slope (%)	= 5.94	0.66	4.45	
Manning's n-value	= 0.012	0.030	0.012	
Velocity (ft/s)	=14.16	3.70	11.74	
Flow length (ft)	({0})1957.0	1673.0	60.0	
Travel Time (min)	**= 2.30 +**	**7.53 +**	**0.09 =**	**9.92**
Total Travel Time, Tc				**37.23 min**

TR55 Worksheet 1B

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 24 of 70



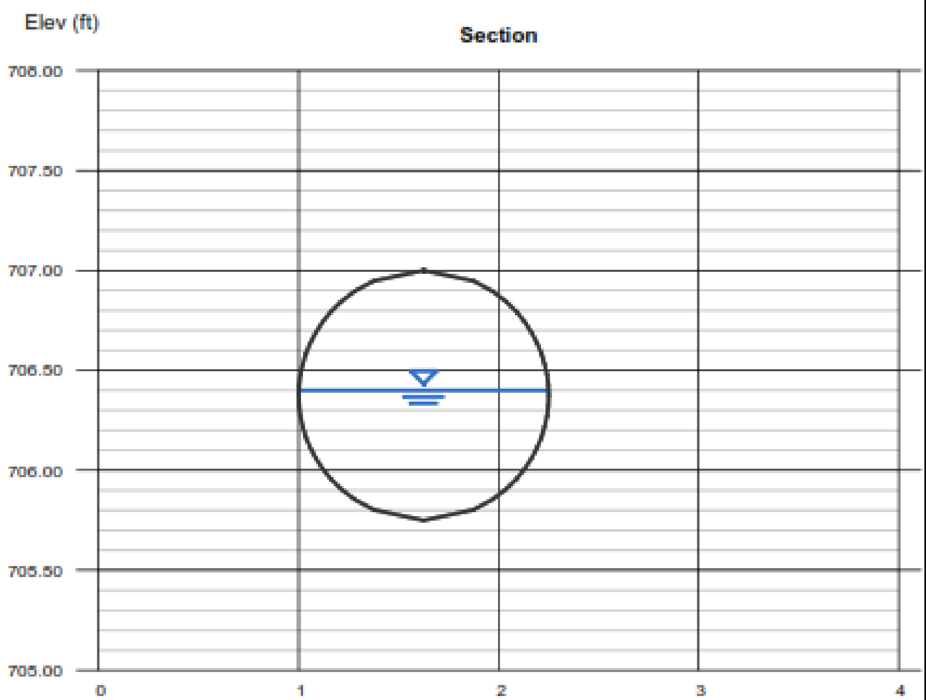
Map 2B

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Sep 7 2023

Cell 357 Downdrain 1B1

Circular		**Highlighted**	
Diameter (ft)	= 1.25	Depth (ft)	= 0.65
		Q (cfs)	= 9.110
		Area (sqft)	= 0.65
Invert Elev (ft)	= 705.75	Velocity (ft/s)	= 14.06
Slope (%)	= 5.94	Wetted Perim (ft)	= 2.02
N-Value	= 0.012	Crit Depth, Yc (ft)	= 1.16
		Top Width (ft)	= 1.25
Calculations		EGL (ft)	= 3.72
Compute by:	Known Q		
Known Q (cfs)	= 9.11		



Channel Report 1B1

Channel Report

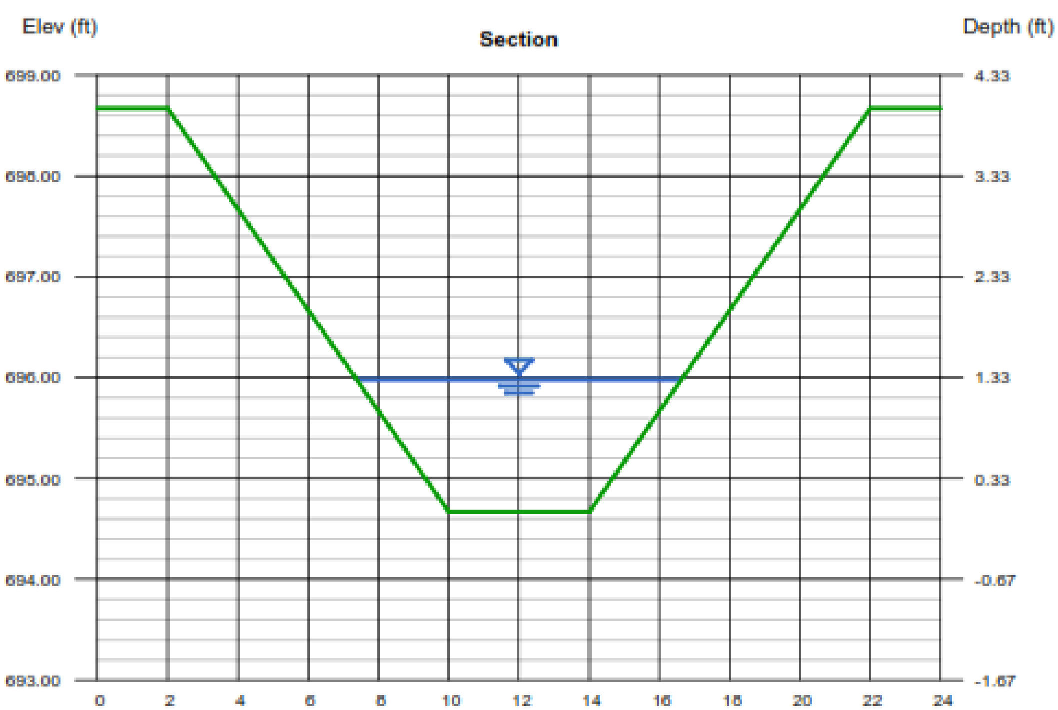
Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Sunday, Aug 20 2023

Cell 357 Ditch 1B2

Trapezoidal
Bottom Width (ft) = 4.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 4.00
Invert Elev (ft) = 694.67
Slope (%) = 0.66
N-Value = 0.030

Calculations
Compute by: Known Q
Known Q (cfs) = 32.02

Highlighted
Depth (ft) = 1.31
Q (cfs) = 32.02
Area (sqft) = 8.67
Velocity (ft/s) = 3.69
Wetted Perim (ft) = 9.86
Crit Depth, Yc (ft) = 1.05
Top Width (ft) = 9.24
EGL (ft) = 1.52



Channel Report 1B2

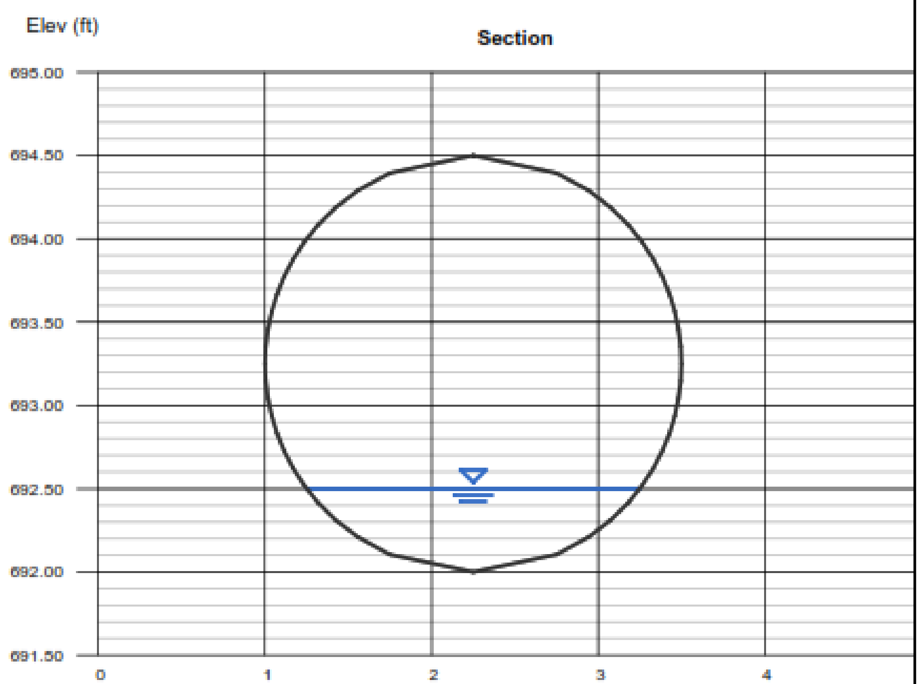
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Sep 7 2023

Cell357_Pipes1B3

Circular		**Highlighted**	
Diameter (ft)	= 2.50	Depth (ft)	= 0.50
		Q (cfs)	= 8.010
		Area (sqft)	= 0.70
Invert Elev (ft)	= 692.00	Velocity (ft/s)	= 11.37
Slope (%)	= 4.45	Wetted Perim (ft)	= 2.32
N-Value	= 0.012	Crit Depth, Yc (ft)	= 0.94
		Top Width (ft)	= 2.00
Calculations		EGL (ft)	= 2.51
Compute by:	Known Q		
Known Q (cfs)	= 8.01		

Q=32.02/4=8.01
Full flow 32.02 is divided by 4 since there are 4 pipes.



Channel Report 1B3

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 28 of 70

Hydrograph Report

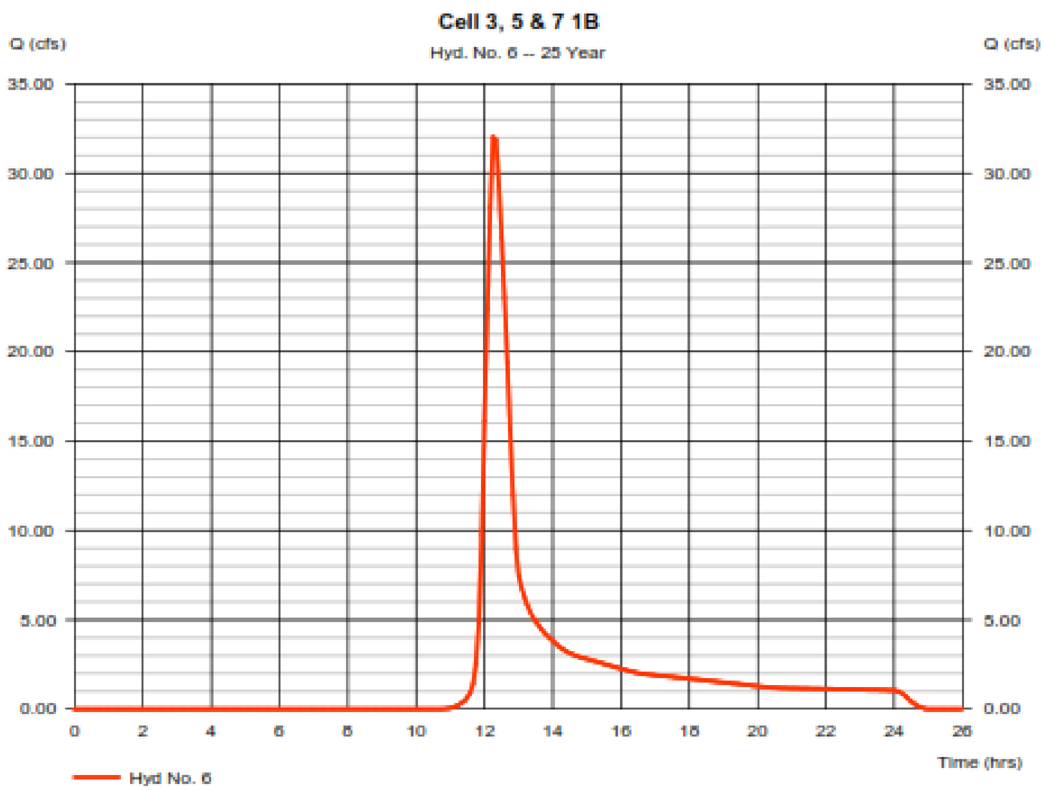
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Thursday, 09 / 7 / 2023

Hyd. No. 6

Cell 3, 5 & 7 1B

Hydrograph type	= SCS Runoff	Peak discharge	= 32.02 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.25 hrs
Time interval	= 5 min	Hyd. volume	= 168,748 cuft
Drainage area	= 23.230 ac	Curve number	= 61*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 37.20 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(22.970 x 61) + (0.260 x 85)] / 23.230



Hydrograph Report 1B

Map 1C

Hydrograph Report

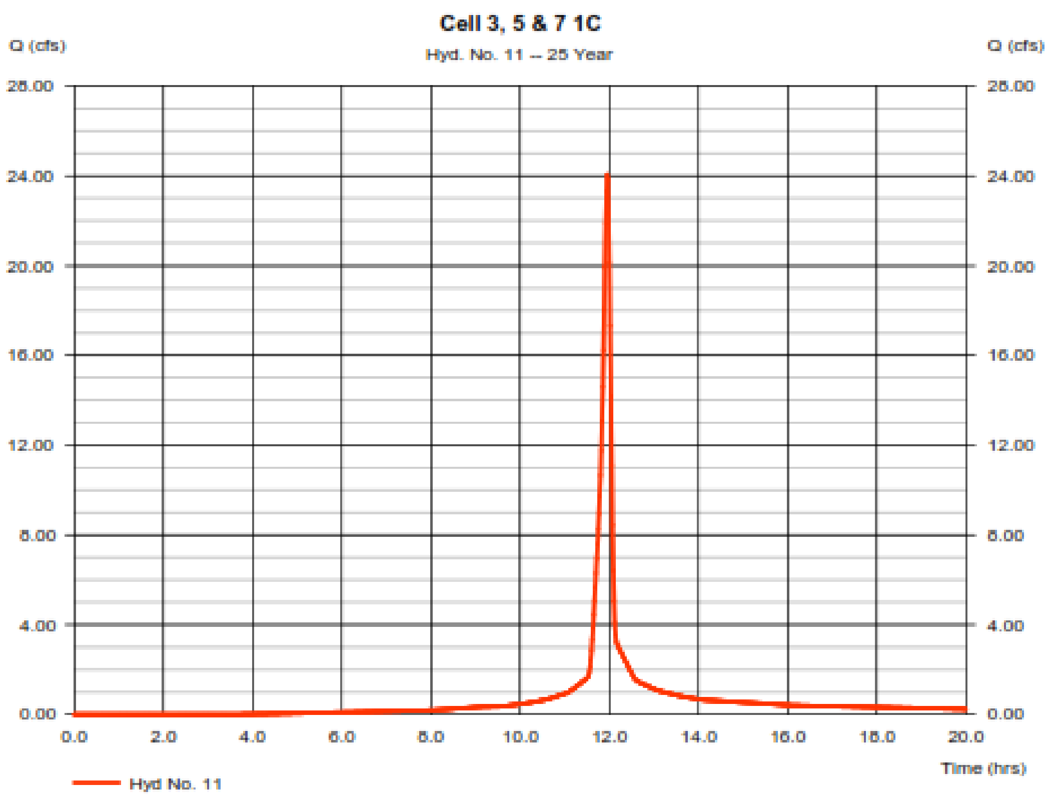
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Sunday, 08 / 20 / 2023

Hyd. No. 11

Cell 3, 5 & 7 1C

Hydrograph type	= SCS Runoff	Peak discharge	= 24.05 cfs
Storm frequency	= 25 yrs	Time to peak	= 11.95 hrs
Time interval	= 1 min	Hyd. volume	= 52,504 cuft
Drainage area	= 2.920 ac	Curve number	= 89*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = + (1.970 x 85) + (0.950 x 98)] / 2.920



Hydrograph Report 1C

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 31 of 70

Hydrograph Report

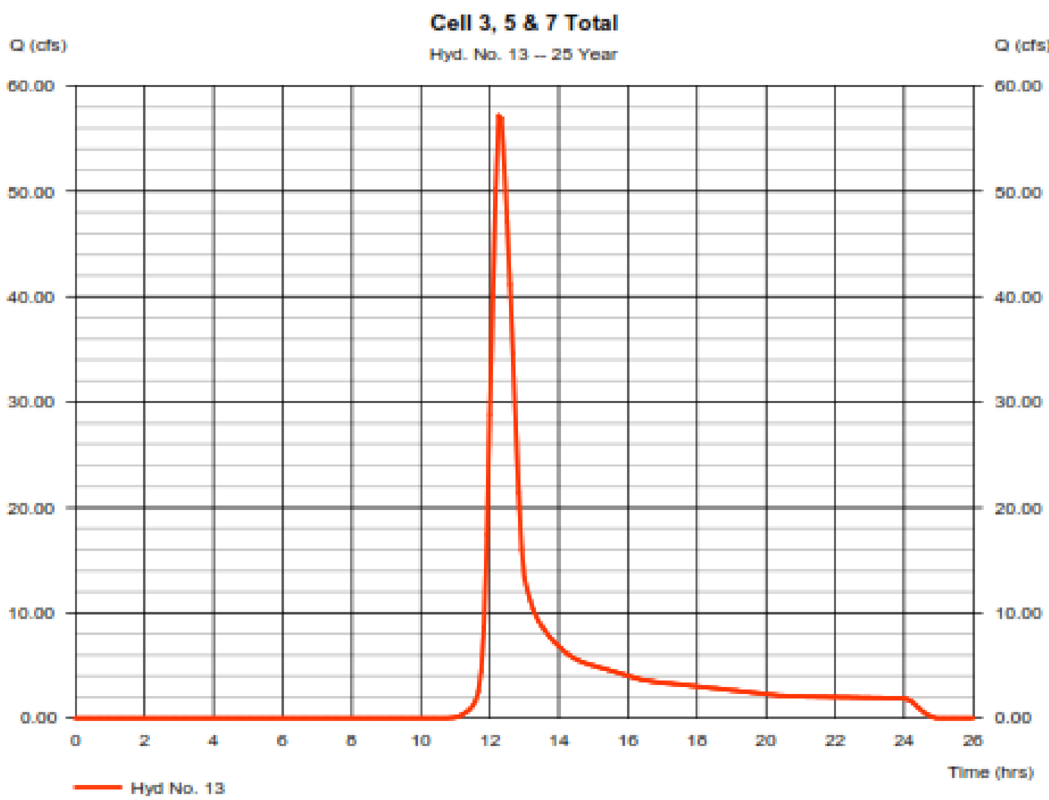
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Thursday, 09 / 7 / 2023

Hyd. No. 13

Cell 3, 5 & 7 Total

Hydrograph type	= SCS Runoff	Peak discharge	= 57.16 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.25 hrs
Time interval	= 5 min	Hyd. volume	= 301,247 cuft
Drainage area	= 41.470 ac	Curve number	= 61*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 37.20 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(37.940 x 61) + (2.580 x 85)] / 41.470



Hydrograph Report 1Total

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 32 of 70

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Monday, 04 / 12 / 2021

Pond No. 1 - Cell 3 Sed Pond/Clear Pool

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 683.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	683.00	9,025	0	0
1.00	684.00	53,992	28,361	28,361
2.00	685.00	57,714	55,837	84,198
2.50	685.50	59,604	29,325	113,523
3.00	686.00	61,514	30,275	143,799
4.00	687.00	65,394	63,438	207,236
5.00	688.00	69,352	67,357	274,593
6.00	689.00	73,388	71,353	345,946
7.00	690.00	77,502	75,428	421,374
7.50	690.50	79,590	39,268	460,642

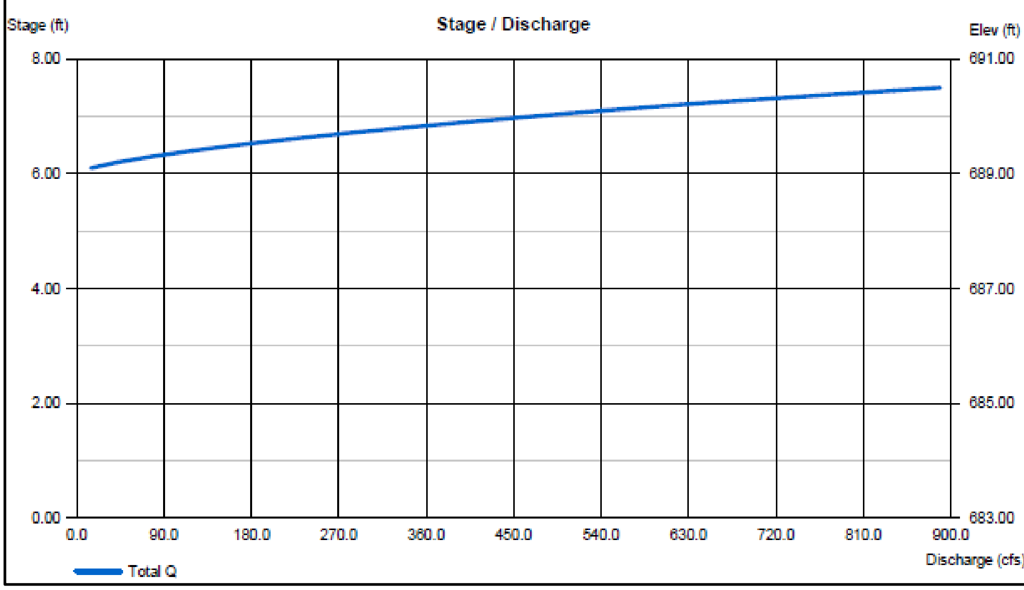
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	0.00	0.00	0.00
Span (in)	= 36.00	0.00	0.00	0.00
No. Barrels	= 2	0	0	0
Invert El. (ft)	= 670.00	0.00	0.00	0.00
Length (ft)	= 117.00	0.00	0.00	0.00
Slope (%)	= 0.25	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

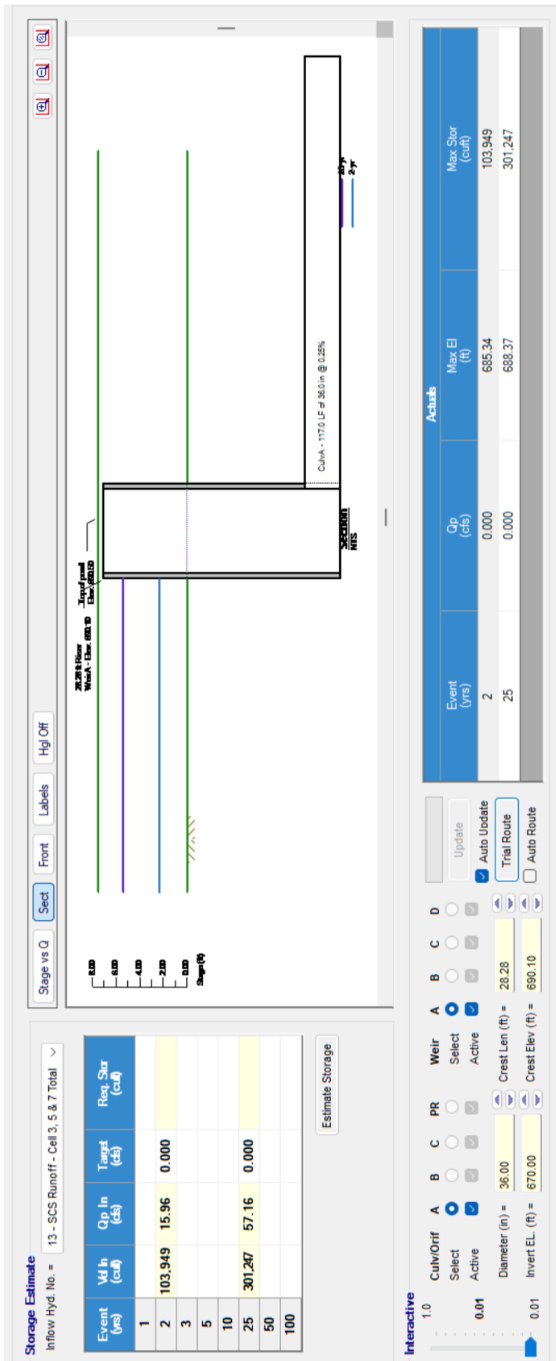
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 28.28	0.00	0.00	0.00
Crest El. (ft)	= 690.10	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Pond Report 1



Pond Report 2

Cell 4

Drainage Area = 12.83 AC (See Map 3)

Curve Number = 64 (See Table 1)
- 10.84 AC @ CN 61 (Grass)
- 1.49 AC @ CN 85 (Gravel)
- 0.50 AC @ CN 98 (Impervious – Liner in Sediment Pond and Clear Pool)
- ((10.84*61)+(1.49*85)+(0.50*98))/12.83 = 65.23 = 65

Time of Concentration = 20.51 Min (See TR55 Worksheet 2 and Map 4)
- Sheet Flow
  - Manning's n-Value = 0.15 (Short Grass) (See Table 2)
  - Flow Length = 167 LF
  - Land Slope = (826.66-822.00)/167 = 0.0279 = 2.79%
- Shallow Concentrated
  - Flow Length = 161 LF
  - Watercourse Slope = (822.00-820.90)/161 = 0.0068 = 0.68%
  - Surface is Unpaved
- Channel Flow (See Channel Report 4)
  - 12" Dia. HDPE Downdrain Pipes
  - Cross Sectional Area = 0.59 SF
  - Wetted Perimeter = 1.98 LF
  - Channel Slope = (820.90-723.50)/1089 = 0.0894 = 8.94%
  - Manning's n-Value = 0.12 (HDPE Pipe)(See Table 4)
  - Flow Length = 1089 LF
- Channel Flow (See Channel Report 5)
  - Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 4' Deep
  - Cross Sectional Area = 5.07 SF
  - Wetted Perimeter = 7.94 LF
  - Channel Slope = (723.50-705.82)/1379 = 0.0128 = 1.28%
  - Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)
  - Flow Length = 1379 LF
- Channel Flow (See Channel Report 6)
  - 2 – 30" Dia. HDPE Pipes
  - Cross Sectional Area = 0.70 SF
  - Wetted Perimeter = 2.32 LF

Channel Slope = (705.82-701.00)/60 = 0.0803 = 8.03%
Manning's n-Value = 0.012 (HDPE Pipe) (See Table 4)
Flow Length = 60 LF

Time Interval = 3 Min
$Tc*0.1333 = 20.51*0.1333 = 2.73 = 3$

Storm Distribution = Type II

Q_{25} = 30.10 CFS (See Hydrograph Report 2)

To Evaluate for Storage Capacity, Treat The Sediment Pond and Clear Pool As One Pond Since They Are Interconnected.

Elevation (FT)	Sed. Pond Area (SF)	Clear Pool Area (SF)	Total Area (SF)	Volume (CF)
697	740	5,913	6,653	0*
698	16,648	6,917	23,565	14,245*
698.5	17,772	7,435	25,207	26,434*
699	18,906	7,962	26,868	39,450
700	21,203	9,045	30,248	67,988
701	23,539	10,168	33,707	99,947
702	25,915	11,330	37,215	135,390

*Dead Storage

Spillways

- Principal Spillway consists of a 66" Dia. Riser with a 42" Dia. HDPE Pipe.
- Auxiliary Spillway consist of a concrete lined trapezoidal weir that is 18' wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end.

High Water Elevation is 701.04 (See Pond Reports 3 & 4)

Map 3

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

Hyd. No. 16

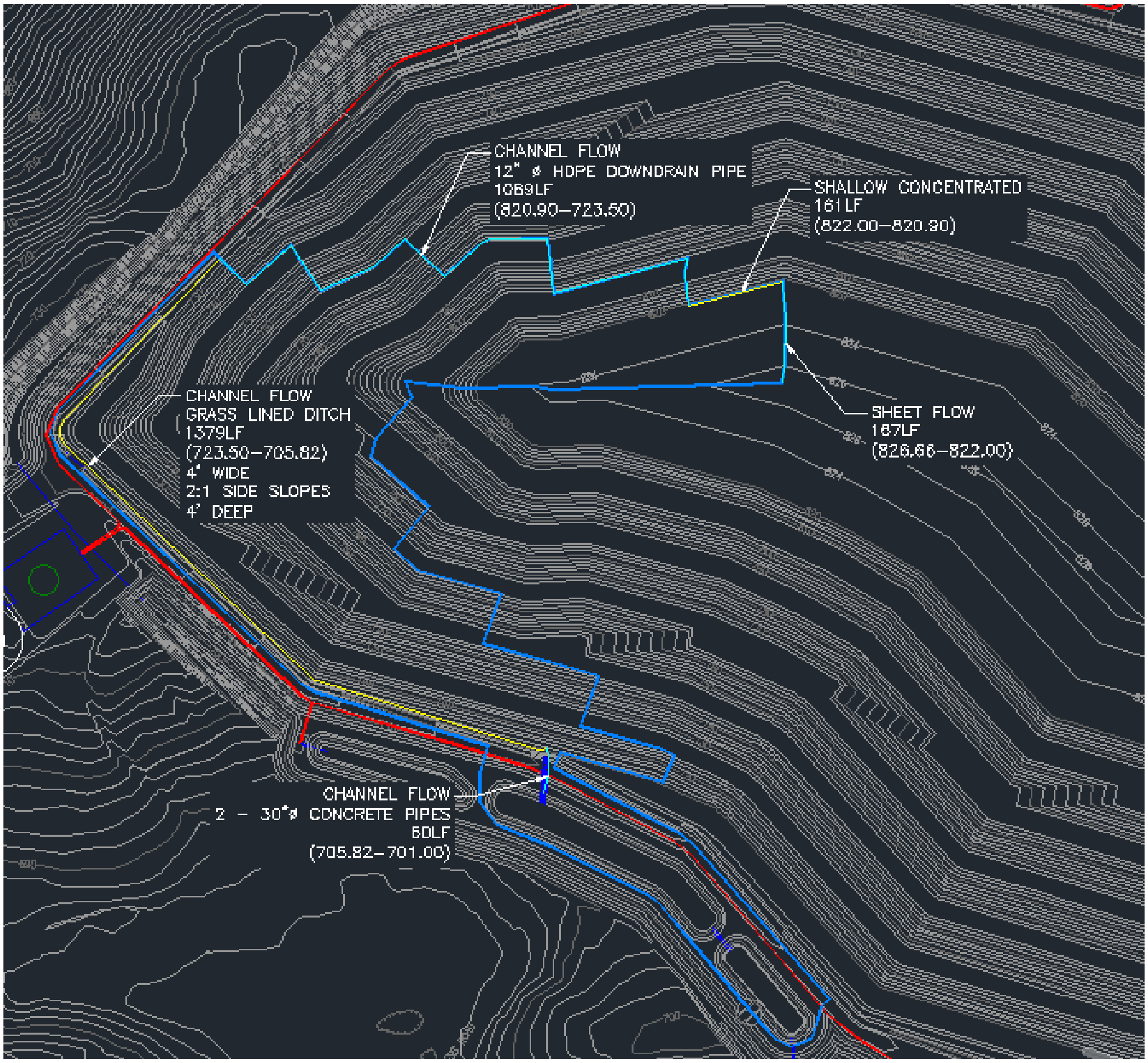
Cell 4

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 167.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.79		0.00		0.00		
Land slope (%)	= 2.79		0.00		0.00		
Travel Time (min)	**= 11.88**	**+**	**0.00**	**+**	**0.00**	**=**	**11.88**
Shallow Concentrated Flow							
Flow length (ft)	= 161.00		0.00		0.00		
Watercourse slope (%)	= 0.68		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.33		0.00		0.00		
Travel Time (min)	**= 2.02**	**+**	**0.00**	**+**	**0.00**	**=**	**2.02**
Channel Flow							
X sectional flow area (sqft)	= 0.59		5.22		0.70		
Wetted perimeter (ft)	= 1.98		8.02		2.32		
Channel slope (%)	= 8.94		1.28		8.03		
Manning's n-value	= 0.012		0.030		0.012		
Velocity (ft/s)	=16.50		4.21		15.77		
Flow length (ft)	({0})1089.0		1379.0		60.0		
Travel Time (min)	**= 1.10**	**+**	**5.45**	**+**	**0.06**	**=**	**6.62**
Total Travel Time, Tc							**20.51 min**

TR55 Worksheet 2

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 38 of 70



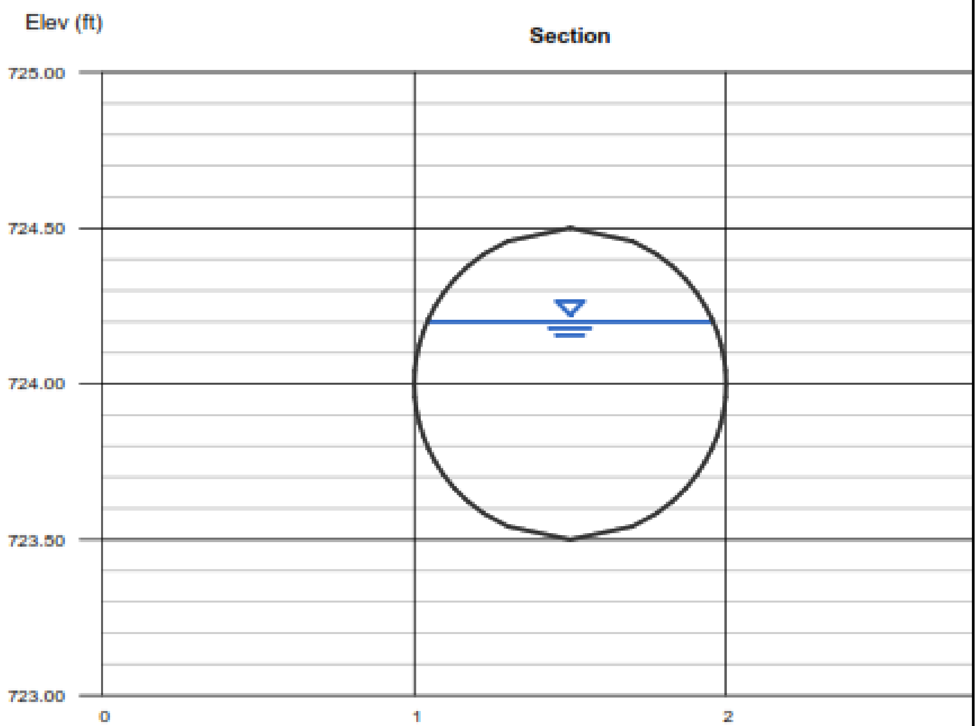
Map 4

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Thursday, Sep 7 2023

Cell 4 Downdrain

Circular		Highlighted	
Diameter (ft)	= 1.00	Depth (ft)	= 0.70
		Q (cfs)	= 9.560
		Area (sqft)	= 0.59
Invert Elev (ft)	= 723.50	Velocity (ft/s)	= 16.25
Slope (%)	= 8.94	Wetted Perim (ft)	= 1.98
N-Value	= 0.012	Crit Depth, Yc (ft)	= 1.00
		Top Width (ft)	= 0.92
Calculations		EGL (ft)	= 4.80
Compute by:	Known Q		
Known Q (cfs)	= 9.56		



Channel Report 4

Design Calculations

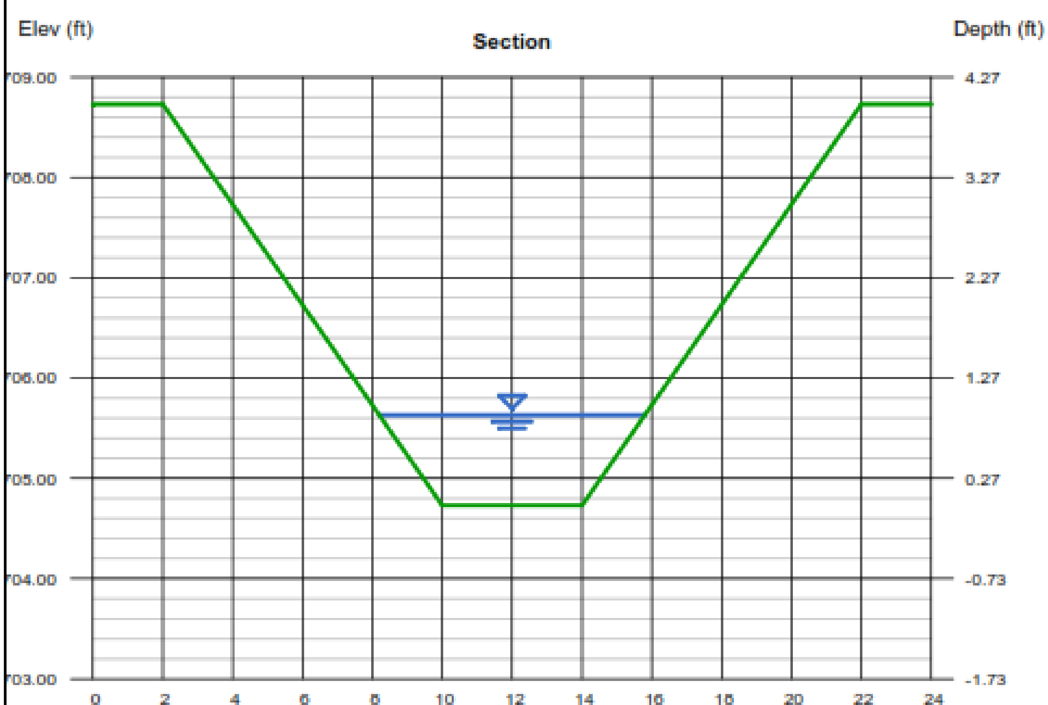
Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 40 of 70

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Sunday, Aug 20 2023

Cell 4 Ditch 1

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 4.00	Depth (ft)	= 0.90
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 21.60
Total Depth (ft)	= 4.00	Area (sqft)	= 5.22
Invert Elev (ft)	= 704.73	Velocity (ft/s)	= 4.14
Slope (%)	= 1.28	Wetted Perim (ft)	= 8.02
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.84
		Top Width (ft)	= 7.60
Calculations		EGL (ft)	= 1.17
Compute by:	Known Q		
Known Q (cfs)	= 21.60		



Channel Report 5

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Monday, Sep 18 2023

Cell 4 Pipes

Circular

Diameter (ft) = 2.50

Invert Elev (ft) = 701.00
Slope (%) = 8.03
N-Value = 0.012

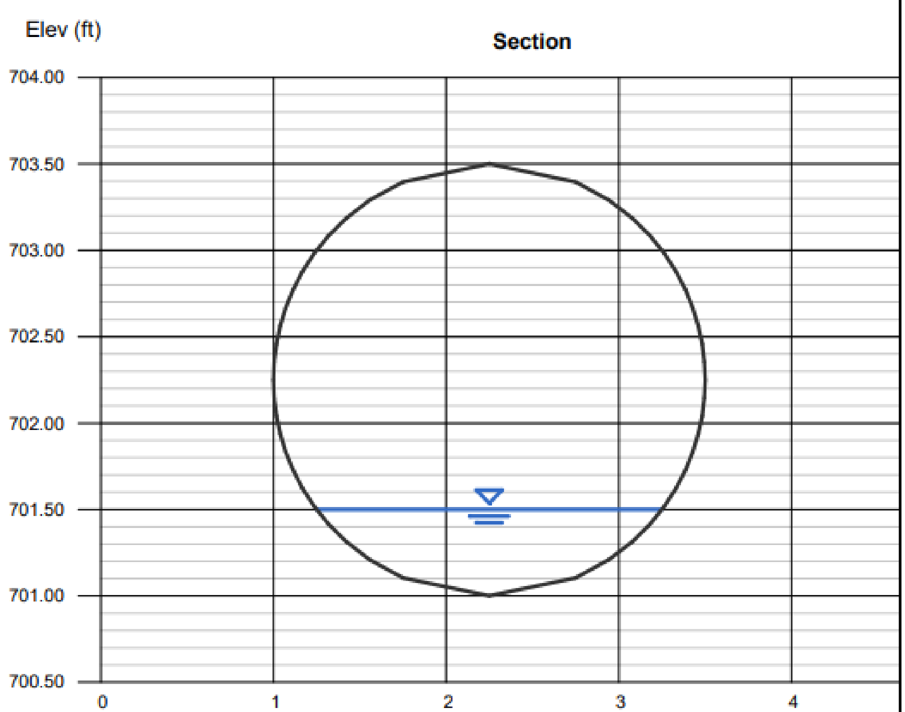
Calculations

Compute by: Known Q
Known Q (cfs) = 10.85

21.70/2=10.85
Total Flow of 21.70 is divided by 2 since there are 2 pipes.

Highlighted

Depth (ft) = 0.50
Q (cfs) = 10.85
Area (sqft) = 0.70
Velocity (ft/s) = 15.40
Wetted Perim (ft) = 2.32
Crit Depth, Yc (ft) = 1.10
Top Width (ft) = 2.00
EGL (ft) = 4.19



Channel Report 6

Hydrograph Report

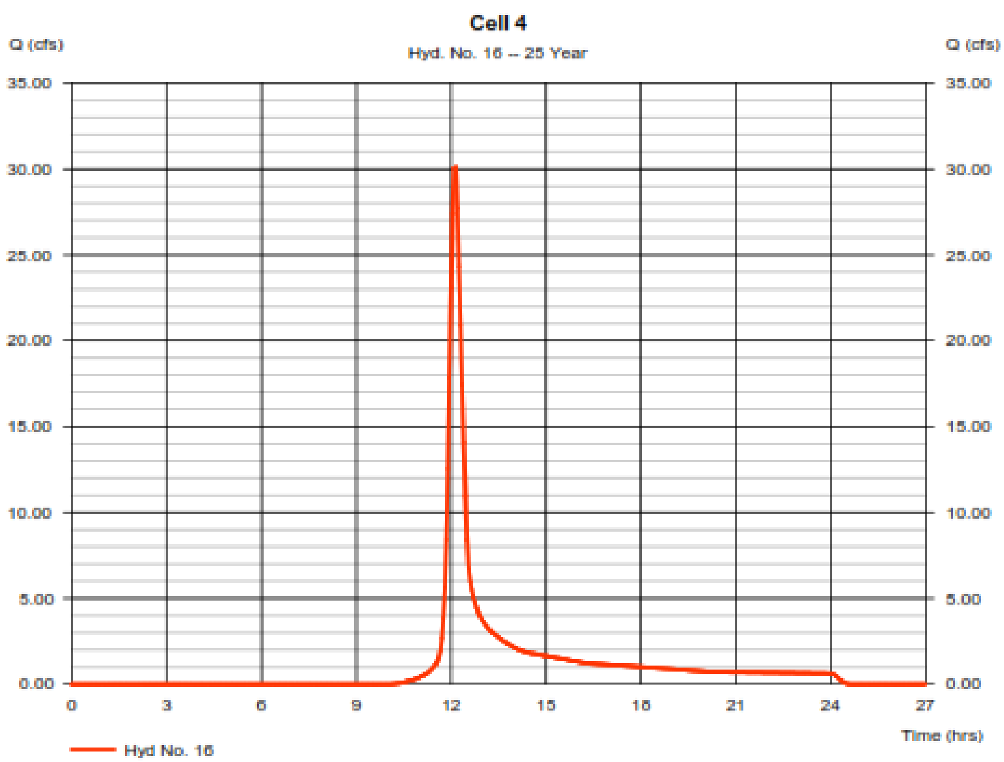
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 Thursday, 09 / 7 / 2023

Hyd. No. 16

Cell 4

Hydrograph type	= SCS Runoff	Peak discharge	= 30.10 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.15 hrs
Time interval	= 3 min	Hyd. volume	= 109,087 cuft
Drainage area	= 12.830 ac	Curve number	= 65*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 20.50 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(10.840 x 61) + (1.490 x 85) + (0.500 x 98)] / 12.830



Hydrograph Report 2

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 43 of 70

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 Thursday, 09 / 7 / 2023

Pond No. 2 - Cell 4 Sed Pond/Clear Pool

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 697.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	697.00	6,653	0	0
1.00	698.00	23,565	14,245	14,245
1.50	698.50	25,207	12,189	26,434
2.00	699.00	26,868	13,015	39,450
3.00	700.00	30,248	28,538	67,988
4.00	701.00	33,707	31,959	99,947
5.00	702.00	37,215	35,443	135,390

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 42.00	0.00	0.00	0.00
Span (in)	= 42.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 681.60	0.00	0.00	0.00
Length (ft)	= 113.00	0.00	0.00	0.00
Slope (%)	= 0.80	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

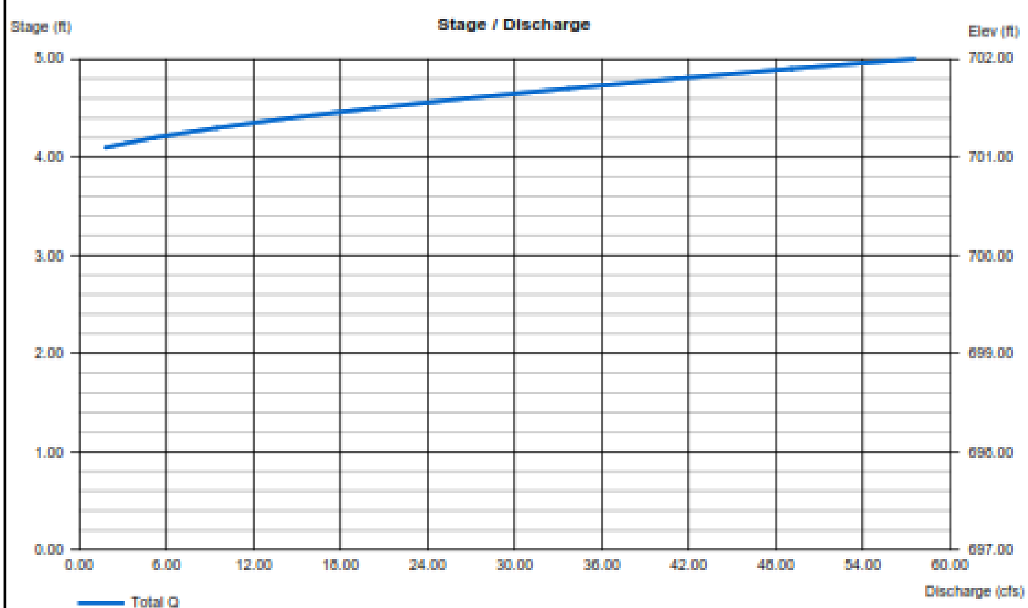
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 17.28	0.00	0.00	0.00
Crest El. (ft)	= 702.43	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

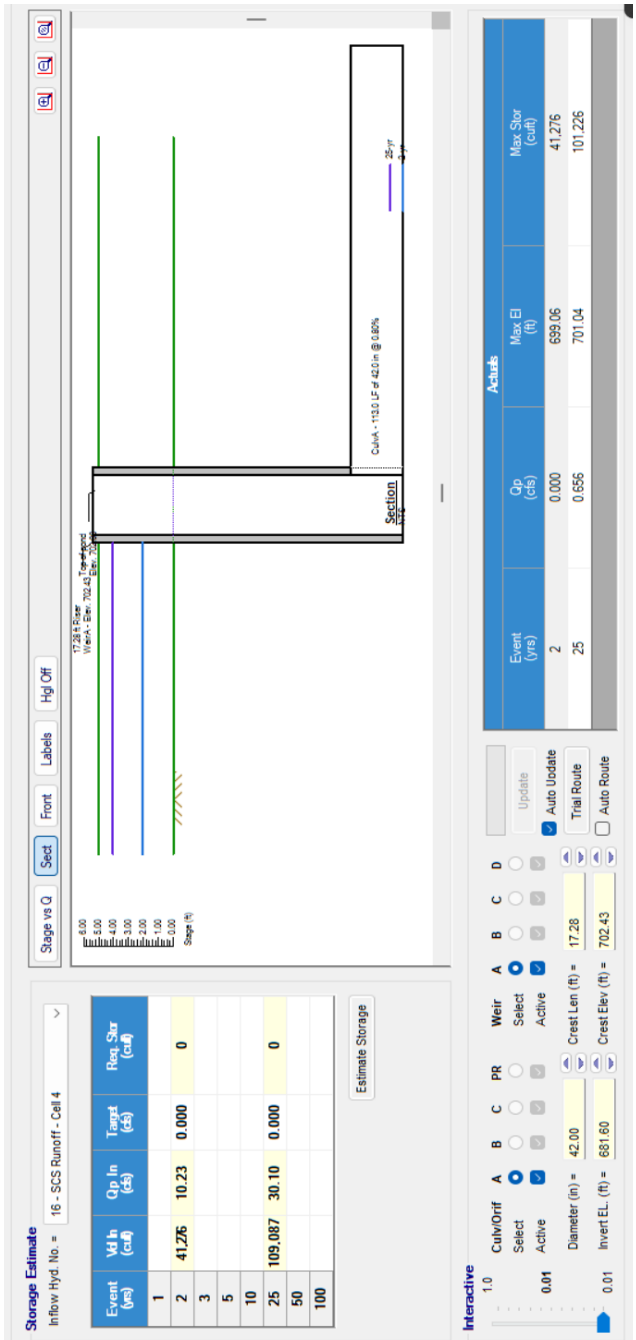
Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Pond Report 3



Pond Report 4

Cell 6

Drainage Area = 28.61 AC (See Map 5)

Curve Number = 64 (See Table 1)

26.50 AC @ CN 61 (Grass)

1.53 AC @ CN 85 (Gravel)

0.58 AC @ CN 98 (Impervious – Liner in Sediment Pond and Clear Pool)

((26.50*61)+(1.53*85)+(0.58*98))/28.61_ = 63.03 = 63

Time of Concentration = 47.04 Min (See TR55 Worksheet 3 and Map 6)

Sheet Flow

Manning's n-Value = 0.15 (Short Grass) (See Table 2)

Flow Length = 300 LF

Land Slope = (828.25-826.75)/300 = 0.0050 = 0.50%

Shallow Concentrated

Flow Length = 403 LF

Watercourse Slope = (826.75-822.00)/403 = 0.0118 = 1.18%

Surface is Unpaved

Channel Flow (See Channel Report 7)

18" Dia. HDPE Downdrain Pipes

Cross Sectional Area = 1.01 SF

Wetted Perimeter = 2.52 LF

Channel Slope = (822.00-703.63)/1778 = 0.0666 = 6.66%

Manning's n-Value = 0.12 (HDPE Pipe) (See Table 4)

Flow Length = 1778 LF

Channel Flow (See Channel Report 8)

Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 4' Deep

Cross Sectional Area = 7.95 SF

Wetted Perimeter = 9.50 LF

Channel Slope = (703.63-697.94)/810 = 0.0070 = 0.70%

Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)

Flow Length = 810 LF

Channel Flow (See Channel Report 9)

5 – 30" Dia. HDPE Pipes

Cross Sectional Area = 0.42 SF

Wetted Perimeter = 1.92 LF

Channel Slope = (697.65-690.00)/79 = 0.0968 = 9.68%
Manning's n-Value = 0.012 (HDPE Pipe) (See Table 4)
Flow Length = 79 LF

Time Interval = 3 Min
Tc*0.1333 = 47.04*0.1333 = 6.27 = 7

Storm Distribution = Type II

Q_{25} = 34.28 CFS (See Hydrograph Report 3)

To Evaluate for Storage Capacity, Treat The Sediment Pond and Clear Pool As One Pond Since They Are Interconnected.

Elevation (FT)	Sed. Pond Area (SF)	Clear Pool Area (SF)	Total Area (SF)	Volume (CF)
685	0	4,531	4,531	0*
686	20,795	5,195	25,990	13,790*
687	22,799	5,899	28,698	41,120
688	24,842	6,642	31,484	71,197
689	26,925	7,245	34,170	104,011
689.50	27,981	7,831	35,812	121,504

*Dead Storage

Spillways

- Principal Spillway consists of a 36" Dia. Riser with two 24" Dia. HDPE Pipes.
- Auxiliary Spillway consist of a grass lined trapezoidal weir that is 8' wide with 3:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end.

High Water Elevation is 688.25 (See Pond Reports 5 & 6)

Map 5

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

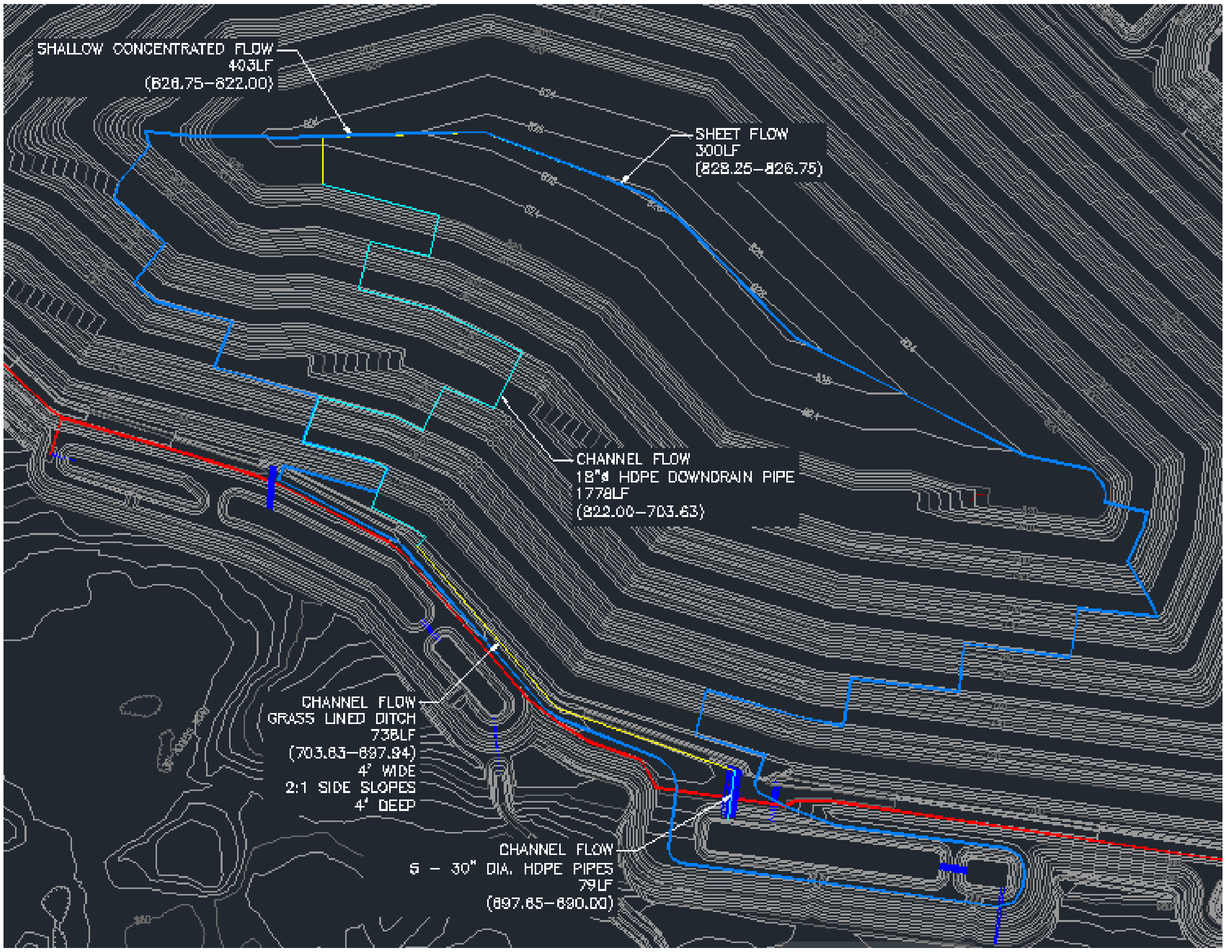
Hyd. No. 22

Cell 6

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.79		0.00		0.00		
Land slope (%)	=	0.50		0.00		0.00		
Travel Time (min)	**=**	**37.75**	**+**	**0.00**	**+**	**0.00**	**=**	**37.75**
Shallow Concentrated Flow								
Flow length (ft)	=	403.00		0.00		0.00		
Watercourse slope (%)	=	1.18		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	1.75		0.00		0.00		
Travel Time (min)	**=**	**3.83**	**+**	**0.00**	**+**	**0.00**	**=**	**3.83**
Channel Flow								
X sectional flow area (sqft)	=	1.01		7.95		0.42		
Wetted perimeter (ft)	=	2.52		9.50		1.92		
Channel slope (%)	=	6.66		0.70		10.05		
Manning's n-value	=	0.012		0.030		0.012		
Velocity (ft/s)	=	17.37		3.69		14.22		
Flow length (ft)		({0})1778.0		810.0		79.0		
Travel Time (min)	**=**	**1.71**	**+**	**3.66**	**+**	**0.09**	**=**	**5.46**

Total Travel Time, Tc .... 47.04 min

TR55 Worksheet 3



SHALLOW CONCENTRATED FLOW
403LF
(828.75–822.00)
SHEET FLOW
300LF
(828.25–826.75)
CHANNEL FLOW
18"Ø HDPE DOWNDRAIN PIPE
1778LF
(822.00–703.63)
CHANNEL FLOW
GRASS LINED DITCH
738LF
(703.63–697.94)
4' WIDE
2:1 SIDE SLOPES
4' DEEP
CHANNEL FLOW
5 – 30" DIA. HDPE PIPES
79LF
(697.65–690.00)

Map 6

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 50 of 70

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Sep 7 2023

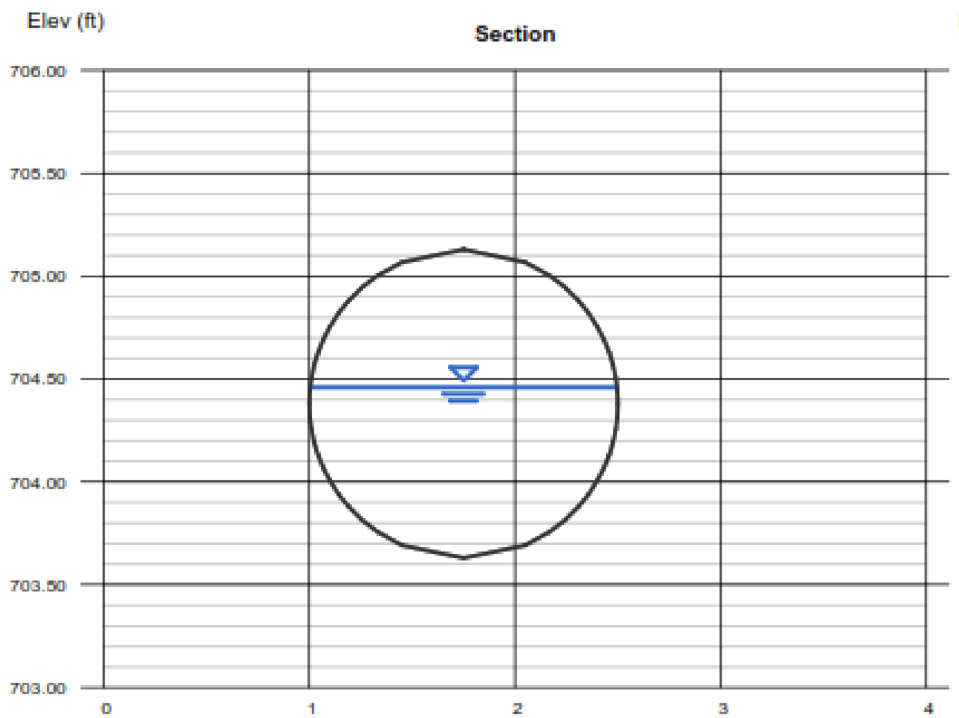
Cell 6 Downdrain

Circular
Diameter (ft) = 1.50

Invert Elev (ft) = 703.63
Slope (%) = 6.66
N-Value = 0.012

Calculations
Compute by: Known Q
Known Q (cfs) = 17.28

Highlighted
Depth (ft) = 0.83
Q (cfs) = 17.28
Area (sqft) = 1.01
Velocity (ft/s) = 17.18
Wetted Perim (ft) = 2.52
Crit Depth, Yc (ft) = 1.45
Top Width (ft) = 1.49
EGL (ft) = 5.42



Channel Report 7

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Sunday, Aug 20 2023

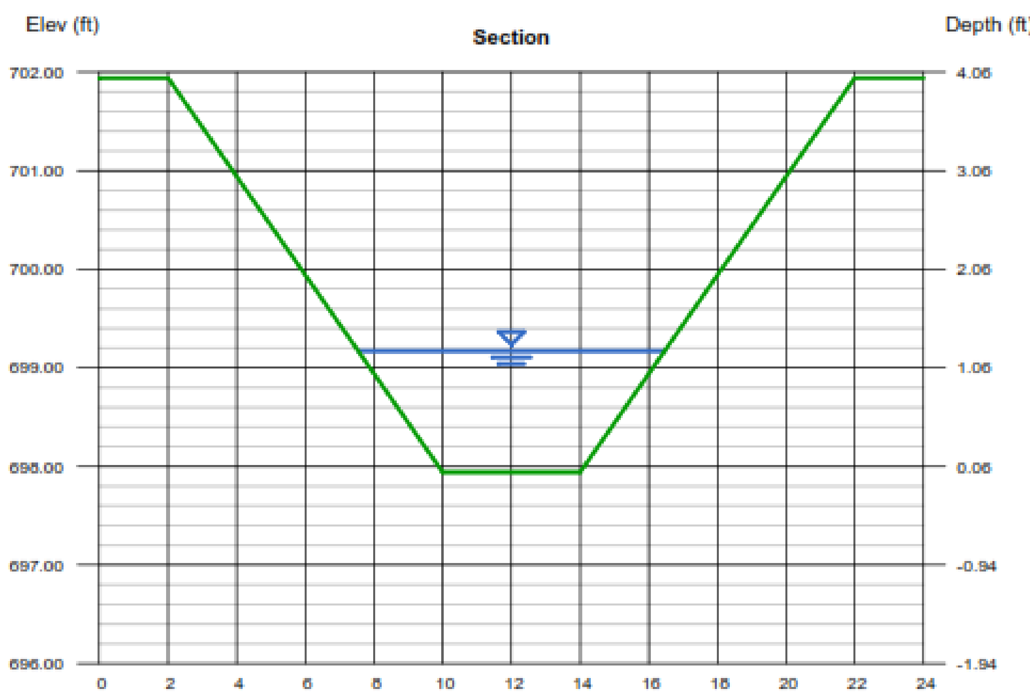
Cell 6 Ditch

Trapezoidal		Highlighted	
Bottom Width (ft)	= 4.00	Depth (ft)	= 1.23
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 28.88
Total Depth (ft)	= 4.00	Area (sqft)	= 7.95
Invert Elev (ft)	= 697.94	Velocity (ft/s)	= 3.63
Slope (%)	= 0.70	Wetted Perim (ft)	= 9.50
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.99
		Top Width (ft)	= 8.92
		EGL (ft)	= 1.44

Calculations

Compute by: Known Q

Known Q (cfs) = 28.88



Channel Report 8

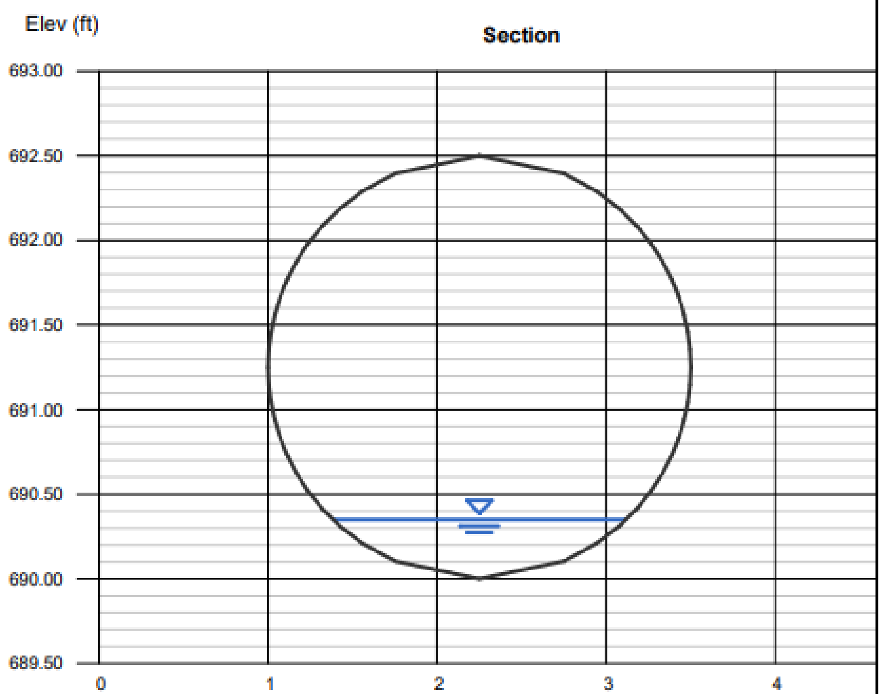
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Sep 18 2023

Cell 6 Pipes

Circular		**Highlighted**	
Diameter (ft)	= 2.50	Depth (ft)	= 0.35
		Q (cfs)	= 5.780
		Area (sqft)	= 0.42
Invert Elev (ft)	= 690.00	Velocity (ft/s)	= 13.69
Slope (%)	= 9.68	Wetted Perim (ft)	= 1.92
N-Value	= 0.012	Crit Depth, Yc (ft)	= 0.80
		Top Width (ft)	= 1.74
Calculations		EGL (ft)	= 3.26
Compute by:	Known Q		
Known Q (cfs)	= 5.78		

28.92/5=5.78
Total Flow of 28.92 is divided by 5 since there are 5 pipes.



Channel Report 9

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 53 of 70

Hydrograph Report

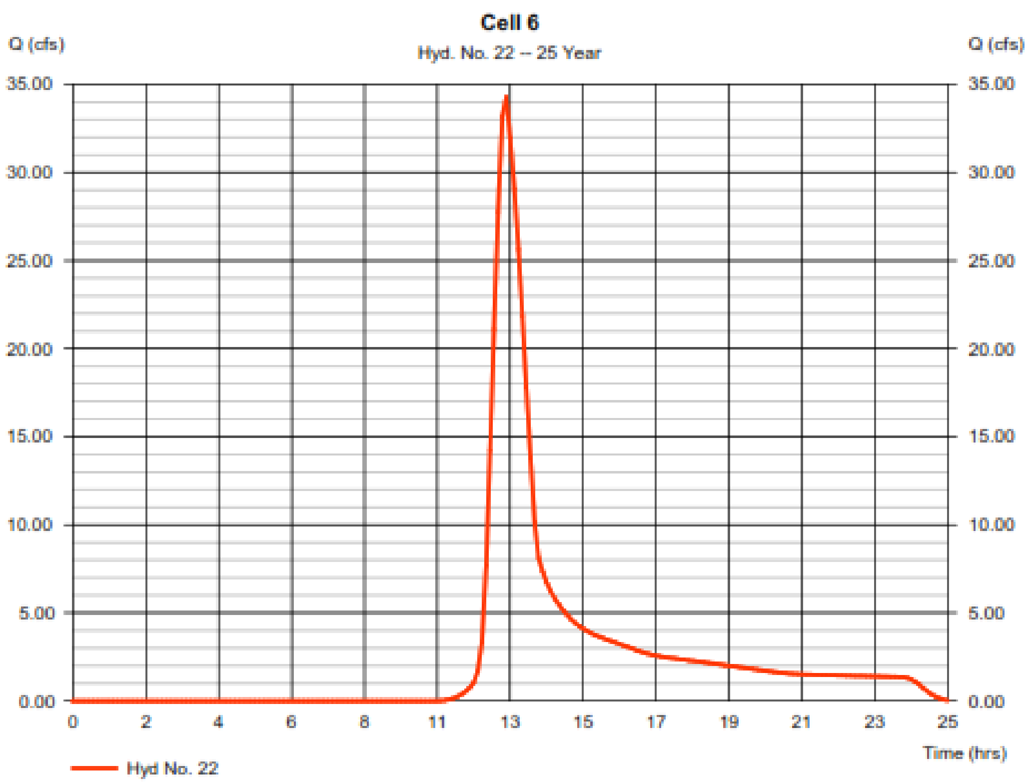
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Friday, 09 / 15 / 2023

Hyd. No. 22

Cell 6

Hydrograph type	= SCS Runoff	Peak discharge	= 34.28 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.48 hrs
Time interval	= 7 min	Hyd. volume	= 224,951 cuft
Drainage area	= 28.610 ac	Curve number	= 63*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 47.00 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(26.500 x 61) + (1.530 x 85) + (0.580 x 98)] / 28.610



Hydrograph Report 3

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 Friday, 09 / 15 / 2023

Pond No. 3 - Cell 6 Sed Pond/Clear Pool

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 685.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	685.00	4,531	0	0
1.00	686.00	25,990	13,790	13,790
2.00	687.00	28,698	27,330	41,120
3.00	688.00	31,484	30,077	71,197
4.00	689.00	34,170	32,815	104,011
4.50	689.50	35,812	17,492	121,504

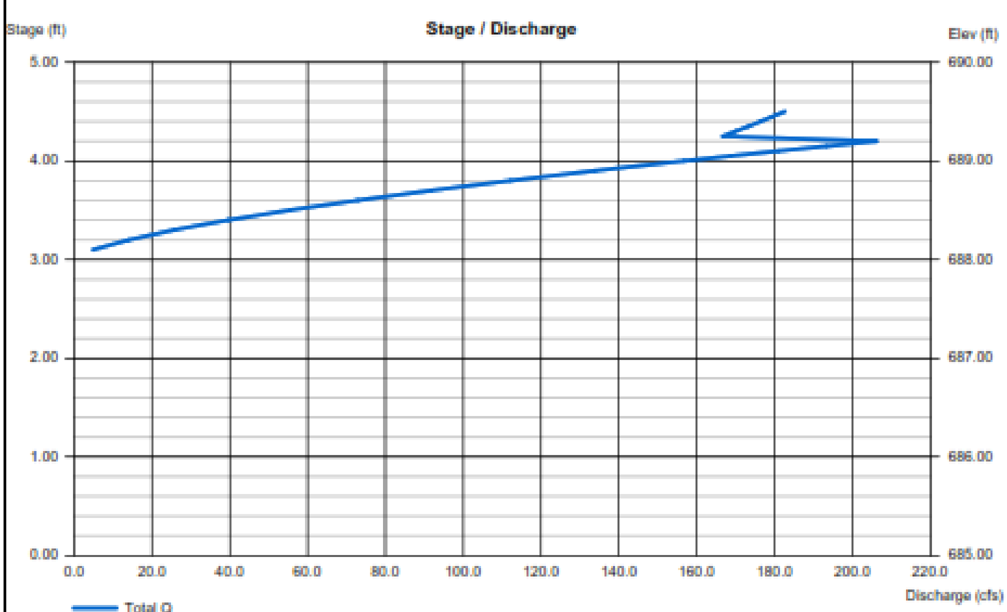
Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	0.00	0.00	0.00
Span (in)	= 24.00	0.00	0.00	0.00
No. Barrels	= 2	0	0	0
Invert EL (ft)	= 670.00	0.00	0.00	0.00
Length (ft)	= 102.00	0.00	0.00	0.00
Slope (%)	= 0.59	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 9.42	0.00	0.00	0.00
Crest El. (ft)	= 688.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

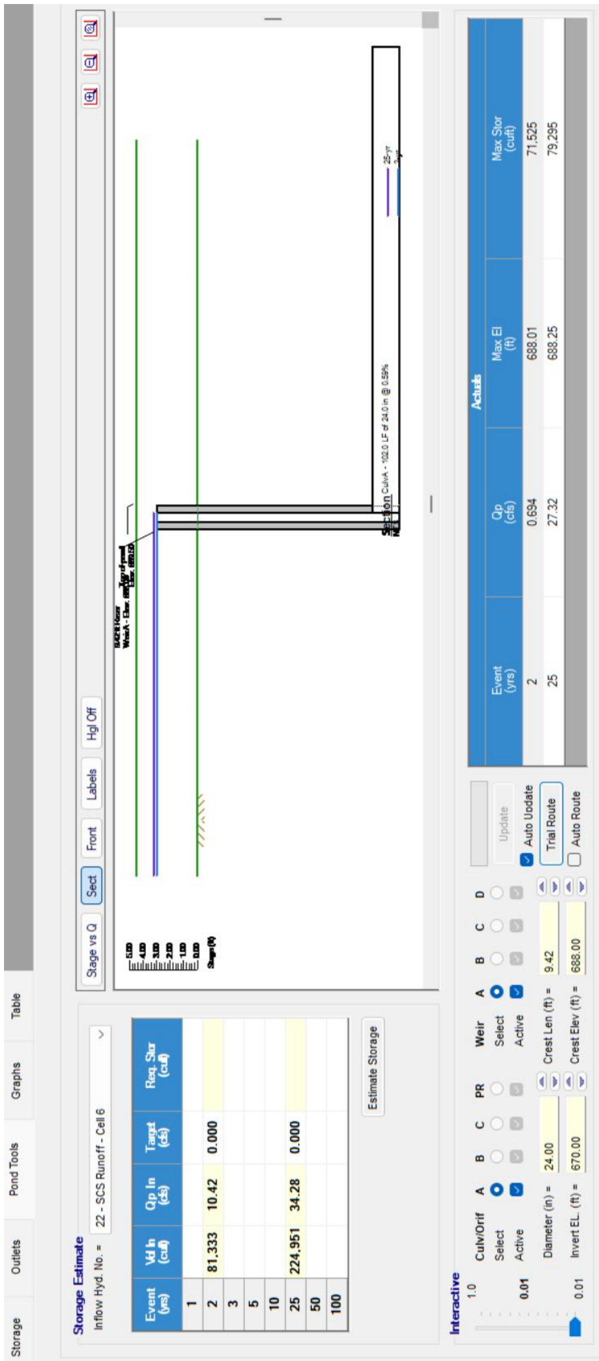
Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Pond Report 5

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 55 of 70



Pond Report 6

<u>Cell 8</u>

Drainage Area = 10.41 AC (See Map 7)

Curve Number = 64 (See Table 1)
- 9.10 AC @ CN 61 (Grass)
- 0.97 AC @ CN 85 (Gravel)
- 0.34 AC @ CN 98 (Impervious – Liner in Sediment Pond and Clear Pool)
- ((9.10*61)+(0.97*85)+(0.34*98))/10.41_ = 64.44 = 64

Time of Concentration = 19.37 Min (See TR55 Worksheet 4 and Map 8)
- Sheet Flow
  - Manning's n-Value = 0.15 (Short Grass) (See Table 2)
  - Flow Length = 99 LF
  - Land Slope = (806.00-805.10)/99 = 0.0091 = 0.91%
- Channel Flow (See Channel Report 10)
  - 15" Dia. HDPE Downdrain Pipes
  - Cross Sectional Area = 0.62 SF
  - Wetted Perimeter = 1.97 LF
  - Channel Slope = (805.10-696.77)/1541 = 0.0703 = 7.03%
  - Manning's n-Value = 0.12 (HDPE Pipe)(See Table 4)
  - Flow Length = 1541 LF
- Channel Flow (See Channel Report 11)
  - Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 4' Deep
  - Cross Sectional Area = 5.76 SF
  - Wetted Perimeter = 8.34 LF
  - Channel Slope = (696.77-692.14)/895 = 0.0052 = 0.52%
  - Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)
  - Flow Length = 895 LF
- Channel Flow (See Channel Report 12)
  - Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 2' Deep
  - Cross Sectional Area = 2.87 SF
  - Wetted Perimeter = 6.50 LF
  - Channel Slope = (692.14-688.00)/52 = 0.0796 = 7.96%
  - Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)
  - Flow Length = 52 LF

Time Interval = 3 Min

Tc*0.1333 = 19.37*0.1333 = 2.58 = 3

Storm Distribution = Type II

Q_{25} = 27.43 CFS (See Hydrograph Report 4)

To Evaluate for Storage Capacity, Treat The Sediment Pond and Clear Pool As One Pond Since They Are Interconnected.

Elevation (FT)	Sed. Pond Area (SF)	Clear Pool Area (SF)	Total Area (SF)	Volume (CF)
685	0	6,230	6,230	0*
686	15,795	6,995	22,790	13,644*
687	17,149	7,789	24,948	37,502
688	18,542	8,642	27,184	63,558
689	19,975	9,525	29,500	91,889
689.50	20,706	9,981	30,687	106,933

*Dead Storage

Spillways

- Principal Spillway consists of a 36” Dia. Riser with two 24” Dia. HDPE Pipes.
- Auxiliary Spillway consist of a grass lined trapezoidal weir that is 8’ wide with 3:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end.

High Water Elevation is 688.03 (See Pond Reports 7 & 8)

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 58 of 70

Map 7

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

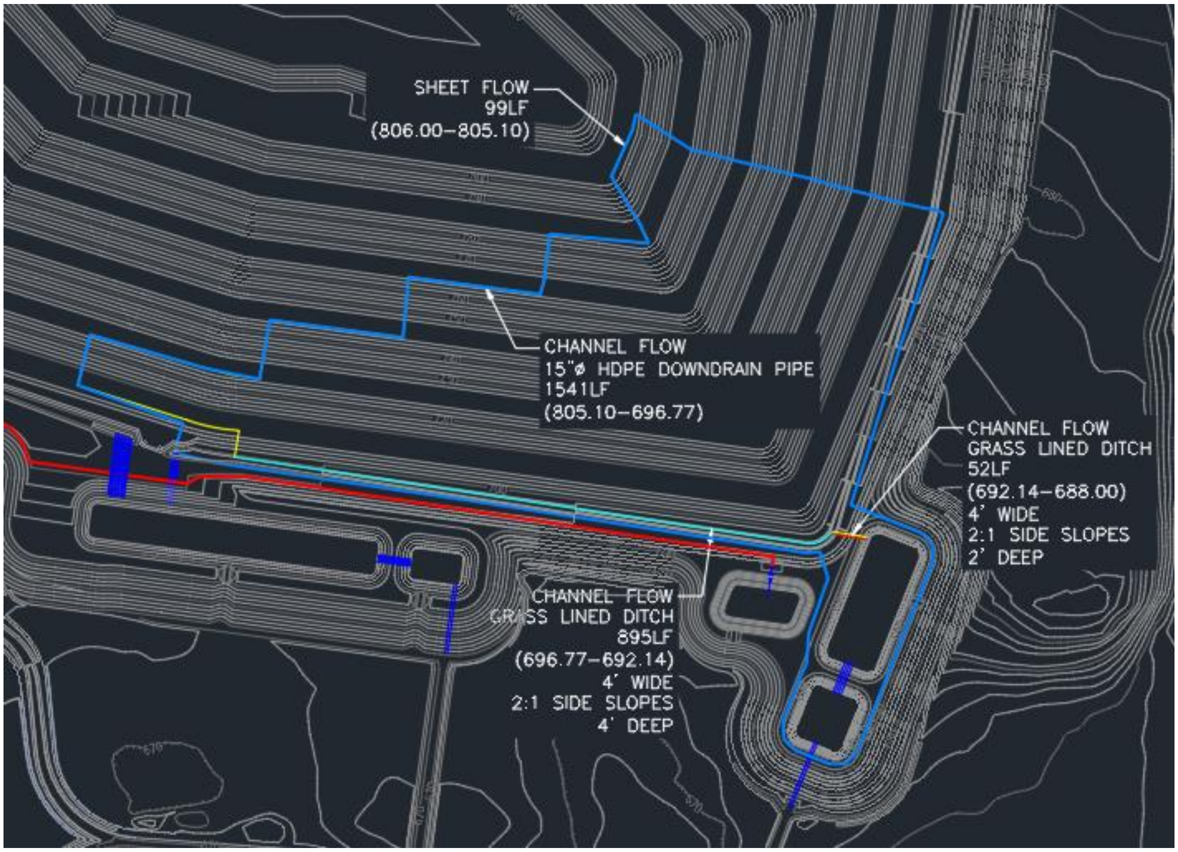
Hyd. No. 28

Cell 8

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 99.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.79		0.00		0.00		
Land slope (%)	= 0.91		0.00		0.00		
Travel Time (min)	**= 12.24**	**+**	**0.00**	**+**	**0.00**	**=**	**12.24**
Shallow Concentrated Flow							
Flow length (ft)	= 0.00		0.00		0.00		
Watercourse slope (%)	= 0.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow							
X sectional flow area (sqft)	= 0.62		5.76		2.87		
Wetted perimeter (ft)	= 1.97		8.34		6.50		
Channel slope (%)	= 7.03		0.52		7.96		
Manning's n-value	= 0.012		0.030		0.030		
Velocity (ft/s)	=15.17		2.79		8.10		
Flow length (ft)	({0})1541.0		895.0		52.0		
Travel Time (min)	**= 1.69**	**+**	**5.34**	**+**	**0.11**	**=**	**7.14**

Total Travel Time, Tc .... 19.37 min

TR55 Worksheet 3



SHEET FLOW
99LF
(806.00–805.10)
CHANNEL FLOW
15"ø HDPE DOWNDRAIN PIPE
1541LF
(805.10–696.77)
CHANNEL FLOW
GRASS LINED DITCH
52LF
(692.14–688.00)
4' WIDE
2:1 SIDE SLOPES
2' DEEP
CHANNEL FLOW
GRASS LINED DITCH
895LF
(696.77–692.14)
4' WIDE
2:1 SIDE SLOPES
4' DEEP

Map 8

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 61 of 70

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Sep 15 2023

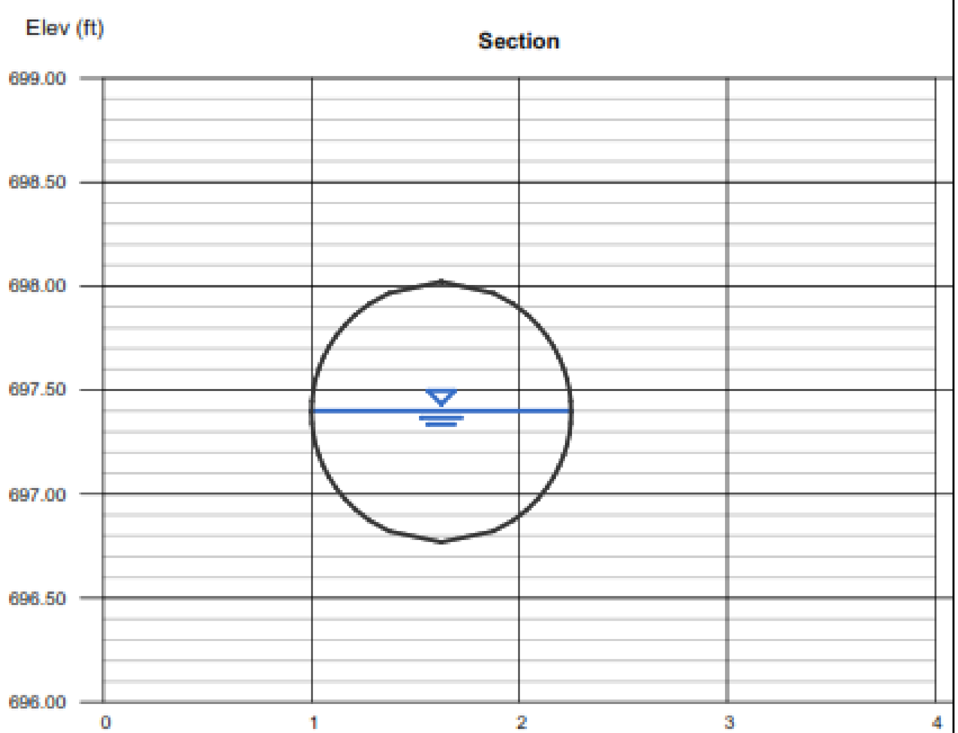
Cell 8 Downdrain

Circular
Diameter (ft) = 1.25

Invert Elev (ft) = 696.77
Slope (%) = 7.03
N-Value = 0.012

Calculations
Compute by: Known Q
Known Q (cfs) = 9.38

Highlighted
Depth (ft) = 0.63
Q (cfs) = 9.380
Area (sqft) = 0.62
Velocity (ft/s) = 15.11
Wetted Perim (ft) = 1.97
Crit Depth, Yc (ft) = 1.17
Top Width (ft) = 1.25
EGL (ft) = 4.18



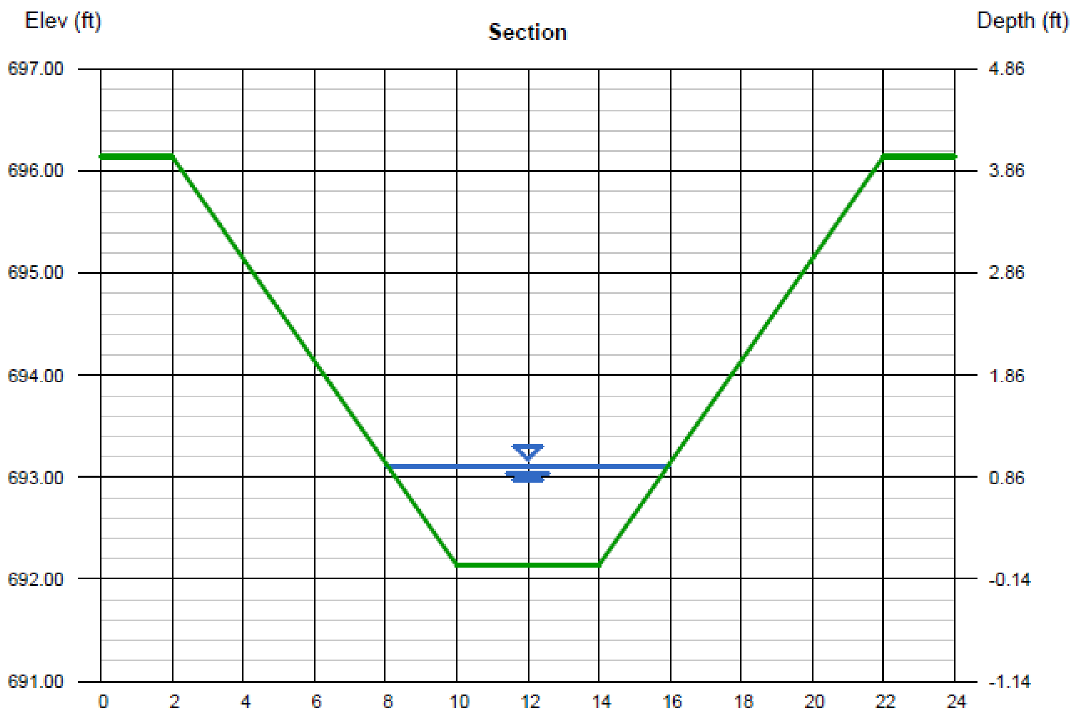
Channel Report 10

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Thursday, Mar 18 2021

Cell 8 Ditch 1

Trapezoidal		Highlighted	
Bottom Width (ft)	= 4.00	Depth (ft)	= 0.97
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 15.81
Total Depth (ft)	= 4.00	Area (sqft)	= 5.76
Invert Elev (ft)	= 692.14	Velocity (ft/s)	= 2.74
Slope (%)	= 0.52	Wetted Perim (ft)	= 8.34
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.70
		Top Width (ft)	= 7.88
Calculations		EGL (ft)	= 1.09
Compute by:	Known Q		
Known Q (cfs)	= 15.81		



Channel Report 11

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 63 of 70

Channel Report

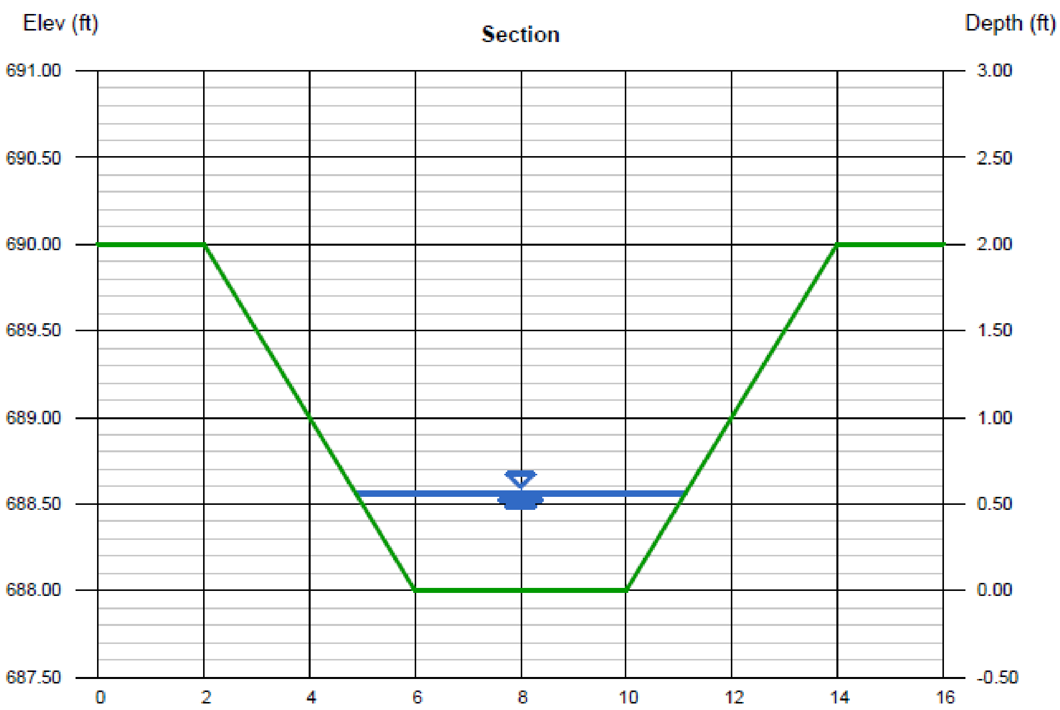
Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Mar 18 2021

Cell 8 Ditch 2

Trapezoidal		Highlighted	
Bottom Width (ft)	= 4.00	Depth (ft)	= 0.56
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 22.51
Total Depth (ft)	= 2.00	Area (sqft)	= 2.87
Invert Elev (ft)	= 688.00	Velocity (ft/s)	= 7.85
Slope (%)	= 7.96	Wetted Perim (ft)	= 6.50
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.86
		Top Width (ft)	= 6.24
		EGL (ft)	= 1.52

Calculations

Compute by:	Known Q
Known Q (cfs)	= 22.51



Channel Report 12

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 64 of 70

Hydrograph Report

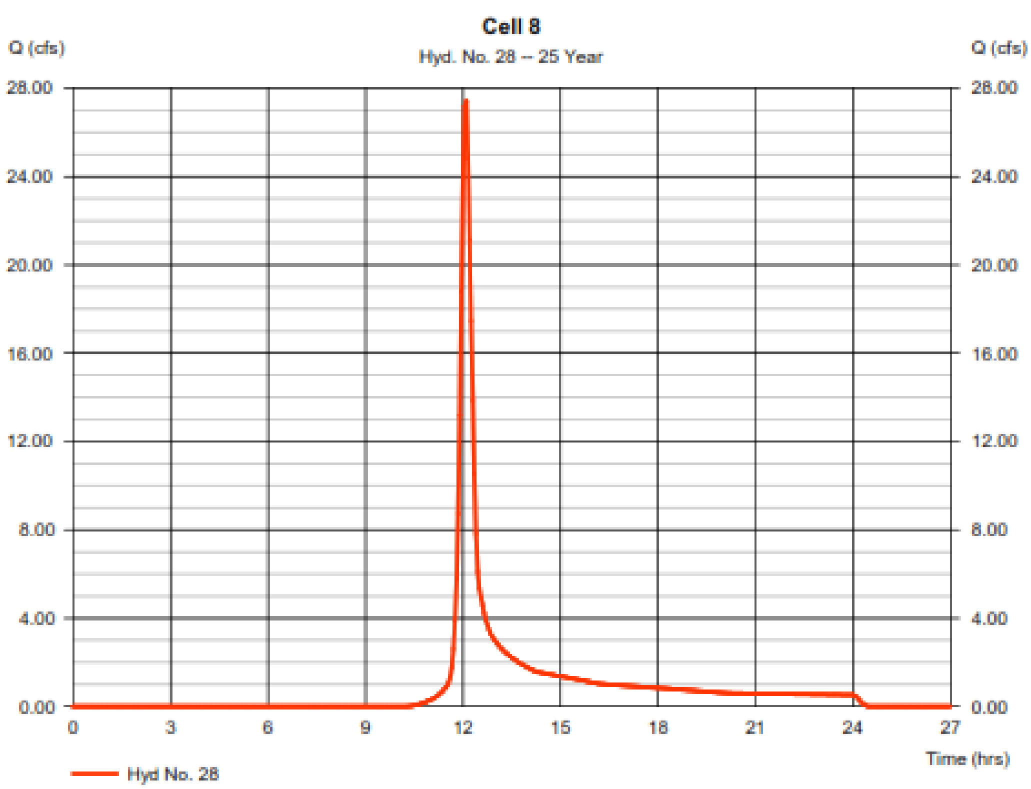
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Friday, 09 / 15 / 2023

Hyd. No. 28

Cell 8

Hydrograph type	= SCS Runoff	Peak discharge	= 27.43 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.10 hrs
Time interval	= 3 min	Hyd. volume	= 90,153 cuft
Drainage area	= 10.410 ac	Curve number	= 64*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.40 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(9.100 x 61) + (0.970 x 85) + (0.340 x 98)] / 10.410



Hydrograph Report 4

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Friday, 09 / 15 / 2023

Pond No. 4 - Cell 8 Sed Pond/Clear Pool

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 685.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	685.00	6,230	0	0
1.00	686.00	22,790	13,644	13,644
2.00	687.00	24,948	23,858	37,502
3.00	688.00	27,184	26,055	63,558
4.00	689.00	29,500	28,331	91,889
4.50	689.50	30,687	15,044	106,933

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	0.00	0.00	0.00
Span (in)	= 24.00	0.00	0.00	0.00
No. Barrels	= 2	0	0	0
Invert El. (ft)	= 670.00	0.00	0.00	0.00
Length (ft)	= 103.00	0.00	0.00	0.00
Slope (%)	= 1.07	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

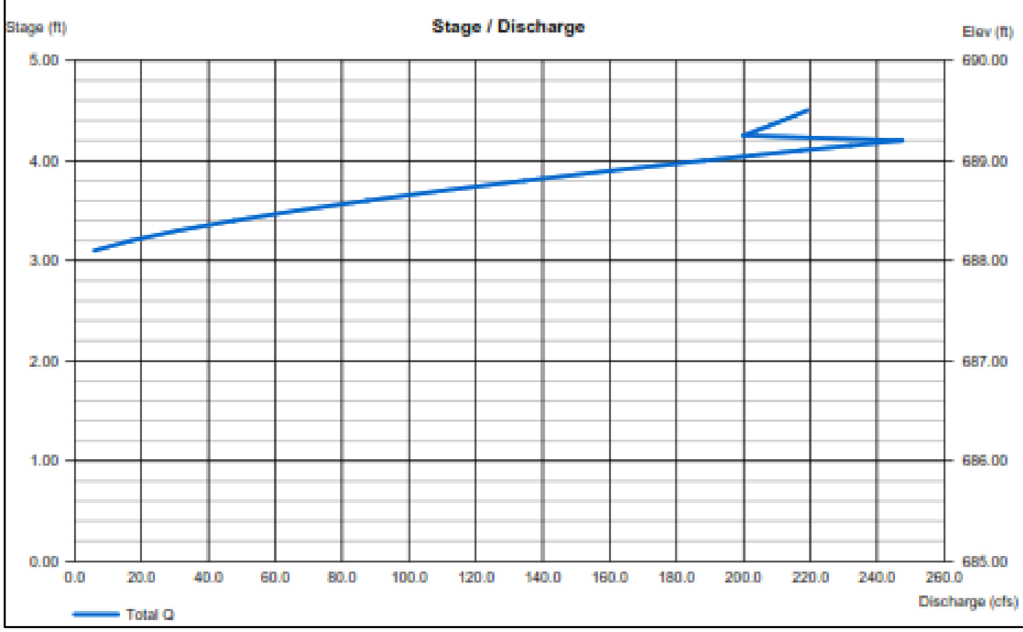
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 9.42	0.00	0.00	0.00
Crest El. (ft)	= 688.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

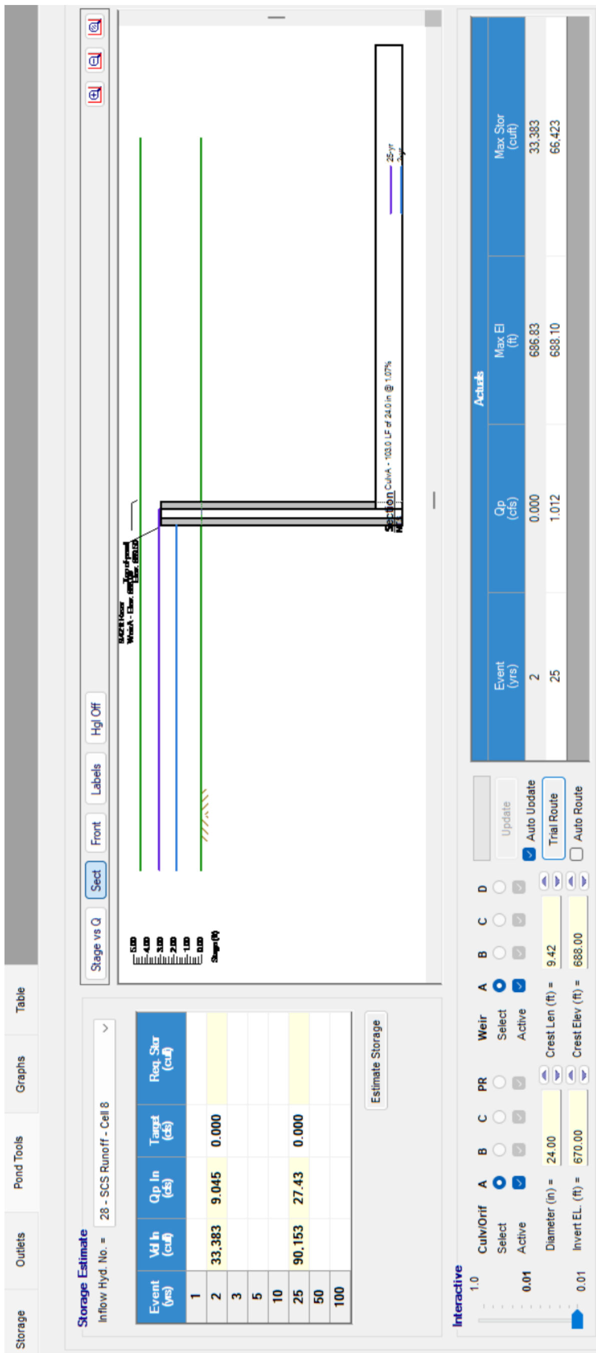
Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Pond Report 7

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 66 of 70



Pond Report 8

Table 2.1.5-1 Runoff Curve Numbers[1]

Cover description: Cover type and hydrologic condition		Average percent impervious area[2]	Curve numbers for hydrologic soil groups: A	B	C	D
Cultivated land:	without conservation treatment		72	81	88	91
	with conservation treatment		62	71	78	81
Pasture or range land:	poor condition		68	79	86	89
	good condition		39	61	74	80
Meadow: good condition			30	58	71	78
Wood or forest land:	thin stand, poor cover		45	66	77	83
	good cover		25	55	70	77
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]						
	Poor condition (grass cover <50%)		68	79	86	89
	Fair condition (grass cover 50% to 75%)		49	69	79	84
	Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:						
	Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:						
	Paved; curbs and storm drains (excluding right-of-way)		98	98	98	98
	Paved; open ditches (including right-of-way)		83	89	92	93
	Gravel (including right-of-way)		76	85	89	91
	Dirt (including right-of-way)		72	82	87	89
Urban districts:						
	Commercial and business	85%	89	92	94	95
	Industrial	72%	81	88	91	93
Residential districts by average lot size:						
	1/8 acre or less (town houses)	65%	77	85	90	92
	1/4 acre	38%	61	75	83	87
	1/3 acre	30%	57	72	81	86
	1/2 acre	25%	54	70	80	85
	1 acre	20%	51	68	79	84
	2 acres	12%	46	65	77	82
Developing urban areas and Newly graded areas (pervious areas only, no vegetation)			77	86	91	94

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. If the impervious area is not connected, the SCS method has an adjustment to reduce the effect.

[3] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

Table 1

Table 2.1.5-2 Roughness Coefficients (Manning's n) for Sheet Flow[1]

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover < 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Source: SCS, TR-55, Second Edition, June 1986

Table 2

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	9/15/23
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 3-8	Reviewed by Ashley Grissom	Date 9/21/23
	Calculation Number DC-BN- 735210-002	Sheet 69 of 70

Manning's n Values

3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.020	0.025
2. random stone mortar	0.020	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.030
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.030		0.500

Table 3

ADS N-12 WT IB Pipe (per AASHTO) Specification

Scope

This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 WT IB pipe (per AASHTO) for use in gravity-flow land drainage applications.

Pipe Requirements

ADS N-12 WT IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.

- 4- through 60-inch (100 to 250 mm) shall meet AASHTO M252, Type S
- 12-through 60-inch (300 to 1500 mm) pipe shall meet AASHTO M294, Type S or ASTM F2306
- Manning's "n" value for use in design shall be 0.012.

Joint Performance

Pipe shall be joined using a bell & spigot joint meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

Fittings

Fittings shall conform to AASHTO M252, AASHTO M294 or ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the watertight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

Field Pipe and Joint Performance

To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field testing any pipe material. Contact the manufacturer for recommended leakage rates.

Material Properties

Material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, and 435400C for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch (300 to 1500 mm) pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively.

Installation

Installation shall be in accordance with ASTM D2321 and ADS' recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot (0.3 m) and for 60-inch (1500 mm) diameter, the minimum cover shall be two feet (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted), Class 2 (minimum 90% SPD) or Class 3 (minimum 95%) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.01. Contact your local ADS representative or visit our website *adspipe.com* for a copy of the latest installation guidelines.

Build America, Buy America (BABA)

ADS N-12 WT IB pipe (per AASHTO), manufactured in accordance with AASHTO M252, AASHTO M294 or ASTM F2306, complies with the requirements in the Build America, Buy America (BABA) Act.

Pipe Dimensions*

Nominal Diameter													
Pipe I.D. in (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Pipe O.D. in (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	67 (1702)

*Check with sales representative for availability by region. **Pipe O.D. values are provided for reference purposes only, values stated for 12- through 60-inch are ±1 inch. Contact a sales representative for exact values.

Table 4

Southern Company

Technical and Project Solutions Calculation

Calculation Number: DC-BN-735210-003

Project/Plant: Bowen	**Unit(s):** 1 - 4	**Discipline/Area:** Civil
Title/Subject: Run-on and Run-off Study for Bowen Cells 9 & 10		
Purpose/Objective: To determine if the Cell's stormwater management can safely manage and pass the design storm event.		
System or Equipment Tag Numbers: N/A	**Originator:** Jeremy Brown	

Contents

Topic	Page	Attachments (Computer Printouts, Tech. Papers, Sketches, Correspondence)	# of Pages
Purpose of Calculation	1		1
Summary of Conclusions	1		1
Project Narrative	1-2		2
Methodology	2		1
Assumptions/Criteria	2		1
Design Inputs/References	3-9		7
Body of Calculation	10-23		14
Total # of pages including cover sheet & attachments:	24		

Revision Record

Rev. No.	Description	Originator Initial / Date	Reviewer Initial / Date	Approver Initial / Date
0	Issued for Review	JKB 2/12/21	AOG 3/1/21	JWM 6/7/21
1	Revised per as-builts	JKB 2/10/22	AOG 2/11/22	JWM 2/11/22

Notes:

GEORGIA REGISTERED No. PE031968 PROFESSIONAL ENGINEER JIM W. MINOR

Jim W. Minor
4/14/22

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
	Calculation Number DC-BN- 735210-003 (Rev1)	Sheet 1 of 23

Purpose of Calculation

The purpose of this calculation is to determine if the existing sedimentation ponds and clear pools can sufficiently handle run-on/run-off during a minimum 25-yr, 24-hr storm event per federal stormwater requirements Title 40 CFR Part 257.81 and the Georgia Environmental Protection Division's (EPD) Georgia CCR Rule (391-3-4-.10).

Summary of Conclusions

Based on our analysis, the detention pond system is adequate to collect and control the volume of water resulting from a 24-hour 25-year storm, as required.

Storage Pond Name	Normal Pool Elevation (feet, NAVD 88)	Maximum 25 year pool elevation (feet, NAVD 88)	Spillway/Top of Dike Elevation (feet, NAVD 88)	Freeboard to Spillway (feet, NAVD 88)
Clear Pool	697.00	701.44	703.50/706.00	2.06/4.56
Sedimentation Pond	697.00	701.44	703.50/706.00	2.06/4.56

Project Narrative

The Plant Bowen CCB Disposal Facility Cells 9 & 10 site is located in Bartow County and is approximately 1.5 miles East of Euharlee, Georgia and 6 miles southwest of Cartersville, Georgia. The plant is bordered on the north and east by the Etowah River and on the south and west by farmland.

Cells 9 & 10 cover 34.71 acres and are not divided by any means. (See Image 1).

Cells 9 & 10 are comprised of a 31.67 acres storage cell, 2.12 acres sedimentation pond, 0.92 acres clear pool, berms, access roads and ditches. (See Image 2) Cells 9 & 10 include a perimeter dike to control surface rainfall run-off. There is no stormwater run-on for these cells. Run-off from this area is directed through interior perimeter ditches and through 4 – 42" diameter HDPE pipes into a sedimentation pond that is connected to a clear pool via two 54" diameter risers and two 36" diameter pipes. Stormwater from the clear pool is discharged through a 54" diameter riser and 42" diameter pipe.

The sediment pond and clear pool have identical auxiliary spillways that are concrete trapezoidal weirs. The auxiliary spillways are 24' wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end. Following pages will show the analysis for Cells 9 & 10.

Leachate is collected separately from stormwater run-off in a sump. From there leachate is pumped to a 592,000 gallon leachate storage tank and then sent to the Low Volume Waste Treatment System.

<u>Methodology</u>

The stormwater flows were calculated using the National Resources Conservation Service method (also known as the Soil Conservation Service (SCS) method) using a 25-yr, 24-hr design storm event.

Storm basin calculation information was gathered from a number of sources to include the Georgia Stormwater Manual and Technical Release 55.

The National Resources Conservation Service (NCRS) provided information on the soil characteristics and hydrologic groups. The soil types found on the site are Etowah Loam and Waynesboro Clay Loam. (See Images 3 & 4). It was determined that the hydrological group "B" should be used to best reflect the characteristics of the soils on site.

Run-off curve number data was determined using Table 2.1.5-1 from the Georgia Stormwater Management Manual. Run-off coefficient data was determined by utilizing Table 2.1.5-2 from the Georgia Stormwater Management Manual and Manning's n for Channels (Chow, 1959).

Appendix B from the TR-55 was used to determine the rain distribution for Plant Bowen is Type II. (See Image 5)

NOAA Atlas 14 was used to determine the 24-hour precipitation for the design storm event of 25-yr for Plant Bowen is 6.07 in. (See Image 6)

<u>Assumptions/Criteria</u>

- Refer to Title 40 CFR Part 257.81 Hydrologic and hydraulic capacity requirements for the run-on and run-off controls for CCR landfills.
- Other assumptions are listed on attached calculation sheets.

Design Inputs/References

- AutoCad Civil 3D 2019, Autodesk, Inc.
- Hydraflow Hydrographs Extension for AutoCad Civil 3D 2019, Autodesk, Inc.
- Hydraflow Express Extension for AutoCad Civil 3D 2019, Autodesk, Inc.
- NOAA Atlas 14, Volume 9, Version 2 for Taylorsville, GA.
- Georgia SW Manual
- TR-55 – Urban Hydrology for Small Watersheds, Appendix B, National Resources Conservation Service, Conservation Engineering Division, 1986.
- Georgia Power Company – Plant Bowen – CCB Disposal Facility Design and Operation Plans H15061 - H15097, H15296 - H15315 and H52258 - H52260.
- Cells 9&10 As-built drawing from 2014 titled "13471-Plant Bowen-CCB Facility CELL9_10 2014.dwg"

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
	Calculation Number DC-BN- 735210-003 (Rev1)	Sheet 4 of 23

Image 1

CELLS 9 & 10 SEDIMENTATION POND
2.12 AC
CELLS 9 & 10 CLEAR POOL
0.92 AC
CELLS 9 & 10
31.67 AC

Image 2

Design Calculations

Southern Company

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
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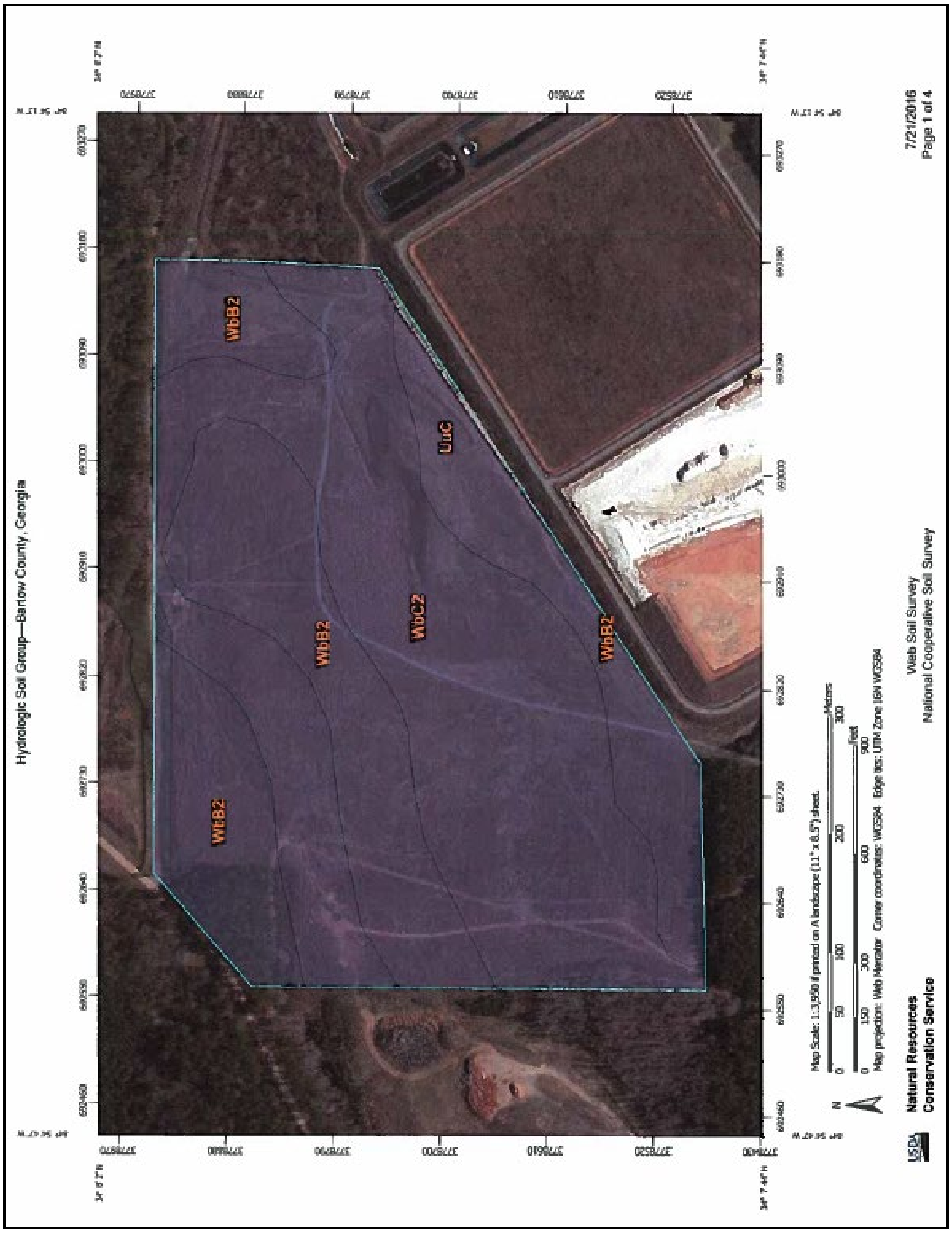

Image 3

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
	Calculation Number DC-BN- 735210-003 (Rev1)	Sheet 7 of 23

Hydrologic Soil Group—Bartow County, Georgia

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Bartow County, Georgia (GA015)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
UuC	Urban land-Udorthents complex, 0 to 10 percent slopes		0.3	0.5%
WbB2	Waynesboro clay loam, 2 to 6 percent slopes, moderately eroded	B	25.4	46.6%
WbC2	Waynesboro clay loam, 6 to 10 percent slopes, moderately eroded	B	28.8	52.9%
Totals for Area of Interest			**54.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Image 4

7/13/2016 Rainfall Distribution Types within USA.gif (652×621)

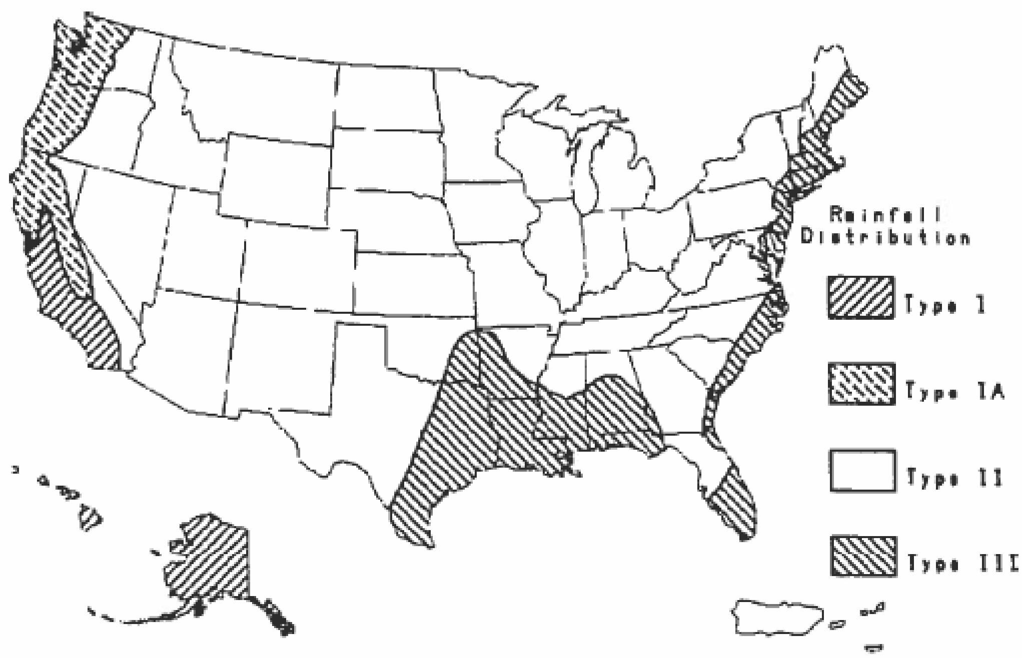

Figure B-2 —Approximate geographic boundaries for SCS rainfall distributions

Image 5

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
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Precipitation Frequency Data Server

Page 1 of 4

NOAA Atlas 14, Volume 9, Version 2
TAYLORSVILLE
Station ID: 09-8600
Location name: Taylorsville, Georgia, US*
Latitude: 34.0861°, Longitude: -84.9828°
Elevation:
Elevation (station metadata): 721 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.406 (0.321-0.518)	0.464 (0.367-0.593)	0.568 (0.448-0.726)	0.662 (0.520-0.849)	0.804 (0.619-1.06)	0.924 (0.695-1.23)	1.05 (0.768-1.42)	1.19 (0.838-1.62)	1.39 (0.943-1.92)	1.55 (1.02-2.14)
10-min	0.594 (0.471-0.759)	0.679 (0.537-0.868)	0.831 (0.655-1.06)	0.969 (0.761-1.24)	1.18 (0.907-1.56)	1.35 (1.02-1.80)	1.54 (1.12-2.07)	1.75 (1.23-2.38)	2.03 (1.38-2.81)	2.27 (1.50-3.14)
15-min	0.725 (0.574-0.926)	0.828 (0.655-1.06)	1.01 (0.799-1.30)	1.18 (0.928-1.52)	1.44 (1.11-1.90)	1.65 (1.24-2.19)	1.88 (1.37-2.53)	2.13 (1.50-2.90)	2.48 (1.68-3.43)	2.77 (1.83-3.83)
30-min	1.02 (0.811-1.31)	1.17 (0.924-1.49)	1.43 (1.13-1.83)	1.66 (1.31-2.13)	2.02 (1.56-2.68)	2.33 (1.75-3.09)	2.65 (1.94-3.57)	3.01 (2.12-4.11)	3.52 (2.39-4.86)	3.93 (2.60-5.44)
60-min	1.33 (1.05-1.70)	1.52 (1.20-1.94)	1.85 (1.46-2.36)	2.15 (1.69-2.76)	2.61 (2.01-3.45)	3.00 (2.25-3.98)	3.41 (2.49-4.58)	3.86 (2.71-5.26)	4.49 (3.05-6.21)	5.01 (3.31-6.93)
2-hr	1.64 (1.31-2.06)	1.86 (1.49-2.35)	2.27 (1.81-2.86)	2.64 (2.10-3.34)	3.20 (2.49-4.17)	3.66 (2.79-4.79)	4.16 (3.08-5.52)	4.70 (3.36-6.33)	5.47 (3.77-7.46)	6.09 (4.09-8.32)
3-hr	1.84 (1.49-2.30)	2.10 (1.69-2.62)	2.55 (2.05-3.19)	2.96 (2.37-3.71)	3.56 (2.80-4.60)	4.07 (3.12-5.28)	4.60 (3.43-6.05)	5.18 (3.73-6.91)	6.00 (4.17-8.12)	6.66 (4.51-9.04)
6-hr	2.27 (1.86-2.79)	2.57 (2.10-3.17)	3.10 (2.53-3.83)	3.57 (2.90-4.41)	4.26 (3.38-5.41)	4.82 (3.75-6.16)	5.42 (4.10-7.02)	6.05 (4.42-7.96)	6.94 (4.90-9.27)	7.65 (5.27-10.3)
12-hr	2.79 (2.32-3.39)	3.15 (2.61-3.83)	3.77 (3.12-4.58)	4.31 (3.54-5.25)	5.08 (4.08-6.34)	5.70 (4.49-7.17)	6.36 (4.87-8.10)	7.04 (5.21-9.11)	7.99 (5.72-10.5)	8.73 (6.11-11.6)
24-hr	3.34 (2.81-3.99)	3.79 (3.18-4.53)	4.54 (3.80-5.44)	5.18 (4.32-6.21)	6.07 (4.93-7.43)	6.77 (5.40-8.36)	7.48 (5.81-9.38)	8.22 (6.17-10.5)	9.21 (6.70-11.9)	9.98 (7.10-13.0)
2-day	3.87 (3.29-4.55)	4.43 (3.77-5.21)	5.34 (4.54-6.30)	6.10 (5.16-7.22)	7.14 (5.88-8.60)	7.95 (6.42-9.65)	8.75 (6.88-10.8)	9.56 (7.27-12.0)	10.6 (7.84-13.6)	11.4 (8.27-14.8)
3-day	4.24 (3.64-4.95)	4.81 (4.13-5.62)	5.76 (4.93-6.73)	6.56 (5.59-7.68)	7.66 (6.37-9.16)	8.53 (6.95-10.3)	9.40 (7.47-11.5)	10.3 (7.92-12.8)	11.5 (8.57-14.6)	12.4 (9.06-15.9)
4-day	4.56 (3.94-5.28)	5.14 (4.43-5.96)	6.10 (5.25-7.08)	6.92 (5.93-8.06)	8.07 (6.76-9.61)	8.98 (7.38-10.8)	9.92 (7.94-12.1)	10.9 (8.43-13.6)	12.2 (9.16-15.4)	13.2 (9.72-16.8)
7-day	5.37 (4.69-6.14)	5.99 (5.22-6.86)	7.04 (6.13-8.07)	7.94 (6.88-9.14)	9.24 (7.84-10.9)	10.3 (8.56-12.2)	11.3 (9.21-13.7)	12.5 (9.80-15.3)	14.0 (10.7-17.5)	15.2 (11.3-19.2)
10-day	6.07 (5.34-6.89)	6.74 (5.92-7.66)	7.88 (6.91-8.97)	8.87 (7.74-10.1)	10.3 (8.79-12.0)	11.4 (9.58-13.5)	12.6 (10.3-15.1)	13.8 (11.0-16.8)	15.5 (11.9-19.3)	16.8 (12.7-21.1)
20-day	8.08 (7.21-9.03)	8.91 (7.95-9.96)	10.3 (9.17-11.5)	11.5 (10.2-12.9)	13.2 (11.5-15.2)	14.6 (12.4-16.9)	16.0 (13.3-18.8)	17.4 (14.0-20.9)	19.4 (15.2-23.7)	21.0 (16.1-25.9)
30-day	9.86 (8.87-10.9)	10.8 (9.75-12.0)	12.5 (11.2-13.8)	13.9 (12.4-15.4)	15.8 (13.8-17.9)	17.3 (14.9-19.8)	18.8 (15.8-22.0)	20.4 (16.6-24.2)	22.5 (17.8-27.3)	24.1 (18.7-29.5)
45-day	12.2 (11.1-13.4)	13.5 (12.2-14.8)	15.4 (14.0-17.0)	17.1 (15.4-18.8)	19.3 (16.9-21.6)	20.9 (18.1-23.7)	22.6 (19.1-26.1)	24.3 (19.9-28.5)	26.4 (21.1-31.7)	28.1 (22.0-34.1)
60-day	14.4 (13.1-15.6)	15.8 (14.4-17.2)	18.1 (16.5-19.6)	19.9 (18.1-21.6)	22.4 (19.8-24.9)	24.2 (21.0-27.2)	25.9 (22.0-29.7)	27.7 (22.8-32.2)	29.8 (23.9-35.5)	31.4 (24.8-37.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

Image 6

Body of Calculation

See detailed calculations and software output.

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
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Drainage Area = 34.71 AC (See Map 1)

Curve Number = 64 (See Attached Table 1)

31.47 AC @ CN 61 (Grass)

2.48 AC @ CN 85 (Gravel)

0.76 AC @ CN 98 (Impervious – Liner in Sediment Pond and Clear Pool)

((31.47*61)+(2.48*85)+(0.76*98))/34.88_ = 63.52 = 64

Time of Concentration = 31.49 Min (See Attached TR55 Worksheet and Map 2)

Sheet Flow

Manning's n-Value = 0.15 (Short Grass) (See Table 2)

Flow Length = 300 LF

Land Slope = (805.50-799.00)/300 = 0.0217 = 2.17%

Shallow Concentrated

Flow Length = 353 LF

Watercourse Slope = (799.00-744.54)/353 = 0.1543 = 15.43%

Surface is Unpaved

Channel Flow (See Channel Report 1)

Grass Lined 4' Wide Ditch with 2:1 Side Slopes and 4' Deep

Cross Sectional Area = 6.57 SF

Wetted Perimeter = 8.79 LF

Channel Slope = (744.54-704.46)/2773 = 0.0145= 1.45%

Manning's n-Value = 0.030 (Vegetal Lining) (See Table 3)

Flow Length = 2773 LF

Channel Flow (See Channel Report 2)

4 – 42" Dia. HDPE Pipes @ 1.51%

Cross Section Area = 1.85 SF

Wetted Perimeter = 3.64 LF

Channel Slope = (704.46-702.92)/102 = 0.0151 = 1.51%

Manning's n-Value = 0.013 (HDPE Pipes) (See Table 4)

Flow Length = 102 LF

Time Interval = 3 Min

Tc*0.1333 = 31.49*0.1333 = 4.20 = 5

Storm Distribution = Type II

Design Calculations

Project	Prepared by	Date
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Q_{25} = 65.64 CFS (See Hydrograph Report 1)

To Evaluate for Storage Capacity, Treat The Sediment Pond and Clear Pool As One Pond Since They Are Interconnected.

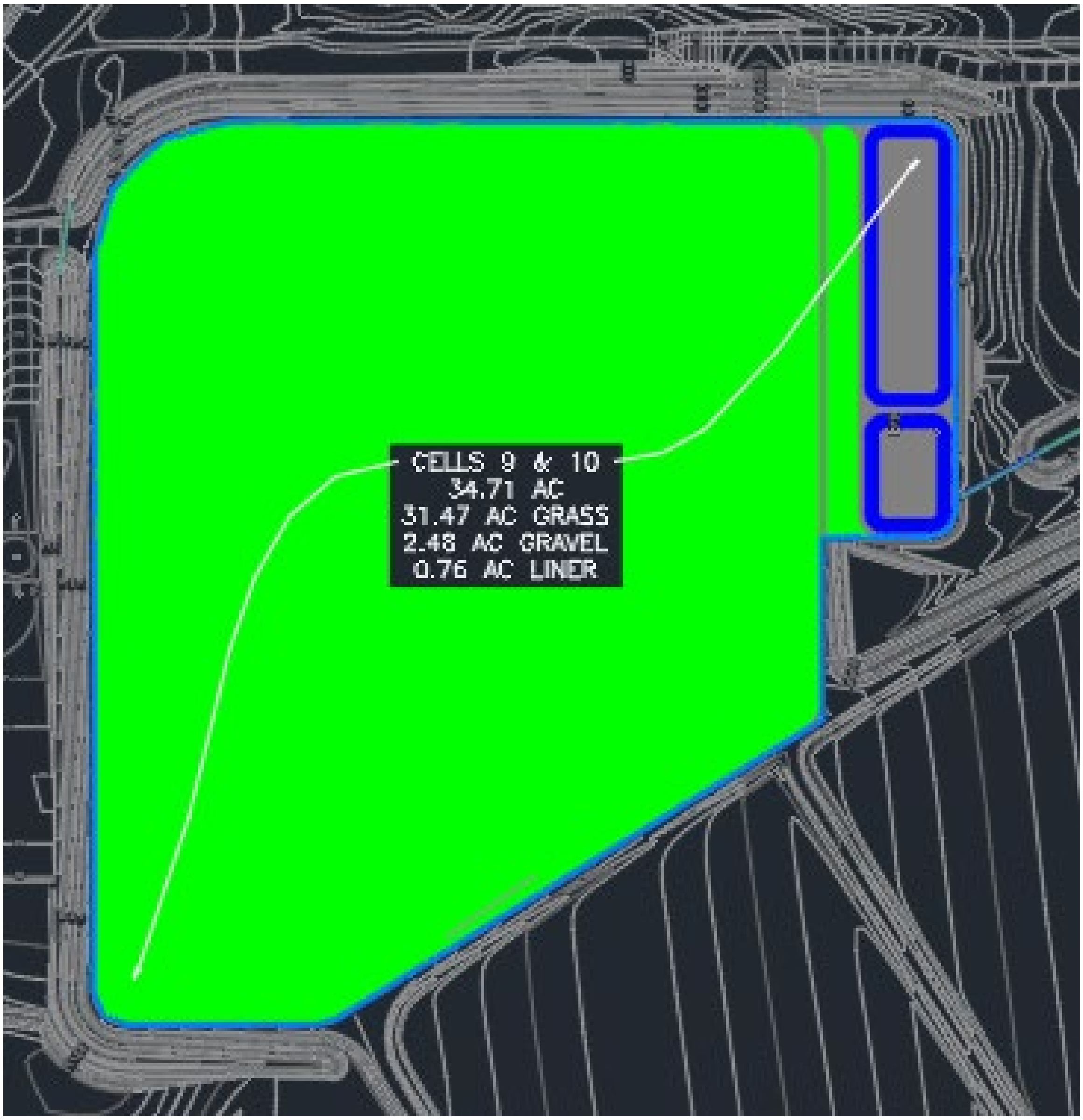
Elevation (FT)	Sed. Pond Area (SF)	Clear Pool Area (SF)	Total Area (SF)	Volume (CF)
695	0	9369	9369	0*
696	30,498	10,378	40,876	23,269*
697	32,804	11,426	44,230	65,807
698	35,149	12,514	47,663	111,738
699	37,533	13,640	51,173	161,141
700	39,956	14,806	54,762	214,093
701	42,419	16,012	58,431	270,674
702	44,921	17,256	62,177	330,962
703	47,462	18,540	66,002	395,036
703.5	48,748	19,197	67,945	428,518

Note: Stage storage is based on topographic information from 2020.
*Dead Storage

Spillways

- Principal Spillway consists of a 54” Dia. Riser with a 42” Dia. HDPE Pipe.
- Auxiliary Spillways in the Clear Pool and Sediment Pond consist of a concrete trapezoidal weir that is 24’ wide with 6:1 side slopes and sloped at 1% in the direction of flow with a 3:1 slope on the discharge channel at the downstream end.

High Water Elevation is 701.44 (See Pond Reports 1 & 2)



Map 1

Table 2.1.5-1 Runoff Curve Numbers[1]

Cover description		Curve numbers for hydrologic soil groups			
Cover type and hydrologic condition	*Average percent impervious area*[2]	A	B	C	D
Cultivated land: without conservation treatment		72	81	88	91
with conservation treatment		62	71	78	81
Pasture or range land: poor condition		68	79	86	89
good condition		39	61	74	80
Meadow: good condition		30	58	71	78
Wood or forest land: thin stand, poor cover		45	66	77	83
good cover		25	55	70	77
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]					
Poor condition (grass cover <50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm drains (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85%	89	92	94	95
Industrial	72%	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65%	77	85	90	92
1/4 acre	38%	61	75	83	87
1/3 acre	30%	57	72	81	86
1/2 acre	25%	54	70	80	85
1 acre	20%	51	68	79	84
2 acres	12%	46	65	77	82
Developing urban areas and Newly graded areas (pervious areas only, no vegetation)		77	86	91	94

[1] Average runoff condition, and $I_a = 0.2S$

[2] The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. If the impervious area is not connected, the SCS method has an adjustment to reduce the effect.

[3] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

Table 1

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12

Hyd. No. 1

Cells 9 & 10

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.150		0.011		0.011		
Flow length (ft)	=	300.0		0.0		0.0		
Two-year 24-hr precip. (in)	=	3.79		0.00		0.00		
Land slope (%)	=	2.17		0.00		0.00		
Travel Time (min)	=	20.99	+	0.00	+	0.00	=	20.99
Shallow Concentrated Flow								
Flow length (ft)	=	353.00		0.00		0.00		
Watercourse slope (%)	=	15.43		0.00		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	6.34		0.00		0.00		
Travel Time (min)	=	0.93	+	0.00	+	0.00	=	0.93
Channel Flow								
X sectional flow area (sqft)	=	6.57		1.79		0.00		
Wetted perimeter (ft)	=	8.79		3.39		0.00		
Channel slope (%)	=	1.45		1.51		0.00		
Manning's n-value	=	0.030		0.013		0.015		
Velocity (ft/s)	=	4.92		9.18		0.00		
Flow length (ft)		({0})2773.0		102.0		0.0		
Travel Time (min)	=	9.39	+	0.19	+	0.00	=	9.58
Total Travel Time, Tc								**31.49 min**

TR55 Worksheet

Design Calculations

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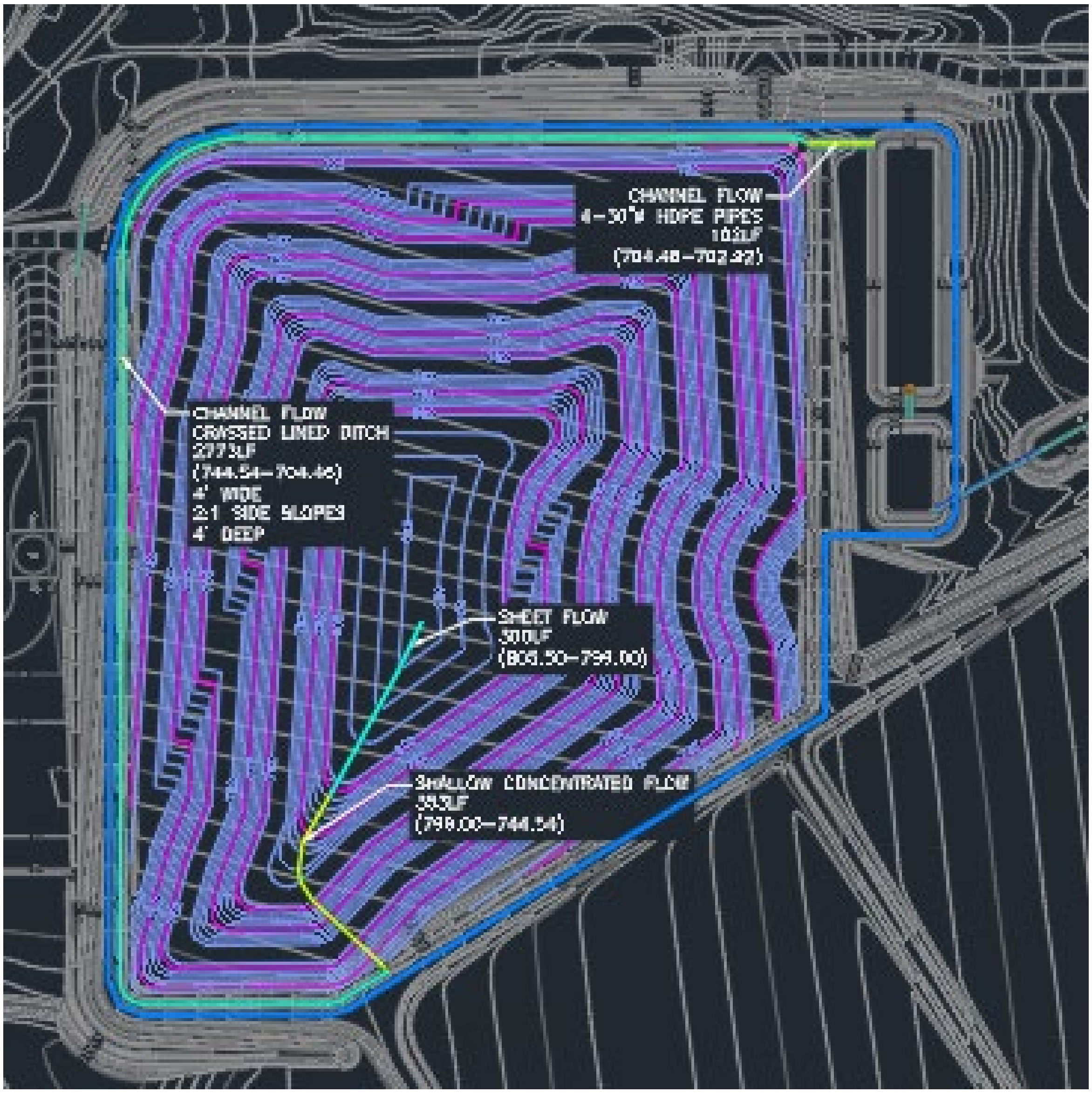

Map 2

Table 2.1.5-2 Roughness Coefficients (Manning's n) for Sheet Flow[1]

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover < 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information by Engman (1986).
[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3] When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Source: SCS, TR-55, Second Edition, June 1986

Table 2

Design Calculations

Project	Prepared by	Date
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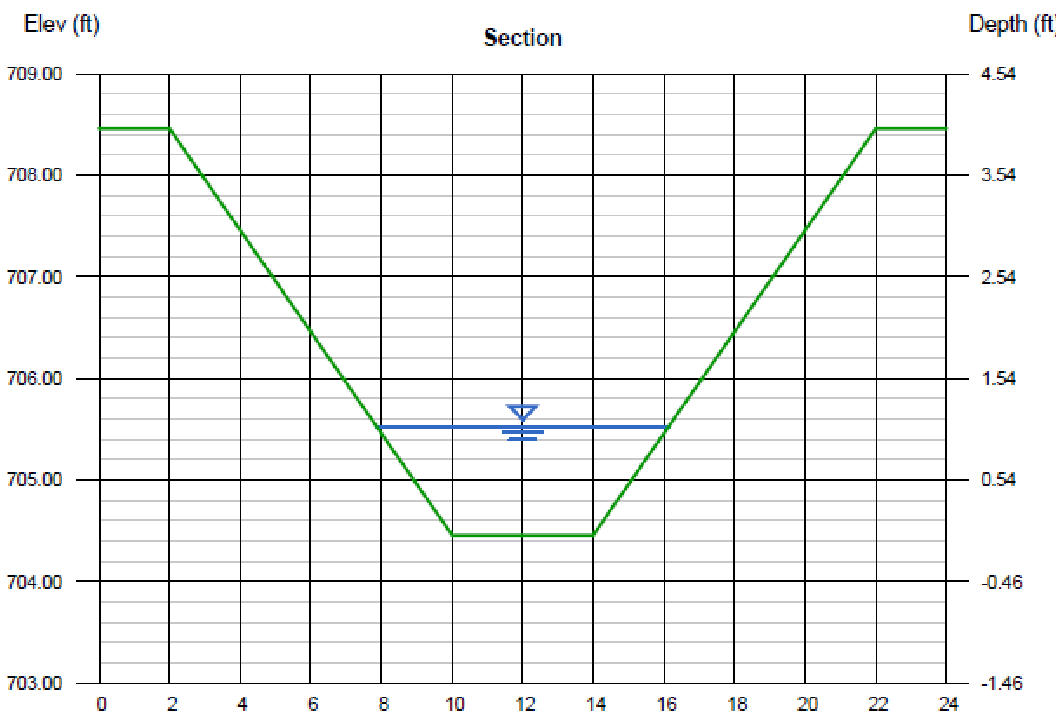
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Thursday, Feb 11 2021

Cells 9 & 10 Ditch

Trapezoidal		Highlighted	
Bottom Width (ft)	= 4.00	Depth (ft)	= 1.07
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 31.97
Total Depth (ft)	= 4.00	Area (sqft)	= 6.57
Invert Elev (ft)	= 704.46	Velocity (ft/s)	= 4.87
Slope (%)	= 1.45	Wetted Perim (ft)	= 8.79
N-Value	= 0.030	Crit Depth, Yc (ft)	= 1.05
		Top Width (ft)	= 8.28
		EGL (ft)	= 1.44

Calculations	
Compute by:	Known Q
Known Q (cfs)	= 31.97



Channel Report 1

Manning's n Values

3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.020	0.025
2. random stone mortar	0.020	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.030
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.030		0.500

Table 3

Design Calculations

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Thursday, Feb 10 2022

Cells 9 & 10 Pipe

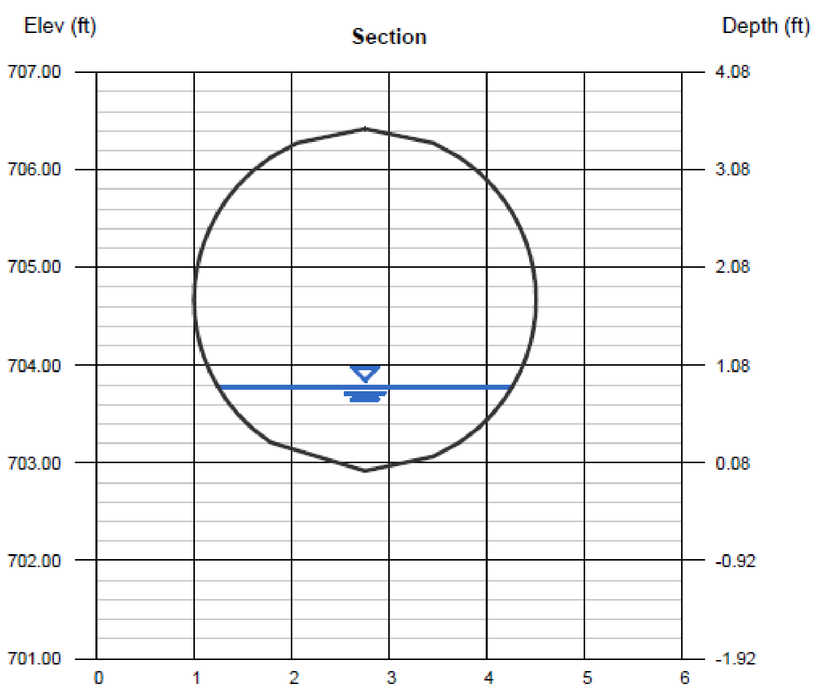
Circular
Diameter (ft) = 3.50

Invert Elev (ft) = 702.92
Slope (%) = 1.51
N-Value = 0.013

Calculations
Compute by: Known Q
Known Q (cfs) = 16.41

Full Flow = 65.64
Pipes = 4
Flow Per Pipe =
65.64/4 = 16.41

Highlighted
Depth (ft) = 0.86
Q (cfs) = 16.41
Area (sqft) = 1.85
Velocity (ft/s) = 8.88
Wetted Perim (ft) = 3.64
Crit Depth, Yc (ft) = 1.24
Top Width (ft) = 3.02
EGL (ft) = 2.09



Channel Report 2

Manning's n Values

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7. Concrete:			
Culvert, straight and free of debris	0.010	0.011	0.013
Culvert with bends, connections, and some debris	0.011	0.013	0.014
Finished	0.011	0.012	0.014
Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
Unfinished, steel form	0.012	0.013	0.014
Unfinished, smooth wood form	0.012	0.014	0.016
Unfinished, rough wood form	0.015	0.017	0.020
8. Wood:			
Stave	0.010	0.012	0.014
Laminated, treated	0.015	0.017	0.020
9. Clay:			
Common drainage tile	0.011	0.013	0.017
Vitrified sewer	0.011	0.014	0.017
Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
Vitrified Subdrain with open joint	0.014	0.016	0.018
10. Brickwork:			
Glazed	0.011	0.013	0.015
Lined with cement mortar	0.012	0.015	0.017
Sanitary sewers coated with sewage slime with bends and connections	0.012	0.013	0.016
Paved invert, sewer, smooth bottom	0.016	0.019	0.020
Rubble masonry, cemented	0.018	0.025	0.030

Table 4

Design Calculations

Southern Company

Project	Prepared by	Date
Plant Bowen Run-on Run-off Control	Jeremy Brown	2/10/22
Subject/Title Provide run-on and run-off system calculations for the peak discharge from a 24-hr 25-year storm Cells 9 & 10	Reviewed by Ashley Grissom	Date 2/11/22
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Hydrograph Report

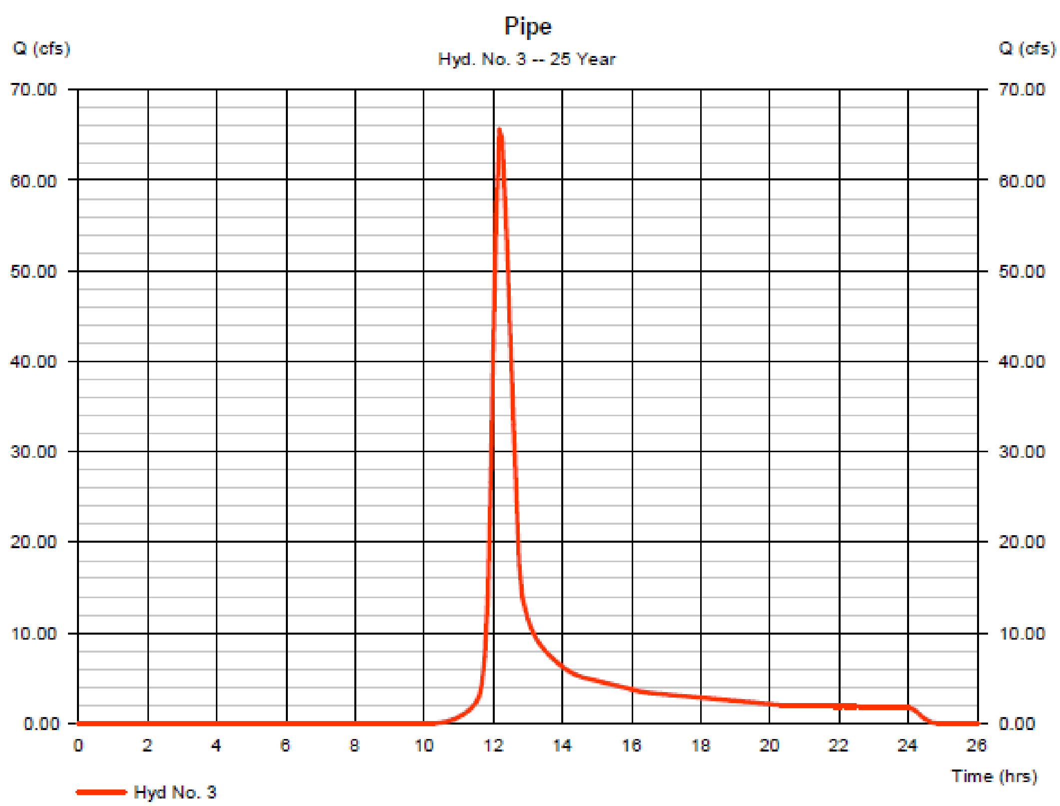
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Thursday, 02 / 11 / 2021

Hyd. No. 3

Pipe

Hydrograph type	= SCS Runoff	Peak discharge	= 65.64 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 300,595 cuft
Drainage area	= 34.710 ac	Curve number	= 64*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 31.50 min
Total precip.	= 6.07 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(31.470 x 61) + (2.480 x 85) + (0.760 x 98)] / 34.710



Hydrograph Report 1

Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v12 — Monday, 01 / 31 / 2022

Pond No. 1 - Cell 9&10 Sed Pond/Clear Pool

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 695.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	695.00	9,369	0	0
1.00	696.00	40,876	23,269	23,269
2.00	697.00	44,230	42,538	65,807
3.00	698.00	47,663	45,931	111,738
4.00	699.00	51,173	49,403	161,141
5.00	700.00	54,762	52,952	214,093
6.00	701.00	58,431	56,581	270,674
7.00	702.00	62,177	60,288	330,962
8.00	703.00	66,002	64,074	395,036
8.50	703.50	67,945	33,482	428,518

Culvert / Orifice Structures

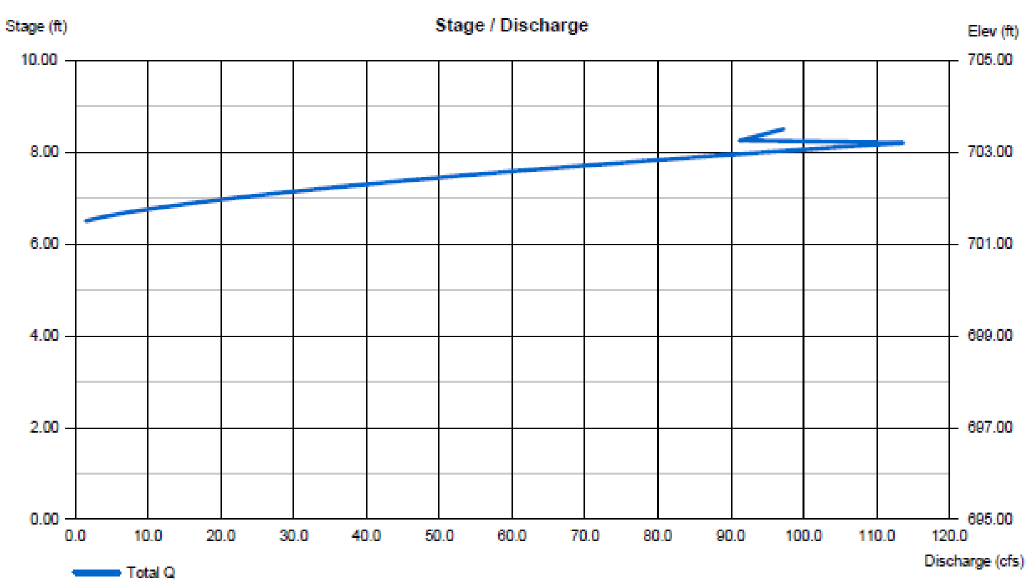
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 42.00	0.00	0.00	0.00
Span (in)	= 42.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 679.90	0.00	0.00	0.00
Length (ft)	= 200.00	0.00	0.00	0.00
Slope (%)	= 2.45	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 14.13	0.00	0.00	0.00
Crest El. (ft)	= 701.40	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Pond Report 1

Design Calculations

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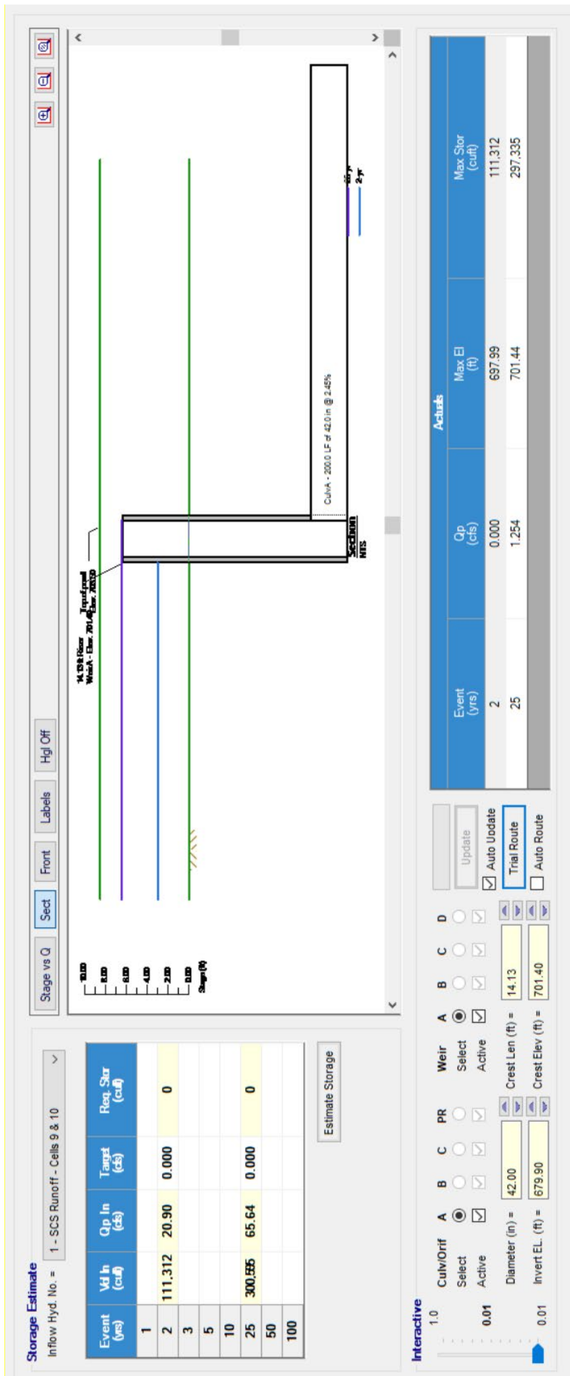

Pond Report 2