# GEORGIA
# OFFSHORE MINERALS ASSESSMENT


by

ZELLARS-WILLIAMS COMPANY

Division of

JACOBS ENGINEERING GROUP INC.
LAKELAND, FLORIDA



Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey


**Project Report No. 14**

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**LAKELAND, FLORIDA**

*In cooperation with*
*Minerals Management Service*
*U.S. Department of the Interior*
*under MMS Agreement No. 14-12-0001-30399*

**Department of Natural Resources**
**J. Leonard Ledbetter, Commissioner**

**Environmental Protection Division**
**Harold F. Reheis, Assistant Director**

**Georgia Geologic Survey**
**William H. McLemore, State Geologist**

**Atlanta**

**1988**

# GEORGIA OFFSHORE MINERALS ASSESSMENT

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## EXECUTIVE SUMMARY

An assessment of mineral resources in the sea-bed on the continental shelf offshore Georgia was undertaken by Zellars-Williams Company, division of Jacobs Engineering Group Inc., pursuant to a contract dated August 12, 1988. The award was made following a request for proposals by the Georgia Department of Natural Resources and the Minerals Management Service, U.S. Department of the Interior, acting cooperatively with other participants, as the TASK FORCE for Offshore Mineral Resources.

Owing to budgetary constraints, the work assesses the economic viability of commercially exploiting offshore phosphorites and heavy minerals utilizing, to the greatest extent possible, commercially available proven technology.

The premises upon which the occurrences of potentially economic resources are located and their areal extent and volume quantified are based entirely on data made available by others. It is emphasized that this study is based on a minerals occurrence inferred by scattered, widely-spaced data points. The conceptual mining and beneficiation flowsheet designs were formulated based on analysis of these data and assumptions as to ore grade, minerals distribution, and ore continuity.

The phosphate-bearing Middle Miocene area targeted for this study is located within a 3-nautical mile radius of a point which is the intersection of $80^{o}40'$ latitude, and $32^{o}$ longitude lines. The ore (matrix) zone identified for mining is 5-7 meters thick, under 8-10 meters of overburden. Water depth, below MSL, is 14-16 meters. The 507 million cubic meters of matrix have the potential of yielding 162 million tonnes of 30% $P_2O_5$ grade phosphate rock product after mining and beneficiation losses.

For phosphate exploitation, all of the required mining, beneficiation, waste disposal, product storage, ship loading, and supporting infrastructure facilities are entirely offshore. Similarly designed, hybrid cutterhead suction-type hydraulic dredges remove overburden and mine matrix independently. Overburden is pumped through a trailing pipeline about 1.5 nautical miles to a floating, constant level head tank and flexible tremie discharging into previously mined cuts at sea bottom. Matrix is pumped to the beneficiation plant through a pipeline, which lengthens as mining progresses to a maximum distance of 3 nautical miles. The overburden dredge must excavate about 1.6 cubic meters for each cubic meter of ore mined by the matrix dredge.

A 15-acre man-made island, located in the center of the proposed mining area, houses all the beneficiation processing units required to produce wet phosphate concentrate. The phosphate beneficiation facility consists of washer, feed preparation, flotation and product storage, and loading areas. The beneficiation facility is designed to receive slurried ore from the matrix dredge, disaggregate the ore, wash and grind the oversize rock, remove the clay, and separate the sand from the feed to produce a marketable phosphate concentrate product. Fresh water, produced by a reverse osmosis desalination plant, is used to rinse the concentrate to remove surficial salt residue remaining from the beneficiation process. Concentrate is loaded aboard ocean-going vessels berthed at a wharf from a walled-in type open storage yard. Clay and sand-sized particles, rejected with sea water in the beneficiation process, are thickened with the aid of flocculants, dewatered, mixed, and then discharged through a submerged pipeline into mined cuts. The dredges and island facilities are self-sustaining and are designed to operate 6,000 and 7,000 hours per year, respectively, in all but the most severe weather conditions. The facilities are designed to yield product at the average annual rate of 4.8 million tonnes.

World-wide and domestic phosphate supply-demand projections support the premise that market entry in about the year 2000 is reasonable. The most optimistic estimate of the time required to implement the exploration, development, and preliminary engineering phase of this enterprise could support start-up in the year 1996. Economic sensitivity analyses, based on constant 1988 dollars, for sales prices (FOB vessel off-shore island) of $36.00 per tonne in 1996, and $42 per tonne in 1999, demonstrate a promise of economic viability. Construction capital, production cost, and after-tax discounted cash flow return on investment for each of five scenarios, with final production in 1999, and revenue based on a $42 per tonne sales price, are summarized below.

| Case No. | Sales Price $/tonne | Construction Capital $ Millions | Production Cost $/tonne | DCFROI % |
|---|---|---|---|---|
| II | 42 | 280 | 16.60 | 12.2 |
| IIa | 42 | 280 | 15.15 | 13.3 |
| IIb | 42 | 280 | 18.05 | 11.1 |
| IIc | 42 | 252 | 16.60 | 14.1 |
| IId | 42 | 308 | 16.60 | 10.6 |

An implied occurrence of surficial sea-bed sands containing heavy minerals and rare earths most amenable to mining by conventional ocean-going dredges targets the area considered in this study. This heavy mineral line, about 30 nautical miles from shore, is about 0.8 nautical miles wide, 8.1 nautical miles long, and 10.4 meters thick. Water depth, below MSL, is 26-30 meters. The 292 million cubic meters of mineral-rich sands have the potential of yielding 15 million tonnes of a suite of heavy minerals and rare earth products, after mining and milling process losses. The dredge is a suction hopper vessel with a leading suction head arm operating from anchored positions to excavate the full depth in panels created in a series of pits.

Dredged sands are processed first in an on-board wet mill and then pumped to a nearby dry mill for final up-grading. The wet mill concentration process rejects oversize and fine sediments, which are collected, thickened, and discharged into the mined cuts. The resulting intermediate product is pumped through a trailing pipeline to a dry mill situated on a semi-submersible platform anchored nearby. The platform is moved, as mining advances, when the distance from mining exceeds about 1.1 nautical miles. This requires the platform to move every five years. The platform is a fully self-contained floating production platform with crew quarters, and product storage and vessel loading equipment.

The heavy mineral facilities are designed to recover rutile, ilmenite, leucoxene, monazite and zircon from heavy mineral sand deposits. Processing facilities include an initial concentration plant (wet mill) located onboard the mining dredge, and a remote-located platform-mounted recovery plant (dry mill). Sea water is used for processing at both the wet and dry mills. The configurations of mine and beneficiation facilities are designed to produce 811,100 tonnes per year of products consisting of a mix of the heavy minerals identified in the study.

Economic analyses are based on capital construction cost of 235 million dollars and a production cost of $42.53 per average tonne of heavy mineral products. Sales price for the average tonne of heavy mineral product was constructed by applying the current quoted market price for each of the five products to the quantities of each. The resulting artificial average sales price of $127.00 per tonne is increased by 30% in increments of 10% to test sensitivity. The resulting after-tax discounted cash flow in percent return on investment is given following.

| Artificial Average Sales Price $/tonne | Construction Capital $ Millions | Production Cost $/tonne | DCFROI % |
|---|---|---|---|
| 127.00 | 235 | 42.53 | 4.2 |
| 130.70 | 235 | 42.53 | 6.8 |
| 152.40 | 235 | 42.53 | 9.0 |
| 165.10 | 235 | 42.53 | 11.7 |

The results of this study indicate that economics for both phosphate and heavy minerals support further explorative work offshore in the described target and other areas. The technical and economic risk associated with the mining, beneficiation, and infrastructure facilities proposed may be reduced to acceptable levels by more detailed engineering study. This effort is not warranted until further exploratory work is carried on to reduce the uncertainties of the minerals occurrences. This exploration work would focus on developing data upon which to base a scientific determination of level-of-confidence as to the quantity and quality of sea-bottom ore.

Limited areal investigation and complete profile core drilling to recover adequate samples in several locations are required to confirm assumptions made as to grade and quality. Properly located drill holes will aid in reducing uncertainties of continuity and variability. Favorable results of bench scale laboratory analysis and beneficiation process testing would then support more engineering.

Concurrent with the initial phases of the exploration program, limited environmental baseline studies are required to identify, evaluate and quantify biota and marine environments on a site-specific basis. These preliminary studies will provide the data with which potential impacts on marine life may be evaluated. Further, these data will provide the means of analyzing and costing mitigative alternatives to various exploitation plans. The success of, and the cost of, mitigation and environmental monitoring may be a significant additional operating cost in the offshore mining of minerals.

The bibliography, contained as Section 9, is intended to recognize Zellars-Williams Company key professional contributors, in addition to J.M. Williams, P.E., as a principal investigator, and all the sources of reference used in preparing the report.

The Draft Final Report was delivered and reviewed in Atlanta at a Task Force meeting on May 17, 1988. A second Task Force meeting in Atlanta was held on June 14, 1988 to receive input and to consider modifications and amendments to the Draft. The Final Report, reflecting comments of the Task Force, was published on July 20, 1988.

"THIS RESEARCH WAS FINANCED THROUGH A GRANT FROM
THE GEORGIA GEOLOGIC SURVEY, ENVIRONMENTAL PROTECTION
DIVISION, DEPARTMENT OF NATURAL RESOURCES.
FUNDED BY THE MINERALS MANAGEMENT SERVICE
DEPARTMENT OF THE INTERIOR
UNDER MMS AGREEMENT NO. 14-12-0001-30399"

# SECTION 2

# SCOPE OF STUDY

## 2.1 OVERVIEW AND OBJECTIVES

In August 1987 Zellars-Williams Company, a member of Jacobs Engineering Group Inc., (ZW), contracted with the Department of Natural Resources, State of Georgia, to provide a resource assessment study for Georgia offshore minerals. The specific study area (Figure 2.1) is defined as the Continental Shelf off of Georgia, lying between Universal Transverse Mercator (UTM) grid lines N 3,362,400 meters and N 3,675,000 meters. The western and eastern study-area boundaries, respectively, are the three geographical-mile line (measured seaward from the coast as depicted on U.S.G.S-U.S.N.O.S. topographic-bathymetric maps) and the shelf break.

Two primary services are defined by the scope of study:

- preparation of resource assessment studies (for heavy mineral sands and phosphorites), which include quantity, chemical analyses and physical properties, and

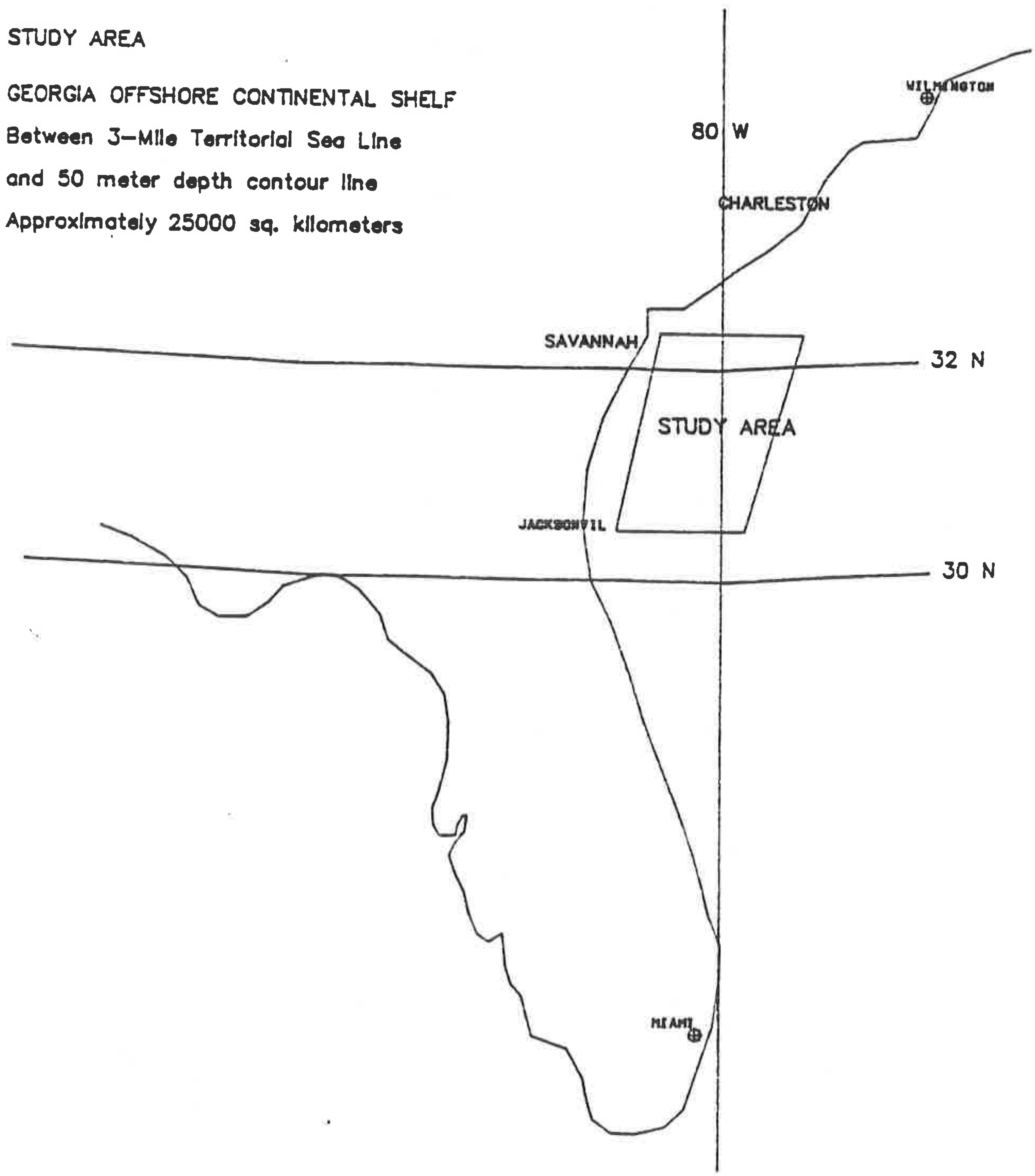
- a general economic feasibility analysis (for both heavy minerals and phosphorites) which consists of a discussion of mining technologies, infrastructure, and other facilities, as well as economic sensitivity analyses of factors relative to exploitation of mineral resources.

Project deliverables are limited to the following items:

- a computerized geologic database,
- digitized resource maps, and
- a final project report describing the physical resource and presenting the economic feasibility analyses.

FIGURE 2.1

Study Area Location Map



## 2.2 DATA COLLECTION

Resource assessment studies in this report are based on published and unpublished reports and databases. The only two potential mineral resources that have been reported for the Atlantic Continental Shelf (ACS) offshore of Georgia are heavy mineral sands and phosphorites. Deposits of materials such as gravel and shell have been located in other ACS areas, but no descriptive evidence of these materials in exploitable concentrations exists for the study area.

Steps leading to the resource description included identification of available data, collection of them, standardization to provide comparable formats, assessment of data quality and assignment of consequent limitations on its use, integration of data sets of comparable character and quality, and assessment of the natural resource in terms of location and probable quantity and quality.

Available data related to potential mineral resources offshore of Georgia were identified by several means. Bibliography and literature reviews were conducted to assess the availability of published information. Data survey forms were prepared and submitted to certain organizations to determine the availability of unpublished data. Additionally, a number of personal contacts were made in order to obtain specific data or samples, or to follow-up on data survey forms.

The Request for Proposal specified eight potential data sources for evaluation during the course of the first phase of the Resource Assessment Study. Contacted potential sources are listed in Table 2-1, with persons contacted at each, as well as an assessment of the current holdings of each.

A. Georgia Geological Survey, EPD, DNR, Atlanta, Georgia
Contact: Mr. Jeff Kellam, 404/656-3214

Holdings of the Georgia Geological Survey are generally duplicative of published information that may be as easily acquired elsewhere. However, a careful file review will be conducted with Survey staff to ensure that essential materials do not escape attention.

Table 2-1

**Organizations Contacted for Data Relevant to**

GEORGIA OFFSHORE MINERAL ASSESSMENT STUDY

| | Organization | Contacts | Method of Response: DSF | Method of Response: Letter | Method of Response: Telephone | Respondent | Type of Data Held | Data Used |
|---|---|---|---|---|---|---|---|---|
| A. | Georgia Geologic Survey * Atlanta | J. Kellam | | | X | J. Kellam | Holdings generally available from published sources or available from other sources. | N/A |
| B. | U.S. Bureau of Mines * Washington, D.C. | A. Barsotti<br>L. Lind | | | X | A. Barsotti | No independent relevant data. | N/A |
| C. | Geology Dept., Univ. of * Georgia, Atlanta | V.J. Henry | | X | | J. Harding | High resolution seismic (HRS) profiles, side scan records, (CCTV) tapes, bathymetric profiles. | No |
| D. | Marine Extension Service * Univ. of Georgia, Savannah | J. Harding | | X | | J. Harding | Box cores, vibracores, HRS profiles, side scan records, gamma-sled traverses. | No - data being reduced, not available until Sept. 88 |
| E. | Center for Applied Isotope * Studies, Univ. of Georgia Athens | J. Noakes | | X | | J. Harding | Same investigation and data as Marine Extension Service | N/A |
| F. | Skidaway Institute of * Oceanography, Univ. of Savannah | V.J. Henry | | X | | J. Harding | Same as Geology Dept. Univ. of Georgia, Atlanta | N/A |
| G. | U.S. Geological Survey-EMR * Reston, Virginia | A. Grosz<br>E. Force<br>J. Wynn | X | | X | A. Grosz | Vibracore and grab samples, HRS profiles, side scan sonar | Geologic Model<br>Phosphate mine model<br>Heavy mineral model |
| H. | U.S.G.S., Office of Marine * Geology, Woods Hole, Mass. | P. Popenoe<br>F. Manheim | | | X | P. Popenoe<br>F. Manheim | Data set of interpreted seismic profiles covering the Georgia shelf and Blake Plateau.<br>Data file of analyzed shelf grab samples | Data set of interpreted sparker and airgun profiles covring the Georgia shelf and Slope.<br>Heavy mineral information from data file phosphate analyses on shelf drill cores. |
| I. | NOAA, Boulder, Colorado | R. Warnken | X | | | R. Warnken | Published data announcements | No - not relevant to study. |
| J. | Mississippi Minerals Research Institute | J. Woolsey | | X | | J. Harding | Proprietary | No - not released. |
| K. | MMS, Vienna, Virginia | R. Amato | X | | | R. Amato | Cores and geophysical logs, HRS profiles | No - not relevant. |

DSF = Data Survey Form
N/A - Not Applicable
* Organizations listed in Request for Proposal for evaluation of data relevant to study.

B. U.S. Bureau of Mines, Washington, D.C.

Contact: Mr. Aldo Barsotti, Division of Minerals Availability 202/634-1138; Mr. Langtrey Lynd, Titanium Commodities Specialist, 202/634-1055.

Mr. Barsoti and Mr. Lynd have jointly reviewed DMA data holdings, along with Mr. Don Rogich (Chief, DMA). They concluded that they have no independently developed information that is relevant to the requirements of the Georgia Offshore Minerals Assessment Study. They hold no samples.

C. Geology Department of Georgia State University, Atlanta, GA.

Contact: Professor Vernon J. Henry, 404/658-227 2

There are virtually no unpublished data in the files of Georgia State. Rather, all assessment work is accessible through published information on file there, or elsewhere.

The recent work of Georgia State is based on two data gathering campaigns, the first reported upon in June, 1983. This was work performed for the U.S. Geological Survey (USGS), in a cooperative program with the Bureau of Land Management (BLM), which consisted of a survey conducted to determine the occurrence and distribution of biological and geological hazards on the ocean bottom between Cape Hatteras, N.C. and Jacksonville, Florida from the three-mile inner-shelf boundary seaward to the 50 meter isobath. During the course of this work nearly 6,000 kilometers of trackline were covered, providing the following information:

- 3.5 khz, 5662 kilometers
- Uniboom - air gun system, 5734 kilometers
- Sidescan sonar system, 5872 kilometers

In addition, underwater television camera work was performed, as well as data gathering from 22 dives of the research submersible, Diaphus.

In 1986 Georgia State reported the results of a survey along 420 kilometers of trackline proceeding from the vicinity of the Altamaha River northward into Port Royal Sound, S.C. This work was supplemented by data from 1984 borings by the South Carolina Water Resources Commission, performed in cooperation with the U.S. Geological Survey.

Interpretation of the seismic data gathered for the BLM has contributed to numerous important reports since 1981. Most notable among those, the 1986 publication by Kellam and Henry, "The Interpretation of Seismic Stratigraphy of the Phosphatic Middle Miocene on the Georgia Continental Shelf". This document contains stratigraphic sections derived from the seismic profiles, as well as contour maps showing the structure of important sedimentary strata. These contour and isopach maps represent two levels of refinement beyond the basic uninterpreted raw seismic data.

D. Marine Extension Service, University of Georgia, Savannah, GA
Contact: Professor James Harding, 912/362-2496

Data collected jointly by Dr. Harding and Dr. Noakes are presently being reduced. Data consists of box cores, vibracores, HRS profiles, side-scan sonar records, gamma-sled traverses, all of which were obtained on a grant to investigate the occurrence of heavy mineral placer deposits offshore Georgia. The investigation is 50 percent complete. Data will be available when investigation is complete (end of August, 1988).

E. Center for Applied Isotope Studies, University of Georgia, Athens, GA.
Contact: Professor John Noakes, 404/542-1395
Work being done jointly with Dr. Harding. Not available until end of August, 1988.

F. Skidaway Institute of Oceanography, University of Georgia, Savannah, GA

Contact: Prof. James Harding, 912/362-2496; Prof. Vernon J. Henry, 404/658-2272

All raw data obtained from high resolution seismic surveys conducted by the University of Georgia are on file at Skidaway. Files containing interpreted seismic data are believed to be located there, as well. Virtually all trackline data have been incorporated into publications.

G. U.S.G.S. Eastern Mineral Resources, Reston, VA

Contact: Mr. Andrew Grosz, 703/648-6314; Mr. Eric Force, 703/648-6325; Mr. Jeff Wynn, 703/648-6389

The U.S.G.S. holds a large body of raw data and interpreted information, as well as a limited amount of unpublished information, that is pertinent to the Atlantic Continental Shelf overall. Certain elements of this work are relevant to the area offshore of Georgia. The most recent data pertinent to offshore Georgia are derived from a survey conducted offshore in June, 1985 in which 26 samples were acquired, including 10 vibracore, three of which have been fully processed. In each instance, surface grab samples were obtained at the location of vibracores. Samples were subjected to mechanical classification on shipboard, with a three-turn spiral classifier; the heavy mineral fraction was then subjected to microscopic analysis and heavy media separation, in order to determine total heavy mineral fraction and other characteristics of the sample.

H. U.S.G.S. Office of Marine Geology, Woods Hole, Massachusetts

Contact: Mr. Peter Popenoe, and Dr. Frank Manheim - 617/548-8700

The Woods Hole, MA office of the U.S. Geological Survey has a large data set of both raw and interpreted seismic profiles as well as the database of analyzed shelf grab samples for the continental shelf off Georgia. The raw seismic data has all been released to the public through the National Geophysical Data Center (NGDC) in Boulder, CO, and most of the interpreted data have been published.

Intepreted, but unpublished, seismic data covering the Georgia continental shelf and slope were also located in Woods Hole, held by Peter Popenoe, who was actively working on the analyses of these data. As a large part of these unpublished data were pertinent to the Georgia Shelf investigation, ZW made an appeal for the unpublished data through the joint Department of Interior-State of Georgia Task Force. These data were released in Open-File (Popenoe and Spalding, 1988), and form the basis for compiling the structure contour and isopach maps.

The unpublished data file of analytical data on Georgia shelf grab samples used in this report was also obtained from the USGS Woods Hole office.

# ATTACHMENT "A"

## GEORGIA OFFSHORE MINERAL ASSESSMENT

## DATA SURVEY FORM

ORGANIZATION:

CONTACT: TEL. NO.:

I Does your organization possess borehole data in the EEZ offshore Georgia? ______

(If answer to above is NO, proceed to Question II.)

A. Type of boring ______

B. Number of borings ______

C. General location of borings ______

D. Average depth of boring ______

E. Geophysical log? ______

   1. Type ______

F. Geological log? ______

   1. Correlations completed? ______

G. Geologic Data Format (hard copy, computer, etc.) ______

H. Sieve analysis ______

I. Heavy mineral analysis ______

J. Phosphorite analysis ______

K. Other mineral analysis (specify mineral) ______

______

L. Have these data been reduced? ______

   1. Maps:

      Type ______

      Scale ______

      Quantity ______

   2. Cross sections:

      Scale ______

      Quantity ______

II Does your organization have bottom grab sample data in the EEZ offshore Georgia? ______

(If answer is NO, proceed to Question III)

A. Approximate number of samples ______
B. General sampling location ______
C. Sieve analysis (specify) ______
D. Heavy mineral analysis ______
E. Phosphorite analysis ______
F. Other mineral analysis (specify) ______

______

G. Data format (Analysis sheets, computer, etc.) ______
H. Have these data been reduced? ______

1. Maps:

Type ______

Scale ______

Quantity ______

2. Cross sections:

Scale ______

Quantity ______

III Does your organization possess samples taken from the EEZ offshore Georgia? ______

(If answer to above is NO, proceed to question IV.)

A. Type ______ Quantity ______
B. Method of preservation and storage ______

______

C. General sampling location ______
D. Typical length ______
E. Diameter ______
F. Storage location ______
G. Have samples been described geologically? ______

1. Method employed ______

H. Have the samples been correlated to geologic strata? ______

IV Does your organization possess geophysical data in the EEZ offshore Georgia? ______________________________

(If answer to above is <u>NO</u>, proceed to Question V.)

A. Type ______________________________

B. Number of surveys ______________________________

C. Length of each survey ______________________________

D. Have the data been interpreted? ______________________________

E. Data storage format ______________________________

F. Format of presentation of interpreted data ______________________________

______________________________

G. Maps:

1. Number ______________________________
2. Scale ______________________________
3. Size ______________________________

H. Cross Sections:

1. Number ______________________________
2. Scale ______________________________
3. Size ______________________________

V Has your organization integrated interpreted data of various types for presentation concerning the EEZ offshore Georgia? ______________

(If answer to above is <u>NO</u>, proceed to Question VI.)

A. Location ______________________________

B. Maps:

1. Number ______________________________
2. Scale ______________________________
3. Size ______________________________

C. Cross Sections:

1. Number ______________________________
2. Scale ______________________________
3. Size ______________________________

VI Does your organization possess any unpublished papers (i.e., theses or dissertations) pertaining to the EEZ offshore Georgia? ________
(If answer to above is NO, proceed to Question VII.)

A. Method of access ________
B. Type(s) ________
C. Titles & Authors (please list)

VII Is your organization, or staff, aware of any other data concerning the EEZ offshore Georgia? ________

A. Identify ________
  1. Type ________
  2. Location ________
  3. Contact ________
  4. Publication ________
B. Description of data ________
________

**Please submit this completed questionnaire to:**

Mr. Thomas P. Oxford
Zellars-Williams Company
P. O. Box 2008
Lakeland, FL

Phone: 813/665-2194

# SECTION 3

# RESOURCES OF THE GEORGIA CONTINENTAL SHELF

## 3.1 INTRODUCTION

Georgia's present-day coast is characterized by tidal inlets and sand shoals associated with numerous barrier islands. The barrier islands tend to be broad nonlinear features unlike the long, narrow islands bordering the Florida coast. This development is due to heavy river sediment loads and coastal energy input favoring constructional rather than erosional features (Pirkle, 1970; Swift, et al, 1972). Oertel and Howard (1972) discuss, in detail, shoal development and morphology on the Georgia coast. Shoals extend two to four miles seaward of estuary entrances at major tidal inlets. Formation and maintenance of these shoals is due to generation of sediment circulation cells which result from dynamic dispersion of tidal and transient currents (Oertel, 1972).

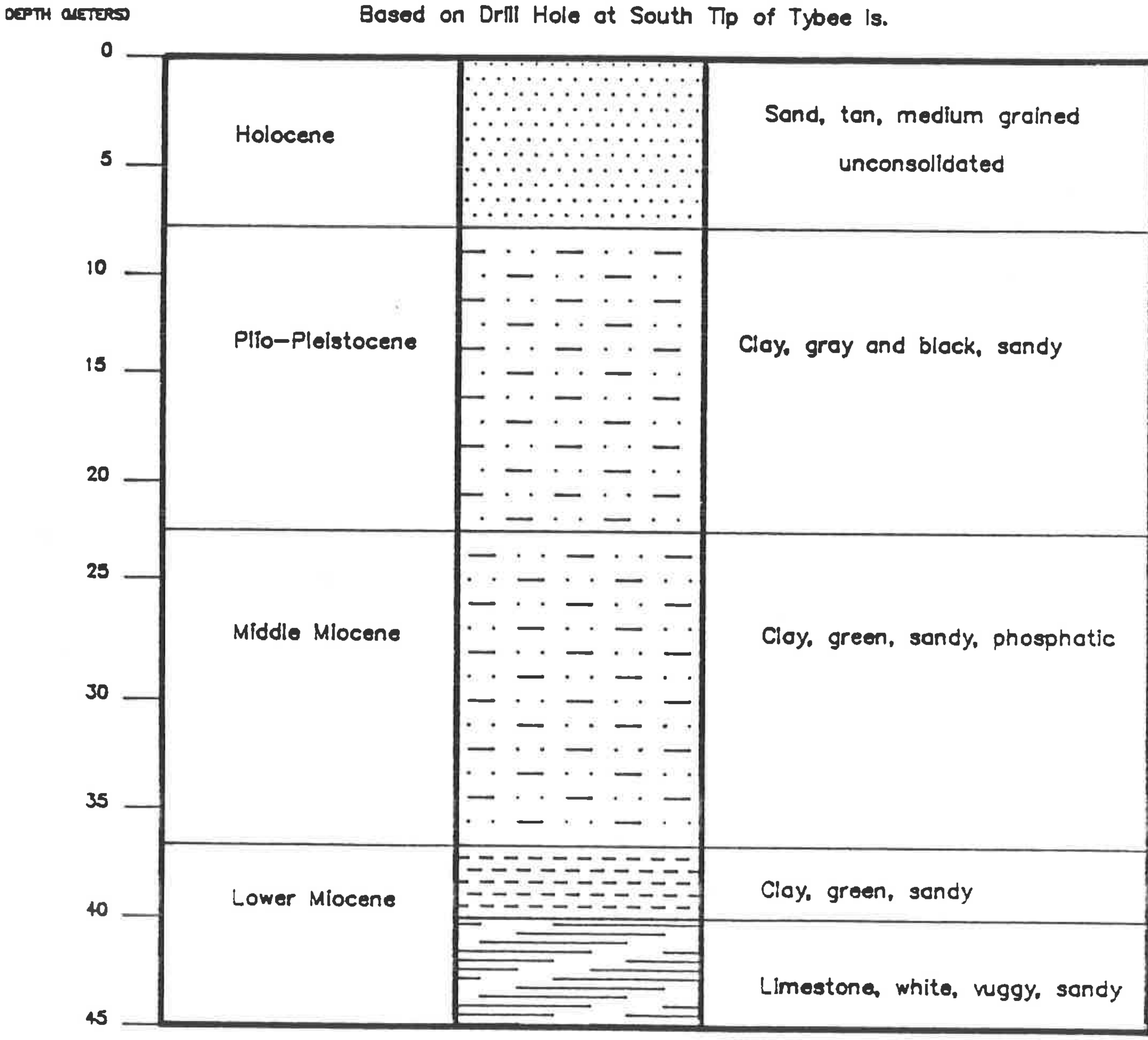
Off of Georgia, the continental shelf extends seaward from the barrier islands between 100 and 200 kilometers to the shelf break where the ocean depth is about 60 meters. Near barrier islands top sediments are generally fine-grained Holocene sands that thin seaward (Foley, undated). Beyond these fine-grained deposits, more coarsly-grained sands, believed to be primarily of fluvial origin, become typical. This textural change occurs at water depths of about 14 meters (Kellam, 1981). Today's shelf morphology and topography resulted from modification of coastal features formed at previously lower sea levels (Swift et al, 1972).

Figure 3.1 shows generalized stratigraphy for the region. For more detailed discussions the reader is referred to Henry and Kellam (1987), Kellam (1981), and Popenoe (1986). Henry and Kellam (1987) provide a good general overview of the geology of the Georgia coastal plain and continental shelf. Discussions include regional structural features, the Floridan Aquifer, and regional stratigraphy. Greater detail related to the Miocene is given by Popenoe (1986).

Figure 3.1

GENERALIZED STRATIGRAPHY

Based on Drill Hole at South Tip of Tybee Is.



## 3.2 DATABASE

### 3.2.1 Purpose and Scope

The database for the Georgia offshore resource assessment study is to be used for making estimates of quantity and quality of potential resources and to identify targets for further exploration. In order to accomplish this goal, the database must be easy to access and manipulate, and must provide the means for input and integration of new data as they become available.

Potential resources of the Georgia continental shelf are economic heavy minerals and phosphorite. Data relevant to these two types of deposits can be grouped into two general categories: geological and analytical. Geological refers to data that relate to the thickness and structure of stratigraphic units. Examples are seismic records and descriptive logs of cores from drill holes. Analytical data are derived by laboratory procedures that quantify mineral or chemical constituents, determine percentage of grains within specified size ranges, or determine sediment age by paleontological or other methods. Analytical data serve to verify interpretations of geological data, and they facilitate economic evaluations of mineral resources. Analyses are conducted on cores from drill holes and on grab samples of ocean bottom sediments.

Commercially economic concentrations of phosphorite can occur in Middle Miocene strata, and heavy minerals have been observed in grab samples of Quaternary sediments from the ocean floor. Since seismic interpreted data provide thicknesses of and depths to geologic strata of interest, they are useful for preliminary assessment of both phosphorites and heavy minerals. When these interpreted seismic data are digitized into a computerized geologic model they provide a means for estimating phosphorite source bed and overburden thicknesses, and heavy mineral sand deposit thickness. Because of the paucity of available analytical data from core drilling, there are gross limitations to the reliability of such estimates. Vertical and horizontal distributions of phosphorite within Middle Miocene strata cannot be determined without abundant core analysis data. Likewise, although grab sample analyses are available, there are on four published vibracore analyses within the study area (Ayers, 1977) to make reliable predictions of heavy mineral vertical distributions in Quaternary sediments.

The available data for this assessment study are adequate for making only gross estimations of resource quantities. The great value of existing data is that it provides a sound and essential basis for identifying targets for further exploration.

Zellars-Williams has integrated the unpublished analytical database into a usable database format. These data come from two primary sources, as follow:

- o interpreted and annotated seismic profiles provided by Peter Popenoe of the U.S. Geological Survey (Popenoe and Spalding, 1988), and

- o tabulated grab sample analyses jointly obtained by the U.S. Geological Survey and Woods Hole Oceanographic Institution (Hathaway, 1971).

Targets for further exploration have been identified by the preparation of maps using data from this database and from review of published reports. Once target locations for heavy minerals and phosphorite were established, hypothetical models of economic deposits were placed at the target locations to establish the economic feasibility of mining at these locations if, by intensive core sampling, the deposits are proven to exist.

### 3.2.2 Database Structure

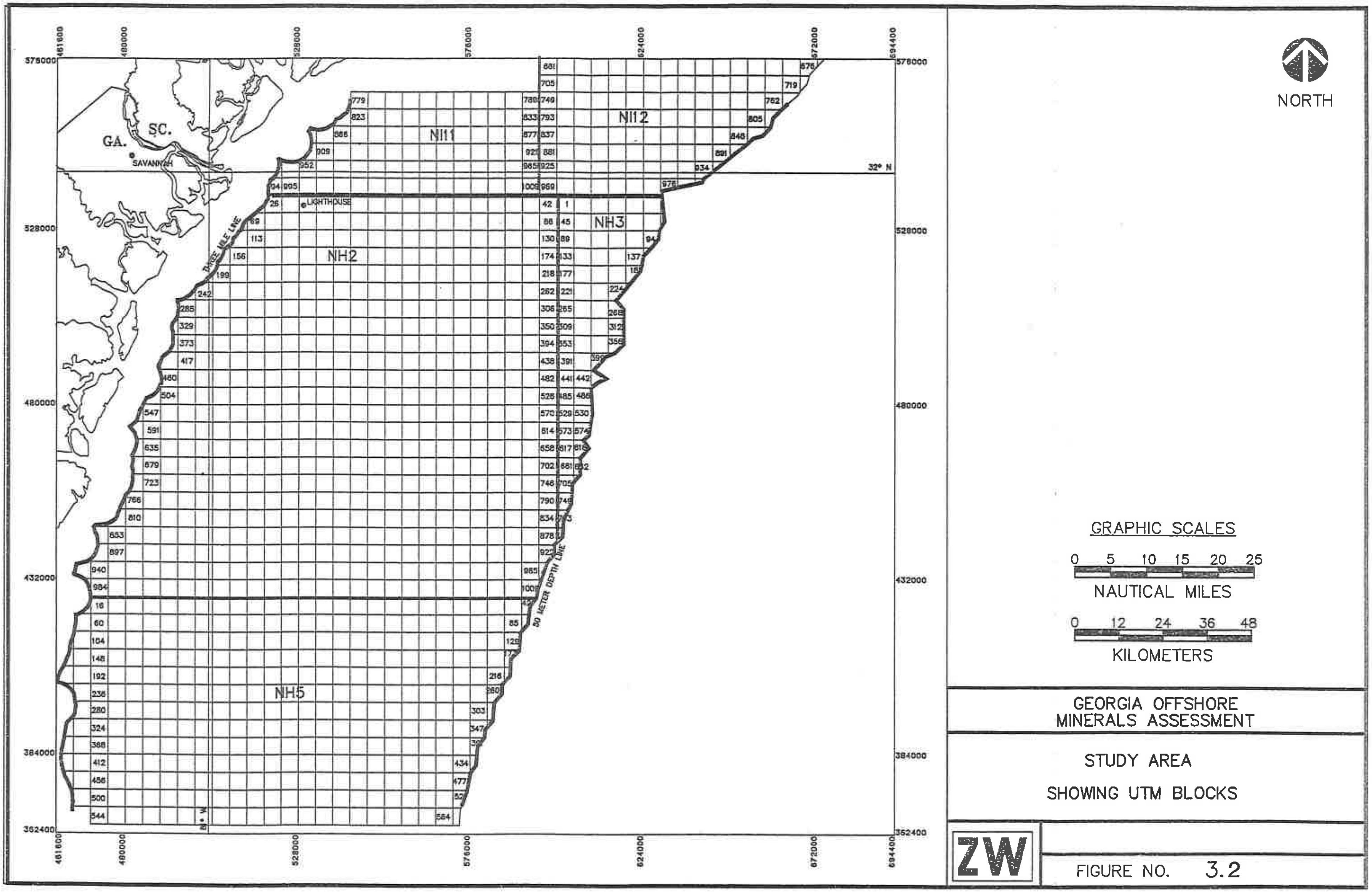
The database prepared by Zellars-Williams contains two separate and distinctly different type of data. The first type is composed of the tabulated analytical data from Hathaway (1971). These quantitative data relate to particle size characterizations, gross mineralogy, heavy mineral concentrations and grab sample locations. For each grab sample location, 45 identified fields of data have been provided for in the database. Fields include those recommended by Grosz and Escowitz (1983), as well as others. The 45 fields are as follow:

1) Sample I.D.
2) Latitude
3) Longitude
4) UTM North
5) UTM East
6) Depth
7) Wt. % Gravel
8) Wt. % Sand
9) Wt. % Silt
10) Wt. % Clay
11) Quartz
12) Potassium Feldspar
13) Plagioclase Feldspar
14) Heavy Minerals
15) Phosphorite
16) Magnetite
17) Ilmenite
18) Apatite
19) Monazite
20) Rutile
21) Zircon
22) Sillimanite
23) Kyanite
24) Staurolite
25) Leucoxene
26) Titanite
27) Mica
28) Garnet
29) Epidote
30) Tourmaline
31) Glauconite
32) Sphene
33) Sulfides
34) Phosphate
35) Amphibole
36) Limonite
37) Zoisite
38) Augite
39) Hypersthene
40) Anadalusite
41) Spinel
42) Dumortierite
43) Glaucophane
44) Hornblende
45) Aegerite

Data for all of these fields are not presently available for the Georgia continental shelf. Edit, retrieve, input and report writing functions have been developed to key on sample number, location, and location ranges. Data entry windows, menus and retrieval queries facilitate these functions for user friendliness. Standard report formats have been developed and ADVANCED REVELATION permits specialized reports to be easily developed by the user.

The second type of data contained in the database is derived from the three-dimensional computer model (Section 3.3) developed for the Georgia offshore area. From the computer model, data were retrieved and stored for each UTM block within the OCS blocks of the study area, as shown in Figure 3.2. Each block is described by its boundary and geographical center-point, both in latitude and longitude and in the AMS coordinate system. The data for each OCS block consist of 25 fields grouped under major headings, as follows:

o Location and area
  - oo Area
  - oo UTM East coordinate of block center
  - oo UTM North coordinate of block center
  - oo Latitude of block center
  - oo Longitude of block center




GEORGIA OFFSHORE MINERALS ASSESSMENT

STUDY AREA SHOWING UTM BLOCKS

ZW

FIGURE NO. 3.2

- o Ocean floor character
  - oo Weight percent gravel
  - oo Weight percent sand
  - oo Weight percent silt
  - oo Weight percent clay

- o Stratigraphy and bathymetry
  - oo Water depth
  - oo Quaternary thickness
  - oo Pliocene thickness
  - oo Upper Miocene thickness
  - oo Middle Miocene thickness
  - oo Lower Miocene thickness
  - oo Middle Miocene bottom structure
  - oo Overburden thickness (thickness of stratigraphic units overlying Middle Miocene)

- o Major heavy minerals on ocean floor
  - oo monazite
  - oo rutile
  - oo staurolite
  - oo titanite
  - oo zircon

- o Gross mineralogy
  - oo quartz
  - oo heavy minerals
  - oo potassium feldspar
  - oo plagioclase feldspar
  - oo phosphorite.

There are no provisions for input of new data for the second data type because such provisions would result in inappropriate mixing of raw and modeled data. Menus have been developed to access retrieval utilities and generate reports concerning the modeled database.

Included with this report (Appendix A) are hard copies of both the raw and modeled databases. In addition, these data, on magnetic media, accompany the report to the Georgia Geologic Survey. Raw data have two magnetic media forms: ASCII files for input into the Georgia Geologic Survey's prime computer and REVELATION database files. Modeled data are in ASCII format accessible through REVELATION and specialty access programs developed by Zellars-Williams.

## 3.3 MODEL CONSTRUCTION

ZW uses the EAGLES-PC software to develop numerical models for natural resource evaluations. The EAGLES-PC program, GRID, provides the capability to produce regular grids from randomly-spaced data points. One grid is produced for each physical and analytical parameter to be evaluated. The grid consists of rows and columns with a calculated numerical value at each intersection. These grids are used to produce maps, cross-sections, volumetric calculations, mine plans, mining sequences, blending and stockpiling alternatives, product quality forecasts, and operating cost evaluations.

There is a virtually unlimited set of equations and parameters to be used to calculate the grid from the data points. For the Offshore Georgia Minerals Assessment project, ZW studied several different sets of equations and parameters prior to selection of the set which provided the best fit with the raw drill-hole data. In general, the selected set is defined as follows:

- Eliptical linear inverse distance weighting
- Anisotropic angle of 140 degrees
- Anisotropic factor of 5
- Direct assignment distance of 240 meters
- Maximum search distance of 48,000 meters
- Extrapolation distance of 22,000 meters
- Minimum number of points for gridding is 2
- Fixed sectors used
- Selection for gridding by number sector
- Number of points per sector is 2

- o Number of sectors is 8
- o Shadow angle is 10.0 degrees
- o Deterministic weight function applied to power of 0.5.

Grids can also be produced using an EAGLES-PC program called GENGRD. As the name implies, this program generates grids from digitized contour files. Creation of new grids by operations involving original grids is accomplished in GRDMOD (GRID MODification). Grid-to-grid operation capabilities consist of modifications based on:

- o Intersections
- o Unions
- o Targets
- o Operands
- o Constants
- o Addition
- o Subtraction
- o Multiplication
- o Division
- o Identity
- o Lower values
- o Upper values
- o Basement limits
- o Ceiling limits
- o Data extensions

### 3.3.1 Geological Model

The study area geologic model contains nine grid files, as follows:

- o Thickness of:
  - Quaternary
  - Pliocene
  - Upper Miocene
  - Middle Miocene
  - Lower Miocene
- o Bathymetry
- o Structural countour - elevation of the base of Middle Miocene
- o Overburden thickness
- o Total depth to phosphate matrix.

Thickness grids for individual stratigraphic units were created from discrete point data using the GRID program. Point data were scaled from interpreted, high-resolution, sparker seismic strip charts provided by the U.S. Geological

Survey. Thicknesses were scaled assuming the seismic velocity for sea water (1500 meters per second) for the entire thickness. Some of the data points in the northernmost part of the study area came from Gilliss lines 1-P, 7-P, and 9-P. The majority of data points, however, are from FAY lines 23, 24, 25, 26, 27, and 28. Figure 3.20, at the end of Section 3, shows all of the data points used to create the geological model.

The bathymetry grid was produced using GENGRD. Contours were digitized from several U.S. Geological Survey-National Oceanographic Survey topographic-bathymetric maps that cover the study area.

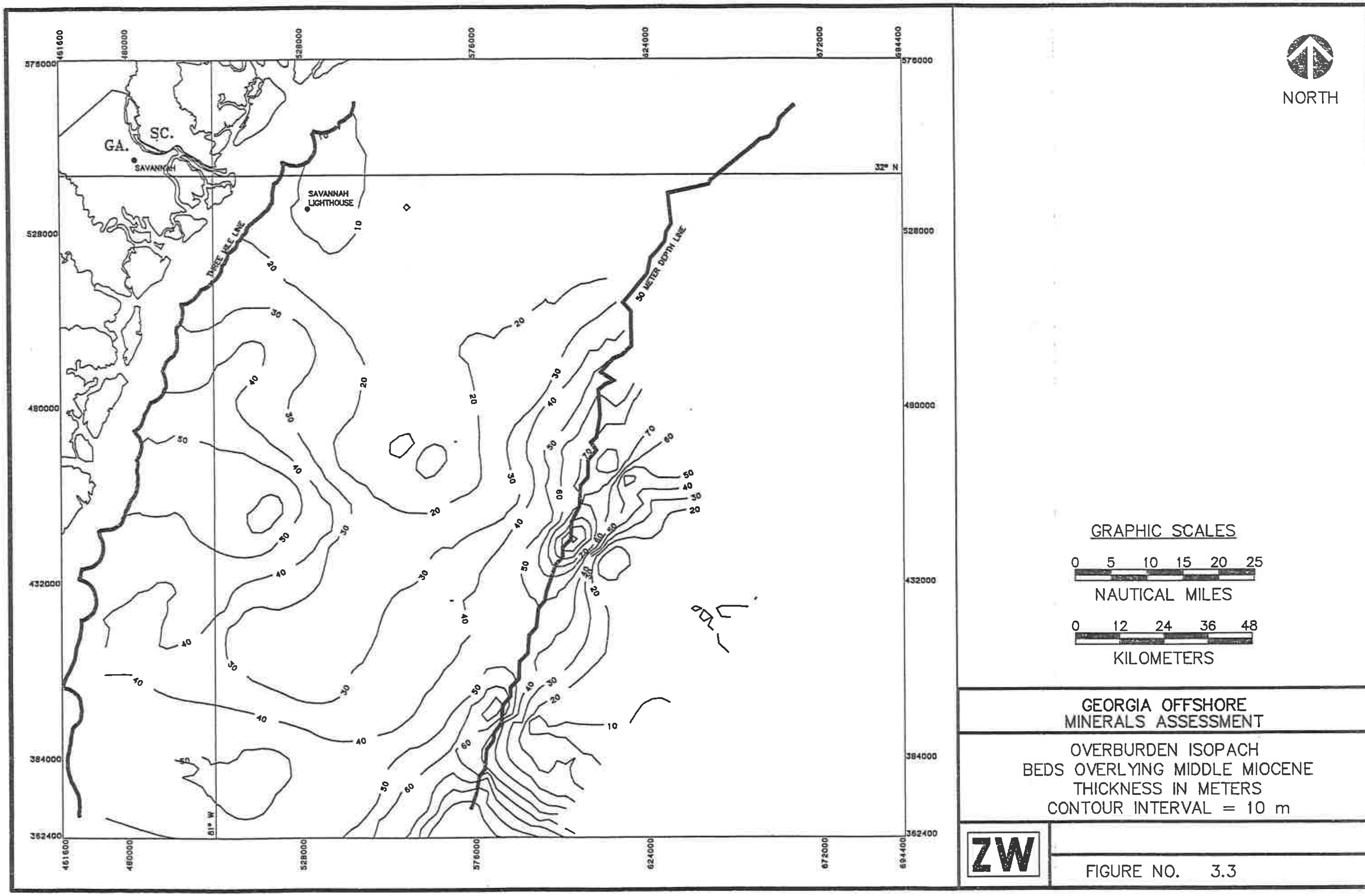
Grids of overburden thickness, total depth to matrix, and the Middle Miocene base structure were produced in GRDMOD. Overburden thickness (Figure 3.3) is the sum of Quaternary, Pliocene and Upper Miocene thicknesses (Figures 3.4, 3.5, and 3.6, respectively). Total depth to ore (Figure 3.7) is the sum of bathymetry (Figure 3.8) and overburden thickness. The base structure (elevation) contour grid for the Middle Miocene (Figure 3.9) was generated by summing bathymetry, overburden thickness and Middle Miocene (Figure 3.10) thicknesses and multiplying this sum by a negative one.

### 3.3.2 Analytical Model

The analytical model of the study area was built using sample mineralogical and grain size analyses data files listed in Hathaway 9971). This database is very extensive in terms of both area covered and number of constituents analyzed. However, since the database results from analysis of grab samples of surficial deposits it relates only to the locating of a hypothetical heavy mineral deposit. It is not relevant for development of a phosphorite deposit model in Middle Miocene strata. To remain within the scope of this study, only sample points within the Georgia ACS study area were considered, and only those constituents relevant to evaluation of economic minerals were modeled.

Grids were created from discrete data points for thirteen different constituents. These constituents are summarized below under their respective data file code lines and the approximate number of data points used within the study area. Data file code lines used here are those presented in Hathaway (1971) and are not related to the database prepared in conjunction with this report. They are included here for reference.

GOSOVBDN

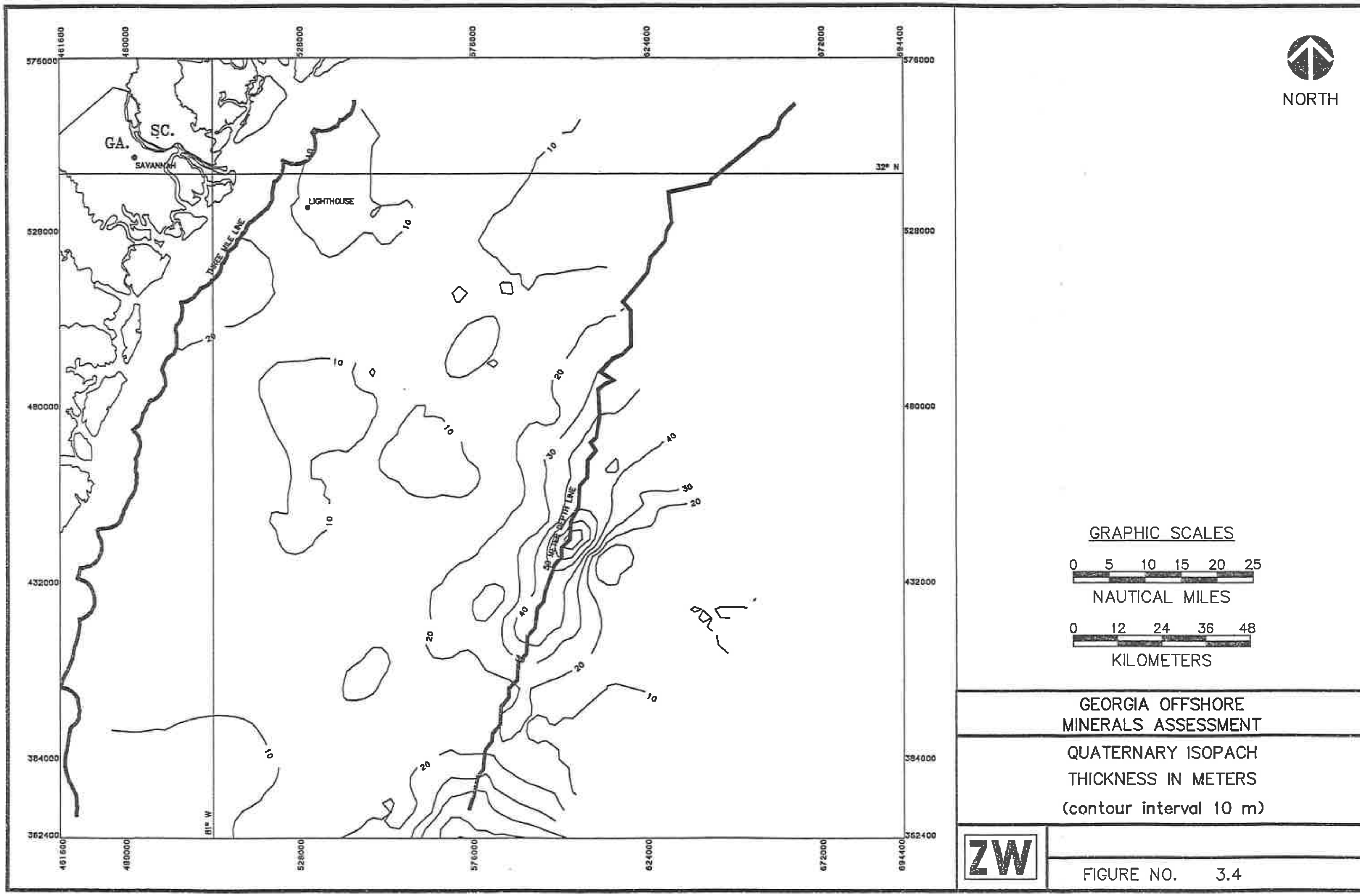



**GEORGIA OFFSHORE**
**MINERALS ASSESSMENT**

OVERBURDEN ISOPACH
BEDS OVERLYING MIDDLE MIOCENE
THICKNESS IN METERS
CONTOUR INTERVAL = 10 m

ZW

FIGURE NO. 3.3



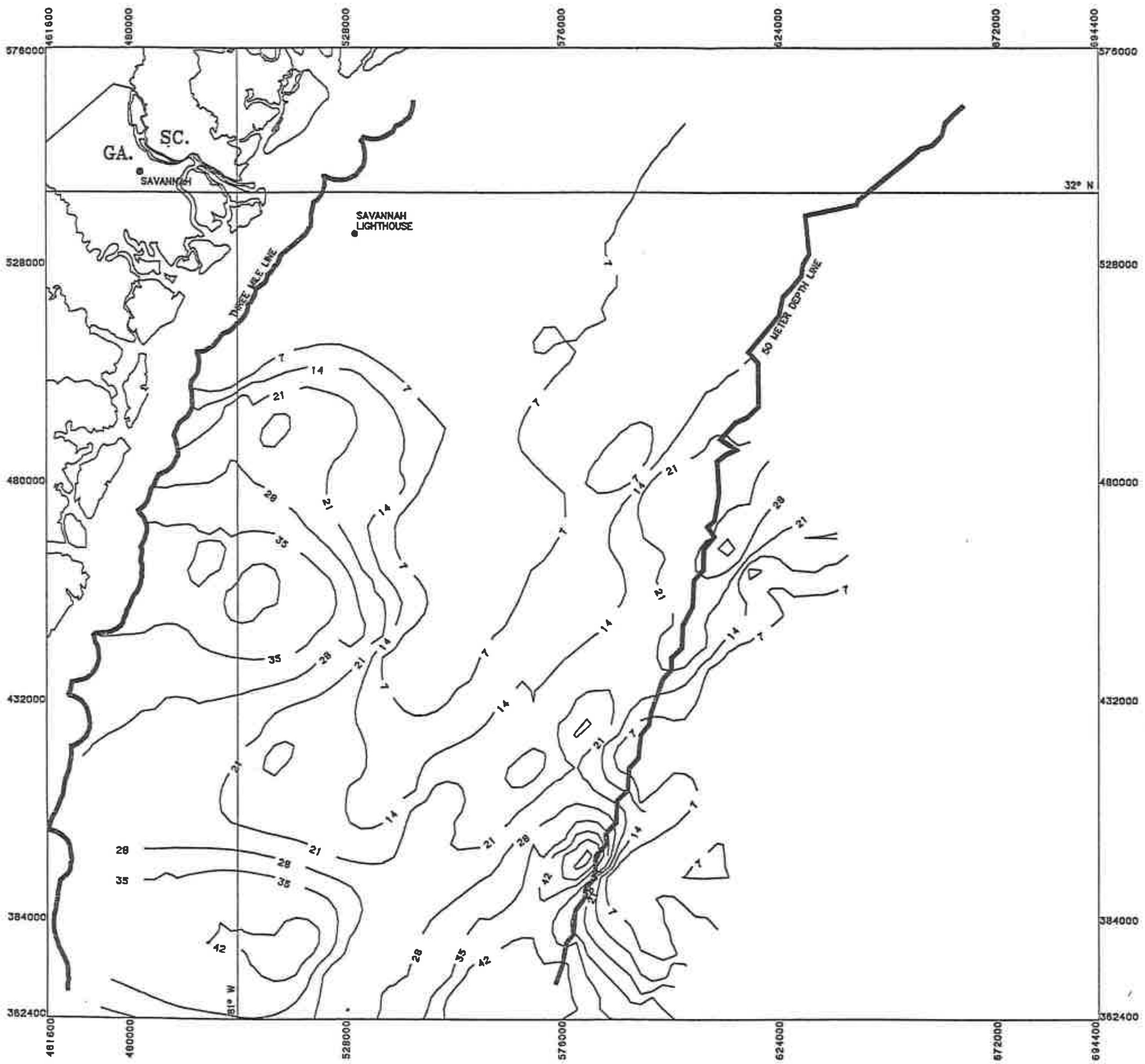

GOSQTK

GEORGIA OFFSHORE
MINERALS ASSESSMENT

QUATERNARY ISOPACH
THICKNESS IN METERS
(contour interval 10 m)

ZW

FIGURE NO. 3.4




GRAPHIC SCALES

NAUTICAL MILES: 0, 5, 10, 15, 20, 25

KILOMETERS: 0, 12, 24, 36, 48

GEORGIA OFFSHORE MINERALS ASSESSMENT

PLIOCENE ISOPACH

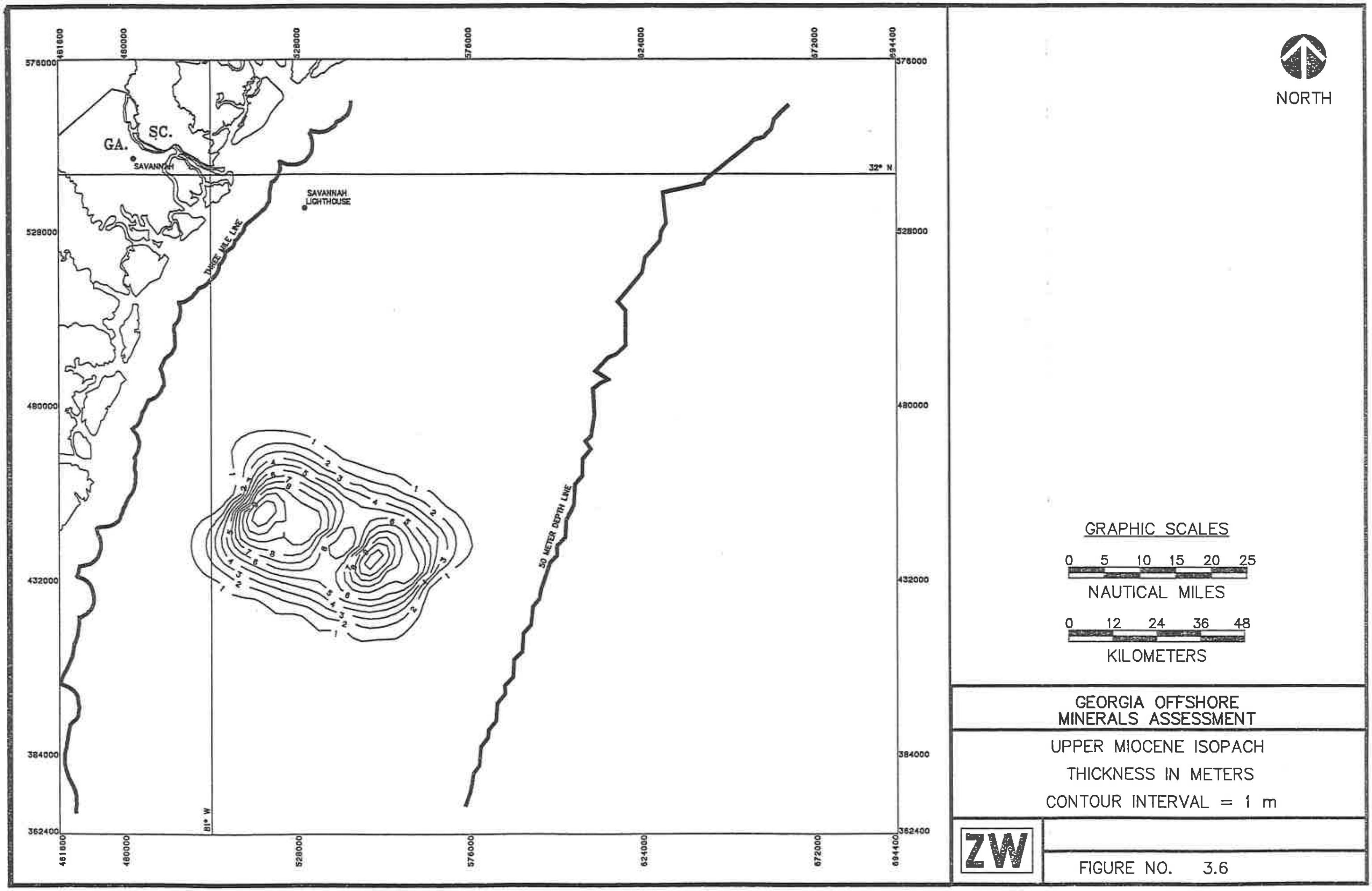
THICKNESS IN METERS

CONTOUR INTERVAL = 7 m

ZW

FIGURE NO. 3.5

GOSPTK




GEORGIA OFFSHORE MINERALS ASSESSMENT

UPPER MIOCENE ISOPACH

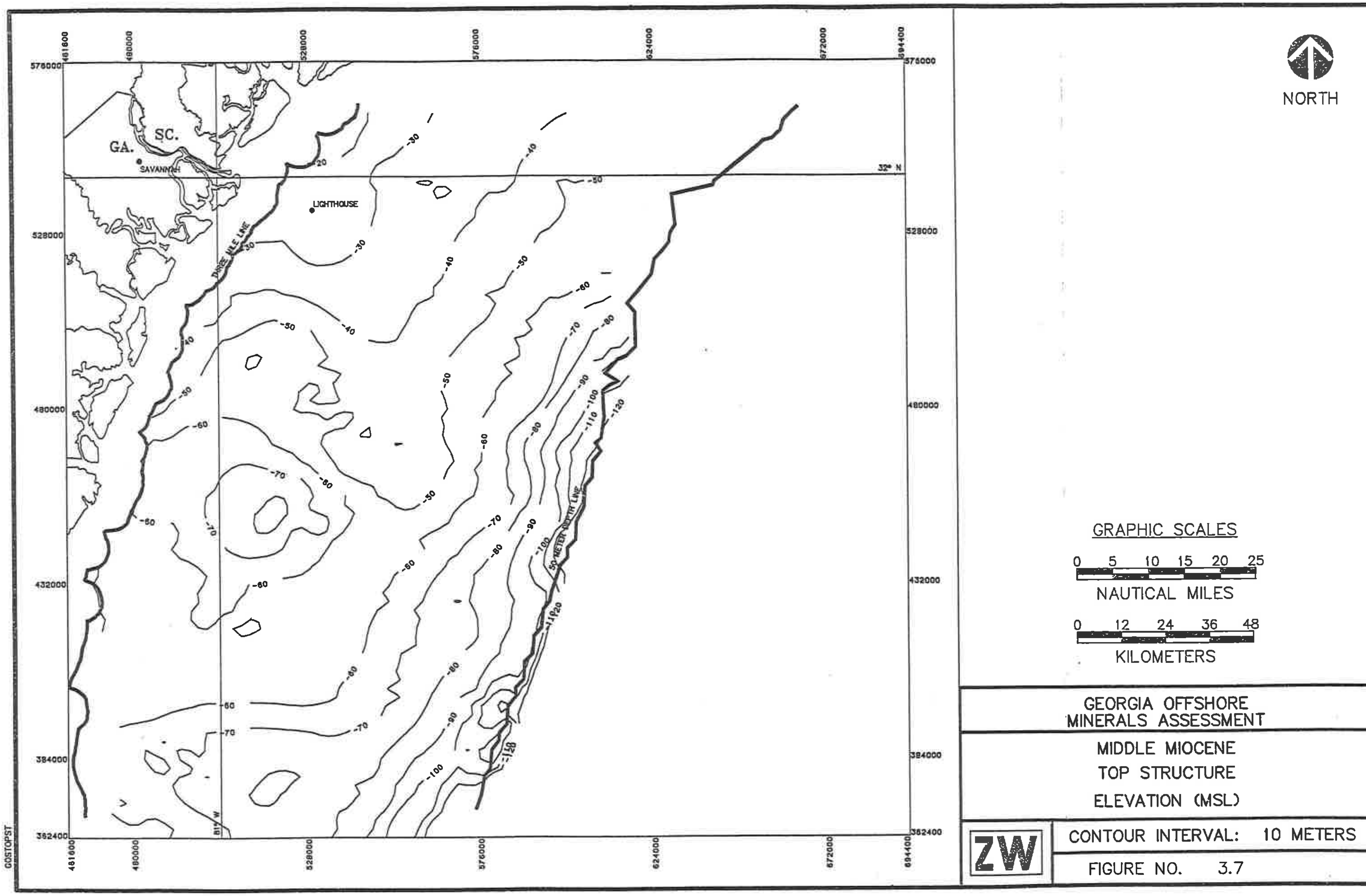
THICKNESS IN METERS

CONTOUR INTERVAL = 1 m

ZW

FIGURE NO. 3.6

GOSPTK



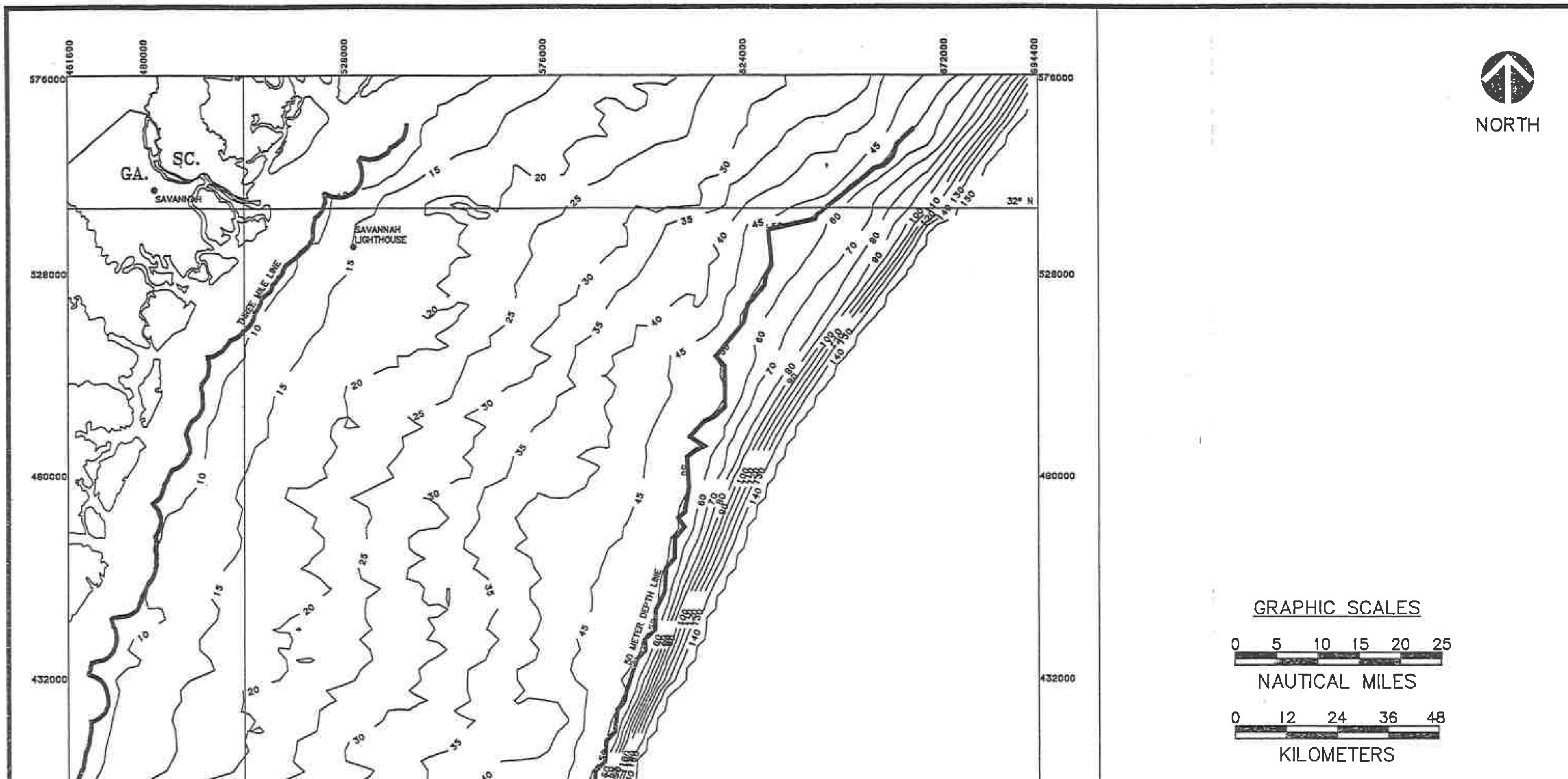

GEORGIA OFFSHORE MINERALS ASSESSMENT

MIDDLE MIOCENE
TOP STRUCTURE
ELEVATION (MSL)

ZW

CONTOUR INTERVAL: 10 METERS

FIGURE NO. 3.7




GEORGIA OFFSHORE MINERALS ASSESSMENT

BATHYMETRY

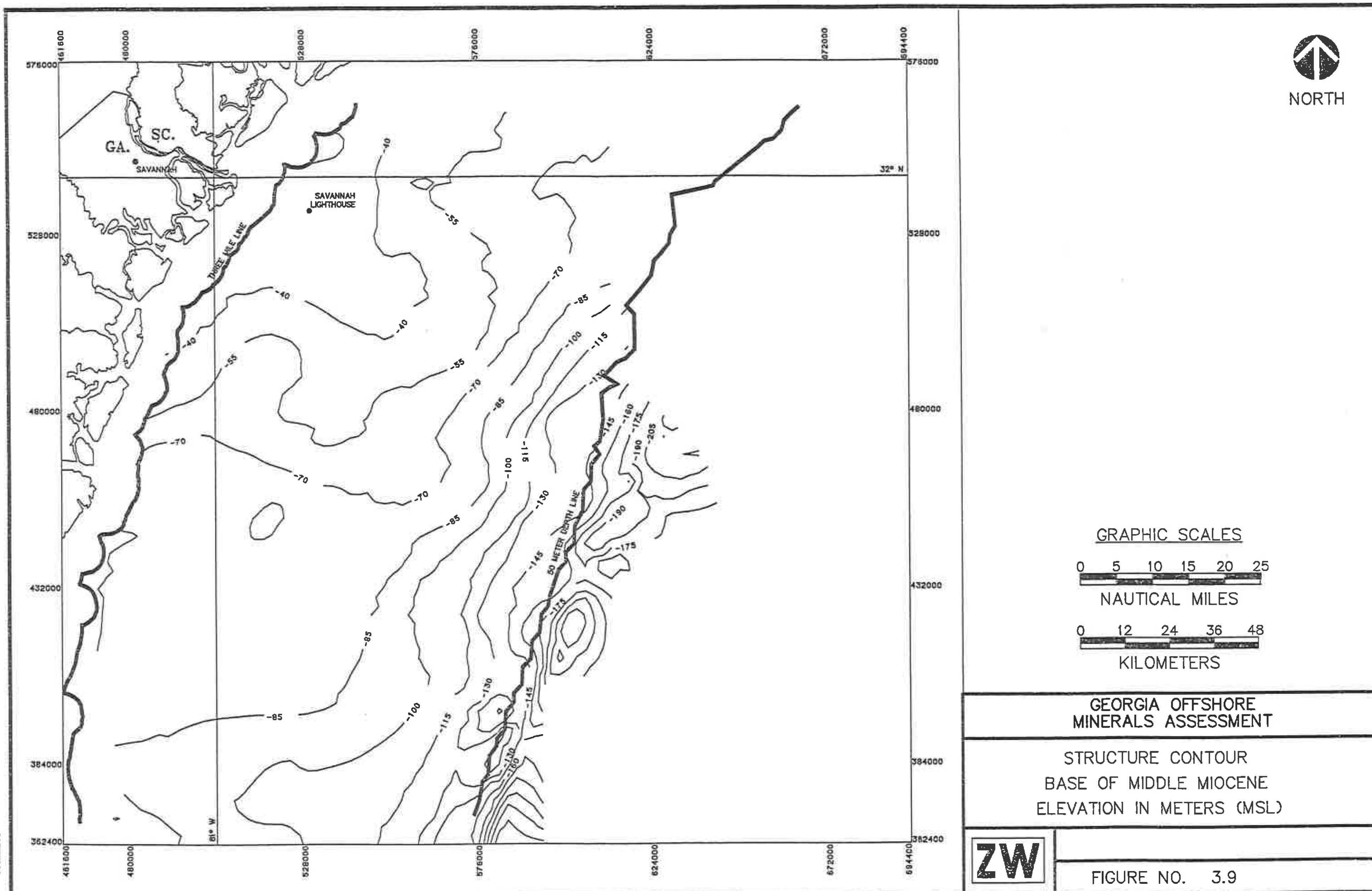
DEPTH BELOW MSL

CONTOUR INTERVAL = 5 & 10 m

ZW

FIGURE NO. 3.8

GOSWATER

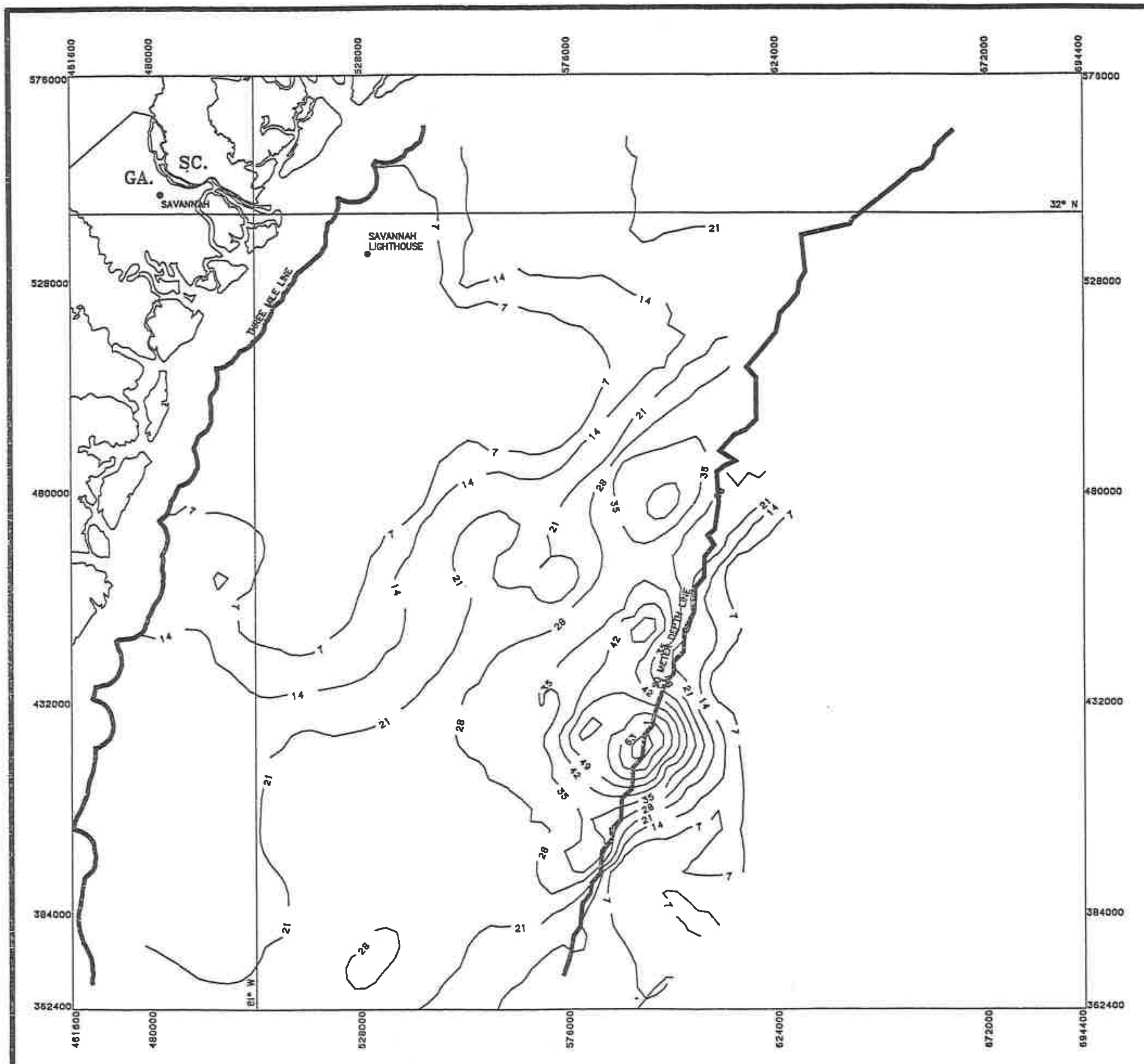



GEORGIA OFFSHORE MINERALS ASSESSMENT

STRUCTURE CONTOUR
BASE OF MIDDLE MIOCENE
ELEVATION IN METERS (MSL)

ZW

FIGURE NO. 3.9




GRAPHIC SCALES

0 5 10 15 20 25
NAUTICAL MILES

0 12 24 36 48
KILOMETERS

GEORGIA OFFSHORE
MINERALS ASSESSMENT

MIDDLE MIOCENE ISOPACH
THICKNESS IN METERS
CONTOUR INTERVAL = 7 m

ZW

FIGURE NO. 3.10

GOSMMTK

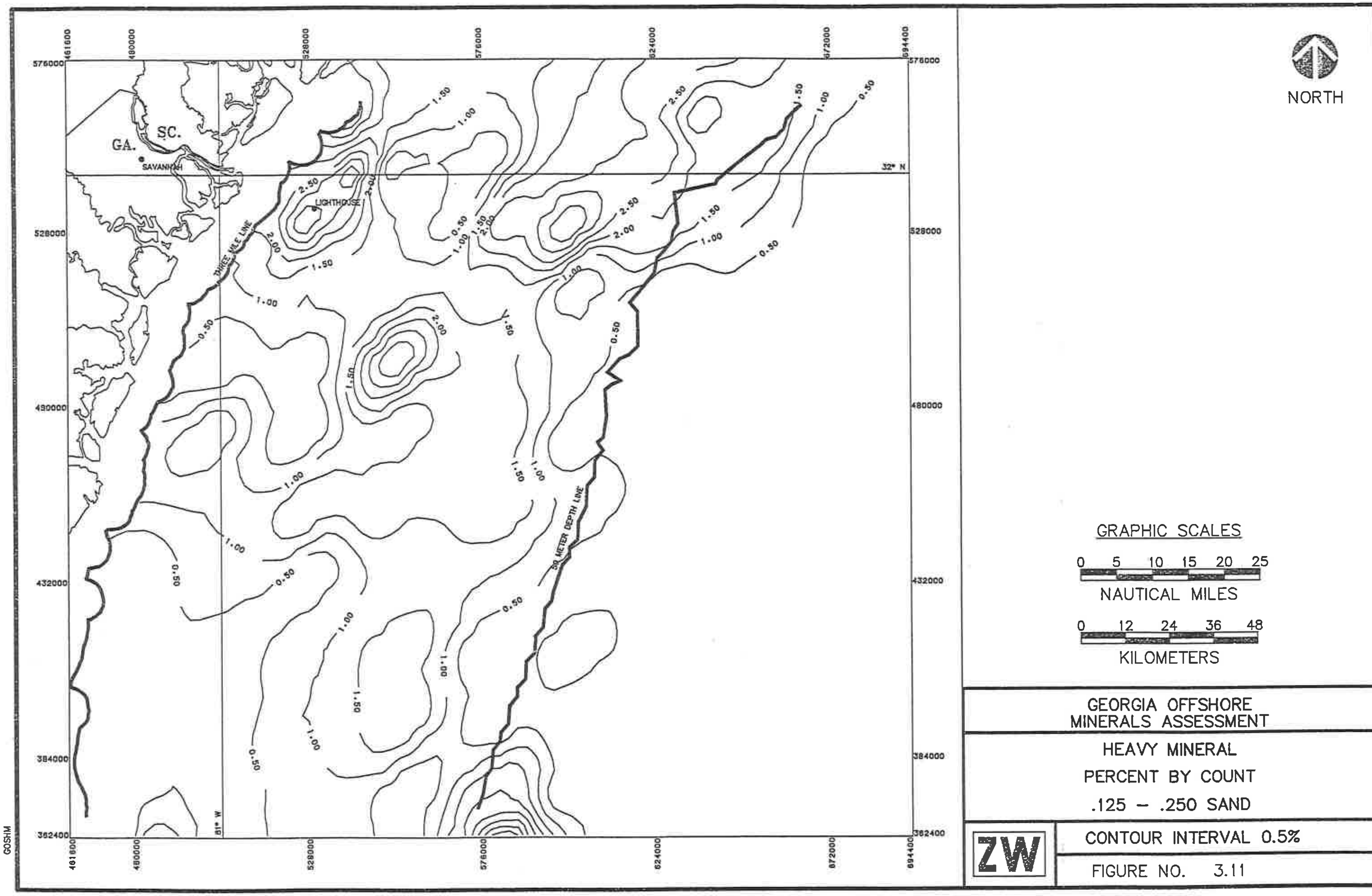
- o Code line 320 - 91 sample points; components given in percent by point count of the fine grain sand fraction (.125-.250 mm)
  - oo Quartz
  - oo Phosphorite
  - oo Potassium feldspar
  - oo Plagioclase
  - oo Heavy minerals

- o Code line 210 - 80 sample points; constituent in percent by weight of total sample
  - oo gravel (greater than 2mm)
  - oo sand (0.062 to 2 mm)
  - oo silt (0.004 to 0.062 mm)
  - oo clay (less than 0.004 mm)

- o Code line 560 - 17 sample points; mineral in percent by weight in the sand fraction (62 um to 2 mm) of the whole sample
  - oo monazite
  - oo rutile
  - oo staurolite
  - oo titanite
  - oo zircon

Figure 3.11 is an isopleth map, built from 91 data points in this database that shows the heavy mineral concentration within the sand fraction. Occurring at water depths between 25 and 40 meters is a linear trend of relatively high heavy mineral concentration (greater than 3%). A detailed bathymetric map (USGS, NOS, 1978) of the study area reveals that within this depth range there are topographic features that could be interpreted as relict sand shoals. Note in Figure 3.12 that between the three-mile line and the 50-meter water-depth contour the sand content is 100%. Development of these features parallels the trend of the higher heavy mineral concentration.

The hypothetical heavy mineral mining location used in this study was selected, in part, because of the distinct heavy-mineral concentration trend seen in Figure 3.11. For this project, this trend has been divided into two parts based on bottom bathymetry and geological interpretations related to




GEORGIA OFFSHORE MINERALS ASSESSMENT

HEAVY MINERAL

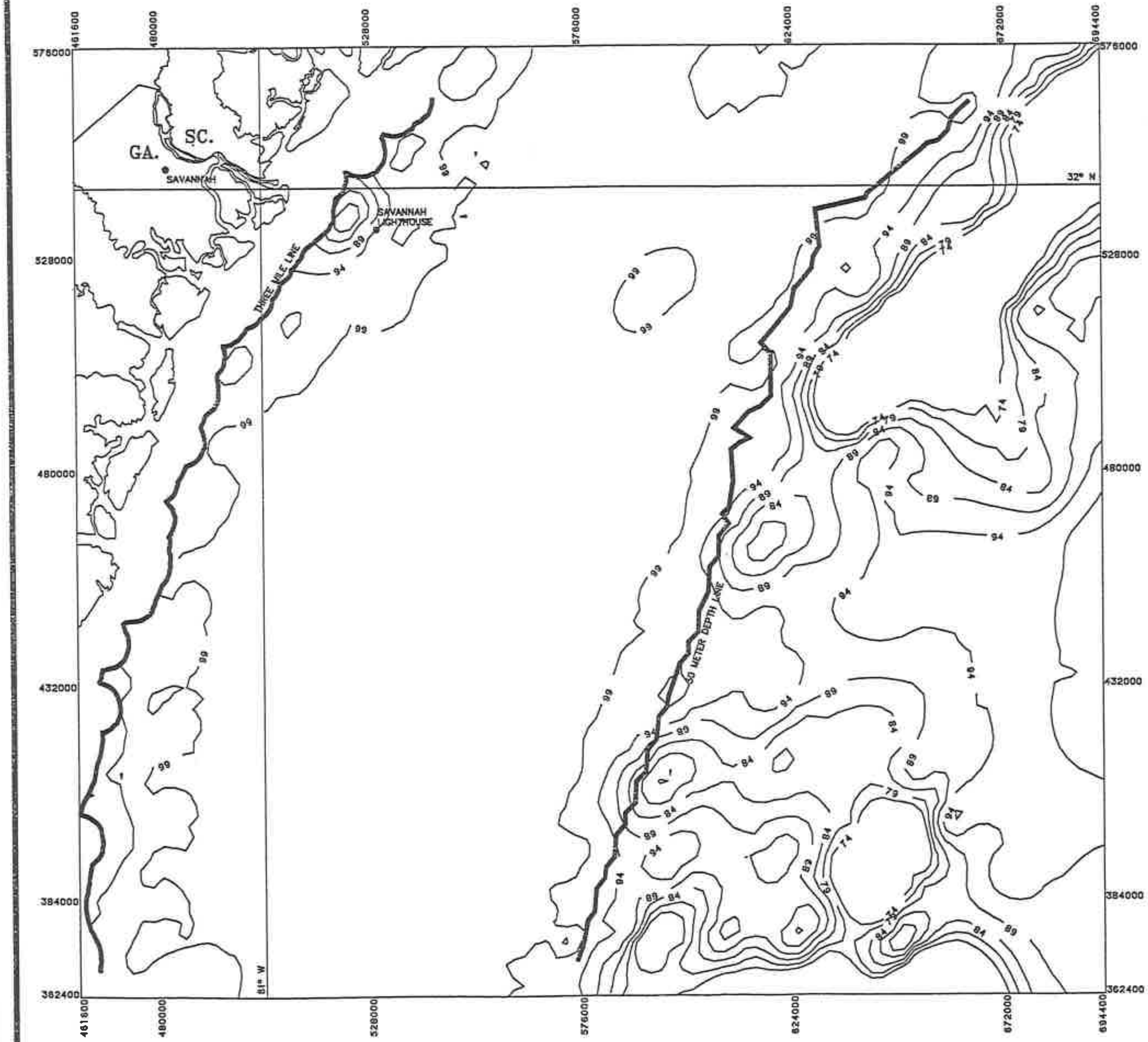
PERCENT BY COUNT

.125 – .250 SAND

ZW

CONTOUR INTERVAL 0.5%

FIGURE NO. 3.11




GRAPHIC SCALES

0 5 10 15 20 25

NAUTICAL MILES

0 12 24 36 48

KILOMETERS

NORTH

GEORGIA OFFSHORE MINERALS ASSESSMENT

SAND
PERCENT BY WEIGHT
OF TOTAL GRAB SAMPLE
CONTOUR INTERVAL = 5 m

ZW

FIGURE NO. 3.12

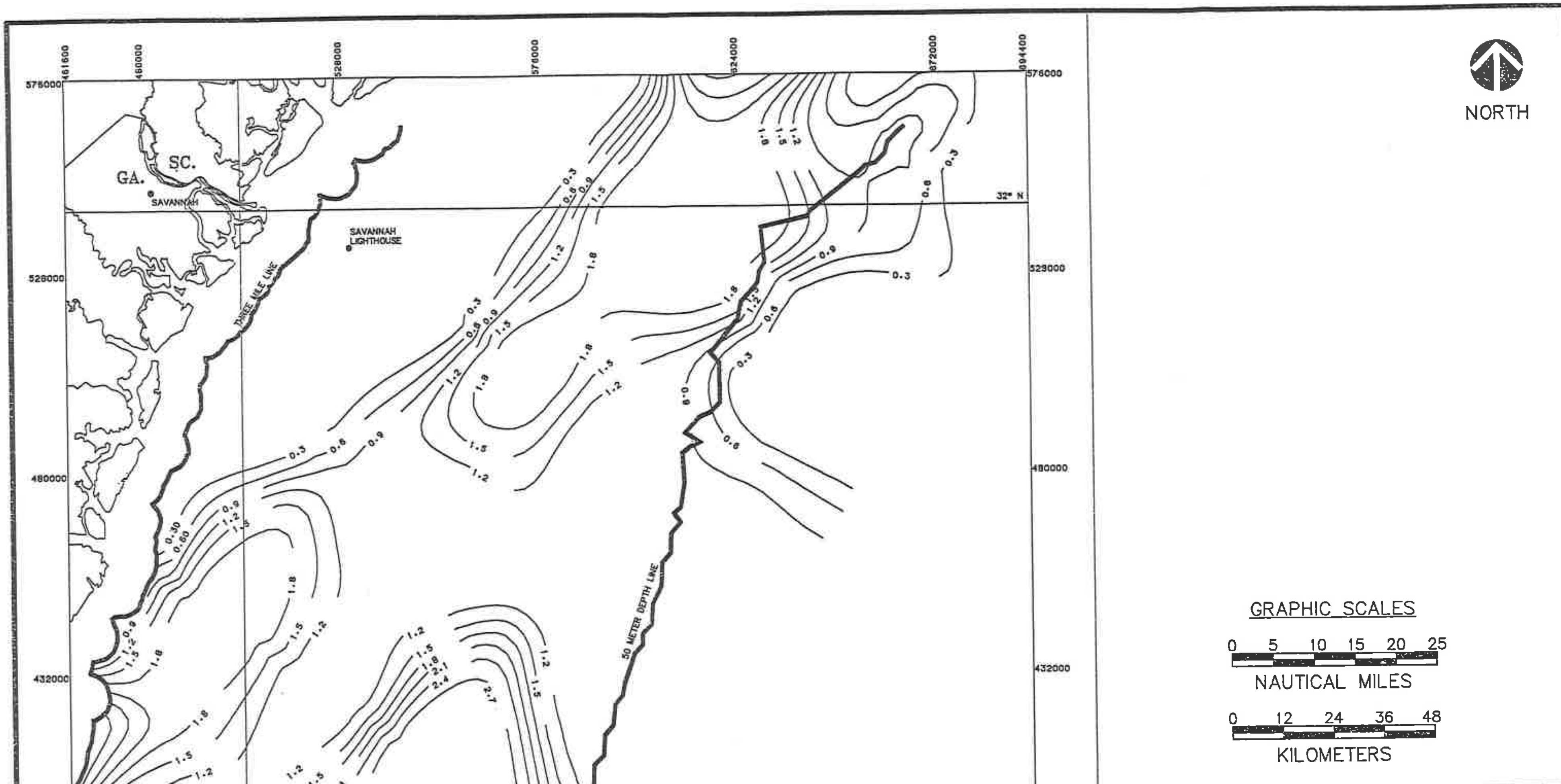
GOSAND

onshore heavy-mineral deposit trends. However distinct this trend is, it must be noted that it is based on grab samples with an average area of influence of 507 square kilometers.

The aforementioned trend is very pronounced using total heavy mineral content and is supported, in general, by trends in the mineral species rutile, monazite, zircon, and staurolite (Figures 3.13 through 3.16). Unfortunately, the mineral species database does not contain a field for ilmenite, and leucoxene is listed under titanite (Figure 3.17). While the trends in the species data approximate the total heavy mineral trend, they do not exactly overlay due to sampling frequency and distribution differences between the data sets. In the area of interest, there are species data at six locations, an average of about 105 kilometers apart. The average area of influence for each site is over 11,000 square kilometers. None of the points lie within the defined heavy mineral trend.

Another notable difference between the two data sets is that the total heavy mineral analyses are percentages of only the fine grained (0.125 to 0.250 mm) sand fraction, while the species analyses are a percent of the total (0.062 to 2.0 mm) sand fraction. Without knowing the heavy-mineral content of sand sizes outside of the 0.125 to 0.250 mm range and the ratio of this size range to total samples, it is not possible to determine in-situ heavy-mineral concentration. If heavy-mineral grains are predominantly in the 0.125 to 0.250 mm size range, then materials outside of this size range decrease the overall in-situ heavy-mineral concentration. Alternatively, in-situ concentration could be the same as, or even higher, than in the 0.125 to 0.250 size range.

In a plan for exploiting East Coast heavy mineral placers, the U.S.B.O.M. (1987) designed a plant to operate aboard a dredge. This plant was designed to recover heavy minerals from sand deposits typical of those found off the coast of Virginia. As designed, material greater than 10 mesh (2 mm) and less than 200 mesh (0.075 mm) would be discarded overboard. It was assumed that only 50 percent of the total material could be eliminated without significantly reducing heavy mineral recovery.




GEORGIA OFFSHORE
MINERALS ASSESSMENT

RUTILE
WEIGHT PERCENT OF HEAVY
MINERALS IN 62um – 2mm SAND
CONTOUR INTERVAL = 0.3 m

ZW

FIGURE NO. 3.13

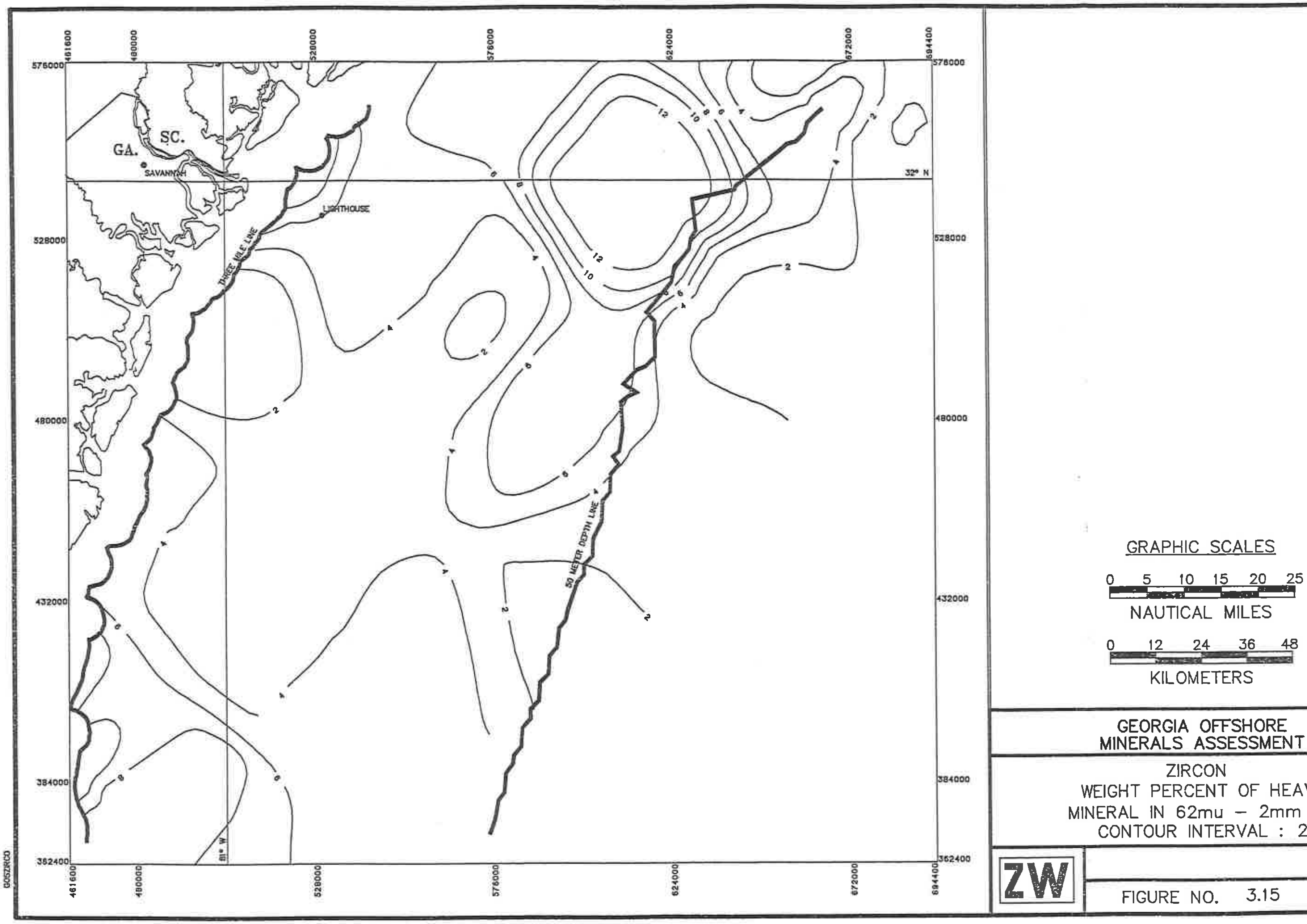
GOSRUTIL


GEORGIA OFFSHORE MINERALS ASSESSMENT

MONAZITE
WEIGHT PERCENT OF HEAVY
MINERALS IN 62um – 2mm SAND
CONTOUR INTERVAL : 0.2%

ZW

FIGURE NO. 3.14

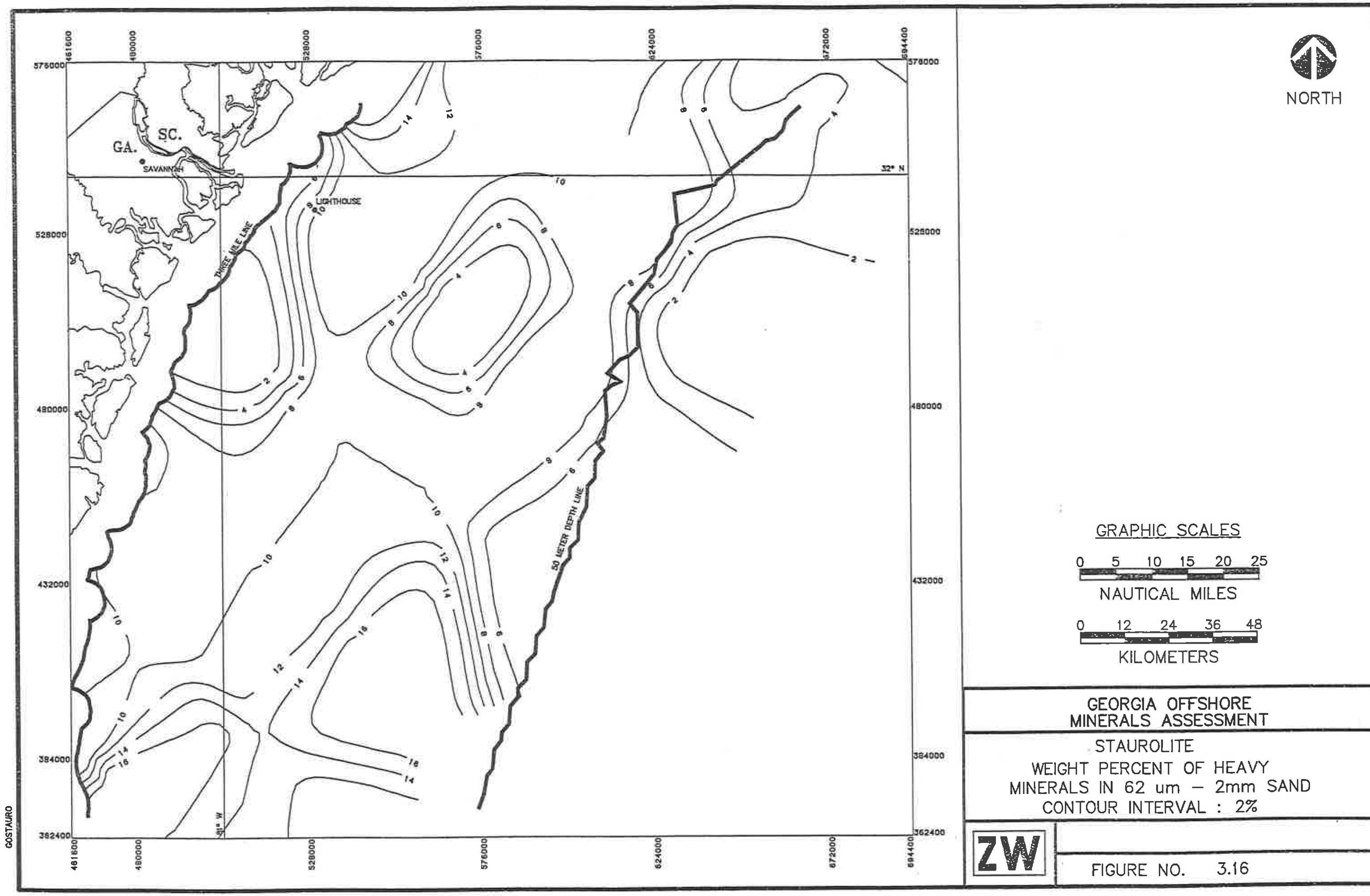



GEORGIA OFFSHORE
MINERALS ASSESSMENT

ZIRCON
WEIGHT PERCENT OF HEAVY
MINERAL IN 62mu – 2mm SAND
CONTOUR INTERVAL : 2%

ZW

FIGURE NO. 3.15

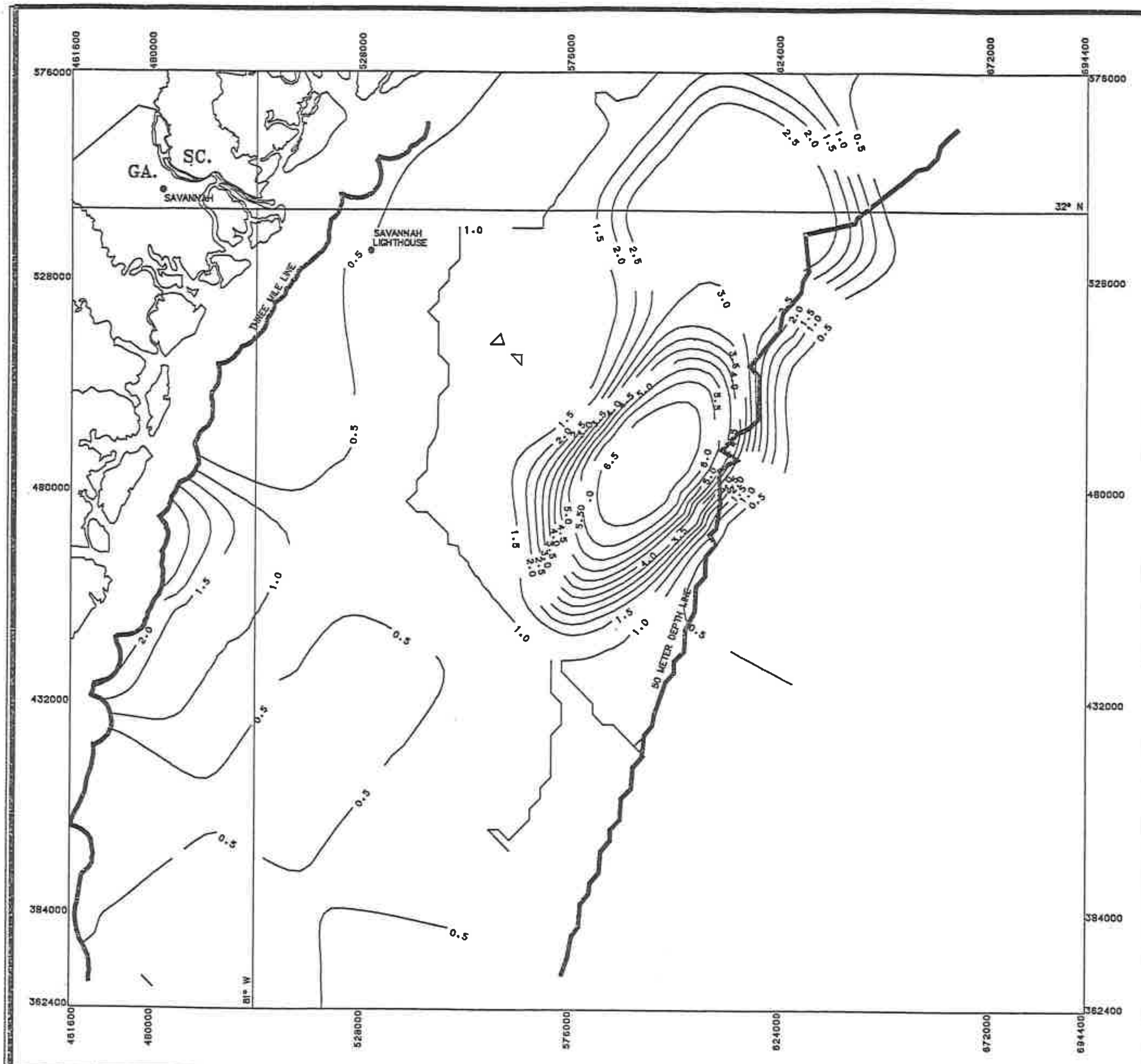



GEORGIA OFFSHORE
MINERALS ASSESSMENT

STAUROLITE
WEIGHT PERCENT OF HEAVY
MINERALS IN 62 um – 2mm SAND
CONTOUR INTERVAL : 2%

ZW

FIGURE NO. 3.16




GRAPHIC SCALES

0 5 10 15 20 25
NAUTICAL MILES

0 12 24 36 48
KILOMETERS

**GEORGIA OFFSHORE MINERALS ASSESSMENT**

TITANITE
WEIGHT PERCENT OF HEAVY
MINERALS IN 62um – 2mm SAND
CONTOUR INTERVAL = 0.5 m

ZW

FIGURE NO. 3.17

GOSTITAN

Pirkle and Yoho (1970) present analyses of twenty surface sand samples of the Trail Ridge type which were selected from localities as far north as southern Georgia, and as far south as central peninsular Florida. In these samples, the heavy minerals tend to be concentrated in the plus 230 to minus 120 mesh (0.062 to 0.125 mm) fraction. Percentages of heavy minerals in total samples were significantly less than in the 0.062 to 0.125 mm fraction.

For the purposes of this study, a hypothetical deposit model has been built using the following assumptions:

- o The mining site has been sized to fit the orebody outline of the Green Cove Springs heavy-mineral deposit in northeastern Florida (Figure 3.18).

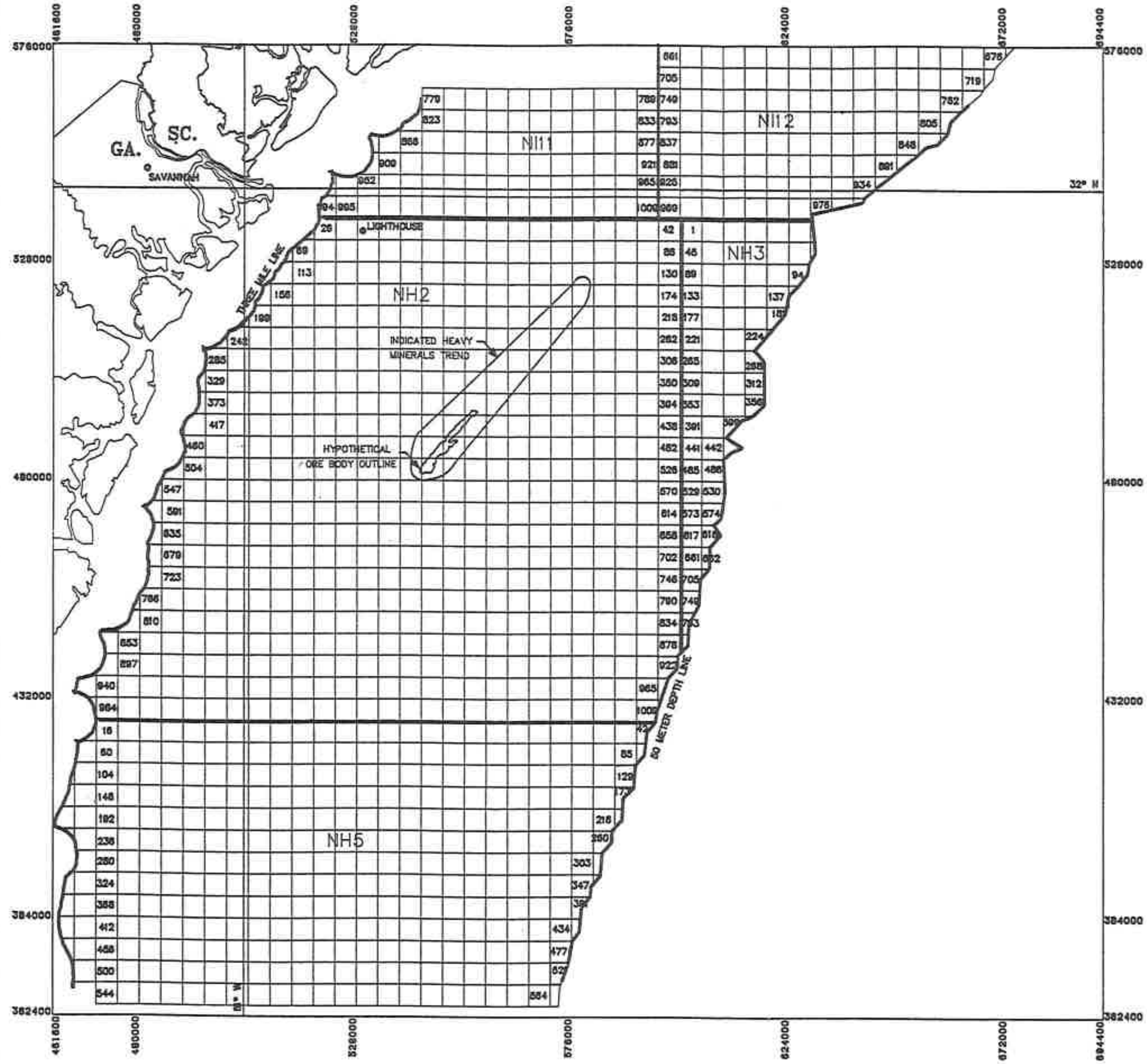
- o Orebody thickness is considered to be the entire thickness of the Quaternary sands within the orebody outline.

- o Species distribution is calculated from U.S.B.O.M. 1987 using annual production estimates for mean grades of mineral species. For annual mining of 5 million short tons the following species recoveries are realized:

| | Tons Recovered | Tons Recovered as Percent of Total Mined | Percent HM Recovery | Tons In-situ | Percent In-situ |
|---|---|---|---|---|---|
| Ilmenite | 221,862 | 4.44 | 83.6 | 265,400 | 5.31 |
| Rutile | 14,119 | 0.28 | 80.8 | 17,500 | .35 |
| Leucoxene | 35,398 | 0.70 | 80.8 | 43,800 | .87 |
| Zircon | 25,994 | 0.52 | 83.6 | 31,000 | .62 |
| Monazite | 6,772 | 0.14 | 83.6 | 8,100 | .17 |

## 3.4 PHOSPHORITE POTENTIAL

Zellars-Williams' (1978) report on known occurrences of phosphate deposits in Georgia, North Carolina and South Carolina was prepared for entry into the U.S. Bureau of Mines' Minerals Availability System. Data were collected from known literature, mineral interests previously




NORTH

GRAPHIC SCALES

0 5 10 15 20 25

NAUTICAL MILES

0 12 24 36 48

KILOMETERS

GEORGIA OFFSHORE
MINERALS ASSESSMENT

HYPOTHETICAL
HEAVY–MINERAL DEPOSIT
LOCATION

ZW

FIGURE NO. 3.18

prospected in the region, and governmental agencies on a regional, deposit summary, or individual prospect hole database. Estimated resources for the "Savannah District" included an offshore portion which had almost no control (two drill cores and seismic profiling).

Subsequently, Zellars-Williams, under the auspices of the U.S. Geological Survey, conducted a technical feasibility and economic potential study (Zellars-Williams, 1979) in the Georgia-South Carolina area near Savannah. This study employed the extrapolation of knowledge of onshore ore characteristics to an inferred offshore deposit because very little data were available offshore.

In general, phosphate minerals occur in marine sedimentary rocks of the Atlantic Coastal Plain from the Florida Keys to North Carolina. The known deposits of marginal or economic grade are confined to sediments of Middle Miocene or, in some cases, younger phosphate containing sediments derived from reworking of middle Miocene beds (Cathcart, 1968). Middle Miocene deposits on the continental shelf of Georgia are represented by The Coosawhatchie Formation (Henry and Kellam, 1987). The Coosawhatchie Formation contains marine sands and clays with variable amounts of phosphate mineral. It has been divided into four members, the most important of which is the Tybee Phosphorite Member. Lithology of the Tybee member is discussed by numerous authors, including Kellam (1981), Henry and Kellam (1987) and Woolsey, (1977).

Savannah is underlain by thousands of feet of sedimentary beds ranging in age from Late Cretaceous to Holocene. Near the center of Chatham County, the top of the phosphate matrix is at Elevation -45 meters. Because the overburden is excessively thick and the matrix thickness is less than 5 meters at this location, the phosphate is not considered mineable under present-day mining criteria. However, to the east and northeast the phosphate matrix thickens and overburden decreases. The higher elevation of the matrix at the coast would appear to contradict the influence of the regional dip to the southeast. The reversal in this case is caused by the north-south trending Beaufort Arch, the axis of which passes beneath the Savannah Light Tower, about 16 kilometers offshore from Savannah Beach on

Tybee Island. Although the limited wide-spaced drilling onshore and the drill data at the Light Tower suggest this structural trend, the seismic profiling work by Woolsey (1976) has provided clear evidence of the structure. It is quite probable that the phosphate matrix in the area north of the Light Tower constitutes the stable sea floor which is being abraded by migrating sand waves.

### 3.4.1 Techniques for Phosphorite Exploration

Seismic reflection surveys yield worthwhile broad-based information on stratigraphy of offshore areas. Middle Miocene strata, which typically contain the phosphate matrix, have seismic signatures that are recognizable and traceable on a regional basis (Kellam, 1981; Woolsey, 1977). Therefore, interpreted seismic data can be used to approximate depth to, and thickness of, Middle Miocene strata. In this manner, favorable sites for detailed exploration can be established. Seismic data, however, do not provide any information on the actual phosphate content of the Middle Miocene.

In phosphate prospecting there is no substitute for a well-designed program to obtain suitable cores of phosphate matrix. Cores are typically retrieved in four-inch core barrels, and coring is continuous between the top and bottom of the phosphate matrix. A properly executed coring effort will not only provide excellent records of matrix characteristics, but more importantly, it will deliver essential samples for determining the processability of the matrix and contained phosphate rock.

### 3.4.2 Phosphorite Exploration Targets

Exploration targets indicated by Henry and Kellam (1987) are the eastern flank of the Beaufort Arch, subsurface topographical features (The Tybee Trough, for example), and basal units along the edge and seaward of the Sea Island Scarp. The eastern flank of the Beaufort Arch is considered to be a primary target because phosphorite deposits tend to accumulate on the nose and flanks of structural highs.

Initial exploration for phosphorite should be conducted in locations where, if a deposit is proven, it will have the most economically favorable potential for development. Since analyses of core samples providing data on phosphate ore grade and quality are very limited, exploration targets must be selected on the basis of relative accessibility. One such site has been selected using unpublished, high-resolution "sparker" seismic-reflection profiles which were collected and interpreted by the U.S. Geological Survey (Popenoe, personal communication).

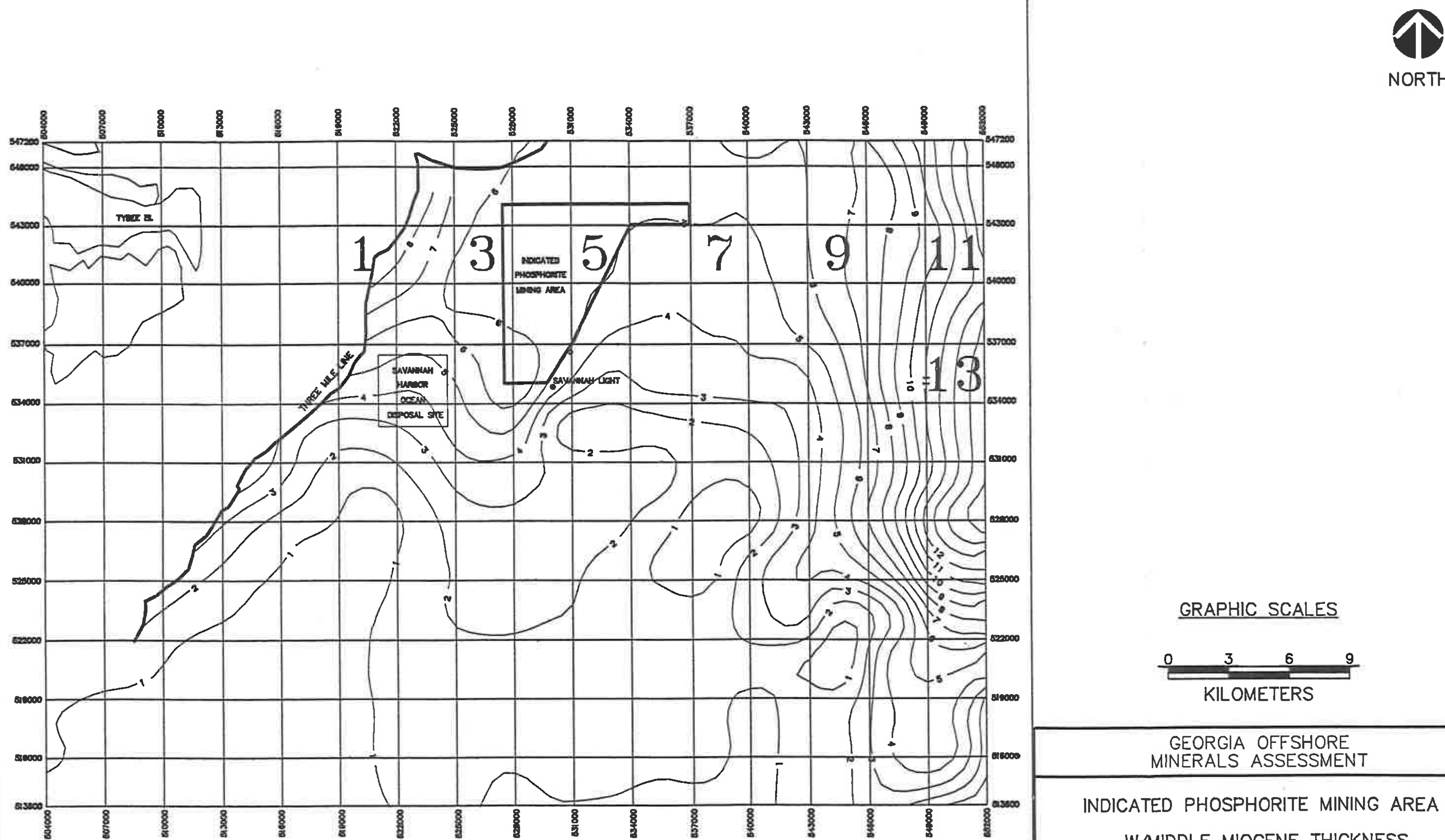
This location, shown in Figure 3.19, has been used in this report for studying the feasibility of phosphate mining on the continental shelf of Georgia. The site selection was confined by an area of zero Middle Miocene thickness immediately to the south, the Corps of Engineers channel widening dump to the southwest, thickening overburden to the east and west, and the South Carolina border immediately to the north. This area contains the shallowest Middle Miocene deposits in the entire study area, as well as the thinnest overburden.

## 3.5 HEAVY MINERAL POTENTIAL

Three heavy-mineral provinces are generally recognized for the Atlantic Continental Shelf (ACS) of the United States: northern, central and southern. The Georgia coast lies within the southern ACS. Grosz, (1983) cites a number of older studies that refer to economic potential of heavy-mineral accumulations within sediments of the ACS, but do not convey sufficient information for making quantitative resource estimates. Recently published studies of ACS economic heavy-minerals contain very limited information specific to Georgia.

A reconnaissance study conducted by the U.S.G.S. (Grosz, 1983) involved analysis of 71 ACS sediment grab samples from Florida, North Carolina and Virginia. Although none of the samples represent the Georgia ACS, the study is important because results indicate that concentrations of heavy minerals occur in surficial ACS sediments in areas offshore of land areas that contain no economic concentrations.

Over the past few years, U.S.G.S. researchers have made significant progress in defining heavy mineral distributions on the ACS. Two characteristics of the southern ACS reported by Grosz (et al, 1986) are pertinent to this study. These are:




GEORGIA OFFSHORE MINERALS ASSESSMENT

INDICATED PHOSPHORITE MINING AREA

W/MIDDLE MIOCENE THICKNESS

ZW

CONTOUR INTERVAL 1 m

FIGURE NO. 3.19

GOSMTKPH

- o elevated heavy mineral concentrations in the southern ACS appear to be limited to inner-shelf sediments (less than 60 meters water depth), and

- o heavy mineral assemblages of the southern ACS are more economically attractive than those of the northern provinces.

Ongoing studies are being conducted by the U.S.G.S. (Grosz, et al, 1986; Grosz, 1987) to assess the potential for the existence of heavy mineral placer deposits in continental shelf sediments. These studies include analyses and interpretations of grab samples, vibracores and seismic reflection profiles. Vibracore analyses have not been completed for the Georgia ACS. However, preliminary reports, based on grab sample analyses, indicate that elevated values of rutile, zircon, monazite and phosphorite are found offshore of central Georgia.

### 3.5.1 Techniques for Heavy Mineral Exploration

Sediment sampling on the ACS is done by either grab sampling or vibracoring. Grosz (et al, 1986) have concluded that grab sample analyses are of limited use in ACS placer resource estimation and the technique should be limited to very broad regional studies of qualitative aspects of heavy-mineral assemblages. The same report further concludes that, at the present time, no substitute for vibracoring is presently available for resource estimation and geologic studies in the marine environment. Vibracores are an essential element for evaluation because they provide important information on the vertical extent of heavy-mineral concentration.

Development of geophysical techniques specifically for heavy-mineral exploration on continental shelves is in its infancy. Radiometric data obtained using towed submersible sleds have shown promise as a tool for offshore ilmenite exploration (Tixeront, et al, 1978). Grosz (et al, 1986) documents testing of induced polarization (IP) with a prototype marine IP electrode streamer. Results indicate that the IP method has potential for application as an offshore exploration system and as a shipboard assaying tool.

### 3.5.2 Heavy Mineral Exploration Targets

In a thorough review of published reports and publically available unpublished documents, no accounts of ACS heavy mineral placer discoveries have been found. The U.S.B.O.M. (1987) reported that two companies explored in 1986 for heavy-mineral placers on the southern ACS. According to Grosz (et al, 1986), the prospect for finding commercially exploitable heavy-mineral deposits in ACS sediments appears favorable.

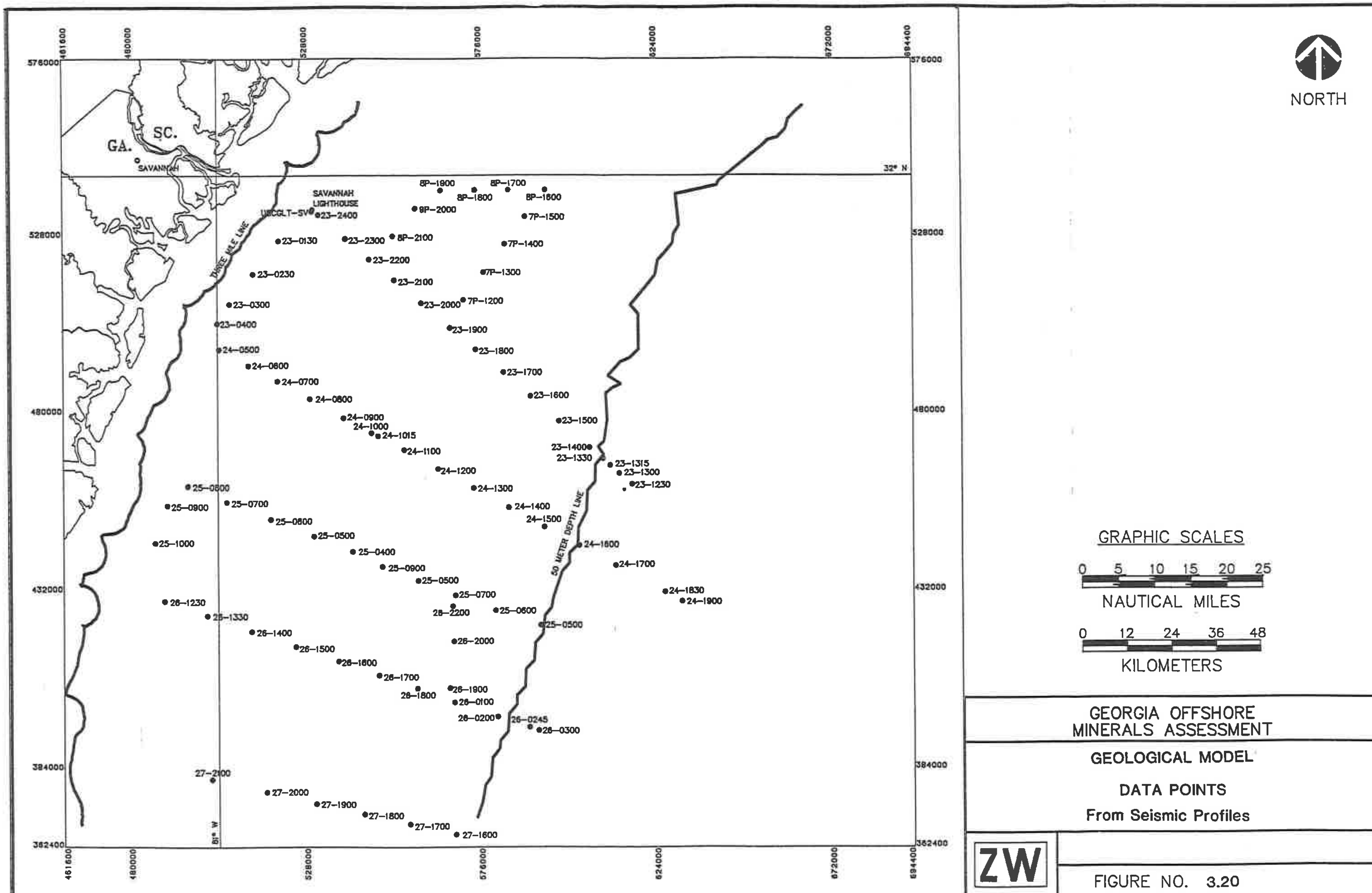
Attanasi (et al, 1987) suggest three types of sediment deposits that are likely to contain offshore titanium mineral placer deposits. These are:

- beach complex or strand-line deposits formed during a previously lower stand of sea level,
- linear shore-tied or isolated sand shoals, and
- older fluvial deposits.

The world's major sources of titanium minerals are onshore beach complex or strand-line deposits (U.S.B.O.M., 1987). In a broad definition presented by Attanasi (et al, 1987) beach complex deposits include beach, aeolean dune, inlet and washover fan deposits. These deposits are generally characterized by fine-grained, well-sorted sands.

Regardless of the exact mechanism, heavy mineral accumulations offshore would have developed during, and as a result of, sea level stands lower than today's. Considering that elevated heavy-mineral concentrations in the southern ACS appear to be limited to inner-shelf sediments, i.e., less than 60 meters water depth (Grosz, 1986), and considering that there is a recognized textural change seaward of 14 meters water depth (Kellam, 1981), primary exploration targets are apparent strand-line deposits lying at water depths between 14 and 60 meters. The location designated as a hypothetical deposit (Figure 3.18) in the Heavy Mineral Analytical Model (Section 3.3.2) is one such exploration target.

An interesting and important feature of the location map for the hypothetical heavy mineral deposit (Figure 3.18) is the relative size of the Green Cove Springs deposit compared to the heavy mineral concentration trend and to the overall study area. Exploration for a heavy-mineral placer deposit having the dimensions of the Green Cove Springs deposit compares to the proverbial needle in the haystack.




GEORGIA OFFSHORE MINERALS ASSESSMENT

GEOLOGICAL MODEL

DATA POINTS

From Seismic Profiles

ZW

FIGURE NO. 3.20

# SECTION 4

# OFFSHORE MINING TECHNOLOGY

## 4.1 INTRODUCTION

The two types of mineral resources that exist off the coast of Georgia are heavy minerals placer deposits and phosphorite sands deposits. Heavy minerals deposits occur when a heavy mineral source is eroded and the resulting sands are transported to the depositional site by vigorous hydraulic conduits such as waves, tides, or wind. Sediments are generally sorted, weathered, and form concentrations of heavy minerals having economic values. Heavy metals are known to exist off the coast of Georgia, but none have been explored sufficiently to warrant construction of a site-specific geologic model. Consequently, the geological model used in this study is hypothetical and is based on current strandline models from other areas of the world. A strandline deposit is one which was formed during srands at or above sea level. The strandline placers, which form the basis for the geologic model, are the primary sources for the world's supply of titanium, zircon, and other heavy minerals.

A typical heavy mineral strandline deposit contains 140,000,000 tonnes of sands located beneath 80 feet of ocean. The deposit thickness is from 3-12 meters, with no defined overburden. Deposits at much deeper ocean depths, and those with overburden, are considered economically unattractive for the present hypothetical conditions.

More information is known about phosphorite, which also occurs offshore Georgia. Extensive work on phosphorite has been done at Onslow Bay off the Atlantic Coast of North Carolina, a geologically similar area. In addition, drilling at Tybee Island and near Savannah indicates that deposits of potential economic value exist off the coastline.

The deposit parameters for phosphorite deposits offshore Georgia are similar to the characteristics listed above for heavy minerals in regard to ocean depth and deposit thickness, except that some overburden above the phosphorite exists. The type of mining systems and equipment that are applicable to heavy minerals mining may also be suitable for phosphorite mining. However, in phosphorite mining, provisions must be made for overburden disposal.

To a considerable degree, the selection of mining equipment is affected by oceanographic and meteorological conditions. Unfavorable conditions may require shutdown and movement to a safe harbor. At other times conditions may result in a lower production rate. In any case, mining equipment must be designed to meet the oceanographic conditions described in Section 5, and/or be capable of moving to safe harbor in the event of a major storm.

## 4.2 STATE-OF-THE-ART

Technical advances in offshore oil production have resulted in advanced technology that is currently available for application in the exploitation of offshore marine deposits. Mining must proceed from a central platform, or working area, from which mining and dispatching operations are controlled. These platforms or working stations consist of three general types:

1) floating platforms
2) fixed platforms
3) walking platforms.

Floating platforms generally take the form of especially designed vessels on flotation hulls with dredging equipment mounted or attached. Pontoon or barge-type hulls are used for dredging work in estuaries, harbors, rivers, ship-channels and in-land waters, as these are not suitable for offshore ocean conditions. Dredged material is pumped as a water-solids mixture (slurry) via trailing pipeline to the point of deposition, or is transferred to tugboat-towed scows for transport. Conventional sea-going transport vessel configuration modified to accommodate dredging equipment is widely used for offshore ocean deep-water dredging. These vessels usually contain compartments to store dredged material and to transport the contents to shore.

In some experimental cases, the actual mining is directed from submersible vessels or bottom-supported vehicles that are attached to the platform by pipelines, power supplies, and mechanical material handling systems such as bucketlines or dippers. While these systems have obtained samples and engaged in exploration activities at depths of over 1000 feet, presently the technology is insufficient to support similar large scale mining operations. Dredges are the only proven mining system that utilize the concept of floating platforms.

Fixed platforms have been used in sulfur mining and oil production for some time. Because they are immobile and above the surface, fixed platforms provide a working area free from movements of the ocean surface and currents. However, this immobility results in a high operating cost when conventional mechanical and hydraulic mining techniques are used. On the other hand, borehole mining can be operated from fixed platforms. In this mining technique, boreholes are drilled through the overburden to the mineral formation (matrix) by mining tools. High presssure water jets, attached to the mining tools, disaggregate the matrix and remove it from the host rock. The slurry is then pumped to the processing plant. Although it has never been successfully applied to commercial phosphate operations, the borehole mining method is being successfully used in commercial mining of sulfur and potash. Borehole mining may be applicable in phosphate deposits with deep overburden. Since it is not necessary to remove overburden, borehole mining techniques result in no overburden removal costs.

A unique walking platform is being developed by IHC Holland. It can be described as a self-elevating platform on which all motions are eliminated because it uses the sea bottom as a supporting structure. In addition, the platform has the ability to walk without being lowered into floating position, a feature that is required since the digging tool must continuously move over the mining area, similar to a land-based dragline. Power for this platform is provided by a surface vessel, which also will receive the material mined for further processing. These supply lines are the only connection between the surface vessel and the walking mining platform. Although several variations of this machine have been developed and tested, currently no commercial walking platforms are in use.

Ellicott Machine Corporation of Baltimore, Maryland has proposed conceptual designs of platform dredges incorporating design features of conventional dredges and offshore exploration platforms. The design is suitable for mining in shallow offshore waters. This design shows a great deal of promise, and if supported by the viability of Atlantic coast OCS mining may be commercially developed in the near future.

## 4.3 DREDGES

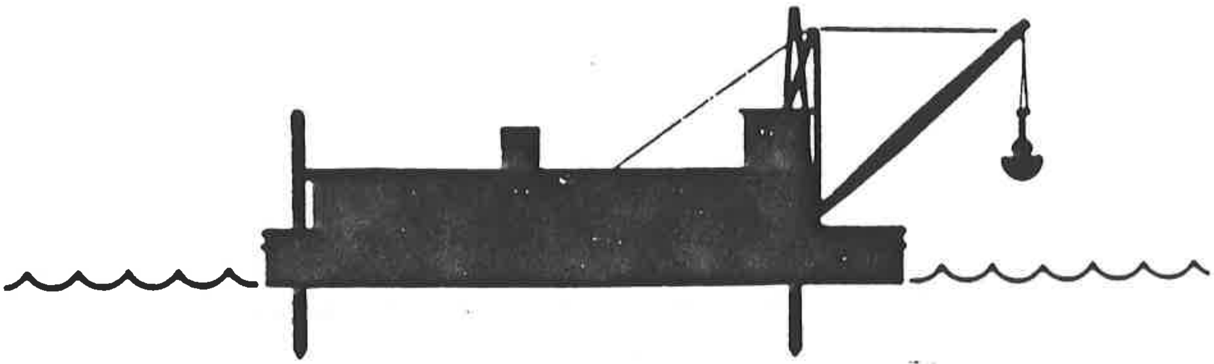
The dredge, of one type or another, is the only system proven to be successful for offshore mining. Several types of dredges have been developed and commonly employed for under-water excavation. Very few of these are suitable for deep water and ocean conditions.

Dredges may be classified as two general types. These are mechanical dredges and hydraulic dredges. The classification is based on the method used to handle excavated material.

### 4.3.1 Mechanical Dredges

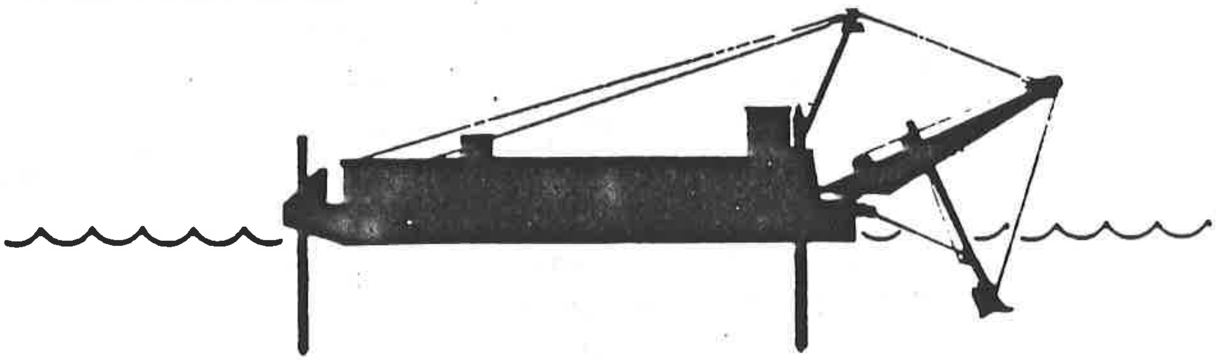
Mechanical dredges consist of three general types, as illustrated on Figure 4.1. These, as a class, are not suitable for production mining of phosphorites or heavy minerals in the offshore ocean environment. They are included here to describe their capabilities, applications, and limitations.

1) grapple dredge
2) dipper dredge
3) bucket dredge.



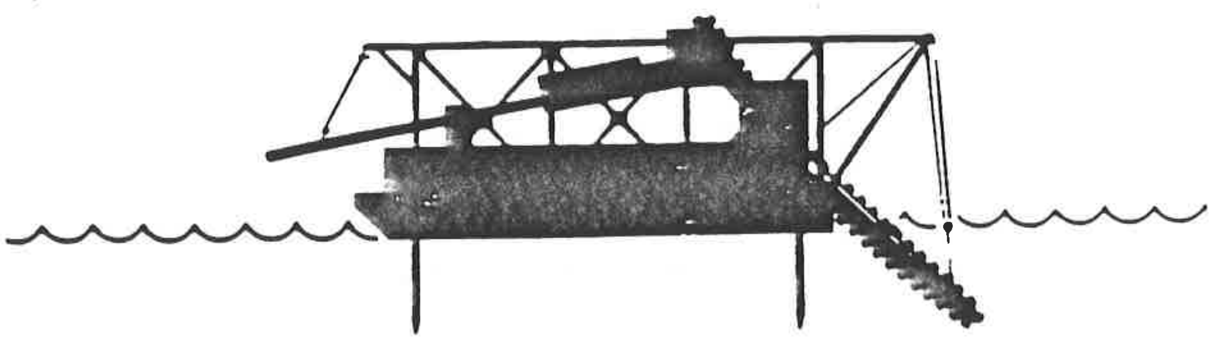
**The Grapple Dredge**

In this type, the work is done by a clamshell bucket suspended from a derrick mounted on a barge. It is most suitable for excavating medium-soft materials in confined areas near docks and breakwaters.



**The Dipper Dredge**

A powerful dipper bucket mounted at the forward end gives the dipper dredge its main advantage: strong "crowding action," produced as the bucket is forced into material being moved. This permits efficient removal of rock and other hard materials. For its size, a dipper dredge can handle larger pieces, thus reducing blastinq needs.



**The Bucket Dredge**

Buckets mounted on an endless chain do the work here. Each bucket digs, conveys and dumps its own load. A continuous work cycle makes the bucket dredge an efficient mechanical dredge, when used in operations such as sand and gravel production.

Excavation Handbook, 1981, by H.K. Church
McGraw Hill Book Co., pages 13-146 and 13-147

## Grapple Dredge

The grapple dredge is a flat-topped barge upon which a derrick is mounted to support the clamshell bucket by means of wire rope lines. The clamshell derrick is attached to a revolving machinery deck similar to a land-based dragline tub. Similarly, the bucket swings around the derrick to load barges anchored nearby, or to spoil material.

Two general types of grab buckets are used -- the clamshell, for mud or stiff mud, and the orange peel, for loose rock or other hard or bulky materials. The grab dredge is used extensively around docks, piers, and particularly in the corners of cuts where it has the ability to get in close without damaging structures. This dredge works well in silts and stiff muds and is particularly effective where there are obstructions and trash. Production is poor, and an irregular bottom is left, making it unsuitable for stiff hard materials.

Since digging action depends upon bucket weight, the grapple dredge does not have sufficient penetration to obtain a "full bite", or full load in hard materials. Dredging depth is restricted only by the length of the hoisting wire. However, deeper dredging will result in lower production due to increased hoisting time. Dredging depths of 100 feet are not uncommon.

## Dipper Dredge

Dipper Dredges - The dipper dredge is a power shovel or backhoe operating from the forward end of a barge. Like its land counterpart, the dipper dredge has good crowding action, making it suitable for handling large rocks, and casting them into nearby barges for removal. To obtain stability, spuds anchor the dredge when excavating. It is most effective in hard materials such as till, soft and broken rock, and shales, but also works well in areas where obstructions such as boulders, snags or timbers exist.

Located on the hull are two forward spuds and one stern or kicking spud, similar to those on grab dredges. The two forward spuds are used to lift the barge above its normal flotation and thereby obtain additional weight for absorbing the reactions of the digging operation. The kicking spud is used to move the dredge forward. Digging depth is limited by the length of the boom, 65 feet being about the maximum.

Both the grapple dredge and the dipper dredge are unsuitable for offshore operations. The grapple dredge is unproductive in large tonnage and deep water deposits, while the dipper dredge has mechanical limitations and limited digging depth.

Bucket Dredge

These dredges excavate with a continuous chain of buckets supported on an inclined ladder that moves up and down around two pivots called tumblers. As the buckets go around the lower tumbler, they scoop up the material, carry it up the ladder, finally dumping it into an ore chute as the buckets pass over the upper tumbler. The continuous action at the bucket chain provides good production and efficient operations. The bucket dredge is extensively used for sand and gravel deposits, and diamond and heavy metal (tin) deposits.

One of the disadvantages of this dredge is that it has to be moored with five or more lines and anchors. These moorings hinder traffic, and moving and resetting the dredge is time-consuming. Not only does this dredge have poor mobility as a result of the moorings, but it is not stable when being towed, principally because of the high center of gravity caused by the ladder, A-frame, and buckets. A second disadvantage is that it is not a rough-weather dredge. In active water the material washes out of the buckets. Waves of three feet or more make it non-productive, although recent design has improved this condition.

### 4.3.2 Hydraulic Dredges

Hydraulic dredges can be classified into two main types - cutter head and suction head - based on the "head" attachment at the end of the suction pipe. For offshore marine applications, both types of hydraulic dredges consist of ocean-worthy self-propelled vessels on which a large centrifugal pump and suction pipes are mounted. The centrifugal pump draws a mixture of water and suspended solids from the sea bottom, which is pumped as a slurry to on-board hoppers, nearby barges, or into slurry pipelines. Loose material can be drawn into the suction head with a plain hydraulic suction head. Hard materials require a cutter head to dislodge and direct material into the suction head.

Plain-Suction Dredges

Plain-suction dredges are similar in hull construction to a regular ship, but they often differ from other dredges in the location of the suction pipe. The plain-suction dredge often has its suction pipe in a well at the bow, whereas other types have their suction pipes alongside. The suction pipe, regardless of its location, extends through the hull to the dredge pump.

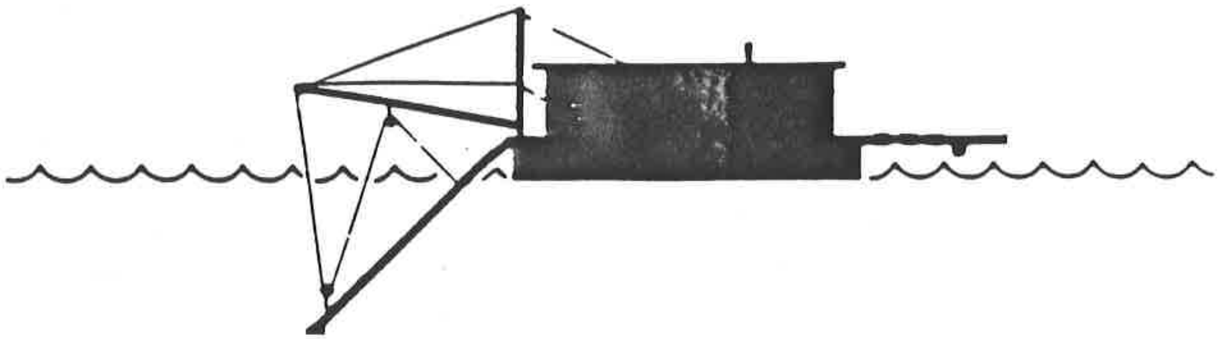
For compacted material, the plain-suction dredge often has water jets installed at the lower end of the suction. High-pressure water is forced through the jets to break up the material. The suction end is also often flattened in a rectangular shape, similar to the mouthpiece of a vacuum cleaner, with the jets attached around the perimeter.

The dredge pump creates a pressure drop resulting in the movement of water and solids material into the suction pipe head. The dredge pump pushes the slurry along the discharge pipe to on-board hoppers or barges moored alongside the barge. Technology for dredge pumps is advanced, with special alloy castings available for pumping abrasive material. Most dredge pumps cannot lift slurry much more than 7 meters above the ocean level. To increase lift, pumps are mounted on the suction pipe boom below water level; however, motors must also be of the submersible type or extended power transmission shafts constructed. Economics is a prime determinate in design of dredge pumping systems. Dredge technology is well advanced.

Figure 4.2 illustrates three types of hydraulic dredges.

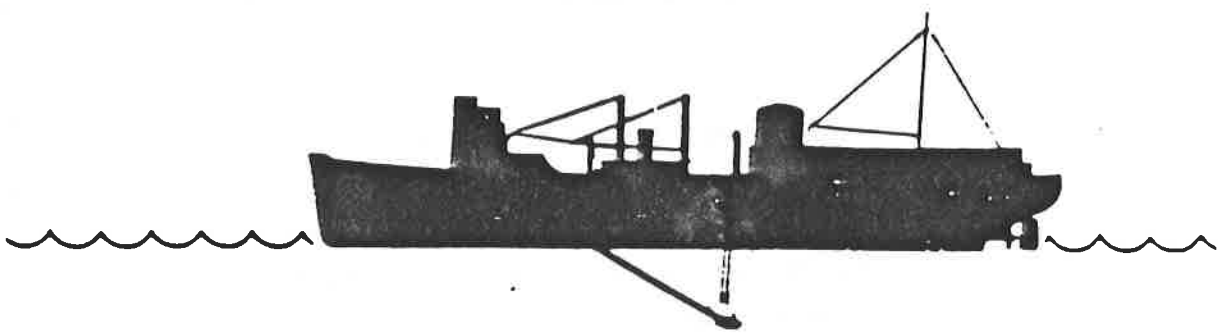
The plain suction dredge shown is commonly employed for civil works excavation in and around harbors and marine facilities. Owing to the design

## HYDRAULIC



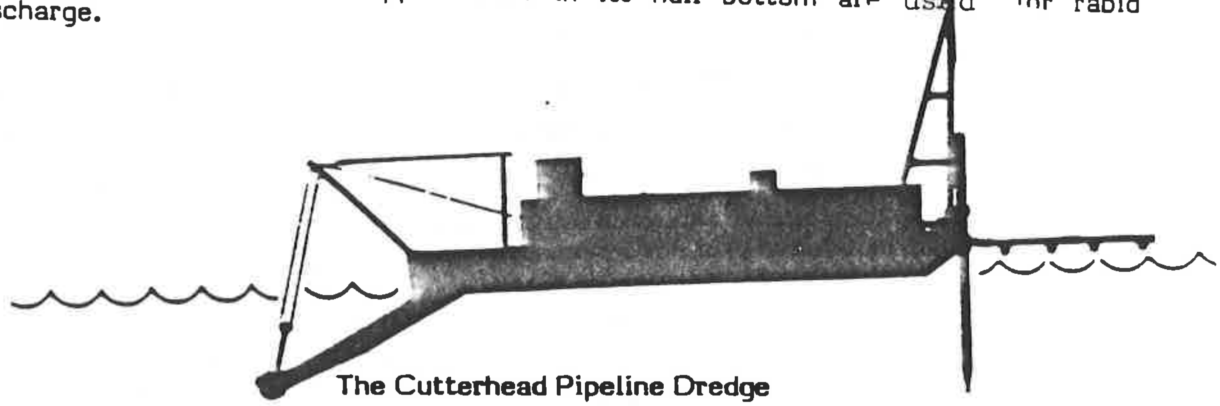
**The Plain Suction Dredge**

In this type of dredge, a suction pipe is lowered to the surface to be worked. A powerful dredge pump draws up the material, mixed with water, and discharges through a pipeline. Units of this type are used for digging soft, free-flowing materials.



**The Self-Propelled Hopper Dredge**

Resembling an ocean-going ship, this vessel functions in a way similar to a plain suction dredge. Material is gathered from the bottom by dragged suction heads, then pumped into storage hoppers. When filled, the dredge proceeds to a deep-water dumping area, where the hopper doors in its hull bottom are used for rapid discharge.



**The Cutterhead Pipeline Dredge**

The most versatile and widely used excavating unit for transporting waterbound solids. A rotating cutter loosens the material, which is then sucked through the dredging pump, discharged via a pipeline at the stern. These dredges can dig and pump all types of alluvial materials, also, clay, hardpan and other compacted deposits.

Excavation Handbook, 1981, by H.K. Church
McGraw Hill Book Co., pages 13-146 and 13-147

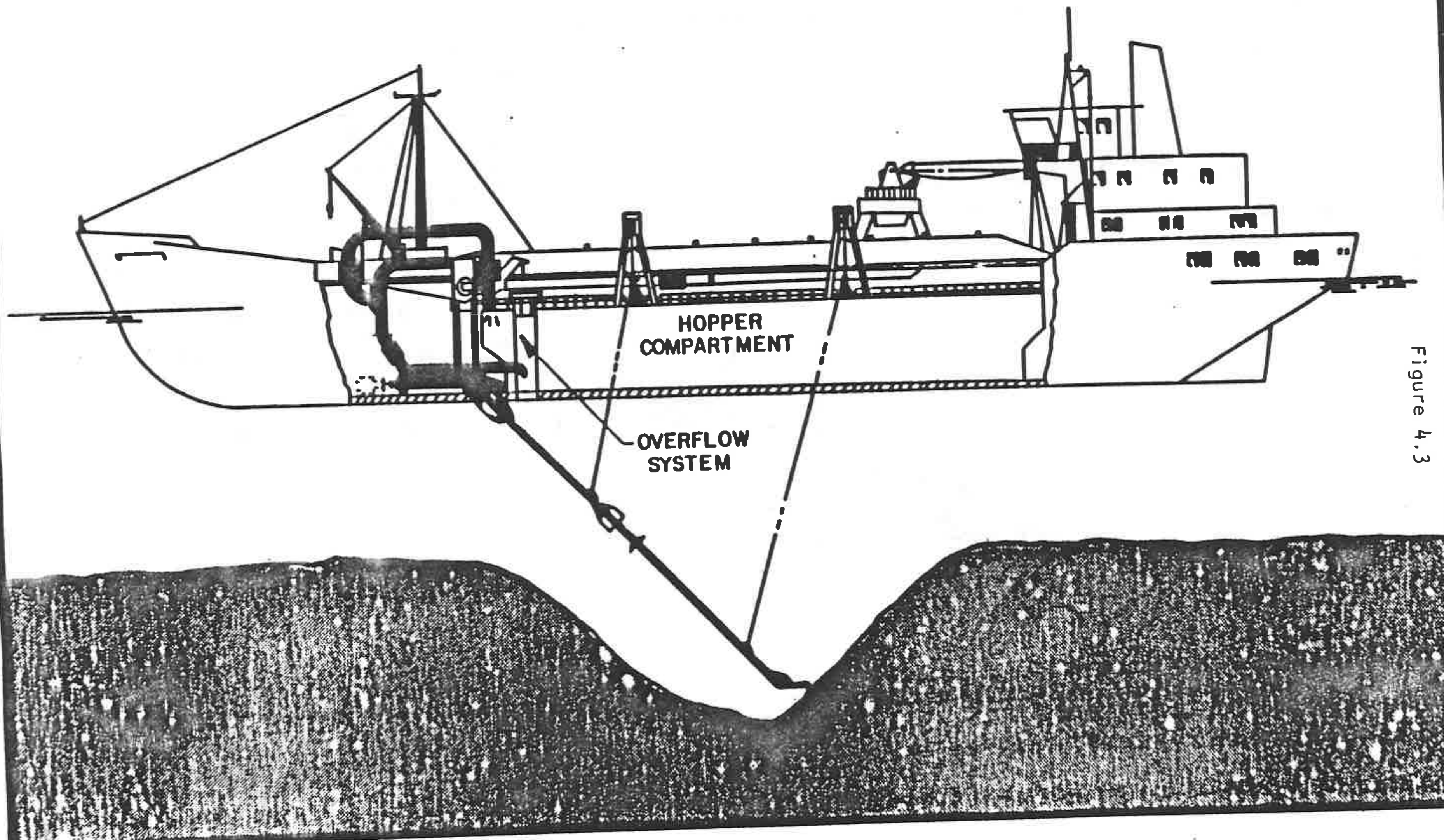
of the hull, which is often a single barge-shaped pontoon, this type suction dredge is not suitable for operating in the offshore ocean environment. The hull is not seaworthy enough to permit safe operation. This dredge may be self-propelled, but is more often towed and positioned by tugboats. The depth capability of this dredge is limited to the net positive suction head available at the dredge pump mounted on the deck, usually 5-8 meters. Depth is theoretically unlimited when the pump is submerged. Submergence is limited by design considerations, such as size of structural components, and the floating platform. Capacity is dictated by pump size, and power available.

The self-propelled hopper dredge is also known as the trailing suction head dredge.

This dredge operates while the vessel is underway, moving forward at about 1-3 knots. As the name indicates, the suction pipe trails behind the vessel dragging along the sea bottom. Figure 4.3 illustrates this type of dredge. Because dredging takes place as the vessel is underway, a deep excavation such as that illustrated is not typical. This shape and depth excavation would result from a fixed position with the vessel anchored.

Specially designed heads, depending upon the material being dredged, are mounted on the pipe and are referred to as dragheads. Figure 4.4 illustrates a typical trailing drag arm and several types of drag heads. For certain applications, a submerged dredge pump is added to the drag arm to increase effective depth and capacity. Dragheads can normally be adjusted and generally cut a path 1 meter wide by 1/3 meter deep. The resulting cuts are numerous shallow trenches in the sea bottom. Mining control is limited with the trailing suction head dredge. The dredged material is pumped into a hopper onboard the vessel, dewatered, washed and screened, then transported to shore when the hopper is full. When material is washed, waste material can be discharged through a pipe/pumping system to the bottom of the ocean, thus avoiding turbulence. The rejected sands partially settle in the mined trenches.

Figure 4.3

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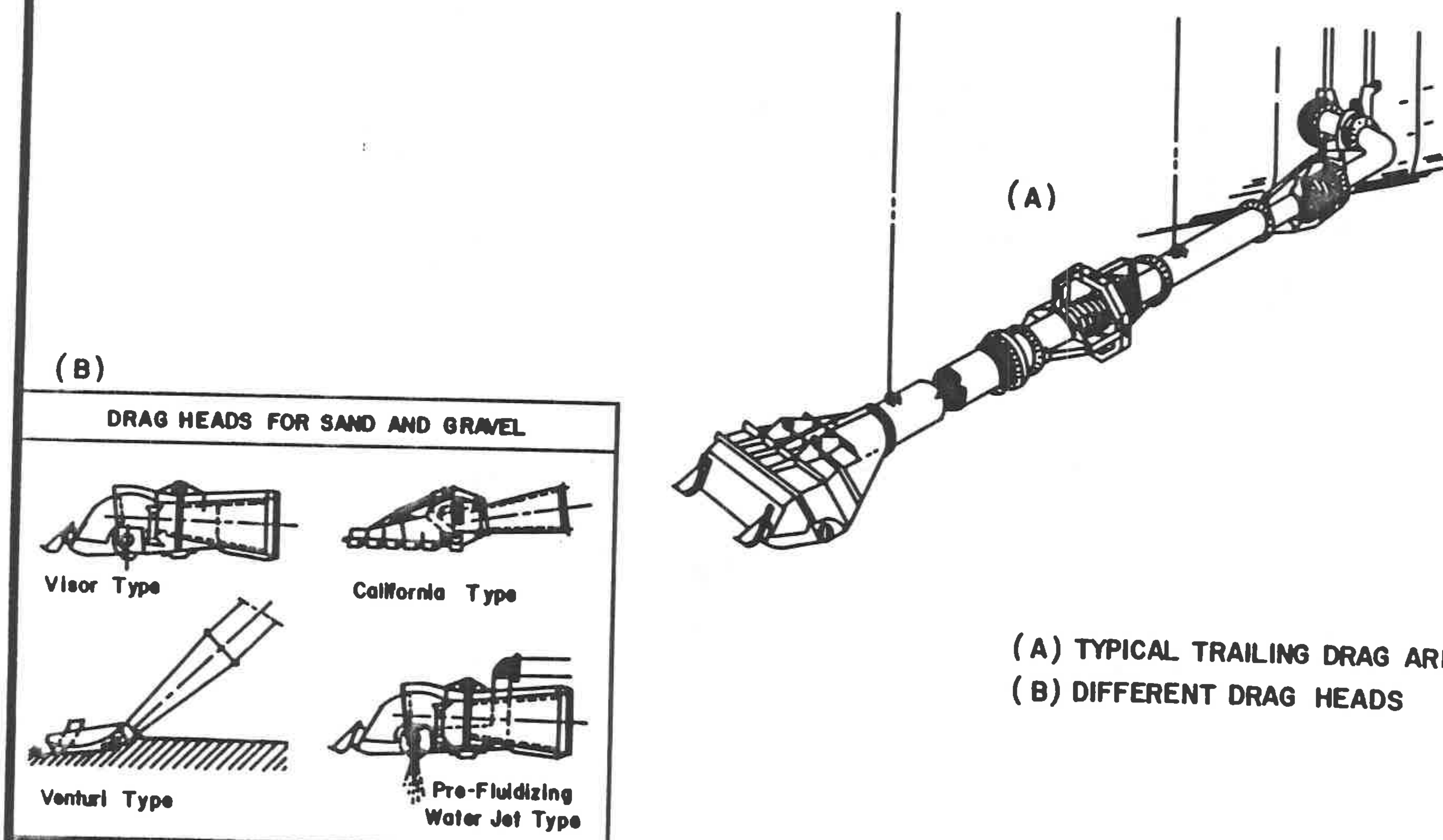


(A) TYPICAL TRAILING DRAG ARM
(B) DIFFERENT DRAG HEADS

Figure 4.4

Trailing suction head dredges are common in channel dredging operations. An example is the DCI Dredge IX built by IHC Holland for the Dredging Corporation of India. This is the fifth trailing suction head dredge bought by this company. The primary function of this dredge is to maintain shipping channels and approaches to several ports. The DCI Dredge IX is a twin-screw trailing suction dredger with a hopper capacity of 4,500 $m^3$. Two 800 mm diameter suction pipes are capable of dredging to a depth of 25 meters. The DCI Dredge IX is equipped with an automatic light mixture installation which ensures that only a mixture with a predetermined solids concentration goes into the hopper. The hopper can be filled in about 40 minutes. Spoil is discharged through 18 conical valves arranged in two rows in the bottom of the hopper. Air conditioned living quarters for the crew of 50 men are built in the rear of the vessel. Complete instrumentation allows the dredge master to optimize the entire hopper charging process. Overall length is 102 meters, with an 18 meter beam. Power is provided by two 1070 kW electric motors operated from the two main 3850 kW propulsion engines.

Another use for trailing suction head dredges is in mining of aggregates off shore in the United Kingdom (U.K.). Twenty million tons of aggregate are mined by trailing suction head dredges in the U.K. The trailing suction dredge is an efficient mining tool and has the ability to operate under almost all conditions in the rough North Sea waters. An example, the Arco Avon has a submersible dredge pump installed in the trailing-suction pipe.

This enables the Arco Avon to dredge approximtely 43 meters deep. The 1,000 kW centrifugal pump has a suction mouth diameter of 700 mm and is capable of pumping sand/gravel at a rate of 2,000 tons/hour. An automatic swell compensator raises and lowers the suction pipe so dredging can continue in sea conditions of up to 6 m swells. The vessel is is 98 meters with length, with a 17 meter beam.

Anchored suction head dredges operate much the same as trailing suction head dredges except that dredges are anchored to a location and angular movement is restrained by those anchors. Figure 4.5 illustrates the configuration of a sea-going anchor-type suction head hopper dredge operating at anchor. The suction head is held in one location longer so pits

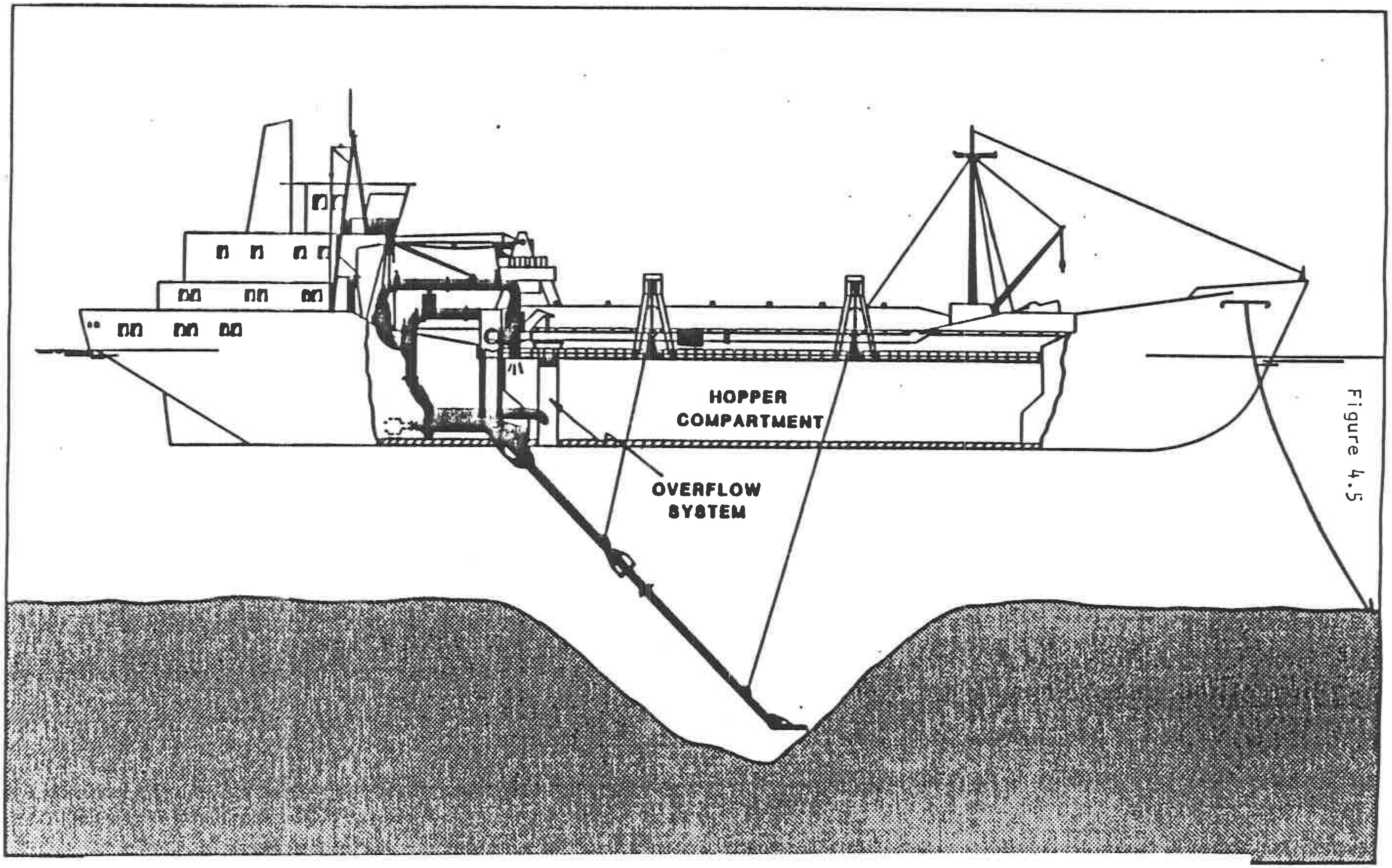


Figure 4.5

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are dug instead of trenches. The dredge can mine panels about 80 meters wide and 1000 meters long in about 60 meter blocks.

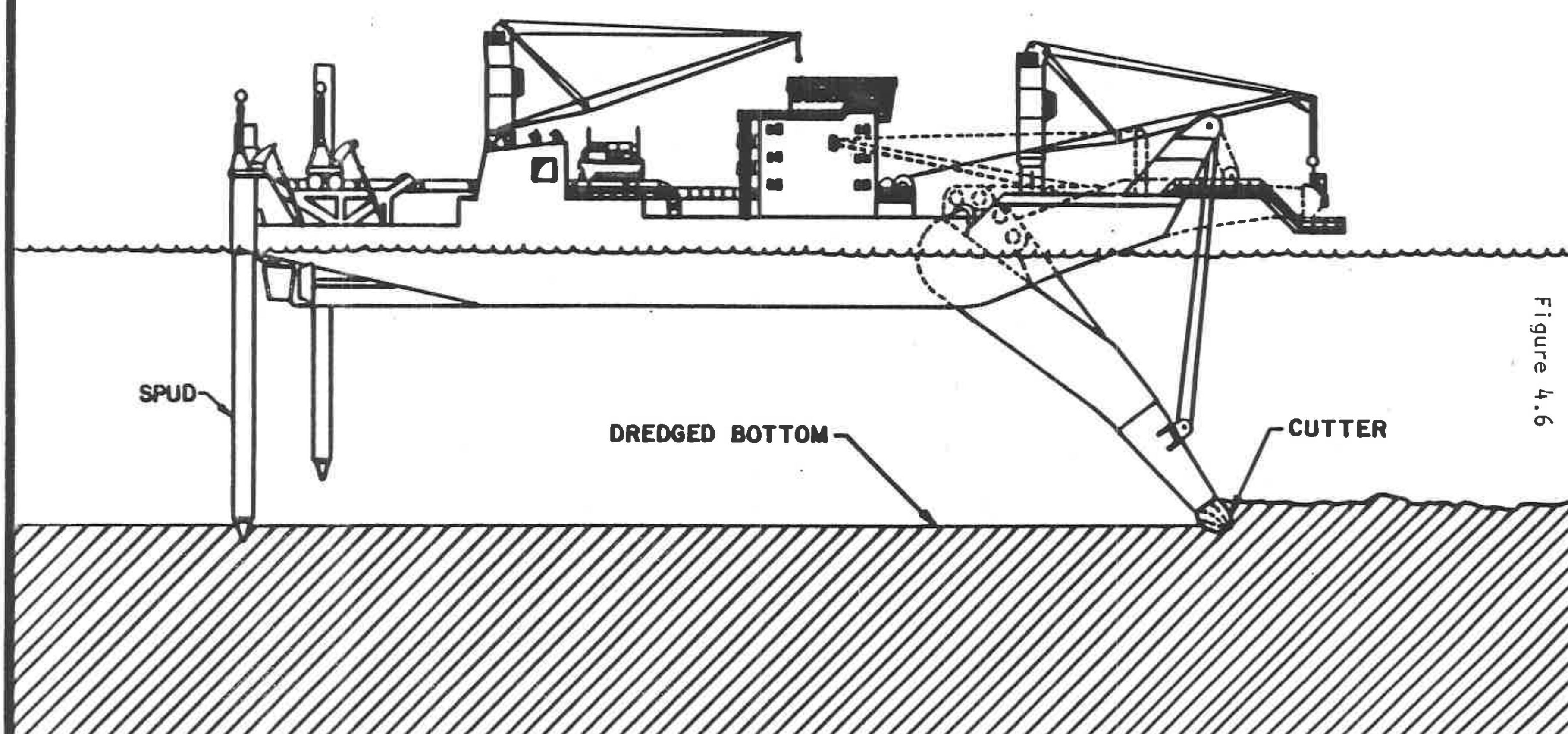
As the desired depth is reached for the panel, the anchor is pulled and the dredge relocated to the next block. The mining process is repeated for each new block. Since the suction head is dragged over the bottom only by the swing motion of the dredge, it has less digging capability than the trailing suction head dredge. Operation of this dredge often requires the use of a separate tug to remove, re-position, and re-set the anchors.

Anchored suction dredges are used in Japan for aggregate mining, usually at depths of around 30 meters. In Europe, these dredges have been used, but in recent years all mining dredges operating offshore the United Kingdom and the European coast have been of the trailing suction head design.

### Cutter Head Dredges

The cutter head dredge is essentially a combination of other dredges, adapted so that material is excavated mechanically and transported hydraulically to another location. The cutters are mounted near the suction intake of the dredge pump and attached to the bottom of a ladder which, in turn, is attached at the bow of the vessel. Cutters are connected by a shaft to the cutter motor. Rotation of the cutter agitates loose material and cuts hard material. Cut material is directed to the suction intake through the motion of the cutter and the design of the suction intake pipe. Material is pumped aboard the vessel and handled in the same manner as the plain suction head dredges. A typical cutter head hydraulic dredge is shown on Figure 4.6. This dredge utilizes a basket type radial cutter head. The blades of the cutter may be plain for semi-compacted material, or may be studded with replaceable teeth for harder material. Spuds are used to position the platform and to resist the reactive force of the cutter head.

Figure 4.6

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In addition to the cutter head, the ladder carries the suction pipe, lubricating lines, motors and reduction gear. The aft, or upper end of the ladder, is supported by heavy trunions set in a well in the bow of the dredge hull. The dredge is held in position by spuds. Movement of the cutter head is from side to side over an arc angle of $90^o$-$100^o$, and is controlled by winching anchored swing lines attached to winch drums on board the vessel.

The A-frame is the main support for the block-and-tackle that supports the ladder. It is usually pinned to the forward end of the dredge hull rather than being fixed rigidly. This arrangement allows for movement while the dredge is operating. It is tied back to an H-frame by flexible wires or steel rods. Angular rotation of the vessel about a spud permits the dredge platform and attached ladder to advance, thereby forming a mining pit.

A cutter head dredge which utilizes a bucket wheel to excavate material is shown on Figure 4.7. This dredge is essentially the same as the basket cutter head dredge. The cutting wheel is designed for the material to be excavated, with or without teeth, and directs the excavated material to a suction pipe. The ladder, or boom, supports the bucket wheel, bucket wheel motor, suction pipe and, if required by depth and capacity, a submerged dredge pump and submersible motor. In recent years many of these type dredges have been built for high capacity or difficult digging conditions. This type dredge has also been adopted to sea-going vessels for mining in offshore ocean conditions.

Cutter head dredges of both types have been used extensively for mining onshore, including heavy minerals and phosphorite and are, in recent years, being extensively adopted to offshore ocean dredging applications.

## 4.4 CURRENTLY AVAILABLE MINERAL DREDGING SYSTEMS

There are many examples of modern dredging applications, many of which are for the purpose of mineral recovery. Table 4-1 lists some of the more important mining dredges world-wide, with statistics of interest. Examples of each type; bucket ladder dredge, cutter suction dredge, bucket wheel dredge.

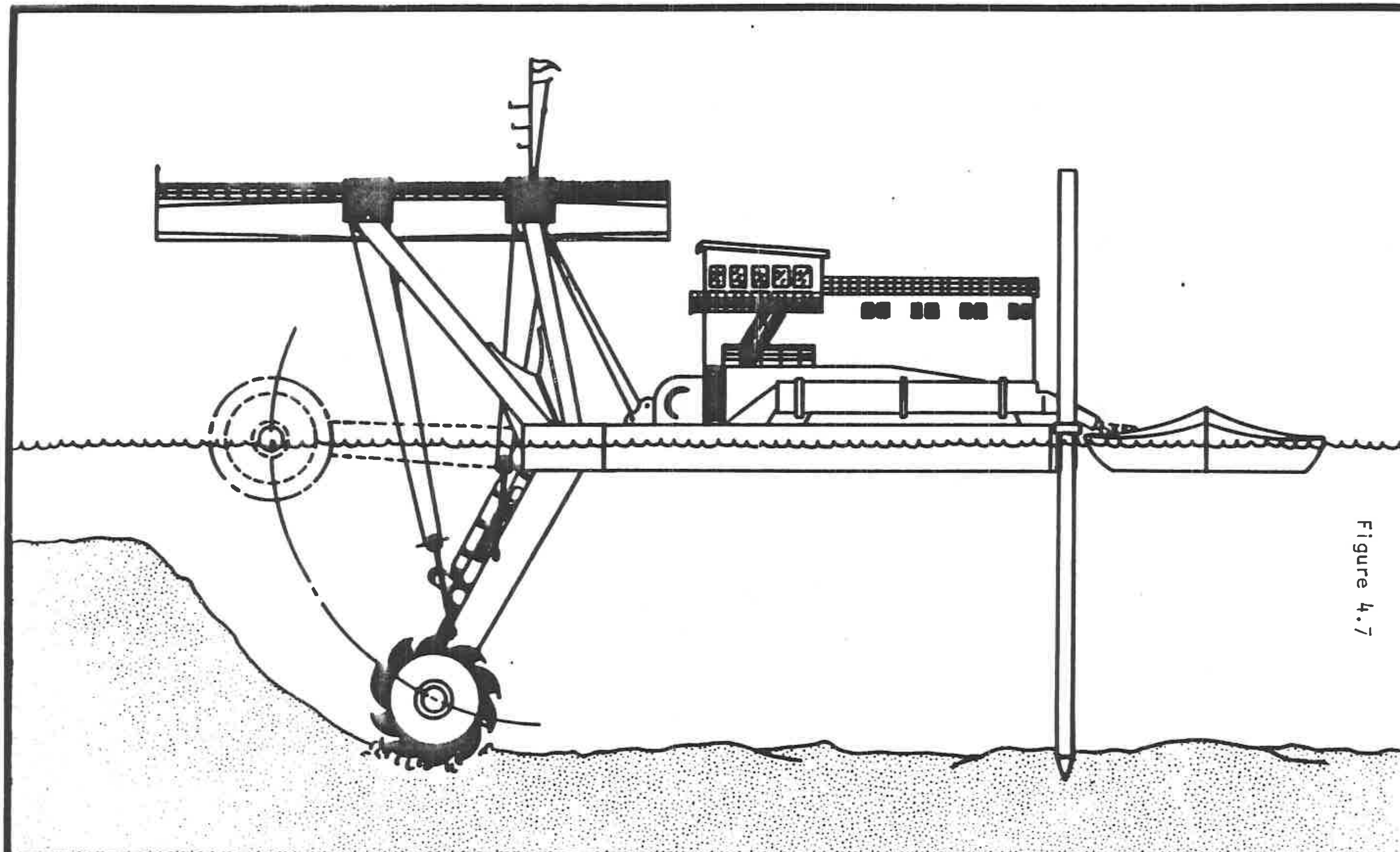

Figure 4.7

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**Table 4-1**

**Commercially Available Mineral Dredging Systems**

| Manufacturer | Description of Dredge | Ore | Depth Meters | Throughput $M^3$/ Month (600 Hrs) |
|---|---|---|---|---|
| **Bucket Ladder Dredges** | | | | |
| Alluvial Dredges Ltd.<br>Blackhall Lane<br>Paisley, PAI ITA Scotland | 100-1,000 liter buckets | NS[1] | 6-50 | NS |
| IHC Holland<br>P.O. Box 3, 3360 AA Sleidrecht<br>Holland | 300 liter bucket, 30/min, 75% full | Au | 11 | 243,000 |
| | 453 liter bucket, 75% full, wave compensated | Sn | 30.6 | 333,000 |
| OCP Group - FW Payne & Son (UK) Ltd.<br>34 Southborough Rd., Bickley<br>Bromley Kent BRI 2EB, England | 100 liter up for prospecting and mining | Various | 12-50 | 81,000-500,000 |
| Richards Structural Steel Co., Ltd.<br>P.O. Box 78, Phoenix Iron Works<br>Leicester, LE4 GFY, England | Various - mobile plants | NS | NS | 400-40,000 |
| **Cutter Suction Dredges** | | | | |
| American Marine & Machinery Co., Inc.<br>P.O. Box 100923<br>Nashville, Tennessee 37210 USA | Submerged pumps (38% solids), hydraulic cutter and spuds, 86-4263 KW | NS | 30+ | 46,800-1,404,000 |
| Dredge Plant (Mining), Pty. Ltd.<br>P.O. Box 317, Palm Beach<br>Queensland 4221, Australia | High speed cutter wheel (70 rpm) 54-463 KW, 600-1,500 mm wheel at 35% solids | Various | NS | 20,700-228,000 |
| Orenstein & Koppell "Bilberg 1" | Self-propelled cutter head<br>900-950 mm suction dredge pump<br>2250 KW, 2600 mm cutterhead | NS | 25 M | 760,000 |

| Manufacturer | Description of Dredge | Ore | Depth Meters | Throughput $M^3$/ Month (600 Hrs) |
|---|---|---|---|---|
| **Cutter Suction Dredges** (contd) | | | | |
| Ellicott Machinery Corp. International Inc. 1600 Bush Street Baltimore, Maryland 21230 USA | Standardized cutter suction (Dragon class) 150-900 mm discharge, to 1,500 HP | Various | 6-30 | 22,800-1,101,000 |
| IHC Holland P.O. Box 3, 3360 AA Sleidrecht Holland | Standardized cutter suction (Beaver class) 250-10,000 KW, hydraulic spuds | NS | NS | NS |
| **Bucket Wheel Dredges** | | | | |
| Ellicott Machinery Corp. International Inc. 1600 Bush Street Baltimore, Maryland 21230 USA | Wheel Dragon class, 254-900 mm wheel 3:1 improvement over cutter for mining | Various | 8-21 plus | 45,600-1,836,000 |
| Humphreys Mineral Industries, Inc. 2219 Market Street Denver, Colorado 80205 USA | Bucket wheel feeding separate process plant 70-90% mineral recovery to 325 mesh | Ba/Sn/Au | 30 | NS |
| IHC Holland P.O. Box 3, 3360 AA Sleidrecht Holland | Beaver wheel class. 2,200 mm wheel, 18.6 rpm 400-650 mm suction 750-4,000 KW | NS | 10-16 | NS |
| Neumann Equpt (Pty) Ltd. P.O. Box 8, Currumbin Queensland 4223, Australia | Series 200-300 200-450 mm suction. 35% solids | NS | 6-15 | to 200,000 |
| Orenstein & Koppell AG Karl Funke Strasse 30 D-4600, Dortmund, FRG | UWS 250, 5,000 mm wheel. 10 x 250 liter buckets 380 KW | NS | NS | NS |
| | Tin dredge (planned) 8,000 mm wheel, submerged pump, 2,400 KW | Sn | 100 | 1,350,000 |

| Manufacturer | Description of Dredge | Ore | Depth Meters | Throughput $M^3$/ Month (600 Hrs) |
|---|---|---|---|---|
| **Deep Water Dredges** | | | | |
| Alluvial Mining and Shaft Sinking Co.<br>High Pavement, Basildon<br>Essex 5514 IEA, England | AMROD 305 mm discharge, submerged centrifugal | Au/diam/Ti | to 300 | 200,000 |
| | DOD series, 150 mm suction and jet. Diver operated. | NS | 200-300 | NS |
| Fuchs Systems Inc.<br>P.O. Box 379<br>Salisbury, N.C. 28144, U.S.A. | Air lift | NS | 15-120 | 160,000-180,000 |
| OCP Group - FW Payne (UK) Ltd.<br>34 Southborough Rd., Bickley<br>Bromley Kent BRI 2EB, England | Remote control underwater suction | Various | 50-150 | NS |
| Orenstein & Koppell AG<br>Karl Funke Strasse 30<br>D-4600, Dortmund, FRG | Multiple head collector 30 m wide | Mn nodules | 6,000 m | NS |
| | Submerged suction with vibrator and jetting | Red Sea muds | 3,000 m | NS |
| Orenstein & Koppell<br>"Draga D-9" | Split hopper suction dredger 2-700 mm suction dredge pump 1200 hp each. | NS | 28 m | 1,480,000 |

NS = Not specified

## 4.5 BOREHOLE MINING

During the past several years there has been a considerable amount of interest in the United States and Canada on the extraction of minerals through a borehole from deeper sedimentary deposits. Several private companies evaluated borehole mining methods for mining deep phosphate rock in North Carolina back in the 1960's, as well as other locations. The concept of mining through a borehole is obviously not novel as Frasch sulfur has been mined commercially through a borehole since the 1890's. The extraction of slurried minerals through a borehole, however, has not achieved any significant commercial success.

In 1973, the United States Bureau of Mines (USBM) took an active interest in the development of this technology as part of their program to increase the domestic availability of critical minerals. In 1976, they developed a tool specifically designed to mine coal, that was built by Flow Industries Inc. (Flow). This early work indicated that coal could be slurried in place by high pressure water and transported by use of an eductor pump. Experimental test work was also conducted in the slurry mining of California oil sands by the USBM.

Emphasis at the USBM then shifted to adapt the concept to the mining of uranium ore-bearing sandstone in Wyoming. The initial tests were conducted during 1977 in conjunction with Rocky Mountain Energy Co. (RME). The result of these tests encouraged RME to develop a prototype system with Flow which was operated over a several month period. The test results indicated that uranium bearing sandstone could be eroded with high pressure water at a standoff distance in excess of 70 feet when the nozzle was operated in an air environment. A satisfactory production rate was achieved when the operating conditions were optimized. They were able to elevate the slurried sandstone with the eductor pump from the air-filled cavity at a depth in excess of 200 feet. The energy required to elevate this slurry by this method was high. Unfortunately, at about that time, the price of uranium dropped dramatically, causing RME to discontinue their program prematurely. At about the same time this test work was being conducted, the USBM became interested in re-evaluating the technology as it could be applied to phosphates.

In 1980 a test program was conducted at a northeast Florida site using the USBM equipment developed for coal and uranium sands. The test results indicated that in that particular environment, borehole mining had to be conducted in a flooded cavity to maintain roof support. It was encouraging to determine that even when operated in a flooded condition, a surprisingly good production rate could be achieved, and that a radius approaching 20 feet was obtainable. When the system was operated with the cavity filled with water to the top of the casing, the energy required to lift the slurry created by the cutting jet action by the eductor pump was considerably less than in earlier tests.

Encouraged by these results, a joint venture research program between Agrico and International Minerals and Chemical Company was established to conduct a new test program. The actual borehole test work was conducted in late 1984.

The results of this test program were encouraging. In all cases, a consistent hole radius of approximately 20 feet was obtained. No subsidence occurred as all the cavities were developed in a flooded environment with a positive casing overflow. The production rates were adequate for the cutting jet flow rates available, and it was apparent that with increased cutting jet nozzle flow rates, and with a system specifically designed for that site, production rates could be substantially improved. In early 1985 most of the waste clay (a major environmental and disposal storage problem in the central Florida strip mines) was successfully thickened and re-injected back into the cavities created by extraction. The drilled holes (16 inches in diameter) were plugged after backfilling and the casings removed. By removing the steel casings (PVC also used and pulled) and repeatedly recycling them, the economics of borehole extraction are decidedly more attractive.

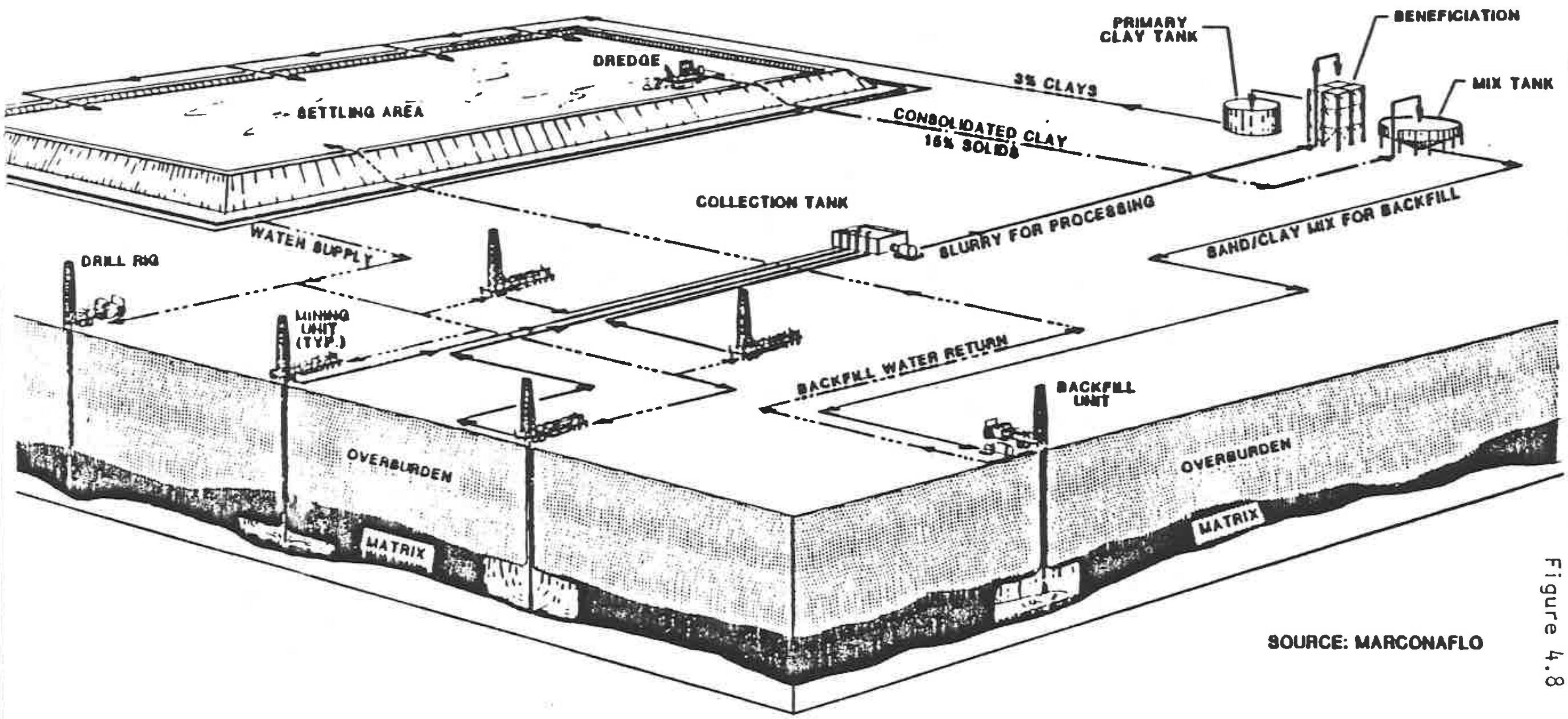
Upon the completion of the test program, an overall conceptual analysis was made to determine how the above results could be converted into a practical commercial development. A mining plan was conceived indicating that a multi-unit system with a portable centralized distribution and receiving unit was the most likely approach. Economic projections made, based on this plan, were encouraging. These projections indicated that land based, large, previously unmineable resources had the potential of being a cost effective, environmentally acceptable, long-term phosphate rock supply.

The basis of the design would be a system having a high operating factor with a minimum mobilization time between pre-drilled boreholes. The mining concept calls for a separation of the four unit functions deemed necessary to mine phosphate rock at that site. The extraction unit's only function is to mine; the other three functions - drilling and casing, backfilling, hole plugging and casing pulling - would be conducted separately.

A land-side borehole slurry mining process would use a 12-inch to 16-inch diameter cased borehole drilled to the matrix and uncased through the ore zone. Figure 4.8 is an illustration of a conceptual arrangement for borehole mining in north Florida. Because of the depth to the base of the orebody (occasionally over 200 feet), a multi-stage turbine pump is required to lift the ore slurry back to the surface. The ore is slurried by a high pressure (275 psi) water jet making an arc of $270^{\circ}$ to $360^{\circ}$. This jetting action creates a cavity approximately 50 feet in diameter at a height determined by the matrix thickness in each hole. Due to the limited size of down-hole equipment, some 20 mining units are necessary to produce 2.5 million tons per year of product. This quantity is based on a 60 percent matrix recovery with each slurry unit producing the equivalent of 50 product tons per hour in recovered ore.

Dedicated mining units produce matrix to a centralized delivery system for transport to the plant. A separate drilling and casing unit is advancing in front of each of the three groups. When a unit finishes mining, a four-hour move is required to set up the next hole in the series. Behind each group is a backfilling unit, placing a mixture of tailings and consolidated clays into the finished boreholes. The 18 to 20 percent solids clay material is dredged from a single 500-acre settling pond that could possibly be used throughout the life of the project. This type of waste disposal may create permitting problems because of the material being placed into an aquifer. But, this type of procedure using sand tailings from the mill, is presently being evaluated as an alternative means of preventing subsidence problems at the surface.

Figure 4.8




SOURCE: MARCONAFLO

Bore hole slurry mining process.

ZELLARS-WILLIAMS, INC.

A typical mining equipment scheme provides 932 tonnes per hour of matrix in a 20% solids slurry to the beneficiation plant.

Some of the positive features that a land-based borehole extraction system would offer industry are partially listed as follows:

- o Low capital cost per unit of material moved.
- o No surface disturbance. Surface can be utilized for practically any use immediately after mining.
- o Waste material resulting from mining and mineral processing can be disposed of back into the mined-out cavity.
- o Small, erratic, or highly faulted deposits can be selectively mined with a minimum of surface infrastructure required.
- o Development drilling necessary to delineate an orebody to justify open pit mining could be reduced when borehole mining is considered. The definition of "proven ore" would take on a different meaning.
- o Only the material that needs to be moved for subsequent processing has to be handled.
- o The system would be very adaptable for automated operation.
- o The concept appears to be environmentally acceptable. It allows potential development of valuable commodities that could not be mined by conventional methods.
- o Borehole extraction could have many other uses besides mining. Any time it would be desirable to create an artificial cavity within a favorable horizon for waste disposal, storage of recoverable material, well field regeneration, etc., through a restricted orifice, this concept should be considered.

The Georgia offshore area of interest between the 3-mile territorial sea line, and the 50-meter contour, indicates some phosphorite occurrence at depths which might fit the borehole mining concept. These areas appear to occur as pockets of what might be phosphate-rich, deep Middle Miocene. Little or nothing is known or available at this time to warrant consideration of borehole mining to Georgia offshore phosphates. The discussion above is given only to acquaint the reader with the general state-of-the-art as it may apply to phosphate mining. Development Planning and Research Associates, Inc., (DPRA) 1987, in their offshore North Carolina phosphate feasibility report, describe a conceptual system for borehole mining a phosphate resource. The 20-meter thick phosphate zone proposed for borehole mining is in 30 meters of water, under 50 meters of overburden, and is centered on an exploratory borehole about 60 kilometers east of Cape Fear. This kind of investigation and work is beyond the scope of this study.

## 4.6 APPLICABILITY OF EXISTING TECHNOLOGY

For a continuous mining operation offshore Georgia, only two types of dredges are feasible - the trailing or anchored suction head dredge, and the cutter head dredge. These dredges can be built on ocean-going vessels with large receiving hoppers and washing plants to reduce the volume of material transported. These dredges can also be integrated into transportation systems utilizing slurry pipelines, barges, or a self-contained load/unload hopper-dredge.

The principal problem with the cutter wheel and bucket line dredges is that being digging dredges they require heavy mechanical equipment and supporting steel structures, resulting in a high bottom contact pressure by design. However, being digging dredges by design, they will dig in response to hull movements making it difficult to maintain permanent contact with the dredging face. Oceanic conditions such as waves, swell currents, and wind causes the dredge hull to surge, heave, pitch, roll, sway and yaw in relation to the ocean bottom. This movement prevents contact with ocean bottom and stresses mechanical and structural components.

Solutions to this problem have been advanced, one of which is to build a semi-submersible hull configuration instead of a surface pontoon. Analysis of response curves for waves striking the hull at 135$^{o}$ (considered the most severe angle) indicates a vast improvement in pitch and heave with the semi-submersible hull design. Solutions to this problem appear to be within the state-of-the-art technology and one dredge operating in moderate oceanic conditions has been built to mine tin in Thailand using a large cutter head dredge. A spud is used to keep the dredge on station balance by shock absorbers which were built into the ladder suspension and swing wires. While not really flexible, this mechanical innovation prevents undue shock loading of critical mechanical components. Further testing and investigation would be necessary to apply this technology to offshore Georgia coastal conditions. Currently, work is being done to create a truly flexible dredge by using a rigid bucket ladder with the supporting pivot shaft connected to the pontoon by link bars and hydro-pneumatic cylinders. Movement in relation to the pontoons is permitted by the pivot shift. In addition, the support bracket is supported by a buffer cylinder which permits the bow to move vertically and keeps the digging force on the bottom by adjusting the pressure on the cylinders.

The trailing suction head dredge, equipped with a draghead, has a low bottom contact pressure and does not sink into the bottom, but maintains contact with the bottom despite dredge hull movements. Because of low weight, the trailing suction head dredge can be equipped with a universal hinge, a horizontal hinge, sliding and turning glands and swell compensation buffer gear. This keeps the draghead on the bottom at constant pressure while the bow moves up and down.

The principal disadvantage of the seagoing trailing suction head dredge is that excavation of material at sea bottom generally occurs while the host vessel is travelling at 1-3 knots. The suction head is dragged along the bottom and the depth of cut depends on the effective contact weight and the consolidation of the material. The suction drag head can not remove (cut) more than a few feet with each pass. The width of the cut is limited by the size of the drag head and the angle of repose of the material being excavated. A single pass may make a cut 1 to 2 meters deep and 5 to 8 meters wide in free-flowing sands and gravels. Many passes are required to mine any significant depth.

The seagoing trailing suction drag head dredge is most effective when operated from a vessel which contains compartments for storing dredged material. Dredged material is deposited directly in the on-board integral hopper either directly or after mechanical sizing to reject oversize material. The dredge hopper vessel, with or without on-board processing, is designed to remain at sea long enough to fill its hoppers. The vessel, when loaded to capacity, returns from the mine site to a designated land-side dump where the hopper is unloaded. Some vessels are designed to bottom dump hopper contents, while others transfer material from the hopper by self-contained slurry pumps, Marcona-flow, or by other conventional methods.

One version of the seagoing suction drag head dredge is the anchor dredger. The seagoing vessel is similarly equipped with a suction head and hopper. This dredge works at anchor and does not move while dredging, other than periodically to winch itself forward as required to keep the flow of material feeding into the suction pipe head. This type of dredge has the advantage that it can work in a deep deposit and covers very little area of the sea bed. The disadvantage is that the sea bottom is left with a series of holes.

The seagoing suction dredge, whether of the anchor type or trailing suction type, is suitable for mining loosely compacted surficial sands containing heavy minerals which do not require removal of overburden.

A system which can operate safely in the offshore Atlantic Ocean coastal water environment is the first requirement which must be met by any equipment assemblage. For the mining of phosphorite, an equally important requirement is that the system be capable of engaging the total horizon of material to be excavated and to do so with an acceptable level of recovery. In other words, overburden and matrix each should be excavated in a single pass, while leaving a minimum of ore having value behind and/or diluting at a minimum the desired ore with barren material. Additional characteristics of the system must be: high level of reliability, and ease of maintenance and component replacement; ability to partially upgrade ore onboard; ability to efficiently transfer or transport upgraded ore to a nearby moored vessel or barge, or to a centrally located offshore beneficiation plant; capable of quickly suspending operation, riding out sudden storms, and quickly resuming work.

The selected systems for mining offshore Georgia phosphorites and heavy minerals are described in Sections 5 and 6, respectively, of this report.

# SECTION 5

# PHOSPHATE DEVELOPMENT FEASIBILITY

## 5.1 INTRODUCTION

This section deals with the work leading to the selection of a preferred configuration for mine, beneficiation, and related infrastructure components required for the commercial exploitation of Middle Miocene phosphorite occurrences offshore the coast of Georgia in the Atlantic Ocean. The reader is taken through a description of the proposed mining area and a comparison of production-configuration schemes. This comparison is based on information and data developed and published in previous studies. Much of this comparative work relies on reports of the Bureau of Mines and Minerals Management Service of the U.S. Department of Interior, Zellars-Williams Company, and Development Planning and Research Associates, Inc.

The configuration selected as a result of the comparative study is that of hybrid dredges mining to an offshore beneficiation facility from which finished product is shipped.

Each component is fully described and capital and operating costs estimated. Economics and viability are based on current phosphate rock sales prices and on supply-demand projections, which indicate the year 2000 as the time-frame in which realization of this enterprise may become viable.

Dredge design and excavating-pumping rate expectations, which underly the premises of the proposed annual production of 4.8 million tonnes of phosphate rock, assume that coquina or similar cemented conglomerates do not occur in the overburden or ore zone horizons scheduled for mining. A phosphate mining enterprise at Santo Domingo on the west coast of Baja Sur California, Mexico, failed to enter production after expenditures of about 60 million dollars because the overburden and ore zones were improperly characterized as uniform beach sands. This soils classification came about as a result of drilling and sampling techniques which failed to characterize in-situ coquina.

The coquina turned out to be impenetrable by the dredges designed and built for this project. Coquina lenses reportedly occur frequently enough to create problems for Texasgulf in mining the marine deposits at their Lee Creek, N.C. mine.

This experience adds emphasis to the importance of a properly designed and executed exploration program for offshore minerals.

## 5.2 MINING

### 5.2.1 Selection of Mining Area

Figure 5.1 shows the area under consideration for phosphate mining. This location contains the thinnest overburden and shallowest phosphate in the study area. Due to the seaward slope of the Miocene sediments, as well as increasing water depths, areas seaward of the model area are increasingly difficult to mine by surface techniques. A more complete review of the model area and geology is given in Section 3.

The area modeled ranges from 6 to 25 nautical miles from shore. Figure 5.2 is a geologic map of this area containing about 180 3-kilometer square blocks. Twenty years of mining to yield 3-5 million tonnes of product per year covers a small fraction of the total blocks identifying Middle Miocene phosphorites. The number of blocks required depends upon the matrix thickness, which is taken as the Middle Miocene thickness. Since matrix thickness, overburden thickness, and depth of water are not constant in the model area, a methodology was developed to select the most favorable economic mining site.

Each block has an overburden thickness, a matrix thickness, and a water depth. The relative proportion of these determines dredge operating and capital costs. By examination of these data, 13 blocks were selected for economic evaluation. Table 5-1 lists the boundary limits of each selected block. These blocks were analyzed for dredge capital costs, and dredge operating costs. Zellars-Williams computerized dredge model was used to calculate production rates and costs. All plant costs are assumed to be location independent. An incremental waste disposal charge was added to the

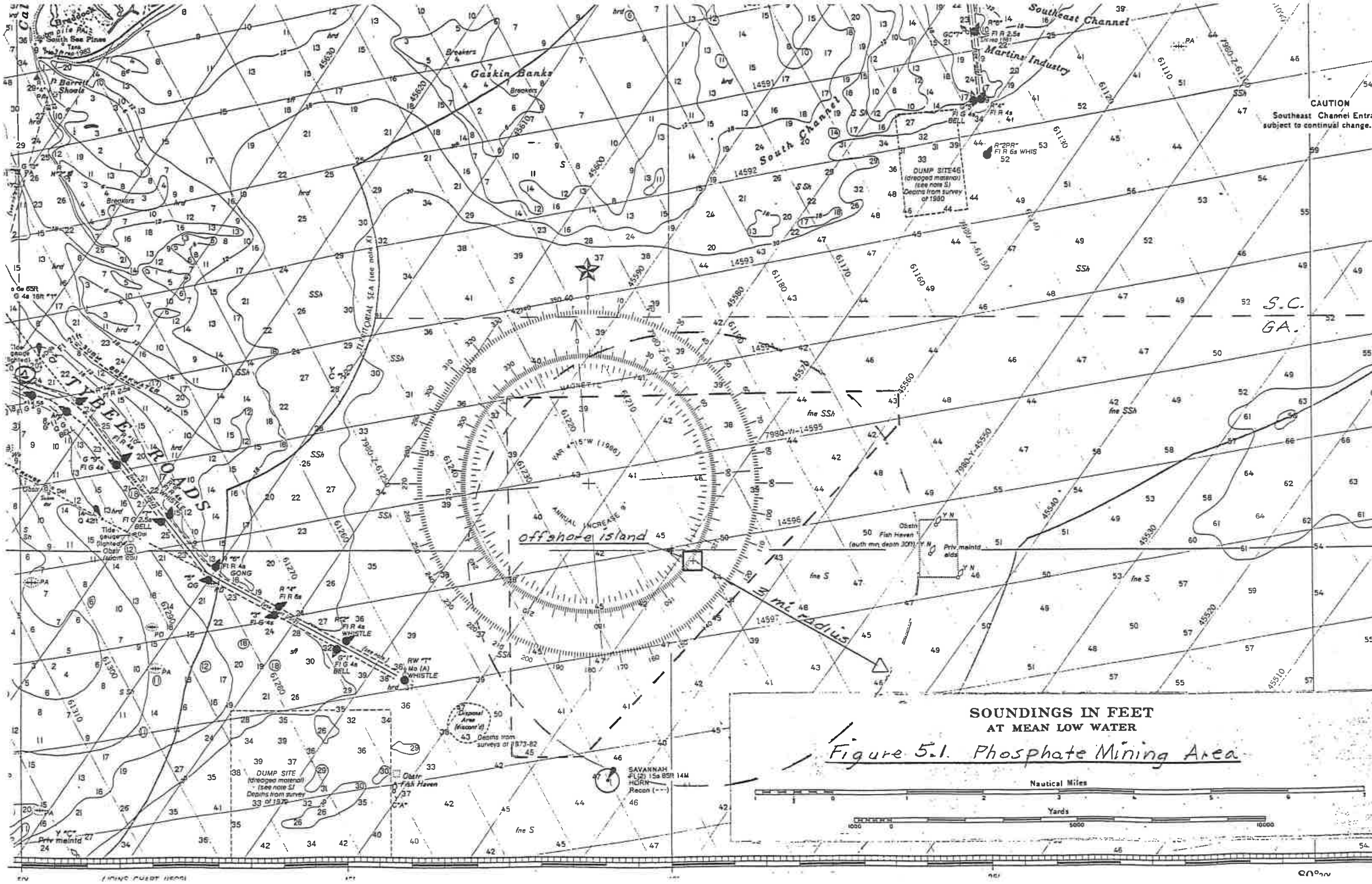
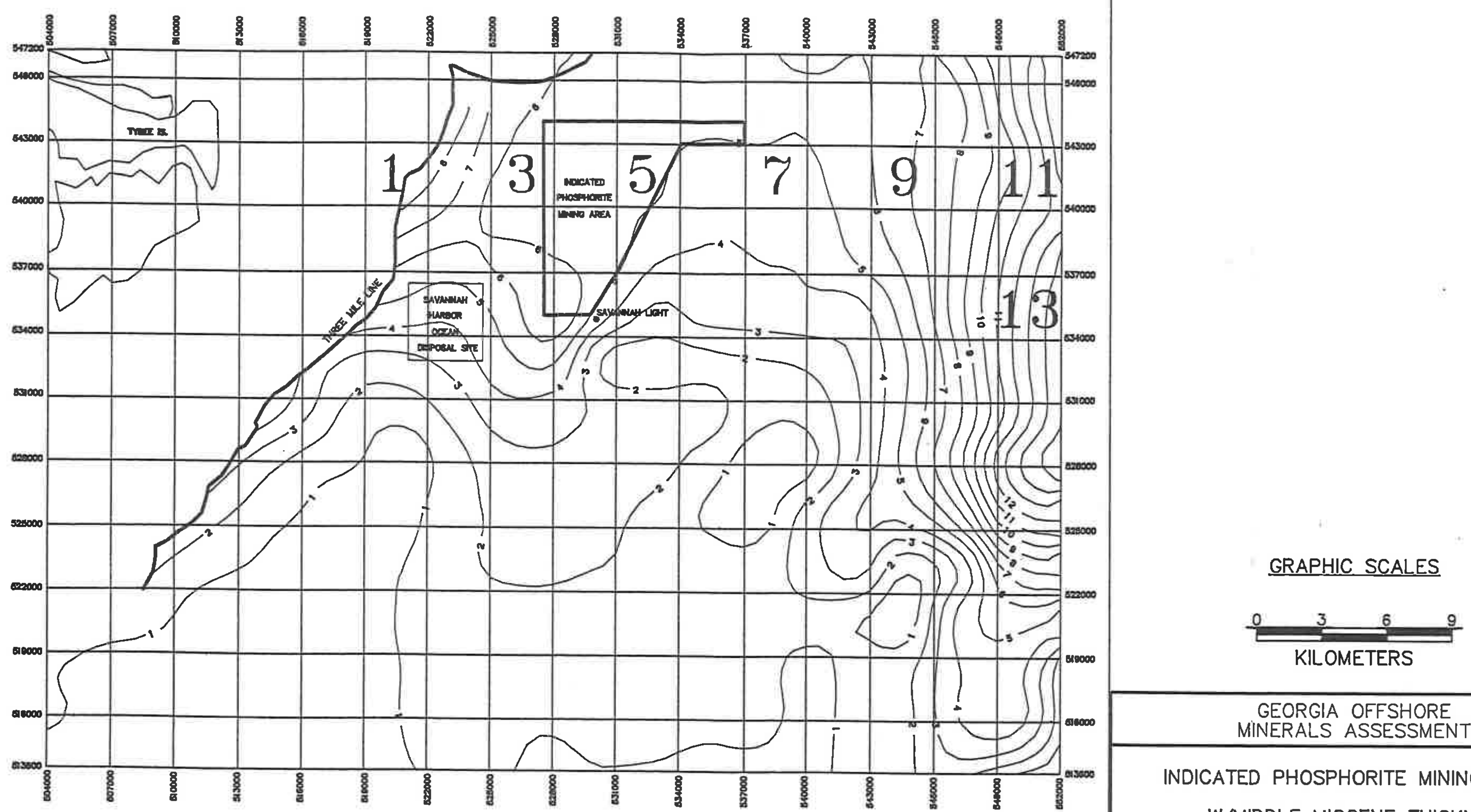



Figure 5.1. Phosphate Mining Area




GEORGIA OFFSHORE MINERALS ASSESSMENT

INDICATED PHOSPHORITE MINING AREA W/MIDDLE MIOCENE THICKNESS

ZW

CONTOUR INTERVAL 1 m

FIGURE NO. 5.2

GOSMTKPH

capital and operating costs, when the mining depth exceeded 27 meters. The sum of dredge operating cost, dredge capital cost, and incremental waste disposal cost, expressed in dollars per tonne of product, was added to give the total cost. Results are summarized in Table 5-2 for each block.

**Table 5-1**

**Block Coordinates**

| Blocks | Northing | Southing | Easting | Westing |
|---|---|---|---|---|
| 1 | 543,000 | 540,000 | 522,000 | 519,000 |
| 2 | 543,000 | 540,000 | 525,000 | 522,000 |
| 3 | 543,000 | 540,000 | 528,000 | 525,000 |
| 4 | 543,000 | 540,000 | 531,000 | 528,000 |
| 5 | 543,000 | 540,000 | 534,000 | 531,000 |
| 6 | 543,000 | 540,000 | 537,000 | 534,000 |
| 7 | 543,000 | 540,000 | 540,000 | 537,000 |
| 8 | 543,000 | 540,000 | 543,000 | 540,000 |
| 9 | 543,000 | 540,000 | 546,000 | 543,000 |
| 10 | 543,000 | 540,000 | 549,000 | 546,000 |
| 11 | 543,000 | 540,000 | 552,000 | 549,000 |
| 12 | 540,000 | 537,000 | 552,000 | 549,000 |
| 13 | 537,000 | 534,000 | 552,000 | 549,000 |

**Table 5-2**

**Mining Area Dredge Operating Costs**

| Block # | Depth Ore m | Depth Ovbd. m | Strip Ratio | Total Mine Depth m | Dredge Cost $/t Matrix | Increm. Waste Cost $/t Matrix | Total Cost $/t Matrix |
|---|---|---|---|---|---|---|---|
| 1 | 9.0 | 15.5 | 1.72 | 32.2 | $2.06 | $.06 | $2.12 |
| 2 | 7.2 | 12.0 | 1.67 | 30.0 | 1.88 | .04 | 1.92 |
| 3 | 5.9 | 11.3 | 1.92 | 27.3 | 1.88 | .04 | 1.92 |
| 4 | 5.6 | 8.5 | 1.52 | 26.3 | 1.66 | .00 | 1.66 |
| 5 | 5.2 | 8.0 | 1.54 | 27.7 | 1.68 | .01 | 1.69 |
| 6 | 4.6 | 7.5 | 1.63 | 28.3 | 1.93 | .02 | 1.95 |
| 7 | 4.7 | 8.2 | 1.74 | 29.6 | 2.01 | .03 | 2.04 |
| 8 | 5.3 | 8.7 | 1.64 | 32.0 | 2.18 | .06 | 2.24 |
| 9 | 6.3 | 9.7 | 1.54 | 35.0 | 2.10 | .09 | 2.19 |
| 10 | 8.1 | 11.3 | 1.40 | 39.0 | 2.14 | .13 | 2.27 |
| 11 | 11.0 | 12.2 | 1.11 | 43.0 | 1.94 | .17 | 2.11 |
| 12 | 12.0 | 12.0 | 1.00 | 43.5 | 1.84 | .17 | 2.01 |
| 13 | 12.2 | 12.0 | .98 | 44.2 | 1.83 | .18 | 2.01 |

Note: Total mine depth includes water depth from MSL to sea floor (top of overburden) at each location.

Using the lowest total cost/tonne of matrix (ore) as the selection criteria, Blocks 4 and 5 were chosen as the core of the initial mining site. The size of the site was matched to an area required to support a 3.5 million tonne (product, dry) per year operation for twenty years. This area contains the shallowest Middle Miocene location, as well as the thinnest overburden in the entire model area.

The initial area is approximately triangular in shape, with the hypotenuse being the 5 meter Middle Miocene thickness contour on the southeastern side. The southwestern and northeastern corners are described as:

| | AMS Coordinates | | Lat. and Long. |
|---|---|---|---|
| | East | North | |
| SW | 527500 | 535000 | 80°42'32.45", 31°57'8.34" |
| NE | 537000 | 544000 | 80°36'29.34", 32°01'59.68" |

The site contains parts of the following OCS blocks:
NI 17-11 - 951, 952, 953, 995, 996, and 997
NH 17-2 - 27 and 28

The site is characterized by the following in-situ parameters:

| | Meters | | | Meters$^3$ |
|---|---|---|---|---|
| Item | Average | Min. | Max. | Volume |
| Water Depth | 13.97 | 11.4 | 16.4 | -- |
| Overburden | 8.02 | 7.1 | 9.9 | 366,746,720 |
| Matrix | 5.44 | 5.0 | 7.0 | 249,040,020 |
| Stripping Ratio (m:m) | 1.47 | 1.42 | 1.41 | |
| Total Mining Depth | 27.43 | 26.4 | 28.8 | |

All overburden material is sand material with no cementing. There is no Pliocene or Upper Miocene material present within the confines of the site.

Using the "Design Basis Data" from Table 10, page 54, of the 1979 ZW report, a target production rate of 3.5 million tonnes for 20 years, and the summarized site data listed below, an annualized production summary was prepared.

Summarized Site Data

| | |
|---|---|
| Total Matrix Volume ($meters^3$) | 249,040,020 |
| Matrix "X" $m^3$ ore to produce 1 ton product | 3.37 |
| Percent Clay Waste | 21.29 |
| Total Product Tonnes (dry) | 73,899,000 |
| Total Area ($meters^2$) | 45,741,096 |
| (acres) | 11,303 |

The initial mining area described above includes parts of eight blocks having the most favorable mining characteristics and is the area targeted for earliest exploitation. The total mineable area, however includes at least eight additional blocks to permit increasing mine life and/or annual yield. Experience in early years will result in improved technology, increase the mineable area, and permit exploitation of as much as 500,000,000 $m^3$ of phosphorite matrix in the Middle Miocene. The product yield over the life of a single enterprise would be as much as 150,000,000 tonnes.

### 5.2.2 Configuration and Production Rate Comparison

The annual production of any mineral beneficiation facility is dependent upon the ability of the mine to supply ore. Normally, plant production is based on operational efficiency which is largely independent of mining because of the ease of providing large stockpiles of plant feed. Most phosphate rock production is based on a link between the mining dragline - ore transportation system and the plant washer. High operating factors are typical and ore storage is not a requirement. Operating factors for most ocean mining equipment, however, are low by comparison. Climatic and other conditions beyond the control of the operator are the major contributors to the reduced operating factor.

Production based on mining of ore at sea for beneficiation at a remotely located land-based facility is greatly dependent on the effective operating factors of the excavating and transporting equipment and systems employed.

As a basis for uniform comparison of alternative configuration schemes certain criteria were established. The criteria adopted for comparative evaluation given in Table 5-3 are based on previous work and on reported experience with ocean-going dredges and transportation systems. These criteria were later modified to better fit the preferred mining equipment and systems configuration.

**Table 5-3**

**Criteria Basis for Configuration Comparison**

| Annual Mining Equipment Availability | |
|---|---|
| Days lost: | |
| annual dry dock/repairs | 30 |
| adverse weather/sea conditions | 36 |
| | 66 |
| Days operational | 299 |
| Hours/day operational | 21 |
| Mechanical availability | 90% |
| Effective operating hours (299 x 21 x .90) | 5,651 |

| Item Description | Unit | Value |
|---|---|---|
| Average overburden thickness | meters | 8.02 |
| Average matrix (ore) thick. | meters | 5.44 |
| Matrix "X" | $m^3$ ore/1 tonne product | 3.37 |
| Matrix & overburden density | tonnes/$m^3$ | 1.36 |
| | lb/$ft^3$ | 85 |
| Mining recovery | percent | 85 |
| Stripping ratio | $m^3$; overburden/$m^3$ matrix | 1.73 |
| Suction head pipe or dredge pump discharge diameter | mm | 900 |
| inches | 36 | |
| Pipeline velocity | m/sec | 4.92 |
| | ft/sec | 15.0 |
| Dredge production dry solids | $m^3$/yr | 12,118,000 |
| | tonnes/hr | 2,196 |
| Average slurry solids | percent | 26 |
| Washer rejects | percent | 20 |
| Distance to land-based beneficiation plant | nautical miles | 27 |
| Average vessel speed | knots | 12 |

Typically, offshore dredges are ocean-going vessels equipped for mining and contain hoppers for collecting dredged material. Since these vessels also serve as transports, their availability for mining is limited. Investment is high and utilization for mining is low. This appears to be the norm as is experienced by operators who use these types of foreign-built dredges in the North Atlantic, Pacific Ocean and Sea of Japan. These systems are most effective where: there is little or no overburden; where the ratio of ore to product is low; and where concentration takes place on board. This is not the case for phosphate.

However, because sea-going suction head hopper type dredges have a long and successful history of operating under ocean conditions, they are considered here in evaluating alternative configuration schemes.

The four major project configuration schemes considered for offshore phosphorite production are:

1. Sea-going hopper dredge for mining and transportation to an onshore plant.
2. Sea-going hopper dredge mining and barge transportation of ore to an onshore plant.
3. Dredge mining and pipeline transportation of ore to onshore plant.
4. Dredge mining and pipeline transportation of ore to nearby offshore island plant.

The mining dredge vessel or platform in each of the four major configurations is equipped with an onboard processing (washing) plant. Flowsheet data indicate that about 20% of the dredged material can be eliminated by washing. This reject material, a mixture of oversize and slimes, would be disposed of in nearby mined-out areas. In Configurations 1, 2, and 3, matrix is transported, after washing, to a land-based plant for further processing. The dredge vessel size is determined by the necessity of making the vessel seaworthy, not by the dredging equipment. In Configuration 1, a large hopper is required for storage as the dredge is also the vessel used to transport ore, after washing, to shore.

Since dredge vessel size is larger than required for the dredging equipment alone, the addition of a washing plant costs only slightly more than if located onshore. Plant operating costs are identical. However, with onboard processing, material transported to shore decreases by 20%, resulting in a corresponding reduction in transportation costs of 20%. In addition, waste disposal of the 20% fraction rejected by washing at an onshore plant must be either re-transported from the plant and disposed of in the mined-out areas, or disposed of in tailing impoundments onshore. Either way, the offshore washing plant reduces costs considerably by wasting the 20% fraction rejected in nearby mine areas.

For Configuration 4, costs are expected to be about equal, with or without onboard processing. This is because the processing plant is located near the mine area. Therefore, for Case 4, either onboard or offboard washing can apply.

1. **Sea-going hopper dredge for mining and transportation to an onshore plant.**

   Figure 5.3 shows this configuration. An anchor suction dredge removes overburden, pumping it to mined-out areas. One anchor suction dredge is dedicated to overburden removal. A second matrix dredge follows at least 2,000 feet behind the overburden dredge. The anchored suction head dredge slurries and pumps the ore to a distribution box, and then the ore is screened, washed and deslimed. About 80 percent of the material is loaded into a hopper on board the vessel. Here, through a series of weirs, the washed matrix is dewatered to 75% solids. When the hopper is full, the suction head and pipes are raised from the bottom to the deck. The dredge now functions as a normal merchant ship and carries the material 27 nautical miles to the plant site. The plant site was selected in an industrial area where permitting problems and land acquisition problems are minimized. It was felt that an onshore plant located closer to the mining operation on the barrier islands would be environmentally unacceptable.

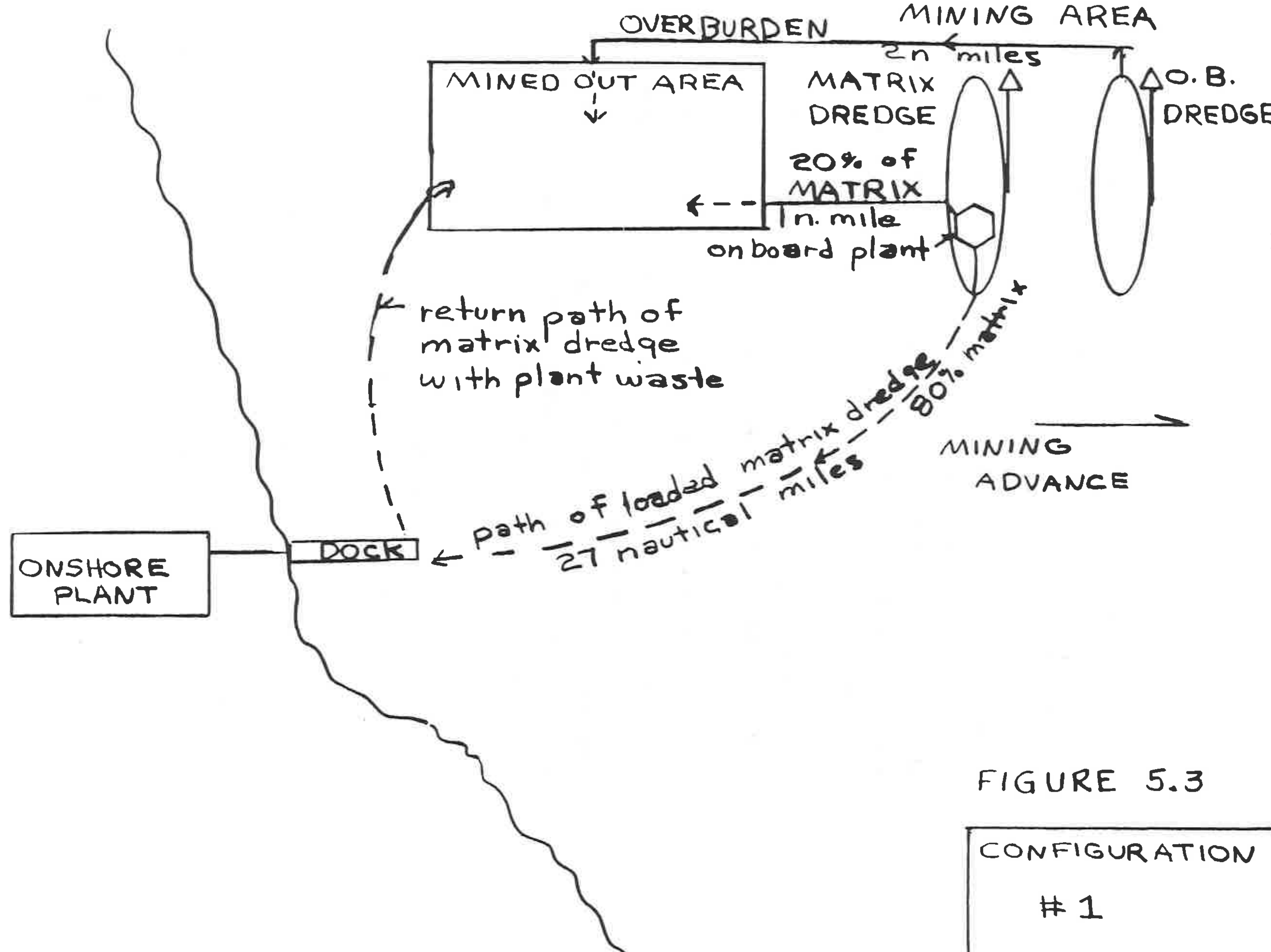



FIGURE 5.3

CONFIGURATION #1

Costs for hopper dredges were taken from the open file report "An Economic Reconnaissance of Selected Heavy Mineral Placer Deposits in the U.S. Exclusive Economic Zone" by the Bureau of Mines Washington Staff, released 4-87.

For a hopper dredge, cycle times consist of loading, travel, unloading and return travel. The hopper size increases capacity, but also increases capital. In an attempt to optimize hopper size, four loading capacities were analyzed. Table 5-3 shows the design criteria used to determine productivity and costs.

Loading and unloading is done by a 900 mm pump using the criteria in Table 5-3 at the rate of 2,916 tonnes per hour.

Table 5-4 shows the time required for each element in the cycle. The cycles per year are based upon 5,651 hours. The tonnes per cycle are based upon the loading time, which is different for each case. Table 5-4 also lists the tonnes per year of product produced for each capacity. As Table 5-4 shows, increases in loading times (hopper capacity) result in only a slight increase in tonnes per year of product.

**Table 5-4**
**Cycle Time Configuration 1**

| Item | Hours | Hours | Hours | Hours |
|---|---|---|---|---|
| Load Ore | 5.00 | 10.00 | 15.00 | 20.00 |
| Travel to Plant | 2.25 | 2.25 | 2.25 | 2.25 |
| Unload Ore | 5.00 | 10.00 | 15.00 | 20.00 |
| Load Tails | 5.00 | 10.00 | 15.00 | 20.00 |
| Travel to Mine | 2.25 | 2.25 | 2.25 | 2.25 |
| Dump Tails | 5.00 | 10.00 | 15.00 | 20.00 |
| Total Cycle Time | 24.50 | 44.50 | 64.50 | 84.50 |

**Table 5-4** (continued)

| | | | | |
|---|---|---|---|---|
| Cycles per year | 230.65 | 127 | 87.6 | 66.88 |
| Tonnes per cycle | 11,666 | 23,300 | 35,000 | 46,600 |
| Tonnes hauled | 2,690,691 | 2,962,400 | 3,066,000 | 3,120,000 |
| Tonnes prod. produced | 734,000 | 808,000 | 836,000 | 851,000 |

The following USBM equations from Open File Report 4-87 were used:

$$\text{(P) Hopper Capacity} = \frac{\text{Daily Haul Capacity (DHC)}}{2.9607(L)^{-.2923}}$$

Where

DHC = short tonnes hauled divided by operating days

L = one way haul distance in nautical miles

Operating Days = 299

Short tonnes hauled will be determined

Dredge capital cost = $7{,}052\ (P)^{.9421}$

Plant capital costs are based upon $20,000,000 for an onshore plant, $4,000,000 for an onboard plant and $15,000,000 for dock construction. Infrastructure is estimated at 30% of the total of these costs. These costs are based on a phosphate plant yielding 4,000,000 tonnes of product per year. To allow for other product rates, an exponent of .7 was usd. The general formula is:

Capital Cost A = $(\text{Production/yr } A \div 4{,}000{,}000)^{.7} * B$

where A = production/year from Table 5-6

B = base cost ($20,000,000, $4,000,000, $28,000,000) for the 4,000,000 tpy case

Table 5-5 is a summary of calculated hopper sizes and the resulting capital required for each production rate from Table 5-4. The overburden dredge does not require a large hopper and its cost is estimated from other sources. Dollars per ton capital is based on 20 years of mine production for each production scenario.

**Table 5-5**

**Capital Costs Configuration 1**

| Product X 1,000 Tonnes | | | Millions of Dollars | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Annual | 20 Yrs. | Hopper ST | Mat. Dredge | Ob. Dredge | Ob. Plant | Dock | OS Plant | Misc | Tot | $/M Ton |
| 734 | 14,680 | 8,780 | 36.60 | 40.00 | 1.22 | 4.58 | 6.10 | 26.55 | 115.05 | 7.84 |
| 808 | 16,160 | 9,668 | 40.08 | 40.00 | 1.31 | 4.90 | 6.53 | 27.84 | 120.65 | 7.47 |
| 836 | 16,720 | 10,005 | 41.39 | 40.00 | 1.34 | 5.02 | 6.69 | 28.33 | 122.77 | 7.34 |
| 851 | 17,020 | 10,183 | 42.08 | 40.00 | 1.35 | 5.08 | 6.77 | 28.59 | 123.87 | 7.28 |

Table 5-7 combines the capital cost per tonne with the operating cost per tonne, to provide a basis for cost comparison.

Operating costs for the suction head hopper type matrix mining dredge are based on the following U.S.B.O.M. formula (from Open File Report 4-87).

$$\text{Dredge operating cost (\$/s.t.)} = \frac{2.7534\ (P) + 5{,}453}{\text{Daily Dredge Capacity}}$$

where P = payload or hopper capacity in short tons
daily dredge capacity = annual capacity in short tons ÷ days.

Operating costs for the overburden dredge and for processing are based on Zellars-Williams operating cost model. Table 5-6 lists a summary of operating costs for the different production rates.

**Table 5-6**

**Operating Cost - Configuration 1**

**Operationg Cost $/Metric Ton Product**

| Tonnes Matrix* | Mat. Dred. | O.B. Dred. | Plant | Waste Disp. | Prod. Hand. | Admin. | Total |
|---|---|---|---|---|---|---|---|
| 3,363,000 | 10.65 | 3.91 | 5.71 | 0.40 | .45 | 1.30 | 22.42 |
| 3,703,000 | 10.45 | 3.91 | 5.71 | 0.40 | .45 | 1.30 | 22.22 |
| 3,832,000 | 10.38 | 3.91 | 5.71 | 0.40 | .45 | 1.30 | 22.15 |
| 3,900,000 | 10.35 | 3.91 | 5.71 | 0.40 | .45 | 1.30 | 22.12 |

* 4.6 tonnes matrix mined results in one tonne of product.

**Table 5-7**

**Total Comparative Cost per Tonne, Configuration 1**

| Tonnes Matrix | Capital | Operation | Total |
|---|---|---|---|
| 3,363,000 | $ 7.84 | $22.42 | $30.26 |
| 3,703,000 | 7.47 | 22.22 | 29.69 |
| 3,832,000 | 7.34 | 22.15 | 29.49 |
| 3,900,000 | 7.28 | 22.12 | 29.40 |

**2. Sea-going Hopper Dredge Mining, Barge Transportation of Ore to an Onshore Plant**

Figure 5.4 shows this configuration. An anchor suction dredge removes overburden, pumping it to mined-out areas. One anchor suction dredge is dedicated to waste and the other is used mostly for matrix. Since no large hoppers are required, as in Configuration 1, both dredges can be identical in design. To maximize production, the matrix dredge is required to operate in overburden some of the time. Table 5-3, shows the design criteria used for production and operating cost calculations.

The stripping ratio expressed in terms of cubic meters waste to cubic meters matrix is defined by the following equation:

$$\text{Stripping Ratio} = \frac{\text{Overburden Thickness}}{\text{matrix thickness x \% recovery}}$$

$$= \frac{8.02}{5.44 \times .85} = 1.73$$

For each cubic meter of matrix mined, 1.73 cubic meters of waste needs to be removed. The total production from the overburden and matrix dredge is:

$$2 \times 12{,}118{,}000 \text{ m}^3/\text{yr} = 24{,}236{,}000 \text{ m}^3$$

This approach assumes that 15% of the ore zone is not recovered, as compared to the alternative approach of adding this volume to the overburden.

This is the total annual production from both dredges. Taking in account the required stripping ratio, the annual ore production is:

$$24{,}236{,}000 \div (1+1.73) = 8{,}877{,}000 \text{ m}^3/\text{yr}$$

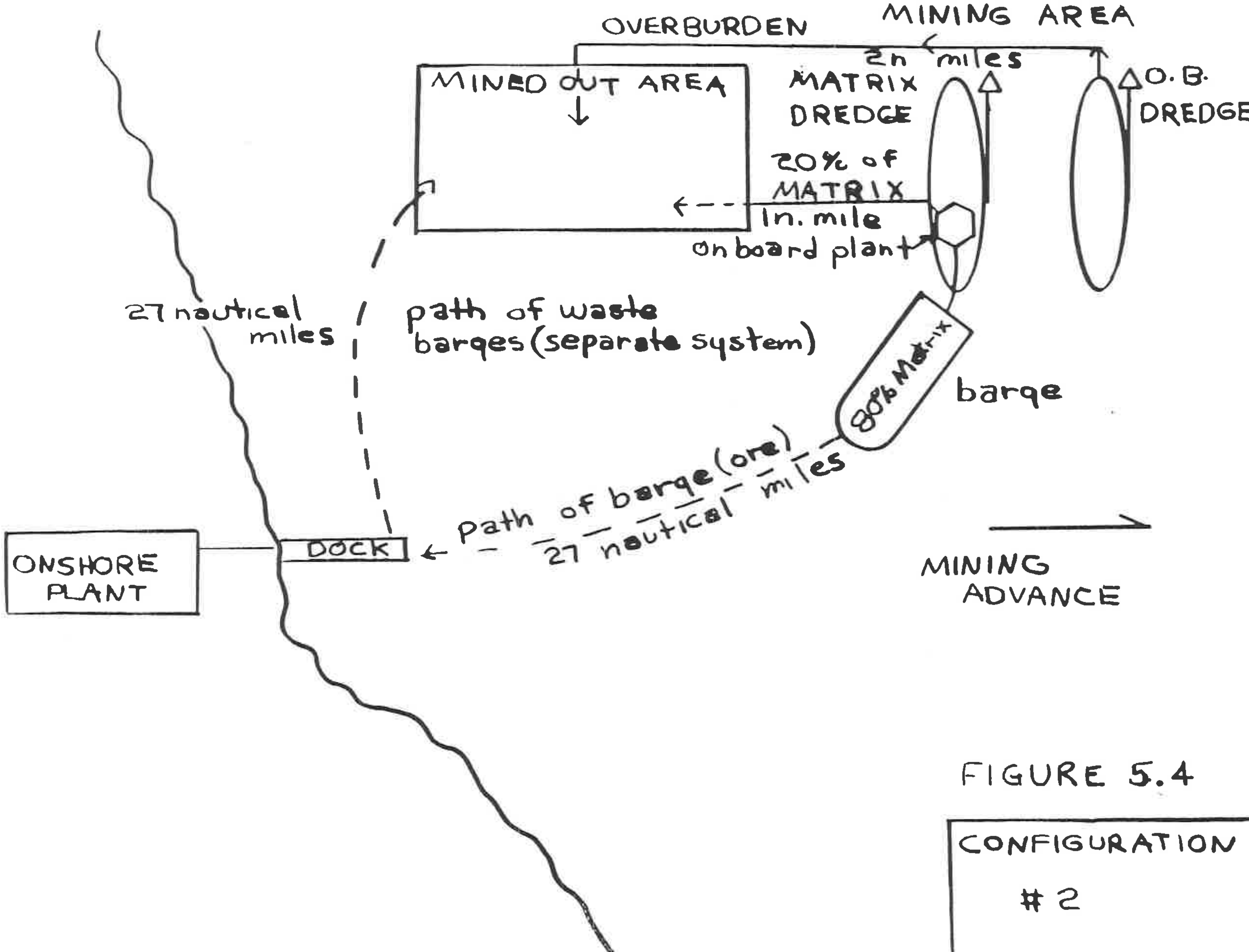



FIGURE 5.4

CONFIGURATION
# 2

Annual matrix tonnage is:

$8{,}877{,}000\text{m}^3\ (1.36\ \text{t/m}^3) = 12{,}074{,}000$ tonnes

Annual product tonnage is:

$8{,}877{,}000\text{m}^3 \div (3.37\ \text{t/m}^3) = 2{,}634{,}000$ tonnes

From these calculations, it is apparent that the matrix dredge must operate in overburden part of the time in order to maximize production.

The matrix dredge pumps matrix into a distribution box from which it is screened, washed, and deslimed. About 20% of the matrix is removed by onboard washing and disposed of in mined-out areas. The remaining 80% of the matrix is dewatered to 75% solids aboard 26,000 tonne barges. These barges are towed to the on shore beneficiation plant by tug boats. After matrix is unloaded by pumping it from the barge into live storage containment, the barge is towed back to the overburden dredge and another cycle begins. In order to avoid a large tailings area, an independent fleet of barges and tugs load, transport, and dump the plant tailings in the mined-out areas. By providing storage at the plant and a separate waste disposal sytem, the plant operation is not directly tied to the mine.

Table 5-8 shows the time required for each element in the cycle. The cycles per year are based upon 4,140 hours (the hours dredging in matrix). The tonnes per cycle are based upon the cycle time. Criteria from Configuration 1 apply here with the exception that barges move at 8 knots.

**Table 5-8**

**Cycle Time Configuration 2**

| Item | Hours |
|---|---|
| Load barge | 8.36 |
| Barge to plant | 3.38 |
| Unload barge | 8.36 |
| Barge return | 3.38 |
| Total cycle time | 23.48 |
| | |
| Cycles per year | 176.3 |
| Tonnes per cycle | 19,500 |
| Tonnes hauled per year | 3,439,000 |

Since the dredge mines 12,074,000 tonnes of matrix annually, the number of dredges required is:

$$12,074,000\ (.8) \div 3,439,000 = 2.81 \text{ or } 3$$

The waste cycle is assumed to be similar to the matrix cycle. Although the waste from the onshore plant is only 7,029,000 tonnes (as shown below), the loading-dumping times and percent solids are expected to compensate for these differences.

$$\text{washed matrix} - \text{product} = \text{waste}$$
$$12,074,000\ (.8) - 2,630,000 = 7,029,000$$

In all, a total of seven barges and tugs are required, three for matrix handling, three for waste disposal, and one for a spare. Dredge, barge, and tug capital costs are estimated from updating previous studies. Plant capital costs are based on $20,000,000 for an on-shore plant, $4,000,000 for an onboard plant, and $28,000,000 for infrastructure and $15,000,000 for dock. These costs are based on a phosphate plant yielding 4,000,000 tonnes of product per year. To adjust cost for other production rates, an exponent of .7 was used. The general formula to estimate capital cost for 2,634,000 tonnes per year production is:

$$\text{Capital Cost} = (2,634,000 \div 4,000,000)^{.7} * B$$

where B = the base cost of capital items.

Table 5-9 itemizes the capital required for comparison of Configuration 2.

**Table 5-9**

**Capital Cost Configuration 2**

| Item | mm $ Unit Cost | No. | Total Cost |
|---|---|---|---|
| Barges | 16.2 | 7 | $113,400,000 |
| Tugs | 5.5 | 7 | 38,500,000 |
| Matrix dredge | 40.00 | 1 | 40,000,000 |
| Overburden Dredge | 40.00 | 1 | 40,000,000 |
| Beneficiation Plant | 14.93 | 1 | 14,930,000 |
| Onboard Plant | 2.99 | 1 | 2,990,000 |
| Infrastructure & Misc. | 20.90 | | 20,900,000 |
| Vessel Berths, loading dock | 11.20 | | 11,200,000 |
| Total | | | $281,900,000 |
| $ per tonne annual production | | | 107.03 |
| $ per tonne mine life (20 years) | | | 5.35 |

Operating costs are computed using Zellars-Williams operating cost model. Table 5-10 summarizes the operating costs.

**Table 5-10**

**Operating Costs Configuration 2**

| | Cost per tonne product |
|---|---|
| Mining | 6.64 |
| Plant | 4.94 |
| Waste/Water | .25 |
| Product Handling | .45 |
| Administration | 1.30 |
| Total | $13.58 |

The total comparative cost for Configuration 2 is $18.93 per tonne product.

3. **Dredge mining, pipeline transportation of ore to onshore plant**

Because the location of the plant is upstream of the river, a pipeline system is not feasible. A substantial part of the pipeline would lie across shipping channels and industrial installations. For this reason, as well as environmental considerations, the pipeline system was not considered in further detail for this report. This is the same conclusion reached by other investigators, i.e., Zellars-Williams 1979, and Development Planning and Research Associates, Inc., 1987 North Carolina Offshore. Figure 5.5 illustrates the configuration.

4. **Dredge mining, pipeline transportation to offshore plant**

Figure 5.6 shows this configuration. An overburden dredge mines overburden sands ahead of the matrix dredge. Overburden is pumped back to the nearby mined-out areas. Trailing about 2,000 feet behind, in the same cut, the matrix dredge mines and pumps directly to a nearby offshore plant. This plant is built on an island formed by dredged material, located equi-distant an average of two nautical miles from the mining areas. The pipeline is flexible and most of it is submerged. Only the flexible portion near the dredge is floating. At the beneficiation plant, matrix is processed, and a saleable product produced. Waste is pumped through a separate pipeline to mined-out areas and released. All processing is done at the island-based processing plant. Product from the beneficiation plant is barged to shore for sale. The dredge production is identical to Configuration 2.

Barges are only needed to transport the product to Savannah Harbor. The cycle time is based on the same criteria as for Configuration 1.

Loading time is:

barge capacity ÷ loading rate = hours

Tonnes (26,000 x .75) ÷ (2916) t/hr = 6.69 hours

Travel time is:

distance ÷ speed = hours

27 (nautical miles) ÷ 12 knots = 2.25

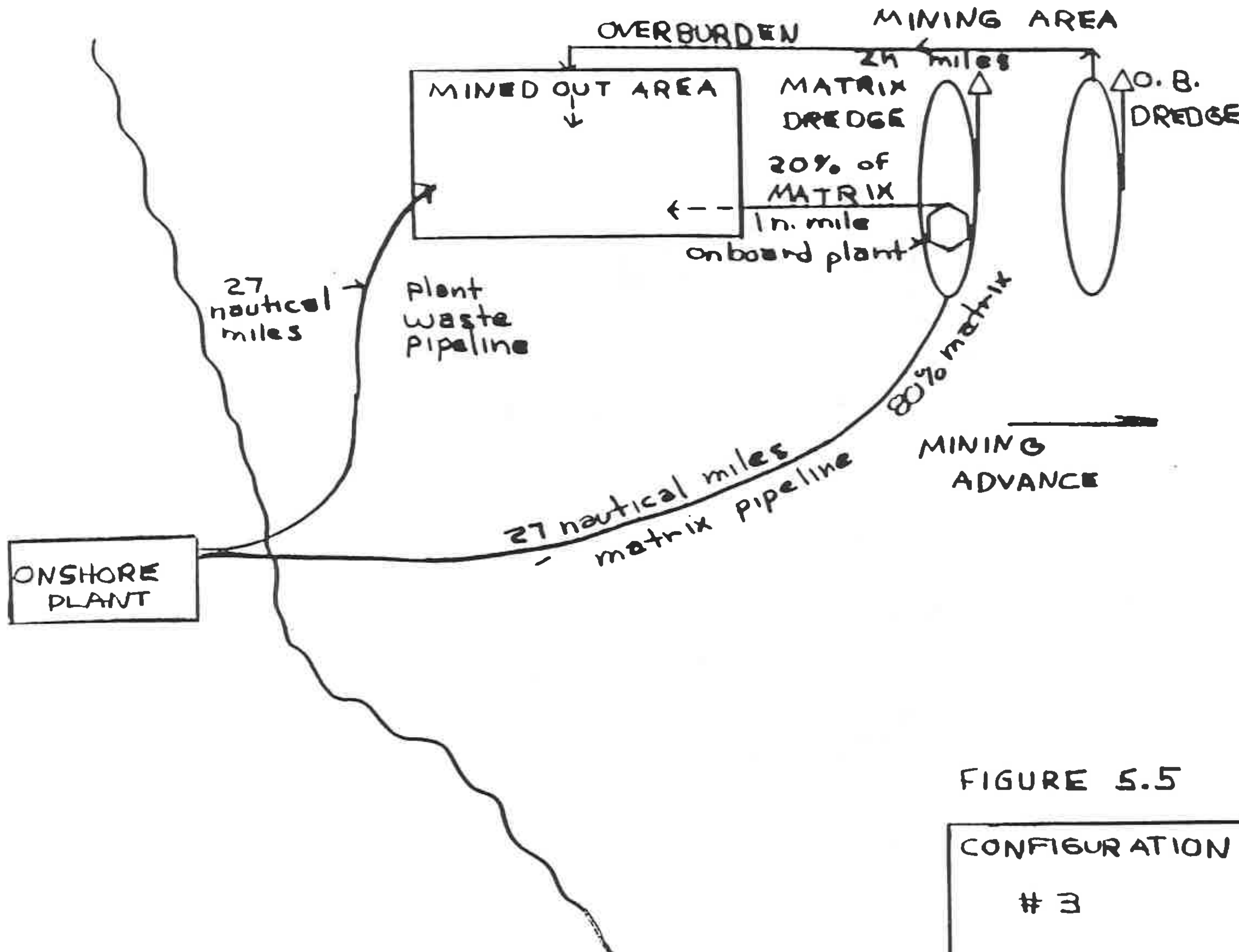



FIGURE 5.5

CONFIGURATION #3

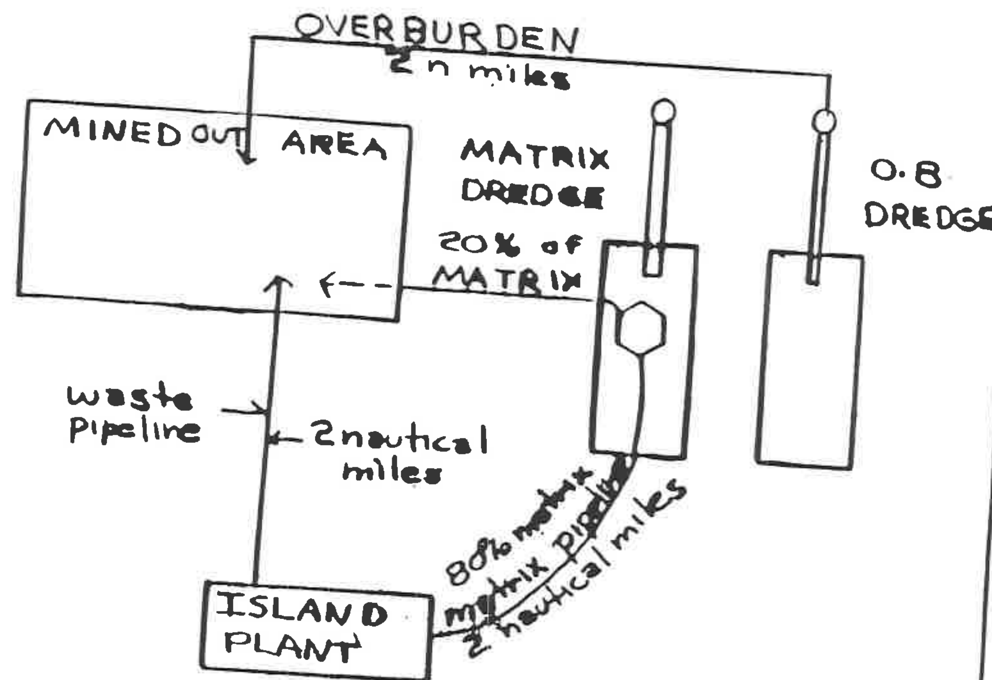



FIGURE 5.6

CONFIGURATION # 4

Assuming that unloading and loading are equivalent, cycle time is:

| | Hours |
|---|---|
| Loading | 2.25 |
| Plant to harbor | 6.69 |
| Unloading | 6.69 |
| Harbor to plant | 2.25 |
| Total Cycle Time | 17.88 |
| Cycle per year | 316 |
| Tonnes per cycle | 19,500 |
| Tonnes hauled per year | 6,162,000 |

Since only 2,634,000 tonnes of product require transport, one tug and one barge is adequate. Employment of contract transport carrier systems for product may be indicated.

Capital costs are summarized in Table 5-11. The only difference from Configuration 2 is the number of barges, tugs, island cost, and pipeline cost.

**Table 5-11**
**Capital Cost Configuration 4**

| Item | mm $ Unit Cost | No. | Total Cost |
|---|---|---|---|
| Barges | 16,200,000 | 1 | $ 16,200,000 |
| Tugs | 5,500,000 | 1 | 5,500,000 |
| Matrix dredge | 40,000,000 | 1 | 40,000,000 |
| Overburden dredge | 40,000,000 | 1 | 40,000,000 |
| Beneficiation plant | 14,930,000 | 1 | 14,930,000 |
| Onboard plant | 2,990,000 | 1 | 2,990,000 |
| Infrastructure & Misc. | 20,900,000 | 1 | 20,900,000 |
| Island | 30,000,000 | 1 | 30,000,000 |
| Pipelines | 2,500,000 | 2 | 5,000,000 |
| Vessel berth & loading dock | 11,200,000 | 1 | 11,200,000 |
| Total Capital | | | $186,720,000 |
| $ per tonne annual production | | | 70.89 |
| $ per tonne mine life (20 years) | | | 3.54 |

Operating costs were computed using Zellars-Williams operating cost model. Table 5-12 summarizes the operating costs.

**Table 5-12**
**Operating Cost Configuration 4**

| Item | $ Cost per tonne |
|---|---|
| Mining | 5.76 |
| Plant | 4.94 |
| Waste/water | .25 |
| Product handling | .46 |
| Administration | 1.30 |
| Total | 12.71 |

The total cost for comparison of Configuration 4 is $16.25 per tonne of product.

### 5.2.3 Selection of Configuration

It is evident that, from a material handling standpoint, the offshore plant should be more efficient. Material is processed near the plant and wasted near the plant in mined-out areas. With onshore plants, washed matrix is hauled 27 nautical miles by barge and tug, processed, and the waste hauled 27 miles back to the mined-out pits for disposal. Table 5-13 outlines comparative capital and operating costs for each configuration. Based upon this trade-off study, Configuration 4, utilizing an offshore plant, was selected as the basis for examining the economic feasibility of exploiting off-shore phosphorites. This configuration is developed in further detail in the following parts of this section.

**Table 5-13**

**Configuration Selection**

| Configuration | Annual Production Tonnes | Cost $/Tonne Concentrate | | |
|---|---|---|---|---|
| | | Capital | Operating | Total |
| 1 | 851,000 | 7.28 | 22.42 | 29.70 |
| 2 | 2,634,000 | 5.35 | 13.58 | 18.93 |
| 3 | Not feasible (no economics done) | | | |
| 4 | 2,634,000 | 3.54 | 12.71 | 16.25 |

Configuration 1) Sea-going hopper dredge for mining and transportation to an onshore plant.

Configuration 2) Seagoing hopper dredge mining and barge transportation of ore to an onshore plant.

Configuration 3) Dredge mining, pipeline transportation of ore to onshore plant.

Configuration 4) Dredge mining, pipeline transportation of ore to nearby offshore island plant.

Zellars-Williams, 1979, treated Configuration 2 in considerable detail and concluded that favorable economics could result if all the assumptions made proved to be valid. The beneficiation process flowsheet suggested by Zellars-Williams, 1979, is adopted for this study, with minor modification in the degree of final processing. Most modern chemical fertilizer production plants use wet phosphate rock as feed stock. Calcination to improve grade of phosphate rock after wet processing is a matter of economics not considered essential to evaluating feasibility.

Capital and operating costs of beneficiation plants of various production rates, together with ancillary facilities and supporting infrastructure, are well known, and no attempt is made in this report to construct new estimates. Capital and operating costs are developed from current in-house data, factored for the production rates and unit costs applicable to the selected configuration and local conditions.

### 5.2.4 Design Criteria

Table 5-14 lists the design criteria used for determining production limits, operating costs, equipment needs, and capital requirements of the selected configuration. As with any mining project, the physical and chemical geologic parameters are site-specific, having been determined by nature. These characteristics were based upon the initial mine site selected in Section 5.1.1.

Operating factors were determined by past experience, as well as consideration of the unique mining environment. In the case of offshore dredging, it is necessary to consider the size and design of the dredge from a seaworthy standpoint. A large vessel is necessary to accommodate the mining depths; therefore, required size is somewhat independent of production. The largest dredge pumps operating in ocean mining today have a suction head pipe diameter of 1200 mm (48"). For the conditions of offshore Georgia, a 900 mm diameter (36") suction head pipe was used to determine productivity. The design philosophy is to use the largest practical dredge pump, mounted on a seaworthy vessel. For example, a dredge pump producing half the capacity of a 900 mm dredge pump gives only a small reduction in capital and operating costs. Therefore, the design philosophy maximizes production while minimizing the costs.

Table 5-15, Climatic and Physical Oceanographic Data, for the southeastern United States continental shelf, indicates conditions which may cause dredge mining operations to shut down which depends upon the specific equipment and configuration utilized.

The production rates are determined from the design criteria. In most land-based phosphate operations, the beneficiation plant is optimized and, because its maintenance and operations are easier, operating hours exceed the dragline (mining) operating hours. Often, several draglines feed the same plant. Stockpiles and surge bins cushion the difference between operating hours and production hours.

## Table 5-14
## Design Criteria

o Ore (matrix) assumed distribution

| Size Fraction | Percent | BPL | Disposition |
|---|---|---|---|
| +4 Mesh | 2.74 | 17.03 | Grind to feed |
| 4x8 Mesh | 0.64 | 33.38 | Grind to feed |
| 8x16 Mesh | 2.05 | 30.18 | Grind to feed |
| 16x150 Mesh | 68.52 | 25.53 | Flotation Feed |
| 16x150 Mesh | 4.76 | 6.00 | Feed dilution |
| -150 Mesh | 21.29 | 15.07 | Clay Waste |

o Grade Criteria (Estimated)

Feed Head 16x150 - 24.20 BPL
Rougher Concentrate - 55.00 BPL
Final Concentrate (Float) - 66.0 BPL
Final Concentrate (if Calcined) - 68.00 BPL

o Recoveries

Mining Recovery - 90%
Primary Cyclone Recovery of Feed - 98%
Secondary Cyclone Recovery - 99%
Rod Mill Weight Recovery - 85%
Flotation Recovery (Overall) - 80% of BPL values in the total feed

o Annual Operating Hours

| | |
|---|---|
| Days lost: | |
| annual dry dock/repairs | 30 |
| hurricane | 1 |
| gale force winds | 5 |
| fog | 1 |
| other | 1 |
| | 38 |
| Days operational | 327 |
| Hours operational/year (327 x 24) | 7,848 |
| Mechanical availability | 90 |
| Overburden dredge Operating factor * | 83 |
| Matrix Dredge Operating factor * | 87 |
| Dredge operating factor - average, use | 85% |
| Overall operating factor - .90 x.85 = | 76.5% |
| Effective production hours/year (7,848 x .715) | 6,000 |

* Note: operating factor for dredges is based on allowing time for resetting spuds at end of each mining cycle.

**Table 5-14** (continued)
**Design Criteria**

| | |
|---|---|
| o Beneficiation Plant | |
| Washer production hours | 6,000 |
| Production hours feed prep. flotation and product to storage | 7,000 |
| o Mining Data | |
| Average Water Depth | 13.97 m |
| Average Overburden Depth | 8.02 m |
| Average Matrix (ore) Depth | 5.44 m |
| Average Mining Depth (below MSL) | 27.43 m |
| Matrix "X" ($m^3$/t prod.) | 3.13 |
| Matrix Density - 1.44 tonnes/$m^3$ (90 lbs/$ft^3$) | 1.44 |
| Stripping Ratio - 1.64 $m^3$ overburden/$m^3$ matrix | 1.64 |
| Overburden Density - 1.6 tonnes/$m^3$ (100 lbs/$ft^3$) | 1.60 |

Note: Oceanographic information is contained in Table 5-15.

## Table 5-15

### Climatic and Physical Oceanographic Data *

Much of the following information applies generally to the Savannah, Georgia region rather than specifically to the proposed offshore mining site. Local measurements within the area of interest have not been made.

Precipitation: Average annual rainfall is 51 inches, half of which falls during the June 15 through September 15 thunderstorm season. Snowfall is rare and occurs, on an average, less than once a year.

Wind: Winter surface winds are chiefly out of the west while the summer months experience north and east winds alternating with those from the west. Average wind speed during the year is about 7 miles per hour with peaks each month ranging up to 30 to 38 miles per hour.

Storms: During an 84-year period to 1970, all tropical cyclones occurred between May 28 and October 19. Severe tropical storms affect the area about once in 10 years. In the period 1954-1975, seven cyclones passed through the Savannah area.

Fog: Heavy fog is common along the coast and Savannah experiences 44 foggy days a year. The distribution of foggy periods is fairly even through the year, although July and August have less.

Temperature: The climate is temperate with a seasonal mean of 51°F in the winter and 80°F in the summer. The record minimum and maximum are 8°F and 105°F.

Tides: The maximum spring tidal range along the southeastern coast is 8 feet and occurs in the Savannah area. Strong onshore winds can raise the water level a significant amount above the maximum normal tide level.

Waves: Spring and summer waves from the southeast are generally small. Although more severe wave conditions result from the strong fall and winter winds from the north and west, the proposed mining site is relatively well sheltered by land from this direction. Offshore from Savannah the recorded percent frequency of two levels of wave height is:

| Wave Height | Feb. | May | Aug. | Nov. | Annual |
|---|---|---|---|---|---|
| 4 foot | 40% | 66% | 74% | 48% | 57% |
| 12 foot | 5% | 2% | 1% | 1.5% | 2.4% |

* From Zellars-Williams (May 1979)

For ocean mining, the plant is dependent on feed from a single dredge, so stockpiling is impractical. Therefore, the washer or front end of the plant must reduce operating hours from the normal of about 7,000 hours per year to match the dredge, which is limited to 6,000 hours per year. A quick look at capital costs from previous studies shows that dredging and transportation comprise a much larger percent of total project capital than does the beneficiation plant. Therefore, the dredging/transportation systems are optimized at a slight reduction in plant capital cost efficiency.

Section 4 lists the available state-of-the-art technologies. The only currently utilized system capable of mining phosphate in offshore Georgia is a plain suction head dredge. There is considerable doubt that this dredge is capable of mining the phosphorite which is consolidated. If this is true, then no currently utilized systems exist for mining offshore Georgia phosphorite.

### 5.2.5 Mining Systems

The system proposed for offshore phosphate mining in the areas identified is an advanced version of a hydraulic dredge of the cutter head suction type.

The platform would be constructed of steel, taking the shape of a large hull comprising a series of watertight compartmentalized buoyant sections fastened together to make a semi-rigid structure. The buoyancy and structural integrity of the platform must be capable of supporting the spuds, pumps, prime movers, deck machinery, operator's house, ladder and superstructure, and as required, certain ore washing and screening equipment. This structure must be capable of floating, with safe freeboard, in moderate seas while being towed or otherwise moved by tug. During operation, the platform will be supported on legs extending to the bottom of the cut and must be structurally capable of carrying the dead load, wind and wave loads, and the dynamic loads imposed by the excavating machinery. The design and construction of this kind of platform is entirely within the technological expertise and experience of U.S. contractors and manufacturers.

The platform-hull will be equipped with a ladder supported by cantilevered overhead structural members. The ladder will pivot on a swivel located on or near deck level at the front end of the platform-hull to permit the ladder to articulate. The ladder, about 250 feet in length, when lowered to $45^{\circ}$ below horizontal, will swing port to starboard over an arc angle of $80^{\circ}$-$90^{\circ}$. At digging depth of about 130 feet (below water surface), the chord distance of the arc swing will permit a cut width of about 360 feet. With the ladder lowered to $60^{\circ}$, digging depth of 165 feet and cut width of about 360 feet can be realized.

An hydraulic or electric motor driven cutter head mounted at the end of the ladder engages and excavates the material to be extracted. The cutter head directs excavated material to the flared open end of a pipe which leads to the suction side of a centrifugal pump. The pump is also submerged and is located about one-third the distance up the ladder. The pump is a high capacity, low head end suction centrifugal pump capable of passing large solids. This pump is direct driven through an extended mechanics shaft arrangement or directly by a variable speed submerged electric motor and gear box mounted on the ladder.

The platform-hull is designed to accommodate eight spuds. The entire platform is supported by four spuds extending to the ocean bottom. The lower end of each spud has an enlarged pad providing the area required for bearing to support the platform-hull. The spuds are of a length, when retracted, to permit floating with minimum draft, and when extended, to provide clearance above high tide and severe weather seas. Four of the spuds (working spuds) are mounted in carriage systems which will facilitate controlled horizontal movement of the platform. This movement, with working spuds extended, will permit advancing the mining face of the cut about 50 feet without resetting spuds.

When the full limit of horizontal travel is completed, the other four spuds (fixed or positioning spuds) are extended, the working spuds retracted, and the platform repositioned.

The working spuds are extended, the positioning spuds are retracted and the advance cycle by manipulation of the carriage system is repeated.

This platform-hull cutter head suction dredge will operate in all but the most severe weather conditions. When gale or hurricane force wind and wave action occurs, the platform will ride out these conditions above the sea, supported on eight legs.

The cutter head may be an open radial multi-blade basket-type with cutter teeth designed for loose sand, sandy-clay and moderately cemented sands and gravels. Since the cutter head is axially mounted and rotates in one direction, excavation occurs when the ladder sweeps in the same direction. During the return sweep, no engagement of the cutter head occurs and the pump will collect material previously loosened. The matrix dredge will be equipped with a radial basket-type cutter head.

The cutter head may be of a bucket wheel design. The rotating axis of the wheel is perpendicular to the ladder and the buckets engage the excavating face in both sweeping directions. Bucket configuration and spacing is arranged for the type of material to be excavated and buckets spaced on the wheel to reject oversize particles. Production from this type of cutter is expected to be better than from a basket-type. The overburden dredge will be equipped with a bucket-wheel type cutter head.

The proper cutter type is a matter of design based upon accurate knowledge of soil conditions. For the purpose of this study, dredge production is based on experience with these two cutter heads in unconsolidated sandy material and on practical limits of centrifugal pump capacity, average solids content of 30-40% by weight in the slurry.

The mining system described above is based on a design proposed by Ellicott Machinery Corporation of Baltimore, MD, for mining sands offshore U.S. Atlantic coastal waters for beach nourishment. The design and construction of the dredge platform described is well within the capability of this manufacturer, who will combine its own dredge construction experience with the experience of offshore gas and oil exploration and production platform contractors.

Production is limited by the capacity of the ladder-mounted dredge pump. The capacity of the dredge pump is restricted by its size (weight) and the power output of the prime mover (motor, speed reducer and power transmission system). GIW Industries, Inc., of Grovetown, Georgia has recently supplied deck and ladder pumps (30 x 34 TBC 84, and 34 x 34 LHD-60) to Shipyard Stapel B.V., The Netherlands, for the dredge "Amazone" built for Dredging International, N.V., Belgium. These pumps have slurry pumping capacity in the range of 50,000-70,000 gpm at discharge heads up to 500 feet.

The practical upper limit of currently manufactured submersible electric motors is about 3000 kW.

The combination of these state-of-the-art currently manufactured components indicates that dredge slurry pump capacities of 70,000 gpm at 40% solids, and 7,200 tonnes (dry solids) per hour are realistic. Total head, and therefore discharge head, is limited for practical purposes only by the amount of energy available at the pump shaft, i.e., by the horesepower (kW) of the prime mover.

The mining and ore transport system described above envisages an arrangement which is an assembly of cutter head, ladder pump and deck pump sized for maximum performance consistent with available power and the practical limitations of the platform and its structural components working in an ocean environment. This is the premise for mining which is the basis for determining the annual production capacity of the selected configuration used in evaluating feasibility of the enterprise.

### 5.2.6 Mining Dredges

Two dredges will be required for the mining of phosphorites from the offshore areas described in Section 5.2.1. One dredge will excavate and remove overburden, the other will mine matrix and remove it to the beneficiation plant.

Overburden from the initial mining area will be used as hydraulic fill in the construction of the off-shore island.

The overburden dredge will excavate overburden and discharge through a trailing pipeline for deposition in mined-out cuts. The pipeline would be supported at a semi-submerged level by floats to minimize wave action effects. The pipeline would discharge to a barge-mounted hopper and tremie.

The tremie would direct discharge of the slurry below water near the bottom of the cut being backfilled. The discharge pipeline and tremie hopper barge would be tended by a tugboat which "shepherds" the pipeline and moves the tremie hopper barge.

The overburden dredge must remove about 7 cubic yards (5.1 cubic meters) for each tonne of final product produced. Average water depth is 45.8 feet, and the average depth of overburden is 26.3 feet (23.3 feet minimum to 32.5 feet maximum) in the area designated for mining. The platform must be capable of operating safely above the water surface with a clear distance of about 6-10 feet. Tide variance of +7.4 feet and wave height of 15 feet should be allowed. This will put the bottom of the platform at Elevation +30.4 (8 + 7.4 + 15). Assuming a depth of the platform-hull of 24 feet, the top of the platform would be at Elevation +54.4. Average overburden digging depth from top of platform to Elevation -72.1 is 126.5 ft. (54.4 + 45.8 + 26.3). Maximum digging depth to Elevation -86.3 is 140.7 feet (54.4 + 53.8 + 32.5).

The overburden dredge will excavate about 11,200 cubic yards (8,564 $m^3$) from one position; the spud carriage system will advance the platform approximately 50 feet, before repositioning. This cycle will take 30-60 minutes.

This dredge is equipped with a GIW 34 x 34 LHD-60 ladder pump and 2500 kW variable speed submersible motor. The pump capacity is 65,000 gpm at about 85 feet head (26 meters). A bucket wheel cutter head, at the end of the ladder, powered by a 1500 kW motor excavates and directs overburden to the ladder pump suction.

The ladder pump discharges directly into the suction of a GIW 30 x 33 MDH 72 slurry pump mounted on the deck. This pump is fitted with an impeller capable of 65,000 gpm at 200 feet head (61 meters) at 350 rpm. The prime mover for this pump is a 4500 kW variable speed electric motor and speed reducer.

The overburden dredge is capable of mining at the average rate of 6,560 tonnes per hour at 35% solids, and transporting this slurry through a trailing pipeline about 1.5 nautical miles (9,120 feet) to waste in nearby mine cuts.

The matrix excavating dredge will excavate matrix and discharge through a trailing pipeline to a central processing plant. The area to be mined over a 20-30 year period will be within a radius of about 3 nautical miles (18,240 feet) from an artificial island on which the plant is built. The maximum pipeline length will be about 25,000 feet. The matrix mining dredge will operate from a stationary position above the water surface as described for the overburden dredge. The matrix dredge must remove about 4 cubic yards (3.1 cubic meters) for each tonne of final product produced. Average depth of matrix is 17.8 feet (16.4 ft. min. to 23 ft. max.). The average bottom of the matrix is at Elevation -90.1. From the top of the platform at Elevation +54.4, the average matrix digging depth is 144.1 ft. Maximum digging depth to Elevation -109.3 is 163.7 feet (54.4 + 53.8 + 32.5 + 23).

For each move, the matrix dredge will excavate about 7,500 cubic yards (5735 $m^3$). The repositioning cycle, which occurs at the end of the spud carriage system travel (about 50 ft.), will take about 30-60 minutes.

This dredge is equipped with a GIW 30 x 33 MDH 72 ladder pump and 1500 kW variable speed submersible motor. The pump capacity is 45,000 gpm at about 90 feet head (27 meters). A radial basket-type cutter head, at the end of the ladder, powered by a 1500 kW motor excavates and directs matrix to the ladder pump suction. The ladder pump discharges directly into the suction of a GIW 30 x 34 T8C 84 slurry pump mounted on the deck. This pump has a capacity of 45,000 gpm at 450 feet head (137 meters), and is driven by a 6,500 kW variable speed motor and speed reducer at 425 rpm. The matrix dredge is capable of mining at the average rate of 3,600 tonnes per hour at 30% solids, and transporting this slurry three nautical miles (18,240 feet) to the island-based beneficiation plant.

The two dredges are to be similar in design and construction. Average digging depth for the overburden dredge from top of deck is about 127 ft. (39 m) and for the matrix dredge about 144 ft. (44 m). Ladder length would be matched to the cut depth. Cutter head power would be the same. Ladder pumps would be similar, the overburden dredge having more capacity. Deck pumps would be sized to accommodate the slurry and pipeline distance.

The overburden dredge requires about 9500 kW diesel engine powered electric energy generating capability to provide power to all equipment. Maximum power demand, which occurs when dredge pumps are being started while the other machine is operating, is about 9400 kW. During normal operation over mine life the power demand is about 7500 kW. Fuel consumption is about 1.4 tonnes per hour.

The matrix dredge requires installed diesel engine electric generating capability of about 10,500 kW. Mine life average power demand is about 8400 kW. Maximum power demand occurs when mining at the extremities of the oredoby, about 3 nautical miles, is estimated to be about 10,500 kW. Fuel consumption for mine life average is about 1.8 tonnes per hour.

The two dredges will be similarly equipped with diesel fuel powered electric generators having a nominal continuous rating of 10,000 kW and standby rating of 12,000 kW. Fuel storage capacity of about 1360 tonnes (10,000 bbls) to permit one month of operation without re-supply is provided.

Fuel is to be supplied by a commercial operator such as Belcher Company of Georgia, Inc., who will contract for delivery to the offshore dredges by fuel barge (10,000-17,000 bbl capacity). This fuel barge would normally deliver and transfer diesel to each dredge on a 10-15 day cycle.

Crew accommodations for three shifts are provided in 2-bed cabins. Crews work two weeks offshore, 14 days @ 12 hours/day, and go ashore for seven days. Shifts are staggered so that while two shifts are on duty offshore, one shift is at rest on shore. Cooking and mess facilities are provided to serve about 40 persons, three meals each day. Provisioning and re-supply occurs on a two-week cycle when crew shifts change. Crews and provisions are transported from Port Savannah by motor launch.

Each dredge has a helicopter landing deck platform positioned in cantiliver-fashion off the stern.

For purposes of estimating capital cost, it is assumed the two dredges are identical; sized for the maximum conditions. Operating cost will be estimated separately for the two machines based on materials handled and distances transported.

## 5.3 BENEFICIATION

The beneficiation facilities have been grouped into the following areas: washer, feed preparation, flotation, reagent, waste disposal, water recirculation, and product storage and loading.

These areas are designed to receive slurried ore from the dredge, disaggregate the ore, wash and grind the oversize rock, remove clay from the feed, and separate the sand from the feed to produce a marketable phosphate concentrate product.

Sea water will be used in the beneficiation process, which will result in a higher level of chlorides in the concentrate. Chlorides will be removed from the concentrate by filtering and rinsing with fresh water supplied by desalination units.

Waste products (clay and sand tailings) will be returned to the mine cuts.

### 5.3.1 Washer

The phosphate rock ore (matrix) is dug and slurried by the dredge and then pumped to the washer for initial processing. The purpose of the washer is to separate the +20 mesh rock from the -20 mesh fines and to grind the +20 mesh rock to pass 20 mesh.

Large clay balls and other deleterious material are discarded at the washer. This material is recovered from the discard pile and used as fill to repair erosion, and/or is placed as fill along the toe of the outer slopes of the island.

The slurried matrix is received from the dredge at the matrix distributor where it is diverted to the trommel screens. The trommel screens separate the material at 2 inch. The +2 inch oversize is conveyed to a reject pile, while the -2 inch undersize from the trommels gravity flows to the flume screens. The flume screens separate the material at about 20 mesh. The flume screens facilitate a quick reduction in flow and removal of a large percentage of the solids. The +20 mesh material from the flume screen oversize is re-screened at the primary vibrating screens. Plus 20 mesh oversize from the primary vibrating screens is then pumped to the milling section which consists of a rod mill in closed circuit with vibrating screens (secondary screens).

The secondary vibrating screens feed a surge bin. Feed retrieval from the bin is achieved by a weigh-belt feeder which is designed to deliver a controlled rate of feed to the rod mill. The rod mill discharge reports to a pump box which recycles the ground pulp to the secondary vibrating screens. The ground -20 mesh material passing the secondary vibrating screens is combined with the -20 mesh undersize from the flume screens and primary vibrating screens and is pumped to feed preparation. The +20 mesh material from the secondary vibrating screens reports to the mill feed surge bin.

The flowsheet for the washer is shown in Figure 5.7.

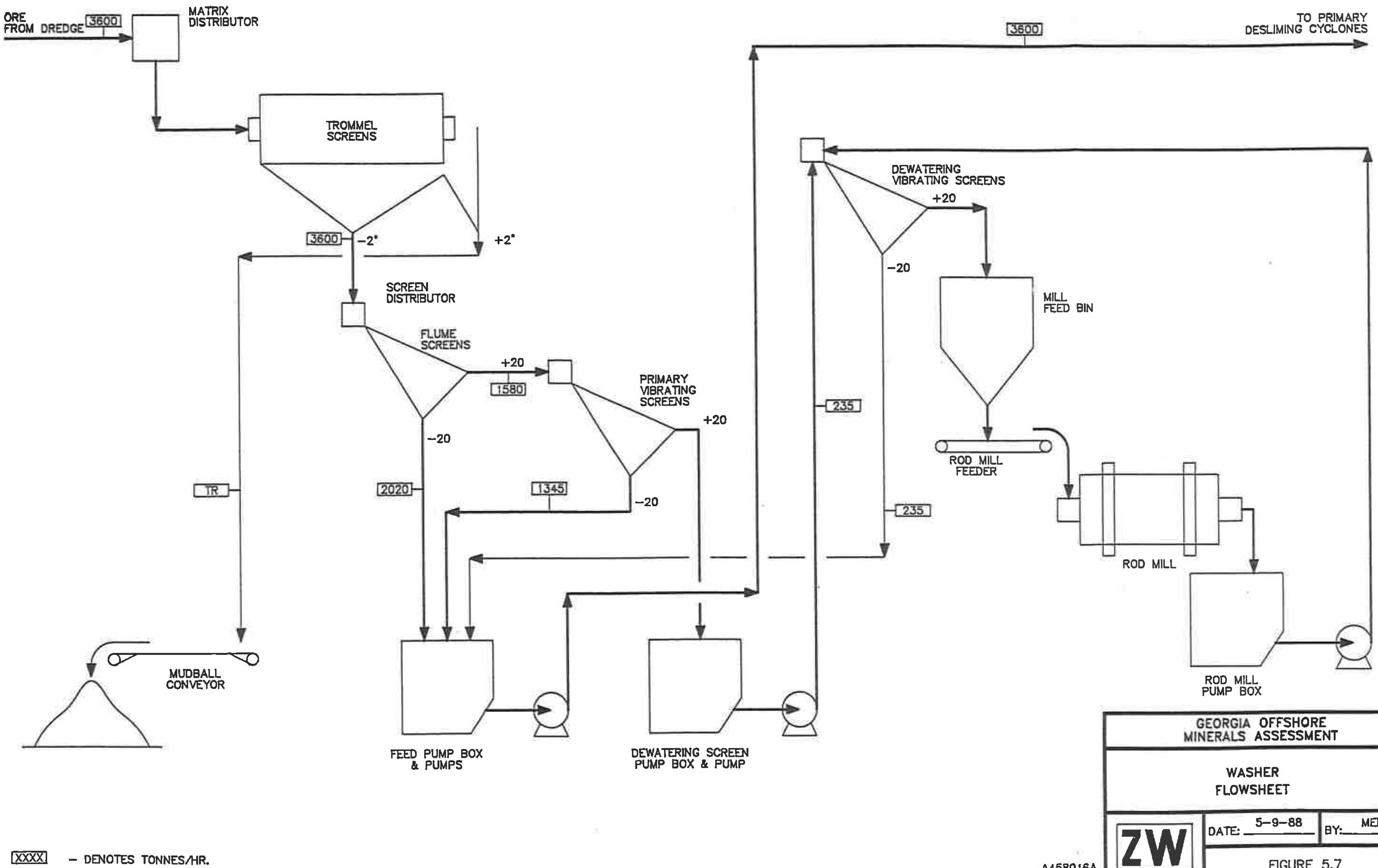
### 5.3.2 Feed Preparation

The -20 mesh feed from the washer is pumped to the feed preparation area. Primary activities conducted in the feed preparation area are:

- Removal of the -150 mesh particles (slimes) from the flotation feed. The -150 mesh slimes are removed in order to improve flotation efficiency and to reduce reagent consumption.
- Perform attrition scrubbing of the flotation plant feed.
- Provide feed to the flotation plant at a uniform rate by feed surge storage and control of feed tonnage rate.

This discussion describes one train. More than one train is required.

Feed from the washer is pumped to the primary desliming cyclones. The cyclones are used to remove -150 mesh slimes (clays) from the feed. The primary desliming cyclone underflow, at about 65% solids, gravity flows to the feed surge bin. The feed surge bin is designed to provide about 24 hours of live feed storage, smooths out upstream process surges, and helps to maintain a constant rate of feed to the feed preparation circuit. When the bin overflows, it also functions as a desliming operation.




GEORGIA OFFSHORE MINERALS ASSESSMENT

WASHER FLOWSHEET

ZW

DATE: 5-9-88 BY: MEK

FIGURE 5.7

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Feed is reclaimed from the storage bin as a slurry and is pumped to the secondary desliming cyclones. The cyclones remove additional -150 mesh slimes and dewater the feed prior to attrition scrubbing. The secondary desliming cyclone underflow, at about 65% solids, gravity flows to the attrition scrubbers. Scrubbing of the feed removes any tramp clay particles, removes some of the friable carbonates by reducing it to slime particle size, and effectively scours the particle surfaces to enhance flotation performance.

Scrubbed feed is then repulped with recycle water and pumped through the tertiary desliming cyclones to remove the slimes produced during the scrubbing step.

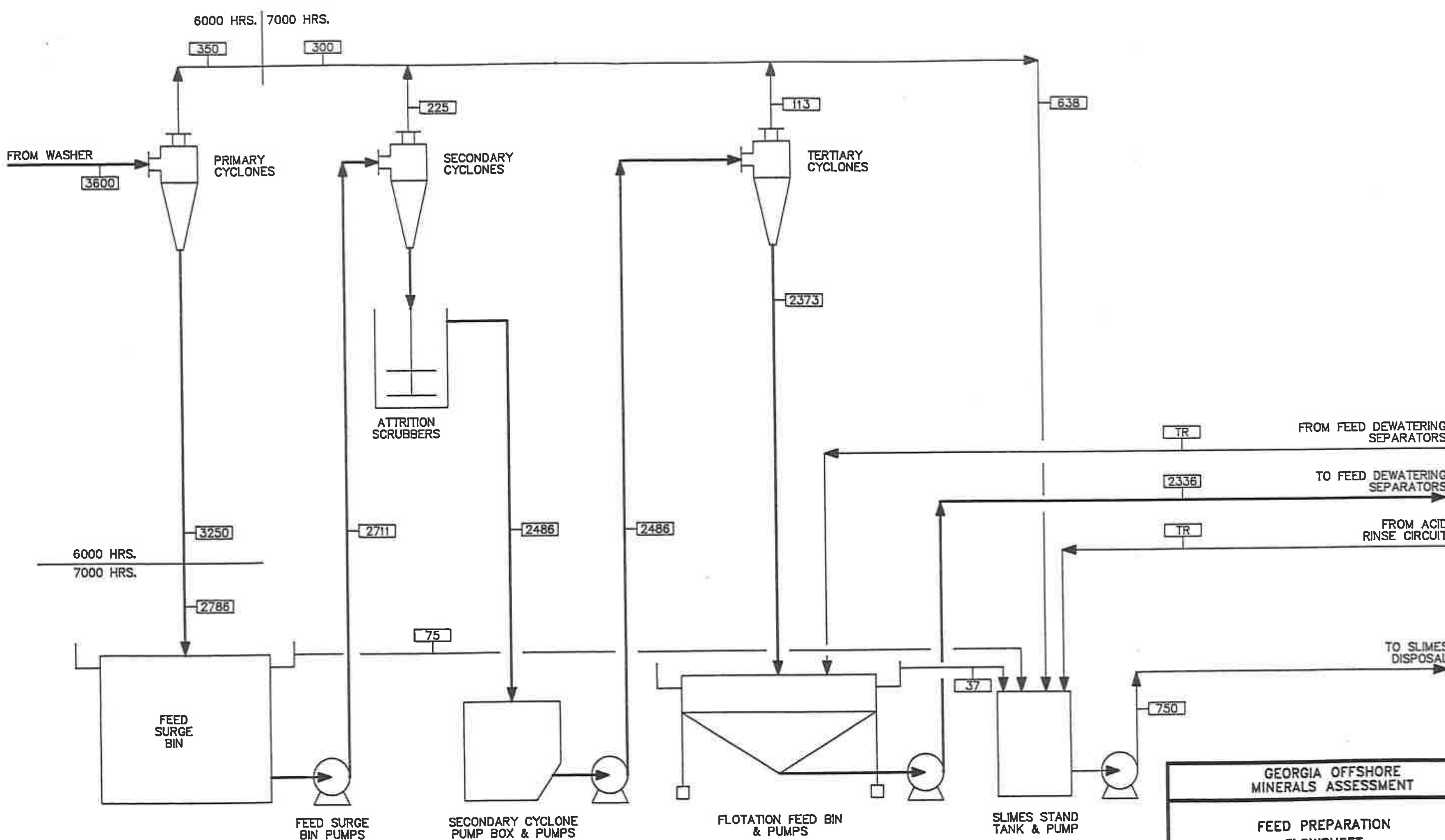
The primary, secondary and tertiary desliming cyclone overflows and bin overflows contain slimes and fine solids entrained in dewatering. The combined slimes collect at the slimes stand tank and then gravity flow to the waste disposal station. Clarified water from the waste disposal station is returned to the plant for re-use in the process. Waste disposal and water distribution are reviewed in Section 5.3.5 and 5.3.6, respectively.

The tertiary desliming cyclone underflow reports to the flotation feed bins. The bins provide about 4 hours of live storage and are used to maintain a constant feed rate to flotation. The bins are designed to overflow, thereby functioning as a desliming operation as well. Feed from the bins is pumped to the feed dewatering separators in the flotation area.

The flowsheet for the washer is shown in Figure 5.8.

### 5.3.3 Flotation

The flotation section is designed to recover the phosphate from the sized, deslimed feed delivered from the feed preparation area and produce a high grade saleable product. The conventional two-stage Crago process is employed for this purpose and consists of anionic rougher flotation of the phosphate particles followed by deoiling and cationic cleaner flotation of the silica particles.

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FEED PREPARATION FLOWSHEET

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FIGURE 5.8

[XXXX] – DENOTES TONNES/HR.

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The objective of rougher flotation is to obtain a bulk separation of the phosphate from the silica, achieving a reasonable recovery of phosphate without an attempt to produce a saleable concentrate. Significant rejection of silica is accomplished in this rougher step, but the concentrate is still high in silica. The rougher flotation reagents are removed by acid scrubbing and then the feed is subjected to cationic cleaner flotation where most of the remaining silica is floated and removed from the phosphate sink particles. The final concentrate product is relatively free of silica.

Reagents used in the rougher flotation circuit are:

- o Fatty Acid (or Fatty Acid Soap). An organic fatty acid (oleic acid, etc.) derived from wood pulp processing.
- o Fuel Oil. An extender used to aid in flotation and froth control.
- o Sodium Hydroxide or Ammonium Hydroxide. Used for pH adjustment.

Sulfuric acid is the deoiling reagent. The acid attacks the reagents, solubilizing them, making it possible to wash the particle surfaces clean.

The reagents used in cationic cleaner flotation are:

- o Organic Amine Reagents. The primary silica flotation chemical.
- o Kerosense. An extender.
- o Sodium hydroxide for pH control, as necessary.

The deslimed feed from storage is pumped to the dewatering separators which dewater the feed to 68-72 percent solids prior to entering the reagent conditioners. Fatty acid, fuel oil and caustic are added at the conditioners and allowed to mix (condition) with the pulp for 3 to 4 minutes. The conditioned feed is then discharged into the rougher flotation machines. Flotation is conducted carrying the rougher concentrate to the overflow.

Rougher concentrate is then pumped through cyclones that dewater the solids to facilitate acid scrubbing. Reagentized water recovered from the cyclone overflow is returned to the flotation feed bin in the feed preparation area.

After scrubbing with sulfuric acid, the feed is washed free of spent rougher reagents by countercurrent flushing with water in primary and secondary wash boxes.

The de-oiled rougher concentrate is then fed to the cationic cleaner flotation cells where amine and kerosene are added to float the silica from the phosphate. Final concentrate reports to a pump box where it is pumped to the filtration section. The rougher tailings and cleaner tailings gravity flow to the general mill tailings pump box, and are combined and pumped to the GMT dewatering cyclones at the waste disposal station.

At the filtration area, the flotation concentrate is dewatered by cyclones followed by filtering and a two-stage countercurrent wash with fresh water to remove chlorides (sea salt). Horizontal table filters with sprays are used to filter and wash the concentrate. The washed and dewatered product is then conveyed to product storage. Wash filtrate from the filters is collected and returned to the plant hydraulic station.

The flowsheet for flotation is shown in Figure 5.9.

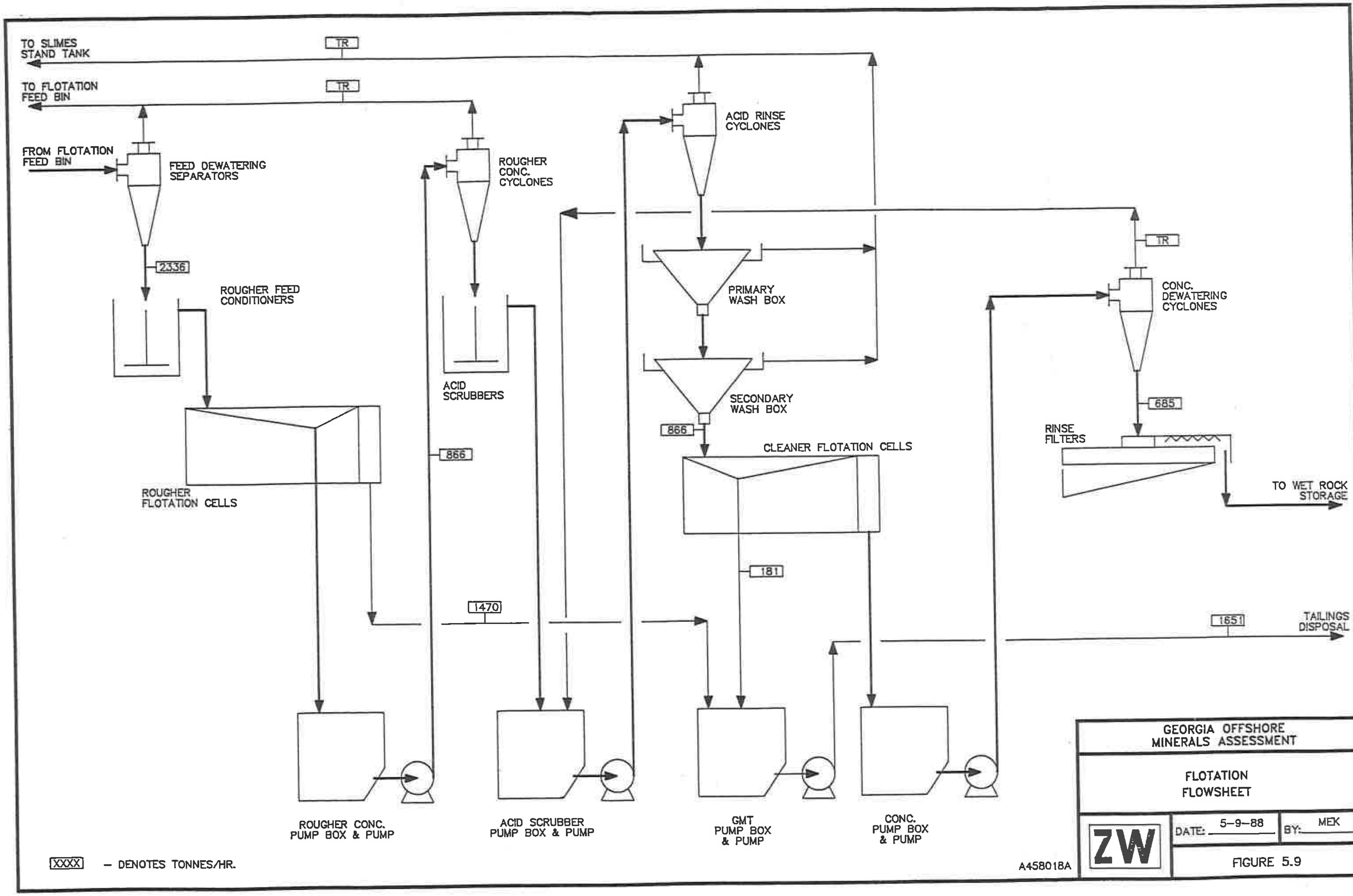
### 5.3.4 Reagent Storage

#### General

This area contains facilities to receive, unload, store, mix, and distribute reagents to the flotation plant and flocculants to the thickeners.

The system is designed to provide storage of reagents with capacity to receive shipments based on normal turnarounds. The mixed reagents storage capacity is based on the concept of one reagent operator five days per week preparing the reagent requirements for three shifts, seven days per week.

Stations for unloading are located to allow the receipt of reagents by ship/barge.




GEORGIA OFFSHORE MINERALS ASSESSMENT

FLOTATION FLOWSHEET

FIGURE 5.9

Electric heat is provided for No. 5 fuel oil, fatty acid, 50% caustic, and amine as required to pump and dilute these reagents for use in the flotation plant.

The tank farm will be enclosed by a wall for spillage containment and to aid in housekeeping.

**Fatty Acid**

This reagent is delivered in 20,000 gallon lots. The fatty acid can be unloaded and stored in two 50,000-gallon storage tanks. Electric heat is provided to heat the fatty acid to about 120°F as necessary to unload, transfer, and store the chemical in a fluid state.

**Fuel Oil**

Number 5 fuel oil will be delivered in 20,000 gallon lots and unloaded using the fatty acid unloading pump. No. 5 fuel oil is viscous and must be heated to approximately 120°F for reasonable handling.

Fuel oil is stored in a 46,000 gallon insulated heated storage tank and is circulated to ensure consistency and to maintain fluidity. The fuel oil is furnished to the fatty acid-fuel oil mix tank as required. The resulting fatty acid/fuel oil mix is metered to the rougher flotation conditioners.

**Sulfuric Acid**

Sulfuric acid (minimum of 93% $H_2SO_4$) will be unloaded into a 24,000 gallon storage tank. It is fed to the acid scrubber circuit at the received concentration and the rate is controlled by a pH indicating/controller located at the acid scrubbers.

**Amine**

Amine will be unloaded into a 24,000 gallon storage tank. The 100% amine will be maintained at approximately 100°F to maintain fluidity.

Temperature control and mixing by an agitator are provided in order to prevent overheating and degradation of the amine.

The 100% amine is pumped to the dilution/ mix tanks (10,000 gallons) where water is added to obtain a 5% solution of amine. The mixture is then transferred to a 14,000 gallon use tank for metering into the process.

**Kerosene**

Kerosene will be stored in a 12,000-gallon storage tank. From storage it will be metered to the flotation area for use as an extender in cleaner flotation.

**Sodium Hydroxide**

Sodium hydroxide will be received as a 50% NaOH solution and stored in a 45,000 gallon storage tank. The 50% caustic must be heated in cool weather to prevent solidification; therefore, the system is provided with heated lines and the storage and mix tanks are heated.

The 50% caustic is diluted to 10% with water for plant use. After mixing, the 10% solution is transferred to a storage tank where it is metered to the rougher flotation section for pH control.

**Flocculant**

Flocculant is diluted directly with water to a low concentration suitable for metering into the thickener. The flocculant tank is provided with an agitator and recirculation capability.

### 5.3.5 Waste Disposal

The combined slimes from the feed preparation area gravity flow to the waste clay thickeners. The type of thickeners required are the high rate compact type that require less land area than conventional earth-bottom thickeners. The typical compact thickener consists of: a shallow, cylindrical, cone-bottom tank; dewatering rakes and rake-drive; and an elaborate feed and discharge system for controlling slurry input, rate of addition of a flocculating agent, and the level and composition of the thickened slurry bed within the machine. Feed is typically injected into the center of the bed and clarified water is usually removed by way of a perimeter launder at the top of the tank. Clarified water from the thickener overflow water is returned to the plant hydraulic station.

The mill tailings (GMT) from the flotation area are pumped to dewatering cyclones. The cyclone overflow is returned to the hydraulic station while the cyclone underflow is fed into the waste clay thickeners. The thickener, therefore, acts as a mixing device, as well as facilitating a high-solids content sand-clay waste stream. It is believed that a high-solids content sand-clay waste stream, carefully deposited at or near ocean bottom, will undergo relatively little dispersion if water depth were sufficient and subsurface currents were not extraordinary.

An array of compact thickeners of adequate capacity could be constructed in various configurations. It is estimated (without specific knowledge of the character of the waste clays to be encountered offshore) that six units of 85-foot diameter, or three units of 140-foot diameter, would be sufficient for the proposed operation. The latter, disposed in a triangular array, would be less space-consuming than six units in a hexagonal configuration.

Whether waste clays are prethickened or not, and whether or not sand tailings addition were practiced, disposal of the waste streams would be within the mined-out areas. Typically, the discharge point would be well below sea level in order to minimize dispersion. The discharge line would require periodic tending to move the effluent point for even distribution of the mined-area backfill.

### 5.3.6 Water Requirements

Water is used extensively in mining and beneficiation as a processing medium and as a means of transporting solids in the form of aqueous slurries. The three main sources of water are: (a) sea water; (b) recirculated process water; and (c) fresh water.

Recirculated process water is collected at the plant hydraulic station where pumps lift the water, via independent distribution systems, to various areas of the beneficiation plant. Sea water is also pumped to the hydraulic station to replace system losses. Fresh water is used to wash the flotation concentrate and is required for reagent dilution, and for laboratory and potable water needs.

Fresh Water

Fresh water is required for the following plant uses:

- o concentrate product wash
- o reagent dilution
- o metallurgical laboratory use
- o potable water.

Systems that in normal circumstances would be supplied with fresh water, such as pump seal water, are not included in the total demand. It is also assumed that a source other than fresh water is used for sanitary fixtures.

A HydroFuge reverse osmosis (R/O) modular system is recommended to fill the planned fresh water needs. Water requirements, based on 150 ppm Cl- content in the treated (fresh) water are presented below.

**Fresh (R/O Desalinated) Water Requirements**

| Description of Water Use | Rate (gpm) |
|---|---|
| Concentrate product washing | 1,315 |
| Reagent dilution | 25 |
| Met. lab | 5 |
| Potable water | 5 |
| Misc. (10% add. capacity) | 135 |
| Total | 1,485 |
| or | 2,138,400 gpd |

On a washed concentrate product tonnage basis, approximately 115 gallons of fresh water are used by the horizontal table filters for each tonne of product.

A 10 percent safety factor has been allowed in computing total fresh water requirements.

Each HydroFuge R/O module proposed will produce approximately 300,000 gallons per day (1,136 $m^3$) of fresh water ($Cl^-$ content approximately 150 ppm) from average sea water feed of 1,000,000 (3,785 $m^3$) gallons per day, at 19,000 to 21,000 ppm $Cl^-$. The units operate at 30 percent recovery. Thirty percent recovery requires a 3-1/3:1 ratio of sea water delivered to the pump per unit of fresh water produced. This assumes a delivery pressure 75 psi (52 m).

In fact, actual operating recovery can be varied from 20 to 70 percent depending on output of water required and its contained chloride (or TDS) content.

The fresh water system installation required for concentrate product rinsing and other uses will require eight reverse osmosis modules.

The high $Cl^-$ filtrate from the R/O units will be discharged as waste. The wash filtrate from the two-stage countercurrent wash on the table filters is collected and returned to the plant hydraulic station.

Process Water

The main sources of process water are: recirculated water from the GMT cyclones overflow, recirculated water from the slimes thickeners overflow, and table filter wash filtrate. Process water make-up requirements are provided by the sea water pump station which supplies water to the hydraulic station.

The beneficiation plant hydraulic station consists of two tanks. Fresh water flows into the first tank which supplies water to a reagent water pump and to the laboratory. Excess water overflows the first tank into the second tank, which satisfies the beneficiation process water supply pumps (high and low pressure) demand for water. The second tank also receives recycled water from the GMT cyclones overflow, the slimes thickeners overflow, table filter wash filtrate, as well as sea water from the sea water pump station.

### 5.3.7 Product Storage and Loading

Washed concentrate is conveyed from the filtration section to the wet rock product storage pile.

The storage pile will be contained in an open-top structure about 200 feet wide by 700 feet long, with concrete walls about 30 feet high. In normal operation, concentrate will be piled as much as 15 feet above the walls, resulting in a storage capacity of approximately 340,000 tonnes.

The storage system consists of a bridge-type dual bucket wheel stacker/reclaimer that spans the total width of the storage area and travels the length of the stockpile. Washed concentrate is stored via the bridge supported stacker conveyer, tripper car, and discharge chute. Concentrate is reclaimed via the bridge supported dual bucket wheels. The independent digging wheels feed a conveyor system which, in turn, feeds a shiploader with the capability of loading vessels at the rate of 3,000-3,500 tonnes/hour. The shiploader is equipped with a cantilevered section that extends out over the mooring berth to distribute the concentrate during loading of the vessel.

The mooring berth will be located along the full length of one side of the island, and adjacent to the wet rock product storage pile. The berth will also permit off-loading of fuel, reagents, and other supplies required to sustain the island operation.

## 5.4 CONFIGURATION AND INFRASTRUCTURE

The preferred configuration of mine, beneficiation and support facilities is that which results in the least investment and the lowest cost of production. Accuracy in assessing and evaluating risks is a necessary and vital element of engineering the design and construction of the preferred configuration.

Depending on the specifics of location conditions, offshore dredging activities may be detrimental, beneficial, or have no determinable effect on fauna, the coastal environment, or the sea floor.

The offshore area targeted for initial exploitation of the phosphorite resource is located in 46 feet of water (average depth) just north of the Savannah Harbor navigation light tower, which marks the entrance to the Tybee Road ship channel. The northern extremity of the proposed mining area is about 2 nautical miles north of the $32^{o}$ latitude line, and 4-7 nautical miles south and west of the Port Royal Sound navigation channel entrance.

The preferred configuration concept envisages the offshore location of all mining, beneficiation and support facilities. No production activity takes place on shore. Finished product is loaded on vessel for transport to the customer from the offshore location.

Zellars-Williams, 1979, under a contract to the U.S.G.S, based their work on mining a hypothetical orebody located in the same area identified and targeted for this study. Matrix, after washing aboard the dredge to reject oversize (+3/4") and fine colloidal material (-200 mesh), was transported by barge for final processing at a beneficiation plant located 27-30 nautical miles up the Savannah River on Hutchinson Island.

Comparative economics based on state-of-the-art technology and current conditions favor locating all of the processing and supporting infrastructure in a single facility on an offshore man-made artificial island. Construction of an island, in the center of the mining area, having a surface area of about 15 acres at Elevation +35.0 is proposed.

The same considerations apply to construction of the beneficiation plant, ancillaries, storage and load-out facilities on the island plant site as for a land side location. In addition to accounting for some increase in the cost of construction owing to the requirement for water-borne transportation of labor, equipment and materials, several specific additional requirements must be considered. These are; 1) getting electric power to the island, 2) providing potable water, and fresh water for de-salting concentrates, 3) standby power generation for minimum maintenance and safety during power outages, 4) worker accommodations, commissary, kitchen and dining facilities, and 5) transportation of workers and supplies. These extra facilities are no more than are ordinarily required of any remote plant site location.

Permitting requirements, once the concept is fully explained and understood, are likely to be less tedious and restrictive, and therefore less time-consuming and less costly. The post-mining use (after 25-30 years) of the island may prove to be an attractive and valuable asset to the environment, and local community.

Any one of several techniques may be employed for the design and construction of the island. One method is to simply dredge overburden material and place it hydraulically in the designated area. Overburden sands may be excavated by mining dredges and pumped to a single general location. The sands would pile up, assuming a natural angle of repose for fully saturated material until they were high enough above sea level to consolidate and permit spreading and leveling. The perimeter would be protected by continuous steel sheet piling, or by the construction of granite rip-rap, granite cobble and reinforced concrete armour.

Another technique would be to construct, on the perimeter, a rubble-mound breakwater using large granite rock and cobble. The inside of the breakwater cofferdam would be filled with dredged sand overburden material. Geotextile fabric placed on the inside stopes of the breakwater would contain the sand, and permit consolidation.

The estimate included in this report is based on island construction, using the average of the costs of the two techniques described above.

A technique which may offer the most potential for savings and economy of time is that of building all of the plant and support facilities, factory style, at land-side, and "sea-lifting" complete assemblies to the site. This concept has been around since the 1950's when refinery units were built in yards at Houston and shipped to Guatemala on commercial freighters. More recently, this concept, using barges on which oil refinery modules were assembled, was employed in the oil fields of Alaska's North Slope. This project could utilize this technology to advantage. All of the beneficiation plant process modules, support facility structures and wharfs would be constructed on the pre-stressed concrete "honeycomb" sandwich cell-type floating platforms. The platforms would be towed offshore to the plant site and grounded on the prepared sea floor. The advantage of precasting and segmental construction on-shore offers the opportunity for achieving high quality, economy, and speed. An additional feature of this construction is that it is likely to result in the least disruption of the marine environment. The honeycomb pattern lends itself to compartmentalization and can provide separate compartments for storage of different liquids.

Ocean-going vessel berthing will be accommodated by facilities located along the full length of one side of the island. Alongside and adjacent to the berths, a walled-in wet rock concentrate storage pile will be located. The wet rock storage capacity is based on the assumption that weather conditions occur to prevent vessels from arriving and berthing for loading a maximum period of 10 consecutive days. It is also assumed that an additional period of up to 5 consecutive days caused by mechanical breakdown, or other cause, would prevent ship loading. Ship loading would be conducted 320 days per year. Storage is provided based on production at 100% of design capacity (16,440 tonnes per day) for 15 days, or a total of 250,000 tonnes (1.9 tonnes/$m^3$). The storage pile is contained in a concrete walled open-top structure, with a pitched floor to facilitate drainage and to collect water.

In plan, the storage structure will be 200 feet wide and about 700 feet long, with concrete walls about 30 feet high. Filled to wall height, about 250,000 tonnes of wet phosphate rock can be contained. In operation under normal conditions, concentrate would be piled an additional 15 feet to result in a trapezoidal cross-section. With this additional storage above the top of the wall, as much as 340,000 tonnes can be contained.

This storage pile will be served by combination stacker-reclaimer equipment, with a bridge spanning the total width which travels longitudinally the length of the pile. The bridge is supported by a hinged leg outside the storage wall, and a fixed leg on the wall. The bridge supports dual bucket wheel booms for reclaiming from the storage pile. The bridge also supports a tripper car, stacker belt, and chute. A belt conveyor from the beneficiation plant feeds the inflow cross belt via a tripper car. The cross belt at the back of the bridge's main girder loads the stack via a chute. The reclaiming bucket wheels feed a conveyor system which, in turn, feeds a ship loader with the capability of loading vessels at the rate of 3000-3500 tph. The linear movements of the bridge type stacker/reclaimer, and its operating conditions, make automatic operation possible. The dual function of stacking and reclaiming are accomplished with the same traveling bridge mounted equipment. A trough, into which reclaimed material is collected for feeding the ship loader, permits reclaiming and ship loading. The bridge is about 260 feet long, spanning the storage pile and feeder trough (about 200 feet). The ship loader, with a cantilevered section extending out over the mooring berth, moves along the length of the dock to transfer and distribute concentrate for uniform loading of a vessel.

The berth, with mooring dolphins, will also permit off-loading of fuel, reagents, spare parts and other supplies required to sustain the island operation. Vessel loading and unloading can be accommodated in all but severe weather conditions, when vessels will be required to stand-off, under power, and/or at anchor until conditions permit returning to the berth.

1) Primary electric service will be supplied by a 750 MCM submarine cable at 115 kv, from Tybee Island by Savannah Electric and Power Co. The jacketed 750 MCM aluminum conductor will be encased in a 6" diameter conduit and cooled by a circulating oil bath. The conduit will be laid about five feet below the sea floor. A substation on the island will reduce voltage to 2.4, 4.16, and 6.9 kv, for distribution to load centers, as required.

2) Desalination of sea water will produce a high quality water suitable for human consumption, and for special uses such as boiler feed make-up, and

reagent solutions. Since the beneficiation process will use sea water for disaggregation, washing and flotation, the concentrate rock will contain a higher level of chlorides. The chlorides which are external to the phosphate particles may be removed by filtering and two-stage counter-current washing with fresh water. Concentrate product washing by this process will require about 115 gallons of fresh water (desalinated to 150 ppm $Cl^-$) per tonne of concentrate. Total fresh water required is estimated to be about 2,000,000 gpd. Desalination by state-of-the-art reverse osmosis HydroFuge units designed by World Water Treatment, Inc. of Concord, CA, is proposed. Each HydroFuge unit will produce approximately 300,000 gpd of fresh water ($Cl^-$ content less than 150 ppm) from 1,000,000 gpd of sea water containing about 35,000 ppm TDS, and 20,000 ppm $Cl^-$. Six units are required to produce 2,140,000 gpd (1440 gpm). Eight units are provided; one for service during maintenance shutdown cycles and one as a standby to augment supply, if necessary. The HydroFuge R/O system and appurtenances is housed in a 10,000 $ft^2$ building. Raw water pumps capable of 6,000,000 gpd (4,200 gpm) are required to feed the R/O modules. Brackish water recovered after countercurrent filter-washing to de-salt concentrate is retained to supplement sea water make-up required for the beneficiation process. The enriched brine from the R/O system is returned to the sea. In addition, a fresh water ground storage tank of about 1,000,000 gallons capacity will be provided, (75' dia. x 30' side water depth.) The balance of the water supply system is the same as for any land side plant location.

3) Power outages are suffered by every user of commercially supplied power. The island location requires that minimum standby power be provided by an automatic starting diesel engine powered 60 Hz generator. Minimum power is required for lighting, heating, air-conditioning, potable and fire-fighting water systems, navigation lighting and personnel accommodations. This requirement will be met by a Caterpillar Model 3616 generator set, with automatic transfer switch, rated at 4000 kW. Fuel oil storage of 5,000 bbls in a 35' dia. x 30' high tank will be provided.

4) Personnel accommodations consisting of temporary housing, commissary, kitchen and dining facilities are required. Housing in dormitory type facilities will be provided for use by personnel during their two-week

tour (two 12-hour shifts, 14 days, 168 hours on three-week cycles). Housing will be sized to accommodate about 150 people. Cooking and dining facilities, including commissary with cold storage will also be designed to feed 150-160 people, 3 meals per day.

5) A motor launch will be provided to transport personnel and supplies from the island to the location of the turning basin in Port of Savannah. The launch will be seaworthy in all but severe weather conditions and capable of making ±30 knots so that a one-way trip takes no longer than one hour.

Matrix is pumped through a trailing pipeline terminating at the distribution head of the washer on the island. The matrix/slurry transportation pipeline is lengthened as mining progresses.

The two dredges are self-contained and, to a great extent, are self-sustaining. They require no direct service link to the island, or to land-side facilities, other than for re-supply and to transport workers. One ocean-going tugboat is assigned to service the mining operation. This tug is equipped with a rotating lift crane suited to at-sea maintenance and repair work. The tug moves and positions pipelines and the overburden waste discharge barge as mining progresses. This tugboat is also used to move the dredges to port for annual drydock maintenance and repairs.

All offshore operations will be based on work crew cycles of two weeks duty and one week off. This requires three completely staffed crews of operating, maintenance and supervisory personnel. While on duty, offshore personnel work 14 twelve-hour shifts, for a total of 168 hours each three week cycle. The wages for this work schedule is based on 40 hours per week, three weeks, 120 hours at regular time, and 48 hours at premium time. All meals and sleeping accommodations are provided by the enterprise at no cost to employees.

Accommodations, consisting of two-bed cabins, each complete with lavatory and shower, clothes lockers and desks are provided. Each offshore operating location contains its own accommodations. A fully-equipped kitchen, provisioned commissary and staff will prepare and serve three meals each day in a dining room. Library, television, and indoor activity rooms will be provided. Physical exercise and conditioning facilities, both indoor and outdoor, will also be provided.

The island facilities will include a first-aid station, with a nurse, to attend to minor maladies and injuries. A heliport will enable the rapid evacuation of seriously sick, or injured, persons to mainland hospitals.

The configuration described above offers the opportunity to realize the commercialization of offshore mining. Mined matrix is delivered to a nearby beneficiation plant where it is upgraded to produce a commercial grade phosphate rock concentrate product. The wet beneficiation process uses sea water, except for final filter-rinsing with desalinated sea water to remove encrusted salt. The final product is loaded on commercial ocean-going transport vessels from an outdoor storage yard, by high capacity reclaimer and ship loader. The dock permits vessel loading of concentrate and vessel unloading of fuels, reagents, supplies, and other dry good commodities required to sustain operations. Utilization of the invested capital is maximized as the mining and beneficiation processes will continue to operate in all but hurricane weather conditions.

The final product is not calcined. Previous work by others, Zellars-Williams 1979, and DPRA 1987, considered calcination as a part of the beneficiation process. These reports indicate that grade is improved by about two BPL percentage points by calcination. No test work has been conducted to support this grade improvement. This report concludes that the benefit gained, solely that of improving $P_2O_5$ grade, does not justify the expense incurred. Cash operating costs of calcination, as reported by Zellars-Williams 1979, adjusted to 1987, and DPRA 1987, vary from $2.78 to $3.22 per tonne. Return on the invested capital required for calcination adds $2.50 to $3.00 per tonne. The premium on penalty for each BPL grade percentage point is on the order of $0.70-$0.90.

The viability of this enterprise does not depend on producing 68 BPL phosphate rock concentrate. Many commercial chemical fertilizer plants use 66 BPL and lower grades for feed to manufacture phosphoric acid and diammonium phosphate (DAP). The supply demand forces of the world market, and particularly the requirements of chemical fertilizer producers within freight cost-effective shipping distances, will dictate viability.

The objective of the configuration selected for this economic feasibility evaluation is to produce a commercially marketable product at the least cost. Implementation economics will be satisfied when the demand for 4.8 million tonnes of 66 BPL phosphate concentrate becomes a reality.

## 5.5 ESTIMATED CAPITAL COST

This section deals with the expenditures required to implement a phosphate mining-beneficiation operation having the configuration and features previously described. Estimated cost is based on conceptual and schematic designs, and is order-of-magnitude having an accuracy of plus or minus 25%.

### 5.5.1 Capital Cost

Estimated capital cost has been prepared by a combination of generally accepted methodology. Island construction cost for building a 15-acre island by conventional civil-marine construction techniques has been prepared by preparing a survey of the quantities of the various work items and estimating the cost of each on an individual basis. Island construction cost includes all of the features required of an isolated offshore facility which would not be required of a conventional mainland site. The cost of island construction includes a ship loading dock as an integral part since no channel dredging is required. Table 5-16, Island Construction Cost Estimate, is a summary of cost by item for all the features included.

Beneficiation plant cost has been estimated for each production section; i.e., washer, feed preparation, flotation, reagents, water recirculation and waste disposal, product rinsing, wet rock storage, and support facilities, by

**Table 5-16**

**Phosphate Mining Enterprise**

**Cost Estimate - Island Construction**

| Item | $X1,000 |
|---|---|
| Mobilization | $ 350 |
| Surveying | 75 |
| Navigation markers | 30 |
| Perimeter armor wall | 7,500 |
| Dredged fill | 11,100 |
| Vessel berth and dock | 3,000 |
| Mooring dolphins | 250 |
| Navigation aids | 150 |
| Submarine electric power service | 12,500 |
| Potable water plant and storage | 150 |
| Communications systems | 100 |
| Motor launch | 500 |
| Living accommodations | 1,080 |
| Kitchen, dining and recreation facilities | 625 |
| Standby generator 5000 kW | 1,000 |
| Fuel storage, 5000 bbl | 125 |
| Total | $ 38,535 |

factoring techniques. Recorded costs of similar plants were compared by production process section for flowsheet applicability, adjusted for throughput or product capacity, and modified for specific dissimilarities. The resulting cost, reflecting the proposed capacity, was adjusted by applying the Engineering News Record (ENR) Construction Cost Index and the Chemical Engineering (CE) Plant Cost Index to determine current (May 1988) cost.

The procedure is to compare the process flowsheets and/or equipment requirements of the proposed plant section with that of a comparable plant section for which cost is known. The known cost estimate is modified to omit items not required of the proposed plant. Cost is adjusted for throughput (annual tonnes of matrix), or for product (annual tonnes of wet rock concentrate) by the ratio of these raised to the 0.7 power. This cost is modified for additions to the plant section, if required, of the proposed plant section. Current cost is determined by applying a multiplier. The multiplier reflects the difference in cost between the date of the known cost and May 1988 by a ratio of the average of ENR and CE indices. No attempt has been made to prepare an itemized equipment list for the beneficiation plant.

Dredge costs have been estimated by preparing a conceptual design with a general description of the principal components. Each dredge is a complete self-sustaining unit designed to remain at sea in all weather conditions. The principal machinery, equipment and structural components are identified, sized, and the weight of each estimated. Cost is the summation of the individual cost of the components. Table 5-17, Dredge Cost Estimate, is a summary of cost by item for each component. The design and construction of the dredges would be undertaken by one of several U.S. manufacturers as a result of a controlled procedure of design/construct competitive bidding. For purposes of this study, the cost of the two dredges is identical, whereas in the case of actual implementation, this may not be true. Dredge cost includes startup, acceptance testing, and commissioning.

The cost of special features and other items is estimated as the result of research of in-house data and telephone conversations with manufacturers, vendors, suppliers and other various experts.

**Table 5-17**

**Dredge Cost Estimate**

| | Weight Short Tons | Cost $X1000 |
|---|---|---|
| Hull-platform (90' x 400' or 100' x 360') | 3,000 | $ 9,000 |
| Upper Deck House 9,2000 ft$^2$ houses bridge, operations, personnel accommodations, kitchen, dining, etc., including furnishings | 235 | 920 |
| Lower Deck House 8,000 ft$^2$ house switchgear, generators, deck pump, other machinery | 200 | 480 |
| Heliport 40' x 40', aft overhung | 200 | 700 |
| Fabricated Steel Components Ladder, ladder superstructure, 8 spuds, spud carriages, etc. | 2,450 | 12,240 |
| Machinery Dredge pumps, cutterhead, motors, speed transmission, generators, hydraulic systems, winches, hoists, etc. | 610 | 7,240 |
| Switchgear Electric controls and wiring | 10 | 850 |
| Navigation and Weather Equipment Radar positioning gear and weather station | 3 | 150 |
| Mass Flow Meter (Producion meter) meters, recorders, instrumentation | 5 | 200 |
| Communications VHF, AM-FM, TV, radio telephone | 2 | 150 |
| Heating, Ventilating and Air-conditioning Upper and lower deck houses | 10 | 200 |
| Spud Hoist and Carriage System Instrumentation and controls | 1 | 150 |
| Tools, Specialty Maintenance Equipment and Supplies | 15 | 250 |

**Table 5-17** (continued)

| | Weight Short Tons | Cost $X1000 |
|---|---|---|
| Protective Coatings and Cathodic Protection | 1 | 750 |
| Engineering | | |
| Preliminary engineering, modeling, design engineering and detailed engineering fabrication | | 1,500 |
| Other | | |
| Undefined development expense | | 500 |
| Transportation | | |
| Shipyard to site by sea | | 180 |
| Commissionning | | |
| Startup, operating training and performance testing | | 2,000 |
| **Total Estimated Cost** | | $ 37,460 |
| Fuel, supplies, and personnel | 1,808 | |
| **Total Estimated Weight** | 8,550 | |

Table 5-18, Phosphate Mining Enterprise Total Facility Capital Cost Estimate, is a summary of the total capital cost required to construct the offshore phosphate mining facilities described in this section. Fifteen percent is included as an allowance for costs which will be incurred for items not now predicted. Total capital costs include design, engineering, procurement, and construction management services as are applicable to each item.

### 5.5.2 Pre-production Cost

Pre-production cost in the amount of 10 million dollars is included as a part of the total investment required to implement the proposed enterprise mining scheme. This cost is intended to include the extensive drilling, sampling, and testing programs required to accurately identify the areal extent and grade-quality characteristics of the Middle Miocene targeted for exploitation. This cost is also intended to include the cost of limited studies required to obtain permits. This program would include exploratory drilling to the extent required to describe and define economically mineable reserves, based on the most effective beneficiation process flowsheet developed by the test work. This program includes the cost of bulk sample collection and a pilot plant test program to verify and refine the process flowsheet, material balances, reagent and water consumption, and recovery efficiencies such as are required to provide criteria and parameters for design and detail engineering. No interest is charged for the use of this money because it is assumed that these expenditures are in the nature of the regular research and development costs incurred by enterprises engaged in commercial minerals exploitation. Payback of pre-production/development cost is, however, included as a part of the total investment required by the enterprise.

The importance of environmental considerations and the related concerns of marine fisheries and others are not to be underestimated. The pre-production cost described herein does not include the cost of comprehensive environmental studies, or the preparation of an EA or EIS. It is unlikely that the private sector alone would undertake these kinds of studies without substantial incentive. Estimating the cost of such studies is beyond the scope of this report.

**Table 5-18**

**Phosphate Mining Enterprise - Total Facility**

**Capital Cost Estimate**
($4.8 \times 10^6$ tonnes/year product)

| Item | Cost $X1000 |
|---|---|
| Island Construction | $ 42,400 |
| Overburden and Matrix Dredges | 74,920 |
| Trailing Pipelines | 4,405 |
| Overburden Water Barge and Tremie | 1,210 |
| Tugboats (2) | 5,000 |
| Washer Section | 3,289 |
| Feed Preparation Section | 19,389 |
| Flotation Section | 26,565 |
| Reagents Storage and Supply Section | 2,240 |
| Water Recirculation and Waste | 18,471 |
| Desalination and Water Storage | 7,073 |
| Desalt Rinsing Section | 1,500 |
| Wet Rock Storage | 10,909 |
| Stacker Reclaimer Shiploader | 15,000 |
| Buildings, Warehouse and Support Facilities | 11,098 |
| Totals | $ 243,469 |
| Contingency - 15% | 36,521 |
| TOTAL | $ 279,990 |

This program will be conducted over a period fo 24-30 months and will be followed by a comprehensive economic analysis based on the latest market supply-demand price scenarios. A list of the tasks/objectives to be accomplished during this pre-production period before design and detailed engineering is undertaken is listed below.

- drilling
- sampling
- geologic database update
- bench scale test work
- economic cutoffs applied
- reserves estimates
- bulk sampling
- pilot scale test program
- fresh water rinse tests
- acidulation test work to determine amenability of concentrate to acidulation of fertilizer manufacture
- preliminary mine plan
- preliminary design of dredges and ancillaries
- island construction engineering alternatives evaluated
- environmental issues identified
- cost and likelihood of permitting estimated
- lease and royalty fees/costs established
- capital cost estimates
- implementation plan and schedule
- supply-demand and market scenarios
- identify potential market
- current product selling price
- bankable document report.

The decision to move forward to implementation by contracting for detailed engineering, procurement, and construction can be taken with a high degree of confidence in the reliability of the economic analysis. Technological and economic risks will have been reduced to an acceptable level. If the economics are favorable and the market supports sales price and demand premises, the final phase of implementation can be initiated.

### 5.5.3 Replacement Capital

The employment of capital to replace equipment when its useful life has expired is replacement capital. Useful life is based on the concept that the level of maintenance is as required to keep the equipment (facilities) operational at an acceptable level of production. Useful or economic life is the period (time in years) until the failure rate increases to such an extent that it is no longer economical to operate.

The proposed mine-beneficiation complex operation and production is based on certain mechanical availability. This level of mechanical availability is the result of regular and scheduled shut-down maintenance. This maintenance for parts, supplies, and labor, in the amount of $12,000,000 per year, is included in operating cost.

The severe service and adverse climatic environment requires a high level of regular and preventive maintenance. During one month of the year when all facilities are shut down while the dredges are in dry-dock, certain capital will be employed to sustain the equipment and facilities at design production capability. The additional sum of one million dollars per year is allowed as replacement capital. It is anticipated that this will maintain facilities at design level for a period of 30 years, without requiring the employment of additional replacement capital. The only exception is in the event technologically superior replacement equipment is warranted as justified by the economics of increased production.

### 5.5.4 Working Capital

- Ordinary operation of a business involves a circulation of capital within the current asset (capital cost) group. Cash is expended for materials (parts, supplies, expendibles), labor and services (electric energy, rental, fees, royalty, ...) and these expenditures are accumulated as costs. These costs are converted (wet rock inventory stock pile) into receivables and ultimately (back out by shipment) into cash again.

- o The average time intervening between the acquisition of materials or services and expenditure for labor entering this process and final cash realization constitutes an operating cycle.
- o The amount of capital committed (taken out of current funds or borrowed) to this cycle is working capital.
- o Cost of working capital (interest) is added.

To simplify economic analysis, the working capital requirement for this enterprise is estimated to be $3.6 million, which is equal to the total production cost of 250,000 tonnes of phosphate rock concentrate for a period of 75 days (15 days supply in storage, plus 60 days for collecting receivables). To simplify economic analysis, working capital of $3,600,000 is used throughout and recovered in the last year.

### 5.5.5 Comparable Capital Cost Estimates

Previous studies of the potential feasibility for commercial exploitation of offshore U.S. Atlantic coast phosphorites have produced capital cost estimates of the investment required.

ZW (1979) and DPRA (1987), each reported capital costs for development of phosphate mining and beneficiation facilities. The cost estimated for each of those studies envisaged offshore mining, on-board scalping/washing and partial desliming, transport of this intermediate product to land, beneficiation and product load-out from a central land-based complex.

The two estimates cover very similar methods of handling and processing matrix and the treatment of beneficiated concentrate. Each estimate has been adjusted for annual volume throughput, product output, and indexed to a comparable economic cost basis. Table 5-19 is a display of costs for annual finished product capacity of 4.8 million tonnes, comparable to the cost estimated for this study.

The table shows reasonable agreement, except for sea transportation cost. If this cost is equalized for the two estimates at the higher cost, the variance between the two estimates is within 5% for wet rock facility cost, and 14% for total facility cost.

**Table 5-19**

**Comparable Capital Cost Estimates from Previous Studies Adjusted for Capacity and Cost Index**

(approximately 4.8 million tonnes product)

| Item | DPRA ($ X 1,000) | Z-W ($ X 1,000) | Equalize to DPRA ($ X 1,000) |
|---|---|---|---|
| Dredge | $ 36,660 | $ 31,340 | -- |
| Scalping/Washer (on-board) | 6,240 | 3,290 | -- |
| Feed Preparation (land-based) | 15,080 | 19,390 | -- |
| Flotation Plant | 13,280 | 26,570 | -- |
| Reagents Section | -- | 2,240 | -- |
| Water Supply, Recirculation and Waste | 22,770 | 18,470 | -- |
| Infrastructure | 26,220 | -- | -- |
| Off-sites | -- | 14,040 | -- |
| Sea Transportation | 232,950 | 51,460 | 181,490 |
| Unloading Rock | 25,750 | -- | -- |
| Wet Rock Storage | -- | 14,230 | -- |
| | $378,950 | $181,030 | $362,520 |
| Contingency | 37,900 | 18,100 | 36,250 |
| Total Wet Rock Facility | $416,850 | $199,130 | $398,770 |
| Calcination* | $110,890* | $ 68,620 | -- |
| Contingency | 11,090 | 6,860 | -- |
| Total Calcination* | $121,980* | $ 75,480 | -- |
| **Total Facility** | $538,830 | $274,610 | $474,252 |

* includes product storage/handling

NOTE: DPRA (1987) and ZW (1979) costs adjusted by ENR Construction Cost Index to 1988, and factored for through-put and production output to ZW (1988) study basis.

This discussion is not intended to be a critique of previous estimates, but is included here as a basis for comparison. Such variance is to be expected from estimates based on conceptual designs and preliminary definition of conditions.

The total costs estimated, at different times, by each of two investigators, are for comparable configurations providing conventional facilities at landside locations. The total wet rock facility cost of about $400 million is comparable to the proposed totally offshore facilities' configurations estimated cost of $280 million.

## 5.6 ESTIMATED OPERATING COST

In view of the uncertainties in geology and production configuration, a detailed operating cost breakdown is not indicated. Zellars-Williams has compiled cost information on phosphate plants for many years and developed a relationship of costs to production for different geological and operating conditions. These relationships are broken down into operating modules and compiled in a computer model. This computer model has been used extensively in projects such as the World Phosphate Study 85, and the Assessment of Alternative Technology Study, for the Florida Institute of Phosphate Research (FIPR), as well as for evaluating performance of numerous operating mines.

Three cost modules specific to the offshore mining configuration were developed to make the cost model applicable to most of the operations. Cost of transportation and accommodations for personnel, and for product rinsing were estimated separately. All ZW operating cost models are based on short tons. Conversion to metric tons is performed for economic analysis. The expression **ton** in this report is for 2000 lbs. The expression **tonne** is for 2205 lbs. A copy of the cost model computer printout (pages 1 through 9 of 9) is included at the end of this section. The modules applicable to offshore Georgia are described in the following text.

## Labor Costs

Labor costs are based on hours consumed for actual production functions. To this, a factor of 26% is added to allow for extra men, foremen, supervisors, and managers. The factors for each division follow:

| | |
|---|---|
| Additional men | 5% |
| Foremen | 16% |
| Supervisors | 3% |
| Managers | 2% |
| Total | 26% |

The average rate used for labor is $17.14 per hour, and includes overtime and fringe benefits.

The basis of this average rate is as follows:

| | |
|---|---|
| Average hourly wage | $ 12.00 |
| Burden, including fringes | 3.00 |
| Total Average Hourly Rate | $ 15.00 |
| Premium Average Hourly Rate | $ 22.50 |
| Work Cycle each 3 week period: | |
| 120 hours @ $15.00 = | $1,800.00 |
| 48 hours @ $22.50 = | 1,080.00 |
| 168 hours = | $2,880.00 |

Average hourly wage: $\frac{\$2,880}{168 \text{ hr.}} = \$17.14/\text{hour}$

## Administrative Costs

A figure of $1.30 was used. This includes clerical, engineering support, planning, accounting, personnel, payroll, safety, legal, and all other local administrative, technical, and laboratory services. This does not include sales expense, taxes, insurance, exploration drilling, depletion, depreciation, or amortization.

## Unit Costs

Unit cost for utilities, reagents, and other items are given on page 1 of the computer printout.

Estimated operating costs taken from the cost model, rounded and converted to metric units are given in Table 5-20. Indirect and offshore costs are individually estimated by other techniques. This is the basis of economic analysis.

The control units are the factors upon which the consumption factors are based. The consumption factors for each module are listed below.

Slurry Pumping of Matrix

This module covers the cost of pumping matrix slurry from the slurry well (pit) at the mine cut near the dragline to the washer, the first production unit in the beneficiation plant. Cost includes all the slurry pumps, pipeline, electric power supply, switchgear, control systems, and all appurtenances required for the matrix pumping system. All components are skid mounted. Cost includes seal water supply systems. Pit pump operation is included except for moving cost, which is a part of hydraulic monitor cost. Cost developed by this module is a function of distance based on transporting 1,000 tph of matrix (dry basis) at 30% solids average (by weight) and a pipeline velocity of 15 fps.

The model for this study is modified to cover the slurry density, pipeline size and lengths, and total system head conditions applicable to the offshore mining configuration described.

COST UNIT: Dry ton-miles matrix

UNIT CONSUMPTION:

| | |
|---|---|
| Fuel | 0.0866 gal. |
| Operating labor | .00046 manhours |
| Operating supplies | $.00197 |
| Maintenance labor | .00046 manhours |
| Maintenance supplies | $.01194 |

**Table 5-20**

**Operating Cost**

**4.8 million tonnes/year**

| Direct Cost | | | |
|---|---|---|---|
| Unit Operation/Item | $/tonne product (wet rock, dry basis) | | |
| Mining | | | |
| Overburden dredge and disposal | 1.60 | | |
| Matrix dredge | 1.50 | | |
| Matrix pumping | 1.30 | | |
| | | | 4.40 |
| Beneficiation | | | |
| Washer | 1.10 | | |
| Feed preparation | 0.85 | | |
| Flotation | 3.03 | | |
| In-process storage | 0.20 | | |
| Hydraulic station | 0.22 | | |
| | | | 5.40 |
| Waste Disposal/Water Reclamation | | | |
| Tailing waste | 0.60 | | |
| Slimes waste | 0.51 | | |
| Make-up water | 0.04 | | |
| | | | 1.15 |
| Product Management | | | |
| Rinsing and conveying | 0.30 | | |
| Handling and storage | 0.25 | | |
| Load-out | 0.25 | | |
| | | | 0.80 |
| Supervisor, clerical and technical support | | | 1.40 |
| Offshore accommodations (personnel live and travel) | | | 0.45 |
| Direct Cost | | | $13.60 |
| **Indirect Cost** | | | |
| Administration | 0.20 | | 0.20 |
| Sales expense | 0.25 | | 0.25 |
| Royalty @ 5% of sales price ($35 & $42) | 1.75 | to | 2.10 |
| Taxes (ad valorem, etc.) | 0.20 | | 0.20 |
| Other (not specifically identified) | 0.25 | | 0.25 |
| Indirect Cost | $ 2.65 | | $ 3.00 |
| **Total Operating Cost:** | | | |
| (@ $35 sales price) | $16.25 | | |
| (@ $42 sales price) | | | $16.60 |

Washer

This module consists of ore disaggregation, and separation and washing of pebble. A common washer includes a trommel, static screens, vibrating screens, and log washers. Battery limits are from the matrix pumping system discharge to the feed distributor for the primary cyclones and the pebble transfer conveyor.

COST UNIT: Tons matrix
UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | 2.25 KWH |
| Operating labor | .00195 manhours |
| Operating supplies | $.001 |
| Maintenance labor | .00199 manhours |
| Maintenance supplies | $0.05114 |

Feed Preparation

This module represents two stages of desliming and includes feed sizing and in-process storage of feed. Battery limits are from primary desliming cyclone feed distributor to the flotation feed dewatering or conditioning.

COST UNIT: Tons Flotation Feed
UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | 3.00 KWH |
| Operating Labor | .00148 manhours |
| Operating Supplies | $.00076 |
| Maintenance labor | .00151 manhours |
| Maintenance supplies | $0.03881 |

Flotation

This module includes anionic rougher flotation for two size fractions, deoiling, and cationic cleaner flotation. Battery limits are from discharge of flotation feed prep to the tails discharge point and the flotation concentrate discharge point.

COST UNIT: Ton Flotation Feed

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | 3.50 KWH |
| Operating labor | .00594 manhours |
| Operating supplies | $.00305 |
| Maintenance labor | .00606 manhours |
| Maintenance supplies | $0.15577 |

Reagents:

| | |
|---|---|
| Fatty Acid | 1.0 lb |
| Fuel Oil | 1.25 lb |
| $NaOH/NH_3$ | .4 lb |
| $H_2SO_4$ | 1.3 lb |
| Amines | .17 lb |
| Kerosene | .1 lb |

<u>In-Process Storage</u> (Product Bins)

This module is for wet bin storage and retrieval of product. Battery limits are between product discharge from the washer and flotation plant to the product conveyor.

COST UNIT: Tons Product (as derived from flotation feed tons)

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | .18 KWH |
| Operating labor | .00074 manhours |
| Operating supplies | $.00030 |
| Maintenance labor | .00075 manhours |
| Maintenance supplies | $0.1941 |

<u>Hydraulic Station</u>

This module is for operation of a plant hydraulic station. Battery limits are from the water collection points of recycled water from other modules, to the make-up water supply points in other modules.

COST UNIT: 1,000,000 gallons

UNIT CONSUMPTION;

| | |
|---|---|
| Electricity | 700 KWH |
| Operating labor | .30140 manhours |

| | |
|---|---|
| Operating supplies | $.15498 |
| Maintenance labor | .30743 manhours |
| Maintenance supplies | $7.90 |

Slurry Pumping of Tailings

This module is for hydraulic transport of tailings as a function of pumping distance to the disposal site. Tails are fed directly from the flotation plant. Battery limits are from the tails slurry pump to discharge from the tails pipeline at the sand-clay mix tank thickener.

COST UNIT: Ton-Miles Tailings

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | .76 KWH |
| Operating labor | .00046 manhours |
| Operating supplies | $.00197 |
| Maintenance labor | .00046 manhours |
| Maintenance supplies | $.01194 |
| Replacement pipe | $.0015/ft. |

Slurry Pumping of Slimes

This module accounts for hydraulic transport of slimes as a function of distance to the disposal site. No credit is implicit in this module for gravity flow. Therefore, unit consumptions should be estimated on the basis of actual pumping distance. Battery limits are from the high grade sand-clay mix thickener to the end of the waste pipe discharge in mined-out cuts.

COST UNIT: Ton-Miles Slimes

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | 1.15 KWH |
| Operating labor | .00141 manhours |
| Operating supplies | $.00604 |
| Maintenance Labor | .00142 manhours |
| Maintenance supplies | $.03661 |
| Pipe replacement | $.00016/ft. |

Make-up Water

This module accounts for fresh water pumped from deep wells as the source supply to make up for system losses. The basis is 7,500 gpm pumped a distance of one mile from a water level of 150 feet below the center line of discharge. The battery limits are from the deep aquifer water level surface to the hydraulic station. For the offshore situation this module is used for the cost of pumping sea water.

COST UNIT: 1,000,000 gallons

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | 850 KWH |
| Operating labor | .301 manhours |
| Operating supplies | $.51591 |
| Maintenance labor | .30501 manhours |
| Maintenance supplies | $7.82 |

Conveyor

This module accounts for transportation by conveyor belt a distance of 600 feet with a 50-foot rise in elevation. The battery limits are from the product bin discharges to the conveyor belt discharge above the stockpiles.

COST UNITS: Tons of Product

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | .05 KWH |
| Operating labor | .00011 manhours |
| Operating supplies | $.0023 |
| Maintenance labor | .00011 manhours |
| Maintenance supplies | $.00286 |

Storage

This module accounts for open pile storage of phosphate pebble and concentrate. Stacker and reclaimer factors are included. Battery limits are from the end of the transportation conveyor to the storage pile by stacker or tripper.

COST UNIT: Ton Product

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | .22 KWH |
| Operating labor | .00351 manhours |
| Operating supplies | $.02166 |
| Maintenance labor | .00355 manhours |
| Maintenance supplies | $.09114 |

Loadout

This module covers getting product from storage to the rail car. Battery limits are from the reclaimer which retrieves material from the wet rock pile to placement into the rail car. In this case, cost is for loading ocean-going vessels.

COST UNIT: Ton Product

UNIT CONSUMPTION:

| | |
|---|---|
| Electricity | .20 KWH |
| Operating labor | .00351 manhours |
| Operating supplies | $.01203 |
| Maintenance labor | .00355 manhours |
| Maintenance supplies | $.09114 |

**Offshore Dredge Mining Cost Modules**

Three unique models were added for offshore Georgia. These are: dredge mining overburden, dredge mining matrix, and barge transportation. These modules are described below:

Dredge Mining Overburden

This module covers the cost of mining overburden and pumping it to nearby mine cuts. It is keyed-off of a dredge program for cost inputs. For the selected system, the unit consumptions follow.

COST UNIT: Cubic yards overburden

UNIT CONSUMPTION:

| | |
|---|---|
| Fuel | .09798 gallons |
| Operating labor | .00489 manhours |
| Operating supplies | $.01245 |
| Maintenance labor | .00153 manhours |
| Maintenance supplies | $.061 |

Dredge Mining Matrix

This module convers the cost of mining matrix and pumping it to the surface. From here the matrix pumping module takes over. This module is keyed off the dredge program for cost inputs. For the selected system, the unit consumptions follow.

COST UNIT: Cubic yards matrix

UNIT CONSUMPTION:

| | |
|---|---|
| Fuel | .11286 gallons |
| Operating labor | .00796 manhours |
| Operating supplies | $.02028 |
| Maintenance labor | .00248 manhours |
| Maintenance supplies | $.09936 |

Barge Transportation System

For configuration 2, barges were used to transport matrix from the dredge to the onshore plant, and transport waste back to the ocean disposal site. Loading and unloading costs are included in this module.

COST UNIT: Cubic yards matrix

UNIT CONSUMPTION:

| | |
|---|---|
| Fuel | .2568 gallons |
| Operating labor | .0103 manhours |
| Operating supplies | $.00722 |
| Maintenance labor | .0088 manhours |
| Maintenance supplies | $.05169 |

## 5.7 ECONOMICS AND VIABILITY

### 5.7.1 Phosphate Market Evaluation

The United States, the leading world producer of phosphate fertilizers, supplies about 30% of world consumption. The long-established dominance of U.S. phosphate fertilizer producers in export markets, mainly from Florida and North Carolina, has been successfully challenged by the state-controlled phosphate producers of North Africa and the Middle East. The erosion of U.S. producers' share of total world markets by these state-controlled producers became evident as domestic consumption peaked in 1980-81, and since contracted. Global $P_2O_5$ fertilizer consumption appears to have levelled off and most forecasters suggest future growth at no more than 2-3% per year.

The U.S. phosphate rock industry capacity has grown from about 12 million tonnes per year in the 1950's to nearly 63 million tonnes per year in the 1980's. In the 1950's, U.S. production represented 50% of world-wide production. Today, U.S. production is only about 30% of world production.

The mature market demands of the U.S. agricultural sector for phosphate fertilizers are being met by domestic mines and rock producers, with minor exceptions. This demand accounts for about 19 million tonnes of phosphate rock (6 million $P_2O_5$ tonnes). Morocco's OCP, from its Bou-Craa mine, is supplying a Gulf Coast U.S. fertilizer manufacturer with about 1 million tonnes of phosphate rock (370,000 $P_2O_5$ tonnes). This rock is shipped after drying by OCP, but before washing to remove the salt water residue which results from beneficiation in sea water. Fresh water rinsing is accomplished at the site before the rock is fed to the chemical plant.

Current U.S. phosphate rock production is about 40 million tonnes per year (12.5 million $P_2O_5$ tonnes), or 64% of capacity. Future demand and market scenarios which drive the industry are unlikely to require or justify any significant increase in this production. Meanwhile, however, exhaustion of economic reserves in areas being mined by present facilities will require that U.S. industry, mainly in Florida and North Carolina, invest in new replacement mines and beneficiation plants. Some estimates indicate that as much as 30 million tonnes of new (replacement) capacity will be required between the years 1990 and 2005.

Total phosphate trade in $P_2O_5$ tonnes (including rock, acids and fertilizer products) is projected in the following table.

**Total Phosphate Trade**

| | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|
| World (million tonnes $P_2O_5$) | 20.1 | 27.8 | 26.5 | 26.3 | 30.3 | 31.1 |
| U.S. (million tonnes $P_2O_5$) | 5.6 | 8.7 | 8.1 | 7.7 | 8.1 | 7.5 |
| U.S. world share | 28% | 31% | 30% | 29% | 27% | 24% |

The U.S. has adequate capacity in-place to supply this projected trade through 1996. A short-fall will be created if replacement costs (new mines and expansion of existing) cannot result in operations which yield favorable economic return.

Assuming stable markets and no significant new investment in new or replacement capacity, a short-fall in U.S. production of acid-grade phosphate rock as indicated in the following table is predicted.

**Million Tonnes of Rock**

| | | |
|---|---|---|
| 1997 - 1.8 | 2002 - 12.2 | 2007 - 21.8 |
| 1998 - 1.5 | 2003 - 13.2 | 2008 - 29.0 |
| 1999 - 2.4 | 2004 - 15.0 | 2009 - 30.3 |
| 2000 - 8.3 | 2005 - 15.0 | 2010 - 30.3 |
| 2001 - 12.2 | 2006 - 15.0 | |

This scenario would indicate, if present capacity is not replaced, that a market would be created in the year 2000 to support an alternative rock production scenario such as from offshore Georgia.

Acid-grade rock is that which is amenable to downstream chemical conversion, first to phosphoric acid and later to fertilizer products. Phosphate rock concentrates of grades 64-66 BPL (29-30% $P_2O_5$) are routinely used by captive producers as feed stock for chemical conversion. This trend will increase as supplies of high grade rock world-wide are depleted.

Whether or not replacement capacity is realized will depend on economics. Replacement capacity will require new investment at the cost, in current dollars, of $65 to $90 per annual tonne of capacity, or a total of $1.95-$2.7 billion.

The lower required investment cost range applies where existing infrastructure can be utilized. The higher cost range includes some additional or new infrastructure. Higher costs will be incurred if totally new infrastructure is required.

Current and near-term future production costs of Florida producers operating existing mines and beneficiation plants provide one rational basis of comparison for any alternative domestic-sourced production. (See Table 5-21). This table shows direct cash cost of production and indirect costs for taxes, sales expense (Phosphate Rock Export Association) and insurance, plus items which account for the cost of money (interest), a minimum return on capital invested for physical improvements (amortization), and reserves (depletion).

To complete the comparison, the cost of handling, drying, transporting, and ship loading must be added to the FOB mine cost. These costs, common to both present and near-term future mines, consist of the following items.

**Dollars Per Short Ton (Dry Basis)**

| | |
|---|---|
| Freight to Port | $3.40 |
| Unload to Storage | .20 |
| Drying (at port) | 1.75 |
| Port Storage (port charge) | .65 |
| Vessel Loading | 2.20 |
| Total | $8.20 |

## Table 5-21

## Cost of Production

**Dollars Per Short Ton (dry basis)**

| | | Current Mines | | Near-Term Future Mines | |
|---|---|---|---|---|---|
| 1. | Mining | $2.45 | | $ 4.24 | |
| 2. | Beneficiation | 3.30 | | 5.27 | |
| 3. | Waste Disposal, Land Reclamation and Water Re-use | 2.44 | | 4.53 | |
| 4. | Product Management | 0.46 | | 0.46 | |
| 5. | Admin., Clerical, Technical | 1.30 | | 1.30 | |
| Cash Cost (Wet) | | | $ 9.95 | | $15.80 |
| | Severance | 1.35 | | 1.35 | |
| | Other taxes | 0.50 | | 0.50 | |
| | Sales exp. (Phosrock) | 0.50 | | 0.50 | |
| | Insurance | 0.10 | | 0.10 | |
| | Sub-total | | 2.45 | | 2.45 |
| * | Interest on Working Capital | 0.40 | | 0.60 | |
| ** | Amortization of Investment ($65/t) | 9.75 | ($90/t) | 13.50 | |
| | Depletion | 1.00 | | 1.00 | |
| | Sub-total | | 11.15 | | 15.10 |
| | Total Cost, Wet FOB Mine | | $23.55 | | $33.35 |

* Cash cost of 3 months production, 20 years @ 10%

** 20 years @ 15%

If all costs and expenses are allocated and a reasonable return on investment accounted for, as indicated in Table 5-21, Florida rock producers can put phosphate rock aboard vessels at Port Tampa for betwen $31.75 and $41.55 per ton ($35.00 and $45.81 per tonne), over the period 1988 through about 1992.

Current selling price of 68 BPL (31% $P_2O_5$) phosphate rock loaded on vessels at Port Tampa is $29.00 to $30.00 per tonne. This pricing is in response to competitive pressure and is possible because most Florida producers have fully amortized the investments made when costs were lower, and/or are willing to sacrifice normally acceptable returns for sustained production and utilization of installed capacity.

Phosphate fertilizer producers will purchase and use 66 BPL (30.2% $P_2O_5$) grade rock, if the quality makes it suitable for acidulation, etc., and if the selling price is attractive. Under certain market conditions a price penalty or premium is recognized when grade is much below or above about 68 BPL. The BPL grade point penalty, when market conditions warrant it, is generally on the order of $0.70 to $0.90, or $1.40 to $1.80 per tonne for 66 BPL rock.

Table 5-22 is constructed from these projections by adding current and estimated future freight, and port handling and ship loading costs. Return on invested capital at the rate of 15% is separately added to amortize the use of money. A 20% pre-tax profit based on cost is added for a total selling price which is the minimum considered necessary to attract investment in new or replacement facilities. Based on this analysis, a case can be made for predicting the selling price of 66 BPL wet rock in the year 1996 of $34.00 to $36.00 per tonne, and $42.00-$44.00 per tonne in the year 2000.

Economic analysis, therefore, is conducted on sales price of 66 BPL wet rock at $35.00 per tonne, based on immediate implementation to achieve the first production in the year 1996. The most favorable scenario is to start production in 1999-2000 when it is more likely that a market will exist. Economic analysis is also conducted on a sales price of $42.00 per tonne.

A charge for royalty or minerals severance tax estimated to be computed as 5% of the sales price is included, as indicated in operating cost Table 5-20, in the economic analysis.

An underlying premise of the economics and viability of the offshore configuration proposed is that implementation and subsequent production is based on having a market. The production from this enterprise needs to be committed on a long-term basis to chemical fertilizer producer customers. Limited storage of finished product is provided on the offshore island. The customer's production of phopshatic fertilizers must be linked to a continuous supply of phosphate rock feed stock from the offshore facilities. Storage of wet rock must be provided by the customer at his plant.

**Table 5-22**

**Cash Cost per Annual Tonne Phosphate Wet Rock**

**Constant 1988 Dollars**

| | 1988 - 1995 | 1996 - 2000 |
|---|---|---|
| Average Wet Rock FOB Mine | $13.25 - 14.35 | $14.77 - 15.10 |
| Freight, Port Storage and Ship Loading | 5.35 - 6.58 | 6.57 - 7.90 |
| Total Cost Aboard Vessel | 18.60 - 20.93 | 21.34 - 23.00 |
| 15% Charge on Invested Capital | 9.75 | 13.50 |
| 20% Pre-tax Profit | 6.00 | 7.00 |
| Total Selling Price | $34.35 - 36.68 | $41.84 - 43.50 |

## 5.7.2. Economic Analysis

The discounted cash flow rate of return on investment (DCFROR) method of economic analysis is used to evaluate the viability potential of exploiting offshore Georgia phosphate as proposed in this study. DCFROR is computed using computer-driven software programs adapted to this type enterprise. The computer software calculates to determine the rate of return at which the positive and negative cash flows, when discounted to the present, equal zero. The present value of cash outflow and inflow is computed to result in the lowest possible positive and negative net present values (NPV). This procedure is repeated for differing scenarios of investment, income (sales price) and operating cost to gain an understanding of sensitivity. All economic values are based on constant 1988 dollars.

Each scenario is represented by a separate computer run computation of DCFROR and net present value (NPV). A copy of each of the computer printouts for Case I and Case II is included at the end of this section.

Extraordinary costs associated with start-up are accounted for by taking into income 2.4 million tonnes of product sales, and taking as cost the production of 4.8 million tonnes. This procedure is used in each case.

Table 5-23 is a summary of DCFROR results for base case investment and operating costs, and for two sales price and revenue scenarios. The lower sales price is based on market penetration in the year 1996. The higher price is based on making market in 1999.

**Table 5-23**

| Case No. | Sales Price $/tonne | Construction Capital Millions Dollars | Production Cost $/tonne | DCFROR % |
|---|---|---|---|---|
| I | 35 | 280 | 16.25 | 6.6% |
| II | 42 | 280 | 16.60 | 12.2% |

Table 5-24 is a summary of DCFROR results for two constant sales prices and revenue, constant production cost, and about 10% increments of change in investment.

**Table 5-24**

| Case No. | Sales Price $/tonne | Construction Capital Millions Dollars | Construction Capital Variance % +/- | Production Cost $/tonne | DCFROR % |
|---|---|---|---|---|---|
| I(a) | 35 | 252 | -10 | 16.25 | 8.4 |
| I(b) | 35 | 308 | +10 | 16.25 | 5.0 |
| II(a) | 42 | 252 | -10 | 16.60 | 14.1 |
| II(b) | 42 | 308 | +10 | 16.60 | 10.6 |

Table 5-25 is a summary of DCFROR results for constant investment, two sales prices, and about 10% increments of change in production cost.

**Table 5-25**

| Case No. | Sales Price $/tonne | Construction Capital Millions Dollars | Production Cost: Cost $/tonne | Production Cost: Variance % +/- | DCFROR % |
|---|---|---|---|---|---|
| I(c) | 35 | 280 | 14.80 | -10% | 8.0 |
| I(d) | 35 | 280 | 17.70 | +10% | 5.1 |
| II(c) | 42 | 280 | 15.15 | -10% | 13.3 |
| II(d) | 42 | 280 | 18.05 | +10% | 11.1 |

PHOSPHORITE SELECTED CASE
OPERATING COSTS

| INPUT FACTORS: | | ITEM | UNIT COST $ |
|---|---|---|---|
| MATRIX % | 3.71 | KWH | .045 |
| TOTAL % | 9.78 | OPERATING LABOR MH | 17.14 |
| TONS OF PRODUCT/YEAR | 5.28 | DIESEL FUEL GAL. | .60 |
| % OF SLIMES IN MATRIX | 24.30 | A-FATTY ACID # | .08 |
| % OF PEBBLE IN MATRIX | .00 | B-FUEL OIL # | .071 |
| % OF SAND TAILS IN MATRIX | 53.50 | C-NAOH/NH3 # | .075 |
| % OF FLOT. CON. IN MATRIX | 22.20 | D-H2SO4 # | .025 |
| MATRIX DRY DENSITY | 1.22 | E-AMINES # | .24 |
| MATRIX PUMPING DISTANCE | 2.84 | F-KEROSENE # | .091 |
| SLIMES PUMPING DISTANCE | 2.84 | | |
| TAILS PUMPING DISTANCE | 2.84 | 36" PIPE MATRIX | 100 |
| THICKNESS OF MATRIX | 17.84 | 42" PIPE O. B. | 100 |
| MM GALLONS/YR HYDR.STA. | 21000 | 30 " PIPE WASTE | 100 |
| MM GALLONS/YR MAKE UP | 3570 | | |
| MM CYD OVERBURDEN | 32.09 | | |
| MM CYD MATRIX | 19.59 | | |
| MM TONS MATRIX | 23.80 | | |
| MM TONS SLIMES | 5.78385 | | |
| MM TONS SANDS | 12.73399 | | |
| MM TONS PEBBLE | | | |
| MM TONS FLOT CON | 5.28401 | | |
| ORE DENSITY WET | 1.40 | | |
| RATIO OF CONCENTRATION | 3.41 | | |
| FEET OVERBURDEN | 26.30 | | |
| ACRES/YEAR | 756 | | |
| TONS/ACRE | 6987 | | |
| ACRE FT SLIMES/YEAR | 14343 | | |
| FLOTATION RECOVERY % | 80 | | |
| MINE RECOVERY % | 90 | | |
| PROD.PEBBLE GRADE %BPL | 67 | | |
| PROD.CON GRADE %BPL | 65.92 | | |
| COMP.PROD. GRADE %BPL | 66 | | |
| FLOT FEED % BPL | 24.2 | | |

UNIT CONSUMPTION

MINING (WORK AREA)

| MODULE | UNITS | CONSUMABLES | ELECTRICITY KWH/UNIT | OPERATING LABOR MH/UNIT | OPERATING SUPPLY $/UNIT | MAINTENANCE LABOR MH/UNIT | MAINTENANCE SUPPLY $/UNIT | FUEL GALLONS/UNIT | REAGENTS $/UNIT | CONTRACT $/UNIT | REPLACEMENT PIPE FT/UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) OVERBURDEN DREDGE | CY OVERBURDEN | | | .00489 | .01245 | .00153 | .06100 | .09798 | | | |
| (b) MATRIX DREDGE | CY MATRIX | | | .00796 | .02028 | .00248 | .09936 | .11286 | | | |
| (d) SLURRY PUMPING MATRIX | MATRIX TONS-MILE | | | .00046 | .00197 | .00046 | .01194 | .0866 | | | .00030 |

BENEFICIATION (WORK AREA)

| MODULE | UNITS | CONSUMABLES | ELECTRICITY KWH/UNIT | OPERATING LABOR MH/UNIT | OPERATING SUPPLY $/UNIT | MAINTENANCE LABOR MH/UNIT | MAINTENANCE SUPPLY $/UNIT | FUEL GALLONS/UNIT | REAGENTS $/UNIT (TON FLT FD | CONTRACT $/UNIT | REPLACEMENT PIPE FT/UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (e) WASHER | TONS MATRIX | | 2.25 | .00195 | .00100 | .00199 | .05114 | A- | 1 | | |
| (f) FLOTATION PREP | TONS FLOAT FEED | | 3.00 | .00148 | .00076 | .00151 | .03881 | B- | 1.25 | | |
| (g) FLOTATION | TONS FLOAT FEED | | 3.50 | .00594 | .00305 | .00606 | .15577 | C- | .4 | | |
| (h) IN PROCESS STORAGE | TONS FLOAT FEED | | .18 | .00074 | .00038 | .00075 | .01941 | D- | 1.3 | | |
| (i) HYDRAULIC STATION | 1,000,000 GALLONS | | 700 | .30140 | .15498 | .30743 | 7.90 | E- | .17 | | |
| | | | | | | | | F- | .1 | | |

WASTE DISPOSAL, LAND RECLAMATION AND WATER RE-USE (WORK AREA)

| MODULE | UNITS | CONSUMABLES | ELECTRICITY KWH/UNIT | OPERATING LABOR MH/UNIT | OPERATING SUPPLY $/UNIT | MAINTENANCE LABOR MH/UNIT | MAINTENANCE SUPPLY $/UNIT | FUEL GALLONS/UNIT | REAGENTS $/UNIT | CONTRACT $/UNIT | REPLACEMENT PIPE FT/UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (j) SLURRY PUMPING TAILS | TAILS TON MILE | | .76 | .00046 | .00197 | .00046 | .01194 | | | | .00015 |
| (k) SLURRY PUMPING SLIMES | SLIMES TON MILE | | 1.15 | .00141 | .00604185 | .00142 | .03661 | | | | .00016 |
| (l) MAKE UP WATER | 1,000,000 GALLONS | | 850 | .30100 | .51591 | .30401 | 7.82 | | | | |

PRODUCT MANAGEMENT (WORK AREA)

| MODULE | UNITS | CONSUMABLES | ELECTRICITY KWH/UNIT | OPERATING LABOR MH/UNIT | OPERATING SUPPLY $/UNIT | MAINTENANCE LABOR MH/UNIT | MAINTENANCE SUPPLY $/UNIT | FUEL GALLONS/UNIT | REAGENTS $/UNIT | CONTRACT $/UNIT | REPLACEMENT PIPE FT/UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (o) CONVEYOR | TONS PRODUCT WET | | .05 | .00011 | .00023 | .00011 | .00286 | | | | |
| (p) STORAGE | TONS PRODUCT | | .22 | .00351 | .02166 | .00355 | .09114 | | | | |
| (q) LOADOUT | TONS PRODUCT | | .20 | .00351 | .01203 | .00355 | .09114 | | | | |

UNIT COST

MINING (WORK AREA) COST

| MODULE | UNITS | CONSUMABLES ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | CONTRACT | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $/UNIT | | $ PER UNIT |
| (a) OVERBURDEN DREDGE | CY OVERBURDEN | $.000 | $.084 | $.012 | $.026 | $.061 | $.059 | | | $.000 | $.242 |
| (b) MATRIX DREDGE | CY MATRIX | $.000 | $.136 | $.020 | $.043 | $.099 | $.068 | | | $.000 | $.366 |
| (d) SLURRY PUMPING MATRIX | MATRIX TONS-MILE | $.000 | $.008 | $.002 | $.008 | $.012 | $.052 | | | $.030 | $.112 |

BENEFICIATION (WORK AREA) COST

| MODULE | UNITS | CONSUMABLES ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | CONTRACT | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $/UNIT | | $ PER UNIT |
| (e) WASHER | TONS MATRIX | $.101 | $.033 | $.001 | $.034 | $.051 | | | | | $.221 |
| (f) FLOTATION PREP | TONS FLOAT FEED | $.135 | $.025 | $.001 | $.026 | $.039 | | | | | $.226 |
| (g) FLOTATION | TONS FLOAT FEED | $,158 | $.102 | $.003 | $.104 | $.156 | | $.281 | | | $.803 |
| (h) IN PROCESS STORAGE | TONS FLOAT FEED | $.008 | $.013 | $.000 | $.013 | $.019 | | | | | $.054 |
| (i) HYDRAULIC STATION | 1,000,000 GALLONS | $31.50 | $5.17 | $.15 | $5.27 | $7.90 | | | | | $49.99 |

WASTE DISPOSAL, LAND RECLAMATION AND WATER RE-USE (WORK AREA)

| MODULE | UNITS | CONSUMABLES ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | CONTRACT | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $/UNIT | | $ PER UNIT |
| (j) SLURRY PUMPING TAILS | TAILS TON MILE | $.034 | $.008 | $.002 | $.008 | $.012 | | | | $.015 | $.079 |
| (k) SLURRY PUMPING SLIMES | SLIMES TON MILE | $.052 | $.024 | $.006 | $.024 | $.037 | | | | $.016 | $.159 |
| (l) MAKE UP WATER | 1,000,000 GALLONS | $38.250 | $5.159 | $.516 | $5.211 | $7.816 | | | | | $56.952 |

PRODUCT MANAGEMENT (WORK AREA) COST

| MODULE | UNITS | CONSUMABLES ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | CONTRACT | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $ PER UNIT | $/UNIT | | $ PER UNIT |
| (o) CONVEYOR | TONS PRODUCT WET | $.002 | $.002 | $.000 | .00 | $.003 | | | | | $.009 |
| (p) STORAGE | TONS PRODUCT | $.010 | $.060 | $.022 | $.061 | $.091 | | | | | $.244 |
| (q) LOADOUT | TONS PRODUCT | $.009 | $.060 | $.012 | $.061 | $.091 | | | | | $.233 |

COSTS PER TON

MINING COST

| MODULE NAME | VARIABLE | TONS OF PRODUCT PER VARIABLE | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | CONTRACT | REPL. PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | | | |
| (a) OVERBURDEN DREDGE | CY OVERBURDEN | 6.07304 | $.000 | $.508 | $.076 | $.159 | $.370 | $.357 | $.000 | $.000 | $.000 | $1.470 |
| (b) MATRIX DREDGE | CY MATRIX | 3.70741 | $.000 | $.506 | $.075 | $.158 | $.368 | $.251 | $.000 | $.000 | $.000 | $1.358 |
| (d) SLURRY PUMPING MATRIX | MATRIX TONS-MILE | 10.52905 | $.000 | $.083 | $.021 | $.084 | $.126 | $.547 | $.000 | $.000 | $.318 | $1.178 |
| TOTAL | | | $.000 | $1.097 | $.172 | $.400 | $.865 | $1.155 | $.000 | $.000 | $.318 | $4.007 |

BENEFICIATION COST

| MODULE NAME | VARIABLE | TONS OF PRODUCT PER VARIABLE | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | REPL. PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | | |
| WASHING | TONS MATRIX | 4.50450 | $.456 | $.151 | $.005 | $.154 | $.230 | | | | $.995 |
| FLOTATION PREP | TONS FLOAT FEED | 3.40991 | $.460 | $.086 | $.003 | $.088 | $.132 | | | | $.770 |
| FLOTATION | TONS FLOAT FEED | 3.40991 | $.537 | $.347 | $.010 | $.354 | $.531 | | $.959 | | $2.739 |
| IN PROCESS STORAGE | TONS FLOAT FEED | 3.40991 | $.028 | $.043 | $.001 | $.044 | $.066 | | | | $.182 |
| HYDRAULIC STATION | 1,000,000 GALLONS | .00397 | $.125 | $.021 | $.001 | $.021 | $.031 | | | | $.199 |
| TOTAL | | | $1.606 | $.648 | $.019 | $.661 | $.991 | $.000 | $.959 | | $4.885 |

WASTE DISPOSAL AND WATER RECLAMATION COST

| MODULE NAME | VARIABLE | TONS OF PRODUCT PER VARIABLE | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | CONTRACT | REPL. PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PR$ | PER TON PRODUCT | | |
| SLURRY PUMPING TAILS | TAILS TON MILE | 6.84414 | $.235 | $.054 | $.013 | $.055 | $.082 | | | | $.103 | $.542 |
| SLURRY PUMPING SLIMES | SLIMES TON MILE | 3.10865 | $.161 | $.075 | $.019 | $.076 | $.114 | | | | $.049 | $.493 |
| MAKE UP WATER | 1,000,000 GALLONS | .00068 | $.026 | $.003 | $.000 | $.004 | $.005 | | | | | $.038 |
| TOTAL | | | $.422 | $.133 | $.033 | $.134 | $.201 | $.000 | $.000 | $.000 | $.152 | $1.074 |

PRODUCT MANAGEMENT COST

| MODULE NAME | VARIABLE | TONS OF PRODUCT PER VARIABLE | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN. LABOR | MAIN. SUPPLIES | FUEL | REAGENTS | REPL. PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | $ PER TON PRODUCT | | TOTAL |
| CONVEYOR | TONS PRODUCT WET | 1.17647058824 | $.003 | $.002 | $.000 | $.002 | $.003 | | | | $.011 |
| STORAGE | TONS PRODUCT | 1 | $.010 | $.060 | $.022 | $.061 | $.091 | | | | $.244 |
| LOADOUT | TONS PRODUCT | 1 | $.009 | $.060 | $.012 | $.061 | $.091 | | | | $.233 |
| TOTAL | | | $.022 | $.123 | $.034 | $.124 | $.186 | $.000 | $.000 | | $.488 |

TOTAL OPERATING COST $ PER SHORT TONS

$ PER SHORT TON OF PRODUCT

| (WORK AREA) | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAIN LABOR | MAIN SUPPLY | FUEL | REAGENT | REPL. PIPE | CONTRACT | ADMIN,CLER,TECH | CAP-AMORT | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MINING | $.000 | $1.097 | $.172 | $.400 | $.865 | $1.155 | $.000 | $.318 | | | | $4.007 |
| BENEFICIATION | $1.606 | $.648 | $.019 | $.661 | $.991 | $.000 | $.959 | $.000 | | | $.000 | $4.885 |
| WASTE, RECLAIM AND WATER | $.422 | $.133 | $.033 | $.134 | $.201 | $.000 | $.000 | $.152 | $.000 | | | $1.074 |
| PROD MANAGEMENT | $.022 | $.123 | $.034 | $.124 | $.186 | $.000 | $.000 | $.000 | | | | $.488 |
| ADMIN, CLER, TECH | | | | | | | | | | $1.300 | | $1.300 |
| TOTAL | $2.050 | $2.000 | $.258 | $1.319 | $2.243 | $1.155 | $.959 | $.470 | $.000 | $1.300 | $.000 | $11.753 |

% OF (WORK AREA) COST BY MODULE

MINING (WORK AREA) % OF TOTAL

| CONSUMABLES | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAINTENANCE LABOR | MAINTENANCE SUPPLY | FUEL | REAGENTS | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| MODULE | % MINE COSTS | % MINE COSTS | % MINE COSTS | % MINE COSTS | % MINE COSTS | % MINE COSTS | % MINE COSTS | % MINE COSTS | % MINE COSTS |
| (a) OVERBURDEN DREDGE | .00 | 12.69 | 1.89 | 3.96 | 9.25 | 8.91 | .00 | .00 | 36.70 |
| (b) MATRIX DREDGE | .00 | 12.62 | 1.88 | 3.94 | 9.19 | 6.27 | .00 | .00 | 33.89 |
| (d) SLURRY PUMPING MATRIX | .00 | 2.07 | .52 | 2.09 | 3.14 | 13.65 | .00 | .00 | 29.41 |
| TOTAL | .00 | 27.38 | 4.28 | 9.99 | 21.58 | 28.83 | .00 | 7.94 | 100.00 |

BENEFICIATION (WORK AREA) % OF TOTAL

| CONSUMABLES | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAINTENANCE LABOR | MAINTENANCE SUPPLY | FUEL | REAGENTS | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| MODULE | % BENEF. COST | % BENEF. COST | % BENEF. COST | % BENEF. COST | % BENEF. COST | % BENEF. COST | % BENEF. COST | % BENEF. COST | % BENEF. COST |
| (e) WASHER | 9.34 | 3.08 | .09 | 3.14 | 4.72 | .00 | .00 | .00 | 20.37 |
| (f) FLOTATION PREP | 9.42 | 1.77 | .05 | 1.81 | 2.71 | .00 | .00 | .00 | 15.76 |
| (g) FLOTATION | 10.99 | 7.11 | .21 | 7.25 | 10.87 | .00 | 19.63 | .00 | 56.06 |
| (h) IN PROCESS STORAGE | .57 | .89 | .03 | .90 | 1.35 | .00 | .00 | .00 | 3.74 |
| (i) HYDRAULIC STATION | 2.56 | .42 | .01 | .43 | .64 | .00 | .00 | .00 | 4.07 |
| TOTAL | 32.88 | 13.27 | .40 | 13.53 | 20.30 | .00 | 19.63 | .00 | 100.00 |

WASTE DISPOSAL, LAND RECLAMATION AND WATER RE-USE (WORK AREA)

| CONSUMABLES | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAINTENANCE LABOR | MAINTENANCE SUPPLY | FUEL | REAGENTS | REPLACEMENT PIPE | CONTRACT | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| MODULE | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. COST | % W.D.,W.R. | % W.D.,W.R. COST |
| (j) SLURRY PUMPING TAILS | 21.91 | 5.02 | 1.26 | 5.07 | 7.61 | .00 | .00 | 9.62 | | 50.49 |
| (k) SLURRY PUMPING SLIMES | 14.98 | 6.99 | 1.75 | 7.06 | 10.60 | .00 | .00 | 4.54 | | 45.92 |
| (l) MAKE UP WATER | 2.41 | .32 | .03 | .33 | .49 | .00 | .00 | .00 | | 3.58 |
| TOTAL | 39.29 | 12.34 | 3.04 | 12.47 | 18.70 | .00 | .00 | 14.17 | .00 | 100.00 |

PRODUCT MANAGEMENT (WORK AREA) % OF TOTAL COST

| CONSUMABLES | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAINTENANCE LABOR | MAINTENANCE SUPPLY | FUEL | REAGENTS | REPLACEMENT PIPE | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| MODULE | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST | % PRO.MAN. COST |
| (o) CONVEYOR | .58 | .45 | .06 | .46 | .69 | .00 | .00 | .00 | 2.24 |
| (p) STORAGE | 2.03 | 12.34 | 4.44 | 12.46 | 18.69 | .00 | .00 | .00 | 49.96 |
| (q) LOADOUT | 1.85 | 12.34 | 2.47 | 12.46 | 18.69 | .00 | .00 | .00 | 47.80 |
| TOTAL | 4.46 | 25.13 | 6.96 | 25.38 | 38.07 | .00 | .00 | .00 | 100.00 |

% OF TOTAL COST BY (WORK AREA)

| | ELECTRICITY | OPERATING LABOR | OPERATING SUPPLY | MAINTENANCE LABOR | MAINTENANCE SUPPLY | FUEL | REAGENTS | REPLACEMENT PIPE | CONTRACT | ADMIN,CLER,TECH | CAP-AMORT | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) OVERBURDEN DREDGE | .00 | 4.33 | .64 | 1.35 | 3.15 | 3.04 | .00 | .00 | | | | |
| (b) MATRIX DREDGE | .00 | 4.30 | .64 | 1.34 | 3.13 | 2.14 | .00 | .00 | | | | 11.55 |
| (d) SLURRY PUMPING MATRIX | .00 | .71 | .18 | .71 | 1.07 | 4.65 | .00 | 2.71 | | | | 10.03 |
| SUBTOTAL MINING | .00 | 9.33 | 1.46 | 3.41 | 7.36 | 9.83 | .00 | 2.71 | | | .00 | 34.09 |
| (e) WASHER | 3.88 | 1.28 | .04 | 1.31 | 1.96 | .00 | .00 | .00 | | | | 8.47 |
| (f) FLOTATION PREP | 3.92 | .74 | .02 | .75 | 1.13 | .00 | .00 | .00 | | | | 6.55 |
| (g) FLOTATION | 4.57 | 2.95 | .09 | 3.01 | 4.52 | .00 | 8.16 | .00 | | | | 23.30 |
| (h) IN PROCESS STORAGE | .23 | .37 | .01 | .38 | .56 | .00 | .00 | .00 | | | | 1.55 |
| (i) HYDRAULIC STATION | 1.07 | .17 | .01 | .18 | .27 | .00 | .00 | .00 | | | | 1.69 |
| SUBTOTAL BENEFICIATION | 13.67 | 5.51 | .17 | 5.62 | 8.44 | .00 | 8.16 | .00 | | | .00 | 41.56 |
| (j) SLURRY PUMPING TAILS | 2.00 | .46 | .11 | .46 | .70 | .00 | .00 | .88 | | | | 4.61 |
| (k) SLURRY PUMPING SLIMES | 1.37 | .64 | .16 | .65 | .97 | .00 | .00 | .42 | | | | 4.20 |
| (l) MAKE UP WATER | .22 | .03 | .00 | .03 | .04 | .00 | .00 | .00 | | | | .33 |
| SUBTOTAL W.D., L.R. & W.R. | 3.59 | 1.13 | .28 | 1.14 | 1.71 | .00 | .00 | 1.29 | .00 | | | 9.14 |
| (o) CONVEYOR | .02 | .02 | .00 | .02 | .03 | .00 | .00 | .00 | | | | .09 |
| (p) STORAGE | .08 | .51 | .18 | .52 | .78 | .00 | .00 | .00 | | | | 2.07 |
| (q) LOADOUT | .08 | .51 | .10 | .52 | .78 | .00 | .00 | .00 | | | | 1.98 |
| SUBTOTAL PRODUCT MAN. | .18 | 1.04 | .29 | 1.05 | 1.58 | .00 | .00 | .00 | | | | 4.15 |
| ADMIN, CLER, TECH | | | | | | | | | | 11.06 | | 11.06054 |
| TOTAL | 17.44 | 17.02 | 2.19 | 11.22 | 19.08 | 9.83 | 8.16 | 4.00 | .00 | 11.06 | .00 | 100.00 |

DREDGING EQUIPMENT ,PRODUCTION COSTS

INPUTS:

| MATERIAL CHARACTERISTICS: | UNITS: | |
|---|---|---|
| SEDIMENT VOLUME | CY | 394470000 |
| TONS SEDIMENTS | TONS | 479281050 |
| DENSITY SEDIMENTS | $/CF | 90.00 |
| % MOISTURE(BY WEIGHT) SEDIMENTS | - | 0 |
| % SOLIDS(BY WEIGHT) SEDIMENTS | - | 100 |
| S. G. SEDIMENTS | - | 1.44 |
| S. G. SOLIDS IN SEDIMENTS | - | 1.44 |
| **DREDGING PARAMETERSSTICS:** | | |
| SIZE OF DISCHARGE PIPE | INCHES | 35.4 |
| LENGTH OF PIPE AVERAGE | FEET | 200 |
| LENGTH OF PIPE MAXIMUM | FEET | 200 |
| DESIGN VELOCITY | FT/SEC | 14.66 |
| % OF SOLIDS(BY WEIGHT) PUMPED | - | 29 |
| HAZEN WILLIAMS NUMBER (70-150) SEE UIO | | 140 |
| FRICTION FACTOR MULTIPLER | (WATER=1) | 1 |
| ELEVATION OF SEDIMENTS | FEET | 0 |
| MAXIMUM ELEVATION PIPE LINE | FEET | 125 |
| VELOCITY HEAD | FEET | 3 |
| DREDGE PUMP EFFICIENCY | - | .8 |
| POWER TRANSMISSION EFFICIENCY | - | 1 |
| HORSEPOWER AUXILLARY MOTORS | - | 7842 |
| **COSTS:** | | |
| LABOR | $/HOUR | 17.14 |
| MEN REQUIRED | MEN/SH | 20 |
| DIESEL FUEL | $/GAL | .6 |
| NUMBER OF DREDGES | # | 1 |
| DREDGE/PIPE/MISC. COST | $ | 40000000 |
| VALUE AFTER JOB | $ | 0 |
| % INTEREST ON CAPITAL | % | 15 |
| % INTEREST ON INSURANCE | % | 1 |
| % INTEREST ON TAXES | % | 1 |
| **DREDGE PRODUCTION FACTORS:** | | |
| SCHEDULES DAYS/YEAR | DAYS | 327 |
| SCHEDULED SHIFTS/DAY | SHIFTS | 3 |
| SCHEDULED HR/SHIFT | HOURS | 8 |
| TOTAL HOURS/YEAR SCHEDULED | HOURS | 7848 |
| HOURS/SHIFT OPERATING | HOURS | 6.8 |
| % MECHANICAL AVAILABILITY | % | 90 |
| TOTAL HOUR/YEAR PRODUCING | HOURS | 6003.72 |

| CONVERSION FACTORS: | |
|---|---|
| PIE | 3.14 |
| GALLONS/CUBIC FEET | 7.48 |
| CUBIC FEET/ CUBIC YAR | 27 |
| WEIGHT CUBIC FOOT WAT | 62.4 |
| MINUTES/HR | 60 |
| GAL/HP | .06 |

CALCULATIONS:

| PRODUCTION AND HORSEPOWER | UNIT: | PER DREDGE QUANITY: | ALL DREDGES QUANITY: |
|---|---|---|---|
| FLOW IN DREDGE OUTPUT | GAL/MIN | 45010 | 45010 |
| PRODUCTION THROUGH PIPE | CY/HOUR | 13372 | 13372 |
| PRODUCTION OF SOLIDS | TONS/HOUR | 3992 | 3992 |
| ANNUAL PRODUCTION | CY/YEAR | 19726506 | 19726506 |
| PER DREDGE | YEARS | 20.00 | 20 |
| VELOCITY HEAD | FEET | 3 | 3 |
| FRICTION HEAD | FEET | 3 | 3 |
| STATIC HEAD | FEET | 125 | 125 |
| TOTAL DYNAMIC HEAD AVE | FEET | 131 | 131 |
| TOTAL DYNAMIC HEAD MAX. | FEET | 131 | 131 |
| PUMP HORSEPOWER AVERAGE | HP | 2259 | 2259 |
| PUMP HORSEPOWER MAXIMUM | HP | 2259 | 2259 |

| ANNUAL OPERATING COSTS PER DREDGE: | UNIT | $/UNIT | QUANITY | $/YEAR | $/CY SEDIMENT | |
|---|---|---|---|---|---|---|
| DEISEL FUEL | GAL | .6 | 2226274 | 1335764 | $.068 | |
| LABOR | MH | 17.14 | 156960 | 2690294 | $.136 | |
| MAINTENANCE | % CAPITAL COST | | .07 | 2800000 | $.142 | |
| MISCELANEOUS SUPPLIES | % CAPITAL COST | | .01 | 400000 | $.020 | |
| CAPITAL COST ALLOWANCE | $/ YEAR CAPITAL | | 2000305 | 2000305 | $.101 | |
| INTEREST | % CAPITAL COST | | FORMULA | 3150023 | $.160 | |
| INSURANCE | % CAPITAL COST | | FORMULA | 210002 | $.011 | |
| TAXES | % CAPITAL COST | | FORMULA | 210002 | $.011 | |
| TOTAL COST | | | | 12796389 | $.649 | $.649 |

| ANNUAL OPERATING COSTS ALL DREDGES: | UNIT | $/UNIT | QUANITY | $/YEAR | $/CY SEDIMENT | |
|---|---|---|---|---|---|---|
| DEISEL FUEL | GAL | .6 | 2226274 | 1335764 | $.068 | |
| LABOR | MH | 17.14 | 156960 | 2690294 | $.136 | |
| MAINTENANCE | % CAPITAL COST | | .07 | 2800000 | $.142 | |
| MISCELANEOUS SUPPLIES | % CAPITAL COST | | .01 | 400000 | $.070 | |
| CAPITAL COST ALLOWANCE | $/ YEAR CAPITAL | | 2000305 | 2000305 | $.101 | |
| INTEREST | % CAPITAL COST | | FORMULA | 3150023 | $.160 | |
| INSURANCE | % CAPITAL COST | | FORMULA | 210002 | $.011 | |
| TAXES | % CAPITAL COST | | FORMULA | 210002 | $.011 | |
| | | | | 12796389 | $.649 | $.649 |

GA DFS 29-A458-00 Phosphate Economics
Project Number: 29-A458-00
File: PHOSERR

5/13/88

PHOSPHATE MINING
(Thousand $ per Year)
CASE I

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total Revenue | | | | | | 84000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 |
| Beneficiation | | | | | | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 |
| Rinsing | | | | | | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 |
| Handling and Storage | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Vessel Loading | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Waste Disposal | | | | | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| Super, Clerical, Tech | | | | | | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Offshore Accommodations | | | | | | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 |
| Total Cash Cost | | | | | | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 |
| Total Production Cost | | | | | | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 |
| Total Cash Cost, $/yr | | | | | | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 |
| Total Indirect Cost, $/yr | | | | | | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 |
| Total Production Cost, $/yr | | | | | | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 6000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 35000 | 85000 | 120000 | 40000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1750 | 7750 | 18000 | 26000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 36750 | 92750 | 138000 | 66000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 343500 | 373650 | 309150 | 291975 | 274800 | 257625 | 240450 | 223275 | 206100 | 188325 | 171750 | 154575 | 137400 | 120225 | 103050 | 85875 | 68700 | 51525 | 34350 | 17175 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 28350 | 37365 | 30915 | 29198 | 27480 | 25763 | 24045 | 22328 | 20610 | 18893 | 17175 | 15458 | 13740 | 12023 | 10305 | 8588 | 6870 | 5153 | 3435 | 1718 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -36750 | -92750 | -138000 | -66000 | -30150 | 49835 | 58085 | 59802 | 61520 | 63237 | 64955 | 66672 | 68390 | 70107 | 71825 | 73542 | 75260 | 76977 | 78695 | 80412 | 82130 | 83847 | 85565 | 90882 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 49086 | 84123 | 60078 | 42303 | 30675 | 30640 | 30675 | 15320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8450 | 15423 | 16293 | 17140 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8449 | 15422 | 16238 | 17140 | 27832 | 44870 | 46587 | 48305 | 50022 | 51740 | 53457 | 55175 | 56892 | 58610 | 60327 | 62045 | 67362 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2957 | 5398 | 5704 | 5999 | 9741 | 15705 | 16305 | 16907 | 17508 | 18109 | 18710 | 19311 | 19912 | 20514 | 21114 | 21716 | 23577 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5492 | 10024 | 10594 | 11141 | 18091 | 29165 | 30282 | 31398 | 32514 | 33631 | 34747 | 35864 | 36980 | 38096 | 39213 | 40329 | 43785 |
| Cash Flow | -10000 | -36750 | -92750 | -138000 | -66000 | -30150 | 32660 | 40310 | 39670 | 38947 | 40358 | 41781 | 39756 | 35510 | 36627 | 37743 | 38859 | 39976 | 41092 | 42203 | 43325 | 44441 | 45558 | 46674 | 67305 |
| Cumul Cash Flow | -10000 | -46750 | -139500 | -277500 | -343500 | -373650 | -340990 | -300080 | -260410 | -221463 | -181105 | -139324 | -99568 | -64058 | -27431 | 10312 | 49171 | 83147 | 130239 | 172448 | 215773 | 260214 | 305772 | 352446 | 419751 |

DCFROR 6.6 %
NPV @ 10% -73108

INPUTS:

**MATERIAL CHARACTERISTICS:**

| | UNITS: | |
|---|---|---|
| SEDIMENT VOLUME | CY | 641800000 |
| TONS SEDIMENTS | TONS | 866430000 |
| DENSITY SEDIMENTS | $/CF | 100.00 |
| % MOISTURE(BY WEIGHT) SEDIMENTS | - | 0 |
| % SOLIDS(BY WEIGHT) SEDIMENTS | - | 100 |
| S. G. SEDIMENTS | - | 1.602 |
| S. G. SOLIDS IN SEDIMENTS | - | 1.60 |

**DREDGING PARAMETERSSTICS:**

| | | |
|---|---|---|
| SIZE OF DISCHARGE PIPE | INCHES | 41.4 |
| LENGTH OF PIPE AVERAGE | FEET | 12000 |
| LENGTH OF PIPE MAXIMUM | FEET | 12000 |
| DESIGN VELOCITY | FT/SEC | 15.5 |
| % OF SOLIDS(BY WEIGHT) PUMPED | - | 34.7 |
| HAZEN WILLIAMS NUMBER (70-150) SEE UIO | | 140 |
| FRICTION FACTOR MULTIPLER | (WATER=1) | 1 |
| ELEVATION OF SEDIMENTS | FEET | 0 |
| MAXIMUM ELEVATION PIPE LINE | FEET | 35 |
| VELOCITY HEAD | FEET | 3 |
| DREDGE PUMP EFFICIENCY | - | .8 |
| POWER TRANSMISSION EFFICIENCY | - | 1 |
| HORSEPOWER AUXILLARY MOTORS | - | 7842 |

**COSTS:**

| | | |
|---|---|---|
| LABOR | $/HOUR | 17.14 |
| MEN REQUIRED PER DREDGE | MEN/SH | 20 |
| DIESEL FUEL | $/GAL | .6 |
| NUMBER OF DREDGES | # | 1 |
| DREDGE/PIPE/MISC. COST PER DREDGE | $ | 40000000 |
| VALUE AFTER JOB | $ | 0 |
| % INTEREST ON CAPITAL | % | 15 |
| % INTEREST ON INSURANCE | % | 1 |
| % INTEREST ON TAXES | % | 1 |

**DREDGE PRODUCTION FACTORS:**

| | | |
|---|---|---|
| SCHEDULES DAYS/YEAR | DAYS | 327 |
| SCHEDULED SHIFTS/DAY | SHIFTS | 3 |
| SCHEDULED HR/SHIFT | HOURS | 8 |
| TOTAL HOURS/YEAR SCHEDULED | HOURS | 7848 |
| HOURS/SHIFT OPERATING | HOURS | 6.8 |
| % MECHANICAL AVAILABILITY | % | 90 |
| TOTAL HOUR/YEAR PRODUCING | HOURS | 6003.72 |

**CONVERSION FACTORS:**

| | |
|---|---|
| PIE | 3.14 |
| GALLONS/CUBIC FEET | 7.48 |
| CUBIC FEET/ CUBIC YAR | 27 |
| WEIGHT CUBIC FOOT WAT | 62.4 |
| MINUTES/HR | 60 |

**CALCULATIONS:**

| PRODUCTION AND HORSEPOWER | UNIT: | PER DREDGE QUANITY: | ALL DREDGES QUANITY: | |
|---|---|---|---|---|
| FLOW IN DREDGE OUTPUT | GAL/MIN | 65088 | 65088 | |
| PRODUCTION THROUGH PIPE | CY/HOUR | 19337 | 19337 | |
| PRODUCTION OF SOLIDS | TONS/HOUR | 7225 | 7225 | |
| ANNUAL PRODUCTION | CY/YEAR | 32130341 | 32130341 | |
| PER DREDGE | YEARS | 19.97 | 19.97 | |
| VELOCITY HEAD | FEET | 3 | 3 | |
| FRICTION HEAD | FEET | 146 | 146 | |
| STATIC HEAD | FEET | 35 | 35 | |
| TOTAL DYNAMIC HEAD AVE | FEET | 184 | 184 | |
| TOTAL DYNAMIC HEAD MAX. | FEET | 184 | 184 | 5794 |
| PUMP HORSEPOWER AVERAGE | HP | 4819 | 4819 | |
| PUMP HORSEPOWER MAXIMUM | HP | 4819 | 4819 | |

| ANNUAL OPERATING COSTS PER DREDGE: | UNIT | $/UNIT | QUANITY | $/YEAR | $/CY SEDIMENT | |
|---|---|---|---|---|---|---|
| DEISEL FUEL | GAL | .6 | 3148211 | 1888927 | $.059 | |
| LABOR | MH | 17.14 | 156960 | 2690294 | $.084 | |
| MAINTENANCE | % CAPITAL COST | | .07 | 2800000 | $.087 | |
| MISCELANEOUS SUPPLIES | % CAPITAL COST | | .01 | 400000 | $.012 | |
| CAPITAL COST ALLOWANCE | $/ YEAR CAPITAL | | 2002514 | 2002514 | $.062 | |
| INTEREST | % CAPITAL COST | | FORMULA | 3150189 | $.098 | |
| INSURANCE | % CAPITAL COST | | FORMULA | 210013 | $.007 | |
| TAXES | % CAPITAL COST | | FORMULA | 210013 | $.007 | |
| TOTAL COST | | | | 13351949 | $.416 | $.416 |

| ANNUAL OPERATING COSTS ALL DREDGES: | UNIT | $/UNIT | QUANITY | $/YEAR | $/CY SEDIMENT | |
|---|---|---|---|---|---|---|
| DEISEL FUEL | GAL | .6 | 3148211 | 1888927 | $.059 | |
| LABOR | MH | 17.14 | 156960 | 2690294 | $.084 | |
| MAINTENANCE | % CAPITAL COST | | .07 | 2800000 | $.087 | |
| MISCELANEOUS SUPPLIES | % CAPITAL COST | | .01 | 400000 | $.012 | |
| CAPITAL COST ALLOWANCE | $/ YEAR CAPITAL | | 2002514 | 2002514 | $.062 | |
| INTEREST | % CAPITAL COST | | FORMULA | 3150189 | $.098 | |
| INSURANCE | % CAPITAL COST | | FORMULA | 210013 | $.007 | |
| TAXES | % CAPITAL COST | | FORMULA | 210013 | $.007 | |
| | | | | 13351949 | $.416 | $.416 |

GA UFS 29 A458-00 Phosphate Economics
Project Number: 29-A458 00
File: PHOS2R2

5/13/88

# PHOSPHATE MINING
(Thousand $ per Year)
CASE I(a)

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total Revenue | | | | | | 84000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 |
| Beneficiation | | | | | | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 |
| Rinsing | | | | | | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 |
| Handling and Storage | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Vessel Loading | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Waste Disposal | | | | | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| Super, Clerical, Tech | | | | | | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Offshore Accommodations | | | | | | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 |
| Total Cash Cost | | | | | | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 |
| Total Production Cost | | | | | | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 |
| Total Cash Cost, $/yr | | | | | | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 |
| Total Indirect Cost, $/yr | | | | | | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 |
| Total Production Cost, $/yr | | | | | | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 6000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 31500 | 76500 | 108000 | 36000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1575 | 6975 | 16200 | 23400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 33075 | 83475 | 124200 | 59400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 310150 | 336965 | 279135 | 263628 | 248120 | 232613 | 217105 | 201598 | 186090 | 170583 | 155075 | 139568 | 124060 | 108553 | 93045 | 77538 | 62030 | 46523 | 31015 | 15509 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15509 | 15508 | 15508 | 15508 | 15508 | 15509 | 15508 | 15509 | 15508 | 15508 | 15505 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 25015 | 33697 | 27914 | 26363 | 24812 | 23261 | 21711 | 20160 | 18609 | 17058 | 15508 | 13957 | 12406 | 10855 | 9305 | 7754 | 6203 | 4652 | 3102 | 1551 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -33075 | -83475 | -124200 | -59400 | -26815 | 53503 | 61066 | 62637 | 64188 | 65739 | 67289 | 68840 | 70391 | 71942 | 73492 | 75043 | 76594 | 78145 | 79695 | 81246 | 82797 | 84348 | 85998 | 91049 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 44320 | 75956 | 54245 | 38738 | 27696 | 27665 | 27696 | 13833 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3421 | 11950 | 10246 | 15037 | 19797 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3420 | 11949 | 10246 | 15037 | 19796 | 31487 | 46871 | 48422 | 49972 | 51523 | 53074 | 54625 | 56175 | 57726 | 59277 | 60828 | 62378 | 67529 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1197 | 4182 | 6386 | 6663 | 6929 | 11020 | 16405 | 16948 | 17490 | 18033 | 18576 | 19119 | 19661 | 20204 | 20747 | 21290 | 21832 | 23635 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2223 | 7767 | 11860 | 12374 | 12867 | 20467 | 30466 | 31474 | 32482 | 33490 | 34498 | 35506 | 36514 | 37522 | 38530 | 39538 | 40546 | 43894 |
| Cash Flow | -10000 | -33075 | -83475 | -124200 | -59400 | -26815 | 37395 | 44381 | 42947 | 42294 | 43568 | 44952 | 42312 | 38478 | 39486 | 40494 | 41502 | 42510 | 43518 | 44526 | 45534 | 46542 | 47550 | 48558 | 67414 |
| Cumul Cash Flow | -10000 | -43075 | -126550 | -250750 | -310150 | -336965 | -298970 | -254589 | -211642 | -169348 | -125780 | -80928 | -38616 | -138 | 39348 | 79842 | 121344 | 163854 | 207372 | 251898 | 297432 | 343974 | 391524 | 440082 | 507496 |

DCFROI 8.4 %
NPV @ 10% -33130

GA OFS 29-A458-00 Phosphate Economics
Project Number: 29 A458 00
File: FHG5233

PHOSPHATE MINING
(Thousand $ per Year)
CASE I(b)

5/13/88

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total Revenue | | | | | | 84000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 |
| Beneficiation | | | | | | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 |
| Rinsing | | | | | | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 |
| Handling and Storage | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Vessel Loading | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Waste Disposal | | | | | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| Super, Clerical, Tech | | | | | | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Offshore Accommodations | | | | | | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 |
| Total Cash Cost | | | | | | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 |
| Total Production Cost | | | | | | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 | 16.25 |
| Total Cash Cost, $/yr | | | | | | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 |
| Total Indirect Cost, $/yr | | | | | | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 | 12720 |
| Total Production Cost, $/yr | | | | | | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 | 78000 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 6000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 | 90000 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 38500 | 93500 | 132000 | 44000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1925 | 8525 | 19800 | 28600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 40425 | 102025 | 151800 | 72600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 376850 | 410335 | 339165 | 320323 | 301480 | 282638 | 263795 | 244953 | 226110 | 207268 | 188425 | 169583 | 150740 | 131898 | 113055 | 94213 | 75370 | 56528 | 37685 | 18843 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 31685 | 41034 | 33917 | 32032 | 30148 | 28264 | 26380 | 24495 | 22611 | 20727 | 18843 | 16958 | 15074 | 13190 | 11306 | 9421 | 7537 | 5653 | 3769 | 1884 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1200 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3600 |
| Cash Flow (After Investment) | -10000 | -40425 | -102025 | -151800 | -72600 | -33485 | 46166 | 55083 | 56968 | 58852 | 60736 | 62620 | 64505 | 66389 | 68273 | 70157 | 72042 | 73926 | 75810 | 77694 | 79579 | 81463 | 83347 | 85231 | 90716 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 53852 | 92291 | 65911 | 47069 | 33653 | 33615 | 33653 | 16808 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4950 | 12600 | 13561 | 14484 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4949 | 12599 | 13560 | 14483 | 24177 | 42869 | 44753 | 46637 | 48522 | 50406 | 52290 | 54174 | 56059 | 57943 | 59827 | 61711 | 67192 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1732 | 4410 | 4746 | 5069 | 8462 | 15004 | 15664 | 16323 | 16983 | 17642 | 18302 | 18961 | 19621 | 20280 | 20939 | 21599 | 23519 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3217 | 8189 | 8814 | 9414 | 15715 | 27865 | 29089 | 30314 | 31539 | 32764 | 33989 | 35213 | 36438 | 37663 | 38888 | 40112 | 43677 |
| Cash Flow | -10000 | -40425 | -102025 | -151800 | -72600 | -33485 | 27323 | 36240 | 36393 | 35599 | 37147 | 38708 | 37200 | 32542 | 33766 | 34991 | 36216 | 37441 | 38665 | 39890 | 41115 | 42340 | 43565 | 44789 | 67197 |
| Cumul Cash Flow | -10000 | -50425 | 152450 | -304250 | -376850 | -410335 | -383012 | -346772 | -310379 | -274780 | -237633 | -198925 | -161725 | -129183 | -95417 | -60426 | -24210 | 13231 | 51896 | 91786 | 132901 | 175241 | 218806 | 263595 | 330792 |

DCFROI 5 %
NPV @ 10% -113609

GN OFS 23 A458 00 Phosphate Economics
Project Number: 23 A458 00
File: PHOS236

PHOSPHATE MINING
(Thousand $ per Year)
CASE 1(c)

5/13/88

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
| Sales Revenue | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total Revenue | | | | | | 84000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 |
| Production Costs | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | |
| Mining | | | | | | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 |
| Beneficiation | | | | | | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 |
| Rinsing | | | | | | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 |
| Handling and Storage | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Vessel Loading | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Waste Disposal | | | | | | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 |
| Super, Clerical, Tech | | | | | | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 |
| Offshore Accomodations | | | | | | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 |
| Total Cash Cost | | | | | | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | |
| Administration | | | | | | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 |
| Sales | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Royalty @ 5% of sales price | | | | | | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Taxes (misc) | | | | | | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 |
| Other | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Total Indirect Cost | | | | | | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 |
| Total Production Cost | | | | | | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 |
| Total Cash Cost, $/yr | | | | | | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 |
| Total Indirect Cost, $/yr | | | | | | 12288 | 12288 | 12288 | 12288 | 12288 | 12288 | 12288 | 12288 | 12288 |
| Total Production Cost, $/yr | | | | | | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 12960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 |
| Investment | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 35000 | 85000 | 120000 | 40000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1750 | 7750 | 18000 | 26000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 36750 | 92750 | 138000 | 66000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 343500 | 366690 | 309150 | 291975 | 274800 | 257625 | 240450 | 223275 | 206100 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 21390 | 36669 | 30915 | 29198 | 27480 | 25763 | 24045 | 22328 | 20610 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow (After Investment) | -10000 | -36750 | -92750 | -138000 | -66000 | -23190 | 57491 | 65045 | 66762 | 68480 | 70197 | 71915 | 73632 | 75350 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 49086 | 84123 | 60078 | 42903 | 30675 | 30640 | 30675 | 15320 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2484 | 11930 | 18903 | 19779 | 20620 | 23520 | 23520 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2483 | 11929 | 18902 | 19778 | 20620 | 34792 | 51830 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 869 | 4175 | 6616 | 6922 | 7217 | 12177 | 18141 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1614 | 7754 | 12286 | 12856 | 13403 | 22615 | 33689 |
| Cash Flow | -10000 | -36750 | -92750 | -138000 | -66000 | -23190 | 40316 | 47001 | 45412 | 44689 | 46100 | 47523 | 44280 | 40034 |
| Cumul Cash Flow | -10000 | -46750 | -139500 | -277500 | -343500 | -366690 | -326374 | -279373 | 233961 | -189272 | 143172 | 95649 | -51369 | 11335 |

| Project Year | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Production, Million TPY | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total Revenue | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 |
| Mining | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 |
| Beneficiation | 4.86 | 4.36 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 | 4.86 |
| Rinsing | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 |
| Handling and Storage | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Vessel Loading | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Waste Disposal | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 |
| Super, Clerical, Tech | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 |
| Offshore Accomodations | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 |
| Total Cash Cost | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 |
| Administration | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 |
| Sales | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Royalty @ 5% of sales price | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Taxes (misc) | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 |
| Other | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Total Indirect Cost | 2.55 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 | 2.56 |
| Total Production Cost | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 | 14.80 |
| Total Cash Cost, $/yr | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 |
| Total Indirect Cost, $/yr | 12288 | 12289 | 12288 | 12288 | 12288 | 12288 | 12288 | 12288 | 12288 | 12289 | 12289 |
| Total Production Cost, $/yr | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 | 71040 |
| Cash Flow (Revenue-Prod Cost) | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 | 96960 |
| Pre-construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 188925 | 171750 | 154575 | 137400 | 120225 | 103050 | 85875 | 68700 | 51525 | 34350 | 17175 |
| Principal Payment | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 0 |
| Interest @ 10% | 18893 | 17175 | 15458 | 13740 | 12023 | 10305 | 8588 | 6870 | 5153 | 3435 | 1718 |
| Replacement Capital | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -2000 |
| Cash Flow (After Investment) | 77067 | 78785 | 80502 | 82220 | 83937 | 85655 | 87372 | 89090 | 90807 | 92525 | 97642 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 |
| Taxable Income | 53547 | 55265 | 56982 | 58700 | 60417 | 62135 | 63852 | 65570 | 67287 | 69005 | 74322 |
| Tax Rate, % | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 18741 | 19343 | 19344 | 20545 | 21146 | 21747 | 22349 | 22950 | 23550 | 24152 | 26013 |
| Net Income After Tax | 34806 | 35922 | 37038 | 38155 | 39271 | 40388 | 41504 | 42620 | 43737 | 44853 | 48309 |
| Cash Flow | 41151 | 42267 | 43383 | 44500 | 45616 | 46733 | 47849 | 48965 | 50082 | 51198 | 71859 |
| Cumul Cash Flow | 29816 | 72083 | 115466 | 159966 | 205582 | 252315 | 300164 | 349129 | 399211 | 450409 | [illegible] |

DCFROR 8 %
NPV @ 10% -43759

GA OFS 29 A+58-00 Phosphate Economics
Project Number: 29 A+58 00
File: PHOS287

PHOSPHATE MINING
(Thousand $ per Year)
CASE 1(d)

5/13/88

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 | 35.00 |
| Total Revenue | | | | | | 84000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 | 168000 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 |
| Beneficiation | | | | | | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 |
| Rinsing | | | | | | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 |
| Handling and Storage | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Vessel Loading | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Waste Disposal | | | | | | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 |
| Super, Clerical, Tech | | | | | | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 |
| Offshore Accommodations | | | | | | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 |
| Total Cash Cost | | | | | | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 |
| Sales | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Royalty @ 5% of sales price | | | | | | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 |
| Taxes (misc) | | | | | | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 |
| Other | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Total Indirect Cost | | | | | | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 | 2.74 |
| Total Production Cost | | | | | | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 | 17.70 |
| Total Cash Cost, $/yr | | | | | | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 |
| Total Indirect Cost, $/yr | | | | | | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 | 13152 |
| Total Production Cost, $/yr | | | | | | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 | 84960 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | -960 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 | 83040 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 35000 | 85000 | 120000 | 40000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1750 | 7750 | 18000 | 26000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 36750 | 92750 | 138000 | 66000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 343500 | 380610 | 309150 | 291975 | 274800 | 257625 | 240450 | 223275 | 206100 | 188925 | 171750 | 154575 | 137400 | 120225 | 103050 | 85875 | 68700 | 51525 | 34350 | 17175 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 35310 | 38061 | 30915 | 29198 | 27480 | 25763 | 24045 | 22328 | 20610 | 18893 | 17175 | 15458 | 13740 | 12023 | 10305 | 8588 | 6870 | 5153 | 3435 | 1716 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -36750 | -92750 | -138000 | -66000 | -37110 | 42179 | 51125 | 52842 | 54560 | 56277 | 57995 | 59712 | 61430 | 63147 | 64865 | 66582 | 68300 | 70017 | 71735 | 73452 | 75170 | 76887 | 78605 | 83922 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 49086 | 84123 | 60078 | 42903 | 30675 | 30640 | 30675 | 15320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4970 | 11943 | 12819 | 13660 | 22196 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 | 23520 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4969 | 11942 | 12818 | 13660 | 22196 | 37910 | 39627 | 41345 | 43062 | 44780 | 46497 | 48215 | 49932 | 51650 | 53367 | 55085 | 60402 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1739 | 4180 | 4486 | 4781 | 7763 | 13269 | 13869 | 14471 | 15072 | 15673 | 16274 | 16875 | 17476 | 18078 | 18678 | 19280 | 21141 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3230 | 7762 | 8332 | 8879 | 14427 | 24641 | 25758 | 26874 | 27990 | 29107 | 30223 | 31340 | 32456 | 33572 | 34689 | 35805 | 39261 |
| Cash Flow | -10000 | -36750 | -92750 | -138000 | -66000 | -37110 | 25004 | 33950 | 33928 | 33205 | 34616 | 36039 | 34768 | 30986 | 32103 | 33219 | 34335 | 35452 | 36568 | 37685 | 38801 | 39917 | 41034 | 42150 | 62781 |
| Cumul Cash Flow | -10000 | -46750 | -139500 | -277500 | -343500 | -380610 | -355606 | -321656 | -287728 | -254523 | -219907 | -183868 | -149100 | -118114 | -86011 | -52792 | -18457 | 16995 | 53563 | 91248 | 130049 | 169966 | 211000 | 253150 | 315931 |

| | |
|---|---|
| DCFROR | 5.1 % |
| NPV @ 10% | -103157 |

GA OFS 29-A458-00 Phosphate Economics
Project Number: 29-A458-00
File: PHOS2?I

5/12/88

# PHOSPHATE MINING
(Thousand $ per Year)
CASE II

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 |
| Total Revenue | | | | | | 100800 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 |
| Beneficiation | | | | | | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 |
| Rinsing | | | | | | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 |
| Handling and Storage | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Vessel Loading | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Waste Disposal | | | | | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| Super, Clerical, Tech | | | | | | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Offshore Accomodations | | | | | | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 |
| Total Cash Cost | | | | | | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Total Production Cost | | | | | | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 |
| Total Cash Cost, $/yr | | | | | | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 |
| Total Indirect Cost, $/yr | | | | | | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 |
| Total Production Cost, $/yr | | | | | | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 21120 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 35000 | 85000 | 120000 | 40000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1750 | 7750 | 18000 | 26000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 36750 | 92750 | 138000 | 66000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 343500 | 358530 | 303150 | 291375 | 274800 | 257625 | 240450 | 223275 | 206100 | 188325 | 171750 | 154575 | 137400 | 120225 | 103050 | 85875 | 68700 | 51525 | 34350 | 17175 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 13230 | 35853 | 30315 | 29198 | 27480 | 25763 | 24045 | 22328 | 20610 | 18893 | 17175 | 15458 | 13740 | 12023 | 10305 | 8588 | 6870 | 5153 | 3435 | 1718 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -36750 | -92750 | -138000 | -66000 | -15030 | 83267 | 90005 | 91722 | 93440 | 95157 | 96875 | 98592 | 100310 | 102027 | 103745 | 105462 | 107180 | 108897 | 110615 | 112332 | 114050 | 115767 | 117485 | 122802 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 49086 | 84123 | 60078 | 42903 | 30675 | 30640 | 30675 | 15320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14964 | 24410 | 28224 | 28224 | 28224 | 23224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14963 | 24409 | 34541 | 36293 | 37376 | 55048 | 72086 | 73803 | 75521 | 77238 | 78956 | 80673 | 82391 | 84108 | 85826 | 87543 | 89261 | 94578 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5237 | 8543 | 12089 | 12703 | 13292 | 19267 | 25230 | 25831 | 26432 | 27033 | 27635 | 28236 | 28837 | 29438 | 30039 | 30640 | 31241 | 33102 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9726 | 15866 | 22452 | 23590 | 24684 | 35781 | 46856 | 47972 | 49089 | 50205 | 51321 | 52437 | 53554 | 54670 | 55787 | 56903 | 58020 | 61476 |
| Cash Flow | -10000 | -36750 | -92750 | -138000 | -66000 | -15030 | 66032 | 67593 | 66004 | 64176 | 65279 | 66400 | 62150 | 57905 | 59021 | 60138 | 61254 | 62370 | 63486 | 64603 | 65719 | 66836 | 67952 | 69069 | 89700 |
| Cumul Cash Flow | -10000 | -46750 | -139500 | -277500 | -343500 | -358530 | -292438 | -224845 | -150841 | -94665 | -29386 | 37022 | 99172 | 157077 | 216098 | 276236 | 337490 | 399860 | 463346 | 527949 | 593668 | 660504 | 728456 | 797525 | 887225 |

DCFROI 12.2 %
NPV @ 10% 53113

[illegible] Phosphate Economics
Project [illegible]
File: [illegible]

PHOSPHATE MINING
(Thousand $ per Year)
[illegible]

5/13/88

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 |
| Total Revenue | | | | | | 100800 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 |
| Beneficiation | | | | | | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 |
| Rinsing | | | | | | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 |
| Handling and Storage | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Vessel Loading | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Waste Disposal | | | | | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| Super, Clerical, Tech | | | | | | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Offshore Accommodations | | | | | | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 |
| Total Cash Cost | | | | | | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Total Production Cost | | | | | | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 |
| Total Cash Cost, $/yr | | | | | | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 |
| Total Indirect Cost, $/yr | | | | | | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 |
| Total Production Cost, $/yr | | | | | | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 21120 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 31500 | 76500 | 108000 | 36000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1575 | 6975 | 16200 | 23400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 33075 | 83475 | 124200 | 59400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 310150 | 321845 | 279135 | 263628 | 248120 | 232613 | 217105 | 201598 | 186090 | 170583 | 155075 | 139568 | 124060 | 108553 | 93045 | 77538 | 62030 | 46523 | 31015 | 15509 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15508 | 15509 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 9695 | 32185 | 27914 | 26363 | 24812 | 23261 | 21711 | 20160 | 18609 | 17058 | 15508 | 13957 | 12406 | 10855 | 9305 | 7754 | 6203 | 4652 | 3102 | 1551 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -33075 | -83475 | -124200 | -59400 | -11695 | 86935 | 93006 | 94557 | 96108 | 97659 | 99209 | 100760 | 102311 | 103862 | 105412 | 106963 | 108514 | 110065 | 111615 | 113166 | 114717 | 116268 | 117818 | 122369 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 44320 | 75956 | 54245 | 38738 | 27696 | 27665 | 27696 | 13833 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 5490 | 19381 | 27910 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 5489 | 19380 | 27909 | 40188 | 41770 | 43289 | 58703 | 74087 | 75638 | 77189 | 78739 | 80290 | 81841 | 83391 | 84942 | 86493 | 88044 | 89594 | 94745 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 1921 | 6783 | 9768 | 14066 | 14620 | 15151 | 20546 | 25930 | 26473 | 27016 | 27559 | 28102 | 28644 | 29187 | 29730 | 30273 | 30815 | 31358 | 33161 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 3568 | 12597 | 18141 | 26122 | 27150 | 28138 | 38157 | 48157 | 49165 | 50172 | 51180 | 52188 | 53197 | 54204 | 55212 | 56220 | 57229 | 58236 | 61584 |
| Cash Flow | -10000 | -33075 | -83475 | -124200 | -59400 | -11695 | 69506 | 70715 | 69281 | 66534 | 67531 | 68550 | 64706 | 60873 | 61881 | 62888 | 63896 | 64904 | 65913 | 66920 | 67928 | 68936 | 69945 | 70952 | 65229 |
| Cumul Cash Flow | -10000 | -43075 | -126550 | -250750 | -310150 | -321845 | -252339 | -181624 | -112343 | -45809 | 21722 | 90272 | 154978 | 215851 | 277732 | 340620 | 404516 | 469420 | 535333 | 602253 | 670181 | 739117 | 809062 | 880014 | [illegible] |

DCFROI 14.1 %
NPV @ 10% 91003

GA OFS 29-A458-00 Phosphate Economics
Project Number: 29 A458 00
File: PHOS235

5/13/88

# PHOSPHATE MINING
(Thousand $ per Year)
CASE II(b)

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 |
| Total Revenue | | | | | | 100800 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 | 4.40 |
| Beneficiation | | | | | | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 | 5.40 |
| Rinsing | | | | | | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 | .30 |
| Handling and Storage | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Vessel Loading | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Waste Disposal | | | | | | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| Super, Clerical, Tech | | | | | | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| Offshore Accommodations | | | | | | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 | .45 |
| Total Cash Cost | | | | | | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 | 13.60 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Total Production Cost | | | | | | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 | 16.60 |
| Total Cash Cost, $/yr | | | | | | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 | 65280 |
| Total Indirect Cost, $/yr | | | | | | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 | 14400 |
| Total Production Cost, $/yr | | | | | | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 | 79680 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 21120 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 | 121920 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 38500 | 93500 | 132000 | 44000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1925 | 8525 | 19800 | 28600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 40425 | 102025 | 151800 | 72600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 376850 | 395215 | 339165 | 320323 | 301480 | 282638 | 263795 | 244953 | 226110 | 207268 | 188425 | 169583 | 150740 | 131898 | 113055 | 94213 | 75370 | 56528 | 37685 | 18843 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 18843 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 16565 | 39522 | 33917 | 32032 | 30148 | 28264 | 26380 | 24495 | 22611 | 20727 | 18843 | 16958 | 15074 | 13190 | 11306 | 9421 | 7537 | 5653 | 3769 | 1884 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -40425 | -102025 | -151800 | -72600 | -18365 | 79598 | 87003 | 88888 | 90772 | 92656 | 94540 | 96425 | 98309 | 100193 | 102077 | 103962 | 105846 | 107730 | 109614 | 111499 | 113383 | 115267 | 117151 | 122636 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 53852 | 92291 | 65911 | 47069 | 33653 | 33615 | 33653 | 16808 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10546 | 20910 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10546 | 20909 | 28895 | 30817 | 32663 | 51393 | 70085 | 71969 | 73853 | 75738 | 77622 | 79506 | 81390 | 83275 | 85159 | 87043 | 88927 | 94412 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3691 | 7318 | 10113 | 10786 | 11432 | 17988 | 24530 | 25189 | 25849 | 26508 | 27168 | 27827 | 28487 | 29146 | 29806 | 30465 | 31124 | 33044 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6855 | 13591 | 18782 | 20031 | 21231 | 33405 | 45555 | 46780 | 48004 | 49230 | 50454 | 51679 | 52903 | 54129 | 55353 | 56578 | 57803 | 61368 |
| Cash Flow | -10000 | -40425 | -102025 | -151800 | -72600 | -18365 | 60755 | 64469 | 62727 | 61816 | 63027 | 64265 | 59594 | 54936 | 56161 | 57385 | 58611 | 59835 | 61060 | 62284 | 63510 | 64734 | 65959 | 67184 | 89592 |
| Cumul Cash Flow | -10000 | -50425 | -152450 | -304250 | -376850 | -395215 | -334460 | -269991 | -207264 | -145448 | -82421 | -18156 | 41438 | 96374 | 152535 | 209920 | 268531 | 328366 | 389426 | 451710 | 515220 | 579954 | 645913 | 713097 | 802689 |
| DCFROI | 10.6 % | | | | | | | | | | | | | | | | | | | | | | | | |
| NPV @ 10% | 14227 | | | | | | | | | | | | | | | | | | | | | | | | |

GA DES 29 A459-00 Phosphate Economics
Project Number: 29 A459 00
File: PHOS238

PHOSPHATE MINING
(Thousand $ per Year)
CASE III(c)

5/13/88

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| ------------- | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | [illegible] | 42.00 | 42.00 | 42.00 | 42.00 |
| Total Revenue | | | | | | 100800 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | [illegible] | 201600 | 201600 | [illegible] | [illegible] |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| [illegible] | | | | | | | | | | | | | | | | | | | | | | | | | |
| [illegible] | | | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Beneficiation | | | | | | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | 4.66 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Firing | | | | | | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 | .27 |
| Handling and Storage | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Vessel Loading | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Waste Disposal | | | | | | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 |
| Super, Clerical, Tech | | | | | | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 |
| Offshore Accommodations | | | | | | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 |
| Total Cash Cost | | | | | | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 | 12.24 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 |
| Sales | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Royalty @ 5% of sales price | | | | | | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 |
| Taxes (misc) | | | | | | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 | .18 |
| Other | | | | | | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 | .23 |
| Total Indirect Cost | | | | | | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 | 2.91 |
| Total Production Cost | | | | | | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 | 15.15 |
| Total Cash Cost, $/yr | | | | | | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 | 58752 |
| Total Indirect Cost, $/yr | | | | | | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 | 13968 |
| Total Production Cost, $/yr | | | | | | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 | 72720 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 28080 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 | 128880 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| ---------- | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 35000 | 85000 | 120000 | 40000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1750 | 7750 | 18000 | 26000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 36750 | 92750 | 138000 | 66000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 343500 | 351570 | 309150 | 291975 | 274800 | 257625 | 240450 | 223275 | 206100 | 188925 | 171750 | 154575 | 137400 | 120225 | 103050 | 85875 | 68700 | 51525 | 34350 | 17175 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 6270 | 35157 | 30915 | 29198 | 27480 | 25763 | 24045 | 22328 | 20610 | 18893 | 17175 | 15458 | 13740 | 12023 | 10305 | 8588 | 6870 | 5153 | 3435 | 1718 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -3600 |
| Cash Flow (After Investment) | -10000 | -36750 | -92750 | -138000 | -66000 | -8070 | 90923 | 96965 | 98682 | 100400 | 102117 | 103835 | 105552 | 107270 | 108987 | 110705 | 112422 | 114140 | 115857 | 117575 | 119292 | 121010 | 122727 | 124445 | 129762 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 49086 | 84123 | 60078 | 42903 | 30675 | 30640 | 30675 | 15320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 3400 | 18444 | 27890 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 3400 | 18443 | 27889 | 41501 | 43253 | 44936 | 62008 | 79046 | 80763 | 82481 | 84198 | 65916 | 87633 | 89351 | 91068 | 92786 | 94503 | 96221 | 101538 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 1190 | 6455 | 9761 | 14525 | 15139 | 15728 | 21703 | 27666 | 28267 | 28868 | 29469 | 30071 | 30672 | 31273 | 31874 | 32475 | 33076 | 33677 | 35539 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 2210 | 11388 | 18128 | 26976 | 28114 | 29208 | 40305 | 51380 | 52496 | 53613 | 54729 | 55845 | 56961 | 58078 | 59194 | 60311 | 61427 | 62544 | [illegible] |
| Cash Flow | -10000 | -36750 | -92750 | -138000 | -66000 | -8070 | 72558 | 73335 | 71746 | 68700 | 69803 | 70932 | 66674 | 62429 | 63545 | 64662 | 65778 | 66894 | 68010 | 69127 | 70243 | 71360 | 72476 | 73593 | 94224 |
| Cumul Cash Flow | -10000 | -46750 | -139500 | -277500 | -343500 | -351570 | -279012 | -205677 | -133931 | -65231 | 4572 | 75504 | 142178 | 204607 | 268152 | 332814 | 398592 | 465486 | 533496 | 602623 | 672866 | 744226 | 816702 | 890295 | 984519 |

DCFROI 13.3 %
NPV @ 10% 80485

GA DFS 29-A458 00 Phosphate Economics
Project Number: 29 A458 00
File: PHOS293

PHOSPHATE MINING
(Thousand $ per Year)
CASE II(d)

5/11/88

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| ------------- | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | 2.4 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 |
| Sales Price, $/Tonne | | | | | | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 | 42.00 |
| Total Revenue | | | | | | 100800 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 | 201600 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| ---------------- | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 | 4.84 |
| Beneficiation | | | | | | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 | 5.94 |
| Rinsing | | | | | | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 | .33 |
| Handling and Storage | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Vessel Loading | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Waste Disposal | | | | | | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 | 1.27 |
| Super, Clerical, Tech | | | | | | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 | 1.54 |
| Offshore Accommodations | | | | | | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 | .50 |
| Total Cash Cost | | | | | | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 | 14.96 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 |
| Sales | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Royalty @ 5% of sales price | | | | | | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 | 2.10 |
| Taxes (misc) | | | | | | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 | .22 |
| Other | | | | | | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 | .28 |
| Total Indirect Cost | | | | | | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 |
| Total Production Cost | | | | | | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 | 18.05 |
| Total Cash Cost, $/yr | | | | | | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 | 71808 |
| Total Indirect Cost, $/yr | | | | | | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 | 14832 |
| Total Production Cost, $/yr | | | | | | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 | 86640 |
| Cash Flow = (Revenue - Pr. [illegible]) [illegible] | 0 | 0 | 0 | 0 | 0 | 14160 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 | 114960 |
| [illegible] | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 35000 | 85000 | 120000 | 44000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1750 | 7750 | 18000 | 22000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 36750 | 92750 | 138000 | 66000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 343500 | 365490 | 309150 | 291975 | 274800 | 257625 | 240450 | 223275 | 206100 | 188925 | 171750 | 154575 | 137400 | 120225 | 103050 | 85875 | 68700 | 51525 | 34350 | 17175 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 17175 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 20190 | 36549 | 30915 | 29198 | 27480 | 25763 | 24045 | 22328 | 20610 | 18893 | 17175 | 15458 | 13740 | 12023 | 10305 | 8588 | 6870 | 5153 | 3435 | 1718 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1800 | 1800 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | [illegible] |
| Cash Flow (After Investment) | -10000 | -36750 | -92750 | -138000 | -66000 | -21990 | 75611 | 83045 | 84762 | 86480 | 88197 | 89915 | 91632 | 93350 | 95067 | 96785 | 98502 | 100220 | 101937 | 103655 | 105372 | 107090 | 108807 | 110525 | 115242 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 49086 | 84123 | 60078 | 42903 | 30675 | 30640 | 30675 | 15320 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11484 | 20930 | 27983 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 | 28224 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11483 | 20329 | 27902 | 29333 | 31016 | 40089 | 65126 | 66843 | 68561 | 70278 | 71996 | 73713 | 75431 | 77148 | 78866 | 80583 | 82301 | 87014 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4019 | 7325 | 9766 | 10267 | 10856 | 16031 | 22794 | 23395 | 23996 | 24597 | 25199 | 25800 | 26401 | 27002 | 27603 | 28204 | 28805 | 30455 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7464 | 13004 | 18136 | 19066 | 20160 | 31257 | 42332 | 43448 | 44565 | 45681 | 46797 | 47913 | 49030 | 50146 | 51263 | 52379 | 53496 | 56559 |
| Cash Flow | -10000 | -36750 | -92750 | -138000 | -66000 | -21990 | 58436 | 61651 | 60262 | 59539 | 60755 | 61884 | 57826 | 53301 | 54497 | 55614 | 56730 | 57946 | 59062 | 60079 | 61195 | 62312 | 63429 | 64545 | 65176 |
| Cumul Cash Flow | -10000 | -46750 | -139500 | -277500 | -343500 | -365490 | -307054 | -245203 | -184341 | -125402 | -64647 | -2763 | 54863 | 108164 | 162741 | 218355 | 275095 | 332931 | 391893 | 451972 | 513167 | 575479 | 638907 | 703452 | 768628 |

DCFROI 11.1 %
NPV @ 10% 25000

# SECTION 6

# HEAVY MINERAL DEVELOPMENT FEASIBILITY

## 6.1 INTRODUCTION

Exploitation of heavy minerals occurring offshore the Atlantic coast of Georgia in OCS waters relies on data and information produced in previous reports. Publications of the Bureau of Mines and Minerals Management Service of the U.S. Department of Interior and of the Marine Mining Journal are the sources of most costs.

This section deals with the possible potential for commercial exploitation of these minerals by employing technology which has been tested in other offshore mineral mining ventures, and/or in offshore oil and gas exploration and production operations. The applicability of the technology to heavy minerals is reviewed in a comparison of alternative configuration schemes. The preferred scenario, which is the result of this comparison, is based on mining and partial on-board beneficiation by an ocean-going vessel. The suction-type hopper dredge commonly employed by United Kingdom and European operators is the obvious choice. These mining-processing platforms are not currently manufactured in the U.S. Final processing of the intermediate product is conducted offshore in a platform-mounted plant. Finished product is transported to port for sales and distribution. Capital and operating cost estimates are based on data gathered from researching previous publications, and from in-house experience with land-based heavy minerals operations. Economic viability is evaluated by discounted cash flow techniques based on the application of several variable cost scenarios.

## 6.2 MINING

### 6.2.1 Area Selection

Section 3 describes the processes that form heavy mineral deposits and how the mineral database was formed. The selected mining area is based on computer modeling techniques using the following sources:

- o discrete points from unpublished "sparker" seismic profiles received from Peter Popenoe, U.S.G.S.,

- o data file of sampling point on the continental margin off the Georgia Coast received from the USGS - Woods Hole
  - percent sand fraction - code line 210
  - percent of sand fraction consisting of heavy minerals, quartz, and feldspar - code line - 320
  - species of heavy minerals - code line 560.

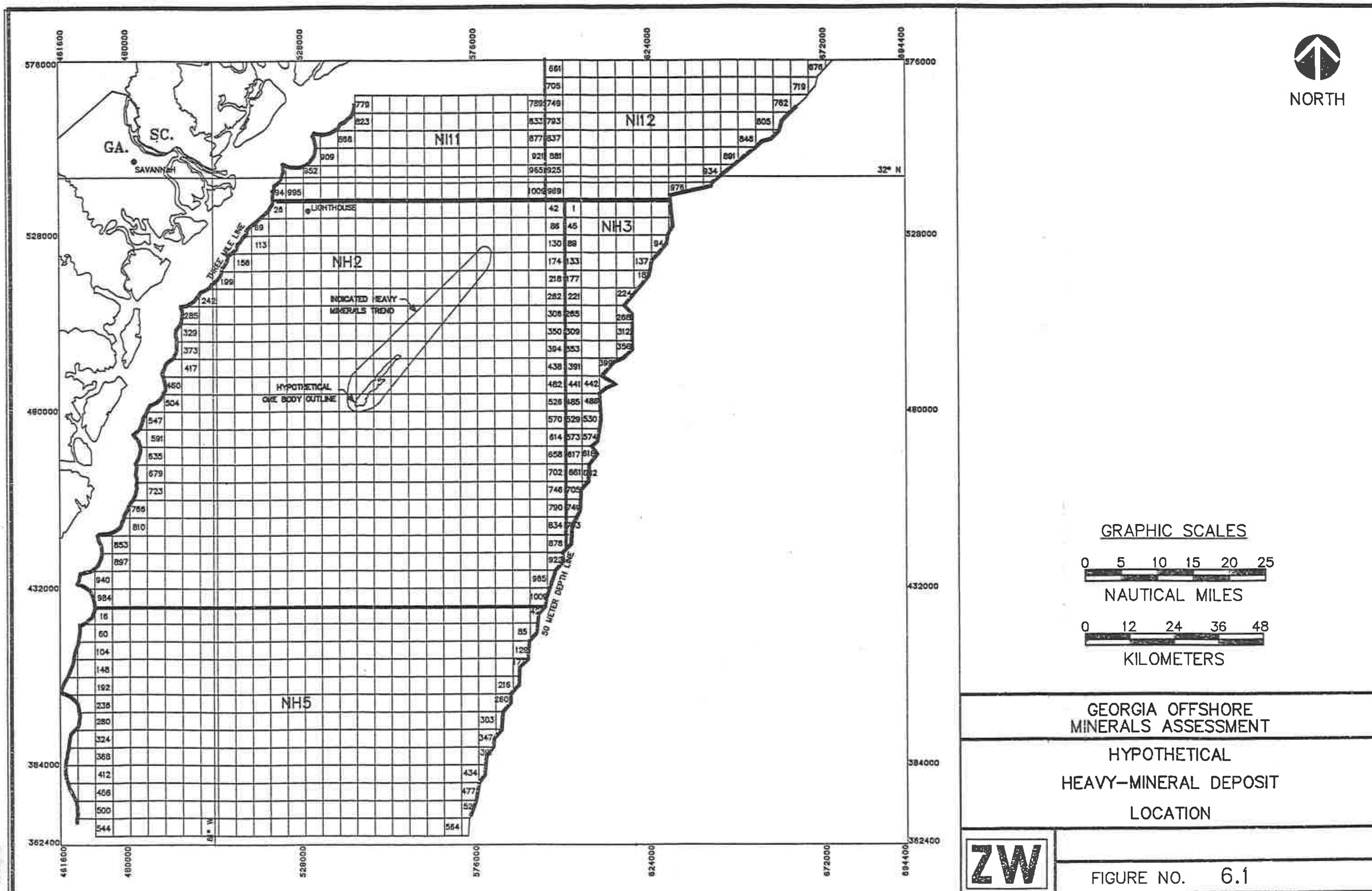
A distinct trend of heavy mineral concentration in ocean bottom grab samples is evident. This trend is supported by total percent mineral species as well as individual species information for rutile, monazite, zircon and staurolite. It should be emphasized that sampling points are widely spaced and have an average area of influence over 11,000 square kilometers. None of the actual sampling points were within the selected mining area. Figure 6.1 shows the selected mining area and geological trends. The selected area has a greater heavy mineral thickness and better data reliability than the trend located closer to shore.

The location and site characteristics are described in Tables 6-1 and 6-2.

**Table 6-1**

| | AMS Coordinates | | Lat. and Long. |
|---|---|---|---|
| | East | North | |
| SW | 543000 | 481400 | 80°32'39.14", 31°28'05.64" |
| NE | 557600 | 495400 | 80°23'34.32", 31°35'38.11" |

(Approximately 18.0 km by 1.5 km)
(Area = 28,134,100$m^2$ or 6,952 acres)




GEORGIA OFFSHORE MINERALS ASSESSMENT

HYPOTHETICAL HEAVY-MINERAL DEPOSIT LOCATION

ZW

FIGURE NO. 6.1

**Table 6-2**
**Site Characteristics of Mining Area**

| Item | Meters Average | Meters Min. | Meters Max. | Meters$^3$ Volume |
|---|---|---|---|---|
| Water Depth | 27.2 | 26.4 | 29.7 | -- |
| Ore Thickness | 10.4 | 9.8 | 11.8 | 292,200,000 |
| Total Mining Depth | 37.6 | 36.4 | 41.4 | |
| Heavy Mineral Percent | 3.6 | 2.6 | 4.0 | |

Since no adequate heavy mineral species data have been made available, for the purpose of this study only, it has been assumed that the contained heavy mineral content expressed in the model represents the total percent oxides of heavy minerals.

Site characteristics show that the total available tonnes of mineral-bearing sands within the study's orebody outline (520,100,000 tonnes) are more than sufficient to support a 15,300,000 tonne per year mining operation for a period of 20 years at minimum (306,000,000 tonnes).

### 6.2.2 Configuration and Production Rate Comparison

Although, at first, the topics of project configuration and production rate appear unrelated for Georgia offshore mining, the production rate depends upon project configuration. As such, they are included in the same discussion.

The annual production of any mineral beneficiation facility is dependent on the ability of the mine to supply ore. Normally, plant production is based on operational efficiency, largely independent of mining because of the ease in providing large stockpiles of plant feed. Most heavy mineral production is based on a linkage between mining, ore transportation, and the plant washer. High operating factors are realized and ore storage is not a requirement. Operating factors for most ocean mining equipment are low compared to onshore mining. This is due to climatic and other conditions beyond the control of the operator.

Production based on mining of ore at sea for beneficiation at a remotely located land-based facility is greatly dependent on the effective operating factors of the excavating and transporting equipment and systems.

As a basis for uniform comparison of alternative configuration schemes certain criteria were established. The criteria adopted for comparative evaluation given below in Table 6-3 are based on previous work and on reported experience with ocean-going dredges and transportation systems. These criteria were later modified to better fit the preferred mining equipment and systems configuration.

Ocean-going vessels equipped for mining are large, containing hoppers for collecting dredged material. These vessels also serve as transports and, therefore, their availability for mining is very limited. Investment is high and utilization for mining is low. This appears to be the norm as is experienced by operators who use these types of foreign-built dredges in the North Atlantic, Pacific Ocean and Sea of Japan. These systems are most effective where there is little or no overburden, where the ratio of ore to product is low, and where concentration takes place on board.

**Table 6-3**

**Criteria Basis for Configuration Comparison**

| | |
|---|---|
| Annual Mining Equipment Availability | |
| Days lost: | |
| annual dry dock/repairs | 30 |
| adverse weather/sea conditions | 36 |
| | 66 |
| Days operational (1) | 299 |
| Hours/day operational | 21 |
| Mechanical availability | 90% |
| Effective operating hours (299 x 21 x .90) | 5,651 |

(1) See Table 5-15, Climatic and Physical Oceanographic Data for basis used to determine days operational.

**Table 6-3** (continued)

| Item Description | Unit | Value |
|---|---|---|
| Average overburden thickness | meters | None |
| Average ore thickness | meters | 9.80 |
| Ore density | tonnes/m$^3$ | 1.78 |
| | lb/ft$^3$ | 111 |
| Mining recovery | percent | 65 |
| Suction head pipe or dredge pump discharge diameter | mm | 900 |
| inches | 36 | |
| Pipeline velocity | m/sec | 4.92 |
| | ft/sec | 16.1 |
| Dredge production dry solids | m$^3$/yr | 10,300,000 |
| | tonnes/hr | 3,240 |
| Average slurry solids | percent | 26 |
| Washer rejects | percent | 50 |
| Distance to land-based beneficiation plant | nautical miles | 50 |
| Average vessel speed | knots | 12 |

Because sea-going suction head hopper type dredges have a long and successful history of operating under ocean conditions they are considered here in evaluating alternative configuration schemes.

The four major project configuration schemes considered for offshore heavy mineral production are:

1. Sea-going hopper dredge for mining and transportation to an onshore plant.
2. Sea-going hopper dredge mining and barge transportation of ore to an onshore plant.
3. Dredge mining, pipeline transportation of ore to onshore plant.
4. Dredge mining, pipeline transportation of ore to a nearby offshore island plant.

The mining dredge vessel or platform in each of the four major configurations is equipped with an onboard processing (washing) plant. Flowsheet data indicate that about 50% of the dredged material can be eliminated by washing. This reject material, a mixture of gravel oversize and sediments, would be disposed of in nearby mined-out areas. In Configurations 1, 2, and 3, matrix is transported, after washing, to a land-based plant for further processing. In configuration 4, matrix is transported by slurry pipeline from the dredge vessel to a nearby offshore plant for further processing. The physical dredge vessel size is determined by the necessity of making the vessel seaworthy, not by the dredging equipment. In Configuration 1 a large hopper is required for storage as the dredge is also the vessel used to transport ore, after washing, to shore.

Since dredge vessel size is larger than required for the dredging equipment alone, the addition of a washing plant costs only slightly more than if located onshore. Plant operating costs are identical. However, with onboard processing, material transported to shore decreases by 50%, resulting in a corresponding reduction in transportation costs of 50%. In addition, waste disposal of the 50% fraction rejected by washing at an onshore plant must be either re-transported from the plant and disposed of in the mined-out areas, or disposed of in tailing impoundments onshore. Either way, the on-vessel washing plant reduces costs considerably by wasting the 50% fraction rejected in nearby mine areas.

The cost comparisons indicate that an on-board washing plant is also favored for configuration 4, even though the cost savings are not as pronounced as for the other configurations.

1. **Sea-going hopper dredge for mining and transportation to an onshore plant.**

   Figure 6.2 shows this configuration. Since the mineral sands are on top of the ocean bottom, no overburden dredge is required. An anchored suction head dredge mines ore by removing the total ore horizon, then moves forward by mining the resulting bank. Mining recovery is limited to about 65% with this system. The anchored suction head dredge deposits the ore into a distribution box, from which it is screened, washed and desilted.

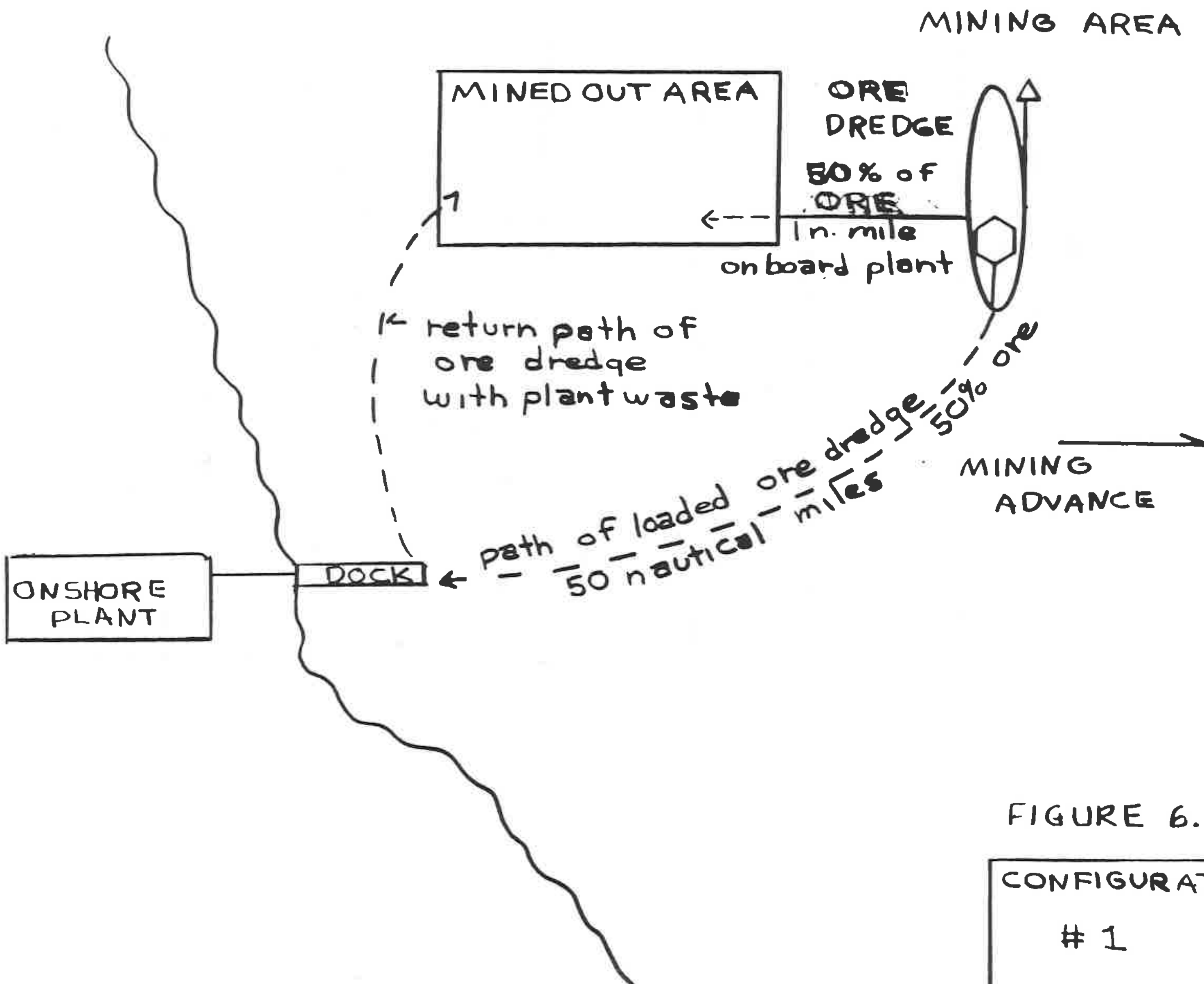



FIGURE 6.2

CONFIGURATION # 1

About 50 percent of the material is loaded into a hopper on board the vessel. Here, through a series of weirs, the washed matrix is dewatered to 75% solids. When the hopper is full, the suction head and pipes are raised from the bottom to the deck. The dredge now functions as a normal merchant ship and carries the material 50 nautical miles to the plant site. The plant site is located in an industrial area on or near Hutchinson Island, where permitting problems and land acquisition problems are minimized. It is felt that an onshore plant located closer on the barrier islands to the mining operation would be environmentally unacceptable.

Cost for hopper dredges were taken from the open file report "An Economic Reconnaissance of Selected Heavy Mineral Placer Deposits in the U.S. Exclusive Economic Zone" by the Bureau of Mines Washington Staff, released 4-87. Capital costs are based on U.S.-built hopper dredges constructed between 1977 and 1985. Operating costs are from actual operating conditions.

For a hopper dredge, cycle times consist of loading, travel, unloading and return travel. The hopper size increases capacity, but also increases capital. In an attempt to optimize hopper size, four loading capacities were analyzed. Table 6-3 shows the design criteria used to determine productivity and costs.

Loading and unloading is done by a 900 mm pump using the criteria in Table 6-3 at the hourly rate of 3,240 tonnes per hour

Table 6-4 shows the time required for each element in the cycle. The cycles per year are based upon 5,651 hours. The tonnes per cycle are based upon the loading time, which is different for each case. Table 6-4 also lists the tonnes per year of product produced for each capacity. As Table 6-4 shows, increases in loading times (hopper capacity) result in only a slight increase in tonnes per year of product.

**Table 6-4**
**Cycle Time Configuration 1**

| Item | Hours | Hours | Hours | Hours |
|---|---|---|---|---|
| Load Ore | 5.00 | 10.00 | 15.00 | 20.00 |
| Travel to Plant | 4.17 | 4.17 | 4.17 | 4.17 |
| Unload Ore | 5.00 | 10.00 | 15.00 | 20.00 |
| Load Tails | 5.00 | 10.00 | 15.00 | 20.00 |
| Travel to Mine | 4.17 | 4.17 | 4.17 | 4.17 |
| Dump Tails | 5.00 | 10.00 | 15.00 | 20.00 |
| Total Cycle Time | 28.34 | 48.34 | 68.34 | 88.34 |
| Cycles per year | 199.40 | 116.90 | 82.70 | 63.97 |
| Tonnes per cycle | 8,100 | 16,200 | 24,300 | 32,400 |
| Tonnes hauled | 1,615,000 | 1,893,000 | 2,009,000 | 2,072,000 |
| Tonnes mined | 3,230,000 | 3,786,000 | 4,018,000 | 4,144,000 |

The following USBM equations from Open File Report 4-87 were used:

$$\text{(P) Hopper Capacity} = \frac{\text{Daily Haul Capacity (DHC)}}{2.9607(L)^{-.2923}}$$

Where

DHC = short tons hauled divided by operating days

L = one way haul distance in nautical miles

Operating Days = 299

Short tons hauled will be determined

Dredge capital cost = $\$7,052\ (P)^{.9421}$

Plant capital cost =

Onboard processing facilities = $319.12(X)^{0.960}$

Onshore processing facilities = $22,500(X)^{0.68}$

where X is plant feed in short tons per day.

Table 6-5 is a summary of calculated hopper sizes and the resulting capital required for each production rate from Table 6-4. The overburden dredge does not require a large hopper and its cost is estimated from other sources. Dollars per ton capital is based on 20 years of mine production for each production scenario.

**Table 6-5**

**Capital Costs Configuration 1**

| Million Prod.Tonnes | | Hopper | Millions of Dollars | | | | | |
|---|---|---|---|---|---|---|---|---|
| Annual | 20 Years | Tons | Mt. Dredge | Ob. Plant | OS Plant | Misc. | Total | $*M Ton |
| 3.230 | 64.6 | 6,308 | 26 | 3 | 8 | 11 | 48 | .75 |
| 3.786 | 75.7 | 7,394 | 31 | 3 | 9 | 13 | 56 | .74 |
| 4.018 | 80.4 | 7,847 | 33 | 3 | 10 | 14 | 60 | .75 |
| 4.144 | 82.9 | 8,093 | 34 | 3 | 10 | 14 | 61 | .74 |

Operating costs for the suction head hopper type ore mining dredge are based on the following U.S.B.O.M. formula (from Open File Report 4-87).

$$\text{Dredge operating cost (\$/s.t.)} = \frac{2.7534\,(P) + 5{,}453}{\text{Daily Dredge Capacity}}$$

where P = payload or hopper capacity in short tons

daily dredge capacity = annual capacity in short tons ÷ days.

Onboard processing facilities = $25.5(X)^{-0.520}$

Onshore processing facilities = $59.4(X)^{-0.345}$

where X is the plant feed throughput in short tons per day.

**Table 6-6**

**Operating Cost - Configuration 1**

**Operating Cost $/Metric Ton Product**

| Tonnes Mined | Dredge | O.B. Plant | O.S. Plant | Total |
|---|---|---|---|---|
| 3,230,000 | $2.11 | $.21 | $1.63 | $3.95 |
| 3,790,000 | 2.04 | .20 | 1.54 | 3.78 |
| 4,020,000 | 2.01 | .19 | 1.51 | 3.71 |
| 4,140,000 | 2.00 | .19 | 1.50 | 3.69 |

**Table 6-7**

**Total Comparative Cost per Tonne, Configuration 1**

| Tonnes Mined | Capital | Operation | Total |
|---|---|---|---|
| 3,230,000 | $ .75 | $ 3.95 | $ 4.70 |
| 3,786,000 | .74 | 3.78 | 4.52 |
| 4,018,000 | .75 | 3.71 | 4.46 |
| 4,144,000 | .74 | 3.69 | 4.43 |

2. **Sea-going Hopper Dredge Mining, Barge Transportation of Ore to an Onshore Plant**

Figure 6.3 shows this configuration. The dredge pumps mined ore into a distribution box from which it is screened, washed, and desilted. About 50% of the ore is removed by onboard washing and disposed of in mined-out areas. The remaining 50% of the ore is dewatered to 75% solids aboard 26,000 tonne barges. These barges are towed to the onshore beneficiation plant by tug boats. After ore is unloaded by pumping it from the barge into live storage containment, the barge is towed back to the overburden dredge and another cycle begins. In order to avoid a large tailings area, an independent fleet of barges and tugs load, transport, and dump the plant tailings in the mined-out areas. By providing storage at the plant and a separate waste disposal sytem, the plant operation is not directly tied to the mine.

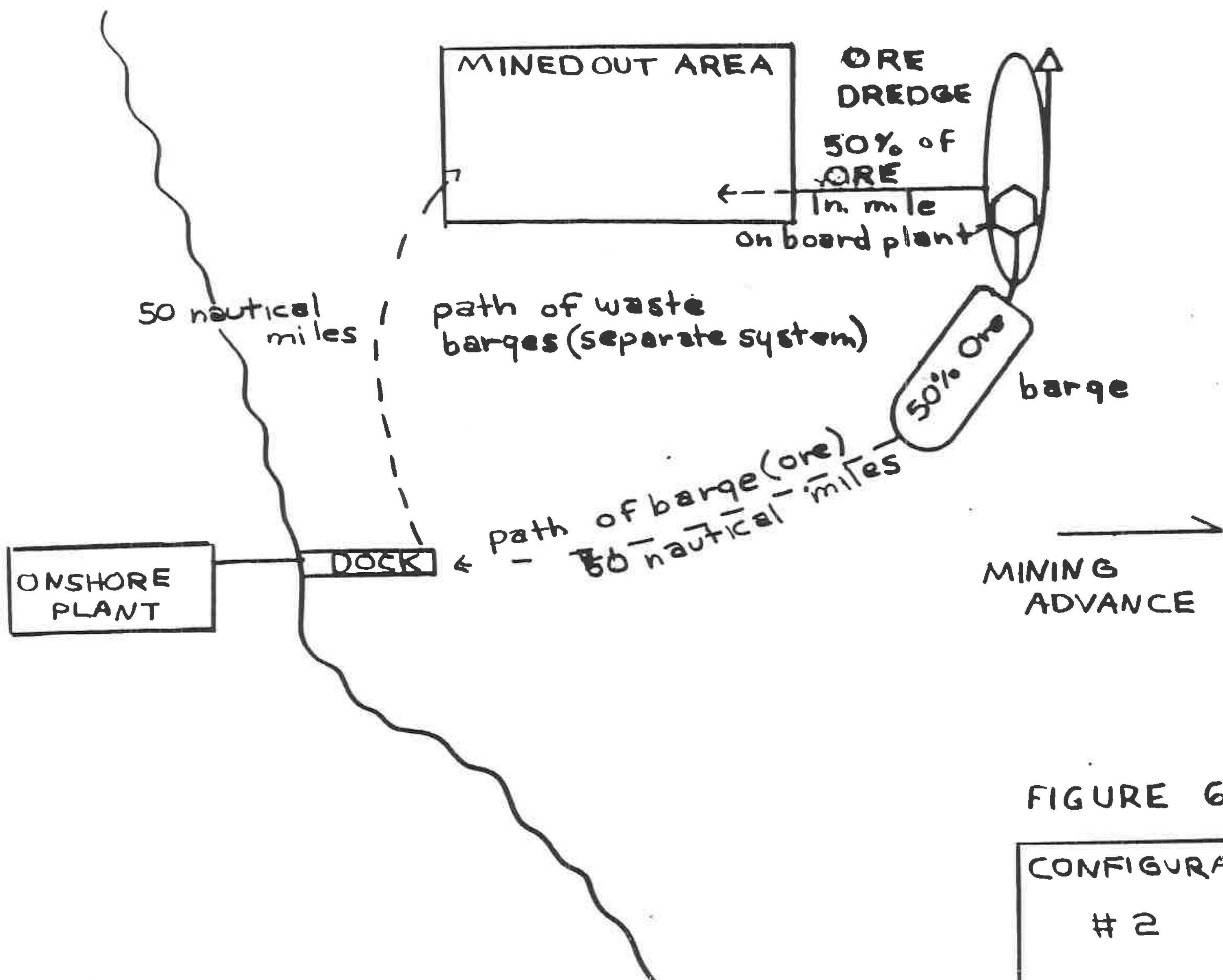



FIGURE 6.3

CONFIGURATION #2

Table 6-8 shows the time required for each element in the cycle. Criteria from Configuration 1 apply here with the exception that barges move at 8 knots.

**Table 6-8**

**Cycle Time Configuration 2**

| Item | Hours |
|---|---|
| Load barge | 12.03 |
| Barge to plant | 6.25 |
| Unload barge | 12.03 |
| Barge return | 6.25 |
| Total cycle time | 36.56 |
| | |
| Cycles per year | 154.8 |
| Tonnes per cycle | 19,500 |
| Tonnes hauled per year | 3,019,000 |

Since the dredge mines 18,310,000 tonnes of ore annually, the number of dredges required is:

$$18{,}310{,}000\ (.5) \div 3{,}019{,}000 = 3.03 \text{ or } 3$$

The waste cycle is assumed to be similar to the ore handling cycle. Since the mineral concentration is only 6%, most of the waste from the onshore plant is barged back to the mined-out areas. In all, a total of seven barges and tugs are required, three for ore handling, three for waste disposal, and one for a spare.

Capital costs are calculated using the same methodology as Configuration 1.

Table 6-9 itemizes the capital required for comparison of Configuration 2.

**Table 6-9**
**Capital Cost Configuration 2**

| Item | mm $ Unit Cost | No. | Total Cost |
|---|---|---|---|
| Barges | 16.2 | 7 | $113,400,000 |
| Tugs | 5.5 | 7 | 38,500,000 |
| Ore dredge | 40.00 | 1 | 40,000,000 |
| Beneficiation Plant | 27.00 | 1 | 27,000,000 |
| Onboard Plant | 13.80 | 1 | 13,800,000 |
| Infrastructure & Misc. | 30% of above | | 69,800,000 |
| Total | | | 302,500,000 |
| $ per tonne annual mined | | | 16.52 |
| $ per tonne mined mine life (20 years) | | | .83 |

Operating costs for the plant are computed using the same methodology as for Configuration 2. Dredge costs are from ZW model explained in Section 5.7 (Operating Costs).

**Table 6-10**
**Operating Costs Configuration 2**

| | Cost per tonne product |
|---|---|
| Mining Dredge | .42 |
| Plant onshore | .90 |
| Plant onboard | .09 |
| Barge transportation | .39 |
| Waste disposal | .39 |
| Total | $2.19 |

The total comparative cost for Configuration 2 is $3.02 per tonne product.

**3. Dredge mining, pipeline transportation of ore to onshore plant**

Because the location of the plant is upstream on the river, a pipeline system is not feasible. A substantial part of the pipeline would lie across shipping channels and industrial installations. For this reason, as well as environmental considerations, the pipeline system was not considered in further detail for this report. This is the same conclusion reached by other investigators, i.e., Zellars-Williams, 1979, and Development Planning and Research Associates, Inc., 1987 North Carolina Offshore. Figure 6.4 illustrates the configuration.

**4. Dredge mining, pipeline transportation to offshore plant**

A sea-going dredge mines ore and pumps it to the on-board washer. The partially beneficiated ore is then pumped directly to a nearby offshore plant. This plant is built on an island formed by dredged material, located equi-distant an average of two nautical miles from the mining areas. The pipeline is flexible and most of it is submerged. Only the flexible portion near the dredge is floating. At the beneficiation plant, partly beneficiated ore is processed, and a saleable product produced. Waste is pumped through a separate pipeline to mined-out areas and released. All processing is done at the island-based processing plant. Product from the beneficiation plant is barged to shore for sale. The dredge production is identical to Configuration 2. Figure 6.5 illustrates this configuration.

Barges or vessels are only needed to transport the product to the final destination. No extra cost was added since the final destination is not known.

Capital costs are summarized in Table 6-11. The only difference from Configuration 2 is the the island cost, and pipeline cost.

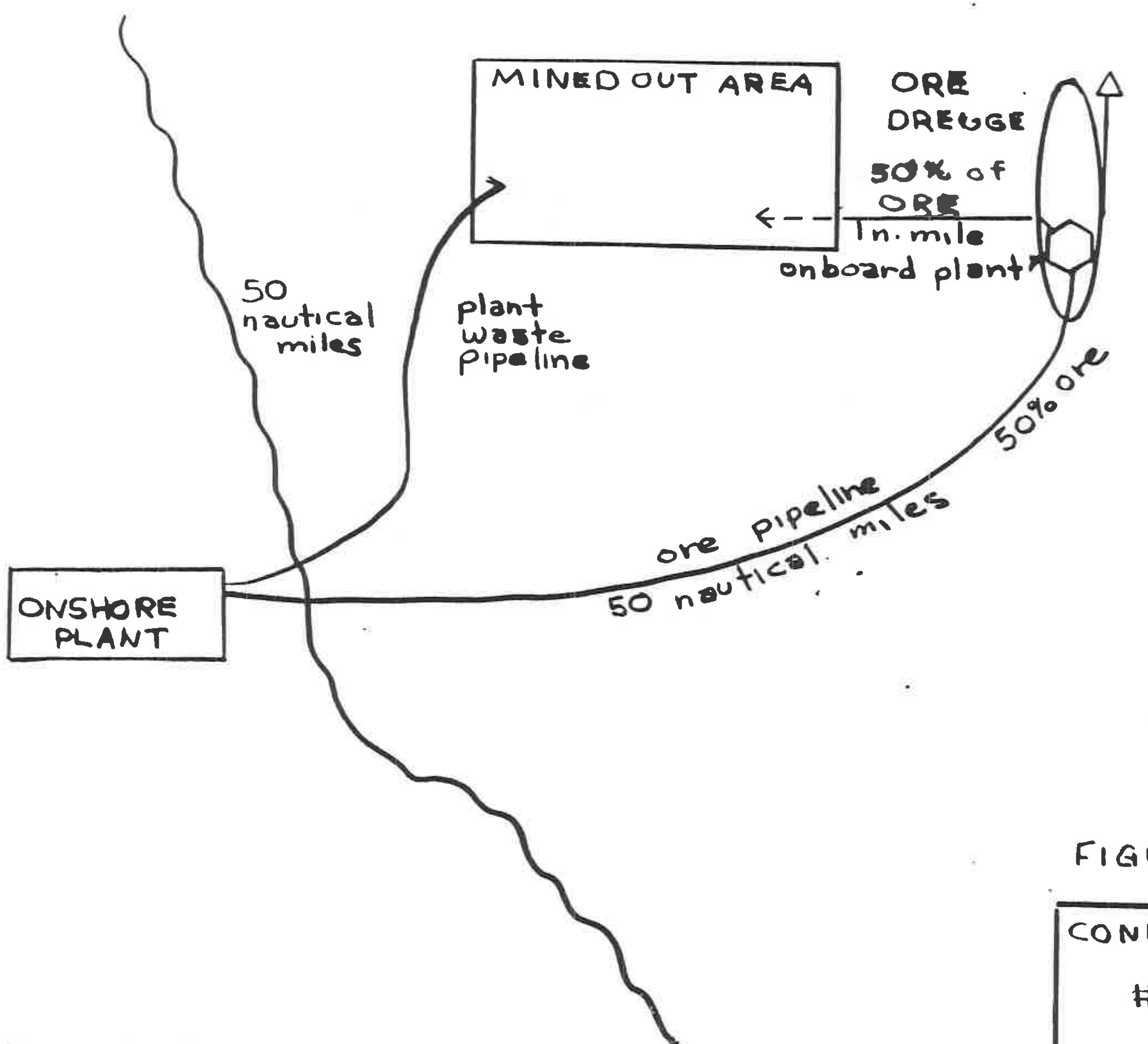



FIGURE 6.4

CONFIGURATION

# 3

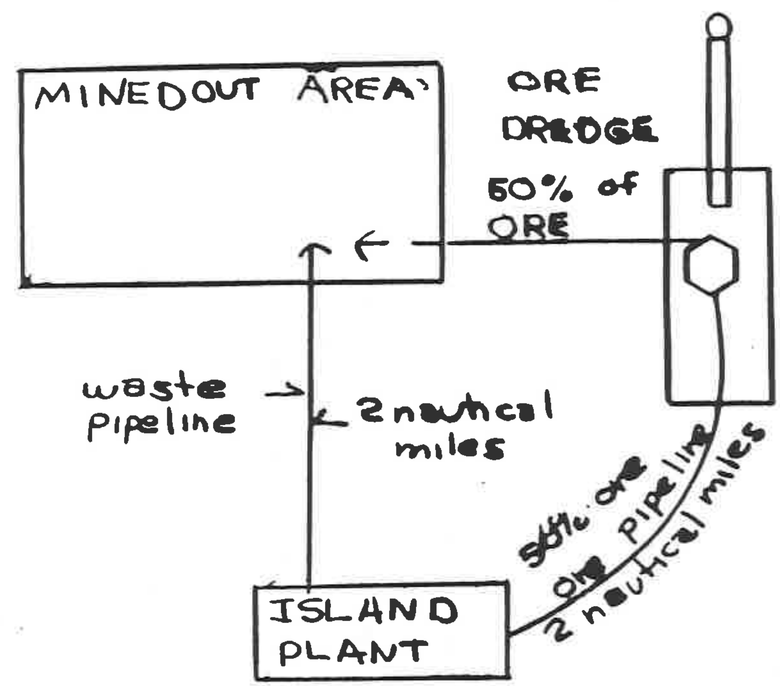



FIGURE 6.5

CONFIGURATION

# 4

**Table 6-11**

**Capital Cost Configuration 4**

| Item | mm $ Unit Cost | No. | Total Cost |
|---|---|---|---|
| Ore dredge | 40,000,000 | 1 | 40,000,000 |
| Beneficiation plant | 27,000,000 | 1 | 27,000,000 |
| Onboard plant | 13,800,000 | 1 | 13,800,000 |
| Island | 60,000,000 | 1 | 60,000,000 |
| Pipelines | 2,500,000 | 2 | 5,000,000 |
| Infrastructure & Misc. | 30% of above | | 43,700,000 |
| Total Capital | | | 189,500,000 |
| Tonnes mined | | | 18,300,000 |
| $ per tonne annual production (mined) | | | 10.36 |
| $ per tonne (mined) mine life (20 years) | | | .52 |

Operating costs for dredge costs and waste disposal were computed using Zellars-Williams operating cost model. Plant costs are from the U.S.B.M. model. Table 6-12 summarizes the operating costs.

**Table 6-12**

**Operating Cost Configuration 4**

| Item | $ Cost per tonne |
|---|---|
| Mining | .42 |
| Plant (onshore) | .90 |
| Plant (offshore) | .09 |
| Waste/water | .51 |
| Total | 1.92 |

The total cost for comparison of Configuration 4 is $2.44 per tonne of product.

### 6.2.3 Selection of Configuration

It is evident that from a material handling standpoint, the offshore plant should be more efficient. Material is processed near the plant and wasted near the plant in mined-out areas. With onshore plants, washed matrix is hauled 50 nautical miles by barge and tug, processed, and the waste hauled 50 nautical miles back to the mined-out pits for disposal. Table 6-13 outlines comparative capital and operating costs for each configuration. Based upon this trade-off study, Configuration 4, utilizing an offshore plant, was selected as the basis for examining the economic feasibility of exploiting offshore heavy minerals. This configuration is developed in further detail in the following parts of this section.

**Table 6-13**
**Configuration Selection**
**$ per tonne concentrate**

| Configuration | Annual Production Tonnes | Capital | Operating | Total |
|---|---|---|---|---|
| 1 | 851,000 | $ .74 | $3.69 | $ 4.43 |
| 2 | 18,300,000 | .83 | 2.19 | 3.02 |
| 3 | Not feasible (no economics done) | | | |
| 4 | 18,300,000 | .52 | 1.92 | 2.44 |

Configuration 1) Sea-going hopper dredge for mining and transportation to an onshore plant.

Configuration 2) Seagoing hopper dredge mining and barge transportation of ore to an onshore plant.

Configuration 3) Dredge mining, pipeline transportation of ore to onshore plant.

Configuration 4) Dredge mining, pipeline transportation of ore to nearby offshore island plant.

### 6.2.4 Design Criteria

Table 6-14 lists the design criteria used for determining production limits, operating costs, equipment needs, and capital requirements of the selected configuration. As with any mining project, the physical and chemical geologic parameters are site-specific, having been determined by nature. These characteristics were based upon the initial mine site selected in Section 5.1.1.

Operating factors were determined by past experience, as well as consideration of the unique mining environment. In the case of offshore dredging, it is necessary to consider the size and design of the dredge from a seaworthy standpoint. A large vessel is necessary to accommodate the mining depths; therefore, required size is somewhat independent of production. The largest dredge pumps operating in ocean mining today have a suction head pipe diameter of 1200 mm (48"). For the conditions of offshore Georgia, a 900 mm diameter (36") suction head pipe was used to determine productivity. The design philosophy is to use the largest practical dredge pump, mounted on a seaworthy vessel. For example, a dredge pump producing half the capacity of a 900 mm dredge pump gives only a small reduction in capital and operating costs. Therefore, the design philosophy maximizes production while minimizing the costs.

**Table 6-14**
**Design Criteria**

- Grade Criteria:

| Feed Grade: | |
|---|---|
| Ilmenite | 5.31% |
| Rutile | .35% |
| Leucoxene | .87% |
| Zircon | .62% |
| Monazite | .17% |

- Recoveries:

| | Mine | Wet Mill | Dry Mill |
|---|---|---|---|
| Ilmenite | 92% | 83% | 97% |
| Rutile | 92% | 85% | 97% |
| Leucoxene | 92% | 70% | 95% |
| Zircon | 92% | 92% | 90% |
| Monazite | 92% | 70% | 90% |

**Table 6-14** (continued)

| | |
|---|---|
| o Operating Factors | |
| Dredge and Washer | 4,700 |
| Beneficiation Plant | 4,700 |
| o Mining Data | |
| Average Water Depth | 27.2 |
| Maximum Mining Depth (below MSL) | 41.4 |
| Average Mining Depth | 37.6 |
| Maximum Ore Thickness | 11.8 |
| Average Ore Thickness | 10.4 |
| Ore Density, tonnes/cm | 1.78 |

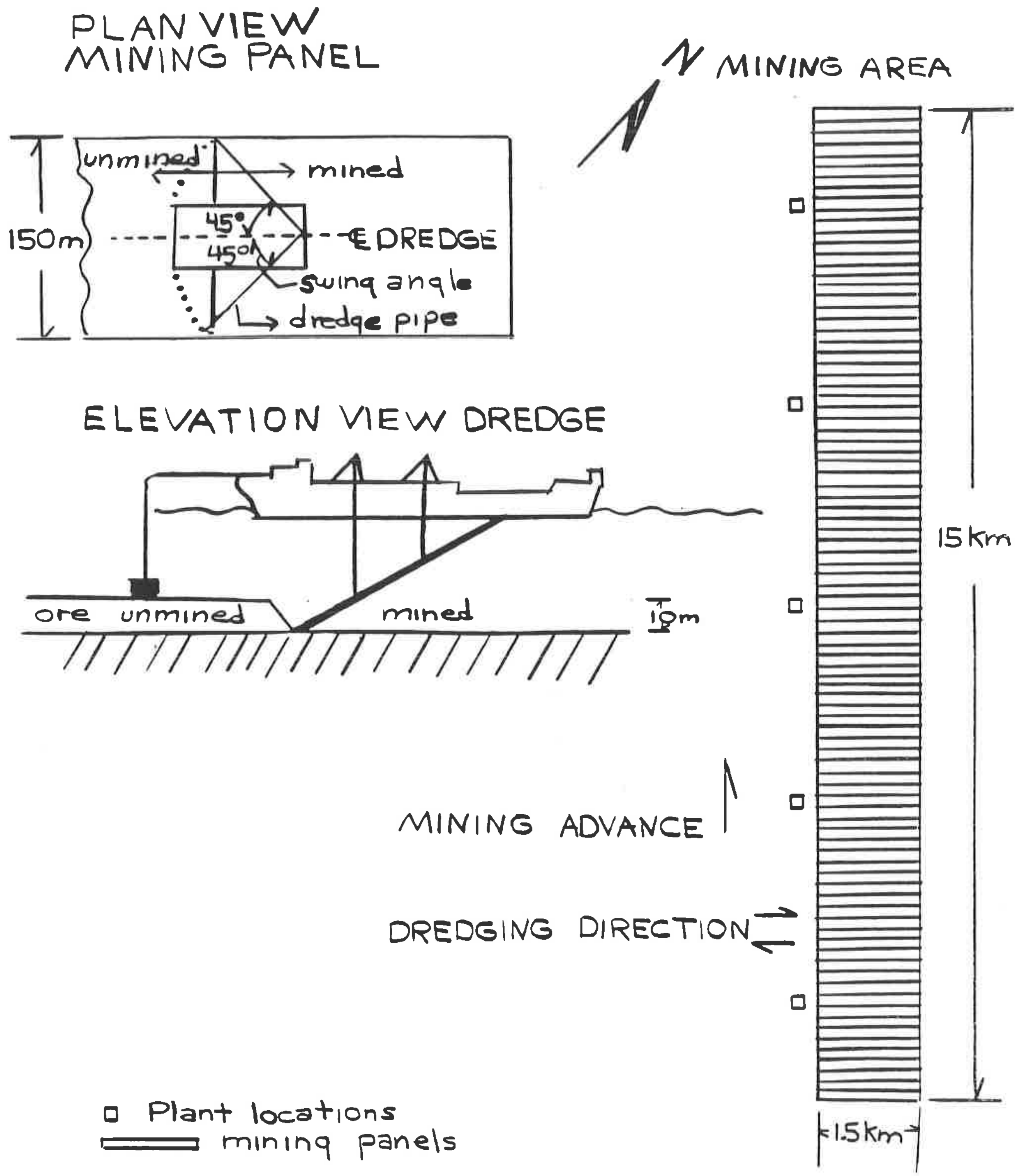
Note: Oceanographic information is contained in Table 5-15.

Section 4 lists the available state-of-the-art technologies. Anchored hopper dredges have been used successfully in the Pacific Ocean for commercial sand and gravel mining. The heavy mineral sands are not consolidated, so a system utilizing this dredge is reasonable.

### 6.2.5 Mining System

The heavy mineral mining area shown in Figure 6.6 is 15 km long and 1.5 km wide. This is a simplified depiction of the strand identified and selected for mining. The anchor suction dredge will start mining at the south end of the mining area. By moving forward slowly through winches operating against anchors, the dredge is able to mine the full 10 meter face. Movement side-to-side is controlled by winches which swing the dredge about $45^{o}$ each side of the center line. With the anchor pivot point 100 meters from the dredge intake, the dredge can mine about 150 meters wide. This "150-meter width" is called a panel.

The anchor dredge starts mining at the south end of the mining area. Movement across the narrow orebody is accomplished by mining panels 150 meters wide. Within these panels a cut face, about 10 meters deep by 150 meters wide, is developed. After the dredge finishes mining the first panel, it reverses direction and mines the adjacent northern panel. Dredge movement is alternately east to west, then west to east, in panel increments. Mine advance is south to north.



PLAN VIEW
MINING PANEL
unmined
mined
150m
45°
45°
℄ DREDGE
swing angle
dredge pipe
ELEVATION VIEW DREDGE
ore
unmined
mined
10m
N
MINING AREA
15 Km
1.5 Km
MINING ADVANCE
DREDGING DIRECTION
Plant locations
mining panels


FIGURE 6.6

On-board the dredge is a wet mill designed to eliminate 50% of the ore which is without heavy minerals. This wet mill is fed directly from the dredge. Waste material from the washer plant is placed in a collection hopper, dewatered to 40% solids, and pumped to mined-out panels. For the first 1000 meters of mining, waste must be disposed of outside the mining area. From this point, a steady-state operation is reached, with disposal 1000 meters from mining. Any closer than 1000 meters could result in some waste being carried into the present mining operations. If necessary, preventive measures, such as turbidity curtains could be maintained between the mining area and the disposal site. However, with 1000 meters between the disposal areas and current mining, it is not anticipated that disposal in mined-out areas will drift into and dilute currently mined ore.

The waste disposal pipe is 24"-30" in diameter and is attached to the dredge with flexible pipe. The pipeline is attached to flotation devices every 50 meters. A small tug will be required to move the pipe into position for waste disposal.

Concentrate from the wet mill is placed in a distribution hopper, dewatered to 40% solids and pumped to the floating dry mill. A 20" pipeline is required to pump 1600 tonnes per hour. When distance exceeds 2.1 km, the dry mill is moved 3 km north and continues to operate at that location until pumping distance again exceeds 2.1 km. Again, the dry mill moves 3 km north. Over 20 years of mine life, the dry mill is moved four times. More mill detail is given in Section 6.3

## 6.3 PROCESSING

### 6.3.1 Design Basis

The processing facilities are designed to recover rutile, ilmenite, leucoxene, monazite, and zircon from heavy mineral sand deposits typical of those found off the coast of Georgia. Processing facilities include an initial concentration plant (wet mill) located onboard the dredge, and a platform-mounted recovery plant (dry mill) located 1 to 3 miles from the wet mill. Sea water will be used for processing at both the wet and dry mills.

Because of probable periods of unscheduled maintenance and unfavorable sea conditions, the dredge wet mill and dry mill are scheduled to operate 250 days per year, 21 hours per day with a 90% availability. This results in 4,725 operating hours per year.

The mineral distribution in the mineral sand deposit is calculated from Open File Report, USBOM 87-04, using annual production estimates for mean grades of the minerals. The in-situ mineral distribution is summarized in Table 6-15.

**Table 6-15**
**Percent Distribution of Individual Minerals**
**(in-situ)**

| Mineral | Mineral Classification | Percent of Ore | Percent of Mineral |
|---|---|---|---|
| Ilmenite | Heavy | 5.31 | 72.54 |
| Rutile | Heavy | 0.35 | 4.78 |
| Leucoxene | Heavy | 0.87 | 11.89 |
| Zircon | Heavy | 0.62 | 8.47 |
| Monazite | Rare Earth | 0.17 | 2.32 |
| Totals | | 7.37 | 100.00 |

Overall recovery for the orebody for the individual minerals is presented in Table 6-16. The overall recovery of 72.42% was based on a mining recovery of 92%, an average wet mill recovery of 82%(1), and an average dry mill recovery of 96%(1). Product tonnages are based on 15,300,000 tonnes/year of ore to the dredge.

### 6.3.2 Initial Concentration Plant (Wet Mill)

The initial concentration plant or wet mill is located onboard the dredge. The onboard processing facilities include trommel screens to eliminate

(1) Based on "in-house" information of recoveries at heavy mineral operations and are considered a realistic representation of the products which could be recovered.

## Table 6-16

## Percent Distribution of Heavy Minerals to Final Product

| | Distribution | | | Weighted % Distribution of Minerals | | | | | | | Product | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mining | | Wet Mill | | Dry Mill | | Overall | | |
| Mineral | Ore % in-situ | Mineral % in-situ | Tonnes in-situ | Rec. | % | Rec. | % | Rec. | % | Rec. | Wt % | Tonnes |
| Ilmenite | 5.31 | 72.54 | 812,419 | 92 | 66.74 | 83 | 55.39 | 97 | 53.73 | 74.07 | 53.73 | 601,750 |
| Rutile | 0.35 | 4.78 | 53,534 | 92 | 4.40 | 85 | 3.74 | 97 | 3.63 | 75.85 | 3.63 | 40,600 |
| Leucoxene | 0.87 | 11.89 | 133,163 | 92 | 10.94 | 70 | 7.66 | 95 | 7.27 | 61.18 | 7.27 | 81,460 |
| Zircon | 0.62 | 8.47 | 94,861 | 92 | 7.79 | 92 | 7.17 | 90 | 6.45 | 76.18 | 6.45 | 72,250 |
| Monazite | 0.17 | 2.32 | 25,983 | 92 | 2.13 | 70 | 1.49 | 90 | 1.34 | 57.96 | 1.34 | 15,040 |
| | 7.32 | 100.00 | 1,119,960 (1) | 92 | 92.00 | 82 | 75.45 | 96 | 72.42 | 72.42 | 72.42 | 811,100 (2) |

**Notes:**

(1) (15,300,000 tonne/year ore)(.0732) = 1,119,960 tonne/year in-situ minerals in ore.

(2) (1,119,960 tonne/year minerals)(.7242) = 811,100 tonne/year recoverable minerals.

oversize material (+10 mesh), cyclones to reduce fines (-200 mesh), and spirals to concentrate the heavy minerals and reject the lighter fractions. Spirals were chosen because they are least affected by ship motion production by wave action.

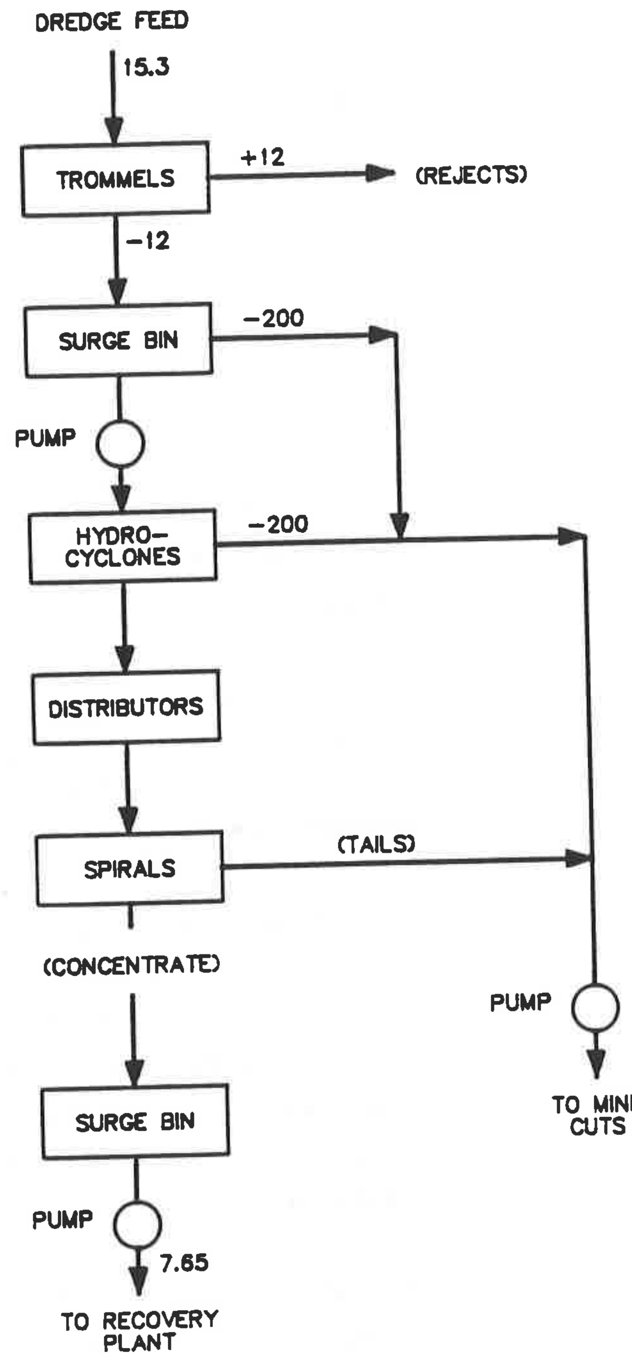
Approximately 50% of the ore consisting of +10 mesh rejects, -200 mesh fines (sediments) and spiral tails is eliminated at the wet mill. This reject material is combined and pumped to the mined-out areas for disposal. Typically, the discharge point would be well below sea level in order to minimize dispersion.

Spiral (rough) concentrate is collected in a surge bin (4 hour capacity) and is then pumped to the platform-mounted recovery plant or dry mill. A flowsheet/material balance for the initial concentration plant is given in Figure 6.7

### 6.3.3 Recovery Plant (Dry Mill)

Rough concentrate from the wet mill reports to a feed surge bin. The bin is designed to provide about 8 hours of live feed storage, smooths out upstream process surges, and helps to maintain a constant rate of feed to the recovery plant. When the bin overflows, it also removes fines. Feed is reclaimed from the storage bin as a slurry and is pumped to the primary vibrating screens where +48 mesh material is removed and sent to the rod milling circuit. The rod mill discharge is treated by hydrocyclones to remove -200 mesh fines and then returned to the primary vibrating screens.

Minus 48-mesh sand from the primary vibrating screens is passed through rougher cone concentrators (Reichert cones), and then concentrating tables, to produce a material containing 70 to 80 percent heavy minerals. Tailings from the cones and tables are sent to scavenger cones to recover additional heavy minerals. The scavenger concentrate is recycled to the rougher cones, while the scavenger tails are discarded.




XXX - DENOTES RATE IN MILLION DRY TONNE/YR.

GEORGIA OFFSHORE MINERALS ASSESSMENT
DATE: 5-17-88 BY: MEK

ZW INITIAL CONCENTRATION PLANT
FIGURE 6.7

A458019A

Most of the ilmenite contained in the heavy mineral concentrate is removed using high-intensity wet magnetic separators. The remaining material is dewatered using classifiers, then dried and heated prior to electrostatic separation. A high tension electrostatic separator is used to separate the conductors (ilmenite, rutile and leucoxene) from the non-conductors (monazite and zircon). A middling fraction is returned to the high tension electrostatic separator feed.

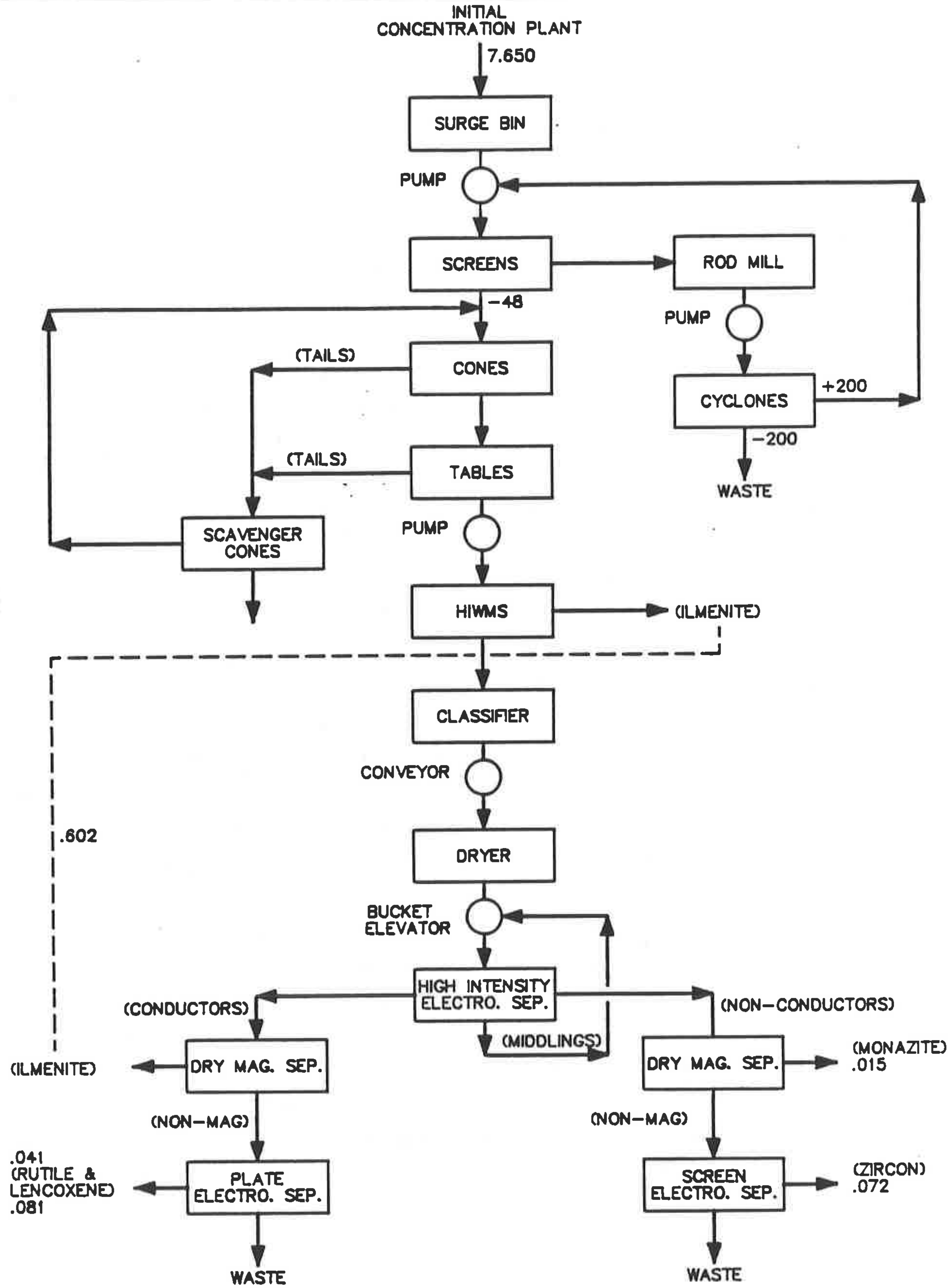
Conductors first report to a dry magnetic separator to recover ilmenite not removed by the high-intensity wet magnetic separators. The non-magnetic conductors are then concentrated into a rutile-leucoxene fraction using plate electrostatic separators. A middling fraction is returned to the plate electrostatic separator feed.

Non-conductors from the high tension electrostatic separators are fed to dry magnetic separators where the monazite fraction is recovered. The non-magnetic non-conducting material then flows to screen electrostatic separators which recover the zircon fraction.

A flowsheet/material balance for the recovery plant is given in Figure 6.8.

In practice, the waste streams from the plate and screen electrostatic separators usually contain other minerals such as sillimanite, kyanite and staurolite, which can be recovered as byproducts. "Zircor" is a product made by heating sillimanite, kyanite and zircon, and marketed as a foundry sand substitute for zircon.

The -200 mesh fines (sediment) and most of the tailings from the dry mill will be combined and pumped to the mined-out areas. Typically, the discharge point would be well below sea level in order to minimize dispersion. The discharge line would require periodic tending to move the effluent point for even distribution of the mined area backfill.




XXX - DENOTES RATE IN MILLION DRY TONNE/YR.

GEORGIA OFFSHORE MINERALS ASSESSMENT

DATE: 5-17-88 BY: MEK

ZW

RECOVERY PLANT
FIGURE 6.8

A458020A

### 6.3.4 Water Requirements

Water is used extensively in mining and beneficiation as a processing medium and as a means of transporting solids in the form of aqueous slurries. The source of water for the initial concentration plant (wet mill) and the recovery plant (dry mill) is sea water.

It is assumed that the recovery plant efficiency and/or product quality is not affected by the presence of chlorides (sea salt) and that a fresh water wash is not required.

### 6.3.5 Product Storage and Loading

Products from the recovery plant will be stored in bins and transferred to vessels/barges alongside the platform, via a shiploader.

## 6.4 CONFIGURATION AND INFRASTRUCTURE

The most favorable configuration for the exploitation of heavy minerals offshore Georgia requires the use of state-of-the-art ocean mining equipment. Seabed mining world-wide is dominated by pump-type ocean-going vessels having hoppers to contain and transport dredged materials. These dredges are known as suction hopper dredges. They may be of the trailing suction head type, or they may be of the leading suction head type. The latter type, which operates at anchor, is preferred for heavy minerals because it permits excavation of the entire mineral-bearing sand horizon. Since no overburden sediments occur in the area targeted for mining, this type dredger will remove all of the mineral-bearing sand within the scope of its anchor chain and suction pipe arm before moving forward. These dredges are essentially ocean-going seaworthy vessels equipped with the specialized apparatus required, and are built in European, Taiwanese, Korean and Japanese shipyards. United Stated shipyards are not able to compete in this market.

The preferred dredge is a vessel with a hopper capacity of about 5000 $m^3$. The hydraulic mining system consists of a suction head, suction pipe arm, a submerged slurry pump, and on-board booster pumps.

This dredge must be capable of mining to about Elevation -140, or 160 to 170 feet below sea level. Depending on specific design, the suction arm will be as much as 300 feet long. The lower end of the arm is hinged to permit raising and stowing within the length of the vessel.

Mineral sands mined from sea bottom are pumped as a solids-water mixture by the submerged pump to an on-board wet processing mill. The wet mill rejects oversize, barren light weight particles and tailings which are wasted overboard. About 50% of the mined materials are rejected from the shipboard plant, and directed to previously mined cuts at sea bottom. The concentrated mineral-laden sands are collected in the hopper. This hopper acts as a live storage sump feeding the suction side of the booster pump(s) which transfer the concentrate slurry to a nearby dry mill via semi-submerged surface buoyed pipeline.

The dry mill completes beneficiation of the mineral sands through a series of unit process steps, each of which produce five or more minerals having value. The complete dry mill is located on a square-hull type semi-submersible platform anchored nearby. Rejects from the dry mill, consisting of sand tailings and sediments, are combined and discharged by pipeline to the mined-out cuts. Products comprising the four heavy minerals and rare earths are separately stored in bins to provide several day's storage. Bins are unloaded by conveyors which transfer material to a ship loader.

The platform envisaged is similar to one designed by Marcon Engineering of the Netherlands (Norring 4). This is a four-column, square-hull, semi-submersible production platform having two 246-foot square main decks. The upper deck is the platform on which the dry mill and ancillary facilities are located. The lower deck contains crew quarters, and all the facilities required to sustain life in a comfortable fashion. The lower deck also contains storage and maintenance facilities. Cantilevered sections extend the effective area of each deck to accommodate shiploading and unloading, heliport, and other features required.

The dredger and floating production platform (FPS) are self-contained and, to a great extent, are self-sustaining. They require no direct service link to the mainland, or to land-side facilities, other than for re-supply and to transport workers. One ocean-going tugboat is assigned to service the mining operation. This tug is equipped with a rotating lift crane suited to at-sea maintenance and repair work. The tug moves and positions pipelines as mining progresses.

All offshore operations will be based on work crew cycles of two weeks duty and one week off. This requires three completely staffed crews of operating, maintenance and supervisory personnel. While on duty, offshore personnel work 14 twelve-hour shifts, for a total of 168 hours each three week cycle. The wages for this work schedule is based on 40 hours per week, three weeks, 120 hours at regular time, and 48 hours at premium time. All meals and sleeping accommodations are provided by the enterprise at no cost to employees.

A motor launch will be provided to transport personnel and supplies from the island to the location of the turning basin in Port of Savannah. The launch will be seaworthy in all but severe weather conditions and capable of making ±30 knots so that a one-way trip takes no longer than one hour.

Accommodations, consisting of two-bed cabins, each complete with lavatory and shower, clothes lockers and desks are provided. Each offshore operating location contains its own accommodations. A fully-equipped kitchen, provisioned commissary and staff will prepare and serve three meals each day in a dining room. Library, television, and indoor acivity rooms will be provided. Physical exercise and conditioning facilities, both indoor and outdoor, will also be provided.

The FPS facilities will include a first-aid station, with a nurse, to attend to minor maladies and injuries. A heliport will enable the rapid evacuation of seriously sick, or injured, persons to mainland hospitals.

Diesel engine electric generators supply power for the marine/vessel systems, the beneficiation plant, living quarters, and to meet other demands as required to make the semi-submersible floating production system totally self-sustaining.

Finished heavy mineral and rare earth products of about 810,000 tonnes per year are loaded aboard bulk cargo vessels on barges for transport to destination. This configuration proposes shipping to Port Savannah by enterprise operated barges, and offloading, warehousing, and distribution by other commercial operators. The point of sale is FOB, Port Savannah.

The configuration selected, using currently available technology and equipment, makes possible the early implementation of the programs required to exploit heavy minerals offshore Georgia. The dredger and FPS have the flexibility to recover mineral-bearing sands at whatever location on the OCS their occurrence warrants it, at the least economic and technical risk.

## 6.5 ESTIMATED CAPITAL COST

This section deals with the expenditures required to implement a heavy minerals mining-beneficiation operation having the configuration and features previously described. Estimated cost is based on conceptual and schematic designs, and is order-of-magnitude having an accuracy of plus or minus 30%.

### 6.5.1 Capital Cost

Estimated capital cost has been prepared by combining techniques developed by the U.S. Bureau of Mines, together with generally accepted methods by factoring in-house or researched information. Dredges, wet mill, and dry mill cost estimates are based on formulas contained in Bureau of Mines Open File Report 4-87. Cost of the semi-submersible production platform is based on data published in Ocean Industry, April 1988.

Table 6-17, Heavy Minerals Mining Enterprise Total Facility Capital Cost Estimate, is a summary of the total capital cost required to construct the offshore phosphate mining facilities described in this section. Twenty percent is included as an allowance for costs which will be incurred for items not now predicted. Total capital costs include design, engineering, procurement, and construction management services as are applicable to each item.

### 6.5.2 Pre-production Cost

Pre-production cost in the amount of 10 million dollars is included as a part of the total investment required to implement the proposed enterprise mining scheme. This cost is intended to include the extensive drilling, sampling, and testing programs required to accurately identify the areal extent and grade-quality characteristics of the Middle Miocene targeted for exploitation. This cost is also intended to include the cost of limited studies required to obtain permits. This program would include exploratory drilling to the extent required to describe and define economically mineable reserves, based on the most effective beneficiation process flowsheet developed by the test work. This program includes the cost of bulk sample collection and a pilot plant test program to verify and refine the process flowsheet, material balances, reagent and water consumption, and recovery efficiencies such as are required to provide criteria and parameters for design and detail engineering. No interest is charged for the use of this money because it is assumed that these expenditures are in the nature of the regular research and development costs incurred by enterprises engaged in commercial minerals exploitation. Payback of pre-production/development cost is, however, included as a part of the total investment required by the enterprise.

This program will be conducted over a period of 24-30 months and will be followed by a comprehensive economic analysis based on the latest market supply-demand price scenarios. A list of the tasks/objectives to be accomplished during this pre-production period before design and detailed engineering is undertaken is listed below.

**Table 6-17**

**Heavy Minerals Mining Enterprise - Total Facility Capital Cost Estimate**

| | Cost $X1000 |
|---|---|
| Floating Production Platform | $ 66,100 |
| Suction Hopper Dredge | 45,800 |
| Trailing Pipelines | 3.800 |
| Waste Disposal at Sea System | 1,100 |
| Tugboat | 2,500 |
| Wet Mill (aboard dredge) | 12,800 |
| Dry Mill (abord platform) | 26,300 |
| Product Storage | 4,400 |
| Shiploader | 9,200 |
| Product Transport (tug-barge) | 22,800 |
| Sub-total | $194,800 |
| Contingency, 20% | 39,000 |
| TOTAL | $233,800 |
| Round-out and use | $235,000 |

Capacity Basis

| | |
|---|---|
| Mineral sands mined | 15,300,000 tonnes/year |
| Intermediate product | 7,650,000 tonnes/year |
| Final heavy mineral product | 811,000 tonnes/year |

- o drilling
- o sampling
- o geologic database update
- o bench scale test work
- o economic cutoffs applied
- o reserves estimates
- o bulk sampling
- o pilot scale test program
- o fresh water rinse tests
- o acidulation test work to determine amenability of concentrate to acidulation of fertilizer manufacture
- o preliminary mine plan
- o preliminary design of dredges and ancillaries
- o island construction engineering alternatives evaluated
- o environmental issues identified
- o cost and likelihood of permitting estimated
- o lease and royalty fees/costs established
- o capital cost estimates
- o implementation plan and schedule
- o supply-demand and market scenarios
- o identify potential market
- o current product selling price
- o bankable document report.

The decision to move forward to implementation by contracting for detailed engineering, procurement, and construction can be taken with a high degree of confidence in the reliability of the economic analysis. Technological and economic risks will have been reduced to an acceptable level. If the economics are favorable and the market supports sales price and demand premises, the final phase of implementation can be initiated.

### 6.5.3 Replacement Capital

The employment of capital to replace equipment when its useful life has expired is replacement capital. Useful life is based on the concept that the level of maintenance is as required to keep the equipment (facilities) operational at an acceptable level of production. Useful or economic life is the period (time in years) until the failure rate increases to such an extent that it is no longer economical to operate.

The proposed mine-mill complex operation and production is based on certain mechanical availability. This level of mechanical availability is the result of regular and scheduled shut-down maintenance. Maintenance expense for parts, supplies, and labor is included in operating cost.

The severe service and adverse climatic environment requires a high level of regular and preventive maintenance. During scheduled periods when all facilities are shut down while the dredger and floating production system are in dry-dock, certain capital will be employed to sustain the equipment and facilities at design production capability. The additional sum of 3 million dollars per year is allowed as replacement capital. It is anticipated that this will maintain facilities at design level for a period of 30 years, without requiring the employment of additional replacement capital. The only exception is in the event technologically superior replacement equipment is warranted as justified by the economics of increased production.

### 6.5.4 Working Capital

- Ordinary operation of a business involves a circulation of capital within the current asset (capital cost) group. Cash is expended for materials (parts, supplies, expendibles), labor and services (electric energy, rental, fees, royalty, ...) and these expenditures are accumulated as costs. These costs are converted (concentrate inventories) into receivables and ultimately (back out by shipment) into cash again.

- The average time intervening between the acquisition of materials or services and expenditure for labor, entering this process and final cash realization constitutes an operating cycle.

- The amount of capital committed (taken out of current funds or borrowed) to this cycle is working capital.

- Cost of working capital (interest) is added.

The working capital requirement for this enterprise is estimated to be equal to about 20 days total cash production cost. To simplify economic analysis, working capital of $3,300,000 is used throughout and recovered in the last year.

## 6.6 ESTIMATED OPERATING COST

Operating costs for dredging were taken from the ZW dredge module. Operating costs for transportation, ore pumping, and waste disposal were also taken from ZW cost modules.

All plant operating costs were taken from formulas in the U.S.B.M. report for heavy minerals. A description of these formulas is given in Section 5.2.2. A complete discussion of ZW modules is given in Section 5.7

Operating costs are listed in Table 6-18.

**Table 6-18**
**Operating Costs**

| | $ per tonne mined | $ per tonne product |
|---|---|---|
| Dredge | .41 | 7.73 |
| Onboard plant (washing) | .09 | 1.70 |
| Offboard plant (concentration) | .90 | 16.98 |
| Ore pumping | .16 | 3.02 |
| Waste disposal | .08 | 1.51 |
| Barge transportation | .02 | .38 |
| Administration, clerical | .16 | 3.02 |
| Island Accommodations | .05 | .94 |
| TOTAL COST | $1.87 | $35.28 |

# 6.7 ECONOMICS AND VIABILITY

## 6.7.1 Market Potential

The United States relies, to a large extent, on the import of certain heavy minerals and rare earths to supply domestic needs. Production and supply is for the most part dominated by Australia, which establishes quality standards and sets market price.

The heavy mineral-bearing sands also contain a host of other not readily identified rare earths for which the U.S. depends totally upon imports for supply. Many of these relate to strategic minerals required to sustain production of vital manufactured goods needed by the U.S. in the event of emergency. There is good reason to believe that the selling price of these minerals will continue to increase as demand grows. Recovery of the minor quantities of high-value rare earth minerals will add significantly to the revenue. These two factors will serve to improve viability and hasten the time when offshore recovery of these minerals is realized. The commitment, if made, by the private sector with the support of responsible agencies of the U.S. Government to pursue the programs necessary can achieve this objective. Some of what is required is described in Section 5.5.2 of this report, and is included as part of enterprise investment in the economic analysis which follows herein for heavy minerals.

## 6.7.2. Sales Price

Total annual revenue from sales is based on an average price for the suite of heavy minerals produced. The price is in dollars per tonne for bulk concentrates, FOB Port Savannah. The average selling price is obtained by computing the total annual sales revenue by summating the annual revenue generated by each of the five minerals. The sales price of each mineral was obtained by converting or otherwise adjusting current bulk quantity market prices quoted by Metal Bulletin and published in Industrial Minerals, April 1988.

It is important to recognize that the average sales price resulting from this computation is a totally hypothetical value based on a theoretical product mix and on recent quoted market prices for each product. No recognition can be made for grade or quality as these are unknown. The average sales price, computed as per the following table, is simply a convenient way to estimate annual sales revenue.

| Mineral | Annual Tonnes | Sale Price $/tonne | Annual Sales Revenue |
|---|---|---|---|
| Ilmenite | 601,750 | 46.00 | $ 27,680,500 |
| Rutile | 40,600 | 430.00 | 17,458,000 |
| Leucoxene | 81,460 | 385.00 | 31,362,100 |
| Zircon | 72,250 | 248.00 | 17,918,000 |
| Monazite | 15,040 | 570.00 | 8,572,800 |
| TOTAL | 811,100 | | $ 102,991,400 |
| Average Selling Price, FOB Savannah | | | $ 126.98 |

### 6.7.3 Economic Analysis

The discounted cash flow rate of return on investment (DCFROR) method of economic analysis is used to evaluate the viability potential of exploiting offshore Georgia heavy minerals as proposed in this study. DCFROR is computed in the same manner described for phosphates in Section 5.7.2. This procedure is repeated for scenarios of investment, income (sales price) and operating cost to gain an understanding of sensitivity. All economic values are based on constant 1988 dollars. A charge computed at 5% of the average product-tonne sales price is included to cover the estimated cost of royalty or severance tax.

Each scenario is represented by a separate computer run computation of DCFROI and net present value (NPV). A copy of the computer printouts is included at the end of this section.

Extraordinary costs associated with start-up are accounted for by taking into income 410,000 tonnes of product sales, and taking as cost the production of 811,100 tonnes. This procedure is used in each case.

Table 6-19 is a summary of DCFROR results for base case investment and operating costs, and for one sales price and revenue scenario.

**Table 6-19**
**Base Case**

| Average Sales Price $/tonne | Construction Capital Millions Dollars | Product Cost $/tonne | DCFROR % |
|---|---|---|---|
| $127.00 | 235 | 42.53 | 4.2 |

### 6.7.4 Sales Price Sensitivity

Sensitivity to sales price is indicated by the results of economic analyses at increased sales price, in increments of 10%, with all other costs remaining constant. Table 6-20 illustrates sensitivity to sales price.

**Table 6-20**
**Sales Price Sensitivity**

| Avg. Sales Price $/tonne | Increase % | DCFROR % |
|---|---|---|
| 130.70 | +10% | 6.8% |
| 152.40 | +20% | 9.0% |
| 165.10 | +30% | 11.7% |

GA OFS 29-A458-00 Heavy Minerals Economics
Project Number: 29-A458-00
File: HEAVMINI

# HEAVY MINERALS
(Thousand $ per Year)
BASE CASE

5/13/88

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Sales Revenue | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | .41 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 |
| Sales Price, $/Tonne | | | | | | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 |
| Total Revenue | | | | | | 52070 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 |
| Production Costs | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | |
| Mining | | | | | | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 |
| On board Processing (Wet Mill) | | | | | | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Slurry Transport (Ore) | | | | | | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Platform Processing (Dry Mill) | | | | | | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 |
| Vessel Transport | | | | | | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 |
| Waste Disposal | | | | | | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 |
| Super, Clerical, Tech | | | | | | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Offshore Accomodations | | | | | | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 |
| Total Cash Cost | | | | | | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 |
| Total Production Cost | | | | | | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 |
| Total Cash Cost, $/yr | | | | | | 28930 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 |
| Total Indirect Cost, $/yr | | | | | | 5946 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 |
| Total Production Cost, $/yr | | | | | | 34876 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 17194 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 |
| Investment | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 30000 | 80000 | 90000 | 35000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1500 | 7000 | 15500 | 21750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 31500 | 87000 | 105500 | 56750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 290750 | 304281 | 261675 | 247138 | 232600 | 218063 | 203525 | 188988 | 174450 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 11891 | 30428 | 26168 | 24714 | 23260 | 21806 | 20353 | 18899 | 17445 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1650 | 1650 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow (After Investment) | -10000 | -31500 | -87000 | -105500 | -56750 | -13531 | 33342 | 39252 | 40706 | 42160 | 43614 | 45067 | 46521 | 47975 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 41548 | 71205 | 50852 | 36315 | 25964 | 25935 | 25964 | 12967 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2196 | 8098 | 8840 | 9552 | 14402 | 14402 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2195 | 8098 | 8839 | 9551 | 19152 | 33573 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 768 | 2834 | 3094 | 3343 | 6703 | 11751 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1427 | 5264 | 5745 | 6208 | 12449 | 21822 |
| Cash Flow | -10000 | -31500 | -87000 | -105500 | -56750 | -13531 | 18804 | 24714 | 25400 | 24708 | 25982 | 27186 | 25200 | 21686 |
| Cumul Cash Flow | -10000 | -41500 | -126500 | -234000 | -290750 | -304281 | -285477 | -260763 | -235363 | -210575 | -184593 | 157407 | -132127 | -110441 |

| Project Year | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Sales Revenue | | | | | | | | | | | |
| Production, Million TPY | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 |
| Sales Price, $/Tonne | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 | 127.00 |
| Total Revenue | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 | 102870 |
| Production Costs | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | |
| Mining | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 |
| On board Processing (Wet Mill) | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Slurry Transport (Ore) | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Platform Processing (Dry Mill) | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 |
| Vessel Transport | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 |
| Waste Disposal | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 |
| Super, Clerical, Tech | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Offshore Accomodations | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 |
| Total Cash Cost | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | |
| Administration | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 | 6.35 |
| Taxes (misc) | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 | 7.25 |
| Total Production Cost | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 | 42.53 |
| Total Cash Cost, $/yr | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 |
| Total Indirect Cost, $/yr | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 | 5873 |
| Total Production Cost, $/yr | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 | 34450 |
| Cash Flow (Revenue-Prod Cost) | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 | 68420 |
| Investment | | | | | | | | | | | |
| Pre-construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 159913 | 145375 | 130838 | 116300 | 101763 | 87225 | 72688 | 58150 | 43613 | 29075 | 14538 |
| Principal Payment | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 0 |
| Interest @ 10% | 15991 | 14538 | 13084 | 11630 | 10176 | 8723 | 7269 | 5815 | 4361 | 2908 | 1454 |
| Replacement Capital | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3300 |
| Cash Flow (After Investment) | 49429 | 50882 | 52336 | 53790 | 55244 | 56697 | 58151 | 59605 | 61059 | 62512 | 60666 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 14402 | 14402 | 14402 | 14402 | 14402 | 14402 | 14402 | 14402 | 14402 | 14402 | 14402 |
| Taxable Income | 35027 | 36480 | 37934 | 39388 | 40842 | 42295 | 43749 | 45203 | 46657 | 48110 | 46224 |
| Tax Rate, % | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 12259 | 12768 | 13277 | 13786 | 14295 | 14803 | 15312 | 15821 | 16330 | 16839 | 16152 |
| Net Income After Tax | 22768 | 23712 | 24657 | 25602 | 26547 | 27492 | 28437 | 29382 | 30327 | 31271 | 30072 |
| Cash Flow | 22632 | 23576 | 24521 | 25466 | 26411 | 27356 | 28301 | 29246 | 30191 | 31135 | 44474 |
| Cumul Cash Flow | -87809 | -64233 | -39712 | -14246 | 12165 | 39521 | 67822 | 97068 | 127259 | 158394 | 202868 |

ROR: 4.2 %

GA DFS 29-A458-00 Heavy Minerals Economics
Project Number: 29-A458-00
File: HEAVMINI

5/16/98

HEAVY MINERALS
(Thousand $ per Year)
BASE CASE
(+20% SALES PRICE)

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Sales Revenue | | | | | | | | | | | | |
| Production, Million TPY | | | | | | .41 | .81 | .81 | .81 | .81 | .81 | .81 |
| Sales Price, $/Tonne | | | | | | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 |
| Total Revenue | | | | | | 62484 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 |
| Production Costs | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | |
| Mining | | | | | | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 |
| On board Processing (Wet Mill) | | | | | | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Slurry Transport (Ore) | | | | | | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Platform Processing (Dry Mill) | | | | | | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 |
| Vessel Transport | | | | | | .38 | .38 | .38 | .38 | .38 | .38 | .38 |
| Waste Disposal | | | | | | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 |
| Super, Clerical, Tech | | | | | | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Offshore Accommodations | | | | | | .94 | .94 | .94 | .94 | .94 | .94 | .94 |
| Total Cash Cost | | | | | | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 |
| Total Production Cost | | | | | | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 |
| Total Cash Cost, $/yr | | | | | | 28930 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 |
| Total Indirect Cost, $/yr | | | | | | 6986 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 |
| Total Production Cost, $/yr | | | | | | 35916 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 26568 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 |
| Investment | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 30000 | 80000 | 90000 | 35000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1500 | 7000 | 15500 | 21750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 31500 | 87000 | 105500 | 56750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 290750 | 294907 | 261675 | 247138 | 232600 | 218063 | 203525 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 2507 | 29491 | 26168 | 24714 | 23260 | 21806 | 20353 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1650 | 1650 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow (After Investment) | -10000 | -31500 | -87000 | -105500 | -56750 | -4157 | 53825 | 58798 | 60252 | 61706 | 63160 | 64613 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 41548 | 71205 | 50852 | 36315 | 25964 | 25935 | 25964 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3973 | 11969 | 17282 | 17282 | 17282 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3973 | 11968 | 18460 | 19943 | 21367 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1391 | 4189 | 6461 | 6980 | 7478 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2582 | 7779 | 11999 | 12963 | 13889 |
| Cash Flow | -10000 | -31500 | -87000 | -105500 | -56750 | -4157 | 39287 | 42869 | 41525 | 40707 | 41642 | 42597 |
| Cuml Cash Flow | -10000 | -41500 | -128500 | -234000 | -290750 | -294907 | -255620 | -212751 | -171226 | -130519 | -88877 | -46280 |
| DCFROI | 9 % | | | | | | | | | | | |
| NPV @ 10% | -16008 | | | | | | | | | | | |

| Project Year | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Sales Revenue | | | | | | | | | | | | | |
| Production, Million TPY | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 |
| Sales Price, $/Tonne | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 | 152.40 |
| Total Revenue | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 | 123444 |
| Production Costs | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | |
| Mining | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 |
| On board Processing (Wet Mill) | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Slurry Transport (Ore) | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Platform Processing (Dry Mill) | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 |
| Vessel Transport | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 |
| Waste Disposal | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 |
| Super, Clerical, Tech | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Offshore Accommodations | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 |
| Total Cash Cost | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | |
| Administration | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 | 7.62 |
| Taxes (misc) | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 | 8.52 |
| Total Production Cost | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 | 43.80 |
| Total Cash Cost, $/yr | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 |
| Total Indirect Cost, $/yr | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 | 6901 |
| Total Production Cost, $/yr | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 | 35478 |
| Cash Flow (Revenue-Prod Cost) | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 | 87966 |
| Investment | | | | | | | | | | | | | |
| Pre-construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 188988 | 174450 | 159913 | 145375 | 130838 | 116300 | 101763 | 87225 | 72688 | 58150 | 43613 | 29075 | 14538 |
| Principal Payment | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 0 |
| Interest @ 10% | 18899 | 17445 | 15991 | 14538 | 13084 | 11630 | 10176 | 8723 | 7269 | 5815 | 4361 | 2908 | 1454 |
| Replacement Capital | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3300 |
| Cash Flow (After Investment) | 66067 | 67521 | 68975 | 70428 | 71882 | 73336 | 74790 | 76243 | 77697 | 79151 | 80605 | 82058 | 80212 |
| Depreciation (7 yr ACRS) | 12967 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 | 17282 |
| Taxable Income | 35818 | 50239 | 51693 | 53146 | 54600 | 56054 | 57508 | 58961 | 60415 | 61869 | 63323 | 64776 | 62930 |
| Tax Rate, % | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 12536 | 17584 | 18093 | 18601 | 19110 | 19619 | 20128 | 20636 | 21145 | 21654 | 22163 | 22672 | 22026 |
| Net Income After Tax | 23282 | 32655 | 33600 | 34545 | 35490 | 36435 | 37380 | 38325 | 39270 | 40215 | 41160 | 42104 | 40904 |
| Cash Flow | 38993 | 35399 | 36344 | 37289 | 38234 | 39179 | 40124 | 41069 | 42014 | 42959 | 43904 | 44848 | 58186 |
| Cuml Cash Flow | -7287 | 28112 | 64456 | 101745 | 139979 | 179158 | 219282 | 260351 | 302365 | 345324 | 389228 | 434076 | 492262 |

GA DFS 29-A458-00 Heavy Minerals Economics
Project Number: 29-A458-00
File: HEAVMINI

5/16/88

HEAVY MINERALS
(Thousand $ per Year)
BASE CASE
(+30% SALES PRICE)

| Project Year | -5 | -4 | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Sales Revenue | | | | | | | | | | | | | | | | | | | | | | | | | |
| Production, Million TPY | | | | | | .41 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 | .81 |
| Sales Price, $/Tonne | | | | | | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 | 165.10 |
| Total Revenue | | | | | | 67691 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 | 133731 |
| Production Costs | | | | | | | | | | | | | | | | | | | | | | | | | |
| Direct Production Costs $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mining | | | | | | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 |
| On board Processing (Wet Mill) | | | | | | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Slurry Transport (Ore) | | | | | | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Platform Processing (Dry Mill) | | | | | | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 | 16.98 |
| Vessel Transport | | | | | | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 | .38 |
| Waste Disposal | | | | | | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 | 1.51 |
| Super, Clerical, Tech | | | | | | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 | 3.02 |
| Offshore Accommodations | | | | | | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 | .94 |
| Total Cash Cost | | | | | | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 | 35.28 |
| Indirect Production Cost, $/Tonne | | | | | | | | | | | | | | | | | | | | | | | | | |
| Administration | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Sales | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Royalty @ 5% of sales price | | | | | | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 | 8.26 |
| Taxes (misc) | | | | | | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 | .20 |
| Other | | | | | | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 | .25 |
| Total Indirect Cost | | | | | | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 | 9.16 |
| Total Production Cost | | | | | | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 | 44.44 |
| Total Cash Cost, $/yr | | | | | | 28930 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 | 28577 |
| Total Indirect Cost, $/yr | | | | | | 7508 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 | 7416 |
| Total Production Cost, $/yr | | | | | | 36438 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 | 35993 |
| Cash Flow (Revenue-Prod Cost) | 0 | 0 | 0 | 0 | 0 | 31253 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 | 97738 |
| Investment | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pre-construction | 10000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction Capital | 0 | 30000 | 80000 | 92000 | 35000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Interest During Construction | 0 | 1500 | 7000 | 15500 | 21750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Investment | 10000 | 31500 | 87000 | 105500 | 56750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Principal | 0 | 0 | 0 | 0 | 0 | 290750 | 528 | 261675 | 247138 | 232600 | 218063 | 203525 | 188988 | 174450 | 159913 | 145375 | 130838 | 116300 | 101763 | 87225 | 72688 | 58150 | 43613 | 29075 | 14538 |
| Principal Payment | 0 | 0 | 0 | 0 | 0 | 0 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 14538 | 0 |
| Interest @ 10% | 0 | 0 | 0 | 0 | 0 | 29075 | 53 | 26168 | 24714 | 23260 | 21806 | 20353 | 18899 | 17445 | 15991 | 14538 | 13084 | 11630 | 10176 | 8723 | 7269 | 5815 | 4361 | 2908 | 1454 |
| Replacement Capital | 0 | 0 | 0 | 0 | 0 | 0 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| Working Capital | 0 | 0 | 0 | 0 | 0 | 1650 | 1650 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3300 |
| Cash Flow (After Investment) | -10000 | -31500 | -87000 | -105500 | -56750 | 528 | 93035 | 68570 | 70024 | 71478 | 72932 | 74385 | 75839 | 77293 | 78747 | 80200 | 81654 | 83108 | 84562 | 86015 | 87469 | 88923 | 90377 | 91830 | 89984 |
| Depreciation (7 yr ACRS) | 0 | 0 | 0 | 0 | 0 | 41548 | 71205 | 50852 | 36315 | 25964 | 25935 | 25964 | 12967 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depletion | 0 | 0 | 0 | 0 | 0 | 0 | 10915 | 8859 | 16855 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 | 18722 |
| Taxable Income | 0 | 0 | 0 | 0 | 0 | 0 | 10915 | 6859 | 16854 | 26792 | 28275 | 29699 | 44150 | 58571 | 60025 | 61478 | 62932 | 64386 | 65840 | 67293 | 68747 | 70201 | 71655 | 73108 | 71262 |
| Tax Rate, % | 0 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| Income Tax | 0 | 0 | 0 | 0 | 0 | 0 | 3820 | 3101 | 5899 | 9377 | 9896 | 10395 | 15453 | 20500 | 21009 | 21517 | 22026 | 22535 | 23044 | 23553 | 24061 | 24570 | 25079 | 25588 | 24942 |
| Net Income After Tax | 0 | 0 | 0 | 0 | 0 | 0 | 7095 | 5758 | 10955 | 17415 | 18379 | 19304 | 28697 | 38071 | 39016 | 39961 | 40906 | 41851 | 42796 | 43740 | 44686 | 45631 | 46576 | 47520 | 46320 |
| Cash Flow | -10000 | -31500 | -87000 | -105500 | -56750 | 528 | 74677 | 50931 | 49587 | 47563 | 48498 | 49452 | 45849 | 42255 | 43200 | 44145 | 45090 | 46035 | 46980 | 47924 | 48870 | 49815 | 50760 | 51704 | 65042 |
| Cumul Cash Flow | -10000 | -41500 | -128500 | -234000 | -290750 | -290222 | -215545 | -164614 | -115027 | -67464 | -18966 | 30486 | 76334 | 118589 | 161789 | 205934 | 251024 | 297059 | 344039 | 391963 | 440833 | 490648 | 541408 | 593112 | 658154 |

DCFROI 11.7 %
NPV @ 10% 32725

# SECTION 7

# ENVIRONMENTAL

## 7.1 ENVIRONMENTAL SETTING

In the present study, two areas are under consideration for potential exploitation of mineral occurrences. The phosphorite occurrence is located 5 nautical miles offshore Savannah, and the heavy minerals location under consideration is 35 nautical miles offshore Savannah. Both of these suspected occurrences lie within that broad portion of the southwestern Atlantic Ocean known as the Georgia Bight. This region is bound by Cape Fear, North Carolina to the north, and by Cape Canaveral, Florida to the south. The Georgia Bight extends seaward from the coast to the Florida-Hatteras Slope which represents the edge of the Contintental Shelf. The coastal margin of the Bight in the vicinity of the mineral resources is characterized mostly by undeveloped sea islands and extensive coastal marshes and tributaries.

The scope of work and assignment described for this resource assessment study includes economic feasibility without the requirement to evaluate environmental considerations. This section presents a very brief overview and describes the kinds of things which would require comprehensive study in an EA or EIS. No attempt is made to describe the scope or content, nor to definitively estimate the cost of such studies.

### Coastal/Estuarine Environment

Coastal Georgia is typified by a barrier island salt marsh regime. Sand beaches of mild relief face the open waters of the southeast Atlantic. Beaches give way to parallel dune lines placed by deposition of sediments transported through wave action. The dune areas generally protect a stand of coastal vegetation that grades from sea oats to salt-tolerant grasses, into oak and pine forests. Behind the islands lie protected salt marshes replete with tidal creeks, streams, and bays.

Salt marshes serve as a mixing zone for fresh water from coastal rivers with saltwater pushed into the marsh during tidal maximums. The dynamics of tidal bore and streamflow drive an ecological mechanism fueled on nutrients and sunlight. Productivity in the salt marsh and estuaries forms the foundation of the marine food chain.

Resort and recreational developments are numerous and notable on the barrier islands. Jekyll, St. Simons, Sea Islands, and Tybee Islands, have commercially important resort areas, along with public access recreational areas. The status of these highly acclaimed vacation destinations gives credence to the value of Georgia's coastal natural resources. Interspersed with commercial developments are large areas of undeveloped lands in the form of parks, reserves, and wildlife management areas.

Jekyll Island State Park, the islands within the Savannah Wildlife Refuge, and Wolf Island National Wildlife Refuge and Wilderness Area are representative of areas that remain as undeveloped, or natural coastline. These sanctuaries of preserved natural ecosystems and geographic microcosms currently protect many coastal resources. Strict coastal zone management practices are now controlling further degradation of barrier islands, while allowing compatible development to continue.

Impacts to the beaches on the barrier islands, or to salt marshes and wetlands in the coastal zone, are a concern for the feasibility of any onshore or offshore activity. Review of the impacts should consider methods to improve the existing natural resource when possible, without defeating the mission of utilization of the discovered mineral.

**Savannah River**

The Savannah River has its headwaters in the Blue Ridge Province in northern Georgia. A significant freshwater river, it transverses a hundred or more kilometers and has a 27,392 $km^2$ drainage basin. Discharge of the lower river has been estimated at over 300 $m^3/s$. Control structures, dams, and maintenance dredging have altered the natural hydraulics of the system and impacted the associated ecosystems.

Deepwater port facilities located on the Savannah River handle a variety of cargoes. Bulk shipments of dry and liquid products, along with increasing numbers of container vessels from other U.S. and foreign locations, now utilize the historic port of Savannah. Continued use of the maintained channel by the river's many industrial facilities further emphasizes the nature of this busy port area. Forest products, petroleum, and basic chemicals are produced and shipped from the Savannah area. Georgia Port Authority reports cargo levels near seven million tons for the 1987 year at the deepwater facilities.

Development of the river frontage began in 1733 with the founding of the city by General James Edward Oglethorpe. General Oglethorpe's planned development of the city has matured into a major east coast port. Commercial and industrial developments along the river and on islands in the river are extensive, above and the below the originally planned community.

At present, concern over the impact of developments on the river and in adjacent coastal marshlands has led to the promulgation of regulations governing future impacts. Due to the importance of the coastal marshlands and riverine wetlands on the river's ecological status, future developments are likely to occur only at suitable non-marsh or non-wetland locations.

## Offshore

The width of the Continental Shelf in the Georgia offshore area is approximately 130 km. The depth of the shelf break off Georgia averages 56 m. The average depth of water at the location of the occurrences (heavy minerals) is 27.2 m, and at the location of the phosphorite occurrences in the Middle Miocene is 15 m.

The shelf is a marine extension of the Atlantic Coastal Plain which is relatively flat and slopes seaward an average of 36 cm/km.

The south Atlantic seafloor is over 80% sand bottom (Hollister, 1973; George & Staiger, 1979). Two major sedimentary regimes occur: an inshore area approximately 10 to 30 km wide characterized by fine to very fine-grained sand, and an offshore expanse stretching to the shelf-slope break covered by coarse-grained sediments (Gorsline, 1963; Henry & Hoyt, 1968). Off the coast of Georgia this boundary is distinct and occurs quite consistently at a depth of 11 meters (Pilkey & Frankenberg, 1964). The near-shore shelf zone acts as an effective sediment trap, beyond which little sediment deposition occurs (Neiheisel & Weaver, 1967; Pilkey, 1963; Bigham, 1973). Distribution of minerals in Continental Shelf waters and sediments off Georgia indicates a long-shore transport from north to south within the near-shore zone. Lateral transport of sediments across the shelf is not extensive.

The shelf surface is generally smooth with rare and intermittent outcrops of hardground; hardgrounds in the South Atlantic are "reefs" and express relief above the surrounding sedimentary regime or are buried under superficial sediments of varying thicknesses. One such "reef" is within the Gray's Reef National Marine Sanctuary. The location of Gray's Reef is 17.5 nautical miles off the coast of Sapelo Island, Georgia, with corner coordinates of: 31°21.45'N, 80°55.17'W; 31°25.25'N, 80°55.17W; 31°25.15N, 80°49.42'W; and 31°21.45'N, 80°49.42'W.

Natural hardground and artificial reefs support a wide variety of marine life. Such hardground is known as a live bottom reef and is defined as: those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography, or whose lithotope favors the accumulation of turtles, fish, and other fauna.

Reef areas support invertebrates, recreational target fish, migratory pelagic fish, small seasonal tropic reef fish, common indigenous fish, small schooling bait fish, mid-water fish, and marine turtles. Pelagic birds are seen in the vicinity of these reef areas. Sport fish such as snapper or grouper tend to be long-lived and do not stray far from the reef areas. Long-lived fish are usually secondary or tertiary consumers, at the top of a reasonably large and diverse food web.

Twenty-five species of cetaceans (whales, dolphins, and porpoises) have been reported in offshore waters within the Georgia Bight. Twelve of these species have been found stranded along the Georgia coastline, and one, the spotted dolphin, has been identified by numerous offshore sightings.

Surface water temperatures follow seasonal air temperatures, with a slight lag. Near-shore in the south Atlantic, surface temperatures often show wide seasonal variation in response to varying climatic and run-off patterns and commonly range from 10 to 25°C. In the offshore zone, surface temperatures also respond to climatic changes, but are moderated by the consistently warm (25°C) Gulf Stream and thereby show only minor seasonal variations. In mid-shelf areas, surface water temperatures are relatively constant (19-27°C) year-round. Offshore at deeper depths, bottom temperatures are not readily influenced by weather or wind and are more stable.

Circulation in the Georgia Bight is affected primarily by freshwater runoff, wind, or the northerly flowing Gulf Stream, and to a minor extent by tidal currents, which proceed in a clockwise fashion, and the Coriolis effect. Surface circulation is northeasterly off the Carolinas and intermittent off Georgia and Florida, with a northerly drift in the autumn and winter. A southerly flowing coastal current prevails nearly year-round, inshore of a predominant northeasterly drift offshore, except during winter when runoff is low and when northeasterlies blow for several days at a time. Circulation off Georgia is strongly influenced by the prevailing winds which are most often northeasterly or southwesterly.

Bottom currents off Georgia show no consistent pattern and it is speculated that these currents are influenced by in-drafts from the northerly flowing Gulf Stream. Reefs often provide areas of calm bottom water or favorable bottom currents by damping or deflecting currents, and it has been noted that vertical relief of natural patch reefs or live-bottoms causes an upwelling effect.

In the offshore area of interest, waves come, on an annual basis, from all directions about the same percentage of the time. Seas of less than 4 feet occur most of the time, while wave heights greater than 12 feet are rare. Wave conditions are more severe during fall and winter in response to weather conditions. During the winter months, the area is subjected to extra-tropical storms, locally known as Hatteras lows, and during the summer and fall, to tropical storms and hurricanes originating in the Caribbean and the Gulf of Mexico.

The primary commercial interest in the Georgia offshore area is shrimping (GMFMC & SAFMC, 1980). Shrimp are harvested offshore of Georgia in amounts of 3,000 to 4,000 tpy, compared to 50 tpy of harvested fin fish. Historically, Georgia's commercial fishery has been based upon a six-month coastal shrimping cycle, commencing in the spring, usually late May or early June, when over-wintering and migratory white shrimp move toward offshore waters. During late August a new crop of white shrimp enters the fishery and provides a major portion of Georgia's catch. Georgia's sounds have not been opened since 1977, but prior to that year they were opened during the fall white shrimp period.

Shrimp are most abundant within 4-5 nautical miles of the Georgia shoreline. This location seems to be associated with depth. White shrimp are concentrated in waters of 27 m or less. The commercially less important brown shrimp and pink shrimp can be found in water depths of 55 m and 11-37 m, respectively.

In Georgia, most spawning of shrimp occurs more than 1.2 nautical miles from the shore; some spawning may occur inshore. Spawning seems to correlate with bottom water temperatures of 17-29°C. The spring spawn occurs with the rapid rise in water temperatures and the fall spawn ends with temperature decline. Shrimp may spawn up to four times within the spawning season. Spawning season ranges April - September.

After emerging from their demersal eggs, shrimp go through eleven stages of larval development. The larval stage of shrimp lasts approximately 12 days. Near shore tidal currents transport the post-larvae from the spawning areas into the estuarine shrimp nurseries. While in the nurseries, the shrimp grow quickly and, as juveniles, migrate toward the commercial fishing areas offshore, in late spring and summer. The adult shrimp move from near-shore spawning areas to commercial fishing areas from August through December. Starting in fall to early winter, the adult shrimp migrate south to Florida offshore waters and return to Georgia waters during late winter and early spring. Some portion of the shrimp will over-winter in Georgia waters. The shrimp spawning area and estuarine nurseries are the most important and sensitive habitats of shrimp, with regard to shrimp development.

## 7.2 PHOSPHATE MINING

The proposed methodology to mine and process the offshore phosphorite occurrence will utilize dredge-type mining equipment, followed by offshore processing. This proposed method will reduce possible onshore impacts associated with site development and plant operations in coastal areas. Infrastructure needs such as power supply, transportation, and operating supplies, would be available from existing on-shore facilities.

Long-term impacts from the mining operations are associated with the condition and characteristics of the mined bottom. Large-scale changes in bottom topography could seriously affect species composition in the mined area waters. If mining operations drastically change the characeristics of the bottom sediments, future biologic development of the bottom and surrounding waters may be severely altered, though it should not be inferred that this represents an adverse impact. The proposed operation would create deep, wide, and long excavations which may cause wave pattern modification. These excavations may never naturally fill due to wave action, since sediment transport is unlikely at water depths greater than 45 feet (Drinnan & Bliss, 1986).

Another area of the proposed mining operation with potential for negative impact on the marine environment concerns the various process effluent streams. The different effluent streams are generated at sea on the mining dredge and artificial island that supports the product beneficiation operations. The effluents can be placed in three categories: sized/inert rejects, process waste clays, and sand tailings.

The mining/beneficiation operations will have a potential impact in three domains within the marine environment. The first region is the upper portion of the euphotic zone. One short-term impact is an influence on phytoplankton. Surface plumes created by effluents from mining or processing can reduce the available sunlight in and beneath the plume. This reduction in sunlight can adversely affect development of phytoplankton by limiting photosynthesis. On the other hand, effluent plumes may concentrate dissolved or suspended nutrients within the euphotic zone, and the presence of these substances may stimulate phytoplankton productivity.

The second area of potential environmental impact due to effluent streams is the water column. Effluent plume turbidity can create a stressful environment for marine organisms. Fin fish and other highly mobile animals can, and usually do, avoid a high particulate area, but eggs and larvae cannot escape. Thus, high concentrations of particulate may create changes in seasonal and spatial patterns of organisms. In addition to particulates, effluent streams may also add dissolved substances to the water column. At significant concentrations these may be toxic to certain organisms, leading to biomass reduction, or they may represent nutrients and lead to inordinate localized rise in biomass.

Shrimp populations are sensitive to conditions that can develop from open-ocean dredging and dumping of dredge spoil. The resulting silt and turbidity from operations could result in shrimp gill erosion. To avoid adverse impacts it is ordinarily necessary to curtail such operations in shrimp trawling grounds when shrimp are abundant. Another adverse effect of dredging on the shrimp fishery is the smothering and destruction of the demersal eggs by the dredge spoil. In addition, severe alteration of bottom contours and substrata composition by dredge spoil can make trawling hazardous, if not impossible, in spoil areas.

Finally, benthic impacts may represent another important receptor of effluent streams. Impacts of effluent streams on the bottom are similar to, but not as severe as, the mining operation itself. If sedimentation is heavy, then benthic communities will be smothered. The characteristics of the sedimentation and type of benthic community will determine whether benthic impacts are severe.

Potential environmental impacts of airborne emissions from the dredging and beneficiation operations are expected to be very light. The only emission from the mining and processing operations will be exhaust from diesel power generation equipment or vessel operation.

Floridan Aquifer

In the vicinity of the hypothetical mine, the Middle Miocene phosphorite source bed overlies the principal artesion aquifer of the region. Because of the importance of the Floridan Aquifer as a water supply, particularly to Savannah, there are concerns about the potential for aquifer contamination from mining activities.

Research will be necessary to define aquifer and aquiclude characteristics in the vicinity of the mine. Items that need to be addressed include the following:

- thickness and effectivenss of the aquiclude after mining,
- potential for breaching the aquifer during mining,
- aquifer water quality and the position of the salt-water/fresh-water interface; if the water quality is poor and the interface is landward of the mining area, then contamination by mining is not an issue.

## 7.3 HEAVY MINERALS MINING

Potential commercial development of the offshore heavy mineral occurrences has been based on the use of a suction-type hopper dredge with support facilities at an offshore platform-mounted processing plant. As in the case of the proposed phosphorite occurrence, all processing will occur offshore, thereby eliminating onshore impacts that would be associated with onshore processing of the heavy minerals.

Because of the nature of heavy mineral occurrences, mining of heavy minerals will differ from the mining of the phosphorite. Where phosphorite mining will require two dredges, one dredge to remove overburden and one dredge to mine phosphorite matrix, heavy mineral mining will require only one dredge since there is not expected to be any overburden needing removal.

Impacts of heavy mineral mining will be similar to those of phosphorite mining, but substantially reduced. The proposed mining of heavy minerals will excavate to a depth of 7 meters into the ocean bottom. Beneficiation, both onboard the dredge and the offshore plant, will generate sand tailings which will be placed into the 7 meter deep mine cuts. There will not be any waste-clay effluents to be dealt with as in the phosphorite mining; therefore, increased turbidity due to very small particle waste-clays will not be an expected problem.

## Coastal/Estuarine Impacts

Coastal or estuarine ecosystems should not receive direct impacts from offshore mining operations. Current movements of turbidity plumes are generally north or south in the offshore mine locations. Should mine operations occur in waters less than 20 meters in depth, a potential for affecting the sediment budgets of coastal shoreline is possible.

Identification of the mining locations and rate of bottom deepening will play an important role in assessing effects to coastal shorelines. Processes of deposition and removal on coastal shorelines have been shown to result from modification of natural bottom conditions at depths less than 20 meters. The dynamics of current movements, wave action, will need identification, along with bottom and shoreline characterization, prior to confirming specific impacts.

The generation of clean well-sorted sands in the mining and processing operations does present an opportunity to mitigate impacts from mining. Production of beach quality sands from mining beyond the 20 meter depth could provide valuable reconstruction materials for shorelines undergoing erosion caused by other forces. As with all activities in natural environments, investigations into habitat biota relationships prior to the actions would be required, but mitigative and restorative practices are possible.

Impacts on estuarine systems should be minimal as no disturbance of natural conditions are projected. Siting of onshore plant facilities in an area of existing suitable locations is likely. Construction of infrastructure such as docks or canals may be needed, but do not represent perturbances to the natural setting that are unacceptable.

## Potential Benefits of Mining

Mining of minerals in the Exclusive Economic Zone (EEZ) is anticipated to generate much interest and debate on the environmental effects associated with resource utilization. While detrimental consequences are discussed at length in many of the available references on the subject, little information has been located that documents positive effects from resource utilization. Lack of information on the environmental benefits may be due to the lack of citable evidence, or lack of directed research on post-utilization conditions. Studies are needed to define methods of reaping potential benefits from mining activities, and to formulate guidelines for making evaluations of what constitutes acceptable impacts versus benefits.

In coastal or deepwater zones of low biologic diversity, mineral resource utilization offers the opportunity to use mining technology to increase habitat diversity and thereby induce biologic diversity with associated benefits. Areas of monotonous bottom conditions, when modified and reclaimed to increase habitat via niche development, offer the potential for increased diversity of species and associated recreational or economic benefits. To effect such measures, actions designed to save potential construction materials are needed. Construction of rock piles, or reef-like areas, when suitable reject materials are encountered, is one technique. Areas excavated to leave behind overhanging ledges or bluffs may be feasible as well, and should be considered.

Similarly, the construction of islands, or the installation of permanent work platforms, offer the potential to incorporate habitat for a variety of species. Artificial habitat in otherwise barren areas will quickly attract a full range of sessile and motile forms of both vertebrates and invertebrates. Clear evidence of this form of pioneer colonization is found at oil platforms and artificial reefs throughout the oceans of the world.

Another potential benefit from mining of offshore bottoms is the generation of materials suitable for beach renourishment. Overburden sands of suitable quality for beach renourishment are expected to occur in mining zones within practical pumping, or barge transportation distances. Use of these materials from deeper waters has the potential to minimize impacts from dredging operations in the near-shore zones. This trade-off of impacts should be considered as a form of mitigation of environmental consequences due to mining.

Emphasis on habitat enhancement or restoration techniques needs to be considered in the planning stages of all projects. Hence, as mining or exploitation technology evolves with the mining experience, so should mitigation technology evolve. Methods to mitigate impacts, restore bottoms, or create new habitats, will improve the overall acceptability of mineral resource utilization in the public's perception of offshore projects.

## Mitigation of Potential Adverse Impacts

Mitigation of potential environmental impacts depends on detailed analysis of mining procedures and plans. While the initial damage to benthic communities may be unavoidable in the short term, measures to re-establish communities may be possible. Careful consideration of waste materials placement may provide an avenue to enhance or reclaim mined-over areas. Methods to re-introduce native flora and faunal components have evolved for land-based mining and need consideration for ocean applications. Similarly, careful consideration of non-benthic components and mining plans may identify measures to alleviate any adverse impacts to those components.

Damage to benthic communities can occur in a variety of forms, including: total removal, substrate removal, smothering of resident sessile forms, reduction of oxygen levels, decreased photoperiod, and loss of food source. These impacts are due to direct and indirect perturbation of the benthic environment. Impacts due to smothering, decreased photoperiod, and decreased oxygen levels from particulates or plume migration may be reduced by careful placement of these materials back into open waters.

Removal of the substrate during mining and elimination of food sources represent more difficult challenges in the reclamation of the seafloor. However, with careful identification of materials handling techniques, and mine planning, the movement of unusable substrate, i.e. overburden, to suitable new locations may be possible. With saved or reclaimed substrate in place, the re-introduction of species appears feasible if similar pre-mine conditions such as depth, lighting, and food source, prevail. Recolonization by pioneer species brought to barren sites by drift in currents may supply adequate innoculation of sites, when nearby undisturbed areas are upgradient.

Avoidance of areas during periods of sensitive activities may be possible as well and should be considered during mine planning. Seasonally utilized areas for spawning, migration, and breeding, can be identified in advance and operations altered to minimize intrusion. Monitoring of currents and prevailing weather patterns also would allow for the shifting of mining or disposal activities away from sensitive areas downgradient to prevailing conditions.

Another valuable technique applicable to highly motile or pelagic species is hazing. By creating annoying or nuisance conditions in areas to be impacted, it may be possible to cause voluntary abandonment by certain sensitive species. This form of activity, along with removal techniques, while not completely effective, does have merit when less favorable circumstances may prevail.

In summary, further development of mitigation procedures need to be explored. Restoration, reclamation, or enhancement of conditions should receive attention at an early stage of planning to allow for consideration of alternatives prior to initiation of operations. Attempts to mitigate impacts from active operations also need to be considered when sensitive or economically important resources are at risk.

## 7.4 PERMITTING

### 7.4.1 Permit Acquisition Procedures

Federal environmental regulations affecting the operation of offshore mining/processing activities are based on two major legislative provisions at the federal level. The Marine Protection Research and Sanctuaries Act (MPRSA), along with the Clean Water Act (CWA), have sections governing the disposal of dredged materials and non-dredged materials in estuarine, coastal, and open ocean waters. Various other secondary acts also have the potential to be cited as being relevant, as well. These secondary acts which may affect both the heavy minerals site and phosphorite sites include:

- o Endangered Species Act (ESA)
- o National Environmental Policy Act (NEPA)
- o Port and Tanker Safety Act (PTSA).

**MPRSA** - Provisions of MPRSA require permits issued from EPA for the transportation and dumping of waste materials into the contiguous zone and beyond with restrictions as specified by EPA for non-dredged materials. MPRSA tasks Corps of Engineers with issuing permits for dumping dredged materials while applying EPA criteria for evaluating the impact on the marine environment. MPRSA further delegates Coast Guard with conducting appropriate enforcement activities for unlawful dumping or transportation for dumping of materials.

Basic to the tasks of EPA and Corps of Engineers under MPRSA, is the determination of whether permitted activities will "unreasonably degrade" public health or the marine environment. In making this determination, EPA and Corps of Engineers use criteria specified by statute or established by the EPA Administrator. MPRSA is generally not applicable in estuarine waters.

**CWA** - The Clean Water Act contains provisions for the establishment of water quality criteria, treatment standards, issuance of discharge permits, and issuance of permits for land-based pollution sources, or stationary pollution sources discharging into territorial waters. Further, the discharge of dredged materials into navigable waters is regulated under the CWA; however, MPRSA usually preempts this provision in coastal or the open ocean.

The CWA will affect any discharges from processing operations associated with the beneficiation of ores. The National Pollutant Discharge Elimination System (NPDES) is the operative format for the execution of CWA provisions as administered by EPA at facilities with pollutant discharges. CWA Section 404 directs Corps of Engineers to issue permits for dredge and fill activities in navigable waters, using criteria promulgated by EPA for disposal sites.

Permitting requirements for the emission of non-dredged material effluents from the offshore processing facilities will be according to NPDES criteria. Application of regulations formulated for the NPDES program have particular relevance to the phosphorite operations. Disposal of spent reagents with tailings or waste clays are anticipated to represent a minor impact due to the bio-degradable nature of the materials utilized. The absorptive capacity of phosphorite matrix clays should immobilize reagents allowing degradation to occur. This form of treatment is common to on-shore operations of a similar nature.

**Air** - Provisions of the Clean Air Act (CAA) will govern air emissions associated with any of the mining/processing facilities. Should heating systems for reagents or drying facilities for product become necessary, applicable CAA emission restrictions would be applicable, particularly for the stationary facilities. Industry standards for mineral processing operations are routinely met by operations at on-shore facilities of a similar nature should air emission sources be defined.

Georgia environmental regulations will affect only the onshore activities associated with ore shipment. The Environmental Protection Division (EPD) of the Georgia Department of Natural Resources administers programs governing:

- o Water quality control discharge (NPDES),
- o Air quality,
- o Groundwater withdrawal,
- o Surface water withdrawal,
- o Solid waste management,

Georgia has a consolidated environmental program with authority delegated from the U.S. Environmental Protection Agency for issuance and enforcement of federal permits.

## Coastal Marshlands

Issues concerning the construction of a storage facility or appurtenant devices in coastal marshlands, are regulated under the Coastal Marshlands Protection Act. Provisions of the Coastal Marshlands Protection Act are administered by a three-member committee, consisting of the EPD Director, Coastal Resources Division Director, and a Natural Resources Commissioner.

Construction and operation of storage or shipping facilities at hypothetical locations on-shore will likely require review and permitting under the Coastal Marshlands Protection Act. Review of dock construction, discharge/intake structures, and other infrastructure, are likely to have temporary impacts on estuarine wetlands. Mitigative measures and procedures would be employed to lessen or alleviate impacts.

## SECTION 8

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Zellars-Williams Company key professional contributors, in addition to J. M. Williams, P.E., as a principal investigator, are recognized as follows.

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| 2 | Scope of Study | T.D. Abel |
| 3 | Resources | J.S. Spalding<br>T.D.Abel |
| 4 | Offshore Mining Technology | J.W. Hughes<br>J.G. Tavrides |
| 5/6 | Phosphate and Heavy Minerals Feasibility Mining Area and Alternative Configuration | J.W. Hughes |
| | Configuration and Infrastructure | J.G. Tavrides |
| | Estimated Capital and Operating Cost | J.W. Hughes<br>J.G. Tavrides |
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| 7 | Environmental Impacts | T.P. Oxford<br>F.I. Nance<br>J.W. Whittington |

Credit is due the computer programmers, operators, and particularly Shirley B. Nicks, secretary and word processor, who put it all in print, and others in Jacobs reproduction department who compile and assemble report documents.

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## SECTION 9

## APPENDIX

9.1 **MODELLED DATA**

Averaged and listed by OCS Block Number (NH21000).

9.2 **RAW DATA**

Sea floor Characterization, listed by U.S.G.S. sample point number.

9.3 **RAW DATA**

Grab sample mineralogy, listed by U.S.G.S. sample point number.

SECTION 9.1

GEORGIA OFFSHORE MINERALS ASSESSMENT MODEL page 1

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MM.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHAT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H21000 | 23.040 | 31.001 | 80.472 | 429600.0 | 550400.0 | 34.5 | 0.00 | 100.00 | 0.00 | 0.00 | 14.60 | 13.70 | 3.80 | 30.40 | 13.50 | -96.90 | 32.00 | 90.60 | 1.30 | 3.20 | 3.50 | 0.00 | 0.00 | 0.00 | 2.90 | 16.60 | 0.90 |
| H21001 | 23.040 | 31.000 | 80.422 | 429600.0 | 555200.0 | 36.4 | 0.00 | 99.90 | 0.10 | 0.00 | 17.40 | 15.50 | 2.10 | 31.50 | 14.90 | -103.00 | 35.00 | 91.00 | 1.20 | 3.40 | 3.10 | 0.00 | 0.00 | 0.00 | 2.90 | 16.40 | 1.00 |
| H21002 | 23.040 | 31.000 | 80.372 | 429600.0 | 560000.0 | 38.1 | 0.00 | 99.90 | 0.10 | 0.00 | 20.20 | 17.40 | 0.50 | 32.20 | 15.00 | -108.60 | 38.20 | 91.30 | 1.00 | 3.70 | 2.80 | 0.00 | 0.10 | 0.10 | 2.70 | 15.40 | 1.00 |
| H21003 | 23.040 | 31.000 | 80.321 | 429600.0 | 564800.0 | 39.0 | 0.00 | 99.80 | 0.10 | 0.00 | 21.40 | 17.40 | 0.10 | 33.90 | 15.20 | -111.90 | 39.00 | 91.40 | 0.90 | 3.80 | 2.80 | 0.00 | 0.40 | 0.40 | 2.30 | 12.70 | 1.00 |
| H21004 | 23.040 | 31.000 | 80.271 | 429600.0 | 569600.0 | 39.2 | 0.00 | 99.60 | 0.30 | 0.10 | 20.90 | 20.10 | 0.00 | 42.80 | 12.70 | -123.00 | 41.00 | 91.80 | 0.80 | 3.70 | 2.50 | 0.00 | 0.70 | 0.70 | 1.60 | 8.90 | 1.00 |
| H21005 | 23.040 | 30.999 | 80.221 | 429600.0 | 574400.0 | 39.8 | 0.00 | 98.90 | 0.70 | 0.30 | 18.70 | 25.80 | 0.00 | 53.90 | 6.20 | -138.30 | 44.60 | 91.50 | 0.60 | 3.70 | 2.20 | 0.00 | 0.90 | 0.90 | 1.20 | 6.30 | 1.00 |
| H21006 | 23.040 | 30.999 | 80.170 | 429600.0 | 579200.0 | 42.7 | 0.10 | 97.70 | 1.50 | 0.60 | 24.30 | 21.80 | 0.00 | 55.40 | 13.40 | -144.20 | 46.00 | 90.00 | 0.40 | 3.90 | 2.30 | 0.00 | 1.00 | 1.00 | 1.00 | 5.30 | 1.00 |
| H21007 | 23.040 | 30.999 | 80.120 | 429600.0 | 584000.0 | 46.8 | 0.20 | 96.50 | 2.20 | 0.90 | 36.60 | 11.80 | 0.00 | 60.10 | 20.60 | -155.30 | 48.40 | 88.40 | 0.30 | 4.30 | 2.50 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H21008 | 23.040 | 30.998 | 80.070 | 429600.0 | 588800.0 | 52.7 | 0.20 | 96.30 | 2.40 | 1.00 | 46.30 | 3.50 | 0.00 | 67.80 | 30.80 | -170.30 | 49.80 | 87.90 | 0.20 | 4.50 | 2.60 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H21009 | 21.900 | 30.998 | 80.020 | 429600.0 | 593600.0 | 48.4 | 0.10 | 98.70 | 0.80 | 0.30 | 41.40 | 10.10 | 0.00 | 56.80 | 37.10 | -156.70 | 51.50 | 87.20 | 0.10 | 4.80 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2111 | 0.338 | 31.868 | 80.924 | 525600.0 | 507200.0 | 8.7 | 0.00 | 94.80 | 5.10 | 0.00 | 21.90 | 0.30 | 0.00 | 2.30 | 12.10 | -33.20 | 22.30 | 86.80 | 1.70 | 5.50 | 5.00 | 0.20 | 0.00 | 0.00 | 0.00 | 1.80 | 0.00 |
| H2112 | 17.490 | 31.868 | 80.873 | 525600.0 | 512000.0 | 9.8 | 0.90 | 94.10 | 5.00 | 0.00 | 20.50 | 0.20 | 0.00 | 2.10 | 12.50 | -32.60 | 20.70 | 87.10 | 2.00 | 5.00 | 5.00 | 0.20 | 0.00 | 0.00 | 0.00 | 2.30 | 0.00 |
| H2113 | 23.040 | 31.868 | 80.822 | 525600.0 | 516800.0 | 14.2 | 0.80 | 97.30 | 1.80 | 0.00 | 17.70 | 0.80 | 0.00 | 1.00 | 10.90 | -33.60 | 18.40 | 0.00 | 3.50 | 2.80 | 5.70 | 0.00 | 0.00 | 0.00 | 0.00 | 5.10 | 0.30 |
| H2114 | 23.040 | 31.868 | 80.772 | 525600.0 | 521600.0 | 16.0 | 1.00 | 97.40 | 1.50 | 0.00 | 13.80 | 0.80 | 0.00 | 1.60 | 8.00 | -32.20 | 14.60 | 87.40 | 3.30 | 3.00 | 5.40 | 0.00 | 0.00 | 0.00 | 0.00 | 8.60 | 0.70 |
| H2115 | 23.040 | 31.868 | 80.721 | 525600.0 | 526400.0 | 17.7 | 1.40 | 97.60 | 0.90 | 0.00 | 11.10 | 0.70 | 0.00 | 1.60 | 6.40 | -31.20 | 11.80 | 87.70 | 2.60 | 3.80 | 4.80 | 0.00 | 0.00 | 0.00 | 0.00 | 10.90 | 0.90 |
| H2116 | 23.040 | 31.867 | 80.670 | 525600.0 | 531200.0 | 18.7 | 0.90 | 98.50 | 0.60 | 0.00 | 10.30 | 0.60 | 0.00 | 1.50 | 6.80 | -31.10 | 10.90 | 87.80 | 2.10 | 4.30 | 4.80 | 0.00 | 0.00 | 0.00 | 0.00 | 11.70 | 1.00 |
| H2117 | 23.040 | 31.867 | 80.619 | 525600.0 | 536000.0 | 18.8 | 0.40 | 99.20 | 0.30 | 0.00 | 11.20 | 0.60 | 0.00 | 1.60 | 10.70 | -32.20 | 11.80 | 87.80 | 1.50 | 4.70 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2118 | 23.040 | 31.867 | 80.569 | 525600.0 | 540800.0 | 19.4 | 0.10 | 99.70 | 0.10 | 0.00 | 12.20 | 0.70 | 0.00 | 2.20 | 14.40 | -34.40 | 12.90 | 88.00 | 1.10 | 4.90 | 5.10 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2119 | 23.040 | 31.867 | 80.518 | 525600.0 | 545600.0 | 19.9 | 0.00 | 99.90 | 0.00 | 0.00 | 11.60 | 1.50 | 0.00 | 4.90 | 13.90 | -37.90 | 13.10 | 88.30 | 0.90 | 4.80 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2120 | 23.040 | 31.867 | 80.467 | 525600.0 | 550400.0 | 20.1 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 1.10 | 0.00 | 4.40 | 12.10 | -37.70 | 13.20 | 89.50 | 0.60 | 4.40 | 4.50 | 0.00 | 0.00 | 0.00 | 0.10 | 11.60 | 1.00 |
| H2121 | 23.040 | 31.867 | 80.416 | 525600.0 | 555200.0 | 21.4 | 0.00 | 100.00 | 0.00 | 0.00 | 12.40 | 1.30 | 0.00 | 5.00 | 13.50 | -40.10 | 13.70 | 90.60 | 0.30 | 4.00 | 4.00 | 0.00 | 0.00 | 0.00 | 0.30 | 10.50 | 1.00 |
| H2122 | 23.040 | 31.866 | 80.366 | 525600.0 | 560000.0 | 23.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.30 | 2.30 | 0.00 | 5.90 | 17.70 | -43.90 | 14.60 | 90.90 | 0.70 | 3.80 | 3.70 | 0.00 | 0.00 | 0.00 | 0.70 | 8.40 | 1.00 |
| H2123 | 23.040 | 31.866 | 80.315 | 525600.0 | 564800.0 | 25.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 4.10 | 0.00 | 6.70 | 24.70 | -47.90 | 15.70 | 91.40 | 1.80 | 3.00 | 2.90 | 0.00 | 0.00 | 0.00 | 1.20 | 5.80 | 1.00 |
| H2124 | 23.040 | 31.866 | 80.264 | 525600.0 | 569600.0 | 27.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 5.70 | 0.00 | 7.60 | 32.10 | -52.20 | 17.00 | 91.70 | 2.60 | 2.40 | 2.30 | 0.00 | 0.00 | 0.00 | 1.60 | 4.20 | 1.10 |
| H2125 | 23.040 | 31.865 | 80.214 | 525600.0 | 574400.0 | 29.4 | 0.10 | 99.80 | 0.00 | 0.00 | 11.00 | 6.20 | 0.00 | 8.60 | 35.70 | -55.20 | 17.20 | 91.30 | 2.70 | 2.70 | 2.40 | 0.00 | 0.00 | 0.00 | 1.70 | 3.40 | 1.10 |
| H2126 | 23.040 | 31.865 | 80.163 | 525600.0 | 579200.0 | 30.9 | 0.40 | 99.20 | 0.00 | 0.00 | 9.70 | 6.70 | 0.00 | 10.10 | 35.10 | -57.50 | 16.40 | 90.40 | 2.90 | 3.70 | 2.40 | 0.00 | 0.10 | 0.00 | 1.80 | 3.30 | 1.30 |
| H2127 | 23.040 | 31.865 | 80.112 | 525600.0 | 584000.0 | 36.0 | 0.70 | 98.50 | 0.00 | 0.00 | 9.50 | 7.90 | 0.00 | 12.40 | 32.40 | -65.80 | 17.30 | 89.50 | 3.50 | 4.50 | 2.20 | 0.00 | 0.10 | 0.10 | 1.80 | 4.10 | 1.80 |
| H2128 | 23.040 | 31.864 | 80.061 | 525600.0 | 588800.0 | 18.6 | 0.90 | 98.20 | 0.00 | 0.00 | 9.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.20 | 3.70 | 4.90 | 2.10 | 0.00 | 0.10 | 0.10 | 1.80 | 5.70 | 2.40 |
| H2129 | 23.040 | 31.864 | 80.011 | 525600.0 | 593600.0 | 37.7 | 0.70 | 98.70 | 0.00 | 0.00 | 9.40 | 8.10 | 0.00 | 13.50 | 31.80 | -68.80 | 17.50 | 89.40 | 3.10 | 4.70 | 2.30 | 0.00 | 0.10 | 0.10 | 1.90 | 7.70 | 3.00 |
| H2130 | 23.040 | 31.864 | 79.960 | 525600.0 | 598400.0 | 39.2 | 0.40 | 99.20 | 0.00 | 0.00 | 9.50 | 8.00 | 0.00 | 14.80 | 31.60 | -71.50 | 17.50 | 89.40 | 2.40 | 4.60 | 2.60 | 0.00 | 0.10 | 0.10 | 1.90 | 9.00 | 3.20 |
| H2155 | 11.421 | 31.825 | 80.924 | 520800.0 | 507200.0 | 9.5 | 0.60 | 95.70 | 3.70 | 0.00 | 23.50 | 0.50 | 0.00 | 1.30 | 11.80 | -34.80 | 24.00 | 87.10 | 1.50 | 5.90 | 5.00 | 0.10 | 0.00 | 0.00 | 0.00 | 1.50 | 0.00 |
| H2156 | 23.040 | 31.824 | 80.873 | 520800.0 | 512000.0 | 13.1 | 0.80 | 97.70 | 1.50 | 0.00 | 22.30 | 1.80 | 0.00 | 0.50 | 11.30 | -37.70 | 24.10 | 0.00 | 2.10 | 5.00 | 5.20 | 0.00 | 0.00 | 0.00 | 0.00 | 2.20 | 0.10 |
| H2157 | 23.040 | 31.824 | 80.822 | 520800.0 | 516800.0 | 14.8 | 0.70 | 97.80 | 1.50 | 0.00 | 18.80 | 2.30 | 0.00 | 1.00 | 10.30 | -36.80 | 21.10 | 87.30 | 2.70 | 3.90 | 5.30 | 0.00 | 0.00 | 0.00 | 0.00 | 4.50 | 0.30 |
| H2158 | 23.040 | 31.824 | 80.772 | 520800.0 | 521600.0 | 16.5 | 0.80 | 98.10 | 1.10 | 0.00 | 15.40 | 2.30 | 0.00 | 0.90 | 8.70 | -35.10 | 17.70 | 87.60 | 2.40 | 4.20 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 8.10 | 0.60 |
| H2159 | 23.040 | 31.824 | 80.721 | 520800.0 | 526400.0 | 18.2 | 1.10 | 98.30 | 0.60 | 0.00 | 12.70 | 1.80 | 0.00 | 0.80 | 7.70 | -33.50 | 14.50 | 87.90 | 1.90 | 4.70 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 10.70 | 0.90 |
| H2160 | 23.040 | 31.824 | 80.670 | 520800.0 | 531200.0 | 19.1 | 0.80 | 98.90 | 0.40 | 0.00 | 11.70 | 1.30 | 0.00 | 0.60 | 8.70 | -32.70 | 13.00 | 88.00 | 1.70 | 4.70 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 11.60 | 1.00 |
| H2161 | 23.040 | 31.824 | 80.620 | 520800.0 | 536000.0 | 19.0 | 0.40 | 99.40 | 0.20 | 0.00 | 12.10 | 0.80 | 0.00 | 1.00 | 11.30 | -32.90 | 12.80 | 88.10 | 1.30 | 4.60 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.80 | 1.00 |
| H2162 | 23.040 | 31.824 | 80.569 | 520800.0 | 540800.0 | 19.4 | 0.10 | 99.80 | 0.10 | 0.00 | 12.20 | 0.80 | 0.00 | 1.80 | 10.10 | -34.70 | 13.10 | 88.40 | 1.10 | 4.60 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.80 | 1.00 |
| H2163 | 23.040 | 31.824 | 80.518 | 520800.0 | 545600.0 | 18.6 | 0.00 | 99.90 | 0.00 | 0.00 | 9.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 88.80 | 1.00 | 4.50 | 4.80 | 0.00 | 0.00 | 0.00 | 0.10 | 11.70 | 1.00 |
| H2164 | 23.040 | 31.823 | 80.467 | 520800.0 | 550400.0 | 20.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 0.70 | 0.00 | 1.70 | 10.00 | -35.60 | 13.40 | 89.60 | 0.80 | 4.20 | 4.40 | 0.00 | 0.00 | 0.00 | 0.20 | 11.00 | 1.00 |
| H2165 | 23.040 | 31.823 | 80.417 | 520800.0 | 555200.0 | 22.4 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 1.20 | 0.00 | 2.40 | 11.20 | -38.90 | 14.00 | 90.30 | 0.70 | 3.90 | 4.10 | 0.00 | 0.00 | 0.00 | 0.60 | 8.80 | 1.00 |
| H2166 | 23.040 | 31.823 | 80.366 | 520800.0 | 560000.0 | 24.6 | 0.00 | 99.90 | 0.00 | 0.00 | 12.60 | 2.30 | 0.00 | 3.00 | 15.20 | -42.50 | 14.90 | 90.70 | 1.10 | 3.60 | 3.60 | 0.00 | 0.00 | 0.00 | 1.30 | 5.80 | 1.00 |
| H2167 | 23.040 | 31.823 | 80.315 | 520800.0 | 564800.0 | 26.7 | 0.00 | 99.90 | 0.00 | 0.00 | 11.50 | 4.90 | 0.00 | 3.80 | 25.30 | -46.90 | 16.40 | 90.90 | 1.90 | 3.10 | 3.10 | 0.00 | 0.00 | 0.00 | 1.70 | 3.70 | 1.00 |
| H2168 | 23.040 | 31.822 | 80.265 | 520800.0 | 569600.0 | 28.8 | 0.10 | 99.90 | 0.00 | 0.00 | 11.40 | 6.50 | 0.00 | 4.80 | 33.00 | -51.50 | 17.90 | 91.00 | 2.30 | 2.90 | 2.90 | 0.00 | 0.00 | 0.00 | 1.80 | 2.90 | 1.10 |
| H2169 | 23.040 | 31.822 | 80.214 | 520800.0 | 574400.0 | 30.5 | 0.20 | 99.60 | 0.00 | 0.00 | 11.30 | 6.50 | 0.00 | 6.30 | 32.80 | -54.50 | 17.80 | 90.50 | 2.30 | 3.40 | 2.90 | 0.00 | 0.00 | 0.00 | 1.90 | 2.70 | 1.20 |
| H2170 | 23.040 | 31.822 | 80.163 | 520800.0 | 579200.0 | 32.5 | 0.50 | 99.00 | 0.00 | 0.00 | 10.20 | 7.00 | 0.00 | 8.00 | 30.60 | -57.70 | 17.10 | 89.80 | 2.70 | 4.10 | 2.70 | 0.00 | 0.10 | 0.10 | 1.90 | 2.90 | 1.40 |
| H2171 | 23.040 | 31.821 | 80.112 | 520800.0 | 584000.0 | 35.1 | 0.70 | 98.60 | 0.00 | 0.00 | 9.90 | 7.50 | 0.00 | 9.50 | 28.80 | -62.10 | 17.40 | 89.50 | 3.20 | 4.60 | 2.30 | 0.00 | 0.10 | 0.10 | 1.80 | 3.80 | 2.00 |
| H2172 | 23.040 | 31.821 | 80.062 | 520800.0 | 588800.0 | 37.7 | 0.60 | 98.70 | 0.00 | 0.00 | 9.90 | 8.20 | 0.00 | 11.00 | 27.40 | -66.80 | 18.10 | 89.70 | 2.90 | 4.60 | 2.20 | 0.00 | 0.20 | 0.30 | 1.70 | 5.30 | 2.80 |
| H2173 | 23.040 | 31.821 | 80.011 | 520800.0 | 593600.0 | 39.5 | 0.40 | 99.30 | 0.00 | 0.00 | 10.10 | 8.30 | 0.00 | 13.00 | 26.60 | -70.90 | 18.40 | 90.20 | 1.90 | 4.40 | 2.40 | 0.00 | 0.30 | 0.30 | 1.70 | 7.10 | 3.50 |
| H2174 | 23.040 | 31.820 | 79.960 | 520800.0 | 598400.0 | 40.3 | 0.20 | 99.50 | 0.10 | 0.00 | 10.30 | 8.10 | 0.00 | 14.70 | 25.90 | -73.50 | 18.50 | 90.10 | 1.50 | 4.30 | 2.60 | 0.00 | 0.30 | 0.30 | 1.70 | 8.50 | 3.80 |

GEORGIA OFFSHORE MINERALS ASSESSMENT MODEL page 2

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | ML.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ' %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHAT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2198 | 2.947 | 31.781 | 80.975 | 516000.0 | 502400.0 | 8.9 | 0.20 | 96.70 | 3.10 | 0.00 | 26.30 | 0.50 | 0.00 | 0.50 | 11.30 | -36.10 | 26.00 | 87.40 | 1.10 | 6.30 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |
| H2199 | 21.051 | 31.781 | 80.924 | 516000.0 | 507200.0 | 10.3 | 0.40 | 97.60 | 2.00 | 0.00 | 25.60 | 0.60 | 0.00 | 0.40 | 11.20 | -36.90 | 26.20 | 87.10 | 1.20 | 6.50 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |
| H2200 | 23.040 | 31.781 | 80.873 | 516000.0 | 512000.0 | 14.4 | 0.70 | 97.80 | 1.50 | 0.00 | 22.00 | 5.00 | 0.00 | 0.50 | 10.10 | -41.90 | 27.00 | 0.00 | 1.00 | 5.10 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.90 | 0.10 |
| H2201 | 23.040 | 31.781 | 80.823 | 516000.0 | 516800.0 | 15.9 | 0.40 | 98.60 | 1.00 | 0.00 | 19.00 | 6.00 | 0.00 | 0.70 | 9.00 | -41.60 | 25.00 | 87.70 | 1.00 | 5.00 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 3.90 | 0.30 |
| H2202 | 23.040 | 31.781 | 80.772 | 516000.0 | 521600.0 | 17.3 | 0.20 | 99.30 | 0.50 | 0.00 | 16.00 | 6.00 | 0.00 | 0.60 | 9.40 | -40.00 | 22.10 | 87.90 | 1.50 | 5.20 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 7.50 | 0.60 |
| H2203 | 23.040 | 31.781 | 80.721 | 516000.0 | 526400.0 | 18.7 | 0.50 | 99.10 | 0.40 | 0.00 | 13.60 | 4.80 | 0.00 | 0.40 | 9.20 | -37.60 | 18.40 | 88.00 | 1.40 | 5.10 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 10.30 | 0.90 |
| H2204 | 23.040 | 31.781 | 80.670 | 516000.0 | 531200.0 | 19.5 | 0.40 | 99.30 | 0.20 | 0.00 | 12.50 | 3.10 | 0.00 | 0.30 | 9.70 | -35.40 | 15.60 | 88.20 | 1.40 | 4.90 | 4.60 | 0.00 | 0.00 | 0.00 | 0.10 | 11.30 | 1.00 |
| H2205 | 23.040 | 31.781 | 80.620 | 516000.0 | 536000.0 | 19.5 | 0.30 | 99.60 | 0.10 | 0.00 | 12.10 | 2.00 | 0.00 | 1.30 | 10.70 | -34.90 | 14.10 | 88.40 | 1.20 | 4.60 | 4.80 | 0.00 | 0.00 | 0.00 | 0.10 | 11.50 | 1.00 |
| H2206 | 23.040 | 31.780 | 80.569 | 516000.0 | 540800.0 | 19.8 | 0.10 | 99.90 | 0.00 | 0.00 | 12.40 | 1.20 | 0.00 | 1.40 | 10.20 | -34.70 | 13.60 | 88.70 | 1.10 | 4.30 | 4.90 | 0.00 | 0.00 | 0.00 | 0.10 | 11.30 | 1.00 |
| H2207 | 23.040 | 31.780 | 80.518 | 516000.0 | 545600.0 | 20.1 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 0.60 | 0.00 | 0.90 | 8.90 | -34.50 | 13.40 | 89.00 | 1.00 | 4.20 | 4.80 | 0.00 | 0.00 | 0.00 | 0.30 | 10.70 | 1.00 |
| H2208 | 23.040 | 31.780 | 80.468 | 516000.0 | 550400.0 | 21.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 0.60 | 0.00 | 1.10 | 8.50 | -36.50 | 13.80 | 89.40 | 1.00 | 4.00 | 4.50 | 0.00 | 0.00 | 0.00 | 0.50 | 9.20 | 1.00 |
| H2209 | 23.040 | 31.780 | 80.417 | 516000.0 | 555200.0 | 24.3 | 0.00 | 100.00 | 0.00 | 0.00 | 13.50 | 0.70 | 0.00 | 0.80 | 8.10 | -39.40 | 14.20 | 89.90 | 1.10 | 3.90 | 4.20 | 0.00 | 0.00 | 0.00 | 1.10 | 6.60 | 1.00 |
| H2210 | 23.040 | 31.780 | 80.366 | 516000.0 | 560000.0 | 26.3 | 0.00 | 99.90 | 0.00 | 0.00 | 12.40 | 2.80 | 0.00 | 1.30 | 14.90 | -42.80 | 15.20 | 90.20 | 1.40 | 3.60 | 3.80 | 0.00 | 0.00 | 0.00 | 1.60 | 3.90 | 1.00 |
| H2211 | 23.040 | 31.779 | 80.316 | 516000.0 | 564800.0 | 28.2 | 0.00 | 99.90 | 0.00 | 0.00 | 10.50 | 6.30 | 0.00 | 1.30 | 27.20 | -46.30 | 16.90 | 90.10 | 1.50 | 3.50 | 3.90 | 0.00 | 0.00 | 0.00 | 1.90 | 2.50 | 1.00 |
| H2212 | 23.040 | 31.779 | 80.265 | 516000.0 | 569600.0 | 30.0 | 0.10 | 99.90 | 0.00 | 0.00 | 10.30 | 7.20 | 0.00 | 2.10 | 29.50 | -49.50 | 17.50 | 89.90 | 1.60 | 3.60 | 3.90 | 0.00 | 0.00 | 0.00 | 1.90 | 2.30 | 1.00 |
| H2213 | 23.040 | 31.779 | 80.214 | 516000.0 | 574400.0 | 31.0 | 0.20 | 99.70 | 0.00 | 0.00 | 10.50 | 7.00 | 0.00 | 4.40 | 25.70 | -53.80 | 17.50 | 89.80 | 1.80 | 3.80 | 3.60 | 0.00 | 0.00 | 0.00 | 1.90 | 2.40 | 1.20 |
| H2214 | 23.040 | 31.778 | 80.164 | 516000.0 | 579200.0 | 34.6 | 0.40 | 99.30 | 0.00 | 0.00 | 10.10 | 7.60 | 0.00 | 6.50 | 22.20 | -58.80 | 17.70 | 89.80 | 2.20 | 4.10 | 3.00 | 0.00 | 0.10 | 0.10 | 1.90 | 2.90 | 1.60 |
| H2215 | 23.040 | 31.778 | 80.113 | 516000.0 | 584000.0 | 37.4 | 0.50 | 99.10 | 0.00 | 0.00 | 10.10 | 8.10 | 0.00 | 9.00 | 20.60 | -64.60 | 18.20 | 89.80 | 2.30 | 4.40 | 2.60 | 0.00 | 0.20 | 0.20 | 1.80 | 4.10 | 2.40 |
| H2216 | 23.040 | 31.778 | 80.062 | 516000.0 | 588800.0 | 39.3 | 0.30 | 99.40 | 0.00 | 0.00 | 10.50 | 8.70 | 0.00 | 11.70 | 19.60 | -70.30 | 19.30 | 90.60 | 1.50 | 4.30 | 2.30 | 0.00 | 0.40 | 0.40 | 1.60 | 5.70 | 3.50 |
| H2217 | 23.040 | 31.777 | 80.011 | 516000.0 | 593600.0 | 40.5 | 0.10 | 99.70 | 0.00 | 0.00 | 11.10 | 8.50 | 0.00 | 14.00 | 18.10 | -74.20 | 19.60 | 91.10 | 0.80 | 4.20 | 2.30 | 0.00 | 0.50 | 0.50 | 1.50 | 7.30 | 4.40 |
| H2218 | 23.040 | 31.777 | 79.961 | 516000.0 | 598400.0 | 41.7 | 0.10 | 99.70 | 0.10 | 0.00 | 12.20 | 9.00 | 0.00 | 18.30 | 16.40 | -81.20 | 21.20 | 90.60 | 0.80 | 4.20 | 2.60 | 0.00 | 0.60 | 0.60 | 1.40 | 8.30 | 4.80 |
| H2242 | 11.392 | 31.738 | 80.975 | 511200.0 | 502400.0 | 6.3 | 0.10 | 94.60 | 5.30 | 0.00 | 25.70 | 3.40 | 0.00 | 0.30 | 9.60 | -35.70 | 29.10 | 87.80 | 0.60 | 6.10 | 4.80 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| H2243 | 23.040 | 31.738 | 80.924 | 511200.0 | 507200.0 | 13.7 | 0.30 | 98.20 | 1.60 | 0.00 | 22.60 | 8.40 | 0.00 | 0.30 | 8.70 | -45.00 | 31.00 | 0.00 | 1.20 | 5.80 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |
| H2244 | 23.040 | 31.738 | 80.873 | 511200.0 | 512000.0 | 15.5 | 0.40 | 98.50 | 1.10 | 0.00 | 20.00 | 11.30 | 0.00 | 0.60 | 8.70 | -47.30 | 31.30 | 87.90 | 1.30 | 5.40 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 1.60 | 0.10 |
| H2245 | 23.040 | 31.738 | 80.823 | 511200.0 | 516800.0 | 16.9 | 0.10 | 99.50 | 0.40 | 0.00 | 17.50 | 12.90 | 0.00 | 0.70 | 9.10 | -48.00 | 30.40 | 88.00 | 1.20 | 5.60 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 3.40 | 0.20 |
| H2246 | 23.040 | 31.738 | 80.772 | 511200.0 | 521600.0 | 17.9 | 0.00 | 99.80 | 0.10 | 0.00 | 15.10 | 12.30 | 0.00 | 0.80 | 10.00 | -46.10 | 27.40 | 88.00 | 1.10 | 5.70 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 6.80 | 0.50 |
| H2247 | 23.040 | 31.738 | 80.721 | 511200.0 | 526400.0 | 19.2 | 0.10 | 99.70 | 0.20 | 0.00 | 13.30 | 9.90 | 0.00 | 0.80 | 10.80 | -43.20 | 23.30 | 88.10 | 1.20 | 5.30 | 4.40 | 0.00 | 0.00 | 0.00 | 0.10 | 9.70 | 0.80 |
| H2248 | 23.040 | 31.737 | 80.671 | 511200.0 | 531200.0 | 19.9 | 0.10 | 99.80 | 0.10 | 0.00 | 12.40 | 6.70 | 0.00 | 0.70 | 10.70 | -39.70 | 19.10 | 88.40 | 1.20 | 4.70 | 4.70 | 0.00 | 0.00 | 0.00 | 0.10 | 10.90 | 0.90 |
| H2249 | 23.040 | 31.737 | 80.620 | 511200.0 | 536000.0 | 20.2 | 0.10 | 99.90 | 0.00 | 0.00 | 12.10 | 4.20 | 0.00 | 1.00 | 10.50 | -37.60 | 16.30 | 88.70 | 1.10 | 4.30 | 4.90 | 0.00 | 0.00 | 0.00 | 0.20 | 10.80 | 1.00 |
| H225 | 2.721 | 31.954 | 80.822 | 535200.0 | 516800.0 | 10.4 | 2.60 | 97.40 | 0.00 | 0.00 | 15.70 | 0.00 | 0.00 | 3.70 | 11.30 | -29.80 | 15.70 | 87.80 | 2.20 | 4.10 | 4.80 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 |
| H2250 | 23.040 | 31.737 | 80.569 | 511200.0 | 540800.0 | 20.7 | 0.00 | 100.00 | 0.00 | 0.00 | 12.40 | 2.40 | 0.00 | 0.80 | 9.70 | -36.30 | 14.80 | 88.90 | 1.10 | 4.10 | 5.00 | 0.00 | 0.00 | 0.00 | 0.40 | 10.20 | 1.00 |
| H2251 | 23.040 | 31.737 | 80.519 | 511200.0 | 545600.0 | 21.2 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 1.60 | 0.00 | 0.90 | 9.00 | -36.40 | 14.30 | 89.00 | 1.10 | 4.00 | 4.90 | 0.00 | 0.00 | 0.00 | 0.60 | 9.00 | 1.00 |
| H2252 | 23.040 | 31.737 | 80.468 | 511200.0 | 550400.0 | 23.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 1.00 | 0.00 | 0.50 | 7.80 | -38.40 | 14.20 | 89.10 | 1.30 | 3.90 | 4.60 | 0.00 | 0.00 | 0.00 | 1.00 | 6.00 | 1.00 |
| H2253 | 23.040 | 31.737 | 80.417 | 511200.0 | 555200.0 | 26.9 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 1.40 | 0.00 | 0.40 | 8.80 | -41.80 | 14.50 | 89.40 | 1.30 | 3.90 | 4.40 | 0.00 | 0.00 | 0.00 | 1.50 | 4.40 | 1.00 |
| H2254 | 23.040 | 31.736 | 80.367 | 511200.0 | 560000.0 | 28.0 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 3.00 | 0.00 | 0.70 | 13.50 | -43.90 | 15.10 | 89.60 | 1.40 | 3.80 | 4.30 | 0.00 | 0.00 | 0.00 | 1.80 | 2.80 | 1.00 |
| H2255 | 23.040 | 31.736 | 80.316 | 511200.0 | 564800.0 | 28.9 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 4.20 | 0.00 | 0.50 | 16.00 | -45.00 | 15.50 | 89.30 | 1.20 | 3.90 | 4.60 | 0.00 | 0.00 | 0.00 | 2.00 | 2.10 | 1.00 |
| H2256 | 23.040 | 31.736 | 80.265 | 511200.0 | 569600.0 | 29.9 | 0.00 | 99.90 | 0.00 | 0.00 | 10.70 | 6.20 | 0.00 | 1.70 | 16.60 | -48.50 | 16.90 | 89.20 | 1.20 | 3.90 | 4.60 | 0.00 | 0.00 | 0.00 | 2.00 | 2.10 | 1.00 |
| H2257 | 23.040 | 31.735 | 80.215 | 511200.0 | 574400.0 | 32.0 | 0.10 | 99.80 | 0.00 | 0.00 | 10.30 | 7.70 | 0.00 | 3.70 | 13.90 | -53.70 | 18.00 | 89.60 | 1.40 | 4.00 | 3.90 | 0.00 | 0.00 | 0.00 | 1.90 | 2.40 | 1.20 |
| H2258 | 23.040 | 31.735 | 80.164 | 511200.0 | 579200.0 | 36.3 | 0.20 | 99.60 | 0.00 | 0.00 | 10.20 | 8.50 | 0.00 | 6.40 | 12.80 | -61.50 | 18.70 | 90.00 | 1.50 | 4.10 | 3.20 | 0.00 | 0.10 | 0.10 | 1.80 | 3.30 | 1.90 |
| H2259 | 23.040 | 31.735 | 80.113 | 511200.0 | 584000.0 | 39.2 | 0.20 | 99.60 | 0.00 | 0.00 | 10.70 | 8.70 | 0.00 | 10.20 | 11.60 | -68.80 | 19.40 | 90.60 | 1.10 | 4.20 | 2.60 | 0.00 | 0.40 | 0.40 | 1.60 | 5.00 | 3.20 |
| H226 | 21.381 | 31.954 | 80.771 | 535200.0 | 521600.0 | 10.4 | 19.90 | 79.50 | 0.60 | 0.00 | 13.70 | 0.00 | 0.00 | 4.50 | 10.50 | -28.60 | 13.70 | 88.70 | 2.10 | 4.00 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 5.60 | 0.30 |
| H2260 | 23.040 | 31.734 | 80.063 | 511200.0 | 588800.0 | 40.3 | 0.10 | 99.80 | 0.00 | 0.00 | 11.60 | 8.90 | 0.00 | 14.10 | 10.60 | -74.90 | 20.50 | 91.40 | 0.50 | 4.10 | 2.20 | 0.00 | 0.60 | 0.60 | 1.40 | 6.80 | 4.60 |
| H2261 | 23.040 | 31.734 | 80.012 | 511200.0 | 593600.0 | 41.7 | 0.00 | 99.90 | 0.00 | 0.00 | 12.90 | 9.20 | 0.00 | 18.20 | 10.10 | -82.00 | 22.10 | 91.40 | 0.30 | 4.10 | 2.30 | 0.00 | 0.70 | 0.70 | 1.30 | 8.10 | 5.40 |
| H2262 | 23.040 | 31.734 | 79.961 | 511200.0 | 598400.0 | 43.7 | 0.00 | 99.70 | 0.10 | 0.00 | 14.70 | 10.10 | 0.00 | 23.10 | 9.20 | -91.70 | 24.80 | 90.50 | 0.50 | 4.20 | 2.80 | 0.00 | 0.80 | 0.80 | 1.20 | 8.80 | 5.80 |
| H227 | 23.040 | 31.954 | 80.721 | 535200.0 | 526400.0 | 16.4 | 1.80 | 97.50 | 0.70 | 0.00 | 8.60 | 0.00 | 0.00 | 2.80 | 4.00 | -27.00 | 8.70 | 0.00 | 3.30 | 3.30 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 10.80 | 0.90 |
| H2279 | 23.040 | 31.694 | 81.329 | 506400.0 | 468800.0 | 1.5 | 0.30 | 94.20 | 2.40 | 2.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 88.20 | 0.20 | 6.30 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 |
| H228 | 23.040 | 31.954 | 80.670 | 535200.0 | 531200.0 | 17.9 | 0.80 | 98.70 | 0.40 | 0.00 | 8.80 | 0.20 | 0.00 | 1.80 | 3.60 | -28.80 | 9.10 | 88.70 | 3.10 | 3.70 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 11.70 | 1.00 |
| H2285 | 22.784 | 31.695 | 81.025 | 506400.0 | 497600.0 | 7.4 | 0.10 | 93.50 | 6.40 | 0.00 | 25.90 | 3.70 | 0.00 | 0.20 | 9.70 | -37.10 | 29.60 | 88.70 | 0.50 | 6.00 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| H2286 | 23.040 | 31.695 | 80.975 | 506400.0 | 502400.0 | 13.2 | 0.10 | 97.70 | 2.20 | 0.00 | 20.20 | 13.90 | 0.00 | 0.20 | 5.90 | -47.40 | 34.10 | 88.60 | 0.80 | 5.40 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| H2287 | 23.040 | 31.695 | 80.924 | 506400.0 | 507200.0 | 14.8 | 0.10 | 98.50 | 1.30 | 0.00 | 18.60 | 17.10 | 0.00 | 0.60 | 6.30 | -51.20 | 35.70 | 88.40 | 1.00 | 5.30 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2288 | 23.040 | 31.695 | 80.873 | 506400.0 | 512000.0 | 16.5 | 0.10 | 99.20 | 0.70 | 0.00 | 16.90 | 19.50 | 0.00 | 1.00 | 7.30 | -53.90 | 36.40 | 88.30 | 1.00 | 5.50 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 1.50 | 0.00 |
| H2289 | 23.040 | 31.694 | 80.823 | 506400.0 | 516800.0 | 18.0 | 0.00 | 99.80 | 0.20 | 0.00 | 15.10 | 19.50 | 0.00 | 1.00 | 9.20 | -53.80 | 34.70 | 88.10 | 1.00 | 5.80 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 3.10 | 0.20 |
| H229 | 23.040 | 31.954 | 80.619 | 535200.0 | 536000.0 | 18.3 | 0.80 | 98.60 | 0.60 | 0.00 | 8.80 | 0.40 | 0.00 | 1.80 | 4.10 | -29.20 | 9.10 | 87.10 | 1.60 | 5.00 | 5.30 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2290 | 23.040 | 31.694 | 80.772 | 506400.0 | 521600.0 | 19.2 | 0.00 | 99.80 | 0.20 | 0.00 | 13.50 | 18.30 | 0.00 | 1.00 | 11.10 | -52.10 | 31.80 | 88.20 | 1.00 | 5.50 | 4.20 | 0.00 | 0.00 | 0.00 | 0.10 | 6.20 | 0.50 |
| H2291 | 23.040 | 31.694 | 80.721 | 506400.0 | 526400.0 | 20.1 | 0.00 | 99.80 | 0.20 | 0.00 | 12.10 | 15.70 | 0.00 | 1.20 | 12.50 | -49.10 | 27.80 | 88.50 | 1.10 | 4.90 | 4.50 | 0.00 | 0.00 | 0.00 | 0.20 | 9.10 | 0.80 |
| H2292 | 23.040 | 31.694 | 80.671 | 506400.0 | 531200.0 | 20.7 | 0.00 | 99.90 | 0.10 | 0.00 | 11.60 | 11.60 | 0.00 | 1.30 | 12.80 | -45.20 | 23.20 | 88.60 | 1.20 | 4.50 | 4.70 | 0.00 | 0.00 | 0.00 | 0.30 | 10.10 | 0.90 |
| H2293 | 23.040 | 31.694 | 80.620 | 506400.0 | 536000.0 | 21.3 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 7.70 | 0.00 | 1.30 | 11.80 | -42.00 | 19.40 | 88.80 | 1.20 | 4.10 | 4.90 | 0.00 | 0.00 | 0.00 | 0.50 | 9.90 | 1.00 |
| H2294 | 23.040 | 31.694 | 80.569 | 506400.0 | 540800.0 | 21.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 4.60 | 0.00 | 1.40 | 10.20 | -39.90 | 16.60 | 88.80 | 1.20 | 4.00 | 4.90 | 0.00 | 0.00 | 0.00 | 0.70 | 8.90 | 1.00 |
| H2295 | 23.040 | 31.694 | 80.519 | 506400.0 | 545600.0 | 22.7 | 0.00 | 100.00 | 0.00 | 0.00 | 12.30 | 2.90 | 0.00 | 1.30 | 9.00 | -39.20 | 15.20 | 88.70 | 1.50 | 3.90 | 4.80 | 0.00 | 0.00 | 0.00 | 1.00 | 7.20 | 1.00 |
| H2296 | 23.040 | 31.694 | 80.468 | 506400.0 | 550400.0 | 25.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 2.30 | 0.00 | 0.90 | 8.60 | -41.20 | 14.80 | 88.70 | 1.70 | 3.80 | 4.70 | 0.00 | 0.00 | 0.00 | 1.40 | 5.10 | 1.00 |
| H2297 | 23.040 | 31.693 | 80.418 | 506400.0 | 555200.0 | 28.3 | 0.00 | 100.00 | 0.00 | 0.00 | 12.40 | 2.40 | 0.00 | 0.70 | 8.20 | -43.70 | 14.80 | 89.00 | 1.60 | 3.90 | 4.50 | 0.00 | 0.00 | 0.00 | 1.80 | 3.40 | 1.00 |
| H2298 | 23.040 | 31.693 | 80.367 | 506400.0 | 560000.0 | 29.4 | 0.00 | 100.00 | 0.00 | 0.00 | 12.30 | 2.00 | 0.00 | 0.40 | 5.50 | -44.10 | 14.30 | 89.10 | 1.30 | 3.90 | 4.60 | 0.00 | 0.00 | 0.00 | 1.90 | 2.40 | 1.00 |
| H2299 | 23.040 | 31.693 | 80.316 | 506400.0 | 564800.0 | 30.2 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 3.50 | 0.00 | 0.60 | 6.30 | -46.00 | 15.10 | 89.10 | 1.10 | 4.00 | 4.80 | 0.00 | 0.00 | 0.00 | 2.00 | 2.10 | 1.00 |
| H230 | 23.040 | 31.954 | 80.568 | 535200.0 | 540800.0 | 18.8 | 0.30 | 99.10 | 0.60 | 0.00 | 9.60 | 1.20 | 0.00 | 5.40 | 10.00 | -35.10 | 10.80 | 86.30 | 0.80 | 5.70 | 6.20 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2300 | 23.040 | 31.692 | 80.266 | 506400.0 | 569600.0 | 31.3 | 0.00 | 99.90 | 0.00 | 0.00 | 9.80 | 8.50 | 0.00 | 1.20 | 7.10 | -50.90 | 18.30 | 89.20 | 1.30 | 4.00 | 4.40 | 0.00 | 0.00 | 0.00 | 2.00 | 2.20 | 1.10 |
| H2301 | 23.040 | 31.692 | 80.215 | 506400.0 | 574400.0 | 33.5 | 0.10 | 99.80 | 0.00 | 0.00 | 9.40 | 10.10 | 0.00 | 3.40 | 5.30 | -56.40 | 19.50 | 89.60 | 1.40 | 4.10 | 3.70 | 0.00 | 0.10 | 0.10 | 1.90 | 2.80 | 1.60 |
| H2302 | 23.040 | 31.692 | 80.164 | 506400.0 | 579200.0 | 36.7 | 0.10 | 99.80 | 0.00 | 0.00 | 10.20 | 9.70 | 0.00 | 8.50 | 5.80 | -65.20 | 19.90 | 90.10 | 1.10 | 4.10 | 3.10 | 0.00 | 0.30 | 0.30 | 1.70 | 4.40 | 2.80 |
| H2303 | 23.040 | 31.692 | 80.114 | 506400.0 | 584000.0 | 39.0 | 0.10 | 99.80 | 0.00 | 0.00 | 11.30 | 9.30 | 0.00 | 13.60 | 5.40 | -73.20 | 20.60 | 90.80 | 0.60 | 4.10 | 2.60 | 0.00 | 0.60 | 0.60 | 1.40 | 6.60 | 4.40 |
| H2304 | 23.040 | 31.691 | 80.063 | 506400.0 | 588800.0 | 40.3 | 0.00 | 99.90 | 0.00 | 0.00 | 12.80 | 9.10 | 0.00 | 18.50 | 5.10 | -80.80 | 22.00 | 91.30 | 0.20 | 4.00 | 2.40 | 0.00 | 0.80 | 0.80 | 1.20 | 8.30 | 5.70 |
| H2305 | 23.040 | 31.691 | 80.012 | 506400.0 | 593600.0 | 42.0 | 0.00 | 99.90 | 0.00 | 0.00 | 14.80 | 9.70 | 0.00 | 23.50 | 5.70 | -90.00 | 24.50 | 90.50 | 0.40 | 4.10 | 2.80 | 0.00 | 0.90 | 0.90 | 1.10 | 9.00 | 6.30 |
| H2306 | 23.040 | 31.690 | 79.962 | 506400.0 | 598400.0 | 43.8 | 0.00 | 99.70 | 0.10 | 0.00 | 17.20 | 10.90 | 0.00 | 27.60 | 6.60 | -99.40 | 28.10 | 89.40 | 0.60 | 4.30 | 3.50 | 0.00 | 0.90 | 0.90 | 1.10 | 9.30 | 6.40 |
| H231 | 23.040 | 31.954 | 80.517 | 535200.0 | 545600.0 | 19.6 | 0.00 | 99.60 | 0.30 | 0.00 | 9.30 | 3.20 | 0.00 | 11.80 | 16.30 | -43.90 | 12.50 | 87.50 | 0.90 | 5.30 | 5.40 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H232 | 23.040 | 31.953 | 80.467 | 535200.0 | 550400.0 | 20.1 | 0.00 | 99.90 | 0.10 | 0.00 | 9.30 | 3.20 | 0.00 | 15.50 | 18.30 | -40.20 | 12.50 | 88.70 | 0.90 | 4.80 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2328 | 6.303 | 31.651 | 81.076 | 501600.0 | 492800.0 | 13.8 | 0.00 | 98.90 | 1.10 | 0.00 | 16.10 | 22.00 | 0.00 | 0.40 | 3.20 | -52.30 | 30.10 | 90.10 | 0.50 | 4.50 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H233 | 23.040 | 31.953 | 80.416 | 535200.0 | 555200.0 | 21.0 | 0.00 | 99.90 | 0.10 | 0.00 | 11.40 | 1.70 | 0.00 | 14.80 | 18.00 | -48.80 | 13.00 | 90.10 | 0.60 | 4.40 | 4.10 | 0.00 | 0.00 | 0.00 | 0.10 | 11.60 | 1.00 |
| H2331 | 23.040 | 31.651 | 80.924 | 501600.0 | 507200.0 | 15.7 | 0.00 | 99.20 | 0.80 | 0.00 | 16.00 | 24.70 | 0.00 | 1.30 | 4.70 | -57.70 | 40.80 | 89.30 | 0.70 | 4.80 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| H2332 | 23.040 | 31.651 | 80.873 | 501600.0 | 512000.0 | 17.6 | 0.00 | 99.50 | 0.50 | 0.00 | 14.70 | 25.50 | 0.00 | 1.40 | 6.80 | -59.30 | 40.20 | 88.70 | 0.80 | 5.20 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 1.40 | 0.00 |
| H2333 | 23.040 | 31.651 | 80.823 | 501600.0 | 516800.0 | 19.2 | 0.00 | 99.70 | 0.30 | 0.00 | 12.60 | 24.30 | 0.00 | 1.30 | 10.60 | -57.30 | 36.90 | 88.50 | 0.80 | 5.40 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 | 0.20 |
| H2334 | 23.040 | 31.651 | 80.772 | 501600.0 | 521600.0 | 19.8 | 0.00 | 99.90 | 0.10 | 0.00 | 11.40 | 22.60 | 0.00 | 1.30 | 13.00 | -55.10 | 33.90 | 88.60 | 0.80 | 5.20 | 4.40 | 0.00 | 0.00 | 0.00 | 0.10 | 5.90 | 0.50 |
| H2335 | 23.040 | 31.651 | 80.722 | 501600.0 | 526400.0 | 20.5 | 0.00 | 99.80 | 0.10 | 0.00 | 10.90 | 19.30 | 0.00 | 1.70 | 14.60 | -52.30 | 30.20 | 88.80 | 0.90 | 4.70 | 4.60 | 0.00 | 0.00 | 0.00 | 0.30 | 8.60 | 0.80 |
| H2336 | 23.040 | 31.651 | 80.671 | 501600.0 | 531200.0 | 21.5 | 0.00 | 99.90 | 0.10 | 0.00 | 10.70 | 15.60 | 0.00 | 1.90 | 15.30 | -49.70 | 26.30 | 88.80 | 1.10 | 4.30 | 4.70 | 0.00 | 0.00 | 0.00 | 0.50 | 9.40 | 0.90 |
| H2337 | 23.040 | 31.651 | 80.620 | 501600.0 | 536000.0 | 22.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.80 | 11.20 | 0.00 | 2.20 | 14.30 | -46.80 | 22.00 | 88.70 | 1.40 | 4.00 | 4.80 | 0.00 | 0.00 | 0.00 | 0.80 | 9.00 | 1.00 |
| H2338 | 23.040 | 31.651 | 80.570 | 501600.0 | 540800.0 | 23.8 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 7.20 | 0.00 | 2.60 | 12.00 | -44.80 | 18.40 | 88.40 | 1.90 | 3.80 | 4.90 | 0.00 | 0.00 | 0.00 | 1.00 | 7.80 | 1.00 |
| H2339 | 23.040 | 31.650 | 80.519 | 501600.0 | 545600.0 | 25.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 4.50 | 0.00 | 2.90 | 9.60 | -44.60 | 16.10 | 88.10 | 2.40 | 3.60 | 4.80 | 0.00 | 0.00 | 0.00 | 1.30 | 6.30 | 1.00 |
| H234 | 23.040 | 31.953 | 80.365 | 535200.0 | 560000.0 | 22.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.90 | 1.60 | 0.00 | 13.80 | 19.60 | -50.00 | 14.50 | 91.40 | 0.30 | 4.10 | 3.50 | 0.00 | 0.00 | 0.00 | 0.20 | 10.90 | 1.00 |
| H2340 | 23.040 | 31.650 | 80.468 | 501600.0 | 550400.0 | 28.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 3.20 | 0.00 | 2.90 | 7.50 | -46.00 | 15.10 | 88.20 | 2.40 | 3.60 | 4.70 | 0.00 | 0.00 | 0.00 | 1.60 | 4.70 | 1.10 |
| H2341 | 23.040 | 31.650 | 80.418 | 501600.0 | 555200.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 3.20 | 0.00 | 2.10 | 6.10 | -47.10 | 15.10 | 88.60 | 2.00 | 3.80 | 4.50 | 0.00 | 0.00 | 0.00 | 1.80 | 3.30 | 1.10 |
| H2342 | 23.040 | 31.650 | 80.367 | 501600.0 | 560000.0 | 30.9 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 3.70 | 0.00 | 1.60 | 3.80 | -47.90 | 15.40 | 88.90 | 1.50 | 4.10 | 4.40 | 0.00 | 0.00 | 0.00 | 1.90 | 2.60 | 1.10 |
| H2343 | 23.040 | 31.649 | 80.317 | 501600.0 | 564800.0 | 31.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 7.50 | 0.00 | 1.40 | 4.50 | -50.90 | 17.70 | 89.00 | 1.40 | 4.20 | 4.30 | 0.00 | 0.00 | 0.00 | 1.90 | 2.40 | 1.20 |
| H2344 | 23.040 | 31.649 | 80.266 | 501600.0 | 569600.0 | 33.1 | 0.00 | 99.90 | 0.00 | 0.00 | 8.60 | 11.70 | 0.00 | 1.20 | 2.30 | -54.50 | 20.20 | 89.20 | 1.50 | 4.30 | 3.90 | 0.00 | 0.10 | 0.10 | 1.90 | 2.80 | 1.50 |
| H2345 | 23.040 | 31.649 | 80.215 | 501600.0 | 574400.0 | 35.3 | 0.00 | 99.90 | 0.00 | 0.00 | 9.10 | 11.20 | 0.00 | 5.50 | 2.70 | -61.20 | 20.30 | 89.50 | 1.40 | 4.30 | 3.40 | 0.00 | 0.20 | 0.30 | 1.70 | 4.10 | 2.50 |
| H2346 | 23.040 | 31.649 | 80.165 | 501600.0 | 579200.0 | 37.7 | 0.10 | 99.90 | 0.00 | 0.00 | 10.40 | 10.20 | 0.00 | 12.80 | 2.10 | -71.20 | 20.60 | 89.90 | 1.10 | 4.20 | 3.10 | 0.00 | 0.50 | 0.50 | 1.50 | 6.20 | 4.20 |
| H2347 | 23.040 | 31.648 | 80.114 | 501600.0 | 584000.0 | 39.5 | 0.00 | 99.90 | 0.00 | 0.00 | 12.00 | 9.30 | 0.00 | 18.10 | 1.90 | -78.90 | 21.30 | 89.90 | 0.70 | 4.10 | 3.10 | 0.00 | 0.80 | 0.80 | 1.20 | 8.40 | 5.80 |
| H2348 | 23.040 | 31.648 | 80.063 | 501600.0 | 588800.0 | 40.6 | 0.00 | 99.90 | 0.00 | 0.00 | 14.50 | 8.50 | 0.00 | 24.00 | 2.50 | -87.70 | 23.10 | 89.50 | 0.50 | 4.10 | 3.30 | 0.00 | 0.90 | 0.90 | 1.10 | 9.40 | 6.50 |
| H2349 | 23.040 | 31.647 | 80.013 | 501600.0 | 593600.0 | 42.5 | 0.00 | 99.80 | 0.10 | 0.00 | 17.00 | 9.40 | 0.00 | 28.80 | 3.50 | -97.70 | 26.40 | 88.80 | 0.60 | 4.10 | 3.70 | 0.00 | 0.90 | 0.90 | 1.00 | 9.60 | 6.70 |
| H235 | 23.040 | 31.953 | 80.314 | 535200.0 | 564800.0 | 24.2 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 2.20 | 0.00 | 14.40 | 23.40 | -53.30 | 14.60 | 92.00 | 0.50 | 3.90 | 3.00 | 0.00 | 0.00 | 0.00 | 0.50 | 9.50 | 1.00 |
| H2350 | 23.040 | 31.647 | 79.962 | 501600.0 | 598400.0 | 44.4 | 0.00 | 99.50 | 0.40 | 0.10 | 19.50 | 12.10 | 0.00 | 31.90 | 5.60 | -107.90 | 31.60 | 88.30 | 0.60 | 4.30 | 4.20 | 0.00 | 0.90 | 0.90 | 1.00 | 9.60 | 6.60 |
| H236 | 23.040 | 31.952 | 80.264 | 535200.0 | 569600.0 | 25.9 | 0.00 | 99.90 | 0.00 | 0.00 | 11.50 | 3.30 | 0.00 | 14.90 | 27.80 | -55.60 | 14.80 | 91.90 | 1.40 | 3.30 | 2.70 | 0.00 | 0.00 | 0.00 | 0.90 | 7.70 | 1.00 |
| H237 | 23.040 | 31.952 | 80.213 | 535200.0 | 574400.0 | 27.5 | 0.00 | 99.90 | 0.00 | 0.00 | 10.30 | 4.90 | 0.00 | 14.90 | 32.00 | -57.60 | 15.20 | 91.60 | 2.20 | 2.90 | 2.40 | 0.00 | 0.00 | 0.00 | 1.20 | 6.20 | 1.10 |
| H2372 | 7.838 | 31.608 | 81.076 | 496800.0 | 492800.0 | 7.7 | 0.10 | 95.90 | 3.80 | 0.20 | 20.70 | 13.30 | 0.00 | 0.30 | 6.40 | -42.00 | 34.00 | 91.20 | 0.50 | 5.40 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2373 | 23.040 | 31.608 | 81.025 | 496800.0 | 497600.0 | 12.5 | 0.00 | 99.10 | 0.80 | 0.00 | 15.10 | 23.70 | 0.00 | 0.60 | 3.00 | -51.90 | 38.00 | 0.00 | 0.20 | 3.60 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 1.20 | 0.00 |
| H2374 | 23.040 | 31.608 | 80.975 | 496800.0 | 502400.0 | 14.2 | 0.00 | 99.40 | 0.50 | 0.00 | 15.40 | 25.60 | 0.00 | 1.20 | 4.30 | -56.40 | 41.00 | 90.90 | 0.30 | 3.70 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |
| H2375 | 23.040 | 31.608 | 80.924 | 496800.0 | 507200.0 | 15.9 | 0.00 | 99.60 | 0.40 | 0.00 | 14.90 | 20.30 | 0.00 | 1.80 | 5.10 | -60.90 | 43.20 | 90.10 | 0.50 | 4.30 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 | 0.00 |
| H2376 | 23.040 | 31.608 | 80.873 | 496800.0 | 512000.0 | 17.6 | 0.00 | 99.70 | 0.30 | 0.00 | 12.70 | 27.20 | 0.00 | 1.50 | 9.10 | -59.10 | 40.00 | 89.40 | 0.60 | 4.80 | 4.10 | 0.00 | 0.00 | 0.00 | 0.10 | 1.60 | 0.10 |
| H2377 | 23.040 | 31.608 | 80.823 | 496800.0 | 516800.0 | 19.2 | 0.00 | 99.80 | 0.20 | 0.00 | 10.30 | 26.10 | 0.00 | 1.20 | 13.30 | -57.00 | 36.50 | 89.00 | 0.50 | 5.00 | 4.50 | 0.00 | 0.00 | 0.00 | 0.10 | 3.00 | 0.20 |
| H2378 | 23.040 | 31.608 | 80.772 | 496800.0 | 521600.0 | 20.2 | 0.00 | 99.90 | 0.10 | 0.00 | 10.00 | 23.80 | 0.00 | 1.60 | 15.00 | -55.60 | 33.80 | 89.00 | 0.40 | 4.90 | 4.60 | 0.00 | 0.00 | 0.00 | 0.30 | 6.00 | 0.50 |
| H2379 | 23.040 | 31.608 | 80.722 | 496800.0 | 526400.0 | 20.8 | 0.00 | 99.90 | 0.00 | 0.00 | 9.80 | 20.30 | 0.00 | 2.20 | 16.80 | -53.10 | 30.10 | 89.00 | 0.80 | 4.60 | 4.60 | 0.00 | 0.00 | 0.00 | 0.60 | 8.40 | 0.80 |
| H238 | 23.040 | 31.952 | 80.162 | 535200.0 | 579200.0 | 29.0 | 0.10 | 99.80 | 0.00 | 0.00 | 8.90 | 6.50 | 0.00 | 14.60 | 34.80 | -59.10 | 15.40 | 91.20 | 2.40 | 3.10 | 2.50 | 0.00 | 0.00 | 0.00 | 1.60 | 5.60 | 1.40 |
| H2380 | 23.040 | 31.608 | 80.671 | 496800.0 | 531200.0 | 22.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 17.30 | 0.00 | 2.40 | 17.50 | -51.80 | 27.20 | 88.00 | 1.30 | 4.20 | 4.60 | 0.00 | 0.00 | 0.00 | 0.80 | 9.10 | 0.90 |
| H2381 | 23.040 | 31.607 | 80.620 | 496800.0 | 536000.0 | 23.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 13.40 | 0.00 | 3.00 | 16.70 | -50.30 | 23.40 | 88.50 | 1.90 | 3.90 | 4.70 | 0.00 | 0.00 | 0.00 | 1.00 | 8.70 | 1.00 |
| H2382 | 23.040 | 31.607 | 80.570 | 496800.0 | 540800.0 | 25.5 | 0.00 | 100.00 | 0.00 | 0.00 | 10.30 | 9.50 | 0.00 | 4.30 | 14.80 | -49.60 | 19.80 | 87.80 | 2.90 | 3.50 | 4.80 | 0.00 | 0.00 | 0.00 | 1.10 | 7.80 | 1.00 |
| H2383 | 23.040 | 31.607 | 80.519 | 496800.0 | 545600.0 | 27.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 6.10 | 0.00 | 5.70 | 12.00 | -49.50 | 16.70 | 87.50 | 3.30 | 3.30 | 4.80 | 0.00 | 0.00 | 0.00 | 1.30 | 6.70 | 1.00 |
| H2384 | 23.040 | 31.607 | 80.469 | 496800.0 | 550400.0 | 28.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 4.00 | 0.00 | 6.50 | 9.50 | -50.40 | 15.20 | 87.90 | 2.90 | 3.50 | 4.70 | 0.00 | 0.00 | 0.00 | 1.50 | 5.30 | 1.10 |
| H2385 | 23.040 | 31.607 | 80.418 | 496800.0 | 555200.0 | 30.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.40 | 4.10 | 0.00 | 5.30 | 5.70 | -50.90 | 15.60 | 88.40 | 2.30 | 3.90 | 4.40 | 0.00 | 0.00 | 0.00 | 1.70 | 4.10 | 1.20 |
| H2386 | 23.040 | 31.606 | 80.367 | 496800.0 | 560000.0 | 31.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.90 | 5.70 | 0.00 | 4.70 | 3.70 | -53.00 | 16.70 | 88.80 | 1.80 | 4.30 | 4.00 | 0.00 | 0.10 | 0.00 | 1.80 | 3.40 | 1.30 |
| H2387 | 23.040 | 31.606 | 80.317 | 496800.0 | 564800.0 | 33.2 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 8.90 | 0.00 | 4.10 | 3.70 | -56.00 | 18.60 | 89.00 | 1.80 | 4.60 | 3.60 | 0.00 | 0.10 | 0.10 | 1.80 | 3.40 | 1.60 |
| H2388 | 23.040 | 31.606 | 80.266 | 496800.0 | 569600.0 | 34.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.30 | 10.80 | 0.00 | 5.00 | 2.10 | -60.70 | 20.00 | 89.00 | 1.70 | 4.50 | 3.50 | 0.00 | 0.20 | 0.20 | 1.70 | 4.10 | 2.30 |
| H2389 | 23.040 | 31.606 | 80.216 | 496800.0 | 574400.0 | 36.7 | 0.00 | 99.90 | 0.00 | 0.00 | 9.80 | 10.70 | 0.00 | 11.90 | 1.60 | -69.10 | 20.50 | 89.10 | 1.50 | 4.40 | 3.50 | 0.00 | 0.50 | 0.50 | 1.50 | 6.00 | 3.90 |
| H239 | 23.040 | 31.951 | 80.111 | 535200.0 | 584000.0 | 38.1 | 0.30 | 99.40 | 0.00 | 0.00 | 8.00 | 7.50 | 0.00 | 15.40 | 34.60 | -61.90 | 16.30 | 90.40 | 2.60 | 3.80 | 2.50 | 0.00 | 0.00 | 0.00 | 1.80 | 6.30 | 1.90 |
| H2390 | 23.040 | 31.605 | 80.165 | 496800.0 | 579200.0 | 38.5 | 0.00 | 99.90 | 0.00 | 0.00 | 10.60 | 10.30 | 0.00 | 16.50 | 0.70 | -76.00 | 20.90 | 89.10 | 1.10 | 4.20 | 3.50 | 0.00 | 0.80 | 0.80 | 1.20 | 8.10 | 5.60 |
| H2391 | 23.040 | 31.605 | 80.115 | 496800.0 | 584000.0 | 39.5 | 0.00 | 99.90 | 0.00 | 0.00 | 13.70 | 7.80 | 0.00 | 23.40 | 0.90 | -84.50 | 21.50 | 88.50 | 0.90 | 4.10 | 3.80 | 0.00 | 0.90 | 0.90 | 1.10 | 9.40 | 6.50 |
| H2392 | 23.040 | 31.605 | 80.064 | 496800.0 | 588800.0 | 40.7 | 0.00 | 99.90 | 0.00 | 0.00 | 17.00 | 6.40 | 0.00 | 30.50 | 1.30 | -94.70 | 23.40 | 87.40 | 0.80 | 4.00 | 4.40 | 0.00 | 1.00 | 1.00 | 1.00 | 9.80 | 6.90 |
| H2393 | 23.040 | 31.604 | 80.013 | 496800.0 | 593600.0 | 43.1 | 0.00 | 99.80 | 0.10 | 0.00 | 18.90 | 9.60 | 0.00 | 33.50 | 3.00 | -105.20 | 28.60 | 87.30 | 0.80 | 4.10 | 4.50 | 0.00 | 1.00 | 1.00 | 1.00 | 9.90 | 6.90 |
| H2394 | 23.040 | 31.604 | 79.963 | 496800.0 | 598400.0 | 45.4 | 0.00 | 99.40 | 0.40 | 0.10 | 21.30 | 14.40 | 0.00 | 35.00 | 6.20 | -116.10 | 35.70 | 87.90 | 0.60 | 4.20 | 4.40 | 0.00 | 1.00 | 1.00 | 1.00 | 9.70 | 6.70 |
| H240 | 23.040 | 31.951 | 80.060 | 535200.0 | 588800.0 | 31.5 | 0.40 | 99.10 | 0.00 | 0.00 | 9.00 | 8.00 | 0.00 | 16.60 | 33.30 | -65.10 | 17.00 | 89.70 | 2.90 | 4.30 | 2.50 | 0.00 | 0.00 | 0.00 | 1.90 | 7.90 | 2.50 |
| H241 | 23.040 | 31.951 | 80.010 | 535200.0 | 593600.0 | 33.7 | 0.50 | 99.00 | 0.00 | 0.00 | 9.00 | 8.10 | 0.00 | 17.20 | 32.70 | -68.10 | 17.10 | 89.30 | 3.00 | 4.50 | 2.60 | 0.00 | 0.00 | 0.00 | 2.00 | 9.30 | 2.80 |
| H2415 | 0.844 | 31.565 | 81.126 | 492000.0 | 488000.0 | 6.7 | 0.30 | 96.50 | 2.30 | 0.80 | 10.10 | 10.50 | 0.00 | 0.90 | 5.50 | -44.20 | 36.60 | 88.90 | 0.60 | 5.50 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 | 0.30 |
| H2416 | 20.973 | 31.565 | 81.076 | 492000.0 | 492800.0 | 8.5 | 0.10 | 97.70 | 1.80 | 0.30 | 17.90 | 18.60 | 0.00 | 0.60 | 5.10 | -45.60 | 36.50 | 91.70 | 0.60 | 5.10 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 1.50 | 0.10 |
| H2417 | 23.040 | 31.565 | 81.025 | 492000.0 | 497600.0 | 13.2 | 0.00 | 99.70 | 0.20 | 0.00 | 14.70 | 25.60 | 0.00 | 1.40 | 4.80 | -55.00 | 40.40 | 0.00 | 0.10 | 3.20 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 | 0.20 |
| H2418 | 23.040 | 31.565 | 80.975 | 492000.0 | 502400.0 | 15.2 | 0.00 | 99.60 | 0.30 | 0.00 | 14.30 | 27.30 | 0.00 | 1.60 | 5.80 | -58.40 | 41.60 | 91.30 | 0.20 | 3.50 | 3.30 | 0.00 | 0.00 | 0.00 | 0.10 | 1.60 | 0.10 |
| H2419 | 23.040 | 31.565 | 80.924 | 492000.0 | 507200.0 | 17.0 | 0.00 | 99.70 | 0.30 | 0.00 | 13.20 | 27.70 | 0.00 | 1.70 | 8.20 | -59.50 | 40.00 | 90.40 | 0.40 | 4.10 | 3.70 | 0.00 | 0.00 | 0.00 | 0.10 | 1.70 | 0.10 |
| H242 | 23.040 | 31.950 | 79.959 | 535200.0 | 598400.0 | 36.4 | 0.40 | 99.20 | 0.00 | 0.00 | 9.00 | 8.10 | 0.00 | 16.90 | 33.10 | -70.30 | 17.10 | 88.50 | 2.90 | 4.80 | 3.00 | 0.00 | 0.00 | 0.00 | 2.00 | 9.80 | 3.00 |
| H2420 | 23.040 | 31.565 | 80.874 | 492000.0 | 512000.0 | 18.2 | 0.00 | 99.80 | 0.20 | 0.00 | 10.40 | 26.80 | 0.00 | 1.30 | 13.00 | -56.80 | 37.20 | 89.70 | 0.30 | 4.60 | 4.20 | 0.00 | 0.00 | 0.00 | 0.20 | 2.70 | 0.20 |
| H2421 | 23.040 | 31.565 | 80.823 | 492000.0 | 516800.0 | 19.3 | 0.00 | 99.90 | 0.00 | 0.00 | 9.40 | 25.70 | 0.00 | 1.30 | 15.20 | -55.80 | 35.20 | 89.20 | 0.20 | 4.90 | 4.70 | 0.00 | 0.00 | 0.00 | 0.40 | 4.60 | 0.40 |
| H2422 | 23.040 | 31.564 | 80.772 | 492000.0 | 521600.0 | 20.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.40 | 22.20 | 0.00 | 2.20 | 17.20 | -54.20 | 31.70 | 89.20 | 0.20 | 4.80 | 4.70 | 0.00 | 0.00 | 0.00 | 0.60 | 6.90 | 0.60 |
| H2423 | 23.040 | 31.564 | 80.722 | 492000.0 | 526400.0 | 21.8 | 0.00 | 100.00 | 0.00 | 0.00 | 9.20 | 19.40 | 0.00 | 2.70 | 19.00 | -53.10 | 28.60 | 89.30 | 0.80 | 4.50 | 4.50 | 0.00 | 0.00 | 0.00 | 0.80 | 8.90 | 0.90 |
| H2424 | 23.040 | 31.564 | 80.671 | 492000.0 | 531200.0 | 23.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.50 | 17.30 | 0.00 | 2.50 | 19.00 | -52.60 | 26.00 | 88.80 | 1.70 | 4.00 | 4.50 | 0.00 | 0.00 | 0.00 | 1.00 | 9.30 | 1.00 |
| H2425 | 23.040 | 31.564 | 80.621 | 492000.0 | 536000.0 | 24.8 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 13.70 | 0.00 | 3.40 | 18.50 | -51.80 | 23.50 | 88.00 | 2.80 | 3.50 | 4.70 | 0.00 | 0.00 | 0.00 | 1.00 | 9.10 | 1.00 |
| H2426 | 23.040 | 31.564 | 80.570 | 492000.0 | 540800.0 | 26.3 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 9.50 | 0.00 | 6.40 | 17.00 | -52.30 | 19.60 | 87.30 | 3.60 | 3.20 | 4.90 | 0.00 | 0.00 | 0.00 | 1.10 | 8.60 | 1.00 |
| H2427 | 23.040 | 31.564 | 80.520 | 492000.0 | 545600.0 | 27.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.30 | 5.70 | 0.00 | 9.80 | 14.50 | -53.60 | 16.00 | 87.30 | 3.60 | 3.20 | 4.80 | 0.00 | 0.00 | 0.00 | 1.20 | 7.90 | 1.00 |
| H2428 | 23.040 | 31.564 | 80.469 | 492000.0 | 550400.0 | 29.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 4.00 | 0.00 | 10.80 | 11.80 | -54.60 | 14.70 | 88.00 | 2.90 | 3.70 | 4.40 | 0.00 | 0.00 | 0.00 | 1.40 | 6.90 | 1.10 |
| H2429 | 23.040 | 31.563 | 80.418 | 492000.0 | 555200.0 | 30.7 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 3.90 | 0.00 | 10.60 | 8.20 | -56.00 | 14.70 | 88.60 | 2.30 | 4.20 | 3.90 | 0.00 | 0.10 | 0.00 | 1.50 | 5.90 | 1.30 |
| H2430 | 23.040 | 31.563 | 80.368 | 492000.0 | 560000.0 | 32.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 5.70 | 0.00 | 9.80 | 5.20 | -58.70 | 16.30 | 88.90 | 2.00 | 4.60 | 3.50 | 0.00 | 0.10 | 0.10 | 1.60 | 5.10 | 1.60 |
| H2431 | 23.040 | 31.563 | 80.317 | 492000.0 | 564800.0 | 34.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 8.00 | 0.00 | 9.60 | 4.30 | -62.40 | 18.20 | 89.00 | 1.90 | 4.90 | 3.20 | 0.00 | 0.20 | 0.20 | 1.60 | 5.00 | 2.20 |
| H2432 | 23.040 | 31.563 | 80.267 | 492000.0 | 569600.0 | 36.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 9.30 | 0.00 | 12.40 | 2.90 | -68.50 | 19.70 | 89.00 | 1.80 | 4.70 | 3.30 | 0.00 | 0.40 | 0.40 | 1.50 | 5.90 | 3.40 |
| H2433 | 23.040 | 31.562 | 80.216 | 492000.0 | 574400.0 | 37.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.90 | 9.80 | 0.00 | 16.70 | 1.20 | -75.20 | 20.70 | 88.70 | 1.50 | 4.30 | 3.60 | 0.00 | 0.70 | 0.70 | 1.30 | 7.80 | 5.10 |
| H2434 | 23.040 | 31.562 | 80.165 | 492000.0 | 579200.0 | 39.3 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 8.10 | 0.00 | 22.00 | 0.90 | -82.20 | 20.90 | 88.00 | 1.20 | 4.10 | 4.10 | 0.00 | 0.90 | 0.90 | 1.10 | 9.20 | 6.40 |
| H2435 | 23.040 | 31.562 | 80.115 | 492000.0 | 584000.0 | 40.0 | 0.00 | 100.00 | 0.00 | 0.00 | 17.40 | 3.50 | 0.00 | 32.30 | 0.70 | -93.20 | 20.90 | 87.00 | 1.00 | 4.00 | 4.50 | 0.00 | 1.00 | 1.00 | 1.00 | 9.80 | 6.90 |
| H2436 | 23.040 | 31.561 | 80.064 | 492000.0 | 588800.0 | 41.2 | 0.00 | 100.00 | 0.00 | 0.00 | 19.10 | 4.40 | 0.00 | 36.20 | 1.00 | -100.90 | 23.60 | 86.40 | 0.90 | 4.00 | 4.80 | 0.00 | 1.00 | 1.00 | 1.00 | 10.00 | 7.00 |
| H2437 | 23.040 | 31.561 | 80.014 | 492000.0 | 593600.0 | 43.7 | 0.00 | 99.80 | 0.20 | 0.00 | 20.10 | 12.50 | 0.00 | 37.30 | 3.20 | -113.70 | 32.60 | 87.00 | 0.80 | 4.10 | 4.70 | 0.00 | 1.00 | 1.00 | 1.00 | 9.90 | 6.90 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MM.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | N.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2438 | 23.040 | 31.560 | 79.963 | 492000.0 | 598400.0 | 46.2 | 0.00 | 99.20 | 0.60 | 0.20 | 22.50 | 18.50 | 0.00 | 37.80 | 7.30 | -125.10 | 41.00 | 88.00 | 0.50 | 4.20 | 4.50 | 0.00 | 0.90 | 0.90 | 1.00 | 9.70 | 6.60 |
| H2460 | 22.457 | 31.521 | 81.076 | 487200.0 | 492000.0 | 9.0 | 0.00 | 99.10 | 0.60 | 0.30 | 16.70 | 21.90 | 0.00 | 1.40 | 4.90 | -49.00 | 38.60 | 91.50 | 0.40 | 4.40 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 2.60 | 0.50 |
| H2461 | 23.040 | 31.521 | 81.025 | 487200.0 | 497600.0 | 14.1 | 0.00 | 99.50 | 0.30 | 0.10 | 13.90 | 28.30 | 0.10 | 2.50 | 6.50 | -58.90 | 42.30 | 91.60 | 0.30 | 3.30 | 3.10 | 0.00 | 0.00 | 0.00 | 0.20 | 3.20 | 0.50 |
| H2462 | 23.040 | 31.521 | 80.975 | 487200.0 | 502400.0 | 16.2 | 0.00 | 99.50 | 0.40 | 0.10 | 13.40 | 27.70 | 0.10 | 2.20 | 8.00 | -59.60 | 41.20 | 91.00 | 0.50 | 3.70 | 3.40 | 0.00 | 0.00 | 0.00 | 0.30 | 3.00 | 0.40 |
| H2463 | 23.040 | 31.521 | 80.924 | 487200.0 | 507200.0 | 18.2 | 0.00 | 99.80 | 0.20 | 0.00 | 11.90 | 27.10 | 0.10 | 1.90 | 10.80 | -59.30 | 39.10 | 90.30 | 0.40 | 4.20 | 3.90 | 0.00 | 0.00 | 0.00 | 0.50 | 3.30 | 0.30 |
| H2464 | 23.040 | 31.521 | 80.874 | 487200.0 | 512000.0 | 19.2 | 0.00 | 99.90 | 0.10 | 0.00 | 10.10 | 26.20 | 0.10 | 1.70 | 13.90 | -57.30 | 36.50 | 89.70 | 0.20 | 4.60 | 4.40 | 0.00 | 0.00 | 0.00 | 0.60 | 4.70 | 0.50 |
| H2465 | 23.040 | 31.521 | 80.823 | 487200.0 | 516800.0 | 19.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.50 | 23.40 | 0.10 | 2.00 | 16.50 | -54.90 | 33.10 | 89.30 | 0.10 | 4.80 | 4.70 | 0.00 | 0.00 | 0.00 | 0.80 | 6.90 | 0.70 |
| H2466 | 23.040 | 31.521 | 80.772 | 487200.0 | 521600.0 | 20.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.20 | 19.90 | 0.10 | 2.80 | 19.10 | -52.60 | 29.20 | 89.80 | 0.30 | 4.50 | 4.30 | 0.00 | 0.00 | 0.00 | 0.90 | 8.60 | 0.80 |
| H2467 | 23.040 | 31.521 | 80.722 | 487200.0 | 526400.0 | 22.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.20 | 18.30 | 0.10 | 2.80 | 19.80 | -52.60 | 27.60 | 89.90 | 0.90 | 4.20 | 4.00 | 0.00 | 0.00 | 0.00 | 0.90 | 9.50 | 0.90 |
| H2468 | 23.040 | 31.521 | 80.671 | 487200.0 | 531200.0 | 23.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.60 | 16.30 | 0.10 | 1.80 | 19.90 | -51.70 | 26.00 | 89.10 | 1.90 | 3.80 | 4.20 | 0.00 | 0.00 | 0.00 | 1.00 | 9.70 | 1.00 |
| H2469 | 23.040 | 31.521 | 80.621 | 487200.0 | 536000.0 | 25.5 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 13.30 | 0.00 | 2.90 | 19.80 | -51.60 | 23.20 | 88.00 | 3.00 | 3.40 | 4.50 | 0.00 | 0.00 | 0.00 | 1.00 | 9.60 | 1.00 |
| H2470 | 23.040 | 31.521 | 80.570 | 487200.0 | 540800.0 | 27.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.90 | 7.90 | 0.00 | 8.80 | 18.00 | -53.90 | 17.80 | 87.50 | 3.50 | 3.30 | 4.70 | 0.00 | 0.00 | 0.00 | 1.10 | 9.40 | 1.00 |
| H2471 | 23.040 | 31.520 | 80.520 | 487200.0 | 545600.0 | 28.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 4.00 | 0.00 | 13.50 | 15.50 | -56.20 | 14.10 | 88.00 | 3.00 | 3.60 | 4.40 | 0.00 | 0.00 | 0.00 | 1.10 | 9.10 | 1.00 |
| H2472 | 23.040 | 31.520 | 80.469 | 487200.0 | 550400.0 | 29.5 | 0.00 | 100.00 | 0.00 | 0.00 | 10.30 | 2.60 | 0.00 | 15.30 | 12.70 | -57.80 | 13.00 | 88.70 | 2.30 | 4.10 | 3.90 | 0.00 | 0.00 | 0.00 | 1.20 | 8.60 | 1.10 |
| H2473 | 23.040 | 31.520 | 80.419 | 487200.0 | 555200.0 | 30.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 2.60 | 0.00 | 16.00 | 9.80 | -59.70 | 12.80 | 88.90 | 2.00 | 4.50 | 3.50 | 0.00 | 0.10 | 0.00 | 1.30 | 7.90 | 1.30 |
| H2474 | 23.040 | 31.520 | 80.368 | 487200.0 | 560000.0 | 33.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 4.40 | 0.00 | 15.20 | 7.40 | -63.30 | 14.70 | 89.00 | 2.00 | 4.80 | 3.20 | 0.00 | 0.10 | 0.10 | 1.40 | 7.10 | 1.80 |
| H2475 | 23.040 | 31.520 | 80.318 | 487200.0 | 564800.0 | 36.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 6.30 | 0.00 | 15.30 | 6.60 | -68.20 | 16.90 | 89.00 | 1.90 | 4.80 | 3.20 | 0.00 | 0.30 | 0.30 | 1.40 | 6.80 | 2.00 |
| H2476 | 23.040 | 31.519 | 80.267 | 487200.0 | 569600.0 | 38.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 7.80 | 0.00 | 17.50 | 5.20 | -74.60 | 19.10 | 89.00 | 1.80 | 4.40 | 3.50 | 0.00 | 0.50 | 0.50 | 1.30 | 7.50 | 4.30 |
| H2477 | 23.040 | 31.519 | 80.216 | 487200.0 | 574400.0 | 38.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 8.00 | 0.00 | 21.70 | 3.40 | -81.40 | 20.80 | 88.60 | 1.50 | 4.10 | 3.90 | 0.00 | 0.80 | 0.80 | 1.20 | 8.70 | 5.70 |
| H2478 | 23.040 | 31.519 | 80.166 | 487200.0 | 579200.0 | 39.6 | 0.00 | 99.90 | 0.00 | 0.00 | 16.00 | 5.70 | 0.00 | 29.40 | 2.10 | -90.70 | 21.70 | 87.80 | 1.20 | 4.00 | 4.30 | 0.00 | 0.90 | 0.90 | 1.00 | 9.60 | 6.60 |
| H2479 | 23.040 | 31.518 | 80.115 | 487200.0 | 584000.0 | 40.3 | 0.00 | 99.90 | 0.00 | 0.00 | 19.10 | 2.80 | 0.00 | 36.40 | 1.00 | -98.60 | 21.90 | 86.90 | 1.00 | 4.00 | 4.70 | 0.00 | 1.00 | 1.00 | 1.00 | 9.90 | 6.90 |
| H2480 | 23.040 | 31.518 | 80.065 | 487200.0 | 588800.0 | 41.9 | 0.00 | 99.90 | 0.10 | 0.00 | 19.50 | 9.20 | 0.00 | 38.60 | 1.80 | -109.30 | 28.70 | 86.90 | 0.90 | 4.00 | 4.70 | 0.00 | 1.00 | 1.00 | 1.00 | 9.90 | 6.90 |
| H2481 | 23.040 | 31.518 | 80.014 | 487200.0 | 593600.0 | 44.1 | 0.00 | 99.50 | 0.40 | 0.10 | 20.10 | 20.20 | 0.00 | 41.20 | 2.90 | -125.70 | 40.40 | 87.90 | 0.60 | 4.10 | 4.50 | 0.00 | 1.00 | 1.00 | 1.00 | 9.80 | 6.70 |
| H2482 | 23.040 | 31.517 | 79.964 | 487200.0 | 598400.0 | 46.4 | 0.00 | 98.80 | 0.90 | 0.20 | 23.50 | 22.80 | 0.00 | 39.80 | 8.60 | -132.40 | 46.30 | 88.60 | 0.30 | 4.10 | 4.30 | 0.00 | 0.90 | 0.90 | 1.00 | 9.30 | 6.10 |
| H2503 | 12.417 | 31.478 | 81.126 | 482400.0 | 488000.0 | 6.5 | 0.10 | 97.20 | 1.40 | 1.20 | 16.50 | 25.70 | 0.00 | 3.90 | 6.20 | -52.60 | 42.10 | 91.40 | 0.50 | 4.80 | 3.50 | 0.00 | 0.00 | 0.00 | 0.10 | 6.50 | 1.60 |
| H2504 | 23.040 | 31.478 | 81.076 | 482400.0 | 492800.0 | 12.8 | 0.00 | 98.90 | 0.60 | 0.40 | 14.70 | 31.00 | 0.10 | 5.40 | 7.70 | -63.90 | 45.80 | 0.00 | 0.70 | 3.30 | 3.00 | 0.00 | 0.00 | 0.00 | 0.40 | 6.00 | 1.30 |
| H2505 | 23.040 | 31.478 | 81.025 | 482400.0 | 497600.0 | 15.0 | 0.00 | 99.50 | 0.30 | 0.20 | 13.80 | 31.00 | 0.20 | 4.50 | 8.30 | -64.60 | 45.00 | 91.30 | 0.80 | 3.30 | 3.10 | 0.00 | 0.00 | 0.00 | 0.60 | 5.40 | 1.00 |
| H2506 | 23.040 | 31.478 | 80.975 | 482400.0 | 502400.0 | 17.2 | 0.00 | 99.70 | 0.30 | 0.00 | 13.00 | 29.30 | 0.30 | 3.40 | 9.70 | -63.20 | 42.60 | 90.90 | 0.90 | 3.60 | 3.30 | 0.00 | 0.00 | 0.00 | 0.80 | 5.20 | 0.80 |
| H2507 | 23.040 | 31.478 | 80.924 | 482400.0 | 507200.0 | 19.2 | 0.00 | 99.80 | 0.20 | 0.00 | 11.60 | 27.90 | 0.40 | 2.70 | 12.00 | -61.80 | 39.90 | 90.50 | 0.60 | 4.10 | 3.80 | 0.00 | 0.00 | 0.00 | 1.00 | 5.60 | 0.70 |
| H2508 | 23.040 | 31.478 | 80.874 | 482400.0 | 512000.0 | 20.2 | 0.00 | 99.90 | 0.00 | 0.00 | 10.40 | 26.00 | 0.40 | 2.40 | 14.40 | -59.40 | 36.80 | 90.30 | 0.30 | 4.40 | 4.00 | 0.00 | 0.00 | 0.00 | 1.10 | 6.00 | 0.70 |
| H2509 | 23.040 | 31.478 | 80.823 | 482400.0 | 516800.0 | 20.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 22.60 | 0.40 | 2.70 | 16.90 | -56.30 | 32.70 | 90.70 | 0.20 | 4.30 | 3.80 | 0.00 | 0.00 | 0.00 | 1.10 | 8.30 | 0.90 |
| H2510 | 23.040 | 31.478 | 80.773 | 482400.0 | 521600.0 | 22.2 | 0.00 | 100.00 | 0.00 | 0.00 | 9.30 | 19.60 | 0.30 | 3.00 | 18.70 | -54.50 | 29.30 | 91.50 | 0.40 | 3.90 | 3.10 | 0.00 | 0.00 | 0.00 | 1.00 | 9.40 | 0.90 |
| H2511 | 23.040 | 31.478 | 80.722 | 482400.0 | 526400.0 | 23.8 | 0.00 | 100.00 | 0.00 | 0.00 | 9.40 | 16.90 | 0.30 | 2.70 | 19.50 | -53.20 | 26.60 | 91.30 | 1.00 | 3.70 | 3.00 | 0.00 | 0.00 | 0.00 | 1.00 | 9.90 | 1.00 |
| H2512 | 23.040 | 31.478 | 80.672 | 482400.0 | 531200.0 | 25.4 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 14.90 | 0.10 | 1.40 | 20.40 | -51.60 | 24.80 | 89.90 | 1.90 | 3.60 | 3.60 | 0.00 | 0.00 | 0.00 | 1.00 | 9.90 | 1.00 |
| H2513 | 23.040 | 31.478 | 80.621 | 482400.0 | 536000.0 | 27.0 | 0.00 | 100.00 | 0.00 | 0.00 | 9.40 | 11.70 | 0.10 | 4.40 | 19.80 | -52.60 | 21.20 | 88.80 | 2.60 | 3.60 | 4.10 | 0.00 | 0.00 | 0.00 | 1.00 | 9.80 | 1.00 |
| H2514 | 23.040 | 31.477 | 80.570 | 482400.0 | 540800.0 | 28.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.30 | 4.60 | 0.00 | 12.60 | 17.80 | -55.30 | 13.90 | 88.60 | 2.60 | 3.80 | 4.00 | 0.00 | 0.00 | 0.00 | 1.00 | 9.00 | 1.00 |
| H2515 | 23.040 | 31.477 | 80.520 | 482400.0 | 545600.0 | 29.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 1.90 | 0.00 | 16.40 | 15.40 | -58.90 | 12.50 | 89.00 | 2.10 | 4.20 | 3.70 | 0.00 | 0.00 | 0.00 | 1.00 | 9.00 | 1.00 |
| H2516 | 23.040 | 31.477 | 80.469 | 482400.0 | 550400.0 | 31.3 | 0.00 | 100.00 | 0.00 | 0.00 | 10.30 | 1.60 | 0.00 | 18.40 | 12.00 | -61.70 | 11.90 | 89.40 | 1.70 | 4.50 | 3.40 | 0.00 | 0.00 | 0.00 | 1.00 | 9.60 | 1.00 |
| H2517 | 23.040 | 31.477 | 80.419 | 482400.0 | 555200.0 | 33.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.90 | 1.70 | 0.00 | 19.60 | 9.60 | -64.50 | 11.60 | 89.30 | 1.80 | 4.60 | 3.30 | 0.00 | 0.00 | 0.00 | 1.10 | 9.10 | 1.20 |
| H2518 | 23.040 | 31.477 | 80.368 | 482400.0 | 560000.0 | 35.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 2.80 | 0.00 | 19.00 | 9.90 | -67.60 | 12.90 | 89.20 | 1.90 | 4.60 | 3.20 | 0.00 | 0.10 | 0.10 | 1.20 | 8.50 | 1.80 |
| H2519 | 23.040 | 31.476 | 80.318 | 482400.0 | 564800.0 | 38.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 4.60 | 0.00 | 19.00 | 10.50 | -72.20 | 15.10 | 89.20 | 1.90 | 4.40 | 3.40 | 0.00 | 0.30 | 0.30 | 1.20 | 8.10 | 3.00 |
| H2520 | 23.040 | 31.476 | 80.267 | 482400.0 | 569600.0 | 39.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 6.40 | 0.00 | 20.90 | 9.70 | -78.50 | 18.10 | 89.30 | 1.80 | 3.90 | 3.70 | 0.00 | 0.60 | 0.60 | 1.20 | 8.50 | 4.60 |
| H2521 | 23.040 | 31.476 | 80.217 | 482400.0 | 574400.0 | 39.8 | 0.00 | 99.90 | 0.00 | 0.00 | 13.90 | 7.40 | 0.00 | 25.30 | 7.70 | -86.40 | 21.40 | 89.00 | 1.60 | 3.70 | 4.00 | 0.00 | 0.80 | 0.80 | 1.10 | 9.20 | 5.90 |
| H2522 | 23.040 | 31.475 | 80.166 | 482400.0 | 579200.0 | 40.0 | 0.00 | 99.90 | 0.10 | 0.00 | 16.90 | 7.30 | 0.00 | 31.30 | 5.60 | -95.50 | 24.20 | 88.20 | 1.30 | 3.80 | 4.30 | 0.00 | 0.90 | 0.90 | 1.00 | 9.60 | 6.60 |
| H2523 | 23.040 | 31.475 | 80.116 | 482400.0 | 584000.0 | 41.0 | 0.00 | 99.80 | 0.10 | 0.00 | 19.00 | 9.50 | 0.00 | 36.00 | 4.50 | -105.50 | 28.50 | 87.70 | 1.00 | 3.90 | 4.50 | 0.00 | 1.00 | 1.00 | 1.00 | 9.80 | 6.80 |
| H2524 | 23.040 | 31.475 | 80.065 | 482400.0 | 588800.0 | 42.6 | 0.00 | 99.60 | 0.30 | 0.10 | 19.70 | 18.80 | 0.00 | 40.70 | 3.40 | -121.90 | 38.50 | 87.90 | 0.70 | 4.00 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.70 |
| H2525 | 23.040 | 31.474 | 80.015 | 482400.0 | 593600.0 | 44.6 | 0.00 | 99.30 | 0.50 | 0.10 | 20.10 | 25.50 | 0.00 | 43.30 | 3.00 | -133.50 | 45.60 | 88.50 | 0.40 | 4.10 | 4.30 | 0.00 | 0.90 | 0.90 | 1.00 | 9.50 | 6.30 |
| H2526 | 23.040 | 31.474 | 79.964 | 482400.0 | 598400.0 | 46.6 | 0.00 | 98.60 | 1.00 | 0.30 | 26.70 | 24.20 | 0.00 | 38.00 | 15.30 | -135.50 | 50.90 | 88.70 | 0.20 | 4.10 | 4.30 | 0.00 | 0.70 | 0.70 | 1.00 | 8.60 | 5.00 |
| H2546 | 5.152 | 31.435 | 81.177 | 477600.0 | 483200.0 | 6.0 | 0.10 | 94.80 | 2.60 | 2.40 | 16.10 | 29.80 | 0.00 | 6.30 | 7.90 | -58.20 | 45.90 | 91.20 | 0.50 | 5.30 | 3.40 | 0.00 | 0.00 | 0.00 | 0.10 | 9.40 | 2.50 |
| H2547 | 23.040 | 31.435 | 81.126 | 477600.0 | 488000.0 | 11.6 | 0.00 | 98.00 | 1.20 | 0.70 | 15.40 | 33.90 | 0.10 | 9.00 | 9.20 | -70.00 | 49.40 | 0.00 | 1.00 | 3.60 | 2.90 | 0.00 | 0.00 | 0.00 | 0.50 | 8.70 | 2.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2548 | 23.040 | 31.435 | 81.076 | 477600.0 | 492800.0 | 13.3 | 0.00 | 99.10 | 0.50 | 0.30 | 15.10 | 34.10 | 0.10 | 8.50 | 9.10 | -71.10 | 49.40 | 91.20 | 1.40 | 3.20 | 2.90 | 0.00 | 0.00 | 0.00 | 0.80 | 7.80 | 1.60 |
| H2549 | 23.040 | 31.435 | 81.025 | 477600.0 | 497600.0 | 14.9 | 0.00 | 99.70 | 0.20 | 0.10 | 14.50 | 33.50 | 0.30 | 7.20 | 9.50 | -70.40 | 48.30 | 91.20 | 1.50 | 3.20 | 3.00 | 0.00 | 0.00 | 0.00 | 1.20 | 7.30 | 1.20 |
| H2550 | 23.040 | 31.435 | 80.975 | 477600.0 | 502400.0 | 16.6 | 0.00 | 99.80 | 0.20 | 0.00 | 13.30 | 32.30 | 0.50 | 5.10 | 10.60 | -67.00 | 46.10 | 91.30 | 1.10 | 3.40 | 3.00 | 0.00 | 0.00 | 0.00 | 1.40 | 7.10 | 1.00 |
| H2551 | 23.040 | 31.435 | 80.924 | 477600.0 | 507200.0 | 18.3 | 0.00 | 99.90 | 0.10 | 0.00 | 11.90 | 30.90 | 0.80 | 3.60 | 12.30 | -65.60 | 43.70 | 91.20 | 0.70 | 3.80 | 3.20 | 0.00 | 0.00 | 0.00 | 1.50 | 7.30 | 0.90 |
| H2552 | 23.040 | 31.435 | 80.874 | 477600.0 | 512000.0 | 19.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.80 | 28.20 | 1.10 | 3.00 | 14.10 | -62.90 | 40.00 | 91.70 | 0.40 | 3.80 | 3.00 | 0.00 | 0.00 | 0.00 | 1.50 | 8.00 | 0.90 |
| H2553 | 23.040 | 31.435 | 80.823 | 477600.0 | 516800.0 | 21.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 24.10 | 1.20 | 3.30 | 16.00 | -59.90 | 35.20 | 93.10 | 0.20 | 3.50 | 2.20 | 0.00 | 0.00 | 0.00 | 1.30 | 8.90 | 0.90 |
| H2554 | 23.040 | 31.435 | 80.773 | 477600.0 | 521600.0 | 22.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.60 | 20.30 | 1.10 | 3.60 | 17.30 | -57.50 | 30.90 | 93.30 | 0.30 | 3.40 | 2.00 | 0.00 | 0.00 | 0.00 | 1.10 | 9.60 | 1.00 |
| H2555 | 23.040 | 31.434 | 80.722 | 477600.0 | 526400.0 | 24.5 | 0.00 | 100.00 | 0.00 | 0.00 | 9.50 | 16.30 | 0.80 | 3.90 | 18.50 | -55.00 | 26.50 | 92.40 | 0.80 | 3.50 | 2.30 | 0.00 | 0.00 | 0.00 | 1.00 | 9.90 | 1.00 |
| H2556 | 23.040 | 31.434 | 80.672 | 477600.0 | 531200.0 | 26.1 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 12.10 | 0.40 | 5.70 | 18.70 | -54.10 | 22.30 | 90.80 | 1.50 | 3.60 | 3.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2557 | 23.040 | 31.434 | 80.621 | 477600.0 | 536000.0 | 27.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.40 | 6.40 | 0.20 | 11.30 | 17.00 | -55.00 | 16.00 | 89.80 | 1.90 | 3.90 | 3.40 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2558 | 23.040 | 31.434 | 80.571 | 477600.0 | 540800.0 | 29.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 1.00 | 0.10 | 16.30 | 16.40 | -57.40 | 12.00 | 89.70 | 1.70 | 4.30 | 3.30 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2559 | 23.040 | 31.434 | 80.520 | 477600.0 | 545600.0 | 30.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 0.00 | 0.10 | 19.30 | 12.40 | -61.90 | 12.50 | 89.80 | 1.30 | 4.70 | 3.20 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2560 | 23.040 | 31.434 | 80.470 | 477600.0 | 550400.0 | 32.0 | 0.00 | 100.00 | 0.00 | 0.00 | 9.90 | 0.60 | 0.00 | 22.30 | 7.60 | -65.00 | 10.60 | 89.80 | 1.40 | 4.60 | 3.10 | 0.00 | 0.00 | 0.00 | 1.00 | 9.90 | 1.00 |
| H2561 | 23.040 | 31.433 | 80.419 | 477600.0 | 555200.0 | 34.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.50 | 0.90 | 0.10 | 22.30 | 8.40 | -67.60 | 10.50 | 89.70 | 1.70 | 4.40 | 3.20 | 0.00 | 0.00 | 0.00 | 1.00 | 9.60 | 1.20 |
| H2562 | 23.040 | 31.433 | 80.369 | 477600.0 | 560000.0 | 37.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.40 | 1.00 | 0.00 | 20.00 | 13.30 | -69.70 | 11.20 | 89.60 | 1.80 | 4.30 | 3.30 | 0.00 | 0.10 | 0.10 | 1.10 | 9.30 | 1.70 |
| H2563 | 23.040 | 31.433 | 80.318 | 477600.0 | 564800.0 | 39.6 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 3.30 | 0.00 | 20.60 | 15.50 | -73.30 | 13.10 | 89.60 | 1.90 | 3.80 | 3.60 | 0.00 | 0.30 | 0.30 | 1.10 | 9.00 | 2.90 |
| H2564 | 23.040 | 31.433 | 80.268 | 477600.0 | 569600.0 | 40.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 5.00 | 0.00 | 22.10 | 15.30 | -79.60 | 17.00 | 89.70 | 1.90 | 3.40 | 3.90 | 0.00 | 0.60 | 0.60 | 1.10 | 9.10 | 4.60 |
| H2565 | 23.040 | 31.432 | 80.217 | 477600.0 | 574400.0 | 41.0 | 0.00 | 99.90 | 0.00 | 0.00 | 13.70 | 8.10 | 0.00 | 25.70 | 13.90 | -88.60 | 21.80 | 89.50 | 1.70 | 3.40 | 4.00 | 0.00 | 0.80 | 0.80 | 1.10 | 9.40 | 5.90 |
| H2566 | 23.040 | 31.432 | 80.167 | 477600.0 | 579200.0 | 41.7 | 0.00 | 99.80 | 0.10 | 0.00 | 16.70 | 10.40 | 0.00 | 30.30 | 12.10 | -99.20 | 27.10 | 89.00 | 1.30 | 3.60 | 4.10 | 0.00 | 0.90 | 0.90 | 1.00 | 9.60 | 6.40 |
| H2567 | 23.040 | 31.432 | 80.116 | 477600.0 | 584000.0 | 42.7 | 0.00 | 99.60 | 0.30 | 0.10 | 19.70 | 15.00 | 0.00 | 35.10 | 10.60 | -112.50 | 34.80 | 88.70 | 0.90 | 3.80 | 4.20 | 0.00 | 0.90 | 0.90 | 1.00 | 9.60 | 6.50 |
| H2568 | 23.040 | 31.431 | 80.066 | 477600.0 | 588800.0 | 43.0 | 0.00 | 99.50 | 0.30 | 0.10 | 21.00 | 21.30 | 0.00 | 39.10 | 9.10 | -126.00 | 43.10 | 89.00 | 0.40 | 4.00 | 4.20 | 0.00 | 0.90 | 0.90 | 1.00 | 9.40 | 6.20 |
| H2569 | 23.040 | 31.431 | 80.015 | 477600.0 | 593600.0 | 45.4 | 0.00 | 99.20 | 0.50 | 0.20 | 25.50 | 24.00 | 0.00 | 38.30 | 14.20 | -133.30 | 49.50 | 89.00 | 0.20 | 4.10 | 4.20 | 0.00 | 0.80 | 0.80 | 1.00 | 8.00 | 5.30 |
| H2570 | 23.040 | 31.431 | 79.965 | 477600.0 | 598400.0 | 47.0 | 0.10 | 98.10 | 1.30 | 0.50 | 34.10 | 23.00 | 0.00 | 31.40 | 30.00 | -136.30 | 57.10 | 88.20 | 0.20 | 4.20 | 4.30 | 0.00 | 0.50 | 0.50 | 1.00 | 7.60 | 3.70 |
| H2590 | 12.698 | 31.391 | 81.177 | 472800.0 | 483200.0 | 8.6 | 0.10 | 95.60 | 2.50 | 1.70 | 15.50 | 33.00 | 0.00 | 7.90 | 9.80 | -65.90 | 49.30 | 91.10 | 0.70 | 4.80 | 3.10 | 0.00 | 0.00 | 0.00 | 0.10 | 10.30 | 2.70 |
| H2591 | 23.040 | 31.391 | 81.126 | 472800.0 | 488000.0 | 12.4 | 0.00 | 98.70 | 0.80 | 0.40 | 15.00 | 35.40 | 0.10 | 11.00 | 9.90 | -74.70 | 51.30 | 0.00 | 1.50 | 3.30 | 2.90 | 0.00 | 0.00 | 0.00 | 0.80 | 9.20 | 2.00 |
| H2592 | 23.040 | 31.391 | 81.076 | 472800.0 | 492800.0 | 13.7 | 0.00 | 99.60 | 0.20 | 0.10 | 16.10 | 34.90 | 0.10 | 11.20 | 9.30 | -76.10 | 51.20 | 91.10 | 1.00 | 3.10 | 2.90 | 0.00 | 0.00 | 0.00 | 1.30 | 8.50 | 1.50 |
| H2593 | 23.040 | 31.391 | 81.025 | 472800.0 | 497600.0 | 15.0 | 0.00 | 99.80 | 0.10 | 0.10 | 15.20 | 35.30 | 0.30 | 9.50 | 9.80 | -75.30 | 50.80 | 91.20 | 1.70 | 3.10 | 2.90 | 0.00 | 0.00 | 0.00 | 1.60 | 8.10 | 1.30 |
| H2594 | 23.040 | 31.391 | 80.975 | 472800.0 | 502400.0 | 16.2 | 0.00 | 99.80 | 0.10 | 0.00 | 13.50 | 36.20 | 0.70 | 6.00 | 11.40 | -72.70 | 50.40 | 91.70 | 1.20 | 3.30 | 2.70 | 0.00 | 0.00 | 0.00 | 1.70 | 7.90 | 1.10 |
| H2595 | 23.040 | 31.391 | 80.924 | 472800.0 | 507200.0 | 17.5 | 0.00 | 99.90 | 0.00 | 0.00 | 12.20 | 35.70 | 1.30 | 3.90 | 12.60 | -70.70 | 49.30 | 92.50 | 0.70 | 3.40 | 2.30 | 0.00 | 0.00 | 0.00 | 1.00 | 8.10 | 1.00 |
| H2596 | 23.040 | 31.391 | 80.874 | 472800.0 | 512000.0 | 18.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 32.50 | 2.20 | 3.40 | 13.20 | -68.10 | 45.90 | 93.60 | 0.30 | 3.30 | 1.80 | 0.00 | 0.00 | 0.00 | 1.70 | 8.50 | 0.90 |
| H2597 | 23.040 | 31.391 | 80.823 | 472800.0 | 516800.0 | 20.2 | 0.00 | 100.00 | 0.00 | 0.00 | 10.30 | 28.10 | 2.00 | 3.70 | 14.00 | -65.10 | 41.20 | 94.50 | 0.10 | 3.10 | 1.30 | 0.00 | 0.00 | 0.00 | 1.40 | 9.10 | 0.90 |
| H2598 | 23.040 | 31.391 | 80.773 | 472800.0 | 521600.0 | 22.0 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 23.00 | 2.60 | 4.50 | 15.10 | -62.00 | 35.40 | 94.00 | 0.30 | 3.20 | 1.50 | 0.00 | 0.00 | 0.00 | 1.20 | 9.70 | 0.90 |
| H2599 | 23.040 | 31.391 | 80.722 | 472800.0 | 526400.0 | 24.1 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 16.90 | 2.00 | 6.30 | 16.30 | -59.00 | 28.60 | 92.70 | 0.80 | 3.50 | 2.10 | 0.00 | 0.00 | 0.00 | 1.00 | 9.90 | 1.00 |
| H2600 | 23.040 | 31.391 | 80.672 | 472800.0 | 531200.0 | 26.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 10.60 | 1.20 | 9.80 | 16.80 | -57.60 | 21.80 | 91.30 | 1.30 | 3.80 | 2.60 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2601 | 23.040 | 31.391 | 80.621 | 472800.0 | 536000.0 | 28.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 5.20 | 0.60 | 14.30 | 15.90 | -58.30 | 15.90 | 90.40 | 1.40 | 4.30 | 2.90 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2602 | 23.040 | 31.391 | 80.571 | 472800.0 | 540800.0 | 29.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 2.20 | 0.40 | 17.60 | 14.20 | -60.60 | 13.20 | 90.10 | 1.20 | 4.70 | 3.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2603 | 23.040 | 31.391 | 80.520 | 472800.0 | 545600.0 | 30.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 0.90 | 0.20 | 21.30 | 9.60 | -63.50 | 11.30 | 90.10 | 1.20 | 4.80 | 3.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2604 | 23.040 | 31.390 | 80.470 | 472800.0 | 550400.0 | 32.6 | 0.00 | 100.00 | 0.00 | 0.00 | 9.30 | 0.40 | 0.20 | 23.00 | 6.40 | -66.30 | 9.90 | 90.10 | 1.40 | 4.40 | 3.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2605 | 23.040 | 31.390 | 80.419 | 472800.0 | 555200.0 | 35.5 | 0.00 | 100.00 | 0.00 | 0.00 | 9.00 | 0.00 | 0.20 | 22.10 | 11.80 | -67.70 | 10.00 | 90.10 | 1.70 | 4.10 | 3.10 | 0.00 | 0.00 | 0.00 | 1.00 | 9.80 | 1.10 |
| H2606 | 23.040 | 31.390 | 80.369 | 472800.0 | 560000.0 | 38.4 | 0.00 | 100.00 | 0.00 | 0.00 | 8.60 | 0.00 | 0.10 | 20.60 | 18.00 | -68.40 | 9.40 | 90.00 | 1.80 | 3.70 | 3.40 | 0.00 | 0.10 | 0.10 | 1.00 | 9.60 | 1.60 |
| H2607 | 23.040 | 31.390 | 80.318 | 472800.0 | 564800.0 | 39.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.00 | 2.60 | 0.10 | 20.70 | 19.40 | -72.30 | 11.70 | 90.00 | 1.90 | 3.30 | 3.80 | 0.00 | 0.30 | 0.30 | 1.10 | 9.50 | 2.80 |
| H2608 | 23.040 | 31.389 | 80.268 | 472800.0 | 569600.0 | 40.7 | 0.00 | 100.00 | 0.00 | 0.00 | 10.50 | 6.40 | 0.00 | 21.70 | 20.90 | -79.30 | 16.90 | 90.00 | 1.90 | 3.10 | 3.90 | 0.00 | 0.60 | 0.60 | 1.10 | 9.40 | 4.40 |
| H2609 | 23.040 | 31.389 | 80.217 | 472800.0 | 574400.0 | 41.6 | 0.00 | 100.00 | 0.00 | 0.00 | 12.60 | 9.20 | 0.00 | 24.10 | 20.80 | -87.50 | 21.80 | 89.90 | 1.70 | 3.30 | 3.80 | 0.00 | 0.80 | 0.80 | 1.00 | 9.50 | 5.60 |
| H2610 | 23.040 | 31.389 | 80.167 | 472800.0 | 579200.0 | 42.6 | 0.00 | 99.80 | 0.10 | 0.00 | 16.10 | 11.90 | 0.00 | 28.50 | 19.00 | -99.20 | 28.00 | 89.60 | 1.20 | 3.60 | 3.90 | 0.00 | 0.90 | 0.90 | 1.00 | 9.40 | 6.00 |
| H2611 | 23.040 | 31.388 | 80.117 | 472800.0 | 584000.0 | 43.6 | 0.00 | 99.60 | 0.20 | 0.10 | 20.00 | 15.90 | 0.00 | 32.70 | 18.20 | -113.10 | 36.80 | 89.50 | 0.60 | 3.90 | 4.00 | 0.00 | 0.80 | 0.80 | 1.00 | 9.10 | 5.00 |
| H2612 | 23.040 | 31.388 | 80.066 | 472800.0 | 588800.0 | 44.6 | 0.00 | 99.70 | 0.20 | 0.10 | 25.70 | 20.00 | 0.00 | 34.30 | 20.60 | -124.60 | 45.70 | 89.70 | 0.20 | 4.00 | 4.00 | 0.00 | 0.80 | 0.80 | 1.00 | 8.60 | 5.10 |
| H2613 | 23.040 | 31.388 | 80.016 | 472800.0 | 593600.0 | 46.1 | 0.00 | 99.20 | 0.50 | 0.20 | 32.70 | 22.70 | 0.00 | 31.60 | 29.40 | -133.10 | 55.40 | 89.20 | 0.10 | 4.10 | 4.10 | 0.00 | 0.60 | 0.50 | 1.00 | 7.60 | 3.70 |
| H2614 | 23.040 | 31.387 | 79.965 | 472800.0 | 598400.0 | 48.5 | 0.10 | 96.70 | 2.20 | 0.90 | 39.40 | 24.00 | 0.00 | 26.90 | 39.80 | -138.90 | 63.50 | 87.10 | 0.20 | 4.30 | 4.40 | 0.00 | 0.30 | 0.30 | 1.00 | 6.40 | 2.00 |
| H2634 | 10.854 | 31.348 | 81.177 | 468000.0 | 483200.0 | 10.2 | 0.00 | 97.00 | 2.40 | 0.50 | 14.70 | 35.90 | 0.00 | 10.60 | 11.30 | -71.40 | 50.60 | 91.10 | 1.20 | 3.90 | 2.90 | 0.00 | 0.00 | 0.00 | 0.20 | 10.60 | 2.80 |
| H2635 | 23.040 | 31.348 | 81.126 | 468000.0 | 488000.0 | 12.6 | 0.00 | 99.40 | 0.50 | 0.10 | 16.20 | 35.50 | 0.00 | 12.20 | 9.90 | -76.50 | 51.70 | 0.00 | 1.70 | 3.20 | 2.80 | 0.00 | 0.00 | 0.00 | 1.20 | 9.00 | 1.80 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2636 | 23.040 | 31.348 | 81.076 | 468000.0 | 492800.0 | 13.8 | 0.00 | 99.80 | 0.20 | 0.00 | 16.90 | 34.30 | 0.10 | 13.30 | 8.40 | -78.50 | 51.40 | 91.20 | 1.00 | 3.10 | 2.00 | 0.00 | 0.00 | 0.00 | 1.60 | 8.40 | 1.30 |
| H2637 | 23.040 | 31.348 | 81.025 | 468000.0 | 497600.0 | 15.0 | 0.00 | 99.80 | 0.20 | 0.00 | 15.20 | 36.90 | 0.30 | 9.70 | 10.40 | -77.10 | 52.40 | 91.70 | 1.40 | 3.10 | 2.50 | 0.00 | 0.00 | 0.00 | 1.00 | 8.20 | 1.10 |
| H2638 | 23.040 | 31.348 | 80.975 | 468000.0 | 502400.0 | 16.2 | 0.00 | 99.90 | 0.10 | 0.00 | 13.20 | 40.50 | 0.60 | 4.60 | 13.10 | -75.10 | 54.30 | 92.40 | 1.00 | 3.20 | 2.20 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2639 | 23.040 | 31.348 | 80.924 | 468000.0 | 507200.0 | 17.4 | 0.00 | 99.90 | 0.00 | 0.00 | 12.20 | 40.20 | 1.70 | 3.10 | 13.10 | -74.60 | 54.10 | 93.20 | 0.60 | 3.20 | 1.80 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 1.00 |
| H2640 | 23.040 | 31.348 | 80.874 | 468000.0 | 512000.0 | 18.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 37.00 | 3.90 | 3.40 | 11.50 | -74.10 | 52.10 | 94.10 | 0.30 | 3.10 | 1.40 | 0.00 | 0.00 | 0.00 | 1.70 | 8.60 | 0.90 |
| H2641 | 23.040 | 31.348 | 80.823 | 468000.0 | 516800.0 | 20.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 33.00 | 5.30 | 4.20 | 10.00 | -72.90 | 48.80 | 94.40 | 0.30 | 3.10 | 1.30 | 0.00 | 0.00 | 0.00 | 1.50 | 9.20 | 0.90 |
| H2642 | 23.040 | 31.348 | 80.773 | 468000.0 | 521600.0 | 21.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.90 | 27.70 | 5.20 | 5.50 | 11.50 | -70.20 | 42.80 | 93.30 | 0.70 | 3.30 | 1.00 | 0.00 | 0.00 | 0.00 | 1.20 | 9.70 | 0.90 |
| H2643 | 23.040 | 31.348 | 80.722 | 468000.0 | 526400.0 | 24.2 | 0.00 | 100.00 | 0.00 | 0.00 | 9.90 | 19.90 | 4.00 | 8.00 | 13.30 | -66.20 | 33.90 | 92.20 | 1.10 | 3.50 | 2.10 | 0.00 | 0.00 | 0.00 | 1.10 | 10.00 | 0.90 |
| H2644 | 23.040 | 31.348 | 80.672 | 468000.0 | 531200.0 | 26.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 12.00 | 2.00 | 12.20 | 13.00 | -63.00 | 25.00 | 91.40 | 1.30 | 3.90 | 2.40 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2645 | 23.040 | 31.348 | 80.622 | 468000.0 | 536000.0 | 28.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 6.00 | 1.00 | 15.50 | 13.60 | -63.30 | 18.90 | 90.80 | 1.30 | 4.30 | 2.60 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2646 | 23.040 | 31.347 | 80.571 | 468000.0 | 540800.0 | 30.5 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 3.70 | 1.20 | 18.20 | 12.50 | -64.00 | 15.30 | 90.50 | 1.30 | 4.50 | 2.70 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2647 | 23.040 | 31.347 | 80.521 | 468000.0 | 545600.0 | 32.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 1.80 | 0.90 | 21.30 | 10.20 | -66.00 | 12.60 | 90.60 | 1.40 | 4.30 | 2.60 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2648 | 23.040 | 31.347 | 80.470 | 468000.0 | 550400.0 | 34.0 | 0.00 | 100.00 | 0.00 | 0.00 | 9.50 | 1.30 | 0.70 | 22.10 | 11.20 | -67.60 | 11.50 | 90.80 | 1.70 | 3.90 | 2.70 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2649 | 23.040 | 31.347 | 80.420 | 468000.0 | 555200.0 | 35.9 | 0.00 | 100.00 | 0.00 | 0.00 | 8.80 | 1.00 | 0.40 | 20.90 | 17.40 | -66.90 | 10.10 | 90.50 | 1.80 | 3.70 | 3.00 | 0.00 | 0.00 | 0.00 | 1.00 | 9.90 | 1.10 |
| H2650 | 23.040 | 31.347 | 80.369 | 468000.0 | 560000.0 | 37.0 | 0.00 | 100.00 | 0.00 | 0.00 | 8.40 | 1.10 | 0.20 | 20.30 | 20.70 | -67.00 | 9.70 | 90.30 | 1.90 | 3.40 | 3.50 | 0.00 | 0.10 | 0.10 | 1.00 | 9.80 | 1.60 |
| H2651 | 23.040 | 31.346 | 80.319 | 468000.0 | 564800.0 | 39.6 | 0.00 | 100.00 | 0.00 | 0.00 | 9.10 | 4.50 | 0.20 | 20.50 | 22.60 | -73.90 | 13.90 | 90.10 | 1.90 | 3.10 | 3.80 | 0.00 | 0.30 | 0.30 | 1.00 | 9.70 | 2.60 |
| H2652 | 23.040 | 31.346 | 80.268 | 468000.0 | 569600.0 | 40.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 8.40 | 0.10 | 20.00 | 26.30 | -78.90 | 18.20 | 90.20 | 1.90 | 3.10 | 3.70 | 0.00 | 0.50 | 0.50 | 1.00 | 9.60 | 4.00 |
| H2653 | 23.040 | 31.346 | 80.218 | 468000.0 | 574400.0 | 41.9 | 0.00 | 99.90 | 0.10 | 0.00 | 11.40 | 10.00 | 0.00 | 22.50 | 25.50 | -85.70 | 21.40 | 90.20 | 1.50 | 3.40 | 3.40 | 0.00 | 0.70 | 0.70 | 1.00 | 9.30 | 5.00 |
| H2654 | 23.040 | 31.345 | 80.167 | 468000.0 | 579200.0 | 43.0 | 0.00 | 99.70 | 0.20 | 0.10 | 15.30 | 11.90 | 0.00 | 20.30 | 23.00 | -90.60 | 27.20 | 89.90 | 1.00 | 3.70 | 3.50 | 0.00 | 0.80 | 0.80 | 1.00 | 8.90 | 5.10 |
| H2655 | 23.040 | 31.345 | 80.117 | 468000.0 | 584000.0 | 44.2 | 0.00 | 99.60 | 0.20 | 0.10 | 20.00 | 14.50 | 0.00 | 31.90 | 23.50 | -110.80 | 34.60 | 89.70 | 0.40 | 3.90 | 3.90 | 0.00 | 0.70 | 0.70 | 1.00 | 8.30 | 4.60 |
| H2656 | 23.040 | 31.345 | 80.066 | 468000.0 | 588800.0 | 45.2 | 0.00 | 99.60 | 0.30 | 0.10 | 26.40 | 17.60 | 0.00 | 33.00 | 27.40 | -122.30 | 44.00 | 89.60 | 0.10 | 4.00 | 4.00 | 0.00 | 0.60 | 0.60 | 1.00 | 7.50 | 3.50 |
| H2657 | 23.040 | 31.344 | 80.016 | 468000.0 | 593600.0 | 46.2 | 0.20 | 98.00 | 1.30 | 0.50 | 34.20 | 21.30 | 0.00 | 30.20 | 35.50 | -132.00 | 55.50 | 88.10 | 0.30 | 4.30 | 4.30 | 0.00 | 0.40 | 0.40 | 1.00 | 6.50 | 2.20 |
| H2658 | 23.040 | 31.344 | 79.966 | 468000.0 | 598400.0 | 48.2 | 0.30 | 94.50 | 3.60 | 1.40 | 40.70 | 25.60 | 0.00 | 25.30 | 43.00 | -139.80 | 66.30 | 85.20 | 0.30 | 4.60 | 4.70 | 0.00 | 0.20 | 0.20 | 1.00 | 5.70 | 1.00 |
| H2678 | 14.140 | 31.305 | 81.177 | 463200.0 | 483200.0 | 10.5 | 0.10 | 98.10 | 1.60 | 0.20 | 14.80 | 35.80 | 0.00 | 12.30 | 11.10 | -73.40 | 50.60 | 91.30 | 1.40 | 3.90 | 3.10 | 0.00 | 0.00 | 0.00 | 0.30 | 10.50 | 2.70 |
| H2679 | 23.040 | 31.305 | 81.126 | 463200.0 | 488000.0 | 13.2 | 0.00 | 99.50 | 0.40 | 0.00 | 16.00 | 35.90 | 0.00 | 12.10 | 10.40 | -77.20 | 51.90 | 0.00 | 1.60 | 3.20 | 2.60 | 0.00 | 0.00 | 0.00 | 1.60 | 8.60 | 1.40 |
| H268 | 3.357 | 31.911 | 80.873 | 530400.0 | 512000.0 | 8.6 | 2.60 | 92.70 | 4.70 | 0.00 | 18.20 | 0.00 | 0.00 | 4.10 | 11.90 | -31.00 | 18.30 | 87.20 | 2.10 | 4.70 | 4.00 | 0.20 | 0.00 | 0.00 | 0.00 | 3.10 | 0.00 |
| H2680 | 23.040 | 31.305 | 81.076 | 463200.0 | 492800.0 | 14.5 | 0.00 | 99.70 | 0.30 | 0.00 | 16.00 | 35.90 | 0.10 | 11.90 | 9.80 | -78.30 | 51.90 | 91.70 | 1.50 | 3.10 | 2.30 | 0.00 | 0.00 | 0.00 | 1.00 | 8.20 | 1.10 |
| H2681 | 23.040 | 31.305 | 81.025 | 463200.0 | 497600.0 | 15.9 | 0.00 | 99.80 | 0.20 | 0.00 | 13.90 | 40.30 | 0.30 | 6.50 | 12.60 | -76.80 | 54.40 | 92.20 | 1.20 | 3.10 | 2.00 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2682 | 23.040 | 31.305 | 80.975 | 463200.0 | 502400.0 | 17.2 | 0.00 | 99.90 | 0.10 | 0.00 | 12.40 | 44.00 | 0.40 | 1.00 | 14.00 | -75.90 | 56.80 | 92.80 | 0.90 | 3.20 | 1.70 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2683 | 23.040 | 31.305 | 80.924 | 463200.0 | 507200.0 | 18.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 42.50 | 2.10 | 2.40 | 13.00 | -77.30 | 56.50 | 93.30 | 0.60 | 3.20 | 1.50 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 0.90 |
| H2684 | 23.040 | 31.305 | 80.874 | 463200.0 | 512000.0 | 19.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 39.00 | 6.30 | 3.70 | 8.00 | -80.30 | 57.20 | 93.60 | 0.60 | 3.20 | 1.50 | 0.00 | 0.00 | 0.00 | 1.00 | 8.60 | 0.90 |
| H2685 | 23.040 | 31.305 | 80.823 | 463200.0 | 516800.0 | 20.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.30 | 37.30 | 8.40 | 4.60 | 7.10 | -81.20 | 56.00 | 93.50 | 0.80 | 3.10 | 1.50 | 0.00 | 0.00 | 0.00 | 1.50 | 9.20 | 0.80 |
| H2686 | 23.040 | 31.305 | 80.773 | 463200.0 | 521600.0 | 22.6 | 0.00 | 100.00 | 0.00 | 0.00 | 9.90 | 32.10 | 7.90 | 6.20 | 8.20 | -78.60 | 49.80 | 92.70 | 1.20 | 3.30 | 1.80 | 0.00 | 0.00 | 0.00 | 1.20 | 9.00 | 0.80 |
| H2687 | 23.040 | 31.305 | 80.723 | 463200.0 | 526400.0 | 24.8 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 24.40 | 6.60 | 9.00 | 10.00 | -74.50 | 40.70 | 92.80 | 1.40 | 3.50 | 2.10 | 0.00 | 0.00 | 0.00 | 1.10 | 10.00 | 0.80 |
| H2688 | 23.040 | 31.304 | 80.672 | 463200.0 | 531200.0 | 27.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 16.40 | 5.20 | 13.10 | 10.70 | -71.90 | 31.80 | 91.50 | 1.40 | 3.80 | 2.30 | 0.00 | 0.00 | 0.00 | 1.00 | 10.10 | 0.90 |
| H2689 | 23.040 | 31.304 | 80.622 | 463200.0 | 536000.0 | 29.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.80 | 10.20 | 3.80 | 15.50 | 11.40 | -69.40 | 24.80 | 91.50 | 1.50 | 3.90 | 2.20 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H269 | 20.801 | 31.911 | 80.822 | 530400.0 | 516800.0 | 10.1 | 7.20 | 89.60 | 3.20 | 0.00 | 16.00 | 0.00 | 0.00 | 2.90 | 11.60 | -29.00 | 16.00 | 87.30 | 2.20 | 4.30 | 4.80 | 0.10 | 0.00 | 0.00 | 0.00 | 3.80 | 0.10 |
| H2690 | 23.040 | 31.304 | 80.571 | 463200.0 | 540800.0 | 30.2 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 5.90 | 2.90 | 18.30 | 11.10 | -68.40 | 19.90 | 91.60 | 1.60 | 3.80 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2691 | 23.040 | 31.304 | 80.521 | 463200.0 | 545600.0 | 31.3 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 3.30 | 2.20 | 20.50 | 11.60 | -68.10 | 16.20 | 91.70 | 1.60 | 3.70 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2692 | 23.040 | 31.304 | 80.470 | 463200.0 | 550400.0 | 33.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 2.50 | 1.70 | 21.30 | 14.10 | -68.80 | 14.40 | 91.40 | 1.80 | 3.50 | 2.30 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.00 |
| H2693 | 23.040 | 31.304 | 80.420 | 463200.0 | 555200.0 | 34.9 | 0.00 | 100.00 | 0.00 | 0.00 | 9.40 | 2.30 | 1.10 | 21.20 | 18.20 | -68.80 | 12.80 | 90.90 | 1.80 | 3.40 | 2.80 | 0.00 | 0.00 | 0.00 | 1.00 | 10.00 | 1.10 |
| H2694 | 23.040 | 31.303 | 80.370 | 463200.0 | 560000.0 | 36.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.30 | 3.90 | 0.70 | 21.10 | 21.40 | -71.70 | 14.00 | 90.60 | 1.90 | 3.30 | 3.30 | 0.00 | 0.10 | 0.10 | 1.00 | 9.90 | 1.50 |
| H2695 | 23.040 | 31.303 | 80.319 | 463200.0 | 564800.0 | 38.5 | 0.00 | 100.00 | 0.00 | 0.00 | 9.60 | 7.90 | 0.40 | 20.20 | 25.90 | -76.60 | 17.90 | 90.60 | 1.90 | 3.20 | 3.30 | 0.00 | 0.30 | 0.30 | 1.00 | 9.80 | 2.40 |
| H2696 | 23.040 | 31.303 | 80.269 | 463200.0 | 569600.0 | 40.1 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 9.80 | 0.10 | 19.70 | 28.40 | -79.60 | 19.70 | 90.90 | 1.80 | 3.20 | 3.00 | 0.00 | 0.50 | 0.50 | 1.00 | 9.40 | 3.50 |
| H2697 | 23.040 | 31.302 | 80.218 | 463200.0 | 574400.0 | 41.7 | 0.00 | 99.90 | 0.10 | 0.00 | 12.20 | 10.70 | 0.10 | 24.70 | 26.00 | -89.40 | 23.10 | 91.00 | 1.50 | 3.40 | 2.70 | 0.00 | 0.70 | 0.70 | 1.00 | 8.70 | 4.10 |
| H2698 | 23.040 | 31.302 | 80.168 | 463200.0 | 579200.0 | 43.2 | 0.10 | 99.70 | 0.20 | 0.10 | 14.90 | 11.70 | 0.00 | 30.40 | 23.80 | -100.20 | 26.60 | 90.40 | 1.80 | 3.60 | 3.00 | 0.00 | 0.70 | 0.70 | 1.00 | 7.90 | 3.90 |
| H2699 | 23.040 | 31.302 | 80.117 | 463200.0 | 584000.0 | 44.7 | 0.10 | 99.40 | 0.30 | 0.10 | 18.60 | 13.40 | 0.00 | 33.40 | 24.70 | -110.10 | 32.00 | 89.50 | 0.60 | 3.90 | 3.60 | 0.00 | 0.70 | 0.70 | 1.00 | 7.10 | 3.10 |
| H270 | 23.040 | 31.911 | 80.772 | 530400.0 | 521600.0 | 15.1 | 1.80 | 96.50 | 1.60 | 0.00 | 12.70 | 0.30 | 0.00 | 2.10 | 8.20 | -30.10 | 12.90 | 87.40 | 3.50 | 2.70 | 5.40 | 0.00 | 0.00 | 0.00 | 0.00 | 8.90 | 0.70 |
| H2700 | 23.040 | 31.301 | 80.067 | 463200.0 | 588800.0 | 45.9 | 0.20 | 98.90 | 0.60 | 0.30 | 26.20 | 17.20 | 0.00 | 36.00 | 29.10 | -125.20 | 43.30 | 88.50 | 0.40 | 4.20 | 4.00 | 0.00 | 0.50 | 0.50 | 1.00 | 6.40 | 2.20 |
| H2701 | 23.040 | 31.301 | 80.016 | 463200.0 | 593600.0 | 46.7 | 0.40 | 97.30 | 1.50 | 0.60 | 34.40 | 21.70 | 0.00 | 33.40 | 36.20 | -136.20 | 56.10 | 86.70 | 0.60 | 4.50 | 4.50 | 0.00 | 0.30 | 0.30 | 1.00 | 5.80 | 1.30 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2702 | 23.040 | 31.301 | 79.966 | 463200.0 | 598400.0 | 49.0 | 0.50 | 94.30 | 3.50 | 1.40 | 41.70 | 25.50 | 0.00 | 24.50 | 46.10 | -140.70 | 67.20 | 84.00 | 0.60 | 4.00 | 4.90 | 0.00 | 0.20 | 0.20 | 1.00 | 5.30 | 0.60 |
| H271 | 23.040 | 31.911 | 80.721 | 530400.0 | 526400.0 | 17.2 | 1.50 | 97.40 | 1.10 | 0.00 | 10.10 | 0.30 | 0.00 | 2.20 | 5.60 | -29.80 | 10.40 | 88.00 | 3.10 | 3.30 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 11.00 | 0.90 |
| H272 | 23.040 | 31.911 | 80.670 | 530400.0 | 531200.0 | 18.3 | 0.90 | 98.40 | 0.70 | 0.00 | 9.00 | 0.30 | 0.00 | 1.30 | 3.00 | -28.80 | 9.20 | 88.00 | 2.60 | 4.00 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 11.00 | 1.00 |
| H2722 | 15.183 | 31.261 | 81.176 | 458400.0 | 483200.0 | 10.7 | 0.00 | 99.40 | 0.50 | 0.10 | 14.50 | 36.40 | 0.00 | 12.00 | 11.70 | -73.60 | 50.90 | 91.60 | 1.30 | 3.90 | 3.10 | 0.00 | 0.00 | 0.00 | 0.60 | 10.10 | 2.40 |
| H2723 | 23.040 | 31.261 | 81.126 | 458400.0 | 488000.0 | 13.8 | 0.10 | 99.30 | 0.60 | 0.00 | 14.40 | 37.10 | 0.10 | 11.10 | 12.00 | -76.50 | 51.60 | 0.00 | 1.30 | 3.40 | 2.20 | 0.00 | 0.00 | 0.00 | 1.00 | 8.30 | 1.20 |
| H2724 | 23.040 | 31.261 | 81.076 | 458400.0 | 492800.0 | 15.2 | 0.00 | 99.70 | 0.20 | 0.00 | 13.90 | 38.30 | 0.30 | 9.20 | 11.80 | -77.00 | 52.60 | 92.30 | 1.20 | 3.20 | 1.70 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2725 | 23.040 | 31.262 | 81.025 | 458400.0 | 497600.0 | 16.6 | 0.00 | 99.90 | 0.10 | 0.00 | 12.50 | 43.00 | 0.40 | 3.40 | 14.20 | -76.00 | 56.00 | 92.60 | 1.10 | 3.10 | 1.40 | 0.00 | 0.00 | 0.00 | 2.00 | 8.00 | 1.00 |
| H2726 | 23.040 | 31.262 | 80.975 | 458400.0 | 502400.0 | 18.0 | 0.00 | 99.90 | 0.10 | 0.00 | 12.00 | 44.00 | 1.30 | 1.90 | 14.00 | -77.20 | 57.30 | 92.70 | 1.00 | 3.20 | 1.40 | 0.00 | 0.00 | 0.00 | 2.00 | 8.10 | 1.00 |
| H2727 | 23.040 | 31.261 | 80.924 | 458400.0 | 507200.0 | 18.9 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 41.80 | 5.00 | 3.50 | 10.00 | -80.50 | 58.10 | 92.90 | 0.90 | 3.30 | 1.50 | 0.00 | 0.00 | 0.00 | 1.90 | 8.30 | 0.90 |
| H2728 | 23.040 | 31.261 | 80.874 | 458400.0 | 512000.0 | 19.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 41.10 | 9.60 | 4.10 | 5.90 | -84.60 | 61.10 | 92.90 | 1.00 | 3.30 | 1.60 | 0.00 | 0.00 | 0.00 | 1.70 | 8.80 | 0.80 |
| H2729 | 23.040 | 31.261 | 80.824 | 458400.0 | 516800.0 | 19.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 39.60 | 10.60 | 4.70 | 4.60 | -84.90 | 65.30 | 92.60 | 1.40 | 3.10 | 1.80 | 0.00 | 0.00 | 0.00 | 1.50 | 9.40 | 0.60 |
| H273 | 23.040 | 31.911 | 80.619 | 530400.0 | 536000.0 | 18.5 | 0.60 | 98.90 | 0.50 | 0.00 | 9.30 | 0.60 | 0.00 | 2.00 | 6.30 | -30.40 | 9.90 | 87.50 | 1.60 | 4.00 | 5.10 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2730 | 23.040 | 31.261 | 80.773 | 458400.0 | 521600.0 | 21.2 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 33.60 | 9.30 | 7.00 | 6.60 | -80.80 | 52.60 | 92.30 | 1.60 | 3.20 | 1.90 | 0.00 | 0.00 | 0.00 | 1.20 | 10.00 | 0.60 |
| H2731 | 23.040 | 31.261 | 80.723 | 458400.0 | 526400.0 | 23.5 | 0.00 | 100.00 | 0.00 | 0.00 | 9.20 | 27.20 | 8.50 | 9.70 | 8.30 | -78.20 | 45.00 | 92.10 | 1.60 | 3.30 | 1.90 | 0.00 | 0.00 | 0.00 | 1.10 | 10.20 | 0.70 |
| H2732 | 23.040 | 31.261 | 80.672 | 458400.0 | 531200.0 | 26.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.20 | 20.70 | 7.30 | 12.30 | 9.00 | -76.70 | 38.20 | 92.00 | 1.60 | 3.50 | 1.90 | 0.00 | 0.00 | 0.00 | 1.00 | 10.20 | 0.80 |
| H2733 | 23.040 | 31.261 | 80.622 | 458400.0 | 536000.0 | 28.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 12.70 | 5.60 | 15.30 | 9.00 | -74.10 | 30.30 | 92.20 | 1.70 | 3.40 | 1.60 | 0.00 | 0.00 | 0.00 | 1.00 | 10.20 | 0.80 |
| H2734 | 23.040 | 31.261 | 80.571 | 458400.0 | 540800.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 7.20 | 4.70 | 18.10 | 10.20 | -72.60 | 24.70 | 92.60 | 1.90 | 3.20 | 1.30 | 0.00 | 0.00 | 0.00 | 1.00 | 10.10 | 0.90 |
| H2735 | 23.040 | 31.261 | 80.521 | 458400.0 | 545600.0 | 30.2 | 0.00 | 100.00 | 0.00 | 0.00 | 12.20 | 4.50 | 4.20 | 20.10 | 11.50 | -71.20 | 20.90 | 92.40 | 1.80 | 3.30 | 1.50 | 0.00 | 0.00 | 0.00 | 1.00 | 10.10 | 0.90 |
| H2736 | 23.040 | 31.260 | 80.471 | 458400.0 | 550400.0 | 31.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 3.70 | 3.50 | 21.60 | 14.00 | -71.10 | 18.50 | 91.00 | 1.00 | 3.30 | 2.10 | 0.00 | 0.00 | 0.00 | 1.00 | 10.10 | 1.00 |
| H2737 | 23.040 | 31.260 | 80.420 | 458400.0 | 555200.0 | 33.2 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 4.20 | 2.70 | 22.50 | 17.20 | -73.20 | 17.50 | 91.30 | 1.80 | 3.30 | 2.60 | 0.00 | 0.00 | 0.00 | 1.00 | 10.10 | 1.00 |
| H2738 | 23.040 | 31.260 | 80.370 | 458400.0 | 560000.0 | 35.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.50 | 6.30 | 1.70 | 22.80 | 21.10 | -77.10 | 18.50 | 91.10 | 1.80 | 3.20 | 2.90 | 0.00 | 0.10 | 0.10 | 1.00 | 9.90 | 1.30 |
| H2739 | 23.040 | 31.260 | 80.319 | 458400.0 | 564800.0 | 38.3 | 0.00 | 100.00 | 0.00 | 0.00 | 10.80 | 8.90 | 0.90 | 22.50 | 25.10 | -81.40 | 20.50 | 91.30 | 1.80 | 3.20 | 2.70 | 0.00 | 0.30 | 0.30 | 1.00 | 9.40 | 1.90 |
| H274 | 23.040 | 31.910 | 80.568 | 530400.0 | 540800.0 | 19.0 | 0.30 | 99.30 | 0.30 | 0.00 | 10.80 | 1.30 | 0.00 | 4.40 | 13.20 | -35.50 | 12.10 | 87.40 | 1.00 | 5.10 | 5.40 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 1.00 |
| H2740 | 23.040 | 31.259 | 80.269 | 458400.0 | 569600.0 | 40.3 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 10.40 | 0.40 | 24.50 | 25.90 | -87.40 | 22.60 | 91.90 | 1.00 | 3.20 | 2.00 | 0.00 | 0.50 | 0.50 | 1.00 | 8.60 | 2.70 |
| H2741 | 23.040 | 31.259 | 80.219 | 458400.0 | 574400.0 | 41.8 | 0.00 | 99.90 | 0.00 | 0.00 | 14.20 | 11.30 | 0.20 | 30.10 | 24.00 | -97.60 | 25.70 | 91.90 | 1.70 | 3.30 | 1.90 | 0.00 | 0.70 | 0.70 | 1.00 | 7.60 | 2.00 |
| H2742 | 23.040 | 31.259 | 80.168 | 458400.0 | 579200.0 | 43.6 | 0.10 | 99.60 | 0.20 | 0.10 | 15.30 | 11.70 | 0.00 | 32.70 | 23.50 | -103.30 | 27.00 | 90.90 | 1.30 | 3.60 | 2.50 | 0.00 | 0.70 | 0.70 | 1.00 | 6.70 | 2.50 |
| H2743 | 23.040 | 31.258 | 80.118 | 458400.0 | 584000.0 | 45.3 | 0.20 | 99.10 | 0.50 | 0.20 | 20.30 | 14.80 | 0.00 | 36.90 | 25.60 | -116.70 | 34.50 | 89.00 | 0.90 | 4.00 | 3.40 | 0.00 | 0.70 | 0.70 | 1.00 | 6.00 | 1.90 |
| H2744 | 23.040 | 31.258 | 80.067 | 458400.0 | 588800.0 | 46.6 | 0.40 | 98.50 | 0.00 | 0.30 | 26.90 | 17.50 | 0.00 | 43.10 | 29.80 | -134.00 | 44.40 | 87.20 | 0.70 | 4.40 | 4.10 | 0.00 | 0.60 | 0.60 | 1.00 | 5.60 | 1.30 |
| H2745 | 23.040 | 31.258 | 80.017 | 458400.0 | 593600.0 | 47.2 | 0.70 | 98.00 | 0.90 | 0.30 | 34.20 | 20.80 | 0.00 | 38.60 | 35.70 | -140.10 | 54.40 | 86.30 | 0.80 | 4.80 | 4.70 | 0.00 | 0.40 | 0.40 | 1.00 | 5.30 | 0.80 |
| H2746 | 23.040 | 31.257 | 79.967 | 458400.0 | 598400.0 | 50.3 | 0.70 | 96.30 | 2.10 | 0.00 | 44.50 | 23.00 | 0.00 | 24.40 | 50.30 | -142.20 | 67.40 | 83.60 | 0.80 | 4.90 | 4.80 | 0.00 | 0.30 | 0.30 | 1.00 | 5.20 | 0.50 |
| H275 | 23.040 | 31.910 | 80.518 | 530400.0 | 545600.0 | 19.8 | 0.10 | 99.80 | 0.10 | 0.00 | 10.00 | 3.30 | 0.00 | 9.70 | 16.70 | -42.80 | 13.20 | 88.00 | 0.90 | 5.00 | 5.10 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 1.00 |
| H276 | 23.040 | 31.910 | 80.467 | 530400.0 | 550400.0 | 20.6 | 0.00 | 99.90 | 0.00 | 0.00 | 10.60 | 2.60 | 0.00 | 10.50 | 16.20 | -44.30 | 13.20 | 88.90 | 0.80 | 4.70 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| H2765 | 3.113 | 31.218 | 81.227 | 453600.0 | 478400.0 | 10.1 | 0.20 | 98.90 | 0.70 | 0.20 | 13.70 | 36.40 | 0.00 | 12.20 | 12.30 | -72.50 | 50.20 | 92.10 | 1.10 | 4.00 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.70 | 2.20 |
| H2766 | 22.581 | 31.218 | 81.176 | 453600.0 | 483200.0 | 10.9 | 0.10 | 99.00 | 0.60 | 0.10 | 13.70 | 37.00 | 0.00 | 11.60 | 12.70 | -73.30 | 50.70 | 90.60 | 1.20 | 4.00 | 2.00 | 0.00 | 0.00 | 0.00 | 1.10 | 9.30 | 1.90 |
| H2767 | 23.040 | 31.218 | 81.126 | 453600.0 | 488000.0 | 13.4 | 0.10 | 99.30 | 0.60 | 0.00 | 12.70 | 35.50 | 0.20 | 13.20 | 11.50 | -75.20 | 48.50 | 0.00 | 1.10 | 3.40 | 1.70 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2768 | 23.040 | 31.218 | 81.076 | 453600.0 | 492800.0 | 15.2 | 0.00 | 99.90 | 0.10 | 0.00 | 12.90 | 37.80 | 0.60 | 9.80 | 11.60 | -76.20 | 51.30 | 92.70 | 1.00 | 3.10 | 1.20 | 0.00 | 0.00 | 0.00 | 2.00 | 8.00 | 1.00 |
| H2769 | 23.040 | 31.218 | 81.025 | 453600.0 | 497600.0 | 16.9 | 0.00 | 99.90 | 0.00 | 0.00 | 12.40 | 40.80 | 1.30 | 5.60 | 12.50 | -77.00 | 54.40 | 92.70 | 1.00 | 3.10 | 1.20 | 0.00 | 0.00 | 0.00 | 2.00 | 8.00 | 1.00 |
| H277 | 23.040 | 31.910 | 80.416 | 530400.0 | 555200.0 | 21.8 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 1.70 | 0.00 | 9.80 | 16.20 | -45.00 | 13.40 | 90.40 | 0.40 | 4.20 | 4.10 | 0.00 | 0.00 | 0.00 | 0.10 | 11.40 | 1.00 |
| H2770 | 23.040 | 31.218 | 80.975 | 453600.0 | 502400.0 | 18.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 41.00 | 3.40 | 4.70 | 10.90 | -79.50 | 56.20 | 92.50 | 1.10 | 3.30 | 1.40 | 0.00 | 0.00 | 0.00 | 2.00 | 8.10 | 1.00 |
| H2771 | 23.040 | 31.218 | 80.924 | 453600.0 | 507200.0 | 19.5 | 0.00 | 100.00 | 0.00 | 0.00 | 10.80 | 40.10 | 8.10 | 5.20 | 6.30 | -83.80 | 59.00 | 92.40 | 1.20 | 3.40 | 1.60 | 0.00 | 0.00 | 0.00 | 1.90 | 8.40 | 0.90 |
| H2772 | 23.040 | 31.218 | 80.874 | 453600.0 | 512000.0 | 19.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 40.50 | 11.00 | 4.80 | 3.90 | -86.30 | 61.70 | 92.30 | 1.50 | 3.30 | 1.80 | 0.00 | 0.00 | 0.00 | 1.60 | 9.10 | 0.70 |
| H2773 | 23.040 | 31.218 | 80.824 | 453600.0 | 516800.0 | 20.4 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 37.00 | 10.40 | 6.20 | 5.00 | -83.80 | 57.20 | 92.10 | 1.80 | 3.10 | 1.90 | 0.00 | 0.00 | 0.00 | 1.40 | 9.80 | 0.50 |
| H2774 | 23.040 | 31.218 | 80.773 | 453600.0 | 521600.0 | 22.0 | 0.00 | 100.00 | 0.00 | 0.00 | 9.20 | 31.00 | 9.60 | 8.80 | 7.00 | -80.60 | 49.80 | 92.10 | 1.80 | 3.10 | 1.90 | 0.00 | 0.00 | 0.00 | 1.20 | 10.30 | 0.40 |
| H2775 | 23.040 | 31.218 | 80.723 | 453600.0 | 526400.0 | 24.2 | 0.00 | 100.00 | 0.00 | 0.00 | 8.60 | 28.10 | 9.50 | 10.10 | 8.00 | -80.50 | 46.20 | 92.20 | 1.60 | 3.30 | 1.80 | 0.00 | 0.00 | 0.00 | 1.10 | 10.50 | 0.40 |
| H2776 | 23.040 | 31.218 | 80.672 | 453600.0 | 531200.0 | 26.5 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 21.40 | 8.10 | 12.50 | 8.40 | -79.00 | 40.00 | 92.40 | 1.70 | 3.30 | 1.60 | 0.00 | 0.00 | 0.00 | 1.00 | 10.50 | 0.50 |
| H2777 | 23.040 | 31.218 | 80.622 | 453600.0 | 536000.0 | 28.6 | 0.00 | 100.00 | 0.00 | 0.00 | 14.10 | 10.50 | 5.80 | 16.30 | 9.00 | -75.30 | 30.40 | 92.70 | 1.90 | 3.10 | 1.30 | 0.00 | 0.00 | 0.00 | 1.00 | 10.50 | 0.60 |
| H2778 | 23.040 | 31.217 | 80.572 | 453600.0 | 540800.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 14.70 | 5.90 | 5.50 | 18.40 | 9.60 | -74.30 | 26.10 | 92.70 | 1.90 | 3.10 | 1.30 | 0.00 | 0.00 | 0.00 | 1.10 | 10.50 | 0.80 |
| H2779 | 23.040 | 31.217 | 80.521 | 453600.0 | 545600.0 | 30.0 | 0.00 | 100.00 | 0.00 | 0.00 | 13.50 | 4.40 | 6.20 | 20.60 | 10.50 | -74.60 | 24.00 | 92.20 | 1.80 | 3.20 | 1.80 | 0.00 | 0.00 | 0.00 | 1.10 | 10.50 | 0.80 |
| H278 | 23.040 | 31.910 | 80.365 | 530400.0 | 560000.0 | 23.4 | 0.00 | 100.00 | 0.00 | 0.00 | 12.20 | 2.10 | 0.00 | 9.80 | 10.80 | -47.40 | 14.20 | 91.00 | 0.30 | 3.90 | 3.80 | 0.00 | 0.00 | 0.00 | 0.40 | 10.10 | 1.00 |
| H2780 | 23.040 | 31.217 | 80.471 | 453600.0 | 550400.0 | 30.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.30 | 4.30 | 6.00 | 22.70 | 12.20 | -75.80 | 22.60 | 91.80 | 1.70 | 3.30 | 2.30 | 0.00 | 0.00 | 0.00 | 1.10 | 10.60 | 0.90 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MI.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2781 | 23.040 | 31.217 | 80.420 | 453600.0 | 555200.0 | 32.7 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 5.70 | 4.70 | 24.60 | 15.10 | -79.60 | 22.20 | 91.50 | 1.70 | 3.20 | 2.50 | 0.00 | 0.00 | 0.00 | 1.20 | 10.60 | 0.90 |
| H2782 | 23.040 | 31.217 | 80.370 | 453600.0 | 560000.0 | 35.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 7.70 | 3.10 | 25.90 | 18.00 | -84.30 | 22.80 | 91.70 | 1.70 | 3.20 | 2.30 | 0.00 | 0.10 | 0.10 | 1.20 | 10.20 | 1.00 |
| H2783 | 23.040 | 31.216 | 80.320 | 453600.0 | 564800.0 | 38.3 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 9.70 | 1.90 | 27.10 | 21.00 | -89.70 | 24.40 | 92.10 | 1.80 | 3.20 | 1.90 | 0.00 | 0.40 | 0.40 | 1.20 | 9.00 | 1.30 |
| H2784 | 23.040 | 31.216 | 80.269 | 453600.0 | 569600.0 | 40.0 | 0.00 | 100.00 | 0.00 | 0.00 | 14.50 | 11.20 | 0.90 | 29.70 | 23.40 | -96.40 | 26.70 | 92.60 | 1.90 | 3.10 | 1.30 | 0.00 | 0.60 | 0.60 | 1.00 | 7.50 | 1.70 |
| H2785 | 23.040 | 31.216 | 80.219 | 453600.0 | 574400.0 | 41.4 | 0.00 | 99.90 | 0.00 | 0.00 | 16.30 | 12.10 | 0.40 | 33.00 | 23.80 | -103.30 | 28.80 | 92.40 | 1.80 | 3.20 | 1.50 | 0.00 | 0.00 | 0.00 | 1.00 | 6.30 | 1.70 |
| H2786 | 23.040 | 31.216 | 80.169 | 453600.0 | 579200.0 | 43.6 | 0.20 | 99.60 | 0.20 | 0.10 | 19.10 | 13.40 | 0.10 | 36.50 | 25.00 | -112.70 | 32.60 | 91.00 | 1.40 | 3.60 | 2.40 | 0.00 | 0.00 | 0.00 | 1.00 | 5.70 | 1.50 |
| H2787 | 23.040 | 31.215 | 80.118 | 453600.0 | 584000.0 | 45.7 | 0.40 | 99.00 | 0.40 | 0.10 | 25.10 | 16.20 | 0.10 | 44.20 | 28.10 | -131.30 | 41.40 | 88.00 | 1.00 | 4.20 | 3.60 | 0.00 | 0.00 | 0.00 | 1.00 | 5.30 | 1.20 |
| H2788 | 23.040 | 31.215 | 80.068 | 453600.0 | 588800.0 | 47.2 | 0.70 | 98.70 | 0.40 | 0.10 | 28.20 | 17.50 | 0.00 | 48.90 | 30.70 | -141.00 | 45.70 | 87.40 | 0.90 | 4.70 | 4.40 | 0.00 | 0.70 | 0.70 | 1.00 | 5.20 | 1.00 |
| H2789 | 23.040 | 31.214 | 80.017 | 453600.0 | 593600.0 | 47.7 | 0.90 | 98.60 | 0.30 | 0.10 | 30.60 | 19.00 | 0.00 | 38.60 | 39.90 | -144.70 | 50.30 | 86.70 | 0.90 | 4.90 | 4.00 | 0.00 | 0.60 | 0.60 | 1.00 | 5.10 | 0.80 |
| H279 | 23.040 | 31.909 | 80.315 | 530400.0 | 564000.0 | 25.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 3.30 | 0.00 | 10.30 | 24.10 | -50.40 | 15.00 | 91.40 | 1.00 | 3.50 | 3.20 | 0.00 | 0.00 | 0.00 | 0.80 | 8.00 | 1.00 |
| H2790 | 23.040 | 31.214 | 79.967 | 453600.0 | 598400.0 | 53.7 | 0.70 | 97.10 | 1.60 | 0.50 | 56.10 | 22.70 | 0.00 | 22.90 | 53.80 | -155.40 | 78.80 | 79.90 | 0.70 | 4.00 | 4.60 | 0.00 | 0.50 | 0.50 | 1.00 | 5.10 | 0.60 |
| H280 | 23.040 | 31.909 | 80.264 | 530400.0 | 569600.0 | 26.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 4.90 | 0.00 | 10.90 | 30.30 | -53.20 | 15.70 | 91.00 | 2.20 | 2.70 | 2.50 | 0.00 | 0.00 | 0.00 | 1.20 | 6.00 | 1.00 |
| H2808 | 2.231 | 31.175 | 81.277 | 448800.0 | 473600.0 | 4.9 | 0.90 | 95.30 | 3.10 | 0.60 | 11.80 | 35.00 | 0.00 | 14.40 | 12.30 | -66.10 | 46.00 | 89.80 | 0.90 | 4.50 | 3.10 | 0.00 | 0.00 | 0.00 | 0.60 | 10.10 | 2.40 |
| H2809 | 14.688 | 31.175 | 81.227 | 448800.0 | 478400.0 | 8.6 | 0.40 | 97.20 | 2.10 | 0.30 | 12.40 | 35.60 | 0.00 | 13.50 | 12.40 | -70.20 | 48.10 | 91.40 | 0.90 | 4.30 | 2.80 | 0.00 | 0.00 | 0.00 | 1.00 | 9.50 | 2.00 |
| H281 | 23.040 | 31.909 | 80.213 | 530400.0 | 574400.0 | 28.3 | 0.00 | 99.90 | 0.00 | 0.00 | 9.50 | 6.00 | 0.00 | 11.50 | 34.00 | -55.30 | 15.60 | 91.70 | 2.70 | 2.40 | 2.20 | 0.00 | 0.00 | 0.00 | 1.50 | 4.70 | 1.10 |
| H2810 | 23.040 | 31.175 | 81.176 | 448800.0 | 483200.0 | 12.4 | 0.20 | 98.40 | 1.30 | 0.10 | 10.90 | 32.80 | 0.10 | 17.30 | 11.00 | -73.60 | 43.80 | 0.00 | 0.80 | 4.00 | 2.10 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.10 |
| H2811 | 23.040 | 31.175 | 81.126 | 448800.0 | 488000.0 | 14.1 | 0.10 | 99.50 | 0.40 | 0.00 | 12.10 | 34.10 | 0.30 | 14.60 | 10.80 | -75.30 | 46.60 | 92.20 | 0.90 | 3.50 | 1.50 | 0.00 | 0.00 | 0.00 | 2.00 | 8.00 | 1.00 |
| H2812 | 23.040 | 31.175 | 81.076 | 448800.0 | 492800.0 | 15.8 | 0.00 | 99.90 | 0.10 | 0.00 | 12.60 | 35.60 | 0.90 | 11.70 | 10.50 | -76.60 | 49.00 | 92.70 | 1.00 | 3.20 | 1.20 | 0.00 | 0.00 | 0.00 | 2.00 | 8.00 | 1.00 |
| H2813 | 23.040 | 31.175 | 81.025 | 448800.0 | 497600.0 | 17.6 | 0.00 | 99.90 | 0.10 | 0.00 | 12.50 | 36.90 | 2.00 | 9.10 | 10.00 | -78.00 | 51.30 | 92.20 | 1.00 | 3.50 | 1.40 | 0.00 | 0.00 | 0.00 | 2.00 | 8.10 | 1.00 |
| H2814 | 23.040 | 31.175 | 80.975 | 448800.0 | 502400.0 | 19.2 | 0.00 | 99.90 | 0.10 | 0.00 | 12.00 | 37.30 | 4.30 | 7.70 | 8.40 | -80.50 | 53.60 | 91.80 | 1.10 | 3.80 | 1.60 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 0.90 |
| H2815 | 23.040 | 31.175 | 80.924 | 448800.0 | 507200.0 | 19.9 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 37.30 | 7.70 | 7.00 | 5.90 | -83.00 | 56.10 | 91.90 | 1.30 | 3.60 | 1.80 | 0.00 | 0.00 | 0.00 | 1.80 | 8.70 | 0.80 |
| H2816 | 23.040 | 31.175 | 80.874 | 448800.0 | 512000.0 | 20.2 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 36.20 | 9.40 | 7.10 | 4.90 | -83.40 | 56.10 | 92.00 | 1.60 | 3.30 | 1.90 | 0.00 | 0.00 | 0.00 | 1.50 | 9.60 | 0.50 |
| H2817 | 23.040 | 31.175 | 80.824 | 448800.0 | 516800.0 | 21.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 31.30 | 9.10 | 9.10 | 6.30 | -80.60 | 50.40 | 92.00 | 1.80 | 3.20 | 2.00 | 0.00 | 0.00 | 0.00 | 1.20 | 10.30 | 0.30 |
| H2818 | 23.040 | 31.175 | 80.773 | 448800.0 | 521600.0 | 22.7 | 0.00 | 100.00 | 0.00 | 0.00 | 9.00 | 27.60 | 9.20 | 10.50 | 7.70 | -79.20 | 45.90 | 92.10 | 1.50 | 3.40 | 1.90 | 0.00 | 0.00 | 0.00 | 1.10 | 10.70 | 0.20 |
| H2819 | 23.040 | 31.175 | 80.723 | 448800.0 | 526400.0 | 24.4 | 0.00 | 100.00 | 0.00 | 0.00 | 9.70 | 24.40 | 8.00 | 11.70 | 8.10 | -79.00 | 42.90 | 92.20 | 1.40 | 3.60 | 1.80 | 0.00 | 0.00 | 0.00 | 1.10 | 10.80 | 0.20 |
| H282 | 23.040 | 31.908 | 80.162 | 530400.0 | 579200.0 | 29.7 | 0.20 | 99.60 | 0.00 | 0.00 | 8.30 | 6.70 | 0.00 | 12.20 | 36.30 | -57.00 | 15.00 | 91.10 | 2.70 | 3.10 | 2.30 | 0.00 | 0.00 | 0.00 | 1.70 | 4.30 | 1.30 |
| H2820 | 23.040 | 31.174 | 80.673 | 448800.0 | 531200.0 | 26.0 | 0.00 | 100.00 | 0.00 | 0.00 | 13.40 | 13.90 | 6.50 | 15.10 | 8.60 | -75.00 | 33.80 | 92.40 | 1.50 | 3.40 | 1.60 | 0.00 | 0.00 | 0.00 | 1.10 | 10.90 | 0.30 |
| H2821 | 23.040 | 31.174 | 80.622 | 448800.0 | 536000.0 | 27.7 | 0.00 | 100.00 | 0.00 | 0.00 | 16.50 | 5.50 | 4.00 | 17.60 | 9.00 | -72.20 | 26.90 | 92.60 | 1.70 | 3.20 | 1.50 | 0.00 | 0.00 | 0.00 | 1.10 | 11.00 | 0.40 |
| H2822 | 23.040 | 31.174 | 80.572 | 448800.0 | 540800.0 | 29.2 | 0.00 | 100.00 | 0.00 | 0.00 | 15.60 | 3.90 | 6.20 | 19.20 | 9.20 | -74.10 | 25.70 | 92.30 | 1.70 | 3.10 | 1.80 | 0.00 | 0.00 | 0.00 | 1.20 | 11.20 | 0.60 |
| H2823 | 23.040 | 31.174 | 80.521 | 448800.0 | 545600.0 | 30.2 | 0.00 | 100.00 | 0.00 | 0.00 | 13.70 | 2.90 | 8.60 | 21.50 | 9.30 | -76.90 | 25.20 | 91.60 | 1.50 | 3.20 | 2.70 | 0.00 | 0.00 | 0.00 | 1.30 | 11.40 | 0.70 |
| H2824 | 23.040 | 31.174 | 80.471 | 448800.0 | 550400.0 | 31.2 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 4.30 | 8.10 | 24.10 | 10.50 | -80.50 | 25.20 | 91.30 | 1.50 | 3.20 | 3.00 | 0.00 | 0.00 | 0.00 | 1.40 | 11.70 | 0.80 |
| H2825 | 23.040 | 31.174 | 80.421 | 448800.0 | 555200.0 | 33.2 | 0.00 | 100.00 | 0.00 | 0.00 | 12.40 | 7.50 | 6.30 | 27.70 | 12.80 | -87.00 | 26.10 | 91.50 | 1.50 | 3.20 | 2.00 | 0.00 | 0.10 | 0.00 | 1.60 | 11.90 | 0.90 |
| H2826 | 23.040 | 31.173 | 80.370 | 448800.0 | 560000.0 | 35.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 9.70 | 4.50 | 29.60 | 15.50 | -92.70 | 27.40 | 91.90 | 1.70 | 3.20 | 2.20 | 0.00 | 0.20 | 0.20 | 1.60 | 11.20 | 1.00 |
| H2827 | 23.040 | 31.173 | 80.320 | 448800.0 | 564800.0 | 38.3 | 0.00 | 100.00 | 0.00 | 0.00 | 14.00 | 11.00 | 2.00 | 31.30 | 18.00 | -98.20 | 28.60 | 92.40 | 1.80 | 3.20 | 1.60 | 0.00 | 0.50 | 0.40 | 1.50 | 9.40 | 1.00 |
| H2828 | 23.040 | 31.173 | 80.270 | 448800.0 | 569600.0 | 40.3 | 0.00 | 100.00 | 0.00 | 0.00 | 17.10 | 12.50 | 1.40 | 33.60 | 21.40 | -104.80 | 30.90 | 92.60 | 1.90 | 3.10 | 1.40 | 0.00 | 0.70 | 0.70 | 1.20 | 7.10 | 1.10 |
| H2829 | 23.040 | 31.173 | 80.219 | 448800.0 | 574400.0 | 42.3 | 0.10 | 99.80 | 0.10 | 0.00 | 19.30 | 13.00 | 0.60 | 36.60 | 23.10 | -112.60 | 33.80 | 91.60 | 1.60 | 3.40 | 1.90 | 0.00 | 0.90 | 0.90 | 1.00 | 5.60 | 1.10 |
| H283 | 23.040 | 31.908 | 80.112 | 530400.0 | 584000.0 | 31.6 | 0.50 | 99.00 | 0.00 | 0.00 | 9.00 | 7.10 | 0.00 | 13.50 | 34.00 | -61.20 | 16.10 | 90.10 | 3.00 | 4.00 | 2.30 | 0.00 | 0.00 | 0.00 | 1.00 | 4.90 | 1.00 |
| H2830 | 23.040 | 31.172 | 80.169 | 448800.0 | 579200.0 | 44.4 | 0.20 | 99.40 | 0.30 | 0.10 | 23.20 | 15.50 | 0.20 | 40.50 | 25.80 | -123.80 | 30.80 | 89.70 | 1.30 | 3.80 | 2.80 | 0.00 | 0.90 | 0.90 | 1.00 | 5.20 | 1.00 |
| H2831 | 23.040 | 31.172 | 80.119 | 448800.0 | 584000.0 | 46.6 | 0.50 | 99.00 | 0.40 | 0.10 | 28.20 | 17.00 | 0.10 | 45.10 | 30.00 | -137.00 | 45.30 | 87.40 | 1.00 | 4.30 | 3.70 | 0.00 | 0.90 | 0.90 | 1.00 | 5.10 | 1.00 |
| H2832 | 23.040 | 31.172 | 80.068 | 448800.0 | 588800.0 | 48.0 | 0.70 | 98.70 | 0.40 | 0.10 | 35.20 | 18.30 | 0.00 | 43.00 | 36.30 | -144.40 | 53.40 | 86.20 | 0.90 | 4.70 | 4.30 | 0.00 | 0.90 | 0.90 | 1.00 | 5.00 | 0.90 |
| H2833 | 23.040 | 31.171 | 80.018 | 448800.0 | 593600.0 | 48.5 | 0.80 | 98.30 | 0.70 | 0.20 | 54.20 | 21.70 | 0.00 | 28.60 | 49.50 | -152.90 | 75.00 | 83.00 | 0.80 | 4.80 | 4.40 | 0.00 | 0.80 | 0.00 | 1.00 | 5.00 | 0.90 |
| H2834 | 23.040 | 31.171 | 79.967 | 448800.0 | 598400.0 | 60.7 | 0.50 | 96.70 | 2.20 | 0.50 | 68.90 | 24.00 | 0.00 | 18.00 | 58.10 | -172.40 | 92.90 | 72.00 | 0.50 | 4.40 | 3.80 | 0.00 | 0.80 | 0.00 | 1.00 | 5.00 | 0.00 |
| H284 | 23.040 | 31.908 | 80.061 | 530400.0 | 588800.0 | 34.2 | 0.00 | 98.50 | 0.00 | 0.00 | 9.00 | 7.80 | 0.00 | 14.40 | 33.70 | -65.40 | 16.00 | 89.30 | 3.50 | 4.70 | 2.20 | 0.00 | 0.10 | 0.00 | 1.90 | 6.70 | 2.40 |
| H285 | 23.040 | 31.907 | 80.010 | 530400.0 | 593600.0 | 35.8 | 0.70 | 98.60 | 0.00 | 0.00 | 9.10 | 8.00 | 0.00 | 15.10 | 32.90 | -68.10 | 17.10 | 89.20 | 3.30 | 4.70 | 2.30 | 0.00 | 0.10 | 0.00 | 1.90 | 8.60 | 2.00 |
| H2853 | 23.040 | 31.131 | 81.227 | 444000.0 | 478400.0 | 11.8 | 0.20 | 97.30 | 2.10 | 0.40 | 10.80 | 32.20 | 0.00 | 17.90 | 10.80 | -72.80 | 43.10 | 0.00 | 0.40 | 5.20 | 3.10 | 0.00 | 0.00 | 0.00 | 1.80 | 8.30 | 1.20 |
| H2854 | 23.040 | 31.131 | 81.176 | 444000.0 | 483200.0 | 13.3 | 0.10 | 98.50 | 1.10 | 0.30 | 11.40 | 31.90 | 0.10 | 17.40 | 10.10 | -74.10 | 43.50 | 90.90 | 0.60 | 4.60 | 2.40 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2855 | 23.040 | 31.132 | 81.126 | 444000.0 | 488000.0 | 14.7 | 0.00 | 99.40 | 0.40 | 0.10 | 12.50 | 32.00 | 0.30 | 15.80 | 9.30 | -75.30 | 44.80 | 91.70 | 0.80 | 4.00 | 1.80 | 0.00 | 0.00 | 0.00 | 2.00 | 8.10 | 1.00 |
| H2856 | 23.040 | 31.132 | 81.076 | 444000.0 | 492800.0 | 16.1 | 0.00 | 99.80 | 0.20 | 0.00 | 12.90 | 32.20 | 0.80 | 14.10 | 8.80 | -76.30 | 46.00 | 91.70 | 0.90 | 4.00 | 1.60 | 0.00 | 0.00 | 0.00 | 2.00 | 8.10 | 1.00 |
| H2857 | 23.040 | 31.132 | 81.025 | 444000.0 | 497600.0 | 17.6 | 0.00 | 99.90 | 0.10 | 0.00 | 13.10 | 32.70 | 1.90 | 12.20 | 8.00 | -77.40 | 47.70 | 91.10 | 1.00 | 4.40 | 1.70 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 0.90 |
| H2858 | 23.040 | 31.132 | 80.975 | 444000.0 | 502400.0 | 19.0 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 32.70 | 3.60 | 10.90 | 6.90 | -79.00 | 49.10 | 90.80 | 1.10 | 4.50 | 1.90 | 0.00 | 0.00 | 0.00 | 1.80 | 8.70 | 0.80 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | ML.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2859 | 23.040 | 31.132 | 80.924 | 444000.0 | 507200.0 | 19.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.10 | 32.10 | 5.50 | 10.40 | 5.00 | -80.00 | 49.80 | 91.30 | 1.30 | 4.10 | 1.90 | 0.00 | 0.00 | 0.00 | 1.50 | 9.30 | 0.60 |
| H286 | 23.040 | 31.907 | 79.959 | 530400.0 | 598400.0 | 37.8 | 0.50 | 99.10 | 0.00 | 0.00 | 9.10 | 8.20 | 0.00 | 15.50 | 33.00 | -70.50 | 17.20 | 88.90 | 2.00 | 4.70 | 2.70 | 0.00 | 0.00 | 0.00 | 2.00 | 9.60 | 3.00 |
| H2860 | 23.040 | 31.132 | 80.874 | 444000.0 | 512000.0 | 20.3 | 0.00 | 100.00 | 0.00 | 0.00 | 11.40 | 30.30 | 6.00 | 10.70 | 5.70 | -79.50 | 48.50 | 91.80 | 1.40 | 3.70 | 1.90 | 0.00 | 0.00 | 0.00 | 1.30 | 10.10 | 0.30 |
| H2861 | 23.040 | 31.131 | 80.824 | 444000.0 | 516800.0 | 21.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 26.90 | 7.60 | 11.00 | 6.60 | -78.30 | 45.20 | 92.00 | 1.30 | 3.70 | 2.00 | 0.00 | 0.00 | 0.00 | 1.10 | 10.70 | 0.10 |
| H2862 | 23.040 | 31.131 | 80.773 | 444000.0 | 521600.0 | 22.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.40 | 23.70 | 7.90 | 12.70 | 7.70 | -77.60 | 42.00 | 92.00 | 1.00 | 4.00 | 1.90 | 0.00 | 0.00 | 0.00 | 1.00 | 10.90 | 0.10 |
| H2863 | 23.040 | 31.131 | 80.723 | 444000.0 | 526400.0 | 24.3 | 0.00 | 100.00 | 0.00 | 0.00 | 12.10 | 17.60 | 7.10 | 14.70 | 8.40 | -75.00 | 36.00 | 92.20 | 0.90 | 4.00 | 1.90 | 0.00 | 0.00 | 0.00 | 1.00 | 11.00 | 0.10 |
| H2864 | 23.040 | 31.131 | 80.673 | 444000.0 | 531200.0 | 25.8 | 0.00 | 100.00 | 0.00 | 0.00 | 15.50 | 7.70 | 5.40 | 17.60 | 8.90 | -72.10 | 28.60 | 92.20 | 1.20 | 3.70 | 1.80 | 0.00 | 0.00 | 0.00 | 1.10 | 11.20 | 0.10 |
| H2865 | 23.040 | 31.131 | 80.622 | 444000.0 | 536000.0 | 27.3 | 0.00 | 100.00 | 0.00 | 0.00 | 16.40 | 3.90 | 5.50 | 19.00 | 9.00 | -72.10 | 25.00 | 92.10 | 1.40 | 3.40 | 2.00 | 0.00 | 0.00 | 0.00 | 1.20 | 11.50 | 0.30 |
| H2866 | 23.040 | 31.131 | 80.572 | 444000.0 | 540800.0 | 28.8 | 0.00 | 100.00 | 0.00 | 0.00 | 14.30 | 2.40 | 0.00 | 20.90 | 8.70 | -75.20 | 25.30 | 91.50 | 1.40 | 3.20 | 2.90 | 0.00 | 0.00 | 0.00 | 1.40 | 12.10 | 0.40 |
| H2867 | 23.040 | 31.131 | 80.522 | 444000.0 | 545600.0 | 30.0 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 1.50 | 10.60 | 22.60 | 8.70 | -77.90 | 25.30 | 90.90 | 1.30 | 3.10 | 3.70 | 0.00 | 0.00 | 0.00 | 1.70 | 12.80 | 0.60 |
| H2868 | 23.040 | 31.130 | 80.471 | 444000.0 | 550400.0 | 31.3 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 5.30 | 0.00 | 26.50 | 10.10 | -84.40 | 26.60 | 90.80 | 1.20 | 3.10 | 3.80 | 0.00 | 0.00 | 0.00 | 1.90 | 13.40 | 0.80 |
| H2869 | 23.040 | 31.130 | 80.421 | 444000.0 | 555200.0 | 33.3 | 0.00 | 100.00 | 0.00 | 0.00 | 11.00 | 9.50 | 7.10 | 31.50 | 11.20 | -93.20 | 28.40 | 91.20 | 1.40 | 3.20 | 3.20 | 0.00 | 0.10 | 0.10 | 2.10 | 13.60 | 0.90 |
| H2870 | 23.040 | 31.130 | 80.371 | 444000.0 | 560000.0 | 35.8 | 0.00 | 100.00 | 0.00 | 0.00 | 13.90 | 11.70 | 5.00 | 32.40 | 13.50 | -98.70 | 30.50 | 91.80 | 1.50 | 3.30 | 2.40 | 0.00 | 0.20 | 0.20 | 2.00 | 12.60 | 0.90 |
| H2871 | 23.040 | 31.130 | 80.320 | 444000.0 | 564800.0 | 38.3 | 0.00 | 100.00 | 0.00 | 0.00 | 17.30 | 12.60 | 2.60 | 33.00 | 17.70 | -104.50 | 32.50 | 92.00 | 1.50 | 3.40 | 2.00 | 0.00 | 0.50 | 0.50 | 1.80 | 10.30 | 1.00 |
| H2872 | 23.040 | 31.130 | 80.270 | 444000.0 | 569600.0 | 40.3 | 0.00 | 99.90 | 0.00 | 0.00 | 19.50 | 14.30 | 1.20 | 35.00 | 19.30 | -111.30 | 35.10 | 91.90 | 1.50 | 3.50 | 2.10 | 0.00 | 0.80 | 0.80 | 1.40 | 7.40 | 1.00 |
| H2873 | 23.040 | 31.129 | 80.220 | 444000.0 | 574400.0 | 42.5 | 0.10 | 99.70 | 0.20 | 0.10 | 21.40 | 16.60 | 0.40 | 39.20 | 19.70 | -120.20 | 38.40 | 91.00 | 1.30 | 3.70 | 2.50 | 0.00 | 0.90 | 0.90 | 1.10 | 5.70 | 1.00 |
| H2874 | 23.040 | 31.129 | 80.169 | 444000.0 | 579200.0 | 45.1 | 0.30 | 99.10 | 0.40 | 0.10 | 24.90 | 17.90 | 0.00 | 43.00 | 22.00 | -130.90 | 42.00 | 89.10 | 1.00 | 4.00 | 3.10 | 0.00 | 1.00 | 1.00 | 1.00 | 5.10 | 1.00 |
| H2875 | 23.040 | 31.129 | 80.119 | 444000.0 | 584000.0 | 47.6 | 0.40 | 98.60 | 0.70 | 0.20 | 30.70 | 18.20 | 0.00 | 44.20 | 29.40 | -140.70 | 48.90 | 86.60 | 0.80 | 4.40 | 3.60 | 0.00 | 0.90 | 0.90 | 1.00 | 5.00 | 1.00 |
| H2876 | 23.040 | 31.128 | 80.069 | 444000.0 | 588800.0 | 49.0 | 0.50 | 98.50 | 0.80 | 0.20 | 41.20 | 18.40 | 0.00 | 38.00 | 40.40 | -147.50 | 59.60 | 84.90 | 0.60 | 4.60 | 3.80 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2877 | 23.040 | 31.128 | 80.018 | 444000.0 | 593600.0 | 50.5 | 0.40 | 98.30 | 0.90 | 0.20 | 56.10 | 20.30 | 0.00 | 27.20 | 53.10 | -154.10 | 76.40 | 81.90 | 0.50 | 4.60 | 3.60 | 0.00 | 0.90 | 0.90 | 1.00 | 5.00 | 0.90 |
| H2878 | 22.890 | 31.127 | 79.968 | 444000.0 | 598400.0 | 48.4 | 0.70 | 98.30 | 0.70 | 0.20 | 55.50 | 21.70 | 0.00 | 27.70 | 50.40 | -153.50 | 77.20 | 71.60 | 0.80 | 4.80 | 4.40 | 0.00 | 0.90 | 0.90 | 1.00 | 5.00 | 0.90 |
| H2895 | 8.862 | 31.088 | 81.327 | 439200.0 | 468800.0 | 6.7 | 0.60 | 95.10 | 3.90 | 0.40 | 11.50 | 34.30 | 0.00 | 15.40 | 12.00 | -67.90 | 45.00 | 90.40 | 0.80 | 4.80 | 3.10 | 0.00 | 0.00 | 0.00 | 0.80 | 9.80 | 2.20 |
| H2896 | 17.723 | 31.088 | 81.277 | 439200.0 | 473600.0 | 8.8 | 0.10 | 94.80 | 4.50 | 0.50 | 11.80 | 33.10 | 0.00 | 16.00 | 11.30 | -69.00 | 44.30 | 89.50 | 0.40 | 5.50 | 3.30 | 0.00 | 0.00 | 0.00 | 1.20 | 9.30 | 1.80 |
| H2897 | 23.040 | 31.088 | 81.226 | 439200.0 | 478400.0 | 11.6 | 0.00 | 98.40 | 1.20 | 0.30 | 11.30 | 30.60 | 0.00 | 18.60 | 9.50 | -72.20 | 41.90 | 0.00 | 0.20 | 5.70 | 3.50 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 1.10 |
| H2898 | 23.040 | 31.088 | 81.176 | 439200.0 | 483200.0 | 13.0 | 0.00 | 99.00 | 0.80 | 0.20 | 11.90 | 29.30 | 0.10 | 19.10 | 8.40 | -73.40 | 41.20 | 90.10 | 0.40 | 5.20 | 2.00 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2899 | 23.040 | 31.088 | 81.126 | 439200.0 | 488000.0 | 14.5 | 0.00 | 99.40 | 0.50 | 0.00 | 12.40 | 28.90 | 0.20 | 18.40 | 7.80 | -74.50 | 41.60 | 90.70 | 0.70 | 4.80 | 2.30 | 0.00 | 0.00 | 0.00 | 1.90 | 8.10 | 1.00 |
| H2900 | 23.040 | 31.088 | 81.075 | 439200.0 | 492800.0 | 15.9 | 0.00 | 99.80 | 0.20 | 0.00 | 13.50 | 29.10 | 0.60 | 16.10 | 7.20 | -75.20 | 43.20 | 90.40 | 0.90 | 5.00 | 2.00 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 0.90 |
| H2901 | 23.040 | 31.088 | 81.025 | 439200.0 | 497600.0 | 17.3 | 0.00 | 99.90 | 0.10 | 0.00 | 14.30 | 28.90 | 1.10 | 14.20 | 6.40 | -75.90 | 44.30 | 89.90 | 1.00 | 5.30 | 2.00 | 0.00 | 0.00 | 0.00 | 1.80 | 8.60 | 0.80 |
| H2902 | 23.040 | 31.088 | 80.975 | 439200.0 | 502400.0 | 18.7 | 0.00 | 100.00 | 0.00 | 0.00 | 14.10 | 28.00 | 2.10 | 13.70 | 5.70 | -76.60 | 44.20 | 90.20 | 1.00 | 5.10 | 2.10 | 0.00 | 0.00 | 0.00 | 1.60 | 9.30 | 0.60 |
| H2903 | 23.040 | 31.088 | 80.925 | 439200.0 | 507200.0 | 19.8 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 26.50 | 3.20 | 14.10 | 5.10 | -76.00 | 43.00 | 91.00 | 1.00 | 4.50 | 2.10 | 0.00 | 0.00 | 0.00 | 1.30 | 10.20 | 0.30 |
| H2904 | 23.040 | 31.088 | 80.874 | 439200.0 | 512000.0 | 20.3 | 0.00 | 100.00 | 0.00 | 0.00 | 12.40 | 24.60 | 4.30 | 14.70 | 5.30 | -76.20 | 41.20 | 91.70 | 1.00 | 4.20 | 2.00 | 0.00 | 0.00 | 0.00 | 1.10 | 10.70 | 0.10 |
| H2905 | 23.040 | 31.088 | 80.824 | 439200.0 | 516800.0 | 21.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.00 | 22.20 | 5.20 | 15.20 | 6.30 | -75.00 | 39.20 | 91.90 | 0.60 | 4.40 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 10.90 | 0.00 |
| H2906 | 23.040 | 31.088 | 80.774 | 439200.0 | 521600.0 | 23.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 19.10 | 5.70 | 15.90 | 7.70 | -75.50 | 36.60 | 92.00 | 0.40 | 4.60 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 11.00 | 0.00 |
| H2907 | 23.040 | 31.088 | 80.723 | 439200.0 | 526400.0 | 24.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 13.90 | 5.60 | 17.40 | 8.00 | -74.60 | 32.50 | 92.00 | 0.50 | 4.40 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 11.10 | 0.00 |
| H2908 | 23.040 | 31.088 | 80.673 | 439200.0 | 531200.0 | 26.3 | 0.00 | 100.00 | 0.00 | 0.00 | 14.60 | 8.20 | 5.50 | 19.10 | 9.30 | -73.00 | 28.40 | 91.90 | 0.90 | 3.90 | 2.30 | 0.00 | 0.00 | 0.00 | 1.10 | 11.40 | 0.10 |
| H2909 | 23.040 | 31.088 | 80.623 | 439200.0 | 536000.0 | 28.0 | 0.00 | 100.00 | 0.00 | 0.00 | 14.50 | 5.10 | 6.90 | 20.00 | 9.30 | -75.30 | 26.50 | 91.50 | 1.10 | 3.40 | 2.00 | 0.00 | 0.00 | 0.00 | 1.40 | 12.10 | 0.30 |
| H2910 | 23.040 | 31.088 | 80.572 | 439200.0 | 540800.0 | 29.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.30 | 3.00 | 9.60 | 22.60 | 8.90 | -78.20 | 25.90 | 90.80 | 1.10 | 3.20 | 3.00 | 0.00 | 0.00 | 0.00 | 1.80 | 13.20 | 0.50 |
| H2911 | 23.040 | 31.087 | 80.522 | 439200.0 | 545600.0 | 31.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.60 | 4.50 | 9.40 | 25.50 | 9.50 | -83.50 | 26.60 | 90.30 | 1.10 | 3.10 | 4.50 | 0.00 | 0.00 | 0.00 | 2.10 | 14.30 | 0.70 |
| H2912 | 23.040 | 31.087 | 80.472 | 439200.0 | 550400.0 | 33.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.50 | 9.00 | 7.80 | 31.20 | 10.60 | -93.00 | 28.30 | 90.50 | 1.10 | 3.10 | 4.20 | 0.00 | 0.00 | 0.00 | 2.40 | 15.00 | 0.80 |
| H2913 | 23.040 | 31.087 | 80.421 | 439200.0 | 555200.0 | 35.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 11.20 | 6.90 | 33.90 | 11.20 | -99.20 | 29.70 | 91.00 | 1.20 | 3.30 | 3.40 | 0.00 | 0.10 | 0.10 | 2.50 | 15.00 | 0.90 |
| H2914 | 23.040 | 31.087 | 80.371 | 439200.0 | 560000.0 | 37.6 | 0.00 | 100.00 | 0.00 | 0.00 | 15.90 | 13.50 | 3.80 | 33.40 | 14.20 | -104.20 | 33.20 | 91.50 | 1.30 | 3.40 | 2.70 | 0.00 | 0.20 | 0.20 | 2.40 | 13.90 | 1.00 |
| H2915 | 23.040 | 31.086 | 80.321 | 439200.0 | 564800.0 | 39.5 | 0.00 | 99.90 | 0.00 | 0.00 | 20.30 | 14.50 | 1.20 | 34.50 | 18.40 | -110.00 | 36.00 | 91.40 | 1.20 | 3.70 | 2.60 | 0.00 | 0.50 | 0.50 | 2.00 | 11.20 | 1.00 |
| H2916 | 23.040 | 31.086 | 80.270 | 439200.0 | 569600.0 | 41.3 | 0.00 | 99.90 | 0.10 | 0.00 | 21.10 | 16.40 | 0.50 | 36.10 | 17.50 | -115.50 | 38.10 | 91.30 | 1.10 | 3.80 | 2.70 | 0.00 | 0.80 | 0.80 | 1.50 | 7.80 | 1.00 |
| H2917 | 23.040 | 31.086 | 80.220 | 439200.0 | 574400.0 | 43.4 | 0.10 | 99.60 | 0.30 | 0.10 | 21.40 | 19.50 | 0.20 | 42.40 | 15.10 | -127.00 | 41.10 | 90.90 | 1.00 | 3.90 | 2.70 | 0.00 | 0.90 | 0.90 | 1.10 | 5.80 | 1.00 |
| H2918 | 23.040 | 31.086 | 80.170 | 439200.0 | 579200.0 | 45.5 | 0.20 | 98.90 | 0.70 | 0.30 | 23.40 | 21.10 | 0.10 | 47.00 | 16.30 | -138.00 | 44.60 | 89.30 | 0.80 | 4.10 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 5.10 | 1.00 |
| H2919 | 23.040 | 31.085 | 80.119 | 439200.0 | 584000.0 | 47.6 | 0.30 | 98.20 | 1.10 | 0.40 | 30.80 | 19.10 | 0.00 | 48.50 | 25.90 | -146.00 | 49.90 | 86.90 | 0.60 | 4.30 | 3.20 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2920 | 23.040 | 31.085 | 80.069 | 439200.0 | 588800.0 | 49.3 | 0.20 | 98.40 | 1.00 | 0.30 | 41.20 | 16.10 | 0.00 | 44.20 | 39.50 | -150.00 | 57.30 | 85.80 | 0.30 | 4.60 | 3.20 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2921 | 23.040 | 31.085 | 80.019 | 439200.0 | 593600.0 | 56.6 | 0.20 | 98.90 | 0.70 | 0.20 | 47.20 | 14.80 | 0.00 | 35.70 | 52.10 | -154.30 | 61.90 | 85.40 | 0.10 | 4.80 | 3.10 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2922 | 18.440 | 31.084 | 79.968 | 439200.0 | 598400.0 | 49.1 | 0.50 | 98.40 | 0.80 | 0.20 | 54.50 | 20.40 | 0.00 | 28.70 | 51.20 | -152.70 | 75.00 | 89.20 | 0.50 | 4.70 | 3.80 | 0.00 | 0.90 | 0.90 | 1.00 | 5.00 | 0.90 |
| H2939 | 18.066 | 31.045 | 81.327 | 434400.0 | 468800.0 | 6.6 | 0.40 | 91.90 | 5.10 | 2.40 | 11.20 | 32.00 | 0.00 | 17.60 | 10.60 | -67.50 | 43.30 | 89.20 | 0.30 | 5.80 | 3.40 | 0.00 | 0.00 | 0.00 | 1.30 | 9.90 | 1.80 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H2940 | 23.040 | 31.045 | 81.277 | 434400.0 | 473600.0 | 13.1 | 0.00 | 98.80 | 0.90 | 0.20 | 11.90 | 28.20 | 0.00 | 20.00 | 7.80 | -73.30 | 40.10 | 0.00 | 0.10 | 5.90 | 3.60 | 0.00 | 0.00 | 0.00 | 1.90 | 8.70 | 1.00 |
| H2942 | 23.040 | 31.045 | 81.176 | 434400.0 | 483200.0 | 14.7 | 0.00 | 99.00 | 0.90 | 0.10 | 12.10 | 27.50 | 0.00 | 20.40 | 7.30 | -74.70 | 39.60 | 89.60 | 0.40 | 5.70 | 2.90 | 0.00 | 0.00 | 0.00 | 1.90 | 8.20 | 1.00 |
| H2943 | 23.040 | 31.045 | 81.126 | 434400.0 | 488000.0 | 16.2 | 0.00 | 99.50 | 0.50 | 0.00 | 12.70 | 27.50 | 0.10 | 19.30 | 7.00 | -75.80 | 40.30 | 89.80 | 0.70 | 5.50 | 2.40 | 0.00 | 0.00 | 0.00 | 1.90 | 8.30 | 0.90 |
| H2944 | 23.040 | 31.045 | 81.075 | 434400.0 | 492800.0 | 17.7 | 0.00 | 99.90 | 0.10 | 0.00 | 14.50 | 27.20 | 0.30 | 16.40 | 6.20 | -76.10 | 42.00 | 89.50 | 0.90 | 5.70 | 2.10 | 0.00 | 0.00 | 0.00 | 1.80 | 8.50 | 0.80 |
| H2945 | 23.040 | 31.045 | 81.025 | 434400.0 | 497600.0 | 19.2 | 0.00 | 100.00 | 0.00 | 0.00 | 15.80 | 26.50 | 0.40 | 14.60 | 5.40 | -76.70 | 42.80 | 89.30 | 0.90 | 5.70 | 2.10 | 0.00 | 0.00 | 0.00 | 1.60 | 9.10 | 0.60 |
| H2946 | 23.040 | 31.045 | 80.975 | 434400.0 | 502400.0 | 20.5 | 0.00 | 100.00 | 0.00 | 0.00 | 15.20 | 25.00 | 0.90 | 15.30 | 4.80 | -76.90 | 41.10 | 90.10 | 0.80 | 5.20 | 2.20 | 0.00 | 0.00 | 0.00 | 1.40 | 9.90 | 0.40 |
| H2947 | 23.040 | 31.045 | 80.925 | 434400.0 | 507200.0 | 21.5 | 0.00 | 100.00 | 0.00 | 0.00 | 14.00 | 21.40 | 1.50 | 17.40 | 3.80 | -75.80 | 36.90 | 91.10 | 0.70 | 4.70 | 2.20 | 0.00 | 0.00 | 0.00 | 1.10 | 10.60 | 0.10 |
| H2948 | 23.040 | 31.045 | 80.874 | 434400.0 | 512000.0 | 22.5 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 19.10 | 2.00 | 18.60 | 3.80 | -75.50 | 34.30 | 91.80 | 0.50 | 4.60 | 2.10 | 0.00 | 0.00 | 0.00 | 1.00 | 10.90 | 0.00 |
| H2949 | 23.040 | 31.045 | 80.824 | 434400.0 | 516800.0 | 23.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 18.10 | 2.80 | 18.70 | 5.80 | -75.90 | 33.40 | 92.00 | 0.20 | 4.80 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 11.00 | 0.00 |
| H2950 | 23.040 | 31.045 | 80.774 | 434400.0 | 521600.0 | 25.0 | 0.00 | 100.00 | 0.00 | 0.00 | 12.20 | 16.40 | 3.50 | 18.90 | 8.30 | -76.00 | 32.10 | 92.10 | 0.20 | 4.80 | 2.00 | 0.00 | 0.00 | 0.00 | 1.00 | 11.00 | 0.00 |
| H2951 | 23.040 | 31.045 | 80.723 | 434400.0 | 526400.0 | 26.2 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 13.20 | 4.00 | 19.80 | 9.80 | -75.90 | 29.90 | 92.10 | 0.50 | 4.30 | 2.10 | 0.00 | 0.00 | 0.00 | 1.10 | 11.20 | 0.00 |
| H2952 | 23.040 | 31.045 | 80.673 | 434400.0 | 531200.0 | 27.5 | 0.00 | 100.00 | 0.00 | 0.00 | 13.30 | 9.90 | 4.80 | 20.90 | 10.50 | -76.40 | 28.00 | 91.70 | 0.80 | 3.70 | 2.70 | 0.00 | 0.00 | 0.00 | 1.30 | 11.70 | 0.10 |
| H2953 | 23.040 | 31.044 | 80.623 | 434400.0 | 536000.0 | 28.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.40 | 7.40 | 6.20 | 22.50 | 10.60 | -78.20 | 27.00 | 90.90 | 1.00 | 3.30 | 3.70 | 0.00 | 0.00 | 0.00 | 1.70 | 13.00 | 0.30 |
| H2954 | 23.040 | 31.044 | 80.572 | 434400.0 | 540800.0 | 30.1 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 6.70 | 7.30 | 24.40 | 10.50 | -81.50 | 27.10 | 90.30 | 1.00 | 3.10 | 4.60 | 0.00 | 0.00 | 0.00 | 2.20 | 14.50 | 0.60 |
| H2955 | 23.040 | 31.044 | 80.522 | 434400.0 | 545600.0 | 31.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 8.70 | 7.00 | 27.80 | 11.00 | -88.10 | 28.40 | 90.10 | 1.10 | 3.00 | 4.70 | 0.00 | 0.00 | 0.00 | 2.50 | 15.50 | 0.80 |
| H2956 | 23.040 | 31.044 | 80.472 | 434400.0 | 550400.0 | 33.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.60 | 11.40 | 6.20 | 32.00 | 11.70 | -96.10 | 30.20 | 90.50 | 1.20 | 3.10 | 4.10 | 0.00 | 0.00 | 0.00 | 2.70 | 16.00 | 0.90 |
| H2957 | 23.040 | 31.044 | 80.422 | 434400.0 | 555200.0 | 36.0 | 0.00 | 100.00 | 0.00 | 0.00 | 14.90 | 13.30 | 4.40 | 33.10 | 13.40 | -101.80 | 32.60 | 91.00 | 1.20 | 3.40 | 3.40 | 0.00 | 0.10 | 0.00 | 2.80 | 15.90 | 0.90 |
| H2958 | 23.040 | 31.043 | 80.371 | 434400.0 | 560000.0 | 38.1 | 0.00 | 99.90 | 0.00 | 0.00 | 19.60 | 15.80 | 1.30 | 33.00 | 16.10 | -107.80 | 36.70 | 91.20 | 1.10 | 3.70 | 2.90 | 0.00 | 0.20 | 0.20 | 2.60 | 14.80 | 1.00 |
| H2959 | 23.040 | 31.043 | 80.321 | 434400.0 | 564800.0 | 39.8 | 0.00 | 100.00 | 0.00 | 0.00 | 21.40 | 16.80 | 0.20 | 33.60 | 17.00 | -111.80 | 38.40 | 91.10 | 1.00 | 3.90 | 2.90 | 0.00 | 0.40 | 0.40 | 2.10 | 11.90 | 1.00 |
| H2960 | 23.040 | 31.043 | 80.271 | 434400.0 | 569600.0 | 40.9 | 0.00 | 99.90 | 0.10 | 0.00 | 21.10 | 18.40 | 0.20 | 37.70 | 15.10 | -118.30 | 39.70 | 91.20 | 1.00 | 3.90 | 2.80 | 0.00 | 0.70 | 0.70 | 1.50 | 8.30 | 1.00 |
| H2961 | 23.040 | 31.043 | 80.220 | 434400.0 | 574400.0 | 42.1 | 0.00 | 99.40 | 0.40 | 0.20 | 19.40 | 23.40 | 0.10 | 48.80 | 9.20 | -134.00 | 43.00 | 91.10 | 0.90 | 3.90 | 2.60 | 0.00 | 0.90 | 0.90 | 1.20 | 6.00 | 1.00 |
| H2962 | 23.040 | 31.042 | 80.170 | 434400.0 | 579200.0 | 44.0 | 0.10 | 98.40 | 1.00 | 0.40 | 20.60 | 24.90 | 0.10 | 53.90 | 9.20 | -143.40 | 45.60 | 89.90 | 0.60 | 4.10 | 2.70 | 0.00 | 1.00 | 1.00 | 1.00 | 5.20 | 1.00 |
| H2963 | 23.040 | 31.042 | 80.120 | 434400.0 | 584000.0 | 46.3 | 0.20 | 97.90 | 1.30 | 0.50 | 30.70 | 18.00 | 0.00 | 53.80 | 23.20 | -148.90 | 48.80 | 88.50 | 0.40 | 4.40 | 2.80 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2964 | 23.040 | 31.042 | 80.069 | 434400.0 | 588800.0 | 48.9 | 0.10 | 98.80 | 0.80 | 0.30 | 41.50 | 10.30 | 0.00 | 56.00 | 37.60 | -156.70 | 51.80 | 88.50 | 0.10 | 4.80 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2965 | 23.040 | 31.041 | 80.019 | 434400.0 | 593600.0 | 67.7 | 0.10 | 98.70 | 0.90 | 0.30 | 42.90 | 8.20 | 0.00 | 49.90 | 47.80 | -168.80 | 51.20 | 86.60 | 0.10 | 4.80 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2966 | 7.200 | 31.041 | 79.969 | 434400.0 | 598400.0 | 50.2 | 0.20 | 98.80 | 0.70 | 0.20 | 47.00 | 16.00 | 0.00 | 38.40 | 47.50 | -151.50 | 63.00 | 89.10 | 0.20 | 4.70 | 3.10 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H2983 | 3.190 | 31.001 | 81.327 | 429600.0 | 468800.0 | 8.8 | 0.20 | 93.40 | 4.70 | 1.60 | 11.50 | 30.70 | 0.00 | 18.30 | 9.60 | -69.30 | 42.20 | 89.10 | 0.10 | 6.10 | 3.70 | 0.00 | 0.00 | 0.00 | 1.90 | 9.90 | 1.10 |
| H2984 | 23.040 | 31.001 | 81.277 | 429600.0 | 473600.0 | 12.0 | 0.00 | 98.00 | 1.70 | 0.20 | 12.20 | 27.70 | 0.00 | 19.90 | 7.50 | -71.80 | 39.90 | 0.00 | 0.00 | 6.20 | 3.70 | 0.00 | 0.00 | 0.00 | 2.10 | 9.10 | 0.80 |
| H2985 | 23.040 | 31.001 | 81.226 | 429600.0 | 478400.0 | 13.6 | 0.00 | 98.10 | 1.60 | 0.30 | 12.30 | 27.20 | 0.00 | 20.30 | 7.10 | -73.40 | 39.50 | 89.20 | 0.20 | 6.30 | 3.10 | 0.00 | 0.00 | 0.00 | 2.00 | 8.50 | 0.90 |
| H2986 | 23.040 | 31.002 | 81.176 | 429600.0 | 483200.0 | 15.2 | 0.00 | 98.80 | 1.00 | 0.10 | 12.60 | 27.00 | 0.00 | 20.00 | 6.80 | -74.80 | 39.50 | 89.50 | 0.40 | 6.10 | 2.70 | 0.00 | 0.00 | 0.00 | 1.90 | 8.40 | 0.90 |
| H2987 | 23.040 | 31.002 | 81.126 | 429600.0 | 488000.0 | 16.8 | 0.00 | 99.60 | 0.40 | 0.00 | 14.20 | 26.70 | 0.00 | 17.60 | 6.20 | -75.30 | 40.90 | 89.50 | 0.70 | 5.80 | 2.40 | 0.00 | 0.00 | 0.00 | 1.80 | 8.50 | 0.80 |
| H2988 | 23.040 | 31.002 | 81.075 | 429600.0 | 492800.0 | 18.4 | 0.00 | 99.90 | 0.10 | 0.00 | 16.00 | 26.10 | 0.10 | 15.10 | 5.30 | -75.80 | 42.20 | 89.40 | 0.80 | 5.70 | 2.30 | 0.00 | 0.00 | 0.00 | 1.70 | 8.90 | 0.70 |
| H2989 | 23.040 | 31.002 | 81.025 | 429600.0 | 497600.0 | 19.7 | 0.00 | 99.90 | 0.00 | 0.00 | 16.40 | 25.30 | 0.10 | 14.80 | 4.80 | -76.40 | 41.90 | 89.90 | 0.80 | 5.30 | 2.50 | 0.00 | 0.00 | 0.00 | 1.50 | 9.60 | 0.50 |
| H2990 | 23.040 | 31.002 | 80.975 | 429600.0 | 502400.0 | 20.6 | 0.00 | 100.00 | 0.00 | 0.00 | 15.20 | 22.10 | 0.40 | 17.10 | 3.80 | -75.50 | 37.70 | 90.00 | 0.60 | 4.70 | 2.70 | 0.00 | 0.00 | 0.00 | 1.20 | 10.30 | 0.20 |
| H2991 | 23.040 | 31.002 | 80.925 | 429600.0 | 507200.0 | 22.0 | 0.00 | 100.00 | 0.00 | 0.00 | 14.10 | 16.70 | 0.50 | 20.60 | 1.90 | -73.90 | 31.30 | 91.50 | 0.50 | 4.50 | 2.50 | 0.00 | 0.00 | 0.00 | 1.10 | 10.00 | 0.10 |
| H2992 | 23.040 | 31.002 | 80.874 | 429600.0 | 512000.0 | 23.4 | 0.00 | 100.00 | 0.00 | 0.00 | 13.60 | 15.30 | 0.70 | 21.40 | 2.20 | -74.40 | 29.60 | 92.00 | 0.30 | 4.50 | 2.10 | 0.00 | 0.00 | 0.00 | 1.00 | 11.00 | 0.00 |
| H2993 | 23.040 | 31.002 | 80.824 | 429600.0 | 516800.0 | 24.7 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 16.10 | 1.30 | 21.00 | 6.10 | -75.60 | 29.90 | 92.20 | 0.20 | 4.60 | 1.90 | 0.00 | 0.00 | 0.00 | 1.00 | 11.00 | 0.00 |
| H2994 | 23.040 | 31.001 | 80.774 | 429600.0 | 521600.0 | 26.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 15.80 | 1.60 | 21.30 | 9.80 | -76.50 | 29.00 | 92.40 | 0.40 | 4.40 | 1.80 | 0.00 | 0.00 | 0.00 | 1.00 | 11.10 | 0.00 |
| H2995 | 23.040 | 31.001 | 80.723 | 429600.0 | 526400.0 | 27.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 14.00 | 2.20 | 21.70 | 11.50 | -77.20 | 28.00 | 92.50 | 0.70 | 3.80 | 1.90 | 0.00 | 0.00 | 0.00 | 1.80 | 11.60 | 0.10 |
| H2996 | 23.040 | 31.001 | 80.673 | 429600.0 | 531200.0 | 28.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.40 | 11.40 | 3.10 | 22.40 | 12.60 | -78.20 | 26.90 | 91.00 | 0.90 | 3.40 | 2.70 | 0.00 | 0.00 | 0.00 | 1.50 | 12.50 | 0.30 |
| H2997 | 23.040 | 31.001 | 80.623 | 429600.0 | 536000.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 10.00 | 4.00 | 23.60 | 13.00 | -80.10 | 26.70 | 90.90 | 1.10 | 3.20 | 3.00 | 0.00 | 0.00 | 0.00 | 2.10 | 14.30 | 0.50 |
| H2998 | 23.040 | 31.001 | 80.573 | 429600.0 | 540800.0 | 30.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 10.30 | 4.60 | 25.30 | 12.60 | -83.70 | 27.60 | 90.30 | 1.10 | 3.10 | 4.40 | 0.00 | 0.00 | 0.00 | 2.60 | 15.70 | 0.80 |
| H2999 | 23.040 | 31.001 | 80.522 | 429600.0 | 545600.0 | 32.6 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 11.90 | 4.60 | 28.00 | 12.60 | -90.20 | 29.60 | 90.30 | 1.20 | 3.10 | 4.20 | 0.00 | 0.00 | 0.00 | 2.80 | 16.40 | 0.90 |
| H31 | 23.040 | 31.950 | 79.908 | 535200.0 | 603200.0 | 38.3 | 0.20 | 99.50 | 0.00 | 0.00 | 8.90 | 8.50 | 0.00 | 16.80 | 33.40 | -72.40 | 17.30 | 0.00 | 2.70 | 5.10 | 3.60 | 0.00 | 0.00 | 0.00 | 2.00 | 10.00 | 3.00 |
| H3133 | 23.040 | 31.820 | 79.910 | 520800.0 | 603200.0 | 41.1 | 0.10 | 99.50 | 0.20 | 0.00 | 10.70 | 8.50 | 0.00 | 18.10 | 24.70 | -78.40 | 19.10 | 0.00 | 1.60 | 4.30 | 3.00 | 0.00 | 0.20 | 0.30 | 1.70 | 9.00 | 3.70 |
| H3134 | 23.040 | 31.819 | 79.859 | 520800.0 | 608000.0 | 42.0 | 0.00 | 99.50 | 0.30 | 0.10 | 10.80 | 8.80 | 0.00 | 20.30 | 23.20 | -81.40 | 19.60 | 89.40 | 1.70 | 4.30 | 3.30 | 0.00 | 0.20 | 0.20 | 1.60 | 8.90 | 3.30 |
| H3135 | 23.040 | 31.819 | 79.808 | 520800.0 | 612800.0 | 45.1 | 0.00 | 99.20 | 0.60 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.10 | 1.50 | 4.40 | 3.50 | 0.00 | 0.10 | 0.10 | 1.50 | 8.20 | 2.80 |
| H3136 | 23.040 | 31.818 | 79.757 | 520800.0 | 617600.0 | 50.1 | 0.00 | 98.00 | 1.70 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 87.60 | 1.20 | 5.00 | 4.20 | 0.00 | 0.00 | 0.00 | 1.30 | 6.90 | 2.20 |
| H3137 | 22.390 | 31.818 | 79.707 | 520800.0 | 622400.0 | 48.2 | 0.00 | 99.20 | 0.70 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.80 | 1.70 | 4.60 | 3.60 | 0.00 | 0.00 | 0.00 | 1.70 | 8.80 | 2.60 |
| H3138 | 2.200 | 31.817 | 79.656 | 520800.0 | 627200.0 | 41.3 | 0.00 | 82.30 | 0.90 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 73.20 | 1.40 | 4.10 | 3.10 | 0.00 | 0.00 | 0.00 | 1.40 | 7.00 | 2.10 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MM.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H3177 | 23.040 | 31.777 | 79.910 | 516000.0 | 603200.0 | 43.3 | 0.10 | 99.40 | 0.40 | 0.10 | 12.90 | 9.30 | 0.00 | 21.90 | 15.00 | -87.50 | 22.30 | 0.00 | 1.10 | 4.30 | 3.10 | 0.00 | 0.50 | 0.50 | 1.30 | 8.70 | 4.60 |
| H3178 | 23.040 | 31.776 | 79.859 | 516000.0 | 608000.0 | 45.6 | 0.00 | 99.00 | 0.80 | 0.10 | 13.70 | 10.00 | 0.00 | 25.30 | 12.50 | -94.20 | 23.60 | 89.10 | 1.10 | 4.40 | 3.60 | 0.00 | 0.40 | 0.40 | 1.20 | 8.10 | 3.90 |
| H3179 | 23.040 | 31.776 | 79.809 | 516000.0 | 612800.0 | 48.9 | 0.00 | 98.60 | 1.10 | 0.20 | 17.50 | 12.40 | 0.00 | 30.80 | 11.30 | -110.10 | 29.90 | 88.40 | 0.80 | 4.70 | 4.20 | 0.00 | 0.20 | 0.20 | 1.00 | 6.60 | 2.80 |
| H3180 | 23.040 | 31.775 | 79.758 | 516000.0 | 617600.0 | 53.6 | 0.00 | 97.40 | 2.10 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 87.50 | 0.60 | 5.00 | 4.60 | 0.00 | 0.10 | 0.10 | 0.70 | 4.70 | 1.60 |
| H3181 | 14.970 | 31.775 | 79.707 | 516000.0 | 622400.0 | 48.7 | 0.00 | 98.50 | 1.30 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.50 | 1.30 | 4.80 | 4.00 | 0.00 | 0.10 | 0.00 | 1.40 | 7.50 | 2.40 |
| H32 | 23.040 | 31.949 | 79.857 | 535200.0 | 608000.0 | 39.4 | 0.10 | 99.80 | 0.10 | 0.00 | 8.80 | 8.70 | 0.00 | 17.30 | 33.00 | -74.00 | 17.50 | 86.80 | 2.50 | 5.20 | 3.90 | 0.00 | 0.00 | 0.00 | 2.00 | 10.00 | 3.00 |
| H3221 | 23.040 | 31.733 | 79.911 | 511200.0 | 603200.0 | 45.7 | 0.00 | 99.40 | 0.50 | 0.10 | 15.90 | 10.70 | 0.00 | 26.70 | 8.20 | -99.10 | 26.60 | 0.00 | 0.70 | 4.40 | 3.50 | 0.00 | 0.70 | 0.70 | 1.10 | 8.70 | 5.50 |
| H3222 | 23.040 | 31.733 | 79.860 | 511200.0 | 608000.0 | 47.8 | 0.00 | 98.80 | 0.90 | 0.20 | 17.80 | 12.20 | 0.00 | 30.20 | 9.20 | -108.10 | 30.00 | 88.60 | 0.50 | 4.60 | 4.20 | 0.00 | 0.60 | 0.60 | 1.00 | 7.70 | 4.50 |
| H3223 | 23.040 | 31.732 | 79.809 | 511200.0 | 612800.0 | 49.9 | 0.00 | 99.10 | 0.80 | 0.20 | 19.20 | 13.40 | 0.00 | 32.40 | 9.90 | -114.30 | 32.60 | 88.10 | 0.20 | 4.90 | 4.70 | 0.00 | 0.30 | 0.30 | 0.70 | 5.60 | 2.90 |
| H3224 | 18.750 | 31.732 | 79.759 | 511200.0 | 617600.0 | 48.2 | 0.00 | 98.70 | 1.00 | 0.20 | 17.20 | 12.20 | 0.00 | 30.60 | 11.50 | -109.20 | 29.50 | 88.80 | 0.90 | 4.70 | 4.10 | 0.00 | 0.20 | 0.20 | 1.10 | 7.00 | 2.90 |
| H3225 | 0.975 | 31.731 | 79.708 | 511200.0 | 622400.0 | 41.3 | 0.00 | 81.90 | 1.20 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 73.30 | 0.90 | 4.00 | 3.50 | 0.00 | 0.10 | 0.10 | 0.90 | 5.40 | 1.00 |
| H3265 | 23.040 | 31.690 | 79.911 | 506400.0 | 603200.0 | 45.6 | 0.00 | 99.30 | 0.50 | 0.10 | 19.00 | 12.90 | 0.00 | 31.20 | 8.10 | -109.50 | 32.70 | 0.00 | 0.40 | 4.50 | 4.10 | 0.00 | 0.80 | 0.80 | 1.00 | 9.00 | 6.00 |
| H3266 | 23.040 | 31.690 | 79.860 | 506400.0 | 608000.0 | 47.4 | 0.00 | 99.20 | 0.70 | 0.10 | 21.50 | 14.00 | 0.00 | 33.30 | 9.80 | -117.00 | 36.30 | 88.30 | 0.20 | 4.80 | 4.70 | 0.00 | 0.70 | 0.70 | 0.80 | 7.70 | 4.90 |
| H3267 | 23.040 | 31.689 | 79.810 | 506400.0 | 612800.0 | 49.3 | 0.00 | 99.20 | 0.60 | 0.10 | 23.50 | 16.70 | 0.00 | 34.50 | 12.50 | -123.40 | 40.20 | 88.00 | 0.10 | 4.90 | 4.90 | 0.00 | 0.40 | 0.40 | 0.60 | 5.30 | 3.00 |
| H3268 | 17.760 | 31.689 | 79.759 | 506400.0 | 617600.0 | 49.4 | 0.00 | 99.10 | 0.70 | 0.10 | 19.20 | 13.50 | 0.00 | 32.40 | 9.80 | -114.30 | 32.70 | 88.30 | 0.20 | 4.90 | 4.70 | 0.00 | 0.40 | 0.40 | 0.70 | 6.00 | 3.20 |
| H33 | 23.040 | 31.949 | 79.807 | 535200.0 | 612800.0 | 48.6 | 0.00 | 99.80 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 87.40 | 2.30 | 5.00 | 3.70 | 0.00 | 0.00 | 0.00 | 2.00 | 9.90 | 3.00 |
| H3309 | 23.040 | 31.647 | 79.912 | 501600.0 | 603200.0 | 46.2 | 0.00 | 99.00 | 0.80 | 0.20 | 22.30 | 15.20 | 0.00 | 33.10 | 9.40 | -116.90 | 37.60 | 0.00 | 0.40 | 4.50 | 4.50 | 0.00 | 0.90 | 0.90 | 1.00 | 9.10 | 6.20 |
| H3310 | 23.040 | 31.646 | 79.861 | 501600.0 | 608000.0 | 48.0 | 0.00 | 98.70 | 1.00 | 0.20 | 24.20 | 17.10 | 0.00 | 33.30 | 13.40 | -122.50 | 41.20 | 88.30 | 0.10 | 4.70 | 4.70 | 0.00 | 0.70 | 0.70 | 0.80 | 7.80 | 5.00 |
| H3311 | 23.040 | 31.646 | 79.810 | 501600.0 | 612800.0 | 58.5 | 0.00 | 97.90 | 1.70 | 0.30 | 26.10 | 18.20 | 0.00 | 34.20 | 16.50 | -127.50 | 44.40 | 88.30 | 0.10 | 4.70 | 4.00 | 0.00 | 0.40 | 0.40 | 0.60 | 5.40 | 3.00 |
| H3312 | 20.160 | 31.645 | 79.760 | 501600.0 | 617600.0 | 49.0 | 0.00 | 99.40 | 0.50 | 0.10 | 23.00 | 16.40 | 0.00 | 34.40 | 12.00 | -122.30 | 39.30 | 88.30 | 0.00 | 4.90 | 4.90 | 0.00 | 0.40 | 0.40 | 0.60 | 5.60 | 3.20 |
| H3353 | 23.040 | 31.603 | 79.912 | 496800.0 | 603200.0 | 47.6 | 0.00 | 98.60 | 1.00 | 0.30 | 24.80 | 18.20 | 0.00 | 34.10 | 12.30 | -124.70 | 43.00 | 0.00 | 0.30 | 4.40 | 4.50 | 0.00 | 0.90 | 0.90 | 1.00 | 9.20 | 6.10 |
| H3354 | 23.040 | 31.603 | 79.862 | 496800.0 | 608000.0 | 49.7 | 0.00 | 98.00 | 1.60 | 0.30 | 28.70 | 20.00 | 0.00 | 32.30 | 28.50 | -130.70 | 48.70 | 88.90 | 0.10 | 4.50 | 4.50 | 0.00 | 0.70 | 0.70 | 0.90 | 7.80 | 4.80 |
| H3355 | 23.040 | 31.602 | 79.811 | 496800.0 | 612800.0 | 55.0 | 0.00 | 97.40 | 2.20 | 0.40 | 31.00 | 20.50 | 0.00 | 32.10 | 24.70 | -134.90 | 51.50 | 89.40 | 0.00 | 4.30 | 4.40 | 0.00 | 0.40 | 0.40 | 0.60 | 5.60 | 2.90 |
| H3356 | 17.280 | 31.602 | 79.760 | 496800.0 | 617600.0 | 49.3 | 0.00 | 98.40 | 1.30 | 0.30 | 25.80 | 18.00 | 0.00 | 34.10 | 16.30 | -126.80 | 43.80 | 88.90 | 0.10 | 4.80 | 4.80 | 0.00 | 0.50 | 0.50 | 0.60 | 5.90 | 3.40 |
| H3397 | 23.040 | 31.560 | 79.913 | 492000.0 | 603200.0 | 48.6 | 0.00 | 98.40 | 1.30 | 0.30 | 27.90 | 21.80 | 0.00 | 34.40 | 16.60 | -132.80 | 49.80 | 0.00 | 0.30 | 4.30 | 4.40 | 0.00 | 0.00 | 0.00 | 1.00 | 8.90 | 5.70 |
| H3398 | 23.040 | 31.560 | 79.862 | 492000.0 | 608000.0 | 51.3 | 0.00 | 98.10 | 1.60 | 0.30 | 32.70 | 22.30 | 0.00 | 30.20 | 27.00 | -136.40 | 54.90 | 89.80 | 0.10 | 4.20 | 4.30 | 0.00 | 0.60 | 0.60 | 0.90 | 7.50 | 4.10 |
| H3399 | 13.575 | 31.559 | 79.812 | 492000.0 | 612800.0 | 49.3 | 0.00 | 98.10 | 1.50 | 0.30 | 28.00 | 19.90 | 0.00 | 32.60 | 19.00 | -129.70 | 47.90 | 89.30 | 0.20 | 4.50 | 4.60 | 0.00 | 0.70 | 0.70 | 0.90 | 8.20 | 5.10 |
| H34 | 23.040 | 31.948 | 79.756 | 535200.0 | 617600.0 | 44.6 | 0.00 | 99.60 | 0.30 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 87.70 | 2.10 | 5.00 | 3.60 | 0.00 | 0.00 | 0.00 | 1.90 | 9.80 | 2.90 |
| H3441 | 23.040 | 31.517 | 79.913 | 487200.0 | 603200.0 | 48.7 | 0.00 | 98.20 | 1.40 | 0.30 | 31.30 | 24.30 | 0.00 | 33.10 | 22.70 | -137.40 | 55.60 | 0.00 | 0.20 | 4.20 | 4.30 | 0.00 | 0.70 | 0.70 | 1.00 | 8.20 | 4.70 |
| H3442 | 23.040 | 31.516 | 79.863 | 487200.0 | 608000.0 | 54.5 | 0.00 | 98.10 | 1.60 | 0.30 | 36.40 | 23.50 | 0.00 | 27.90 | 33.80 | -142.20 | 59.80 | 90.10 | 0.00 | 4.10 | 4.20 | 0.00 | 0.40 | 0.40 | 0.90 | 6.80 | 2.90 |
| H3443 | 9.740 | 31.516 | 79.812 | 487200.0 | 612800.0 | 49.9 | 0.00 | 98.00 | 1.60 | 0.30 | 32.30 | 23.00 | 0.00 | 30.40 | 25.40 | -135.60 | 55.30 | 88.70 | 0.10 | 4.20 | 4.30 | 0.00 | 0.70 | 0.70 | 0.90 | 8.00 | 4.60 |
| H345 | 23.040 | 31.906 | 79.909 | 530400.0 | 603200.0 | 39.2 | 0.20 | 99.50 | 0.00 | 0.00 | 9.10 | 8.30 | 0.00 | 15.90 | 33.20 | -72.50 | 17.40 | 0.00 | 2.40 | 4.80 | 3.20 | 0.00 | 0.00 | 0.00 | 2.00 | 9.90 | 3.00 |
| H346 | 23.040 | 31.906 | 79.858 | 530400.0 | 608000.0 | 39.8 | 0.10 | 99.80 | 0.10 | 0.00 | 9.30 | 8.60 | 0.00 | 16.80 | 32.70 | -74.50 | 17.90 | 88.40 | 2.20 | 4.70 | 3.40 | 0.00 | 0.00 | 0.00 | 2.00 | 9.90 | 3.00 |
| H347 | 23.040 | 31.906 | 79.807 | 530400.0 | 612800.0 | 41.4 | 0.00 | 99.80 | 0.10 | 0.00 | 9.60 | 8.70 | 0.00 | 17.40 | 32.40 | -75.70 | 18.30 | 89.20 | 2.00 | 4.30 | 3.20 | 0.00 | 0.00 | 0.00 | 1.90 | 9.80 | 2.90 |
| H348 | 23.040 | 31.905 | 79.756 | 530400.0 | 617600.0 | 46.1 | 0.00 | 99.50 | 0.40 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 88.80 | 1.90 | 4.50 | 3.40 | 0.00 | 0.00 | 0.00 | 1.90 | 9.40 | 2.80 |
| H3485 | 23.040 | 31.473 | 79.914 | 482400.0 | 603200.0 | 48.8 | 0.00 | 97.30 | 1.90 | 0.60 | 36.30 | 24.90 | 0.00 | 29.70 | 32.20 | -139.70 | 61.20 | 0.00 | 0.10 | 4.20 | 4.30 | 0.00 | 0.40 | 0.40 | 1.00 | 7.10 | 3.00 |
| H3486 | 23.040 | 31.473 | 79.863 | 482400.0 | 608000.0 | 56.2 | 0.00 | 95.80 | 3.10 | 1.00 | 40.40 | 25.50 | 0.00 | 24.80 | 40.80 | -147.00 | 66.00 | 88.50 | 0.00 | 4.30 | 4.50 | 0.00 | 0.20 | 0.20 | 1.00 | 5.90 | 1.50 |
| H349 | 23.040 | 31.905 | 79.706 | 530400.0 | 622400.0 | 58.2 | 0.00 | 98.10 | 1.60 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 86.90 | 1.70 | 5.30 | 4.00 | 0.00 | 0.00 | 0.00 | 1.60 | 8.20 | 2.40 |
| H35 | 23.040 | 31.948 | 79.705 | 535200.0 | 622400.0 | 48.9 | 0.00 | 98.80 | 1.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 86.70 | 1.80 | 5.40 | 3.90 | 0.00 | 0.00 | 0.00 | 1.80 | 9.10 | 2.70 |
| H350 | 23.040 | 31.904 | 79.655 | 530400.0 | 627200.0 | 56.4 | 0.00 | 95.90 | 3.40 | 0.60 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.60 | 1.40 | 6.30 | 4.00 | 0.00 | 0.00 | 0.00 | 1.10 | 5.90 | 1.60 |
| H351 | 3.290 | 31.903 | 79.604 | 530400.0 | 632000.0 | 43.6 | 0.00 | 86.10 | 1.10 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.30 | 1.60 | 5.00 | 3.60 | 0.00 | 0.00 | 0.00 | 1.50 | 7.60 | 2.30 |
| H3529 | 23.040 | 31.430 | 79.914 | 477600.0 | 603200.0 | 58.0 | 0.10 | 96.00 | 2.80 | 1.00 | 40.60 | 24.50 | 0.00 | 26.30 | 40.70 | -141.50 | 65.20 | 87.00 | 0.10 | 4.30 | 4.50 | 0.00 | 0.30 | 0.30 | 1.00 | 6.30 | 1.80 |
| H3530 | 23.040 | 31.430 | 79.864 | 477600.0 | 608000.0 | 60.2 | 0.00 | 91.50 | 5.90 | 2.30 | 43.80 | 28.50 | 0.00 | 22.20 | 45.20 | -154.80 | 72.30 | 85.30 | 0.10 | 4.70 | 5.00 | 0.00 | 0.10 | 0.10 | 1.00 | 5.40 | 0.60 |
| H3573 | 23.040 | 31.387 | 79.915 | 472800.0 | 603200.0 | 51.3 | 0.10 | 92.50 | 5.00 | 2.00 | 43.80 | 27.10 | 0.00 | 25.10 | 42.40 | -147.40 | 70.90 | 84.20 | 0.20 | 4.60 | 4.90 | 0.00 | 0.10 | 0.10 | 1.00 | 5.60 | 0.80 |
| H3574 | 20.025 | 31.386 | 79.864 | 472800.0 | 608000.0 | 49.5 | 0.10 | 96.40 | 2.50 | 0.90 | 39.90 | 23.90 | 0.00 | 26.70 | 40.30 | -148.00 | 63.80 | 81.60 | 0.10 | 4.30 | 4.40 | 0.00 | 0.30 | 0.30 | 1.00 | 6.40 | 2.00 |
| H36 | 23.040 | 31.947 | 79.654 | 535200.0 | 627200.0 | 51.9 | 0.00 | 97.40 | 2.00 | 0.50 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 85.00 | 1.70 | 6.10 | 4.50 | 0.00 | 0.00 | 0.00 | 1.50 | 7.80 | 2.20 |
| H3617 | 23.040 | 31.344 | 79.915 | 468000.0 | 603200.0 | 55.1 | 0.20 | 88.70 | 7.60 | 3.10 | 45.30 | 30.30 | 0.00 | 19.30 | 49.20 | -150.00 | 75.60 | 0.00 | 0.20 | 5.00 | 5.40 | 0.00 | 0.10 | 0.10 | 1.00 | 5.20 | 0.30 |
| H3618 | 15.280 | 31.343 | 79.865 | 468000.0 | 608000.0 | 49.9 | 0.10 | 93.80 | 4.20 | 1.60 | 42.60 | 25.60 | 0.00 | 25.70 | 42.10 | -143.70 | 68.10 | 79.30 | 0.20 | 4.50 | 4.80 | 0.00 | 0.20 | 0.20 | 1.00 | 5.70 | 1.00 |
| H3661 | 23.040 | 31.300 | 79.916 | 463200.0 | 603200.0 | 60.6 | 0.30 | 88.90 | 7.40 | 3.00 | 45.30 | 26.90 | 0.00 | 14.70 | 56.90 | -147.50 | 72.20 | 0.00 | 0.40 | 5.10 | 5.30 | 0.00 | 0.10 | 0.10 | 1.00 | 5.10 | 0.20 |
| H3662 | 8.640 | 31.300 | 79.865 | 463200.0 | 608000.0 | 50.3 | 0.20 | 91.30 | 5.80 | 2.30 | 43.90 | 28.30 | 0.00 | 21.90 | 46.50 | -144.40 | 72.20 | 89.10 | 0.30 | 4.80 | 5.10 | 0.00 | 0.10 | 0.10 | 1.00 | 5.30 | 0.50 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H37 | 3.120 | 31.947 | 79.603 | 535200.0 | 632000.0 | 49.9 | 0.00 | 99.10 | 0.70 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 88.40 | 1.90 | 6.00 | 4.10 | 0.00 | 0.00 | 0.00 | 1.90 | 9.50 | 2.00 |
| H3749 | 19.465 | 31.214 | 79.917 | 453600.0 | 603200.0 | 18.6 | 0.10 | 94.60 | 5.30 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.50 | 0.60 | 6.10 | 4.00 | 0.00 | 0.30 | 0.30 | 1.00 | 1.00 | 0.50 |
| H3793 | 2.973 | 31.170 | 79.917 | 448800.0 | 603200.0 | 42.2 | 0.30 | 75.60 | 5.10 | 2.10 | 37.00 | 23.60 | 0.00 | 15.90 | 41.00 | -118.70 | 60.60 | 84.20 | 0.30 | 4.10 | 4.30 | 0.00 | 0.10 | 0.10 | 0.80 | 4.30 | 0.30 |
| H3837 | 5.945 | 31.127 | 79.918 | 444000.0 | 603200.0 | 46.6 | 0.60 | 90.50 | 1.30 | 0.30 | 60.10 | 22.00 | 0.00 | 19.80 | 51.60 | -148.60 | 82.10 | 73.80 | 0.60 | 4.30 | 4.00 | 0.00 | 0.70 | 0.70 | 0.90 | 4.70 | 0.70 |
| H389 | 23.040 | 31.863 | 79.909 | 525600.0 | 603200.0 | 40.2 | 0.20 | 99.50 | 0.10 | 0.00 | 9.50 | 8.10 | 0.00 | 15.60 | 31.40 | -73.30 | 17.60 | 0.00 | 2.00 | 4.50 | 3.00 | 0.00 | 0.10 | 0.10 | 1.90 | 9.60 | 3.20 |
| H390 | 23.040 | 31.863 | 79.858 | 525600.0 | 608000.0 | 40.3 | 0.00 | 99.80 | 0.10 | 0.00 | 9.60 | 8.30 | 0.00 | 16.60 | 31.50 | -74.70 | 17.90 | 89.50 | 1.90 | 4.30 | 3.10 | 0.00 | 0.10 | 0.00 | 1.90 | 9.60 | 3.10 |
| H391 | 23.040 | 31.862 | 79.808 | 525600.0 | 612800.0 | 42.7 | 0.00 | 99.80 | 0.10 | 0.00 | 9.60 | 8.70 | 0.00 | 17.40 | 32.40 | -75.70 | 18.30 | 89.60 | 1.90 | 4.20 | 3.10 | 0.00 | 0.00 | 0.00 | 1.80 | 9.30 | 2.90 |
| H392 | 23.040 | 31.862 | 79.757 | 525600.0 | 617600.0 | 48.5 | 0.00 | 99.00 | 0.80 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 88.50 | 1.70 | 4.70 | 3.60 | 0.00 | 0.00 | 0.00 | 1.70 | 8.60 | 2.60 |
| H393 | 23.040 | 31.861 | 79.706 | 525600.0 | 622400.0 | 53.5 | 0.00 | 97.20 | 2.40 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 86.40 | 1.40 | 5.50 | 4.40 | 0.00 | 0.00 | 0.00 | 1.30 | 6.80 | 1.90 |
| H394 | 17.880 | 31.861 | 79.655 | 525600.0 | 627200.0 | 49.2 | 0.00 | 98.50 | 1.20 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.70 | 1.80 | 5.10 | 3.90 | 0.00 | 0.00 | 0.00 | 1.70 | 8.60 | 2.50 |
| H5102 | 2.367 | 30.871 | 81.377 | 415200.0 | 464000.0 | 8.3 | 0.00 | 92.20 | 5.80 | 1.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.10 | 0.00 | 6.00 | 3.00 | 0.00 | 0.00 | 0.00 | 2.90 | 11.30 | 0.00 |
| H5103 | 22.892 | 30.871 | 81.326 | 415200.0 | 468800.0 | 9.3 | 0.10 | 93.40 | 5.30 | 1.20 | 12.40 | 27.60 | 0.00 | 19.70 | 7.30 | -69.90 | 40.00 | 89.10 | 0.00 | 6.80 | 3.00 | 0.00 | 0.00 | 0.00 | 2.70 | 11.10 | 0.00 |
| H5104 | 23.040 | 30.871 | 81.276 | 415200.0 | 473600.0 | 13.2 | 0.10 | 99.00 | 0.60 | 0.30 | 13.30 | 26.60 | 0.00 | 19.10 | 6.40 | -72.10 | 39.80 | 89.00 | 0.00 | 7.80 | 2.10 | 0.00 | 0.10 | 0.10 | 1.60 | 9.90 | 0.10 |
| H5105 | 23.040 | 30.872 | 81.226 | 415200.0 | 478400.0 | 14.8 | 0.10 | 99.20 | 0.50 | 0.20 | 13.80 | 26.10 | 0.00 | 18.60 | 6.00 | -73.20 | 39.80 | 89.30 | 0.00 | 7.20 | 2.50 | 0.00 | 0.10 | 0.10 | 1.50 | 9.90 | 0.20 |
| H5106 | 23.040 | 30.872 | 81.176 | 415200.0 | 483200.0 | 16.4 | 0.10 | 99.40 | 0.40 | 0.10 | 14.40 | 25.20 | 0.00 | 18.00 | 5.50 | -74.00 | 39.60 | 90.00 | 0.10 | 5.90 | 3.20 | 0.00 | 0.10 | 0.10 | 1.30 | 10.00 | 0.30 |
| H5107 | 23.040 | 30.872 | 81.126 | 415200.0 | 488000.0 | 18.0 | 0.00 | 99.80 | 0.20 | 0.00 | 14.80 | 24.00 | 0.00 | 17.80 | 5.00 | -74.50 | 38.80 | 91.00 | 0.10 | 4.40 | 4.00 | 0.00 | 0.10 | 0.10 | 1.30 | 10.20 | 0.40 |
| H5108 | 23.040 | 30.872 | 81.075 | 415200.0 | 492800.0 | 19.4 | 0.00 | 100.00 | 0.00 | 0.00 | 14.60 | 22.30 | 0.00 | 18.40 | 4.40 | -74.80 | 36.90 | 91.70 | 0.00 | 3.40 | 4.60 | 0.00 | 0.10 | 0.10 | 1.20 | 10.40 | 0.30 |
| H5109 | 23.040 | 30.872 | 81.025 | 415200.0 | 497600.0 | 20.8 | 0.00 | 100.00 | 0.00 | 0.00 | 14.20 | 19.40 | 0.00 | 20.00 | 3.80 | -74.40 | 33.60 | 91.90 | 0.10 | 3.20 | 4.50 | 0.00 | 0.00 | 0.00 | 1.10 | 10.60 | 0.20 |
| H5110 | 23.040 | 30.872 | 80.975 | 415200.0 | 502400.0 | 22.3 | 0.00 | 100.00 | 0.00 | 0.00 | 13.50 | 17.00 | 0.00 | 21.50 | 3.90 | -74.40 | 30.50 | 92.20 | 0.20 | 3.30 | 3.60 | 0.00 | 0.00 | 0.00 | 1.10 | 10.90 | 0.10 |
| H5111 | 23.040 | 30.872 | 80.925 | 415200.0 | 507200.0 | 23.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 16.20 | 0.00 | 22.30 | 5.00 | -75.10 | 28.90 | 93.10 | 0.50 | 3.30 | 2.30 | 0.00 | 0.00 | 0.00 | 1.20 | 11.30 | 0.10 |
| H5112 | 23.040 | 30.872 | 80.874 | 415200.0 | 512000.0 | 25.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.50 | 16.40 | 0.10 | 22.70 | 9.70 | -76.10 | 28.00 | 94.10 | 0.70 | 3.20 | 1.00 | 0.00 | 0.00 | 0.00 | 1.30 | 11.70 | 0.10 |
| H5113 | 23.040 | 30.872 | 80.824 | 415200.0 | 516800.0 | 26.9 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 16.50 | 0.00 | 23.00 | 12.70 | -77.10 | 27.20 | 94.70 | 0.90 | 3.00 | 0.30 | 0.00 | 0.00 | 0.00 | 1.40 | 12.30 | 0.20 |
| H5114 | 23.040 | 30.872 | 80.774 | 415200.0 | 521600.0 | 28.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 15.00 | 0.10 | 23.30 | 14.70 | -77.90 | 26.20 | 94.70 | 1.00 | 3.00 | 0.30 | 0.00 | 0.00 | 0.00 | 1.00 | 13.40 | 0.40 |
| H5115 | 23.040 | 30.871 | 80.724 | 415200.0 | 526400.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.10 | 11.80 | 0.20 | 23.80 | 18.00 | -77.70 | 24.20 | 93.80 | 1.10 | 3.00 | 0.90 | 0.00 | 0.00 | 0.00 | 2.30 | 15.00 | 0.70 |
| H5116 | 23.040 | 30.871 | 80.674 | 415200.0 | 531200.0 | 31.0 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 10.60 | 0.10 | 24.00 | 19.70 | -78.30 | 23.20 | 92.30 | 1.30 | 3.00 | 1.90 | 0.00 | 0.00 | 0.00 | 2.70 | 16.20 | 0.90 |
| H5117 | 23.040 | 30.871 | 80.623 | 415200.0 | 536000.0 | 32.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 14.80 | 0.30 | 24.50 | 16.80 | -83.40 | 26.40 | 90.90 | 1.70 | 3.10 | 2.70 | 0.00 | 0.00 | 0.00 | 2.90 | 16.80 | 1.00 |
| H5118 | 23.040 | 30.871 | 80.573 | 415200.0 | 540800.0 | 34.3 | 0.00 | 100.00 | 0.00 | 0.00 | 9.20 | 21.30 | 0.30 | 25.00 | 12.70 | -90.10 | 30.80 | 90.20 | 1.90 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5119 | 23.040 | 30.871 | 80.523 | 415200.0 | 545600.0 | 36.1 | 0.00 | 100.00 | 0.00 | 0.00 | 8.90 | 23.50 | 0.20 | 25.30 | 11.60 | -94.10 | 32.60 | 90.20 | 1.90 | 3.10 | 3.00 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5120 | 23.040 | 30.871 | 80.473 | 415200.0 | 550400.0 | 37.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 20.20 | 0.30 | 25.90 | 14.60 | -96.00 | 33.00 | 90.80 | 1.50 | 3.20 | 2.90 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5121 | 23.040 | 30.870 | 80.423 | 415200.0 | 555200.0 | 39.4 | 0.00 | 99.90 | 0.10 | 0.00 | 15.50 | 17.00 | 0.20 | 26.20 | 17.30 | -99.20 | 33.60 | 92.00 | 1.00 | 3.20 | 2.40 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5122 | 23.040 | 30.870 | 80.372 | 415200.0 | 560000.0 | 40.2 | 0.00 | 99.70 | 0.20 | 0.10 | 18.60 | 17.50 | 0.10 | 28.10 | 20.50 | -104.50 | 36.20 | 93.50 | 0.40 | 3.10 | 1.60 | 0.00 | 0.10 | 0.00 | 2.90 | 16.30 | 1.00 |
| H5123 | 23.040 | 30.870 | 80.322 | 415200.0 | 564800.0 | 40.5 | 0.00 | 99.80 | 0.20 | 0.10 | 19.30 | 20.60 | 0.00 | 30.00 | 22.50 | -110.50 | 39.90 | 94.50 | 0.10 | 3.00 | 1.20 | 0.00 | 0.20 | 0.20 | 2.60 | 14.50 | 1.00 |
| H5124 | 23.040 | 30.870 | 80.272 | 415200.0 | 569600.0 | 40.9 | 0.00 | 98.90 | 0.70 | 0.30 | 18.90 | 24.70 | 0.00 | 32.90 | 21.50 | -117.40 | 43.50 | 94.00 | 0.10 | 3.00 | 1.20 | 0.00 | 0.50 | 0.50 | 2.00 | 11.10 | 1.00 |
| H5125 | 23.040 | 30.869 | 80.222 | 415200.0 | 574400.0 | 42.7 | 0.10 | 95.70 | 2.80 | 1.20 | 21.00 | 26.60 | 0.00 | 37.60 | 22.10 | -127.90 | 47.60 | 92.00 | 0.30 | 3.00 | 1.40 | 0.00 | 0.00 | 0.00 | 1.50 | 7.00 | 1.00 |
| H5126 | 23.040 | 30.869 | 80.172 | 415200.0 | 579200.0 | 46.5 | 0.20 | 89.40 | 7.00 | 3.10 | 24.60 | 24.00 | 0.00 | 40.60 | 26.70 | -135.70 | 48.60 | 89.00 | 0.50 | 3.00 | 1.40 | 0.00 | 0.90 | 0.90 | 1.20 | 5.90 | 1.00 |
| H5127 | 23.040 | 30.869 | 80.121 | 415200.0 | 584000.0 | 55.6 | 0.30 | 81.30 | 12.30 | 5.40 | 27.60 | 18.00 | 0.00 | 40.40 | 32.10 | -142.40 | 46.40 | 87.90 | 0.70 | 3.00 | 1.20 | 0.00 | 1.00 | 1.00 | 1.00 | 5.30 | 1.00 |
| H5128 | 23.040 | 30.868 | 80.071 | 415200.0 | 588800.0 | 101.2 | 0.20 | 75.50 | 16.20 | 7.20 | 29.00 | 10.90 | 0.00 | 35.80 | 39.50 | -176.90 | 39.90 | 89.70 | 0.90 | 3.00 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H5129 | 21.120 | 30.868 | 80.021 | 415200.0 | 593600.0 | 49.2 | 0.30 | 87.60 | 8.10 | 3.50 | 36.00 | 11.50 | 0.00 | 54.60 | 33.50 | -151.30 | 47.50 | 89.20 | 0.50 | 3.30 | 1.50 | 0.00 | 1.00 | 1.00 | 1.00 | 5.20 | 1.00 |
| H5146 | 8.597 | 30.828 | 81.376 | 410400.0 | 464000.0 | 8.5 | 0.10 | 93.40 | 5.30 | 1.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.30 | 0.00 | 7.00 | 2.60 | 0.00 | 0.00 | 0.00 | 2.70 | 11.20 | 0.00 |
| H5147 | 23.040 | 30.828 | 81.326 | 410400.0 | 468800.0 | 12.4 | 0.60 | 95.30 | 2.30 | 1.80 | 13.20 | 26.90 | 0.00 | 19.10 | 6.50 | -72.10 | 40.10 | 0.00 | 0.00 | 7.40 | 2.40 | 0.00 | 0.10 | 0.10 | 1.50 | 9.80 | 0.10 |
| H5148 | 23.040 | 30.828 | 81.276 | 410400.0 | 473600.0 | 14.3 | 0.30 | 97.70 | 1.10 | 0.80 | 13.50 | 26.60 | 0.00 | 18.80 | 6.20 | -73.20 | 40.10 | 89.10 | 0.00 | 7.40 | 2.50 | 0.00 | 0.10 | 0.10 | 1.30 | 10.00 | 0.10 |
| H5149 | 23.040 | 30.828 | 81.226 | 410400.0 | 478400.0 | 16.1 | 0.30 | 98.20 | 0.90 | 0.60 | 13.90 | 26.10 | 0.00 | 18.40 | 5.80 | -74.50 | 40.00 | 89.40 | 0.00 | 6.50 | 3.10 | 0.00 | 0.20 | 0.20 | 1.20 | 10.50 | 0.20 |
| H515 | 4.580 | 30.958 | 81.327 | 424800.0 | 468800.0 | 9.1 | 0.10 | 93.50 | 5.90 | 0.50 | 11.90 | 28.80 | 0.00 | 19.30 | 8.30 | -69.10 | 40.80 | 89.00 | 0.00 | 6.20 | 3.70 | 0.00 | 0.00 | 0.00 | 2.60 | 10.70 | 0.40 |
| H5150 | 23.040 | 30.828 | 81.176 | 410400.0 | 483200.0 | 18.0 | 0.20 | 99.00 | 0.40 | 0.30 | 14.10 | 25.40 | 0.00 | 18.20 | 5.50 | -75.80 | 39.50 | 90.20 | 0.10 | 5.30 | 3.70 | 0.00 | 0.30 | 0.30 | 1.10 | 11.10 | 0.30 |
| H5151 | 23.040 | 30.828 | 81.125 | 410400.0 | 488000.0 | 19.7 | 0.10 | 99.80 | 0.10 | 0.00 | 14.00 | 24.50 | 0.00 | 18.60 | 5.20 | -76.80 | 38.50 | 91.20 | 0.10 | 4.10 | 4.10 | 0.00 | 0.30 | 0.30 | 1.00 | 11.70 | 0.40 |
| H5152 | 23.040 | 30.828 | 81.075 | 410400.0 | 492800.0 | 20.9 | 0.00 | 99.90 | 0.00 | 0.00 | 13.70 | 23.10 | 0.00 | 19.40 | 5.00 | -77.10 | 36.80 | 91.80 | 0.00 | 3.40 | 4.40 | 0.00 | 0.20 | 0.20 | 1.00 | 11.70 | 0.30 |
| H5153 | 23.040 | 30.828 | 81.025 | 410400.0 | 497600.0 | 22.2 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 21.30 | 0.00 | 20.50 | 5.10 | -77.20 | 34.50 | 92.00 | 0.10 | 3.30 | 3.90 | 0.00 | 0.10 | 0.10 | 1.00 | 11.40 | 0.20 |
| H5154 | 23.040 | 30.828 | 80.975 | 410400.0 | 502400.0 | 23.6 | 0.00 | 100.00 | 0.00 | 0.00 | 12.70 | 19.80 | 0.00 | 21.50 | 6.00 | -77.50 | 32.50 | 92.50 | 0.30 | 3.30 | 2.90 | 0.00 | 0.00 | 0.00 | 1.10 | 11.30 | 0.10 |
| H5155 | 23.040 | 30.828 | 80.925 | 410400.0 | 507200.0 | 24.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 18.70 | 0.00 | 22.20 | 8.00 | -77.90 | 30.70 | 93.40 | 0.50 | 3.20 | 1.80 | 0.00 | 0.00 | 0.00 | 1.20 | 11.60 | 0.10 |
| H5156 | 23.040 | 30.828 | 80.875 | 410400.0 | 512000.0 | 26.3 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 18.00 | 0.00 | 22.80 | 10.70 | -78.40 | 29.40 | 94.30 | 0.80 | 3.00 | 0.80 | 0.00 | 0.00 | 0.00 | 1.40 | 12.30 | 0.20 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H5157 | 23.040 | 30.828 | 80.824 | 410400.0 | 516800.0 | 27.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 17.10 | 0.00 | 23.10 | 13.00 | -78.90 | 28.20 | 94.00 | 0.90 | 2.90 | 0.30 | 0.00 | 0.00 | 0.00 | 1.00 | 13.30 | 0.40 |
| H5158 | 23.040 | 30.828 | 80.774 | 410400.0 | 521600.0 | 29.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.40 | 15.30 | 0.10 | 23.50 | 15.30 | -79.30 | 26.00 | 94.50 | 1.00 | 2.90 | 0.50 | 0.00 | 0.00 | 0.00 | 2.20 | 14.50 | 0.60 |
| H5159 | 23.040 | 30.828 | 80.724 | 410400.0 | 526400.0 | 30.1 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 13.40 | 0.10 | 23.90 | 17.60 | -79.40 | 25.40 | 93.60 | 1.10 | 2.90 | 1.20 | 0.00 | 0.00 | 0.00 | 2.60 | 15.70 | 0.00 |
| H516 | 23.040 | 30.958 | 81.276 | 424800.0 | 473600.0 | 12.3 | 0.10 | 97.50 | 2.10 | 0.20 | 12.50 | 27.30 | 0.00 | 19.80 | 7.10 | -71.90 | 39.80 | 0.00 | 0.10 | 6.00 | 3.00 | 0.00 | 0.00 | 0.00 | 2.20 | 9.60 | 0.40 |
| H5160 | 23.040 | 30.828 | 80.674 | 410400.0 | 531200.0 | 31.2 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 14.10 | 0.10 | 24.20 | 17.40 | -81.30 | 25.90 | 92.10 | 1.40 | 3.00 | 2.00 | 0.00 | 0.00 | 0.00 | 2.80 | 16.50 | 0.90 |
| H5161 | 23.040 | 30.828 | 80.624 | 410400.0 | 536000.0 | 32.8 | 0.00 | 100.00 | 0.00 | 0.00 | 9.80 | 19.70 | 0.20 | 24.60 | 13.90 | -87.10 | 29.70 | 90.80 | 1.70 | 3.10 | 2.70 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5162 | 23.040 | 30.828 | 80.573 | 410400.0 | 540800.0 | 34.6 | 0.00 | 100.00 | 0.00 | 0.00 | 8.30 | 24.20 | 0.10 | 24.90 | 11.30 | -92.00 | 32.50 | 90.20 | 1.90 | 3.10 | 3.00 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5163 | 23.040 | 30.828 | 80.523 | 410400.0 | 545600.0 | 36.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 22.80 | 0.10 | 24.90 | 12.90 | -94.20 | 32.90 | 90.30 | 1.80 | 3.30 | 3.10 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5164 | 23.040 | 30.827 | 80.473 | 410400.0 | 550400.0 | 38.2 | 0.00 | 99.90 | 0.10 | 0.00 | 13.00 | 19.40 | 0.10 | 24.40 | 15.90 | -95.20 | 32.50 | 90.90 | 1.40 | 3.40 | 2.90 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5165 | 23.040 | 30.827 | 80.423 | 410400.0 | 555200.0 | 39.8 | 0.00 | 99.70 | 0.20 | 0.10 | 14.50 | 19.00 | 0.00 | 24.60 | 17.00 | -97.90 | 33.50 | 92.00 | 0.90 | 3.30 | 2.30 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5166 | 23.040 | 30.827 | 80.373 | 410400.0 | 560000.0 | 40.6 | 0.00 | 99.60 | 0.30 | 0.10 | 17.50 | 21.20 | 0.00 | 27.10 | 22.70 | -106.40 | 38.70 | 93.30 | 0.40 | 3.10 | 1.60 | 0.00 | 0.00 | 0.00 | 2.90 | 16.50 | 1.00 |
| H5167 | 23.040 | 30.827 | 80.322 | 410400.0 | 564800.0 | 41.2 | 0.00 | 99.40 | 0.40 | 0.20 | 17.10 | 25.60 | 0.00 | 28.30 | 24.00 | -112.20 | 42.70 | 93.90 | 0.20 | 2.90 | 1.40 | 0.00 | 0.20 | 0.20 | 2.70 | 14.90 | 1.00 |
| H5168 | 23.040 | 30.826 | 80.272 | 410400.0 | 569600.0 | 42.1 | 0.20 | 97.90 | 1.30 | 0.50 | 16.70 | 29.50 | 0.00 | 30.60 | 22.10 | -118.90 | 46.20 | 92.70 | 0.20 | 2.80 | 1.50 | 0.00 | 0.40 | 0.40 | 2.10 | 11.80 | 1.00 |
| H5169 | 23.040 | 30.826 | 80.222 | 410400.0 | 574400.0 | 44.5 | 0.40 | 94.50 | 3.40 | 1.50 | 18.40 | 34.70 | 0.00 | 34.80 | 21.40 | -132.40 | 53.10 | 90.60 | 0.30 | 2.70 | 1.60 | 0.00 | 0.70 | 0.70 | 1.60 | 8.50 | 1.00 |
| H517 | 23.040 | 30.958 | 81.226 | 424800.0 | 478400.0 | 13.8 | 0.00 | 98.30 | 1.40 | 0.30 | 12.70 | 26.80 | 0.00 | 19.80 | 6.80 | -73.10 | 39.50 | 89.20 | 0.10 | 6.90 | 2.70 | 0.00 | 0.00 | 0.00 | 2.00 | 8.90 | 0.60 |
| H5170 | 23.040 | 30.826 | 80.172 | 410400.0 | 579200.0 | 48.1 | 0.50 | 88.70 | 7.20 | 3.10 | 19.70 | 34.20 | 0.00 | 34.00 | 24.80 | -136.10 | 54.00 | 87.40 | 0.50 | 2.70 | 1.40 | 0.00 | 0.90 | 0.90 | 1.20 | 6.40 | 1.00 |
| H5171 | 23.040 | 30.825 | 80.122 | 410400.0 | 584000.0 | 67.2 | 0.70 | 81.70 | 11.80 | 5.20 | 21.30 | 24.20 | 0.00 | 27.40 | 32.60 | -140.10 | 45.50 | 84.00 | 0.70 | 2.80 | 1.20 | 0.00 | 1.00 | 1.00 | 1.10 | 5.40 | 1.00 |
| H5172 | 23.040 | 30.825 | 80.072 | 410400.0 | 588800.0 | 120.1 | 0.70 | 79.20 | 13.50 | 5.90 | 21.30 | 13.80 | 0.00 | 19.80 | 41.00 | -177.60 | 35.20 | 79.10 | 0.80 | 2.70 | 1.00 | 0.00 | 1.00 | 1.00 | 1.00 | 5.10 | 1.00 |
| H5173 | 11.630 | 30.825 | 80.021 | 410400.0 | 593600.0 | 49.7 | 0.30 | 83.70 | 10.60 | 4.70 | 27.90 | 19.50 | 0.00 | 42.50 | 30.00 | -139.60 | 47.40 | 89.40 | 0.60 | 3.00 | 1.30 | 0.00 | 1.00 | 1.00 | 1.10 | 5.30 | 1.00 |
| H518 | 23.040 | 30.958 | 81.176 | 424800.0 | 483200.0 | 15.3 | 0.00 | 98.90 | 0.90 | 0.10 | 13.50 | 26.40 | 0.00 | 18.90 | 6.30 | -74.00 | 39.80 | 89.40 | 0.30 | 6.40 | 2.50 | 0.00 | 0.00 | 0.00 | 1.80 | 8.60 | 0.70 |
| H519 | 23.040 | 30.958 | 81.126 | 424800.0 | 488000.0 | 16.8 | 0.00 | 99.60 | 0.40 | 0.00 | 15.10 | 25.60 | 0.00 | 16.80 | 5.50 | -74.40 | 40.70 | 89.70 | 0.50 | 5.70 | 2.60 | 0.00 | 0.00 | 0.00 | 1.70 | 8.80 | 0.70 |
| H5190 | 18.346 | 30.785 | 81.376 | 405600.0 | 464000.0 | 9.4 | 0.50 | 89.70 | 5.90 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.90 | 0.00 | 6.70 | 2.40 | 0.00 | 0.00 | 0.00 | 2.40 | 10.80 | 0.00 |
| H5191 | 23.040 | 30.785 | 81.326 | 405600.0 | 468800.0 | 13.2 | 1.30 | 93.90 | 2.40 | 2.40 | 13.20 | 27.60 | 0.00 | 18.80 | 6.50 | -73.30 | 40.80 | 0.00 | 0.00 | 6.80 | 2.80 | 0.00 | 0.10 | 0.10 | 1.10 | 9.50 | 0.10 |
| H5192 | 23.040 | 30.785 | 81.276 | 405600.0 | 473600.0 | 14.7 | 0.60 | 97.00 | 1.20 | 1.10 | 13.30 | 27.60 | 0.00 | 18.60 | 6.40 | -74.20 | 40.90 | 89.00 | 0.00 | 6.00 | 3.10 | 0.00 | 0.20 | 0.20 | 1.00 | 10.30 | 0.20 |
| H5193 | 23.040 | 30.785 | 81.226 | 405600.0 | 478400.0 | 16.2 | 0.40 | 98.30 | 0.70 | 0.60 | 13.40 | 27.40 | 0.00 | 18.50 | 6.10 | -75.60 | 40.80 | 89.30 | 0.00 | 6.30 | 3.50 | 0.00 | 0.30 | 0.30 | 1.00 | 11.10 | 0.30 |
| H5194 | 23.040 | 30.785 | 81.176 | 405600.0 | 483200.0 | 17.8 | 0.20 | 99.10 | 0.40 | 0.20 | 13.20 | 27.40 | 0.00 | 18.70 | 6.10 | -77.10 | 40.60 | 90.10 | 0.00 | 5.30 | 3.80 | 0.00 | 0.40 | 0.40 | 0.90 | 12.40 | 0.40 |
| H5195 | 23.040 | 30.785 | 81.125 | 405600.0 | 488000.0 | 19.2 | 0.10 | 99.70 | 0.10 | 0.00 | 12.80 | 27.30 | 0.00 | 19.20 | 6.20 | -78.50 | 40.00 | 91.10 | 0.10 | 4.10 | 3.90 | 0.00 | 0.50 | 0.50 | 0.90 | 13.40 | 0.50 |
| H5196 | 23.040 | 30.785 | 81.075 | 405600.0 | 492800.0 | 20.1 | 0.00 | 99.90 | 0.00 | 0.00 | 12.30 | 26.90 | 0.00 | 19.90 | 6.50 | -79.20 | 39.20 | 91.80 | 0.10 | 3.40 | 3.70 | 0.00 | 0.50 | 0.50 | 0.90 | 13.80 | 0.50 |
| H5197 | 23.040 | 30.785 | 81.025 | 405600.0 | 497600.0 | 21.3 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 26.30 | 0.00 | 20.60 | 7.00 | -80.00 | 38.10 | 92.10 | 0.10 | 3.20 | 3.30 | 0.00 | 0.30 | 0.30 | 1.00 | 13.10 | 0.40 |
| H5198 | 23.040 | 30.785 | 80.975 | 405600.0 | 502400.0 | 22.7 | 0.00 | 100.00 | 0.00 | 0.00 | 11.50 | 25.20 | 0.00 | 21.30 | 8.00 | -80.70 | 36.70 | 92.50 | 0.20 | 3.10 | 2.60 | 0.00 | 0.10 | 0.10 | 1.20 | 12.30 | 0.20 |
| H5199 | 23.040 | 30.785 | 80.925 | 405600.0 | 507200.0 | 24.2 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 23.70 | 0.00 | 22.00 | 9.40 | -81.20 | 34.90 | 93.50 | 0.50 | 3.00 | 1.70 | 0.00 | 0.00 | 0.00 | 1.40 | 12.30 | 0.20 |
| H520 | 23.040 | 30.958 | 81.075 | 424800.0 | 492000.0 | 18.4 | 0.00 | 99.90 | 0.10 | 0.00 | 16.20 | 25.00 | 0.00 | 15.40 | 4.90 | -75.00 | 41.20 | 90.20 | 0.50 | 5.00 | 3.00 | 0.00 | 0.00 | 0.00 | 1.50 | 9.40 | 0.50 |
| H5200 | 23.040 | 30.785 | 80.875 | 405600.0 | 512000.0 | 25.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 22.20 | 0.00 | 22.60 | 11.00 | -81.50 | 33.20 | 94.50 | 0.80 | 2.80 | 0.80 | 0.00 | 0.00 | 0.00 | 1.80 | 13.30 | 0.40 |
| H5201 | 23.040 | 30.785 | 80.824 | 405600.0 | 516800.0 | 27.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 20.20 | 0.00 | 23.20 | 12.80 | -81.70 | 31.40 | 95.00 | 0.90 | 2.60 | 0.40 | 0.00 | 0.00 | 0.00 | 2.10 | 14.20 | 0.50 |
| H5202 | 23.040 | 30.785 | 80.774 | 405600.0 | 521600.0 | 28.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.50 | 18.00 | 0.00 | 23.70 | 14.70 | -81.80 | 29.60 | 94.70 | 1.00 | 2.60 | 0.60 | 0.00 | 0.00 | 0.00 | 2.40 | 15.30 | 0.70 |
| H5203 | 23.040 | 30.785 | 80.724 | 405600.0 | 526400.0 | 30.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 17.00 | 0.00 | 24.00 | 15.60 | -82.70 | 28.60 | 93.60 | 1.20 | 2.80 | 1.30 | 0.00 | 0.00 | 0.00 | 2.70 | 16.20 | 0.90 |
| H5204 | 23.040 | 30.785 | 80.674 | 405600.0 | 531200.0 | 31.6 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 18.20 | 0.10 | 24.30 | 15.00 | -85.20 | 29.30 | 92.00 | 1.40 | 3.00 | 2.10 | 0.00 | 0.00 | 0.00 | 2.90 | 16.70 | 0.90 |
| H5205 | 23.040 | 30.785 | 80.624 | 405600.0 | 536000.0 | 33.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 21.40 | 0.10 | 24.70 | 13.40 | -89.20 | 31.50 | 90.80 | 1.70 | 3.20 | 2.80 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5206 | 23.040 | 30.784 | 80.574 | 405600.0 | 540800.0 | 34.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 23.00 | 0.00 | 24.80 | 12.80 | -92.40 | 33.10 | 90.10 | 1.00 | 3.40 | 3.20 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5207 | 23.040 | 30.784 | 80.523 | 405600.0 | 545600.0 | 36.1 | 0.00 | 100.00 | 0.00 | 0.00 | 11.80 | 21.80 | 0.00 | 24.60 | 14.80 | -94.40 | 33.70 | 89.90 | 1.80 | 3.60 | 3.40 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5208 | 23.040 | 30.784 | 80.473 | 405600.0 | 550400.0 | 37.6 | 0.00 | 99.90 | 0.00 | 0.00 | 13.60 | 20.50 | 0.00 | 24.30 | 17.10 | -96.10 | 34.20 | 90.40 | 1.50 | 3.60 | 3.20 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5209 | 23.040 | 30.784 | 80.423 | 405600.0 | 555200.0 | 39.1 | 0.00 | 99.70 | 0.20 | 0.10 | 15.00 | 22.50 | 0.00 | 25.70 | 19.80 | -102.30 | 37.50 | 91.50 | 1.00 | 3.40 | 2.60 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H521 | 23.040 | 30.958 | 81.025 | 424800.0 | 497600.0 | 19.6 | 0.00 | 99.90 | 0.10 | 0.00 | 15.70 | 22.50 | 0.10 | 16.90 | 4.00 | -74.70 | 38.30 | 90.80 | 0.40 | 4.40 | 3.40 | 0.00 | 0.00 | 0.00 | 1.30 | 10.00 | 0.30 |
| H5210 | 23.040 | 30.784 | 80.373 | 405600.0 | 560000.0 | 40.6 | 0.00 | 99.40 | 0.30 | 0.10 | 15.60 | 27.40 | 0.00 | 27.40 | 22.00 | -111.00 | 43.00 | 92.40 | 0.50 | 3.10 | 2.00 | 0.00 | 0.00 | 0.00 | 2.90 | 16.60 | 1.00 |
| H5211 | 23.040 | 30.783 | 80.323 | 405600.0 | 564800.0 | 42.3 | 0.00 | 99.10 | 0.60 | 0.30 | 13.60 | 33.10 | 0.00 | 28.00 | 21.80 | -117.00 | 46.70 | 92.60 | 0.30 | 2.80 | 1.70 | 0.00 | 0.10 | 0.10 | 2.70 | 15.40 | 1.00 |
| H5212 | 23.040 | 30.783 | 80.273 | 405600.0 | 569600.0 | 44.3 | 0.20 | 98.40 | 1.00 | 0.40 | 15.60 | 36.40 | 0.00 | 31.20 | 20.70 | -127.50 | 52.00 | 92.20 | 0.20 | 2.40 | 1.00 | 0.00 | 0.40 | 0.40 | 2.30 | 12.70 | 1.00 |
| H5213 | 23.040 | 30.783 | 80.222 | 405600.0 | 574400.0 | 46.7 | 0.50 | 96.20 | 2.20 | 0.90 | 16.70 | 46.20 | 0.00 | 35.70 | 18.30 | -145.30 | 62.90 | 89.60 | 0.20 | 2.30 | 1.80 | 0.00 | 0.60 | 0.60 | 1.70 | 9.40 | 1.00 |
| H5214 | 23.040 | 30.782 | 80.172 | 405600.0 | 579200.0 | 51.3 | 1.10 | 90.90 | 5.40 | 2.30 | 17.50 | 45.10 | 0.00 | 33.40 | 21.30 | -147.20 | 62.60 | 83.60 | 0.40 | 2.40 | 1.50 | 0.00 | 0.80 | 0.80 | 1.30 | 6.90 | 1.00 |
| H5215 | 23.040 | 30.782 | 80.122 | 405600.0 | 584000.0 | 86.5 | 1.50 | 86.30 | 8.20 | 3.40 | 20.40 | 21.20 | 0.00 | 17.60 | 36.20 | -145.70 | 41.50 | 73.60 | 0.50 | 2.50 | 1.20 | 0.00 | 0.90 | 0.90 | 1.10 | 5.60 | 1.00 |
| H5216 | 22.760 | 30.782 | 80.072 | 405600.0 | 588800.0 | 47.9 | 0.50 | 88.90 | 7.10 | 3.10 | 19.80 | 34.20 | 0.00 | 34.20 | 24.70 | -136.10 | 54.00 | 54.00 | 0.50 | 2.70 | 1.50 | 0.00 | 0.90 | 0.90 | 1.20 | 6.40 | 1.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H5217 | 5.280 | 30.781 | 80.822 | 405600.0 | 593600.0 | 47.3 | 0.50 | 77.50 | 9.90 | 4.30 | 28.10 | 25.00 | 0.00 | 30.10 | 26.90 | -123.20 | 45.00 | 88.60 | 0.60 | 2.60 | 1.20 | 0.00 | 0.90 | 0.90 | 1.00 | 5.20 | 0.90 |
| H522 | 23.040 | 30.958 | 80.975 | 424800.0 | 502400.0 | 20.5 | 0.00 | 100.00 | 0.00 | 0.00 | 14.40 | 17.10 | 0.20 | 20.50 | 2.00 | -72.60 | 31.70 | 91.50 | 0.30 | 4.00 | 3.40 | 0.00 | 0.00 | 0.00 | 1.20 | 10.60 | 0.20 |
| H523 | 23.040 | 30.958 | 80.925 | 424800.0 | 507200.0 | 22.1 | 0.00 | 100.00 | 0.00 | 0.00 | 13.90 | 13.90 | 0.10 | 22.50 | 0.90 | -72.50 | 28.00 | 92.00 | 0.30 | 4.00 | 2.80 | 0.00 | 0.00 | 0.00 | 1.10 | 10.90 | 0.10 |
| H5234 | 3.054 | 30.741 | 81.376 | 400000.0 | 464000.0 | 10.4 | 1.30 | 86.90 | 6.00 | 5.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 90.30 | 0.00 | 6.50 | 2.30 | 0.00 | 0.00 | 0.00 | 1.90 | 10.10 | 0.00 |
| H5235 | 22.440 | 30.741 | 81.326 | 400000.0 | 468800.0 | 11.7 | 1.90 | 89.30 | 4.30 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 90.00 | 0.00 | 6.60 | 2.40 | 0.00 | 0.00 | 0.00 | 1.30 | 9.30 | 0.00 |
| H5236 | 23.040 | 30.741 | 81.276 | 400000.0 | 473600.0 | 14.3 | 0.50 | 98.20 | 0.60 | 0.60 | 12.10 | 31.30 | 0.00 | 18.90 | 7.50 | -76.50 | 43.30 | 0.00 | 0.00 | 6.70 | 3.70 | 0.00 | 0.30 | 0.30 | 0.90 | 11.00 | 0.30 |
| H5237 | 23.040 | 30.742 | 81.226 | 400000.0 | 478400.0 | 15.7 | 0.30 | 99.00 | 0.40 | 0.30 | 12.20 | 30.90 | 0.00 | 18.90 | 7.10 | -77.70 | 43.00 | 88.90 | 0.00 | 6.30 | 3.70 | 0.00 | 0.50 | 0.40 | 0.90 | 12.60 | 0.40 |
| H5238 | 23.040 | 30.742 | 81.176 | 400000.0 | 483200.0 | 17.1 | 0.20 | 99.20 | 0.30 | 0.30 | 11.70 | 31.70 | 0.00 | 19.20 | 7.40 | -79.70 | 43.40 | 90.10 | 0.00 | 5.20 | 3.60 | 0.00 | 0.60 | 0.60 | 0.90 | 14.00 | 0.60 |
| H5239 | 23.040 | 30.742 | 81.125 | 400000.0 | 488000.0 | 18.5 | 0.10 | 99.70 | 0.10 | 0.10 | 11.00 | 32.40 | 0.00 | 19.70 | 7.80 | -81.60 | 43.40 | 91.30 | 0.00 | 4.00 | 3.50 | 0.00 | 0.70 | 0.70 | 0.90 | 14.90 | 0.70 |
| H524 | 23.040 | 30.958 | 80.874 | 424800.0 | 512000.0 | 23.9 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 14.60 | 0.30 | 22.30 | 3.30 | -74.30 | 28.10 | 92.40 | 0.40 | 4.20 | 2.10 | 0.00 | 0.00 | 0.00 | 1.10 | 11.10 | 0.00 |
| H5240 | 23.040 | 30.742 | 81.075 | 400000.0 | 492800.0 | 19.8 | 0.00 | 99.90 | 0.00 | 0.00 | 10.40 | 33.30 | 0.00 | 20.10 | 8.40 | -83.70 | 43.70 | 91.90 | 0.00 | 3.30 | 3.20 | 0.00 | 0.80 | 0.80 | 1.00 | 15.40 | 0.70 |
| H5241 | 23.040 | 30.742 | 81.025 | 400000.0 | 497600.0 | 21.2 | 0.00 | 100.00 | 0.00 | 0.00 | 10.10 | 33.50 | 0.00 | 20.60 | 9.00 | -85.30 | 43.60 | 92.10 | 0.10 | 3.00 | 3.00 | 0.00 | 0.70 | 0.70 | 1.20 | 15.10 | 0.70 |
| H5242 | 23.040 | 30.742 | 80.975 | 400000.0 | 502400.0 | 22.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 32.60 | 0.00 | 21.10 | 9.50 | -86.40 | 42.70 | 92.70 | 0.20 | 2.90 | 2.50 | 0.00 | 0.50 | 0.50 | 1.50 | 14.00 | 0.50 |
| H5243 | 23.040 | 30.742 | 80.925 | 400000.0 | 507200.0 | 24.1 | 0.00 | 99.90 | 0.00 | 0.00 | 10.20 | 31.10 | 0.00 | 21.70 | 10.10 | -87.00 | 41.30 | 93.80 | 0.60 | 2.70 | 1.60 | 0.00 | 0.20 | 0.20 | 1.80 | 13.30 | 0.40 |
| H5244 | 23.040 | 30.742 | 80.875 | 400000.0 | 512000.0 | 25.5 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 28.90 | 0.00 | 22.40 | 10.90 | -87.40 | 39.50 | 94.90 | 0.80 | 2.40 | 0.70 | 0.00 | 0.10 | 0.10 | 2.10 | 13.80 | 0.50 |
| H5245 | 23.040 | 30.742 | 80.824 | 400000.0 | 516800.0 | 26.9 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 26.10 | 0.00 | 23.20 | 11.90 | -87.30 | 37.20 | 95.50 | 1.00 | 2.20 | 0.20 | 0.00 | 0.00 | 0.00 | 2.40 | 14.80 | 0.60 |
| H5246 | 23.040 | 30.742 | 80.774 | 400000.0 | 521600.0 | 28.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 23.50 | 0.00 | 23.00 | 12.90 | -87.30 | 35.10 | 94.90 | 1.00 | 2.40 | 0.50 | 0.00 | 0.00 | 0.00 | 2.70 | 15.70 | 0.80 |
| H5247 | 23.040 | 30.741 | 80.724 | 400000.0 | 526400.0 | 29.7 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 21.00 | 0.00 | 24.30 | 13.30 | -87.80 | 33.80 | 93.40 | 1.20 | 2.80 | 1.40 | 0.00 | 0.00 | 0.00 | 2.80 | 16.30 | 0.90 |
| H5248 | 23.040 | 30.741 | 80.674 | 400000.0 | 531200.0 | 31.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.00 | 21.50 | 0.00 | 24.60 | 13.40 | -88.90 | 33.30 | 91.70 | 1.40 | 3.20 | 2.40 | 0.00 | 0.00 | 0.00 | 2.90 | 16.70 | 0.90 |
| H5249 | 23.040 | 30.741 | 80.624 | 400000.0 | 536000.0 | 32.5 | 0.00 | 100.00 | 0.00 | 0.00 | 11.60 | 22.30 | 0.00 | 24.70 | 13.20 | -91,10 | 33.90 | 90.50 | 1.60 | 3.50 | 3.10 | 0.00 | 0.00 | 0.00 | 3.00 | 16.80 | 1.00 |
| H525 | 23.040 | 30.958 | 80.824 | 424800.0 | 516800.0 | 25.8 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 15.90 | 0.50 | 22.20 | 8.50 | -76.10 | 28.10 | 93.00 | 0.50 | 4.00 | 1.50 | 0.00 | 0.00 | 0.00 | 1.10 | 11.20 | 0.00 |
| H5250 | 23.040 | 30.741 | 80.574 | 400000.0 | 540800.0 | 34.2 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 22.90 | 0.00 | 24.60 | 13.80 | -93.50 | 34.80 | 89.60 | 1.80 | 3.80 | 3.60 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5251 | 23.040 | 30.741 | 80.524 | 400000.0 | 545600.0 | 35.8 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 22.00 | 0.00 | 24.60 | 15.90 | -96.30 | 35.90 | 89.40 | 1.90 | 3.90 | 3.00 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5252 | 23.040 | 30.741 | 80.473 | 400000.0 | 550400.0 | 37.4 | 0.00 | 99.90 | 0.00 | 0.00 | 14.30 | 23.30 | 0.00 | 24.90 | 18.30 | -100.00 | 37.60 | 90.10 | 1.60 | 3.70 | 3.40 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5253 | 23.040 | 30.740 | 80.423 | 400000.0 | 555200.0 | 39.1 | 0.10 | 99.70 | 0.10 | 0.00 | 15.00 | 26.50 | 0.00 | 26.20 | 20.50 | -106.80 | 41.60 | 91.30 | 1.00 | 3.40 | 2.80 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5254 | 23.040 | 30.740 | 80.373 | 400000.0 | 560000.0 | 40.8 | 0.10 | 99.40 | 0.30 | 0.10 | 14.50 | 31.40 | 0.00 | 27.10 | 21.00 | -113.80 | 45.90 | 92.20 | 0.50 | 2.90 | 2.30 | 0.00 | 0.00 | 0.00 | 3.00 | 16.80 | 1.00 |
| H5255 | 23.040 | 30.740 | 80.323 | 400000.0 | 564800.0 | 42.2 | 0.10 | 99.30 | 0.40 | 0.20 | 14.50 | 36.50 | 0.00 | 28.60 | 20.00 | -121.80 | 51.00 | 92.80 | 0.30 | 2.50 | 2.00 | 0.00 | 0.10 | 0.10 | 2.80 | 16.00 | 1.00 |
| H5256 | 23.040 | 30.740 | 80.273 | 400000.0 | 569600.0 | 43.8 | 0.10 | 99.40 | 0.30 | 0.10 | 16.60 | 44.30 | 0.00 | 33.20 | 19.00 | -130.00 | 60.90 | 93.40 | 0.10 | 2.10 | 2.00 | 0.00 | 0.30 | 0.30 | 2.50 | 13.90 | 1.00 |
| H5257 | 23.040 | 30.739 | 80.223 | 400000.0 | 574400.0 | 46.8 | 0.70 | 97.60 | 1.20 | 0.40 | 16.50 | 52.30 | 0.00 | 36.10 | 17.30 | -151.70 | 68.80 | 88.40 | 0.20 | 2.20 | 1.90 | 0.00 | 0.60 | 0.60 | 1.80 | 9.90 | 1.00 |
| H5258 | 23.040 | 30.739 | 80.173 | 400000.0 | 579200.0 | 57.9 | 1.80 | 93.60 | 3.20 | 1.20 | 20.00 | 36.50 | 0.00 | 25.50 | 26.50 | -139.90 | 56.50 | 73.60 | 0.30 | 2.20 | 1.50 | 0.00 | 0.70 | 0.70 | 1.50 | 8.30 | 1.00 |
| H5259 | 23.040 | 30.739 | 80.123 | 400000.0 | 584000.0 | 100.7 | 2.50 | 91.30 | 4.40 | 1.60 | 23.30 | 9.20 | 0.00 | 7.00 | 43.10 | -148.30 | 32.60 | 53.50 | 0.30 | 2.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H526 | 23.040 | 30.958 | 80.774 | 424800.0 | 521600.0 | 27.6 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 16.30 | 0.50 | 22.60 | 11.90 | -77.60 | 27.40 | 93.30 | 0.70 | 3.70 | 1.20 | 0.00 | 0.00 | 0.00 | 1.20 | 11.50 | 0.10 |
| H5260 | 17.160 | 30.738 | 80.072 | 400000.0 | 588800.0 | 49.1 | 1.00 | 91.80 | 4.90 | 2.00 | 17.00 | 48.00 | 0.00 | 35.40 | 19.40 | -149.60 | 65.00 | 88.50 | 0.40 | 2.40 | 1.60 | 0.00 | 0.00 | 0.00 | 1.30 | 7.10 | 1.00 |
| H527 | 23.040 | 30.958 | 80.724 | 424800.0 | 526400.0 | 29.2 | 0.00 | 100.00 | 0.00 | 0.00 | 11.10 | 14.70 | 1.00 | 22.70 | 13.10 | -78.80 | 26.00 | 93.20 | 0.90 | 3.40 | 1.40 | 0.00 | 0.00 | 0.00 | 1.50 | 12.50 | 0.30 |
| H5278 | 0.249 | 30.698 | 81.376 | 396000.0 | 464000.0 | 11.0 | 5.30 | 89.40 | 3.00 | 2.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 91.60 | 0.00 | 5.00 | 2.40 | 0.00 | 0.00 | 0.00 | 0.30 | 7.00 | 0.00 |
| H5279 | 21.264 | 30.698 | 81.326 | 396000.0 | 468800.0 | 11.7 | 3.30 | 90.40 | 3.20 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 90.60 | 0.00 | 5.00 | 2.60 | 0.00 | 0.10 | 0.10 | 0.70 | 8.50 | 0.10 |
| H528 | 23.040 | 30.958 | 80.673 | 424800.0 | 531200.0 | 30.6 | 0.00 | 100.00 | 0.00 | 0.00 | 12.20 | 11.00 | 1.40 | 23.30 | 15.50 | -79.30 | 25.40 | 92.30 | 1.00 | 3.20 | 2.30 | 0.00 | 0.00 | 0.00 | 2.00 | 14.00 | 0.50 |
| H5280 | 23.040 | 30.698 | 81.276 | 396000.0 | 473600.0 | 16.0 | 0.30 | 99.30 | 0.20 | 0.20 | 9.80 | 37.30 | 0.00 | 19.50 | 9.40 | -82.70 | 47.10 | 0.00 | 0.00 | 6.70 | 3.00 | 0.00 | 0.50 | 0.50 | 0.80 | 12.70 | 0.50 |
| H5281 | 23.040 | 30.698 | 81.226 | 396000.0 | 478400.0 | 17.3 | 0.30 | 99.30 | 0.20 | 0.10 | 9.90 | 37.30 | 0.00 | 19.50 | 9.20 | -84.10 | 47.20 | 89.40 | 0.00 | 5.90 | 3.60 | 0.00 | 0.60 | 0.60 | 0.90 | 14.30 | 0.60 |
| H5282 | 23.040 | 30.698 | 81.175 | 396000.0 | 483200.0 | 18.6 | 0.20 | 99.50 | 0.20 | 0.10 | 9.80 | 37.90 | 0.00 | 19.60 | 9.40 | -85.80 | 47.60 | 90.70 | 0.00 | 4.70 | 3.40 | 0.00 | 0.80 | 0.00 | 0.90 | 15.30 | 0.70 |
| H5283 | 23.040 | 30.698 | 81.125 | 396000.0 | 488000.0 | 19.4 | 0.10 | 99.80 | 0.10 | 0.00 | 9.50 | 37.60 | 0.00 | 20.10 | 9.40 | -86.60 | 47.10 | 91.70 | 0.00 | 3.60 | 3.20 | 0.00 | 0.80 | 0.00 | 1.00 | 15.90 | 0.80 |
| H5284 | 23.040 | 30.698 | 81.075 | 396000.0 | 492800.0 | 20.5 | 0.00 | 99.90 | 0.00 | 0.00 | 9.00 | 38.80 | 0.00 | 20.20 | 9.90 | -88.50 | 47.00 | 92.00 | 0.00 | 3.10 | 3.00 | 0.00 | 0.90 | 0.90 | 1.20 | 16.30 | 0.90 |
| H5285 | 23.040 | 30.698 | 81.025 | 396000.0 | 497600.0 | 21.8 | 0.00 | 99.90 | 0.10 | 0.00 | 8.80 | 39.10 | 0.00 | 20.40 | 10.20 | -90.10 | 47.90 | 92.40 | 0.10 | 2.90 | 2.80 | 0.00 | 1.10 | 1.00 | 1.70 | 16.20 | 0.90 |
| H5286 | 23.040 | 30.698 | 80.975 | 396000.0 | 502400.0 | 23.2 | 0.00 | 99.90 | 0.10 | 0.00 | 8.90 | 38.60 | 0.00 | 20.70 | 10.30 | -91.40 | 47.50 | 93.20 | 0.30 | 2.80 | 2.20 | 0.00 | 1.00 | 1.00 | 2.30 | 15.30 | 0.80 |
| H5287 | 23.040 | 30.698 | 80.925 | 396000.0 | 507200.0 | 24.5 | 0.00 | 99.90 | 0.10 | 0.00 | 9.40 | 37.50 | 0.00 | 21.30 | 10.30 | -92.60 | 46.80 | 94.40 | 0.70 | 2.40 | 1.20 | 0.00 | 0.70 | 0.70 | 2.80 | 14.20 | 0.60 |
| H5288 | 23.040 | 30.698 | 80.875 | 396000.0 | 512000.0 | 25.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.00 | 35.70 | 0.00 | 22.20 | 10.30 | -93.70 | 45.80 | 95.40 | 0.90 | 2.20 | 0.40 | 0.00 | 0.40 | 0.40 | 3.00 | 14.00 | 0.60 |
| H5289 | 23.040 | 30.698 | 80.825 | 396000.0 | 516800.0 | 27.1 | 0.00 | 100.00 | 0.00 | 0.00 | 10.90 | 33.20 | 0.00 | 23.10 | 10.60 | -94.30 | 44.10 | 95.50 | 1.00 | 2.20 | 0.30 | 0.00 | 0.10 | 0.10 | 3.00 | 14.70 | 0.60 |
| H529 | 23.040 | 30.958 | 80.623 | 424800.0 | 536000.0 | 31.6 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 11.20 | 1.80 | 24.10 | 16.20 | -81.20 | 25.40 | 91.10 | 1.20 | 3.10 | 3.30 | 0.00 | 0.00 | 0.00 | 2.50 | 15.50 | 0.80 |
| H5290 | 23.040 | 30.698 | 80.774 | 396000.0 | 521600.0 | 28.4 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 29.90 | 0.00 | 24.00 | 10.90 | -94.20 | 41.80 | 94.20 | 1.00 | 2.50 | 1.00 | 0.00 | 0.00 | 0.00 | 3.00 | 15.40 | 0.70 |
| H5291 | 23.040 | 30.698 | 80.724 | 396000.0 | 526400.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 13.00 | 26.40 | 0.00 | 24.80 | 11.20 | -94.00 | 39.40 | 92.60 | 1.20 | 3.00 | 1.90 | 0.00 | 0.00 | 0.00 | 3.00 | 16.00 | 0.80 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H5292 | 23.040 | 30.698 | 80.674 | 396000.0 | 531200.0 | 31.2 | 0.00 | 100.00 | 0.00 | 0.00 | 13.60 | 24.40 | 0.00 | 25.20 | 11.50 | -94.40 | 30.00 | 91.00 | 1.40 | 3.40 | 2.80 | 0.00 | 0.00 | 0.00 | 3.00 | 16.30 | 0.90 |
| H5293 | 23.040 | 30.698 | 80.624 | 396000.0 | 536000.0 | 32.7 | 0.00 | 100.00 | 0.00 | 0.00 | 13.60 | 24.20 | 0.00 | 25.00 | 12.10 | -95.50 | 37.00 | 89.90 | 1.70 | 3.80 | 3.50 | 0.00 | 0.00 | 0.00 | 3.00 | 16.60 | 0.90 |
| H5294 | 23.040 | 30.698 | 80.574 | 396000.0 | 540800.0 | 34.1 | 0.00 | 100.00 | 0.00 | 0.00 | 13.90 | 24.60 | 0.00 | 24.60 | 13.70 | -97.20 | 38.50 | 89.30 | 1.90 | 3.90 | 3.00 | 0.00 | 0.00 | 0.00 | 3.00 | 16.70 | 0.90 |
| H5295 | 23.040 | 30.698 | 80.524 | 396000.0 | 545600.0 | 35.6 | 0.00 | 100.00 | 0.00 | 0.00 | 14.60 | 25.20 | 0.00 | 24.50 | 16.00 | -99.90 | 39.80 | 89.40 | 1.80 | 4.00 | 3.80 | 0.00 | 0.00 | 0.00 | 3.00 | 16.80 | 1.00 |
| H5296 | 23.040 | 30.697 | 80.474 | 396000.0 | 550400.0 | 37.1 | 0.00 | 99.90 | 0.00 | 0.00 | 15.10 | 27.40 | 0.00 | 25.00 | 18.00 | -104.70 | 42.50 | 90.20 | 1.30 | 3.80 | 3.40 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5297 | 23.040 | 30.697 | 80.424 | 396000.0 | 555200.0 | 38.6 | 0.10 | 99.80 | 0.00 | 0.00 | 15.50 | 30.50 | 0.00 | 25.70 | 19.90 | -110.20 | 46.00 | 90.90 | 0.90 | 3.40 | 2.80 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5298 | 23.040 | 30.697 | 80.373 | 396000.0 | 560000.0 | 40.3 | 0.30 | 99.50 | 0.10 | 0.00 | 15.90 | 33.40 | 0.00 | 26.40 | 21.20 | -116.10 | 49.40 | 91.80 | 0.50 | 2.80 | 2.40 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H5299 | 23.040 | 30.697 | 80.323 | 396000.0 | 564800.0 | 42.9 | 0.30 | 99.50 | 0.20 | 0.10 | 16.70 | 39.50 | 0.00 | 28.10 | 28.60 | -127.10 | 56.20 | 93.00 | 0.20 | 2.30 | 2.10 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H530 | 23.040 | 30.958 | 80.573 | 424800.0 | 540800.0 | 32.7 | 0.00 | 100.00 | 0.00 | 0.00 | 12.30 | 13.20 | 2.20 | 25.40 | 14.70 | -85.90 | 27.80 | 90.50 | 1.40 | 3.10 | 3.60 | 0.00 | 0.00 | 0.00 | 2.80 | 16.50 | 0.90 |
| H5300 | 23.040 | 30.696 | 80.273 | 396000.0 | 569600.0 | 45.6 | 0.30 | 99.20 | 0.30 | 0.10 | 17.60 | 43.30 | 0.00 | 29.70 | 21.40 | -136.10 | 60.90 | 91.90 | 0.10 | 2.20 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5301 | 23.040 | 30.696 | 80.223 | 396000.0 | 574400.0 | 48.9 | 1.50 | 96.90 | 1.20 | 0.40 | 17.80 | 38.40 | 0.00 | 26.10 | 26.40 | -131.30 | 56.30 | 81.00 | 0.40 | 2.30 | 1.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5302 | 23.040 | 30.696 | 80.173 | 396000.0 | 579200.0 | 71.8 | 3.00 | 94.10 | 2.20 | 0.60 | 20.40 | 16.60 | 0.00 | 11.50 | 40.00 | -120.30 | 37.00 | 60.70 | 0.40 | 2.20 | 1.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5303 | 23.040 | 30.695 | 80.123 | 396000.0 | 584000.0 | 129.8 | 3.30 | 93.60 | 2.40 | 0.60 | 17.30 | 2.60 | 0.00 | 1.90 | 51.30 | -151.50 | 19.90 | 35.80 | 0.20 | 1.70 | 0.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5304 | 0.640 | 30.695 | 80.073 | 396000.0 | 588800.0 | 49.7 | 1.30 | 95.20 | 2.40 | 0.90 | 17.20 | 40.10 | 0.00 | 32.00 | 20.40 | -147.00 | 65.30 | 90.00 | 0.30 | 2.20 | 1.70 | 0.00 | 0.70 | 0.70 | 1.50 | 0.30 | 1.00 |
| H531 | 23.040 | 30.957 | 80.523 | 424800.0 | 545600.0 | 33.7 | 0.00 | 100.00 | 0.00 | 0.00 | 12.80 | 15.40 | 2.30 | 27.10 | 13.80 | -91.40 | 30.60 | 90.40 | 1.50 | 3.10 | 3.50 | 0.00 | 0.00 | 0.00 | 2.90 | 16.80 | 1.00 |
| H532 | 23.040 | 30.957 | 80.472 | 424800.0 | 550400.0 | 34.7 | 0.00 | 100.00 | 0.00 | 0.00 | 14.80 | 16.20 | 1.90 | 28.60 | 14.50 | -96.20 | 32.90 | 90.60 | 1.50 | 3.20 | 3.20 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5322 | 9.700 | 30.655 | 81.376 | 391200.0 | 464000.0 | 11.4 | 5.60 | 90.40 | 2.50 | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 92.70 | 0.00 | 4.30 | 2.10 | 0.00 | 0.00 | 0.00 | 0.20 | 7.60 | 0.00 |
| H5323 | 23.040 | 30.655 | 81.326 | 391200.0 | 468800.0 | 16.2 | 1.00 | 97.80 | 0.70 | 0.50 | 8.20 | 41.30 | 0.00 | 28.10 | 10.90 | -86.20 | 49.50 | 0.00 | 0.00 | 5.70 | 3.40 | 0.00 | 0.50 | 0.50 | 0.80 | 13.20 | 0.50 |
| H5324 | 23.040 | 30.655 | 81.276 | 391200.0 | 473600.0 | 18.7 | 0.50 | 98.80 | 0.40 | 0.30 | 8.40 | 40.90 | 0.00 | 28.00 | 10.70 | -87.90 | 49.20 | 89.90 | 0.00 | 5.70 | 3.50 | 0.00 | 0.70 | 0.70 | 0.90 | 15.20 | 0.70 |
| H5325 | 23.040 | 30.655 | 81.225 | 391200.0 | 478400.0 | 20.1 | 0.50 | 98.90 | 0.30 | 0.20 | 8.40 | 41.00 | 0.00 | 19.90 | 10.70 | -89.40 | 49.40 | 91.00 | 0.00 | 4.00 | 3.30 | 0.00 | 0.80 | 0.80 | 0.90 | 16.10 | 0.80 |
| H5326 | 23.040 | 30.655 | 81.175 | 391200.0 | 483200.0 | 19.9 | 0.30 | 99.30 | 0.20 | 0.10 | 8.50 | 41.00 | 0.00 | 20.00 | 10.50 | -89.50 | 49.50 | 91.70 | 0.00 | 3.90 | 3.20 | 0.00 | 0.90 | 0.90 | 1.00 | 16.50 | 0.90 |
| H5327 | 23.040 | 30.655 | 81.125 | 391200.0 | 488000.0 | 20.1 | 0.10 | 99.70 | 0.10 | 0.00 | 8.50 | 40.90 | 0.00 | 20.20 | 10.40 | -89.70 | 49.40 | 92.00 | 0.10 | 3.30 | 3.10 | 0.00 | 1.00 | 1.00 | 1.20 | 16.60 | 0.90 |
| H5328 | 23.040 | 30.655 | 81.075 | 391200.0 | 492800.0 | 20.1 | 0.00 | 99.80 | 0.10 | 0.00 | 8.30 | 41.40 | 0.00 | 20.20 | 10.60 | -90.10 | 49.70 | 92.30 | 0.10 | 3.00 | 2.90 | 0.00 | 1.10 | 1.10 | 1.60 | 16.50 | 0.90 |
| H5329 | 23.040 | 30.655 | 81.025 | 391200.0 | 497600.0 | 21.3 | 0.00 | 99.70 | 0.20 | 0.00 | 8.20 | 41.50 | 0.00 | 20.20 | 10.80 | -91.20 | 49.70 | 92.80 | 0.20 | 2.80 | 2.70 | 0.00 | 1.20 | 1.20 | 2.30 | 16.20 | 0.90 |
| H533 | 23.040 | 30.957 | 80.422 | 424800.0 | 555200.0 | 35.7 | 0.00 | 99.80 | 0.10 | 0.00 | 18.00 | 16.40 | 1.10 | 30.70 | 15.70 | -101.80 | 35.40 | 91.10 | 1.30 | 3.40 | 2.90 | 0.00 | 0.00 | 0.00 | 2.90 | 16.70 | 1.00 |
| H5330 | 23.040 | 30.655 | 80.975 | 391200.0 | 502400.0 | 22.7 | 0.00 | 99.70 | 0.30 | 0.00 | 8.40 | 41.10 | 0.00 | 20.40 | 10.70 | -92.70 | 49.50 | 93.70 | 0.40 | 2.60 | 2.10 | 0.00 | 1.30 | 1.30 | 3.10 | 15.30 | 0.90 |
| H5331 | 23.040 | 30.655 | 80.925 | 391200.0 | 507200.0 | 24.1 | 0.00 | 99.80 | 0.20 | 0.00 | 9.00 | 40.80 | 0.00 | 21.20 | 10.10 | -95.10 | 49.90 | 94.60 | 0.70 | 2.40 | 1.30 | 0.00 | 1.20 | 1.20 | 3.70 | 14.20 | 0.70 |
| H5332 | 23.040 | 30.655 | 80.875 | 391200.0 | 512000.0 | 25.4 | 0.00 | 99.90 | 0.10 | 0.00 | 9.60 | 40.60 | 0.00 | 22.10 | 9.70 | -97.70 | 50.20 | 95.00 | 0.90 | 2.30 | 0.80 | 0.00 | 0.80 | 0.80 | 3.90 | 13.50 | 0.60 |
| H5333 | 23.040 | 30.655 | 80.825 | 391200.0 | 516800.0 | 26.8 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 38.70 | 0.00 | 22.90 | 9.50 | -99.00 | 49.30 | 94.30 | 0.90 | 2.50 | 1.10 | 0.00 | 0.40 | 0.40 | 3.70 | 13.70 | 0.50 |
| H5334 | 23.040 | 30.655 | 80.775 | 391200.0 | 521600.0 | 28.1 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 33.00 | 0.00 | 24.30 | 9.40 | -98.80 | 46.30 | 92.30 | 1.00 | 3.10 | 2.10 | 0.00 | 0.20 | 0.20 | 3.50 | 14.20 | 0.60 |
| H5335 | 23.040 | 30.655 | 80.724 | 391200.0 | 526400.0 | 29.5 | 0.00 | 100.00 | 0.00 | 0.00 | 14.80 | 28.20 | 0.00 | 25.80 | 9.40 | -98.30 | 43.00 | 91.10 | 1.20 | 3.50 | 2.80 | 0.00 | 0.00 | 0.00 | 3.40 | 14.70 | 0.60 |
| H5336 | 23.040 | 30.655 | 80.674 | 391200.0 | 531200.0 | 30.7 | 0.00 | 100.00 | 0.00 | 0.00 | 15.90 | 25.60 | 0.00 | 26.20 | 9.70 | -98.50 | 41.60 | 90.30 | 1.40 | 3.70 | 3.20 | 0.00 | 0.00 | 0.00 | 3.30 | 15.10 | 0.70 |
| H5337 | 23.040 | 30.655 | 80.624 | 391200.0 | 536000.0 | 32.1 | 0.00 | 100.00 | 0.00 | 0.00 | 16.20 | 25.40 | 0.00 | 25.60 | 10.70 | -99.30 | 41.60 | 89.80 | 1.60 | 3.90 | 3.60 | 0.00 | 0.00 | 0.00 | 3.20 | 15.50 | 0.80 |
| H5338 | 23.040 | 30.654 | 80.574 | 391200.0 | 540800.0 | 33.6 | 0.00 | 100.00 | 0.00 | 0.00 | 16.20 | 26.40 | 0.00 | 24.60 | 12.50 | -100.90 | 42.70 | 89.60 | 1.60 | 4.00 | 3.70 | 0.00 | 0.00 | 0.00 | 3.20 | 15.80 | 0.80 |
| H5339 | 23.040 | 30.654 | 80.524 | 391200.0 | 545600.0 | 35.1 | 0.00 | 100.00 | 0.00 | 0.00 | 16.40 | 28.50 | 0.00 | 24.00 | 14.60 | -104.00 | 44.90 | 89.90 | 1.30 | 4.10 | 3.50 | 0.00 | 0.00 | 0.00 | 3.10 | 16.10 | 0.80 |
| H534 | 23.040 | 30.957 | 80.372 | 424800.0 | 560000.0 | 36.8 | 0.00 | 99.70 | 0.20 | 0.10 | 21.10 | 15.20 | 0.40 | 32.20 | 17.10 | -105.70 | 36.70 | 91.70 | 0.90 | 3.50 | 2.60 | 0.00 | 0.10 | 0.10 | 2.80 | 15.90 | 1.00 |
| H5340 | 23.040 | 30.654 | 80.474 | 391200.0 | 550400.0 | 36.6 | 0.10 | 99.90 | 0.00 | 0.00 | 16.60 | 31.90 | 0.00 | 23.50 | 16.50 | -108.60 | 40.50 | 90.50 | 0.80 | 4.00 | 3.10 | 0.00 | 0.00 | 0.00 | 3.10 | 16.40 | 0.90 |
| H5341 | 23.040 | 30.654 | 80.424 | 391200.0 | 555200.0 | 38.1 | 0.10 | 99.80 | 0.00 | 0.00 | 17.50 | 34.00 | 0.00 | 23.80 | 19.10 | -113.30 | 51.50 | 90.50 | 0.60 | 3.60 | 2.80 | 0.00 | 0.00 | 0.00 | 3.00 | 16.70 | 1.00 |
| H5342 | 23.040 | 30.654 | 80.374 | 391200.0 | 560000.0 | 39.6 | 0.30 | 99.60 | 0.10 | 0.00 | 18.80 | 36.20 | 0.00 | 24.40 | 21.00 | -119.00 | 55.00 | 90.40 | 0.50 | 3.00 | 2.50 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H5343 | 23.040 | 30.653 | 80.324 | 391200.0 | 564800.0 | 41.7 | 0.70 | 98.90 | 0.30 | 0.10 | 19.80 | 39.60 | 0.00 | 24.70 | 22.20 | -125.80 | 59.50 | 90.00 | 0.50 | 2.60 | 2.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5344 | 23.040 | 30.653 | 80.274 | 391200.0 | 569600.0 | 45.3 | 1.10 | 97.90 | 0.60 | 0.30 | 19.40 | 36.60 | 0.00 | 22.50 | 27.10 | -123.80 | 56.00 | 86.90 | 0.60 | 2.60 | 2.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5345 | 23.040 | 30.653 | 80.223 | 391200.0 | 574400.0 | 52.2 | 2.30 | 95.90 | 1.20 | 0.40 | 19.60 | 27.30 | 0.00 | 17.10 | 34.00 | -116.20 | 46.90 | 75.10 | 0.80 | 2.70 | 2.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5346 | 23.040 | 30.653 | 80.173 | 391200.0 | 579200.0 | 90.0 | 4.40 | 93.40 | 1.70 | 0.40 | 18.80 | 13.80 | 0.00 | 8.60 | 43.60 | -131.20 | 32.60 | 54.70 | 0.70 | 2.50 | 1.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5347 | 21.560 | 30.652 | 80.123 | 391200.0 | 584000.0 | 48.4 | 1.30 | 97.20 | 1.10 | 0.40 | 17.70 | 40.10 | 0.00 | 27.20 | 25.30 | -133.40 | 57.80 | 91.90 | 0.30 | 2.30 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5348 | 1.600 | 30.652 | 80.073 | 391200.0 | 588800.0 | 42.3 | 1.40 | 79.60 | 1.60 | 0.50 | 15.10 | 30.10 | 0.00 | 20.70 | 23.30 | -108.20 | 45.20 | 64.10 | 0.20 | 1.80 | 1.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H535 | 23.040 | 30.957 | 80.322 | 424800.0 | 564800.0 | 37.8 | 0.00 | 99.60 | 0.30 | 0.10 | 23.60 | 12.80 | 0.10 | 33.80 | 19.40 | -108.10 | 36.50 | 92.50 | 0.60 | 3.50 | 2.20 | 0.00 | 0.30 | 0.30 | 2.40 | 13.40 | 1.00 |
| H536 | 23.040 | 30.956 | 80.271 | 424800.0 | 569600.0 | 38.8 | 0.00 | 99.30 | 0.50 | 0.20 | 22.00 | 18.10 | 0.00 | 40.80 | 16.00 | -119.70 | 40.00 | 92.90 | 0.40 | 3.40 | 1.80 | 0.00 | 0.60 | 0.60 | 1.80 | 9.60 | 1.00 |
| H5366 | 14.344 | 30.611 | 81.376 | 386400.0 | 464000.0 | 11.8 | 4.50 | 92.60 | 2.00 | 0.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 94.30 | 0.00 | 3.30 | 1.50 | 0.00 | 0.10 | 0.10 | 0.30 | 8.30 | 0.10 |
| H5367 | 23.040 | 30.611 | 81.325 | 386400.0 | 468800.0 | 15.6 | 1.00 | 98.10 | 0.70 | 0.20 | 8.10 | 41.40 | 0.00 | 20.20 | 11.00 | -86.20 | 49.50 | 0.00 | 0.00 | 4.40 | 3.00 | 0.00 | 0.80 | 0.80 | 0.90 | 16.20 | 0.80 |
| H5368 | 23.040 | 30.612 | 81.275 | 386400.0 | 473600.0 | 17.8 | 0.50 | 98.80 | 0.40 | 0.20 | 8.10 | 41.10 | 0.00 | 20.40 | 11.00 | -88.00 | 49.20 | 92.00 | 0.10 | 4.20 | 3.10 | 0.00 | 0.90 | 0.90 | 1.00 | 17.10 | 0.90 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MI.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H5369 | 23.040 | 30.612 | 81.225 | 386400.0 | 478400.0 | 20.0 | 0.40 | 98.90 | 0.30 | 0.30 | 8.10 | 41.20 | 0.00 | 20.30 | 11.00 | -89.60 | 49.30 | 92.10 | 0.10 | 4.00 | 3.10 | 0.00 | 0.90 | 0.90 | 1.00 | 17.30 | 0.90 |
| H537 | 23.040 | 30.956 | 80.221 | 424000.0 | 574400.0 | 40.1 | 0.00 | 98.30 | 1.10 | 0.50 | 21.90 | 22.00 | 0.00 | 49.00 | 13.40 | -132.90 | 43.90 | 92.20 | 0.30 | 3.40 | 1.00 | 0.00 | 0.90 | 0.90 | 1.30 | 6.60 | 1.00 |
| H5370 | 23.040 | 30.612 | 81.175 | 386400.0 | 483200.0 | 20.5 | 0.30 | 99.10 | 0.30 | 0.20 | 8.10 | 41.50 | 0.00 | 20.20 | 11.00 | -90.20 | 49.60 | 92.30 | 0.10 | 3.50 | 3.00 | 0.00 | 1.00 | 1.00 | 1.10 | 17.10 | 0.90 |
| H5371 | 23.040 | 30.612 | 81.125 | 386400.0 | 488000.0 | 20.0 | 0.10 | 99.40 | 0.30 | 0.10 | 8.10 | 41.80 | 0.00 | 20.10 | 10.90 | -89.90 | 49.80 | 92.50 | 0.20 | 3.00 | 3.00 | 0.00 | 1.10 | 1.00 | 1.40 | 16.90 | 0.90 |
| H5372 | 23.040 | 30.612 | 81.075 | 386400.0 | 492800.0 | 20.4 | 0.00 | 99.50 | 0.40 | 0.00 | 8.10 | 41.90 | 0.00 | 20.10 | 10.90 | -90.50 | 50.00 | 92.00 | 0.20 | 2.80 | 2.90 | 0.00 | 1.20 | 1.20 | 2.00 | 16.50 | 0.90 |
| H5373 | 23.040 | 30.612 | 81.025 | 386400.0 | 497600.0 | 21.4 | 0.00 | 99.40 | 0.50 | 0.00 | 8.10 | 42.00 | 0.00 | 20.10 | 10.90 | -91.50 | 50.10 | 93.30 | 0.20 | 2.50 | 2.80 | 0.00 | 1.40 | 1.40 | 2.80 | 15.80 | 0.90 |
| H5374 | 23.040 | 30.612 | 80.975 | 386400.0 | 502400.0 | 22.8 | 0.00 | 99.50 | 0.50 | 0.00 | 8.30 | 42.00 | 0.00 | 20.50 | 10.60 | -93.70 | 50.40 | 93.70 | 0.30 | 2.50 | 2.40 | 0.00 | 1.50 | 1.50 | 3.70 | 14.90 | 0.90 |
| H5375 | 23.040 | 30.612 | 80.925 | 386400.0 | 507200.0 | 24.4 | 0.00 | 99.70 | 0.30 | 0.00 | 9.10 | 42.20 | 0.00 | 21.50 | 9.80 | -97.20 | 51.30 | 94.00 | 0.60 | 2.50 | 1.80 | 0.00 | 1.40 | 1.40 | 4.20 | 13.90 | 0.80 |
| H5376 | 23.040 | 30.612 | 80.875 | 386400.0 | 512000.0 | 26.0 | 0.00 | 99.80 | 0.20 | 0.00 | 9.40 | 43.10 | 0.00 | 22.10 | 9.20 | -100.70 | 52.50 | 93.90 | 0.80 | 2.60 | 1.60 | 0.00 | 1.10 | 1.00 | 4.30 | 13.00 | 0.60 |
| H5377 | 23.040 | 30.612 | 80.825 | 386400.0 | 516800.0 | 27.6 | 0.00 | 99.90 | 0.10 | 0.00 | 10.20 | 41.60 | 0.00 | 22.70 | 9.10 | -102.10 | 51.80 | 92.50 | 0.90 | 3.00 | 2.20 | 0.00 | 0.60 | 0.60 | 4.20 | 12.70 | 0.40 |
| H5378 | 23.040 | 30.612 | 80.775 | 386400.0 | 521600.0 | 29.0 | 0.00 | 100.00 | 0.00 | 0.00 | 13.60 | 34.00 | 0.00 | 25.00 | 8.70 | -101.50 | 47.60 | 90.70 | 1.00 | 3.60 | 3.10 | 0.00 | 0.30 | 0.30 | 4.00 | 12.70 | 0.40 |
| H5379 | 23.040 | 30.612 | 80.725 | 386400.0 | 526400.0 | 29.6 | 0.00 | 100.00 | 0.00 | 0.00 | 17.00 | 26.60 | 0.00 | 27.40 | 8.20 | -100.50 | 43.60 | 90.00 | 1.10 | 3.80 | 3.50 | 0.00 | 0.10 | 0.10 | 3.80 | 12.80 | 0.30 |
| H538 | 23.040 | 30.956 | 80.171 | 424000.0 | 579200.0 | 43.6 | 0.10 | 96.50 | 2.20 | 1.00 | 30.40 | 16.10 | 0.00 | 54.20 | 23.00 | -144.20 | 46.40 | 89.70 | 0.30 | 3.60 | 2.00 | 0.00 | 1.00 | 1.00 | 1.10 | 5.40 | 1.00 |
| H5380 | 23.040 | 30.611 | 80.675 | 386400.0 | 531200.0 | 30.1 | 0.00 | 99.90 | 0.00 | 0.00 | 18.00 | 24.90 | 0.00 | 27.40 | 8.40 | -100.40 | 42.90 | 90.00 | 1.20 | 3.90 | 3.50 | 0.00 | 0.00 | 0.00 | 3.70 | 13.20 | 0.40 |
| H5381 | 23.040 | 30.611 | 80.624 | 386400.0 | 536000.0 | 31.0 | 0.00 | 100.00 | 0.00 | 0.00 | 18.00 | 26.00 | 0.00 | 25.80 | 9.40 | -100.00 | 44.00 | 89.90 | 1.30 | 4.00 | 3.50 | 0.00 | 0.00 | 0.00 | 3.60 | 13.60 | 0.40 |
| H5382 | 23.040 | 30.611 | 80.574 | 386400.0 | 540800.0 | 32.5 | 0.00 | 99.90 | 0.00 | 0.00 | 18.00 | 28.00 | 0.00 | 24.10 | 10.50 | -102.70 | 46.00 | 90.10 | 1.10 | 4.20 | 3.40 | 0.00 | 0.00 | 0.00 | 3.50 | 14.00 | 0.50 |
| H5383 | 23.040 | 30.611 | 80.524 | 386400.0 | 545600.0 | 34.2 | 0.10 | 99.90 | 0.00 | 0.00 | 18.00 | 30.90 | 0.00 | 22.90 | 12.50 | -106.00 | 48.90 | 90.40 | 0.70 | 4.40 | 3.20 | 0.00 | 0.00 | 0.00 | 3.40 | 14.50 | 0.60 |
| H5384 | 23.040 | 30.611 | 80.474 | 386400.0 | 550400.0 | 35.9 | 0.10 | 99.90 | 0.00 | 0.00 | 18.50 | 35.00 | 0.00 | 21.60 | 15.00 | -111.00 | 53.50 | 90.50 | 0.50 | 4.40 | 3.00 | 0.00 | 0.00 | 0.00 | 3.30 | 15.00 | 0.70 |
| H5385 | 23.040 | 30.611 | 80.424 | 386400.0 | 555200.0 | 37.6 | 0.20 | 99.80 | 0.00 | 0.00 | 19.90 | 37.70 | 0.00 | 21.10 | 19.20 | -116.30 | 57.70 | 89.90 | 0.50 | 4.00 | 2.80 | 0.00 | 0.00 | 0.00 | 3.20 | 15.00 | 0.80 |
| H5386 | 23.040 | 30.610 | 80.374 | 386400.0 | 560000.0 | 39.4 | 0.40 | 99.60 | 0.00 | 0.00 | 22.60 | 40.10 | 0.00 | 20.00 | 21.10 | -122.00 | 62.70 | 88.70 | 0.70 | 3.50 | 2.70 | 0.00 | 0.00 | 0.00 | 3.10 | 16.40 | 0.90 |
| H5387 | 23.040 | 30.610 | 80.324 | 386400.0 | 564800.0 | 42.3 | 0.00 | 98.80 | 0.20 | 0.10 | 25.10 | 40.40 | 0.00 | 19.90 | 23.00 | -127.70 | 65.50 | 86.70 | 1.00 | 3.30 | 2.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5388 | 23.040 | 30.610 | 80.274 | 386400.0 | 569600.0 | 46.3 | 1.60 | 97.40 | 0.60 | 0.30 | 24.80 | 34.50 | 0.00 | 17.10 | 29.70 | -122.70 | 59.20 | 84.00 | 1.30 | 3.30 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5389 | 23.040 | 30.609 | 80.224 | 386400.0 | 574400.0 | 50.9 | 3.10 | 95.20 | 1.10 | 0.50 | 24.10 | 27.20 | 0.00 | 13.60 | 35.00 | -123.00 | 51.30 | 76.30 | 1.40 | 3.30 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H539 | 23.040 | 30.955 | 80.121 | 424000.0 | 584000.0 | 47.9 | 0.20 | 93.30 | 4.30 | 1.90 | 42.00 | 6.00 | 0.00 | 64.50 | 35.50 | -161.20 | 48.00 | 87.40 | 0.30 | 3.80 | 2.10 | 0.00 | 1.00 | 1.00 | 1.00 | 5.10 | 1.00 |
| H5390 | 23.040 | 30.609 | 80.174 | 386400.0 | 579200.0 | 110.0 | 5.20 | 93.10 | 1.20 | 0.40 | 20.40 | 17.10 | 0.00 | 8.70 | 42.50 | -156.20 | 37.60 | 57.00 | 1.00 | 2.90 | 2.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H5391 | 12.600 | 30.609 | 80.124 | 386400.0 | 584000.0 | 48.5 | 1.00 | 96.60 | 1.00 | 0.40 | 19.30 | 31.40 | 0.00 | 19.00 | 31.20 | -119.00 | 50.70 | 93.20 | 0.70 | 2.70 | 2.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| H540 | 23.040 | 30.955 | 80.070 | 424000.0 | 588800.0 | 62.0 | 0.30 | 88.60 | 7.40 | 3.20 | 46.30 | 2.50 | 0.00 | 67.30 | 39.90 | -178.10 | 48.80 | 86.70 | 0.40 | 3.80 | 1.90 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H541 | 23.040 | 30.955 | 80.020 | 424000.0 | 593600.0 | 114.0 | 0.60 | 85.60 | 9.30 | 4.00 | 40.50 | 3.50 | 0.00 | 53.60 | 45.50 | -211.60 | 44.00 | 82.00 | 0.50 | 3.40 | 1.70 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H5410 | 15.644 | 30.568 | 81.375 | 381600.0 | 464000.0 | 11.6 | 3.30 | 93.60 | 2.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 95.30 | 0.00 | 2.50 | 1.10 | 0.00 | 0.20 | 0.20 | 0.50 | 9.90 | 0.20 |
| H5411 | 23.040 | 30.568 | 81.325 | 381600.0 | 468800.0 | 14.8 | 0.70 | 98.70 | 0.50 | 0.10 | 8.30 | 37.80 | 0.00 | 21.60 | 11.30 | -82.90 | 46.00 | 0.00 | 0.10 | 3.50 | 2.80 | 0.00 | 0.90 | 0.90 | 0.90 | 17.40 | 0.90 |
| H5412 | 23.040 | 30.568 | 81.275 | 381600.0 | 473600.0 | 16.7 | 0.20 | 99.40 | 0.20 | 0.10 | 8.20 | 39.50 | 0.00 | 21.10 | 11.80 | -85.70 | 47.70 | 93.20 | 0.10 | 3.40 | 3.00 | 0.00 | 1.00 | 1.00 | 1.00 | 17.00 | 1.00 |
| H5413 | 23.040 | 30.568 | 81.225 | 381600.0 | 478400.0 | 18.5 | 0.20 | 99.10 | 0.30 | 0.20 | 8.10 | 40.40 | 0.00 | 20.00 | 11.10 | -87.00 | 48.50 | 92.60 | 0.20 | 3.50 | 3.00 | 0.00 | 1.00 | 1.00 | 1.00 | 17.70 | 1.00 |
| H5414 | 23.040 | 30.568 | 81.175 | 381600.0 | 483200.0 | 19.9 | 0.20 | 99.00 | 0.40 | 0.30 | 8.10 | 41.10 | 0.00 | 20.50 | 11.00 | -89.60 | 49.20 | 92.60 | 0.30 | 3.20 | 2.90 | 0.00 | 1.00 | 1.00 | 1.20 | 17.40 | 1.00 |
| H5415 | 23.040 | 30.568 | 81.125 | 381600.0 | 488000.0 | 20.7 | 0.10 | 99.20 | 0.50 | 0.20 | 8.10 | 41.60 | 0.00 | 20.30 | 10.90 | -90.70 | 49.70 | 92.00 | 0.30 | 2.90 | 2.90 | 0.00 | 1.10 | 1.10 | 1.70 | 16.90 | 1.00 |
| H5416 | 23.040 | 30.568 | 81.075 | 381600.0 | 492800.0 | 21.4 | 0.00 | 99.20 | 0.70 | 0.10 | 8.10 | 41.80 | 0.00 | 20.20 | 10.90 | -91.50 | 49.90 | 93.30 | 0.20 | 2.50 | 2.90 | 0.00 | 1.40 | 1.30 | 2.60 | 16.10 | 1.00 |
| H5417 | 23.040 | 30.568 | 81.025 | 381600.0 | 497600.0 | 21.8 | 0.00 | 99.10 | 0.80 | 0.00 | 8.20 | 41.90 | 0.00 | 20.40 | 10.80 | -92.30 | 50.10 | 93.70 | 0.10 | 2.20 | 2.90 | 0.00 | 1.60 | 1.50 | 3.50 | 15.20 | 0.90 |
| H5418 | 23.040 | 30.568 | 80.975 | 381600.0 | 502400.0 | 23.5 | 0.00 | 99.30 | 0.70 | 0.00 | 8.80 | 42.30 | 0.00 | 21.20 | 10.10 | -95.00 | 51.10 | 93.50 | 0.20 | 2.40 | 2.80 | 0.00 | 1.60 | 1.60 | 4.10 | 14.40 | 0.90 |
| H5419 | 23.040 | 30.568 | 80.925 | 381600.0 | 507200.0 | 26.0 | 0.00 | 99.60 | 0.40 | 0.00 | 9.20 | 43.30 | 0.00 | 21.90 | 9.30 | -100.50 | 52.60 | 93.10 | 0.50 | 2.70 | 2.60 | 0.00 | 1.50 | 1.50 | 4.50 | 13.70 | 0.80 |
| H542 | 13.165 | 30.954 | 79.970 | 424000.0 | 598400.0 | 48.6 | 0.10 | 96.90 | 2.00 | 0.80 | 45.10 | 4.70 | 0.00 | 66.60 | 37.50 | -165.00 | 49.80 | 68.50 | 0.20 | 4.50 | 2.70 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H5420 | 23.040 | 30.568 | 80.875 | 381600.0 | 512000.0 | 28.5 | 0.00 | 99.80 | 0.20 | 0.00 | 9.40 | 43.80 | 0.00 | 22.20 | 9.00 | -104.00 | 53.20 | 92.20 | 0.70 | 3.10 | 2.70 | 0.00 | 1.20 | 1.20 | 4.50 | 12.90 | 0.60 |
| H5421 | 23.040 | 30.568 | 80.825 | 381600.0 | 516800.0 | 29.9 | 0.00 | 99.90 | 0.10 | 0.00 | 11.50 | 39.20 | 0.00 | 23.60 | 8.70 | -104.30 | 50.70 | 90.80 | 0.90 | 3.50 | 3.20 | 0.00 | 0.00 | 0.00 | 4.30 | 12.30 | 0.40 |
| H5422 | 23.040 | 30.568 | 80.775 | 381600.0 | 521600.0 | 30.6 | 0.00 | 100.00 | 0.00 | 0.00 | 15.90 | 29.80 | 0.00 | 26.70 | 8.00 | -102.90 | 45.60 | 89.50 | 1.00 | 3.90 | 3.70 | 0.00 | 0.40 | 0.40 | 4.10 | 11.80 | 0.20 |
| H5423 | 23.040 | 30.568 | 80.725 | 381600.0 | 526400.0 | 30.7 | 0.00 | 100.00 | 0.00 | 0.00 | 19.00 | 23.10 | 0.00 | 29.00 | 7.40 | -101.90 | 42.20 | 89.70 | 1.00 | 3.90 | 3.70 | 0.00 | 0.20 | 0.20 | 4.00 | 11.70 | 0.20 |
| H5424 | 23.040 | 30.568 | 80.675 | 381600.0 | 531200.0 | 31.4 | 0.10 | 99.90 | 0.00 | 0.00 | 19.10 | 23.90 | 0.00 | 28.00 | 7.80 | -102.40 | 43.00 | 90.10 | 1.00 | 4.00 | 3.40 | 0.00 | 0.10 | 0.10 | 3.90 | 11.70 | 0.10 |
| H5425 | 23.040 | 30.568 | 80.625 | 381600.0 | 536000.0 | 32.6 | 0.10 | 99.90 | 0.00 | 0.00 | 18.90 | 26.80 | 0.00 | 25.20 | 8.00 | -103.40 | 45.60 | 90.30 | 0.80 | 4.20 | 3.30 | 0.00 | 0.00 | 0.00 | 3.90 | 11.90 | 0.10 |
| H5426 | 23.040 | 30.568 | 80.575 | 381600.0 | 540800.0 | 34.0 | 0.10 | 99.90 | 0.00 | 0.00 | 19.00 | 28.50 | 0.00 | 23.30 | 9.20 | -104.90 | 47.50 | 90.60 | 0.50 | 4.50 | 3.10 | 0.00 | 0.00 | 0.00 | 3.80 | 12.20 | 0.20 |
| H5427 | 23.040 | 30.568 | 80.524 | 381600.0 | 545600.0 | 35.5 | 0.00 | 99.90 | 0.00 | 0.00 | 19.10 | 31.90 | 0.00 | 21.90 | 11.80 | -108.50 | 51.00 | 90.80 | 0.20 | 4.80 | 3.00 | 0.00 | 0.00 | 0.00 | 3.70 | 12.60 | 0.30 |
| H5428 | 23.040 | 30.567 | 80.474 | 381600.0 | 550400.0 | 36.9 | 0.10 | 99.90 | 0.00 | 0.00 | 19.40 | 38.40 | 0.00 | 19.60 | 16.80 | -114.20 | 57.70 | 90.60 | 0.30 | 4.70 | 3.00 | 0.00 | 0.00 | 0.00 | 3.60 | 13.10 | 0.40 |
| H5429 | 23.040 | 30.567 | 80.424 | 381600.0 | 555200.0 | 38.3 | 0.30 | 99.60 | 0.00 | 0.00 | 20.90 | 42.00 | 0.00 | 18.20 | 20.00 | -119.50 | 63.00 | 89.60 | 0.70 | 4.30 | 3.00 | 0.00 | 0.00 | 0.00 | 3.60 | 13.60 | 0.40 |
| H5430 | 23.040 | 30.567 | 80.374 | 381600.0 | 560000.0 | 40.0 | 0.50 | 99.30 | 0.10 | 0.10 | 26.30 | 43.20 | 0.00 | 17.30 | 22.00 | -126.90 | 69.50 | 87.80 | 1.20 | 3.90 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MM.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H5431 | 23.040 | 30.567 | 80.324 | 381600.0 | 564800.0 | 43.4 | 0.60 | 99.10 | 0.20 | 0.10 | 32.90 | 42.40 | 0.00 | 15.90 | 24.90 | -134.50 | 75.30 | 86.10 | 1.60 | 3.80 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5432 | 23.040 | 30.566 | 80.274 | 381600.0 | 569600.0 | 48.1 | 0.70 | 98.80 | 0.20 | 0.20 | 35.00 | 39.20 | 0.00 | 14.30 | 28.30 | -136.50 | 74.10 | 86.20 | 1.00 | 3.80 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5433 | 23.040 | 30.566 | 80.224 | 381600.0 | 574400.0 | 71.0 | 3.00 | 95.80 | 0.70 | 0.40 | 34.30 | 35.10 | 0.00 | 13.20 | 30.60 | -154.40 | 69.40 | 77.90 | 1.70 | 3.70 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5434 | 23.040 | 30.566 | 80.174 | 381600.0 | 579200.0 | 129.6 | 6.20 | 92.30 | 1.00 | 0.40 | 26.40 | 23.90 | 0.00 | 9.50 | 38.70 | -109.30 | 50.20 | 56.20 | 1.10 | 3.20 | 2.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5435 | 6.740 | 30.566 | 80.124 | 381600.0 | 584000.0 | 49.0 | 2.30 | 96.30 | 0.90 | 0.40 | 23.60 | 29.90 | 0.00 | 15.40 | 33.00 | -110.00 | 53.50 | 93.40 | 1.40 | 3.30 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5454 | 8.357 | 30.525 | 81.375 | 376800.0 | 464000.0 | 11.7 | 2.70 | 94.90 | 1.80 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 95.00 | 0.00 | 2.60 | 1.40 | 0.00 | 0.50 | 0.50 | 0.80 | 12.00 | 0.50 |
| H5455 | 23.040 | 30.525 | 81.325 | 376800.0 | 468800.0 | 15.4 | 0.40 | 99.20 | 0.30 | 0.10 | 8.40 | 35.20 | 0.00 | 22.60 | 11.60 | -83.40 | 43.60 | 0.00 | 0.10 | 3.30 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 17.80 | 1.00 |
| H5456 | 23.040 | 30.525 | 81.275 | 376800.0 | 473600.0 | 16.6 | 0.20 | 99.20 | 0.20 | 0.20 | 8.30 | 36.70 | 0.00 | 22.00 | 11.50 | -83.60 | 45.00 | 92.80 | 0.20 | 3.50 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 17.90 | 1.00 |
| H5457 | 23.040 | 30.525 | 81.225 | 376800.0 | 478400.0 | 17.1 | 0.20 | 98.70 | 0.40 | 0.40 | 8.20 | 38.20 | 0.00 | 21.40 | 11.30 | -85.00 | 46.40 | 92.30 | 0.50 | 3.50 | 2.90 | 0.00 | 1.00 | 1.00 | 1.10 | 17.70 | 1.00 |
| H5458 | 23.040 | 30.525 | 81.175 | 376800.0 | 483200.0 | 18.6 | 0.10 | 98.60 | 0.50 | 0.40 | 8.10 | 39.60 | 0.00 | 20.90 | 11.20 | -87.30 | 47.70 | 92.50 | 0.60 | 3.10 | 2.90 | 0.00 | 1.10 | 1.10 | 1.40 | 17.30 | 1.00 |
| H5459 | 23.040 | 30.525 | 81.125 | 376800.0 | 488000.0 | 20.6 | 0.00 | 98.90 | 0.70 | 0.20 | 8.10 | 40.60 | 0.00 | 20.60 | 11.00 | -89.90 | 48.70 | 93.00 | 0.40 | 2.70 | 2.90 | 0.00 | 1.30 | 1.30 | 2.30 | 16.50 | 1.00 |
| H5460 | 23.040 | 30.525 | 81.075 | 376800.0 | 492800.0 | 22.2 | 0.00 | 99.00 | 0.90 | 0.00 | 8.20 | 41.00 | 0.00 | 20.60 | 10.90 | -92.00 | 49.20 | 93.70 | 0.10 | 2.20 | 3.00 | 0.00 | 1.50 | 1.50 | 3.30 | 15.40 | 1.00 |
| H5461 | 23.040 | 30.525 | 81.025 | 376800.0 | 497600.0 | 23.8 | 0.00 | 99.10 | 0.90 | 0.00 | 8.60 | 41.10 | 0.00 | 20.90 | 10.60 | -94.40 | 49.70 | 93.70 | 0.10 | 2.20 | 3.00 | 0.00 | 1.70 | 1.70 | 4.10 | 14.60 | 0.90 |
| H5462 | 23.040 | 30.525 | 80.975 | 376800.0 | 502400.0 | 25.4 | 0.00 | 99.30 | 0.60 | 0.00 | 9.30 | 41.50 | 0.00 | 21.00 | 9.00 | -98.00 | 50.00 | 93.10 | 0.20 | 2.60 | 3.00 | 0.00 | 1.70 | 1.70 | 4.50 | 14.10 | 0.90 |
| H5463 | 23.040 | 30.525 | 80.925 | 376800.0 | 507200.0 | 26.9 | 0.00 | 99.60 | 0.30 | 0.00 | 9.70 | 42.40 | 0.00 | 22.30 | 9.20 | -101.40 | 52.10 | 92.20 | 0.50 | 3.10 | 3.10 | 0.00 | 1.60 | 1.60 | 4.70 | 13.70 | 0.80 |
| H5464 | 23.040 | 30.525 | 80.875 | 376800.0 | 512000.0 | 28.5 | 0.00 | 99.80 | 0.10 | 0.00 | 10.70 | 40.70 | 0.00 | 23.00 | 8.90 | -102.90 | 51.50 | 91.00 | 0.00 | 3.50 | 3.30 | 0.00 | 1.30 | 1.30 | 4.60 | 13.00 | 0.60 |
| H5465 | 23.040 | 30.525 | 80.825 | 376800.0 | 516800.0 | 29.8 | 0.00 | 100.00 | 0.00 | 0.00 | 14.00 | 32.00 | 0.00 | 25.70 | 8.30 | -102.30 | 46.00 | 89.00 | 0.90 | 3.80 | 3.70 | 0.00 | 0.70 | 0.70 | 4.40 | 12.10 | 0.40 |
| H5466 | 23.040 | 30.525 | 80.775 | 376800.0 | 521600.0 | 30.3 | 0.00 | 100.00 | 0.00 | 0.00 | 18.60 | 24.00 | 0.00 | 28.60 | 7.50 | -101.60 | 42.60 | 89.50 | 1.00 | 3.90 | 3.80 | 0.00 | 0.30 | 0.30 | 4.20 | 11.50 | 0.20 |
| H5467 | 23.040 | 30.525 | 80.725 | 376800.0 | 526400.0 | 31.0 | 0.00 | 99.90 | 0.00 | 0.00 | 19.60 | 22.40 | 0.00 | 28.90 | 7.30 | -102.00 | 42.00 | 90.20 | 0.90 | 3.90 | 3.40 | 0.00 | 0.10 | 0.10 | 4.10 | 11.30 | 0.10 |
| H5468 | 23.040 | 30.525 | 80.675 | 376800.0 | 531200.0 | 32.3 | 0.10 | 99.90 | 0.00 | 0.00 | 19.20 | 25.00 | 0.00 | 26.40 | 8.00 | -103.00 | 44.30 | 90.60 | 0.80 | 4.00 | 3.20 | 0.00 | 0.10 | 0.10 | 4.00 | 11.20 | 0.00 |
| H5469 | 23.040 | 30.525 | 80.625 | 376800.0 | 536000.0 | 33.6 | 0.10 | 99.80 | 0.00 | 0.00 | 19.00 | 27.60 | 0.00 | 23.90 | 8.40 | -104.10 | 46.60 | 90.00 | 0.50 | 4.40 | 3.00 | 0.00 | 0.00 | 0.00 | 4.00 | 11.20 | 0.00 |
| H5470 | 23.040 | 30.524 | 80.575 | 376800.0 | 540800.0 | 34.9 | 0.10 | 99.90 | 0.00 | 0.00 | 19.10 | 29.20 | 0.00 | 22.60 | 9.10 | -105.90 | 48.30 | 90.90 | 0.20 | 4.80 | 3.00 | 0.00 | 0.00 | 0.00 | 3.90 | 11.30 | 0.00 |
| H5471 | 23.040 | 30.524 | 80.525 | 376800.0 | 545600.0 | 36.3 | 0.10 | 99.90 | 0.00 | 0.00 | 19.60 | 34.30 | 0.00 | 20.60 | 13.30 | -110.90 | 54.10 | 90.90 | 0.10 | 4.90 | 3.00 | 0.00 | 0.00 | 0.00 | 3.90 | 11.50 | 0.10 |
| H5472 | 23.040 | 30.524 | 80.475 | 376800.0 | 550400.0 | 37.6 | 0.20 | 99.70 | 0.10 | 0.10 | 19.50 | 42.60 | 0.00 | 17.50 | 19.20 | -117.30 | 62.10 | 90.40 | 0.40 | 4.60 | 2.90 | 0.00 | 0.00 | 0.00 | 3.90 | 11.70 | 0.10 |
| H5473 | 23.040 | 30.524 | 80.425 | 376800.0 | 555200.0 | 39.0 | 0.40 | 99.20 | 0.20 | 0.20 | 20.90 | 45.10 | 0.00 | 16.40 | 21.30 | -121.40 | 66.00 | 89.40 | 0.90 | 4.30 | 3.00 | 0.00 | 0.00 | 0.00 | 3.80 | 12.10 | 0.20 |
| H5474 | 23.040 | 30.524 | 80.375 | 376800.0 | 560000.0 | 41.2 | 0.70 | 98.60 | 0.30 | 0.30 | 30.50 | 45.10 | 0.00 | 15.20 | 23.00 | -131.90 | 75.60 | 87.00 | 1.60 | 4.10 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5475 | 23.040 | 30.523 | 80.325 | 376800.0 | 564800.0 | 44.9 | 0.60 | 98.80 | 0.30 | 0.30 | 42.30 | 45.10 | 0.00 | 13.10 | 25.90 | -145.40 | 87.40 | 87.10 | 2.00 | 4.00 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5476 | 23.040 | 30.523 | 80.275 | 376800.0 | 569600.0 | 51.4 | 1.50 | 97.60 | 0.50 | 0.30 | 45.00 | 44.30 | 0.00 | 12.50 | 26.90 | -153.20 | 89.30 | 85.60 | 2.10 | 4.00 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5477 | 21.120 | 30.523 | 80.225 | 376800.0 | 574400.0 | 47.4 | 0.70 | 98.90 | 0.20 | 0.20 | 34.40 | 39.00 | 0.00 | 14.30 | 20.40 | -135.10 | 73.40 | 92.10 | 1.00 | 3.80 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5498 | 1.147 | 30.481 | 81.375 | 372000.0 | 464000.0 | 11.8 | 2.20 | 96.10 | 1.50 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 93.60 | 0.00 | 3.40 | 2.40 | 0.00 | 0.00 | 0.00 | 0.90 | 16.30 | 0.80 |
| H5499 | 23.040 | 30.481 | 81.325 | 372000.0 | 468800.0 | 17.9 | 0.30 | 98.70 | 0.30 | 0.40 | 8.60 | 31.10 | 0.00 | 24.00 | 12.00 | -82.40 | 39.70 | 0.00 | 0.20 | 4.00 | 2.90 | 0.00 | 1.00 | 1.00 | 1.00 | 17.00 | 1.00 |
| H5500 | 23.040 | 30.482 | 81.275 | 372000.0 | 473600.0 | 19.4 | 0.20 | 98.10 | 0.40 | 0.70 | 8.40 | 32.40 | 0.00 | 23.40 | 11.90 | -83.70 | 40.90 | 91.40 | 0.50 | 4.20 | 2.80 | 0.00 | 1.00 | 1.00 | 1.10 | 17.70 | 1.00 |
| H5501 | 23.040 | 30.482 | 81.225 | 372000.0 | 478400.0 | 17.3 | 0.20 | 97.50 | 0.60 | 1.00 | 8.30 | 34.30 | 0.00 | 22.70 | 11.80 | -82.60 | 42.60 | 91.70 | 0.00 | 3.60 | 2.70 | 0.00 | 1.10 | 1.10 | 1.40 | 17.40 | 1.00 |
| H5502 | 23.040 | 30.482 | 81.175 | 372000.0 | 483200.0 | 16.8 | 0.10 | 98.00 | 0.70 | 0.70 | 8.20 | 36.20 | 0.00 | 22.00 | 11.60 | -83.10 | 44.40 | 92.30 | 0.00 | 3.00 | 2.80 | 0.00 | 1.20 | 1.20 | 2.00 | 16.00 | 1.00 |
| H5503 | 23.040 | 30.482 | 81.125 | 372000.0 | 488000.0 | 19.2 | 0.00 | 98.70 | 0.80 | 0.30 | 8.20 | 37.50 | 0.00 | 21.50 | 11.40 | -86.40 | 45.80 | 93.00 | 0.50 | 2.50 | 2.90 | 0.00 | 1.50 | 1.50 | 3.10 | 15.70 | 1.00 |
| H5504 | 23.040 | 30.482 | 81.075 | 372000.0 | 492800.0 | 21.2 | 0.00 | 99.00 | 0.80 | 0.10 | 8.30 | 38.30 | 0.00 | 21.30 | 11.20 | -89.10 | 46.60 | 93.40 | 0.20 | 2.40 | 3.00 | 0.00 | 1.70 | 1.70 | 4.10 | 14.70 | 1.00 |
| H5505 | 23.040 | 30.482 | 81.025 | 372000.0 | 497600.0 | 22.8 | 0.00 | 99.20 | 0.70 | 0.10 | 8.80 | 38.70 | 0.00 | 21.50 | 10.80 | -91.70 | 47.50 | 93.00 | 0.10 | 2.80 | 3.20 | 0.00 | 1.80 | 1.80 | 4.60 | 14.20 | 0.90 |
| H5506 | 23.040 | 30.482 | 80.975 | 372000.0 | 502400.0 | 24.3 | 0.00 | 99.50 | 0.40 | 0.00 | 9.50 | 39.10 | 0.00 | 22.00 | 10.20 | -94.90 | 48.60 | 92.20 | 0.30 | 3.30 | 3.30 | 0.00 | 1.80 | 1.80 | 4.80 | 13.90 | 0.90 |
| H5507 | 23.040 | 30.482 | 80.925 | 372000.0 | 507200.0 | 25.8 | 0.00 | 99.70 | 0.20 | 0.00 | 10.50 | 38.00 | 0.00 | 22.60 | 9.60 | -97.70 | 49.30 | 91.50 | 0.50 | 3.60 | 3.40 | 0.00 | 1.70 | 1.70 | 4.80 | 13.70 | 0.90 |
| H5508 | 23.040 | 30.482 | 80.875 | 372000.0 | 512000.0 | 27.4 | 0.00 | 99.90 | 0.10 | 0.00 | 12.40 | 35.70 | 0.00 | 23.70 | 9.20 | -99.10 | 48.10 | 90.80 | 0.80 | 3.70 | 3.40 | 0.00 | 1.40 | 1.30 | 4.60 | 13.00 | 0.70 |
| H5509 | 23.040 | 30.482 | 80.825 | 372000.0 | 516800.0 | 28.9 | 0.00 | 99.90 | 0.00 | 0.00 | 16.00 | 28.90 | 0.00 | 25.90 | 8.50 | -99.70 | 44.90 | 90.30 | 0.90 | 3.80 | 3.50 | 0.00 | 0.70 | 0.70 | 4.30 | 12.10 | 0.30 |
| H5510 | 23.040 | 30.482 | 80.775 | 372000.0 | 521600.0 | 30.3 | 0.00 | 100.00 | 0.00 | 0.00 | 18.60 | 24.20 | 0.00 | 27.60 | 8.00 | -100.80 | 42.80 | 90.70 | 0.90 | 3.70 | 3.30 | 0.00 | 0.30 | 0.30 | 4.10 | 11.40 | 0.10 |
| H5511 | 23.040 | 30.482 | 80.725 | 372000.0 | 526400.0 | 31.7 | 0.10 | 99.90 | 0.00 | 0.00 | 19.20 | 24.60 | 0.00 | 26.00 | 8.30 | -102.30 | 43.80 | 91.50 | 0.90 | 3.60 | 2.90 | 0.00 | 0.10 | 0.10 | 4.00 | 11.10 | 0.00 |
| H5512 | 23.040 | 30.481 | 80.675 | 372000.0 | 531200.0 | 33.0 | 0.20 | 99.80 | 0.00 | 0.00 | 19.10 | 27.70 | 0.00 | 23.90 | 9.10 | -103.00 | 46.90 | 91.50 | 0.70 | 3.90 | 2.80 | 0.00 | 0.10 | 0.00 | 4.00 | 11.10 | 0.00 |
| H5513 | 23.040 | 30.481 | 80.625 | 372000.0 | 536000.0 | 34.3 | 0.30 | 99.70 | 0.00 | 0.00 | 19.30 | 29.10 | 0.00 | 22.60 | 9.20 | -105.30 | 48.50 | 91.00 | 0.50 | 4.30 | 2.80 | 0.00 | 0.00 | 0.00 | 4.00 | 11.00 | 0.00 |
| H5514 | 23.040 | 30.481 | 80.575 | 372000.0 | 540800.0 | 35.6 | 0.30 | 99.70 | 0.00 | 0.00 | 19.70 | 32.60 | 0.00 | 21.00 | 11.80 | -109.00 | 52.30 | 90.90 | 0.20 | 4.60 | 2.80 | 0.00 | 0.00 | 0.00 | 4.00 | 11.10 | 0.00 |
| H5515 | 23.040 | 30.481 | 80.525 | 372000.0 | 545600.0 | 36.9 | 0.30 | 99.60 | 0.00 | 0.00 | 19.90 | 40.00 | 0.00 | 17.90 | 17.80 | -115.60 | 60.80 | 90.70 | 0.20 | 4.60 | 2.80 | 0.00 | 0.00 | 0.00 | 4.00 | 11.10 | 0.00 |
| H5516 | 23.040 | 30.481 | 80.475 | 372000.0 | 550400.0 | 38.3 | 0.30 | 99.50 | 0.10 | 0.10 | 19.80 | 45.60 | 0.00 | 16.10 | 21.30 | -119.80 | 65.40 | 89.80 | 0.60 | 4.40 | 2.70 | 0.00 | 0.00 | 0.00 | 4.00 | 11.10 | 0.00 |
| H5517 | 23.040 | 30.481 | 80.425 | 372000.0 | 555200.0 | 39.7 | 0.60 | 98.90 | 0.20 | 0.20 | 26.40 | 45.90 | 0.00 | 15.00 | 22.50 | -127.00 | 72.30 | 88.10 | 1.10 | 4.30 | 2.90 | 0.00 | 0.00 | 0.00 | 4.00 | 11.20 | 0.00 |
| H5518 | 23.040 | 30.480 | 80.375 | 372000.0 | 560000.0 | 42.4 | 0.80 | 98.30 | 0.40 | 0.50 | 39.90 | 46.20 | 0.00 | 13.10 | 24.90 | -141.60 | 86.00 | 86.50 | 1.80 | 4.20 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHAT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H5519 | 23.040 | 30.400 | 80.325 | 372000.0 | 564800.0 | 46.0 | 1.30 | 97.30 | 0.60 | 0.60 | 49.40 | 46.50 | 0.00 | 11.50 | 27.10 | -153.40 | 95.90 | 85.50 | 2.40 | 4.20 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5520 | 23.040 | 30.400 | 80.275 | 372000.0 | 569600.0 | 55.7 | 2.70 | 95.00 | 1.30 | 0.90 | 49.60 | 45.30 | 0.00 | 11.30 | 26.00 | -161.90 | 94.90 | 82.00 | 2.70 | 4.20 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5521 | 15.120 | 30.400 | 80.225 | 372000.0 | 574400.0 | 48.2 | 0.00 | 98.00 | 0.30 | 0.20 | 44.60 | 44.50 | 0.00 | 12.60 | 26.90 | -149.90 | 89.10 | 90.70 | 2.00 | 4.00 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5542 | 0.371 | 30.438 | 81.375 | 367200.0 | 464000.0 | 12.7 | 1.60 | 72.70 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 93.20 | 0.10 | 2.70 | 2.00 | 0.00 | 0.70 | 0.70 | 0.70 | 12.60 | 0.70 |
| H5543 | 23.040 | 30.438 | 81.325 | 367200.0 | 468800.0 | 16.5 | 0.20 | 98.00 | 0.40 | 0.00 | 8.80 | 27.00 | 0.00 | 25.50 | 12.40 | -78.10 | 35.00 | 0.00 | 0.20 | 5.00 | 2.80 | 0.00 | 1.00 | 1.00 | 1.10 | 17.60 | 1.00 |
| H5544 | 23.040 | 30.438 | 81.275 | 367200.0 | 473600.0 | 19.2 | 0.10 | 97.00 | 0.60 | 1.30 | 8.70 | 28.50 | 0.00 | 24.80 | 12.30 | -81.20 | 37.10 | 90.50 | 0.50 | 4.70 | 2.70 | 0.00 | 1.00 | 1.00 | 1.20 | 17.50 | 1.00 |
| H5545 | 23.040 | 30.438 | 81.225 | 367200.0 | 478400.0 | 19.3 | 0.10 | 96.70 | 0.70 | 1.50 | 8.50 | 30.20 | 0.00 | 24.10 | 12.20 | -82.00 | 38.60 | 91.90 | 1.00 | 3.30 | 2.60 | 0.00 | 1.20 | 1.20 | 1.80 | 17.00 | 1.00 |
| H5546 | 23.040 | 30.438 | 81.175 | 367200.0 | 483200.0 | 18.6 | 0.10 | 97.50 | 0.00 | 1.00 | 8.30 | 32.00 | 0.00 | 23.20 | 12.10 | -82.10 | 40.30 | 92.60 | 1.00 | 2.60 | 2.80 | 0.00 | 1.40 | 1.40 | 2.70 | 16.10 | 1.00 |
| H5547 | 23.040 | 30.438 | 81.125 | 367200.0 | 488000.0 | 20.3 | 0.00 | 98.50 | 0.00 | 0.40 | 8.20 | 33.50 | 0.00 | 22.50 | 11.90 | -84.50 | 41.70 | 93.00 | 0.60 | 2.50 | 2.90 | 0.00 | 1.60 | 1.60 | 3.70 | 15.10 | 1.00 |
| H5548 | 23.040 | 30.439 | 81.075 | 367200.0 | 492800.0 | 22.2 | 0.00 | 99.00 | 0.70 | 0.20 | 8.30 | 34.60 | 0.00 | 22.00 | 11.70 | -87.10 | 42.90 | 92.00 | 0.20 | 2.90 | 3.20 | 0.00 | 1.80 | 1.80 | 4.50 | 14.30 | 1.00 |
| H5549 | 23.040 | 30.439 | 81.025 | 367200.0 | 497600.0 | 23.7 | 0.00 | 99.40 | 0.50 | 0.10 | 8.70 | 35.50 | 0.00 | 21.80 | 11.30 | -89.70 | 44.20 | 92.40 | 0.20 | 3.40 | 3.40 | 0.00 | 1.90 | 1.90 | 4.80 | 14.00 | 1.00 |
| H5550 | 23.040 | 30.439 | 80.975 | 367200.0 | 502400.0 | 25.2 | 0.00 | 99.70 | 0.20 | 0.00 | 9.50 | 35.90 | 0.00 | 21.90 | 10.80 | -92.60 | 45.50 | 91.70 | 0.30 | 3.90 | 3.50 | 0.00 | 1.90 | 1.80 | 4.90 | 13.90 | 0.90 |
| H5551 | 23.040 | 30.439 | 80.925 | 367200.0 | 507200.0 | 26.7 | 0.00 | 99.80 | 0.10 | 0.00 | 10.90 | 35.00 | 0.00 | 22.40 | 10.30 | -95.10 | 45.90 | 91.30 | 0.50 | 3.90 | 3.50 | 0.00 | 1.70 | 1.70 | 4.80 | 13.60 | 0.80 |
| H5552 | 23.040 | 30.438 | 80.875 | 367200.0 | 512000.0 | 28.2 | 0.00 | 99.90 | 0.10 | 0.00 | 13.10 | 32.10 | 0.00 | 23.50 | 9.80 | -96.80 | 45.20 | 91.00 | 0.70 | 3.80 | 3.40 | 0.00 | 1.30 | 1.30 | 4.60 | 13.00 | 0.70 |
| H5553 | 23.040 | 30.438 | 80.825 | 367200.0 | 516800.0 | 29.3 | 0.00 | 99.90 | 0.00 | 0.00 | 16.00 | 27.90 | 0.00 | 25.00 | 9.20 | -98.20 | 43.80 | 91.30 | 0.90 | 3.60 | 3.10 | 0.00 | 0.70 | 0.70 | 4.30 | 12.00 | 0.30 |
| H5554 | 23.040 | 30.438 | 80.775 | 367200.0 | 521600.0 | 30.5 | 0.00 | 99.90 | 0.00 | 0.00 | 18.00 | 25.40 | 0.00 | 25.00 | 9.00 | -99.00 | 43.50 | 92.00 | 0.90 | 3.40 | 2.00 | 0.00 | 0.20 | 0.20 | 4.10 | 11.30 | 0.10 |
| H5555 | 23.040 | 30.438 | 80.725 | 367200.0 | 526400.0 | 31.0 | 0.10 | 99.90 | 0.00 | 0.00 | 18.90 | 25.90 | 0.00 | 24.90 | 9.30 | -101.50 | 44.90 | 92.30 | 0.90 | 3.40 | 2.60 | 0.00 | 0.10 | 0.10 | 4.00 | 11.10 | 0.00 |
| H5556 | 23.040 | 30.438 | 80.675 | 367200.0 | 531200.0 | 33.1 | 0.20 | 99.80 | 0.00 | 0.00 | 19.40 | 28.40 | 0.00 | 22.90 | 9.90 | -103.00 | 47.00 | 92.00 | 0.00 | 3.70 | 2.60 | 0.00 | 0.00 | 0.00 | 4.00 | 11.00 | 0.00 |
| H5557 | 23.040 | 30.438 | 80.625 | 367200.0 | 536000.0 | 34.4 | 0.40 | 99.60 | 0.00 | 0.00 | 19.90 | 30.70 | 0.00 | 21.50 | 10.00 | -106.50 | 50.70 | 91.20 | 0.50 | 4.20 | 2.60 | 0.10 | 0.00 | 0.00 | 4.00 | 11.00 | 0.00 |
| H5558 | 23.040 | 30.438 | 80.575 | 367200.0 | 540800.0 | 35.7 | 0.50 | 99.50 | 0.00 | 0.00 | 20.70 | 35.20 | 0.00 | 19.50 | 13.90 | -111.20 | 56.00 | 90.80 | 0.30 | 4.30 | 2.60 | 0.00 | 0.00 | 0.00 | 4.00 | 11.00 | 0.00 |
| H5559 | 23.040 | 30.438 | 80.525 | 367200.0 | 545600.0 | 36.9 | 0.40 | 99.60 | 0.00 | 0.00 | 21.20 | 42.50 | 0.00 | 16.00 | 19.20 | -117.30 | 63.60 | 90.60 | 0.30 | 4.30 | 2.40 | 0.00 | 0.00 | 0.00 | 4.00 | 11.00 | 0.00 |
| H5560 | 23.040 | 30.437 | 80.475 | 367200.0 | 550400.0 | 38.2 | 0.30 | 99.50 | 0.10 | 0.10 | 22.50 | 45.20 | 0.00 | 15.60 | 21.40 | -121.60 | 67.00 | 89.60 | 0.60 | 4.30 | 2.50 | 0.10 | 0.00 | 0.00 | 4.00 | 11.00 | 0.00 |
| H5561 | 23.040 | 30.437 | 80.425 | 367200.0 | 555200.0 | 39.6 | 0.60 | 99.00 | 0.20 | 0.10 | 33.90 | 45.10 | 0.00 | 13.90 | 23.00 | -132.50 | 79.00 | 87.50 | 1.30 | 4.30 | 2.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5562 | 23.040 | 30.437 | 80.375 | 367200.0 | 560000.0 | 42.4 | 1.20 | 97.80 | 0.50 | 0.40 | 47.10 | 46.10 | 0.00 | 11.80 | 26.00 | -147.30 | 93.20 | 85.60 | 2.00 | 4.40 | 3.10 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5563 | 23.040 | 30.437 | 80.325 | 367200.0 | 564800.0 | 46.2 | 1.00 | 96.30 | 0.90 | 0.80 | 50.90 | 46.00 | 0.00 | 11.10 | 26.90 | -154.20 | 97.00 | 84.10 | 3.00 | 4.50 | 3.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5564 | 23.040 | 30.437 | 80.275 | 367200.0 | 569600.0 | 59.5 | 2.40 | 94.40 | 1.60 | 1.40 | 51.00 | 43.90 | 0.00 | 10.70 | 25.40 | -165.10 | 94.90 | 81.50 | 3.00 | 4.50 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H5565 | 9.510 | 30.436 | 80.225 | 367200.0 | 574400.0 | 48.9 | 2.00 | 96.30 | 0.90 | 0.70 | 50.30 | 46.00 | 0.00 | 11.30 | 27.20 | -156.50 | 96.30 | 88.10 | 2.60 | 4.20 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| H558 | 23.040 | 30.914 | 81.377 | 420000.0 | 464000.0 | 12.4 | 0.10 | 98.40 | 1.20 | 0.30 | 12.90 | 26.00 | 0.00 | 19.50 | 6.70 | -71.70 | 39.70 | 89.10 | 0.00 | 7.50 | 2.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| H559 | 20.285 | 30.915 | 81.327 | 420000.0 | 468800.0 | 9.0 | 0.00 | 93.10 | 6.20 | 0.60 | 12.10 | 28.10 | 0.00 | 19.60 | 7.70 | -69.20 | 40.20 | 89.00 | 0.00 | 6.40 | 3.50 | 0.00 | 0.00 | 0.00 | 2.00 | 11.10 | 0.10 |
| H561 | 23.040 | 30.915 | 81.226 | 420000.0 | 478400.0 | 13.0 | 0.00 | 99.20 | 0.60 | 0.10 | 13.30 | 26.40 | 0.00 | 19.10 | 6.40 | -72.60 | 39.70 | 89.20 | 0.10 | 7.30 | 2.40 | 0.00 | 0.00 | 0.00 | 1.80 | 9.40 | 0.30 |
| H562 | 23.040 | 30.915 | 81.176 | 420000.0 | 483200.0 | 15.3 | 0.00 | 99.30 | 0.50 | 0.00 | 14.20 | 25.70 | 0.00 | 18.10 | 5.80 | -73.30 | 39.90 | 89.60 | 0.20 | 6.40 | 2.70 | 0.00 | 0.00 | 0.00 | 1.60 | 9.20 | 0.50 |
| H563 | 23.040 | 30.915 | 81.126 | 420000.0 | 488000.0 | 16.7 | 0.00 | 99.70 | 0.30 | 0.00 | 15.10 | 24.00 | 0.00 | 17.00 | 5.20 | -73.60 | 39.90 | 90.30 | 0.30 | 5.30 | 3.20 | 0.00 | 0.00 | 0.00 | 1.50 | 9.30 | 0.50 |
| H564 | 23.040 | 30.915 | 81.075 | 420000.0 | 492800.0 | 18.1 | 0.00 | 99.90 | 0.10 | 0.00 | 15.40 | 23.30 | 0.00 | 17.00 | 4.60 | -73.90 | 38.80 | 91.10 | 0.20 | 4.10 | 3.90 | 0.00 | 0.00 | 0.00 | 1.40 | 9.00 | 0.40 |
| H565 | 23.040 | 30.915 | 81.025 | 420000.0 | 497600.0 | 19.6 | 0.00 | 100.00 | 0.00 | 0.00 | 14.80 | 20.00 | 0.10 | 18.90 | 3.60 | -73.40 | 34.90 | 91.70 | 0.10 | 3.50 | 4.40 | 0.00 | 0.00 | 0.00 | 1.20 | 10.30 | 0.20 |
| H566 | 23.040 | 30.915 | 80.975 | 420000.0 | 502400.0 | 21.4 | 0.00 | 100.00 | 0.00 | 0.00 | 14.00 | 15.90 | 0.10 | 21.50 | 2.30 | -72.00 | 29.90 | 91.90 | 0.20 | 3.50 | 3.00 | 0.00 | 0.00 | 0.00 | 1.10 | 10.80 | 0.10 |
| H567 | 23.040 | 30.915 | 80.925 | 420000.0 | 507200.0 | 23.4 | 0.00 | 100.00 | 0.00 | 0.00 | 13.40 | 14.50 | 0.10 | 22.50 | 2.00 | -73.90 | 28.00 | 92.50 | 0.40 | 3.60 | 2.00 | 0.00 | 0.00 | 0.00 | 1.10 | 11.00 | 0.10 |
| H568 | 23.040 | 30.915 | 80.874 | 420000.0 | 512000.0 | 25.4 | 0.00 | 100.00 | 0.00 | 0.00 | 12.00 | 15.70 | 0.20 | 22.50 | 7.60 | -75.00 | 27.90 | 93.20 | 0.50 | 3.60 | 1.80 | 0.00 | 0.00 | 0.00 | 1.10 | 11.30 | 0.10 |
| H569 | 23.040 | 30.915 | 80.824 | 420000.0 | 516800.0 | 27.4 | 0.00 | 100.00 | 0.00 | 0.00 | 10.60 | 16.60 | 0.10 | 22.00 | 11.90 | -77.50 | 27.30 | 94.00 | 0.80 | 3.40 | 0.90 | 0.00 | 0.00 | 0.00 | 1.20 | 11.60 | 0.10 |
| H570 | 23.040 | 30.915 | 80.774 | 420000.0 | 521600.0 | 29.3 | 0.00 | 100.00 | 0.00 | 0.00 | 10.50 | 16.10 | 0.10 | 23.10 | 13.40 | -79.00 | 26.70 | 94.40 | 0.90 | 3.20 | 0.50 | 0.00 | 0.00 | 0.00 | 1.40 | 12.30 | 0.20 |
| H571 | 23.040 | 30.915 | 80.724 | 420000.0 | 526400.0 | 30.7 | 0.00 | 100.00 | 0.00 | 0.00 | 11.40 | 13.60 | 0.50 | 23.40 | 15.40 | -79.60 | 25.50 | 93.80 | 1.00 | 3.20 | 1.00 | 0.00 | 0.00 | 0.00 | 1.90 | 13.70 | 0.50 |
| H572 | 23.040 | 30.915 | 80.673 | 420000.0 | 531200.0 | 31.8 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 10.60 | 0.40 | 23.80 | 18.70 | -79.10 | 23.50 | 92.50 | 1.20 | 3.10 | 2.00 | 0.00 | 0.00 | 0.00 | 2.50 | 15.50 | 0.80 |
| H573 | 23.040 | 30.914 | 80.623 | 420000.0 | 536000.0 | 32.9 | 0.00 | 100.00 | 0.00 | 0.00 | 12.50 | 11.10 | 0.60 | 24.20 | 18.60 | -81.30 | 24.20 | 91.30 | 1.40 | 3.10 | 2.80 | 0.00 | 0.00 | 0.00 | 2.00 | 16.50 | 0.90 |
| H574 | 23.040 | 30.914 | 80.573 | 420000.0 | 540800.0 | 33.9 | 0.00 | 100.00 | 0.00 | 0.00 | 11.20 | 16.30 | 0.90 | 25.10 | 14.90 | -87.40 | 28.40 | 90.50 | 1.70 | 3.10 | 3.10 | 0.00 | 0.00 | 0.00 | 2.90 | 16.90 | 1.00 |
| H575 | 23.040 | 30.914 | 80.523 | 420000.0 | 545600.0 | 35.0 | 0.00 | 100.00 | 0.00 | 0.00 | 10.70 | 20.00 | 0.90 | 25.80 | 12.90 | -92.30 | 31.50 | 90.20 | 1.80 | 3.00 | 3.10 | 0.00 | 0.00 | 0.00 | 3.00 | 17.00 | 1.00 |
| H576 | 23.040 | 30.914 | 80.473 | 420000.0 | 550400.0 | 36.0 | 0.00 | 100.00 | 0.00 | 0.00 | 13.30 | 18.90 | 0.80 | 27.00 | 14.20 | -96.00 | 33.00 | 90.60 | 1.60 | 3.10 | 3.00 | 0.00 | 0.00 | 0.00 | 3.00 | 16.90 | 1.00 |
| H577 | 23.040 | 30.914 | 80.422 | 420000.0 | 555200.0 | 37.1 | 0.00 | 99.80 | 0.10 | 0.10 | 17.30 | 16.60 | 0.50 | 28.90 | 16.60 | -100.40 | 34.50 | 91.50 | 1.20 | 3.30 | 2.60 | 0.00 | 0.00 | 0.00 | 3.00 | 16.80 | 1.00 |
| H578 | 23.040 | 30.913 | 80.372 | 420000.0 | 560000.0 | 38.1 | 0.00 | 99.60 | 0.30 | 0.10 | 21.60 | 13.40 | 0.20 | 30.70 | 19.90 | -103.90 | 35.20 | 92.60 | 0.70 | 3.30 | 2.10 | 0.00 | 0.10 | 0.10 | 2.90 | 16.10 | 1.00 |
| H579 | 23.040 | 30.913 | 80.322 | 420000.0 | 564800.0 | 38.8 | 0.00 | 99.60 | 0.30 | 0.10 | 22.70 | 14.30 | 0.00 | 32.60 | 21.00 | -108.50 | 37.00 | 93.80 | 0.30 | 3.20 | 1.50 | 0.00 | 0.20 | 0.20 | 2.50 | 14.10 | 1.00 |
| H580 | 23.040 | 30.913 | 80.272 | 420000.0 | 569600.0 | 39.6 | 0.00 | 99.30 | 0.40 | 0.20 | 21.00 | 20.20 | 0.00 | 36.00 | 19.10 | -117.60 | 41.20 | 94.10 | 0.20 | 3.10 | 1.30 | 0.00 | 0.60 | 0.50 | 1.90 | 10.40 | 1.00 |
| H581 | 23.040 | 30.913 | 80.221 | 420000.0 | 574400.0 | 41.4 | 0.00 | 97.30 | 1.80 | 0.80 | 22.90 | 21.70 | 0.00 | 42.70 | 19.60 | -128.70 | 44.60 | 92.50 | 0.20 | 3.10 | 1.40 | 0.00 | 0.80 | 0.80 | 1.40 | 7.10 | 1.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H582 | 23.040 | 30.912 | 80.171 | 420000.0 | 579200.0 | 45.5 | 0.20 | 93.20 | 4.40 | 1.90 | 29.60 | 17.40 | 0.00 | 49.30 | 26.30 | -141.80 | 47.00 | 89.40 | 0.40 | 3.30 | 1.60 | 0.00 | 0.90 | 0.90 | 1.10 | 5.60 | 1.00 |
| H583 | 23.040 | 30.912 | 80.121 | 420000.0 | 584000.0 | 49.9 | 0.30 | 87.60 | 8.10 | 3.50 | 37.20 | 10.50 | 0.00 | 55.90 | 34.10 | -153.50 | 47.70 | 86.80 | 0.50 | 3.30 | 1.60 | 0.00 | 1.00 | 1.00 | 1.00 | 5.10 | 1.00 |
| H584 | 23.040 | 30.912 | 80.071 | 420000.0 | 588800.0 | 78.1 | 0.30 | 80.80 | 13.20 | 5.00 | 39.40 | 5.30 | 0.00 | 54.40 | 39.90 | -177.20 | 44.70 | 87.80 | 0.80 | 3.20 | 1.30 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H585 | 23.040 | 30.911 | 80.020 | 420000.0 | 593600.0 | 134.0 | 0.50 | 77.80 | 14.50 | 6.40 | 32.70 | 6.30 | 0.00 | 40.00 | 45.10 | -213.10 | 39.00 | 85.60 | 0.80 | 3.00 | 1.20 | 0.00 | 1.00 | 1.00 | 1.00 | 5.00 | 1.00 |
| H586 | 5.590 | 30.955 | 80.070 | 424800.0 | 588800.0 | 18.6 | 2.50 | 97.30 | 0.20 | 0.00 | 9.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.90 | 1.90 | 6.00 | 4.80 | 0.00 | 9.40 | 0.10 | 1.80 | 9.00 | 2.50 |
| I111000 | 23.040 | 32.040 | 80.517 | 544800.0 | 545600.0 | 20.0 | 0.00 | 99.60 | 0.40 | 0.00 | 9.80 | 1.40 | 0.00 | 17.00 | 17.40 | -48.20 | 11.30 | 88.00 | 0.70 | 5.20 | 5.20 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| I111001 | 23.040 | 32.040 | 80.466 | 544800.0 | 550400.0 | 21.0 | 0.00 | 99.80 | 0.20 | 0.00 | 11.30 | 0.60 | 0.00 | 18.30 | 18.00 | -51.20 | 11.90 | 89.90 | 0.50 | 4.60 | 4.20 | 0.00 | 0.00 | 0.00 | 0.10 | 11.70 | 1.00 |
| I111002 | 23.040 | 32.040 | 80.415 | 544800.0 | 555200.0 | 22.4 | 0.00 | 99.90 | 0.10 | 0.00 | 14.40 | 0.80 | 0.00 | 16.30 | 19.00 | -53.90 | 15.20 | 91.90 | 0.30 | 4.20 | 3.10 | 0.00 | 0.00 | 0.00 | 0.10 | 11.30 | 1.00 |
| I111003 | 23.040 | 32.039 | 80.365 | 544800.0 | 560000.0 | 23.9 | 0.00 | 100.00 | 0.00 | 0.00 | 13.40 | 1.10 | 0.00 | 17.40 | 22.20 | -55.80 | 14.50 | 93.10 | 0.20 | 4.00 | 2.40 | 0.00 | 0.00 | 0.00 | 0.30 | 10.40 | 1.00 |
| I111004 | 23.040 | 32.039 | 80.314 | 544800.0 | 564800.0 | 25.5 | 0.00 | 100.00 | 0.00 | 0.00 | 12.30 | 1.60 | 0.00 | 18.40 | 25.40 | -57.80 | 13.90 | 92.60 | 0.70 | 3.70 | 2.50 | 0.00 | 0.00 | 0.00 | 0.60 | 9.20 | 1.00 |
| I111005 | 23.040 | 32.039 | 80.263 | 544800.0 | 569600.0 | 27.0 | 0.00 | 99.90 | 0.00 | 0.00 | 11.30 | 2.90 | 0.00 | 18.10 | 29.40 | -59.30 | 14.20 | 91.00 | 1.40 | 3.40 | 2.50 | 0.00 | 0.00 | 0.00 | 1.00 | 7.90 | 1.20 |
| I111006 | 23.040 | 32.039 | 80.212 | 544800.0 | 574400.0 | 28.4 | 0.10 | 99.80 | 0.00 | 0.00 | 10.40 | 4.50 | 0.00 | 17.90 | 31.00 | -61.20 | 14.90 | 91.10 | 1.90 | 3.50 | 2.60 | 0.00 | 0.00 | 0.00 | 1.40 | 7.20 | 1.60 |
| I111007 | 23.040 | 32.038 | 80.161 | 544800.0 | 579200.0 | 29.5 | 0.10 | 99.70 | 0.00 | 0.00 | 9.30 | 7.40 | 0.00 | 17.50 | 33.00 | -63.70 | 16.70 | 90.30 | 2.20 | 3.80 | 2.70 | 0.00 | 0.00 | 0.00 | 1.80 | 7.80 | 2.20 |
| I111008 | 23.040 | 32.038 | 80.110 | 544800.0 | 584000.0 | 30.0 | 0.10 | 99.70 | 0.00 | 0.00 | 9.10 | 8.60 | 0.00 | 19.00 | 31.70 | -66.60 | 17.70 | 89.90 | 2.30 | 4.10 | 2.80 | 0.00 | 0.00 | 0.00 | 2.00 | 8.90 | 2.70 |
| I111009 | 23.040 | 32.038 | 80.060 | 544800.0 | 588800.0 | 31.7 | 0.20 | 99.60 | 0.00 | 0.00 | 9.10 | 8.30 | 0.00 | 19.00 | 31.70 | -68.10 | 17.40 | 89.40 | 2.50 | 4.30 | 2.90 | 0.00 | 0.00 | 0.00 | 2.00 | 9.70 | 2.90 |
| I11778 | 0.920 | 32.214 | 80.567 | 564000.0 | 540800.0 | 8.3 | 2.20 | 95.70 | 2.10 | 0.00 | 9.50 | 0.60 | 0.00 | 11.20 | 0.00 | -29.70 | 10.10 | 86.60 | 1.40 | 6.80 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 10.30 | 0.40 |
| I11779 | 23.040 | 32.213 | 80.516 | 564000.0 | 545600.0 | 11.9 | 1.00 | 98.10 | 0.90 | 0.00 | 11.00 | 0.30 | 0.00 | 12.30 | 12.50 | -35.40 | 11.30 | 0.00 | 1.00 | 5.10 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 15.40 | 0.60 |
| I11780 | 23.040 | 32.213 | 80.465 | 564000.0 | 550400.0 | 13.7 | 0.60 | 98.70 | 0.60 | 0.00 | 12.30 | 0.80 | 0.00 | 15.70 | 16.30 | -42.00 | 13.10 | 88.10 | 1.00 | 4.40 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 14.10 | 0.80 |
| I11781 | 23.040 | 32.213 | 80.414 | 564000.0 | 555200.0 | 14.7 | 0.30 | 99.40 | 0.30 | 0.00 | 13.90 | 0.60 | 0.00 | 17.20 | 18.10 | -46.60 | 14.50 | 87.60 | 1.70 | 3.50 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 13.10 | 0.80 |
| I11782 | 23.040 | 32.213 | 80.363 | 564000.0 | 560000.0 | 16.3 | 0.10 | 99.80 | 0.10 | 0.00 | 14.80 | 0.40 | 0.00 | 17.90 | 19.10 | -49.40 | 15.20 | 86.40 | 1.40 | 3.50 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.40 | 0.90 |
| I11783 | 23.040 | 32.212 | 80.312 | 564000.0 | 564800.0 | 18.0 | 0.00 | 99.90 | 0.00 | 0.00 | 15.10 | 0.20 | 0.00 | 18.40 | 20.20 | -51.80 | 15.30 | 86.00 | 1.00 | 3.90 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 0.90 |
| I11784 | 23.040 | 32.212 | 80.261 | 564000.0 | 569600.0 | 17.9 | 0.00 | 100.00 | 0.00 | 0.00 | 14.90 | 0.40 | 0.00 | 18.90 | 21.60 | -52.00 | 15.20 | 81.20 | 1.00 | 3.80 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.70 | 0.90 |
| I11785 | 23.040 | 32.212 | 80.211 | 564000.0 | 574400.0 | 18.6 | 0.00 | 100.00 | 0.00 | 0.00 | 14.40 | 0.80 | 0.00 | 19.50 | 23.50 | -53.30 | 15.20 | 74.00 | 1.20 | 3.60 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 11.50 | 1.00 |
| I11786 | 23.040 | 32.211 | 80.160 | 564000.0 | 579200.0 | 20.2 | 0.00 | 100.00 | 0.00 | 0.00 | 13.10 | 1.80 | 0.00 | 20.30 | 25.40 | -55.40 | 14.00 | 74.10 | 1.40 | 3.30 | 3.30 | 0.00 | 0.00 | 0.00 | 0.10 | 11.30 | 1.10 |
| I11787 | 23.040 | 32.211 | 80.109 | 564000.0 | 584000.0 | 21.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.90 | 3.20 | 0.00 | 20.80 | 27.00 | -56.90 | 15.10 | 82.30 | 1.00 | 3.10 | 2.60 | 0.00 | 0.00 | 0.00 | 0.30 | 11.00 | 1.30 |
| I11788 | 23.040 | 32.211 | 80.058 | 564000.0 | 588800.0 | 22.4 | 0.00 | 100.00 | 0.00 | 0.00 | 11.30 | 4.30 | 0.00 | 21.60 | 27.30 | -59.60 | 15.70 | 88.50 | 2.00 | 3.10 | 2.20 | 0.00 | 0.00 | 0.00 | 0.00 | 10.60 | 1.00 |
| I11789 | 23.040 | 32.210 | 80.007 | 564000.0 | 593600.0 | 24.0 | 0.20 | 99.80 | 0.00 | 0.00 | 10.80 | 5.60 | 0.00 | 22.30 | 27.40 | -62.70 | 16.40 | 83.90 | 2.00 | 3.40 | 2.60 | 0.00 | 0.00 | 0.00 | 1.30 | 10.30 | 2.30 |
| I11821 | 0.322 | 32.170 | 80.618 | 559200.0 | 536000.0 | 7.7 | 0.60 | 98.90 | 0.50 | 0.00 | 10.10 | 0.00 | 0.00 | 8.20 | 0.00 | -26.00 | 10.10 | 88.30 | 0.70 | 5.70 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 13.00 | 0.40 |
| I11822 | 14.032 | 32.170 | 80.567 | 559200.0 | 540800.0 | 8.8 | 1.10 | 97.80 | 1.00 | 0.00 | 9.40 | 0.50 | 0.00 | 9.00 | 8.60 | -27.70 | 9.90 | 87.70 | 1.00 | 6.00 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 15.60 | 0.40 |
| I11823 | 23.040 | 32.170 | 80.516 | 559200.0 | 545600.0 | 14.7 | 0.30 | 99.50 | 0.20 | 0.00 | 10.40 | 0.80 | 0.00 | 12.10 | 12.30 | -38.00 | 11.20 | 0.00 | 1.00 | 4.30 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 | 13.00 | 0.00 |
| I11824 | 23.040 | 32.170 | 80.465 | 559200.0 | 550400.0 | 16.4 | 0.40 | 99.20 | 0.40 | 0.00 | 11.70 | 0.90 | 0.00 | 15.20 | 15.70 | -44.20 | 12.60 | 89.50 | 1.70 | 4.30 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 13.20 | 0.80 |
| I11825 | 23.040 | 32.170 | 80.415 | 559200.0 | 555200.0 | 17.2 | 0.20 | 99.50 | 0.30 | 0.00 | 13.50 | 0.70 | 0.00 | 17.10 | 17.90 | -48.40 | 14.20 | 87.00 | 1.40 | 4.00 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 12.70 | 0.90 |
| I11826 | 23.040 | 32.169 | 80.364 | 559200.0 | 560000.0 | 18.6 | 0.10 | 99.80 | 0.10 | 0.00 | 14.90 | 0.40 | 0.00 | 17.50 | 18.80 | -51.40 | 15.30 | 88.10 | 1.10 | 3.90 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.30 | 0.90 |
| I11827 | 23.040 | 32.169 | 80.313 | 559200.0 | 564800.0 | 19.6 | 0.00 | 99.90 | 0.00 | 0.00 | 15.40 | 0.20 | 0.00 | 18.00 | 19.00 | -53.20 | 15.60 | 87.20 | 1.00 | 4.00 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 0.90 |
| I11828 | 23.040 | 32.169 | 80.262 | 559200.0 | 569600.0 | 19.2 | 0.00 | 99.90 | 0.00 | 0.00 | 14.90 | 0.40 | 0.00 | 18.80 | 21.50 | -53.20 | 15.30 | 82.70 | 1.00 | 3.80 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 11.60 | 1.00 |
| I11829 | 23.040 | 32.169 | 80.211 | 559200.0 | 574400.0 | 19.4 | 0.00 | 100.00 | 0.00 | 0.00 | 14.10 | 0.80 | 0.00 | 19.40 | 23.90 | -53.70 | 14.90 | 88.30 | 1.10 | 3.60 | 3.30 | 0.00 | 0.00 | 0.00 | 0.10 | 11.40 | 1.00 |
| I11830 | 23.040 | 32.168 | 80.160 | 559200.0 | 579200.0 | 21.0 | 0.00 | 100.00 | 0.00 | 0.00 | 13.00 | 1.50 | 0.00 | 20.20 | 25.00 | -55.70 | 14.50 | 81.90 | 1.50 | 3.40 | 2.90 | 0.00 | 0.00 | 0.00 | 0.30 | 11.10 | 1.20 |
| I11831 | 23.040 | 32.168 | 80.109 | 559200.0 | 584000.0 | 23.0 | 0.00 | 100.00 | 0.00 | 0.00 | 11.70 | 3.30 | 0.00 | 20.60 | 27.70 | -58.50 | 15.00 | 85.70 | 1.00 | 3.30 | 2.50 | 0.00 | 0.00 | 0.00 | 0.70 | 10.70 | 1.70 |
| I11832 | 23.040 | 32.167 | 80.058 | 559200.0 | 588800.0 | 24.7 | 0.00 | 100.00 | 0.00 | 0.00 | 10.90 | 4.90 | 0.00 | 21.40 | 28.10 | -62.00 | 15.90 | 87.60 | 1.90 | 3.30 | 2.50 | 0.00 | 0.00 | 0.00 | 1.20 | 10.40 | 2.20 |
| I11833 | 23.040 | 32.167 | 80.007 | 559200.0 | 593600.0 | 25.6 | 0.20 | 99.80 | 0.00 | 0.00 | 10.30 | 6.60 | 0.00 | 22.20 | 28.00 | -64.70 | 16.90 | 84.60 | 2.00 | 3.80 | 2.90 | 0.00 | 0.00 | 0.00 | 1.70 | 10.20 | 2.70 |
| I11864 | 6.625 | 32.127 | 80.669 | 554400.0 | 531200.0 | 18.6 | 2.50 | 97.30 | 0.20 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 89.40 | 0.60 | 5.40 | 4.10 | 0.10 | 0.00 | 0.00 | 0.00 | 6.00 | 0.20 |
| I11866 | 23.040 | 32.127 | 80.567 | 554400.0 | 540800.0 | 16.0 | 0.70 | 99.00 | 0.30 | 0.00 | 9.20 | 0.70 | 0.00 | 8.10 | 8.00 | -34.00 | 10.00 | 0.00 | 1.60 | 4.70 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 12.40 | 0.90 |
| I11867 | 23.040 | 32.127 | 80.517 | 554400.0 | 545600.0 | 17.9 | 0.40 | 99.20 | 0.30 | 0.00 | 10.40 | 1.00 | 0.00 | 11.40 | 12.50 | -40.80 | 11.40 | 89.30 | 1.60 | 4.60 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 12.50 | 0.90 |
| I11868 | 23.040 | 32.127 | 80.466 | 554400.0 | 550400.0 | 18.6 | 0.40 | 99.10 | 0.50 | 0.00 | 11.10 | 1.00 | 0.00 | 15.30 | 15.60 | -46.00 | 12.10 | 88.20 | 1.30 | 4.80 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 12.40 | 0.90 |
| I11869 | 23.040 | 32.126 | 80.415 | 554400.0 | 555200.0 | 18.4 | 0.20 | 99.40 | 0.30 | 0.00 | 13.00 | 0.70 | 0.00 | 17.10 | 17.80 | -49.30 | 13.80 | 88.10 | 1.10 | 4.40 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 12.20 | 0.90 |
| I11870 | 23.040 | 32.126 | 80.364 | 554400.0 | 560000.0 | 19.2 | 0.10 | 99.70 | 0.20 | 0.00 | 15.30 | 0.30 | 0.00 | 17.00 | 18.40 | -51.90 | 15.70 | 88.90 | 1.00 | 4.10 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 1.00 |
| I11871 | 23.040 | 32.126 | 80.313 | 554400.0 | 564800.0 | 20.5 | 0.00 | 99.90 | 0.10 | 0.00 | 16.00 | 0.20 | 0.00 | 17.40 | 19.50 | -54.00 | 16.20 | 88.50 | 0.90 | 4.00 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 11.70 | 1.00 |
| I11872 | 23.040 | 32.126 | 80.262 | 554400.0 | 569600.0 | 21.3 | 0.00 | 99.90 | 0.00 | 0.00 | 14.90 | 0.50 | 0.00 | 18.60 | 21.70 | -55.40 | 15.40 | 87.10 | 0.80 | 3.90 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 11.50 | 1.00 |
| I11873 | 23.040 | 32.125 | 80.211 | 554400.0 | 574400.0 | 22.2 | 0.00 | 99.90 | 0.00 | 0.00 | 13.60 | 0.90 | 0.00 | 19.60 | 24.40 | -56.30 | 14.50 | 86.20 | 1.00 | 3.70 | 2.80 | 0.00 | 0.00 | 0.00 | 0.20 | 11.20 | 1.10 |
| I11874 | 23.040 | 32.125 | 80.160 | 554400.0 | 579200.0 | 23.6 | 0.00 | 99.90 | 0.00 | 0.00 | 12.50 | 1.50 | 0.00 | 20.10 | 27.00 | -57.70 | 14.00 | 86.10 | 1.40 | 3.50 | 2.70 | 0.00 | 0.00 | 0.00 | 0.50 | 10.80 | 1.50 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MN.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 111875 | 23.040 | 32.125 | 80.110 | 554400.0 | 584000.0 | 25.1 | 0.00 | 99.90 | 0.00 | 0.00 | 11.40 | 3.20 | 0.00 | 20.50 | 20.70 | -60.20 | 14.60 | 86.00 | 1.00 | 3.50 | 2.60 | 0.00 | 0.00 | 0.00 | 1.10 | 10.40 | 2.10 |
| 111876 | 23.040 | 32.124 | 80.059 | 554400.0 | 588800.0 | 26.6 | 0.00 | 99.90 | 0.00 | 0.00 | 10.40 | 6.00 | 0.00 | 21.40 | 20.00 | -64.40 | 16.30 | 87.00 | 2.00 | 3.70 | 2.70 | 0.00 | 0.00 | 0.00 | 1.60 | 10.20 | 2.60 |
| 111877 | 23.040 | 32.124 | 80.008 | 554400.0 | 593600.0 | 27.5 | 0.00 | 99.90 | 0.00 | 0.00 | 9.80 | 8.00 | 0.00 | 22.50 | 20.10 | -67.00 | 17.00 | 88.00 | 2.10 | 4.00 | 3.00 | 0.00 | 0.00 | 0.00 | 1.90 | 10.10 | 2.90 |
| 111908 | 11.142 | 32.084 | 80.669 | 549600.0 | 531200.0 | 3.7 | 2.50 | 97.30 | 0.20 | 0.00 | 9.20 | 0.10 | 0.00 | 6.70 | 5.20 | -19.80 | 9.30 | 88.20 | 0.60 | 5.40 | 4.10 | 0.10 | 0.00 | 0.00 | 0.00 | 6.00 | 0.20 |
| 111909 | 23.040 | 32.084 | 80.619 | 549600.0 | 536000.0 | 16.9 | 1.90 | 97.80 | 0.30 | 0.00 | 8.20 | 0.30 | 0.00 | 5.50 | 5.90 | -31.00 | 8.50 | 0.00 | 1.80 | 4.70 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.20 | 0.90 |
| 111910 | 23.040 | 32.084 | 80.568 | 549600.0 | 540800.0 | 18.9 | 0.90 | 98.70 | 0.40 | 0.00 | 9.20 | 0.70 | 0.00 | 6.90 | 8.50 | -35.00 | 10.00 | 88.00 | 1.40 | 5.10 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 11.50 | 1.00 |
| 111911 | 23.040 | 32.083 | 80.517 | 549600.0 | 545600.0 | 20.5 | 0.40 | 99.00 | 0.50 | 0.00 | 10.60 | 1.20 | 0.00 | 10.80 | 12.60 | -43.20 | 11.00 | 87.50 | 1.00 | 5.40 | 5.10 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 1.00 |
| 111912 | 23.040 | 32.083 | 80.466 | 549600.0 | 550400.0 | 22.6 | 0.20 | 99.20 | 0.50 | 0.00 | 11.30 | 1.10 | 0.00 | 15.40 | 15.90 | -50.40 | 12.40 | 87.50 | 0.90 | 5.20 | 5.10 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 1.00 |
| 111913 | 23.040 | 32.083 | 80.415 | 549600.0 | 555200.0 | 22.3 | 0.20 | 99.50 | 0.40 | 0.00 | 12.70 | 0.70 | 0.00 | 17.20 | 17.60 | -52.90 | 13.40 | 88.00 | 0.90 | 4.80 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| 111914 | 23.040 | 32.083 | 80.364 | 549600.0 | 560000.0 | 20.5 | 0.10 | 99.70 | 0.20 | 0.00 | 16.40 | 0.20 | 0.00 | 16.60 | 17.90 | -53.70 | 16.60 | 90.00 | 0.80 | 4.30 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.70 | 1.00 |
| 111915 | 23.040 | 32.083 | 80.313 | 549600.0 | 564800.0 | 21.2 | 0.00 | 99.90 | 0.10 | 0.00 | 16.00 | 0.20 | 0.00 | 16.90 | 19.20 | -55.10 | 17.00 | 91.00 | 0.50 | 4.00 | 3.00 | 0.00 | 0.00 | 0.00 | 0.10 | 11.40 | 1.00 |
| 111916 | 23.040 | 32.082 | 80.263 | 549600.0 | 569600.0 | 22.7 | 0.00 | 100.00 | 0.00 | 0.00 | 14.30 | 0.30 | 0.00 | 19.10 | 22.40 | -56.50 | 14.70 | 91.50 | 0.50 | 3.90 | 2.50 | 0.00 | 0.00 | 0.00 | 0.20 | 11.00 | 1.00 |
| 111917 | 23.040 | 32.082 | 80.212 | 549600.0 | 574400.0 | 24.2 | 0.00 | 99.90 | 0.00 | 0.00 | 13.00 | 0.00 | 0.00 | 20.00 | 24.90 | -58.00 | 13.80 | 90.40 | 0.80 | 3.80 | 2.50 | 0.00 | 0.00 | 0.00 | 0.40 | 10.60 | 1.20 |
| 111918 | 23.040 | 32.082 | 80.161 | 549600.0 | 579200.0 | 25.6 | 0.00 | 99.90 | 0.00 | 0.00 | 12.10 | 1.30 | 0.00 | 20.30 | 28.40 | -59.30 | 13.40 | 89.30 | 1.40 | 3.70 | 2.50 | 0.00 | 0.00 | 0.00 | 0.90 | 10.10 | 1.00 |
| 111919 | 23.040 | 32.081 | 80.110 | 549600.0 | 584000.0 | 27.1 | 0.00 | 99.90 | 0.00 | 0.00 | 11.00 | 3.30 | 0.00 | 20.40 | 29.70 | -61.90 | 14.30 | 88.00 | 1.00 | 3.70 | 2.70 | 0.00 | 0.00 | 0.00 | 1.50 | 10.00 | 2.40 |
| 111920 | 23.040 | 32.081 | 80.059 | 549600.0 | 588800.0 | 28.6 | 0.00 | 99.90 | 0.00 | 0.00 | 9.00 | 7.00 | 0.00 | 21.90 | 28.00 | -68.00 | 17.50 | 89.20 | 2.00 | 3.90 | 2.90 | 0.00 | 0.00 | 0.00 | 1.80 | 10.00 | 2.00 |
| 111921 | 23.040 | 32.080 | 80.008 | 549600.0 | 593600.0 | 29.6 | 0.00 | 100.00 | 0.00 | 0.00 | 9.30 | 9.70 | 0.00 | 23.00 | 27.00 | -71.60 | 19.00 | 89.60 | 2.10 | 4.00 | 3.00 | 0.00 | 0.00 | 0.00 | 2.00 | 10.00 | 3.00 |
| 111950 | 16.689 | 32.041 | 80.771 | 544800.0 | 521600.0 | 9.5 | 20.10 | 79.50 | 0.30 | 0.00 | 14.70 | 0.00 | 0.00 | 7.20 | 11.50 | -31.40 | 14.70 | 88.00 | 1.90 | 4.20 | 4.00 | 0.10 | 0.00 | 0.00 | 0.00 | 5.00 | 0.10 |
| 111951 | 21.435 | 32.041 | 80.720 | 544800.0 | 526400.0 | 10.9 | 12.60 | 87.20 | 0.20 | 0.00 | 11.50 | 0.10 | 0.00 | 6.90 | 8.10 | -29.40 | 11.60 | 88.20 | 1.30 | 4.70 | 4.40 | 0.10 | 0.00 | 0.00 | 0.00 | 5.00 | 0.10 |
| 111952 | 23.040 | 32.041 | 80.670 | 544800.0 | 531200.0 | 16.7 | 2.80 | 96.90 | 0.30 | 0.00 | 7.50 | 0.10 | 0.00 | 4.50 | 4.30 | -20.80 | 7.60 | 0.00 | 2.50 | 4.10 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 10.30 | 0.00 |
| 111953 | 23.040 | 32.040 | 80.619 | 544800.0 | 536000.0 | 17.8 | 1.40 | 98.30 | 0.30 | 0.00 | 8.10 | 0.30 | 0.00 | 4.00 | 5.50 | -30.90 | 8.40 | 88.40 | 2.30 | 4.40 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.60 | 0.90 |
| 111954 | 23.040 | 32.040 | 80.568 | 544800.0 | 540800.0 | 18.8 | 0.60 | 98.70 | 0.60 | 0.00 | 9.30 | 0.00 | 0.00 | 6.00 | 8.90 | -35.70 | 10.10 | 86.20 | 1.00 | 5.00 | 6.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| 111955 | 23.040 | 32.040 | 80.517 | 544800.0 | 545600.0 | 19.3 | 0.10 | 99.10 | 0.00 | 0.00 | 10.50 | 1.40 | 0.00 | 10.70 | 13.10 | -41.90 | 11.90 | 85.60 | 0.40 | 6.20 | 6.70 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| 111956 | 23.040 | 32.040 | 80.466 | 544800.0 | 550400.0 | 20.4 | 0.10 | 99.30 | 0.50 | 0.00 | 11.20 | 1.20 | 0.00 | 15.40 | 16.40 | -48.10 | 12.40 | 87.30 | 0.60 | 5.60 | 5.70 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| 111957 | 23.040 | 32.040 | 80.415 | 544800.0 | 555200.0 | 22.5 | 0.10 | 99.50 | 0.30 | 0.00 | 12.60 | 0.50 | 0.00 | 17.90 | 17.60 | -53.50 | 13.10 | 89.30 | 0.60 | 4.80 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 11.70 | 1.00 |
| 111958 | 23.040 | 32.039 | 80.365 | 544800.0 | 560000.0 | 22.2 | 0.10 | 99.80 | 0.10 | 0.00 | 17.00 | 0.20 | 0.00 | 16.30 | 17.00 | -55.70 | 17.20 | 91.30 | 0.40 | 4.30 | 3.40 | 0.00 | 0.00 | 0.00 | 0.10 | 11.50 | 1.00 |
| 111959 | 23.040 | 32.039 | 80.314 | 544800.0 | 564800.0 | 22.9 | 0.00 | 100.00 | 0.00 | 0.00 | 15.60 | 0.40 | 0.00 | 17.60 | 20.30 | -56.50 | 15.90 | 92.90 | 0.20 | 4.00 | 2.50 | 0.00 | 0.00 | 0.00 | 0.20 | 11.00 | 1.00 |
| 111960 | 23.040 | 32.039 | 80.263 | 544800.0 | 569600.0 | 24.4 | 0.00 | 100.00 | 0.00 | 0.00 | 13.20 | 0.40 | 0.00 | 19.90 | 23.40 | -58.00 | 13.70 | 93.10 | 0.30 | 3.90 | 2.30 | 0.00 | 0.00 | 0.00 | 0.40 | 10.30 | 1.00 |
| 111961 | 23.040 | 32.039 | 80.212 | 544800.0 | 574400.0 | 25.9 | 0.00 | 99.90 | 0.00 | 0.00 | 12.30 | 1.10 | 0.00 | 19.90 | 26.00 | -59.30 | 13.40 | 91.90 | 0.90 | 3.70 | 2.40 | 0.00 | 0.00 | 0.00 | 0.70 | 9.40 | 1.20 |
| 111962 | 23.040 | 32.038 | 80.161 | 544800.0 | 579200.0 | 27.4 | 0.10 | 99.90 | 0.00 | 0.00 | 11.60 | 1.60 | 0.00 | 20.20 | 29.00 | -60.90 | 13.20 | 90.70 | 1.50 | 3.70 | 2.50 | 0.00 | 0.00 | 0.00 | 1.20 | 8.80 | 1.80 |
| 111963 | 23.040 | 32.038 | 80.110 | 544800.0 | 584000.0 | 28.9 | 0.10 | 99.90 | 0.00 | 0.00 | 10.20 | 5.50 | 0.00 | 20.10 | 30.50 | -64.70 | 15.70 | 90.00 | 2.00 | 3.00 | 2.70 | 0.00 | 0.00 | 0.00 | 1.70 | 9.10 | 2.40 |
| 111964 | 23.040 | 32.038 | 80.060 | 544800.0 | 588800.0 | 29.7 | 0.00 | 99.90 | 0.00 | 0.00 | 9.20 | 9.40 | 0.00 | 22.10 | 28.00 | -70.50 | 18.60 | 89.90 | 2.00 | 4.00 | 2.90 | 0.00 | 0.00 | 0.00 | 1.90 | 9.60 | 2.80 |
| 111965 | 23.040 | 32.037 | 80.009 | 544800.0 | 593600.0 | 30.0 | 0.10 | 99.90 | 0.00 | 0.00 | 9.10 | 9.70 | 0.00 | 21.70 | 29.20 | -71.20 | 18.70 | 89.70 | 2.10 | 4.10 | 3.00 | 0.00 | 0.00 | 0.00 | 2.00 | 9.90 | 3.00 |
| 111994 | 5.683 | 31.998 | 80.771 | 540000.0 | 521600.0 | 9.4 | 14.20 | 85.40 | 0.40 | 0.00 | 14.10 | 0.10 | 0.00 | 8.70 | 10.70 | -32.30 | 14.20 | 88.30 | 1.40 | 4.60 | 4.20 | 0.20 | 0.00 | 0.00 | 0.00 | 4.50 | 0.10 |
| 111995 | 23.040 | 31.997 | 80.721 | 540000.0 | 526400.0 | 15.9 | 5.20 | 94.40 | 0.50 | 0.00 | 7.50 | 0.00 | 0.00 | 4.30 | 4.30 | -27.70 | 7.50 | 0.00 | 2.90 | 3.70 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 9.70 | 0.70 |
| 111996 | 23.040 | 31.997 | 80.670 | 540000.0 | 531200.0 | 17.6 | 1.10 | 98.70 | 0.20 | 0.00 | 7.80 | 0.10 | 0.00 | 3.00 | 3.40 | -20.60 | 8.00 | 89.30 | 3.40 | 3.50 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.10 | 0.90 |
| 111997 | 23.040 | 31.997 | 80.619 | 540000.0 | 536000.0 | 18.0 | 0.70 | 98.80 | 0.40 | 0.00 | 8.60 | 0.30 | 0.00 | 3.50 | 5.20 | -30.40 | 8.90 | 87.60 | 2.10 | 4.70 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 11.00 | 1.00 |
| 111998 | 23.040 | 31.997 | 80.568 | 540000.0 | 540800.0 | 18.6 | 0.20 | 99.00 | 0.80 | 0.00 | 9.60 | 0.00 | 0.00 | 6.00 | 9.00 | -33.00 | 10.40 | 85.30 | 0.60 | 6.30 | 6.90 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| 111999 | 23.040 | 31.997 | 80.517 | 540000.0 | 545600.0 | 19.3 | 0.00 | 99.30 | 0.70 | 0.00 | 10.00 | 1.00 | 0.00 | 11.60 | 14.50 | -42.70 | 11.70 | 86.00 | 0.50 | 6.00 | 6.50 | 0.00 | 0.00 | 0.00 | 0.00 | 11.90 | 1.00 |
| 112661 | 23.040 | 32.297 | 79.955 | 573600.0 | 598400.0 | 20.8 | 1.20 | 98.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 56.90 | 1.90 | 4.20 | 3.90 | 0.00 | 0.00 | 0.00 | 1.00 | 10.50 | 1.90 |
| 112662 | 23.040 | 32.296 | 79.904 | 573600.0 | 603200.0 | 21.9 | 2.10 | 97.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 40.70 | 2.00 | 5.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 |
| 112664 | 23.040 | 32.295 | 79.802 | 573600.0 | 612800.0 | 26.6 | 2.60 | 97.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 58.40 | 2.20 | 5.70 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.30 |
| 112665 | 23.040 | 32.295 | 79.751 | 573600.0 | 617600.0 | 28.4 | 1.30 | 98.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 73.40 | 2.30 | 5.00 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 |
| 112666 | 23.040 | 32.294 | 79.700 | 573600.0 | 622400.0 | 30.1 | 0.50 | 99.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 80.20 | 2.70 | 5.90 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 |
| 112667 | 23.040 | 32.294 | 79.649 | 573600.0 | 627200.0 | 30.9 | 0.30 | 99.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.20 | 2.90 | 6.00 | 3.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.20 |
| 112668 | 23.040 | 32.293 | 79.598 | 573600.0 | 632000.0 | 32.2 | 0.20 | 99.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.80 | 3.00 | 6.00 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.80 |
| 112669 | 23.040 | 32.293 | 79.547 | 573600.0 | 636800.0 | 33.3 | 0.00 | 99.90 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.40 | 3.10 | 6.10 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 |
| 112670 | 23.040 | 32.292 | 79.496 | 573600.0 | 641600.0 | 34.1 | 0.00 | 99.80 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.20 | 2.90 | 6.20 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 |
| 112671 | 23.040 | 32.291 | 79.445 | 573600.0 | 646400.0 | 36.3 | 0.00 | 99.40 | 0.50 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.30 | 2.20 | 6.60 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112672 | 23.040 | 32.291 | 79.394 | 573600.0 | 651200.0 | 40.1 | 0.00 | 98.80 | 0.90 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.00 | 1.20 | 7.10 | 5.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MM.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 112673 | 23.040 | 32.290 | 79.343 | 573600.0 | 656000.0 | 44.4 | 0.00 | 98.50 | 1.10 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 0.00 | 7.00 | 5.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112674 | 23.040 | 32.289 | 79.292 | 573600.0 | 660800.0 | 47.6 | 0.10 | 98.20 | 1.30 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.00 | 0.00 | 6.70 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112675 | 23.040 | 32.289 | 79.241 | 573600.0 | 665600.0 | 53.8 | 0.20 | 96.10 | 2.60 | 0.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.90 | 0.00 | 6.60 | 5.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112676 | 19.705 | 32.288 | 79.190 | 573600.0 | 670400.0 | 47.8 | 0.30 | 97.00 | 2.10 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.00 | 0.60 | 6.90 | 5.40 | 0.00 | 0.50 | 0.50 | 0.50 | 3.50 | 0.00 |
| 112677 | 1.995 | 32.287 | 79.140 | 573600.0 | 675200.0 | 40.6 | 0.60 | 79.70 | 2.50 | 0.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 67.90 | 0.30 | 5.70 | 4.30 | 0.00 | 0.30 | 0.30 | 0.30 | 2.70 | 0.00 |
| 112705 | 23.040 | 32.253 | 79.955 | 568800.0 | 598400.0 | 22.5 | 1.00 | 98.90 | 0.00 | 0.00 | 10.60 | 6.00 | 0.00 | 22.50 | 27.40 | -62.40 | 16.60 | 0.00 | 2.00 | 4.00 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 |
| 112706 | 23.040 | 32.253 | 79.904 | 568800.0 | 603200.0 | 23.4 | 1.60 | 98.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 61.30 | 2.20 | 4.70 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 |
| 112707 | 23.040 | 32.252 | 79.854 | 568800.0 | 608000.0 | 25.7 | 1.70 | 98.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 65.40 | 2.50 | 5.10 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 |
| 112708 | 23.040 | 32.252 | 79.803 | 568800.0 | 612800.0 | 27.5 | 1.10 | 98.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 77.20 | 2.00 | 5.20 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 |
| 112709 | 23.040 | 32.251 | 79.752 | 568800.0 | 617600.0 | 29.3 | 0.70 | 99.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 80.40 | 2.70 | 5.40 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.60 |
| 112710 | 23.040 | 32.251 | 79.701 | 568800.0 | 622400.0 | 30.9 | 0.10 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.70 | 2.60 | 5.00 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.30 |
| 112711 | 23.040 | 32.250 | 79.650 | 568800.0 | 627200.0 | 32.6 | 0.10 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.70 | 2.60 | 5.90 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 |
| 112712 | 23.040 | 32.250 | 79.599 | 568800.0 | 632000.0 | 35.0 | 0.10 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.90 | 2.50 | 6.00 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.10 |
| 112713 | 23.040 | 32.249 | 79.548 | 568800.0 | 636800.0 | 36.1 | 0.00 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.00 | 2.30 | 6.00 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 |
| 112714 | 23.040 | 32.249 | 79.497 | 568800.0 | 641600.0 | 37.3 | 0.00 | 99.80 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.00 | 2.20 | 6.20 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 |
| 112715 | 23.040 | 32.248 | 79.446 | 568800.0 | 646400.0 | 39.2 | 0.00 | 99.40 | 0.40 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.00 | 1.90 | 6.50 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112716 | 23.040 | 32.247 | 79.395 | 568800.0 | 651200.0 | 41.0 | 0.00 | 98.90 | 0.00 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 1.30 | 6.60 | 5.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112717 | 23.040 | 32.247 | 79.344 | 568800.0 | 656000.0 | 46.5 | 0.00 | 98.80 | 0.80 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.00 | 1.00 | 6.50 | 5.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112718 | 23.040 | 32.246 | 79.293 | 568800.0 | 660800.0 | 50.9 | 0.00 | 98.80 | 0.80 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.40 | 0.90 | 6.20 | 5.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112719 | 23.040 | 32.245 | 79.242 | 568800.0 | 665600.0 | 59.4 | 0.10 | 94.90 | 3.50 | 1.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.00 | 0.00 | 6.60 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112720 | 7.275 | 32.245 | 79.191 | 568800.0 | 670400.0 | 46.0 | 0.20 | 91.10 | 1.00 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 77.00 | 0.00 | 6.20 | 5.30 | 0.00 | 0.70 | 0.70 | 0.70 | 3.90 | 0.00 |
| 112749 | 23.040 | 32.210 | 79.956 | 564000.0 | 598400.0 | 24.8 | 0.70 | 99.30 | 0.00 | 0.00 | 10.20 | 7.00 | 0.00 | 22.70 | 27.70 | -65.00 | 17.20 | 0.00 | 2.20 | 4.10 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.70 |
| 112750 | 23.040 | 32.210 | 79.905 | 564000.0 | 603200.0 | 25.6 | 0.60 | 99.40 | 0.00 | 0.00 | 9.90 | 7.00 | 0.00 | 23.10 | 27.50 | -67.00 | 17.00 | 76.40 | 2.50 | 4.70 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 |
| 112751 | 23.040 | 32.209 | 79.854 | 564000.0 | 608000.0 | 26.9 | 0.60 | 99.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.10 | 2.00 | 5.00 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112752 | 23.040 | 32.209 | 79.803 | 564000.0 | 612800.0 | 28.5 | 0.30 | 99.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.00 | 2.90 | 5.10 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112753 | 23.040 | 32.208 | 79.752 | 564000.0 | 617600.0 | 30.4 | 0.40 | 99.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.50 | 2.60 | 5.40 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 |
| 112754 | 23.040 | 32.208 | 79.701 | 564000.0 | 622400.0 | 32.6 | 0.10 | 99.90 | 0.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 81.90 | 2.20 | 5.00 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.70 |
| 112755 | 23.040 | 32.207 | 79.650 | 564000.0 | 627200.0 | 34.9 | 0.00 | 99.90 | 0.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.40 | 2.00 | 5.90 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.20 |
| 112756 | 23.040 | 32.207 | 79.599 | 564000.0 | 632000.0 | 37.4 | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.20 | 2.00 | 6.00 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.50 |
| 112757 | 23.040 | 32.206 | 79.549 | 564000.0 | 636800.0 | 38.8 | 0.00 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.20 | 2.00 | 6.10 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 |
| 112758 | 23.040 | 32.205 | 79.498 | 564000.0 | 641600.0 | 39.8 | 0.00 | 99.70 | 0.20 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.60 | 2.00 | 6.20 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 |
| 112759 | 23.040 | 32.205 | 79.447 | 564000.0 | 646400.0 | 41.9 | 0.00 | 99.10 | 0.60 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.20 | 1.70 | 6.40 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| 112760 | 23.040 | 32.204 | 79.396 | 564000.0 | 651200.0 | 45.2 | 0.00 | 98.70 | 0.90 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.90 | 1.30 | 6.40 | 5.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112761 | 23.040 | 32.203 | 79.345 | 564000.0 | 656000.0 | 50.8 | 0.00 | 99.00 | 0.60 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.40 | 1.00 | 6.20 | 5.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112762 | 23.040 | 32.203 | 79.294 | 564000.0 | 660800.0 | 57.8 | 0.00 | 97.50 | 1.70 | 0.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.90 | 0.90 | 6.30 | 6.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112763 | 11.290 | 32.202 | 79.243 | 564000.0 | 665600.0 | 46.6 | 0.00 | 94.30 | 0.80 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 80.50 | 0.90 | 6.00 | 5.60 | 0.00 | 0.00 | 0.00 | 0.00 | 4.40 | 0.00 |
| 112793 | 23.040 | 32.167 | 79.956 | 559200.0 | 598400.0 | 26.2 | 0.20 | 99.70 | 0.00 | 0.00 | 9.90 | 7.00 | 0.00 | 23.00 | 27.60 | -66.00 | 17.70 | 0.00 | 2.20 | 4.30 | 3.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 |
| 112794 | 23.040 | 32.166 | 79.905 | 559200.0 | 603200.0 | 26.8 | 0.20 | 99.80 | 0.00 | 0.00 | 9.70 | 8.40 | 0.00 | 23.20 | 27.60 | -68.10 | 18.10 | 82.10 | 2.50 | 4.00 | 3.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112795 | 23.040 | 32.166 | 79.855 | 559200.0 | 608000.0 | 28.0 | 0.20 | 99.80 | 0.00 | 0.00 | 9.40 | 9.30 | 0.00 | 22.90 | 28.00 | -69.30 | 18.70 | 84.00 | 2.70 | 5.00 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112796 | 23.040 | 32.165 | 79.804 | 559200.0 | 612800.0 | 29.4 | 0.30 | 99.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.70 | 2.70 | 5.30 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112797 | 23.040 | 32.165 | 79.753 | 559200.0 | 617600.0 | 31.9 | 0.30 | 99.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.40 | 2.30 | 5.60 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112798 | 23.040 | 32.164 | 79.702 | 559200.0 | 622400.0 | 35.1 | 0.00 | 100.00 | 0.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.30 | 1.70 | 5.90 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 |
| 112799 | 23.040 | 32.164 | 79.651 | 559200.0 | 627200.0 | 37.5 | 0.00 | 100.00 | 0.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.50 | 1.50 | 6.00 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.60 |
| 112800 | 23.040 | 32.163 | 79.600 | 559200.0 | 632000.0 | 39.5 | 0.00 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.40 | 1.00 | 6.10 | 4.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.90 |
| 112801 | 23.040 | 32.163 | 79.549 | 559200.0 | 636800.0 | 40.2 | 0.00 | 99.80 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.70 | 1.90 | 6.20 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| 112802 | 23.040 | 32.162 | 79.498 | 559200.0 | 641600.0 | 41.0 | 0.00 | 99.40 | 0.40 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.30 | 1.00 | 6.40 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 |
| 112803 | 23.040 | 32.161 | 79.447 | 559200.0 | 646400.0 | 45.1 | 0.00 | 98.50 | 1.00 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 1.60 | 6.50 | 5.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| 112804 | 23.040 | 32.161 | 79.397 | 559200.0 | 651200.0 | 50.7 | 0.00 | 97.50 | 1.70 | 0.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 1.20 | 6.40 | 5.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112805 | 23.040 | 32.160 | 79.346 | 559200.0 | 656000.0 | 60.3 | 0.00 | 96.70 | 2.10 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.40 | 1.00 | 6.40 | 5.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112806 | 12.695 | 32.159 | 79.295 | 559200.0 | 660800.0 | 48.2 | 0.00 | 99.00 | 0.70 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 86.00 | 1.00 | 6.20 | 5.80 | 0.00 | 0.90 | 0.90 | 0.90 | 4.80 | 0.00 |

| BLOCKID | AREA (sq.km) | LATITUDE (deg) | LONGITUDE (deg) | NORTH (m) | EAST (m) | DEPTH (m) | GRAVEL wt % | SAND wt % | SILT wt % | CLAY wt % | QUATERN thk (m) | PLIOCEN thk (m) | UP.MIOC thk (m) | MD.MIOC thk (m) | LW.MIOC thk (m) | MM.BOTS thk (m) | OVRBRDN thk (m) | QUARTZ %count | K.FLDSP %count | P.FLDSP %count | HVYMINS %count | PHSPHRT %count | MONAZ %count | RUTILE %count | STAURO %count | TITAN %count | ZIRCON %count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 112837 | 23.040 | 32.123 | 79.957 | 554400.0 | 598400.0 | 27.8 | 0.00 | 99.90 | 0.00 | 0.00 | 9.60 | 8.90 | 0.00 | 23.10 | 27.70 | -69.30 | 18.50 | 0.00 | 2.20 | 4.30 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112838 | 23.040 | 32.123 | 79.906 | 554400.0 | 603200.0 | 28.1 | 0.10 | 99.90 | 0.00 | 0.00 | 9.20 | 9.70 | 0.00 | 22.60 | 28.40 | -69.70 | 18.90 | 84.70 | 2.40 | 4.80 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112839 | 23.040 | 32.123 | 79.855 | 554400.0 | 608000.0 | 29.3 | 0.10 | 99.90 | 0.00 | 0.00 | 9.10 | 10.10 | 0.00 | 22.30 | 28.70 | -70.30 | 19.20 | 84.30 | 2.50 | 5.20 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112840 | 23.040 | 32.122 | 79.804 | 554400.0 | 612800.0 | 32.0 | 0.10 | 99.80 | 0.00 | 0.00 | 9.00 | 10.20 | 0.00 | 22.00 | 29.00 | -71.70 | 19.20 | 84.60 | 2.40 | 5.60 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112841 | 23.040 | 32.122 | 79.753 | 554400.0 | 617600.0 | 35.3 | 0.00 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.40 | 1.90 | 5.00 | 3.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112842 | 23.040 | 32.121 | 79.703 | 554400.0 | 622400.0 | 38.2 | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.10 | 1.30 | 6.00 | 2.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 |
| 112843 | 23.040 | 32.120 | 79.652 | 554400.0 | 627200.0 | 40.0 | 0.00 | 99.90 | 0.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.90 | 1.40 | 6.00 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.80 |
| 112844 | 23.040 | 32.120 | 79.601 | 554400.0 | 632000.0 | 41.0 | 0.00 | 99.80 | 0.10 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.00 | 1.80 | 6.30 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.20 |
| 112845 | 23.040 | 32.119 | 79.550 | 554400.0 | 636800.0 | 41.7 | 0.00 | 99.70 | 0.20 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.40 | 1.90 | 6.50 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.30 |
| 112846 | 23.040 | 32.119 | 79.499 | 554400.0 | 641600.0 | 45.1 | 0.00 | 99.20 | 0.50 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 1.80 | 6.70 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 |
| 112847 | 23.040 | 32.118 | 79.448 | 554400.0 | 646400.0 | 53.6 | 0.00 | 97.70 | 1.50 | 0.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.30 | 1.50 | 6.70 | 5.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 |
| 112848 | 23.040 | 32.118 | 79.397 | 554400.0 | 651200.0 | 63.2 | 0.00 | 95.20 | 3.10 | 1.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.70 | 1.20 | 6.60 | 5.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112849 | 14.995 | 32.117 | 79.346 | 554400.0 | 656000.0 | 48.2 | 0.00 | 97.00 | 1.40 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 88.10 | 1.30 | 6.40 | 5.60 | 0.00 | 0.90 | 0.90 | 0.90 | 4.70 | 0.00 |
| 112881 | 23.040 | 32.080 | 79.957 | 549600.0 | 598400.0 | 29.6 | 0.00 | 99.90 | 0.00 | 0.00 | 9.10 | 10.20 | 0.00 | 22.30 | 28.60 | -71.20 | 19.30 | 0.00 | 2.20 | 4.30 | 3.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112882 | 23.040 | 32.080 | 79.907 | 549600.0 | 603200.0 | 30.2 | 0.10 | 99.90 | 0.00 | 0.00 | 9.00 | 10.20 | 0.00 | 21.90 | 29.10 | -71.40 | 19.20 | 86.20 | 2.40 | 4.90 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112883 | 23.040 | 32.079 | 79.856 | 549600.0 | 608000.0 | 31.3 | 0.10 | 99.90 | 0.00 | 0.00 | 9.00 | 10.20 | 0.00 | 21.80 | 29.20 | -72.30 | 19.20 | 84.90 | 2.50 | 5.40 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 112884 | 23.040 | 32.079 | 79.805 | 549600.0 | 612800.0 | 34.1 | 0.00 | 100.00 | 0.00 | 0.00 | 9.00 | 10.20 | 0.00 | 21.80 | 29.20 | -73.20 | 19.20 | 84.40 | 2.60 | 5.80 | 4.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112885 | 23.040 | 32.078 | 79.754 | 549600.0 | 617600.0 | 38.3 | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.10 | 2.20 | 5.90 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112886 | 23.040 | 32.078 | 79.703 | 549600.0 | 622400.0 | 41.2 | 0.00 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.90 | 1.60 | 6.00 | 3.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112887 | 23.040 | 32.077 | 79.652 | 549600.0 | 627200.0 | 43.1 | 0.00 | 99.80 | 0.10 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.60 | 1.70 | 6.20 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.80 |
| 112888 | 23.040 | 32.077 | 79.601 | 549600.0 | 632000.0 | 45.0 | 0.00 | 99.80 | 0.20 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.60 | 1.90 | 6.60 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 |
| 112889 | 23.040 | 32.076 | 79.551 | 549600.0 | 636800.0 | 47.3 | 0.00 | 99.80 | 0.20 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.80 | 1.90 | 6.90 | 4.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.60 |
| 112890 | 23.040 | 32.075 | 79.500 | 549600.0 | 641600.0 | 54.0 | 0.00 | 98.80 | 0.00 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 1.80 | 6.90 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.70 |
| 112891 | 22.390 | 32.075 | 79.449 | 549600.0 | 646400.0 | 44.5 | 0.00 | 99.20 | 0.50 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.50 | 1.80 | 6.70 | 4.90 | 0.00 | 0.70 | 0.70 | 1.00 | 5.50 | 0.50 |
| 112892 | 9.120 | 32.074 | 79.398 | 549600.0 | 651200.0 | 46.0 | 0.00 | 93.80 | 1.10 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 79.70 | 1.50 | 6.30 | 4.90 | 0.00 | 0.00 | 0.00 | 0.90 | 4.60 | 0.10 |
| 112925 | 23.040 | 32.037 | 79.958 | 544800.0 | 598400.0 | 32.9 | 0.10 | 99.80 | 0.00 | 0.00 | 9.00 | 9.60 | 0.00 | 21.00 | 30.00 | -72.40 | 18.50 | 0.00 | 2.40 | 4.50 | 3.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112926 | 23.040 | 32.036 | 79.907 | 544800.0 | 603200.0 | 35.4 | 0.10 | 99.80 | 0.00 | 0.00 | 8.90 | 9.50 | 0.00 | 20.70 | 30.20 | -74.60 | 18.50 | 86.40 | 2.60 | 5.10 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112927 | 23.040 | 32.036 | 79.856 | 544800.0 | 608000.0 | 37.3 | 0.00 | 99.90 | 0.00 | 0.00 | 8.90 | 9.80 | 0.00 | 20.70 | 30.20 | -76.60 | 18.60 | 85.00 | 2.70 | 5.60 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112928 | 23.040 | 32.035 | 79.805 | 544800.0 | 612800.0 | 38.8 | 0.00 | 100.00 | 0.00 | 0.00 | 8.90 | 9.80 | 0.00 | 20.70 | 30.20 | -77.40 | 18.70 | 84.30 | 2.80 | 5.90 | 4.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112929 | 23.040 | 32.035 | 79.755 | 544800.0 | 617600.0 | 41.6 | 0.00 | 99.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.60 | 2.40 | 5.90 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112930 | 23.040 | 32.034 | 79.704 | 544800.0 | 622400.0 | 46.4 | 0.00 | 99.80 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.50 | 2.00 | 6.00 | 3.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112931 | 23.040 | 32.034 | 79.653 | 544800.0 | 627200.0 | 49.2 | 0.00 | 99.50 | 0.40 | 0.10 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.20 | 1.90 | 6.30 | 4.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.80 |
| 112932 | 23.040 | 32.033 | 79.602 | 544800.0 | 632000.0 | 50.4 | 0.00 | 99.60 | 0.30 | 0.10 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.90 | 1.90 | 6.00 | 4.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 |
| 112933 | 23.040 | 32.033 | 79.551 | 544800.0 | 636800.0 | 54.3 | 0.00 | 99.20 | 0.60 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.70 | 1.90 | 6.90 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.70 |
| 112934 | 20.640 | 32.032 | 79.500 | 544800.0 | 641600.0 | 46.3 | 0.00 | 99.80 | 0.10 | 0.00 | 9.00 | 8.20 | 0.00 | 18.60 | 32.10 | -70.80 | 17.30 | 88.20 | 1.90 | 6.90 | 4.90 | 0.00 | 0.40 | 0.40 | 1.50 | 7.50 | 1.60 |
| 112935 | 4.900 | 32.032 | 79.450 | 544800.0 | 646400.0 | 47.3 | 0.00 | 99.50 | 0.30 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 83.70 | 1.90 | 6.90 | 4.90 | 0.00 | 0.60 | 0.60 | 1.20 | 6.10 | 0.90 |
| 112969 | 23.040 | 31.993 | 79.958 | 540000.0 | 598400.0 | 35.0 | 0.20 | 99.80 | 0.00 | 0.00 | 9.00 | 8.50 | 0.00 | 18.30 | 32.10 | -70.80 | 17.50 | 88.40 | 2.70 | 4.70 | 3.20 | 0.00 | 0.00 | 0.00 | 1.00 | 6.50 | 3.00 |
| 112970 | 23.040 | 31.993 | 79.908 | 540000.0 | 603200.0 | 37.3 | 0.10 | 99.70 | 0.00 | 0.00 | 9.00 | 8.50 | 0.00 | 18.90 | 31.80 | -73.80 | 17.50 | 86.50 | 2.70 | 5.20 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112971 | 23.040 | 31.993 | 79.857 | 540000.0 | 608000.0 | 38.8 | 0.00 | 99.90 | 0.00 | 0.00 | 8.90 | 8.90 | 0.00 | 19.40 | 31.40 | -76.00 | 17.80 | 85.40 | 2.80 | 5.60 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112972 | 23.040 | 31.992 | 79.806 | 540000.0 | 612800.0 | 40.0 | 0.00 | 99.90 | 0.00 | 0.00 | 8.80 | 9.40 | 0.00 | 19.90 | 31.00 | -77.30 | 18.20 | 85.30 | 2.60 | 5.70 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112973 | 23.040 | 31.992 | 79.755 | 540000.0 | 617600.0 | 43.5 | 0.00 | 99.70 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 86.00 | 2.20 | 5.50 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 |
| 112974 | 23.040 | 31.991 | 79.704 | 540000.0 | 622400.0 | 48.5 | 0.00 | 99.40 | 0.50 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 85.70 | 1.90 | 5.70 | 3.90 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.90 |
| 112975 | 23.040 | 31.991 | 79.654 | 540000.0 | 627200.0 | 50.5 | 0.00 | 98.80 | 0.90 | 0.20 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.60 | 1.80 | 6.30 | 4.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.70 |
| 112976 | 14.890 | 31.990 | 79.603 | 540000.0 | 632000.0 | 48.2 | 0.00 | 99.60 | 0.30 | 0.10 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 84.10 | 1.90 | 6.30 | 4.10 | 0.00 | 0.00 | 0.00 | 1.90 | 9.70 | 2.90 |
| 112978 | 2.600 | 31.989 | 79.501 | 540000.0 | 641600.0 | 43.0 | 0.00 | 87.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 73.50 | 1.70 | 6.10 | 4.40 | 0.00 | 0.30 | 0.30 | 1.40 | 7.10 | 1.70 |

## SECTION 9.2

| Key............ | SAMPLEID.. | LAT.... | LON.... | NORTH.. | EAST... | DEPTH | WTGRAV | WTSAND | WTSILT | WTCLAY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1649 | 1649 | 30.017 | 79.717 | 321146 | 623761 | 871.0 | 0 | 40 | 37 | 22 |
| 1650 | 1650 | 30.017 | 79.508 | 321389 | 643855 | 779.0 | 0 | 96 | 4 | 0 |
| 1733 | 1733 | 30.238 | 79.650 | 345785 | 629901 | 861 | 0 | 64 | 21 | 14 |
| 2279 | 2279 | 31.132 | 81.414 | 444139 | 460547 | 8 | 9 | 91 | 0 | 0 |
| 2280 | 2280 | 31.097 | 81.282 | 440165 | 473137 | 6 | 0 | 95 | 5 | 0 |
| 2284 | 2284 | 30.478 | 81.385 | 371671 | 463046 | 8 | 3 | 95 | 2 | 0 |
| 2419 | 2419 | 30.333 | 80.795 | 355558 | 519706 | 33.0 | 0 | 100 | 0 | 0 |
| 2420 | 2420 | 30.353 | 80.892 | 357762 | 510411 | 28.0 | 0 | 100 | 0 | 0 |
| 1498 | 1498 | 30.670 | 81.003 | 392848 | 499681 | 20.0 | 0 | 100 | 0 | 0 |
| 1663 | 1663 | 31.678 | 79.995 | 505034 | 595262 | 36.0 | 0 | 100 | 0 | 0 |
| 1681 | 1681 | 30.830 | 80.750 | 410605 | 523909 | 24.0 | 0 | 100 | 0 | 0 |
| 1696 | 1696 | 30.155 | 80.488 | 335891 | 549274 | 36.0 | 1 | 99 | 0 | 0 |
| 1706 | 1706 | 31.333 | 80.232 | 466614 | 573096 | 36.0 | 0 | 100 | 0 | 0 |
| 1743 | 1743 | 30.850 | 79.400 | 413891 | 652997 | 802 | 0 | 92 | 8 | 0 |
| 1752 | 1752 | 31.478 | 79.403 | 483425 | 644073 | 449 | 0 | 97 | 2 | 0 |
| 2373 | 2373 | 30.263 | 78.750 | 349927 | 716464 | 804.0 | 0 | 94 | 6 | 0 |
| 2472 | 2472 | 30.142 | 79.545 | 335197 | 640142 | 776.0 | 31 | 61 | 7 | 0 |
| 2702 | 2702 | 31.800 | 79.200 | 519491 | 670404 | 556.0 | 0 | 0 | 0 | 0 |
| 1668 | 1668 | 31.823 | 80.018 | 521006 | 592905 | 30.0 | 1 | 98 | 0 | 0 |
| 2277A | 2277A | 32.320 | 81.304 | 464922 | 471059 | 6 | 0 | 100 | 0 | 0 |
| 1653 | 1653 | 30.375 | 79.442 | 361108 | 649741 | 835.0 | 0 | 34 | 30 | 35 |
| 1742 | 1742 | 30.745 | 79.317 | 402369 | 661141 | 752 | 0 | 100 | 0 | 0 |
| 2374 | 2374 | 30.517 | 79.022 | 377521 | 689832 | 876.0 | 4 | 90 | 6 | 0 |
| 2405 | 2405 | 32.453 | 79.847 | 591002 | 608404 | 29.0 | 0 | 100 | 0 | 0 |
| 2411 | 2411 | 32.297 | 79.717 | 573855 | 620832 | 40.0 | 1 | 99 | 0 | 0 |
| 2421 | 2421 | 30.350 | 80.933 | 357390 | 506400 | 26.0 | 2 | 98 | 0 | 0 |
| 2476 | 2476 | 30.863 | 79.168 | 415709 | 675129 | 743.0 | 15 | 82 | 3 | 0 |
| 2706B | 2706B | 31.800 | 79.200 | 519491 | 670404 | 556.0 | 0 | 0 | 0 | 0 |
| 1488A | 1488A | 31.842 | 80.750 | 522726 | 523655 | 17.0 | 0 | 98 | 2 | 0 |
| 1658 | 1658 | 30.830 | 80.007 | 411001 | 595001 | 146.0 | 0 | 73 | 18 | 8 |
| 1695 | 1695 | 30.000 | 80.493 | 318714 | 548900 | 38.0 | 0 | 100 | 0 | 0 |
| 1705 | 1705 | 31.502 | 80.275 | 485244 | 568850 | 32.0 | 0 | 100 | 0 | 0 |
| 1711 | 1711 | 30.497 | 80.228 | 373894 | 574055 | 43.0 | 0 | 100 | 0 | 0 |
| 1747 | 1747 | 31.147 | 79.775 | 446318 | 616773 | 254 | 0 | 95 | 5 | 0 |
| 1757 | 1757 | 32.013 | 79.507 | 542700 | 641043 | 54 | 0 | 100 | 0 | 0 |
| 2269 | 2269 | 32.145 | 80.827 | 556333 | 516346 | 9 | 0 | 100 | 0 | 0 |
| 2275 | 2275 | 31.517 | 81.199 | 486717 | 471594 | 3 | 0 | 89 | 3 | 7 |
| 1664 | 1664 | 31.673 | 80.243 | 504290 | 571726 | 28.0 | 0 | 100 | 0 | 0 |
| 2270 | 2270 | 32.073 | 80.968 | 548376 | 502989 | 8 | 0 | 100 | 0 | 0 |
| 1654 | 1654 | 30.498 | 79.453 | 374041 | 648434 | 752.0 | 0 | 99 | 1 | 0 |
| 2278 | 2278 | 31.333 | 81.384 | 466386 | 463500 | 4 | 0 | 100 | 0 | 0 |
| 2377 | 2377 | 30.358 | 78.083 | 361919 | 780355 | 813.0 | 0 | 96 | 4 | 0 |
| 2383 | 2383 | 30.940 | 78.572 | 425297 | 732006 | 845.0 | 0 | 100 | 0 | 0 |
| 2424 | 2424 | 30.367 | 81.058 | 359236 | 494395 | 21.0 | 0 | 100 | 0 | 0 |
| 2474A | 2474A | 30.572 | 79.525 | 382078 | 641448 | 828.0 | 39 | 11 | 23 | 25 |
| 2482 | 2482 | 31.922 | 78.578 | 534126 | 728969 | 444.0 | 0 | 0 | 0 | 0 |
| 1497 | 1497 | 30.833 | 81.000 | 410948 | 500000 | 18.0 | 0 | 100 | 0 | 0 |
| 1685 | 1685 | 30.167 | 80.750 | 337100 | 524072 | 32.0 | 0 | 100 | 0 | 0 |
| 1701 | 1701 | 31.003 | 80.492 | 429098 | 548528 | 31.0 | 0 | 100 | 0 | 0 |
| 1737 | 1737 | 30.507 | 80.040 | 375140 | 592120 | 284 | 34 | 57 | 8 | 0 |
| 2429 | 2429 | 30.385 | 81.250 | 361293 | 475981 | 23.0 | 0 | 100 | 0 | 0 |
| 2265 | 2265 | 32.435 | 80.380 | 588634 | 559286 | 9 | 0 | 100 | 0 | 0 |
| 1753 | 1753 | 31.653 | 79.497 | 502806 | 642540 | 166 | 0 | 30 | 56 | 13 |
| 1731 | 1731 | 30.183 | 79.887 | 339443 | 607186 | 534.0 | 0 | 64 | 19 | 16 |
| 2379 | 2379 | 30.475 | 78.067 | 374097 | 781622 | 825.0 | 0 | 100 | 0 | 0 |
| 2380 | 2380 | 30.830 | 78.075 | 414241 | 779796 | 949.0 | 0 | 100 | 0 | 0 |
| 2426 | 2426 | 30.375 | 81.142 | 360167 | 486388 | 19.0 | 5 | 95 | 0 | 0 |
| 2473 | 2473 | 30.252 | 79.243 | 347798 | 669014 | 830.0 | 10 | 89 | 0 | 0 |
| 2477 | 2477 | 31.008 | 79.323 | 431548 | 660065 | 684.0 | 0 | 0 | 0 | 0 |

| Key........... | SAMPLEID.. | LAT.... | LON.... | NORTH.. | EAST... | DEPTH | WTGRAV | WTSAND | WTSILT | WTCLAY |
|---|---|---|---|---|---|---|---|---|---|---|
| 2478 | 2478 | 31.133 | 79.125 | 445707 | 678768 | 649.0 | 16 | 81 | 2 | 0 |
| 1665 | 1665 | 31.685 | 80.510 | 505439 | 546442 | 20.0 | 0 | 100 | 0 | 0 |
| 1674 | 1674 | 32.460 | 79.980 | 591694 | 595865 | 16.0 | 0 | 100 | 0 | 0 |
| 1763 | 1763 | 31.830 | 79.242 | 522753 | 666405 | 259 | 0 | 20 | 56 | 23 |
| 2295 | 2295 | 32.085 | 80.625 | 549731 | 535389 | 8.0 | 0 | 100 | 0 | 0 |
| 1773 | 1773 | 32.347 | 78.740 | 580919 | 712690 | 347 | 0 | 53 | 29 | 18 |
| 1767 | 1767 | 31.827 | 78.492 | 523216 | 711690 | 455 | | | | |
| 2281 | 2281 | 30.930 | 81.315 | 421703 | 469906 | 7 | 0 | 93 | 7 | 0 |
| 2285 | 2285 | 30.362 | 81.380 | 358742 | 463483 | 8 | 0 | 100 | 0 | 0 |
| 2289 | 2289 | 31.325 | 81.197 | 465453 | 481288 | 7.0 | 0 | 97 | 3 | 0 |
| 2290 | 2290 | 31.520 | 81.065 | 487049 | 493828 | 9.0 | 0 | 100 | 0 | 0 |
| 2384 | 2384 | 30.908 | 78.717 | 421493 | 718221 | 843.0 | 0 | 100 | 0 | 0 |
| 2388 | 2388 | 31.533 | 78.967 | 490317 | 693048 | 494.0 | 0 | 0 | 0 | 0 |
| 2398 | 2398 | 32.083 | 78.450 | 552330 | 740683 | 489.0 | 0 | 0 | 0 | 0 |
| 2408 | 2408 | 32.380 | 79.788 | 583014 | 613980 | 36.0 | 1 | 99 | 0 | 0 |
| 2474B | 2474B | 30.572 | 79.525 | 382878 | 641448 | 828.0 | 0 | 0 | 0 | 0 |
| 2483 | 2483 | 32.147 | 78.593 | 559043 | 726994 | 449.0 | 0 | 0 | 0 | 0 |
| 1482 | 1482 | 32.327 | 80.038 | 576863 | 590515 | 16 | 0 | 100 | 0 | 0 |
| 1660 | 1660 | 31.168 | 79.967 | 448532 | 598479 | 46.0 | 1 | 99 | 0 | 0 |
| 1669 | 1669 | 32.008 | 79.980 | 541626 | 596340 | 27.0 | 0 | 100 | 0 | 0 |
| 1670 | 1670 | 32.180 | 80.000 | 560638 | 594274 | 19.0 | 0 | 100 | 0 | 0 |
| 1712 | 1712 | 30.337 | 80.250 | 356149 | 572093 | 49.0 | 0 | 100 | 0 | 0 |
| 1659 | 1659 | 31.002 | 79.983 | 430047 | 597060 | 48.0 | 0 | 100 | 0 | 0 |
| 1758 | 1758 | 31.995 | 79.753 | 540373 | 617768 | 32 | 0 | 100 | 0 | 0 |
| 1746 | 1746 | 31.000 | 79.742 | 430098 | 620135 | 347 | 0 | 96 | 4 | 0 |
| 1764 | 1764 | 31.675 | 79.243 | 505567 | 666525 | 504 | 0 | 68 | 18 | 13 |
| 2268 | 2268 | 32.273 | 80.695 | 570585 | 528724 | 11 | 3 | 97 | 0 | 0 |
| 2389 | 2389 | 31.383 | 78.667 | 474254 | 721891 | 512.0 | 0 | 100 | 0 | 0 |
| 2390 | 2390 | 31.213 | 78.483 | 455790 | 739761 | 648.0 | 0 | 0 | 0 | 0 |
| 2404 | 2404 | 32.467 | 79.875 | 592532 | 605726 | 27.0 | 1 | 99 | 0 | 0 |
| 2705 | 2705 | 31.800 | 79.200 | 519491 | 670404 | 556.0 | 0 | 0 | 0 | 0 |
| 2706A | 2706A | 31.800 | 79.200 | 519491 | 670404 | 556.0 | 0 | 0 | 0 | 0 |
| 1492 | 1492 | 31.340 | 81.017 | 467098 | 498414 | 15.0 | 0 | 100 | 0 | 0 |
| 1679 | 1679 | 31.160 | 80.760 | 447174 | 522874 | 19.0 | 0 | 100 | 0 | 0 |
| 2296 | 2296 | 32.262 | 80.450 | 569385 | 551004 | 11.0 | 5 | 90 | 5 | 0 |
| 1680 | 1680 | 31.000 | 80.747 | 429446 | 524185 | 24.0 | 0 | 100 | 0 | 0 |
| 2291 | 2291 | 31.678 | 81.022 | 504596 | 497946 | 8.0 | 0 | 92 | 8 | 0 |
| 1700 | 1700 | 30.833 | 80.497 | 411056 | 548136 | 33.0 | 0 | 100 | 0 | 0 |
| 1502 | 1502 | 30.312 | 80.977 | 353141 | 502243 | 21.0 | 0 | 100 | 0 | 0 |
| 1483 | 1483 | 32.333 | 80.225 | 577459 | 572939 | 13.0 | 0 | 100 | 0 | 0 |
| 1736 | 1736 | 30.390 | 80.090 | 362171 | 587436 | 319 | 0 | 76 | 9 | 14 |
| 1732 | 1732 | 30.147 | 79.725 | 335543 | 622797 | 802 | 0 | 19 | 40 | 40 |
| 1768 | 1768 | 31.897 | 78.492 | 531540 | 737229 | 534 | 0 | 99 | 1 | 0 |
| 2399 | 2399 | 32.177 | 78.767 | 562016 | 710572 | 423.0 | 0 | 0 | 0 | 0 |
| 2410 | 2410 | 32.323 | 79.740 | 576784 | 618601 | 40.0 | 10 | 90 | 0 | 0 |
| 2414 | 2414 | 30.267 | 79.918 | 348649 | 604050 | 510.0 | 25 | 66 | 9 | 0 |
| 2701 | 2701 | 31.800 | 79.200 | 519491 | 670404 | 542.0 | 0 | 0 | 0 | 0 |
| 1503A | 1503A | 30.330 | 81.250 | 355198 | 475968 | 12.0 | 0 | 94 | 1 | 3 |
| 1675 | 1675 | 32.225 | 80.325 | 565387 | 563603 | 14.0 | 0 | 100 | 0 | 0 |
| 1684 | 1684 | 30.330 | 80.737 | 355201 | 525314 | 35.0 | 0 | 100 | 0 | 0 |
| 1774 | 1774 | 32.333 | 79.000 | 578953 | 688245 | 85 | 2 | 96 | 2 | 0 |
| 2409 | 2409 | 32.350 | 79.760 | 579718 | 616604 | 38.0 | 11 | 89 | 0 | 0 |
| 1487 | 1487 | 31.850 | 80.460 | 523749 | 551090 | 18.0 | 0 | 100 | 0 | 0 |
| 2293 | 2293 | 31.868 | 80.873 | 525661 | 511982 | 9.0 | 0 | 94 | 6 | 0 |
| 2417 | 2417 | 30.313 | 80.537 | 353415 | 544547 | 41.0 | 2 | 98 | 0 | 0 |
| 2475 | 2475 | 30.683 | 79.523 | 395255 | 641446 | 900.0 | 78 | 21 | 0 | 0 |
| 1485 | 1485 | 31.980 | 80.247 | 538279 | 571174 | 21 | 0 | 99 | 1 | 0 |
| 1667 | 1667 | 31.840 | 80.192 | 522799 | 576486 | 22.0 | 0 | 100 | 0 | 0 |
| 1678 | 1678 | 31.340 | 80.772 | 467121 | 521721 | 22.0 | 0 | 100 | 0 | 0 |

| Key........... | SAMPLEID.. | LAT.... | LON.... | NORTH.. | EAST... | DEPTH | WTGRAV | WTSAND | WTSILT | WTCLAY |
|---|---|---|---|---|---|---|---|---|---|---|
| 1657B | 1657B | 30.667 | 80.000 | 392985 | 595801 | 244.0 | 0 | 0 | 0 | 0 |
| 1505 | 1505 | 30.165 | 81.213 | 336987 | 479458 | 15.0 | 0 | 100 | 0 | 0 |
| 1739 | 1739 | 30.518 | 79.693 | 376767 | 625373 | 639 | 0 | 100 | 0 | 0 |
| 1740 | 1740 | 30.597 | 79.332 | 385987 | 659950 | 802 | | | | |
| 2397 | 2397 | 31.995 | 78.257 | 542983 | 759186 | 651.0 | 0 | 100 | 0 | 0 |
| 2407 | 2407 | 32.403 | 79.810 | 585577 | 611913 | 32.0 | 0 | 100 | 0 | 0 |
| 2704 | 2704 | 31.800 | 79.200 | 519491 | 670404 | 555.0 | 0 | 0 | 0 | 0 |
| 1495 | 1495 | 30.992 | 81.225 | 428517 | 478518 | 16.0 | 0 | 100 | 0 | 0 |
| 1683 | 1683 | 30.497 | 80.733 | 373671 | 525591 | 32.0 | 0 | 100 | 0 | 0 |
| 1714 | 1714 | 30.010 | 80.257 | 319946 | 571688 | 86.0 | 0 | 100 | 0 | 0 |
| 1756 | 1756 | 31.830 | 79.510 | 522373 | 641008 | 69 | 0 | 97 | 3 | 0 |
| 1772 | 1772 | 32.175 | 78.750 | 561864 | 722148 | 406 | 0 | 70 | 16 | 13 |
| 1703 | 1703 | 31.350 | 80.492 | 468318 | 548351 | 28.0 | 0 | 100 | 0 | 0 |
| 2273U | 2273U | 31.703 | 81.173 | 507379 | 483575 | 11 | | | | |
| 2288 | 2288 | 31.242 | 81.187 | 456216 | 482224 | 10.0 | 0 | 100 | 0 | 0 |
| 2372 | 2372 | 30.017 | 79.000 | 322137 | 692887 | 798.0 | 0 | 98 | 2 | 0 |
| 1652 | 1652 | 30.152 | 79.447 | 336430 | 649599 | 769.0 | 0 | 0 | 0 | 0 |
| 1488C | 1488C | 31.842 | 80.750 | 522726 | 523655 | 17.0 | 0 | 0 | 0 | 0 |
| 2376 | 2376 | 30.513 | 78.500 | 378145 | 739911 | 806.0 | 0 | 100 | 0 | 0 |
| 2382 | 2382 | 31.027 | 78.313 | 435474 | 756464 | 851.0 | 0 | 100 | 0 | 0 |
| 2387 | 2387 | 31.253 | 78.983 | 459247 | 692035 | 546.0 | 0 | 0 | 0 | 0 |
| 1486B | 1486B | 31.970 | 80.500 | 537032 | 547244 | 18.0 | 0 | 0 | 0 | 0 |
| 1508B | 1508B | 30.000 | 81.250 | 318632 | 475888 | 19.0 | 0 | 0 | 0 | 0 |
| 1496 | 1496 | 30.835 | 81.223 | 411154 | 478642 | 15.0 | 0 | 100 | 0 | 0 |
| 1506 | 1506 | 30.167 | 81.020 | 337073 | 498074 | 21.0 | 0 | 99 | 1 | 0 |
| 1704 | 1704 | 31.513 | 80.500 | 486416 | 547477 | 24.0 | 0 | 100 | 0 | 0 |
| 1776 | 1776 | 32.362 | 79.447 | 581397 | 646152 | 36 | 0 | 100 | 0 | 0 |
| 2428 | 2428 | 30.367 | 81.213 | 359254 | 479500 | 22.0 | 0 | 100 | 0 | 0 |
| 2471 | 2471 | 30.067 | 79.678 | 326729 | 627395 | 894.0 | 8 | 11 | 37 | 42 |
| 2418 | 2418 | 30.330 | 80.703 | 355209 | 528519 | 33.0 | 0 | 100 | 0 | 0 |
| 2283 | 2283 | 30.643 | 81.405 | 389962 | 461192 | 8 | 8 | 90 | 2 | 0 |
| 1730B | 1730B | 30.088 | 80.070 | 328757 | 589621 | 374.0 | 0 | 0 | 0 | 0 |
| 1766 | 1766 | 31.817 | 79.003 | 521665 | 688992 | 450 | 0 | 99 | 1 | 0 |
| 1741 | 1741 | 30.655 | 79.175 | 392606 | 674868 | 792 | 0 | 97 | 3 | 0 |
| 1797 | 1797 | 32.475 | 78.000 | 596864 | 781956 | 324 | | | | |
| 2423 | 2423 | 30.363 | 81.025 | 358865 | 497598 | 24.0 | 0 | 100 | 0 | 0 |
| 2700 | 2700 | 31.300 | 78.883 | 464599 | 701460 | 542.0 | 0 | 0 | 0 | 0 |
| 1677 | 1677 | 31.948 | 80.620 | 534584 | 535914 | 17.0 | 0 | 100 | 0 | 0 |
| 1698 | 1698 | 30.492 | 80.478 | 373202 | 550065 | 35.0 | 0 | 100 | 0 | 0 |
| 1708 | 1708 | 31.000 | 80.250 | 429659 | 571602 | 36.0 | 0 | 100 | 0 | 0 |
| 1751 | 1751 | 31.498 | 79.770 | 485301 | 616815 | 64 | 0 | 99 | 1 | 0 |
| 2273 | 2273 | 31.709 | 81.129 | 508021 | 487793 | 13 | 0 | 100 | 0 | 0 |
| 2294 | 2294 | 31.972 | 80.752 | 537135 | 523464 | 10.0 | 26 | 74 | 0 | 0 |
| 1662 | 1662 | 31.513 | 80.020 | 486724 | 593056 | 41.0 | 0 | 100 | 0 | 0 |
| 1761 | 1761 | 32.177 | 79.258 | 561160 | 664208 | 54 | 0 | 100 | 0 | 0 |
| 2406 | 2406 | 32.430 | 79.847 | 588496 | 608432 | 27.0 | 0 | 100 | 0 | 0 |
| 1651 | 1651 | 30.043 | 79.333 | 324577 | 660691 | 792.0 | 0 | 0 | 0 | 0 |
| 1744 | 1744 | 30.843 | 79.575 | 412925 | 636271 | 787 | 8 | 81 | 10 | 0 |
| 1749 | 1749 | 31.342 | 79.475 | 468288 | 645075 | 484 | | | | |
| 1499 | 1499 | 30.660 | 81.228 | 391762 | 478125 | 19.0 | 0 | 100 | 0 | 0 |
| 1676 | 1676 | 32.127 | 80.473 | 554410 | 549680 | 14.0 | 0 | 100 | 0 | 0 |
| 1702 | 1702 | 31.187 | 80.533 | 450199 | 544465 | 31.0 | 0 | 100 | 0 | 0 |
| 2266 | 2266 | 32.495 | 80.495 | 595228 | 547443 | 12 | 1 | 99 | 0 | 0 |
| 2297 | 2297 | 32.467 | 80.222 | 592242 | 573145 | 11.0 | 0 | 100 | 0 | 0 |
| 1750 | 1750 | 31.303 | 79.763 | 463694 | 617691 | 144 | 0 | 76 | 16 | 7 |
| 1775 | 1775 | 32.330 | 79.275 | 578133 | 662363 | 44 | 0 | 99 | 1 | 0 |
| 1738 | 1738 | 30.520 | 79.867 | 376772 | 608738 | 480 | 0 | 96 | 4 | 0 |
| 1765 | 1765 | 31.762 | 79.108 | 515389 | 679157 | 550 | 0 | 95 | 5 | 0 |
| 2386 | 2386 | 31.003 | 79.000 | 431504 | 690948 | 782.0 | 0 | 99 | 1 | 0 |

| Key........... | SAMPLEID.. | LAT.... | LON.... | NORTH.. | EAST... | DEPTH | WTGRAV | WTSAND | WTSILT | WTCLAY |
|---|---|---|---|---|---|---|---|---|---|---|
| 2412 | 2412 | 30.517 | 80.117 | 376189 | 584754 | 43.0 | 5 | 95 | 0 | 0 |
| 1655 | 1655 | 30.668 | 79.483 | 393644 | 645300 | 797.0 | 0 | 22 | 38 | 39 |
| 2277B | 2277B | 32.320 | 81.304 | 464922 | 471059 | 6 | 0 | 100 | 0 | 0 |
| 2277C | 2277C | 32.320 | 81.304 | 464922 | 471059 | 6 | 0 | 100 | 0 | 0 |
| 2422 | 2422 | 30.357 | 80.978 | 358127 | 502083 | 24.0 | 0 | 100 | 0 | 0 |
| 2287 | 2287 | 31.003 | 81.438 | 429869 | 458155 | 6 | 0 | 73 | 10 | 16 |
| 2375 | 2375 | 30.805 | 78.750 | 409973 | 715265 | 949.0 | 0 | 0 | 0 | 0 |
| 2708 | 2708 | 31.800 | 79.250 | 519414 | 665670 | 546.0 | 0 | 0 | 0 | 0 |
| 1488B | 1488B | 31.842 | 80.750 | 522726 | 523655 | 17.0 | 0 | 0 | 0 | 0 |
| 1500A | 1500A | 30.000 | 81.250 | 318632 | 475808 | 19.0 | 0 | 98 | 2 | 0 |
| 1697 | 1697 | 30.340 | 80.500 | 356386 | 548060 | 36.0 | 0 | 100 | 0 | 0 |
| 1707 | 1707 | 31.157 | 80.210 | 447049 | 575297 | 36.0 | 0 | 100 | 0 | 0 |
| 1754 | 1754 | 31.657 | 79.753 | 502870 | 618198 | 46 | 0 | 100 | 0 | 0 |
| 2272 | 2272 | 31.903 | 81.175 | 529547 | 483453 | 7 | 1 | 98 | 1 | 0 |
| 2276 | 2276 | 31.404 | 81.304 | 474195 | 471132 | 8 | 0 | 71 | 10 | 18 |
| 1730A | 1730A | 30.088 | 80.070 | 328757 | 589621 | 374.0 | 0 | 66 | 18 | 15 |
| 2282 | 2282 | 30.812 | 81.368 | 400605 | 464767 | 8 | 0 | 958 | 5 | 0 |
| 2381 | 2381 | 31.070 | 78.142 | 440688 | 772733 | 849.0 | 0 | 100 | 0 | 0 |
| 1734 | 1734 | 30.340 | 79.733 | 356960 | 621756 | 664 | 0 | 34 | 36 | 29 |
| 2703 | 2703 | 31.800 | 79.200 | 519491 | 670404 | 556.0 | 0 | 0 | 0 | 0 |
| 1484 | 1484 | 32.160 | 80.268 | 558217 | 568992 | 15 | 0 | 100 | 0 | 0 |
| 1486A | 1486A | 31.970 | 80.500 | 537032 | 547244 | 18.0 | 0 | 99 | 1 | 0 |
| 1494 | 1494 | 30.992 | 80.997 | 428495 | 500318 | 19.0 | 0 | 100 | 0 | 0 |
| 1504 | 1504 | 30.255 | 81.327 | 346906 | 468574 | 15.0 | 0 | 100 | 0 | 0 |
| 1661 | 1661 | 31.327 | 80.007 | 466047 | 594509 | 41.0 | 0 | 100 | 0 | 0 |
| 1666 | 1666 | 31.850 | 80.342 | 523811 | 562286 | 20.0 | 0 | 100 | 0 | 0 |
| 1672 | 1672 | 32.298 | 79.583 | 574197 | 633386 | 25.0 | 0 | 100 | 0 | 0 |
| 1682 | 1682 | 30.667 | 80.787 | 392498 | 520437 | 26.0 | 0 | 100 | 0 | 0 |
| 1713 | 1713 | 30.177 | 80.245 | 338422 | 572691 | 77.0 | 0 | 99 | 1 | 0 |
| 1755 | 1755 | 31.832 | 79.757 | 522264 | 617660 | 40 | 0 | 100 | 0 | 0 |
| 1759 | 1759 | 32.082 | 79.638 | 550111 | 628511 | 35 | 0 | 100 | 0 | 0 |
| 1760 | 1760 | 32.167 | 79.500 | 559697 | 640651 | 36 | 0 | 100 | 0 | 0 |
| 1771 | 1771 | 32.162 | 79.012 | 559900 | 687499 | 181 | 0 | 42 | 42 | 15 |
| 2271 | 2271 | 31.842 | 81.065 | 522701 | 493850 | 9 | 2 | 94 | 4 | 0 |
| 1769 | 1769 | 31.985 | 78.750 | 540797 | 712588 | 386 | | | | |
| 1770 | 1770 | 32.003 | 79.000 | 542351 | 688138 | 406 | 0 | 70 | 16 | 13 |
| 2385 | 2385 | 30.953 | 78.910 | 426119 | 699646 | 802.0 | 0 | 100 | 0 | 0 |
| 2479 | 2479 | 31.383 | 79.150 | 473380 | 675920 | 491.0 | 26 | 73 | 0 | 0 |
| 2480 | 2480 | 31.598 | 79.070 | 497345 | 683109 | 501.0 | 0 | 0 | 0 | 0 |
| 2391 | 2391 | 31.403 | 78.303 | 477262 | 756400 | 621.0 | 0 | 0 | 0 | 0 |
| 1489 | 1489 | 31.683 | 80.750 | 505177 | 523695 | 17.0 | 0 | 100 | 0 | 0 |
| 1490 | 1490 | 31.490 | 80.767 | 483746 | 522161 | 20.0 | 0 | 100 | 0 | 0 |
| 1656 | 1656 | 30.672 | 79.737 | 393714 | 621024 | 579.0 | 0 | 97 | 3 | 0 |
| 1657A | 1657A | 30.667 | 80.000 | 392905 | 595801 | 244.0 | 0 | 99 | 1 | 0 |
| 1671 | 1671 | 32.167 | 79.760 | 559395 | 616919 | 27.0 | 0 | 100 | 0 | 0 |
| 2292 | 2292 | 31.765 | 80.890 | 514207 | 510417 | 13.0 | 0 | 100 | 0 | 0 |
| 2416 | 2416 | 30.275 | 80.312 | 349278 | 566206 | 55.0 | 3 | 97 | 0 | 0 |
| 2427 | 2427 | 30.367 | 81.173 | 359248 | 483344 | 22.0 | 11 | 89 | 0 | 0 |
| 2286 | 2286 | 30.722 | 81.487 | 398675 | 453404 | 7 | 0 | 38 | 21 | 40 |
| 1500 | 1500 | 30.493 | 81.255 | 373298 | 475528 | 17.0 | 0 | 100 | 0 | 0 |
| 1748 | 1748 | 31.190 | 79.475 | 451476 | 645307 | 524 | 0 | 95 | 5 | 0 |
| 2378 | 2378 | 30.442 | 78.100 | 371119 | 778515 | 829.0 | 0 | 78 | 15 | 6 |
| 2415 | 2415 | 30.300 | 80.128 | 352169 | 583820 | 217.0 | 0 | 88 | 8 | 3 |
| 2707 | 2707 | 31.800 | 79.250 | 519414 | 665670 | 505.0 | 0 | 0 | 0 | 0 |
| 1481 | 1481 | 32.333 | 79.768 | 577861 | 615921 | 25 | 0 | 100 | 0 | 0 |
| 2392 | 2392 | 31.483 | 78.000 | 486882 | 785009 | 649.0 | 1 | 99 | 0 | 0 |
| 2413 | 2413 | 30.247 | 79.740 | 346609 | 621230 | 640.0 | 33 | 61 | 5 | 0 |
| 1735 | 1735 | 30.355 | 79.887 | 358467 | 606999 | 534 | 12 | 55 | 19 | 13 |
| 1762 | 1762 | 31.987 | 79.252 | 540106 | 665178 | 105 | 0 | 89 | 6 | 4 |

| Key........... | SAMPLEID.. | LAT.... | LON.... | NORTH.. | EAST... | DEPTH | WTGRAV | WTSAND | WTSILT | WTCLAY |
|---|---|---|---|---|---|---|---|---|---|---|
| 15030 | 15030 | 30.330 | 81.250 | 355198 | 475968 | 12.0 | 0 | 0 | 0 | 0 |
| 2425 | 2425 | 30.373 | 81.102 | 359977 | 490231 | 22.0 | 0 | 100 | 0 | 0 |
| 1686 | 1686 | 30.000 | 80.758 | 318630 | 523341 | 36.0 | 0 | 100 | 0 | 0 |
| 1699 | 1699 | 30.667 | 80.497 | 392587 | 548219 | 38.0 | 0 | 100 | 0 | 0 |
| 1709 | 1709 | 30.833 | 80.255 | 411185 | 571248 | 37.0 | 0 | 100 | 0 | 0 |
| 1710 | 1710 | 30.675 | 80.225 | 393658 | 574239 | 42.0 | 0 | 100 | 0 | 0 |
| 2274 | 2274 | 31.543 | 81.193 | 489649 | 481696 | 12 | 1 | 95 | 4 | 0 |
| 2481 | 2481 | 31.680 | 78.800 | 506884 | 708548 | 543.0 | 0 | 0 | 0 | 0 |
| 1480 | 1480 | 32.493 | 79.763 | 595604 | 616187 | 20.0 | 0 | 100 | 0 | 0 |
| 1491 | 1491 | 31.512 | 80.988 | 486124 | 501108 | 13.0 | 0 | 100 | 0 | 0 |
| 1501 | 1501 | 30.483 | 81.000 | 372162 | 500000 | 26.0 | 0 | 99 | 1 | 0 |
| 1745 | 1745 | 30.863 | 79.728 | 414964 | 621581 | 461 | 21 | 78 | 0 | 0 |
| 1493 | 1493 | 31.155 | 81.012 | 446596 | 498888 | 14.0 | 0 | 100 | 0 | 0 |
| 1479 | 1479 | 32.493 | 79.502 | 595919 | 640772 | 20.0 | 0 | 100 | 0 | 0 |

250 Records Processed

| Key............ | SAMPLEID.. | QUARTZ | KFELDSPAR | PFELDSPAR | HEAVYS | PHOSPHORITE |
|---|---|---|---|---|---|---|
| 1649 | 1649 | | | | | |
| 1650 | 1650 | | | | | |
| 1733 | 1733 | | | | | |
| 2279 | 2279 | | | | | |
| 2280 | 2280 | | | | | |
| 2284 | 2284 | | | | | |
| 2419 | 2419 | | | | | |
| 2420 | 2420 | | | | | |
| 1498 | 1498 | 92 | 3 | 3 | 0 | 0 |
| 1663 | 1663 | 92 | 4 | 2 | 0 | 0 |
| 1681 | 1681 | 95 | 3 | 0 | 1 | 0 |
| 1696 | 1696 | 86 | 5 | 2 | 2 | 3 |
| 1706 | 1706 | 80 | 3 | 4 | 2 | 0 |
| 1743 | 1743 | | | | | |
| 1752 | 1752 | | | | | |
| 2373 | 2373 | | | | | |
| 2472 | 2472 | | | | | |
| 2702 | 2702 | | | | | |
| 1668 | 1668 | 89 | 5 | 2 | 4 | 0 |
| 2277A | 2277A | 87 | 4 | 2 | 0 | 0 |
| 1653 | 1653 | | | | | |
| 1742 | 1742 | | | | | |
| 2374 | 2374 | | | | | |
| 2405 | 2405 | | | | | |
| 2411 | 2411 | | | | | |
| 2421 | 2421 | | | | | |
| 2476 | 2476 | | | | | |
| 2706B | 2706B | | | | | |
| 1488A | 1488A | 87 | 2 | 6 | 4 | 0 |
| 1658 | 1658 | 93 | 3 | 1 | 1 | 0 |
| 1695 | 1695 | 86 | 5 | 3 | 2 | 0 |
| 1705 | 1705 | 89 | 5 | 3 | 2 | 0 |
| 1711 | 1711 | 89 | 4 | 4 | 2 | 0 |
| 1747 | 1747 | 19 | 3 | 2 | 0 | 0 |
| 1757 | 1757 | 84 | 7 | 5 | 2 | 0 |
| 2269 | 2269 | 87 | 6 | 3 | 3 | 0 |
| 2275 | 2275 | 88 | 7 | 3 | 0 | 0 |
| 1664 | 1664 | 89 | 4 | 5 | 1 | 0 |
| 2270 | 2270 | 67 | 9 | 2 | 5 | 6 |
| 1654 | 1654 | | | | | |
| 2278 | 2278 | | | | | |
| 2377 | 2377 | | | | | |
| 2383 | 2383 | | | | | |
| 2424 | 2424 | | | | | |
| 2474A | 2474A | | | | | |
| 2482 | 2482 | | | | | |
| 1497 | 1497 | 92 | 3 | 5 | 0 | 0 |
| 1685 | 1685 | 92 | 1 | 3 | 3 | 0 |
| 1701 | 1701 | 90 | 3 | 5 | 1 | 0 |
| 1737 | 1737 | 28 | 3 | 2 | 0 | 0 |
| 2429 | 2429 | 89 | 6 | 3 | 0 | 0 |
| 2265 | 2265 | 94 | 4 | 2 | 0 | 0 |
| 1753 | 1753 | 72 | 5 | 8 | 0 | 0 |
| 1731 | 1731 | | | | | |
| 2379 | 2379 | | | | | |
| 2380 | 2380 | | | | | |
| 2426 | 2426 | | | | | |
| 2473 | 2473 | | | | | |
| 2477 | 2477 | | | | | |

| Key............ | SAMPLEID.. | QUARTZ | KFELDSPAR | PFELDSPAR | HEAVYS | PHOSPHORITE |
|---|---|---|---|---|---|---|
| 2478 | 2478 | | | | | |
| 1665 | 1665 | 89 | 4 | 5 | 1 | 0 |
| 1674 | 1674 | 87 | 8 | 4 | 4 | 0 |
| 1763 | 1763 | 74 | 5 | 13 | 0 | 0 |
| 2295 | 2295 | 88 | 6 | 5 | 0 | 0 |
| 1773 | 1773 | 45 | 3 | 1 | 0 | 0 |
| 1767 | 1767 | | | | | |
| 2281 | 2281 | | | | | |
| 2285 | 2285 | | | | | |
| 2289 | 2289 | | | | | |
| 2290 | 2290 | | | | | |
| 2384 | 2384 | | | | | |
| 2388 | 2388 | | | | | |
| 2398 | 2398 | | | | | |
| 2408 | 2408 | | | | | |
| 2474B | 2474B | | | | | |
| 2483 | 2483 | | | | | |
| 1482 | 1482 | 91 | 2 | 5 | 1 | 0 |
| 1660 | 1660 | 88 | 5 | 5 | 1 | 0 |
| 1669 | 1669 | 90 | 4 | 3 | 2 | 0 |
| 1670 | 1670 | 92 | 3 | 2 | 2 | 0 |
| 1712 | 1712 | 85 | 5 | 3 | 6 | 0 |
| 1659 | 1659 | 90 | 5 | 3 | 0 | 0 |
| 1758 | 1758 | 84 | 6 | 5 | 3 | 0 |
| 1746 | 1746 | | | | | |
| 1764 | 1764 | | | | | |
| 2268 | 2268 | | | | | |
| 2389 | 2389 | | | | | |
| 2390 | 2390 | | | | | |
| 2404 | 2404 | | | | | |
| 2705 | 2705 | | | | | |
| 2706A | 2706A | | | | | |
| 1492 | 1492 | 91 | 3 | 3 | 2 | 0 |
| 1679 | 1679 | 92 | 3 | 2 | 2 | 0 |
| 2296 | 2296 | 82 | 10 | 5 | 2 | 0 |
| 1680 | 1680 | 92 | 5 | 2 | 0 | 0 |
| 2291 | 2291 | | | | | |
| 1700 | 1700 | 90 | 3 | 3 | 2 | 0 |
| 1502 | 1502 | 91 | 5 | 4 | 0 | 0 |
| 1483 | 1483 | 86 | 5 | 8 | 0 | 0 |
| 1736 | 1736 | | | | | |
| 1732 | 1732 | | | | | |
| 1768 | 1768 | | | | | |
| 2399 | 2399 | | | | | |
| 2410 | 2410 | | | | | |
| 2414 | 2414 | | | | | |
| 2701 | 2701 | | | | | |
| 1503A | 1503A | 92 | 5 | 2 | 0 | 0 |
| 1675 | 1675 | 91 | 2 | 4 | 2 | 0 |
| 1684 | 1684 | 94 | 3 | 2 | 1 | 0 |
| 1774 | 1774 | 78 | 5 | 3 | 0 | 0 |
| 2409 | 2409 | 87 | 8 | 4 | 0 | 0 |
| 1487 | 1487 | 88 | 5 | 5 | 1 | 0 |
| 2293 | 2293 | | | | | |
| 2417 | 2417 | | | | | |
| 2475 | 2475 | | | | | |
| 1485 | 1485 | 94 | 4 | 2 | 0 | 0 |
| 1667 | 1667 | 92 | 2 | 2 | 3 | 0 |
| 1678 | 1678 | 95 | 3 | 1 | 0 | 0 |

| Key............ | SAMPLEID.. | QUARTZ | KFELDSPAR | PFELDSPAR | HEAVYS | PHOSPHORITE |
|---|---|---|---|---|---|---|
| 1657B | 1657B | | | | | |
| 1505 | 1505 | | | | | |
| 1739 | 1739 | | | | | |
| 1740 | 1740 | | | | | |
| 2397 | 2397 | | | | | |
| 2407 | 2407 | | | | | |
| 2704 | 2704 | | | | | |
| 1495 | 1495 | 89 | 6 | 4 | 0 | 0 |
| 1683 | 1683 | 89 | 4 | 4 | 1 | 0 |
| 1714 | 1714 | 95 | 2 | 2 | 0 | 0 |
| 1756 | 1756 | 82 | 8 | 6 | 1 | 0 |
| 1772 | 1772 | 43 | 6 | 4 | 0 | 0 |
| 1703 | 1703 | 90 | 5 | 3 | 1 | 0 |
| 2273U | 2273U | | | | | |
| 2288 | 2288 | | | | | |
| 2372 | 2372 | | | | | |
| 1652 | 1652 | | | | | |
| 1488C | 1488C | | | | | |
| 2376 | 2376 | | | | | |
| 2382 | 2382 | | | | | |
| 2387 | 2387 | | | | | |
| 1486B | 1486B | 85 | 8 | 5 | 1 | 0 |
| 1500B | 1500B | 88 | 6 | 4 | 0 | 0 |
| 1496 | 1496 | 89 | 8 | 2 | 0 | 0 |
| 1506 | 1506 | 91 | 4 | 4 | 0 | 0 |
| 1704 | 1704 | 87 | 3 | 5 | 4 | 0 |
| 1776 | 1776 | 85 | 6 | 1 | 7 | 0 |
| 2428 | 2428 | 92 | 3 | 2 | 2 | 0 |
| 2471 | 2471 | 69 | 23 | 4 | 0 | 0 |
| 2418 | 2418 | | | | | |
| 2283 | 2283 | | | | | |
| 1730B | 1730B | | | | | |
| 1766 | 1766 | | | | | |
| 1741 | 1741 | | | | | |
| 1797 | 1797 | | | | | |
| 2423 | 2423 | | | | | |
| 2700 | 2700 | | | | | |
| 1677 | 1677 | 90 | 3 | 2 | 4 | 0 |
| 1698 | 1698 | 91 | 5 | 3 | 0 | 0 |
| 1700 | 1700 | 91 | 4 | 3 | 1 | 0 |
| 1751 | 1751 | 91 | 4 | 4 | 0 | 0 |
| 2273 | 2273 | 88 | 6 | 5 | 0 | 0 |
| 2294 | 2294 | 88 | 4 | 5 | 2 | 0 |
| 1662 | 1662 | 86 | 4 | 5 | 1 | 0 |
| 1761 | 1761 | 85 | 6 | 6 | 1 | 0 |
| 2406 | 2406 | | | | | |
| 1651 | 1651 | | | | | |
| 1744 | 1744 | | | | | |
| 1749 | 1749 | | | | | |
| 1499 | 1499 | 88 | 7 | 4 | 0 | 0 |
| 1676 | 1676 | 91 | 4 | 2 | 2 | 0 |
| 1702 | 1702 | 93 | 3 | 1 | 2 | 0 |
| 2266 | 2266 | 93 | 2 | 1 | 3 | 0 |
| 2297 | 2297 | 84 | 8 | 5 | 1 | 0 |
| 1750 | 1750 | 83 | 6 | 7 | 0 | 0 |
| 1775 | 1775 | 84 | 8 | 6 | 0 | 0 |
| 1738 | 1738 | | | | | |
| 1765 | 1765 | | | | | |
| 2386 | 2386 | | | | | |

| Key............ | SAMPLEID.. | QUARTZ | KFELDSPAR | PFELDSPAR | HEAVYS | PHOSPHORITE |
|---|---|---|---|---|---|---|
| 2412 | 2412 | | | | | |
| 1655 | 1655 | | | | | |
| 2277B | 2277B | | | | | |
| 2277C | 2277C | | | | | |
| 2422 | 2422 | | | | | |
| 2287 | 2287 | | | | | |
| 2375 | 2375 | | | | | |
| 2708 | 2708 | | | | | |
| 1488B | 1488B | 84 | 7 | 6 | 1 | 0 |
| 1508A | 1508A | 91 | 3 | 4 | 2 | 0 |
| 1697 | 1697 | 91 | 4 | 2 | 0 | 0 |
| 1707 | 1707 | 93 | 3 | 1 | 2 | 0 |
| 1754 | 1754 | 88 | 5 | 5 | 0 | 0 |
| 2272 | 2272 | 90 | 5 | 4 | 0 | 0 |
| 2276 | 2276 | 80 | 9 | 8 | 1 | 0 |
| 1730A | 1730A | | | | | |
| 2282 | 2282 | | | | | |
| 2381 | 2381 | | | | | |
| 1734 | 1734 | | | | | |
| 2703 | 2703 | | | | | |
| 1484 | 1484 | 90 | 4 | 4 | 1 | 0 |
| 1486A | 1486A | 84 | 7 | 8 | 0 | 0 |
| 1494 | 1494 | 89 | 6 | 2 | 1 | 0 |
| 1504 | 1504 | 89 | 7 | 3 | 1 | 0 |
| 1661 | 1661 | 90 | 4 | 4 | 0 | 0 |
| 1666 | 1666 | 91 | 4 | 4 | 0 | 0 |
| 1672 | 1672 | 87 | 6 | 3 | 3 | 0 |
| 1682 | 1682 | 96 | 2 | 0 | 1 | 0 |
| 1713 | 1713 | 93 | 3 | 2 | 1 | 0 |
| 1755 | 1755 | 90 | 4 | 3 | 2 | 0 |
| 1759 | 1759 | 90 | 6 | 2 | 1 | 0 |
| 1760 | 1760 | 82 | 6 | 5 | 2 | 0 |
| 1771 | 1771 | 67 | 14 | 7 | 0 | 0 |
| 2271 | 2271 | | | | | |
| 1769 | 1769 | | | | | |
| 1770 | 1770 | | | | | |
| 2385 | 2385 | | | | | |
| 2479 | 2479 | | | | | |
| 2480 | 2480 | | | | | |
| 2391 | 2391 | | | | | |
| 1489 | 1489 | 86 | 6 | 4 | 1 | 0 |
| 1490 | 1490 | 89 | 5 | 5 | 0 | 0 |
| 1656 | 1656 | 34 | 5 | 2 | 0 | 0 |
| 1657A | 1657A | 12 | 1 | 0 | 0 | 0 |
| 1671 | 1671 | 87 | 5 | 4 | 3 | 0 |
| 2292 | 2292 | 87 | 7 | 5 | 1 | 0 |
| 2416 | 2416 | 80 | 5 | 3 | 1 | 0 |
| 2427 | 2427 | 93 | 2 | 3 | 1 | 0 |
| 2286 | 2286 | | | | | |
| 1500 | 1500 | 94 | 3 | 3 | 0 | 0 |
| 1748 | 1748 | | | | | |
| 2378 | 2378 | | | | | |
| 2415 | 2415 | | | | | |
| 2707 | 2707 | | | | | |
| 1481 | 1481 | 83 | 6 | 7 | 2 | 0 |
| 2392 | 2392 | | | | | |
| 2413 | 2413 | | | | | |
| 1735 | 1735 | 63 | 6 | 7 | 0 | 0 |
| 1762 | 1762 | 77 | 7 | 6 | 0 | 0 |

| Key........... | SAMPLEID.. | QUARTZ | KFELDSPAR | PFELDSPAR | HEAVYS | PHOSPHORITE |
|---|---|---|---|---|---|---|
| 15038 | 15038 | | | | | |
| 2425 | 2425 | | | | | |
| 1686 | 1686 | 94 | 1 | 0 | 3 | 0 |
| 1699 | 1699 | 89 | 4 | 4 | 2 | 0 |
| 1709 | 1709 | 95 | 3 | 1 | 0 | 0 |
| 1710 | 1710 | 95 | 2 | 2 | 0 | 0 |
| 2274 | 2274 | 88 | 6 | 4 | 1 | 0 |
| 2481 | 2481 | | | | | |
| 1480 | 1480 | 85 | 6 | 5 | 1 | 0 |
| 1491 | 1491 | 92 | 3 | 3 | 0 | 0 |
| 1501 | 1501 | 94 | 2 | 3 | 0 | 0 |
| 1745 | 1745 | 11 | 1 | 1 | 0 | 0 |
| 1493 | 1493 | 93 | 3 | 1 | 1 | 0 |
| 1479 | 1479 | 8888 | 6 | 5 | 0 | 0 |

250 Records Processed

| Key............ | SAMPLEID.. | MAGNETITE | APATITE | MONAZITE | RUTILE | ZIRCON | SILLIMANITE | KYANITE | STAUROLITE | LEUCOXENE | TITANITE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1649 | 1649 | | | | | | | | | | |
| 1650 | 1650 | | | | | | | | | | |
| 1733 | 1733 | | | | | | | | | | |
| 2279 | 2279 | | | | | | | | | | |
| 2280 | 2280 | | | | | | | | | | |
| 2284 | 2284 | | | | | | | | | | |
| 2419 | 2419 | | | | | | | | | | |
| 2420 | 2420 | | | | | | | | | | |
| 1498 | 1498 | | | | | | | | | | |
| 1663 | 1663 | | | | | | | | | | |
| 1681 | 1681 | | | | | | | | | | |
| 1696 | 1696 | | | | | | | | | | |
| 1706 | 1706 | | | | | | | | | | |
| 1743 | 1743 | | | | | | | | | | |
| 1752 | 1752 | | | | | | | | | | |
| 2373 | 2373 | | | | | | | | | | |
| 2472 | 2472 | | | | | | | | | | |
| 2702 | 2702 | | | | | | | | | | |
| 1668 | 1668 | | | | | | | | | | |
| 2277A | 2277A | | 0 | 0 | 6 | 6 | 1 | 2 | 1 | | 3 |
| 1653 | 1653 | | | | | | | | | | |
| 1742 | 1742 | | | | | | | | | | |
| 2374 | 2374 | | | | | | | | | | |
| 2405 | 2405 | | | | | | | | | | |
| 2411 | 2411 | | | | | | | | | | |
| 2421 | 2421 | | | | | | | | | | |
| 2476 | 2476 | | | | | | | | | | |
| 2706B | 2706B | | | | | | | | | | |
| 1488A | 1488A | | | | | | | | | | |
| 1658 | 1658 | | | | | | | | | | |
| 1695 | 1695 | | | | | | | | | | |
| 1705 | 1705 | | | | | | | | | | |
| 1711 | 1711 | | | | | | | | | | |
| 1747 | 1747 | | | | | | | | | | |
| 1757 | 1757 | | | | | | | | | | |
| 2269 | 2269 | | | | | | | | | | |
| 2275 | 2275 | | | | | | | | | | |
| 1664 | 1664 | | 0 | 2 | 3 | 2 | | 0 | 0 | | 1 |
| 2270 | 2270 | | 0 | 0 | 2 | 10 | | 1 | 0 | | 0 |
| 1654 | 1654 | | | | | | | | | | |
| 2278 | 2278 | | | | | | | | | | |
| 2377 | 2377 | | | | | | | | | | |
| 2383 | 2383 | | | | | | | | | | |
| 2424 | 2424 | | | | | | | | | | |
| 2474A | 2474A | | | | | | | | | | |
| 2482 | 2482 | | | | | | | | | | |
| 1497 | 1497 | | | | | | | | | | |
| 1685 | 1685 | | | | | | | | | | |
| 1701 | 1701 | | | | | | | | | | |
| 1737 | 1737 | | | | | | | | | | |
| 2429 | 2429 | | | | | | | | | | |
| 2265 | 2265 | | 0 | 0 | 8 | 5 | | 0 | 1 | | 0 |
| 1753 | 1753 | | 0 | 0 | 1 | 2 | | 1 | 0 | | 0 |
| 1731 | 1731 | | | | | | | | | | |
| 2379 | 2379 | | | | | | | | | | |
| 2380 | 2380 | | | | | | | | | | |
| 2426 | 2426 | | | | | | | | | | |
| 2473 | 2473 | | | | | | | | | | |
| 2477 | 2477 | | | | | | | | | | |

| Key........... | SAMPLEID.. | MAGNETITE | APATITE | MONAZITE | RUTILE | ZIRCON | SILLIMANITE | KYANITE | STAUROLITE | LEUCOXENE | TITANITE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2478 | 2478 | | | | | | | | | | |
| 1665 | 1665 | | | | | | | | | | |
| 1674 | 1674 | | | | | | | | | | |
| 1763 | 1763 | | | | | | | | | | |
| 2295 | 2295 | | | | | | | | | | |
| 1773 | 1773 | | 0 | 0 | 4 | 6 | | 2 | 0 | | 1 |
| 1767 | 1767 | | | | | | | | | | |
| 2281 | 2281 | | | | | | | | | | |
| 2285 | 2285 | | | | | | | | | | |
| 2289 | 2289 | | | | | | | | | | |
| 2290 | 2290 | | | | | | | | | | |
| 2384 | 2384 | | | | | | | | | | |
| 2388 | 2388 | | | | | | | | | | |
| 2398 | 2398 | | | | | | | | | | |
| 2408 | 2408 | | | | | | | | | | |
| 2474B | 2474B | | | | | | | | | | |
| 2483 | 2483 | | | | | | | | | | |
| 1482 | 1482 | | | | | | | | | | |
| 1660 | 1660 | | | | | | | | | | |
| 1669 | 1669 | | | | | | | | | | |
| 1670 | 1670 | | | | | | | | | | |
| 1712 | 1712 | | | | | | | | | | |
| 1659 | 1659 | | 0 | 1 | 4 | 2 | | 2 | 0 | | 1 |
| 1758 | 1758 | | 0 | 2 | 4 | 13 | | 1 | 1 | | 3 |
| 1746 | 1746 | | | | | | | | | | |
| 1764 | 1764 | | | | | | | | | | |
| 2268 | 2268 | | | | | | | | | | |
| 2389 | 2389 | | | | | | | | | | |
| 2390 | 2390 | | | | | | | | | | |
| 2404 | 2404 | | | | | | | | | | |
| 2705 | 2705 | | | | | | | | | | |
| 2706A | 2706A | | | | | | | | | | |
| 1492 | 1492 | | | | | | | | | | |
| 1679 | 1679 | | | | | | | | | | |
| 2296 | 2296 | | | | | | | | | | |
| 1680 | 1680 | | 0 | 1 | 5 | 4 | | 0 | 1 | | 0 |
| 2291 | 2291 | | 0 | 0 | 2 | 1 | | 0 | 1 | | 0 |
| 1700 | 1700 | | 0 | 3 | 9 | 5 | | 2 | 0 | | 1 |
| 1502 | 1502 | | 0 | 5 | 2 | 8 | | 2 | 0 | | 1 |
| 1483 | 1483 | | 0 | 0 | 0 | 7 | | 0 | 0 | | 1 |
| 1736 | 1736 | | | | | | | | | | |
| 1732 | 1732 | | | | | | | | | | |
| 1768 | 1768 | | | | | | | | | | |
| 2399 | 2399 | | | | | | | | | | |
| 2410 | 2410 | | | | | | | | | | |
| 2414 | 2414 | | | | | | | | | | |
| 2701 | 2701 | | | | | | | | | | |
| 1503A | 1503A | | | | | | | | | | |
| 1675 | 1675 | | | | | | | | | | |
| 1684 | 1684 | | | | | | | | | | |
| 1774 | 1774 | | | | | | | | | | |
| 2409 | 2409 | | | | | | | | | | |
| 1487 | 1487 | | 0 | 0 | 5 | 5 | | 0 | 1 | | 1 |
| 2293 | 2293 | | | | | | | | | | |
| 2417 | 2417 | | | | | | | | | | |
| 2475 | 2475 | | | | | | | | | | |
| 1485 | 1485 | | | | | | | | | | |
| 1667 | 1667 | | | | | | | | | | |
| 1678 | 1678 | | | | | | | | | | |

| Key........... | SAMPLEID.. | MAGNETITE | APATITE | MONAZITE | RUTILE | ZIRCON | SILLIMANITE | KYANITE | STAUROLITE | LEUCOXENE | TITANITE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1657B | 1657B | | | | | | | | | | |
| 1505 | 1505 | | | | | | | | | | |
| 1739 | 1739 | | | | | | | | | | |
| 1740 | 1740 | | | | | | | | | | |
| 2397 | 2397 | | | | | | | | | | |
| 2407 | 2407 | | | | | | | | | | |
| 2704 | 2704 | | | | | | | | | | |
| 1495 | 1495 | | | | | | | | | | |
| 1683 | 1683 | | | | | | | | | | |
| 1714 | 1714 | | | | | | | | | | |
| 1756 | 1756 | | | | | | | | | | |
| 1772 | 1772 | | | | | | | | | | |
| 1703 | 1703 | | 0 | 1 | 3 | 4 | | 0 | 0 | | 1 |
| 2273U | 2273U | | | | | | | | | | |
| 2288 | 2288 | | | | | | | | | | |
| 2372 | 2372 | | | | | | | | | | |
| 1652 | 1652 | | | | | | | | | | |
| 1488C | 1488C | | | | | | | | | | |
| 2376 | 2376 | | | | | | | | | | |
| 2382 | 2382 | | | | | | | | | | |
| 2387 | 2387 | | | | | | | | | | |
| 1486B | 1486B | | | | | | | | | | |
| 1500B | 1500B | | | | | | | | | | |
| 1496 | 1496 | | | | | | | | | | |
| 1506 | 1506 | | | | | | | | | | |
| 1704 | 1704 | | | | | | | | | | |
| 1776 | 1776 | | | | | | | | | | |
| 2428 | 2428 | | | | | | | | | | |
| 2471 | 2471 | | | | | | | | | | |
| 2418 | 2418 | | 0 | 4 | 7 | 5 | | 0 | 1 | | 0 |
| 2283 | 2283 | | 0 | 0 | 5 | 4 | | 1 | 0 | | 0 |
| 1730B | 1730B | | | | | | | | | | |
| 1766 | 1766 | | | | | | | | | | |
| 1741 | 1741 | | | | | | | | | | |
| 1797 | 1797 | | | | | | | | | | |
| 2423 | 2423 | | | | | | | | | | |
| 2700 | 2700 | | | | | | | | | | |
| 1677 | 1677 | | | | | | | | | | |
| 1698 | 1698 | | | | | | | | | | |
| 1700 | 1700 | | | | | | | | | | |
| 1751 | 1751 | | | | | | | | | | |
| 2273 | 2273 | | | | | | | | | | |
| 2294 | 2294 | | | | | | | | | | |
| 1662 | 1662 | | 0 | 1 | 4 | 8 | | 7 | 3 | | 7 |
| 1761 | 1761 | | 0 | 1 | 5 | 6 | | 2 | 0 | | 0 |
| 2406 | 2406 | | | | | | | | | | |
| 1651 | 1651 | | | | | | | | | | |
| 1744 | 1744 | | | | | | | | | | |
| 1749 | 1749 | | | | | | | | | | |
| 1499 | 1499 | | | | | | | | | | |
| 1676 | 1676 | | | | | | | | | | |
| 1702 | 1702 | | | | | | | | | | |
| 2266 | 2266 | | | | | | | | | | |
| 2297 | 2297 | | | | | | | | | | |
| 1750 | 1750 | | 0 | 1 | 5 | 4 | | 0 | 0 | | 0 |
| 1775 | 1775 | | 0 | 0 | 4 | 0 | | 1 | 0 | | 0 |
| 1738 | 1738 | | | | | | | | | | |
| 1765 | 1765 | | | | | | | | | | |
| 2386 | 2386 | | | | | | | | | | |

| Key............ | SAMPLEID.. | MAGNETITE | APATITE | MONAZITE | RUTILE | ZIRCON | SILLIMANITE | KYANITE | STAUROLITE | LEUCOXENE | TITANITE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2412 | 2412 | | | | | | | | | | |
| 1655 | 1655 | | | | | | | | | | |
| 2277B | 2277B | | | | | | | | | | |
| 2277C | 2277C | | | | | | | | | | |
| 2422 | 2422 | | | | | | | | | | |
| 2287 | 2287 | | | | | | | | | | |
| 2375 | 2375 | | | | | | | | | | |
| 2708 | 2708 | | | | | | | | | | |
| 1488B | 1488B | | | | | | | | | | |
| 1508A | 1508A | | | | | | | | | | |
| 1697 | 1697 | | | | | | | | | | |
| 1707 | 1707 | | | | | | | | | | |
| 1754 | 1754 | | | | | | | | | | |
| 2272 | 2272 | | | | | | | | | | |
| 2276 | 2276 | | | | | | | | | | |
| 1730A | 1730A | | | | | | | | | | |
| 2282 | 2282 | | | | | | | | | | |
| 2381 | 2381 | | | | | | | | | | |
| 1734 | 1734 | | | | | | | | | | |
| 2703 | 2703 | | | | | | | | | | |
| 1484 | 1484 | | | | | | | | | | |
| 1486A | 1486A | | | | | | | | | | |
| 1494 | 1494 | | | | | | | | | | |
| 1504 | 1504 | | | | | | | | | | |
| 1661 | 1661 | | | | | | | | | | |
| 1666 | 1666 | | | | | | | | | | |
| 1672 | 1672 | | | | | | | | | | |
| 1682 | 1682 | | | | | | | | | | |
| 1713 | 1713 | | | | | | | | | | |
| 1755 | 1755 | | | | | | | | | | |
| 1759 | 1759 | | | | | | | | | | |
| 1760 | 1760 | | | | | | | | | | |
| 1771 | 1771 | | 0 | 0 | 4 | 0 | | 0 | 0 | | 0 |
| 2271 | 2271 | | | | | | | | | | |
| 1769 | 1769 | | | | | | | | | | |
| 1770 | 1770 | | | | | | | | | | |
| 2385 | 2385 | | | | | | | | | | |
| 2479 | 2479 | | | | | | | | | | |
| 2480 | 2480 | | | | | | | | | | |
| 2391 | 2391 | | | | | | | | | | |
| 1489 | 1489 | | | | | | | | | | |
| 1490 | 1490 | | | | | | | | | | |
| 1656 | 1656 | | | | | | | | | | |
| 1657A | 1657A | | | | | | | | | | |
| 1671 | 1671 | | | | | | | | | | |
| 2292 | 2292 | | | | | | | | | | |
| 2416 | 2416 | | | | | | | | | | |
| 2427 | 2427 | | | | | | | | | | |
| 2286 | 2286 | | 0 | 4 | 5 | 11 | | 2 | 0 | | 0 |
| 1500 | 1500 | | 0 | 1 | 3 | 10 | | 0 | 1 | | 0 |
| 1748 | 1748 | | | | | | | | | | |
| 2378 | 2378 | | | | | | | | | | |
| 2415 | 2415 | | | | | | | | | | |
| 2707 | 2707 | | | | | | | | | | |
| 1481 | 1481 | | | | | | | | | | |
| 2392 | 2392 | | | | | | | | | | |
| 2413 | 2413 | | | | | | | | | | |
| 1735 | 1735 | | | | | | | | | | |
| 1762 | 1762 | | | | | | | | | | |

| Key............ | SAMPLEID.. | MAGNETITE | APATITE | MONAZITE | RUTILE | ZIRCON | SILLIMANITE | KYANITE | STAUROLITE | LEUCOXENE | TITANITE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1503B | 1503B | | | | | | | | | | |
| 2425 | 2425 | | | | | | | | | | |
| 1686 | 1686 | | | | | | | | | | |
| 1699 | 1699 | | | | | | | | | | |
| 1709 | 1709 | | | | | | | | | | |
| 1710 | 1710 | | | | | | | | | | |
| 2274 | 2274 | | | | | | | | | | |
| 2481 | 2481 | | | | | | | | | | |
| 1480 | 1480 | | | | | | | | | | |
| 1491 | 1491 | | | | | | | | | | |
| 1501 | 1501 | | | | | | | | | | |
| 1745 | 1745 | | | | | | | | | | |
| 1493 | 1493 | | 0 | 2 | 5 | 4 | | 1 | 0 | | 1 |
| 1479 | 1479 | | 0 | 3 | 5 | 7 | | 0 | 0 | | 1 |

250 Records Processed

SECTION 9.3

PAGE 1 10:57:29 15 JUL 1988

| Key | SAMPLEID | MICA | GARNET | EPIDOTE | TOURMALINE | GLAUCONITE | SPHENE | SULFIDES | PHOSPHATE | AMPHIBOLE | LIMONITE | ZOISITE | AUGITE | HYPERSTHENE | ANDALUSITE | SPINEL | DUMORTIERITE | GLAUCOPHANE | HORNBLENDE | REBERITE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1649 | 1649 | | | | | | | | | | | | | | | | | | | |
| 1650 | 1650 | | | | | | | | | | | | | | | | | | | |
| 1733 | 1733 | | | | | | | | | | | | | | | | | | | |
| 2279 | 2279 | | | | | | | | | | | | | | | | | | | |
| 2280 | 2280 | | | | | | | | | | | | | | | | | | | |
| 2284 | 2284 | | | | | | | | | | | | | | | | | | | |
| 2419 | 2419 | | | | | | | | | | | | | | | | | | | |
| 2420 | 2420 | | | | | | | | | | | | | | | | | | | |
| 1490 | 1490 | | | | | | | | | | | | | | | | | | | |
| 1663 | 1663 | | | | | | | | | | | | | | | | | | | |
| 1681 | 1681 | | | | | | | | | | | | | | | | | | | |
| 1696 | 1696 | | | | | | | | | | | | | | | | | | | |
| 1706 | 1706 | | | | | | | | | | | | | | | | | | | |
| 1743 | 1743 | | | | | | | | | | | | | | | | | | | |
| 1752 | 1752 | | | | | | | | | | | | | | | | | | | |
| 2373 | 2373 | | | | | | | | | | | | | | | | | | | |
| 2472 | 2472 | | | | | | | | | | | | | | | | | | | |
| 2702 | 2702 | | | | | | | | | | | | | | | | | | | |
| 1660 | 1660 | | | | | | | | | | | | | | | | | | | |
| 2277A | 2277A | | 0 | 39 | 4 | | | | | 13 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1653 | 1653 | | | | | | | | | | | | | | | | | | | |
| 1742 | 1742 | | | | | | | | | | | | | | | | | | | |
| 2374 | 2374 | | | | | | | | | | | | | | | | | | | |
| 2405 | 2405 | | | | | | | | | | | | | | | | | | | |
| 2411 | 2411 | | | | | | | | | | | | | | | | | | | |
| 2421 | 2421 | | | | | | | | | | | | | | | | | | | |
| 2476 | 2476 | | | | | | | | | | | | | | | | | | | |
| 2706B | 2706B | | | | | | | | | | | | | | | | | | | |
| 1488A | 1488A | | | | | | | | | | | | | | | | | | | |
| 1658 | 1658 | | | | | | | | | | | | | | | | | | | |
| 1695 | 1695 | | | | | | | | | | | | | | | | | | | |
| 1705 | 1705 | | | | | | | | | | | | | | | | | | | |
| 1711 | 1711 | | | | | | | | | | | | | | | | | | | |
| 1747 | 1747 | | | | | | | | | | | | | | | | | | | |
| 1757 | 1757 | | | | | | | | | | | | | | | | | | | |
| 2269 | 2269 | | | | | | | | | | | | | | | | | | | |
| 2275 | 2275 | | | | | | | | | | | | | | | | | | | |
| 1664 | 1664 | | 0 | 51 | 1 | | | | | 29 | | 1 | 0 | 1 | | 3 | 0 | 0 | 0 | 0 |
| 2270 | 2270 | | 0 | 58 | 1 | | | | | 12 | | 1 | 0 | 1 | | 1 | 1 | 0 | 0 | 0 |
| 1654 | 1654 | | | | | | | | | | | | | | | | | | | |
| 2278 | 2278 | | | | | | | | | | | | | | | | | | | |
| 2377 | 2377 | | | | | | | | | | | | | | | | | | | |
| 2383 | 2383 | | | | | | | | | | | | | | | | | | | |
| 2424 | 2424 | | | | | | | | | | | | | | | | | | | |
| 2474A | 2474A | | | | | | | | | | | | | | | | | | | |
| 2482 | 2482 | | | | | | | | | | | | | | | | | | | |
| 1497 | 1497 | | | | | | | | | | | | | | | | | | | |
| 1685 | 1685 | | | | | | | | | | | | | | | | | | | |
| 1701 | 1701 | | | | | | | | | | | | | | | | | | | |
| 1737 | 1737 | | | | | | | | | | | | | | | | | | | |
| 2429 | 2429 | | | | | | | | | | | | | | | | | | | |
| 2265 | 2265 | | 0 | 41 | 3 | | | | | 9 | | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| 1753 | 1753 | | 0 | 28 | 4 | | | | | 56 | | 0 | 0 | 1 | | 0 | 0 | 0 | 0 | 0 |
| 1731 | 1731 | | | | | | | | | | | | | | | | | | | |
| 2379 | 2379 | | | | | | | | | | | | | | | | | | | |
| 2380 | 2380 | | | | | | | | | | | | | | | | | | | |
| 2426 | 2426 | | | | | | | | | | | | | | | | | | | |
| 2473 | 2473 | | | | | | | | | | | | | | | | | | | |
| 2477 | 2477 | | | | | | | | | | | | | | | | | | | |

| Key | SAMPLEID | MICA | GARNET | EPIDOTE | TOURMALINE | GLAUCONITE | SPHENE | SULFIDES | PHOSPHATE | AMPHIBOLE | LIMONITE | ZOISITE | AUGITE | HYPERSTHENE | ANDALUSITE | SPINEL | DUMORTIERITE | GLAUCOPHANE | HORNBLENDE | AEGERITE |
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| 2478 | 2478 | | | | | | | | | | | | | | | | | | | |
| 1665 | 1665 | | | | | | | | | | | | | | | | | | | |
| 1674 | 1674 | | | | | | | | | | | | | | | | | | | |
| 1763 | 1763 | | | | | | | | | | | | | | | | | | | |
| 2295 | 2295 | | | | | | | | | | | | | | | | | | | |
| 1773 | 1773 | | 0 | 41 | 2 | | | | | 15 | | 4 | 0 | | 1 | 0 | 0 | 0 | 0 | 0 |
| 1767 | 1767 | | | | | | | | | | | | | | | | | | | |
| 2281 | 2281 | | | | | | | | | | | | | | | | | | | |
| 2285 | 2285 | | | | | | | | | | | | | | | | | | | |
| 2289 | 2289 | | | | | | | | | | | | | | | | | | | |
| 2290 | 2290 | | | | | | | | | | | | | | | | | | | |
| 2384 | 2384 | | | | | | | | | | | | | | | | | | | |
| 2388 | 2388 | | | | | | | | | | | | | | | | | | | |
| 2398 | 2398 | | | | | | | | | | | | | | | | | | | |
| 2400 | 2400 | | | | | | | | | | | | | | | | | | | |
| 2474B | 2474B | | | | | | | | | | | | | | | | | | | |
| 2483 | 2483 | | | | | | | | | | | | | | | | | | | |
| 1482 | 1482 | | | | | | | | | | | | | | | | | | | |
| 1660 | 1660 | | | | | | | | | | | | | | | | | | | |
| 1669 | 1669 | | | | | | | | | | | | | | | | | | | |
| 1670 | 1670 | | | | | | | | | | | | | | | | | | | |
| 1712 | 1712 | | | | | | | | | | | | | | | | | | | |
| 1659 | 1659 | | 0 | 49 | 2 | | | | | 17 | | 2 | 0 | 2 | | 0 | 0 | 0 | 0 | 0 |
| 1758 | 1758 | | 0 | 27 | 3 | | | | | 21 | | 4 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| 1746 | 1746 | | | | | | | | | | | | | | | | | | | |
| 1764 | 1764 | | | | | | | | | | | | | | | | | | | |
| 2268 | 2268 | | | | | | | | | | | | | | | | | | | |
| 2389 | 2389 | | | | | | | | | | | | | | | | | | | |
| 2390 | 2390 | | | | | | | | | | | | | | | | | | | |
| 2404 | 2404 | | | | | | | | | | | | | | | | | | | |
| 2705 | 2705 | | | | | | | | | | | | | | | | | | | |
| 2706A | 2706A | | | | | | | | | | | | | | | | | | | |
| 1492 | 1492 | | | | | | | | | | | | | | | | | | | |
| 1679 | 1679 | | | | | | | | | | | | | | | | | | | |
| 2296 | 2296 | | | | | | | | | | | | | | | | | | | |
| 1680 | 1680 | | 0 | 46 | 3 | | | | | 25 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2291 | 2291 | | 0 | 43 | 3 | | | | | 45 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1700 | 1700 | | 0 | 37 | 1 | | | | | 9 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1582 | 1582 | | 0 | 39 | 1 | | | | | 7 | | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 2 |
| 1483 | 1483 | | 0 | 49 | 3 | | | | | 20 | | 1 | 0 | 1 | 1 | 3 | 1 | 0 | 0 | 0 |
| 1736 | 1736 | | | | | | | | | | | | | | | | | | | |
| 1732 | 1732 | | | | | | | | | | | | | | | | | | | |
| 1768 | 1768 | | | | | | | | | | | | | | | | | | | |
| 2399 | 2399 | | | | | | | | | | | | | | | | | | | |
| 2410 | 2410 | | | | | | | | | | | | | | | | | | | |
| 2414 | 2414 | | | | | | | | | | | | | | | | | | | |
| 2701 | 2701 | | | | | | | | | | | | | | | | | | | |
| 1503A | 1503A | | | | | | | | | | | | | | | | | | | |
| 1675 | 1675 | | | | | | | | | | | | | | | | | | | |
| 1684 | 1684 | | | | | | | | | | | | | | | | | | | |
| 1774 | 1774 | | | | | | | | | | | | | | | | | | | |
| 2409 | 2409 | | | | | | | | | | | | | | | | | | | |
| 1487 | 1487 | | 0 | 53 | 2 | | | | | 11 | | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 2293 | 2293 | | | | | | | | | | | | | | | | | | | |
| 2417 | 2417 | | | | | | | | | | | | | | | | | | | |
| 2475 | 2475 | | | | | | | | | | | | | | | | | | | |
| 1485 | 1485 | | | | | | | | | | | | | | | | | | | |
| 1667 | 1667 | | | | | | | | | | | | | | | | | | | |
| 1678 | 1678 | | | | | | | | | | | | | | | | | | | |

PAGE 3 

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| Key............ | SAMPLEID.. | MICA | GARNET | EPIDOTE | TOURMALINE | GLAUCONITE | SPHENE | SULFIDES | PHOSPHATE | AMPHIBOLE | LIMONITE | ZOISITE | AUGITE | HYPERSTHENE | ANDALUSITE | SPINEL | DUMORTIERITE | GLAUCOPHANE | HORNBLENDE | AEGERITE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1657B | 1657B | | | | | | | | | | | | | | | | | | | |
| 1585 | 1585 | | | | | | | | | | | | | | | | | | | |
| 1739 | 1739 | | | | | | | | | | | | | | | | | | | |
| 1740 | 1740 | | | | | | | | | | | | | | | | | | | |
| 2397 | 2397 | | | | | | | | | | | | | | | | | | | |
| 2407 | 2407 | | | | | | | | | | | | | | | | | | | |
| 2704 | 2704 | | | | | | | | | | | | | | | | | | | |
| 1495 | 1495 | | | | | | | | | | | | | | | | | | | |
| 1683 | 1683 | | | | | | | | | | | | | | | | | | | |
| 1714 | 1714 | | | | | | | | | | | | | | | | | | | |
| 1756 | 1756 | | | | | | | | | | | | | | | | | | | |
| 1772 | 1772 | | | | | | | | | | | | | | | | | | | |
| 1783 | 1783 | | 0 | 45 | 0 | | | | | 31 | | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 2273U | 2273U | | | | | | | | | | | | | | | | | | | |
| 2288 | 2288 | | | | | | | | | | | | | | | | | | | |
| 2372 | 2372 | | | | | | | | | | | | | | | | | | | |
| 1652 | 1652 | | | | | | | | | | | | | | | | | | | |
| 1488C | 1488C | | | | | | | | | | | | | | | | | | | |
| 2376 | 2376 | | | | | | | | | | | | | | | | | | | |
| 2382 | 2382 | | | | | | | | | | | | | | | | | | | |
| 2387 | 2387 | | | | | | | | | | | | | | | | | | | |
| 1486B | 1486B | | | | | | | | | | | | | | | | | | | |
| 1508B | 1508B | | | | | | | | | | | | | | | | | | | |
| 1496 | 1496 | | | | | | | | | | | | | | | | | | | |
| 1506 | 1506 | | | | | | | | | | | | | | | | | | | |
| 1704 | 1704 | | | | | | | | | | | | | | | | | | | |
| 1776 | 1776 | | | | | | | | | | | | | | | | | | | |
| 2428 | 2428 | | | | | | | | | | | | | | | | | | | |
| 2471 | 2471 | | | | | | | | | | | | | | | | | | | |
| 2418 | 2418 | | 0 | 45 | 3 | | | | | 15 | | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 2283 | 2283 | | 0 | 54 | 1 | | | | | 22 | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |
| 1730B | 1730B | | | | | | | | | | | | | | | | | | | |
| 1766 | 1766 | | | | | | | | | | | | | | | | | | | |
| 1741 | 1741 | | | | | | | | | | | | | | | | | | | |
| 1797 | 1797 | | | | | | | | | | | | | | | | | | | |
| 2423 | 2423 | | | | | | | | | | | | | | | | | | | |
| 2700 | 2700 | | | | | | | | | | | | | | | | | | | |
| 1677 | 1677 | | | | | | | | | | | | | | | | | | | |
| 1698 | 1698 | | | | | | | | | | | | | | | | | | | |
| 1708 | 1708 | | | | | | | | | | | | | | | | | | | |
| 1751 | 1751 | | | | | | | | | | | | | | | | | | | |
| 2273 | 2273 | | | | | | | | | | | | | | | | | | | |
| 2294 | 2294 | | | | | | | | | | | | | | | | | | | |
| 1662 | 1662 | | 0 | 34 | 1 | | | | | 11 | | 5 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| 1761 | 1761 | | 0 | 34 | 5 | | | | | 27 | | 0 | 0 | 0 | | 2 | 0 | 0 | 0 | 1 |
| 2486 | 2486 | | | | | | | | | | | | | | | | | | | |
| 1651 | 1651 | | | | | | | | | | | | | | | | | | | |
| 1744 | 1744 | | | | | | | | | | | | | | | | | | | |
| 1749 | 1749 | | | | | | | | | | | | | | | | | | | |
| 1499 | 1499 | | | | | | | | | | | | | | | | | | | |
| 1676 | 1676 | | | | | | | | | | | | | | | | | | | |
| 1702 | 1702 | | | | | | | | | | | | | | | | | | | |
| 2266 | 2266 | | | | | | | | | | | | | | | | | | | |
| 2297 | 2297 | | | | | | | | | | | | | | | | | | | |
| 1750 | 1750 | | 0 | 51 | 3 | | | | | 21 | | 4 | 0 | 2 | | 0 | 1 | 0 | 0 | 0 |
| 1775 | 1775 | | 0 | 55 | 1 | | | | | 33 | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |
| 1738 | 1738 | | | | | | | | | | | | | | | | | | | |
| 1765 | 1765 | | | | | | | | | | | | | | | | | | | |
| 2386 | 2386 | | | | | | | | | | | | | | | | | | | |

| Key............ | SAMPLEID.. | MICA | GARNET | EPIDOTE | TOURMALINE | GLAUCONITE | SPHENE | SULFIDES | PHOSPHATE | AMPHIBOLE | LIMONITE | ZOISITE | AUGITE | HYPERSTHENE | ANDALUSITE | SPINEL | DUMORTIERITE | GLAUCOPHANE | HORNBLENDE | AEGERITE |
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| 2412 | 2412 | | | | | | | | | | | | | | | | | | | |
| 1655 | 1655 | | | | | | | | | | | | | | | | | | | |
| 2277B | 2277B | | | | | | | | | | | | | | | | | | | |
| 2277C | 2277C | | | | | | | | | | | | | | | | | | | |
| 2422 | 2422 | | | | | | | | | | | | | | | | | | | |
| 2287 | 2287 | | | | | | | | | | | | | | | | | | | |
| 2375 | 2375 | | | | | | | | | | | | | | | | | | | |
| 2708 | 2708 | | | | | | | | | | | | | | | | | | | |
| 1488B | 1488B | | | | | | | | | | | | | | | | | | | |
| 1500A | 1500A | | | | | | | | | | | | | | | | | | | |
| 1697 | 1697 | | | | | | | | | | | | | | | | | | | |
| 1707 | 1707 | | | | | | | | | | | | | | | | | | | |
| 1754 | 1754 | | | | | | | | | | | | | | | | | | | |
| 2272 | 2272 | | | | | | | | | | | | | | | | | | | |
| 2276 | 2276 | | | | | | | | | | | | | | | | | | | |
| 1730A | 1730A | | | | | | | | | | | | | | | | | | | |
| 2282 | 2282 | | | | | | | | | | | | | | | | | | | |
| 2381 | 2381 | | | | | | | | | | | | | | | | | | | |
| 1734 | 1734 | | | | | | | | | | | | | | | | | | | |
| 2703 | 2703 | | | | | | | | | | | | | | | | | | | |
| 1484 | 1484 | | | | | | | | | | | | | | | | | | | |
| 1486A | 1486A | | | | | | | | | | | | | | | | | | | |
| 1494 | 1494 | | | | | | | | | | | | | | | | | | | |
| 1504 | 1504 | | | | | | | | | | | | | | | | | | | |
| 1661 | 1661 | | | | | | | | | | | | | | | | | | | |
| 1666 | 1666 | | | | | | | | | | | | | | | | | | | |
| 1672 | 1672 | | | | | | | | | | | | | | | | | | | |
| 1682 | 1682 | | | | | | | | | | | | | | | | | | | |
| 1713 | 1713 | | | | | | | | | | | | | | | | | | | |
| 1755 | 1755 | | | | | | | | | | | | | | | | | | | |
| 1759 | 1759 | | | | | | | | | | | | | | | | | | | |
| 1760 | 1760 | | | | | | | | | | | | | | | | | | | |
| 1771 | 1771 | | 0 | 53 | 1 | | | | | 37 | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |
| 2271 | 2271 | | | | | | | | | | | | | | | | | | | |
| 1769 | 1769 | | | | | | | | | | | | | | | | | | | |
| 1770 | 1770 | | | | | | | | | | | | | | | | | | | |
| 2385 | 2385 | | | | | | | | | | | | | | | | | | | |
| 2479 | 2479 | | | | | | | | | | | | | | | | | | | |
| 2480 | 2480 | | | | | | | | | | | | | | | | | | | |
| 2391 | 2391 | | | | | | | | | | | | | | | | | | | |
| 1489 | 1489 | | | | | | | | | | | | | | | | | | | |
| 1490 | 1490 | | | | | | | | | | | | | | | | | | | |
| 1656 | 1656 | | | | | | | | | | | | | | | | | | | |
| 1657A | 1657A | | | | | | | | | | | | | | | | | | | |
| 1671 | 1671 | | | | | | | | | | | | | | | | | | | |
| 2292 | 2292 | | | | | | | | | | | | | | | | | | | |
| 2416 | 2416 | | | | | | | | | | | | | | | | | | | |
| 2427 | 2427 | | | | | | | | | | | | | | | | | | | |
| 2286 | 2286 | | 0 | 42 | 1 | | | | | 11 | | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1500 | 1500 | | 0 | 35 | 2 | | | | | 9 | | 3 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 1 |
| 1748 | 1748 | | | | | | | | | | | | | | | | | | | |
| 2378 | 2378 | | | | | | | | | | | | | | | | | | | |
| 2415 | 2415 | | | | | | | | | | | | | | | | | | | |
| 2707 | 2707 | | | | | | | | | | | | | | | | | | | |
| 1481 | 1481 | | | | | | | | | | | | | | | | | | | |
| 2392 | 2392 | | | | | | | | | | | | | | | | | | | |
| 2413 | 2413 | | | | | | | | | | | | | | | | | | | |
| 1735 | 1735 | | | | | | | | | | | | | | | | | | | |
| 1762 | 1762 | | | | | | | | | | | | | | | | | | | |

| Key............ | SAMPLEID.. | MICA | GARNET | EPIDOTE | TOURMALINE | GLAUCONITE | SPHENE | SULFIDES | PHOSPHATE | AMPHIBOLE | LIMONITE | ZOISITE | AUGITE | HYPERSTHENE | ANDALUSITE | SPINEL | DUMORTIERITE | GLAUCOPHANE | HORNBLENDE | AEGERITE |
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| 15030 | 15030 | | | | | | | | | | | | | | | | | | | |
| 2425 | 2425 | | | | | | | | | | | | | | | | | | | |
| 1686 | 1686 | | | | | | | | | | | | | | | | | | | |
| 1699 | 1699 | | | | | | | | | | | | | | | | | | | |
| 1709 | 1709 | | | | | | | | | | | | | | | | | | | |
| 1710 | 1710 | | | | | | | | | | | | | | | | | | | |
| 2274 | 2274 | | | | | | | | | | | | | | | | | | | |
| 2481 | 2481 | | | | | | | | | | | | | | | | | | | |
| 1480 | 1480 | | | | | | | | | | | | | | | | | | | |
| 1491 | 1491 | | | | | | | | | | | | | | | | | | | |
| 1501 | 1501 | | | | | | | | | | | | | | | | | | | |
| 1745 | 1745 | | | | | | | | | | | | | | | | | | | |
| 1493 | 1493 | | 0 | 46 | 0 | | | | | 15 | | 6 | 2 | 0 | | 0 | 0 | 0 | 0 | 0 |
| 1479 | 1479 | | 0 | 40 | 1 | | | | | 19 | | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

250 Records Processed

For convenience in selecting our reports from your bookshelves, they are color-keyed across the spine by subject as follows:

| | |
|---|---|
| Red | Valley and Ridge mapping and structural geology |
| Dk. Purple | Piedmont and Blue Ridge mapping and structural geology |
| Maroon | Coastal Plain mapping and stratigraphy |
| Lt. Green | Paleontology |
| Lt. Blue | Coastal Zone studies |
| Dk. Green | Geochemical and geophysical studies |
| Dk. Blue | Hydrology |
| Olive | Economic geology |
| | Mining directory |
| Yellow | Environmental studies |
| | Engineering studies |
| Dk. Orange | Bibliographies and lists of publications |
| Brown | Petroleum and natural gas |
| Black | Field trip guidebooks |
| Dk. Brown | Collections of papers |

Colors have been selected at random, and will be augmented as new subjects are published.

**Publications Editor: Patricia Allgood**