Volume VI
APPENDIX L:
Engineering

Medium Diversion at White Ditch Final Feasibility Report
Appendix L1 – Engineering Investigations and Cost Estimates
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L1. General

The White Ditch project area is located in the Breton Sound estuary and covers the area extending north and south from just south of Belair, Louisiana to the coastline of Louisiana and extending east and west from the Mississippi River to the Oak River. This area extends about 50 km in the NW-SE directions and about 30 km in the SW-NE direction. Subsidence, erosion, channelization, saltwater intrusion, storm damage and the absence of fresh water, sediments and nutrients from the Mississippi River have all caused significant adverse impacts to the White Ditch project area resulting in extensive wetland loss and ecosystem degradation. There is an existing siphon at the mouth of White Ditch that was built in 1963 and has not been in operation since 1991, except for two brief episodes.

The absence of a supply of fresh water, sediment, and nutrients has caused the marsh to degrade. This degradation coupled with the subsidence and sea level rise rate of approximately 1.04 cm per year has led to an increase in saltwater intrusion. The additional influx of saltwater from the Gulf of Mexico through the vast canal network in the project area has further damaged the marsh vegetation. In August and September of 2005 Louisiana was hit by hurricanes Katrina and Rita. These hurricanes brought high winds and high tidal surges and destroyed thousands of acres of already weakened marsh. In September of 2008 hurricanes Ike and Gustav also hit the Gulf coast. While they did not make direct landfall in the project area, the tidal surges from these storms caused the loss of additional marsh acreage.

The White Ditch area is part of the Breton Sound estuary system. Breton Sound estuary is located in southern Louisiana, between Breton Sound Bay and approximately the last 85 miles of the Mississippi River before it discharges into the Gulf of Mexico. The estuary consists of about 430 square miles (1,100 km2) of fresh and brackish coastal wetlands that are made up of shallow water ponds, lakes, bays, and a man-made canal system (Figure 1). The major rivers in the estuary are the Oak River (also known as River aux Chenes) and Bayou Terra aux Boeufs. The larger water bodies are Big Mar, Lake Leary, Spanish Lake, Grand Lake, and Little Lake.

The project is examining alternative designs for a fresh water diversion from the Mississippi River to the White Ditch Project area. Different alternative locations, channel depths and widths are considered for different peak diversion flow rates, ranging from 5,000 to 100,000 cfs.

L2. Hydraulics and Hydrology

L2.1 Climatology

The climate of the White Ditch study area is subtropical marine with long humid summers and short moderate winters. The climate is strongly influenced by the water surface of many sounds, bays, lakes and the Gulf of Mexico and seasonal changes in atmospheric circulation. During the fall and winter, the study area experiences cold continental air masses which produce frontal passages with temperature drops. During the spring and summer, the study area experiences tropical air masses which produce a warm, moist airflow conducive to thunderstorm development (USACE 2008a (MRGO LEIS)). The study area is also subject to periods of both drought and flood, and the climate rarely seems to truly exhibit “average” conditions (MsCIP 2008).

The study area is susceptible to tropical waves, tropical depressions, tropical storms and hurricanes. These weather systems can cause considerable property and environmental damage and loss of human life. Historical data from 1899 to 2007 indicate that 30 hurricanes and 41 tropical storms have made landfall along the Louisiana coastline (NOAA 2009). The largest recent hurricanes were Katrina and Rita in 2005, which caused devastating damage in the study area. Hurricane Gustav, while much smaller and less intense, caused additional damage in the study area. Hurricane Ike, which made landfall in Galveston, Texas in 2008, caused flooding and wind damage in coastal areas as it passed the Louisiana Coast.

The total amount of marsh lost as a result of Hurricanes Katrina and Rita was over one third of the total predicted wetland losses predicted by the Coast 2050 Report (1999). Within the study area, about 40,910 acres of wetlands were converted to open water (Barras 2006). This loss rate exceeded the average background loss rate of about 2,160 acres per year for the period from 1956 to 2004 (Wicker 1980; Barras et al. 1994; Barras et al. 2003; Morton et al. 2005). New water bodies formed and existing water bodies expanded north and west of Lake Lery (USGS 2006). These changes occurred largely as a result of Hurricanes Katrina and Rita. The combined land-water changes caused by Hurricanes Katrina and Rita exceeded coastal land change from previous recent hurricanes combined, such as Hurricanes Andrew (1992), Lili (2002), and Tropical Storm Isidore (2002) (Barras 2006).

L2.2 Selection of a Hydrodynamic Modeling Program

A modeling program for a hydrologic study is primarily selected based on the following factors:

a. The configuration of water bodies, channels, and flow control structures in the study area;
b. The nature of water movement inside the system; and
c. The parameters to be studied (e.g., water level, velocity, sediment movement, and/or salinity etc.).

The project area is comprised of areas of marsh and open water with bounding channels and several intersecting interior channels. Since the project area is shallow, the vertical movement of water is insignificant relative to that in the longitudinal and transverse directions and can be ignored during hydrodynamic and salinity computations without loss of accuracy in the final results. The marsh system is assumed to be well mixed vertically. Sediment transportation is an important feature that the model must have; however, due to time constraints hydrodynamic sediment modeling will not be conducted as a part of this study. The project delivery team wants to ensure the opprotunity for this modeling to be done in the future to investigate likely sedimentation patterns within the project area. Therefore, a modeling program that can simulate 2D, vertically averaged movement of water and salinity is the most appropriate for the study. A number of hydraulic models meet the above criteria and were considered for use in simulating the White Ditch diversion alternatives. The candidate models are listed below and organized into finite element and finite volume categories. In general, the finite element models have unstructured meshing capabilities that allow for the efficient detailed resolution of small features, However, they are difficult to implement in projects with large areas of wetting and drying, often requiring excessive bathymetric and topographic smoothing to achieve a stable solution.

Finite Element Models include:
ADCIRC – Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters: unstructured mesh, no salinity, poor wetting and drying.

FESWMS – Finite Element Surface Water Modeling System: unstructured mesh, no salinity, poor wetting and drying.

RMA2 – Resource Management Associates: unstructured mesh, salinity transport, poor wetting and drying

Finite Volume Models include:
CMS– Coastal Modeling System: salinity transport, good wetting and drying, rectilinear mesh

EFDC – Environmental Fluid Dynamics Code: salinity transport, good wetting and drying, curvilinear mesh

FVCOM – Finite Volume Community Ocean Model: unstructured mesh, good wetting and drying, commercial availability

POM– Princeton Ocean Model: salinity transport, good wetting and drying, curvilinear mesh

The finite difference models typically will not have any stability problems when considering wetting and drying, but often do not have the benefits of unstructured meshes since they typically use rectilinear or curvilinear structured meshes. The FVCOM model is unique in that it is a finite volume model that uses an unstructured mesh and therefore can realize the mesh generation benefits often associated with finite elements. However, the model is relatively new and limited to research applications. Non-research applications are occurring but model documentation and general industrial familiarity with the model are not mature. The remaining three finite volume models (CMS, EFDC and POM) all have similar capabilities and are suitable for the project.

OF those three, the CMS is supported by the USACE and therefore was selected for the project. CMS-Flow is a process-based 2D depth-averaged hydrodynamic, sediment transport and morphology model developed by the USACE for application in and around inlets and channels. It is accessible via the Surfacewater Modeling System (SMS) graphical user interface.

L2.3 Data Collection for Modeling Purposes

There were a number of existing data sets available to support the configuration, calibration and application of the hydrodynamic and salinity transport model. In addition to the existing data sets, a bathymetric survey and a field measurement program were conducted prior to the modeling analysis in order to provide site-specific data. Each of these data sets is briefly described below.

L2.3.1 Bathymetry

There was sparse data within the coverage area, and the resolution of any available data was insufficient for model use. Digital Elevation Model (DEM) and contoured elevation coverages were available at http://atlas.lsu.edu/rasterdown.htm for portions of the modeled area, however the elevation values available in these datasets did not contain the precision necessary for use in the model.

The USACE conducted a bathymetric survey of the White Ditch area to both support of the modeling analysis and the alternative designs. The survey transects are shown in Figure C2.1. These data provide information on the channel depths and widths, the lake depths, ridges bounding the channels as well as the characteristics of the inter-tidal and land areas.

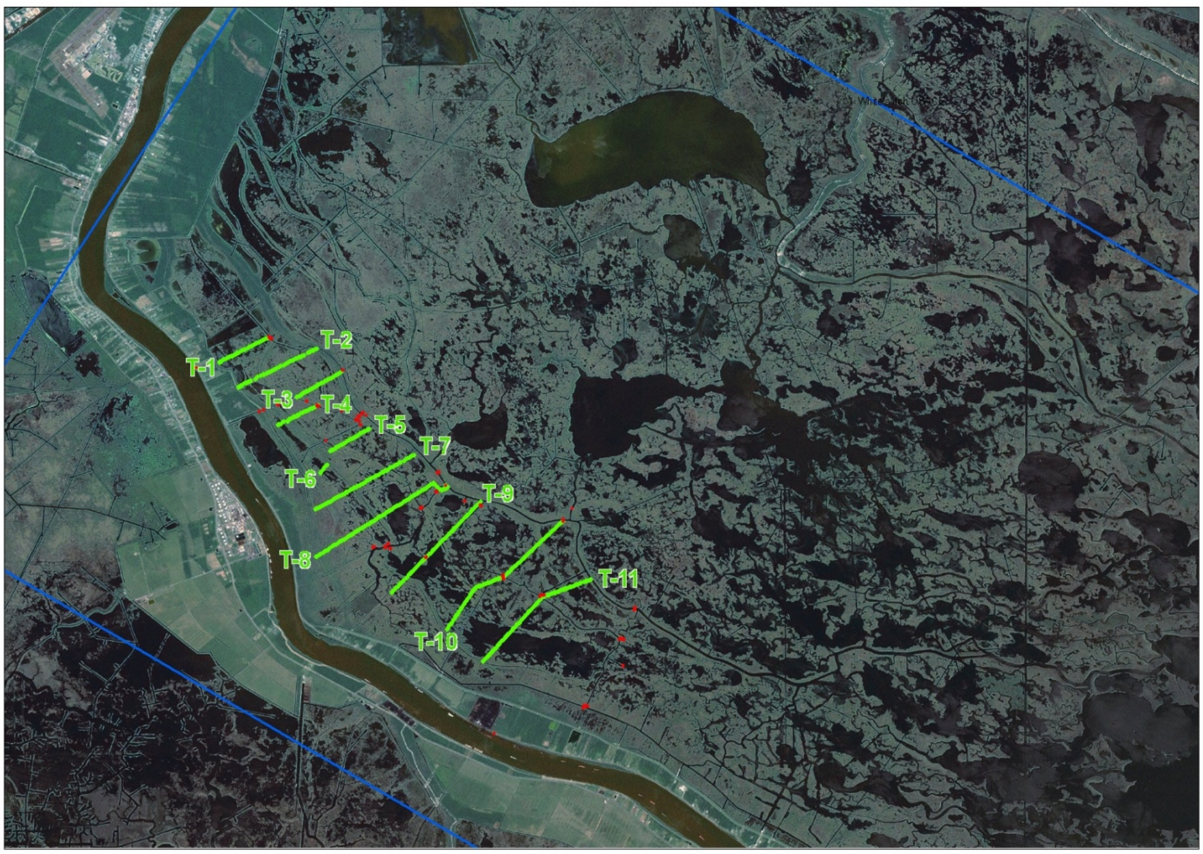


Figure L2.1: Surveys contract by the USACE to assist in Hydrodynamic modeling analysis of the White Ditch project area.

L2.3.2 Tidal Stages

Real-time tide data were downloaded from http://waterdata.usgs.gov/nwis for three U.S. Geological Survey (USGS) stations. Station locations include: Northeast Bay Gardene (Station

ID: 7374527), Black Bay near Snake Island (Station ID: 7374526) and Cow Bayou at American Bay (Station ID: 73745258). Tide data were also obtained from http://tidesonline.nos.noaa.gov/ for the National Atmospheric Oceanic and Atmospheric Administration (NOAA) Station Pilot East (Station ID: 8761305). Station locations are shown in Figure L2.2.

A review of the tide gages revealed that there were no suitable gage locations in the proximity of the White Ditch area. The closest gages were Cow Bayou at American Bay and Northeast Bay Gardene. Data from the Bay Gardene station was chosen for model use since it provided the most available data with the fewest data gaps.

Utilization of the Bay Gardene data was not without difficulty. A downward shift of 0.5 feet was done on the gage by the USGS in January 2010. They note that there is a level of uncertainty surrounding this gage considering its datum has been tied to a nearby telephone pole which has been through multiple hurricanes and is continually experiencing the effects of subsidence and erosion. In addition, although NOAA often publishes datum conversion between geodetic (i.e. NAV 88) and tidal datum for many gages along the US coast, its website Benchmark Page and does not contain the NAVD 88 and tidal datum conversion for the Bay Gardene station. This is likely due to accuracy and or data issues. NOAA does provide the VDATUM software for converting data to various datum along the US coastline and the coastal regions of the Great Lakes. It also provides estimates of the accuracy in the conversions. The published VDATUM accuracy information for the East Louisiana/Mississippi area is +/- 17.1 cm.

When the Bay Gardene data was averaged over a period multi-year period of time, it was discovered that the average was approximately 1.0 feet above sea level (0.0 feet NAVD88). Using standard modeling practices, all data was shifted downward by 1.0’ for the average to coincide with approximate sea level. This 1.0 downward shift falls within the acceptable range established by coupling the USGS’ 0.5 downward shift with the NOAA +/- 17.1 cm accuracy range. Most importantly, this adjustment reflects locally observed conditions and results in an accurately responding model.

It is important to note that the results of the model and its calibration are completely dependent on the accuracy of the tidal data that is used as input. Although it was the best available, there is a level of uncertainty surrounding the datum of the Bay Gardene gage which was used in the White Ditch Hydrodynamic Model. The USGS plans to re-survey the gage with state-of-the-art GPS in the near future, with possible publishing of the results in April 2010. It is recommended that the issue of calibration be revisited when this more accurate survey data is complete. It is also recommended that a sensitivity analysis be performed with different levels of tidal drivers (i.e. 0.5 feet above and below the level the model is currently calibrated at) to examine changes in salinity distribution. This sensitivity analysis should demonstrate that the tidal driver used in the model was indeed accurate. These efforts should be conducted before or as part PED phase.

Figure L2.2: Salinity and Tidal gages used in the modeling process

L2.3.3 Salinity

Salinity data are available from the USGS. Data was accessed from http://waterdata.usgs.gov. Data originate from three Louisiana stations including: Northeast Bay Gardene (Station ID 7374527), Black Bay near Snake Island (Station ID 7374526), and Cow Bayou at American Bay (Station ID 73745258). Station locations are shown in Figure L2.2. Another salinity data set was available from Strategic Online Natural Resources Information System (SONRIS). This data set included hourly or monthly salinity measurements and stations were located throughout the Breton Sound with varying periods of record Figure L2.3. The average, max and minimum salinity values at stations with sufficient data are shown in the table in Figure 10. The data reflect the freshwater source of the Caernarvon Diversion.

L2.3.4 Meteorological Data

Wind data are available from various stations in the project area. The wind data were collected by NOAA from 1999 through 2009 (http://www.ncdc.noaa.gov/oa/ncdc.html). Louisiana wind station locations include: Grand Isle (Station Number 8762417), Pilot East (Station Number 8760922) and Shell Beach (Station Number 8761305). The location of these stations is shown in Figure 6. Hourly data was available from the Pilot East station and was downloaded for the time period of 3/25/2004 through 7/23/2009. Acquired data is noncontiguous in content, containing a number of dates with no recorded data.

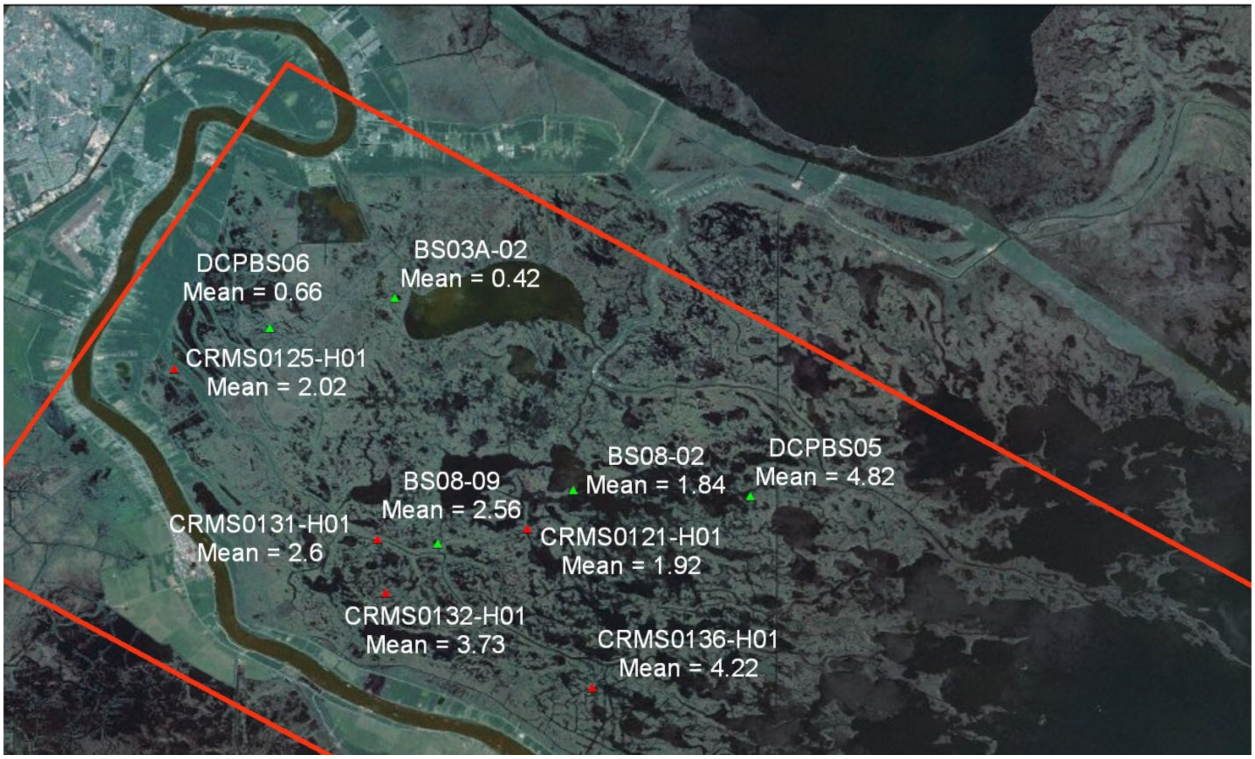


Figure L2.3: Salinity gages used in the modeling process

Rainfall data were obtained from the NOAA Port Sulfer Station (Station 167471) and from a Bell Chasse station. Station locations are shown in Figure L2.4.The data included a daily sum of rainfall in inches for 1/1/2004 through 8/27/2009 for Port Sulfur and 9/28/2006 through 8/20/2009 for Belle Chasse.

There were no daily evaporation data available from stations near the project area. In order to provide some information for evaporation rates, data in the literature was reviewed. A study conducted by Cooke et. al. (2008) provided measured data at a variety of stations in Louisiana. The nearest station was Houma for which summer evaporation rates were available. The data indicate some daily fluctuations do occur, ranging between 2 and 8 mm/day, with an average rate on the order of 5 mm/day.

L2.3.5 Caernarvon

On the northern edge of Breton Sound estuary is the Caernarvon freshwater diversion structure. It is located on the east bank of a Mississippi River oxbow at river mile 81.5. The diversion structure began operating in 1991 as a means for establishing optimal salinity conditions for oyster production, and can also be used to prevent saltwater intrusion during storms or droughts. The 23-meter-wide structure has the capacity to divert up to about 8,000cfs (226m^3/s) of Mississippi River water into the Breton Sound estuary, and has been managed at many different discharge rates since its commencement.

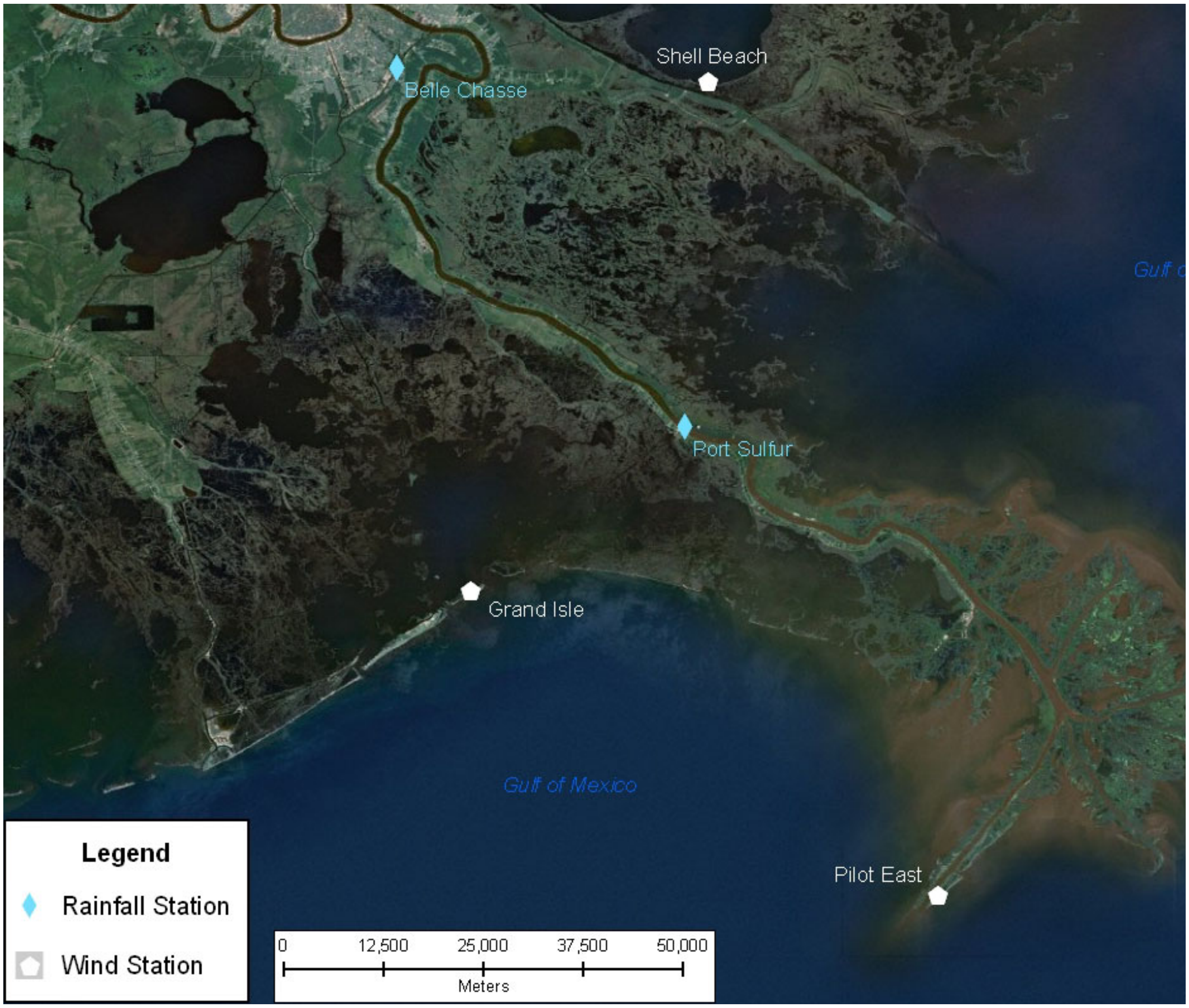


Figure L2.4: NOAA rainfall and wind stations used in the modeling process

The Louisiana Department of Natural Resources manages the Caernarvon Freshwater Diversion Project and provides daily flow data in cubic feet per second (cfs) from 1992 through 2009. Average monthly flows from the diversion are shown in Figure L2.5.

Based on discussions with local land managers, it is believed that the flow from the diversion followed two dominant paths from the diversion. The main one is to the south through the Bayou Mandeville area. The second one is directed to the west, through the Delacroix Canal, and ultimately merges with the Oaks River. It is believed that about 20 to 30 percent of the diversion flows went through the western path until Hurricane Katrina impacted the area. After Katrina, many of the smaller channels to the west were clogged with debris, and it is believed that only 5 to 10 percent of the diversion flow now flows westward.

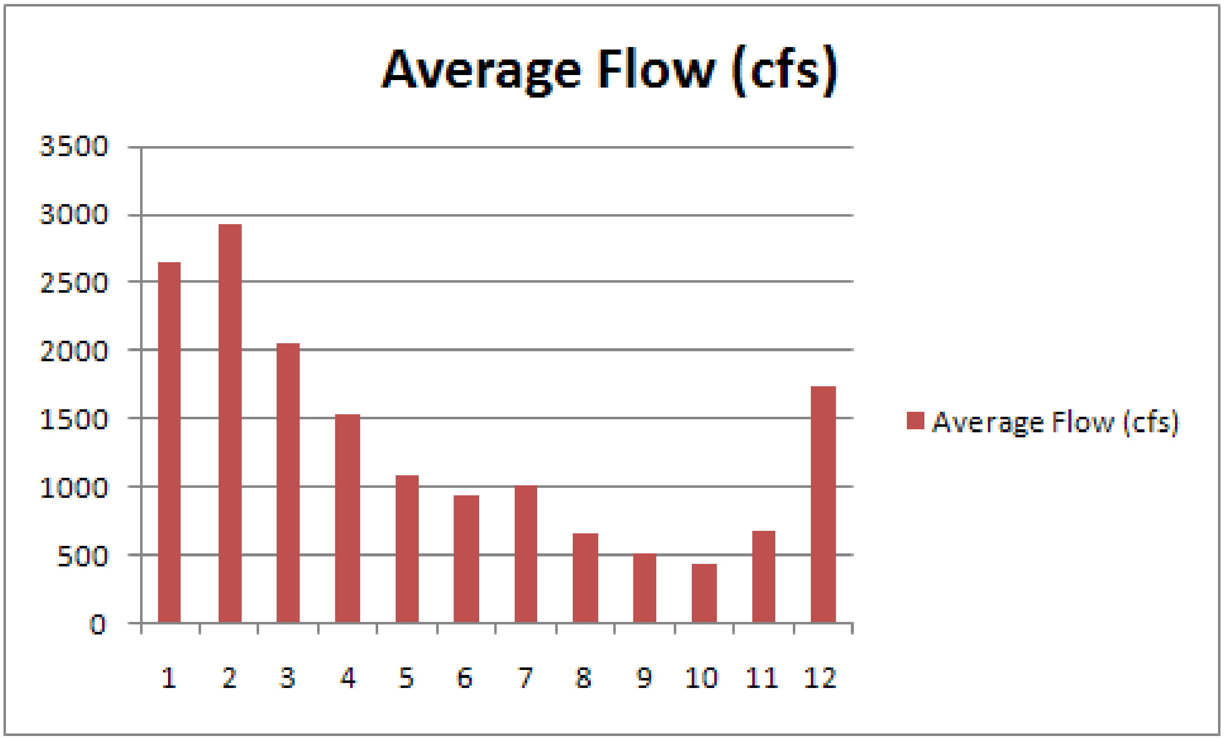


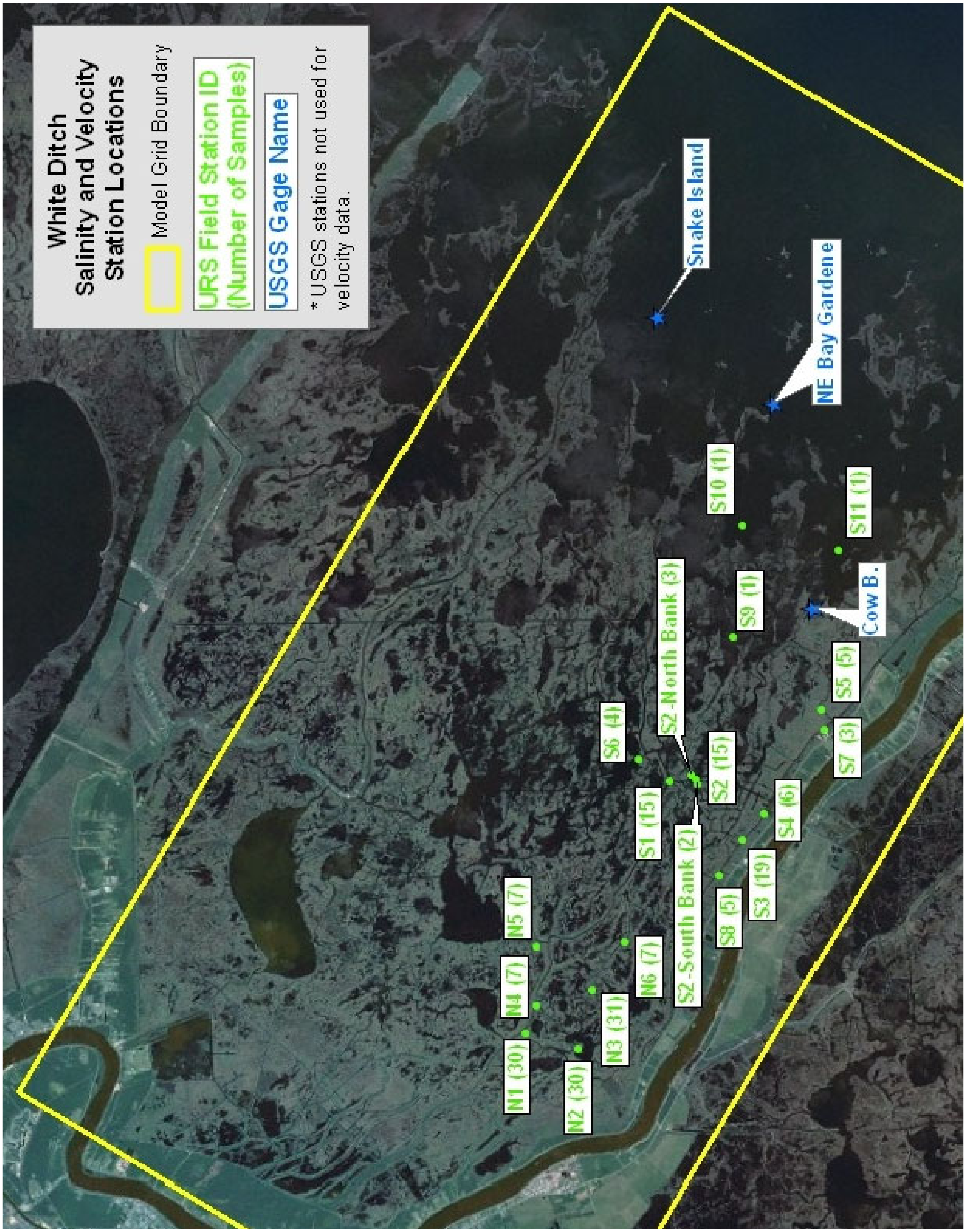
Figure L2.5: Average monthly flows from the Caernarvon Diversion.

L2.3.6 URS Field Investigation

The White Ditch field investigation was conducted from July 20, 2009 through July 23, 2009 to collect necessary calibration data for the CMS-Flow hydrodynamic model of the study area. The field investigation was conducted by two crews of URS field staff operating from airboats hired for the project. The field crews were accompanied by William Terry of the U.S. Army Corps of Engineers (USACE) St. Louis District Office for most of the field investigation. A summary of the two data sets explicitly used in the modeling analysis, the water elevations and the salinity data, are summarized here.

The study area and sampling stations are shown in Figure L2.6. Measurements of flow velocity, temperature, salinity and turbidity were collected periodically between July 21 and 23, 2009 at the primary stations (N1, N2, N3, S1, S2, and S3). Water level measurements were collected at stations N3 and S3 from July 20 to July 23, 2009 using temporary staff gauges and recording pressure transducers that were installed at these locations. Less frequent flow velocity, temperature and salinity measurements were collected at the secondary locations (Oak River Channel, N4, N5, N6, S4, S5, S6, S7, S8, S9, S10, and S11). Water depth measurements were collected at each of the primary and secondary locations, and at additional field locations (S12-S33) shown on Figure L2.7.

Figure L2.6: URS data collection stations for the modeling process.



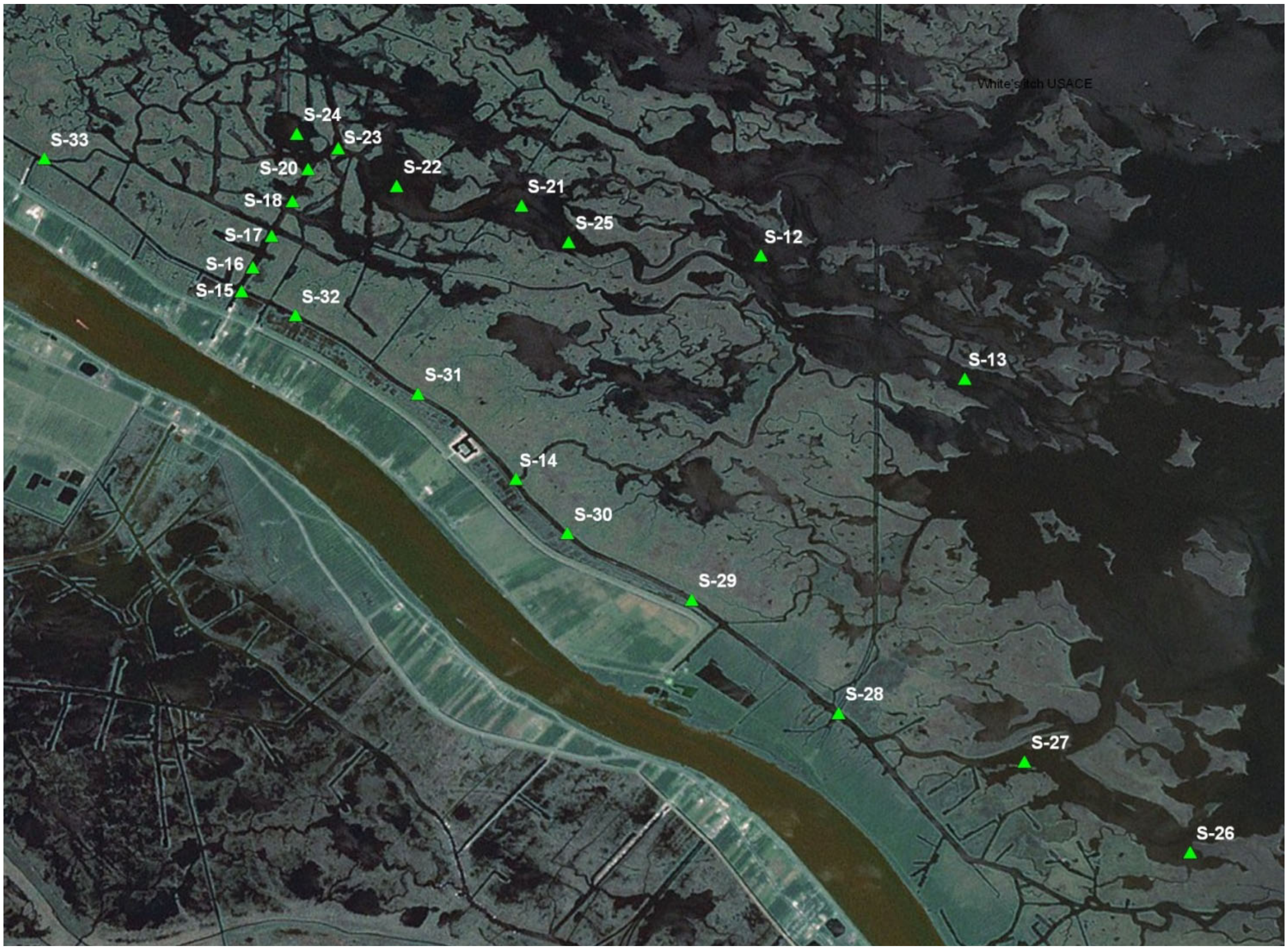


Figure L2.7: Additional URS field stations for the modeling process.

Staff gauges and recording pressure transducers were installed at locations S3 and N3 to measure water level fluctuations within the study area. The transducers used were Micro-Diver Dataloggers (Model DI601) manufactured by the Schlumberger Corporation. The data loggers were initially programmed to collect pressure measurements every five minutes in feet of water. The sample interval was changed to 30 seconds after approximately 24 hours.

Staff gauges constructed of 1-inch diameter PVC pipe was also installed at locations S3 and N3. Periodic measurements of the water level at each staff gauge were recorded. When compared to the tides at the Bay Gardene Station, it is evident that there is s significant loss of tidal amplitude as the tides propagate into the White Ditch area.

Salinity data (as well as temperature and turbidity measurements) were collected at each primary location and other select locations using a HydroLab Quanta system. The mean, maximum and minimum salinity at each station was also recorded. The SONRIS salinity data are also shown in Figure L2.3, and although the data represent different time periods, they show a general trends in the salinity patterns. The trends show a basic low to higher salinity gradient from offshore to the NW as well as a high to low gradient from the east bank of the Mississippi River to the NE. The

general gradients, even those in the White Ditch area, point towards the Caernarvon Diversion, indicating that it is a significant source of freshwater in the area.
Salinity measurements were also made at surface and bottom. The data indicates a very minor difference between the two; less than 0.5 ppt.

L2.4 Hydrodynamic Model Domain and Grid Generation

The model domain is shown in Figure L2.8. The domain includes all of the white ditch area as well as an extensive portion of Breton Sound. A primary reason for including the larger portion of Breton Sound was the potential influence of the diversion peak flows on the east of the Oaks River. Also, the channels providing flow pathways from the Caernarvon Diversion to the White Ditch area required inclusion since the Caernarvon Diversion flows provided a significant portion of the freshwater to the White Ditch area (the other being rainfall).

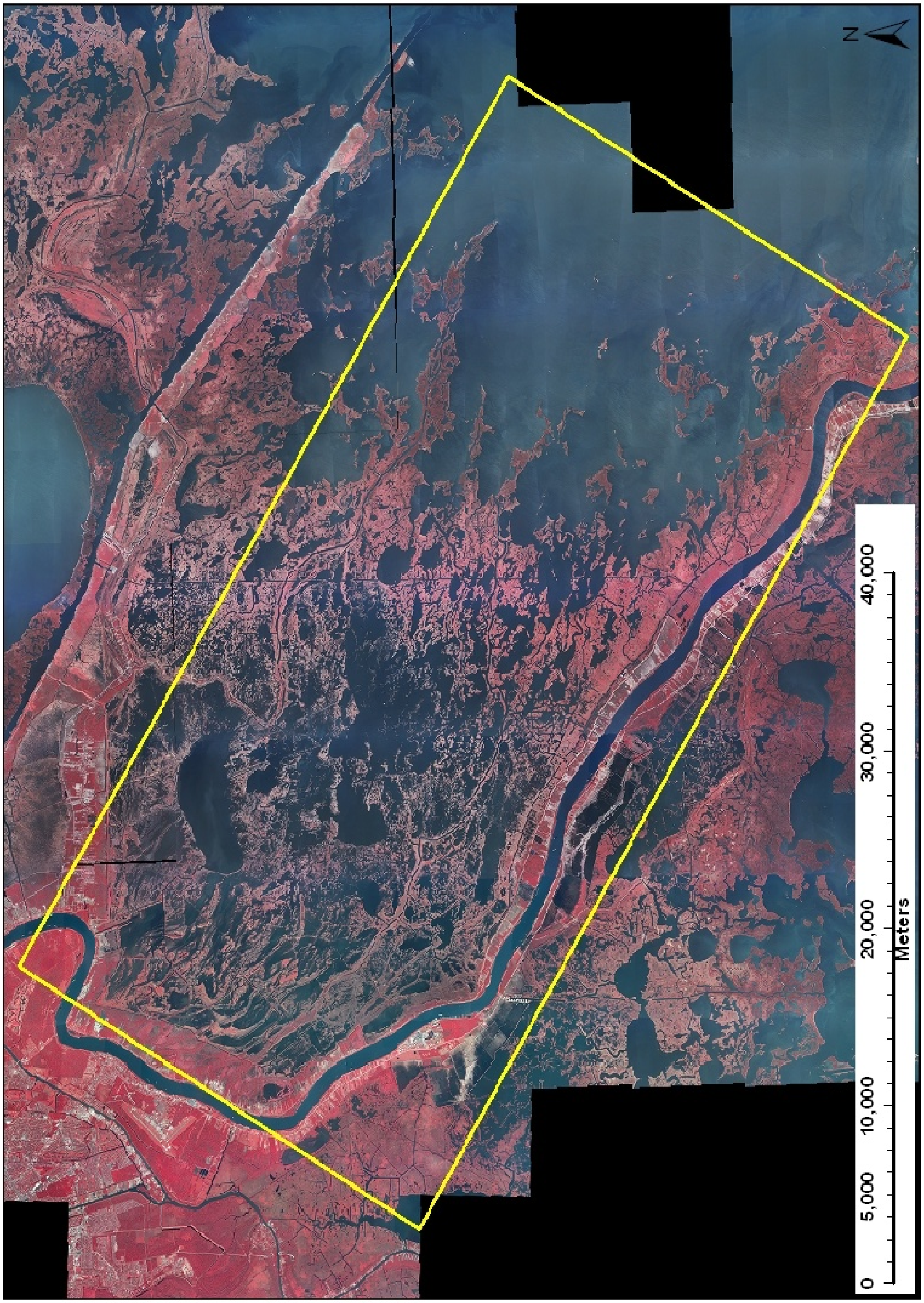
To provide bathymetric data for the model grid, a project-specific bathymetric and topographic data set was developed. This data was used to set the bottom elevation of the cells in the model grid. Initial experiments with the model indicated that the grid resolution in the White

Ditch area would need to be on the order of 10 to 30 meters. This level of resolution would provide sufficient resolution of the channel features but allow for reasonable simulation times on high-end workstations. Therefore, the bathymetric and topographic data should have a minimum resolution of 10 meters in the White Ditch area.

The area bathymetry and topography were developed from existing bathymetric data, land/water boundary data and results from the project field survey. It was determined early in the bathymetric data development that existing bathymetric data were limited to areas above MSL and sets did not provide sufficient resolution for direct use in the grid generation. Therefore the following approach was used to develop the bathymetric and topographic data set:

- Acquire the most recent land/water boundary data
- Update the land/water boundary data for Post Katrina conditions
- Divide the land/water boundaries into small polygons representing channels, lakes, land segments and other features
- Assign depths to each polygon
- Convert the polygons to a 10 meter grid and export
- Import the 10 meter grid into SMS and use to populate the CMS

Figure L2.8: Grid/Model extents.



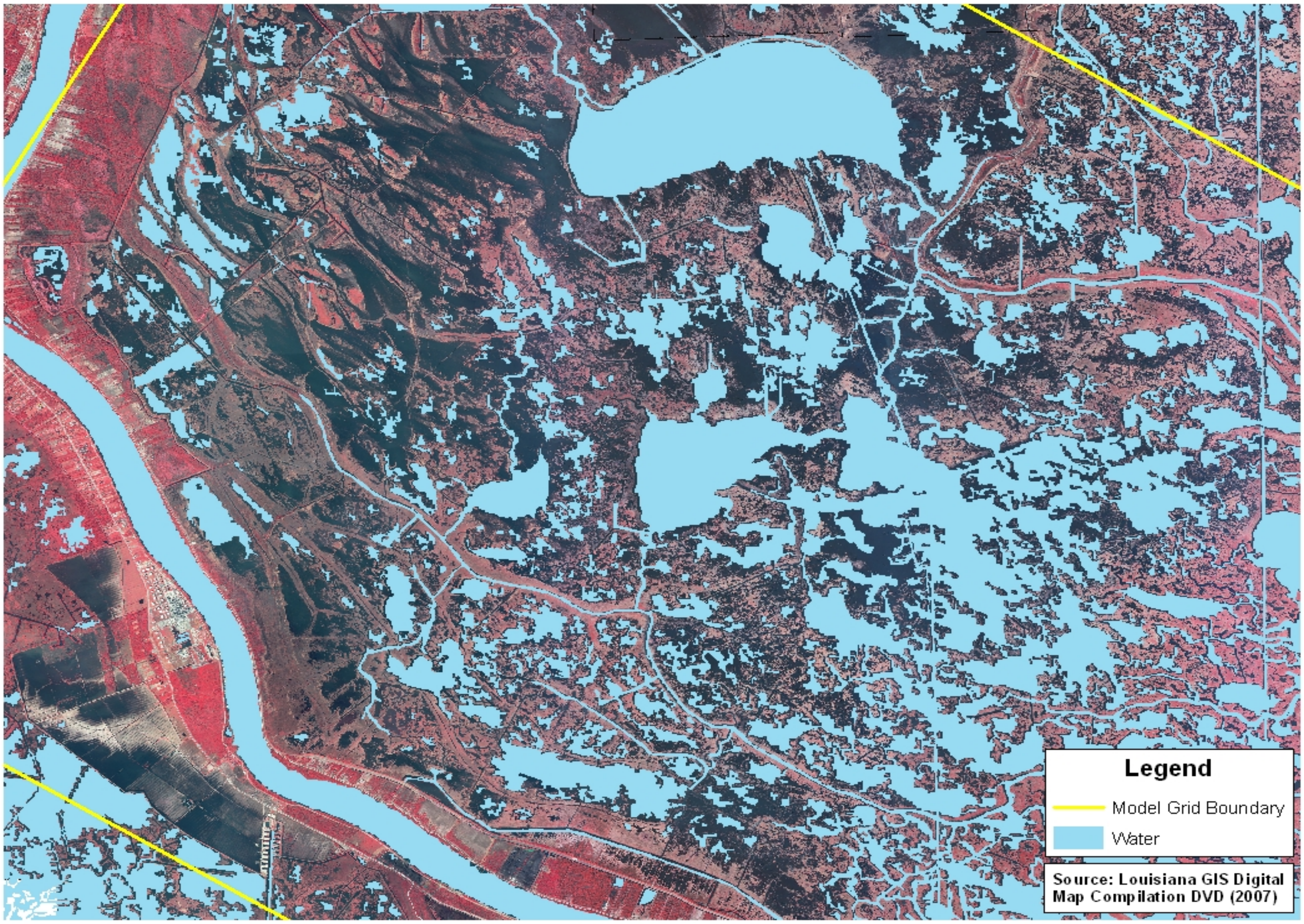


Figure L2.9: Marsh loss attributed to Hurricanes Katrina and Rita

Several datasets of land and water polygons were obtained for use in developing the bathymetric dataset; one from the Louisiana GIS Digital Map Compilation DVD (2007) and one from the ESRI Streetmap dataset. The land/water polygon data from the LA GIS Digital Map Compilation DVD was used to start the bathymetric data processing. This polygon data represents pre-Katrina conditions and is shown in Figure L2.9 overlaying post-Katrina aerial images. It is clear that there were some significant changes in the land mass in the White Ditch area, especially in the NW region. These changes were confirmed in a USGS study, the results of which are shown in Figure L2.10. Therefore In order to update the land/water polygons to reflect post-Katrina conditions, polygons from the ESRI dataset were used in compliment and this set was further modified. Additional digitizing was conducted so that the final set of polygons reflected the land and water boundaries as depicted in the most current aerial photography available for the area. Additional reviews of the polygon data set indicated that not all of the canals in the study area were completely represented in the processing. Canals not represented were digitized and canal water body connections that were inaccurate were modified. The final set of polygons is shown in Figure L2.11a and L2.11b.

Figure L2.10: USGS Water Area Change in Southeastern Louisiana

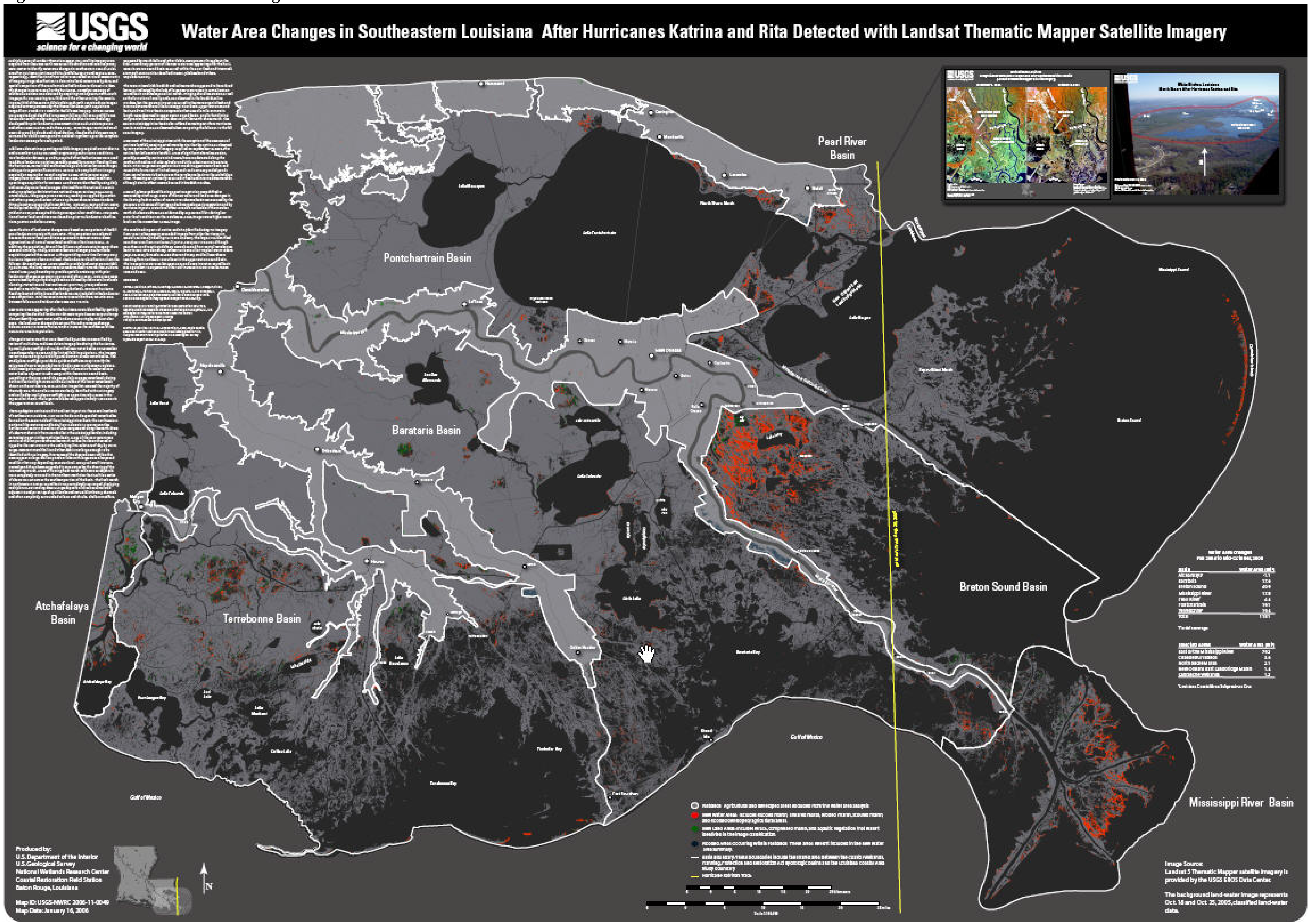


Figure L2.11a: Land analysis polygons

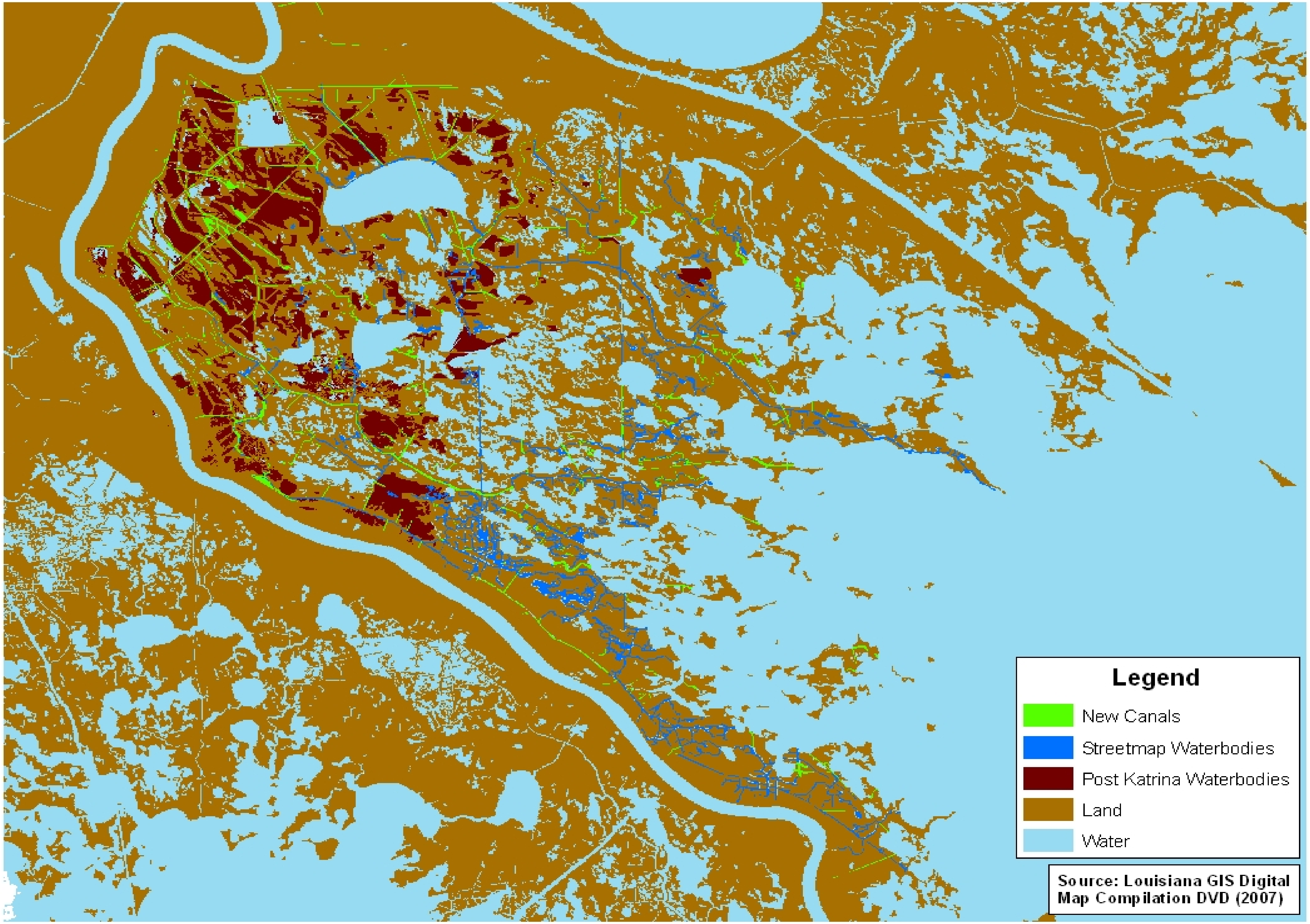


Figure L2.11b: Land analysis polygons

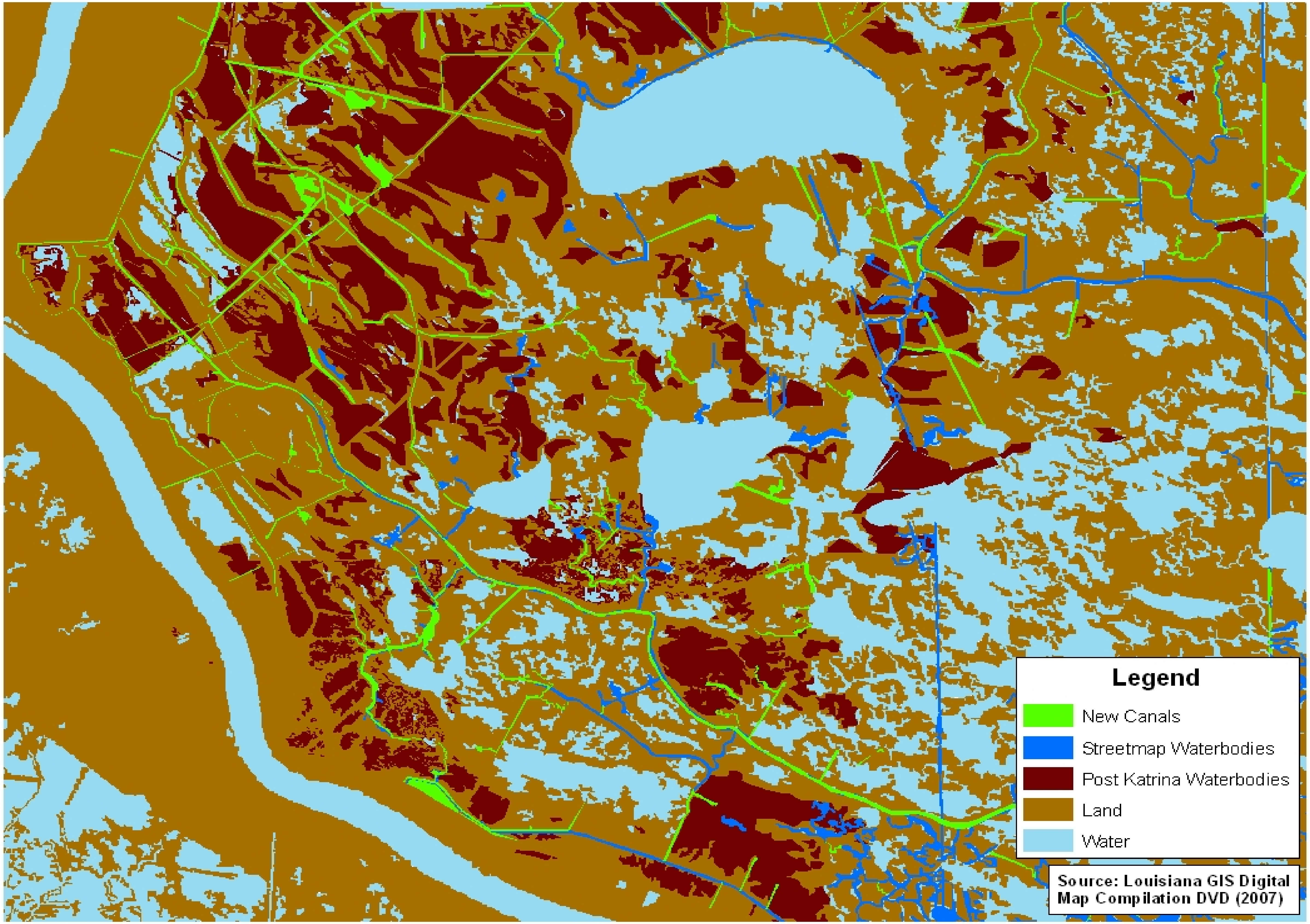
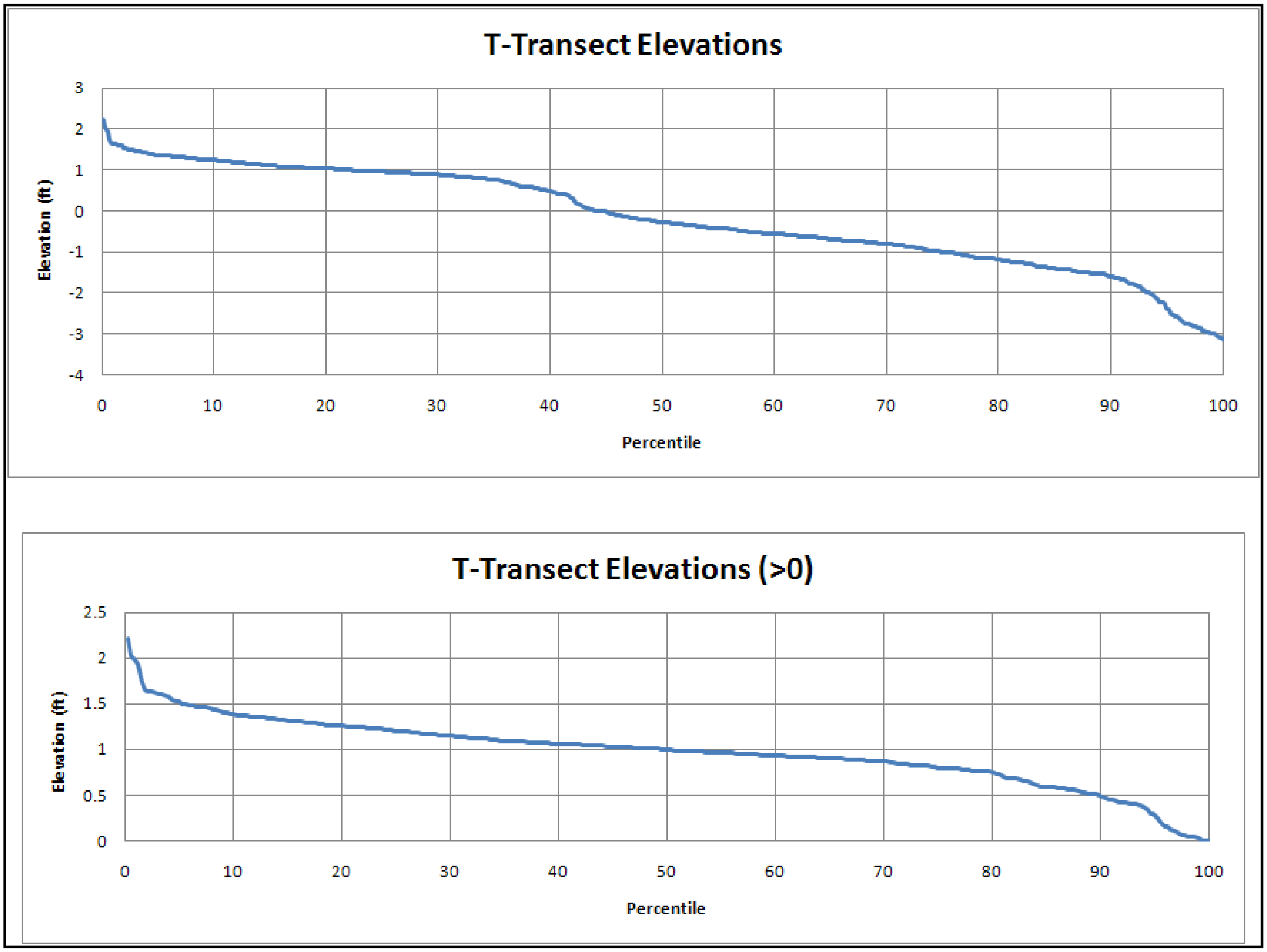


Figure L2.12: Distributed survey data developed by URS Corp.



The next step was to assign depth values to each of the polygons in the data set. As pointed out in Section 2, there was no comprehensive bathymetric data set available. In order to assign depths, information from the project bathymetric survey and NOAA nautical chart data were used. The first step was to set the land elevation. For this purpose, all of the survey data was pooled and sorted to identify the distribution and range. The distribution of the data is shown in Figure L2.12. There is a distinctive break in the distribution at elevation 0 ft (NAVD 88) that is likely representative of MSL, where the channel and lake banks are steepest. Assuming that most of the inter-tidal zones and land segments lie at or above 0 ft elevation, the data was filtered to eliminate values below 0 feet, and then resorted. The results are also shown in Figure L2.12, and indicate that the median land elevation is 1 foot NAVD 88. This value was adopted as the land elevation and all land polygons were assigned a depth of -1 ft.

In order to assign depth values to the canals and lakes, the survey data transects were processed and used to develop a suitable average depth for each cross-section. Each transect cross-section was clipped so that the only the portion below MSL remained. Then the hydraulic radius of the cross-section was calculated. Then the cross-section effective depth was calculated so that it would yield the same hydraulic radius as the original cross-section. This value was then assigned to the center point of the cross-section transect and used to assign depth values in the canal and lake polygons. The effective depths and their locations, as obtained by this procedure, are shown in Figure L2.13. The effective depth data did not provide sufficient information to assign depths to all canal and lake polygons. Therefore a generalized template for canal and lake depths was developed and used to assign the depths to the remaining polygons. A review of Figure L2.13 indicates that there is a general increase in the canal and lake depths from the NW to the SE. A template, shown in Figure L2.14, was developed using this trend.

After completing the depth assignments to each polygon, the depth data were interpolated from the polygons to a point grid. The point grid consisted of 10 m spacing in the White Ditch area and expanded to 50 m spacing to the east of the Oaks River and to the SE. The 50 m resolution was necessary to keep the file size manageable and still provide sufficient resolution of key features. A view of the bathymetric data as reflected by the point grid is shown in Figure L2.15. An enlarged portion of the point grid data is shown in Figure L2.16, where the points are color coded by the assigned depths.

The point grid bathymetry dataset was imported into SMS, triangulated, and the depths were interpolated on to the CMS grid. Based on trials in the focus area near White Ditch, a 20 meter resolution was determined to be optimal for areas in the vicinity of the proposed diversion.

The grid was designed with 20 meter spacing in the White Ditch area with the cell spacing expanding to the SE and SW. In these regions of grid expansion, the grid was allowed to increase to a maximum grid cell size of 500 meters in order to keep the number of cells as low as possible and help manage simulation run time while still providing detailed resolution in the White Ditch study area. Certain cells are ‘inactive’ and represent areas protected by levees or that are above 4 feet elevation. These cells are not used in the model simulations and are a by-product of the inherent CMS rectangular grid structure. A QAQC process was performed in order to ensure canal connections and other components necessary for accurate flow simulation, and cell properties were adjusted manually where appropriate. The final grid contains 866,791 active cells in 992 Columns and 569 Rows. After some initial testing, a time step of 1.5 seconds was found to provide numerically stable solutions, and the model simulations (including salinity transport) were determined to take about two days (48 hours) in order to simulate a one month period on an HP Workstation Z400 with an Intel 2.93 Ghz Xeon Quad processor and 8gb DD3 SDRam.

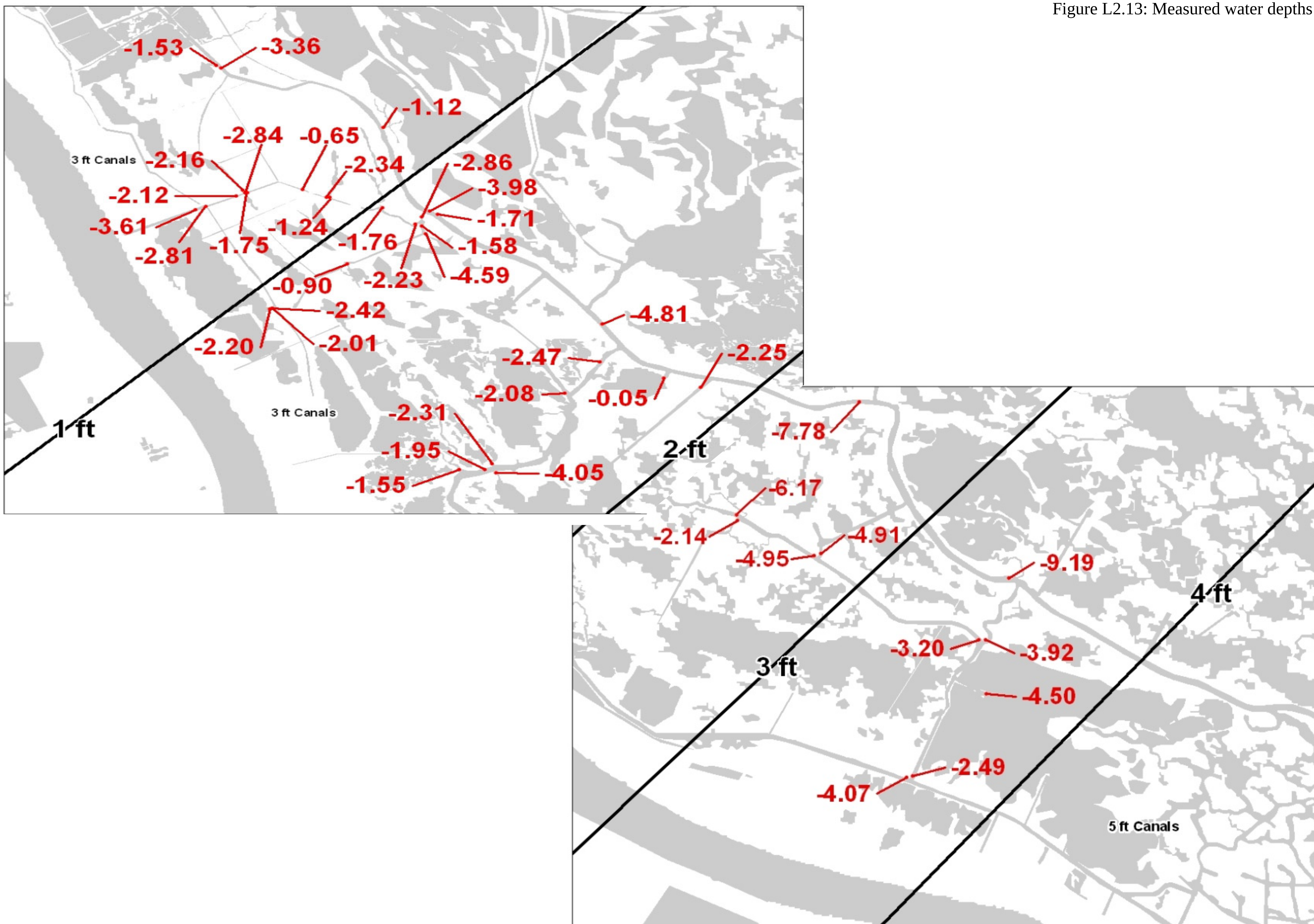


Figure L2.13: Measured water depths within the White Ditch project area

Figure L2.14: Water depth trend used for modeling purposes

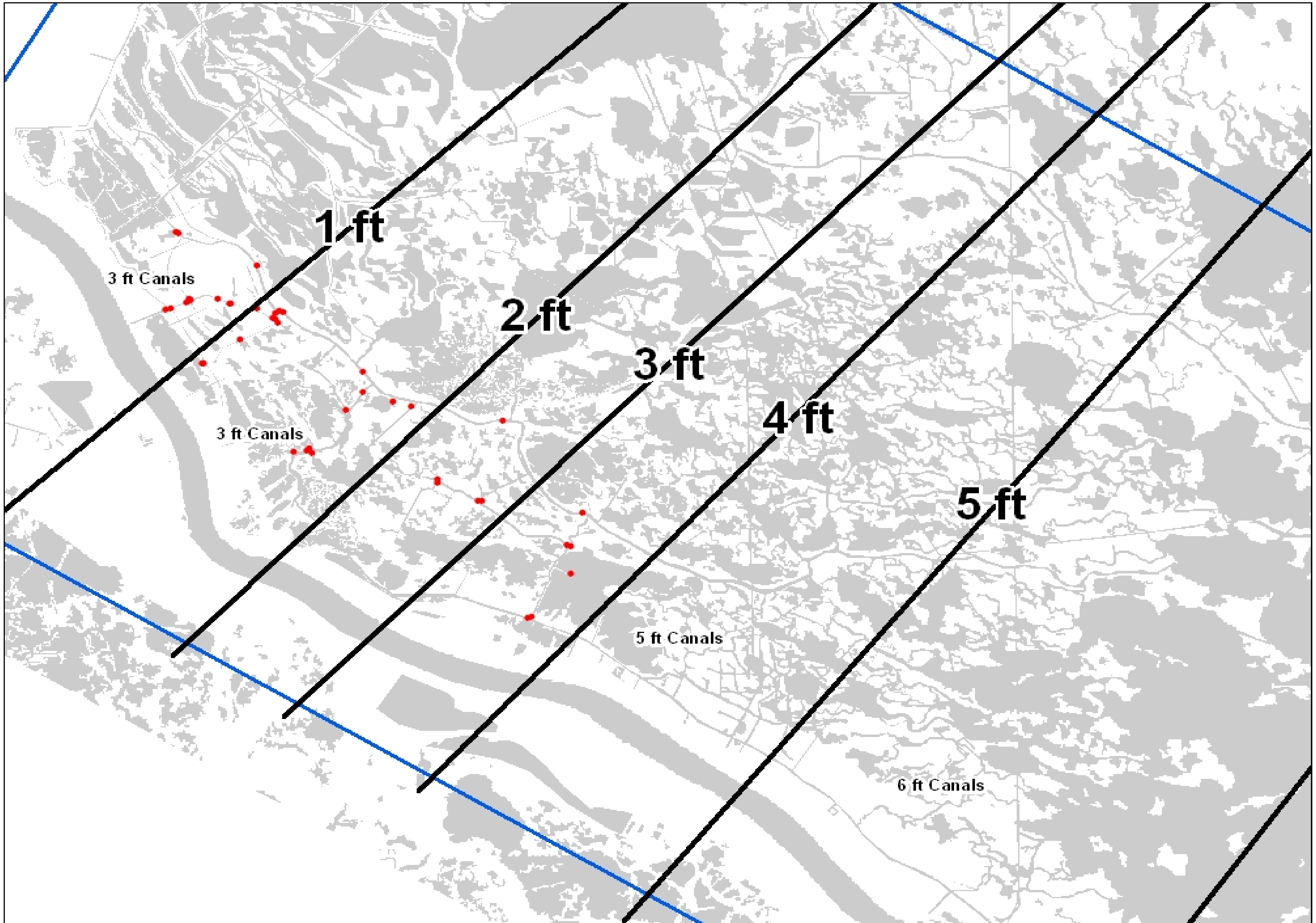


Figure L2.15: A view of the bathymetric data for the White Ditch project area, as reflected by the point grid

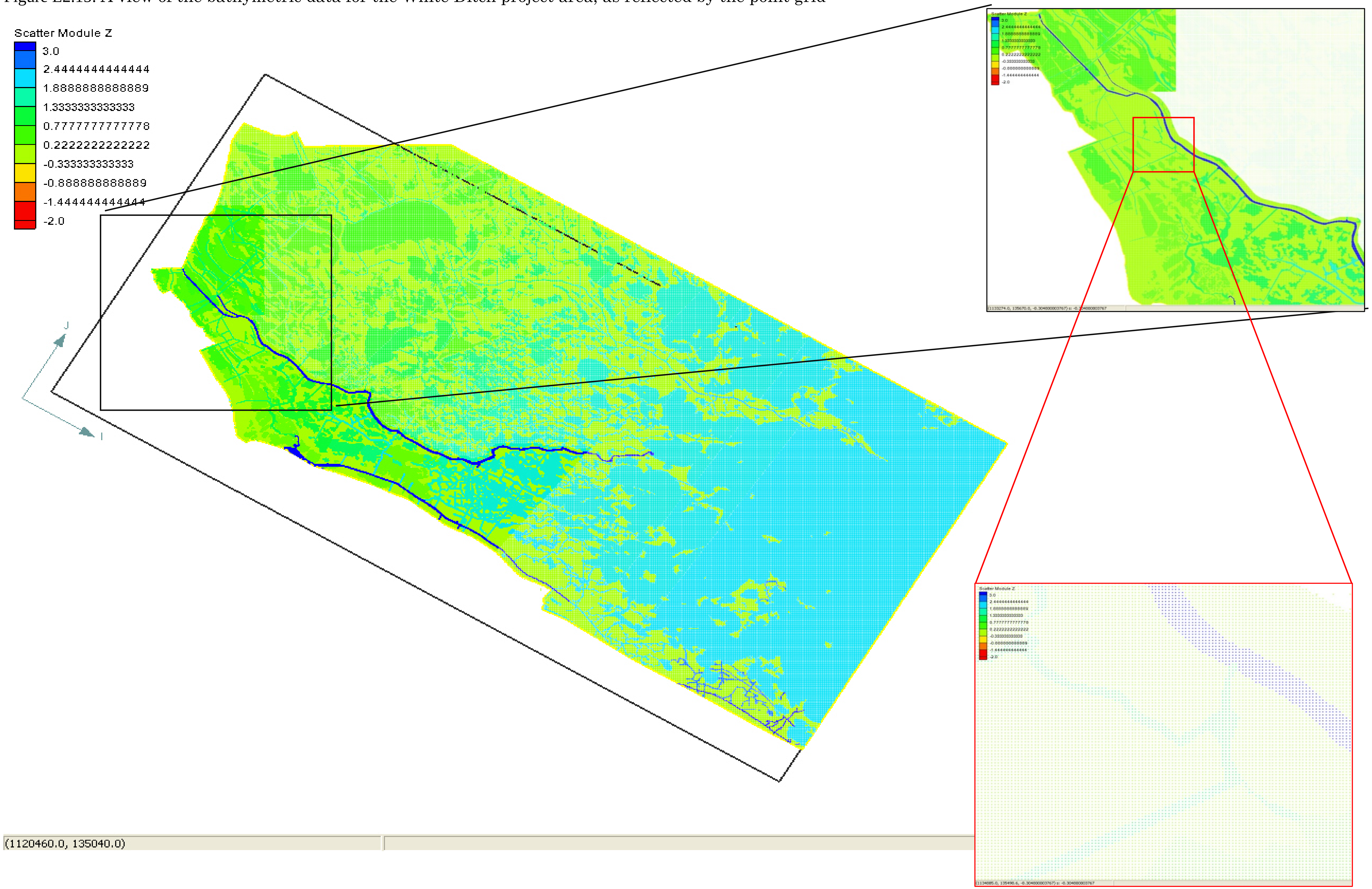
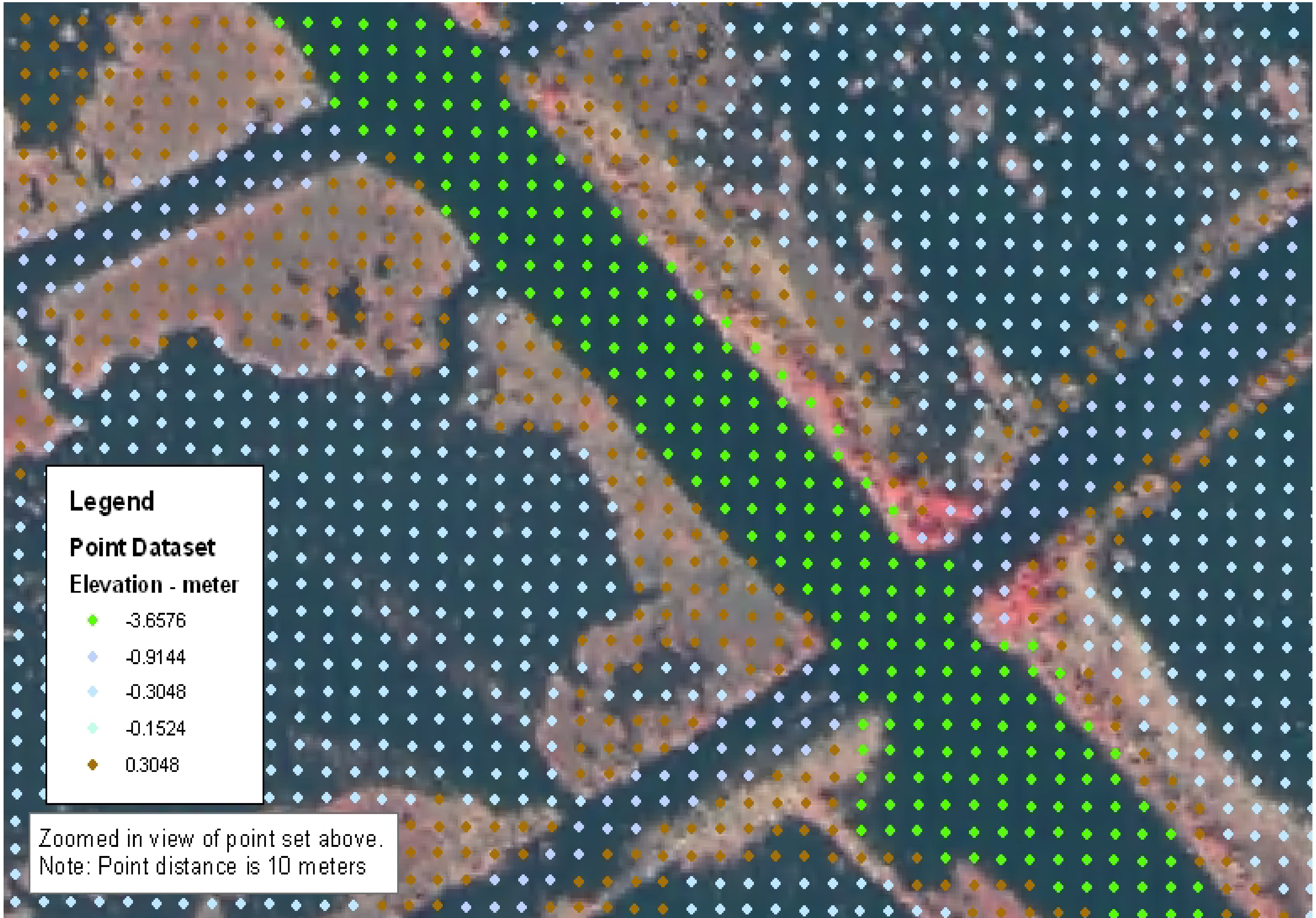


Figure L2.16: An enlarged portion of the point grid data for the White Ditch hydrodynamic model



L2.5 Boundary Conditions

The boundary conditions required for the White Ditch model simulations included:

- Offshore tide elevation
- Offshore salinity values
- Flow boundaries (flow rate and salinity)
- Rainfall and Evaporation
- Wind Forcing

As discussed in the Section L2.3, it was not possible to obtain a tidal calibration to measured data in the White Ditch area without shifting the reported elevation of the tide data. The Bay Gardene tide data is reported as NAVD 88 and the mean tide elevation for one or more year period is approximately one foot above sea level; therefore, a shift of 1.0 feet down was made to set the average at approximately sea level.

Local survey data in the White Ditch area indicates that the median land elevation (based on numerous survey points on transects across the area) is about 1 foot. During the rising tide, it would be expected that land would become inundated and during a falling tide the inundated areas would become dry. When this was reproduced in the model simulations it caused a severe attenuation of the tide range in the White Ditch area. The effect was so severe that there was no possibility of matching the measured tide range in the White Ditch area. Local knowledge of the area, based on discussion with airboat operators who spend a sufficient amount of time in the White Ditch area, indicates that during normal tides the land areas do not become submerged, even at high tides. These two factors further supported the decision to shift the Bay Gardene data downward by 1.0 feet.

Note that during the model calibration, it was found that the salinity calibration was sensitive to both the total flow rate from the Caernarvon Diversion as well as the split between the amounts assumed to flow through the Delacroix Canal to the west and the through Bayou Mandeville to the south. Therefore, the grid was modified slightly in the region of the Caernarvon Diversion so that the flow splits could be assigned directly.

The actual values assigned to each boundary condition varied for the model calibrations and the alternatives and the specific values used are discussed in the subsequent sections.

L2.6 Hydrodynamic Model Calibration

A model calibration was conducted for both hydrodynamics and salinity transport, with the hydrodynamic calibration completed first. The hydrodynamic and salinity calibration were conducted simultaneously. This was necessary because it was learned in the preliminary salinity calibration simulations that the salinity calibration was sensitive to the total flow and flow split assumed for the Caernarvon Diversion. Since these flow rates may influence the tidal response in the project area, it was necessary to conduct the hydrodynamic and salinity calibration simultaneously.

The hydrodynamic calibration period was selected to coincide with the period for which the stage data was available from the project field program, namely the four day period July 20 through July 24th. Preliminary testing with the model indicated that the tidal flows required a relatively short spin-up period, on the order of one-week, but it was found that the salinity simulations required a much longer spin-up period.

The salinity calibration focused on the same period for data comparison, July 20th through July 24th, for which salinity data was available from the project field program. After some preliminary testing with the model, it was found that a two-month spin-up was required to eliminate the effects of the initial conditions on the solution.

For the calibration simulation, the model was configured with measured wind, tide, rainfall, evaporation, salinity and Caernarvon flow data corresponding to the calibration period. For the evaporation, the average value of 5 mm/day adopted from the Cooke et al. (2008) study was used. For the Caernarvon diversion flows, freshwater was assumed, and the corresponding salinity was assigned a value of zero.

The key calibration parameters are:

- Bottom Fiction (Manning's n)
- Lateral Dispersion
- Fresh Water flow and flow split from Caernarvon
- Fresh Water from Caernarvon reaching River Aux Chenes

The calibration simulations indicated that the hydrodynamic calibration was most sensitive to the bottom friction, with a minor sensitivity to the Caernarvon flow splits. The salinity calibration was most sensitive to the Caernarvon Diversion flow rate and flow split, with a lower level of sensitivity to the lateral dispersion.

An initial range for the lateral dispersion was obtained by considering the length scales of the water bodies in the White Ditch area and the length-scale dependent dispersion values from a study by URS. For this analysis, a length scale was developed by taking the square-root of the area of each of the polygons used to represent each water body and then selecting the median value. The median value is approximately 300 meters, for which the associated dispersion coefficient is $10 m^2/s$.

The rational for adjusting the total Caernarvon flow is that the model grid domain does not contain the entire area influenced by the diversion flow. Therefore, only a portion of the flow actually drains through the region covered by the model grid. The remaining portion of the flow drains towards the MRGO channel that is not represented in the model grid. Thus it is appropriate to reduce the Caernarvon flow rates so that they better represent the flow entering the area covered by the model gird. The 'best' reduction level was determined via the salinity calibration.

It was found the salinity calibration was sensitive, albeit to a smaller degree, to the assumed split in Caernarvon flows that go off to the west and south. Historically the portion flowing to the west, directly towards the White Ditch area, was about 20 to 30 percent. However, it is believed by local land managers that after Hurricane Katrina, the percentage flowing directly to the west is lower, due to blockage of many of the smaller canals, and is currently about 5 to 10 percent.

After assigning the dispersion value, a sequence of final calibration simulations were completed in which the bottom friction and the total flow and flow split for the Caernarvon were systematically altered. The final calibration was obtained with the following parameter values:

- Manning's n: 0.012
- Dispersion Coefficient: 10 m2/s
- Amount of Measured Caernarvon Flow applied: 58%
- Amount of Applied Caernarvon Flow directed to the west: 5%

The final stage calibration is shown in Figure L2.17 and the final salinity calibration is shown in Figure L2.18. The simulated stage calibration indicates that the model represents the measured tide amplitude reduction and phase shifts at stations S3 and N3. The salinity calibration results shown in Figure L2.18 represent the time-averaged salinity values over the last four days of the simulation, which correspond to the time period of the measured values obtained during the project field program. The spatial gradients and the actual salinity levels are well represented in the simulated results. The largest discrepancy occurs in the southern station (Simulated Salinity Point 37) where the model results slightly under-predict the salinity levels.

Figure L2.17: Final Stage Calibration

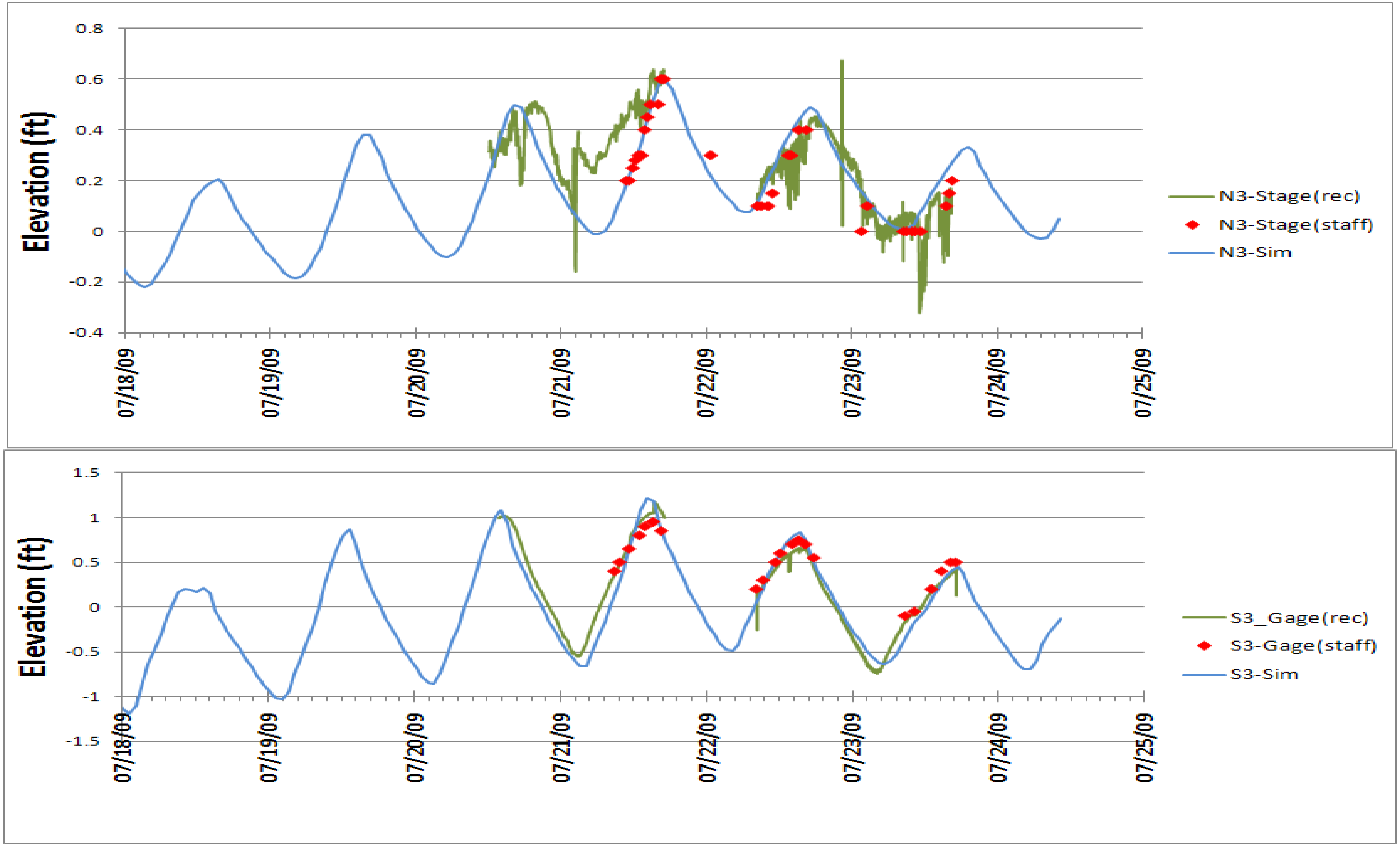
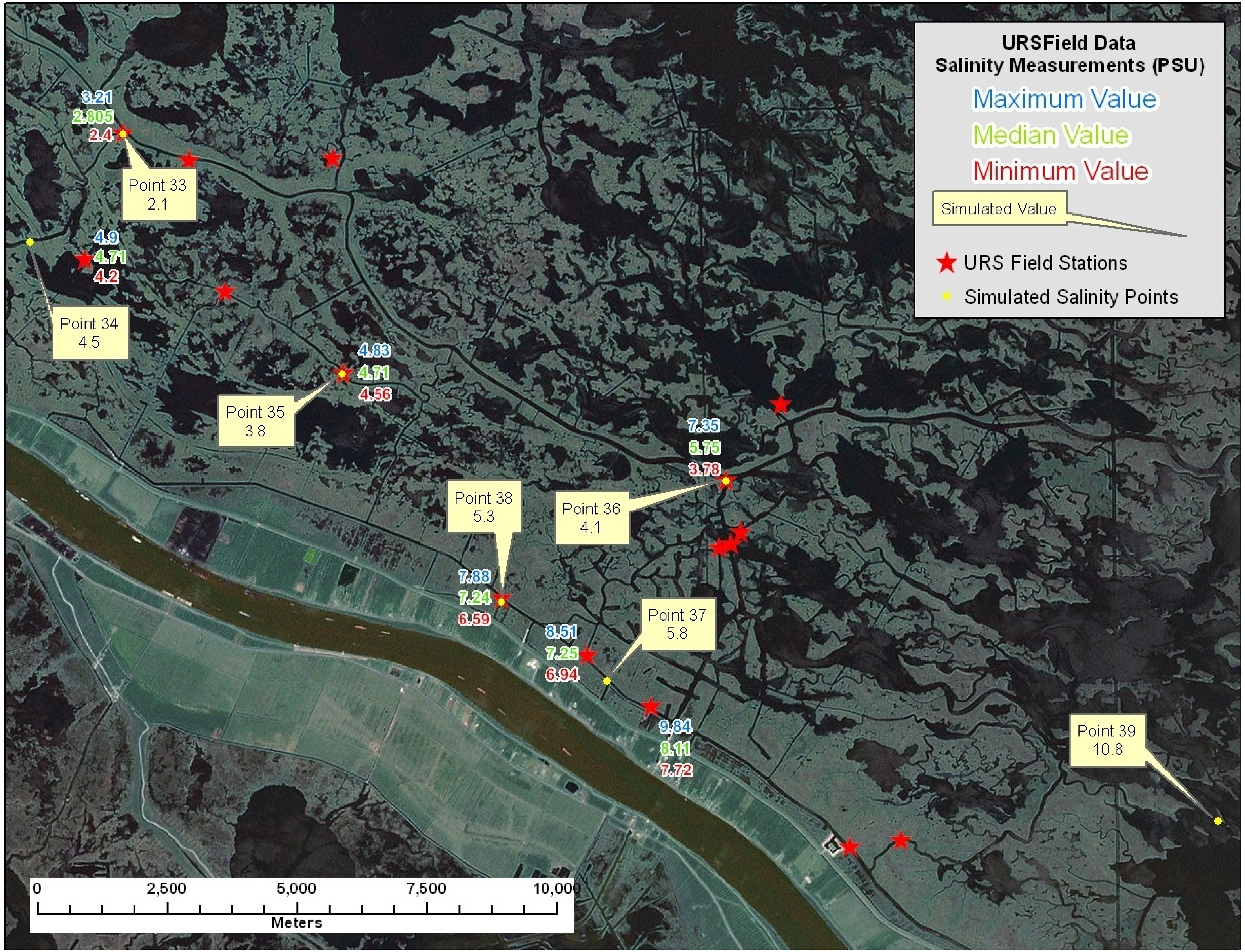


Figure L2.18: Final Salinity calibration results



L2.7 Hydrodynamic Alternatives Analysis

The hydrodynamic model's primary purpose is to compare the different alternatives developed by the project delivery team and support the quantification of environmental benefits. Each series of simulations were established with the same background, or boundary conditions, to allow for a direct comparison of benefits between each diversion alternative. There were thirteen total alternatives being modeled as shown in Figure L2.19. Alternatives at each location consist of a similar layout with expanded channels for the larger flow diversions. Layouts for Location 2 at the existing White Ditch are shown in Figure L2.20. Layouts for Location 3 at the existing White Ditch are shown in Figure L2.21. Specifics showing channel cross-sections and dimensions of the features involved please see section L7 - Civil Design Criteria.

	Location 2 White Ditch, LA	Location 3 Phoenix, LA
5,000 cfs	X	X
10,000 cfs	X	X
15,000 cfs	X	X
35,000 cfs	X	X
70,000 cfs	X	X
100,000 cfs	X	X
NO ACTION	X	

Figure L2.19

Figure L2.20: General Layout of Outfall Features for Location 2

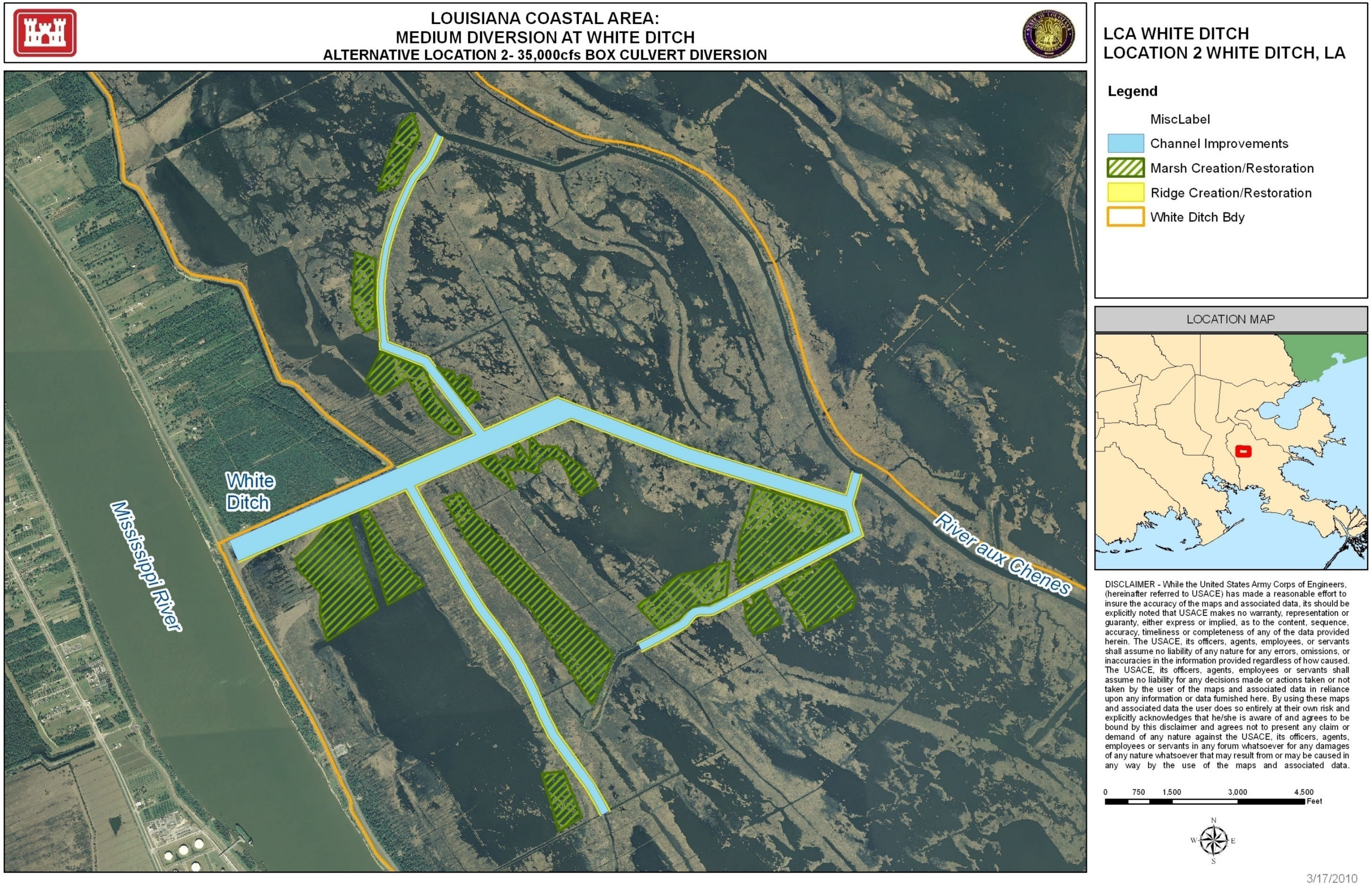
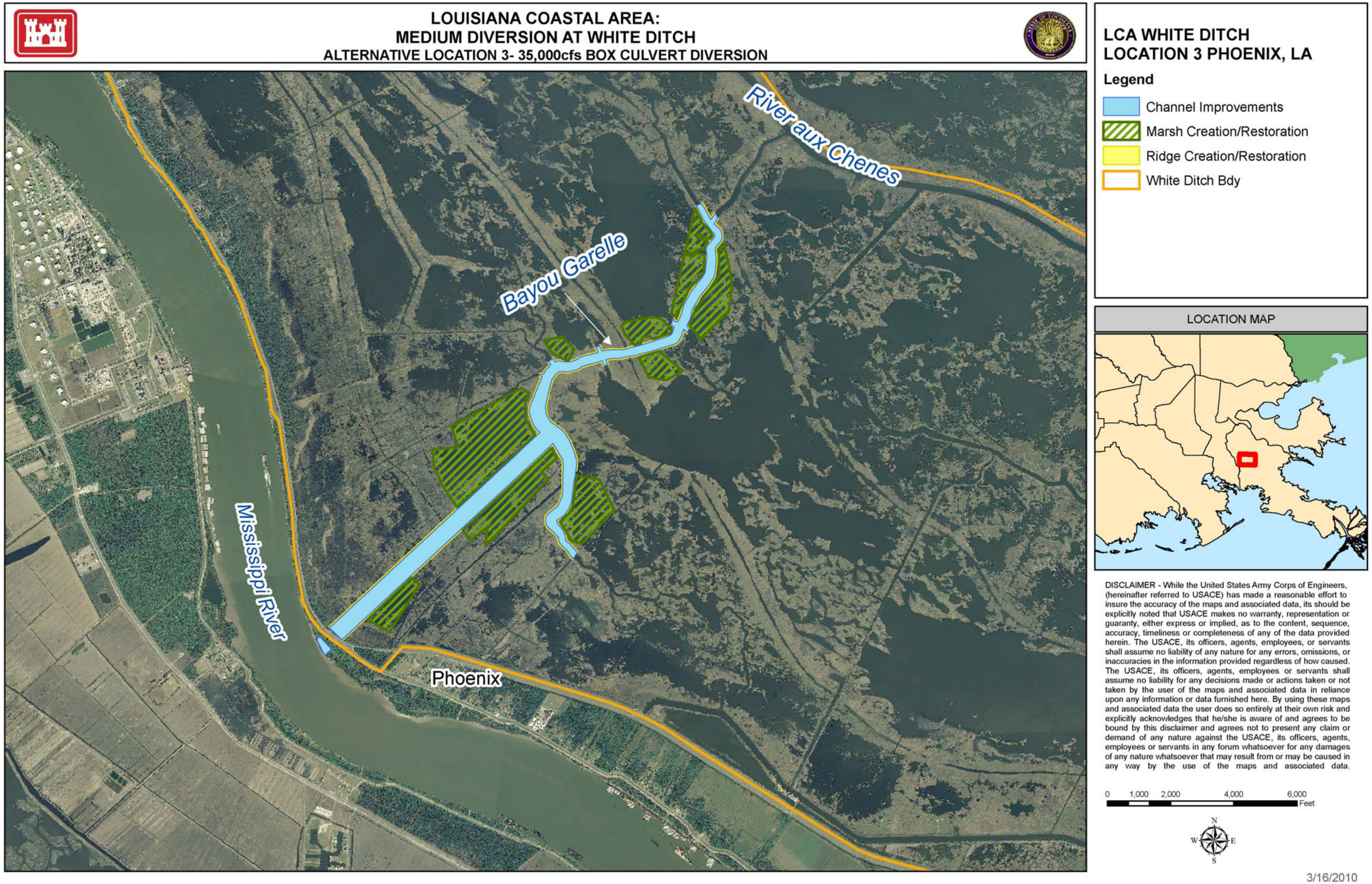


Figure L2.21: General Layout of Outfall Features for Location 3



L2.7.1 Initial Screening Analysis

The initial screening of alternatives was conducted to narrow down the number of alternatives to be run for the WVA Analysis based on time constraints. These simulations were setup to examine a hypothetical spring pulse period and allow for the comparison of results between all runs. Each simulation was to run for a one month duration with "maximum" flows from the proposed new diversion as well as from the existing Caernarvon diversion (8,000cfs). Other parameters are as follows:

- Average spring (March-May) tidal conditions.
- Average spring (March-May) wind forcing conditions for Plaquemines Parish, LA.
- Average spring (March-May) rainfall inputs.
- An average evaporation constant of 5mm/day.
- Starting salinity over the entire grid of 7ppt.

Images of the salinity results can be seen on Figure L2.21 thru Figure L2.28. It is very apparent that any diversion alternative will greatly freshen the project area, particularly if the diversion is operated in conjunction with Caernarvon. Other conclusions that were drawn from this initial modeling are that the larger diversions, 70,000cfs and 100,000cfs, will overtop the River Aux Chene ridge which violates our project scope.

675 Figure L2.21: Initial screening analysis at Location 2 with a 5,000cfs outfall

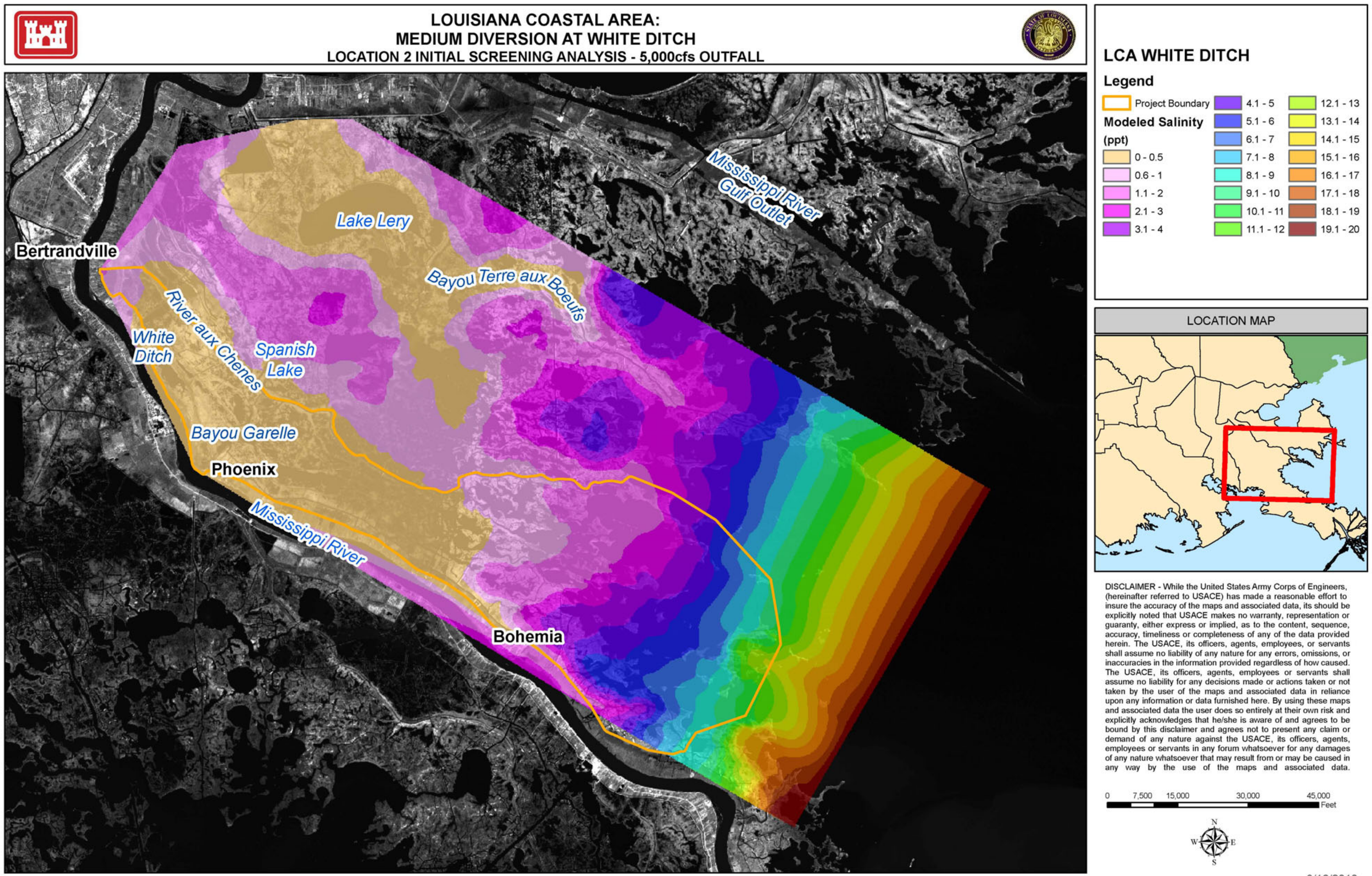


Figure L2.22: Initial screening analysis at Location 2 with a 10,000cfs outfall

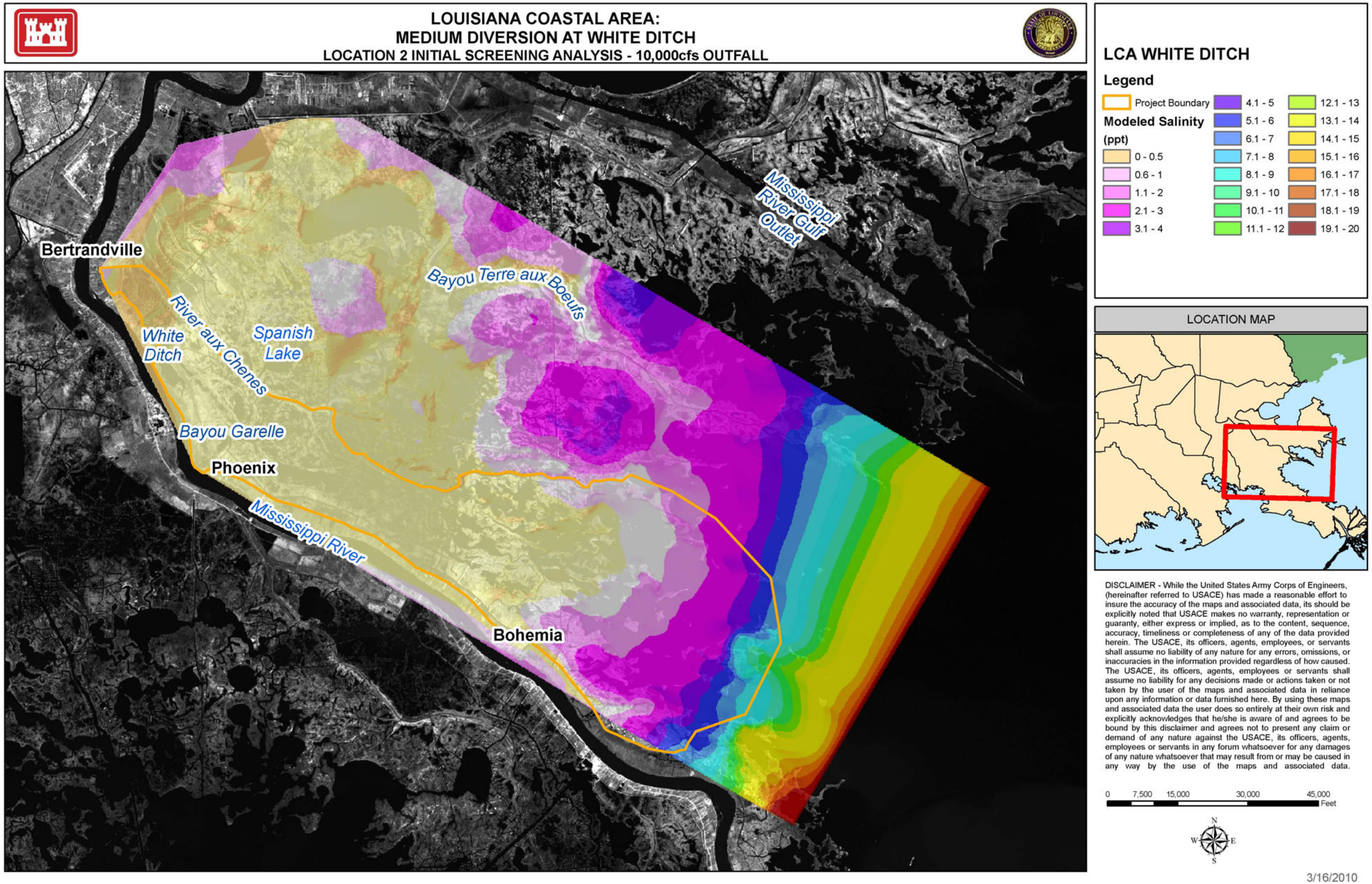


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Figure L2.23: Initial screening analysis at Location 2 with a 15,000cfs outfall

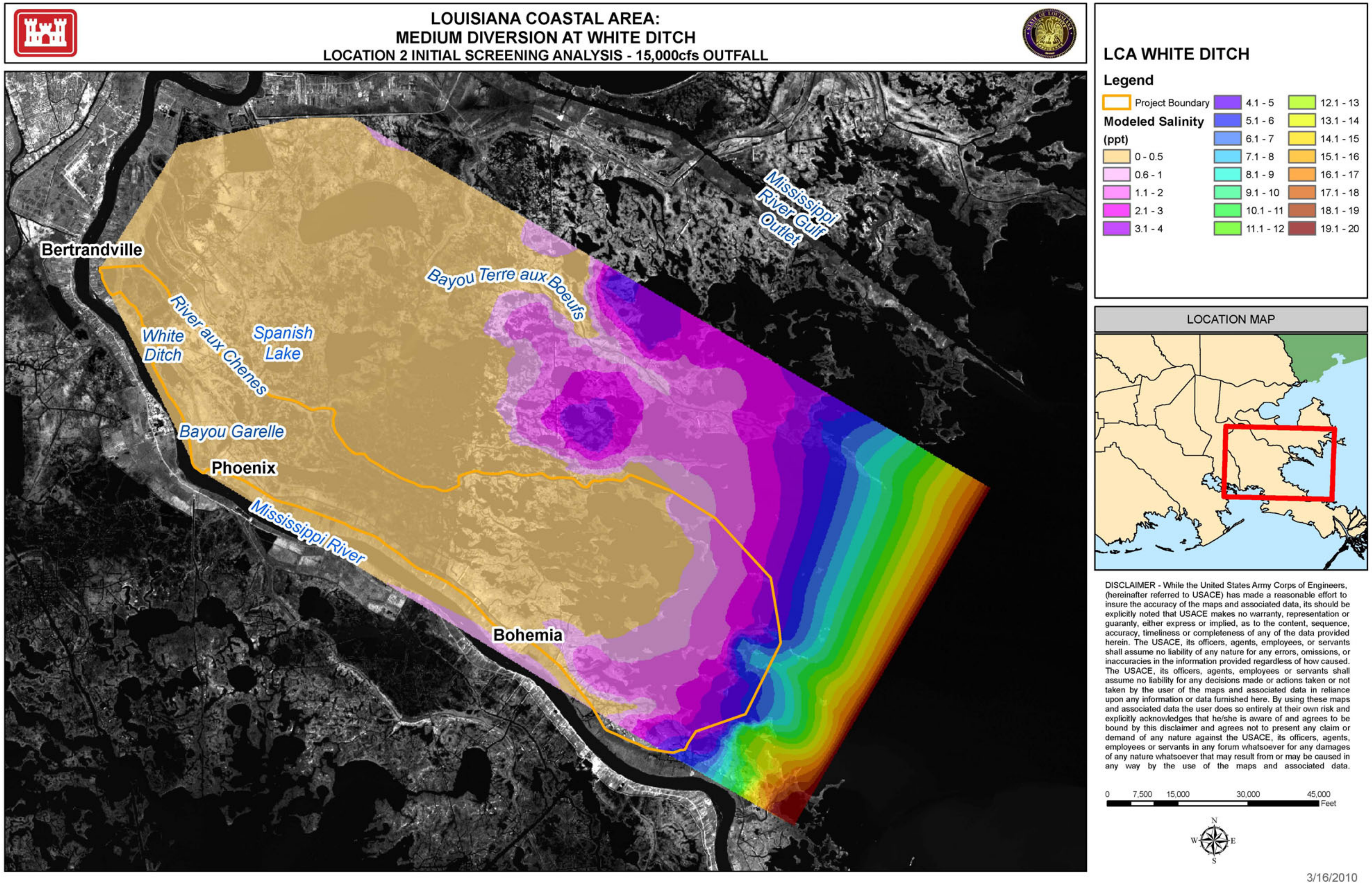


Figure L2.24: Initial screening analysis at Location 2 with a 35,000cfs outfall

685

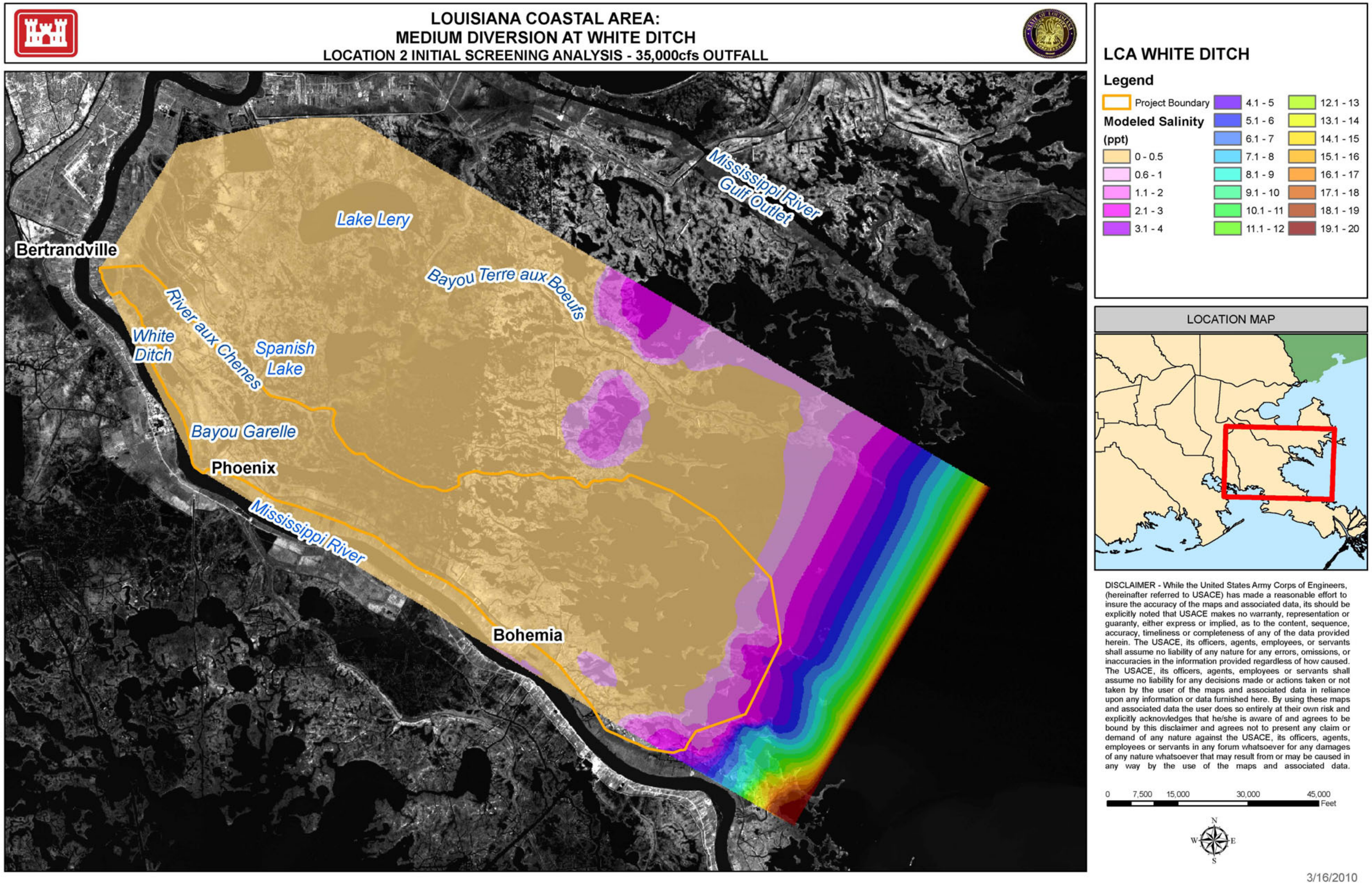
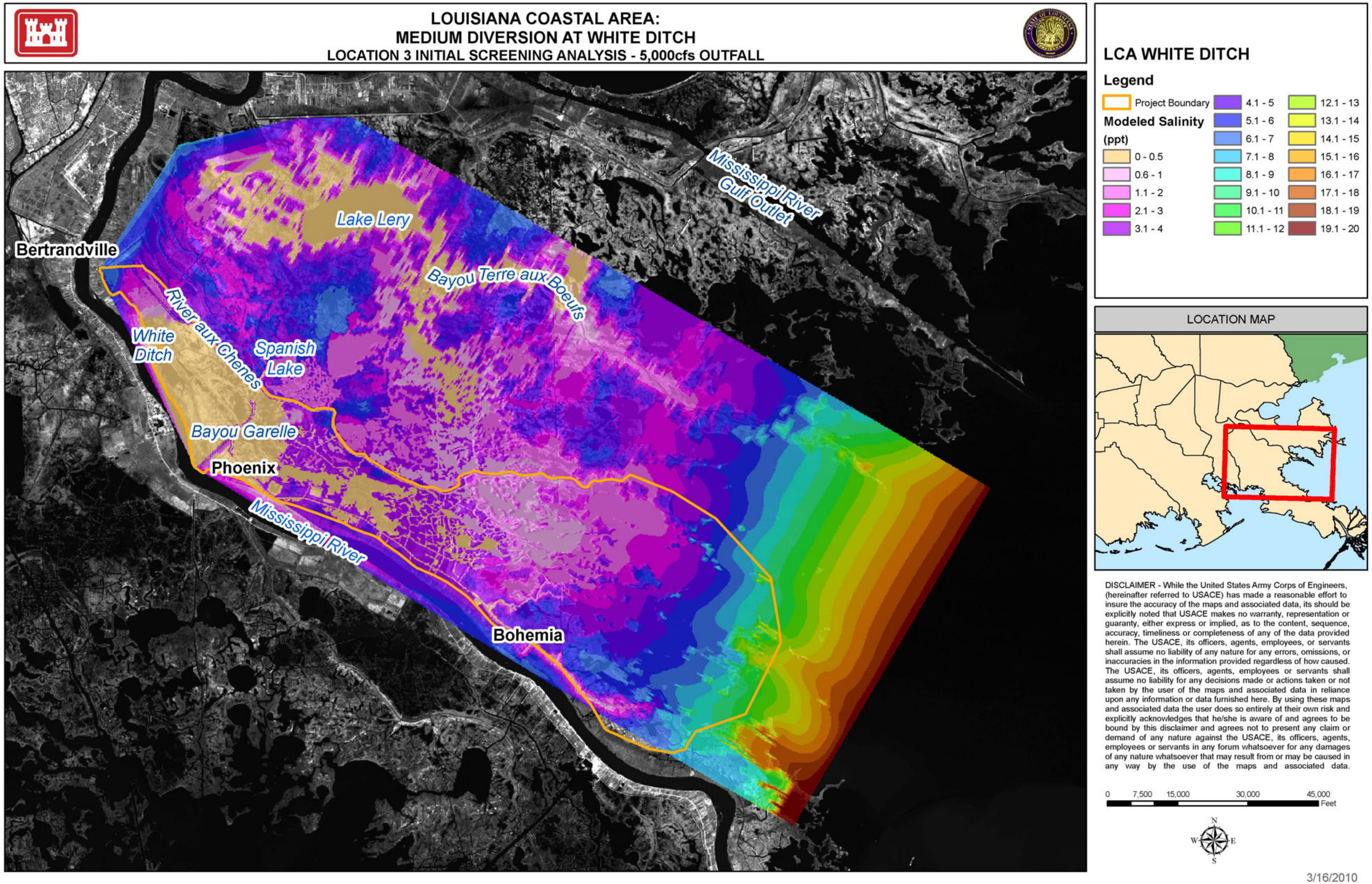


Figure L2.25: Initial screening analysis at Location 3 with a 5,000cfs outfall



690 Figure L2.26: Initial screening analysis at Location 3 with a 10,000cfs outfall

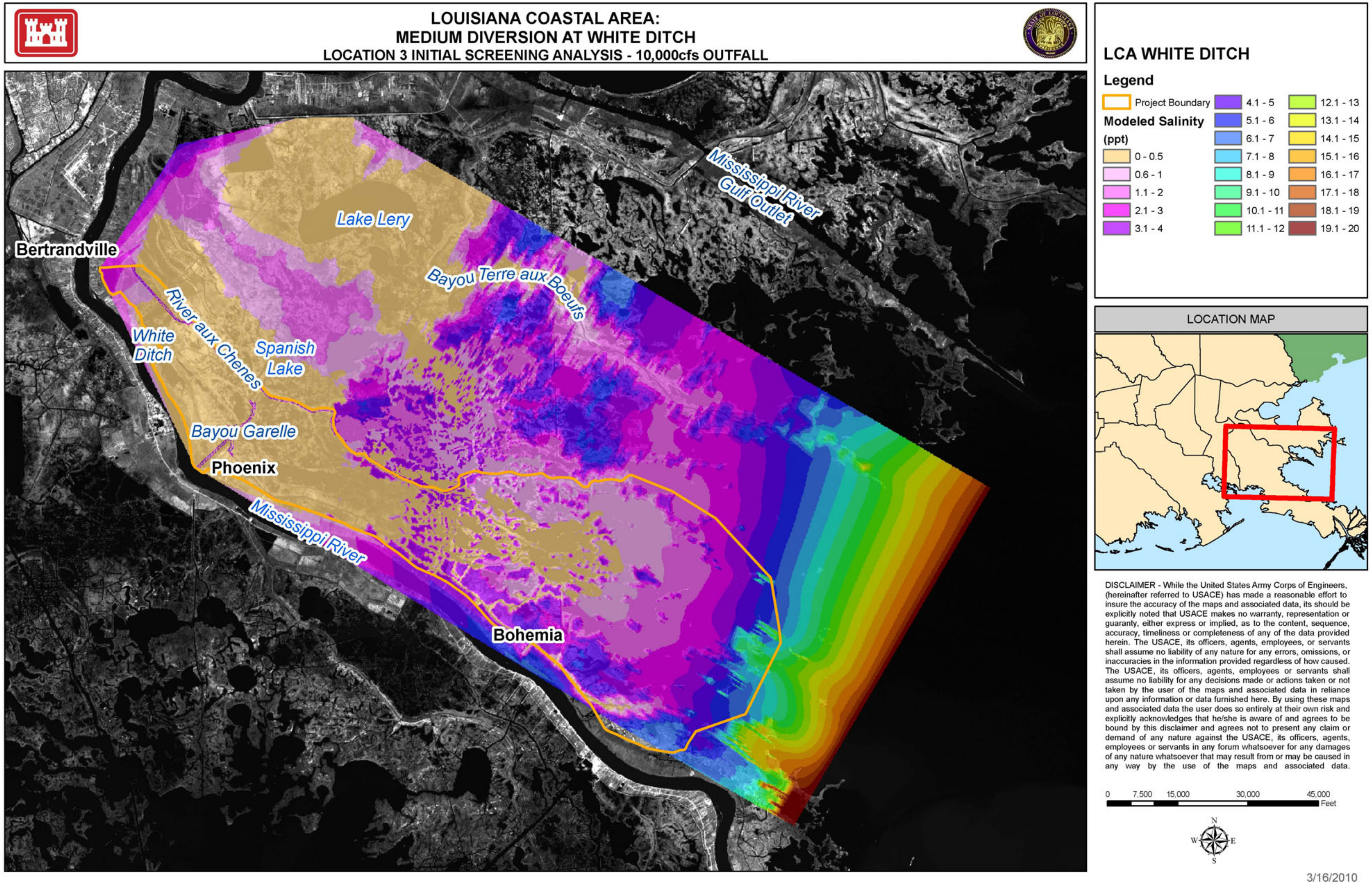


Figure L2.27: Initial screening analysis at Location 3 with a 15,000cfs outfall

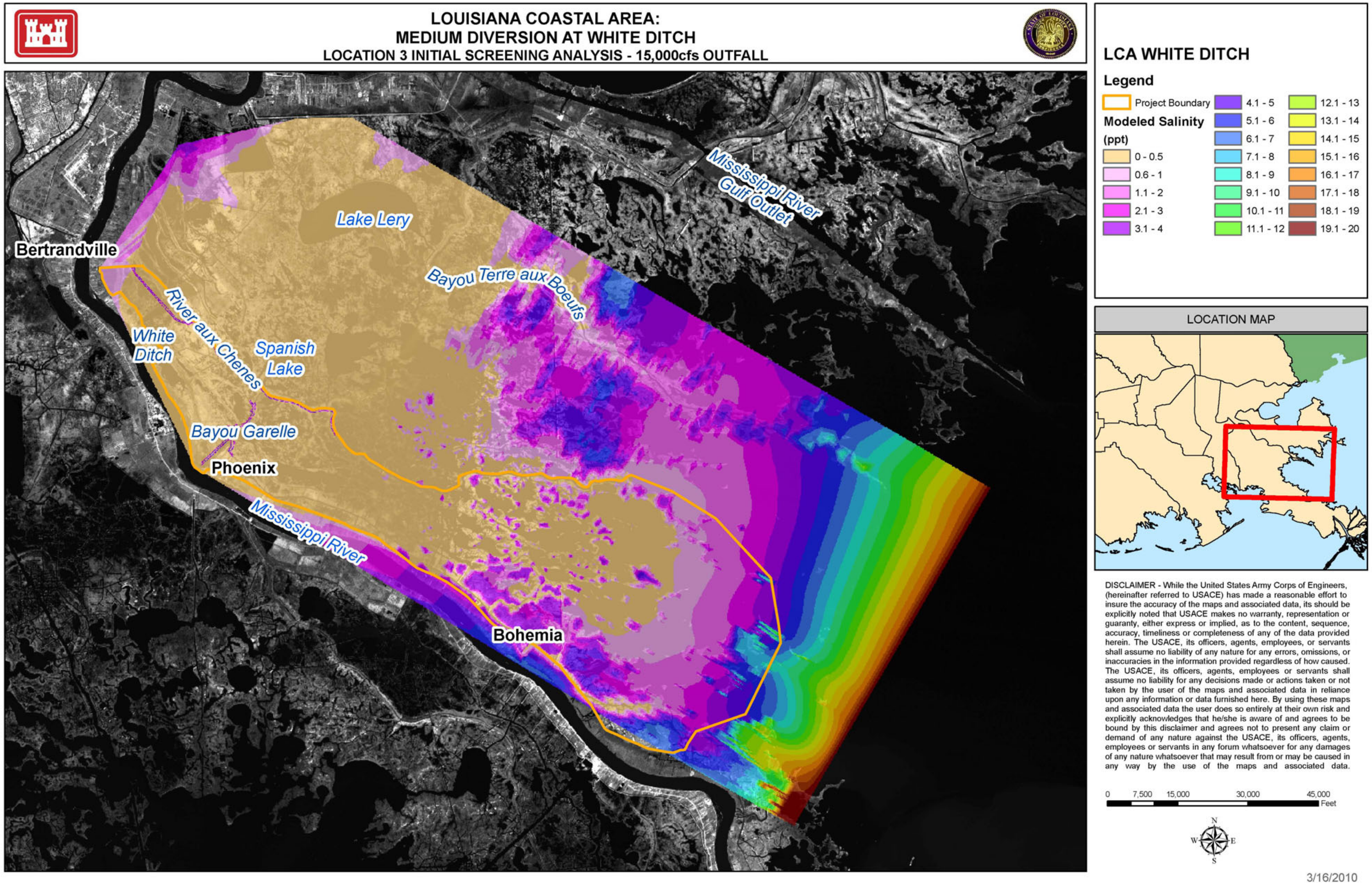


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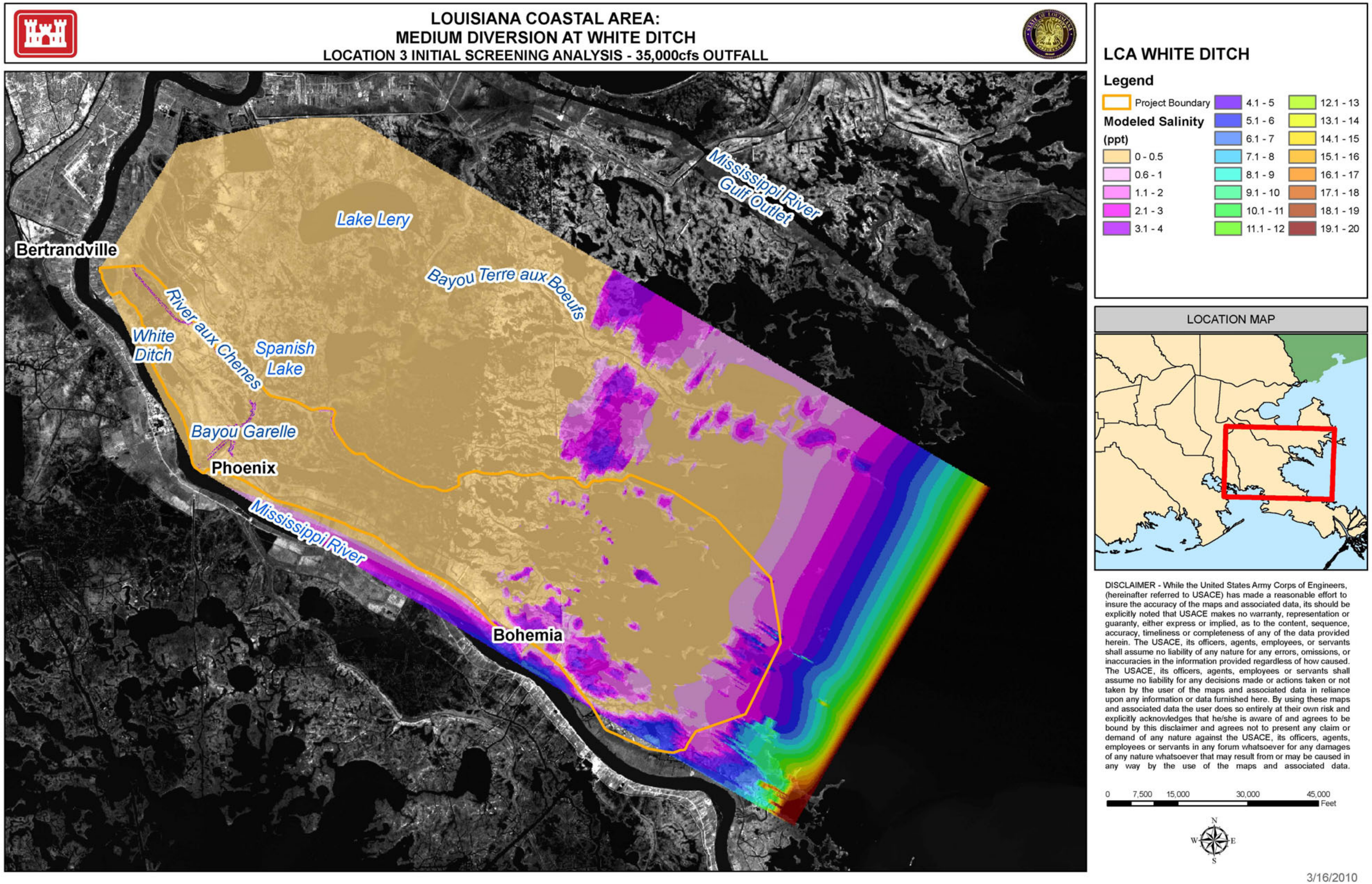
Figure L2.28: Initial screening analysis at Location 3 with a 35,000cfs outfall



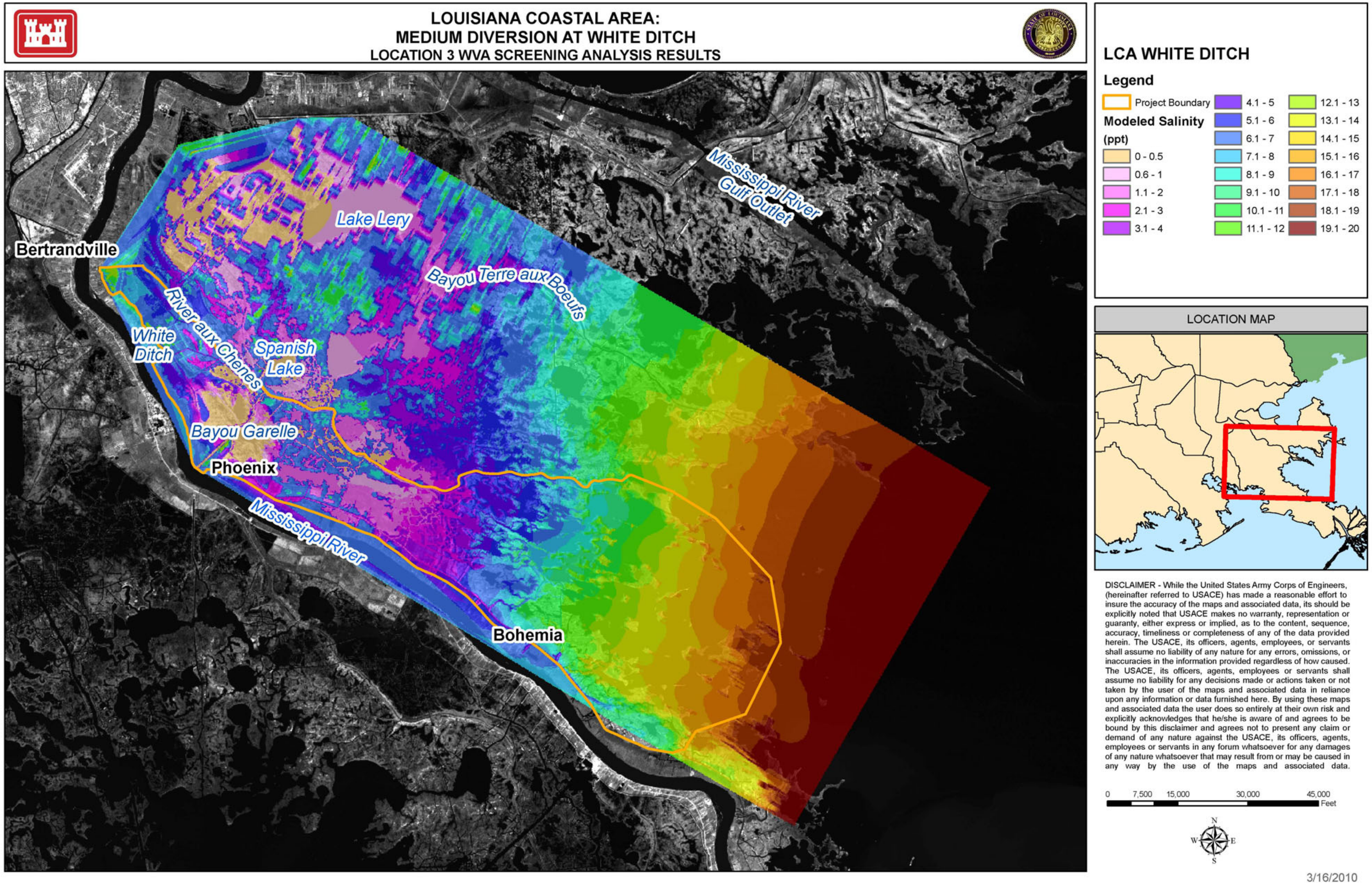
L2.7.2 WVA Screening Analysis

Based off of a preliminary screening involving costs and benefits for each alternative by the project delivery team, it was assessed that only the diversions at Phoenix, LA of 35,000cfs and less would have further analysis conducted on them. These runs are conducted to analyze how salinities would encroach back into the Breton Sound with "maintenance" flows coming from the proposed diversion (1000cfs) and Caernarvon (800cfs). For these runs, simulations would start following the final results of their particular runs from the initial screening of alternatives using the salinities that were estimated there. These simulations would continue for a 3 month period with the following parameters:

- Average summer (June-August) tidal conditions.
- Average summer (June-August) wind forcing conditions for Plaquemines Parish, LA.
- Average summer (June-August) rainfall inputs.
- An average evaporation constant of 5mm/day.

Images of the salinity result show the models progression back to a natural salinity state can be seen in Figure L2.29. It appears that no matter the maximum diversion capacity, salinities will still re-regulate themselves in the sound with the maintenance flows.

Figure L2.29: Results from the WVA Analysis of Location 3 Alternatives



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L2.8 Ecohydraulic Modeling

The ERDC-SAND2 Model is the tool used to project marsh acreages throughout the life of the project. It is an ecohydraulic model specifically designed to estimate impacts from flow diversions on the land loss rates of coastal marsh. The ERDC-SAND2 Model is fundamentally based on three processes impacting marsh accretion due to flow diversion:

1) Historical land loss rates are applied to account for marsh loss due to all negatively impacting system processes (e.g. sea level rise, compaction, subsidence, etc.) along with background processes existing prior to the diversion operation (e.g. marsh nutrient cycling, net tidal and groundwater inputs, etc.).

2) Inorganic benefits of flow diversion from the addition of sediment.

3) Organic benefits of flow diversion due to plant growth, mortality, and burial stimulated by addition of the limiting nutrient (nitrogen).

The model applies these processes to assess Future With Project (FWP) and Future WithOut Project (FWOP) conditions for alternative comparison. Since the FWOP condition is without diversion, FWOP marsh acreage is a function of land loss only. The model processes these categories and projects acres of marsh within a specified project area.

For the Medium Diversion at White Ditch (MDWD) there were three different land loss rates that were examined. These land loss rates were developed for the three relative sea level rise rates that were specified by the by USACE New Orleans District (MVN). The projected sea level rise rates that were used for analysis are shown in Figure 2.8.1 and are:

- Low Scenario (Historic Rate) – 0.40 inches per year
- Intermediate Scenario – 0.50 inches per year
- High Scenario – 0.81 inches per year

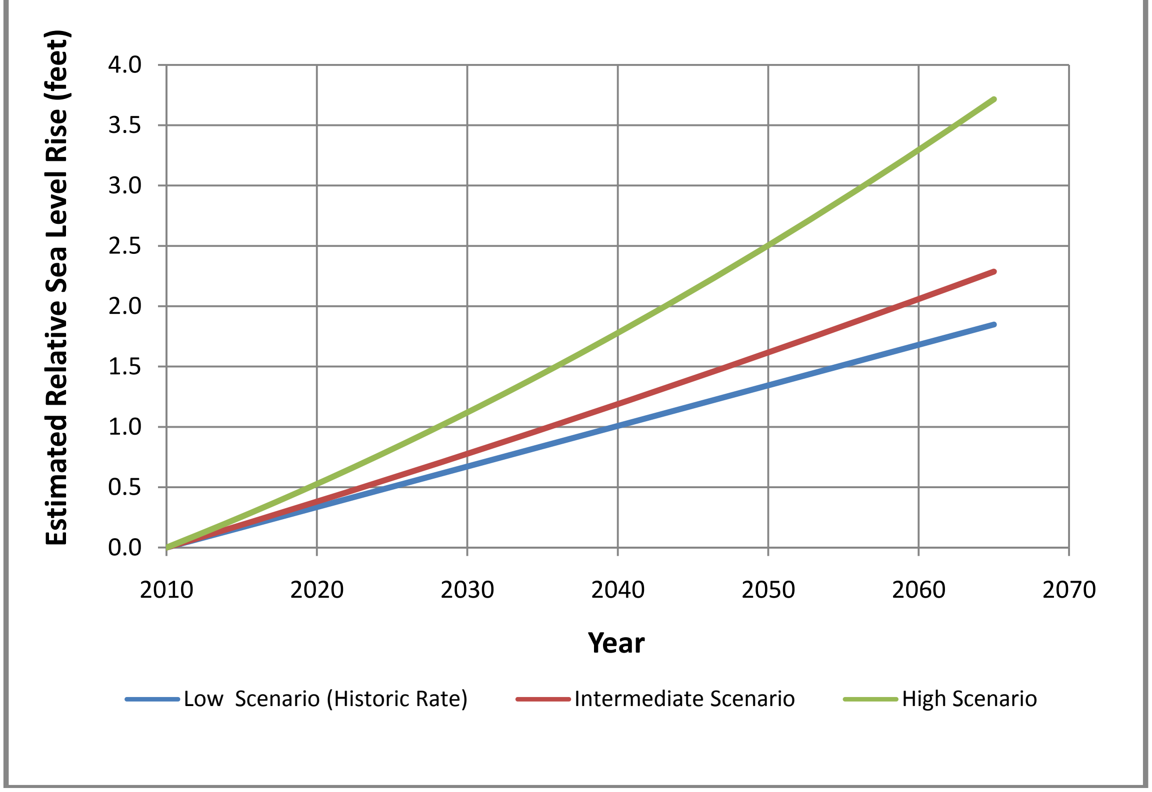


Figure 2.8.1: Projected Sea Level Rise for White Ditch, LA

Benefits from sediment introduction, or inorganic benefits, come from calculations within the model. The model has 25 years of flow and suspended sediment load data from the Mississippi River built in. This data set is rolled forward to allow for a 50 year project life. With the MDWD, project maximum operations of the diversion are only proposed for March and April; throughout the remainder of the year there is a 1,000cfs maintenance flow. During March and April, the modeler assumed that 3% of the total flow in the Mississippi River would be diverted (The flow through the diversion will be driven by the head difference between the river and marsh; however, there is no good correlation between stage and flow built into the model) up to the maximum capacity of the diversion. The modeler also assumed that the diversion would be shut down at any time the Mississippi River went below 300,000cfs to protect navigational interests. Calculations within the model distribute the sediment over open water areas.

Benefits from increased plant productivity are derived from higher nutrient rates entering into the marsh. Nutrient levels are pulled from existing Mississippi River flow data and correspond to diverted flows into the project area. Benefits from increased plant productivity result in vertical accretion for areas of existing marsh.

For land building to occur in the ERDC-SAND2 Model, you must simply have more accretion than sea level rise. With the MDWD, the majority of the benefits come from sediment deposition. Greater diversion capacities allow for more sediment deposition and more benefits. Results from the model for the MDWD can be seen in Table 2.8.1 and Table 2.8.2.

Table 2.8.1: ERDC-SAND2 Model Calculations of Acreages for the MDWD Project Area under Historical Sea Level Rise Rates

Historic RSLR	Gross Acres of Marsh					
Project Life Years	0	10	20	30	40	50
No Action Alternative (FWOP)	38,700	36,000	33,300	30,500	27,800	25,000
5,000 cfs Diversion Alternative	38,700	38,300	37,800	37,000	36,600	35,600
10,000 cfs Diversion Alternative	38,700	39,300	39,900	39,900	40,700	40,400
15,000 cfs Diversion Alternative	38,700	40,300	41,900	42,700	44,600	45,000
35,000 cfs Diversion Alternative	38,700	43,800	48,800	52,200	57,300	59,900

*** The total project area for the Medium Diversion at White Ditch is 98,000 acres

Table 2.8.2: ERDC-SAND2 Model Calculations of Acreages for the MDWD Project Area under the Intermediate and High Sea Level Rise Rates

Intermediate RSLR	Gross Acres of Marsh					
Project Life Years	0	10	20	30	40	50
No Action Alternative (FWOP)	38,700	34,900	30,900	26,500	21,800	16,900
35,000 cfs Diversion Alternative	38,700	42,800	46,600	48,500	51,800	52,400
High RSLR	Gross Acres of Marsh					
Project Life Years	0	10	20	30	40	50
No Action Alternative (FWOP)	38,700	31,500	23,700	14,000	2,900	0
35,000 cfs Diversion Alternative	38,700	39,500	39,600	36,300	33,800	27,600

*** The total project area for the Medium Diversion at White Ditch is 98,000 acres

Further information on the ERDC-SAND2 Model concerning data from the runs used in the MDWD Analysis, model verification, and the equations behind the model can be found in Annexes of Appendix L.

L3. Surveying, Mapping, and Geospatial Data Requirements

L3.1 Geospatial Data

The data which represents the potential features in the project were created using ArcGIS 9.3. The horizontal coordinate system used for the features is NAD 1983 StatePlane Louisiana South FIPS 1702 Feet. The data that were created during this project references the 2008 Digital Orthophoto Quarter Quadrangles, for further information on that data set see C.3.2.

Plaquemine Parish provided oil gas well data, and landowner data. The horizontal coordinate system for both sets of data is NAD 1983 StatePlane Louisiana South FIPS 1702 Feet. Additional landowner data were provided by Ralph Gipson of Fenstermaker & Associates, Inc. The horizontal coordinate system for the Fenstermaker data is NAD 1927 StatePlane Louisiana South FIPS 1702 Feet. General base data is licensed for use from Tele Atlas North America. The horizontal coordinate system for the Tele Atlas data is GCS WGS 1984. The Mississippi Valley- New Orleans District provided pipeline data. This data set was produced by the Coastal Management Division (CMD) of the Louisiana Department of Natural Resources in a cooperative agreement with the U.S. Minerals Management Service (MMS). The data set is a map and database of all of the pipelines that could be identified in the data available to the CMD. The data sets used included the Coastal Use Permit files, State Land Office Right Of Way files, the DNR Office of Conservation files, and MMS records. Also used were wall maps produced by the Louisiana Geological Survey and maps and information from individual companies. The horizontal coordinate system for the pipeline data is NAD 1983 UTM Zone 15N.

ArcGIS software provided the capabilities of transforming the data and aerial photography into one uniform coordinate system for analysis of features and map production. The uniform coordinate system used for these tasks was NAD 1983 StatePlane Louisiana South FIPS 1702 Feet.

L3.2 Aerial Photography and LIDAR

L3.2.1 2008 DOQQ Aerial Photography

The 2008 Digital Orthophoto Quarter Quadrangles (DOQQs) were provided by the Mississippi Valley- New Orleans District. The following information is provided in the metadata of the DOQQ data set. This data set was produced in accordance with USGS Standards for Digital Orthophotos, 1996. Review was provided by the USGS National Geospatial Technical Operations Center (NGTOC). The data set was created by Photo Science, Inc. in 2009 for the USGS National Wetlands Research Center and CWPPRA Task Force.

The horizontal coordinate system is projected coordinate system NAD 1983 UTM Zone 15N. The DOQQ horizontal positional accuracy and the assurance of that accuracy depend, in part, on the accuracy of the data inputs to the rectification process. These inputs consist of the digital elevation model (DEM), aero triangulation control and methods, sensor calibration, and aerial imagery that meet National Aerial Photography Program (NAPP) standards. The vertical accuracy of the verified USGS format DEM is equivalent to or better than a USGS level 1 or 2

DEM, with a root mean square error (RMSE) of no greater than 7.0 meters. Field control is acquired by third-order class 1 or better survey methods sufficiently spaced to meet National Map Accuracy Standards (NMAS) for 1:12,000-scale products. Photo-identifiable ground test points are identified in the orthorectified image and measured. The image coordinates are compared to the known positions of these points and the radial differences for each point computed. A radial RMSE value is then calculated for the DOQQ. Note: Adjacent DOQQ's, when displayed together in a common planimetric coordinate system, and may exhibit positional discrepancies across common DOQQ boundaries. Linear features, such as streets, may be offset between images. However, these edge mismatches still conform to NMAS positional horizontal accuracy requirements. The estimated accuracy is 3.34 meters which was determined by the Federal Geographic Data Committee, 1998, Geospatial Positioning Accuracy Standard, Part 3, National Standard for Spatial Data Accuracy, FGDC-STD-007.3-1998.

L3.2.2 1992 Landsat Thermatic Satellite Image of Louisiana, UMT 15 NAD27

The 1992 Landsat Imagery was provided by the Mississippi Valley- New Orleans District. The following information is provided in the metadata of the Landsat data set. The originator of the data is Louisiana Oil Spill Coordinator's Office (LOSCO) and the publication date is 1996.

The horizontal coordinate system is projected coordinate system NAD 1983 UTM Zone 15N. This data set is comprised of a pair of satellite images of Louisiana that were produced from ten scenes of 30-meter resolution TM imagery. The original image data were geo-rectified and re-sampled to 25-meter cells by the Earth observation Satellite Corporation, EOSAT. These data were obtained by LSU from the Baton Rouge office of the USGS National Wetlands Research Center through a cooperative agreement. The processing to make a seamless enhanced image was performed by LSU and funded by the Louisiana Oil Spill Coordinator's Office. The locational accuracy of the satellite imagery is approximately 98 feet (30 meters). The image was constructed from a red, green, blue (RGB) composite of bands 7,5 & 3 which has the relative appearance of a normal color image, unlike typical false color composites using infrared light in which vegetation is red instead of green. The image is a simulation of the natural environment and is not an accurate representation of "true-color" as perceived by humans. Band 7 is mid-infrared, band 5 is near-infrared, and band 3 is red-visible light. The 3-band, 24-bit composite images were contrast stretched, histogram corrected, and color-matched, and then reduced to a single band, 8-bit image resembling the original composites. They were mosaicked and clipped to fit the 'state boundary'. That data set, which was in UTM zone 15, NAD27 coordinates, was published on the Louisiana Oil Spill Contingency Plan Map CD in 1996. This pair of images in UTM zone 15, NAD83 coordinates was derived by projecting and clipping splitting that UTM zone 15 NAD27 image. The images are in GeoTIFF format, but are accompanied by world files (.tfw) so they can be used in GIS that support TIFF but do not read georeferencing information from GeoTIFF format files.

L3.2.3 2007 Mississippi River LIDAR

The LIDAR was provided by the Mississippi Valley- New Orleans District. The following information is provided in the metadata of the LIDAR data set. The originator of the data is NGS and the date is 2006.

This data set was created to evaluate the condition of the Mississippi River Levee System and river banks as a part of a larger levee assessment process to determine encroachments and calculate slope stability. Data were collected through John Chance and Associates FLI-MAP system, in which a helicopter flies over a given corridor at a low altitude, collecting GPS coordinates and laser rangings. These coordinates and elevations are validated against a video simultaneously recorded by the helicopter. The horizontal controls are "B" order or better and the absolute accuracy is on the order of 15cm. The vertical control references the revised 2003 Geoid (revised in 2005 for South Louisiana) and the absolute accuracy is on the order of 10cm.

L3.3 Ground Topographic Surveys

No surveying was conducted during the feasibility stage of this project.

L4. Geology

The study area is from the Mississippi River, at approximately Mississippi River Mile 60, near the Plaquemines Parish town of Phoenix and extending into the marsh towards Oak River. This is an area of low relief ranging from below sea level to approximately +7 NGVD in elevation on the area adjacent to the river.

Fine grained material make up the majority of the stratigraphy with deposits in the area consisting of a silt to sandy silt layer with clay seams extending from ground surface to approximately -80 and -40 NGVD in elevation for borings R-59.75-LU and R-60.3-UL, respectively, shown in Figure L4.1. The silt to sandy silt layers are underlain by a clay layer with silt seams. After an average depth of -108 NGVD for the previously two mentioned borings, various silt and clay seams layers alternate until the end of the two borings. Borings R-59.75-LU and R-60.3-UL can be seen in Figures L4.2 and L4.3, respectively.

Ground water is at or near the surface in the study area and is directly connected to the Mississippi River.

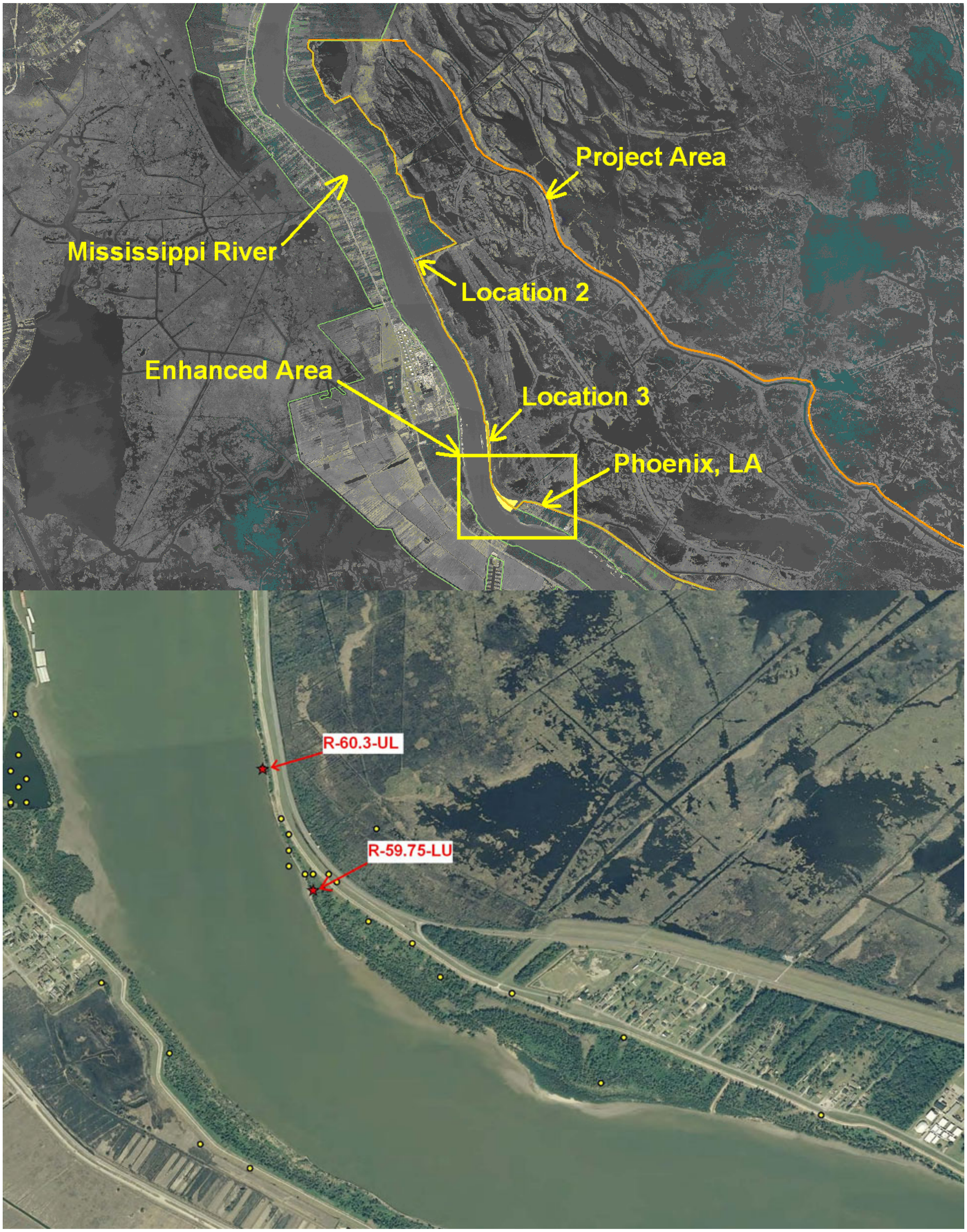


Figure L4.1 Overview of the project area with the boring locations used for the subsurface evaluation.

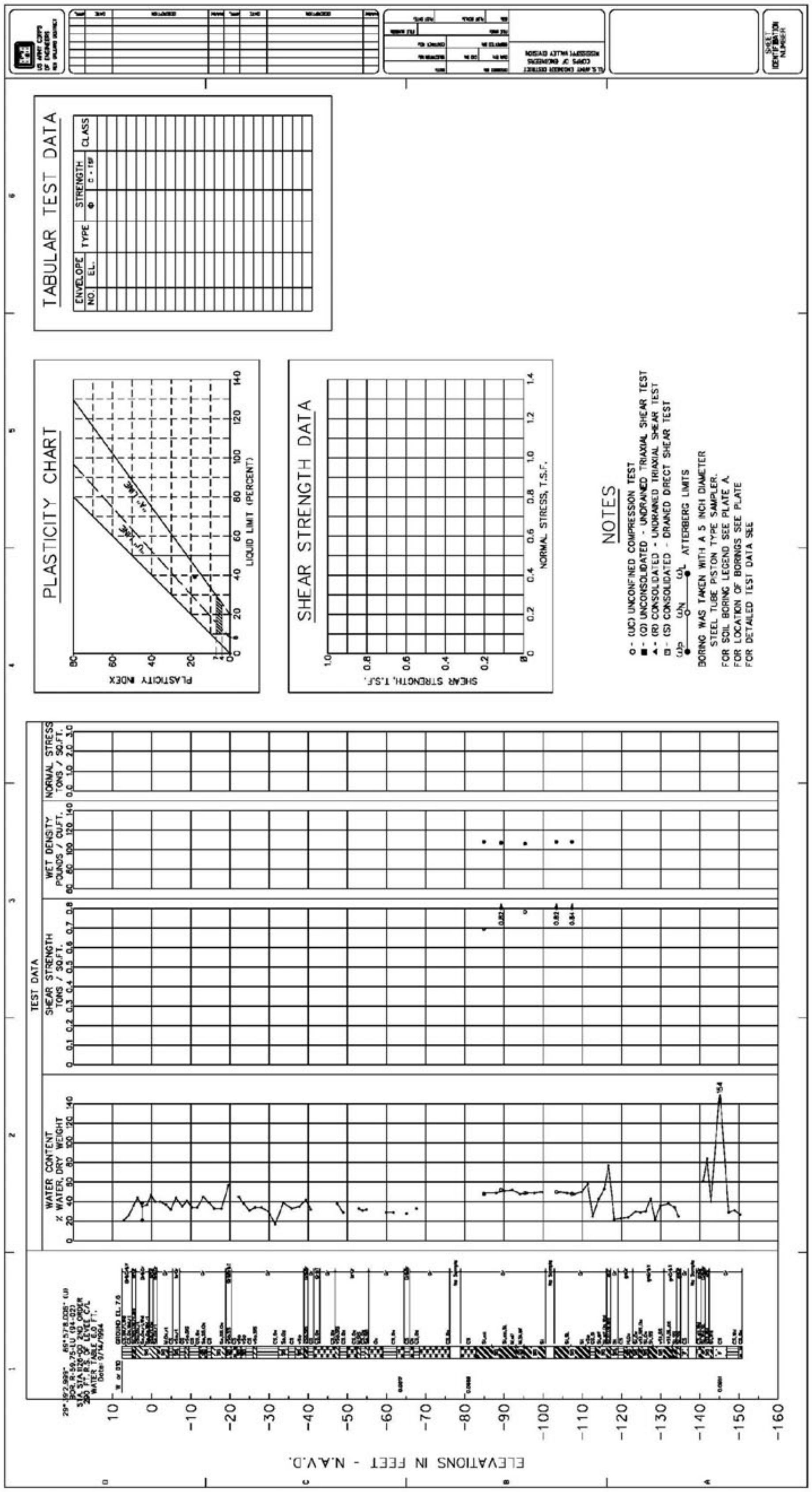


Figure L4.2 Subsurface exploration details for Borings R-59.75-LU.

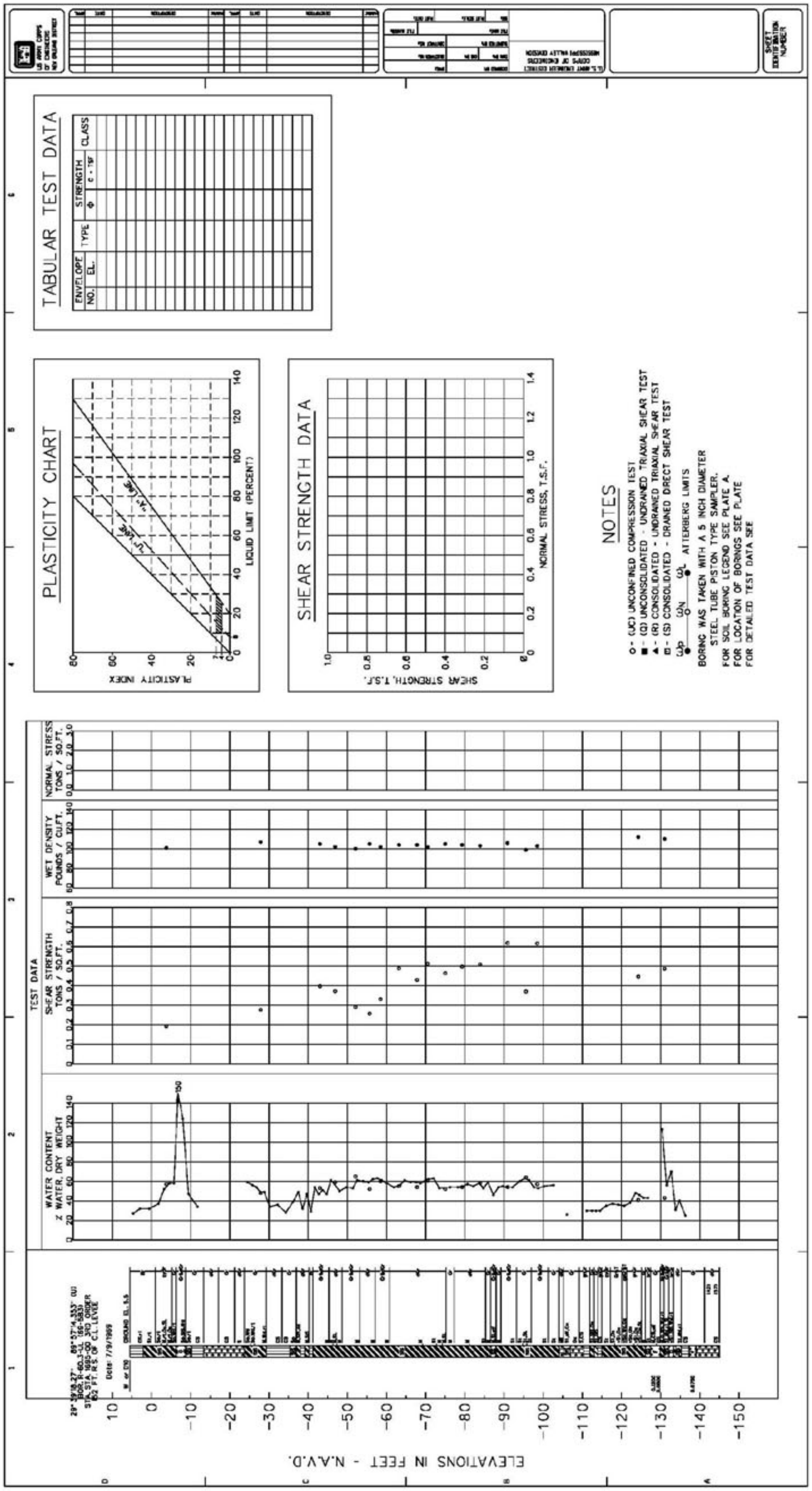


Figure L4.3 Subsurface exploration details for Borings R-60.3-UL.

L5. Geotechnical Investigations and Design

L5.1 General

The project area is located on the east bank of the Mississippi River near the town of Phoenix and the unincorporated area of Plaquemines Parish, Louisiana. See the vicinity map on Figure L4.1 and Section L4 for the regional geology of the area. (This report was written after Location 3 was selected for the area of construction, and substantially, this geotechnical investigation and design only refers to Location 3.) This section describes the results of geotechnical investigation and designs performed for the diversion facility (box culvert) and transmission system (dredged canals), discussed in Sections L5.2 and L5.3, respectively. The subsurface information available for the design of the diversion facility and transmission system is for a general design and cost estimate purposes only. A significant subsurface exploration will be needed in the future to accurately determine the geology of the construction area. The analyses shall be revised using the newly collected data including slope stability analyses, settlement analyses, pile foundation design, etc. Construction considerations shall include all aspects of construction including backfilling, dewatering, pile installation, culvert construction, and dredging. The subsequent geotechnical design on the detail features will be presented in a Design Report (DR) in an appropriate time prior to the preparation of the Plans and Specifications of the project.

L5.2 Geotechnical Design for Diversion Facility

L5.2.1 Stability Analyses

The results of the soil borings and laboratory test data were evaluated and the shear strength and density parameters were selected for design. In general, design shear strengths were based on the results of unconfined compression tests (UCT) and recommendation from the Hurricane and Storm Damage Reduction System Design Guidelines (HSDRSDG). The boring locations used for design are located in Location 3 and are shown in Figure L4.1. In addition, the available soil design shear strengths and stratification from the borings are shown on Figures L5.1 and L5.2.

Global stability of the diversion facility was analyzed using the Spencer Method in GeoStudio 2007 (Version 7.14, Build 4606) for the slope stability analysis. Design requirements are such that a minimum factor of safety of 1.4 evaluated by unconsolidated-undrained (Q) shear strength parameters is required for low water conditions, where the Q-tests are supplemented by UCT tests. Due to time constraints, no new borings were drilled and design was based on existing borings with UCT test results. The analyses are shown on Plate L5.1. The results for the global stability analysis showed that there were no unbalanced loads and the required factors or safety were met. A summary of the results are presented in Table L5.1.

Table L5.1 Global stability summary for the diversion facility

Case	**Boring Number**	**Factor of Safety**	
		Required	**Obtained**
Water at Project Grade (levees)	R-59.75-LU	1.4	7.38
	R-60.3-UL	1.4	7.08
Low Water (non-hurricane condition) S-Case	R-59.75-LU	1.4	10.23*
	R-60.3-UL	1.4	5.11*

Note: * indicates that analysis was performed using an infinitely strong and weightless material to prevent the failure surface from cutting into the diversion facility

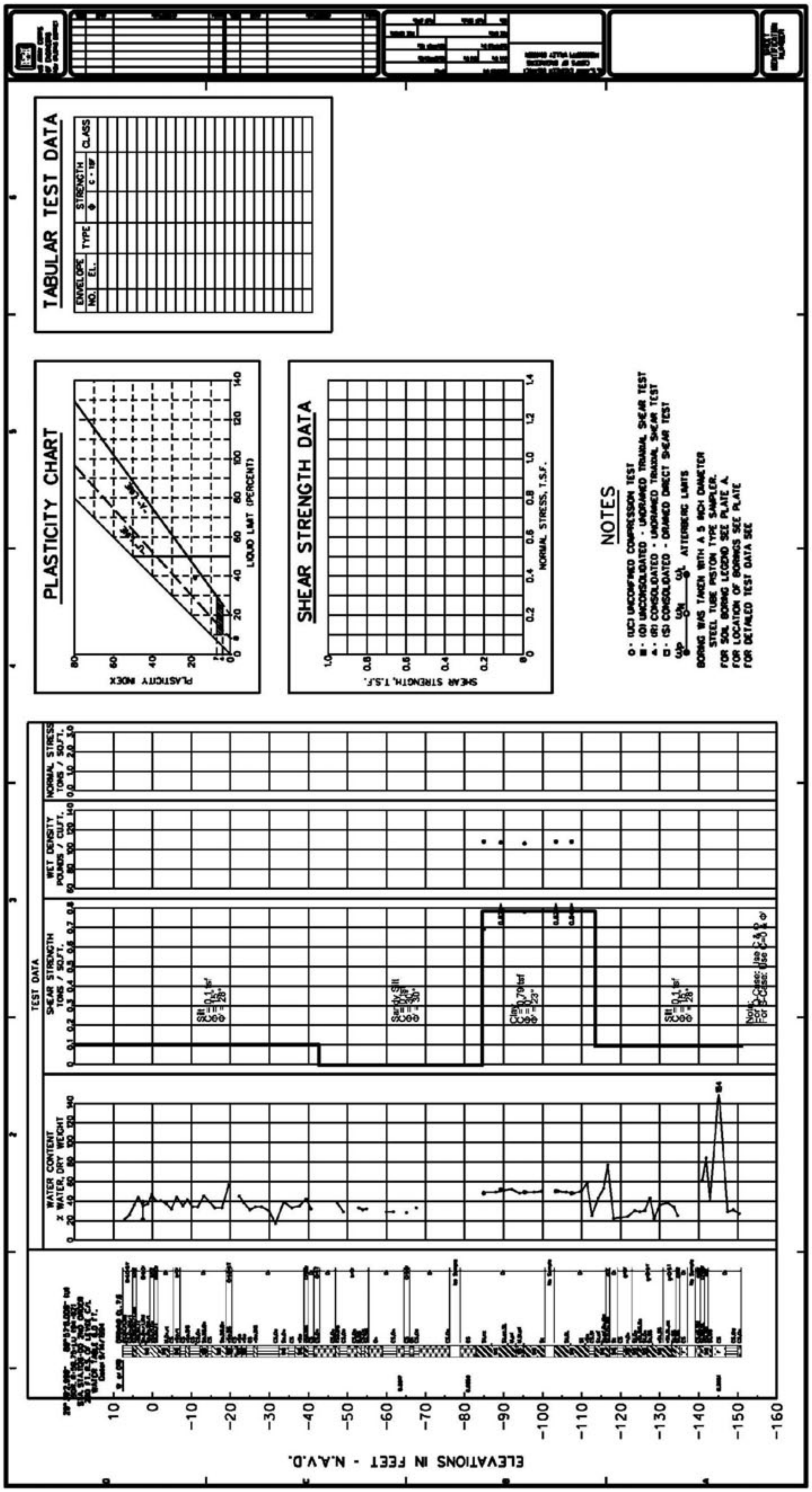


Figure L5.1 Strength lines shown for Borings R-59.75-LU.

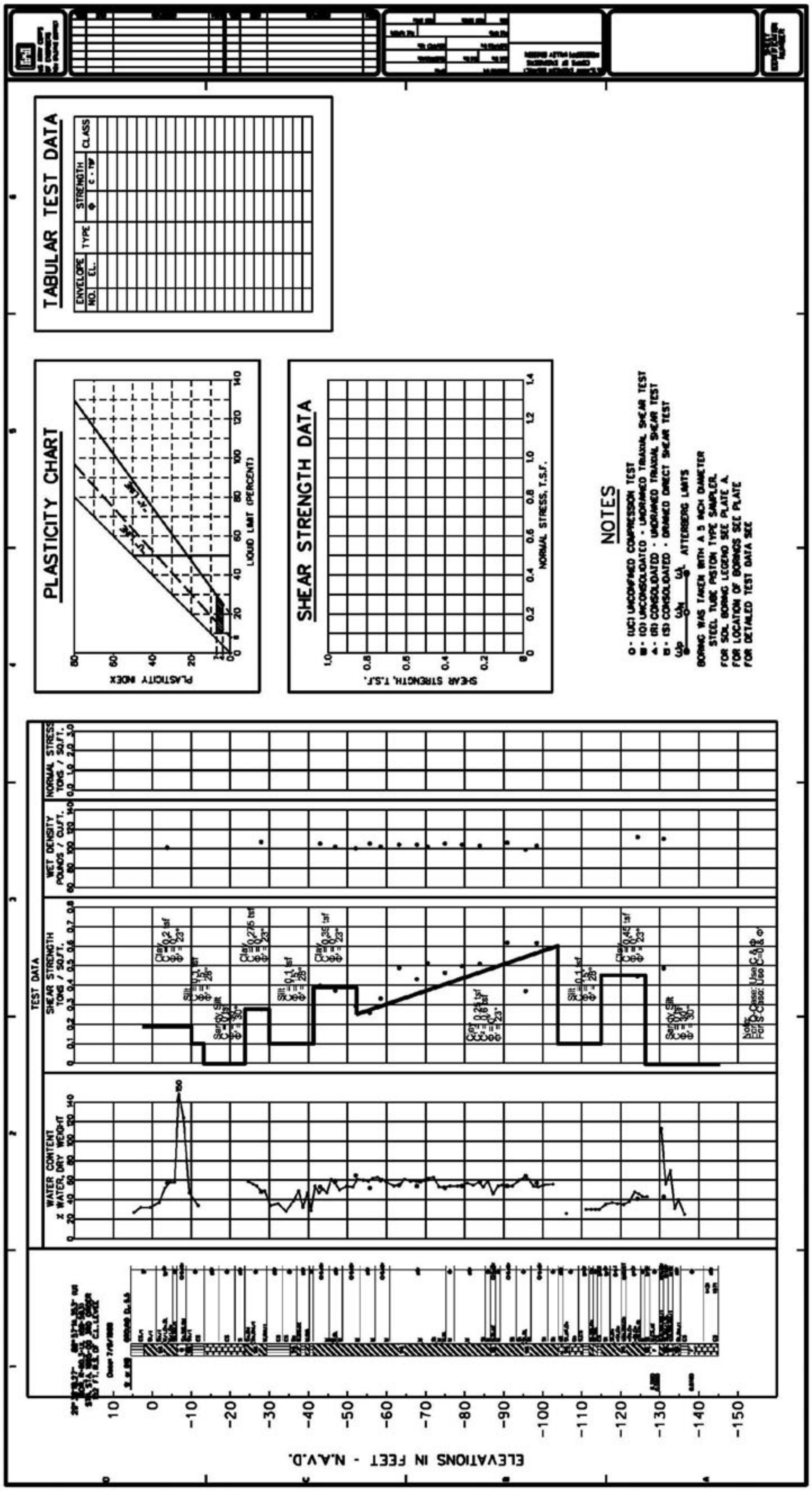


Figure L5.2 Subsurface exploration details for Borings R-60.3-UL.

L5.2.2 Construction Excavation

There was determined to be sufficient land both riverside and landside of the Mississippi River Levee (MRL) for construction of temporary flood protection, which consists of natural ground. Excavated material from the degrading of the MRL will be used to construct this temporary earthen barrier. The diversion facility will be constructed using an engineered staged design. A carefully planned construction excavation should consider the following:

a. Risk of flooding.

b. Historical river elevations in the area of construction.

c. Excavation will be to Elevation –20 NGVD.

d. The approximate prevailing ground surface elevation is 6.5 NGVD.

e. Ground water outside the excavation is dependent on the river level of the Mississippi River (Approximate Elevation is 4 NGVD).

Following completion of the diversion facility construction, the temporary earthen barrier can be recycled into the MRL.

L5.2.3 Pile Foundations

A deep pile foundation is recommended for the diversion facility. The type of pile to be used and the estimated ultimate pile load capacity versus tip elevation curves for cost estimate purposes is presented. The final design should be verified in the forthcoming DR after site specific subsurface exploration and testing is completed. The overburden pressure will be limited to approximately 3500 psf in accordance with the HSDRSDG.

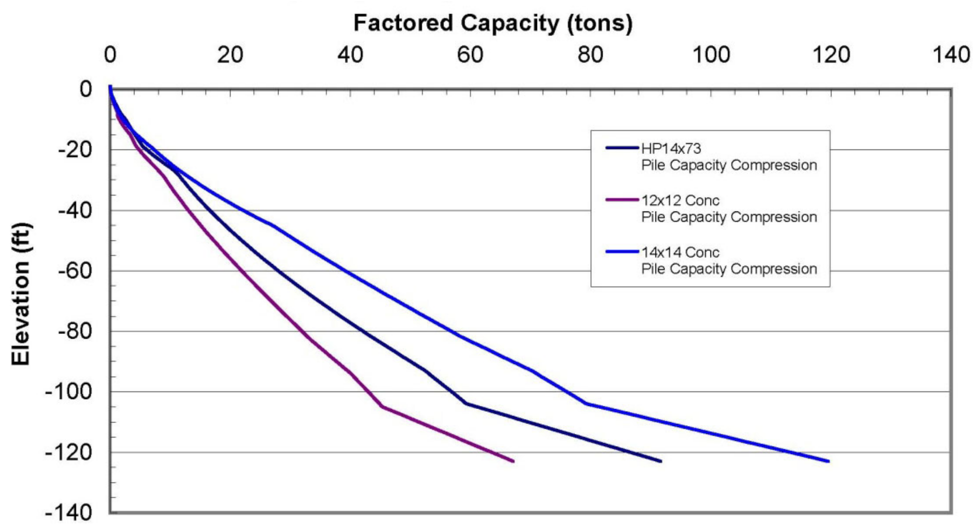
Analyses have been made to determine the estimated allowable single pile load capacities in compression and tension for square, prestressed, precast concrete piles (12”x12” and 14”x14”) and steel H-piles (HP14x73) for support of the proposed structures, as indicated by the Structural Design Section. The results of the estimated pile load capacities are given on Figures L5.3 and L.5.4 and consider the two design borings (R-59.75-LU and R-60.3-UL). The allowable load capacities assume the piles are installed vertically and neglect skin friction along the top 2 feet to allow for embedment in the concrete and seal slab. These allowable load capacities contain an estimated factor of safety shown in the table below against failure of a single pile through the soil. The output for the pile design spreadsheet for both borings is shown in Plate L5.2. The pile capacities, which accounted for the factor of safety, for the two borings were combined and the lower, more conservative strength was chosen for design.

The Structural Design Section determined from the pile capacity charts that all piles tips would terminate at EL. -90.0’ (a total pile length of ≈ 70’, excluding the 2’ placed in the pile cap). Due to lack of boring information, negative skin friction was not accounted for. Negative skin friction from dragdown should be considered in subsequent design reports.

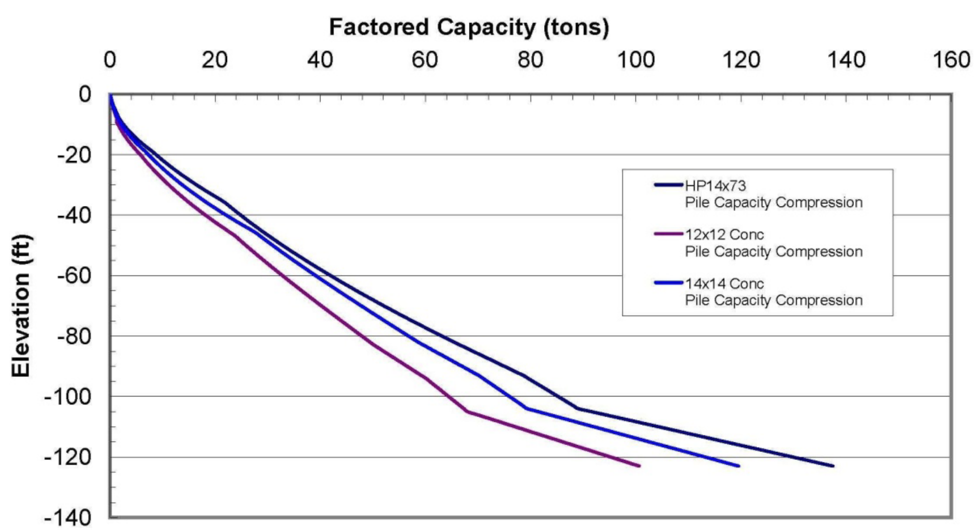
Recommended factors-of-safety for compression and tension design loads are:

Design Case	With Pile Load Test	Without Pile Load Test
Q-Case	2.0	3.0
S-Case	1.5	1.5

Note: Q-Case is characterized as a short term undrained case relative to the soil. S-Case is characterized as a long term consolidated drained case relative to the soil.

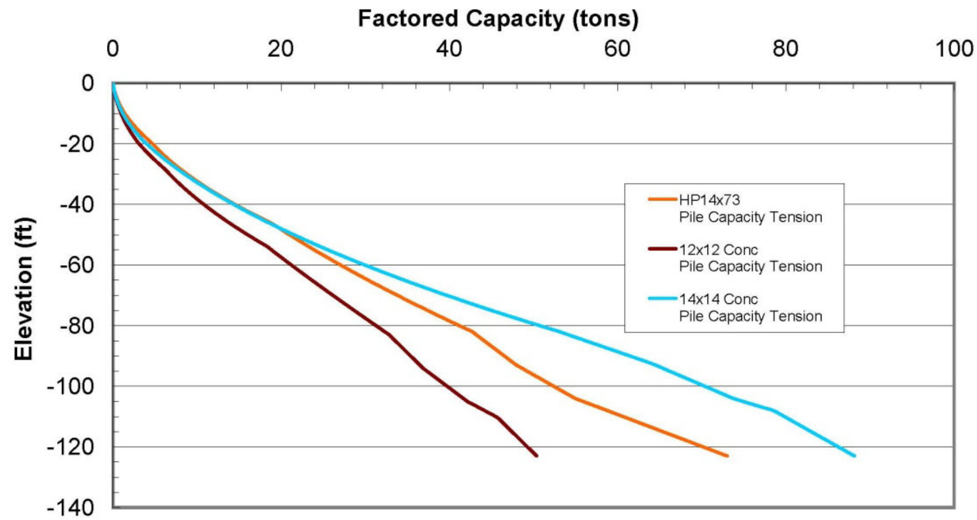


(a)

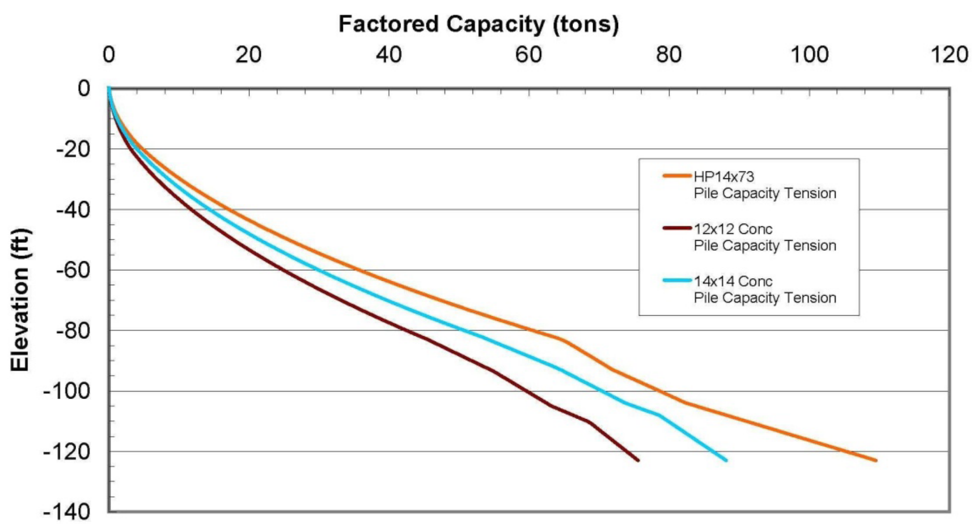


(b)

Figure L5.3 Pile design charts for piles in compression without load tests (a) and with load tests (b).



(a)



(b)

Figure L5.3 Pile design charts for piles in tension without load tests (a) and with load tests (b).

Precast concrete piles should meet the requirements outlined in Section 805.14 of the LSSRB. The design of the pile should consider allowable driving stresses.

Analyses for pile capacities are based only on a soil-pile relationship. Therefore, the structural capacity of the piles and their connections to transmit these loads should be determined by a structural engineer.

The piles will derive the majority of their supporting capacity from skin friction. Therefore, it is necessary to consider the effect of group action. In this regard, the supporting value of friction piles installed in groups should be investigated on the basis of group perimeter. All piles should be installed to the same tip embedment in order to minimize differential foundation settlements.

All pile driving operations should be supervised by experienced personnel to ensure proper procedures are followed and accurate records are kept during all pile driving operations. The driving records should include the date, type of pile, pile size, hammer model, driving energy, and number of blows per foot of penetration for the embedment of the pile. An accurate driving record is especially important to verify piles are installed to the required tip embedment and to give an indication of any unusual driving characteristics which may include pile breakage.

L5.2.4 Lateral Earth Pressures

Lateral earth pressures and lateral fluid pressures from ground water should be calculated prior to design of the diversion facility.

L5.2.5 Hydrostatic Uplift

Hydrostatic uplift during construction should be controlled by dewatering using sumps and pumps, piezometers, positive cutoff, well points and/or deep wells if required. A passive trench collection system (French drain) with gravel fill is recommended; however the contractor is responsible for designing the necessary dewatering system. A registered professional engineer having qualifications and experience in similar dewatering and pressure relief systems shall design this system. If a trench collection system is chosen, the trenches should not be continuous from the riverside to the landside as to allow for uncontrollable seepage during a flood event after construction. For cost estimating purposes, the trapezoidal trench was 3 feet deep with an 8 foot width on top and a 2 foot width on the bottom. The design along with assumptions, computations, figures and detail plans, shall be submitted for review. Piezometric levels in the foundation strata should be reduced to no higher than the excavation surface. Adequate temporary piezometers shall be required to monitor the performance of the dewatering system. Because dewatering and pressure relief operations will lower the ground water level in the vicinity of the excavations and thus result in settlement of the adjacent ground surface, measures such as cutoff walls, recharge wells, and/or some other method may be necessary design of the dewatering system and excavation cofferdam to minimize these effects. Minimizing the duration of dewatering and pressure relief will also minimize these effects. The pressure relief system should be designed, installed and operated by a contractor experienced and qualified in the field of pressure relief

Hydrostatic uplift will act upon the box culvert after construction due to the return of normal ground water levels. The total weight of the culvert plus overlying overburden must counteract this hydrostatic uplift. A minimum factor of safety against flotation, found in the HSDRSDG and based on total weights, should be provided at all times.

L5.2.6 Backfill

Placement of approved materials as backfill should be completed according to current recommended guidelines.

L5.3 Geotechnical Design for Transmission System

Due to the time constraints and limited existing borings away from the Mississippi River levee, limited soil data is known for the marsh wetlands. The previously mentioned two borings (R-60.3-UL and R-59.75-LU) were assumed to be representative of the entire marsh. It is recommended that additional subsurface exploration and testing be completed to verify these assumptions.

The results of the soil borings and laboratory test data were evaluated and the shear strength and density parameters were selected for design. In general, design shear strengths were based on the results of UCT. The available soil design shear strengths and stratification are located on the previously mentioned Figures L5.1 and L5.2.

Stability of earth cuts were analyzed using the Spencer Method in GeoStudio 2007 (Version 7.14, Build 4606) for the slope stability analysis. Design requirements are such that a minimum factor of safety of 1.4 evaluated by unconsolidated-undrained (Q) shear strength parameters is required for low water conditions, where the Q-tests are supplemented by UCT tests. Due to time constraints, no new borings were drilled and design was based off of existing borings with UCT test results. This analysis is shown on Plate L.5.3.

The main channel leading away from the diversion facility was analyzed for slope stability. For the 35,000 cfs outflow option, the slope for the main channel extends from +6 to -16 NGVD with a 10 foot wide access berm above the slope. Using this cross-section with the boring information, the maximum slope, meeting the required factors of safety, was determined to be 1 on 4.5 (Vertical on Horizontal). The results are summarized in Table L5.2.

For cost estimating purposes, a 50% reduction factor was assumed for the consolidation of dredged material. In subsequent design reports, additional borings need to be taken along the transmission system in order to determine accurate material information. This additional information will be used for determining the transmission system's slope stability and for the settlement of the foundation and placement of the ridges lining the canals.

Table L5.2 Slope stability summary of the transmission system

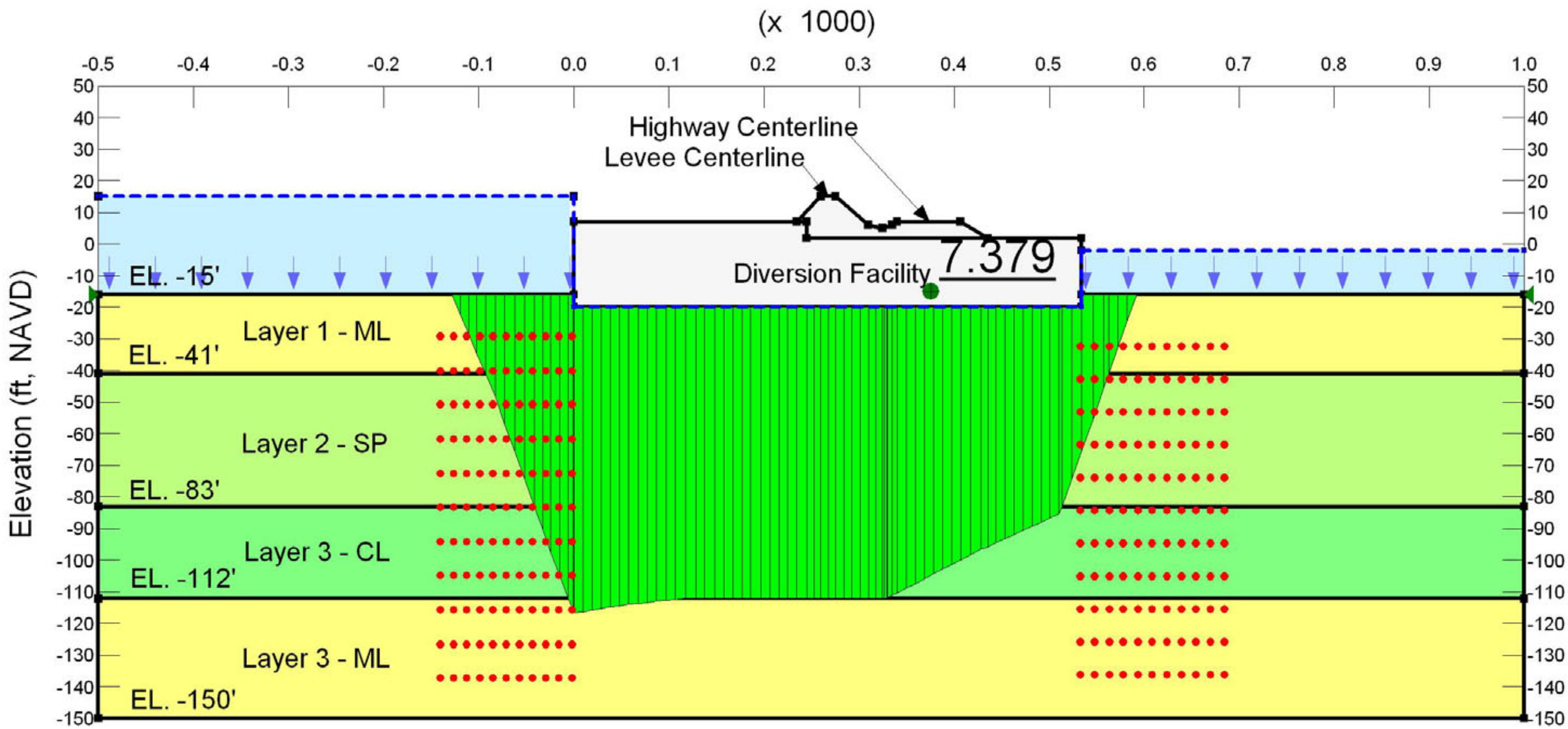
Boring/Slope	**Case**	**Factor of Safety**	
		Required	**Obtained**
R-59.75-LU 1 on 3.5	Low Water (hurricane condition)	1.4	1.84
	Low Water(non-hurricane condition)	1.4	1.81
	Water at Project Grade (levees)	1.4	3.48
R-60.3-UL 1 on 4.5	Low Water (hurricane condition)	1.4	2.64
	Low Water(non-hurricane condition)	1.4	1.48
	Water at Project Grade (levees)	1.4	5.15

L5.4 Laboratory Testing Program and Evaluations

Soil mechanics laboratory tests consisting of natural water content, unit weight, Atterberg liquid and plastic limits, and unconfined compression shear were performed on undisturbed samples obtained from the borings. There were two 5 inch diameter borings used in this evaluation. The borings are both in the vicinity of Location 3 and are shown on Figure L4.1. Boring R-59.75-LU is located 290 FT. R.S. from STA.1126+00 of MRL and Boring R-60.3-UL is located 152 FT. R.S. from STA. 1695+00 of the MRL. The results of these laboratory tests are presented on the boring logs in Figures L4.2 and L4.3. It is recommended that additional site specific subsurface exploration and testing be completed to verify the results of these two borings.

Plate L5.1

LCA MVN - WHITE DITCH
Location 3 - Diversion Facility
Spencer's Block Search
Boring: R-59.75-LU
TOW EL. 15.0'
Optimization



Name: Layer 1-ML	Model: Mohr-Coulomb	Unit Weight: 117 pcf	Cohesion: 200 psf	Phi: 15 °	Piezometric Line: 1
Name: Layer 2-SP	Model: Mohr-Coulomb	Unit Weight: 122 pcf	Cohesion: 0 psf	Phi: 33 °	Piezometric Line: 1
Name: Layer 3-CL	Model: Mohr-Coulomb	Unit Weight: 105 pcf	Cohesion: 1580 psf	Phi: 0 °	Piezometric Line: 1
Name: Layer 4-ML	Model: Mohr-Coulomb	Unit Weight: 117 pcf	Cohesion: 200 psf	Phi: 15 °	Piezometric Line: 1

Top of Levee

1.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 90
Last Edited By: Goetz, Ryan MVS
Date: 3/3/2010
Time: 3:29:48 PM
File Name: Location 3 - 35k cfs - Global Stability_R-59.75-LU.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/3/2010
Last Solved Time: 3:31:00 PM

2.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

3.0 ANALYSIS SETTINGS

3.1 Top of Levee

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Restrict Block Crossing: Yes
Advanced
Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

4.0 MATERIALS

4.1 Layer 1-ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

4.2 Layer 2-SP

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

4.3 Layer 3-CL

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 1580 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

4.4 Layer 4-ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

5.0 SLIP SURFACE LIMITS

Left Coordinate: (-500, -16) ft
Right Coordinate: (1000, -16) ft

6.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (-140.5428, -29.3568) ft
Lower Left: (-140.5428, -137.335) ft
Lower Right: (-1.358, -137.335) ft
X Increments: 10
Y Increments: 10
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3
Right Grid
Upper Left: (532.9439, -32.40831) ft
Lower Left: (532.9439, -136.39582) ft
Lower Right: (684.9054, -136.39582) ft
X Increments: 10
Y Increments: 10

Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

7.0 PIEZOMETRIC LINES

260 7.1 Piezometric Line 1

7.1.1 Coordinates

	X (ft)	Y (ft)
	-500	15
	0	15
	0	-20
	534	-20
	534	-16
	534	-2
	1000	-2

8.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 1-ML	1,2,3,4,5,6,11,7	35364
Region 2	Layer 2-SP	7,11,12,8	63000
Region 3	Layer 3-CL	9,8,12,13	43500
Region 4	Layer 4-ML	10,9,13,14	57000
Region 5		17,15,16,19,20,21,22,23,24,25,26	1182.5
Region 6		3,2,18,17,26,25,24,27,28,5,4	12973

9.0 POINTS

	X (ft)	Y (ft)
Point 1	-500	-16
Point 2	0	-16

Point 3	0	-20
Point 4	534	-20
Point 5	534	-16
Point 6	1000	-16
Point 7	-500	-41
Point 8	-500	-83
Point 9	-500	-112
Point 10	-500	-150
Point 11	1000	-41
Point 12	1000	-83
Point 13	1000	-112
Point 14	1000	-150
Point 15	260	15
Point 16	275	15
Point 17	235	7
Point 18	0	7
Point 19	310	6
Point 20	325	5
Point 21	335	6
Point 22	340	7
Point 23	407	7
Point 24	435	2
Point 25	245	2
Point 26	245	7

Point 27	534	2
Point 28	534	-2
Point 29	0	15
Point 30	-500	15

10.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	7.379	(273.321, -16)	272.7444	(-128.336, -16)	(591.648, -16)
2	17388	14.640	(273.321, -16)	282.839	(-101.097, -16)	(647.738, -16)

265 ## 10.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-123.90385	-19.125	2129.4231	2263.9411	36.043996	200
2	Optimized	-115.03955	-25.375	2519.424	2982.4463	124.06645	200
3	Optimized	-106.17525	-31.625	2909.4248	3701.0436	212.11361	200
4	Optimized	-97.31094	-37.875	3299.4257	4419.5487	300.13606	200
5	Optimized	-87.70344	-44.649	3722.1245	5183.4177	948.97486	0
6	Optimized	-77.38865	-52.63575	4220.4652	6096.5083	1218.3167	0
7	Optimized	-67.10975	-61.31125	4761.8517	7112.6674	1526.6376	0
8	Optimized	-56.83085	-69.98675	5303.1638	8128.9752	1835.1034	0
9	Optimized	-46.55195	-78.66225	5844.5503	9144.5395	2143.0381	0
10	Optimized	-37.090075	-86.648175	6342.8683	10113.69	0	1580
11	Optimized	-28.445225	-93.94452	6798.1214	10873.918	0	1580
12	Optimized	-19.56274	-101.1945	7250.5169	11646.947	0	1580
13	Optimized	-10.442624	-108.39815	7700.012	12398.113	0	1580
14	Optimized	-3.3970835	-113.9632	8047.2428	13007.31	1329.0459	200

15	Optimized	-0.4558	-116.2457	8189.6958	13297.755	1368.7004	200
16	Optimized	0.0404	-116.5933	6027.4621	10954.322	1320.1483	200
17	Optimized	4.8526085	-116.3976	6015.201	11156.434	1377.5893	200
18	Optimized	14.396224	-115.94955	5987.2549	11104.101	1371.0547	200
19	Optimized	23.93984	-115.5015	5959.3089	11051.767	1364.5201	200
20	Optimized	33.48346	-115.0535	5931.3629	10999.434	1357.9856	200
21	Optimized	43.027075	-114.60545	5903.4168	10947.101	1351.451	200
22	Optimized	52.57069	-114.1574	5875.4708	10894.767	1344.9164	200
23	Optimized	62.2438	-113.7759	5851.6512	10845.605	1338.126	200
24	Optimized	72.0464	-113.4609	5831.9727	10808.899	1333.5635	200
25	Optimized	81.849	-113.1459	5812.2942	10771.174	1328.7278	200
26	Optimized	91.6516	-112.8309	5792.6158	10734.468	1324.1653	200
27	Optimized	101.4542	-112.5159	5773.0392	10697.762	1319.5754	200
28	Optimized	111.8586	-112.2709	5757.6636	10664.46	1314.7721	200
29	Optimized	122.8648	-112.09585	5746.762	10643.565	1312.0944	200
30	Optimized	133.2148	-112.00845	5741.2826	10628.413	1309.5027	200
31	Optimized	142.90865	-112.0088	5741.3857	10628.413	1309.4751	200
32	Optimized	152.6025	-112.00915	5741.3857	10628.413	1309.4751	200
33	Optimized	162.2963	-112.0095	5741.3857	10628.413	1309.4751	200
34	Optimized	171.9901	-112.00985	5741.3857	10628.413	1309.4751	200
35	Optimized	181.68395	-112.0102	5741.3857	10629.445	1309.7515	200
36	Optimized	191.3778	-112.01055	5741.4889	10629.445	1309.7239	200
37	Optimized	201.0716	-112.0109	5741.4889	10629.445	1309.7239	200
38	Optimized	210.7654	-112.01125	5741.4889	10629.445	1309.7239	200

39	Optimized	220.45925	-112.0116	5741.4889	10629.445	1309.7239	200
40	Optimized	230.1531	-112.01195	5741.592	10629.445	1309.6962	200
41	Optimized	240	-112.0123	5741.6	10629	1309.5749	200
42	Optimized	248.75	-112.0126	5741.6	10629.2	1309.6285	200
43	Optimized	256.25	-112.01285	5741.6	10629.333	1309.6642	200
44	Optimized	263.75	-112.01315	5741.6	10629.333	1309.6642	200
45	Optimized	271.25	-112.01345	5741.6	10629.333	1309.6642	200
46	Optimized	279.375	-112.01375	5741.6	10629.371	1309.6744	200
47	Optimized	288.125	-112.01405	5741.7143	10629.371	1309.6438	200
48	Optimized	296.875	-112.01435	5741.7143	10629.486	1309.6744	200
49	Optimized	305.625	-112.01465	5741.7143	10629.486	1309.6744	200
50	Optimized	314.02885	-112.01495	5741.7129	10629.46	1309.6679	200
51	Optimized	321.5351	-112.06035	5744.6104	10631.037	1309.3141	200
52	Optimized	325.71125	-112.1178	5748.1717	10636.654	1309.8649	200
53	Optimized	327.78545	-112.065	5744.8768	10649.5	1314.1899	200
54	Optimized	329.28115	-111.9943	5740.2673	10641.691	0	1580
55	Optimized	332.2007	-111.55325	5712.9393	10628.478	0	1580
56	Optimized	337.5	-110.72905	5661.5325	10541.857	0	1580
57	Optimized	344.7857	-109.5959	5590.7689	10422.75	0	1580
58	Optimized	354.35715	-108.10725	5497.8561	10266.244	0	1580
59	Optimized	363.9286	-106.61855	5405.0466	10109.737	0	1580
60	Optimized	373.5	-105.1299	5312.1338	9953.2308	0	1580
61	Optimized	383.0714	-103.64125	5219.221	9796.7244	0	1580
62	Optimized	392.64285	-102.1526	5126.3082	9640.1147	0	1580

63	Optimized	402.2143	-100.66396	5033.3954	9483.6083	0	1580
64	Optimized	412.3263	-99.09121	4935.3148	9318.5303	0	1580
65	Optimized	422.9789	-97.434395	4831.8889	9144.0513	0	1580
66	Optimized	431.6526	-96.1431	4751.3452	9003.3198	0	1580
67	Optimized	439.69645	-95.03077	4681.8775	8886.3396	0	1580
68	Optimized	449.08935	-93.731885	4600.8846	8749.7694	0	1580
69	Optimized	458.4823	-92.433	4519.7862	8613.1993	0	1580
70	Optimized	467.87525	-91.134115	4438.7932	8476.7346	0	1580
71	Optimized	477.26815	-89.83523	4357.6948	8340.1645	0	1580
72	Optimized	486.6611	-88.536345	4276.7019	8203.5943	0	1580
73	Optimized	496.05405	-87.23746	4195.6035	8067.0242	0	1580
74	Optimized	505.44695	-85.938575	4114.6105	7930.4541	0	1580
75	Optimized	511.5134	-84.144565	4002.6619	7939.2243	0	1580
76	Optimized	518.16255	-78.58949	3655.9989	7372.3253	2413.4106	0
77	Optimized	528.72085	-69.76847	3105.5639	6244.9984	2038.7726	0
78	Optimized	539.9296	-60.404015	3644.436	6418.2556	1801.3395	0
79	Optimized	551.78885	-50.49612	3026.1263	5152.2576	1380.7258	0
80	Optimized	560.32685	-43.271085	2575.3772	4236.0574	1078.4584	0
81	Optimized	567.72065	-36.833335	2173.6081	3399.7299	328.53833	200
82	Optimized	577.29155	-28.5	1653.6096	2401.8906	200.50129	200
83	Optimized	586.8625	-20.166665	1133.611	1404.13	72.485353	200

10.2 Slices of Slip Surface: 17388

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	17388	-96.930715	-20.166665	2194.3792	2386.7406	51.543076	200

2	17388	-88.59736	-28.5	2714.4422	3346.511	169.36232	200
3	17388	-80.264025	-36.833335	3234.4204	4306.2814	287.20429	200
4	17388	-70.84736	-46.25	3822.0138	5390.0402	1018.2882	0
5	17388	-60.34736	-56.75	4477.1988	6635.6258	1401.6989	0
6	17388	-49.84736	-67.25	5132.3839	7881.2114	1785.1095	0
7	17388	-39.34736	-77.75	5787.5689	9127.0664	2168.695	0
8	17388	-29.264025	-87.833335	6416.7751	10305.96	0	1580
9	17388	-19.59736	-97.499985	7020.0348	11313.222	0	1580
10	17388	-9.930695	-107.16665	7622.8555	12320.483	0	1580
11	17388	-3.22768	-113.8697	8041.4065	13044.003	1340.4416	200
12	17388	-0.679	-115.7392	8158.3211	13466.863	1422.4195	200
13	17388	4.8958335	-115.73775	5974.0594	11064.51	1363.9822	200
14	17388	14.687499	-115.73525	5973.8551	11063.489	1363.7633	200
15	17388	24.479165	-115.73275	5973.753	11063.489	1363.7907	200
16	17388	34.270835	-115.73025	5973.5487	11063.489	1363.8454	200
17	17388	44.0625	-115.7277	5973.4466	11063.489	1363.8727	200
18	17388	53.854165	-115.72515	5973.2423	11062.468	1363.6538	200
19	17388	63.645835	-115.72265	5973.1402	11062.468	1363.6812	200
20	17388	73.4375	-115.72015	5972.936	11062.468	1363.7359	200
21	17388	83.229165	-115.71765	5972.7317	11061.446	1363.517	200
22	17388	93.020835	-115.71515	5972.6296	11061.446	1363.5444	200
23	17388	102.81249	-115.71265	5972.4253	11061.446	1363.5991	200
24	17388	112.60415	-115.71015	5972.3232	11061.446	1363.6265	200
25	17388	122.39585	-115.7076	5972.1189	11060.425	1363.4075	200

26	17388	132.1875	-115.70505	5972.0168	11060.425	1363.4349	200
27	17388	141.97915	-115.70255	5971.8126	11060.425	1363.4896	200
28	17388	151.77085	-115.70005	5971.7104	11059.404	1363.2433	200
29	17388	161.5625	-115.69755	5971.5062	11059.404	1363.2981	200
30	17388	171.35415	-115.69505	5971.4041	11059.404	1363.3254	200
31	17388	181.14585	-115.69255	5971.1998	11058.383	1363.1065	200
32	17388	190.9375	-115.69	5971.0977	11058.383	1363.1339	200
33	17388	200.72915	-115.68745	5970.8934	11058.383	1363.1886	200
34	17388	210.52085	-115.68495	5970.7913	11058.383	1363.216	200
35	17388	220.3125	-115.68245	5970.587	11057.361	1362.9971	200
36	17388	230.10415	-115.67995	5970.3828	11057.361	1363.0518	200
37	17388	240	-115.6774	5970.3	11057	1362.9772	200
38	17388	248.75	-115.67515	5970.1333	11056.8	1362.9682	200
39	17388	256.25	-115.67325	5970	11056.667	1362.9682	200
40	17388	263.75	-115.67135	5969.8667	11056.4	1362.9325	200
41	17388	271.25	-115.6694	5969.7333	11056.133	1362.8968	200
42	17388	279.375	-115.6673	5969.6	11055.886	1362.8661	200
43	17388	288.125	-115.66505	5969.4857	11055.657	1362.8355	200
44	17388	296.875	-115.6628	5969.3714	11055.429	1362.8049	200
45	17388	305.625	-115.66055	5969.2571	11055.2	1362.7743	200
46	17388	313.75	-115.65845	5969.0667	11054.933	1362.7539	200
47	17388	321.25	-115.65655	5968.9333	11054.667	1362.7181	200
48	17388	330	-115.6543	5968.8	11054	1362.5752	200
49	17388	337.5	-115.65235	5968.8	11054.2	1362.6288	200

50	17388	344.7857	-115.6505	5968.5967	11053.731	1362.5576	200
51	17388	354.35715	-115.64805	5968.3878	11053.731	1362.6136	200
52	17388	363.9286	-115.6456	5968.2833	11053.731	1362.6416	200
53	17388	373.5	-115.64315	5968.1788	11052.686	1362.3896	200
54	17388	383.0714	-115.6407	5967.9699	11052.686	1362.4456	200
55	17388	392.64285	-115.63825	5967.8654	11052.686	1362.4736	200
56	17388	402.2143	-115.63575	5967.6564	11052.686	1362.5296	200
57	17388	411.66665	-115.6333	5967.5353	11051.785	1362.3206	200
58	17388	421	-115.63095	5967.321	11051.785	1362.378	200
59	17388	430.33335	-115.6286	5967.2139	11051.785	1362.4067	200
60	17388	439.95	-115.6261	5967.0707	11051.515	1362.3728	200
61	17388	449.85	-115.62355	5966.8687	11050.505	1362.1563	200
62	17388	459.75	-115.621	5966.7677	11050.505	1362.1833	200
63	17388	469.65	-115.61845	5966.5657	11050.505	1362.2375	200
64	17388	479.55	-115.61595	5966.4646	11049.495	1361.9939	200
65	17388	489.45	-115.6134	5966.2626	11049.495	1362.048	200
66	17388	499.35	-115.61085	5966.1616	11049.495	1362.0751	200
67	17388	509.25	-115.6083	5965.9596	11049.495	1362.1292	200
68	17388	519.15	-115.60575	5965.7576	11048.485	1361.9127	200
69	17388	529.05	-115.6032	5965.6566	11048.485	1361.9397	200
70	17388	541.07	-115.6001	7088.3766	12389.631	1420.4668	200
71	17388	549.9392	-113.79915	6976.3146	12385.459	1449.3759	200
72	17388	556.5717	-107.16665	6562.4147	11657.022	0	1580
73	17388	566.23835	-97.499985	5959.2282	10634.399	0	1580

74	17388	575.90505	-87.833335	5355.9686	9611.7764	0	1580
75	17388	585.9884	-77.75	4726.7739	8515.5873	2460.4842	0
76	17388	596.4884	-67.25	4071.5888	7194.981	2028.3546	0
77	17388	606.9884	-56.75	3416.4038	5874.4421	1596.2687	0
78	17388	617.4884	-46.25	2761.2188	4553.7011	1164.0516	0
79	17388	626.90505	-36.833335	2173.5902	3372.4759	321.24046	200
80	17388	635.23835	-28.5	1653.6121	2381.31	194.98607	200
81	17388	643.5717	-20.166665	1133.6339	1390.144	68.73168	200

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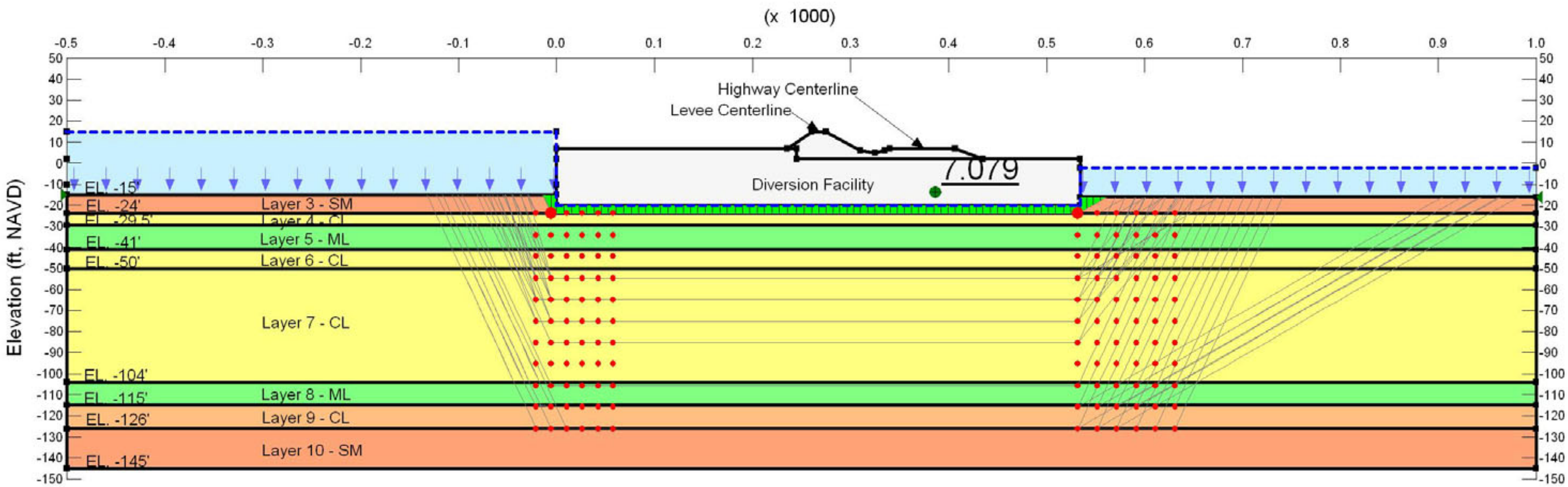
LCA MVN - WHITE DITCH
Location 3 - Diversion Facility
Spencer's Block Search
Boring: R-60.3-LU

TOW EL. 15.0'
Optimization



Name: Layer 5 - ML Model: Mohr-Coulomb Unit Weight: 117 pcf Cohesion: 200 psf Phi: 15 ° Piezometric Line: 1
Name: Layer 4 - CL Model: Mohr-Coulomb Unit Weight: 107 pcf Cohesion: 550 psf Phi: 0 ° Piezometric Line: 1
Name: Layer 6 - CL Model: Mohr-Coulomb Unit Weight: 101 pcf Cohesion: 780 psf Phi: 0 ° Piezometric Line: 1
Name: Layer 7 - CL Model: S=f(depth) Unit Weight: 101 pcf C-Top of Layer: 500 psf C-Rate of Change: 14 psf/ft Limiting C: 1200 psf Piezometric Line: 1
Name: Layer 3 - SM Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Layer 9 - CL Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 900 psf Phi: 0 ° Piezometric Line: 1
Name: Layer 10 - SM Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 30 ° Piezometric Line: 1
Name: Layer 8 - ML Model: Mohr-Coulomb Unit Weight: 117 pcf Cohesion: 200 psf Phi: 15 ° Piezometric Line: 1

Water at Project Grade (levee)

11.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 96
Last Edited By: Goetz, Ryan MVS
Date: 3/7/2010
Time: 11:30:30 AM
File Name: Location 3 - 35k cfs - Global Stability_R-60.3-LU.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/7/2010
Last Solved Time: 11:30:55 AM

12.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

13.0 ANALYSIS SETTINGS

13.1 Low Water (hurricane condition)

Description: Active and Passive Wedge Method
Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No

Slip Surface Option: Block
Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Restrict Block Crossing: Yes
Advanced
Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

14.0MATERIALS

14.1 Layer 5 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

14.2 Layer 4 - CL

Model: Mohr-Coulomb
Unit Weight: 107 pcf
Cohesion: 550 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1

14.3 Layer 6 - CL

Model: Mohr-Coulomb
Unit Weight: 101 pcf
Cohesion: 780 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

14.4 Layer 7 - CL

Model: S=f(depth)
Unit Weight: 101 pcf
C-Top of Layer: 500 psf
C-Rate of Change: 14 psf/ft
Limiting C: 1200 psf
Pore Water Pressure
Piezometric Line: 1

14.5 Layer 3 - SM

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

14.6 Layer 9 - CL

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 900 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

14.7 Layer 10 - SM

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

14.8 Layer 8 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

15.0 SLIP SURFACE LIMITS

Left Coordinate: (-500, -15) ft
Right Coordinate: (1000, -16) ft

16.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (-21.2598, -24) ft
Lower Left: (-21.2598, -126) ft
Lower Right: (57.7899, -126) ft
X Increments: 5
Y Increments: 10
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3
Right Grid
Upper Left: (531.875, -24) ft
Lower Left: (531.875, -126) ft
Lower Right: (631.067, -126) ft
X Increments: 5
Y Increments: 10
Starting Angle: 0 °

Ending Angle: 45 °

Angle Increments: 3

17.0 PIEZOMETRIC LINES

17.1 Piezometric Line 1

17.1.1 Coordinates

	X (ft)	Y (ft)
	-500	15
	0	15
	0	-20
	534	-20
	534	-2
	1000	-2

18.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 10 - SM	17,18,12,8	28500
Region 2	Layer 9 - CL	17,7,11,18	16500
Region 3	Layer 8 - ML	7,6,10,11	16500
Region 4	Layer 5 - ML	15,16,9,21	17250
Region 5	Layer 4 - CL	5,15,21,20	8250
Region 6	Layer 3 - SM	14,23,3,4,24,19,20,5	10364
Region 7	Layer 6 - CL	16,25,26,9	13500
Region 8	Layer 7 - CL	25,6,10,26	81000
Region 9		29,27,28,31,32,33,34,35,36,37,38	1182.5
Region 10		3,23,22,2,30,29,38,37,36,39,40,24,4	12973

19.0 POINTS

	X (ft)	Y (ft)

Point 1	-500	2
Point 2	0	2
Point 3	0	-20
Point 4	534	-20
Point 5	-500	-24
Point 6	-500	-104
Point 7	-500	-115
Point 8	-500	-145
Point 9	1000	-41
Point 10	1000	-104
Point 11	1000	-115
Point 12	1000	-145
Point 13	-500	-10
Point 14	-500	-15
Point 15	-500	-29.5
Point 16	-500	-41
Point 17	-500	-126
Point 18	1000	-126
Point 19	1000	-16
Point 20	1000	-24
Point 21	1000	-29.5
Point 22	0	-10
Point 23	0	-15
Point 24	534	-16

Point 25	-500	-50
Point 26	1000	-50
Point 27	260	15
Point 28	275	15
Point 29	235	7
Point 30	0	7
Point 31	310	6
Point 32	325	5
Point 33	335	6
Point 34	340	7
Point 35	407	7
Point 36	435	2
Point 37	245	2
Point 38	245	7
Point 39	534	2
Point 40	534	-2
Point 41	1000	-2
Point 42	-500	15
Point 43	0	15

20.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	7.079	(273.642, -14.75)	198.0375	(-14.4499, -15)	(561.731, -16)
2	170	7.079	(273.642, -14.75)	198.038	(-14.4499, -15)	(561.731, -16)

20.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-9.94986	-19.5	2152.8262	2386.9572	135.17557	0
2	Optimized	-2.72493	-24	2433.6405	2970.3515	309.87026	0
3	Optimized	3.7903225	-24	249.59618	488.12469	137.7145	0
4	Optimized	11.370967	-24	249.59618	488.12469	137.7145	0
5	Optimized	18.951615	-24	249.59618	488.12469	137.7145	0
6	Optimized	26.53226	-24	249.59618	488.12469	137.7145	0
7	Optimized	34.112905	-24	249.59618	488.12469	137.7145	0
8	Optimized	41.69355	-24	249.59618	488.12469	137.7145	0
9	Optimized	49.274195	-24	249.59618	488.12469	137.7145	0
10	Optimized	56.85484	-24	249.59618	488.12469	137.7145	0
11	Optimized	64.435485	-24	249.59618	488.12469	137.7145	0
12	Optimized	72.01613	-24	249.59618	488.12469	137.7145	0
13	Optimized	79.596775	-24	249.59618	488.12469	137.7145	0
14	Optimized	87.17742	-24	249.59618	488.12469	137.7145	0
15	Optimized	94.758065	-24	249.59618	488.12469	137.7145	0
16	Optimized	102.3387	-24	249.59618	488.12469	137.7145	0
17	Optimized	109.91935	-24	249.59618	488.12469	137.7145	0
18	Optimized	117.5	-24	249.59618	488.12469	137.7145	0
19	Optimized	125.08065	-24	249.59618	488.12469	137.7145	0
20	Optimized	132.6613	-24	249.59618	488.12469	137.7145	0
21	Optimized	140.24195	-24	249.59618	488.12469	137.7145	0
22	Optimized	147.8226	-24	249.59618	488.12469	137.7145	0
23	Optimized	155.4032	-24	249.59618	488.12469	137.7145	0

24	Optimized	162.98385	-24	249.59618	488.12469	137.7145	0
25	Optimized	170.5645	-24	249.59618	488.12469	137.7145	0
26	Optimized	178.14515	-24	249.59618	488.12469	137.7145	0
27	Optimized	185.7258	-24	249.59618	488.12469	137.7145	0
28	Optimized	193.30645	-24	249.59618	488.12469	137.7145	0
29	Optimized	200.8871	-24	249.59618	488.12469	137.7145	0
30	Optimized	208.46775	-24	249.59618	488.12469	137.7145	0
31	Optimized	216.0484	-24	249.59618	488.12469	137.7145	0
32	Optimized	223.62905	-24	249.59618	488.12469	137.7145	0
33	Optimized	231.2097	-24	249.59618	488.12469	137.7145	0
34	Optimized	240	-24	249.6	488.12	137.70959	0
35	Optimized	248.75	-24	249.6	488.12	137.70959	0
36	Optimized	256.25	-24	249.6	488.12	137.70959	0
37	Optimized	263.75	-24	249.6	488.12	137.70959	0
38	Optimized	271.25	-24	249.6	488.12	137.70959	0
39	Optimized	278.5	-24	249.6	488.12857	137.71453	0
40	Optimized	285.5	-24	249.6	488.12857	137.71453	0
41	Optimized	292.5	-24	249.6	488.12857	137.71453	0
42	Optimized	299.5	-24	249.6	488.12857	137.71453	0
43	Optimized	306.5	-24	249.6	488.12857	137.71453	0
44	Optimized	313.75	-24	249.6	488.12	137.70959	0
45	Optimized	321.25	-24	249.6	488.12	137.70959	0
46	Optimized	330	-24	249.6	488.12	137.70959	0
47	Optimized	337.5	-24	249.6	488.12	137.70959	0

48	Optimized	343.7222	-24	249.59554	488.12242	137.71356	0
49	Optimized	351.16665	-24	249.59554	488.12242	137.71356	0
50	Optimized	358.6111	-24	249.59554	488.12242	137.71356	0
51	Optimized	366.05555	-24	249.59554	488.12242	137.71356	0
52	Optimized	373.5	-24	249.59554	488.12242	137.71356	0
53	Optimized	380.94445	-24	249.59554	488.12242	137.71356	0
54	Optimized	388.3889	-24	249.59554	488.12242	137.71356	0
55	Optimized	395.83335	-24	249.59554	488.12242	137.71356	0
56	Optimized	403.2778	-24	249.59554	488.12242	137.71356	0
57	Optimized	410.5	-24	249.6	488.12857	137.71453	0
58	Optimized	417.5	-24	249.6	488.12857	137.71453	0
59	Optimized	424.5	-24	249.6	488.12857	137.71453	0
60	Optimized	431.5	-24	249.6	488.12857	137.71453	0
61	Optimized	438.72595	-24	249.6	488.12904	137.7148	0
62	Optimized	446.17785	-24	249.6	488.12904	137.7148	0
63	Optimized	453.6298	-24	249.6	488.12904	137.7148	0
64	Optimized	461.08175	-24	249.6	488.12904	137.7148	0
65	Optimized	468.53365	-24	249.6	488.12904	137.7148	0
66	Optimized	475.98555	-24	249.6	488.12904	137.7148	0
67	Optimized	483.4375	-24	249.6	488.12904	137.7148	0
68	Optimized	490.88945	-24	249.6	488.12904	137.7148	0
69	Optimized	498.34135	-24	249.6	488.12904	137.7148	0
70	Optimized	505.79325	-24	249.6	488.12904	137.7148	0
71	Optimized	513.2452	-24	249.6	488.12904	137.7148	0

72	Optimized	520.69715	-24	249.6	488.12904	137.7148	0
73	Optimized	528.14905	-24	249.6	488.12904	137.7148	0
74	Optimized	532.9375	-23.715305	231.83582	459.14429	131.23661	0
75	Optimized	537.46645	-22.501785	1279.3044	1678.5985	230.53257	0
76	Optimized	544.3993	-20.64413	1163.3992	1448.9894	164.88561	0
77	Optimized	551.33215	-18.786475	1047.48	1219.4639	99.294951	0
78	Optimized	558.265	-16.928825	931.56088	989.89664	33.680165	0

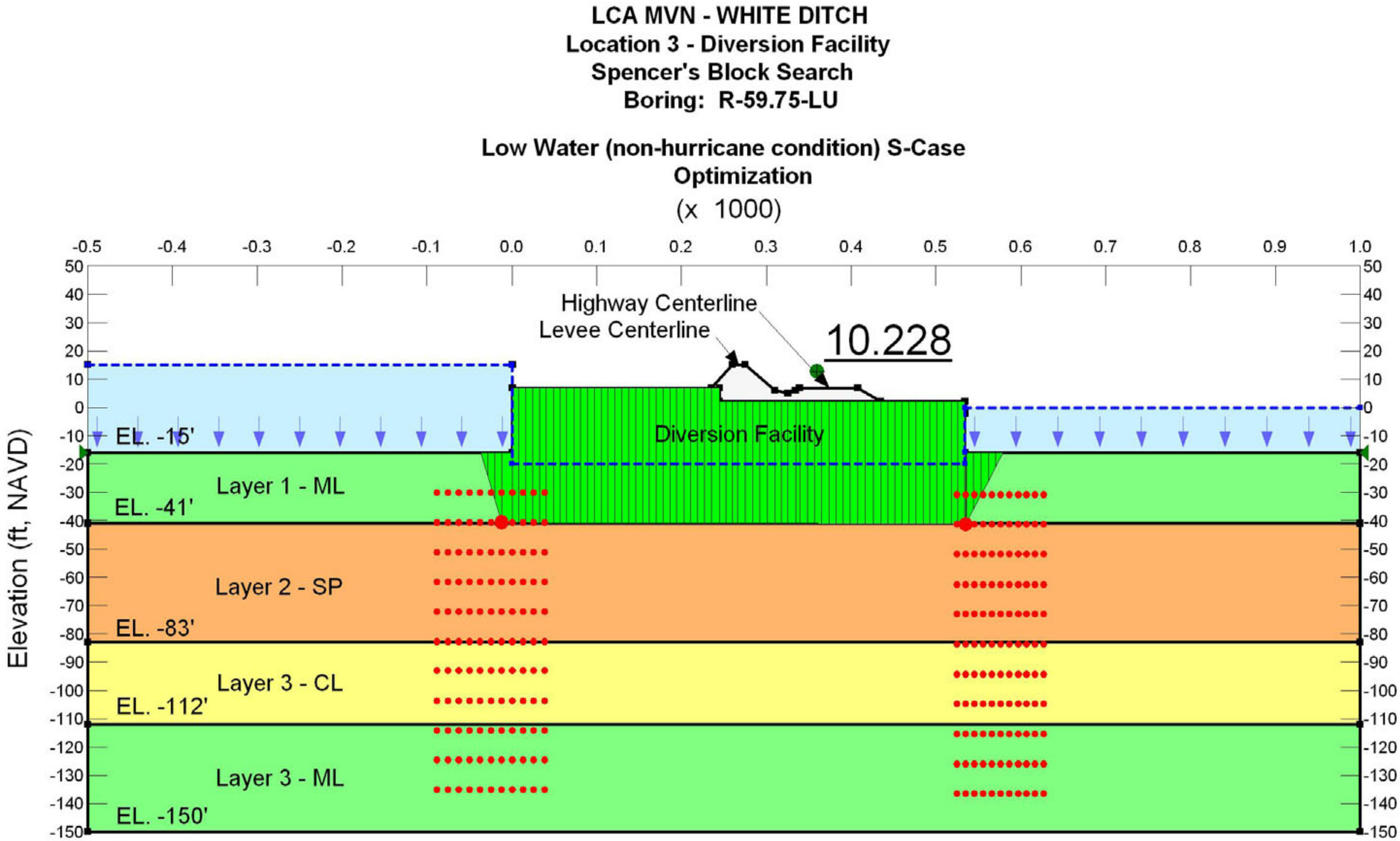
20.2 Slices of Slip Surface: 170

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	170	-9.94986	-19.5	2152.8262	2386.9572	135.17557	0
2	170	-2.72493	-24	2433.6405	2970.3515	309.87026	0
3	170	3.7903225	-24	249.59618	488.12469	137.7145	0
4	170	11.370967	-24	249.59618	488.12469	137.7145	0
5	170	18.951615	-24	249.59618	488.12469	137.7145	0
6	170	26.53226	-24	249.59618	488.12469	137.7145	0
7	170	34.112905	-24	249.59618	488.12469	137.7145	0
8	170	41.69355	-24	249.59618	488.12469	137.7145	0
9	170	49.274195	-24	249.59618	488.12469	137.7145	0
10	170	56.85484	-24	249.59618	488.12469	137.7145	0
11	170	64.435485	-24	249.59618	488.12469	137.7145	0
12	170	72.01613	-24	249.59618	488.12469	137.7145	0
13	170	79.596775	-24	249.59618	488.12469	137.7145	0
14	170	87.17742	-24	249.59618	488.12469	137.7145	0
15	170	94.758065	-24	249.59618	488.12469	137.7145	0

16	170	102.3387	-24	249.59618	488.12469	137.7145	0
17	170	109.91935	-24	249.59618	488.12469	137.7145	0
18	170	117.5	-24	249.59618	488.12469	137.7145	0
19	170	125.08065	-24	249.59618	488.12469	137.7145	0
20	170	132.6613	-24	249.59618	488.12469	137.7145	0
21	170	140.24195	-24	249.59618	488.12469	137.7145	0
22	170	147.8226	-24	249.59618	488.12469	137.7145	0
23	170	155.4032	-24	249.59618	488.12469	137.7145	0
24	170	162.98385	-24	249.59618	488.12469	137.7145	0
25	170	170.5645	-24	249.59618	488.12469	137.7145	0
26	170	178.14515	-24	249.59618	488.12469	137.7145	0
27	170	185.7258	-24	249.59618	488.12469	137.7145	0
28	170	193.30645	-24	249.59618	488.12469	137.7145	0
29	170	200.8871	-24	249.59618	488.12469	137.7145	0
30	170	208.46775	-24	249.59618	488.12469	137.7145	0
31	170	216.0484	-24	249.59618	488.12469	137.7145	0
32	170	223.62905	-24	249.59618	488.12469	137.7145	0
33	170	231.2097	-24	249.59618	488.12469	137.7145	0
34	170	240	-24	249.6	488.12	137.70959	0
35	170	248.75	-24	249.6	488.12	137.70959	0
36	170	256.25	-24	249.6	488.12	137.70959	0
37	170	263.75	-24	249.6	488.12	137.70959	0
38	170	271.25	-24	249.6	488.12	137.70959	0
39	170	278.5	-24	249.6	488.12857	137.71453	0

40	170	285.5	-24	249.6	488.12857	137.71453	0
41	170	292.5	-24	249.6	488.12857	137.71453	0
42	170	299.5	-24	249.6	488.12857	137.71453	0
43	170	306.5	-24	249.6	488.12857	137.71453	0
44	170	313.75	-24	249.6	488.12	137.70959	0
45	170	321.25	-24	249.6	488.12	137.70959	0
46	170	330	-24	249.6	488.12	137.70959	0
47	170	337.5	-24	249.6	488.12	137.70959	0
48	170	343.7222	-24	249.59554	488.12242	137.71356	0
49	170	351.16665	-24	249.59554	488.12242	137.71356	0
50	170	358.6111	-24	249.59554	488.12242	137.71356	0
51	170	366.05555	-24	249.59554	488.12242	137.71356	0
52	170	373.5	-24	249.59554	488.12242	137.71356	0
53	170	380.94445	-24	249.59554	488.12242	137.71356	0
54	170	388.3889	-24	249.59554	488.12242	137.71356	0
55	170	395.83335	-24	249.59554	488.12242	137.71356	0
56	170	403.2778	-24	249.59554	488.12242	137.71356	0
57	170	410.5	-24	249.6	488.12857	137.71453	0
58	170	417.5	-24	249.6	488.12857	137.71453	0
59	170	424.5	-24	249.6	488.12857	137.71453	0
60	170	431.5	-24	249.6	488.12857	137.71453	0
61	170	438.72595	-24	249.6	488.12904	137.7148	0
62	170	446.17785	-24	249.6	488.12904	137.7148	0
63	170	453.6298	-24	249.6	488.12904	137.7148	0

64	170	461.08175	-24	249.6	488.12904	137.7148	0
65	170	468.53365	-24	249.6	488.12904	137.7148	0
66	170	475.98555	-24	249.6	488.12904	137.7148	0
67	170	483.4375	-24	249.6	488.12904	137.7148	0
68	170	490.88945	-24	249.6	488.12904	137.7148	0
69	170	498.34135	-24	249.6	488.12904	137.7148	0
70	170	505.79325	-24	249.6	488.12904	137.7148	0
71	170	513.2452	-24	249.6	488.12904	137.7148	0
72	170	520.69715	-24	249.6	488.12904	137.7148	0
73	170	528.14905	-24	249.6	488.12904	137.7148	0
74	170	532.9375	-23.715305	231.83582	459.14429	131.23661	0
75	170	537.46645	-22.501785	1279.3044	1678.5985	230.53257	0
76	170	544.3993	-20.64413	1163.3992	1448.9894	164.88561	0
77	170	551.33215	-18.786475	1047.48	1219.4639	99.294951	0
78	170	558.265	-16.928825	931.56088	989.89664	33.680165	0



Name: Concrete Model: Mohr-Coulomb Unit Weight: 0.001 pcf Cohesion: 2e+005 psf Phi: 0 ° Piezometric Line: 1
Name: Layer 1 -ML - S Case Model: Mohr-Coulomb Unit Weight: 117 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1
Name: Layer 2-SP - S Case Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 33 ° Piezometric Line: 1
Name: Layer 3 - CL - S Case Model: Mohr-Coulomb Unit Weight: 105 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Layer 4 -ML - S Case Model: Mohr-Coulomb Unit Weight: 117 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1

Top of Levee - S-Case

21.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 100
Last Edited By: Goetz, Ryan MVS
Date: 3/8/2010
Time: 4:40:55 PM
File Name: Location 3 - 35k cfs - Global Stability_R-59.75-LU.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/8/2010
Last Solved Time: 4:42:13 PM

22.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

23.0 ANALYSIS SETTINGS

23.1 Top of Levee - S-Case (2)

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Restrict Block Crossing: Yes
Advanced
Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

24.0MATERIALS

24.1 Concrete

Model: Mohr-Coulomb
Unit Weight: 0.001 pcf
Cohesion: 2e+005 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

24.2 Layer 1 -ML - S Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

24.3 Layer 2-SP - S Case

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

24.4 Layer 3 - CL - S Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

24.5 Layer 4 -ML - S Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

25.0 SLIP SURFACE LIMITS

Left Coordinate: (-500, -16) ft
Right Coordinate: (1000, -16) ft

26.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (-87.8848, -30.20441) ft
Lower Left: (-87.8848, -135.18302) ft
Lower Right: (38.9764, -135.18302) ft
X Increments: 10
Y Increments: 10

Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3

Right Grid

Upper Left: (524.8026, -30.69344) ft
Lower Left: (524.8026, -136.65011) ft
Lower Right: (627.3109, -136.65011) ft
X Increments: 10
Y Increments: 10
Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

27.0 PIEZOMETRIC LINES

27.1 Piezometric Line 1

27.1.1 Coordinates

	X (ft)	Y (ft)
	-500	15
	0	15
	0	-20
	534	-20
	534	-16
	534	0
	1000	0

28.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 1 -ML - S Case	1,2,3,4,5,6,11,7	35364
Region 2	Layer 2-SP - S Case	7,11,12,8	63000
Region 3	Layer 3 - CL - S Case	9,8,12,13	43500
Region 4	Layer 4 -ML - S Case	10,9,13,14	57000

Region 5		17,15,16,19,20,21,22,23,24,25,26	1182.5
Region 6	Concrete	3,2,18,17,26,25,24,27,28,5,4	12973

555 **29.0 POINTS**

	X (ft)	Y (ft)
Point 1	-500	-16
Point 2	0	-16
Point 3	0	-20
Point 4	534	-20
Point 5	534	-16
Point 6	1000	-16
Point 7	-500	-41
Point 8	-500	-83
Point 9	-500	-112
Point 10	-500	-150
Point 11	1000	-41
Point 12	1000	-83
Point 13	1000	-112
Point 14	1000	-150
Point 15	260	15
Point 16	275	15
Point 17	235	7
Point 18	0	7
Point 19	310	6
Point 20	325	5

Point 21	335	6
Point 22	340	7
Point 23	407	7
Point 24	435	2
Point 25	245	2
Point 26	245	7
Point 27	534	2
Point 28	534	-2
Point 29	0	15
Point 30	-500	15

30.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	10.228	(271.193, -16)	214.4399	(-36.4704, -16)	(578.855, -16)
2	3131	10.228	(271.193, -16)	214.44	(-36.4704, -16)	(578.855, -16)

30.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-32.353305	-20.117045	2191.286	2363.3806	91.504308	0
2	Optimized	-24.119215	-28.351135	2705.0794	3288.6036	310.26535	0
3	Optimized	-15.885125	-36.585225	3218.9586	4213.8266	528.98074	0
4	Optimized	-5.88404	-40.708585	3476.1801	4826.4417	717.94683	0
5	Optimized	4.051724	-40.71925	1292.9056	2360.9688	567.89928	0
6	Optimized	12.155174	-40.727945	1293.3992	2426.1262	602.28163	0
7	Optimized	20.25862	-40.73664	1294.0163	2427.2369	602.54409	0
8	Optimized	28.362065	-40.74534	1294.5099	2428.2241	602.80655	0

9	Optimized	36.465515	-40.754035	1295.0035	2429.2113	603.06901	0
10	Optimized	44.568965	-40.76273	1295.6205	2430.1986	603.26586	0
11	Optimized	52.672415	-40.77143	1296.1141	2431.3092	603.59393	0
12	Optimized	60.775865	-40.780125	1296.7312	2432.2965	603.79078	0
13	Optimized	68.87931	-40.78882	1297.2248	2433.2837	604.05324	0
14	Optimized	76.982755	-40.797515	1297.7184	2434.2709	604.3157	0
15	Optimized	85.086205	-40.80621	1298.3354	2435.3816	604.57816	0
16	Optimized	93.189655	-40.81491	1298.829	2436.3688	604.84062	0
17	Optimized	101.29309	-40.823605	1299.4461	2437.356	605.03747	0
18	Optimized	109.39655	-40.8323	1299.9397	2438.3433	605.29993	0
19	Optimized	117.5	-40.841	1300.4333	2439.4539	605.628	0
20	Optimized	125.60345	-40.849695	1301.0503	2440.4411	605.82485	0
21	Optimized	133.7069	-40.85839	1301.5439	2441.4284	606.08731	0
22	Optimized	141.81035	-40.86709	1302.1609	2442.4156	606.28415	0
23	Optimized	149.9138	-40.875785	1302.6546	2443.5262	606.61223	0
24	Optimized	158.01725	-40.88448	1303.1482	2444.5135	606.87469	0
25	Optimized	166.1207	-40.89318	1303.7652	2445.5007	607.07154	0
26	Optimized	174.22415	-40.901875	1304.2588	2446.4879	607.334	0
27	Optimized	182.3276	-40.91057	1304.8758	2447.5986	607.59646	0
28	Optimized	190.43105	-40.919265	1305.3695	2448.5858	607.85892	0
29	Optimized	198.5345	-40.92796	1305.8631	2449.573	608.12138	0
30	Optimized	206.63795	-40.93666	1306.4801	2450.5603	608.31822	0
31	Optimized	214.7414	-40.945355	1306.9737	2451.6709	608.6463	0
32	Optimized	222.84485	-40.95405	1307.5907	2452.6581	608.84315	0

33	Optimized	230.9483	-40.96275	1308.0843	2453.6454	609.10561	0
34	Optimized	240	-40.972465	1308.6987	2454.7975	609.39157	0
35	Optimized	248.75	-40.981855	1309.266	2455.8654	609.65771	0
36	Optimized	256.25	-40.989905	1309.7726	2456.7987	609.88457	0
37	Optimized	262.82985	-40.996965	1310.205	2457.7166	610.14273	0
38	Optimized	270.32985	-41.00501	1310.6668	2458.8117	745.61406	0
39	Optimized	279.375	-41.014715	1311.3135	2459.9986	745.9648	0
40	Optimized	288.125	-41.024105	1311.885	2461.1415	746.33589	0
41	Optimized	296.875	-41.033495	1312.4564	2462.2843	746.70698	0
42	Optimized	305.625	-41.042885	1313.0278	2463.4272	747.07807	0
43	Optimized	313.75	-41.051605	1313.626	2464.532	747.40713	0
44	Optimized	321.25	-41.059655	1314.1193	2465.4654	747.69287	0
45	Optimized	330	-41.069045	1314.6987	2466.6975	748.1168	0
46	Optimized	337.5	-41.077095	1315.2192	2467.5985	748.36387	0
47	Optimized	344.1875	-41.084275	1315.7007	2468.5358	748.65989	0
48	Optimized	352.5625	-41.093265	1316.1783	2469.6105	749.04759	0
49	Optimized	360.9375	-41.10225	1316.7753	2470.6851	749.35776	0
50	Optimized	369.3125	-41.111235	1317.3723	2471.8791	749.74547	0
51	Optimized	377.6875	-41.120225	1317.85	2472.9537	750.13317	0
52	Optimized	386.0625	-41.129215	1318.447	2474.0284	750.44334	0
53	Optimized	394.4375	-41.138205	1319.044	2475.103	750.7535	0
54	Optimized	402.8125	-41.14719	1319.641	2476.1776	751.06366	0
55	Optimized	411.66665	-41.15669	1320.2135	2477.3556	751.4569	0
56	Optimized	421	-41.16671	1320.7492	2478.6414	751.94396	0

57	Optimized	430.33335	-41.176725	1321.3921	2479.8199	752.29185	0
58	Optimized	439.125	-41.18616	1322.0598	2480.9682	752.60391	0
59	Optimized	447.375	-41.195015	1322.5447	2482.0591	752.99749	0
60	Optimized	455.625	-41.203865	1323.1507	2483.15	753.31235	0
61	Optimized	463.875	-41.21272	1323.6356	2484.2409	753.70593	0
62	Optimized	472.125	-41.221575	1324.2416	2485.3318	754.0208	0
63	Optimized	480.375	-41.230425	1324.7265	2486.4227	754.41438	0
64	Optimized	488.625	-41.23928	1325.3325	2487.5136	754.72924	0
65	Optimized	496.875	-41.248135	1325.9386	2488.4833	754.96539	0
66	Optimized	505.125	-41.25699	1326.4234	2489.5742	755.35897	0
67	Optimized	513.375	-41.265845	1327.0295	2490.6652	755.67383	0
68	Optimized	521.625	-41.274695	1327.5143	2491.7561	756.06741	0
69	Optimized	529.875	-41.28355	1328.1204	2510.9076	768.11096	0
70	Optimized	534.5267	-41.288545	2576.4383	3960.0126	898.50362	0
71	Optimized	535.3038	-41.144555	2567.3885	4040.1996	956.45471	0
72	Optimized	539.8843	-38.5	2402.4	3711.3	695.95448	0
73	Optimized	548.54455	-33.5	2090.4	3110.9	542.60948	0
74	Optimized	557.2048	-28.5	1778.4	2510.5	389.26447	0
75	Optimized	565.86505	-23.5	1466.4	1910.1	235.91947	0
76	Optimized	574.5253	-18.5	1154.4	1309.8	82.627646	0

30.2 Slices of Slip Surface: 3131

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	3131	-32.353305	-20.117045	2191.286	2363.3806	91.504308	0
2	3131	-24.119215	-28.351135	2705.0794	3288.6036	310.26535	0

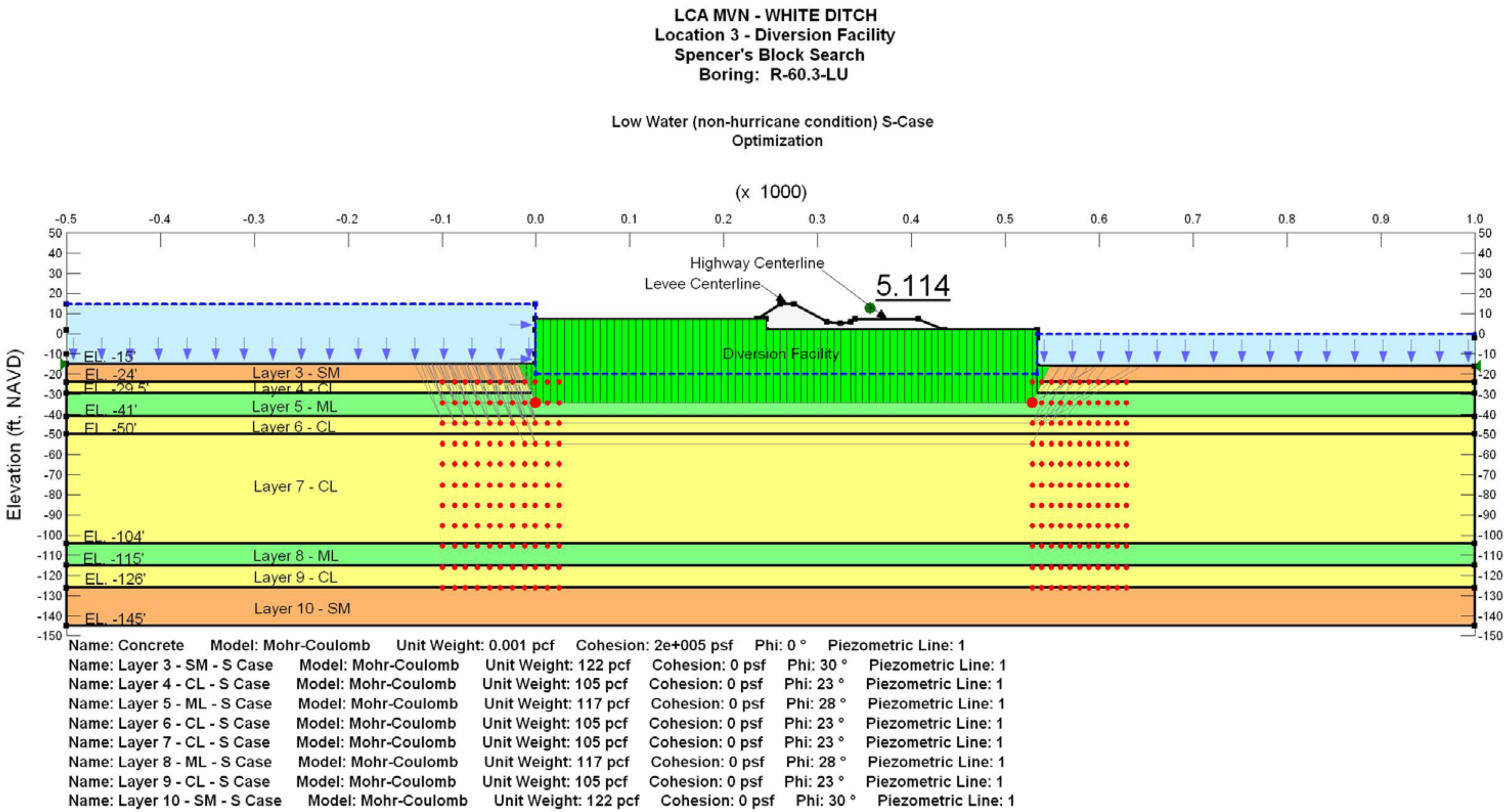
3	3131	-15.885125	-36.585225	3218.9586	4213.8266	528.98074	0
4	3131	-5.88404	-40.708585	3476.1801	4826.4417	717.94683	0
5	3131	4.051724	-40.71925	1292.9056	2360.9688	567.89928	0
6	3131	12.155174	-40.727945	1293.3992	2426.1262	602.28163	0
7	3131	20.25862	-40.73664	1294.0163	2427.2369	602.54409	0
8	3131	28.362065	-40.74534	1294.5099	2428.2241	602.80655	0
9	3131	36.465515	-40.754035	1295.0035	2429.2113	603.06901	0
10	3131	44.568965	-40.76273	1295.6205	2430.1986	603.26586	0
11	3131	52.672415	-40.77143	1296.1141	2431.3092	603.59393	0
12	3131	60.775865	-40.780125	1296.7312	2432.2965	603.79078	0
13	3131	68.87931	-40.78882	1297.2248	2433.2837	604.05324	0
14	3131	76.982755	-40.797515	1297.7184	2434.2709	604.3157	0
15	3131	85.086205	-40.80621	1298.3354	2435.3816	604.57816	0
16	3131	93.189655	-40.81491	1298.829	2436.3688	604.84062	0
17	3131	101.29309	-40.823605	1299.4461	2437.356	605.03747	0
18	3131	109.39655	-40.8323	1299.9397	2438.3433	605.29993	0
19	3131	117.5	-40.841	1300.4333	2439.4539	605.628	0
20	3131	125.60345	-40.849695	1301.0503	2440.4411	605.82485	0
21	3131	133.7069	-40.85839	1301.5439	2441.4284	606.08731	0
22	3131	141.81035	-40.86709	1302.1609	2442.4156	606.28415	0
23	3131	149.9138	-40.875785	1302.6546	2443.5262	606.61223	0
24	3131	158.01725	-40.88448	1303.1482	2444.5135	606.87469	0
25	3131	166.1207	-40.89318	1303.7652	2445.5007	607.07154	0
26	3131	174.22415	-40.901875	1304.2588	2446.4879	607.334	0

27	3131	182.3276	-40.91057	1304.8758	2447.5986	607.59646	0
28	3131	190.43105	-40.919265	1305.3695	2448.5858	607.85892	0
29	3131	198.5345	-40.92796	1305.8631	2449.573	608.12138	0
30	3131	206.63795	-40.93666	1306.4801	2450.5603	608.31822	0
31	3131	214.7414	-40.945355	1306.9737	2451.6709	608.6463	0
32	3131	222.84485	-40.95405	1307.5907	2452.6581	608.84315	0
33	3131	230.9483	-40.96275	1308.0843	2453.6454	609.10561	0
34	3131	240	-40.972465	1308.6987	2454.7975	609.39157	0
35	3131	248.75	-40.981855	1309.266	2455.8654	609.65771	0
36	3131	256.25	-40.989905	1309.7726	2456.7987	609.88457	0
37	3131	262.82985	-40.996965	1310.205	2457.7166	610.14273	0
38	3131	270.32985	-41.00501	1310.6668	2458.8117	745.61406	0
39	3131	279.375	-41.014715	1311.3135	2459.9986	745.9648	0
40	3131	288.125	-41.024105	1311.885	2461.1415	746.33589	0
41	3131	296.875	-41.033495	1312.4564	2462.2843	746.70698	0
42	3131	305.625	-41.042885	1313.0278	2463.4272	747.07807	0
43	3131	313.75	-41.051605	1313.626	2464.532	747.40713	0
44	3131	321.25	-41.059655	1314.1193	2465.4654	747.69287	0
45	3131	330	-41.069045	1314.6987	2466.6975	748.1168	0
46	3131	337.5	-41.077095	1315.2192	2467.5985	748.36387	0
47	3131	344.1875	-41.084275	1315.7007	2468.5358	748.65989	0
48	3131	352.5625	-41.093265	1316.1783	2469.6105	749.04759	0
49	3131	360.9375	-41.10225	1316.7753	2470.6851	749.35776	0
50	3131	369.3125	-41.111235	1317.3723	2471.8791	749.74547	0

51	3131	377.6875	-41.120225	1317.85	2472.9537	750.13317	0
52	3131	386.0625	-41.129215	1318.447	2474.0284	750.44334	0
53	3131	394.4375	-41.138205	1319.044	2475.103	750.7535	0
54	3131	402.8125	-41.14719	1319.641	2476.1776	751.06366	0
55	3131	411.66665	-41.15669	1320.2135	2477.3556	751.4569	0
56	3131	421	-41.16671	1320.7492	2478.6414	751.94396	0
57	3131	430.33335	-41.176725	1321.3921	2479.8199	752.29185	0
58	3131	439.125	-41.18616	1322.0598	2480.9682	752.60391	0
59	3131	447.375	-41.195015	1322.5447	2482.0591	752.99749	0
60	3131	455.625	-41.203865	1323.1507	2483.15	753.31235	0
61	3131	463.875	-41.21272	1323.6356	2484.2409	753.70593	0
62	3131	472.125	-41.221575	1324.2416	2485.3318	754.0208	0
63	3131	480.375	-41.230425	1324.7265	2486.4227	754.41438	0
64	3131	488.625	-41.23928	1325.3325	2487.5136	754.72924	0
65	3131	496.875	-41.248135	1325.9386	2488.4833	754.96539	0
66	3131	505.125	-41.25699	1326.4234	2489.5742	755.35897	0
67	3131	513.375	-41.265845	1327.0295	2490.6652	755.67383	0
68	3131	521.625	-41.274695	1327.5143	2491.7561	756.06741	0
69	3131	529.875	-41.28355	1328.1204	2510.9076	768.11096	0
70	3131	534.5267	-41.288545	2576.4383	3960.0126	898.50362	0
71	3131	535.3038	-41.144555	2567.3885	4040.1996	956.45471	0
72	3131	539.8843	-38.5	2402.4	3711.3	695.95448	0
73	3131	548.54455	-33.5	2090.4	3110.9	542.60948	0
74	3131	557.2048	-28.5	1778.4	2510.5	389.26447	0

75	3131	565.86505	-23.5	1466.4	1910.1	235.91947	0
76	3131	574.5253	-18.5	1154.4	1309.8	82.627646	0

560



Low Water S-Case

565 **31.0FILE INFORMATION**

Created By: Goetz, Ryan MVS
Revision Number: 98
Last Edited By: Goetz, Ryan MVS

Date: 3/8/2010
Time: 4:56:57 PM
File Name: Location 3 - 35k cfs - Global Stability_R-60.3-LU.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/8/2010
Last Solved Time: 4:58:20 PM

32.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

33.0 ANALYSIS SETTINGS

33.1 Low Water S-Case

Description: Active and Passive Wedge Method
Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: Yes
Advanced

Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

34.0MATERIALS

34.1 Concrete

Model: Mohr-Coulomb
Unit Weight: 0.001 pcf
Cohesion: 2e+005 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.2 Layer 3 - SM - S Case

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.3 Layer 4 - CL - S Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1

34.4 Layer 5 - ML - S Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.5 Layer 6 - CL - S Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.6 Layer 7 - CL - S Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.7 Layer 8 - ML - S Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.8 Layer 9 - CL - S Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

34.9 Layer 10 - SM - S Case

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

35.0 SLIP SURFACE LIMITS

Left Coordinate: (-500, -15) ft
Right Coordinate: (1000, -16) ft

36.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (-99.2758, -24) ft
Lower Left: (-99.2758, -126) ft
Lower Right: (24.6802, -126) ft
X Increments: 10
Y Increments: 10
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3
Right Grid
Upper Left: (528.863, -24) ft
Lower Left: (528.863, -126) ft
Lower Right: (629.013, -126) ft
X Increments: 10
Y Increments: 10
Starting Angle: 0 °

Ending Angle: 45 °
Angle Increments: 3

37.0 PIEZOMETRIC LINES

710 37.1 Piezometric Line 1

37.1.1 Coordinates

	X (ft)	Y (ft)
	-500	15
	0	15
	0	-20
	534	-20
	534	0
	1000	0

38.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 10 - SM - S Case	17,18,12,8	28500
Region 2	Layer 9 - CL - S Case	17,7,11,18	16500
Region 3	Layer 8 - ML - S Case	7,6,10,11	16500
Region 4	Layer 5 - ML - S Case	15,16,9,21	17250
Region 5	Layer 4 - CL - S Case	5,15,21,20	8250
Region 6	Layer 3 - SM - S Case	14,23,3,4,24,19,20,5	10364
Region 7	Layer 6 - CL - S Case	16,25,26,9	13500
Region 8	Layer 7 - CL - S Case	25,6,10,26	81000
Region 9		29,27,28,31,32,33,34,35,36,37,38	1182.5
Region 10	Concrete	3,23,22,2,30,29,38,37,36,39,40,24,4	12973

39.0 POINTS

	X (ft)	Y (ft)

Point 1	-500	2
Point 2	0	2
Point 3	0	-20
Point 4	534	-20
Point 5	-500	-24
Point 6	-500	-104
Point 7	-500	-115
Point 8	-500	-145
Point 9	1000	-41
Point 10	1000	-104
Point 11	1000	-115
Point 12	1000	-145
Point 13	-500	-10
Point 14	-500	-15
Point 15	-500	-29.5
Point 16	-500	-41
Point 17	-500	-126
Point 18	1000	-126
Point 19	1000	-16
Point 20	1000	-24
Point 21	1000	-29.5
Point 22	0	-10
Point 23	0	-15
Point 24	534	-16

Point 25	-500	-50
Point 26	1000	-50
Point 27	260	15
Point 28	275	15
Point 29	235	7
Point 30	0	7
Point 31	310	6
Point 32	325	5
Point 33	335	6
Point 34	340	7
Point 35	407	7
Point 36	435	2
Point 37	245	2
Point 38	245	7
Point 39	534	2
Point 40	534	-2
Point 41	1000	-2
Point 42	-500	15
Point 43	0	15

40.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	5.114	(263.877, -14.75)	196.2609	(-19.311, -15)	(547.063, -16)
2	3480	5.114	(263.877, -14.75)	196.261	(-19.311, -15)	(547.063, -16)

40.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-14.811	-19.5	2152.8262	2347.8306	112.58582	0
2	Optimized	-7.561	-26.75	2605.2384	3145.7251	229.42299	0
3	Optimized	-2.4055	-31.85	2923.391	3669.6274	396.78092	0
4	Optimized	3.7903225	-34.2	886.08555	1541.1617	348.31019	0
5	Optimized	11.370967	-34.2	886.08555	1617.1447	388.71105	0
6	Optimized	18.951615	-34.2	886.08555	1617.1447	388.71105	0
7	Optimized	26.53226	-34.2	886.08555	1617.1447	388.71105	0
8	Optimized	34.112905	-34.2	886.08555	1617.1447	388.71105	0
9	Optimized	41.69355	-34.2	886.08555	1617.1447	388.71105	0
10	Optimized	49.274195	-34.2	886.08555	1617.1447	388.71105	0
11	Optimized	56.85484	-34.2	886.08555	1617.1447	388.71105	0
12	Optimized	64.435485	-34.2	886.08555	1617.1447	388.71105	0
13	Optimized	72.01613	-34.2	886.08555	1617.1447	388.71105	0
14	Optimized	79.596775	-34.2	886.08555	1617.1447	388.71105	0
15	Optimized	87.17742	-34.2	886.08555	1617.1447	388.71105	0
16	Optimized	94.758065	-34.2	886.08555	1617.1447	388.71105	0
17	Optimized	102.3387	-34.2	886.08555	1617.1447	388.71105	0
18	Optimized	109.91935	-34.2	886.08555	1617.1447	388.71105	0
19	Optimized	117.5	-34.2	886.08555	1617.1447	388.71105	0
20	Optimized	125.08065	-34.2	886.08555	1617.1447	388.71105	0
21	Optimized	132.6613	-34.2	886.08555	1617.1447	388.71105	0
22	Optimized	140.24195	-34.2	886.08555	1617.1447	388.71105	0
23	Optimized	147.8226	-34.2	886.08555	1617.1447	388.71105	0

24	Optimized	155.4032	-34.2	886.08555	1617.1447	388.71105	0
25	Optimized	162.98385	-34.2	886.08555	1617.1447	388.71105	0
26	Optimized	170.5645	-34.2	886.08555	1617.1447	388.71105	0
27	Optimized	178.14515	-34.2	886.08555	1617.1447	388.71105	0
28	Optimized	185.7258	-34.2	886.08555	1617.1447	388.71105	0
29	Optimized	193.30645	-34.2	886.08555	1617.1447	388.71105	0
30	Optimized	200.8871	-34.2	886.08555	1617.1447	388.71105	0
31	Optimized	208.46775	-34.2	886.08555	1617.1447	388.71105	0
32	Optimized	216.0484	-34.2	886.08555	1617.1447	388.71105	0
33	Optimized	223.62905	-34.2	886.08555	1617.1447	388.71105	0
34	Optimized	231.2097	-34.2	886.08555	1617.1447	388.71105	0
35	Optimized	240	-34.2	886.08	1617.1	388.69023	0
36	Optimized	248.75	-34.2	886.08	1617.0667	388.67251	0
37	Optimized	256.25	-34.2	886.08	1617.0667	388.67251	0
38	Optimized	263.75	-34.2	886.08	1617.0667	388.67251	0
39	Optimized	271.25	-34.2	886.08	1617.0667	388.67251	0
40	Optimized	278.5	-34.2	886.08571	1617.1429	388.70998	0
41	Optimized	285.5	-34.2	886.08571	1617.1429	388.70998	0
42	Optimized	292.5	-34.2	886.08571	1617.1429	388.70998	0
43	Optimized	299.5	-34.2	886.08571	1617.1429	388.70998	0
44	Optimized	306.5	-34.2	886.08571	1617.1429	388.70998	0
45	Optimized	313.75	-34.2	886.08	1617.0667	388.67251	0
46	Optimized	321.25	-34.2	886.08	1617.0667	388.67251	0
47	Optimized	330	-34.2	886.08	1617.1	388.69023	0

48	Optimized	337.5	-34.2	886.08	1617.1	388.69023	0
49	Optimized	343.7222	-34.2	886.08363	1617.0449	388.65898	0
50	Optimized	351.16665	-34.2	886.08363	1617.0449	388.65898	0
51	Optimized	358.6111	-34.2	886.08363	1617.0449	388.65898	0
52	Optimized	366.05555	-34.2	886.08363	1617.0449	388.65898	0
53	Optimized	373.5	-34.2	886.08363	1617.0449	388.65898	0
54	Optimized	380.94445	-34.2	886.08363	1617.0449	388.65898	0
55	Optimized	388.3889	-34.2	886.08363	1617.0449	388.65898	0
56	Optimized	395.83335	-34.2	886.08363	1617.0449	388.65898	0
57	Optimized	403.2778	-34.2	886.08363	1617.0449	388.65898	0
58	Optimized	410.5	-34.2	886.08571	1617.1429	388.70998	0
59	Optimized	417.5	-34.2	886.08571	1617.1429	388.70998	0
60	Optimized	424.5	-34.2	886.08571	1617.1429	388.70998	0
61	Optimized	431.5	-34.2	886.08571	1617.1429	388.70998	0
62	Optimized	438.91095	-34.2	886.07435	1617.1228	388.70534	0
63	Optimized	446.73285	-34.2	886.07435	1617.1228	388.70534	0
64	Optimized	454.5548	-34.2	886.07435	1617.1228	388.70534	0
65	Optimized	462.37675	-34.2	886.07435	1617.1228	388.70534	0
66	Optimized	470.19865	-34.2	886.07435	1617.1228	388.70534	0
67	Optimized	478.02055	-34.2	886.07435	1617.1228	388.70534	0
68	Optimized	485.84245	-34.2	886.07435	1617.1228	388.70534	0
69	Optimized	493.66435	-34.2	886.07435	1617.1228	388.70534	0
70	Optimized	501.4863	-34.2	886.07435	1617.1228	388.70534	0
71	Optimized	509.30825	-34.2	886.07435	1617.1228	388.70534	0

72	Optimized	517.13015	-34.2	886.07435	1617.1228	388.70534	0
73	Optimized	524.95205	-34.2	886.07435	1617.1228	388.70534	0
74	Optimized	531.213	-31.85	739.43808	1447.4776	376.4713	0
75	Optimized	533.7815	-29.2815	579.16417	1562.3501	417.33766	0
76	Optimized	536.5315	-26.5315	1655.5489	2350.7845	295.10999	0
77	Optimized	543.063	-20	1248.0433	1556.165	177.89417	0

40.2 Slices of Slip Surface: 3480

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	3480	-14.811	-19.5	2152.8262	2347.8306	112.58582	0
2	3480	-7.561	-26.75	2605.2384	3145.7251	229.42299	0
3	3480	-2.4055	-31.85	2923.391	3669.6274	396.78092	0
4	3480	3.7903225	-34.2	886.08555	1541.1617	348.31019	0
5	3480	11.370967	-34.2	886.08555	1617.1447	388.71105	0
6	3480	18.951615	-34.2	886.08555	1617.1447	388.71105	0
7	3480	26.53226	-34.2	886.08555	1617.1447	388.71105	0
8	3480	34.112905	-34.2	886.08555	1617.1447	388.71105	0
9	3480	41.69355	-34.2	886.08555	1617.1447	388.71105	0
10	3480	49.274195	-34.2	886.08555	1617.1447	388.71105	0
11	3480	56.85484	-34.2	886.08555	1617.1447	388.71105	0
12	3480	64.435485	-34.2	886.08555	1617.1447	388.71105	0
13	3480	72.01613	-34.2	886.08555	1617.1447	388.71105	0
14	3480	79.596775	-34.2	886.08555	1617.1447	388.71105	0
15	3480	87.17742	-34.2	886.08555	1617.1447	388.71105	0
16	3480	94.758065	-34.2	886.08555	1617.1447	388.71105	0

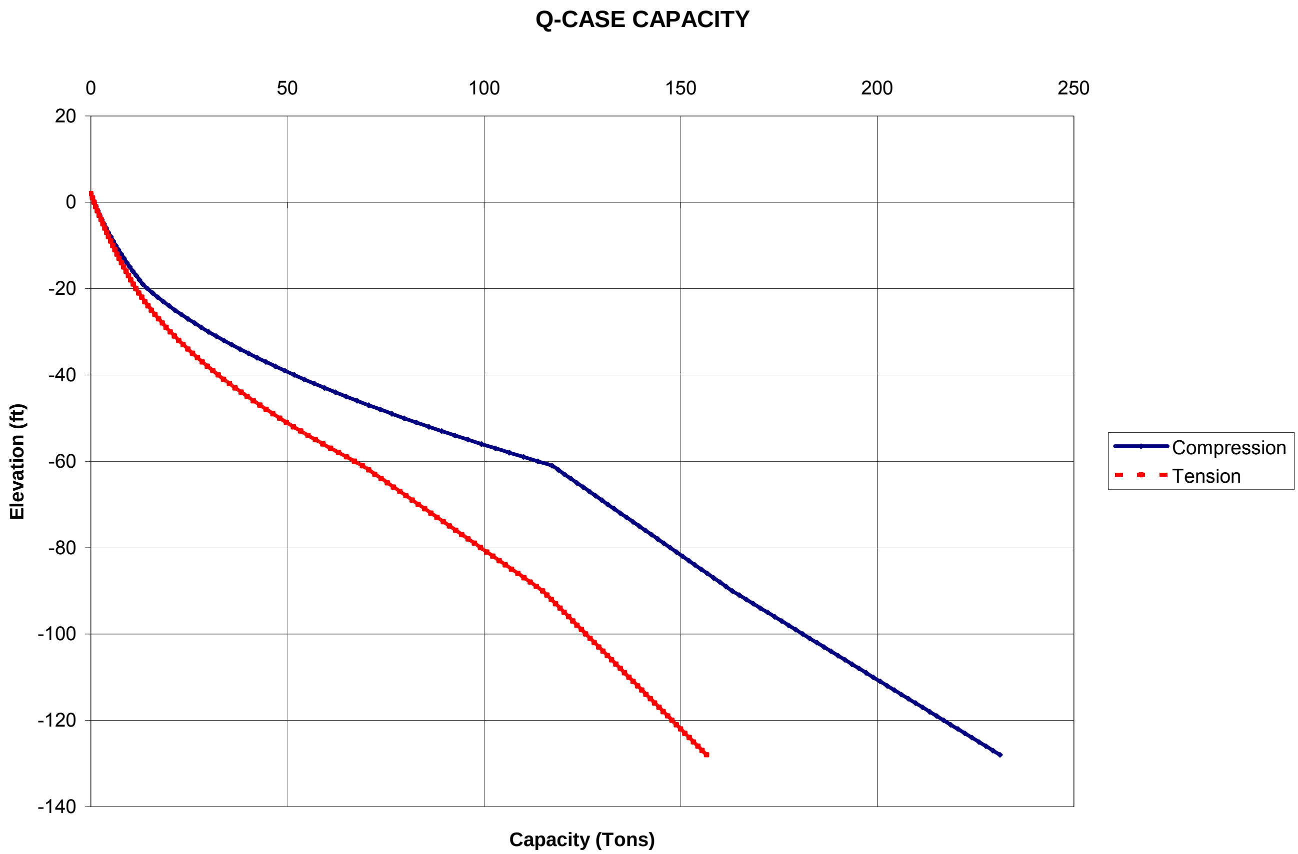
17	3480	102.3387	-34.2	886.08555	1617.1447	388.71105	0
18	3480	109.91935	-34.2	886.08555	1617.1447	388.71105	0
19	3480	117.5	-34.2	886.08555	1617.1447	388.71105	0
20	3480	125.08065	-34.2	886.08555	1617.1447	388.71105	0
21	3480	132.6613	-34.2	886.08555	1617.1447	388.71105	0
22	3480	140.24195	-34.2	886.08555	1617.1447	388.71105	0
23	3480	147.8226	-34.2	886.08555	1617.1447	388.71105	0
24	3480	155.4032	-34.2	886.08555	1617.1447	388.71105	0
25	3480	162.98385	-34.2	886.08555	1617.1447	388.71105	0
26	3480	170.5645	-34.2	886.08555	1617.1447	388.71105	0
27	3480	178.14515	-34.2	886.08555	1617.1447	388.71105	0
28	3480	185.7258	-34.2	886.08555	1617.1447	388.71105	0
29	3480	193.30645	-34.2	886.08555	1617.1447	388.71105	0
30	3480	200.8871	-34.2	886.08555	1617.1447	388.71105	0
31	3480	208.46775	-34.2	886.08555	1617.1447	388.71105	0
32	3480	216.0484	-34.2	886.08555	1617.1447	388.71105	0
33	3480	223.62905	-34.2	886.08555	1617.1447	388.71105	0
34	3480	231.2097	-34.2	886.08555	1617.1447	388.71105	0
35	3480	240	-34.2	886.08	1617.1	388.69023	0
36	3480	248.75	-34.2	886.08	1617.0667	388.67251	0
37	3480	256.25	-34.2	886.08	1617.0667	388.67251	0
38	3480	263.75	-34.2	886.08	1617.0667	388.67251	0
39	3480	271.25	-34.2	886.08	1617.0667	388.67251	0
40	3480	278.5	-34.2	886.08571	1617.1429	388.70998	0

41	3480	285.5	-34.2	886.08571	1617.1429	388.70998	0
42	3480	292.5	-34.2	886.08571	1617.1429	388.70998	0
43	3480	299.5	-34.2	886.08571	1617.1429	388.70998	0
44	3480	306.5	-34.2	886.08571	1617.1429	388.70998	0
45	3480	313.75	-34.2	886.08	1617.0667	388.67251	0
46	3480	321.25	-34.2	886.08	1617.0667	388.67251	0
47	3480	330	-34.2	886.08	1617.1	388.69023	0
48	3480	337.5	-34.2	886.08	1617.1	388.69023	0
49	3480	343.7222	-34.2	886.08363	1617.0449	388.65898	0
50	3480	351.16665	-34.2	886.08363	1617.0449	388.65898	0
51	3480	358.6111	-34.2	886.08363	1617.0449	388.65898	0
52	3480	366.05555	-34.2	886.08363	1617.0449	388.65898	0
53	3480	373.5	-34.2	886.08363	1617.0449	388.65898	0
54	3480	380.94445	-34.2	886.08363	1617.0449	388.65898	0
55	3480	388.3889	-34.2	886.08363	1617.0449	388.65898	0
56	3480	395.83335	-34.2	886.08363	1617.0449	388.65898	0
57	3480	403.2778	-34.2	886.08363	1617.0449	388.65898	0
58	3480	410.5	-34.2	886.08571	1617.1429	388.70998	0
59	3480	417.5	-34.2	886.08571	1617.1429	388.70998	0
60	3480	424.5	-34.2	886.08571	1617.1429	388.70998	0
61	3480	431.5	-34.2	886.08571	1617.1429	388.70998	0
62	3480	438.91095	-34.2	886.07435	1617.1228	388.70534	0
63	3480	446.73285	-34.2	886.07435	1617.1228	388.70534	0
64	3480	454.5548	-34.2	886.07435	1617.1228	388.70534	0

65	3480	462.37675	-34.2	886.07435	1617.1228	388.70534	0
66	3480	470.19865	-34.2	886.07435	1617.1228	388.70534	0
67	3480	478.02055	-34.2	886.07435	1617.1228	388.70534	0
68	3480	485.84245	-34.2	886.07435	1617.1228	388.70534	0
69	3480	493.66435	-34.2	886.07435	1617.1228	388.70534	0
70	3480	501.4863	-34.2	886.07435	1617.1228	388.70534	0
71	3480	509.30825	-34.2	886.07435	1617.1228	388.70534	0
72	3480	517.13015	-34.2	886.07435	1617.1228	388.70534	0
73	3480	524.95205	-34.2	886.07435	1617.1228	388.70534	0
74	3480	531.213	-31.85	739.43808	1447.4776	376.4713	0
75	3480	533.7815	-29.2815	579.16417	1562.3501	417.33766	0
76	3480	536.5315	-26.5315	1655.5489	2350.7845	295.10999	0
77	3480	543.063	-20	1248.0433	1556.165	177.89417	0

Plate L5.2

Boring
R-59.75-LU
12x12 Concrete Pile Capacities


Q-CASE CAPACITY
0
50
100
150
200
250
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

755


S-CASE CAPACITY
0
50
100
150
200
250
300
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

Boring R-59.75-LU_12x12 Concrete Pile_Q-Case

								Q-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	φ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	117	54.5999985	0	0	0	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	117	54.5999985	27.2999992	27.2999992	54.5999985	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.400	0.011	0.005	0.000	0.411	0.405
1	0	1	117	54.5999985	81.8999939	81.8999939	109.199997	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.800	0.043	0.022	0.000	0.843	0.822
1	-1	1	117	54.5999985	136.5	136.5	163.799988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	1.200	0.098	0.049	0.000	1.298	1.249
1	-2	1	117	54.5999985	191.099991	191.099991	218.399994	200	200	15	11.25	1.00	0.50	4.40	12.90	No	1.600	0.174	0.087	0.000	1.774	1.687
1	-3	1	117	54.5999985	245.699997	245.699997	273	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.000	0.272	0.136	0.000	2.272	2.136
1	-4	1	117	54.5999985	300.299988	300.299988	327.600006	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.400	0.391	0.195	0.000	2.791	2.595
1	-5	1	117	54.5999985	354.899994	354.899994	382.200012	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.800	0.532	0.266	0.000	3.332	3.066
1	-6	1	117	54.5999985	409.5	409.5	436.800018	200	200	15	11.25	1.00	0.50	4.40	12.90	No	3.200	0.695	0.348	0.000	3.895	3.548
1	-7	1	117	54.5999985	464.100006	464.100006	491.400024	200	200	15	11.25	1.00	0.50	4.40	12.90	No	3.600	0.880	0.440	0.000	4.480	4.040
1	-8	1	117	54.5999985	518.700012	518.700012	546	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.000	1.086	0.543	0.000	5.086	4.543
1	-9	1	117	54.5999985	573.299988	573.299988	600.599976	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.400	1.314	0.657	0.000	5.714	5.057
1	-10	1	117	54.5999985	627.899963	627.899963	655.199951	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.800	1.564	0.782	0.000	6.364	5.582
1	-11	1	117	54.5999985	682.499939	682.499939	709.799927	200	200	15	11.25	1.00	0.50	4.40	12.90	No	5.200	1.835	0.918	0.000	7.035	6.118
1	-12	1	117	54.5999985	737.099915	737.099915	764.399902	200	200	15	11.25	1.00	0.50	4.40	12.90	No	5.600	2.129	1.064	0.000	7.729	6.664
1	-13	1	117	54.5999985	791.69989	791.69989	818.999878	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.000	2.444	1.222	0.000	8.444	7.222
1	-14	1	117	54.5999985	846.299866	846.299866	873.599854	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.400	2.780	1.390	0.000	9.180	7.790
1	-15	1	117	54.5999985	900.899841	900.899841	928.199829	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.800	3.139	1.569	0.000	9.939	8.369
1	-16	1	117	54.5999985	955.499817	955.499817	982.799805	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.200	3.519	1.759	0.000	10.719	8.959
1	-17	1	117	54.5999985	1010.09979	1010.09979	1037.39978	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.600	3.921	1.960	0.000	11.521	9.560
1	-18	1	117	54.5999985	1064.69983	1064.69983	1091.99976	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.000	4.344	2.172	0.000	12.344	10.172
1	-19	1	117	54.5999985	1119.2998	1119.2998	1146.59973	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.400	4.790	2.395	0.000	13.190	10.795
2	-20	1	122	59.5999985	1176.39978	1176.39978	1206.19971	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	6.008	3.077	0.000	14.408	11.477
2	-21	1	122	59.5999985	1235.99976	1235.99976	1265.79968	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	7.288	3.794	0.000	15.688	12.194
2	-22	1	122	59.5999985	1295.59973	1295.59973	1325.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	8.629	4.545	0.000	17.029	12.945
2	-23	1	122	59.5999985	1355.19971	1355.19971	1384.99963	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	10.033	5.331	0.000	18.433	13.731
2	-24	1	122	59.5999985	1414.79968	1414.79968	1444.59961	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	11.498	6.151	0.000	19.898	14.551
2	-25	1	122	59.5999985	1474.39966	1474.39966	1504.19958	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	13.025	7.006	0.000	21.425	15.406
2	-26	1	122	59.5999985	1533.99963	1533.99963	1563.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	14.613	7.896	0.000	23.013	16.296
2	-27	1	122	59.5999985	1593.59961	1593.59961	1623.39954	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	16.263	8.820	0.000	24.663	17.220
2	-28	1	122	59.5999985	1653.19958	1653.19958	1682.99951	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	17.975	9.779	0.000	26.375	18.179
2	-29	1	122	59.5999985	1712.79956	1712.79956	1742.59949	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	19.749	10.772	0.000	28.149	19.172
2	-30	1	122	59.5999985	1772.39954	1772.39954	1802.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	21.584	11.800	0.000	29.984	20.200
2	-31	1	122	59.5999985	1831.99951	1831.99951	1861.79944	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	23.481	12.862	0.000	31.881	21.262
2	-32	1	122	59.5999985	1891.59949	1891.59949	1921.39941	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	25.440	13.959	0.000	33.840	22.359
2	-33	1	122	59.5999985	1951.19946	1951.19946	1980.99939	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	27.461	15.091	0.000	35.861	23.491
2	-34	1	122	59.5999985	2010.79944	2010.79944	2040.59937	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	29.543	16.257	0.000	37.943	24.657
2	-35	1	122	59.5999985	2070.39941	2070.39941	2100.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	31.687	17.457	0.000	40.087	25.857
2	-36	1	122	59.5999985	2129.99951	2129.99951	2159.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	33.893	18.692	0.000	42.293	27.092
2	-37	1	122	59.5999985	2189.59961	2189.59961	2219.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	36.160	19.962	0.000	44.560	28.362
2	-38	1	122	59.5999985	2249.19971	2249.19971	2278.99976	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	38.489	21.267	0.000	46.889	29.667
2	-39	1	122	59.5999985	2308.7998	2308.7998	2338.59985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	40.880	22.605	0.000	49.280	31.005
2	-40	1	122	59.5999985	2368.3999	2368.3999	2398.19995	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	43.333	23.979	0.000	51.733	32.379
2	-41	1	122	59.5999985	2428	2428	2457.80005	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	45.847	25.387	0.000	54.247	33.787
2	-42	1	122	59.5999985	2487.6001	2487.6001	2517.40015	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	48.423	26.829	0.000	56.823	35.229
2	-43	1	122	59.5999985	2547.2002	2547.2002	2577.00024	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	51.060	28.307	0.000	59.460	36.707
2	-44	1	122	59.5999985	2606.80029	2606.80029	2636.60034	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	53.760	29.818	0.000	62.160	38.218
2	-45	1	122	59.5999985	2666.40039	2666.40039	2696.20044	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	56.521	31.364	0.000	64.921	39.764
2	-46	1	122	59.5999985	2726.00049	2726.00049	2755.80054	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	59.344	32.945	0.000	67.744	41.345

2	-47	1	122	59.5999985	2785.60059	2785.60059	2815.40063	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	62.229	34.561	0.000	70.629	42.961
2	-48	1	122	59.5999985	2845.20068	2845.20068	2875.00073	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	65.175	36.211	0.000	73.575	44.611
2	-49	1	122	59.5999985	2904.80078	2904.80078	2934.60083	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	68.183	37.895	0.000	76.583	46.295
2	-50	1	122	59.5999985	2964.40088	2964.40088	2994.20093	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	71.253	39.614	0.000	79.653	48.014
2	-51	1	122	59.5999985	3024.00098	3024.00098	3053.80103	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	74.384	41.368	0.000	82.784	49.768
2	-52	1	122	59.5999985	3083.60107	3083.60107	3113.40112	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	77.577	43.156	0.000	85.977	51.556
2	-53	1	122	59.5999985	3143.20117	3143.20117	3173.00122	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	80.832	44.979	0.000	89.232	53.379
2	-54	1	122	59.5999985	3202.80127	3202.80127	3232.60132	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	84.149	46.836	0.000	92.549	55.236
2	-55	1	122	59.5999985	3262.40137	3262.40137	3292.20142	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	87.527	48.728	0.000	95.927	57.128
2	-56	1	122	59.5999985	3322.00146	3322.00146	3351.80151	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	90.967	50.654	0.000	99.367	59.054
2	-57	1	122	59.5999985	3381.60156	3381.60156	3411.40161	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	94.469	52.615	0.000	102.869	61.015
2	-58	1	122	59.5999985	3441.20166	3441.20166	3471.00171	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	98.032	54.611	0.000	106.432	63.011
2	-59	1	122	59.5999985	3500.80176	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	101.657	56.640	0.000	110.057	65.040
2	-60	1	122	59.5999985	3560.40186	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	105.281	58.670	0.000	113.681	67.070
2	-61	1	122	59.5999985	3620.00195	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	8.400	108.905	60.700	0.000	117.305	69.100
3	-62	1	105	42.5999985	3671.10205	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	9.980	108.905	60.700	0.000	118.885	70.680
3	-63	1	105	42.5999985	3713.70215	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	11.560	108.905	60.700	0.000	120.465	72.260
3	-64	1	105	42.5999985	3756.30225	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	13.140	108.905	60.700	0.000	122.045	73.840
3	-65	1	105	42.5999985	3798.90234	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	14.720	108.905	60.700	0.000	123.625	75.420
3	-66	1	105	42.5999985	3841.50244	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	16.300	108.905	60.700	0.000	125.205	77.000
3	-67	1	105	42.5999985	3884.10254	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	17.880	108.905	60.700	0.000	126.785	78.580
3	-68	1	105	42.5999985	3926.70264	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	19.460	108.905	60.700	0.000	128.365	80.160
3	-69	1	105	42.5999985	3969.30273	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	21.040	108.905	60.700	0.000	129.945	81.740
3	-70	1	105	42.5999985	4011.90283	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	22.620	108.905	60.700	0.000	131.525	83.320
3	-71	1	105	42.5999985	4054.50293	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	24.200	108.905	60.700	0.000	133.105	84.900
3	-72	1	105	42.5999985	4097.10303	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	25.780	108.905	60.700	0.000	134.685	86.480
3	-73	1	105	42.5999985	4139.70264	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	27.360	108.905	60.700	0.000	136.265	88.060
3	-74	1	105	42.5999985	4182.30273	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	28.940	108.905	60.700	0.000	137.845	89.640
3	-75	1	105	42.5999985	4224.90283	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	30.520	108.905	60.700	0.000	139.425	91.220
3	-76	1	105	42.5999985	4267.50293	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	32.100	108.905	60.700	0.000	141.005	92.800
3	-77	1	105	42.5999985	4310.10303	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	33.680	108.905	60.700	0.000	142.585	94.380
3	-78	1	105	42.5999985	4352.70313	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	35.260	108.905	60.700	0.000	144.165	95.960
3	-79	1	105	42.5999985	4395.30322	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	36.840	108.905	60.700	0.000	145.745	97.540
3	-80	1	105	42.5999985	4437.90332	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	38.420	108.905	60.700	0.000	147.325	99.120
3	-81	1	105	42.5999985	4480.50342	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	40.000	108.905	60.700	0.000	148.905	100.700
3	-82	1	105	42.5999985	4523.10352	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	41.580	108.905	60.700	0.000	150.485	102.280
3	-83	1	105	42.5999985	4565.70361	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	43.160	108.905	60.700	0.000	152.065	103.860
3	-84	1	105	42.5999985	4608.30371	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	44.740	108.905	60.700	0.000	153.645	105.440
3	-85	1	105	42.5999985	4650.90381	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	46.320	108.905	60.700	0.000	155.225	107.020
3	-86	1	105	42.5999985	4693.50391	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	47.900	108.905	60.700	0.000	156.805	108.600
3	-87	1	105	42.5999985	4736.104	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	49.480	108.905	60.700	0.000	158.385	110.180
3	-88	1	105	42.5999985	4778.7041	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	51.060	108.905	60.700	0.000	159.965	111.760
3	-89	1	105	42.5999985	4821.3042	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	52.640	108.905	60.700	0.000	161.545	113.340
3	-90	1	105	42.5999985	4863.9043	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	54.220	108.905	60.700	0.000	163.125	114.920
4	-91	1	117	54.5999985	4912.50439	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	54.620	110.298	61.396	0.000	164.918	116.016
4	-92	1	117	54.5999985	4967.10449	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	55.020	111.690	62.092	0.000	166.710	117.112
4	-93	1	117	54.5999985	5021.70459	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	55.420	113.083	62.788	0.000	168.503	118.208
4	-94	1	117	54.5999985	5076.30469	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	55.820	114.475	63.484	0.000	170.295	119.304
4	-95	1	117	54.5999985	5130.90479	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	56.220	115.867	64.181	0.000	172.087	120.401
4	-96	1	117	54.5999985	5185.50488	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	56.620	117.260	64.877	0.000	173.880	121.497
4	-97	1	117	54.5999985	5240.10498	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	57.020	118.652	65.573	0.000	175.672	122.593
4	-98	1	117	54.5999985	5294.70508	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	57.420	120.045	66.269	0.000	177.465	123.689
4	-99	1	117	54.5999985	5349.30518	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	57.820	121.437	66.965	0.000	179.257	124.785
4	-100	1	117	54.5999985	5403.90527	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	58.220	122.829	67.662	0.000	181.049	125.882
4	-101	1	117	54.5999985	5458.50537	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	58.620	124.222	68.358	0.000	182.842	126.978

4	-102	1	117	54.5999985	5513.10547	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	59.020	125.614	69.054	0.000	184.634	128.074
4	-103	1	117	54.5999985	5567.70557	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	59.420	127.006	69.750	0.000	186.427	129.170
4	-104	1	117	54.5999985	5622.30566	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	59.820	128.399	70.446	0.000	188.219	130.266
4	-105	1	117	54.5999985	5676.90576	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	60.220	129.791	71.143	0.000	190.011	131.363
4	-106	1	117	54.5999985	5731.50586	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	60.620	131.184	71.839	0.000	191.804	132.459
4	-107	1	117	54.5999985	5786.10596	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	61.020	132.576	72.535	0.000	193.596	133.555
4	-108	1	117	54.5999985	5840.70605	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	61.420	133.968	73.231	0.000	195.388	134.651
4	-109	1	117	54.5999985	5895.30615	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	61.820	135.361	73.927	0.000	197.181	135.747
4	-110	1	117	54.5999985	5949.90625	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	62.220	136.753	74.623	0.000	198.973	136.844
4	-111	1	117	54.5999985	6004.50635	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	62.620	138.146	75.320	0.000	200.766	137.940
4	-112	1	117	54.5999985	6059.10645	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	63.020	139.538	76.016	0.000	202.558	139.036
4	-113	1	117	54.5999985	6113.70654	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	63.420	140.930	76.712	0.000	204.350	140.132
4	-114	1	117	54.5999985	6168.30664	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	63.820	142.323	77.408	0.000	206.143	141.228
4	-115	1	117	54.5999985	6222.90674	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	64.220	143.715	78.104	0.000	207.935	142.325
4	-116	1	117	54.5999985	6277.50684	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	64.620	145.107	78.801	0.000	209.728	143.421
4	-117	1	117	54.5999985	6332.10693	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	65.020	146.500	79.497	0.000	211.520	144.517
4	-118	1	117	54.5999985	6386.70703	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	65.420	147.892	80.193	0.000	213.312	145.613
4	-119	1	117	54.5999985	6441.30713	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	65.820	149.285	80.889	0.000	215.105	146.709
4	-120	1	117	54.5999985	6495.90723	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	66.220	150.677	81.585	0.000	216.897	147.805
4	-121	1	117	54.5999985	6550.50732	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	66.620	152.069	82.282	0.000	218.690	148.902
4	-122	1	117	54.5999985	6605.10742	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	67.020	153.462	82.978	0.000	220.482	149.998
4	-123	1	117	54.5999985	6659.70752	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	67.420	154.854	83.674	0.000	222.274	151.094
4	-124	1	117	54.5999985	6714.30762	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	67.820	156.246	84.370	0.000	224.067	152.190
4	-125	1	117	54.5999985	6768.90771	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	68.220	157.639	85.066	0.000	225.859	153.286
4	-126	1	117	54.5999985	6823.50781	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	68.620	159.031	85.763	0.000	227.651	154.383
4	-127	1	117	54.5999985	6878.10791	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	69.020	160.424	86.459	0.000	229.444	155.479
4	-128	1	117	54.5999985	6932.70801	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	69.420	161.816	87.155	0.000	231.236	156.575

760

Boring R-59.75-LU_12x12 Concrete Pile_S-Case

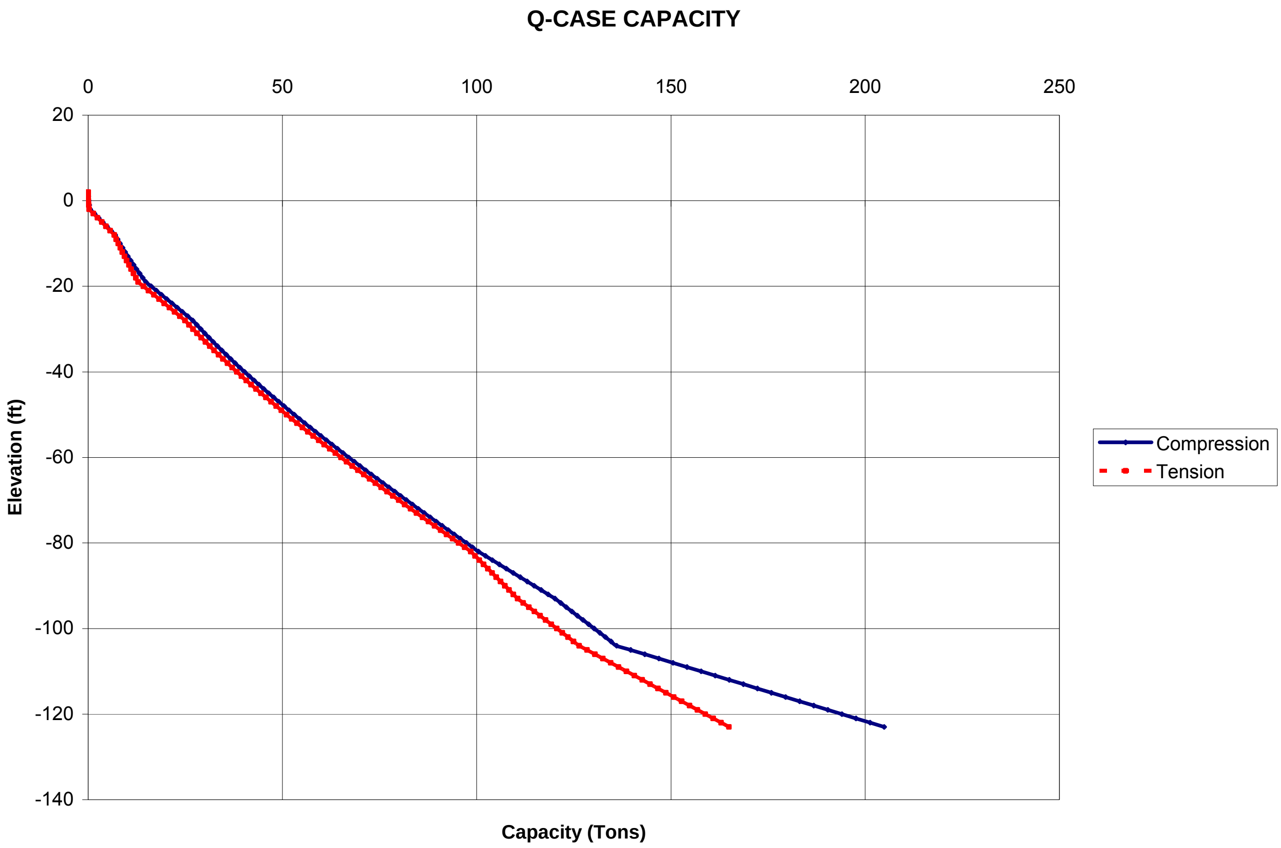
								S-CASE													
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	117	54.5999985	0	0	0	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	117	54.5999985	27.2999992	27.2999992	54.5999985	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.021	0.010	0.000	0.021	0.010
1	0	1	117	54.5999985	81.8999939	81.8999939	109.199997	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.084	0.042	0.000	0.084	0.042
1	-1	1	117	54.5999985	136.5	136.5	163.799988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.189	0.094	0.000	0.189	0.094
1	-2	1	117	54.5999985	191.099991	191.099991	218.399994	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.335	0.168	0.000	0.335	0.168
1	-3	1	117	54.5999985	245.699997	245.699997	273	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.524	0.262	0.000	0.524	0.262
1	-4	1	117	54.5999985	300.299988	300.299988	327.600006	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.755	0.377	0.000	0.755	0.377
1	-5	1	117	54.5999985	354.899994	354.899994	382.200012	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.027	0.513	0.000	1.027	0.513
1	-6	1	117	54.5999985	409.5	409.5	436.800018	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.341	0.671	0.000	1.341	0.671
1	-7	1	117	54.5999985	464.100006	464.100006	491.400024	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.698	0.849	0.000	1.698	0.849
1	-8	1	117	54.5999985	518.700012	518.700012	546	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.096	1.048	0.000	2.096	1.048
1	-9	1	117	54.5999985	573.299988	573.299988	600.599976	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.536	1.268	0.000	2.536	1.268
1	-10	1	117	54.5999985	627.899963	627.899963	655.199951	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.018	1.509	0.000	3.018	1.509
1	-11	1	117	54.5999985	682.499939	682.499939	709.799927	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.542	1.771	0.000	3.542	1.771
1	-12	1	117	54.5999985	737.099915	737.099915	764.399902	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.108	2.054	0.000	4.108	2.054
1	-13	1	117	54.5999985	791.69989	791.69989	818.999878	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.716	2.358	0.000	4.716	2.358
1	-14	1	117	54.5999985	846.299866	846.299866	873.599854	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.365	2.683	0.000	5.365	2.683
1	-15	1	117	54.5999985	900.899841	900.899841	928.199829	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.057	3.029	0.000	6.057	3.029
1	-16	1	117	54.5999985	955.499817	955.499817	982.799805	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.791	3.395	0.000	6.791	3.395
1	-17	1	117	54.5999985	1010.09979	1010.09979	1037.39978	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.566	3.783	0.000	7.566	3.783
1	-18	1	117	54.5999985	1064.69983	1064.69983	1091.99976	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	8.384	4.192	0.000	8.384	4.192
1	-19	1	117	54.5999985	1119.2998	1119.2998	1146.59973	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	9.243	4.621	0.000	9.243	4.621
2	-20	1	122	59.5999985	1176.39978	1176.39978	1206.19971	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	10.461	5.304	0.000	10.461	5.304
2	-21	1	122	59.5999985	1235.99976	1235.99976	1265.79968	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	11.741	6.020	0.000	11.741	6.020
2	-22	1	122	59.5999985	1295.59973	1295.59973	1325.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	13.083	6.772	0.000	13.083	6.772
2	-23	1	122	59.5999985	1355.19971	1355.19971	1384.99963	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	14.486	7.558	0.000	14.486	7.558
2	-24	1	122	59.5999985	1414.79968	1414.79968	1444.59961	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	15.951	8.378	0.000	15.951	8.378
2	-25	1	122	59.5999985	1474.39966	1474.39966	1504.19958	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	17.478	9.233	0.000	17.478	9.233
2	-26	1	122	59.5999985	1533.99963	1533.99963	1563.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	19.066	10.123	0.000	19.066	10.123
2	-27	1	122	59.5999985	1593.59961	1593.59961	1623.39954	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	20.717	11.047	0.000	20.717	11.047
2	-28	1	122	59.5999985	1653.19958	1653.19958	1682.99951	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	22.429	12.005	0.000	22.429	12.005
2	-29	1	122	59.5999985	1712.79956	1712.79956	1742.59949	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	24.202	12.999	0.000	24.202	12.999
2	-30	1	122	59.5999985	1772.39954	1772.39954	1802.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	26.038	14.026	0.000	26.038	14.026
2	-31	1	122	59.5999985	1831.99951	1831.99951	1861.79944	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	27.935	15.089	0.000	27.935	15.089
2	-32	1	122	59.5999985	1891.59949	1891.59949	1921.39941	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	29.894	16.186	0.000	29.894	16.186
2	-33	1	122	59.5999985	1951.19946	1951.19946	1980.99939	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	31.914	17.317	0.000	31.914	17.317
2	-34	1	122	59.5999985	2010.79944	2010.79944	2040.59937	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	33.996	18.483	0.000	33.996	18.483
2	-35	1	122	59.5999985	2070.39941	2070.39941	2100.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	36.140	19.684	0.000	36.140	19.684
2	-36	1	122	59.5999985	2129.99951	2129.99951	2159.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	38.346	20.919	0.000	38.346	20.919
2	-37	1	122	59.5999985	2189.59961	2189.59961	2219.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	40.613	22.189	0.000	40.613	22.189
2	-38	1	122	59.5999985	2249.19971	2249.19971	2278.99976	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	42.942	23.493	0.000	42.942	23.493
2	-39	1	122	59.5999985	2308.7998	2308.7998	2338.59985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	45.333	24.832	0.000	45.333	24.832
2	-40	1	122	59.5999985	2368.3999	2368.3999	2398.19995	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	47.786	26.206	0.000	47.786	26.206
2	-41	1	122	59.5999985	2428	2428	2457.80005	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	50.300	27.614	0.000	50.300	27.614
2	-42	1	122	59.5999985	2487.6001	2487.6001	2517.40015	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	52.876	29.056	0.000	52.876	29.056
2	-43	1	122	59.5999985	2547.2002	2547.2002	2577.00024	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	55.514	30.533	0.000	55.514	30.533
2	-44	1	122	59.5999985	2606.80029	2606.80029	2636.60034	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	58.213	32.045	0.000	58.213	32.045
2	-45	1	122	59.5999985	2666.40039	2666.40039	2696.20044	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	60.974	33.591	0.000	60.974	33.591
2	-46	1	122	59.5999985	2726.00049	2726.00049	2755.80054	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	63.797	35.172	0.000	63.797	35.172

2	-47	1	122	59.5999985	2785.60059	2785.60059	2815.40063	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	66.682	36.787	0.000	66.682	36.787
2	-48	1	122	59.5999985	2845.20068	2845.20068	2875.00073	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	69.628	38.437	0.000	69.628	38.437
2	-49	1	122	59.5999985	2904.80078	2904.80078	2934.60083	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	72.636	40.122	0.000	72.636	40.122
2	-50	1	122	59.5999985	2964.40088	2964.40088	2994.20093	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	75.706	41.841	0.000	75.706	41.841
2	-51	1	122	59.5999985	3024.00098	3024.00098	3053.80103	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	78.837	43.594	0.000	78.837	43.594
2	-52	1	122	59.5999985	3083.60107	3083.60107	3113.40112	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	82.031	45.383	0.000	82.031	45.383
2	-53	1	122	59.5999985	3143.20117	3143.20117	3173.00122	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	85.285	47.205	0.000	85.285	47.205
2	-54	1	122	59.5999985	3202.80127	3202.80127	3232.60132	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	88.602	49.063	0.000	88.602	49.063
2	-55	1	122	59.5999985	3262.40137	3262.40137	3292.20142	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	91.980	50.954	0.000	91.980	50.954
2	-56	1	122	59.5999985	3322.00146	3322.00146	3351.80151	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	95.420	52.881	0.000	95.420	52.881
2	-57	1	122	59.5999985	3381.60156	3381.60156	3411.40161	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	98.922	54.842	0.000	98.922	54.842
2	-58	1	122	59.5999985	3441.20166	3441.20166	3471.00171	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	102.486	56.837	0.000	102.486	56.837
2	-59	1	122	59.5999985	3500.80176	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	106.110	58.867	0.000	106.110	58.867
2	-60	1	122	59.5999985	3560.40186	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	109.734	60.897	0.000	109.734	60.897
2	-61	1	122	59.5999985	3620.00195	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	113.359	62.926	0.000	113.359	62.926
3	-62	1	105	42.5999985	3671.10205	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	115.532	64.448	0.000	115.532	64.448
3	-63	1	105	42.5999985	3713.70215	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	117.706	65.969	0.000	117.706	65.969
3	-64	1	105	42.5999985	3756.30225	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	119.880	67.491	0.000	119.880	67.491
3	-65	1	105	42.5999985	3798.90234	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	122.053	69.012	0.000	122.053	69.012
3	-66	1	105	42.5999985	3841.50244	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	124.227	70.534	0.000	124.227	70.534
3	-67	1	105	42.5999985	3884.10254	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	126.400	72.055	0.000	126.400	72.055
3	-68	1	105	42.5999985	3926.70264	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	128.574	73.577	0.000	128.574	73.577
3	-69	1	105	42.5999985	3969.30273	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	130.747	75.098	0.000	130.747	75.098
3	-70	1	105	42.5999985	4011.90283	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	132.921	76.620	0.000	132.921	76.620
3	-71	1	105	42.5999985	4054.50293	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	135.094	78.141	0.000	135.094	78.141
3	-72	1	105	42.5999985	4097.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	137.268	79.663	0.000	137.268	79.663
3	-73	1	105	42.5999985	4139.70264	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	139.442	81.184	0.000	139.442	81.184
3	-74	1	105	42.5999985	4182.30273	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	141.615	82.706	0.000	141.615	82.706
3	-75	1	105	42.5999985	4224.90283	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	143.789	84.227	0.000	143.789	84.227
3	-76	1	105	42.5999985	4267.50293	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	145.962	85.749	0.000	145.962	85.749
3	-77	1	105	42.5999985	4310.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	148.136	87.270	0.000	148.136	87.270
3	-78	1	105	42.5999985	4352.70313	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	150.309	88.792	0.000	150.309	88.792
3	-79	1	105	42.5999985	4395.30322	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	152.483	90.313	0.000	152.483	90.313
3	-80	1	105	42.5999985	4437.90332	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	154.656	91.835	0.000	154.656	91.835
3	-81	1	105	42.5999985	4480.50342	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	156.830	93.356	0.000	156.830	93.356
3	-82	1	105	42.5999985	4523.10352	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	159.003	94.878	0.000	159.003	94.878
3	-83	1	105	42.5999985	4565.70361	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	161.177	96.399	0.000	161.177	96.399
3	-84	1	105	42.5999985	4608.30371	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	163.351	97.921	0.000	163.351	97.921
3	-85	1	105	42.5999985	4650.90381	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	165.524	99.442	0.000	165.524	99.442
3	-86	1	105	42.5999985	4693.50391	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	167.698	100.964	0.000	167.698	100.964
3	-87	1	105	42.5999985	4736.104	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	169.871	102.485	0.000	169.871	102.485
3	-88	1	105	42.5999985	4778.7041	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	172.045	104.007	0.000	172.045	104.007
3	-89	1	105	42.5999985	4821.3042	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	174.218	105.528	0.000	174.218	105.528
3	-90	1	105	42.5999985	4863.9043	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	176.392	107.050	0.000	176.392	107.050
4	-91	1	117	54.5999985	4912.50439	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	179.079	108.393	0.000	179.079	108.393
4	-92	1	117	54.5999985	4967.10449	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	181.766	109.737	0.000	181.766	109.737
4	-93	1	117	54.5999985	5021.70459	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	184.453	111.080	0.000	184.453	111.080
4	-94	1	117	54.5999985	5076.30469	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	187.140	112.424	0.000	187.140	112.424
4	-95	1	117	54.5999985	5130.90479	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	189.827	113.767	0.000	189.827	113.767
4	-96	1	117	54.5999985	5185.50488	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	192.514	115.111	0.000	192.514	115.111
4	-97	1	117	54.5999985	5240.10498	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	195.201	116.454	0.000	195.201	116.454
4	-98	1	117	54.5999985	5294.70508	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	197.888	117.798	0.000	197.888	117.798
4	-99	1	117	54.5999985	5349.30518	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	200.575	119.141	0.000	200.575	119.141
4	-100	1	117	54.5999985	5403.90527	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	203.262	120.485	0.000	203.262	120.485
4	-101	1	117	54.5999985	5458.50537	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	205.949	121.828	0.000	205.949	121.828

4	-102	1	117	54.5999985	5513.10547	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	208.636	123.172	0.000	208.636	123.172
4	-103	1	117	54.5999985	5567.70557	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	211.323	124.515	0.000	211.323	124.515
4	-104	1	117	54.5999985	5622.30566	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	214.011	125.859	0.000	214.011	125.859
4	-105	1	117	54.5999985	5676.90576	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	216.698	127.202	0.000	216.698	127.202
4	-106	1	117	54.5999985	5731.50586	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	219.385	128.546	0.000	219.385	128.546
4	-107	1	117	54.5999985	5786.10596	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	222.072	129.889	0.000	222.072	129.889
4	-108	1	117	54.5999985	5840.70605	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	224.759	131.233	0.000	224.759	131.233
4	-109	1	117	54.5999985	5895.30615	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	227.446	132.577	0.000	227.446	132.577
4	-110	1	117	54.5999985	5949.90625	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	230.133	133.920	0.000	230.133	133.920
4	-111	1	117	54.5999985	6004.50635	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	232.820	135.264	0.000	232.820	135.264
4	-112	1	117	54.5999985	6059.10645	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	235.507	136.607	0.000	235.507	136.607
4	-113	1	117	54.5999985	6113.70654	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	238.194	137.951	0.000	238.194	137.951
4	-114	1	117	54.5999985	6168.30664	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	240.881	139.294	0.000	240.881	139.294
4	-115	1	117	54.5999985	6222.90674	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	243.568	140.638	0.000	243.568	140.638
4	-116	1	117	54.5999985	6277.50684	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	246.255	141.981	0.000	246.255	141.981
4	-117	1	117	54.5999985	6332.10693	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	248.942	143.325	0.000	248.942	143.325
4	-118	1	117	54.5999985	6386.70703	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	251.629	144.668	0.000	251.629	144.668
4	-119	1	117	54.5999985	6441.30713	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	254.316	146.012	0.000	254.316	146.012
4	-120	1	117	54.5999985	6495.90723	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	257.003	147.355	0.000	257.003	147.355
4	-121	1	117	54.5999985	6550.50732	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	259.690	148.699	0.000	259.690	148.699
4	-122	1	117	54.5999985	6605.10742	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	262.377	150.042	0.000	262.377	150.042
4	-123	1	117	54.5999985	6659.70752	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	265.064	151.386	0.000	265.064	151.386
4	-124	1	117	54.5999985	6714.30762	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	267.751	152.729	0.000	267.751	152.729
4	-125	1	117	54.5999985	6768.90771	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	270.438	154.073	0.000	270.438	154.073
4	-126	1	117	54.5999985	6823.50781	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	273.125	155.416	0.000	273.125	155.416
4	-127	1	117	54.5999985	6878.10791	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	275.813	156.760	0.000	275.813	156.760
4	-128	1	117	54.5999985	6932.70801	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	278.500	158.103	0.000	278.500	158.103

765

Boring
R-60.3-UL
12x12 Concrete Pile Capacities


Q-CASE CAPACITY
0
50
100
150
200
250
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension


S-CASE CAPACITY
0
50
100
150
200
250
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

Boring R-60.3-UL_12x12 Concrete Pile_Q-Case

								Q-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	122	59.5999985	0	0	0	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	122	59.5999985	29.7999992	29.7999992	59.5999985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.031	0.017	0.000	0.031	0.017
1	0	1	122	59.5999985	89.3999939	89.3999939	119.199997	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.123	0.069	0.000	0.123	0.069
1	-1	1	122	59.5999985	149	149	178.799988	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.278	0.156	0.000	0.278	0.156
1	-2	1	122	59.5999985	208.599991	208.599991	238.399994	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.494	0.276	0.000	0.494	0.276
2	-3	1	107	44.5999985	260.699982	260.699982	283	550	536.25	0	0	1.00	1.00	1.00	9.00	No	1.072	0.494	0.276	0.000	1.566	1.349
2	-4	1	107	44.5999985	305.299988	305.299988	327.600006	550	536.25	0	0	1.00	1.00	1.00	9.00	No	2.145	0.494	0.276	0.000	2.639	2.421
2	-5	1	107	44.5999985	349.899994	349.899994	372.200012	550	536.25	0	0	1.00	1.00	1.00	9.00	No	3.217	0.494	0.276	0.000	3.711	3.494
2	-6	1	107	44.5999985	394.5	394.5	416.800018	550	536.25	0	0	1.00	1.00	1.00	9.00	No	4.290	0.494	0.276	0.000	4.784	4.566
2	-7	1	107	44.5999985	439.100006	439.100006	461.400024	550	536.25	0	0	1.00	1.00	1.00	9.00	No	5.363	0.494	0.276	0.000	5.856	5.639
2	-8	1	107	44.5999985	483.700012	483.700012	506.000031	550	536.25	0	0	1.00	1.00	1.00	9.00	No	6.435	0.494	0.276	0.000	6.929	6.711
3	-9	1	117	54.5999985	533.300049	533.300049	560.600037	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.835	0.706	0.383	0.000	7.541	7.218
3	-10	1	117	54.5999985	587.900024	587.900024	615.200012	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.235	0.940	0.500	0.000	8.175	7.735
3	-11	1	117	54.5999985	642.5	642.5	669.799988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.635	1.195	0.627	0.000	8.830	8.262
3	-12	1	117	54.5999985	697.099976	697.099976	724.399963	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.035	1.473	0.766	0.000	9.508	8.801
3	-13	1	117	54.5999985	751.699951	751.699951	778.999939	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.435	1.772	0.916	0.000	10.207	9.351
3	-14	1	117	54.5999985	806.299927	806.299927	833.599915	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.835	2.093	1.076	0.000	10.928	9.911
3	-15	1	117	54.5999985	860.899902	860.899902	888.19989	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.235	2.435	1.247	0.000	11.670	10.482
3	-16	1	117	54.5999985	915.499878	915.499878	942.799866	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.635	2.799	1.429	0.000	12.434	11.064
3	-17	1	117	54.5999985	970.099854	970.099854	997.399841	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.035	3.185	1.622	0.000	13.220	11.657
3	-18	1	117	54.5999985	1024.69983	1024.69983	1051.99988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.435	3.593	1.826	0.000	14.028	12.261
3	-19	1	117	54.5999985	1079.29993	1079.29993	1106.59985	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.835	4.022	2.041	0.000	14.857	12.876
4	-20	1	101	38.5999985	1125.8999	1125.8999	1145.19983	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	12.177	4.022	2.041	0.000	16.199	14.217
4	-21	1	101	38.5999985	1164.49988	1164.49988	1183.7998	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	13.518	4.022	2.041	0.000	17.540	15.559
4	-22	1	101	38.5999985	1203.09985	1203.09985	1222.39978	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	14.860	4.022	2.041	0.000	18.882	16.901
4	-23	1	101	38.5999985	1241.69983	1241.69983	1260.99976	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	16.201	4.022	2.041	0.000	20.224	18.242
4	-24	1	101	38.5999985	1280.2998	1280.2998	1299.59973	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	17.543	4.022	2.041	0.000	21.565	19.584
4	-25	1	101	38.5999985	1318.89978	1318.89978	1338.19971	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	18.885	4.022	2.041	0.000	22.907	20.925
4	-26	1	101	38.5999985	1357.49976	1357.49976	1376.79968	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	20.226	4.022	2.041	0.000	24.248	22.267
4	-27	1	101	38.5999985	1396.09973	1396.09973	1415.39966	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	21.568	4.022	2.041	0.000	25.590	23.609
4	-28	1	101	38.5999985	1434.69971	1434.69971	1453.99963	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	22.909	4.022	2.041	0.000	26.932	24.950
5	-29	1	101	38.5999985	1473.29968	1473.29968	1492.59961	512.962952	504.819092	0	0	1.00	1.00	1.00	9.00	No	23.919	4.022	2.041	0.000	27.941	25.960
5	-30	1	101	38.5999985	1511.89966	1511.89966	1531.19958	525.925903	514.373291	0	0	1.00	1.00	1.00	9.00	No	24.948	4.022	2.041	0.000	28.970	26.988
5	-31	1	101	38.5999985	1550.49963	1550.49963	1569.79956	538.888916	523.759399	0	0	1.00	1.00	1.00	9.00	No	25.995	4.022	2.041	0.000	30.017	28.036
5	-32	1	101	38.5999985	1589.09961	1589.09961	1608.39954	551.851868	532.977539	0	0	1.00	1.00	1.00	9.00	No	27.061	4.022	2.041	0.000	31.083	29.102
5	-33	1	101	38.5999985	1627.69958	1627.69958	1646.99951	564.814819	542.027588	0	0	1.00	1.00	1.00	9.00	No	28.145	4.022	2.041	0.000	32.167	30.186
5	-34	1	101	38.5999985	1666.29956	1666.29956	1685.59949	577.777771	550.909668	0	0	1.00	1.00	1.00	9.00	No	29.247	4.022	2.041	0.000	33.269	31.288
5	-35	1	101	38.5999985	1704.89954	1704.89954	1724.19946	590.740723	559.623657	0	0	1.00	1.00	1.00	9.00	No	30.366	4.022	2.041	0.000	34.389	32.407
5	-36	1	101	38.5999985	1743.49951	1743.49951	1762.79944	603.703674	568.169556	0	0	1.00	1.00	1.00	9.00	No	31.503	4.022	2.041	0.000	35.525	33.543
5	-37	1	101	38.5999985	1782.09949	1782.09949	1801.39941	616.666687	576.547485	0	0	1.00	1.00	1.00	9.00	No	32.656	4.022	2.041	0.000	36.678	34.697
5	-38	1	101	38.5999985	1820.69946	1820.69946	1839.99939	629.629639	584.757385	0	0	1.00	1.00	1.00	9.00	No	33.825	4.022	2.041	0.000	37.847	35.866
5	-39	1	101	38.5999985	1859.29944	1859.29944	1878.59937	642.59259	592.799194	0	0	1.00	1.00	1.00	9.00	No	35.011	4.022	2.041	0.000	39.033	37.052
5	-40	1	101	38.5999985	1897.89941	1897.89941	1917.19934	655.555542	600.672974	0	0	1.00	1.00	1.00	9.00	No	36.212	4.022	2.041	0.000	40.234	38.253
5	-41	1	101	38.5999985	1936.49939	1936.49939	1955.79932	668.518494	608.378784	0	0	1.00	1.00	1.00	9.00	No	37.429	4.022	2.041	0.000	41.451	39.470
5	-42	1	101	38.5999985	1975.09937	1975.09937	1994.39929	681.481506	615.916504	0	0	1.00	1.00	1.00	9.00	No	38.661	4.022	2.041	0.000	42.683	40.702
5	-43	1	101	38.5999985	2013.69934	2013.69934	2032.99927	694.444458	623.286194	0	0	1.00	1.00	1.00	9.00	No	39.907	4.022	2.041	0.000	43.930	41.948
5	-44	1	101	38.5999985	2052.29932	2052.29932	2071.59937	707.40741	630.487793	0	0	1.00	1.00	1.00	9.00	No	41.168	4.022	2.041	0.000	45.191	43.209
5	-45	1	101	38.5999985	2090.89941	2090.89941	2110.19946	720.370361	637.521423	0	0	1.00	1.00	1.00	9.00	No	42.443	4.022	2.041	0.000	46.466	44.484
5	-46	1	101	38.5999985	2129.49951	2129.49951	2148.79956	733.333313	644.386963	0	0	1.00	1.00	1.00	9.00	No	43.732	4.022	2.041	0.000	47.754	45.773

5	-47	1	101	38.5999985	2168.09961	2168.09961	2187.39966	746.296326	651.084534	0	0	1.00	1.00	1.00	9.00	No	45.034	4.022	2.041	0.000	49.057	47.075
5	-48	1	101	38.5999985	2206.69971	2206.69971	2225.99976	759.259277	657.614014	0	0	1.00	1.00	1.00	9.00	No	46.350	4.022	2.041	0.000	50.372	48.390
5	-49	1	101	38.5999985	2245.2998	2245.2998	2264.59985	772.222229	663.975464	0	0	1.00	1.00	1.00	9.00	No	47.678	4.022	2.041	0.000	51.700	49.718
5	-50	1	101	38.5999985	2283.8999	2283.8999	2303.19995	785.185181	670.168884	0	0	1.00	1.00	1.00	9.00	No	49.018	4.022	2.041	0.000	53.040	51.059
5	-51	1	101	38.5999985	2322.5	2322.5	2341.80005	798.148132	676.194214	0	0	1.00	1.00	1.00	9.00	No	50.370	4.022	2.041	0.000	54.392	52.411
5	-52	1	101	38.5999985	2361.1001	2361.1001	2380.40015	811.111084	682.051575	0	0	1.00	1.00	1.00	9.00	No	51.734	4.022	2.041	0.000	55.757	53.775
5	-53	1	101	38.5999985	2399.7002	2399.7002	2419.00024	824.074097	687.740906	0	0	1.00	1.00	1.00	9.00	No	53.110	4.022	2.041	0.000	57.132	55.151
5	-54	1	101	38.5999985	2438.30029	2438.30029	2457.60034	837.037048	693.262207	0	0	1.00	1.00	1.00	9.00	No	54.496	4.022	2.041	0.000	58.519	56.537
5	-55	1	101	38.5999985	2476.90039	2476.90039	2496.20044	850	698.615356	0	0	1.00	1.00	1.00	9.00	No	55.894	4.022	2.041	0.000	59.916	57.934
5	-56	1	101	38.5999985	2515.50049	2515.50049	2534.80054	862.962952	703.800537	0	0	1.00	1.00	1.00	9.00	No	57.301	4.022	2.041	0.000	61.323	59.342
5	-57	1	101	38.5999985	2554.10059	2554.10059	2573.40063	875.925903	708.817749	0	0	1.00	1.00	1.00	9.00	No	58.719	4.022	2.041	0.000	62.741	60.760
5	-58	1	101	38.5999985	2592.70068	2592.70068	2612.00073	888.888916	713.66687	0	0	1.00	1.00	1.00	9.00	No	60.146	4.022	2.041	0.000	64.168	62.187
5	-59	1	101	38.5999985	2631.30078	2631.30078	2650.60083	901.851868	718.3479	0	0	1.00	1.00	1.00	9.00	No	61.583	4.022	2.041	0.000	65.605	63.624
5	-60	1	101	38.5999985	2669.90088	2669.90088	2689.20093	914.814819	722.860962	0	0	1.00	1.00	1.00	9.00	No	63.029	4.022	2.041	0.000	67.051	65.069
5	-61	1	101	38.5999985	2708.50098	2708.50098	2727.80103	927.777771	727.205933	0	0	1.00	1.00	1.00	9.00	No	64.483	4.022	2.041	0.000	68.505	66.524
5	-62	1	101	38.5999985	2747.10107	2747.10107	2766.40112	940.740723	731.382874	0	0	1.00	1.00	1.00	9.00	No	65.946	4.022	2.041	0.000	69.968	67.987
5	-63	1	101	38.5999985	2785.70117	2785.70117	2805.00122	953.703674	735.391785	0	0	1.00	1.00	1.00	9.00	No	67.417	4.022	2.041	0.000	71.439	69.457
5	-64	1	101	38.5999985	2824.30127	2824.30127	2843.60132	966.666687	739.232666	0	0	1.00	1.00	1.00	9.00	No	68.895	4.022	2.041	0.000	72.917	70.936
5	-65	1	101	38.5999985	2862.90137	2862.90137	2882.20142	979.629639	742.905518	0	0	1.00	1.00	1.00	9.00	No	70.381	4.022	2.041	0.000	74.403	72.422
5	-66	1	101	38.5999985	2901.50146	2901.50146	2920.80151	992.59259	746.410339	0	0	1.00	1.00	1.00	9.00	No	71.874	4.022	2.041	0.000	75.896	73.914
5	-67	1	101	38.5999985	2940.10156	2940.10156	2959.40161	1005.55554	749.74707	0	0	1.00	1.00	1.00	9.00	No	73.373	4.022	2.041	0.000	77.395	75.414
5	-68	1	101	38.5999985	2978.70166	2978.70166	2998.00171	1018.51849	752.915771	0	0	1.00	1.00	1.00	9.00	No	74.879	4.022	2.041	0.000	78.901	76.920
5	-69	1	101	38.5999985	3017.30176	3017.30176	3036.60181	1031.48145	755.916504	0	0	1.00	1.00	1.00	9.00	No	76.391	4.022	2.041	0.000	80.413	78.432
5	-70	1	101	38.5999985	3055.90186	3055.90186	3075.2019	1044.44446	758.749146	0	0	1.00	1.00	1.00	9.00	No	77.908	4.022	2.041	0.000	81.931	79.949
5	-71	1	101	38.5999985	3094.50195	3094.50195	3113.802	1057.40735	761.413757	0	0	1.00	1.00	1.00	9.00	No	79.431	4.022	2.041	0.000	83.453	81.472
5	-72	1	101	38.5999985	3133.10205	3133.10205	3152.4021	1070.37036	763.910278	0	0	1.00	1.00	1.00	9.00	No	80.959	4.022	2.041	0.000	84.981	83.000
5	-73	1	101	38.5999985	3171.70215	3171.70215	3191.0022	1083.33337	766.238892	0	0	1.00	1.00	1.00	9.00	No	82.491	4.022	2.041	0.000	86.514	84.532
5	-74	1	101	38.5999985	3210.30225	3210.30225	3229.60229	1096.29626	768.399353	0	0	1.00	1.00	1.00	9.00	No	84.028	4.022	2.041	0.000	88.050	86.069
5	-75	1	101	38.5999985	3248.90234	3248.90234	3268.20239	1109.25928	770.391785	0	0	1.00	1.00	1.00	9.00	No	85.569	4.022	2.041	0.000	89.591	87.610
5	-76	1	101	38.5999985	3287.50244	3287.50244	3306.80249	1122.22217	772.216187	0	0	1.00	1.00	1.00	9.00	No	87.113	4.022	2.041	0.000	91.136	89.154
5	-77	1	101	38.5999985	3326.10254	3326.10254	3345.40259	1135.18518	773.872559	0	0	1.00	1.00	1.00	9.00	No	88.661	4.022	2.041	0.000	92.683	90.702
5	-78	1	101	38.5999985	3364.70264	3364.70264	3384.00269	1148.14819	775.360962	0	0	1.00	1.00	1.00	9.00	No	90.212	4.022	2.041	0.000	94.234	92.253
5	-79	1	101	38.5999985	3403.30273	3403.30273	3422.60278	1161.11108	776.681274	0	0	1.00	1.00	1.00	9.00	No	91.765	4.022	2.041	0.000	95.787	93.806
5	-80	1	101	38.5999985	3441.90283	3441.90283	3461.20288	1174.0741	777.833496	0	0	1.00	1.00	1.00	9.00	No	93.321	4.022	2.041	0.000	97.343	95.362
5	-81	1	101	38.5999985	3480.50293	3480.50293	3499.80298	1187.03699	778.817749	0	0	1.00	1.00	1.00	9.00	No	94.879	4.022	2.041	0.000	98.901	96.919
5	-82	1	101	38.5999985	3519.10303	3500	3500	1200	779.633911	0	0	1.00	1.00	1.00	9.00	No	96.438	4.022	2.041	0.000	100.460	98.479
6	-83	1	117	54.5999985	3565.70313	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	96.838	5.415	2.737	0.000	102.252	99.575
6	-84	1	117	54.5999985	3620.30322	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	97.238	6.807	3.433	0.000	104.045	100.671
6	-85	1	117	54.5999985	3674.90332	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	97.638	8.199	4.129	0.000	105.837	101.767
6	-86	1	117	54.5999985	3729.50342	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	98.038	9.592	4.825	0.000	107.630	102.863
6	-87	1	117	54.5999985	3784.10352	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	98.438	10.984	5.522	0.000	109.422	103.960
6	-88	1	117	54.5999985	3838.70361	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	98.838	12.376	6.218	0.000	111.214	105.056
6	-89	1	117	54.5999985	3893.30371	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	99.238	13.769	6.914	0.000	113.007	106.152
6	-90	1	117	54.5999985	3947.90381	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	99.638	15.161	7.610	0.000	114.799	107.248
6	-91	1	117	54.5999985	4002.50391	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	100.038	16.554	8.306	0.000	116.592	108.344
6	-92	1	117	54.5999985	4057.104	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	100.438	17.946	9.003	0.000	118.384	109.441
6	-93	1	117	54.5999985	4111.7041	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	100.838	19.338	9.699	0.000	120.176	110.537
7	-94	1	115	52.5999985	4165.30371	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	102.278	19.338	9.699	0.000	121.616	111.977
7	-95	1	115	52.5999985	4217.90381	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	103.718	19.338	9.699	0.000	123.056	113.417
7	-96	1	115	52.5999985	4270.50391	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	105.158	19.338	9.699	0.000	124.496	114.857
7	-97	1	115	52.5999985	4323.104	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	106.598	19.338	9.699	0.000	125.936	116.297
7	-98	1	115	52.5999985	4375.7041	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	108.038	19.338	9.699	0.000	127.376	117.737
7	-99	1	115	52.5999985	4428.3042	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	109.478	19.338	9.699	0.000	128.816	119.177
7	-100	1	115	52.5999985	4480.9043	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	110.918	19.338	9.699	0.000	130.256	120.617
7	-101	1	115	52.5999985	4533.50439	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	112.358	19.338	9.699	0.000	131.696	122.057

7	-102	1	115	52.5999985	4586.10449	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	113.798	19.338	9.699	0.000	133.136	123.497
7	-103	1	115	52.5999985	4638.70459	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	115.238	19.338	9.699	0.000	134.576	124.937
7	-104	1	115	52.5999985	4691.30469	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	116.678	19.338	9.699	0.000	136.016	126.377
8	-105	1	122	59.5999985	4747.40479	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	22.963	11.728	0.000	139.641	128.406
8	-106	1	122	59.5999985	4807.00488	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	26.587	13.758	0.000	143.265	130.436
8	-107	1	122	59.5999985	4866.60498	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	30.212	15.788	0.000	146.889	132.466
8	-108	1	122	59.5999985	4926.20508	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	33.836	17.817	0.000	150.514	134.495
8	-109	1	122	59.5999985	4985.80518	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	37.460	19.847	0.000	154.138	136.525
8	-110	1	122	59.5999985	5045.40527	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	41.085	21.877	0.000	157.763	138.555
8	-111	1	122	59.5999985	5105.00537	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	44.709	23.906	0.000	161.387	140.584
8	-112	1	122	59.5999985	5164.60547	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	48.333	25.936	0.000	165.011	142.614
8	-113	1	122	59.5999985	5224.20557	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	51.958	27.966	0.000	168.636	144.644
8	-114	1	122	59.5999985	5283.80566	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	55.582	29.995	0.000	172.260	146.673
8	-115	1	122	59.5999985	5343.40576	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	59.206	32.025	0.000	175.884	148.703
8	-116	1	122	59.5999985	5403.00586	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	62.831	34.055	0.000	179.509	150.732
8	-117	1	122	59.5999985	5462.60596	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	66.455	36.084	0.000	183.133	152.762
8	-118	1	122	59.5999985	5522.20605	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	70.080	38.114	0.000	186.758	154.792
8	-119	1	122	59.5999985	5581.80615	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	73.704	40.144	0.000	190.382	156.821
8	-120	1	122	59.5999985	5641.40625	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	77.328	42.173	0.000	194.006	158.851
8	-121	1	122	59.5999985	5701.00635	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	80.953	44.203	0.000	197.631	160.881
8	-122	1	122	59.5999985	5760.60645	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	84.577	46.232	0.000	201.255	162.910
8	-123	1	122	59.5999985	5820.20654	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	116.678	88.201	48.262	0.000	204.879	164.940
4	-124	1	117	54.5999985	6714.30762	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	67.820	156.246	84.370	0.000	224.067	152.190
4	-125	1	117	54.5999985	6768.90771	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	68.220	157.639	85.066	0.000	225.859	153.286
4	-126	1	117	54.5999985	6823.50781	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	68.620	159.031	85.763	0.000	227.651	154.383
4	-127	1	117	54.5999985	6878.10791	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	69.020	160.424	86.459	0.000	229.444	155.479
4	-128	1	117	54.5999985	6932.70801	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	69.420	161.816	87.155	0.000	231.236	156.575

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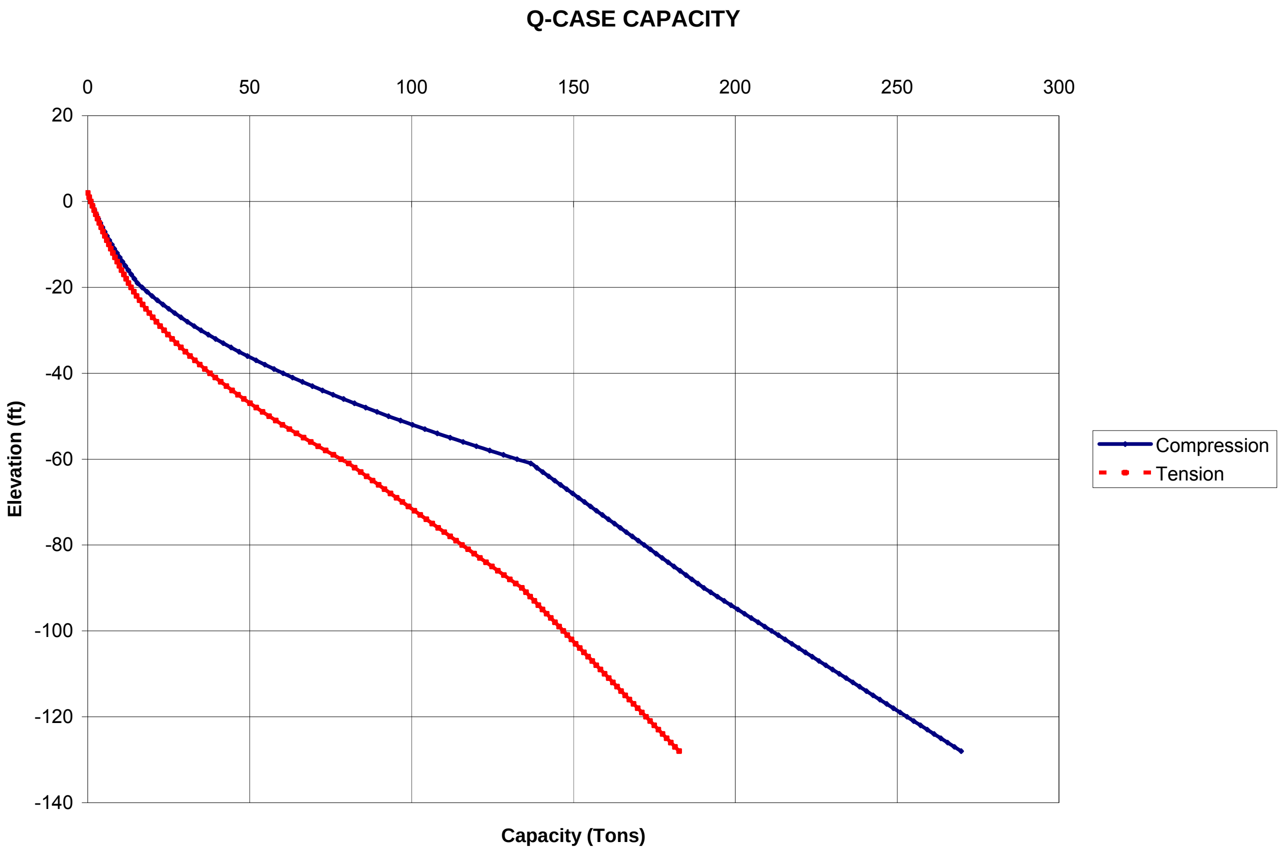
Boring R-60.3-UL_12x12 Concrete Pile_S-Case

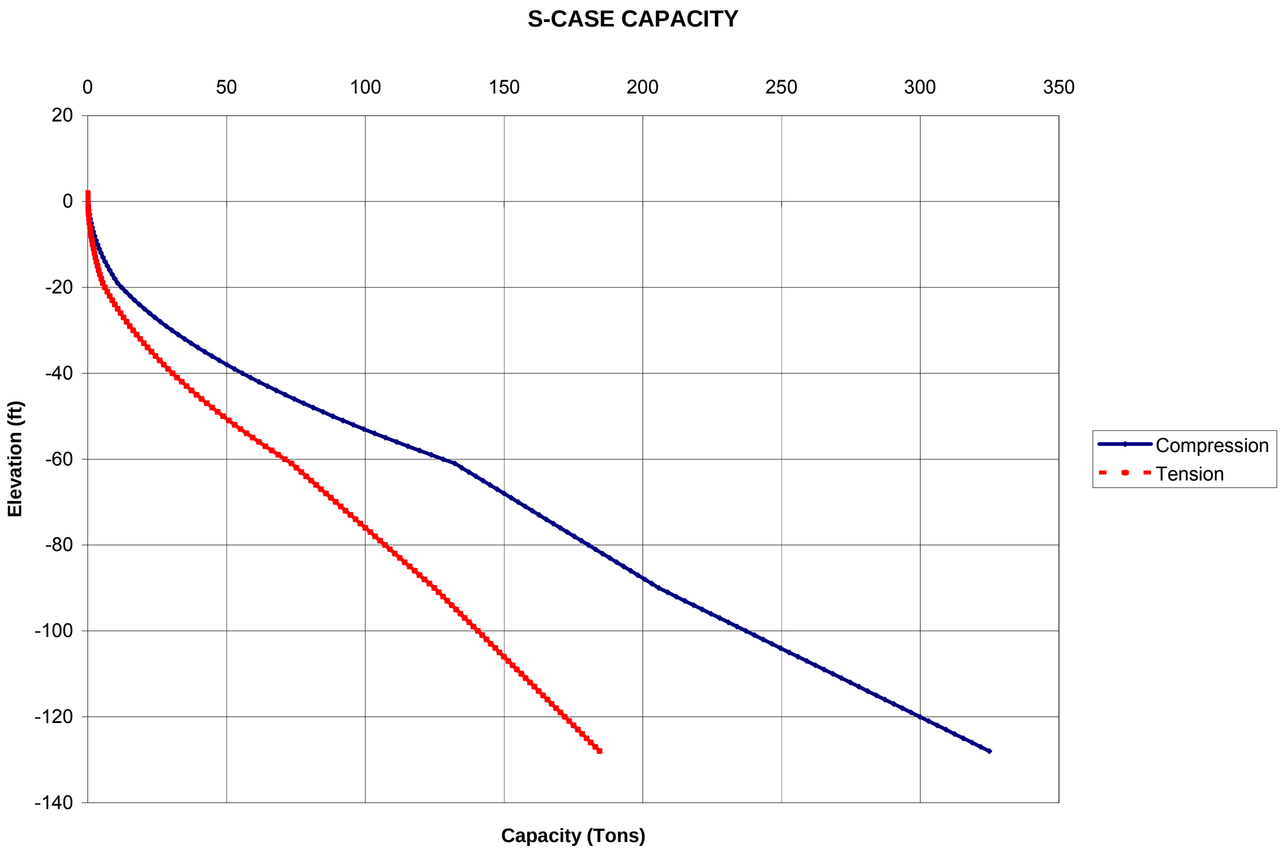
								S-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	φ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	122	59.5999985	0	0	0	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	122	59.5999985	29.7999992	29.7999992	59.5999985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.031	0.017	0.000	0.031	0.017
1	0	1	122	59.5999985	89.3999939	89.3999939	119.199997	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.123	0.069	0.000	0.123	0.069
1	-1	1	122	59.5999985	149	149	178.799988	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.278	0.156	0.000	0.278	0.156
1	-2	1	122	59.5999985	208.599991	208.599991	238.399994	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.494	0.276	0.000	0.494	0.276
2	-3	1	107	44.5999985	260.699982	260.699982	283	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	0.656	0.390	0.000	0.656	0.390
2	-4	1	107	44.5999985	305.299988	305.299988	327.600006	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	0.845	0.523	0.000	0.845	0.523
2	-5	1	107	44.5999985	349.899994	349.899994	372.200012	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.063	0.675	0.000	1.063	0.675
2	-6	1	107	44.5999985	394.5	394.5	416.800018	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.308	0.846	0.000	1.308	0.846
2	-7	1	107	44.5999985	439.100006	439.100006	461.400024	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.580	1.037	0.000	1.580	1.037
2	-8	1	107	44.5999985	483.700012	483.700012	506.000031	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.881	1.247	0.000	1.881	1.247
3	-9	1	117	54.5999985	533.300049	533.300049	560.600037	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.290	1.452	0.000	2.290	1.452
3	-10	1	117	54.5999985	587.900024	587.900024	615.200012	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.741	1.678	0.000	2.741	1.678
3	-11	1	117	54.5999985	642.5	642.5	669.799988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.235	1.924	0.000	3.235	1.924
3	-12	1	117	54.5999985	697.099976	697.099976	724.399963	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.770	2.192	0.000	3.770	2.192
3	-13	1	117	54.5999985	751.699951	751.699951	778.999939	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.347	2.480	0.000	4.347	2.480
3	-14	1	117	54.5999985	806.299927	806.299927	833.599915	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.966	2.790	0.000	4.966	2.790
3	-15	1	117	54.5999985	860.899902	860.899902	888.19989	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.627	3.120	0.000	5.627	3.120
3	-16	1	117	54.5999985	915.499878	915.499878	942.799866	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.330	3.472	0.000	6.330	3.472
3	-17	1	117	54.5999985	970.099854	970.099854	997.399841	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.075	3.844	0.000	7.075	3.844
3	-18	1	117	54.5999985	1024.69983	1024.69983	1051.99988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.861	4.238	0.000	7.861	4.238
3	-19	1	117	54.5999985	1079.29993	1079.29993	1106.59985	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	8.690	4.652	0.000	8.690	4.652
4	-20	1	101	38.5999985	1125.8999	1125.8999	1145.19983	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	9.389	5.141	0.000	9.389	5.141
4	-21	1	101	38.5999985	1164.49988	1164.49988	1183.7998	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	10.112	5.648	0.000	10.112	5.648
4	-22	1	101	38.5999985	1203.09985	1203.09985	1222.39978	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	10.859	6.171	0.000	10.859	6.171
4	-23	1	101	38.5999985	1241.69983	1241.69983	1260.99976	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	11.630	6.710	0.000	11.630	6.710
4	-24	1	101	38.5999985	1280.2998	1280.2998	1299.59973	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	12.426	7.267	0.000	12.426	7.267
4	-25	1	101	38.5999985	1318.89978	1318.89978	1338.19971	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	13.245	7.840	0.000	13.245	7.840
4	-26	1	101	38.5999985	1357.49976	1357.49976	1376.79968	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	14.088	8.430	0.000	14.088	8.430
4	-27	1	101	38.5999985	1396.09973	1396.09973	1415.39966	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	14.955	9.037	0.000	14.955	9.037
4	-28	1	101	38.5999985	1434.69971	1434.69971	1453.99963	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	15.846	9.661	0.000	15.846	9.661
5	-29	1	101	38.5999985	1473.29968	1473.29968	1492.59961	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	16.761	10.301	0.000	16.761	10.301
5	-30	1	101	38.5999985	1511.89966	1511.89966	1531.19958	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	17.699	10.959	0.000	17.699	10.959
5	-31	1	101	38.5999985	1550.49963	1550.49963	1569.79956	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	18.662	11.633	0.000	18.662	11.633
5	-32	1	101	38.5999985	1589.09961	1589.09961	1608.39954	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	19.649	12.323	0.000	19.649	12.323
5	-33	1	101	38.5999985	1627.69958	1627.69958	1646.99951	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	20.660	13.031	0.000	20.660	13.031
5	-34	1	101	38.5999985	1666.29956	1666.29956	1685.59949	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	21.695	13.755	0.000	21.695	13.755
5	-35	1	101	38.5999985	1704.89954	1704.89954	1724.19946	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	22.754	14.497	0.000	22.754	14.497
5	-36	1	101	38.5999985	1743.49951	1743.49951	1762.79944	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	23.836	15.254	0.000	23.836	15.254
5	-37	1	101	38.5999985	1782.09949	1782.09949	1801.39941	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	24.943	16.029	0.000	24.943	16.029
5	-38	1	101	38.5999985	1820.69946	1820.69946	1839.99939	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	26.074	16.821	0.000	26.074	16.821
5	-39	1	101	38.5999985	1859.29944	1859.29944	1878.59937	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	27.228	17.629	0.000	27.228	17.629
5	-40	1	101	38.5999985	1897.89941	1897.89941	1917.19934	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	28.407	18.454	0.000	28.407	18.454
5	-41	1	101	38.5999985	1936.49939	1936.49939	1955.79932	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	29.610	19.296	0.000	29.610	19.296
5	-42	1	101	38.5999985	1975.09937	1975.09937	1994.39929	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	30.836	20.154	0.000	30.836	20.154
5	-43	1	101	38.5999985	2013.69934	2013.69934	2032.99927	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	32.087	21.030	0.000	32.087	21.030
5	-44	1	101	38.5999985	2052.29932	2052.29932	2071.59937	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	33.361	21.922	0.000	33.361	21.922
5	-45	1	101	38.5999985	2090.89941	2090.89941	2110.19946	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	34.660	22.831	0.000	34.660	22.831
5	-46	1	101	38.5999985	2129.49951	2129.49951	2148.79956	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	35.982	23.757	0.000	35.982	23.757

5	-47	1	101	38.5999985	2168.09961	2168.09961	2187.39966	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	37.329	24.699	0.000	37.329	24.699
5	-48	1	101	38.5999985	2206.69971	2206.69971	2225.99976	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	38.699	25.658	0.000	38.699	25.658
5	-49	1	101	38.5999985	2245.2998	2245.2998	2264.59985	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	40.093	26.634	0.000	40.093	26.634
5	-50	1	101	38.5999985	2283.8999	2283.8999	2303.19995	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	41.512	27.627	0.000	41.512	27.627
5	-51	1	101	38.5999985	2322.5	2322.5	2341.80005	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	42.954	28.637	0.000	42.954	28.637
5	-52	1	101	38.5999985	2361.1001	2361.1001	2380.40015	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	44.420	29.663	0.000	44.420	29.663
5	-53	1	101	38.5999985	2399.7002	2399.7002	2419.00024	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	45.911	30.706	0.000	45.911	30.706
5	-54	1	101	38.5999985	2438.30029	2438.30029	2457.60034	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	47.425	31.766	0.000	47.425	31.766
5	-55	1	101	38.5999985	2476.90039	2476.90039	2496.20044	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	48.963	32.843	0.000	48.963	32.843
5	-56	1	101	38.5999985	2515.50049	2515.50049	2534.80054	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	50.525	33.937	0.000	50.525	33.937
5	-57	1	101	38.5999985	2554.10059	2554.10059	2573.40063	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	52.111	35.047	0.000	52.111	35.047
5	-58	1	101	38.5999985	2592.70068	2592.70068	2612.00073	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	53.721	36.174	0.000	53.721	36.174
5	-59	1	101	38.5999985	2631.30078	2631.30078	2650.60083	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	55.355	37.318	0.000	55.355	37.318
5	-60	1	101	38.5999985	2669.90088	2669.90088	2689.20093	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	57.014	38.478	0.000	57.014	38.478
5	-61	1	101	38.5999985	2708.50098	2708.50098	2727.80103	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	58.696	39.656	0.000	58.696	39.656
5	-62	1	101	38.5999985	2747.10107	2747.10107	2766.40112	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	60.402	40.850	0.000	60.402	40.850
5	-63	1	101	38.5999985	2785.70117	2785.70117	2805.00122	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	62.132	42.061	0.000	62.132	42.061
5	-64	1	101	38.5999985	2824.30127	2824.30127	2843.60132	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	63.885	43.289	0.000	63.885	43.289
5	-65	1	101	38.5999985	2862.90137	2862.90137	2882.20142	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	65.663	44.533	0.000	65.663	44.533
5	-66	1	101	38.5999985	2901.50146	2901.50146	2920.80151	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	67.465	45.795	0.000	67.465	45.795
5	-67	1	101	38.5999985	2940.10156	2940.10156	2959.40161	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	69.291	47.073	0.000	69.291	47.073
5	-68	1	101	38.5999985	2978.70166	2978.70166	2998.00171	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	71.141	48.368	0.000	71.141	48.368
5	-69	1	101	38.5999985	3017.30176	3017.30176	3036.60181	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	73.015	49.679	0.000	73.015	49.679
5	-70	1	101	38.5999985	3055.90186	3055.90186	3075.2019	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	74.912	51.008	0.000	74.912	51.008
5	-71	1	101	38.5999985	3094.50195	3094.50195	3113.802	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	76.834	52.353	0.000	76.834	52.353
5	-72	1	101	38.5999985	3133.10205	3133.10205	3152.4021	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	78.780	53.715	0.000	78.780	53.715
5	-73	1	101	38.5999985	3171.70215	3171.70215	3191.0022	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	80.750	55.094	0.000	80.750	55.094
5	-74	1	101	38.5999985	3210.30225	3210.30225	3229.60229	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	82.743	56.489	0.000	82.743	56.489
5	-75	1	101	38.5999985	3248.90234	3248.90234	3268.20239	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	84.761	57.902	0.000	84.761	57.902
5	-76	1	101	38.5999985	3287.50244	3287.50244	3306.80249	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	86.802	59.331	0.000	86.802	59.331
5	-77	1	101	38.5999985	3326.10254	3326.10254	3345.40259	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	88.868	60.777	0.000	88.868	60.777
5	-78	1	101	38.5999985	3364.70264	3364.70264	3384.00269	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	90.958	62.239	0.000	90.958	62.239
5	-79	1	101	38.5999985	3403.30273	3403.30273	3422.60278	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	93.071	63.719	0.000	93.071	63.719
5	-80	1	101	38.5999985	3441.90283	3441.90283	3461.20288	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	95.209	65.215	0.000	95.209	65.215
5	-81	1	101	38.5999985	3480.50293	3480.50293	3499.80298	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	97.370	66.728	0.000	97.370	66.728
5	-82	1	101	38.5999985	3519.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	99.544	68.250	0.000	99.544	68.250
6	-83	1	117	54.5999985	3565.70313	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	102.231	69.593	0.000	102.231	69.593
6	-84	1	117	54.5999985	3620.30322	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	104.918	70.937	0.000	104.918	70.937
6	-85	1	117	54.5999985	3674.90332	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	107.605	72.280	0.000	107.605	72.280
6	-86	1	117	54.5999985	3729.50342	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	110.292	73.624	0.000	110.292	73.624
6	-87	1	117	54.5999985	3784.10352	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	112.979	74.967	0.000	112.979	74.967
6	-88	1	117	54.5999985	3838.70361	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	115.666	76.311	0.000	115.666	76.311
6	-89	1	117	54.5999985	3893.30371	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	118.353	77.654	0.000	118.353	77.654
6	-90	1	117	54.5999985	3947.90381	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	121.040	78.998	0.000	121.040	78.998
6	-91	1	117	54.5999985	4002.50391	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	123.727	80.341	0.000	123.727	80.341
6	-92	1	117	54.5999985	4057.104	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	126.414	81.685	0.000	126.414	81.685
6	-93	1	117	54.5999985	4111.7041	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	129.101	83.028	0.000	129.101	83.028
7	-94	1	115	52.5999985	4165.30371	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	131.275	84.550	0.000	131.275	84.550
7	-95	1	115	52.5999985	4217.90381	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	133.448	86.071	0.000	133.448	86.071
7	-96	1	115	52.5999985	4270.50391	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	135.622	87.593	0.000	135.622	87.593
7	-97	1	115	52.5999985	4323.104	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	137.795	89.114	0.000	137.795	89.114
7	-98	1	115	52.5999985	4375.7041	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	139.969	90.636	0.000	139.969	90.636
7	-99	1	115	52.5999985	4428.3042	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	142.142	92.157	0.000	142.142	92.157
7	-100	1	115	52.5999985	4480.9043	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	144.316	93.679	0.000	144.316	93.679
7	-101	1	115	52.5999985	4533.50439	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	146.490	95.200	0.000	146.490	95.200

7	-102	1	115	52.5999985	4586.10449	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	148.663	96.722	0.000	148.663	96.722
7	-103	1	115	52.5999985	4638.70459	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	150.837	98.243	0.000	150.837	98.243
7	-104	1	115	52.5999985	4691.30469	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	153.010	99.765	0.000	153.010	99.765
8	-105	1	122	59.5999985	4747.40479	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	156.635	101.794	0.000	156.635	101.794
8	-106	1	122	59.5999985	4807.00488	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	160.259	103.824	0.000	160.259	103.824
8	-107	1	122	59.5999985	4866.60498	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	163.883	105.854	0.000	163.883	105.854
8	-108	1	122	59.5999985	4926.20508	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	167.508	107.883	0.000	167.508	107.883
8	-109	1	122	59.5999985	4985.80518	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	171.132	109.913	0.000	171.132	109.913
8	-110	1	122	59.5999985	5045.40527	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	174.756	111.943	0.000	174.756	111.943
8	-111	1	122	59.5999985	5105.00537	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	178.381	113.972	0.000	178.381	113.972
8	-112	1	122	59.5999985	5164.60547	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	182.005	116.002	0.000	182.005	116.002
8	-113	1	122	59.5999985	5224.20557	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	185.630	118.031	0.000	185.630	118.031
8	-114	1	122	59.5999985	5283.80566	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	189.254	120.061	0.000	189.254	120.061
8	-115	1	122	59.5999985	5343.40576	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	192.878	122.091	0.000	192.878	122.091
8	-116	1	122	59.5999985	5403.00586	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	196.503	124.120	0.000	196.503	124.120
8	-117	1	122	59.5999985	5462.60596	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	200.127	126.150	0.000	200.127	126.150
8	-118	1	122	59.5999985	5522.20605	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	203.751	128.180	0.000	203.751	128.180
8	-119	1	122	59.5999985	5581.80615	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	207.376	130.209	0.000	207.376	130.209
8	-120	1	122	59.5999985	5641.40625	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	211.000	132.239	0.000	211.000	132.239
8	-121	1	122	59.5999985	5701.00635	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	214.625	134.269	0.000	214.625	134.269
8	-122	1	122	59.5999985	5760.60645	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	218.249	136.298	0.000	218.249	136.298
8	-123	1	122	59.5999985	5820.20654	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	221.873	138.328	0.000	221.873	138.328

Boring
R-59.75-LU
14x14 Concrete Pile Capacities


Q-CASE CAPACITY
0
50
100
150
200
250
300
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension


S-CASE CAPACITY
0
50
100
150
200
250
300
350
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

Boring R-59.75-LU_14x14 Concrete Pile_Q-Case

								Q-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	φ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	117	54.5999985	0	0	0	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	117	54.5999985	27.2999992	27.2999992	54.5999985	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.467	0.013	0.006	0.000	0.479	0.473
1	0	1	117	54.5999985	81.8999939	81.8999939	109.199997	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.933	0.051	0.025	0.000	0.984	0.959
1	-1	1	117	54.5999985	136.5	136.5	163.799988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	1.400	0.114	0.057	0.000	1.514	1.457
1	-2	1	117	54.5999985	191.099991	191.099991	218.399994	200	200	15	11.25	1.00	0.50	4.40	12.90	No	1.867	0.203	0.101	0.000	2.069	1.968
1	-3	1	117	54.5999985	245.699997	245.699997	273	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.333	0.317	0.158	0.000	2.650	2.492
1	-4	1	117	54.5999985	300.299988	300.299988	327.600006	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.800	0.456	0.228	0.000	3.256	3.028
1	-5	1	117	54.5999985	354.899994	354.899994	382.200012	200	200	15	11.25	1.00	0.50	4.40	12.90	No	3.267	0.621	0.310	0.000	3.888	3.577
1	-6	1	117	54.5999985	409.5	409.5	436.800018	200	200	15	11.25	1.00	0.50	4.40	12.90	No	3.733	0.811	0.405	0.000	4.544	4.139
1	-7	1	117	54.5999985	464.100006	464.100006	491.400024	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.200	1.026	0.513	0.000	5.226	4.713
1	-8	1	117	54.5999985	518.700012	518.700012	546	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.667	1.267	0.634	0.000	5.934	5.300
1	-9	1	117	54.5999985	573.299988	573.299988	600.599976	200	200	15	11.25	1.00	0.50	4.40	12.90	No	5.133	1.533	0.767	0.000	6.666	5.900
1	-10	1	117	54.5999985	627.899963	627.899963	655.199951	200	200	15	11.25	1.00	0.50	4.40	12.90	No	5.600	1.825	0.912	0.000	7.425	6.512
1	-11	1	117	54.5999985	682.499939	682.499939	709.799927	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.067	2.141	1.071	0.000	8.208	7.137
1	-12	1	117	54.5999985	737.099915	737.099915	764.399902	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.533	2.483	1.242	0.000	9.017	7.775
1	-13	1	117	54.5999985	791.69989	791.69989	818.999878	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.000	2.851	1.425	0.000	9.851	8.425
1	-14	1	117	54.5999985	846.299866	846.299866	873.599854	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.467	3.244	1.622	0.000	10.710	9.089
1	-15	1	117	54.5999985	900.899841	900.899841	928.199829	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.933	3.662	1.831	0.000	11.595	9.764
1	-16	1	117	54.5999985	955.499817	955.499817	982.799805	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.400	4.105	2.053	0.000	12.505	10.453
1	-17	1	117	54.5999985	1010.09979	1010.09979	1037.39978	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.867	4.574	2.287	0.000	13.441	11.154
1	-18	1	117	54.5999985	1064.69983	1064.69983	1091.99976	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.333	5.068	2.534	0.000	14.402	11.867
1	-19	1	117	54.5999985	1119.2998	1119.2998	1146.59973	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.800	5.588	2.794	0.000	15.388	12.594
2	-20	1	122	59.5999985	1176.39978	1176.39978	1206.19971	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	7.009	3.590	0.000	16.809	13.390
2	-21	1	122	59.5999985	1235.99976	1235.99976	1265.79968	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	8.502	4.426	0.000	18.302	14.226
2	-22	1	122	59.5999985	1295.59973	1295.59973	1325.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	10.068	5.303	0.000	19.868	15.103
2	-23	1	122	59.5999985	1355.19971	1355.19971	1384.99963	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	11.705	6.219	0.000	21.505	16.019
2	-24	1	122	59.5999985	1414.79968	1414.79968	1444.59961	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	13.414	7.177	0.000	23.214	16.977
2	-25	1	122	59.5999985	1474.39966	1474.39966	1504.19958	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	15.195	8.174	0.000	24.995	17.974
2	-26	1	122	59.5999985	1533.99963	1533.99963	1563.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	17.049	9.212	0.000	26.849	19.012
2	-27	1	122	59.5999985	1593.59961	1593.59961	1623.39954	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	18.974	10.290	0.000	28.774	20.090
2	-28	1	122	59.5999985	1653.19958	1653.19958	1682.99951	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	20.971	11.409	0.000	30.771	21.209
2	-29	1	122	59.5999985	1712.79956	1712.79956	1742.59949	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	23.040	12.567	0.000	32.840	22.367
2	-30	1	122	59.5999985	1772.39954	1772.39954	1802.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	25.182	13.766	0.000	34.982	23.566
2	-31	1	122	59.5999985	1831.99951	1831.99951	1861.79944	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	27.395	15.006	0.000	37.195	24.806
2	-32	1	122	59.5999985	1891.59949	1891.59949	1921.39941	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	29.680	16.286	0.000	39.480	26.086
2	-33	1	122	59.5999985	1951.19946	1951.19946	1980.99939	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	32.037	17.606	0.000	41.837	27.406
2	-34	1	122	59.5999985	2010.79944	2010.79944	2040.59937	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	34.467	18.966	0.000	44.267	28.766
2	-35	1	122	59.5999985	2070.39941	2070.39941	2100.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	36.968	20.367	0.000	46.768	30.167
2	-36	1	122	59.5999985	2129.99951	2129.99951	2159.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	39.541	21.808	0.000	49.341	31.608
2	-37	1	122	59.5999985	2189.59961	2189.59961	2219.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	42.187	23.289	0.000	51.987	33.089
2	-38	1	122	59.5999985	2249.19971	2249.19971	2278.99976	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	44.904	24.811	0.000	54.704	34.611
2	-39	1	122	59.5999985	2308.7998	2308.7998	2338.59985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	47.693	26.373	0.000	57.493	36.173
2	-40	1	122	59.5999985	2368.3999	2368.3999	2398.19995	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	50.555	27.975	0.000	60.355	37.775
2	-41	1	122	59.5999985	2428	2428	2457.80005	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	53.488	29.618	0.000	63.288	39.418
2	-42	1	122	59.5999985	2487.6001	2487.6001	2517.40015	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	56.493	31.301	0.000	66.293	41.101
2	-43	1	122	59.5999985	2547.2002	2547.2002	2577.00024	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	59.571	33.024	0.000	69.371	42.824
2	-44	1	122	59.5999985	2606.80029	2606.80029	2636.60034	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	62.720	34.788	0.000	72.520	44.588
2	-45	1	122	59.5999985	2666.40039	2666.40039	2696.20044	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	65.941	36.592	0.000	75.741	46.392
2	-46	1	122	59.5999985	2726.00049	2726.00049	2755.80054	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	69.235	38.436	0.000	79.035	48.236

815

2	-47	1	122	59.5999985	2785.60059	2785.60059	2815.40063	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	72.600	40.321	0.000	82.400	50.121
2	-48	1	122	59.5999985	2845.20068	2845.20068	2875.00073	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	76.037	42.246	0.000	85.837	52.046
2	-49	1	122	59.5999985	2904.80078	2904.80078	2934.60083	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	79.547	44.211	0.000	89.347	54.011
2	-50	1	122	59.5999985	2964.40088	2964.40088	2994.20093	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	83.128	46.216	0.000	92.928	56.016
2	-51	1	122	59.5999985	3024.00098	3024.00098	3053.80103	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	86.781	48.262	0.000	96.581	58.062
2	-52	1	122	59.5999985	3083.60107	3083.60107	3113.40112	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	90.507	50.349	0.000	100.307	60.148
2	-53	1	122	59.5999985	3143.20117	3143.20117	3173.00122	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	94.304	52.475	0.000	104.104	62.275
2	-54	1	122	59.5999985	3202.80127	3202.80127	3232.60132	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	98.173	54.642	0.000	107.973	64.442
2	-55	1	122	59.5999985	3262.40137	3262.40137	3292.20142	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	102.115	56.849	0.000	111.915	66.649
2	-56	1	122	59.5999985	3322.00146	3322.00146	3351.80151	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	106.128	59.097	0.000	115.928	68.897
2	-57	1	122	59.5999985	3381.60156	3381.60156	3411.40161	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	110.214	61.384	0.000	120.014	71.184
2	-58	1	122	59.5999985	3441.20166	3441.20166	3471.00171	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	114.371	63.713	0.000	124.171	73.513
2	-59	1	122	59.5999985	3500.80176	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	118.599	66.080	0.000	128.399	75.880
2	-60	1	122	59.5999985	3560.40186	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	122.828	68.448	0.000	132.628	78.248
2	-61	1	122	59.5999985	3620.00195	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.800	127.056	70.816	0.000	136.856	80.616
3	-62	1	105	42.5999985	3671.10205	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	11.643	127.056	70.816	0.000	138.700	82.460
3	-63	1	105	42.5999985	3713.70215	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	13.487	127.056	70.816	0.000	140.543	84.303
3	-64	1	105	42.5999985	3756.30225	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	15.330	127.056	70.816	0.000	142.386	86.146
3	-65	1	105	42.5999985	3798.90234	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	17.173	127.056	70.816	0.000	144.230	87.990
3	-66	1	105	42.5999985	3841.50244	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	19.017	127.056	70.816	0.000	146.073	89.833
3	-67	1	105	42.5999985	3884.10254	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	20.860	127.056	70.816	0.000	147.916	91.676
3	-68	1	105	42.5999985	3926.70264	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	22.703	127.056	70.816	0.000	149.760	93.520
3	-69	1	105	42.5999985	3969.30273	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	24.547	127.056	70.816	0.000	151.603	95.363
3	-70	1	105	42.5999985	4011.90283	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	26.390	127.056	70.816	0.000	153.446	97.206
3	-71	1	105	42.5999985	4054.50293	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	28.233	127.056	70.816	0.000	155.290	99.050
3	-72	1	105	42.5999985	4097.10303	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	30.077	127.056	70.816	0.000	157.133	100.893
3	-73	1	105	42.5999985	4139.70264	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	31.920	127.056	70.816	0.000	158.976	102.736
3	-74	1	105	42.5999985	4182.30273	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	33.763	127.056	70.816	0.000	160.820	104.580
3	-75	1	105	42.5999985	4224.90283	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	35.607	127.056	70.816	0.000	162.663	106.423
3	-76	1	105	42.5999985	4267.50293	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	37.450	127.056	70.816	0.000	164.506	108.266
3	-77	1	105	42.5999985	4310.10303	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	39.293	127.056	70.816	0.000	166.350	110.110
3	-78	1	105	42.5999985	4352.70313	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	41.137	127.056	70.816	0.000	168.193	111.953
3	-79	1	105	42.5999985	4395.30322	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	42.980	127.056	70.816	0.000	170.036	113.796
3	-80	1	105	42.5999985	4437.90332	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	44.823	127.056	70.816	0.000	171.880	115.640
3	-81	1	105	42.5999985	4480.50342	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	46.667	127.056	70.816	0.000	173.723	117.483
3	-82	1	105	42.5999985	4523.10352	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	48.510	127.056	70.816	0.000	175.566	119.326
3	-83	1	105	42.5999985	4565.70361	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	50.353	127.056	70.816	0.000	177.410	121.170
3	-84	1	105	42.5999985	4608.30371	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	52.197	127.056	70.816	0.000	179.253	123.013
3	-85	1	105	42.5999985	4650.90381	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	54.040	127.056	70.816	0.000	181.096	124.856
3	-86	1	105	42.5999985	4693.50391	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	55.883	127.056	70.816	0.000	182.940	126.700
3	-87	1	105	42.5999985	4736.104	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	57.727	127.056	70.816	0.000	184.783	128.543
3	-88	1	105	42.5999985	4778.7041	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	59.570	127.056	70.816	0.000	186.626	130.386
3	-89	1	105	42.5999985	4821.3042	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	61.413	127.056	70.816	0.000	188.470	132.230
3	-90	1	105	42.5999985	4863.9043	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	63.257	127.056	70.816	0.000	190.313	134.073
4	-91	1	117	54.5999985	4912.50439	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	63.723	128.681	71.629	0.000	192.404	135.352
4	-92	1	117	54.5999985	4967.10449	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	64.190	130.305	72.441	0.000	194.495	136.631
4	-93	1	117	54.5999985	5021.70459	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	64.657	131.930	73.253	0.000	196.586	137.910
4	-94	1	117	54.5999985	5076.30469	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	65.123	133.554	74.065	0.000	198.678	139.188
4	-95	1	117	54.5999985	5130.90479	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	65.590	135.179	74.877	0.000	200.769	140.467
4	-96	1	117	54.5999985	5185.50488	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	66.057	136.803	75.690	0.000	202.860	141.746
4	-97	1	117	54.5999985	5240.10498	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	66.523	138.428	76.502	0.000	204.951	143.025
4	-98	1	117	54.5999985	5294.70508	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	66.990	140.052	77.314	0.000	207.042	144.304
4	-99	1	117	54.5999985	5349.30518	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	67.457	141.676	78.126	0.000	209.133	145.583
4	-100	1	117	54.5999985	5403.90527	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	67.923	143.301	78.939	0.000	211.224	146.862
4	-101	1	117	54.5999985	5458.50537	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	68.390	144.925	79.751	0.000	213.315	148.141

4	-102	1	117	54.5999985	5513.10547	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	68.857	146.550	80.563	0.000	215.406	149.419
4	-103	1	117	54.5999985	5567.70557	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	69.323	148.174	81.375	0.000	217.498	150.698
4	-104	1	117	54.5999985	5622.30566	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	69.790	149.799	82.187	0.000	219.589	151.977
4	-105	1	117	54.5999985	5676.90576	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	70.257	151.423	83.000	0.000	221.680	153.256
4	-106	1	117	54.5999985	5731.50586	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	70.723	153.048	83.812	0.000	223.771	154.535
4	-107	1	117	54.5999985	5786.10596	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	71.190	154.672	84.624	0.000	225.862	155.814
4	-108	1	117	54.5999985	5840.70605	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	71.657	156.296	85.436	0.000	227.953	157.093
4	-109	1	117	54.5999985	5895.30615	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	72.123	157.921	86.249	0.000	230.044	158.372
4	-110	1	117	54.5999985	5949.90625	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	72.590	159.545	87.061	0.000	232.135	159.651
4	-111	1	117	54.5999985	6004.50635	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	73.057	161.170	87.873	0.000	234.226	160.929
4	-112	1	117	54.5999985	6059.10645	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	73.523	162.794	88.685	0.000	236.318	162.208
4	-113	1	117	54.5999985	6113.70654	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	73.990	164.419	89.497	0.000	238.409	163.487
4	-114	1	117	54.5999985	6168.30664	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	74.457	166.043	90.310	0.000	240.500	164.766
4	-115	1	117	54.5999985	6222.90674	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	74.923	167.668	91.122	0.000	242.591	166.045
4	-116	1	117	54.5999985	6277.50684	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	75.390	169.292	91.934	0.000	244.682	167.324
4	-117	1	117	54.5999985	6332.10693	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	75.857	170.917	92.746	0.000	246.773	168.603
4	-118	1	117	54.5999985	6386.70703	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	76.323	172.541	93.559	0.000	248.864	169.882
4	-119	1	117	54.5999985	6441.30713	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	76.790	174.165	94.371	0.000	250.955	171.161
4	-120	1	117	54.5999985	6495.90723	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	77.257	175.790	95.183	0.000	253.046	172.439
4	-121	1	117	54.5999985	6550.50732	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	77.723	177.414	95.995	0.000	255.138	173.718
4	-122	1	117	54.5999985	6605.10742	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	78.190	179.039	96.807	0.000	257.229	174.997
4	-123	1	117	54.5999985	6659.70752	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	78.657	180.663	97.620	0.000	259.320	176.276
4	-124	1	117	54.5999985	6714.30762	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	79.123	182.288	98.432	0.000	261.411	177.555
4	-125	1	117	54.5999985	6768.90771	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	79.590	183.912	99.244	0.000	263.502	178.834
4	-126	1	117	54.5999985	6823.50781	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	80.057	185.537	100.056	0.000	265.593	180.113
4	-127	1	117	54.5999985	6878.10791	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	80.523	187.161	100.869	0.000	267.684	181.392
4	-128	1	117	54.5999985	6932.70801	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	80.990	188.785	101.681	0.000	269.775	182.671

Boring R-59.75-LU_14x14 Concrete Pile_S-Case

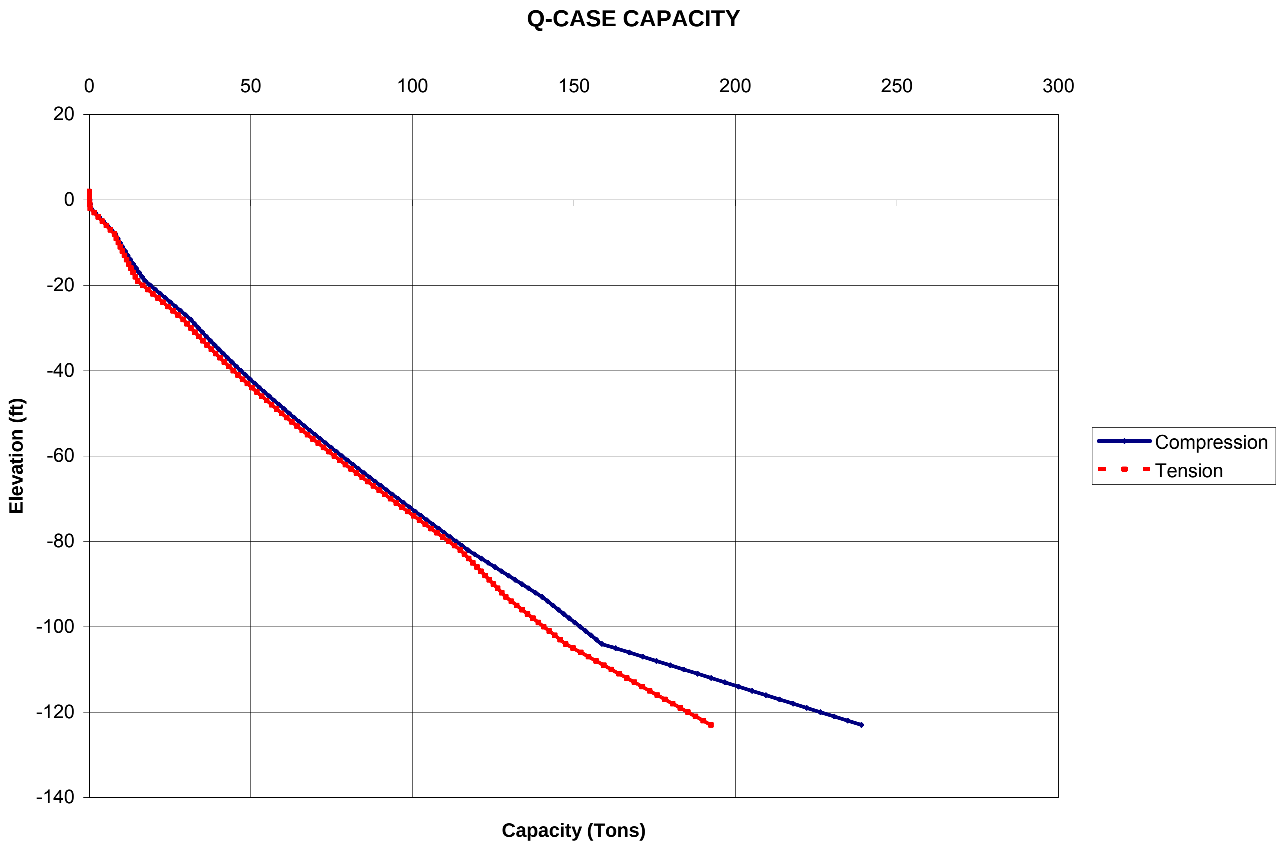
								S-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	117	54.5999985	0	0	0	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	117	54.5999985	27.2999992	27.2999992	54.5999985	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.024	0.012	0.000	0.024	0.012
1	0	1	117	54.5999985	81.8999939	81.8999939	109.199997	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.098	0.049	0.000	0.098	0.049
1	-1	1	117	54.5999985	136.5	136.5	163.799988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.220	0.110	0.000	0.220	0.110
1	-2	1	117	54.5999985	191.099991	191.099991	218.399994	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.391	0.196	0.000	0.391	0.196
1	-3	1	117	54.5999985	245.699997	245.699997	273	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.611	0.306	0.000	0.611	0.306
1	-4	1	117	54.5999985	300.299988	300.299988	327.600006	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.880	0.440	0.000	0.880	0.440
1	-5	1	117	54.5999985	354.899994	354.899994	382.200012	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.198	0.599	0.000	1.198	0.599
1	-6	1	117	54.5999985	409.5	409.5	436.800018	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.565	0.782	0.000	1.565	0.782
1	-7	1	117	54.5999985	464.100006	464.100006	491.400024	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.981	0.990	0.000	1.981	0.990
1	-8	1	117	54.5999985	518.700012	518.700012	546	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.445	1.223	0.000	2.445	1.223
1	-9	1	117	54.5999985	573.299988	573.299988	600.599976	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.959	1.479	0.000	2.959	1.479
1	-10	1	117	54.5999985	627.899963	627.899963	655.199951	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.521	1.761	0.000	3.521	1.761
1	-11	1	117	54.5999985	682.499939	682.499939	709.799927	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.132	2.066	0.000	4.132	2.066
1	-12	1	117	54.5999985	737.099915	737.099915	764.399902	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.793	2.396	0.000	4.793	2.396
1	-13	1	117	54.5999985	791.69989	791.69989	818.999878	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.502	2.751	0.000	5.502	2.751
1	-14	1	117	54.5999985	846.299866	846.299866	873.599854	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.260	3.130	0.000	6.260	3.130
1	-15	1	117	54.5999985	900.899841	900.899841	928.199829	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.067	3.533	0.000	7.067	3.533
1	-16	1	117	54.5999985	955.499817	955.499817	982.799805	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.922	3.961	0.000	7.922	3.961
1	-17	1	117	54.5999985	1010.09979	1010.09979	1037.39978	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	8.827	4.414	0.000	8.827	4.414
1	-18	1	117	54.5999985	1064.69983	1064.69983	1091.99976	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	9.781	4.890	0.000	9.781	4.890
1	-19	1	117	54.5999985	1119.2998	1119.2998	1146.59973	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	10.783	5.392	0.000	10.783	5.392
2	-20	1	122	59.5999985	1176.39978	1176.39978	1206.19971	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	12.205	6.188	0.000	12.205	6.188
2	-21	1	122	59.5999985	1235.99976	1235.99976	1265.79968	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	13.698	7.024	0.000	13.698	7.024
2	-22	1	122	59.5999985	1295.59973	1295.59973	1325.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	15.263	7.900	0.000	15.263	7.900
2	-23	1	122	59.5999985	1355.19971	1355.19971	1384.99963	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	16.900	8.817	0.000	16.900	8.817
2	-24	1	122	59.5999985	1414.79968	1414.79968	1444.59961	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	18.610	9.774	0.000	18.610	9.774
2	-25	1	122	59.5999985	1474.39966	1474.39966	1504.19958	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	20.391	10.772	0.000	20.391	10.772
2	-26	1	122	59.5999985	1533.99963	1533.99963	1563.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	22.244	11.810	0.000	22.244	11.810
2	-27	1	122	59.5999985	1593.59961	1593.59961	1623.39954	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	24.169	12.888	0.000	24.169	12.888
2	-28	1	122	59.5999985	1653.19958	1653.19958	1682.99951	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	26.167	14.006	0.000	26.167	14.006
2	-29	1	122	59.5999985	1712.79956	1712.79956	1742.59949	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	28.236	15.165	0.000	28.236	15.165
2	-30	1	122	59.5999985	1772.39954	1772.39954	1802.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	30.377	16.364	0.000	30.377	16.364
2	-31	1	122	59.5999985	1831.99951	1831.99951	1861.79944	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	32.590	17.604	0.000	32.590	17.604
2	-32	1	122	59.5999985	1891.59949	1891.59949	1921.39941	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	34.876	18.883	0.000	34.876	18.883
2	-33	1	122	59.5999985	1951.19946	1951.19946	1980.99939	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	37.233	20.204	0.000	37.233	20.204
2	-34	1	122	59.5999985	2010.79944	2010.79944	2040.59937	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	39.662	21.564	0.000	39.662	21.564
2	-35	1	122	59.5999985	2070.39941	2070.39941	2100.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	42.164	22.965	0.000	42.164	22.965
2	-36	1	122	59.5999985	2129.99951	2129.99951	2159.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	44.737	24.406	0.000	44.737	24.406
2	-37	1	122	59.5999985	2189.59961	2189.59961	2219.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	47.382	25.887	0.000	47.382	25.887
2	-38	1	122	59.5999985	2249.19971	2249.19971	2278.99976	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	50.100	27.409	0.000	50.100	27.409
2	-39	1	122	59.5999985	2308.7998	2308.7998	2338.59985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	52.889	28.971	0.000	52.889	28.971
2	-40	1	122	59.5999985	2368.3999	2368.3999	2398.19995	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	55.750	30.573	0.000	55.750	30.573
2	-41	1	122	59.5999985	2428	2428	2457.80005	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	58.684	32.216	0.000	58.684	32.216
2	-42	1	122	59.5999985	2487.6001	2487.6001	2517.40015	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	61.689	33.899	0.000	61.689	33.899
2	-43	1	122	59.5999985	2547.2002	2547.2002	2577.00024	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	64.766	35.622	0.000	64.766	35.622
2	-44	1	122	59.5999985	2606.80029	2606.80029	2636.60034	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	67.916	37.386	0.000	67.916	37.386
2	-45	1	122	59.5999985	2666.40039	2666.40039	2696.20044	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	71.137	39.190	0.000	71.137	39.190
2	-46	1	122	59.5999985	2726.00049	2726.00049	2755.80054	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	74.430	41.034	0.000	74.430	41.034

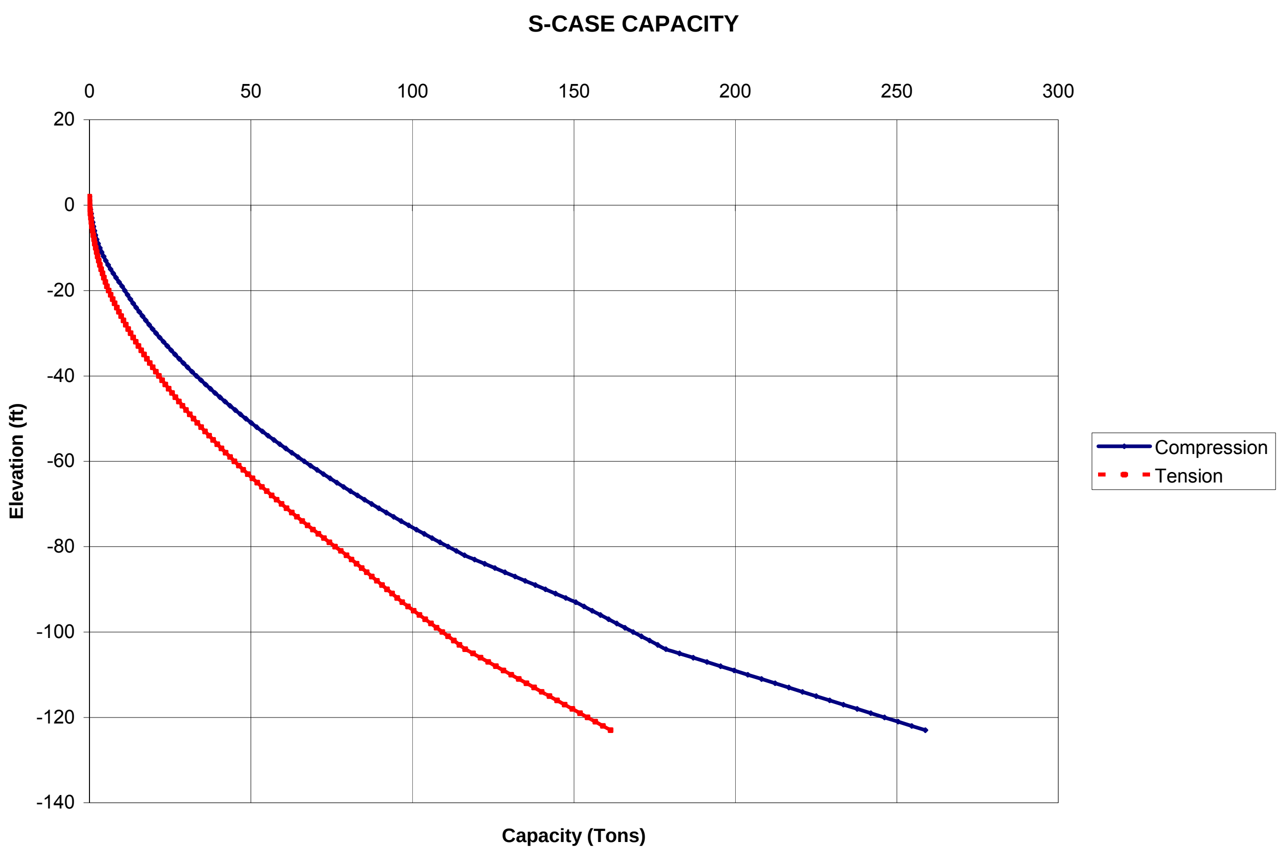
2	-47	1	122	59.5999985	2785.60059	2785.60059	2815.40063	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	77.796	42.918	0.000	77.796	42.918
2	-48	1	122	59.5999985	2845.20068	2845.20068	2875.00073	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	81.233	44.843	0.000	81.233	44.843
2	-49	1	122	59.5999985	2904.80078	2904.80078	2934.60083	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	84.742	46.809	0.000	84.742	46.809
2	-50	1	122	59.5999985	2964.40088	2964.40088	2994.20093	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	88.324	48.814	0.000	88.324	48.814
2	-51	1	122	59.5999985	3024.00098	3024.00098	3053.80103	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	91.977	50.860	0.000	91.977	50.860
2	-52	1	122	59.5999985	3083.60107	3083.60107	3113.40112	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	95.702	52.946	0.000	95.702	52.946
2	-53	1	122	59.5999985	3143.20117	3143.20117	3173.00122	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	99.500	55.073	0.000	99.500	55.073
2	-54	1	122	59.5999985	3202.80127	3202.80127	3232.60132	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	103.369	57.240	0.000	103.369	57.240
2	-55	1	122	59.5999985	3262.40137	3262.40137	3292.20142	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	107.310	59.447	0.000	107.310	59.447
2	-56	1	122	59.5999985	3322.00146	3322.00146	3351.80151	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	111.324	61.694	0.000	111.324	61.694
2	-57	1	122	59.5999985	3381.60156	3381.60156	3411.40161	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	115.409	63.982	0.000	115.409	63.982
2	-58	1	122	59.5999985	3441.20166	3441.20166	3471.00171	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	119.567	66.310	0.000	119.567	66.310
2	-59	1	122	59.5999985	3500.80176	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	123.795	68.678	0.000	123.795	68.678
2	-60	1	122	59.5999985	3560.40186	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	128.024	71.046	0.000	128.024	71.046
2	-61	1	122	59.5999985	3620.00195	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	132.252	73.414	0.000	132.252	73.414
3	-62	1	105	42.5999985	3671.10205	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	134.788	75.189	0.000	134.788	75.189
3	-63	1	105	42.5999985	3713.70215	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	137.324	76.964	0.000	137.324	76.964
3	-64	1	105	42.5999985	3756.30225	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	139.859	78.739	0.000	139.859	78.739
3	-65	1	105	42.5999985	3798.90234	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	142.395	80.514	0.000	142.395	80.514
3	-66	1	105	42.5999985	3841.50244	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	144.931	82.289	0.000	144.931	82.289
3	-67	1	105	42.5999985	3884.10254	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	147.467	84.064	0.000	147.467	84.064
3	-68	1	105	42.5999985	3926.70264	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	150.003	85.840	0.000	150.003	85.840
3	-69	1	105	42.5999985	3969.30273	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	152.538	87.615	0.000	152.538	87.615
3	-70	1	105	42.5999985	4011.90283	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	155.074	89.390	0.000	155.074	89.390
3	-71	1	105	42.5999985	4054.50293	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	157.610	91.165	0.000	157.610	91.165
3	-72	1	105	42.5999985	4097.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	160.146	92.940	0.000	160.146	92.940
3	-73	1	105	42.5999985	4139.70264	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	162.682	94.715	0.000	162.682	94.715
3	-74	1	105	42.5999985	4182.30273	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	165.217	96.490	0.000	165.217	96.490
3	-75	1	105	42.5999985	4224.90283	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	167.753	98.265	0.000	167.753	98.265
3	-76	1	105	42.5999985	4267.50293	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	170.289	100.040	0.000	170.289	100.040
3	-77	1	105	42.5999985	4310.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	172.825	101.815	0.000	172.825	101.815
3	-78	1	105	42.5999985	4352.70313	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	175.361	103.590	0.000	175.361	103.590
3	-79	1	105	42.5999985	4395.30322	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	177.897	105.365	0.000	177.897	105.365
3	-80	1	105	42.5999985	4437.90332	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	180.432	107.140	0.000	180.432	107.140
3	-81	1	105	42.5999985	4480.50342	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	182.968	108.915	0.000	182.968	108.915
3	-82	1	105	42.5999985	4523.10352	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	185.504	110.691	0.000	185.504	110.691
3	-83	1	105	42.5999985	4565.70361	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	188.040	112.466	0.000	188.040	112.466
3	-84	1	105	42.5999985	4608.30371	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	190.576	114.241	0.000	190.576	114.241
3	-85	1	105	42.5999985	4650.90381	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	193.111	116.016	0.000	193.111	116.016
3	-86	1	105	42.5999985	4693.50391	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	195.647	117.791	0.000	195.647	117.791
3	-87	1	105	42.5999985	4736.104	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	198.183	119.566	0.000	198.183	119.566
3	-88	1	105	42.5999985	4778.7041	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	200.719	121.341	0.000	200.719	121.341
3	-89	1	105	42.5999985	4821.3042	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	203.255	123.116	0.000	203.255	123.116
3	-90	1	105	42.5999985	4863.9043	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	205.790	124.891	0.000	205.790	124.891
4	-91	1	117	54.5999985	4912.50439	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	208.925	126.459	0.000	208.925	126.459
4	-92	1	117	54.5999985	4967.10449	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	212.060	128.026	0.000	212.060	128.026
4	-93	1	117	54.5999985	5021.70459	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	215.195	129.593	0.000	215.195	129.593
4	-94	1	117	54.5999985	5076.30469	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	218.330	131.161	0.000	218.330	131.161
4	-95	1	117	54.5999985	5130.90479	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	221.465	132.728	0.000	221.465	132.728
4	-96	1	117	54.5999985	5185.50488	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	224.600	134.296	0.000	224.600	134.296
4	-97	1	117	54.5999985	5240.10498	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	227.735	135.863	0.000	227.735	135.863
4	-98	1	117	54.5999985	5294.70508	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	230.870	137.431	0.000	230.870	137.431
4	-99	1	117	54.5999985	5349.30518	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	234.004	138.998	0.000	234.004	138.998
4	-100	1	117	54.5999985	5403.90527	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	237.139	140.566	0.000	237.139	140.566
4	-101	1	117	54.5999985	5458.50537	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	240.274	142.133	0.000	240.274	142.133

4	-102	1	117	54.5999985	5513.10547	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	243.409	143.700	0.000	243.409	143.700
4	-103	1	117	54.5999985	5567.70557	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	246.544	145.268	0.000	246.544	145.268
4	-104	1	117	54.5999985	5622.30566	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	249.679	146.835	0.000	249.679	146.835
4	-105	1	117	54.5999985	5676.90576	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	252.814	148.403	0.000	252.814	148.403
4	-106	1	117	54.5999985	5731.50586	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	255.949	149.970	0.000	255.949	149.970
4	-107	1	117	54.5999985	5786.10596	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	259.084	151.538	0.000	259.084	151.538
4	-108	1	117	54.5999985	5840.70605	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	262.218	153.105	0.000	262.218	153.105
4	-109	1	117	54.5999985	5895.30615	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	265.353	154.673	0.000	265.353	154.673
4	-110	1	117	54.5999985	5949.90625	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	268.488	156.240	0.000	268.488	156.240
4	-111	1	117	54.5999985	6004.50635	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	271.623	157.807	0.000	271.623	157.807
4	-112	1	117	54.5999985	6059.10645	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	274.758	159.375	0.000	274.758	159.375
4	-113	1	117	54.5999985	6113.70654	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	277.893	160.942	0.000	277.893	160.942
4	-114	1	117	54.5999985	6168.30664	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	281.028	162.510	0.000	281.028	162.510
4	-115	1	117	54.5999985	6222.90674	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	284.163	164.077	0.000	284.163	164.077
4	-116	1	117	54.5999985	6277.50684	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	287.298	165.645	0.000	287.298	165.645
4	-117	1	117	54.5999985	6332.10693	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	290.432	167.212	0.000	290.432	167.212
4	-118	1	117	54.5999985	6386.70703	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	293.567	168.780	0.000	293.567	168.780
4	-119	1	117	54.5999985	6441.30713	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	296.702	170.347	0.000	296.702	170.347
4	-120	1	117	54.5999985	6495.90723	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	299.837	171.914	0.000	299.837	171.914
4	-121	1	117	54.5999985	6550.50732	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	302.972	173.482	0.000	302.972	173.482
4	-122	1	117	54.5999985	6605.10742	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	306.107	175.049	0.000	306.107	175.049
4	-123	1	117	54.5999985	6659.70752	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	309.242	176.617	0.000	309.242	176.617
4	-124	1	117	54.5999985	6714.30762	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	312.377	178.184	0.000	312.377	178.184
4	-125	1	117	54.5999985	6768.90771	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	315.512	179.752	0.000	315.512	179.752
4	-126	1	117	54.5999985	6823.50781	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	318.646	181.319	0.000	318.646	181.319
4	-127	1	117	54.5999985	6878.10791	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	321.781	182.887	0.000	321.781	182.887
4	-128	1	117	54.5999985	6932.70801	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	324.916	184.454	0.000	324.916	184.454

820

Boring
R-60.3-UL
14x14 Concrete Pile Capacities


Q-CASE CAPACITY
0
50
100
150
200
250
300
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension


S-CASE CAPACITY
0
50
100
150
200
250
300
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

Boring R-60.3-UL_14x14 Concrete Pile_Q-Case

								Q-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	122	59.5999985	0	0	0	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	122	59.5999985	29.7999992	29.7999992	59.5999985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.036	0.020	0.000	0.036	0.020
1	0	1	122	59.5999985	89.3999939	89.3999939	119.199997	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.144	0.081	0.000	0.144	0.081
1	-1	1	122	59.5999985	149	149	178.799988	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.324	0.181	0.000	0.324	0.181
1	-2	1	122	59.5999985	208.599991	208.599991	238.399994	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.576	0.323	0.000	0.576	0.323
2	-3	1	107	44.5999985	260.699982	260.699982	283	550	536.25	0	0	1.00	1.00	1.00	9.00	No	1.251	0.576	0.323	0.000	1.827	1.574
2	-4	1	107	44.5999985	305.299988	305.299988	327.600006	550	536.25	0	0	1.00	1.00	1.00	9.00	No	2.502	0.576	0.323	0.000	3.079	2.825
2	-5	1	107	44.5999985	349.899994	349.899994	372.200012	550	536.25	0	0	1.00	1.00	1.00	9.00	No	3.754	0.576	0.323	0.000	4.330	4.076
2	-6	1	107	44.5999985	394.5	394.5	416.800018	550	536.25	0	0	1.00	1.00	1.00	9.00	No	5.005	0.576	0.323	0.000	5.581	5.328
2	-7	1	107	44.5999985	439.100006	439.100006	461.400024	550	536.25	0	0	1.00	1.00	1.00	9.00	No	6.256	0.576	0.323	0.000	6.832	6.579
2	-8	1	107	44.5999985	483.700012	483.700012	506.000031	550	536.25	0	0	1.00	1.00	1.00	9.00	No	7.507	0.576	0.323	0.000	8.084	7.830
3	-9	1	117	54.5999985	533.300049	533.300049	560.600037	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.974	0.824	0.446	0.000	8.798	8.421
3	-10	1	117	54.5999985	587.900024	587.900024	615.200012	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.441	1.096	0.583	0.000	9.537	9.024
3	-11	1	117	54.5999985	642.5	642.5	669.799988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.907	1.395	0.732	0.000	10.302	9.639
3	-12	1	117	54.5999985	697.099976	697.099976	724.399963	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.374	1.718	0.894	0.000	11.092	10.268
3	-13	1	117	54.5999985	751.699951	751.699951	778.999939	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.841	2.067	1.068	0.000	11.908	10.909
3	-14	1	117	54.5999985	806.299927	806.299927	833.599915	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.307	2.441	1.255	0.000	12.749	11.563
3	-15	1	117	54.5999985	860.899902	860.899902	888.19989	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.774	2.841	1.455	0.000	13.615	12.229
3	-16	1	117	54.5999985	915.499878	915.499878	942.799866	200	200	15	11.25	1.00	0.50	4.40	12.90	No	11.241	3.266	1.667	0.000	14.507	12.908
3	-17	1	117	54.5999985	970.099854	970.099854	997.399841	200	200	15	11.25	1.00	0.50	4.40	12.90	No	11.707	3.716	1.893	0.000	15.424	13.600
3	-18	1	117	54.5999985	1024.69983	1024.69983	1051.99988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	12.174	4.192	2.130	0.000	16.366	14.305
3	-19	1	117	54.5999985	1079.29993	1079.29993	1106.59985	200	200	15	11.25	1.00	0.50	4.40	12.90	No	12.641	4.693	2.381	0.000	17.333	15.022
4	-20	1	101	38.5999985	1125.8999	1125.8999	1145.19983	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	14.206	4.693	2.381	0.000	18.899	16.587
4	-21	1	101	38.5999985	1164.49988	1164.49988	1183.7998	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	15.771	4.693	2.381	0.000	20.464	18.152
4	-22	1	101	38.5999985	1203.09985	1203.09985	1222.39978	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	17.336	4.693	2.381	0.000	22.029	19.717
4	-23	1	101	38.5999985	1241.69983	1241.69983	1260.99976	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	18.902	4.693	2.381	0.000	23.594	21.282
4	-24	1	101	38.5999985	1280.2998	1280.2998	1299.59973	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	20.467	4.693	2.381	0.000	25.159	22.848
4	-25	1	101	38.5999985	1318.89978	1318.89978	1338.19971	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	22.032	4.693	2.381	0.000	26.725	24.413
4	-26	1	101	38.5999985	1357.49976	1357.49976	1376.79968	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	23.597	4.693	2.381	0.000	28.290	25.978
4	-27	1	101	38.5999985	1396.09973	1396.09973	1415.39966	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	25.162	4.693	2.381	0.000	29.855	27.543
4	-28	1	101	38.5999985	1434.69971	1434.69971	1453.99963	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	26.728	4.693	2.381	0.000	31.420	29.108
5	-29	1	101	38.5999985	1473.29968	1473.29968	1492.59961	512.962952	504.819092	0	0	1.00	1.00	1.00	9.00	No	27.906	4.693	2.381	0.000	32.598	30.286
5	-30	1	101	38.5999985	1511.89966	1511.89966	1531.19958	525.925903	514.373291	0	0	1.00	1.00	1.00	9.00	No	29.106	4.693	2.381	0.000	33.798	31.487
5	-31	1	101	38.5999985	1550.49963	1550.49963	1569.79956	538.888916	523.759399	0	0	1.00	1.00	1.00	9.00	No	30.328	4.693	2.381	0.000	35.020	32.709
5	-32	1	101	38.5999985	1589.09961	1589.09961	1608.39954	551.851868	532.977539	0	0	1.00	1.00	1.00	9.00	No	31.571	4.693	2.381	0.000	36.264	33.952
5	-33	1	101	38.5999985	1627.69958	1627.69958	1646.99951	564.814819	542.027588	0	0	1.00	1.00	1.00	9.00	No	32.836	4.693	2.381	0.000	37.529	35.217
5	-34	1	101	38.5999985	1666.29956	1666.29956	1685.59949	577.777771	550.909668	0	0	1.00	1.00	1.00	9.00	No	34.122	4.693	2.381	0.000	38.814	36.502
5	-35	1	101	38.5999985	1704.89954	1704.89954	1724.19946	590.740723	559.623657	0	0	1.00	1.00	1.00	9.00	No	35.427	4.693	2.381	0.000	40.120	37.808
5	-36	1	101	38.5999985	1743.49951	1743.49951	1762.79944	603.703674	568.169556	0	0	1.00	1.00	1.00	9.00	No	36.753	4.693	2.381	0.000	41.446	39.134
5	-37	1	101	38.5999985	1782.09949	1782.09949	1801.39941	616.666687	576.547485	0	0	1.00	1.00	1.00	9.00	No	38.098	4.693	2.381	0.000	42.791	40.479
5	-38	1	101	38.5999985	1820.69946	1820.69946	1839.99939	629.629639	584.757385	0	0	1.00	1.00	1.00	9.00	No	39.463	4.693	2.381	0.000	44.155	41.844
5	-39	1	101	38.5999985	1859.29944	1859.29944	1878.59937	642.59259	592.799194	0	0	1.00	1.00	1.00	9.00	No	40.846	4.693	2.381	0.000	45.539	43.227
5	-40	1	101	38.5999985	1897.89941	1897.89941	1917.19934	655.555542	600.672974	0	0	1.00	1.00	1.00	9.00	No	42.248	4.693	2.381	0.000	46.940	44.628
5	-41	1	101	38.5999985	1936.49939	1936.49939	1955.79932	668.518494	608.378784	0	0	1.00	1.00	1.00	9.00	No	43.667	4.693	2.381	0.000	48.360	46.048
5	-42	1	101	38.5999985	1975.09937	1975.09937	1994.39929	681.481506	615.916504	0	0	1.00	1.00	1.00	9.00	No	45.104	4.693	2.381	0.000	49.797	47.485
5	-43	1	101	38.5999985	2013.69934	2013.69934	2032.99927	694.444458	623.286194	0	0	1.00	1.00	1.00	9.00	No	46.559	4.693	2.381	0.000	51.251	48.940
5	-44	1	101	38.5999985	2052.29932	2052.29932	2071.59937	707.40741	630.487793	0	0	1.00	1.00	1.00	9.00	No	48.030	4.693	2.381	0.000	52.722	50.411
5	-45	1	101	38.5999985	2090.89941	2090.89941	2110.19946	720.370361	637.521423	0	0	1.00	1.00	1.00	9.00	No	49.517	4.693	2.381	0.000	54.210	51.898
5	-46	1	101	38.5999985	2129.49951	2129.49951	2148.79956	733.333313	644.386963	0	0	1.00	1.00	1.00	9.00	No	51.021	4.693	2.381	0.000	55.713	53.402

5	-47	1	101	38.5999985	2168.09961	2168.09961	2187.39966	746.296326	651.084534	0	0	1.00	1.00	1.00	9.00	No	52.540	4.693	2.381	0.000	57.233	54.921
5	-48	1	101	38.5999985	2206.69971	2206.69971	2225.99976	759.259277	657.614014	0	0	1.00	1.00	1.00	9.00	No	54.075	4.693	2.381	0.000	58.767	56.455
5	-49	1	101	38.5999985	2245.2998	2245.2998	2264.59985	772.222229	663.975464	0	0	1.00	1.00	1.00	9.00	No	55.624	4.693	2.381	0.000	60.316	58.005
5	-50	1	101	38.5999985	2283.8999	2283.8999	2303.19995	785.185181	670.168884	0	0	1.00	1.00	1.00	9.00	No	57.188	4.693	2.381	0.000	61.880	59.568
5	-51	1	101	38.5999985	2322.5	2322.5	2341.80005	798.148132	676.194214	0	0	1.00	1.00	1.00	9.00	No	58.765	4.693	2.381	0.000	63.458	61.146
5	-52	1	101	38.5999985	2361.1001	2361.1001	2380.40015	811.111084	682.051575	0	0	1.00	1.00	1.00	9.00	No	60.357	4.693	2.381	0.000	65.049	62.738
5	-53	1	101	38.5999985	2399.7002	2399.7002	2419.00024	824.074097	687.740906	0	0	1.00	1.00	1.00	9.00	No	61.962	4.693	2.381	0.000	66.654	64.342
5	-54	1	101	38.5999985	2438.30029	2438.30029	2457.60034	837.037048	693.262207	0	0	1.00	1.00	1.00	9.00	No	63.579	4.693	2.381	0.000	68.272	65.960
5	-55	1	101	38.5999985	2476.90039	2476.90039	2496.20044	850	698.615356	0	0	1.00	1.00	1.00	9.00	No	65.209	4.693	2.381	0.000	69.902	67.590
5	-56	1	101	38.5999985	2515.50049	2515.50049	2534.80054	862.962952	703.800537	0	0	1.00	1.00	1.00	9.00	No	66.851	4.693	2.381	0.000	71.544	69.232
5	-57	1	101	38.5999985	2554.10059	2554.10059	2573.40063	875.925903	708.817749	0	0	1.00	1.00	1.00	9.00	No	68.505	4.693	2.381	0.000	73.198	70.886
5	-58	1	101	38.5999985	2592.70068	2592.70068	2612.00073	888.888916	713.66687	0	0	1.00	1.00	1.00	9.00	No	70.171	4.693	2.381	0.000	74.863	72.551
5	-59	1	101	38.5999985	2631.30078	2631.30078	2650.60083	901.851868	718.3479	0	0	1.00	1.00	1.00	9.00	No	71.847	4.693	2.381	0.000	76.539	74.228
5	-60	1	101	38.5999985	2669.90088	2669.90088	2689.20093	914.814819	722.860962	0	0	1.00	1.00	1.00	9.00	No	73.533	4.693	2.381	0.000	78.226	75.914
5	-61	1	101	38.5999985	2708.50098	2708.50098	2727.80103	927.777771	727.205933	0	0	1.00	1.00	1.00	9.00	No	75.230	4.693	2.381	0.000	79.923	77.611
5	-62	1	101	38.5999985	2747.10107	2747.10107	2766.40112	940.740723	731.382874	0	0	1.00	1.00	1.00	9.00	No	76.937	4.693	2.381	0.000	81.629	79.318
5	-63	1	101	38.5999985	2785.70117	2785.70117	2805.00122	953.703674	735.391785	0	0	1.00	1.00	1.00	9.00	No	78.653	4.693	2.381	0.000	83.345	81.034
5	-64	1	101	38.5999985	2824.30127	2824.30127	2843.60132	966.666687	739.232666	0	0	1.00	1.00	1.00	9.00	No	80.378	4.693	2.381	0.000	85.070	82.758
5	-65	1	101	38.5999985	2862.90137	2862.90137	2882.20142	979.629639	742.905518	0	0	1.00	1.00	1.00	9.00	No	82.111	4.693	2.381	0.000	86.804	84.492
5	-66	1	101	38.5999985	2901.50146	2901.50146	2920.80151	992.59259	746.410339	0	0	1.00	1.00	1.00	9.00	No	83.853	4.693	2.381	0.000	88.545	86.233
5	-67	1	101	38.5999985	2940.10156	2940.10156	2959.40161	1005.55554	749.74707	0	0	1.00	1.00	1.00	9.00	No	85.602	4.693	2.381	0.000	90.295	87.983
5	-68	1	101	38.5999985	2978.70166	2978.70166	2998.00171	1018.51849	752.915771	0	0	1.00	1.00	1.00	9.00	No	87.359	4.693	2.381	0.000	92.051	89.740
5	-69	1	101	38.5999985	3017.30176	3017.30176	3036.60181	1031.48145	755.916504	0	0	1.00	1.00	1.00	9.00	No	89.123	4.693	2.381	0.000	93.815	91.503
5	-70	1	101	38.5999985	3055.90186	3055.90186	3075.2019	1044.44446	758.749146	0	0	1.00	1.00	1.00	9.00	No	90.893	4.693	2.381	0.000	95.586	93.274
5	-71	1	101	38.5999985	3094.50195	3094.50195	3113.802	1057.40735	761.413757	0	0	1.00	1.00	1.00	9.00	No	92.670	4.693	2.381	0.000	97.362	95.051
5	-72	1	101	38.5999985	3133.10205	3133.10205	3152.4021	1070.37036	763.910278	0	0	1.00	1.00	1.00	9.00	No	94.452	4.693	2.381	0.000	99.145	96.833
5	-73	1	101	38.5999985	3171.70215	3171.70215	3191.0022	1083.33337	766.238892	0	0	1.00	1.00	1.00	9.00	No	96.240	4.693	2.381	0.000	100.933	98.621
5	-74	1	101	38.5999985	3210.30225	3210.30225	3229.60229	1096.29626	768.399353	0	0	1.00	1.00	1.00	9.00	No	98.033	4.693	2.381	0.000	102.726	100.414
5	-75	1	101	38.5999985	3248.90234	3248.90234	3268.20239	1109.25928	770.391785	0	0	1.00	1.00	1.00	9.00	No	99.831	4.693	2.381	0.000	104.523	102.211
5	-76	1	101	38.5999985	3287.50244	3287.50244	3306.80249	1122.22217	772.216187	0	0	1.00	1.00	1.00	9.00	No	101.632	4.693	2.381	0.000	106.325	104.013
5	-77	1	101	38.5999985	3326.10254	3326.10254	3345.40259	1135.18518	773.872559	0	0	1.00	1.00	1.00	9.00	No	103.438	4.693	2.381	0.000	108.131	105.819
5	-78	1	101	38.5999985	3364.70264	3364.70264	3384.00269	1148.14819	775.360962	0	0	1.00	1.00	1.00	9.00	No	105.247	4.693	2.381	0.000	109.940	107.628
5	-79	1	101	38.5999985	3403.30273	3403.30273	3422.60278	1161.11108	776.681274	0	0	1.00	1.00	1.00	9.00	No	107.060	4.693	2.381	0.000	111.752	109.440
5	-80	1	101	38.5999985	3441.90283	3441.90283	3461.20288	1174.0741	777.833496	0	0	1.00	1.00	1.00	9.00	No	108.874	4.693	2.381	0.000	113.567	111.255
5	-81	1	101	38.5999985	3480.50293	3480.50293	3499.80298	1187.03699	778.817749	0	0	1.00	1.00	1.00	9.00	No	110.692	4.693	2.381	0.000	115.384	113.073
5	-82	1	101	38.5999985	3519.10303	3500	3500	1200	779.633911	0	0	1.00	1.00	1.00	9.00	No	112.511	4.693	2.381	0.000	117.203	114.892
6	-83	1	117	54.5999985	3565.70313	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	112.978	6.317	3.193	0.000	119.295	116.171
6	-84	1	117	54.5999985	3620.30322	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	113.444	7.941	4.005	0.000	121.386	117.449
6	-85	1	117	54.5999985	3674.90332	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	113.911	9.566	4.818	0.000	123.477	118.728
6	-86	1	117	54.5999985	3729.50342	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	114.378	11.190	5.630	0.000	125.568	120.007
6	-87	1	117	54.5999985	3784.10352	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	114.844	12.815	6.442	0.000	127.659	121.286
6	-88	1	117	54.5999985	3838.70361	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	115.311	14.439	7.254	0.000	129.750	122.565
6	-89	1	117	54.5999985	3893.30371	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	115.778	16.064	8.066	0.000	131.841	123.844
6	-90	1	117	54.5999985	3947.90381	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	116.244	17.688	8.879	0.000	133.932	125.123
6	-91	1	117	54.5999985	4002.50391	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	116.711	19.313	9.691	0.000	136.023	126.402
6	-92	1	117	54.5999985	4057.104	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	117.178	20.937	10.503	0.000	138.115	127.681
6	-93	1	117	54.5999985	4111.7041	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	117.644	22.561	11.315	0.000	140.206	128.960
7	-94	1	115	52.5999985	4165.30371	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	119.324	22.561	11.315	0.000	141.886	130.639
7	-95	1	115	52.5999985	4217.90381	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	121.004	22.561	11.315	0.000	143.566	132.319
7	-96	1	115	52.5999985	4270.50391	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	122.684	22.561	11.315	0.000	145.246	133.999
7	-97	1	115	52.5999985	4323.104	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	124.364	22.561	11.315	0.000	146.926	135.679
7	-98	1	115	52.5999985	4375.7041	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	126.044	22.561	11.315	0.000	148.606	137.359
7	-99	1	115	52.5999985	4428.3042	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	127.724	22.561	11.315	0.000	150.286	139.039
7	-100	1	115	52.5999985	4480.9043	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	129.404	22.561	11.315	0.000	151.966	140.719
7	-101	1	115	52.5999985	4533.50439	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	131.084	22.561	11.315	0.000	153.646	142.399

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7	-102	1	115	52.5999985	4586.10449	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	132.764	22.561	11.315	0.000	155.326	144.079
7	-103	1	115	52.5999985	4638.70459	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	134.444	22.561	11.315	0.000	157.006	145.759
7	-104	1	115	52.5999985	4691.30469	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	136.124	22.561	11.315	0.000	158.686	147.439
8	-105	1	122	59.5999985	4747.40479	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	26.790	13.683	0.000	162.914	149.807
8	-106	1	122	59.5999985	4807.00488	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	31.018	16.051	0.000	167.142	152.175
8	-107	1	122	59.5999985	4866.60498	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	35.247	18.419	0.000	171.371	154.543
8	-108	1	122	59.5999985	4926.20508	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	39.475	20.787	0.000	175.599	156.911
8	-109	1	122	59.5999985	4985.80518	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	43.704	23.155	0.000	179.828	159.279
8	-110	1	122	59.5999985	5045.40527	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	47.932	25.523	0.000	184.056	161.647
8	-111	1	122	59.5999985	5105.00537	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	52.161	27.891	0.000	188.285	164.015
8	-112	1	122	59.5999985	5164.60547	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	56.389	30.259	0.000	192.513	166.383
8	-113	1	122	59.5999985	5224.20557	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	60.617	32.627	0.000	196.741	168.751
8	-114	1	122	59.5999985	5283.80566	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	64.846	34.995	0.000	200.970	171.119
8	-115	1	122	59.5999985	5343.40576	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	69.074	37.362	0.000	205.198	173.487
8	-116	1	122	59.5999985	5403.00586	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	73.303	39.730	0.000	209.427	175.854
8	-117	1	122	59.5999985	5462.60596	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	77.531	42.098	0.000	213.655	178.222
8	-118	1	122	59.5999985	5522.20605	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	81.760	44.466	0.000	217.883	180.590
8	-119	1	122	59.5999985	5581.80615	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	85.988	46.834	0.000	222.112	182.958
8	-120	1	122	59.5999985	5641.40625	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	90.216	49.202	0.000	226.340	185.326
8	-121	1	122	59.5999985	5701.00635	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	94.445	51.570	0.000	230.569	187.694
8	-122	1	122	59.5999985	5760.60645	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	98.673	53.938	0.000	234.797	190.062
8	-123	1	122	59.5999985	5820.20654	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	136.124	102.902	56.306	0.000	239.026	192.430

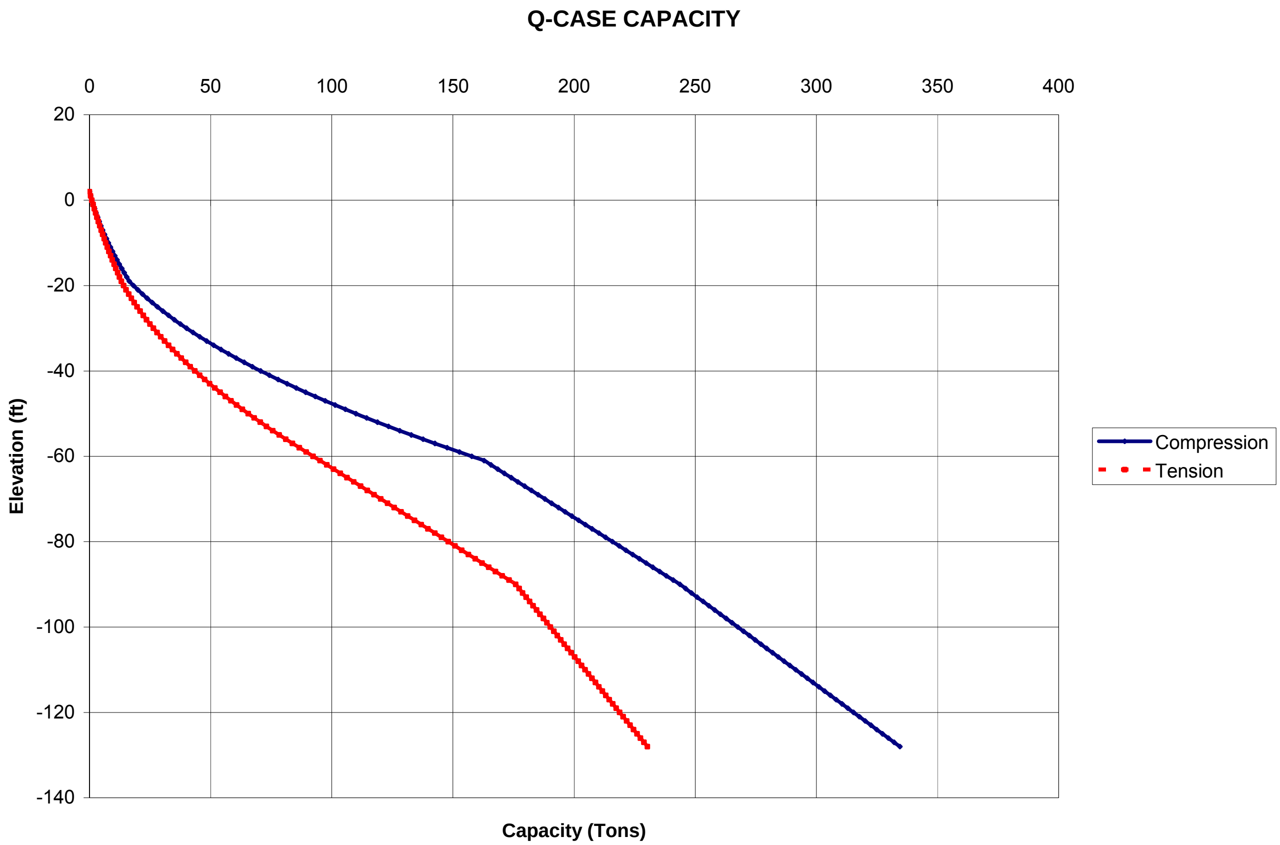
Boring R-60.3-UL_14x14 Concrete Pile_S-Case

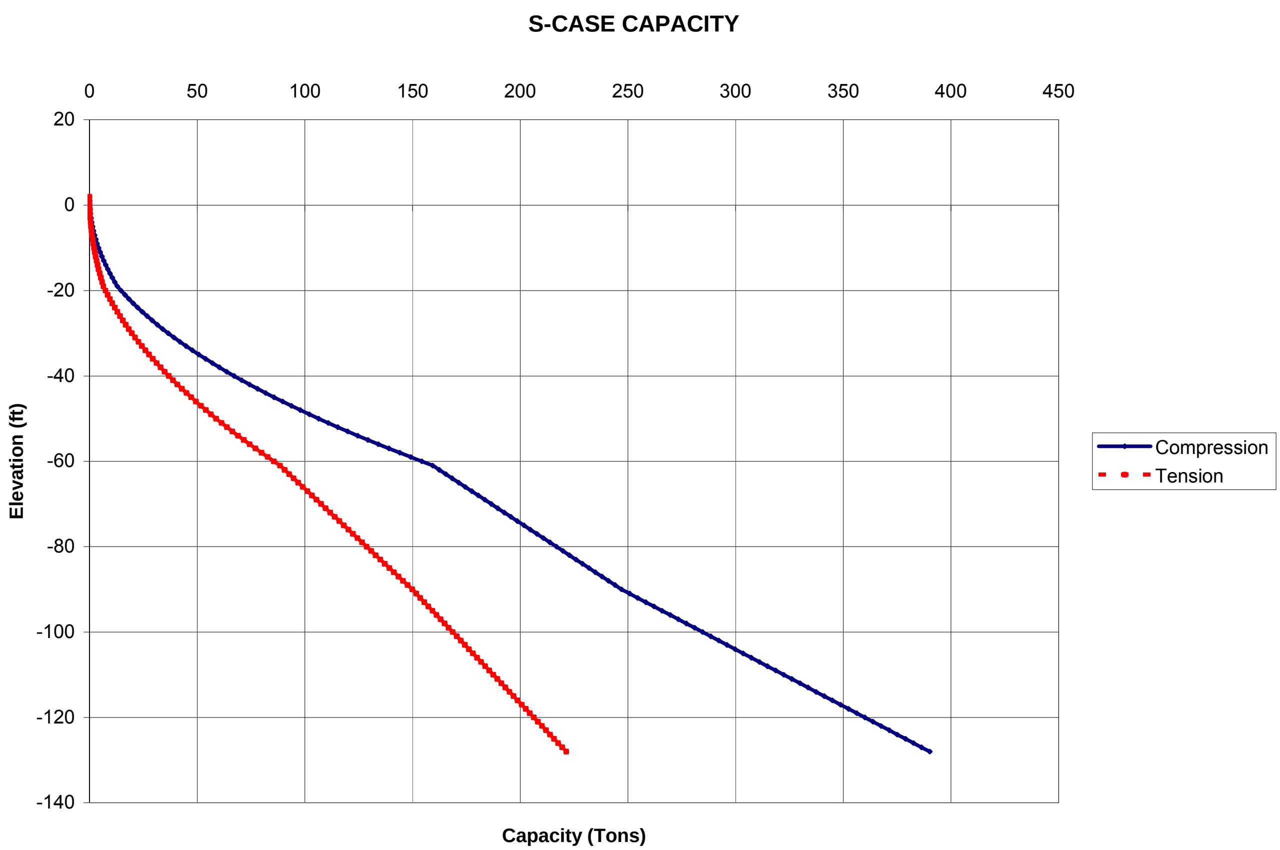
								S-CASE															
Stratum	Tip	Increment	γ (moist)	γ (sub)	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	122	59.5999985	0	0	0	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	122	59.5999985	29.7999992	29.7999992	59.5999985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.036	0.020	0.000	0.036	0.020
1	0	1	122	59.5999985	89.3999939	89.3999939	119.199997	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.144	0.081	0.000	0.144	0.081
1	-1	1	122	59.5999985	149	149	178.799988	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.324	0.181	0.000	0.324	0.181
1	-2	1	122	59.5999985	208.599991	208.599991	238.399994	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.576	0.323	0.000	0.576	0.323
2	-3	1	107	44.5999985	260.699982	260.699982	283	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	0.765	0.455	0.000	0.765	0.455
2	-4	1	107	44.5999985	305.299988	305.299988	327.600006	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	0.986	0.610	0.000	0.986	0.610
2	-5	1	107	44.5999985	349.899994	349.899994	372.200012	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.240	0.787	0.000	1.240	0.787
2	-6	1	107	44.5999985	394.5	394.5	416.800018	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.525	0.987	0.000	1.525	0.987
2	-7	1	107	44.5999985	439.100006	439.100006	461.400024	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.844	1.210	0.000	1.844	1.210
2	-8	1	107	44.5999985	483.700012	483.700012	506.000031	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	2.194	1.455	0.000	2.194	1.455
3	-9	1	117	54.5999985	533.300049	533.300049	560.600037	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.672	1.694	0.000	2.672	1.694
3	-10	1	117	54.5999985	587.900024	587.900024	615.200012	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.198	1.957	0.000	3.198	1.957
3	-11	1	117	54.5999985	642.5	642.5	669.799988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.774	2.245	0.000	3.774	2.245
3	-12	1	117	54.5999985	697.099976	697.099976	724.399963	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.398	2.557	0.000	4.398	2.557
3	-13	1	117	54.5999985	751.699951	751.699951	778.999939	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.071	2.894	0.000	5.071	2.894
3	-14	1	117	54.5999985	806.299927	806.299927	833.599915	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.794	3.255	0.000	5.794	3.255
3	-15	1	117	54.5999985	860.899902	860.899902	888.19989	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.565	3.641	0.000	6.565	3.641
3	-16	1	117	54.5999985	915.499878	915.499878	942.799866	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.385	4.051	0.000	7.385	4.051
3	-17	1	117	54.5999985	970.099854	970.099854	997.399841	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	8.254	4.485	0.000	8.254	4.485
3	-18	1	117	54.5999985	1024.69983	1024.69983	1051.99988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	9.171	4.944	0.000	9.171	4.944
3	-19	1	117	54.5999985	1079.29993	1079.29993	1106.59985	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	10.138	5.427	0.000	10.138	5.427
4	-20	1	101	38.5999985	1125.8999	1125.8999	1145.19983	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	10.954	5.998	0.000	10.954	5.998
4	-21	1	101	38.5999985	1164.49988	1164.49988	1183.7998	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	11.798	6.589	0.000	11.798	6.589
4	-22	1	101	38.5999985	1203.09985	1203.09985	1222.39978	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	12.669	7.199	0.000	12.669	7.199
4	-23	1	101	38.5999985	1241.69983	1241.69983	1260.99976	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	13.569	7.829	0.000	13.569	7.829
4	-24	1	101	38.5999985	1280.2998	1280.2998	1299.59973	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	14.496	8.478	0.000	14.496	8.478
4	-25	1	101	38.5999985	1318.89978	1318.89978	1338.19971	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	15.452	9.147	0.000	15.452	9.147
4	-26	1	101	38.5999985	1357.49976	1357.49976	1376.79968	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	16.436	9.835	0.000	16.436	9.835
4	-27	1	101	38.5999985	1396.09973	1396.09973	1415.39966	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	17.447	10.543	0.000	17.447	10.543
4	-28	1	101	38.5999985	1434.69971	1434.69971	1453.99963	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	18.487	11.271	0.000	18.487	11.271
5	-29	1	101	38.5999985	1473.29968	1473.29968	1492.59961	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	19.554	12.018	0.000	19.554	12.018
5	-30	1	101	38.5999985	1511.89966	1511.89966	1531.19958	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	20.649	12.785	0.000	20.649	12.785
5	-31	1	101	38.5999985	1550.49963	1550.49963	1569.79956	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	21.773	13.571	0.000	21.773	13.571
5	-32	1	101	38.5999985	1589.09961	1589.09961	1608.39954	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	22.924	14.377	0.000	22.924	14.377
5	-33	1	101	38.5999985	1627.69958	1627.69958	1646.99951	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	24.103	15.203	0.000	24.103	15.203
5	-34	1	101	38.5999985	1666.29956	1666.29956	1685.59949	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	25.311	16.048	0.000	25.311	16.048
5	-35	1	101	38.5999985	1704.89954	1704.89954	1724.19946	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	26.546	16.913	0.000	26.546	16.913
5	-36	1	101	38.5999985	1743.49951	1743.49951	1762.79944	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	27.809	17.797	0.000	27.809	17.797
5	-37	1	101	38.5999985	1782.09949	1782.09949	1801.39941	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	29.100	18.701	0.000	29.100	18.701
5	-38	1	101	38.5999985	1820.69946	1820.69946	1839.99939	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	30.419	19.624	0.000	30.419	19.624
5	-39	1	101	38.5999985	1859.29944	1859.29944	1878.59937	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	31.766	20.567	0.000	31.766	20.567
5	-40	1	101	38.5999985	1897.89941	1897.89941	1917.19934	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	33.142	21.530	0.000	33.142	21.530
5	-41	1	101	38.5999985	1936.49939	1936.49939	1955.79932	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	34.545	22.512	0.000	34.545	22.512
5	-42	1	101	38.5999985	1975.09937	1975.09937	1994.39929	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	35.976	23.513	0.000	35.976	23.513
5	-43	1	101	38.5999985	2013.69934	2013.69934	2032.99927	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	37.435	24.535	0.000	37.435	24.535
5	-44	1	101	38.5999985	2052.29932	2052.29932	2071.59937	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	38.921	25.576	0.000	38.921	25.576
5	-45	1	101	38.5999985	2090.89941	2090.89941	2110.19946	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	40.436	26.636	0.000	40.436	26.636
5	-46	1	101	38.5999985	2129.49951	2129.49951	2148.79956	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	41.979	27.716	0.000	41.979	27.716

5	-47	1	101	38.5999985	2168.09961	2168.09961	2187.39966	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	43.550	28.816	0.000	43.550	28.816
5	-48	1	101	38.5999985	2206.69971	2206.69971	2225.99976	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	45.149	29.935	0.000	45.149	29.935
5	-49	1	101	38.5999985	2245.2998	2245.2998	2264.59985	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	46.776	31.073	0.000	46.776	31.073
5	-50	1	101	38.5999985	2283.8999	2283.8999	2303.19995	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	48.430	32.232	0.000	48.430	32.232
5	-51	1	101	38.5999985	2322.5	2322.5	2341.80005	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	50.113	33.410	0.000	50.113	33.410
5	-52	1	101	38.5999985	2361.1001	2361.1001	2380.40015	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	51.824	34.607	0.000	51.824	34.607
5	-53	1	101	38.5999985	2399.7002	2399.7002	2419.00024	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	53.562	35.824	0.000	53.562	35.824
5	-54	1	101	38.5999985	2438.30029	2438.30029	2457.60034	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	55.329	37.061	0.000	55.329	37.061
5	-55	1	101	38.5999985	2476.90039	2476.90039	2496.20044	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	57.123	38.317	0.000	57.123	38.317
5	-56	1	101	38.5999985	2515.50049	2515.50049	2534.80054	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	58.946	39.593	0.000	58.946	39.593
5	-57	1	101	38.5999985	2554.10059	2554.10059	2573.40063	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	60.796	40.888	0.000	60.796	40.888
5	-58	1	101	38.5999985	2592.70068	2592.70068	2612.00073	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	62.675	42.203	0.000	62.675	42.203
5	-59	1	101	38.5999985	2631.30078	2631.30078	2650.60083	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	64.581	43.538	0.000	64.581	43.538
5	-60	1	101	38.5999985	2669.90088	2669.90088	2689.20093	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	66.516	44.892	0.000	66.516	44.892
5	-61	1	101	38.5999985	2708.50098	2708.50098	2727.80103	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	68.478	46.265	0.000	68.478	46.265
5	-62	1	101	38.5999985	2747.10107	2747.10107	2766.40112	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	70.468	47.658	0.000	70.468	47.658
5	-63	1	101	38.5999985	2785.70117	2785.70117	2805.00122	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	72.487	49.071	0.000	72.487	49.071
5	-64	1	101	38.5999985	2824.30127	2824.30127	2843.60132	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	74.533	50.504	0.000	74.533	50.504
5	-65	1	101	38.5999985	2862.90137	2862.90137	2882.20142	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	76.607	51.956	0.000	76.607	51.956
5	-66	1	101	38.5999985	2901.50146	2901.50146	2920.80151	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	78.709	53.427	0.000	78.709	53.427
5	-67	1	101	38.5999985	2940.10156	2940.10156	2959.40161	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	80.840	54.918	0.000	80.840	54.918
5	-68	1	101	38.5999985	2978.70166	2978.70166	2998.00171	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	82.998	56.429	0.000	82.998	56.429
5	-69	1	101	38.5999985	3017.30176	3017.30176	3036.60181	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	85.184	57.959	0.000	85.184	57.959
5	-70	1	101	38.5999985	3055.90186	3055.90186	3075.2019	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	87.398	59.509	0.000	87.398	59.509
5	-71	1	101	38.5999985	3094.50195	3094.50195	3113.802	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	89.640	61.078	0.000	89.640	61.078
5	-72	1	101	38.5999985	3133.10205	3133.10205	3152.4021	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	91.910	62.667	0.000	91.910	62.667
5	-73	1	101	38.5999985	3171.70215	3171.70215	3191.0022	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	94.208	64.276	0.000	94.208	64.276
5	-74	1	101	38.5999985	3210.30225	3210.30225	3229.60229	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	96.534	65.904	0.000	96.534	65.904
5	-75	1	101	38.5999985	3248.90234	3248.90234	3268.20239	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	98.888	67.552	0.000	98.888	67.552
5	-76	1	101	38.5999985	3287.50244	3287.50244	3306.80249	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	101.270	69.219	0.000	101.270	69.219
5	-77	1	101	38.5999985	3326.10254	3326.10254	3345.40259	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	103.679	70.906	0.000	103.679	70.906
5	-78	1	101	38.5999985	3364.70264	3364.70264	3384.00269	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	106.117	72.613	0.000	106.117	72.613
5	-79	1	101	38.5999985	3403.30273	3403.30273	3422.60278	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	108.583	74.339	0.000	108.583	74.339
5	-80	1	101	38.5999985	3441.90283	3441.90283	3461.20288	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	111.077	76.084	0.000	111.077	76.084
5	-81	1	101	38.5999985	3480.50293	3480.50293	3499.80298	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	113.598	77.849	0.000	113.598	77.849
5	-82	1	101	38.5999985	3519.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	116.134	79.624	0.000	116.134	79.624
6	-83	1	117	54.5999985	3565.70313	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	119.269	81.192	0.000	119.269	81.192
6	-84	1	117	54.5999985	3620.30322	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	122.404	82.759	0.000	122.404	82.759
6	-85	1	117	54.5999985	3674.90332	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	125.539	84.327	0.000	125.539	84.327
6	-86	1	117	54.5999985	3729.50342	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	128.674	85.894	0.000	128.674	85.894
6	-87	1	117	54.5999985	3784.10352	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	131.809	87.462	0.000	131.809	87.462
6	-88	1	117	54.5999985	3838.70361	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	134.943	89.029	0.000	134.943	89.029
6	-89	1	117	54.5999985	3893.30371	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	138.078	90.597	0.000	138.078	90.597
6	-90	1	117	54.5999985	3947.90381	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	141.213	92.164	0.000	141.213	92.164
6	-91	1	117	54.5999985	4002.50391	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	144.348	93.731	0.000	144.348	93.731
6	-92	1	117	54.5999985	4057.104	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	147.483	95.299	0.000	147.483	95.299
6	-93	1	117	54.5999985	4111.7041	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	150.618	96.866	0.000	150.618	96.866
7	-94	1	115	52.5999985	4165.30371	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	153.154	98.641	0.000	153.154	98.641
7	-95	1	115	52.5999985	4217.90381	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	155.690	100.416	0.000	155.690	100.416
7	-96	1	115	52.5999985	4270.50391	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	158.225	102.192	0.000	158.225	102.192
7	-97	1	115	52.5999985	4323.104	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	160.761	103.967	0.000	160.761	103.967
7	-98	1	115	52.5999985	4375.7041	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	163.297	105.742	0.000	163.297	105.742
7	-99	1	115	52.5999985	4428.3042	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	165.833	107.517	0.000	165.833	107.517
7	-100	1	115	52.5999985	4480.9043	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	168.369	109.292	0.000	168.369	109.292
7	-101	1	115	52.5999985	4533.50439	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	170.904	111.067	0.000	170.904	111.067

7	-102	1	115	52.5999985	4586.10449	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	173.440	112.842	0.000	173.440	112.842
7	-103	1	115	52.5999985	4638.70459	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	175.976	114.617	0.000	175.976	114.617
7	-104	1	115	52.5999985	4691.30469	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	178.512	116.392	0.000	178.512	116.392
8	-105	1	122	59.5999985	4747.40479	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	182.740	118.760	0.000	182.740	118.760
8	-106	1	122	59.5999985	4807.00488	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	186.969	121.128	0.000	186.969	121.128
8	-107	1	122	59.5999985	4866.60498	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	191.197	123.496	0.000	191.197	123.496
8	-108	1	122	59.5999985	4926.20508	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	195.426	125.864	0.000	195.426	125.864
8	-109	1	122	59.5999985	4985.80518	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	199.654	128.232	0.000	199.654	128.232
8	-110	1	122	59.5999985	5045.40527	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	203.882	130.600	0.000	203.882	130.600
8	-111	1	122	59.5999985	5105.00537	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	208.111	132.968	0.000	208.111	132.968
8	-112	1	122	59.5999985	5164.60547	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	212.339	135.335	0.000	212.339	135.335
8	-113	1	122	59.5999985	5224.20557	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	216.568	137.703	0.000	216.568	137.703
8	-114	1	122	59.5999985	5283.80566	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	220.796	140.071	0.000	220.796	140.071
8	-115	1	122	59.5999985	5343.40576	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	225.024	142.439	0.000	225.024	142.439
8	-116	1	122	59.5999985	5403.00586	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	229.253	144.807	0.000	229.253	144.807
8	-117	1	122	59.5999985	5462.60596	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	233.481	147.175	0.000	233.481	147.175
8	-118	1	122	59.5999985	5522.20605	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	237.710	149.543	0.000	237.710	149.543
8	-119	1	122	59.5999985	5581.80615	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	241.938	151.911	0.000	241.938	151.911
8	-120	1	122	59.5999985	5641.40625	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	246.167	154.279	0.000	246.167	154.279
8	-121	1	122	59.5999985	5701.00635	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	250.395	156.647	0.000	250.395	156.647
8	-122	1	122	59.5999985	5760.60645	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	254.623	159.015	0.000	254.623	159.015
8	-123	1	122	59.5999985	5820.20654	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	258.852	161.383	0.000	258.852	161.383

Boring
R-59.75-LU
HP14x73 Steel Pile Capacities


Q-CASE CAPACITY
0
50
100
150
200
250
300
350
400
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension


S-CASE CAPACITY
0
50
100
150
200
250
300
350
400
450
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

870

Boring R-59.75-LU_HP14x73 Steel Pile_Q-Case

								Q-CASE													
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	117	54.5999985	0	0	0	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	117	54.5999985	27.2999992	27.2999992	54.5999985	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.470	0.015	0.007	0.000	0.485	0.477
1	0	1	117	54.5999985	81.8999939	81.8999939	109.199997	200	200	15	11.25	1.00	0.50	4.40	12.90	No	0.940	0.060	0.030	0.000	1.000	0.970
1	-1	1	117	54.5999985	136.5	136.5	163.799988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	1.410	0.135	0.067	0.000	1.545	1.477
1	-2	1	117	54.5999985	191.099991	191.099991	218.399994	200	200	15	11.25	1.00	0.50	4.40	12.90	No	1.880	0.240	0.120	0.000	2.120	2.000
1	-3	1	117	54.5999985	245.699997	245.699997	273	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.350	0.374	0.187	0.000	2.724	2.537
1	-4	1	117	54.5999985	300.299988	300.299988	327.600006	200	200	15	11.25	1.00	0.50	4.40	12.90	No	2.820	0.539	0.270	0.000	3.359	3.090
1	-5	1	117	54.5999985	354.899994	354.899994	382.200012	200	200	15	11.25	1.00	0.50	4.40	12.90	No	3.290	0.734	0.367	0.000	4.024	3.657
1	-6	1	117	54.5999985	409.5	409.5	436.800018	200	200	15	11.25	1.00	0.50	4.40	12.90	No	3.760	0.958	0.479	0.000	4.718	4.239
1	-7	1	117	54.5999985	464.100006	464.100006	491.400024	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.230	1.213	0.607	0.000	5.443	4.837
1	-8	1	117	54.5999985	518.700012	518.700012	546	200	200	15	11.25	1.00	0.50	4.40	12.90	No	4.700	1.498	0.749	0.000	6.198	5.449
1	-9	1	117	54.5999985	573.299988	573.299988	600.599976	200	200	15	11.25	1.00	0.50	4.40	12.90	No	5.170	1.812	0.906	0.000	6.982	6.076
1	-10	1	117	54.5999985	627.899963	627.899963	655.199951	200	200	15	11.25	1.00	0.50	4.40	12.90	No	5.640	2.157	1.078	0.000	7.797	6.718
1	-11	1	117	54.5999985	682.499939	682.499939	709.799927	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.110	2.531	1.265	0.000	8.641	7.375
1	-12	1	117	54.5999985	737.099915	737.099915	764.399902	200	200	15	11.25	1.00	0.50	4.40	12.90	No	6.580	2.935	1.468	0.000	9.515	8.048
1	-13	1	117	54.5999985	791.69989	791.69989	818.999878	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.050	3.370	1.685	0.000	10.420	8.735
1	-14	1	117	54.5999985	846.299866	846.299866	873.599854	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.520	3.834	1.917	0.000	11.354	9.437
1	-15	1	117	54.5999985	900.899841	900.899841	928.199829	200	200	15	11.25	1.00	0.50	4.40	12.90	No	7.990	4.328	2.164	0.000	12.318	10.154
1	-16	1	117	54.5999985	955.499817	955.499817	982.799805	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.460	4.852	2.426	0.000	13.312	10.886
1	-17	1	117	54.5999985	1010.09979	1010.09979	1037.39978	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.930	5.406	2.703	0.000	14.336	11.633
1	-18	1	117	54.5999985	1064.69983	1064.69983	1091.99976	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.400	5.990	2.995	0.000	15.390	12.395
1	-19	1	117	54.5999985	1119.2998	1119.2998	1146.59973	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.870	6.604	3.302	0.000	16.474	13.172
2	-20	1	122	59.5999985	1176.39978	1176.39978	1206.19971	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	8.318	4.262	0.000	18.188	14.132
2	-21	1	122	59.5999985	1235.99976	1235.99976	1265.79968	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	10.118	5.270	0.000	19.988	15.140
2	-22	1	122	59.5999985	1295.59973	1295.59973	1325.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	12.004	6.326	0.000	21.874	16.196
2	-23	1	122	59.5999985	1355.19971	1355.19971	1384.99963	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	13.978	7.432	0.000	23.848	17.302
2	-24	1	122	59.5999985	1414.79968	1414.79968	1444.59961	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	16.039	8.585	0.000	25.909	18.455
2	-25	1	122	59.5999985	1474.39966	1474.39966	1504.19958	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	18.186	9.788	0.000	28.056	19.658
2	-26	1	122	59.5999985	1533.99963	1533.99963	1563.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	20.420	11.039	0.000	30.290	20.909
2	-27	1	122	59.5999985	1593.59961	1593.59961	1623.39954	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	22.741	12.339	0.000	32.611	22.209
2	-28	1	122	59.5999985	1653.19958	1653.19958	1682.99951	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	25.148	13.687	0.000	35.018	23.557
2	-29	1	122	59.5999985	1712.79956	1712.79956	1742.59949	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	27.643	15.084	0.000	37.513	24.954
2	-30	1	122	59.5999985	1772.39954	1772.39954	1802.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	30.224	16.529	0.000	40.094	26.399
2	-31	1	122	59.5999985	1831.99951	1831.99951	1861.79944	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	32.892	18.023	0.000	42.762	27.893
2	-32	1	122	59.5999985	1891.59949	1891.59949	1921.39941	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	35.647	19.566	0.000	45.517	29.436
2	-33	1	122	59.5999985	1951.19946	1951.19946	1980.99939	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	38.489	21.157	0.000	48.359	31.027
2	-34	1	122	59.5999985	2010.79944	2010.79944	2040.59937	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	41.417	22.797	0.000	51.287	32.667
2	-35	1	122	59.5999985	2070.39941	2070.39941	2100.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	44.432	24.486	0.000	54.302	34.356
2	-36	1	122	59.5999985	2129.99951	2129.99951	2159.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	47.534	26.223	0.000	57.404	36.093
2	-37	1	122	59.5999985	2189.59961	2189.59961	2219.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	50.723	28.009	0.000	60.593	37.879
2	-38	1	122	59.5999985	2249.19971	2249.19971	2278.99976	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	53.999	29.843	0.000	63.869	39.713
2	-39	1	122	59.5999985	2308.7998	2308.7998	2338.59985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	57.361	31.726	0.000	67.231	41.596
2	-40	1	122	59.5999985	2368.3999	2368.3999	2398.19995	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	60.811	33.658	0.000	70.681	43.528
2	-41	1	122	59.5999985	2428	2428	2457.80005	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	64.347	35.638	0.000	74.217	45.508
2	-42	1	122	59.5999985	2487.6001	2487.6001	2517.40015	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	67.969	37.667	0.000	77.839	47.537
2	-43	1	122	59.5999985	2547.2002	2547.2002	2577.00024	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	71.679	39.744	0.000	81.549	49.614
2	-44	1	122	59.5999985	2606.80029	2606.80029	2636.60034	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	75.476	41.870	0.000	85.346	51.740
2	-45	1	122	59.5999985	2666.40039	2666.40039	2696.20044	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	79.359	44.045	0.000	89.229	53.915
2	-46	1	122	59.5999985	2726.00049	2726.00049	2755.80054	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	83.329	46.268	0.000	93.199	56.138

2	-47	1	122	59.5999985	2785.60059	2785.60059	2815.40063	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	87.386	48.540	0.000	97.256	58.410
2	-48	1	122	59.5999985	2845.20068	2845.20068	2875.00073	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	91.529	50.860	0.000	101.399	60.730
2	-49	1	122	59.5999985	2904.80078	2904.80078	2934.60083	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	95.760	53.229	0.000	105.630	63.099
2	-50	1	122	59.5999985	2964.40088	2964.40088	2994.20093	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	100.077	55.647	0.000	109.947	65.517
2	-51	1	122	59.5999985	3024.00098	3024.00098	3053.80103	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	104.481	58.113	0.000	114.351	67.983
2	-52	1	122	59.5999985	3083.60107	3083.60107	3113.40112	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	108.972	60.628	0.000	118.842	70.498
2	-53	1	122	59.5999985	3143.20117	3143.20117	3173.00122	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	113.549	63.191	0.000	123.419	73.061
2	-54	1	122	59.5999985	3202.80127	3202.80127	3232.60132	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	118.214	65.804	0.000	128.084	75.673
2	-55	1	122	59.5999985	3262.40137	3262.40137	3292.20142	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	122.965	68.464	0.000	132.835	78.334
2	-56	1	122	59.5999985	3322.00146	3322.00146	3351.80151	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	127.803	71.173	0.000	137.673	81.043
2	-57	1	122	59.5999985	3381.60156	3381.60156	3411.40161	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	132.728	73.931	0.000	142.598	83.801
2	-58	1	122	59.5999985	3441.20166	3441.20166	3471.00171	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	137.740	76.738	0.000	147.610	86.608
2	-59	1	122	59.5999985	3500.80176	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	142.837	79.592	0.000	152.707	89.462
2	-60	1	122	59.5999985	3560.40186	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	147.934	82.447	0.000	157.804	92.317
2	-61	1	122	59.5999985	3620.00195	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	9.870	153.031	85.301	0.000	162.901	95.171
3	-62	1	105	42.5999985	3671.10205	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	12.655	153.031	85.301	0.000	165.686	97.956
3	-63	1	105	42.5999985	3713.70215	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	15.439	153.031	85.301	0.000	168.471	100.741
3	-64	1	105	42.5999985	3756.30225	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	18.224	153.031	85.301	0.000	171.256	103.526
3	-65	1	105	42.5999985	3798.90234	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	21.009	153.031	85.301	0.000	174.040	106.310
3	-66	1	105	42.5999985	3841.50244	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	23.794	153.031	85.301	0.000	176.825	109.095
3	-67	1	105	42.5999985	3884.10254	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	26.578	153.031	85.301	0.000	179.610	111.880
3	-68	1	105	42.5999985	3926.70264	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	29.363	153.031	85.301	0.000	182.395	114.665
3	-69	1	105	42.5999985	3969.30273	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	32.148	153.031	85.301	0.000	185.179	117.449
3	-70	1	105	42.5999985	4011.90283	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	34.933	153.031	85.301	0.000	187.964	120.234
3	-71	1	105	42.5999985	4054.50293	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	37.717	153.031	85.301	0.000	190.749	123.019
3	-72	1	105	42.5999985	4097.10303	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	40.502	153.031	85.301	0.000	193.534	125.804
3	-73	1	105	42.5999985	4139.70264	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	43.287	153.031	85.301	0.000	196.318	128.588
3	-74	1	105	42.5999985	4182.30273	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	46.072	153.031	85.301	0.000	199.103	131.373
3	-75	1	105	42.5999985	4224.90283	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	48.857	153.031	85.301	0.000	201.888	134.158
3	-76	1	105	42.5999985	4267.50293	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	51.641	153.031	85.301	0.000	204.673	136.943
3	-77	1	105	42.5999985	4310.10303	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	54.426	153.031	85.301	0.000	207.457	139.727
3	-78	1	105	42.5999985	4352.70313	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	57.211	153.031	85.301	0.000	210.242	142.512
3	-79	1	105	42.5999985	4395.30322	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	59.996	153.031	85.301	0.000	213.027	145.297
3	-80	1	105	42.5999985	4437.90332	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	62.780	153.031	85.301	0.000	215.811	148.082
3	-81	1	105	42.5999985	4480.50342	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	65.565	153.031	85.301	0.000	218.596	150.866
3	-82	1	105	42.5999985	4523.10352	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	68.350	153.031	85.301	0.000	221.381	153.651
3	-83	1	105	42.5999985	4565.70361	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	71.135	153.031	85.301	0.000	224.166	156.436
3	-84	1	105	42.5999985	4608.30371	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	73.919	153.031	85.301	0.000	226.950	159.220
3	-85	1	105	42.5999985	4650.90381	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	76.704	153.031	85.301	0.000	229.735	162.005
3	-86	1	105	42.5999985	4693.50391	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	79.489	153.031	85.301	0.000	232.520	164.790
3	-87	1	105	42.5999985	4736.104	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	82.274	153.031	85.301	0.000	235.305	167.575
3	-88	1	105	42.5999985	4778.7041	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	85.058	153.031	85.301	0.000	238.089	170.359
3	-89	1	105	42.5999985	4821.3042	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	87.843	153.031	85.301	0.000	240.874	173.144
3	-90	1	105	42.5999985	4863.9043	3500	3500	1580	790	0	0	1.00	1.00	1.00	9.00	No	90.628	153.031	85.301	0.000	243.659	175.929
4	-91	1	117	54.5999985	4912.50439	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	91.098	154.951	86.261	0.000	246.049	177.359
4	-92	1	117	54.5999985	4967.10449	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	91.568	156.871	87.221	0.000	248.439	178.789
4	-93	1	117	54.5999985	5021.70459	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	92.038	158.791	88.181	0.000	250.829	180.219
4	-94	1	117	54.5999985	5076.30469	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	92.508	160.711	89.141	0.000	253.219	181.649
4	-95	1	117	54.5999985	5130.90479	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	92.978	162.631	90.101	0.000	255.609	183.079
4	-96	1	117	54.5999985	5185.50488	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	93.448	164.551	91.061	0.000	257.999	184.509
4	-97	1	117	54.5999985	5240.10498	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	93.918	166.471	92.021	0.000	260.389	185.939
4	-98	1	117	54.5999985	5294.70508	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	94.388	168.391	92.981	0.000	262.779	187.369
4	-99	1	117	54.5999985	5349.30518	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	94.858	170.311	93.941	0.000	265.169	188.799
4	-100	1	117	54.5999985	5403.90527	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	95.328	172.231	94.901	0.000	267.559	190.229
4	-101	1	117	54.5999985	5458.50537	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	95.798	174.151	95.861	0.000	269.949	191.659

4	-102	1	117	54.5999985	5513.10547	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	96.268	176.071	96.821	0.000	272.338	193.089
4	-103	1	117	54.5999985	5567.70557	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	96.738	177.991	97.781	0.000	274.728	194.519
4	-104	1	117	54.5999985	5622.30566	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	97.208	179.911	98.741	0.000	277.118	195.949
4	-105	1	117	54.5999985	5676.90576	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	97.678	181.831	99.701	0.000	279.508	197.379
4	-106	1	117	54.5999985	5731.50586	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	98.148	183.751	100.661	0.000	281.898	198.809
4	-107	1	117	54.5999985	5786.10596	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	98.618	185.671	101.621	0.000	284.288	200.239
4	-108	1	117	54.5999985	5840.70605	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	99.088	187.591	102.581	0.000	286.678	201.669
4	-109	1	117	54.5999985	5895.30615	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	99.558	189.511	103.541	0.000	289.068	203.099
4	-110	1	117	54.5999985	5949.90625	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	100.028	191.431	104.501	0.000	291.458	204.529
4	-111	1	117	54.5999985	6004.50635	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	100.498	193.351	105.461	0.000	293.848	205.958
4	-112	1	117	54.5999985	6059.10645	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	100.968	195.271	106.421	0.000	296.238	207.388
4	-113	1	117	54.5999985	6113.70654	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	101.438	197.191	107.381	0.000	298.628	208.818
4	-114	1	117	54.5999985	6168.30664	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	101.908	199.111	108.341	0.000	301.018	210.248
4	-115	1	117	54.5999985	6222.90674	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	102.378	201.031	109.301	0.000	303.408	211.678
4	-116	1	117	54.5999985	6277.50684	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	102.848	202.951	110.261	0.000	305.798	213.108
4	-117	1	117	54.5999985	6332.10693	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	103.318	204.870	111.221	0.000	308.188	214.538
4	-118	1	117	54.5999985	6386.70703	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	103.788	206.790	112.181	0.000	310.578	215.968
4	-119	1	117	54.5999985	6441.30713	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	104.258	208.710	113.141	0.000	312.968	217.398
4	-120	1	117	54.5999985	6495.90723	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	104.728	210.630	114.101	0.000	315.358	218.828
4	-121	1	117	54.5999985	6550.50732	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	105.198	212.550	115.061	0.000	317.748	220.258
4	-122	1	117	54.5999985	6605.10742	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	105.668	214.470	116.021	0.000	320.138	221.688
4	-123	1	117	54.5999985	6659.70752	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	106.138	216.390	116.981	0.000	322.527	223.118
4	-124	1	117	54.5999985	6714.30762	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	106.608	218.310	117.941	0.000	324.917	224.548
4	-125	1	117	54.5999985	6768.90771	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	107.078	220.230	118.901	0.000	327.307	225.978
4	-126	1	117	54.5999985	6823.50781	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	107.548	222.150	119.861	0.000	329.697	227.408
4	-127	1	117	54.5999985	6878.10791	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	108.018	224.070	120.821	0.000	332.087	228.838
4	-128	1	117	54.5999985	6932.70801	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	108.488	225.990	121.781	0.000	334.477	230.268

Boring R-59.75-LU_HP14x73 Steel Pile_S-Case

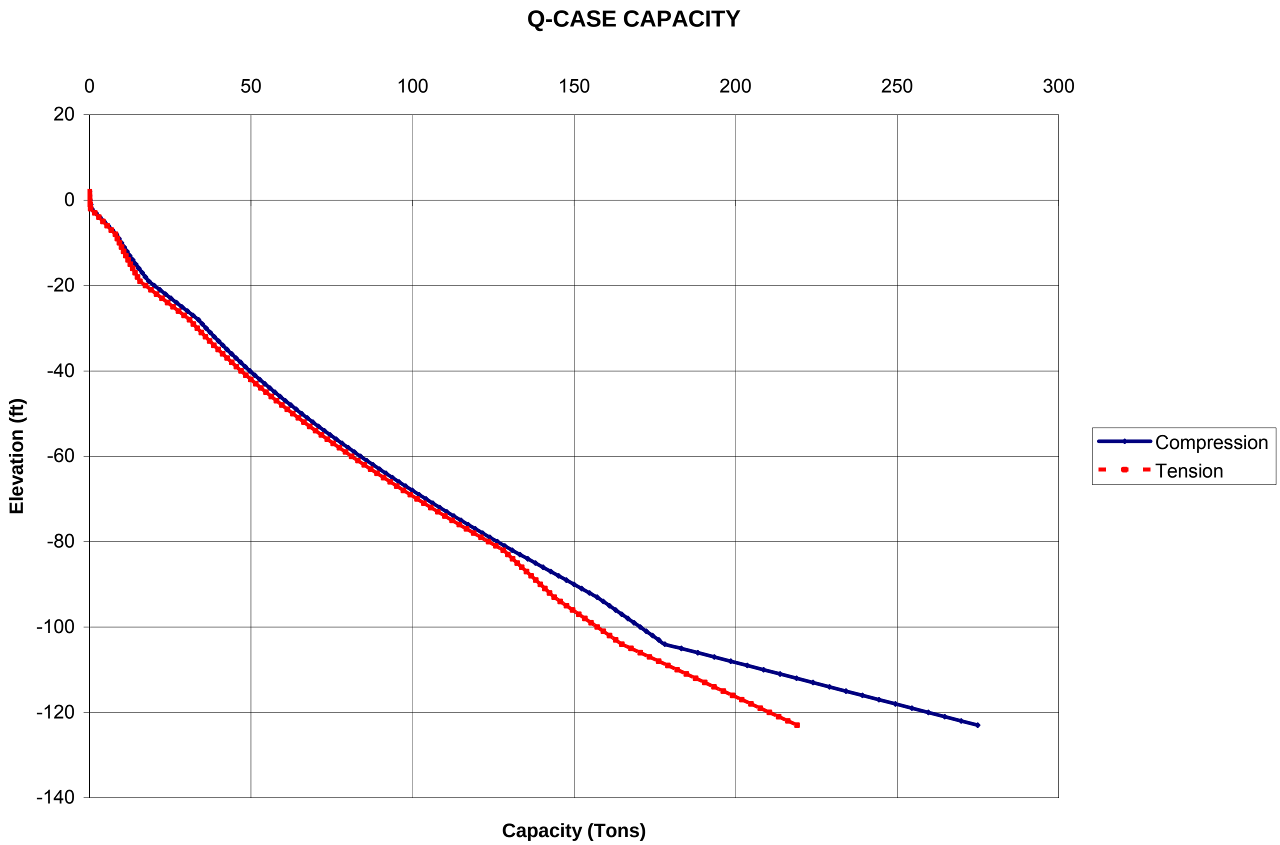
								S-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	117	54.5999985	0	0	0	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	117	54.5999985	27.2999992	27.2999992	54.5999985	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.029	0.015	0.000	0.029	0.015
1	0	1	117	54.5999985	81.8999939	81.8999939	109.199997	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.117	0.059	0.000	0.117	0.059
1	-1	1	117	54.5999985	136.5	136.5	163.799988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.264	0.132	0.000	0.264	0.132
1	-2	1	117	54.5999985	191.099991	191.099991	218.399994	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.470	0.235	0.000	0.470	0.235
1	-3	1	117	54.5999985	245.699997	245.699997	273	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	0.734	0.367	0.000	0.734	0.367
1	-4	1	117	54.5999985	300.299988	300.299988	327.600006	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.057	0.529	0.000	1.057	0.529
1	-5	1	117	54.5999985	354.899994	354.899994	382.200012	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.439	0.720	0.000	1.439	0.720
1	-6	1	117	54.5999985	409.5	409.5	436.800018	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	1.880	0.940	0.000	1.880	0.940
1	-7	1	117	54.5999985	464.100006	464.100006	491.400024	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.379	1.189	0.000	2.379	1.189
1	-8	1	117	54.5999985	518.700012	518.700012	546	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	2.937	1.468	0.000	2.937	1.468
1	-9	1	117	54.5999985	573.299988	573.299988	600.599976	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.554	1.777	0.000	3.554	1.777
1	-10	1	117	54.5999985	627.899963	627.899963	655.199951	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.229	2.115	0.000	4.229	2.115
1	-11	1	117	54.5999985	682.499939	682.499939	709.799927	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.963	2.482	0.000	4.963	2.482
1	-12	1	117	54.5999985	737.099915	737.099915	764.399902	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.756	2.878	0.000	5.756	2.878
1	-13	1	117	54.5999985	791.69989	791.69989	818.999878	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.608	3.304	0.000	6.608	3.304
1	-14	1	117	54.5999985	846.299866	846.299866	873.599854	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.519	3.759	0.000	7.519	3.759
1	-15	1	117	54.5999985	900.899841	900.899841	928.199829	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	8.488	4.244	0.000	8.488	4.244
1	-16	1	117	54.5999985	955.499817	955.499817	982.799805	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	9.516	4.758	0.000	9.516	4.758
1	-17	1	117	54.5999985	1010.09979	1010.09979	1037.39978	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	10.602	5.301	0.000	10.602	5.301
1	-18	1	117	54.5999985	1064.69983	1064.69983	1091.99976	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	11.748	5.874	0.000	11.748	5.874
1	-19	1	117	54.5999985	1119.2998	1119.2998	1146.59973	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	12.952	6.476	0.000	12.952	6.476
2	-20	1	122	59.5999985	1176.39978	1176.39978	1206.19971	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	14.665	7.435	0.000	14.665	7.435
2	-21	1	122	59.5999985	1235.99976	1235.99976	1265.79968	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	16.465	8.443	0.000	16.465	8.443
2	-22	1	122	59.5999985	1295.59973	1295.59973	1325.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	18.352	9.500	0.000	18.352	9.500
2	-23	1	122	59.5999985	1355.19971	1355.19971	1384.99963	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	20.326	10.605	0.000	20.326	10.605
2	-24	1	122	59.5999985	1414.79968	1414.79968	1444.59961	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	22.386	11.759	0.000	22.386	11.759
2	-25	1	122	59.5999985	1474.39966	1474.39966	1504.19958	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	24.533	12.962	0.000	24.533	12.962
2	-26	1	122	59.5999985	1533.99963	1533.99963	1563.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	26.767	14.213	0.000	26.767	14.213
2	-27	1	122	59.5999985	1593.59961	1593.59961	1623.39954	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	29.088	15.512	0.000	29.088	15.512
2	-28	1	122	59.5999985	1653.19958	1653.19958	1682.99951	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	31.496	16.861	0.000	31.496	16.861
2	-29	1	122	59.5999985	1712.79956	1712.79956	1742.59949	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	33.990	18.258	0.000	33.990	18.258
2	-30	1	122	59.5999985	1772.39954	1772.39954	1802.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	36.572	19.703	0.000	36.572	19.703
2	-31	1	122	59.5999985	1831.99951	1831.99951	1861.79944	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	39.240	21.197	0.000	39.240	21.197
2	-32	1	122	59.5999985	1891.59949	1891.59949	1921.39941	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	41.995	22.740	0.000	41.995	22.740
2	-33	1	122	59.5999985	1951.19946	1951.19946	1980.99939	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	44.836	24.331	0.000	44.836	24.331
2	-34	1	122	59.5999985	2010.79944	2010.79944	2040.59937	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	47.765	25.971	0.000	47.765	25.971
2	-35	1	122	59.5999985	2070.39941	2070.39941	2100.19946	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	50.780	27.660	0.000	50.780	27.660
2	-36	1	122	59.5999985	2129.99951	2129.99951	2159.79956	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	53.882	29.397	0.000	53.882	29.397
2	-37	1	122	59.5999985	2189.59961	2189.59961	2219.39966	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	57.071	31.183	0.000	57.071	31.183
2	-38	1	122	59.5999985	2249.19971	2249.19971	2278.99976	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	60.346	33.017	0.000	60.346	33.017
2	-39	1	122	59.5999985	2308.7998	2308.7998	2338.59985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	63.709	34.900	0.000	63.709	34.900
2	-40	1	122	59.5999985	2368.3999	2368.3999	2398.19995	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	67.158	36.831	0.000	67.158	36.831
2	-41	1	122	59.5999985	2428	2428	2457.80005	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	70.694	38.812	0.000	70.694	38.812
2	-42	1	122	59.5999985	2487.6001	2487.6001	2517.40015	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	74.317	40.840	0.000	74.317	40.840
2	-43	1	122	59.5999985	2547.2002	2547.2002	2577.00024	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	78.027	42.918	0.000	78.027	42.918
2	-44	1	122	59.5999985	2606.80029	2606.80029	2636.60034	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	81.823	45.044	0.000	81.823	45.044
2	-45	1	122	59.5999985	2666.40039	2666.40039	2696.20044	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	85.706	47.218	0.000	85.706	47.218
2	-46	1	122	59.5999985	2726.00049	2726.00049	2755.80054	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	89.676	49.442	0.000	89.676	49.442

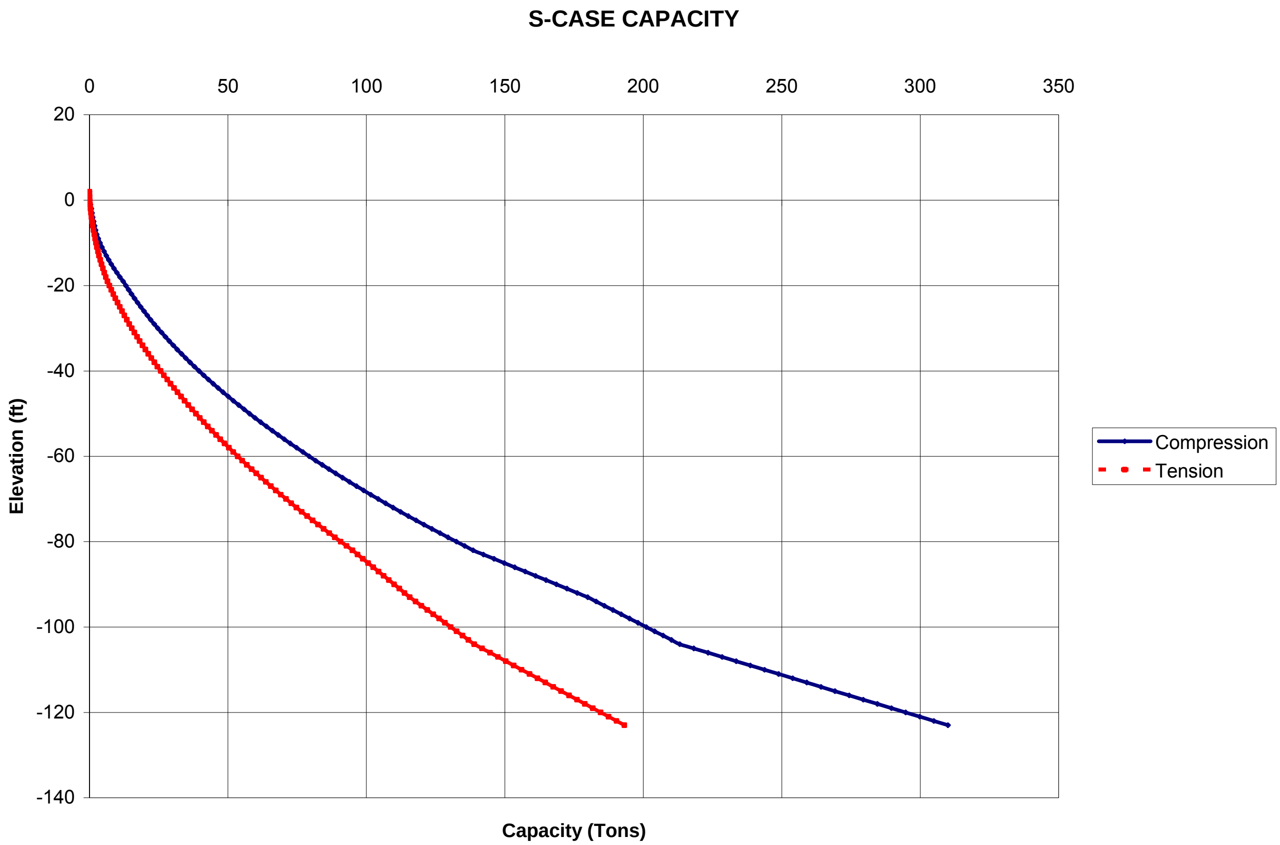
2	-47	1	122	59.5999985	2785.60059	2785.60059	2815.40063	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	93.733	51.713	0.000	93.733	51.713
2	-48	1	122	59.5999985	2845.20068	2845.20068	2875.00073	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	97.877	54.034	0.000	97.877	54.034
2	-49	1	122	59.5999985	2904.80078	2904.80078	2934.60083	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	102.107	56.403	0.000	102.107	56.403
2	-50	1	122	59.5999985	2964.40088	2964.40088	2994.20093	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	106.424	58.821	0.000	106.424	58.821
2	-51	1	122	59.5999985	3024.00098	3024.00098	3053.80103	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	110.829	61.287	0.000	110.829	61.287
2	-52	1	122	59.5999985	3083.60107	3083.60107	3113.40112	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	115.319	63.802	0.000	115.319	63.802
2	-53	1	122	59.5999985	3143.20117	3143.20117	3173.00122	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	119.897	66.365	0.000	119.897	66.365
2	-54	1	122	59.5999985	3202.80127	3202.80127	3232.60132	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	124.561	68.977	0.000	124.561	68.977
2	-55	1	122	59.5999985	3262.40137	3262.40137	3292.20142	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	129.313	71.638	0.000	129.313	71.638
2	-56	1	122	59.5999985	3322.00146	3322.00146	3351.80151	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	134.151	74.347	0.000	134.151	74.347
2	-57	1	122	59.5999985	3381.60156	3381.60156	3411.40161	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	139.075	77.105	0.000	139.075	77.105
2	-58	1	122	59.5999985	3441.20166	3441.20166	3471.00171	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	144.087	79.912	0.000	144.087	79.912
2	-59	1	122	59.5999985	3500.80176	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	149.184	82.766	0.000	149.184	82.766
2	-60	1	122	59.5999985	3560.40186	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	154.282	85.621	0.000	154.282	85.621
2	-61	1	122	59.5999985	3620.00195	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	159.379	88.475	0.000	159.379	88.475
3	-62	1	105	42.5999985	3671.10205	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	162.402	90.591	0.000	162.402	90.591
3	-63	1	105	42.5999985	3713.70215	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	165.424	92.707	0.000	165.424	92.707
3	-64	1	105	42.5999985	3756.30225	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	168.447	94.823	0.000	168.447	94.823
3	-65	1	105	42.5999985	3798.90234	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	171.469	96.938	0.000	171.469	96.938
3	-66	1	105	42.5999985	3841.50244	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	174.492	99.054	0.000	174.492	99.054
3	-67	1	105	42.5999985	3884.10254	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	177.515	101.170	0.000	177.515	101.170
3	-68	1	105	42.5999985	3926.70264	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	180.537	103.286	0.000	180.537	103.286
3	-69	1	105	42.5999985	3969.30273	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	183.560	105.402	0.000	183.560	105.402
3	-70	1	105	42.5999985	4011.90283	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	186.582	107.518	0.000	186.582	107.518
3	-71	1	105	42.5999985	4054.50293	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	189.605	109.633	0.000	189.605	109.633
3	-72	1	105	42.5999985	4097.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	192.628	111.749	0.000	192.628	111.749
3	-73	1	105	42.5999985	4139.70264	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	195.650	113.865	0.000	195.650	113.865
3	-74	1	105	42.5999985	4182.30273	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	198.673	115.981	0.000	198.673	115.981
3	-75	1	105	42.5999985	4224.90283	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	201.695	118.097	0.000	201.695	118.097
3	-76	1	105	42.5999985	4267.50293	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	204.718	120.213	0.000	204.718	120.213
3	-77	1	105	42.5999985	4310.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	207.741	122.328	0.000	207.741	122.328
3	-78	1	105	42.5999985	4352.70313	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	210.763	124.444	0.000	210.763	124.444
3	-79	1	105	42.5999985	4395.30322	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	213.786	126.560	0.000	213.786	126.560
3	-80	1	105	42.5999985	4437.90332	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	216.809	128.676	0.000	216.809	128.676
3	-81	1	105	42.5999985	4480.50342	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	219.831	130.792	0.000	219.831	130.792
3	-82	1	105	42.5999985	4523.10352	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	222.854	132.908	0.000	222.854	132.908
3	-83	1	105	42.5999985	4565.70361	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	225.876	135.023	0.000	225.876	135.023
3	-84	1	105	42.5999985	4608.30371	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	228.899	137.139	0.000	228.899	137.139
3	-85	1	105	42.5999985	4650.90381	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	231.922	139.255	0.000	231.922	139.255
3	-86	1	105	42.5999985	4693.50391	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	234.944	141.371	0.000	234.944	141.371
3	-87	1	105	42.5999985	4736.104	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	237.967	143.487	0.000	237.967	143.487
3	-88	1	105	42.5999985	4778.7041	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	240.989	145.602	0.000	240.989	145.602
3	-89	1	105	42.5999985	4821.3042	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	244.012	147.718	0.000	244.012	147.718
3	-90	1	105	42.5999985	4863.9043	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	247.035	149.834	0.000	247.035	149.834
4	-91	1	117	54.5999985	4912.50439	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	250.800	151.717	0.000	250.800	151.717
4	-92	1	117	54.5999985	4967.10449	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	254.565	153.599	0.000	254.565	153.599
4	-93	1	117	54.5999985	5021.70459	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	258.331	155.482	0.000	258.331	155.482
4	-94	1	117	54.5999985	5076.30469	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	262.096	157.365	0.000	262.096	157.365
4	-95	1	117	54.5999985	5130.90479	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	265.861	159.247	0.000	265.861	159.247
4	-96	1	117	54.5999985	5185.50488	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	269.626	161.130	0.000	269.626	161.130
4	-97	1	117	54.5999985	5240.10498	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	273.392	163.013	0.000	273.392	163.013
4	-98	1	117	54.5999985	5294.70508	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	277.157	164.895	0.000	277.157	164.895
4	-99	1	117	54.5999985	5349.30518	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	280.922	166.778	0.000	280.922	166.778
4	-100	1	117	54.5999985	5403.90527	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	284.688	168.661	0.000	284.688	168.661
4	-101	1	117	54.5999985	5458.50537	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	288.453	170.543	0.000	288.453	170.543

875

4	-102	1	117	54.5999985	5513.10547	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	292.218	172.426	0.000	292.218	172.426
4	-103	1	117	54.5999985	5567.70557	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	295.983	174.309	0.000	295.983	174.309
4	-104	1	117	54.5999985	5622.30566	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	299.749	176.191	0.000	299.749	176.191
4	-105	1	117	54.5999985	5676.90576	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	303.514	178.074	0.000	303.514	178.074
4	-106	1	117	54.5999985	5731.50586	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	307.279	179.956	0.000	307.279	179.956
4	-107	1	117	54.5999985	5786.10596	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	311.045	181.839	0.000	311.045	181.839
4	-108	1	117	54.5999985	5840.70605	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	314.810	183.722	0.000	314.810	183.722
4	-109	1	117	54.5999985	5895.30615	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	318.575	185.604	0.000	318.575	185.604
4	-110	1	117	54.5999985	5949.90625	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	322.340	187.487	0.000	322.340	187.487
4	-111	1	117	54.5999985	6004.50635	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	326.106	189.370	0.000	326.106	189.370
4	-112	1	117	54.5999985	6059.10645	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	329.871	191.252	0.000	329.871	191.252
4	-113	1	117	54.5999985	6113.70654	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	333.636	193.135	0.000	333.636	193.135
4	-114	1	117	54.5999985	6168.30664	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	337.402	195.018	0.000	337.402	195.018
4	-115	1	117	54.5999985	6222.90674	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	341.167	196.900	0.000	341.167	196.900
4	-116	1	117	54.5999985	6277.50684	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	344.932	198.783	0.000	344.932	198.783
4	-117	1	117	54.5999985	6332.10693	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	348.698	200.666	0.000	348.698	200.666
4	-118	1	117	54.5999985	6386.70703	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	352.463	202.548	0.000	352.463	202.548
4	-119	1	117	54.5999985	6441.30713	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	356.228	204.431	0.000	356.228	204.431
4	-120	1	117	54.5999985	6495.90723	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	359.993	206.313	0.000	359.993	206.313
4	-121	1	117	54.5999985	6550.50732	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	363.759	208.196	0.000	363.759	208.196
4	-122	1	117	54.5999985	6605.10742	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	367.524	210.079	0.000	367.524	210.079
4	-123	1	117	54.5999985	6659.70752	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	371.289	211.961	0.000	371.289	211.961
4	-124	1	117	54.5999985	6714.30762	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	375.055	213.844	0.000	375.055	213.844
4	-125	1	117	54.5999985	6768.90771	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	378.820	215.727	0.000	378.820	215.727
4	-126	1	117	54.5999985	6823.50781	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	382.585	217.609	0.000	382.585	217.609
4	-127	1	117	54.5999985	6878.10791	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	386.350	219.492	0.000	386.350	219.492
4	-128	1	117	54.5999985	6932.70801	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	390.116	221.375	0.000	390.116	221.375

Boring
R-60.3-LU
HP14x73 Steel Pile Capacities


Q-CASE CAPACITY
0
50
100
150
200
250
300
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension


S-CASE CAPACITY
0
50
100
150
200
250
300
350
20
0
-20
-40
-60
-80
-100
-120
-140
Elevation (ft)
Capacity (Tons)
Compression
Tension

Boring R-60.3-UL_HP14x73 Steel Pile_Q-Case

								Q-CASE														
Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	122	59.5999985	0	0	0	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	122	59.5999985	29.7999992	29.7999992	59.5999985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.043	0.024	0.000	0.043	0.024
1	0	1	122	59.5999985	89.3999939	89.3999939	119.199997	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.174	0.097	0.000	0.174	0.097
1	-1	1	122	59.5999985	149	149	178.799988	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.391	0.219	0.000	0.391	0.219
1	-2	1	122	59.5999985	208.599991	208.599991	238.399994	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.694	0.389	0.000	0.694	0.389
2	-3	1	107	44.5999985	260.699982	260.699982	283	550	536.25	0	0	1.00	1.00	1.00	9.00	No	1.276	0.694	0.389	0.000	1.971	1.665
2	-4	1	107	44.5999985	305.299988	305.299988	327.600006	550	536.25	0	0	1.00	1.00	1.00	9.00	No	2.553	0.694	0.389	0.000	3.247	2.942
2	-5	1	107	44.5999985	349.899994	349.899994	372.200012	550	536.25	0	0	1.00	1.00	1.00	9.00	No	3.829	0.694	0.389	0.000	4.523	4.218
2	-6	1	107	44.5999985	394.5	394.5	416.800018	550	536.25	0	0	1.00	1.00	1.00	9.00	No	5.105	0.694	0.389	0.000	5.800	5.494
2	-7	1	107	44.5999985	439.100006	439.100006	461.400024	550	536.25	0	0	1.00	1.00	1.00	9.00	No	6.382	0.694	0.389	0.000	7.076	6.771
2	-8	1	107	44.5999985	483.700012	483.700012	506.000031	550	536.25	0	0	1.00	1.00	1.00	9.00	No	7.658	0.694	0.389	0.000	8.352	8.047
3	-9	1	117	54.5999985	533.300049	533.300049	560.600037	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.128	0.987	0.535	0.000	9.115	8.663
3	-10	1	117	54.5999985	587.900024	587.900024	615.200012	200	200	15	11.25	1.00	0.50	4.40	12.90	No	8.598	1.309	0.696	0.000	9.908	9.294
3	-11	1	117	54.5999985	642.5	642.5	669.799988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.068	1.662	0.873	0.000	10.730	9.941
3	-12	1	117	54.5999985	697.099976	697.099976	724.399963	200	200	15	11.25	1.00	0.50	4.40	12.90	No	9.538	2.044	1.064	0.000	11.582	10.602
3	-13	1	117	54.5999985	751.699951	751.699951	778.999939	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.008	2.457	1.270	0.000	12.465	11.278
3	-14	1	117	54.5999985	806.299927	806.299927	833.599915	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.478	2.899	1.491	0.000	13.377	11.969
3	-15	1	117	54.5999985	860.899902	860.899902	888.19989	200	200	15	11.25	1.00	0.50	4.40	12.90	No	10.948	3.371	1.727	0.000	14.319	12.675
3	-16	1	117	54.5999985	915.499878	915.499878	942.799866	200	200	15	11.25	1.00	0.50	4.40	12.90	No	11.418	3.873	1.978	0.000	15.291	13.396
3	-17	1	117	54.5999985	970.099854	970.099854	997.399841	200	200	15	11.25	1.00	0.50	4.40	12.90	No	11.888	4.406	2.244	0.000	16.294	14.133
3	-18	1	117	54.5999985	1024.69983	1024.69983	1051.99988	200	200	15	11.25	1.00	0.50	4.40	12.90	No	12.358	4.968	2.526	0.000	17.326	14.884
3	-19	1	117	54.5999985	1079.29993	1079.29993	1106.59985	200	200	15	11.25	1.00	0.50	4.40	12.90	No	12.828	5.560	2.822	0.000	18.388	15.650
4	-20	1	101	38.5999985	1125.8999	1125.8999	1145.19983	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	14.533	5.560	2.822	0.000	20.093	17.354
4	-21	1	101	38.5999985	1164.49988	1164.49988	1183.7998	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	16.237	5.560	2.822	0.000	21.797	19.059
4	-22	1	101	38.5999985	1203.09985	1203.09985	1222.39978	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	17.942	5.560	2.822	0.000	23.502	20.764
4	-23	1	101	38.5999985	1241.69983	1241.69983	1260.99976	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	19.647	5.560	2.822	0.000	25.207	22.468
4	-24	1	101	38.5999985	1280.2998	1280.2998	1299.59973	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	21.352	5.560	2.822	0.000	26.911	24.173
4	-25	1	101	38.5999985	1318.89978	1318.89978	1338.19971	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	23.056	5.560	2.822	0.000	28.616	25.878
4	-26	1	101	38.5999985	1357.49976	1357.49976	1376.79968	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	24.761	5.560	2.822	0.000	30.321	27.582
4	-27	1	101	38.5999985	1396.09973	1396.09973	1415.39966	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	26.466	5.560	2.822	0.000	32.025	29.287
4	-28	1	101	38.5999985	1434.69971	1434.69971	1453.99963	780	670.799988	0	0	1.00	1.00	1.00	9.00	No	28.170	5.560	2.822	0.000	33.730	30.992
5	-29	1	101	38.5999985	1473.29968	1473.29968	1492.59961	512.962952	504.819092	0	0	1.00	1.00	1.00	9.00	No	29.359	5.560	2.822	0.000	34.918	32.180
5	-30	1	101	38.5999985	1511.89966	1511.89966	1531.19958	525.925903	514.373291	0	0	1.00	1.00	1.00	9.00	No	30.573	5.560	2.822	0.000	36.133	33.395
5	-31	1	101	38.5999985	1550.49963	1550.49963	1569.79956	538.888916	523.759399	0	0	1.00	1.00	1.00	9.00	No	31.814	5.560	2.822	0.000	37.374	34.636
5	-32	1	101	38.5999985	1589.09961	1589.09961	1608.39954	551.851868	532.977539	0	0	1.00	1.00	1.00	9.00	No	33.081	5.560	2.822	0.000	38.641	35.903
5	-33	1	101	38.5999985	1627.69958	1627.69958	1646.99951	564.814819	542.027588	0	0	1.00	1.00	1.00	9.00	No	34.374	5.560	2.822	0.000	39.934	37.196
5	-34	1	101	38.5999985	1666.29956	1666.29956	1685.59949	577.777771	550.909668	0	0	1.00	1.00	1.00	9.00	No	35.693	5.560	2.822	0.000	41.253	38.514
5	-35	1	101	38.5999985	1704.89954	1704.89954	1724.19946	590.740723	559.623657	0	0	1.00	1.00	1.00	9.00	No	37.037	5.560	2.822	0.000	42.597	39.858
5	-36	1	101	38.5999985	1743.49951	1743.49951	1762.79944	603.703674	568.169556	0	0	1.00	1.00	1.00	9.00	No	38.406	5.560	2.822	0.000	43.966	41.228
5	-37	1	101	38.5999985	1782.09949	1782.09949	1801.39941	616.666687	576.547485	0	0	1.00	1.00	1.00	9.00	No	39.801	5.560	2.822	0.000	45.360	42.622
5	-38	1	101	38.5999985	1820.69946	1820.69946	1839.99939	629.629639	584.757385	0	0	1.00	1.00	1.00	9.00	No	41.220	5.560	2.822	0.000	46.780	44.041
5	-39	1	101	38.5999985	1859.29944	1859.29944	1878.59937	642.59259	592.799194	0	0	1.00	1.00	1.00	9.00	No	42.664	5.560	2.822	0.000	48.224	45.485
5	-40	1	101	38.5999985	1897.89941	1897.89941	1917.19934	655.555542	600.672974	0	0	1.00	1.00	1.00	9.00	No	44.132	5.560	2.822	0.000	49.692	46.954
5	-41	1	101	38.5999985	1936.49939	1936.49939	1955.79932	668.518494	608.378784	0	0	1.00	1.00	1.00	9.00	No	45.625	5.560	2.822	0.000	51.185	48.447
5	-42	1	101	38.5999985	1975.09937	1975.09937	1994.39929	681.481506	615.916504	0	0	1.00	1.00	1.00	9.00	No	47.142	5.560	2.822	0.000	52.702	49.963
5	-43	1	101	38.5999985	2013.69934	2013.69934	2032.99927	694.444458	623.286194	0	0	1.00	1.00	1.00	9.00	No	48.683	5.560	2.822	0.000	54.242	51.504
5	-44	1	101	38.5999985	2052.29932	2052.29932	2071.59937	707.40741	630.487793	0	0	1.00	1.00	1.00	9.00	No	50.247	5.560	2.822	0.000	55.807	53.069
5	-45	1	101	38.5999985	2090.89941	2090.89941	2110.19946	720.370361	637.521423	0	0	1.00	1.00	1.00	9.00	No	51.835	5.560	2.822	0.000	57.395	54.657
5	-46	1	101	38.5999985	2129.49951	2129.49951	2148.79956	733.333313	644.386963	0	0	1.00	1.00	1.00	9.00	No	53.446	5.560	2.822	0.000	59.006	56.268

5	-47	1	101	38.5999985	2168.09961	2168.09961	2187.39966	746.296326	651.084534	0	0	1.00	1.00	1.00	9.00	No	55.080	5.560	2.822	0.000	60.640	57.902
5	-48	1	101	38.5999985	2206.69971	2206.69971	2225.99976	759.259277	657.614014	0	0	1.00	1.00	1.00	9.00	No	56.738	5.560	2.822	0.000	62.297	59.559
5	-49	1	101	38.5999985	2245.2998	2245.2998	2264.59985	772.222229	663.975464	0	0	1.00	1.00	1.00	9.00	No	58.418	5.560	2.822	0.000	63.977	61.239
5	-50	1	101	38.5999985	2283.8999	2283.8999	2303.19995	785.185181	670.168884	0	0	1.00	1.00	1.00	9.00	No	60.120	5.560	2.822	0.000	65.680	62.942
5	-51	1	101	38.5999985	2322.5	2322.5	2341.80005	798.148132	676.194214	0	0	1.00	1.00	1.00	9.00	No	61.845	5.560	2.822	0.000	67.405	64.666
5	-52	1	101	38.5999985	2361.1001	2361.1001	2380.40015	811.111084	682.051575	0	0	1.00	1.00	1.00	9.00	No	63.592	5.560	2.822	0.000	69.151	66.413
5	-53	1	101	38.5999985	2399.7002	2399.7002	2419.00024	824.074097	687.740906	0	0	1.00	1.00	1.00	9.00	No	65.360	5.560	2.822	0.000	70.920	68.182
5	-54	1	101	38.5999985	2438.30029	2438.30029	2457.60034	837.037048	693.262207	0	0	1.00	1.00	1.00	9.00	No	67.151	5.560	2.822	0.000	72.711	69.972
5	-55	1	101	38.5999985	2476.90039	2476.90039	2496.20044	850	698.615356	0	0	1.00	1.00	1.00	9.00	No	68.963	5.560	2.822	0.000	74.523	71.784
5	-56	1	101	38.5999985	2515.50049	2515.50049	2534.80054	862.962952	703.800537	0	0	1.00	1.00	1.00	9.00	No	70.796	5.560	2.822	0.000	76.356	73.618
5	-57	1	101	38.5999985	2554.10059	2554.10059	2573.40063	875.925903	708.817749	0	0	1.00	1.00	1.00	9.00	No	72.651	5.560	2.822	0.000	78.210	75.472
5	-58	1	101	38.5999985	2592.70068	2592.70068	2612.00073	888.888916	713.66687	0	0	1.00	1.00	1.00	9.00	No	74.526	5.560	2.822	0.000	80.086	77.348
5	-59	1	101	38.5999985	2631.30078	2631.30078	2650.60083	901.851868	718.3479	0	0	1.00	1.00	1.00	9.00	No	76.422	5.560	2.822	0.000	81.982	79.244
5	-60	1	101	38.5999985	2669.90088	2669.90088	2689.20093	914.814819	722.860962	0	0	1.00	1.00	1.00	9.00	No	78.339	5.560	2.822	0.000	83.899	81.160
5	-61	1	101	38.5999985	2708.50098	2708.50098	2727.80103	927.777771	727.205933	0	0	1.00	1.00	1.00	9.00	No	80.276	5.560	2.822	0.000	85.836	83.097
5	-62	1	101	38.5999985	2747.10107	2747.10107	2766.40112	940.740723	731.382874	0	0	1.00	1.00	1.00	9.00	No	82.233	5.560	2.822	0.000	87.793	85.054
5	-63	1	101	38.5999985	2785.70117	2785.70117	2805.00122	953.703674	735.391785	0	0	1.00	1.00	1.00	9.00	No	84.210	5.560	2.822	0.000	89.770	87.032
5	-64	1	101	38.5999985	2824.30127	2824.30127	2843.60132	966.666687	739.232666	0	0	1.00	1.00	1.00	9.00	No	86.207	5.560	2.822	0.000	91.767	89.028
5	-65	1	101	38.5999985	2862.90137	2862.90137	2882.20142	979.629639	742.905518	0	0	1.00	1.00	1.00	9.00	No	88.223	5.560	2.822	0.000	93.783	91.045
5	-66	1	101	38.5999985	2901.50146	2901.50146	2920.80151	992.59259	746.410339	0	0	1.00	1.00	1.00	9.00	No	90.259	5.560	2.822	0.000	95.819	93.080
5	-67	1	101	38.5999985	2940.10156	2940.10156	2959.40161	1005.55554	749.74707	0	0	1.00	1.00	1.00	9.00	No	92.314	5.560	2.822	0.000	97.874	95.135
5	-68	1	101	38.5999985	2978.70166	2978.70166	2998.00171	1018.51849	752.915771	0	0	1.00	1.00	1.00	9.00	No	94.388	5.560	2.822	0.000	99.947	97.209
5	-69	1	101	38.5999985	3017.30176	3017.30176	3036.60181	1031.48145	755.916504	0	0	1.00	1.00	1.00	9.00	No	96.480	5.560	2.822	0.000	102.040	99.302
5	-70	1	101	38.5999985	3055.90186	3055.90186	3075.2019	1044.44446	758.749146	0	0	1.00	1.00	1.00	9.00	No	98.591	5.560	2.822	0.000	104.151	101.413
5	-71	1	101	38.5999985	3094.50195	3094.50195	3113.802	1057.40735	761.413757	0	0	1.00	1.00	1.00	9.00	No	100.721	5.560	2.822	0.000	106.281	103.542
5	-72	1	101	38.5999985	3133.10205	3133.10205	3152.4021	1070.37036	763.910278	0	0	1.00	1.00	1.00	9.00	No	102.868	5.560	2.822	0.000	108.428	105.690
5	-73	1	101	38.5999985	3171.70215	3171.70215	3191.0022	1083.33337	766.238892	0	0	1.00	1.00	1.00	9.00	No	105.034	5.560	2.822	0.000	110.594	107.856
5	-74	1	101	38.5999985	3210.30225	3210.30225	3229.60229	1096.29626	768.399353	0	0	1.00	1.00	1.00	9.00	No	107.218	5.560	2.822	0.000	112.777	110.039
5	-75	1	101	38.5999985	3248.90234	3248.90234	3268.20239	1109.25928	770.391785	0	0	1.00	1.00	1.00	9.00	No	109.418	5.560	2.822	0.000	114.978	112.240
5	-76	1	101	38.5999985	3287.50244	3287.50244	3306.80249	1122.22217	772.216187	0	0	1.00	1.00	1.00	9.00	No	111.637	5.560	2.822	0.000	117.197	114.458
5	-77	1	101	38.5999985	3326.10254	3326.10254	3345.40259	1135.18518	773.872559	0	0	1.00	1.00	1.00	9.00	No	113.872	5.560	2.822	0.000	119.432	116.694
5	-78	1	101	38.5999985	3364.70264	3364.70264	3384.00269	1148.14819	775.360962	0	0	1.00	1.00	1.00	9.00	No	116.125	5.560	2.822	0.000	121.685	118.946
5	-79	1	101	38.5999985	3403.30273	3403.30273	3422.60278	1161.11108	776.681274	0	0	1.00	1.00	1.00	9.00	No	118.394	5.560	2.822	0.000	123.954	121.216
5	-80	1	101	38.5999985	3441.90283	3441.90283	3461.20288	1174.0741	777.833496	0	0	1.00	1.00	1.00	9.00	No	120.680	5.560	2.822	0.000	126.240	123.502
5	-81	1	101	38.5999985	3480.50293	3480.50293	3499.80298	1187.03699	778.817749	0	0	1.00	1.00	1.00	9.00	No	122.982	5.560	2.822	0.000	128.542	125.804
5	-82	1	101	38.5999985	3519.10303	3500	3500	1200	779.633911	0	0	1.00	1.00	1.00	9.00	No	125.301	5.560	2.822	0.000	130.861	128.122
6	-83	1	117	54.5999985	3565.70313	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	125.771	7.480	3.782	0.000	133.250	129.552
6	-84	1	117	54.5999985	3620.30322	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	126.241	9.400	4.742	0.000	135.640	130.982
6	-85	1	117	54.5999985	3674.90332	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	126.711	11.320	5.701	0.000	138.030	132.412
6	-86	1	117	54.5999985	3729.50342	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	127.181	13.240	6.661	0.000	140.420	133.842
6	-87	1	117	54.5999985	3784.10352	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	127.651	15.160	7.621	0.000	142.810	135.272
6	-88	1	117	54.5999985	3838.70361	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	128.121	17.080	8.581	0.000	145.200	136.702
6	-89	1	117	54.5999985	3893.30371	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	128.591	19.000	9.541	0.000	147.590	138.132
6	-90	1	117	54.5999985	3947.90381	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	129.061	20.919	10.501	0.000	149.980	139.562
6	-91	1	117	54.5999985	4002.50391	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	129.531	22.839	11.461	0.000	152.370	140.992
6	-92	1	117	54.5999985	4057.104	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	130.001	24.759	12.421	0.000	154.760	142.422
6	-93	1	117	54.5999985	4111.7041	3500	3500	200	200	15	11.25	1.00	0.50	4.40	12.90	No	130.471	26.679	13.381	0.000	157.150	143.852
7	-94	1	115	52.5999985	4165.30371	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	132.374	26.679	13.381	0.000	159.054	145.756
7	-95	1	115	52.5999985	4217.90381	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	134.278	26.679	13.381	0.000	160.957	147.659
7	-96	1	115	52.5999985	4270.50391	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	136.181	26.679	13.381	0.000	162.861	149.563
7	-97	1	115	52.5999985	4323.104	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	138.085	26.679	13.381	0.000	164.764	151.466
7	-98	1	115	52.5999985	4375.7041	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	139.988	26.679	13.381	0.000	166.668	153.370
7	-99	1	115	52.5999985	4428.3042	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	141.892	26.679	13.381	0.000	168.571	155.273
7	-100	1	115	52.5999985	4480.9043	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	143.795	26.679	13.381	0.000	170.475	157.177
7	-101	1	115	52.5999985	4533.50439	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	145.699	26.679	13.381	0.000	172.378	159.080

7	-102	1	115	52.5999985	4586.10449	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	147.602	26.679	13.381	0.000	174.282	160.984
7	-103	1	115	52.5999985	4638.70459	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	149.506	26.679	13.381	0.000	176.185	162.887
7	-104	1	115	52.5999985	4691.30469	3500	3500	900	720	0	0	1.00	1.00	1.00	9.00	No	151.409	26.679	13.381	0.000	178.089	164.791
8	-105	1	122	59.5999985	4747.40479	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	31.777	16.236	0.000	183.186	167.645
8	-106	1	122	59.5999985	4807.00488	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	36.874	19.090	0.000	188.283	170.500
8	-107	1	122	59.5999985	4866.60498	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	41.971	21.945	0.000	193.380	173.354
8	-108	1	122	59.5999985	4926.20508	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	47.068	24.799	0.000	198.478	176.208
8	-109	1	122	59.5999985	4985.80518	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	52.166	27.654	0.000	203.575	179.063
8	-110	1	122	59.5999985	5045.40527	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	57.263	30.508	0.000	208.672	181.917
8	-111	1	122	59.5999985	5105.00537	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	62.360	33.363	0.000	213.770	184.772
8	-112	1	122	59.5999985	5164.60547	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	67.457	36.217	0.000	218.867	187.626
8	-113	1	122	59.5999985	5224.20557	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	72.555	39.072	0.000	223.964	190.481
8	-114	1	122	59.5999985	5283.80566	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	77.652	41.926	0.000	229.061	193.335
8	-115	1	122	59.5999985	5343.40576	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	82.749	44.780	0.000	234.159	196.190
8	-116	1	122	59.5999985	5403.00586	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	87.847	47.635	0.000	239.256	199.044
8	-117	1	122	59.5999985	5462.60596	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	92.944	50.489	0.000	244.353	201.899
8	-118	1	122	59.5999985	5522.20605	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	98.041	53.344	0.000	249.450	204.753
8	-119	1	122	59.5999985	5581.80615	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	103.138	56.198	0.000	254.548	207.608
8	-120	1	122	59.5999985	5641.40625	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	108.236	59.053	0.000	259.645	210.462
8	-121	1	122	59.5999985	5701.00635	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	113.333	61.907	0.000	264.742	213.316
8	-122	1	122	59.5999985	5760.60645	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	118.430	64.762	0.000	269.839	216.171
8	-123	1	122	59.5999985	5820.20654	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	151.409	123.527	67.616	0.000	274.937	219.025

900

Boring R-60.3-UL_HP14x73 Steel Pile_S-Case

Stratum	Tip	Increment	$\gamma_{(moist)}$	$\gamma_{(sub)}$	γh	Mid-layer γh (used)	Bottom γh (used)	S-CASE Cohesion	Mid-Layer Adhesion	ϕ	δ	Kc	Kt	Nq	Nc	End Bearing	Coh./Adh Resistance	Friction Compression	Friction Tension	End Bearing	Pile Capacity Compression	Pile Capacity Tension
1	2	0	122	59.5999985	0	0	0	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.000	0.000	0.000	0.000	0.000
1	1	1	122	59.5999985	29.7999992	29.7999992	59.5999985	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.043	0.024	0.000	0.043	0.024
1	0	1	122	59.5999985	89.3999939	89.3999939	119.199997	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.174	0.097	0.000	0.174	0.097
1	-1	1	122	59.5999985	149	149	178.799988	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.391	0.219	0.000	0.391	0.219
1	-2	1	122	59.5999985	208.599991	208.599991	238.399994	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	0.694	0.389	0.000	0.694	0.389
2	-3	1	107	44.5999985	260.699982	260.699982	283	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	0.920	0.546	0.000	0.920	0.546
2	-4	1	107	44.5999985	305.299988	305.299988	327.600006	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.183	0.731	0.000	1.183	0.731
2	-5	1	107	44.5999985	349.899994	349.899994	372.200012	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.485	0.943	0.000	1.485	0.943
2	-6	1	107	44.5999985	394.5	394.5	416.800018	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	1.826	1.181	0.000	1.826	1.181
2	-7	1	107	44.5999985	439.100006	439.100006	461.400024	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	2.205	1.446	0.000	2.205	1.446
2	-8	1	107	44.5999985	483.700012	483.700012	506.000031	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	2.623	1.739	0.000	2.623	1.739
3	-9	1	117	54.5999985	533.300049	533.300049	560.600037	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.197	2.026	0.000	3.197	2.026
3	-10	1	117	54.5999985	587.900024	587.900024	615.200012	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	3.829	2.342	0.000	3.829	2.342
3	-11	1	117	54.5999985	642.5	642.5	669.799988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	4.520	2.688	0.000	4.520	2.688
3	-12	1	117	54.5999985	697.099976	697.099976	724.399963	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	5.270	3.063	0.000	5.270	3.063
3	-13	1	117	54.5999985	751.699951	751.699951	778.999939	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.079	3.467	0.000	6.079	3.467
3	-14	1	117	54.5999985	806.299927	806.299927	833.599915	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	6.946	3.901	0.000	6.946	3.901
3	-15	1	117	54.5999985	860.899902	860.899902	888.19989	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	7.873	4.364	0.000	7.873	4.364
3	-16	1	117	54.5999985	915.499878	915.499878	942.799866	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	8.857	4.856	0.000	8.857	4.856
3	-17	1	117	54.5999985	970.099854	970.099854	997.399841	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	9.901	5.378	0.000	9.901	5.378
3	-18	1	117	54.5999985	1024.69983	1024.69983	1051.99988	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	11.003	5.929	0.000	11.003	5.929
3	-19	1	117	54.5999985	1079.29993	1079.29993	1106.59985	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	12.165	6.510	0.000	12.165	6.510
4	-20	1	101	38.5999985	1125.8999	1125.8999	1145.19983	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	13.137	7.190	0.000	13.137	7.190
4	-21	1	101	38.5999985	1164.49988	1164.49988	1183.7998	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	14.143	7.894	0.000	14.143	7.894
4	-22	1	101	38.5999985	1203.09985	1203.09985	1222.39978	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	15.182	8.622	0.000	15.182	8.622
4	-23	1	101	38.5999985	1241.69983	1241.69983	1260.99976	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	16.254	9.372	0.000	16.254	9.372
4	-24	1	101	38.5999985	1280.2998	1280.2998	1299.59973	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	17.360	10.146	0.000	17.360	10.146
4	-25	1	101	38.5999985	1318.89978	1318.89978	1338.19971	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	18.499	10.943	0.000	18.499	10.943
4	-26	1	101	38.5999985	1357.49976	1357.49976	1376.79968	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	19.671	11.764	0.000	19.671	11.764
4	-27	1	101	38.5999985	1396.09973	1396.09973	1415.39966	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	20.877	12.608	0.000	20.877	12.608
4	-28	1	101	38.5999985	1434.69971	1434.69971	1453.99963	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	22.116	13.475	0.000	22.116	13.475
5	-29	1	101	38.5999985	1473.29968	1473.29968	1492.59961	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	23.388	14.366	0.000	23.388	14.366
5	-30	1	101	38.5999985	1511.89966	1511.89966	1531.19958	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	24.694	15.280	0.000	24.694	15.280
5	-31	1	101	38.5999985	1550.49963	1550.49963	1569.79956	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	26.033	16.217	0.000	26.033	16.217
5	-32	1	101	38.5999985	1589.09961	1589.09961	1608.39954	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	27.405	17.178	0.000	27.405	17.178
5	-33	1	101	38.5999985	1627.69958	1627.69958	1646.99951	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	28.811	18.162	0.000	28.811	18.162
5	-34	1	101	38.5999985	1666.29956	1666.29956	1685.59949	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	30.250	19.169	0.000	30.250	19.169
5	-35	1	101	38.5999985	1704.89954	1704.89954	1724.19946	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	31.722	20.200	0.000	31.722	20.200
5	-36	1	101	38.5999985	1743.49951	1743.49951	1762.79944	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	33.228	21.254	0.000	33.228	21.254
5	-37	1	101	38.5999985	1782.09949	1782.09949	1801.39941	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	34.767	22.331	0.000	34.767	22.331
5	-38	1	101	38.5999985	1820.69946	1820.69946	1839.99939	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	36.339	23.432	0.000	36.339	23.432
5	-39	1	101	38.5999985	1859.29944	1859.29944	1878.59937	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	37.945	24.556	0.000	37.945	24.556
5	-40	1	101	38.5999985	1897.89941	1897.89941	1917.19934	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	39.584	25.703	0.000	39.584	25.703
5	-41	1	101	38.5999985	1936.49939	1936.49939	1955.79932	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	41.256	26.874	0.000	41.256	26.874
5	-42	1	101	38.5999985	1975.09937	1975.09937	1994.39929	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	42.962	28.068	0.000	42.962	28.068
5	-43	1	101	38.5999985	2013.69934	2013.69934	2032.99927	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	44.701	29.285	0.000	44.701	29.285
5	-44	1	101	38.5999985	2052.29932	2052.29932	2071.59937	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	46.473	30.526	0.000	46.473	30.526
5	-45	1	101	38.5999985	2090.89941	2090.89941	2110.19946	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	48.279	31.790	0.000	48.279	31.790
5	-46	1	101	38.5999985	2129.49951	2129.49951	2148.79956	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	50.118	33.077	0.000	50.118	33.077

5	-47	1	101	38.5999985	2168.09961	2168.09961	2187.39966	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	51.991	34.388	0.000	51.991	34.388
5	-48	1	101	38.5999985	2206.69971	2206.69971	2225.99976	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	53.896	35.722	0.000	53.896	35.722
5	-49	1	101	38.5999985	2245.2998	2245.2998	2264.59985	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	55.835	37.079	0.000	55.835	37.079
5	-50	1	101	38.5999985	2283.8999	2283.8999	2303.19995	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	57.808	38.460	0.000	57.808	38.460
5	-51	1	101	38.5999985	2322.5	2322.5	2341.80005	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	59.813	39.864	0.000	59.813	39.864
5	-52	1	101	38.5999985	2361.1001	2361.1001	2380.40015	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	61.853	41.291	0.000	61.853	41.291
5	-53	1	101	38.5999985	2399.7002	2399.7002	2419.00024	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	63.925	42.742	0.000	63.925	42.742
5	-54	1	101	38.5999985	2438.30029	2438.30029	2457.60034	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	66.031	44.216	0.000	66.031	44.216
5	-55	1	101	38.5999985	2476.90039	2476.90039	2496.20044	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	68.170	45.713	0.000	68.170	45.713
5	-56	1	101	38.5999985	2515.50049	2515.50049	2534.80054	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	70.342	47.234	0.000	70.342	47.234
5	-57	1	101	38.5999985	2554.10059	2554.10059	2573.40063	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	72.548	48.778	0.000	72.548	48.778
5	-58	1	101	38.5999985	2592.70068	2592.70068	2612.00073	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	74.787	50.345	0.000	74.787	50.345
5	-59	1	101	38.5999985	2631.30078	2631.30078	2650.60083	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	77.059	51.936	0.000	77.059	51.936
5	-60	1	101	38.5999985	2669.90088	2669.90088	2689.20093	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	79.365	53.550	0.000	79.365	53.550
5	-61	1	101	38.5999985	2708.50098	2708.50098	2727.80103	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	81.704	55.187	0.000	81.704	55.187
5	-62	1	101	38.5999985	2747.10107	2747.10107	2766.40112	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	84.077	56.848	0.000	84.077	56.848
5	-63	1	101	38.5999985	2785.70117	2785.70117	2805.00122	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	86.482	58.532	0.000	86.482	58.532
5	-64	1	101	38.5999985	2824.30127	2824.30127	2843.60132	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	88.921	60.239	0.000	88.921	60.239
5	-65	1	101	38.5999985	2862.90137	2862.90137	2882.20142	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	91.394	61.970	0.000	91.394	61.970
5	-66	1	101	38.5999985	2901.50146	2901.50146	2920.80151	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	93.900	63.724	0.000	93.900	63.724
5	-67	1	101	38.5999985	2940.10156	2940.10156	2959.40161	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	96.439	65.502	0.000	96.439	65.502
5	-68	1	101	38.5999985	2978.70166	2978.70166	2998.00171	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	99.011	67.302	0.000	99.011	67.302
5	-69	1	101	38.5999985	3017.30176	3017.30176	3036.60181	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	101.617	69.126	0.000	101.617	69.126
5	-70	1	101	38.5999985	3055.90186	3055.90186	3075.2019	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	104.256	70.974	0.000	104.256	70.974
5	-71	1	101	38.5999985	3094.50195	3094.50195	3113.802	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	106.928	72.844	0.000	106.928	72.844
5	-72	1	101	38.5999985	3133.10205	3133.10205	3152.4021	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	109.634	74.738	0.000	109.634	74.738
5	-73	1	101	38.5999985	3171.70215	3171.70215	3191.0022	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	112.373	76.656	0.000	112.373	76.656
5	-74	1	101	38.5999985	3210.30225	3210.30225	3229.60229	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	115.146	78.596	0.000	115.146	78.596
5	-75	1	101	38.5999985	3248.90234	3248.90234	3268.20239	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	117.951	80.560	0.000	117.951	80.560
5	-76	1	101	38.5999985	3287.50244	3287.50244	3306.80249	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	120.790	82.548	0.000	120.790	82.548
5	-77	1	101	38.5999985	3326.10254	3326.10254	3345.40259	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	123.663	84.559	0.000	123.663	84.559
5	-78	1	101	38.5999985	3364.70264	3364.70264	3384.00269	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	126.569	86.593	0.000	126.569	86.593
5	-79	1	101	38.5999985	3403.30273	3403.30273	3422.60278	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	129.508	88.650	0.000	129.508	88.650
5	-80	1	101	38.5999985	3441.90283	3441.90283	3461.20288	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	132.480	90.731	0.000	132.480	90.731
5	-81	1	101	38.5999985	3480.50293	3480.50293	3499.80298	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	135.486	92.835	0.000	135.486	92.835
5	-82	1	101	38.5999985	3519.10303	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	138.509	94.951	0.000	138.509	94.951
6	-83	1	117	54.5999985	3565.70313	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	142.274	96.833	0.000	142.274	96.833
6	-84	1	117	54.5999985	3620.30322	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	146.039	98.716	0.000	146.039	98.716
6	-85	1	117	54.5999985	3674.90332	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	149.805	100.598	0.000	149.805	100.598
6	-86	1	117	54.5999985	3729.50342	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	153.570	102.481	0.000	153.570	102.481
6	-87	1	117	54.5999985	3784.10352	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	157.335	104.364	0.000	157.335	104.364
6	-88	1	117	54.5999985	3838.70361	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	161.100	106.246	0.000	161.100	106.246
6	-89	1	117	54.5999985	3893.30371	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	164.866	108.129	0.000	164.866	108.129
6	-90	1	117	54.5999985	3947.90381	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	168.631	110.012	0.000	168.631	110.012
6	-91	1	117	54.5999985	4002.50391	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	172.396	111.894	0.000	172.396	111.894
6	-92	1	117	54.5999985	4057.104	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	176.162	113.777	0.000	176.162	113.777
6	-93	1	117	54.5999985	4111.7041	3500	3500	0	0	28	21	1.00	0.50	19.50	0.00	No	0.000	179.927	115.660	0.000	179.927	115.660
7	-94	1	115	52.5999985	4165.30371	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	182.949	117.775	0.000	182.949	117.775
7	-95	1	115	52.5999985	4217.90381	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	185.972	119.891	0.000	185.972	119.891
7	-96	1	115	52.5999985	4270.50391	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	188.995	122.007	0.000	188.995	122.007
7	-97	1	115	52.5999985	4323.104	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	192.017	124.123	0.000	192.017	124.123
7	-98	1	115	52.5999985	4375.7041	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	195.040	126.239	0.000	195.040	126.239
7	-99	1	115	52.5999985	4428.3042	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	198.063	128.355	0.000	198.063	128.355
7	-100	1	115	52.5999985	4480.9043	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	201.085	130.470	0.000	201.085	130.470
7	-101	1	115	52.5999985	4533.50439	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	204.108	132.586	0.000	204.108	132.586

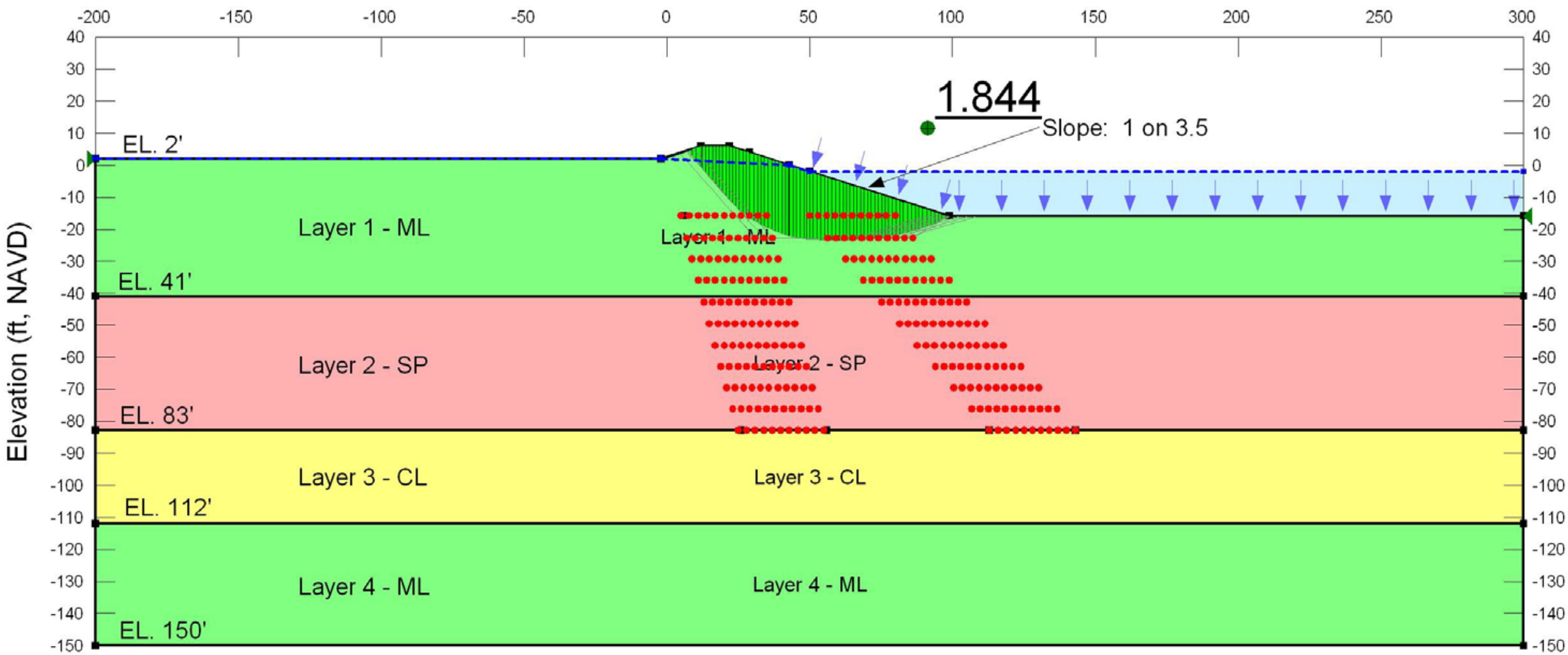
7	-102	1	115	52.5999985	4586.10449	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	207.130	134.702	0.000	207.130	134.702
7	-103	1	115	52.5999985	4638.70459	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	210.153	136.818	0.000	210.153	136.818
7	-104	1	115	52.5999985	4691.30469	3500	3500	0	0	23	17.25	1.00	0.70	10.00	0.00	No	0.000	213.176	138.934	0.000	213.176	138.934
8	-105	1	122	59.5999985	4747.40479	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	218.273	141.788	0.000	218.273	141.788
8	-106	1	122	59.5999985	4807.00488	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	223.370	144.643	0.000	223.370	144.643
8	-107	1	122	59.5999985	4866.60498	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	228.467	147.497	0.000	228.467	147.497
8	-108	1	122	59.5999985	4926.20508	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	233.565	150.352	0.000	233.565	150.352
8	-109	1	122	59.5999985	4985.80518	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	238.662	153.206	0.000	238.662	153.206
8	-110	1	122	59.5999985	5045.40527	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	243.759	156.061	0.000	243.759	156.061
8	-111	1	122	59.5999985	5105.00537	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	248.856	158.915	0.000	248.856	158.915
8	-112	1	122	59.5999985	5164.60547	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	253.954	161.769	0.000	253.954	161.769
8	-113	1	122	59.5999985	5224.20557	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	259.051	164.624	0.000	259.051	164.624
8	-114	1	122	59.5999985	5283.80566	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	264.148	167.478	0.000	264.148	167.478
8	-115	1	122	59.5999985	5343.40576	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	269.245	170.333	0.000	269.245	170.333
8	-116	1	122	59.5999985	5403.00586	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	274.343	173.187	0.000	274.343	173.187
8	-117	1	122	59.5999985	5462.60596	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	279.440	176.042	0.000	279.440	176.042
8	-118	1	122	59.5999985	5522.20605	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	284.537	178.896	0.000	284.537	178.896
8	-119	1	122	59.5999985	5581.80615	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	289.634	181.751	0.000	289.634	181.751
8	-120	1	122	59.5999985	5641.40625	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	294.732	184.605	0.000	294.732	184.605
8	-121	1	122	59.5999985	5701.00635	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	299.829	187.460	0.000	299.829	187.460
8	-122	1	122	59.5999985	5760.60645	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	304.926	190.314	0.000	304.926	190.314
8	-123	1	122	59.5999985	5820.20654	3500	3500	0	0	30	22.5	1.25	0.70	22.50	0.00	No	0.000	310.023	193.169	0.000	310.023	193.169

Plate L5.3

Boring
R-59.75-LU

LCA MVN - WHITE DITCH
Location 3 - Transmission System
Spencer's Block Search
Boring: R-59.75-UL

Low Water (hurricane condition)
Optimization



Name: Layer 1 - ML	Model: Mohr-Coulomb	Unit Weight: 117 pcf	Cohesion: 200 psf	Phi: 15 °	Piezometric Line: 1
Name: Layer 2 - SP	Model: Mohr-Coulomb	Unit Weight: 122 pcf	Cohesion: 0 psf	Phi: 33 °	Piezometric Line: 1
Name: Layer 3 - CL	Model: Mohr-Coulomb	Unit Weight: 105 pcf	Cohesion: 1580 psf	Phi: 0 °	Piezometric Line: 1
Name: Layer 4 - ML	Model: Mohr-Coulomb	Unit Weight: 117 pcf	Cohesion: 200 psf	Phi: 15 °	Piezometric Line: 1

965

Low Water (hurricane condition)

41.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 76
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 2:46:08 PM
File Name: Location 3 - 35k cfs - MC_R-59.75-LU_1on3.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010
Last Solved Time: 2:47:01 PM

42.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

43.0 ANALYSIS SETTINGS

43.1 Low Water (hurricane condition)

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block

Critical slip surfaces saved: 1
Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Restrict Block Crossing: Yes
Advanced
Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

44.0MATERIALS

44.1 Layer 1 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

44.2 Layer 2 - SP

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

44.3 Layer 3 - CL

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 1580 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

44.4 Layer 4 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

45.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft
Right Coordinate: (300, -16) ft

46.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (5, -16) ft
Lower Left: (25, -83) ft
Lower Right: (55, -83) ft
X Increments: 10
Y Increments: 10
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3
Right Grid
Upper Left: (50, -16) ft
Lower Left: (113, -83) ft
Lower Right: (143, -83) ft
X Increments: 10
Y Increments: 10

Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

47.0 PIEZOMETRIC LINES

47.1 Piezometric Line 1

47.1.1 Coordinates

	X (ft)	Y (ft)
	-200	2
	-2	2
	43	0
	50	-2
	300	-2

48.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 1 - ML	1,2,3,4,25,7,8,5,6,13,9	17411
Region 2	Layer 2 - SP	9,13,14,23,22,21,24,10	21000
Region 3	Layer 3 - CL	11,10,24,21,22,23,14,15	14500
Region 4	Layer 4 - ML	12,11,15,16	19000

49.0 POINTS

	X (ft)	Y (ft)
Point 1	-200	2
Point 2	-2	2
Point 3	12	6
Point 4	22	6
Point 5	99	-16
Point 6	300	-16

Point 7	43	0
Point 8	50	-2
Point 9	-200	-41
Point 10	-200	-83
Point 11	-200	-112
Point 12	-200	-150
Point 13	300	-41
Point 14	300	-83
Point 15	300	-112
Point 16	300	-150
Point 17	36	-16
Point 18	50	-16
Point 19	80	-16
Point 20	6	-16
Point 21	56	-83
Point 22	113	-83
Point 23	143	-83
Point 24	26	-83
Point 25	29	4

50.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.844	(56.457, 9.639)	44.17684	(7.41969, 4.69134)	(98.9963, -15.9989)
2	3678	1.973	(56.457, 9.639)	44.081	(6.78889, 4.51111)	(99.3047, -16)

50.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	8.1455825	3.881579	-145.54597	7.2864937	1.9524101	200
2	Optimized	9.597375	2.262059	-48.515322	195.39003	52.354602	200
3	Optimized	11.161635	0.51708	56.031921	404.58431	93.39433	200
4	Optimized	12.248425	-0.6952645	128.66829	547.27083	112.16421	200
5	Optimized	13.06283	-1.6159035	183.8568	634.71523	120.80715	200
6	Optimized	14.194795	-2.902931	261.02729	762.31172	134.31876	200
7	Optimized	15.326765	-4.189959	338.19779	889.96655	147.84599	200
8	Optimized	16.45873	-5.4769865	415.37412	1017.563	161.35603	200
9	Optimized	17.64662	-6.708378	488.91753	1190.4811	187.98338	200
10	Optimized	18.89044	-7.8841335	558.83551	1309.9615	201.26361	200
11	Optimized	20.134265	-9.059889	628.77685	1429.5004	214.55323	200
12	Optimized	21.37809	-10.235644	698.65393	1548.9809	227.84441	200
13	Optimized	22.56526	-11.357845	765.3991	1647.5976	236.38437	200
14	Optimized	23.695775	-12.426495	828.97344	1725.3138	240.17368	200
15	Optimized	24.8534	-13.37356	884.85524	1882.0401	267.19487	200
16	Optimized	26.038145	-14.19904	933.05586	1934.7422	268.40104	200
17	Optimized	27.22289	-15.024525	981.25647	1987.4443	269.60721	200
18	Optimized	28.40763	-15.85001	1029.5263	2040.1464	270.79483	200
19	Optimized	29.73613	-16.775655	1083.5982	2099.2626	272.14644	200
20	Optimized	31.10362	-17.584995	1130.2679	2244.6216	298.59017	200
21	Optimized	32.366345	-18.177865	1163.8168	2270.8586	296.63094	200
22	Optimized	33.62907	-18.770735	1197.294	2297.0955	294.69092	200
23	Optimized	34.891795	-19.363605	1230.7712	2323.3325	292.7509	200

24	Optimized	36.15452	-19.956475	1264.2484	2349.5694	290.81088	200
25	Optimized	37.3735	-20.434415	1290.7076	2442.556	308.63684	200
26	Optimized	38.548735	-20.797425	1310.1381	2446.1331	304.38895	200
27	Optimized	39.72397	-21.160435	1329.4873	2449.629	300.14105	200
28	Optimized	40.899205	-21.523445	1348.9179	2453.2062	295.89316	200
29	Optimized	42.07444	-21.886455	1368.2671	2456.702	291.64526	200
30	Optimized	42.83103	-22.096955	1379.3204	2526.6639	307.42977	200
31	Optimized	43.62076	-22.232465	1376.2422	2516.3893	305.5015	200
32	Optimized	44.86228	-22.445495	1367.4303	2500.1945	303.52325	200
33	Optimized	46.103795	-22.65853	1358.539	2483.9203	301.545	200
34	Optimized	47.34531	-22.871565	1349.7271	2467.7255	299.56675	200
35	Optimized	48.474555	-23.011175	1338.3154	2503.1473	312.11577	200
36	Optimized	49.49152	-23.077365	1324.2837	2477.0463	308.88182	200
37	Optimized	50.63841	-23.15201	1319.8689	2459.2015	305.28325	200
38	Optimized	51.91523	-23.23511	1325.1053	2449.6667	301.32533	200
39	Optimized	53.19205	-23.31821	1330.2634	2440.1319	297.38836	200
40	Optimized	54.495005	-23.37417	1333.7596	2450.0527	299.10983	200
41	Optimized	55.824095	-23.40299	1335.5649	2433.2029	294.11122	200
42	Optimized	57.15318	-23.431815	1337.3702	2416.4285	289.13278	200
43	Optimized	58.482265	-23.46064	1339.1756	2399.5788	284.13418	200
44	Optimized	59.811355	-23.48946	1340.9057	2382.7291	279.15573	200
45	Optimized	61.08876	-23.479885	1340.3117	2393.9086	282.31046	200
46	Optimized	62.314475	-23.431915	1337.3769	2369.2888	276.49998	200
47	Optimized	63.54019	-23.383945	1334.3605	2344.5875	270.68951	200

48	Optimized	64.76591	-23.33598	1331.3442	2319.9677	264.90088	200
49	Optimized	65.99163	-23.288015	1328.4094	2295.3479	259.0904	200
50	Optimized	67.217345	-23.240045	1325.393	2270.7281	253.30177	200
51	Optimized	68.44306	-23.192075	1322.3767	2246.1083	247.51314	200
52	Optimized	69.66708	-23.10344	1316.8525	2249.6976	249.95509	200
53	Optimized	70.889405	-22.974145	1308.7981	2214.9579	242.80479	200
54	Optimized	72.11173	-22.84485	1300.7437	2180.2182	235.6545	200
55	Optimized	73.33405	-22.71555	1292.6893	2145.4786	228.5042	200
56	Optimized	74.556375	-22.586255	1284.5535	2110.7389	221.37571	200
57	Optimized	75.7787	-22.45696	1276.4992	2075.9993	214.22542	200
58	Optimized	77.04339	-22.27818	1265.3334	2066.5579	214.68747	200
59	Optimized	78.350455	-22.049925	1251.0891	2017.871	205.4586	200
60	Optimized	79.65752	-21.82167	1236.8447	1969.184	196.22972	200
61	Optimized	80.96458	-21.59341	1222.6004	1920.4971	187.00085	200
62	Optimized	82.271645	-21.365155	1208.3561	1871.8101	177.77197	200
63	Optimized	83.57871	-21.1369	1194.1117	1823.1231	168.5431	200
64	Optimized	84.89841	-20.848375	1176.1263	1803.1081	167.99926	200
65	Optimized	86.230745	-20.499585	1154.3435	1738.1227	156.42317	200
66	Optimized	87.56308	-20.150795	1132.6333	1673.1374	144.82762	200
67	Optimized	88.895415	-19.802005	1110.8505	1608.152	133.25153	200
68	Optimized	90.27097	-19.39268	1085.2736	1560.9339	127.45279	200
69	Optimized	91.689745	-18.922825	1055.9672	1478.3005	113.16388	200
70	Optimized	93.10852	-18.45297	1026.6608	1395.6672	98.874968	200
71	Optimized	94.46521	-17.940655	994.70555	1341.326	92.87667	200

72	Optimized	95.759805	-17.38588	960.05771	1248.1034	77.181616	200
73	Optimized	97.0544	-16.831105	925.48086	1154.9518	61.486562	200
74	Optimized	98.348995	-16.27633	890.83302	1061.7293	45.791508	200

080 **50.2 Slices of Slip Surface: 3678**

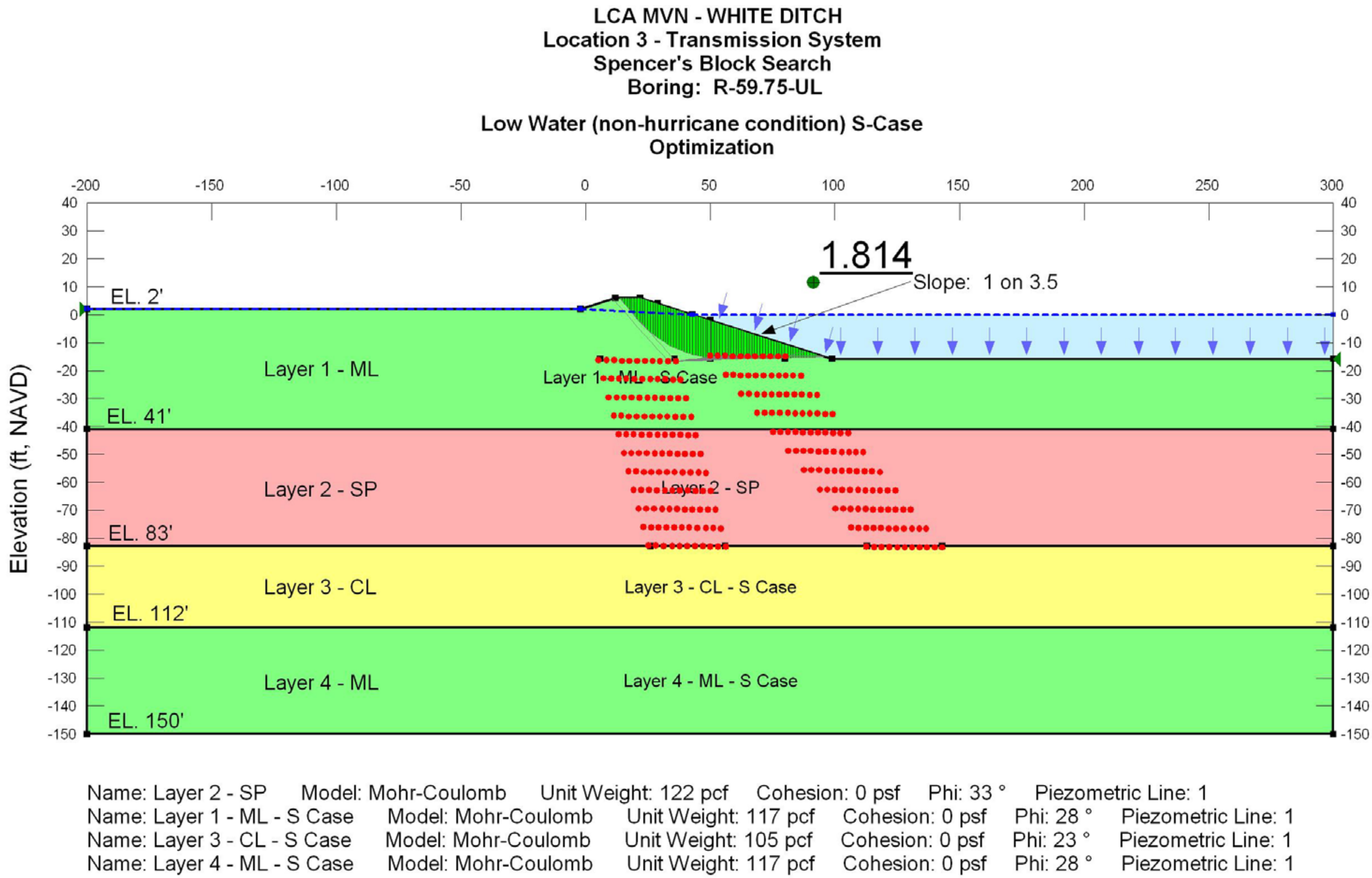
	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	3678	7.548062	3.751938	-135.80059	19.260306	5.1607834	200
2	3678	9.066408	2.233592	-45.266865	205.27964	55.004515	200
3	3678	10.369186	0.93081415	32.413339	368.09305	89.945108	200
4	3678	11.456395	-0.15639535	97.239367	507.69863	109.98223	200
5	3678	12.625	-1.325	166.92245	640.75186	126.96221	200
6	3678	13.875	-2.575	241.4515	767.23912	140.88437	200
7	3678	15.125	-3.825	315.98621	893.66981	154.78985	200
8	3678	16.375	-5.075	390.52092	1020.1571	168.7105	200
9	3678	17.625	-6.325	465.05563	1146.6443	182.63114	200
10	3678	18.875	-7.575	539.58469	1273.1316	196.5533	200
11	3678	20.125	-8.825	614.10808	1399.6188	210.47697	200
12	3678	21.375	-10.075	688.66542	1526.0495	224.3764	200
13	3678	22.583335	-11.283335	760.70539	1632.4467	233.58239	200
14	3678	23.75	-12.45	830.28469	1718.7542	238.06468	200
15	3678	24.916665	-13.616665	899.80338	1805.001	242.54697	200
16	3678	26.083335	-14.783335	969.38268	1891.3084	247.02925	200
17	3678	27.25	-15.95	1038.962	1977.5552	251.4953	200
18	3678	28.416665	-17.116665	1108.5413	2063.8626	255.97759	200
19	3678	29.625	-18.325	1180.5855	2153.2249	260.61797	200

20	3678	30.875	-19.575	1255.0862	2245.6579	265.42289	200
21	3678	32.125	-20.825	1329.6436	2338.0909	270.21266	200
22	3678	33.375	-22.075	1404.2009	2430.5239	275.00243	200
23	3678	34.642855	-22.7	1439.667	2968.234	409.57829	200
24	3678	35.92857	-22.7	1436.0892	2924.6784	398.86628	200
25	3678	37.214285	-22.7	1432.5114	2881.1229	388.15426	200
26	3678	38.5	-22.7	1428.9337	2837.5673	377.44225	200
27	3678	39.785715	-22.7	1425.3559	2794.0117	366.73023	200
28	3678	41.07143	-22.7	1421.8559	2750.4562	355.99738	200
29	3678	42.357145	-22.7	1418.2781	2706.9006	345.28536	200
30	3678	43.583335	-22.7	1406.0567	2665.4564	337.45512	200
31	3678	44.75	-22.7	1385.3139	2626.1992	332.49423	200
32	3678	45.916665	-22.7	1364.4853	2586.9421	327.55631	200
33	3678	47.083335	-22.7	1343.6568	2547.685	322.61839	200
34	3678	48.25	-22.7	1322.9139	2508.4279	317.6575	200
35	3678	49.416665	-22.7	1302.0853	2469.1707	312.71959	200
36	3678	50.6075	-22.7	1291.6872	2440.2469	307.75564	200
37	3678	51.8225	-22.7	1291.6872	2421.6461	302.77156	200
38	3678	53.0375	-22.7	1291.6872	2403.1276	297.80954	200
39	3678	54.2525	-22.7	1291.6872	2384.5267	292.82546	200
40	3678	55.4675	-22.7	1291.6872	2366.0082	287.86344	200
41	3678	56.6825	-22.7	1291.6872	2347.4074	282.87937	200
42	3678	57.8975	-22.7	1291.6872	2328.8889	277.91734	200
43	3678	59.1125	-22.7	1291.6872	2310.2881	272.93327	200

44	3678	60.3275	-22.7	1291.6872	2291.6872	267.94919	200
45	3678	61.5425	-22.7	1291.6872	2273.1687	262.98717	200
46	3678	62.7575	-22.7	1291.6872	2254.5679	258.00309	200
47	3678	63.9725	-22.7	1291.6872	2236.0494	253.04107	200
48	3678	65.1875	-22.7	1291.6872	2217.4486	248.057	200
49	3678	66.4025	-22.7	1291.6872	2198.93	243.09498	200
50	3678	67.6175	-22.7	1291.6872	2180.3292	238.1109	200
51	3678	68.8325	-22.7	1291.6872	2161.8107	233.14888	200
52	3678	70.0475	-22.7	1291.6872	2143.2099	228.1648	200
53	3678	71.2625	-22.7	1291.6872	2124.6091	223.18073	200
54	3678	72.4775	-22.7	1291.6872	2106.0905	218.2187	200
55	3678	73.6925	-22.7	1291.6872	2087.4897	213.23463	200
56	3678	74.9175	-22.53454	1281.3574	2172.6684	238.82608	200
57	3678	76.1525	-22.203625	1260.7093	2111.5844	227.9913	200
58	3678	77.3875	-21.87271	1240.0611	2050.5003	217.15653	200
59	3678	78.6225	-21.54179	1219.413	1989.3381	206.3008	200
60	3678	79.8575	-21.21087	1198.7649	1928.254	195.46602	200
61	3678	81.0925	-20.879955	1178.1167	1867.0917	184.61029	200
62	3678	82.3275	-20.54904	1157.4686	1806.0077	173.77552	200
63	3678	83.5625	-20.21812	1136.8205	1744.8454	162.91979	200
64	3678	84.7975	-19.8872	1116.1723	1683.7613	152.08501	200
65	3678	86.0325	-19.556285	1095.5242	1622.6773	141.25024	200
66	3678	87.2675	-19.22537	1074.8761	1561.515	130.39451	200
67	3678	88.5025	-18.89445	1054.2279	1500.431	119.55974	200

68	3678	89.7375	-18.563535	1033.5798	1439.2687	108.70401	200
69	3678	90.9725	-18.23262	1012.9317	1378.1846	97.869232	200
70	3678	92.2075	-17.9017	992.28354	1317.0224	87.013502	200
71	3678	93.4425	-17.57078	971.63541	1255.9383	76.178728	200
72	3678	94.6775	-17.239865	950.98728	1194.8542	65.343954	200
73	3678	95.9125	-16.90895	930.33915	1133.692	54.488224	200
74	3678	97.1475	-16.57803	909.69101	1072.6079	43.65345	200
75	3678	98.3825	-16.24711	889.04288	1011.4456	32.797719	200
76	3678	99.15237	-16.040825	876.1595	947.00157	18.982075	200

085


LCA MVN - WHITE DITCH
Location 3 - Transmission System
Spencer's Block Search
Boring: R-59.75-UL
Low Water (non-hurricane condition) S-Case
Optimization
1.814
Slope: 1 on 3.5
EL. 2'
EL. 41'
EL. 83'
EL. 112'
EL. 150'
Layer 1 - ML
Layer 1 - ML - S Case
Layer 2 - SP
Layer 3 - CL
Layer 3 - CL - S Case
Layer 4 - ML
Layer 4 - ML - S Case
Elevation (ft, NAVD)
Name: Layer 2 - SP Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 33 ° Piezometric Line: 1
Name: Layer 1 - ML - S Case Model: Mohr-Coulomb Unit Weight: 117 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1
Name: Layer 3 - CL - S Case Model: Mohr-Coulomb Unit Weight: 105 pcf Cohesion: 0 psf Phi: 23 ° Piezometric Line: 1
Name: Layer 4 - ML - S Case Model: Mohr-Coulomb Unit Weight: 117 pcf Cohesion: 0 psf Phi: 28 ° Piezometric Line: 1

Low Water (non-hurricane condition) S-Case

51.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 76
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 2:46:08 PM
File Name: Location 3 - 35k cfs - MC_R-59.75-LU_1on3.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010
Last Solved Time: 2:48:02 PM

52.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

53.0 ANALYSIS SETTINGS

53.1 Low Water (non-hurricane condition) S-Case

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Restrict Block Crossing: Yes
Advanced
Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

54.0 MATERIALS

54.1 Layer 2 - SP

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

54.2 Layer 1 - ML - S Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

54.3 Layer 3 - CL - S Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1

54.4 Layer 4 - ML - S Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1

55.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft
Right Coordinate: (300, -16) ft

56.0 SLIP SURFACE BLOCK

Left Grid
  Upper Left: (5.2803, -16.2114) ft
  Lower Left: (25.2901, -82.6562) ft
  Lower Right: (56.3051, -83.1814) ft
  X Increments: 10
  Y Increments: 10
  Starting Angle: 115 °
  Ending Angle: 135 °
  Angle Increments: 3
Right Grid
  Upper Left: (50.0021, -14.6356) ft
  Lower Left: (112.8326, -83.1814) ft
  Lower Right: (143.1473, -83.5754) ft
  X Increments: 10
  Y Increments: 10

Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

57.0PIEZOMETRIC LINES

195 57.1 Piezometric Line 1

57.1.1 Coordinates

	X (ft)	Y (ft)
	-200	2
	-2	2
	43	0
	300	0

58.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 1 - ML - S Case	1,2,3,4,25,7,8,5,6,13,9	17411
Region 2	Layer 2 - SP	9,13,14,23,22,21,24,10	21000
Region 3	Layer 3 - CL - S Case	11,10,24,21,22,23,14,15	14500
Region 4	Layer 4 - ML - S Case	12,11,15,16	19000

59.0 POINTS

	X (ft)	Y (ft)
Point 1	-200	2
Point 2	-2	2
Point 3	12	6
Point 4	22	6
Point 5	99	-16
Point 6	300	-16
Point 7	43	0

Point 8	50	-2
Point 9	-200	-41
Point 10	-200	-83
Point 11	-200	-112
Point 12	-200	-150
Point 13	300	-41
Point 14	300	-83
Point 15	300	-112
Point 16	300	-150
Point 17	36	-16
Point 18	50	-16
Point 19	80	-16
Point 20	6	-16
Point 21	56	-83
Point 22	113	-83
Point 23	143	-83
Point 24	26	-83
Point 25	29	4

60.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.814	(58.624, 11.257)	39.36311	(13.6629, 6)	(95.8818, -15.1091)
2	1933	2.049	(58.624, 11.257)	39.345	(13.5587, 6)	(95.6036, -15.0296)

200

60.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)

1	Optimized	14.171655	5.4559975	-260.50041	45.366879	24.121997	0
2	Optimized	15.189125	4.3679925	-195.43069	136.10064	72.365992	0
3	Optimized	16.2066	3.2799875	-130.36097	226.83439	120.60999	0
4	Optimized	17.224075	2.1919825	-65.294606	317.56815	168.85398	0
5	Optimized	17.991895	1.373968	-16.380069	387.1074	205.82865	0
6	Optimized	18.875815	0.43912265	39.503025	473.13687	230.5672	0
7	Optimized	20.12549	-0.88254435	118.50962	599.36534	255.67552	0
8	Optimized	21.375165	-2.2042115	197.51787	725.53884	280.75373	0
9	Optimized	22.38843	-3.2758525	261.57299	818.59072	296.17158	0
10	Optimized	23.306425	-4.1045975	310.74577	931.26639	329.93667	0
11	Optimized	24.365555	-4.9404725	359.96614	987.2239	333.51886	0
12	Optimized	25.424685	-5.7763475	409.18652	1043.1814	337.10106	0
13	Optimized	26.483815	-6.6122225	458.40689	1099.1389	340.68326	0
14	Optimized	27.510035	-7.324373	500.0013	1195.7381	369.92984	0
15	Optimized	28.503345	-7.912799	533.96355	1229.172	369.6489	0
16	Optimized	29.513105	-8.51097	568.48964	1263.2078	369.38822	0
17	Optimized	30.539315	-9.1188855	603.57642	1297.7497	369.09846	0
18	Optimized	31.565525	-9.7268015	638.6632	1332.2915	368.8087	0
19	Optimized	32.591735	-10.334715	673.74998	1366.8333	368.51895	0
20	Optimized	33.617945	-10.94263	708.83675	1401.3751	368.22919	0
21	Optimized	34.68081	-11.44973	737.53905	1497.2931	403.96838	0
22	Optimized	35.78033	-11.85601	759.83934	1508.4688	398.05335	0
23	Optimized	36.87985	-12.262285	782.13963	1519.5592	392.09296	0
24	Optimized	37.979375	-12.66856	804.43992	1530.735	386.17794	0

25	Optimized	39.0789	-13.07484	826.74875	1541.8254	380.21301	0
26	Optimized	40.17842	-13.48112	849.04904	1553.0012	374.29798	0
27	Optimized	41.296135	-13.81673	866.85751	1604.8567	392.40111	0
28	Optimized	42.432045	-14.081665	880.23203	1598.6838	382.00759	0
29	Optimized	43.52619	-14.33686	894.61868	1601.9389	376.08882	0
30	Optimized	44.578575	-14.582315	909.93385	1614.6167	374.68651	0
31	Optimized	45.63096	-14.82777	925.24902	1627.2945	373.2842	0
32	Optimized	46.68334	-15.073225	940.56419	1639.9723	371.8819	0
33	Optimized	47.67461	-15.231855	950.46297	1705.1759	401.28796	0
34	Optimized	48.604765	-15.303665	954.9435	1699.602	395.94194	0
35	Optimized	49.53492	-15.37547	959.42404	1693.9209	390.53893	0
36	Optimized	50.19992	-15.426805	962.62197	1689.9496	386.72699	0
37	Optimized	50.958185	-15.454835	964.39129	1704.4264	393.48366	0
38	Optimized	52.074875	-15.48002	965.91326	1690.2811	385.15319	0
39	Optimized	53.191565	-15.505205	967.52476	1676.0462	376.72752	0
40	Optimized	54.33328	-15.54119	969.79123	1655.6847	364.69604	0
41	Optimized	55.500015	-15.587975	972.703	1643.3525	356.59067	0
42	Optimized	56.66675	-15.63476	975.61477	1631.0203	348.4853	0
43	Optimized	57.773945	-15.661875	977.30969	1629.9949	347.03887	0
44	Optimized	58.82159	-15.66932	977.78694	1614.7229	338.66487	0
45	Optimized	59.869235	-15.67676	978.26419	1599.3555	330.24012	0
46	Optimized	60.91688	-15.684205	978.74144	1583.9881	321.81537	0
47	Optimized	61.964525	-15.69165	979.12324	1568.6207	313.44137	0
48	Optimized	63.012175	-15.699095	979.60049	1553.3488	305.06737	0

49	Optimized	64.05982	-15.706545	980.07773	1537.9814	296.64262	0
50	Optimized	65.107465	-15.71399	980.55498	1522.6139	288.21786	0
51	Optimized	66.15511	-15.72143	981.03223	1507.2465	279.79311	0
52	Optimized	67.202755	-15.728875	981.50948	1491.8791	271.36836	0
53	Optimized	68.27925	-15.727635	981.37309	1480.3825	265.328	0
54	Optimized	69.384595	-15.71771	980.73983	1461.9275	255.852	0
55	Optimized	70.48994	-15.70779	980.19703	1443.4724	246.3279	0
56	Optimized	71.595285	-15.697865	979.56377	1425.1079	236.9	0
57	Optimized	72.70063	-15.687935	978.93051	1406.6529	227.424	0
58	Optimized	73.805975	-15.67801	978.29725	1388.2883	217.9961	0
59	Optimized	74.915375	-15.660235	977.15541	1372.8481	210.39355	0
60	Optimized	76.028825	-15.63461	975.62903	1352.2868	200.27251	0
61	Optimized	77.14227	-15.608985	974.01286	1331.7255	190.19921	0
62	Optimized	78.255715	-15.58336	972.39668	1311.254	180.17365	0
63	Optimized	79.369165	-15.557735	970.78051	1290.6927	170.10035	0
64	Optimized	80.475775	-15.527915	968.91845	1271.6543	160.96753	0
65	Optimized	81.57555	-15.4939	966.82811	1250.2965	150.72282	0
66	Optimized	82.675325	-15.459885	964.73777	1228.9387	140.47812	0
67	Optimized	83.775095	-15.425875	962.55654	1207.49	130.23341	0
68	Optimized	84.874865	-15.391865	960.4662	1186.1321	119.9887	0
69	Optimized	85.97464	-15.35785	958.28498	1164.6834	109.744	0
70	Optimized	87.074415	-15.323835	956.19463	1143.3256	99.499292	0
71	Optimized	88.174895	-15.291735	954.24057	1121.5413	88.955381	0
72	Optimized	89.27609	-15.261545	952.33427	1100.572	78.819391	0

73	Optimized	90.37729	-15.231355	950.42796	1079.6027	68.6834	0
74	Optimized	91.478485	-15.201165	948.52166	1058.7241	58.595677	0
75	Optimized	92.51067	-15.176445	947.01519	1038.4335	48.607955	0
76	Optimized	93.47385	-15.1572	945.81109	1020.9947	39.975862	0
77	Optimized	94.437035	-15.137955	944.60699	1003.5976	31.365846	0
78	Optimized	95.40022	-15.11871	943.40289	986.21076	22.76135	0

60.2 Slices of Slip Surface: 1933

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	1933	14.172415	5.3862865	-256.15781	53.095785	28.23153	0
2	1933	15.39984	4.15886	-182.96575	159.28851	84.695202	0
3	1933	16.627265	2.9314335	-109.77945	265.47893	141.15765	0
4	1933	17.854695	1.7040065	-36.593726	371.66934	197.6201	0
5	1933	19.057005	0.50169418	35.095918	481.58077	237.40021	0
6	1933	20.2342	-0.67550332	105.29136	595.21543	260.49725	0
7	1933	21.4114	-1.852701	175.47959	708.85008	283.59812	0
8	1933	22.583335	-3.0246335	245.35795	807.55626	298.92615	0
9	1933	23.75	-4.1913	314.92512	891.3181	306.47358	0
10	1933	24.916665	-5.3579665	384.48624	975.07994	314.02424	0
11	1933	26.083335	-6.5246335	454.05342	1058.9024	321.6039	0
12	1933	27.25	-7.6913	523.61454	1142.6642	329.15456	0
13	1933	28.416665	-8.8579665	593.18171	1226.4261	336.702	0
14	1933	29.521095	-9.962395	659.03236	1305.7434	343.86238	0
15	1933	30.56328	-11.00458	721.16119	1380.5803	350.61935	0
16	1933	31.605465	-12.046765	783.31037	1455.4171	357.3655	0

17	1933	32.64765	-13.08895	845.45955	1530.254	364.11165	0
18	1933	33.689835	-14.131135	907.60873	1605.0908	370.8578	0
19	1933	34.73202	-15.17332	969.75791	1679.9276	377.60395	0
20	1933	35.774205	-16.215505	1031.9071	1754.7645	384.3501	0
21	1933	36.854025	-16.714935	1060.1007	2221.2485	617.39325	0
22	1933	37.971475	-16.671605	1054.2882	2176.9845	596.94819	0
23	1933	39.088925	-16.628275	1048.4758	2132.7205	576.50313	0
24	1933	40.206375	-16.584945	1042.6634	2088.4565	556.05807	0
25	1933	41.323825	-16.541615	1036.8509	2044.1925	535.61301	0
26	1933	42.441275	-16.498285	1031.0385	1999.9285	515.16795	0
27	1933	43.583335	-16.454	1026.7716	1965.9233	499.35582	0
28	1933	44.75	-16.40876	1023.9452	1942.1126	488.1983	0
29	1933	45.916665	-16.36352	1021.1187	1918.3876	477.08633	0
30	1933	47.083335	-16.31828	1018.2923	1894.6626	465.97435	0
31	1933	48.25	-16.27304	1015.4658	1870.8519	454.81683	0
32	1933	49.416665	-16.2278	1012.6394	1847.1268	443.70486	0
33	1933	50.54137	-16.184185	1009.9146	1824.1772	432.95113	0
34	1933	51.624115	-16.1422	1007.2382	1802.2125	422.69535	0
35	1933	52.70686	-16.100215	1004.6541	1780.1555	412.34142	0
36	1933	53.7896	-16.05823	1002.07	1758.0986	401.9875	0
37	1933	54.87234	-16.016245	999.39366	1736.0416	391.68264	0
38	1933	55.955085	-15.97426	996.80958	1713.9846	381.32872	0
39	1933	57.03783	-15.932275	994.13321	1691.9276	371.02386	0
40	1933	58.12057	-15.89029	991.54913	1669.8706	360.66993	0

41	1933	59.203315	-15.848305	988.96505	1647.8136	350.31601	0
42	1933	60.28606	-15.80632	986.28868	1625.8489	340.06022	0
43	1933	61.3688	-15.764335	983.7046	1603.792	329.7063	0
44	1933	62.45154	-15.72235	981.12051	1581.735	319.35237	0
45	1933	63.534285	-15.680365	978.44414	1559.678	309.04752	0
46	1933	64.61703	-15.63838	975.86006	1537.621	298.69359	0
47	1933	65.69977	-15.596395	973.18369	1515.564	288.38874	0
48	1933	66.782515	-15.55441	970.59961	1493.507	278.03481	0
49	1933	67.86526	-15.512425	968.01553	1471.45	267.68088	0
50	1933	68.948	-15.47044	965.33916	1449.4854	257.4251	0
51	1933	70.03074	-15.428455	962.75507	1427.4284	247.07117	0
52	1933	71.113485	-15.38647	960.0787	1405.3714	236.76632	0
53	1933	72.19623	-15.344485	957.49462	1383.3144	226.41239	0
54	1933	73.27897	-15.3025	954.91054	1361.2574	216.05847	0
55	1933	74.361715	-15.260515	952.23417	1339.2004	205.75361	0
56	1933	75.44446	-15.21853	949.65009	1317.1434	195.39968	0
57	1933	76.5272	-15.176545	946.97372	1295.0865	185.09483	0
58	1933	77.60994	-15.13456	944.38964	1273.1218	174.78997	0
59	1933	78.692685	-15.092575	941.80555	1251.0648	164.43605	0
60	1933	79.77543	-15.05059	939.12918	1229.0078	154.13119	0
61	1933	80.862755	-15.0296	937.80279	1200.4608	139.65776	0
62	1933	81.95467	-15.0296	937.80279	1183.6097	130.69785	0
63	1933	83.046585	-15.0296	937.80279	1166.7586	121.73794	0
64	1933	84.1385	-15.0296	937.80279	1149.8158	112.72933	0

65	1933	85.230415	-15.0296	937.80279	1132.9647	103.76942	0
66	1933	86.32233	-15.0296	937.80279	1116.1135	94.809505	0
67	1933	87.414245	-15.0296	937.80279	1099.1708	85.800898	0
68	1933	88.506155	-15.0296	937.80279	1082.3197	76.840986	0
69	1933	89.59807	-15.0296	937.80279	1065.3769	67.832379	0
70	1933	90.689985	-15.0296	937.80279	1048.5258	58.872466	0
71	1933	91.7819	-15.0296	937.80279	1031.6747	49.912554	0
72	1933	92.873815	-15.0296	937.80279	1014.7319	40.903947	0
73	1933	93.96573	-15.0296	937.80279	997.88079	31.944035	0
74	1933	95.057645	-15.0296	937.80279	981.02964	22.984123	0

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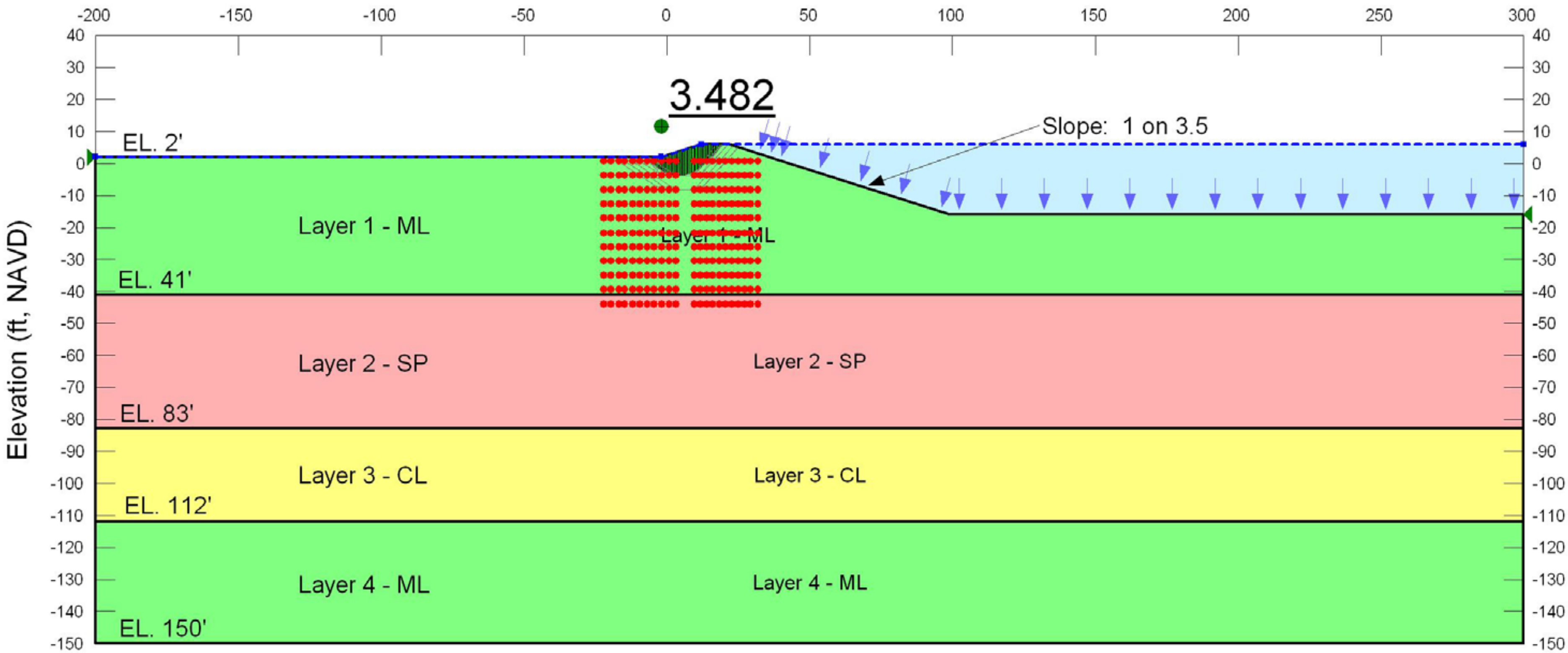
LCA MVN - WHITE DITCH
Location 3 - Transmission System
Spencer's Block Search
Boring: R-59.75-UL

Water at Project Grade (levee)
Optimization



Name: Layer 1 - ML	Model: Mohr-Coulomb	Unit Weight: 117 pcf	Cohesion: 200 psf	Phi: 15 °	Piezometric Line: 1
Name: Layer 2 - SP	Model: Mohr-Coulomb	Unit Weight: 122 pcf	Cohesion: 0 psf	Phi: 33 °	Piezometric Line: 1
Name: Layer 3 - CL	Model: Mohr-Coulomb	Unit Weight: 105 pcf	Cohesion: 1580 psf	Phi: 0 °	Piezometric Line: 1
Name: Layer 4 - ML	Model: Mohr-Coulomb	Unit Weight: 117 pcf	Cohesion: 200 psf	Phi: 15 °	Piezometric Line: 1

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Water at Project Grade (levee)

61.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 76
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 2:46:08 PM
File Name: Location 3 - 35k cfs - MC_R-59.75-LU_1on3.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010
Last Solved Time: 2:48:58 PM

62.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

63.0 ANALYSIS SETTINGS

63.1 Water at Project Grade (levee)

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: Yes
Tension Crack
Tension Crack Option: (none)
FOS Distribution
FOS Calculation Option: Constant
Restrict Block Crossing: Yes
Advanced
Number of Slices: 75
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 5000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

64.0 MATERIALS

64.1 Layer 1 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

64.2 Layer 2 - SP

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

64.3 Layer 3 - CL

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 1580 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

64.4 Layer 4 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

65.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft
Right Coordinate: (300, -16) ft

66.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (-22, 0.75) ft
Lower Left: (-22, -44) ft
Lower Right: (3.25, -44) ft
X Increments: 10
Y Increments: 10
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 3
Right Grid
Upper Left: (9.5, 0.75) ft
Lower Left: (9.5, -44) ft
Lower Right: (31.7145, -44) ft
X Increments: 10
Y Increments: 10

Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 3

67.0 PIEZOMETRIC LINES

67.1 Piezometric Line 1

67.1.1 Coordinates

	X (ft)	Y (ft)
	-200	2
	-2	2
	12	6
	300	6

68.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 1 - ML	1,2,3,4,25,7,8,5,6,13,9	17411
Region 2	Layer 2 - SP	9,13,14,23,22,21,24,10	21000
Region 3	Layer 3 - CL	11,10,24,21,22,23,14,15	14500
Region 4	Layer 4 - ML	12,11,15,16	19000

69.0 POINTS

	X (ft)	Y (ft)
Point 1	-200	2
Point 2	-2	2
Point 3	12	6
Point 4	22	6
Point 5	99	-16
Point 6	300	-16
Point 7	43	0

Point 8	50	-2
Point 9	-200	-41
Point 10	-200	-83
Point 11	-200	-112
Point 12	-200	-150
Point 13	300	-41
Point 14	300	-83
Point 15	300	-112
Point 16	300	-150
Point 17	36	-16
Point 18	50	-16
Point 19	80	-16
Point 20	6	-16
Point 21	56	-83
Point 22	113	-83
Point 23	143	-83
Point 24	26	-83
Point 25	29	4

70.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	3.482	(4.595, 7)	13.00373	(19.7249, 6)	(-7.62206, 2)
2	3565	3.719	(4.595, 7)	13.359	(19.225, 6)	(-9.19099, 2)

70.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)

1	Optimized	-7.4328265	1.8498675	9.3682715	77.713247	18.312981	200
2	Optimized	-7.054362	1.5496025	28.105435	116.80998	23.768311	200
3	Optimized	-6.6758975	1.2493375	46.840322	155.90672	29.224252	200
4	Optimized	-6.2974325	0.9490725	65.577279	195.00345	34.679638	200
5	Optimized	-5.908756	0.654508	83.957735	226.37665	38.161032	200
6	Optimized	-5.509868	0.365644	101.98421	263.6357	43.314384	200
7	Optimized	-5.11098	0.07678	120.00866	300.87444	48.46284	200
8	Optimized	-4.712092	-0.212084	138.0331	338.11319	53.611296	200
9	Optimized	-4.313204	-0.500948	156.05958	375.37224	58.764649	200
10	Optimized	-3.9253275	-0.77269125	173.01627	404.3591	61.988125	200
11	Optimized	-3.5484625	-1.0273138	188.90393	436.9875	66.473794	200
12	Optimized	-3.1715975	-1.281936	204.79378	469.59391	70.952982	200
13	Optimized	-2.7947325	-1.5365585	220.68144	502.20033	75.43276	200
14	Optimized	-2.454725	-1.7543395	234.26958	519.17336	76.339738	200
15	Optimized	-2.151575	-1.935278	245.56002	542.08848	79.454561	200
16	Optimized	-1.8355415	-2.123906	260.26415	571.93682	83.512442	200
17	Optimized	-1.506625	-2.3202235	278.37148	608.69449	88.509785	200
18	Optimized	-1.1777085	-2.516541	296.48925	645.47827	93.511326	200
19	Optimized	-0.82208	-2.695074	313.96675	653.80404	91.059129	200
20	Optimized	-0.43974	-2.8558215	330.81998	687.22118	95.497414	200
21	Optimized	-0.0574	-3.0165685	347.67321	720.6142	99.929238	200
22	Optimized	0.32494	-3.177316	364.52644	754.03133	104.36752	200
23	Optimized	0.695751	-3.30288	378.97243	755.40758	100.86549	200
24	Optimized	1.055033	-3.39326	391.01101	778.75595	103.89594	200

25	Optimized	1.414315	-3.48364	403.04959	802.13132	106.93362	200
26	Optimized	1.773597	-3.57402	415.08818	825.50668	109.97131	200
27	Optimized	2.132879	-3.6644	427.15375	848.88204	113.00176	200
28	Optimized	2.501518	-3.725149	437.49293	840.78901	108.06286	200
29	Optimized	2.879514	-3.756267	446.19375	857.2942	110.15403	200
30	Optimized	3.25751	-3.787385	454.8682	873.77302	112.24521	200
31	Optimized	3.635506	-3.818503	463.54265	890.27821	114.34345	200
32	Optimized	4.013502	-3.849621	472.2171	906.75703	116.43462	200
33	Optimized	4.3700325	-3.851335	478.6929	891.50381	110.61235	200
34	Optimized	4.7050975	-3.823645	482.94623	899.38585	111.58466	200
35	Optimized	5.0401625	-3.795955	487.16982	907.29764	112.57291	200
36	Optimized	5.3752275	-3.768265	491.42315	915.20943	113.55319	200
37	Optimized	5.7102925	-3.740575	495.67648	923.12122	114.53347	200
38	Optimized	6.0453575	-3.712885	499.92981	931.03301	115.51375	200
39	Optimized	6.408551	-3.649795	502.47085	908.12015	108.6934	200
40	Optimized	6.799873	-3.551305	503.28864	909.6566	108.88597	200
41	Optimized	7.191195	-3.452815	504.13121	911.16828	109.06525	200
42	Optimized	7.582517	-3.354325	504.949	912.67995	109.25118	200
43	Optimized	7.973839	-3.255835	505.79157	914.19163	109.43047	200
44	Optimized	8.3715985	-3.1224835	504.54257	886.35857	102.30729	200
45	Optimized	8.775796	-2.954271	501.25342	880.46551	101.60957	200
46	Optimized	9.1799935	-2.786059	497.96426	874.57244	100.91186	200
47	Optimized	9.584191	-2.6178465	494.67511	868.65653	100.20802	200
48	Optimized	9.9767	-2.421651	489.44743	834.2715	92.395332	200

49	Optimized	10.35752	-2.1974735	482.22871	821.59914	90.934033	200
50	Optimized	10.738345	-1.9732965	475.03261	808.92678	89.466671	200
51	Optimized	11.11917	-1.749119	467.83652	796.27704	88.005372	200
52	Optimized	11.482185	-1.5021405	458.89045	755.15496	79.383836	200
53	Optimized	11.827395	-1.232361	448.23131	736.73543	77.304445	200
54	Optimized	12.186105	-0.95203195	433.79742	711.89602	74.516297	200
55	Optimized	12.558315	-0.6611538	415.65549	680.60808	70.993832	200
56	Optimized	12.93052	-0.37027555	397.51356	649.32013	67.471368	200
57	Optimized	13.302725	-0.07939731	379.35046	618.03219	63.954575	200
58	Optimized	13.674935	0.21148089	361.20854	586.74424	60.43211	200
59	Optimized	14.035995	0.50915085	342.629	545.33463	54.31481	200
60	Optimized	14.385905	0.8136125	323.63478	512.88707	50.709998	200
61	Optimized	14.735815	1.1180742	304.64056	480.43951	47.105186	200
62	Optimized	15.085725	1.422536	285.62478	447.99195	43.506151	200
63	Optimized	15.435635	1.7269975	266.63056	415.54439	39.901339	200
64	Optimized	15.785545	2.031459	247.63634	383.09683	36.296528	200
65	Optimized	16.13198	2.34798	227.89379	342.00912	30.57711	200
66	Optimized	16.47494	2.67656	207.3825	307.29026	26.770204	200
67	Optimized	16.817895	3.00514	186.87964	272.59247	22.966682	200
68	Optimized	17.16085	3.33372	166.37678	237.87361	19.157519	200
69	Optimized	17.50381	3.6623	145.87181	203.16318	15.351176	200
70	Optimized	17.84677	3.99088	125.36895	168.45275	11.54427	200
71	Optimized	18.188915	4.339653	103.60628	124.17395	5.5110895	200
72	Optimized	18.530245	4.708619	80.581561	85.670755	1.3636455	200

73	Optimized	18.87157	5.077585	57.558826	47.167559	-2.7843316	200
74	Optimized	19.212895	5.446551	34.536091	8.6631694	-6.9326286	200
75	Optimized	19.554225	5.815517	11.511765	-29.840822	-11.080392	200

325 **70.2 Slices of Slip Surface: 3565**

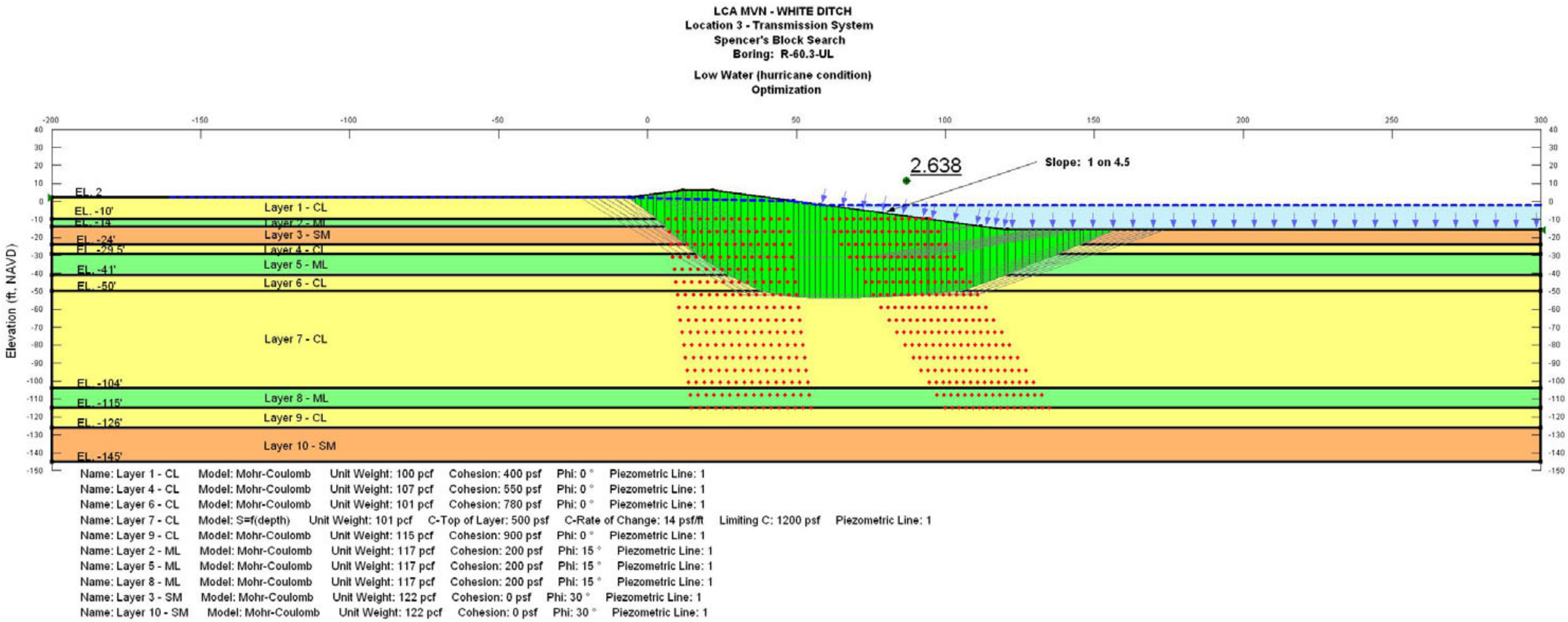
	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	3565	-9.0017545	1.890744	6.817487	53.457116	12.497051	200
2	3565	-8.623281	1.6722325	20.45269	81.08494	16.246362	200
3	3565	-8.2448075	1.453721	34.087435	108.71048	19.995183	200
4	3565	-7.8663345	1.2352095	47.722867	136.3383	23.744434	200
5	3565	-7.4878615	1.016698	61.358299	163.96384	27.493071	200
6	3565	-7.1093885	0.7981862	74.99373	191.58937	31.241708	200
7	3565	-6.730915	0.5796746	88.629162	219.21719	34.990958	200
8	3565	-6.3524415	0.361163	102.26231	246.85188	38.742661	200
9	3565	-5.9739685	0.14265137	115.89774	274.47055	42.489458	200
10	3565	-5.5954955	-0.07586028	129.53317	302.08923	46.236256	200
11	3565	-5.2170225	-0.2943719	143.1686	329.73078	49.989185	200
12	3565	-4.838549	-0.5128835	156.80403	357.34945	53.735983	200
13	3565	-4.4600755	-0.7313951	170.43946	384.96812	57.48278	200
14	3565	-4.0816025	-0.94990645	184.0749	412.60967	61.235709	200
15	3565	-3.7031295	-1.168418	197.71033	440.22834	64.982507	200
16	3565	-3.3246565	-1.38693	211.34347	467.84702	68.729918	200
17	3565	-2.946183	-1.6054415	224.9789	495.48857	72.482847	200
18	3565	-2.5677095	-1.823953	238.61433	523.10724	76.229644	200
19	3565	-2.1892365	-2.042465	252.25205	550.72591	79.975829	200

20	3565	-1.805357	-2.264098	269.5389	585.7955	84.740702	200
21	3565	-1.4160715	-2.488852	290.51737	628.26412	90.498968	200
22	3565	-1.026786	-2.713606	311.4736	670.73274	96.263196	200
23	3565	-0.6375	-2.93836	332.45207	713.2236	102.02742	200
24	3565	-0.24821426	-3.1631145	353.4083	755.69222	107.79165	200
25	3565	0.14107144	-3.387869	374.36453	798.18308	113.56184	200
26	3565	0.53035715	-3.612623	395.343	840.6517	119.32011	200
27	3565	0.915761	-3.725	409.22967	774.2941	97.818718	200
28	3565	1.2972825	-3.725	416.01828	787.08498	99.427024	200
29	3565	1.678804	-3.725	422.83309	799.87587	101.02831	200
30	3565	2.060326	-3.725	429.6217	812.66675	102.63661	200
31	3565	2.441848	-3.725	436.43651	825.45763	104.2379	200
32	3565	2.8233695	-3.725	443.22512	838.24852	105.8462	200
33	3565	3.204891	-3.725	450.03993	851.0394	107.44748	200
34	3565	3.586413	-3.725	456.82854	863.83029	109.05579	200
35	3565	3.967935	-3.725	463.64335	876.62117	110.65707	200
36	3565	4.3494565	-3.725	470.43196	889.41206	112.26538	200
37	3565	4.730978	-3.725	477.24677	902.20294	113.86666	200
38	3565	5.1125	-3.725	484.03538	914.99383	115.47497	200
39	3565	5.494022	-3.725	490.85019	927.78471	117.07625	200
40	3565	5.8755435	-3.725	497.6388	940.5756	118.68456	200
41	3565	6.257065	-3.725	504.45361	953.36648	120.28584	200
42	3565	6.638587	-3.725	511.24222	966.15736	121.89415	200
43	3565	7.020109	-3.725	518.05703	978.94825	123.49543	200

44	3565	7.4016305	-3.725	524.84564	991.73913	125.10373	200
45	3565	7.783152	-3.725	531.66045	1004.53	126.70502	200
46	3565	8.164674	-3.725	538.44906	1017.3209	128.31332	200
47	3565	8.546196	-3.725	545.26387	1030.1118	129.91461	200
48	3565	8.9277175	-3.725	552.07869	1042.9289	131.52291	200
49	3565	9.309239	-3.725	558.86729	1055.7198	133.13122	200
50	3565	9.6785715	-3.5464285	554.31229	890.51892	90.086295	200
51	3565	10.035716	-3.1892855	538.3939	863.71109	87.168477	200
52	3565	10.39286	-2.8321425	522.47552	836.92305	84.255964	200
53	3565	10.75	-2.475	506.55713	810.11522	81.338147	200
54	3565	11.10714	-2.1178575	490.63874	783.32719	78.425634	200
55	3565	11.464285	-1.7607145	474.72035	756.53916	75.513122	200
56	3565	11.82143	-1.4035715	458.80197	729.73133	72.595304	200
57	3565	12.19013	-1.0348684	438.9768	696.3715	68.968703	200
58	3565	12.570395	-0.65460525	415.24933	656.42902	64.623904	200
59	3565	12.95066	-0.27434212	391.52186	616.48654	60.279105	200
60	3565	13.33092	0.10592104	367.79438	576.54406	55.934306	200
61	3565	13.711185	0.4861842	344.06691	536.60158	51.589507	200
62	3565	14.09145	0.8664474	320.33944	496.65909	47.244708	200
63	3565	14.47171	1.2467105	296.61197	456.71661	42.899909	200
64	3565	14.851975	1.6269735	272.8845	416.77413	38.55511	200
65	3565	15.23224	2.0072365	249.15703	376.83165	34.21031	200
66	3565	15.6125	2.3875	225.41097	336.88917	29.870494	200
67	3565	15.99276	2.7677635	201.6835	296.94669	25.525695	200

68	3565	16.373025	3.1480265	177.96347	257.00421	21.178903	200
69	3565	16.75329	3.5282895	154.23414	217.06172	16.834602	200
70	3565	17.13355	3.9085525	130.50667	177.11552	12.488806	200
71	3565	17.513815	4.2888155	106.77734	137.17304	8.1445053	200
72	3565	17.89408	4.669079	83.049865	97.230562	3.7997062	200
73	3565	18.27434	5.0493425	59.320535	57.28808	-0.54459466	200
74	3565	18.654605	5.4296055	35.593065	17.345413	-4.8894436	200
75	3565	19.03487	5.8098685	11.864293	-22.596882	-9.2338441	200

Boring
R-60.3-UL



Low Water (hurricane condition)

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71.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 74
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 10:57:29 AM
File Name: Location 3 - 35k cfs - Main Channel_R-60.3-LU_1on4.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010

Last Solved Time: 11:01:41 AM

72.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

73.0 ANALYSIS SETTINGS

73.1 Low Water (hurricane condition)

Description: Active and Passive Wedge Method
Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: Yes
Advanced
- Number of Slices: 75
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 5000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

74.0MATERIALS

74.1 Layer 1 - CL

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 400 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

74.2 Layer 4 - CL

Model: Mohr-Coulomb
Unit Weight: 107 pcf
Cohesion: 550 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

74.3 Layer 6 - CL

Model: Mohr-Coulomb
Unit Weight: 101 pcf
Cohesion: 780 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

74.4 Layer 7 - CL

Model: S=f(depth)
Unit Weight: 101 pcf
C-Top of Layer: 500 psf

C-Rate of Change: 14 psf/ft
Limiting C: 1200 psf
Pore Water Pressure
Piezometric Line: 1

74.5 Layer 9 - CL

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 900 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

74.6 Layer 2 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

74.7 Layer 5 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

74.8 Layer 8 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

74.9 Layer 3 - SM

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion: 0 psf

Phi: 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

74.10 Layer 10 - SM

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion: 0 psf

Phi: 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

75.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft

Right Coordinate: (300, -16) ft

76.0 SLIP SURFACE BLOCK

Left Grid

Upper Left: (7, -10) ft

Lower Left: (15, -115) ft

Lower Right: (55, -115) ft

X Increments: 15

Y Increments: 15

Starting Angle: 115 °

Ending Angle: 135 °

Angle Increments: 3

Right Grid

Upper Left: (60, -10) ft

Lower Left: (100, -115) ft

Lower Right: (135, -115) ft

X Increments: 15
Y Increments: 15
Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

77.0 PIEZOMETRIC LINES

77.1 Piezometric Line 1

77.1.1 Coordinates

	X (ft)	Y (ft)
	-160	2
	-6	2
	49	0
	58	-2
	300	-2

78.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 10 - SM	20,21,15,11	9500
Region 2	Layer 9 - CL	20,10,14,21	5500
Region 3	Layer 8 - ML	10,9,13,14	5500
Region 4	Layer 5 - ML	18,19,12,23	5750
Region 5	Layer 4 - CL	8,18,23,22	2750
Region 6	Layer 1 - CL	1,2,3,4,28,7,24,16	3316
Region 7	Layer 2 - ML	17,16,24,25	1212
Region 8	Layer 3 - SM	17,25,5,6,22,8	4633
Region 9	Layer 6 - CL	19,26,27,12	4500
Region 10	Layer 7 - CL	26,9,13,27	27000

79.0 POINTS

	X (ft)	Y (ft)
Point 1	-200	2
Point 2	-6	2
Point 3	12	6
Point 4	22	6
Point 5	121	-16
Point 6	300	-16
Point 7	58	-2
Point 8	-200	-24
Point 9	-200	-104
Point 10	-200	-115
Point 11	-200	-145
Point 12	300	-41
Point 13	300	-104
Point 14	300	-115
Point 15	300	-145
Point 16	-200	-10
Point 17	-200	-14
Point 18	-200	-29.5
Point 19	-200	-41
Point 20	-200	-126
Point 21	300	-126
Point 22	300	-24

Point 23	300	-29.5
Point 24	94	-10
Point 25	112	-14
Point 26	-200	-50
Point 27	300	-50
Point 28	49	0

80.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.638	(76.138, 6.5)	75.4855	(-6.32844, 2)	(157.054, -16)
2	27631	2.758	(76.138, 6.5)	79.983	(-14.4667, 2)	(164.021, -16)

80.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-6.1642215	1.794791	12.805052	-156.18089	0	400
2	Optimized	-5.006771	0.34845795	100.80397	3.2180647	0	400
3	Optimized	-3.0203135	-2.1337901	251.18582	282.77513	0	400
4	Optimized	-1.0338562	-4.616038	401.57396	562.33565	0	400
5	Optimized	0.95260125	-7.098286	551.95581	841.89932	0	400
6	Optimized	2.500418	-9.169705	677.68177	1028.0652	0	400
7	Optimized	4.3908875	-12	850.02155	1396.5026	146.42915	200
8	Optimized	6.8136695	-15.62724	1070.8537	1814.1401	429.13661	0
9	Optimized	8.98747	-18.88172	1269.0038	2184.2246	528.40303	0
10	Optimized	11.037185	-21.7788	1445.1415	2559.2361	643.22282	0
11	Optimized	12.36067	-23.52432	1551.0343	2757.9899	696.83615	0

12	Optimized	13.76389	-25.375	1663.3499	3021.6383	0	550
13	Optimized	15.848995	-28.125	1830.2238	3302.4177	0	550
14	Optimized	17.646385	-30.49554	1974.0641	3523.588	415.19368	200
15	Optimized	19.300915	-32.51975	2096.6182	3795.9016	455.32161	200
16	Optimized	21.100305	-34.577085	2220.9043	4016.5212	481.13411	200
17	Optimized	23.17948	-36.954315	2364.549	4248.7423	504.86807	200
18	Optimized	25.59142	-39.712015	2531.1368	4497.9766	527.01314	200
19	Optimized	27.98083	-42.005455	2668.8234	4839.9829	0	780
20	Optimized	30.29473	-43.774065	2773.9598	4963.592	0	780
21	Optimized	32.60863	-45.542675	2879.0619	5087.2011	0	780
22	Optimized	34.92253	-47.311285	2984.164	5211.1535	0	780
23	Optimized	37.23643	-49.079895	3089.266	5334.7626	0	780
24	Optimized	39.68681	-50.39752	3165.9271	5651.3991	0	505.82
25	Optimized	42.220245	-51.246265	3213.1436	5679.2721	0	517.45
26	Optimized	44.70025	-52.07711	3259.3685	5706.4183	0	529.08
27	Optimized	47.470125	-52.750555	3295.2375	5779.9593	0	538.51
28	Optimized	49.910215	-53.162095	3304.6736	5767.1589	0	544.27
29	Optimized	51.73065	-53.469125	3298.6069	5757.4088	0	548.57
30	Optimized	53.551085	-53.776155	3292.5402	5748.2004	0	552.87
31	Optimized	55.345975	-53.920115	3276.6058	5798.4021	0	554.88
32	Optimized	57.115325	-53.901005	3250.8917	5757.1464	0	554.61
33	Optimized	59.05812	-53.88002	3237.3021	5726.3387	0	554.32
34	Optimized	61.174355	-53.85716	3235.8846	5706.4934	0	554
35	Optimized	63.29059	-53.8343	3234.4671	5686.648	0	553.68

36	Optimized	65.40683	-53.81144	3233.0496	5667.2751	0	553.36
37	Optimized	67.52307	-53.78858	3231.5848	5647.4297	0	553.04
38	Optimized	69.639305	-53.76572	3230.1673	5627.5843	0	552.72
39	Optimized	71.75554	-53.74286	3228.7497	5607.7389	0	552.4
40	Optimized	73.872975	-53.637525	3222.1847	5611.8126	0	550.93
41	Optimized	75.99161	-53.44971	3210.4778	5575.1403	0	548.3
42	Optimized	78.110245	-53.261895	3198.7238	5538.4679	0	545.67
43	Optimized	80.22888	-53.07408	3187.0169	5501.7955	0	543.04
44	Optimized	82.347515	-52.886265	3175.3099	5465.1232	0	540.41
45	Optimized	84.466145	-52.69845	3163.603	5428.4508	0	537.78
46	Optimized	86.58478	-52.510635	3151.849	5391.7784	0	535.15
47	Optimized	88.703415	-52.32282	3140.142	5355.1061	0	532.52
48	Optimized	90.82205	-52.135005	3128.4351	5318.4337	0	529.89
49	Optimized	92.940685	-51.947195	3116.7281	5281.7613	0	527.26
50	Optimized	94.246845	-51.831405	3109.4004	5258.3994	0	525.64
51	Optimized	95.50457	-51.62857	3096.8447	5257.8099	0	522.8
52	Optimized	97.52633	-51.266665	3074.2535	5196.4631	0	517.73
53	Optimized	99.548105	-50.90476	3051.6623	5134.6294	0	512.67
54	Optimized	101.56985	-50.542855	3029.0711	5072.7958	0	507.6
55	Optimized	103.6358	-50.173035	3006.0138	5009.9453	0	502.53
56	Optimized	105.9091	-49.33031	2953.4203	5093.4259	0	780
57	Optimized	108.34545	-48.02259	2871.7968	4928.5152	0	780
58	Optimized	110.7818	-46.71487	2790.2094	4763.9661	0	780
59	Optimized	112.3072	-45.896125	2739.139	4660.6952	0	780

60	Optimized	113.82185	-44.9427	2679.6314	4597.3983	0	780
61	Optimized	116.23675	-43.36562	2581.1999	4401.5061	0	780
62	Optimized	118.6516	-41.78854	2482.8031	4205.9607	0	780
63	Optimized	120.4295	-40.62744	2410.3317	4015.5073	430.10549	200
64	Optimized	122.27035	-39.425265	2335.3298	3850.0894	405.8786	200
65	Optimized	124.69765	-37.83768	2236.2765	3653.3213	379.69599	200
66	Optimized	127.0115	-36.32174	2141.6719	3464.9435	354.56955	200
67	Optimized	129.32535	-34.805795	2047.0673	3276.4211	329.40436	200
68	Optimized	131.63925	-33.28985	1952.4989	3087.9349	304.23918	200
69	Optimized	133.95315	-31.77391	1857.8943	2899.4487	279.08367	200
70	Optimized	136.32305	-30.22129	1760.9991	2706.7892	253.42369	200
71	Optimized	138.50255	-28.74831	1669.076	2577.9683	0	550
72	Optimized	140.43565	-27.39165	1584.4323	2428.9633	0	550
73	Optimized	142.36875	-26.03499	1499.7887	2280.0006	0	550
74	Optimized	144.30185	-24.67833	1415.1451	2130.9957	0	550
75	Optimized	145.84915	-23.59244	1347.3991	1946.8539	346.0954	0
76	Optimized	147.4923	-22.46639	1277.0987	1786.2385	293.95198	0
77	Optimized	149.6171	-21.029415	1187.434	1589.3269	232.033	0
78	Optimized	151.74195	-19.59244	1097.7693	1392.3764	170.09151	0
79	Optimized	153.8668	-18.155465	1008.1045	1195.4648	108.17253	0
80	Optimized	155.9916	-16.71849	918.43979	998.51429	46.231038	0

80.2 Slices of Slip Surface: 27631

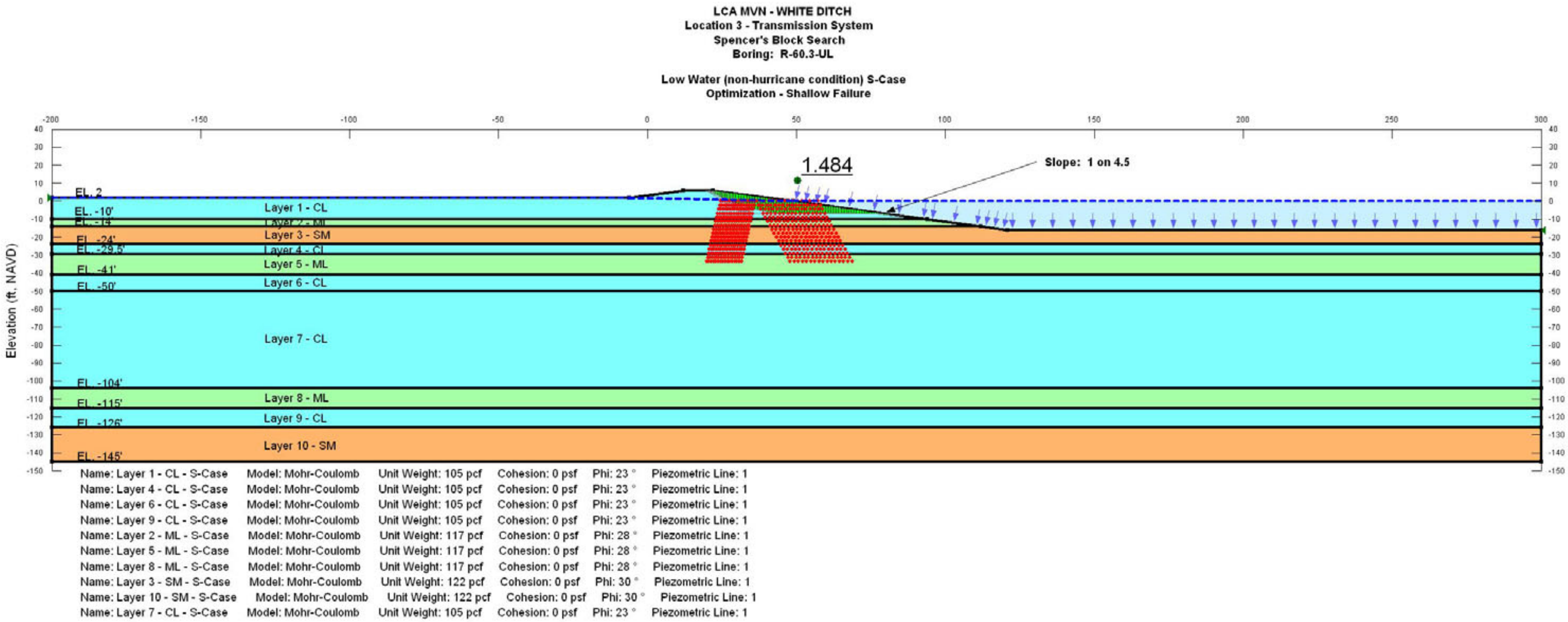
	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	27631	-13.408335	0.94166665	66.04154	-32.957631	0	400

2	27631	-11.291665	-1.1749999	198.12128	171.58974	0	400
3	27631	-9.1749985	-3.2916665	330.20102	376.12509	0	400
4	27631	-7.0583335	-5.4083335	462.28076	580.6738	0	400
5	27631	-4.2333335	-8.2333335	634.55495	891.63495	0	400
6	27631	-1.4666669	-11	800.90453	1260.8068	123.23044	200
7	27631	0.53333315	-13	921.1834	1517.5219	159.78843	200
8	27631	2.783333	-15.25	1056.4741	1802.3303	430.62029	0
9	27631	5.283333	-17.75	1206.805	2118.407	526.31368	0
10	27631	7.783333	-20.25	1357.1359	2434.4837	622.00708	0
11	27631	10.283331	-22.75	1507.4385	2750.5605	717.71681	0
12	27631	11.766665	-24.233335	1596.5967	3010.6083	0	550
13	27631	13.258335	-25.725	1686.3514	3169.8989	0	550
14	27631	15.775	-28.241665	1837.6816	3430.0768	0	550
15	27631	18.275	-30.741665	1988.0044	3666.8941	449.85713	200
16	27631	20.758335	-33.225	2137.3226	3936.8285	482.17616	200
17	27631	23.08889	-35.555555	2277.4538	4168.3943	506.67599	200
18	27631	25.26667	-37.73333	2408.402	4362.2353	523.52807	200
19	27631	27.444445	-39.91111	2539.3502	4556.0764	540.38015	200
20	27631	29.65833	-42.125	2672.4861	4727.8724	0	780
21	27631	31.90833	-44.375	2807.7792	4899.4636	0	780
22	27631	34.15833	-46.625	2943.0723	5070.7405	0	780
23	27631	36.40833	-48.875	3078.3653	5242.0175	0	780
24	27631	38.53333	-51	3206.1637	5493.5128	0	514
25	27631	40.716665	-52	3263.577	5923.9428	0	528

26	27631	43.083335	-52	3258.2108	5871.1259	0	528
27	27631	45.45	-52	3252.8446	5818.7316	0	528
28	27631	47.816665	-52	3247.4784	5765.9147	0	528
29	27631	50.125	-52	3229.2	5714.6667	0	528
30	27631	52.375	-52	3198	5664.8889	0	528
31	27631	54.625	-52	3166.8	5614.6667	0	528
32	27631	56.875	-52	3135.6	5564.8889	0	528
33	27631	59.2	-52	3120	5529.5833	0	528
34	27631	61.6	-52	3120	5510	0	528
35	27631	64	-52	3120	5490	0	528
36	27631	66.4	-52	3120	5470.4167	0	528
37	27631	68.8	-52	3120	5450.4167	0	528
38	27631	71.2	-52	3120	5430.8333	0	528
39	27631	73.6	-52	3120	5410.8333	0	528
40	27631	76	-52	3120	5391.25	0	528
41	27631	78.4	-52	3120	5371.25	0	528
42	27631	80.8	-52	3120	5351.6667	0	528
43	27631	83.2	-52	3120	5331.6667	0	528
44	27631	85.6	-52	3120	5312.0833	0	528
45	27631	88	-52	3120	5292.0833	0	528
46	27631	90.4	-52	3120	5272.5	0	528
47	27631	92.8	-52	3120	5252.5	0	528
48	27631	95.27778	-52	3119.9864	5227.4339	0	528
49	27631	97.833335	-52	3119.9864	5196.5208	0	528

50	27631	100.3889	-52	3119.9864	5165.9991	0	528
51	27631	103.39875	-51	3057.5	5241.5	0	514
52	27631	106.27565	-49.33901	2953.9681	5094.9917	0	780
53	27631	108.5654	-48.017025	2871.4784	4930.8445	0	780
54	27631	110.85515	-46.69504	2788.9888	4766.3191	0	780
55	27631	113.0899	-45.404795	2708.4764	4604.6442	0	780
56	27631	115.2697	-44.14628	2629.9312	4445.7264	0	780
57	27631	117.4495	-42.887765	2551.3861	4286.8085	0	780
58	27631	119.6293	-41.629255	2472.8807	4127.8907	0	780
59	27631	120.8596	-40.918945	2428.5464	4001.1055	421.36593	200
60	27631	122.22735	-40.129275	2379.2774	3894.5497	406.016	200
61	27631	124.6821	-38.71204	2290.8307	3719.9142	382.92177	200
62	27631	127.13685	-37.2948	2202.3839	3545.6314	359.92207	200
63	27631	129.59155	-35.877565	2113.9725	3371.1369	336.8562	200
64	27631	132.04625	-34.46033	2025.5257	3196.713	313.8187	200
65	27631	134.501	-33.04309	1937.079	3022.2891	290.78119	200
66	27631	136.95575	-31.625855	1848.6675	2847.83	267.72477	200
67	27631	139.41045	-30.20862	1760.2208	2673.4061	244.68726	200
68	27631	141.8286	-28.8125	1673.0909	2537.5636	0	550
69	27631	144.21015	-27.4375	1587.3091	2387.4545	0	550
70	27631	146.5917	-26.0625	1501.4909	2237.3091	0	550
71	27631	148.9733	-24.6875	1415.7091	2087.1636	0	550
72	27631	151.3188	-23.333335	1331.2123	1875.7123	314.36718	0
73	27631	153.6282	-22	1247.9998	1697.2498	259.37458	0

74	27631	155.9376	-20.666665	1164.7874	1518.8248	204.40362	0
75	27631	158.247	-19.333335	1081.6124	1340.3623	149.38936	0
76	27631	160.5564	-18	998.39988	1161.8999	94.396757	0
77	27631	162.8658	-16.666665	915.18739	983.43738	39.404151	0



Low Water S-Case - Flood Side - Shallow

81.0FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 74
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 10:57:29 AM
File Name: Location 3 - 35k cfs - Main Channel_R-60.3-LU_1on4.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010
Last Solved Time: 11:06:07 AM

82.0 PROJECT SETTINGS

- Length(L) Units: feet
- Time(t) Units: Seconds
- Force(F) Units: lbf
- Pressure(p) Units: psf
- Strength Units: psf
- Unit Weight of Water: 62.4 pcf
- View: 2D

83.0 ANALYSIS SETTINGS

83.1 Low Water S-Case - Flood Side - Shallow

- Description: Active and Passive Wedge Method
- Kind: SLOPE/W
- Method: Spencer
- Settings
  - Apply Phreatic Correction: No
  - PWP Conditions Source: Piezometric Line
  - Use Staged Rapid Drawdown: No
- SlipSurface
  - Direction of movement: Left to Right
  - Use Passive Mode: No
  - Slip Surface Option: Block
  - Critical slip surfaces saved: 1
  - Optimize Critical Slip Surface Location: Yes
  - Tension Crack
    - Tension Crack Option: (none)
- FOS Distribution
  - FOS Calculation Option: Constant
- Restrict Block Crossing: Yes
- Advanced
  - Number of Slices: 75
  - Optimization Tolerance: 0.01
  - Minimum Slip Surface Depth: 0.1 ft
  - Optimization Maximum Iterations: 5000
  - Optimization Convergence Tolerance: 1e-007
  - Starting Optimization Points: 8

Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

84.0MATERIALS

84.1 Layer 1 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.2 Layer 4 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.3 Layer 6 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.4 Layer 9 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °

Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.5 Layer 2 - ML - S-Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.6 Layer 5 - ML - S-Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.7 Layer 8 - ML - S-Case

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.8 Layer 3 - SM - S-Case

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1

84.9 Layer 10 - SM - S-Case

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

84.10 Layer 7 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

85.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft
Right Coordinate: (300, -16) ft

86.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (24.6008, 0) ft
Lower Left: (19.9471, -33.5) ft
Lower Right: (31.5812, -33.5) ft
X Increments: 15
Y Increments: 15
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3
Right Grid
Upper Left: (36.6357, 0) ft
Lower Left: (47.9905, -33.5) ft
Lower Right: (68.6991, -33.5) ft
X Increments: 15

Y Increments: 15
Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

695 **87.0 PIEZOMETRIC LINES**

87.1 Piezometric Line 1

87.1.1 Coordinates

	X (ft)	Y (ft)
	-200	2
	-6	2
	49	0
	300	0

88.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 10 - SM - S-Case	20,21,15,11	9500
Region 2	Layer 9 - CL - S-Case	20,10,14,21	5500
Region 3	Layer 8 - ML - S-Case	10,9,13,14	5500
Region 4	Layer 5 - ML - S-Case	18,19,12,23	5750
Region 5	Layer 4 - CL - S-Case	8,18,23,22	2750
Region 6	Layer 1 - CL - S-Case	1,2,3,4,28,7,24,16	3316
Region 7	Layer 2 - ML - S-Case	17,16,24,25	1212
Region 8	Layer 3 - SM - S-Case	17,25,5,6,22,8	4633
Region 9	Layer 6 - CL - S-Case	19,26,27,12	4500
Region 10	Layer 7 - CL - S-Case	26,9,13,27	27000

89.0 POINTS

	X (ft)	Y (ft)

Point 1	-200	2
Point 2	-6	2
Point 3	12	6
Point 4	22	6
Point 5	121	-16
Point 6	300	-16
Point 7	58	-2
Point 8	-200	-24
Point 9	-200	-104
Point 10	-200	-115
Point 11	-200	-145
Point 12	300	-41
Point 13	300	-104
Point 14	300	-115
Point 15	300	-145
Point 16	-200	-10
Point 17	-200	-14
Point 18	-200	-29.5
Point 19	-200	-41
Point 20	-200	-126
Point 21	300	-126
Point 22	300	-24
Point 23	300	-29.5
Point 24	94	-10

Point 25	112	-14
Point 26	-200	-50
Point 27	300	-50
Point 28	49	0

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90.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	1.484	(52.6, 9.175)	28.67836	(20.6797, 6)	(85.4425, -8.09833)
2	16117	1.650	(52.6, 9.175)	25.958	(21.8286, 6)	(79.15, -6.7)

90.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	21.00979	5.6961825	-291.92407	23.756726	10.084132	0
2	Optimized	21.66993	5.0885475	-255.51158	71.270177	30.252395	0
3	Optimized	22.390885	4.424935	-215.73999	116.36388	49.393538	0
4	Optimized	23.17265	3.705345	-172.60705	159.05448	67.514622	0
5	Optimized	23.954415	2.985755	-129.48352	201.73567	85.631712	0
6	Optimized	24.742605	2.323275	-89.93029	252.0771	107.00038	0
7	Optimized	25.537215	1.717905	-53.958174	287.31444	121.95774	0
8	Optimized	26.33183	1.1125348	-17.986058	322.55178	136.91511	0
9	Optimized	27.21776	0.43759719	22.119914	365.01317	145.54955	0
10	Optimized	28.195	-0.30690761	66.359742	414.69039	147.85759	0
11	Optimized	29.142185	-0.931291	103.1708	481.92552	160.77184	0
12	Optimized	30.05931	-1.435553	132.56081	511.4493	160.82862	0
13	Optimized	30.976435	-1.939815	161.94127	540.96353	160.8854	0
14	Optimized	31.89356	-2.444077	191.32173	570.47775	160.94218	0

15	Optimized	32.810685	-2.948339	220.71174	599.99197	160.99491	0
16	Optimized	33.72914	-3.382438	245.71217	648.21306	170.85149	0
17	Optimized	34.64892	-3.746374	266.33561	664.49952	169.01055	0
18	Optimized	35.568705	-4.11031	286.95906	680.78598	167.16961	0
19	Optimized	36.48849	-4.474246	307.5825	697.08254	165.33296	0
20	Optimized	37.40827	-4.838182	328.20595	713.369	163.49201	0
21	Optimized	38.31437	-5.136275	344.75156	748.60464	171.42546	0
22	Optimized	39.206785	-5.368525	357.22252	752.3893	167.73834	0
23	Optimized	40.0992	-5.600775	369.68264	756.16312	164.05123	0
24	Optimized	40.991615	-5.833025	382.1536	759.94779	160.36412	0
25	Optimized	41.88403	-6.065275	394.62456	763.73245	156.677	0
26	Optimized	42.809035	-6.25524	404.37163	782.91013	160.68006	0
27	Optimized	43.766625	-6.40292	411.42078	776.32541	154.89283	0
28	Optimized	44.724215	-6.5506	418.45962	769.73038	149.10559	0
29	Optimized	45.61221	-6.6486935	422.57046	777.96925	150.85784	0
30	Optimized	46.430615	-6.6972	423.74142	763.78355	144.33932	0
31	Optimized	47.24902	-6.7457065	424.90019	749.59785	137.82598	0
32	Optimized	47.993665	-6.764812	424.40113	748.08225	137.39449	0
33	Optimized	48.664555	-6.754516	422.24007	730.7044	130.93534	0
34	Optimized	49.45014	-6.74246	420.72833	717.01072	125.76441	0
35	Optimized	50.350425	-6.7286435	419.86204	707.00396	121.88451	0
36	Optimized	51.250715	-6.714827	419.00685	696.98609	117.99518	0
37	Optimized	52.151	-6.701011	418.14056	686.97932	114.11528	0
38	Optimized	53.05128	-6.6871945	417.28538	676.96145	110.22595	0

39	Optimized	53.951565	-6.673378	416.41909	666.95469	106.34605	0
40	Optimized	54.854935	-6.660895	415.64508	656.57781	102.26988	0
41	Optimized	55.761385	-6.649745	414.93909	646.80416	98.420884	0
42	Optimized	56.667835	-6.638595	414.24412	637.0305	94.567209	0
43	Optimized	57.56053	-6.633044	413.89628	626.20884	90.121334	0
44	Optimized	58.44488	-6.633093	413.90937	617.88572	86.582825	0
45	Optimized	59.33464	-6.6331425	413.90937	609.51268	83.028679	0
46	Optimized	60.2244	-6.6331915	413.90937	601.13963	79.474532	0
47	Optimized	61.11416	-6.6332405	413.90937	592.76659	75.920386	0
48	Optimized	62.00392	-6.6332895	413.92061	584.39354	72.361468	0
49	Optimized	62.89368	-6.6333385	413.92061	576.0205	68.807322	0
50	Optimized	63.78344	-6.6333875	413.92061	567.64746	65.253175	0
51	Optimized	64.6732	-6.6334365	413.93185	559.27441	61.694258	0
52	Optimized	65.56296	-6.6334855	413.93185	550.90137	58.140112	0
53	Optimized	66.411265	-6.6383875	414.23378	542.12885	54.288235	0
54	Optimized	67.218115	-6.6481425	414.84103	535.61016	51.263454	0
55	Optimized	68.02497	-6.6578975	415.44829	529.09148	48.238674	0
56	Optimized	68.831825	-6.6676525	416.05554	522.5604	45.208633	0
57	Optimized	69.728485	-6.687035	417.27569	514.58023	41.303328	0
58	Optimized	70.71496	-6.716045	419.07931	508.48033	37.948481	0
59	Optimized	71.61636	-6.753485	421.41237	501.71983	34.088496	0
60	Optimized	72.43268	-6.799355	424.27438	499.02906	31.731478	0
61	Optimized	73.249	-6.845225	427.13639	496.33828	29.374461	0
62	Optimized	74.06532	-6.891095	429.9984	493.65973	27.022635	0

63	Optimized	74.88164	-6.936965	432.87264	490.96896	24.660425	0
64	Optimized	75.69796	-6.982835	435.73464	488.27818	22.303408	0
65	Optimized	76.531585	-7.046219	439.68918	484.40334	18.980032	0
66	Optimized	77.38251	-7.127117	444.73152	485.11698	17.142614	0
67	Optimized	78.233435	-7.208015	449.78555	485.84233	15.305196	0
68	Optimized	79.08436	-7.288913	454.82788	486.56768	13.472744	0
69	Optimized	79.935285	-7.369811	459.88192	487.28133	11.63036	0
70	Optimized	80.784225	-7.467599	465.97442	487.10509	8.9694346	0
71	Optimized	81.63118	-7.582277	473.13498	491.39908	7.7526508	0
72	Optimized	82.478135	-7.696955	480.29554	495.68138	6.5309006	0
73	Optimized	83.325085	-7.8116325	487.4444	499.96367	5.3141168	0
74	Optimized	84.17204	-7.92631	494.60495	504.24596	4.0923666	0
75	Optimized	85.018995	-8.040988	501.75381	508.53996	2.8805493	0

90.2 Slices of Slip Surface: 16117

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	16117	21.914275	5.9142765	-307.59021	6.638973	2.8180768	0
2	16117	22.35926	5.469294	-280.83756	34.917467	14.821585	0
3	16117	23.07778	4.7507755	-237.62497	78.196979	33.192648	0
4	16117	23.7963	4.0322565	-194.42222	121.47944	51.564964	0
5	16117	24.514815	3.313738	-151.21947	164.76092	69.936863	0
6	16117	25.23333	2.5952195	-108.01672	208.03256	88.304584	0
7	16117	25.95185	1.8767005	-64.808063	251.31404	106.67648	0
8	16117	26.67037	1.1581818	-21.60236	294.59552	125.04838	0
9	16117	27.404575	0.42397638	22.545799	342.53396	135.82691	0

10	16117	28.15447	-0.32591587	67.637396	395.13139	139.01295	0
11	16117	28.904365	-1.075808	112.72899	447.72882	142.19899	0
12	16117	29.654255	-1.8257	157.82059	500.33569	145.38903	0
13	16117	30.404145	-2.5755925	202.91219	552.93312	148.57507	0
14	16117	31.154035	-3.325485	248.00379	605.53056	151.76111	0
15	16117	31.90393	-4.075377	293.09538	658.12799	154.94715	0
16	16117	32.653825	-4.825269	338.18698	710.72543	158.13319	0
17	16117	33.403715	-5.5751615	383.27858	763.32286	161.31923	0
18	16117	34.153605	-6.325054	428.37018	815.92029	164.50526	0
19	16117	34.90938	-6.7	450.05935	1052.7862	255.84238	0
20	16117	35.671035	-6.7	448.32628	1034.4446	248.79246	0
21	16117	36.43269	-6.7	446.59322	1016.103	241.74254	0
22	16117	37.194345	-6.7	444.87328	997.77445	234.69262	0
23	16117	37.956	-6.7	443.14021	979.43282	227.64271	0
24	16117	38.717655	-6.7	441.40714	961.10431	220.59836	0
25	16117	39.47931	-6.7	439.6872	942.76268	213.54287	0
26	16117	40.240965	-6.7	437.95413	924.42104	206.49295	0
27	16117	41.00262	-6.7	436.22107	906.09253	199.44861	0
28	16117	41.764275	-6.7	434.50113	887.7509	192.39311	0
29	16117	42.52593	-6.7	432.76806	869.40926	185.34319	0
30	16117	43.287585	-6.7	431.04812	851.08076	178.29328	0
31	16117	44.04924	-6.7	429.31505	832.73912	171.24336	0
32	16117	44.810895	-6.7	427.58199	814.39749	164.19344	0
33	16117	45.57255	-6.7	425.86205	796.06898	157.14352	0

34	16117	46.334205	-6.7	424.12898	777.72735	150.0936	0
35	16117	47.09586	-6.7	422.39591	759.39884	143.04926	0
36	16117	47.857515	-6.7	420.67597	741.05721	135.99376	0
37	16117	48.61917	-6.7	418.9429	722.71557	128.94385	0
38	16117	49.392705	-6.7	418.07394	709.8701	123.86012	0
39	16117	50.178115	-6.7	418.07394	702.49817	120.73092	0
40	16117	50.963525	-6.7	418.07394	695.13897	117.60712	0
41	16117	51.74894	-6.7	418.07394	687.76703	114.47792	0
42	16117	52.534355	-6.7	418.07394	680.40783	111.35413	0
43	16117	53.319765	-6.7	418.07394	673.0359	108.22493	0
44	16117	54.105175	-6.7	418.07394	665.6767	105.10113	0
45	16117	54.890585	-6.7	418.07394	658.3175	101.97734	0
46	16117	55.675995	-6.7	418.07394	650.94556	98.848137	0
47	16117	56.461405	-6.7	418.07394	643.58636	95.724341	0
48	16117	57.427055	-6.7	418.07787	634.52155	91.874892	0
49	16117	58.37768	-6.7	418.0804	625.61138	88.091675	0
50	16117	59.133035	-6.7	418.0804	618.52864	85.085229	0
51	16117	59.88839	-6.7	418.0804	611.4459	82.078783	0
52	16117	60.64375	-6.7	418.0804	604.36315	79.072337	0
53	16117	61.39911	-6.7	418.0804	597.28041	76.065891	0
54	16117	62.154465	-6.7	418.0804	590.19767	73.059445	0
55	16117	62.90982	-6.7	418.0804	583.11493	70.053	0
56	16117	63.66518	-6.7	418.0804	576.03218	67.046554	0
57	16117	64.420535	-6.7	418.0804	568.94944	64.040108	0
58	16117	65.17589	-6.7	418.0804	561.8667	61.033662	0

59	16117	65.93125	-6.7	418.0804	554.77072	58.021596	0
60	16117	66.68661	-6.7	418.0804	547.68797	55.01515	0
61	16117	67.441965	-6.7	418.0804	540.60523	52.008705	0
62	16117	68.19732	-6.7	418.0804	533.52249	49.002259	0
63	16117	68.95268	-6.7	418.0804	526.43975	45.995813	0
64	16117	69.708035	-6.7	418.0804	519.357	42.989367	0
65	16117	70.46339	-6.7	418.0804	512.27426	39.982921	0
66	16117	71.21875	-6.7	418.0804	505.19152	36.976475	0
67	16117	71.97411	-6.7	418.0804	498.10878	33.970029	0
68	16117	72.729465	-6.7	418.0804	491.02603	30.963583	0
69	16117	73.48482	-6.7	418.0804	483.94329	27.957137	0
70	16117	74.24018	-6.7	418.0804	476.86055	24.950691	0
71	16117	74.995535	-6.7	418.0804	469.7778	21.944245	0
72	16117	75.75089	-6.7	418.0804	462.69506	18.937799	0
73	16117	76.50625	-6.7	418.0804	455.61232	15.931354	0
74	16117	77.26161	-6.7	418.0804	448.52958	12.924908	0
75	16117	78.016965	-6.7	418.0804	441.44683	9.9184618	0
76	16117	78.77232	-6.7	418.0804	434.36409	6.9120158	0

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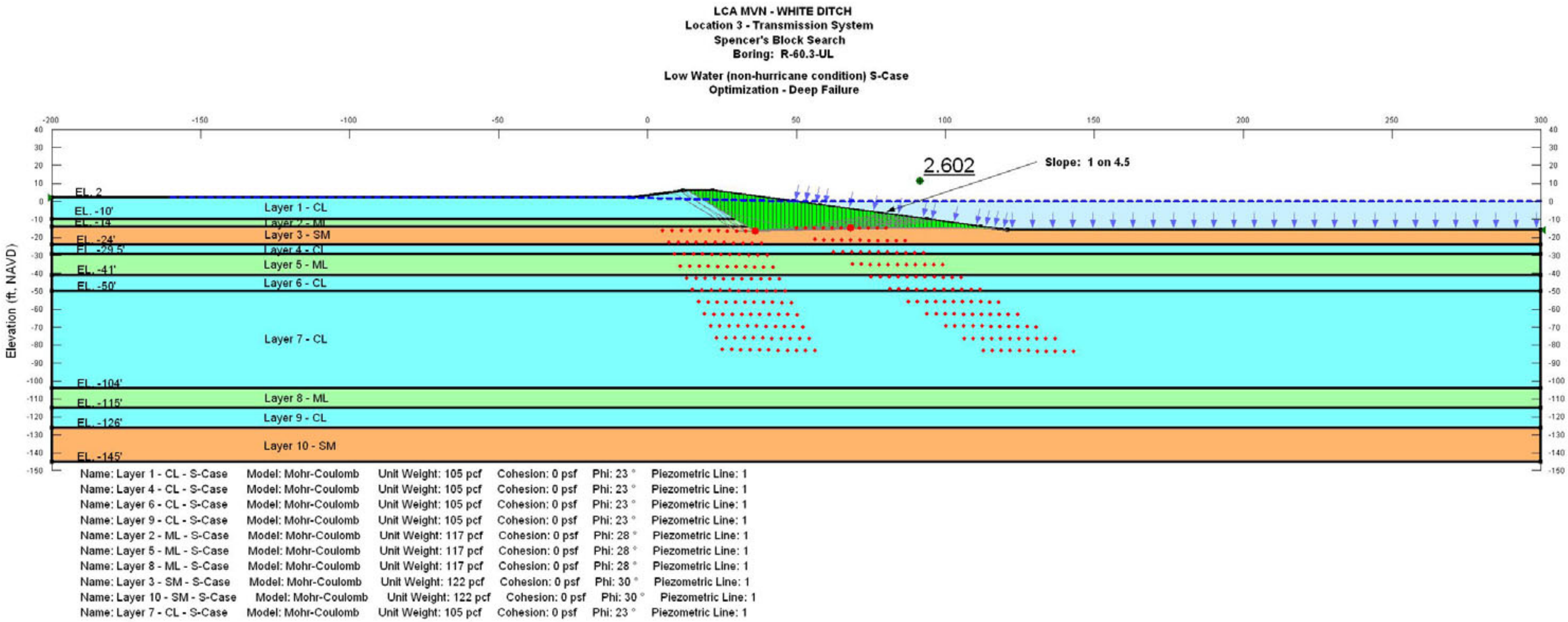


Low Water S-Case - Flood Side

91.0FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 76
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 1:00:10 PM
File Name: Location 3 - 35k cfs - Main Channel_R-60.3-LU_1on4.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010
Last Solved Time: 1:01:27 PM

92.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

93.0 ANALYSIS SETTINGS

93.1 Low Water S-Case - Flood Side

Description: Active and Passive Wedge Method
Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: Yes
Advanced
- Number of Slices: 75
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 5000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8

Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

94.0MATERIALS

94.1 Layer 1 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

94.2 Layer 4 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

94.3 Layer 6 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

94.4 Layer 9 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

94.5 Layer 2 - ML - S-Case

Model: Mohr-Coulomb

Unit Weight: 117 pcf

Cohesion: 0 psf

Phi: 28 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

94.6 Layer 5 - ML - S-Case

Model: Mohr-Coulomb

Unit Weight: 117 pcf

Cohesion: 0 psf

Phi: 28 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

94.7 Layer 8 - ML - S-Case

Model: Mohr-Coulomb

Unit Weight: 117 pcf

Cohesion: 0 psf

Phi: 28 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

94.8 Layer 3 - SM - S-Case

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion: 0 psf

Phi: 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

94.9 Layer 10 - SM - S-Case

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

94.10 Layer 7 - CL - S-Case

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion: 0 psf
Phi: 23 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

95.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft
Right Coordinate: (300, -16) ft

96.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (5.2803, -16.2114) ft
Lower Left: (25.2901, -82.6562) ft
Lower Right: (56.3051, -83.1814) ft
X Increments: 10
Y Increments: 10
Starting Angle: 115 °
Ending Angle: 135 °
Angle Increments: 3
Right Grid
Upper Left: (50.0021, -14.6356) ft
Lower Left: (112.8326, -83.1814) ft
Lower Right: (143.1473, -83.5754) ft
X Increments: 10

Y Increments: 10
Starting Angle: 0 °
Ending Angle: 45 °
Angle Increments: 3

97.0PIEZOMETRIC LINES

97.1 Piezometric Line 1

97.1.1 Coordinates

	X (ft)	Y (ft)
	-160	2
	-6	2
	49	0
	300	0

98.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 10 - SM - S-Case	20,21,15,11	9500
Region 2	Layer 9 - CL - S-Case	20,10,14,21	5500
Region 3	Layer 8 - ML - S-Case	10,9,13,14	5500
Region 4	Layer 5 - ML - S-Case	18,19,12,23	5750
Region 5	Layer 4 - CL - S-Case	8,18,23,22	2750
Region 6	Layer 1 - CL - S-Case	1,2,3,4,28,7,24,16	3316
Region 7	Layer 2 - ML - S-Case	17,16,24,25	1212
Region 8	Layer 3 - SM - S-Case	17,25,5,6,22,8	4633
Region 9	Layer 6 - CL - S-Case	19,26,27,12	4500
Region 10	Layer 7 - CL - S-Case	26,9,13,27	27000

99.0 POINTS

	X (ft)	Y (ft)

Point 1	-200	2
Point 2	-6	2
Point 3	12	6
Point 4	22	6
Point 5	121	-16
Point 6	300	-16
Point 7	58	-2
Point 8	-200	-24
Point 9	-200	-104
Point 10	-200	-115
Point 11	-200	-145
Point 12	300	-41
Point 13	300	-104
Point 14	300	-115
Point 15	300	-145
Point 16	-200	-10
Point 17	-200	-14
Point 18	-200	-29.5
Point 19	-200	-41
Point 20	-200	-126
Point 21	300	-126
Point 22	300	-24
Point 23	300	-29.5
Point 24	94	-10

Point 25	112	-14
Point 26	-200	-50
Point 27	300	-50
Point 28	49	0

100.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	2.187	(67.933, 11.218)	47.02012	(13.4298, 6)	(120.99, -15.9979)
2	1917	2.602	(67.933, 11.218)	45.214	(13.5587, 6)	(115.924, -14.872)

100.1 Slices of Slip Surface: Optimized

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	14.23555	5.186277	-244.74054	67.100292	28.482384	0
2	Optimized	15.847045	3.558831	-146.8452	201.30088	85.447152	0
3	Optimized	17.458535	1.9313855	-48.949855	335.50146	142.41192	0
4	Optimized	18.5473	0.8318415	17.192643	428.56681	174.61797	0
5	Optimized	19.62274	-0.1226788	74.3154	533.43518	194.88478	0
6	Optimized	21.20758	-1.4600763	154.17154	657.51118	213.655	0
7	Optimized	22.78061	-2.7875095	233.43631	765.80151	225.97562	0
8	Optimized	24.341835	-4.104978	312.10181	858.32036	231.85602	0
9	Optimized	25.90306	-5.422446	390.7673	950.8392	237.73642	0
10	Optimized	27.45553	-6.4077485	448.72873	1090.859	272.56812	0
11	Optimized	28.99925	-7.060885	485.98558	1122.5377	270.20036	0
12	Optimized	30.542965	-7.7140215	523.23646	1154.1568	267.80981	0
13	Optimized	32.08668	-8.3671585	560.48734	1185.8356	265.44459	0
14	Optimized	33.6304	-9.020295	597.72032	1217.4547	263.06164	0

15	Optimized	35.17412	-9.6734315	635.007	1249.0738	260.65589	0
16	Optimized	36.543555	-10.25283	668.04446	1271.1446	320.67406	0
17	Optimized	37.73871	-10.758495	696.87947	1301.1201	321.28045	0
18	Optimized	38.93387	-11.26416	725.72219	1331.0956	321.88274	0
19	Optimized	40.274185	-11.710655	750.55093	1393.3592	341.7872	0
20	Optimized	41.759655	-12.097985	771.3308	1404.1725	336.48791	0
21	Optimized	43.245125	-12.485315	792.11068	1414.9859	331.18861	0
22	Optimized	44.7306	-12.872645	812.9557	1425.7992	325.85468	0
23	Optimized	46.216075	-13.259975	833.73558	1436.5474	320.52075	0
24	Optimized	47.701545	-13.647305	854.51545	1447.3608	315.22146	0
25	Optimized	48.72214	-13.871935	866.24487	1491.2353	332.31328	0
26	Optimized	49.43561	-13.95145	870.57374	1490.0459	329.37918	0
27	Optimized	50.70291	-14.09269	879.3822	1495.2126	355.54987	0
28	Optimized	52.154375	-14.19252	885.5854	1524.9687	369.14812	0
29	Optimized	53.393925	-14.2068	886.47276	1515.1271	362.95374	0
30	Optimized	54.678085	-14.22952	887.94792	1502.1834	354.62901	0
31	Optimized	56.00685	-14.260685	889.90409	1493.6064	348.54767	0
32	Optimized	57.335615	-14.29185	891.78501	1485.0293	342.50976	0
33	Optimized	58.388745	-14.31655	893.34783	1478.1977	337.66325	0
34	Optimized	59.453825	-14.350665	895.4699	1468.4643	330.81844	0
35	Optimized	60.80649	-14.400655	898.57276	1462.0369	325.31618	0
36	Optimized	62.159155	-14.45065	901.74949	1455.6096	319.77126	0
37	Optimized	63.511825	-14.500645	904.85235	1449.1822	314.26899	0
38	Optimized	65.121885	-14.529585	906.62914	1447.0403	312.00653	0

39	Optimized	66.74872	-14.5343	906.92348	1433.245	303.87185	0
40	Optimized	68.134945	-14.53584	907.06776	1420.4043	296.37501	0
41	Optimized	69.52117	-14.537385	907.13989	1407.4916	288.87817	0
42	Optimized	70.907395	-14.53893	907.21203	1394.6509	281.42298	0
43	Optimized	72.29362	-14.54047	907.35631	1381.8103	273.92615	0
44	Optimized	73.68717	-14.543025	907.49517	1368.6309	266.23685	0
45	Optimized	75.088055	-14.546595	907.70932	1355.9247	258.77727	0
46	Optimized	76.48894	-14.550165	907.92347	1343.2185	251.31769	0
47	Optimized	77.889825	-14.55374	908.13762	1330.4409	243.8169	0
48	Optimized	79.29071	-14.557315	908.35177	1317.7347	236.35733	0
49	Optimized	80.691595	-14.560885	908.56592	1305.0284	228.89775	0
50	Optimized	82.09248	-14.564455	908.85145	1292.2508	221.35575	0
51	Optimized	83.493365	-14.568025	909.0656	1279.5446	213.89617	0
52	Optimized	84.89425	-14.571595	909.27975	1266.8384	206.43659	0
53	Optimized	86.295135	-14.57517	909.4939	1254.1322	198.97701	0
54	Optimized	87.69602	-14.578745	909.70805	1241.3546	191.47622	0
55	Optimized	89.096905	-14.582315	909.9222	1228.6484	184.01665	0
56	Optimized	90.49779	-14.585885	910.13635	1215.9422	176.55707	0
57	Optimized	91.898675	-14.589455	910.3505	1203.1646	169.05628	0
58	Optimized	93.29956	-14.593025	910.63603	1190.4583	161.55549	0
59	Optimized	94.75608	-14.59674	910.8133	1175.1363	152.60696	0
60	Optimized	96.26824	-14.600595	911.07783	1157.2811	142.14554	0
61	Optimized	97.7804	-14.60445	911.34235	1139.4259	131.68411	0
62	Optimized	99.29254	-14.608305	911.54074	1121.5046	121.22269	0

63	Optimized	100.8047	-14.61216	911.80526	1103.6494	110.76127	0
64	Optimized	102.3169	-14.616015	912.06978	1085.7942	100.29985	0
65	Optimized	103.82905	-14.61987	912.26817	1067.939	89.876603	0
66	Optimized	105.2684	-14.653655	914.38855	1048.5242	77.443261	0
67	Optimized	106.63495	-14.717365	918.33587	1039.9717	70.226477	0
68	Optimized	108.00145	-14.781075	922.35628	1031.4923	63.009694	0
69	Optimized	109.20845	-14.840075	926.02267	1023.6282	56.352578	0
70	Optimized	110.29915	-14.910655	930.43665	1016.2609	49.550642	0
71	Optimized	111.43305	-14.997525	935.8886	1013.447	44.778346	0
72	Optimized	112.67175	-15.09242	941.73475	1009.5687	39.163975	0
73	Optimized	114.0152	-15.195345	948.1916	1004.6705	32.60808	0
74	Optimized	115.47485	-15.34069	957.2809	998.99496	24.083622	0
75	Optimized	117.0507	-15.52845	969.00116	1001.5154	18.772128	0
76	Optimized	118.62655	-15.71621	980.72143	1004.0359	13.460635	0
77	Optimized	120.2024	-15.90397	992.37868	1006.5564	8.1855211	0

100.2 Slices of Slip Surface: 1917

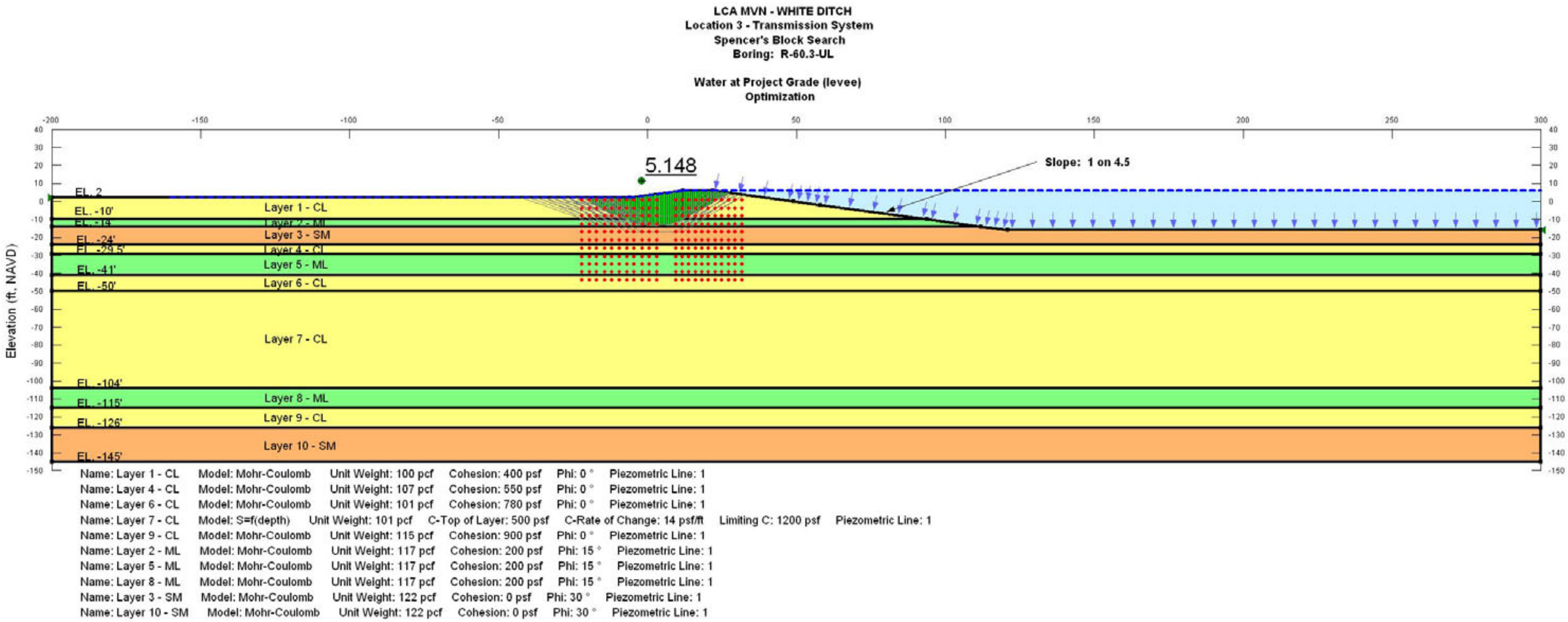
	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	1917	14.169825	5.388874	-257.23088	51.316585	21.782598	0
2	1917	15.392075	4.166622	-183.74047	153.95207	65.348776	0
3	1917	16.61433	2.94437	-110.24428	256.58292	108.91299	0
4	1917	17.836585	1.722118	-36.747516	359.21957	152.47966	0
5	1917	19.03976	0.51894348	35.600248	464.41856	182.02258	0
6	1917	20.223855	-0.66515402	106.80373	572.17776	197.53956	0
7	1917	21.40795	-1.8492515	178.00422	679.93696	213.05781	0

8	1917	22.62989	-3.0711915	251.47578	779.41045	224.09497	0
9	1917	23.889675	-4.330975	327.22778	870.56432	230.63268	0
10	1917	25.14946	-5.5907585	402.97979	961.66205	237.14655	0
11	1917	26.40924	-6.8505415	478.73179	1052.8159	243.68425	0
12	1917	27.669025	-8.110325	554.4838	1143.9698	250.22196	0
13	1917	28.92881	-9.3701085	630.21897	1235.1236	256.7668	0
14	1917	30.225365	-10.666665	708.20283	1317.287	323.85578	0
15	1917	31.5587	-12	788.38874	1425.7395	338.88539	0
16	1917	32.892035	-13.333335	868.57465	1534.1389	353.88681	0
17	1917	34.24285	-14.68415	949.78574	1638.237	397.47752	0
18	1917	35.61115	-16.05245	1032.0568	1754.4086	417.05005	0
19	1917	37.001115	-16.69534	1068.9915	2179.9903	641.43543	0
20	1917	38.41275	-16.612815	1060.6467	2135.4372	620.53059	0
21	1917	39.824385	-16.53029	1052.3018	2090.8841	599.62576	0
22	1917	41.236015	-16.44777	1043.9569	2046.2603	578.68009	0
23	1917	42.64765	-16.365245	1035.6121	2001.7072	557.77526	0
24	1917	44.059285	-16.28272	1027.2672	1957.1541	536.87043	0
25	1917	45.470915	-16.2002	1018.9223	1912.5302	515.92476	0
26	1917	46.88255	-16.117675	1010.5775	1867.9771	495.01993	0
27	1917	48.294185	-16.03515	1002.1619	1823.3533	474.1151	0
28	1917	49.642855	-15.95631	995.64488	1790.2662	458.77486	0
29	1917	50.92857	-15.88115	990.98616	1768.6032	448.95741	0
30	1917	52.214285	-15.805985	986.32745	1746.9402	439.13997	0
31	1917	53.5	-15.73082	981.59109	1725.2772	429.36736	0
32	1917	54.785715	-15.65566	976.93238	1703.5365	419.50509	0

33	1917	56.07143	-15.5805	972.19602	1681.8735	409.73248	0
34	1917	57.357145	-15.50534	967.5373	1660.2105	399.91504	0
35	1917	58.727925	-15.425205	962.53868	1637.1455	389.48441	0
36	1917	60.18377	-15.340095	957.1901	1612.5969	378.39927	0
37	1917	61.639615	-15.254985	951.91009	1588.0483	367.27454	0
38	1917	63.09546	-15.169875	946.63009	1563.4996	356.14981	0
39	1917	64.551305	-15.08477	941.28151	1538.951	345.06466	0
40	1917	66.00715	-14.999665	936.0015	1514.4024	333.93993	0
41	1917	67.462995	-14.914555	930.65292	1489.9224	322.89438	0
42	1917	68.870105	-14.872	928.02198	1454.7551	304.10949	0
43	1917	70.22848	-14.872	928.02198	1442.0192	296.75646	0
44	1917	71.586855	-14.872	928.02198	1429.357	289.44593	0
45	1917	72.945225	-14.872	928.02198	1416.6212	282.0929	0
46	1917	74.303595	-14.872	928.02198	1403.8854	274.73986	0
47	1917	75.66197	-14.872	928.02198	1391.1496	267.38683	0
48	1917	77.020345	-14.872	928.02198	1378.4874	260.0763	0
49	1917	78.378715	-14.872	928.02198	1365.7515	252.72327	0
50	1917	79.737085	-14.872	928.02198	1353.0157	245.37024	0
51	1917	81.09546	-14.872	928.02198	1340.2799	238.01721	0
52	1917	82.453835	-14.872	928.02198	1327.6177	230.70668	0
53	1917	83.812205	-14.872	928.02198	1314.8818	223.35365	0
54	1917	85.170575	-14.872	928.02198	1302.146	216.00062	0
55	1917	86.52895	-14.872	928.02198	1289.4838	208.69009	0
56	1917	87.887325	-14.872	928.02198	1276.748	201.33706	0
57	1917	89.245695	-14.872	928.02198	1264.0122	193.98403	0
58	1917	90.604065	-14.872	928.02198	1251.2763	186.63099	0

59	1917	91.96244	-14.872	928.02198	1238.6141	179.32047	0
60	1917	93.320815	-14.872	928.02198	1225.8783	171.96743	0
61	1917	94.69231	-14.872	927.98359	1211.167	163.49602	0
62	1917	96.076925	-14.872	927.98359	1194.4114	153.82219	0
63	1917	97.46154	-14.872	927.98359	1177.6559	144.14836	0
64	1917	98.846155	-14.872	927.98359	1160.9003	134.47454	0
65	1917	100.23078	-14.872	927.98359	1144.217	124.84241	0
66	1917	101.6154	-14.872	927.98359	1127.4614	115.16858	0
67	1917	103	-14.872	927.98359	1110.7059	105.49475	0
68	1917	104.3846	-14.872	927.98359	1093.9503	95.820926	0
69	1917	105.7692	-14.872	927.98359	1077.1947	86.147099	0
70	1917	107.15385	-14.872	927.98359	1060.5114	76.514969	0
71	1917	108.5385	-14.872	927.98359	1043.7558	66.841142	0
72	1917	109.9231	-14.872	927.98359	1027.0003	57.167315	0
73	1917	111.3077	-14.872	927.98359	1010.2447	47.493488	0
74	1917	112.654	-14.872	927.98165	993.27217	37.695499	0
75	1917	113.962	-14.872	927.98165	975.91743	27.675735	0
76	1917	115.27	-14.872	927.98165	958.63914	17.700111	0

870



Water at Project Grade (levees)

101.0 FILE INFORMATION

Created By: Goetz, Ryan MVS
Revision Number: 74
Last Edited By: Goetz, Ryan MVS
Date: 3/5/2010
Time: 10:57:29 AM
File Name: Location 3 - 35k cfs - Main Channel_R-60.3-LU_1on4.5 Slope.gsz
Directory: C:\Documents and Settings\B3ECGRPG\My Documents\White Ditch\
Last Solved Date: 3/5/2010
Last Solved Time: 11:07:39 AM

102.0 PROJECT SETTINGS

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

103.0 ANALYSIS SETTINGS

103.1 Water at Project Grade (levees)

Description: Active and Passive Wedge Method
Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: Yes
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Restrict Block Crossing: Yes
Advanced
- Number of Slices: 75
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 5000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8

Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

104.0 MATERIALS

104.1 Layer 1 - CL

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion: 400 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.2 Layer 4 - CL

Model: Mohr-Coulomb
Unit Weight: 107 pcf
Cohesion: 550 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.3 Layer 6 - CL

Model: Mohr-Coulomb
Unit Weight: 101 pcf
Cohesion: 780 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.4 Layer 7 - CL

Model: S=f(depth)
Unit Weight: 101 pcf
C-Top of Layer: 500 psf
C-Rate of Change: 14 psf/ft

Limiting C: 1200 psf
Pore Water Pressure
Piezometric Line: 1

104.5 Layer 9 - CL

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 900 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.6 Layer 2 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.7 Layer 5 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.8 Layer 8 - ML

Model: Mohr-Coulomb
Unit Weight: 117 pcf
Cohesion: 200 psf
Phi: 15 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1

104.9 Layer 3 - SM

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

104.10 Layer 10 - SM

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

105.0 SLIP SURFACE LIMITS

Left Coordinate: (-200, 2) ft
Right Coordinate: (300, -16) ft

106.0 SLIP SURFACE BLOCK

Left Grid
Upper Left: (-22, 0.75) ft
Lower Left: (-22, -44) ft
Lower Right: (3.25, -44) ft
X Increments: 10
Y Increments: 10
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 3
Right Grid
Upper Left: (9.5, 0.75) ft
Lower Left: (9.5, -44) ft
Lower Right: (31.7145, -44) ft
X Increments: 10

Y Increments: 10
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 3

107.0 PIEZOMETRIC LINES

107.1 Piezometric Line 1

107.1.1Coordinates

	X (ft)	Y (ft)
	-160	2
	-6	2
	12	6
	22	6
	300	6

108.0 REGIONS

	Material	Points	Area (ft²)
Region 1	Layer 10 - SM	20,21,15,11	9500
Region 2	Layer 9 - CL	20,10,14,21	5500
Region 3	Layer 8 - ML	10,9,13,14	5500
Region 4	Layer 5 - ML	18,19,12,23	5750
Region 5	Layer 4 - CL	8,18,23,22	2750
Region 6	Layer 1 - CL	1,2,3,4,28,7,24,16	3316
Region 7	Layer 2 - ML	17,16,24,25	1212
Region 8	Layer 3 - SM	17,25,5,6,22,8	4633
Region 9	Layer 6 - CL	19,26,27,12	4500
Region 10	Layer 7 - CL	26,9,13,27	27000

109.0 POINTS

	X (ft)	Y (ft)
Point 1	-200	2
Point 2	-6	2
Point 3	12	6
Point 4	22	6
Point 5	121	-16
Point 6	300	-16
Point 7	58	-2
Point 8	-200	-24
Point 9	-200	-104
Point 10	-200	-115
Point 11	-200	-145
Point 12	300	-41
Point 13	300	-104
Point 14	300	-115
Point 15	300	-145
Point 16	-200	-10
Point 17	-200	-14
Point 18	-200	-29.5
Point 19	-200	-41
Point 20	-200	-126
Point 21	300	-126
Point 22	300	-24

Point 23	300	-29.5
Point 24	94	-10
Point 25	112	-14
Point 26	-200	-50
Point 27	300	-50
Point 28	49	0

110.0 CRITICAL SLIP SURFACES

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	Optimized	5.148	(-0.197, 5.597)	22.84998	(27.7539, 4.72135)	(-21.8475, 2)
2	7261	5.447	(-0.197, 5.597)	24.266	(27.0523, 4.87727)	(-27.2178, 2)

035 **110.1 Slices of Slip Surface: Optimized**

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	Optimized	-21.49106	1.6675915	20.742061	110.4554	0	400
2	Optimized	-20.778165	1.002774	62.227208	178.61419	0	400
3	Optimized	-20.06527	0.33795625	103.71543	246.77297	0	400
4	Optimized	-19.352375	-0.32686125	145.19135	314.9215	0	400
5	Optimized	-18.628945	-0.984035	186.20427	378.02018	0	400
6	Optimized	-17.89497	-1.633565	226.73049	444.52317	0	400
7	Optimized	-17.160995	-2.283095	267.2669	511.02615	0	400
8	Optimized	-16.42702	-2.932625	307.79311	577.53934	0	400
9	Optimized	-15.699745	-3.5610085	347.00806	637.79273	0	400
10	Optimized	-14.97918	-4.168245	384.89359	699.89528	0	400
11	Optimized	-14.258615	-4.7754815	422.78972	761.99783	0	400
12	Optimized	-13.53108	-5.371695	459.99868	818.30547	0	400

13	Optimized	-12.796585	-5.956885	496.51192	878.07474	0	400
14	Optimized	-12.062095	-6.542075	533.02516	937.85466	0	400
15	Optimized	-11.3276	-7.127265	569.5384	997.62392	0	400
16	Optimized	-10.622345	-7.675958	603.7853	1049.4703	0	400
17	Optimized	-9.946339	-8.188154	635.73786	1101.7381	0	400
18	Optimized	-9.270335	-8.70035	667.7022	1153.9941	0	400
19	Optimized	-8.594329	-9.212546	699.66654	1206.2972	0	400
20	Optimized	-7.918323	-9.724742	731.61909	1258.5296	0	400
21	Optimized	-7.177338	-10.22512	762.84827	1289.0446	140.99387	200
22	Optimized	-6.387178	-10.7041	792.73822	1346.7406	148.44449	200
23	Optimized	-5.6616215	-11.14392	824.86688	1407.6529	156.15703	200
24	Optimized	-4.984865	-11.55416	859.85603	1472.7284	164.21865	200
25	Optimized	-4.3081085	-11.9644	894.84517	1537.8039	172.28027	200
26	Optimized	-3.633315	-12.28104	923.95438	1558.7577	170.09504	200
27	Optimized	-2.960485	-12.504075	947.20384	1600.5165	175.05459	200
28	Optimized	-2.287655	-12.72711	970.4533	1642.2752	180.01413	200
29	Optimized	-1.614825	-12.950145	993.70275	1684.0339	184.97368	200
30	Optimized	-0.941995	-13.17318	1016.9381	1725.7927	189.93701	200
31	Optimized	-0.24735	-13.31199	1035.2437	1726.4268	185.20195	200
32	Optimized	0.46911	-13.36657	1048.5764	1748.8335	187.63332	200
33	Optimized	1.18557	-13.421155	1061.923	1771.2402	190.06097	200
34	Optimized	1.90203	-13.47574	1075.2556	1793.6468	192.49234	200
35	Optimized	2.61849	-13.53032	1088.6022	1816.0535	194.91998	200
36	Optimized	3.333657	-13.492205	1096.1466	1795.4956	187.39002	200

37	Optimized	4.047531	-13.36139	1097.8827	1796.0468	187.07251	200
38	Optimized	4.761405	-13.230575	1099.6188	1796.5979	186.755	200
39	Optimized	5.475279	-13.09976	1101.3549	1797.2869	186.47441	200
40	Optimized	6.189153	-12.968945	1103.091	1797.838	186.1569	200
41	Optimized	6.883003	-12.749075	1098.9832	1755.238	175.84293	200
42	Optimized	7.556829	-12.44015	1089.0543	1734.4628	172.93668	200
43	Optimized	8.230655	-12.131225	1079.1253	1713.8224	170.06657	200
44	Optimized	8.904481	-11.8223	1069.1829	1693.1821	167.20008	200
45	Optimized	9.578307	-11.513375	1059.254	1672.4068	164.29382	200
46	Optimized	10.213105	-11.132425	1044.279	1610.3449	151.6769	200
47	Optimized	10.80887	-10.679455	1024.2766	1572.1306	146.79703	200
48	Optimized	11.404635	-10.226485	1004.2743	1533.7827	141.88136	200
49	Optimized	11.85126	-9.88691	989.29305	1498.3361	0	400
50	Optimized	12.29563	-9.54905	970.26688	1468.4735	0	400
51	Optimized	12.886885	-9.09951	942.20876	1424.3129	0	400
52	Optimized	13.528845	-8.575649	909.52568	1361.5405	0	400
53	Optimized	14.221515	-7.9774675	872.19012	1303.0842	0	400
54	Optimized	14.914185	-7.379286	834.86549	1244.5186	0	400
55	Optimized	15.60686	-6.781104	797.54086	1186.0623	0	400
56	Optimized	16.299535	-6.1829225	760.21623	1127.606	0	400
57	Optimized	16.992205	-5.584741	722.89159	1069.0841	0	400
58	Optimized	17.636515	-5.004634	686.6832	1004.2731	0	400
59	Optimized	18.232465	-4.442602	651.6233	949.42488	0	400
60	Optimized	18.82842	-3.88057	616.5512	894.58886	0	400

61	Optimized	19.424375	-3.318538	581.4791	839.75284	0	400
62	Optimized	20.020325	-2.756506	546.407	784.90462	0	400
63	Optimized	20.598585	-2.193963	511.3012	724.2217	0	400
64	Optimized	21.15915	-1.6309085	476.17316	669.3711	0	400
65	Optimized	21.719715	-1.0678541	441.03253	614.52051	0	400
66	Optimized	22.32385	-0.4610388	403.17016	552.74136	0	400
67	Optimized	22.971555	0.189538	362.5721	484.03947	0	400
68	Optimized	23.61926	0.8401147	321.97405	415.33759	0	400
69	Optimized	24.26696	1.4906915	281.37599	346.6357	0	400
70	Optimized	24.90712	2.1065175	242.94941	288.5148	0	400
71	Optimized	25.53974	2.687592	206.69734	226.56963	0	400
72	Optimized	26.17236	3.2686665	170.43363	164.62445	0	400
73	Optimized	26.80498	3.8497415	134.18156	102.6851	0	400
74	Optimized	27.4376	4.430816	97.916682	40.739924	0	400

110.2 Slices of Slip Surface: 7261

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	7261	-26.85949	1.7931035	12.909833	66.031792	0	400
2	7261	-26.142775	1.3793105	38.730709	108.05158	0	400
3	7261	-25.426065	0.96551735	64.551584	150.075	0	400
4	7261	-24.709355	0.55172415	90.372459	192.08875	0	400
5	7261	-23.992645	0.13793104	116.19333	234.1025	0	400
6	7261	-23.275935	-0.27586206	142.01542	276.12834	0	400
7	7261	-22.559225	-0.68965515	167.8375	318.14209	0	400
8	7261	-21.842515	-1.1034484	193.65958	360.16792	0	400

9	7261	-21.125805	-1.5172415	219.48167	402.18167	0	400
10	7261	-20.409095	-1.9310345	245.29167	444.2075	0	400
11	7261	-19.692385	-2.3448275	271.11375	486.22125	0	400
12	7261	-18.975675	-2.7586205	296.93584	528.24709	0	400
13	7261	-18.258965	-3.1724135	322.75792	570.26084	0	400
14	7261	-17.542255	-3.5862065	348.58	612.27459	0	400
15	7261	-16.825545	-4	374.40209	654.30042	0	400
16	7261	-16.10883	-4.4137935	400.22417	696.31417	0	400
17	7261	-15.392115	-4.8275865	426.04625	738.34001	0	400
18	7261	-14.675405	-5.2413795	451.85625	780.35376	0	400
19	7261	-13.958695	-5.6551725	477.67834	822.37959	0	400
20	7261	-13.241985	-6.0689655	503.50042	864.39334	0	400
21	7261	-12.525275	-6.4827585	529.3225	906.40709	0	400
22	7261	-11.808565	-6.8965515	555.14459	948.43292	0	400
23	7261	-11.091855	-7.3103445	580.96667	990.44667	0	400
24	7261	-10.375145	-7.7241375	606.78876	1032.4725	0	400
25	7261	-9.6584345	-8.137931	632.61084	1074.4863	0	400
26	7261	-8.9417235	-8.5517245	658.43292	1116.5121	0	400
27	7261	-8.2250125	-8.9655175	684.24292	1158.5258	0	400
28	7261	-7.508302	-9.3793105	710.06501	1200.5396	0	400
29	7261	-6.7915915	-9.7931035	735.88709	1242.5292	0	400
30	7261	-6.216618	-10.125065	756.61004	1271.4447	137.94953	200
31	7261	-5.65	-10.4522	781.87246	1318.8329	143.87813	200
32	7261	-4.95	-10.856345	816.79802	1383.5374	151.85736	200

33	7261	-4.25	-11.26049	851.72359	1448.2419	159.83659	200
34	7261	-3.55	-11.664635	886.64915	1513.0701	167.84897	200
35	7261	-2.85	-12.06878	921.57472	1577.7745	175.82821	200
36	7261	-2.15	-12.472925	956.50029	1642.479	183.80744	200
37	7261	-1.446875	-12.675	978.86018	1616	170.7211	200
38	7261	-0.740625	-12.675	988.64425	1631.7168	172.31077	200
39	7261	-0.034375	-12.675	998.44248	1647.292	173.85871	200
40	7261	0.671875	-12.675	1008.2407	1663.0088	175.44459	200
41	7261	1.378125	-12.675	1018.0248	1678.7257	177.03427	200
42	7261	2.084375	-12.675	1027.823	1694.4425	178.62015	200
43	7261	2.790625	-12.675	1037.6212	1710.1593	180.20603	200
44	7261	3.496875	-12.675	1047.4053	1725.8761	181.7957	200
45	7261	4.203125	-12.675	1057.2035	1741.5929	183.38158	200
46	7261	4.909375	-12.675	1067.0018	1757.3097	184.96746	200
47	7261	5.615625	-12.675	1076.7858	1773.0265	186.55714	200
48	7261	6.321875	-12.675	1086.5841	1788.7434	188.14302	200
49	7261	7.028125	-12.675	1096.3823	1804.3186	189.69096	200
50	7261	7.734375	-12.675	1106.1664	1820.0354	191.28063	200
51	7261	8.440625	-12.675	1115.9646	1835.7522	192.86651	200
52	7261	9.146875	-12.675	1125.7628	1851.469	194.45239	200
53	7261	9.916665	-12.258335	1110.4691	1708.5118	160.24508	200
54	7261	10.75	-11.425	1069.9943	1633.1625	150.90048	200
55	7261	11.583335	-10.591665	1029.5195	1557.8132	141.55588	200
56	7261	12.0875	-10.0875	1003.8491	1510.3799	135.72453	200
57	7261	12.525895	-9.649107	976.50832	1455.0494	0	400

58	7261	13.22768	-8.9473215	932.70873	1386.6346	0	400
59	7261	13.929465	-8.245536	888.91921	1318.3205	0	400
60	7261	14.63125	-7.54375	845.12969	1249.9057	0	400
61	7261	15.333035	-6.841964	801.34016	1181.5916	0	400
62	7261	16.03482	-6.1401785	757.55064	1113.1768	0	400
63	7261	16.736605	-5.438393	713.75105	1044.7619	0	400
64	7261	17.438395	-4.736607	669.96153	976.41764	0	400
65	7261	18.14018	-4.0348215	626.17201	908.04312	0	400
66	7261	18.841965	-3.333036	582.38249	839.65851	0	400
67	7261	19.54375	-2.63125	538.59297	771.28399	0	400
68	7261	20.245535	-1.929464	494.80345	702.90946	0	400
69	7261	20.94732	-1.2276783	451.00385	634.53494	0	400
70	7261	21.649105	-0.52589285	407.21433	566.16041	0	400
71	7261	22.360875	0.1858766	362.80522	493.85087	0	400
72	7261	23.08263	0.9076296	317.76807	417.59045	0	400
73	7261	23.804385	1.629383	272.73092	341.33983	0	400
74	7261	24.526135	2.3511365	227.69378	265.07941	0	400
75	7261	25.24789	3.0728895	182.64684	188.82879	0	400
76	7261	25.969645	3.7946425	137.60969	112.57817	0	400
77	7261	26.691395	4.516396	92.576464	36.322649	0	400

L6. Environmental Engineering

The proposed project will make beneficial use of dredge spoil produced. Dredged material from the proposed channel enhancement features, in addition to any other spoil available, will allow new areas of marsh to be created.

Regenerative planting, with native species, will be done to stabilize the placed dredge spoil and prevent return of the material to the waterway. The use of native species plantings to quickly establish targeted vegetative communities will assist in reducing the risk of invasive species impacts. Native vegetation will trap sediment following into the marsh from the proposed project, accreting additional marsh area over time.

L7. Civil Design Criteria

L7.1 Site Recommendations

Multiple features were considered to reintroduce and distribute Mississippi River water into the marsh. An inlet and outfall channel, working in conjunction with a structure, would feed distributary channels containing strategically positioned culverts or openings that allow sediment and freshwater to flow into the marsh. Notched dikes to constrict flow, but still allow boat traffic through, would be placed in key locations to prevent the loss of the valuable sediments and nutrients from the freshwater diversion. Areas of new marsh would be created from dredged material out of the proposed channel enhancement features as well as any other beneficial spoil that is available.

Four alternatives, utilizing box culverts described in section C8, were considered at Location 2, White Ditch, LA. Six alternatives, utilizing box culverts and siphons, also described in section C8, were considered at Location 3, Phoenix, LA.

Modeling was done with Bentley InRoads XM Edition v08. Data used for the modeling included a topographic survey of the marsh area performed by FTN Associates, LTD (July 2009) and LIDAR flown within approximately 250 feet of the levee corridor. The topographic survey contained points, but the cross-sectional data was spread out over a large area, with cross-sections ranging from 915 feet apart to 3850 feet apart. Quantities were prepared by analyzing the proposed channel areas and using the closes cross-sectional data along the channel until the proposed channel changed.

The following assumptions were made concerning Marsh Creation:

- Berm: 6’ tall (feasibility quantities only – during construction contractor shall maintain a berm height of 5’), 10’ crown, 1 on 6 side slopes.
- This material will be pushed up from the interior of the footprint of the marsh creation area.
- Excavation will be in the wet, material will settle under its own weight.
- 1 unit of material pushed up with no compaction will result in 0.75 units in the containment dike.

- In marsh areas with no compaction, 1 unit dredged from the channel will result in 1 unit in the marsh creation area.
- All material for marsh creation will be all excess material dredged from the channel not used for the side berms on the channel.
- Marsh areas are calculated to be 4' thick

L7.2 Civil Site Design for Diversion Facility

L7.2.1 General

Ten alternatives were studied for this proposed diversion project. Each alternative consists of, at a minimum, an inlet channel, structure, outfall structure with a concrete apron, outfall channel, system of distributary channels in the marsh with culverts or cutoffs to smaller channels and plugs at Oak River. Following is a description of the features that will hold constant for each alternative, although quantities will change according to design template:

- Inlet: entire length will be reinforced with rock, on both side slopes and 15 feet past the top of the new bank. Top of rock should be the same elevation as the top of natural ground. Layers will match 400lb rip protection.
- Outlet: at the end of the concrete apron for 100 feet there will be 1000 lb rip protection. At 100 feet, transitions to 400lb rip rap protection.
- At culverts and cutoffs to smaller channels, anywhere there is a velocity change there will be 400lb rip rap for a minimum of 100 feet each side of cutoff.
- Rock protection, 400lb rip rap, will be placed adjacent to the box culvert and as protection for the proposed road perpendicular to the structure.
    - 400lb protection:
        Geotextile
        12" bedding material
        Geogrid
        12" bedding material
        30" 400lb rip rap
    - 1000lb protection:
        Geotextile
        12" bedding material
        Geogrid
        12" bedding material
        42" 1000lb rip rap

L7.2.2 Alternatives Array

Below are the alternatives for the proposed diversion project:

Alternative	Location	Outfall Capacity	Structure
2B	2	5,000 cfs	3-box culvert
2D	2	10,000 cfs	3-box culvert
2E	2	15,000 cfs	10-box culvert
2F	2	35,000 cfs	10-box culvert
3A	3	5,000 cfs	30-pipe siphon
3B	3	5,000 cfs	3-box culvert
3C	3	10,000 cfs	30-pipe siphon
3D	3	10,000 cfs	3-box culvert
3E	3	15,000 cfs	10-box culvert
3F	3	35,000 cfs	10-box culvert

Table 1

L7.2.3 Description of Civil Site Alternatives

Plan views of the alternatives are shown on the following plates:

Alternative	Location	Outfall Capacity	Sheet
2B	2	5,000 cfs	C1
2D	2	10,000 cfs	C2
2E	2	15,000 cfs	C3
2F	2	35,000 cfs	C4
3B	3	5,000 cfs	C5
3D	3	10,000 cfs	C6
3E	3	15,000 cfs	C7
3F	3	35,000 cfs	C8

Table 2

Quantities for the alternatives are shown in the tables below:

Location 2
15’ x 15’ Box Culverts

		3 5,000 cfs	3 10,000 cfs	10 15,000 cfs	10 35,000 cfs
Excavation	CY	1,487,300	2,316,200	4,962,000	6,278,700
Berm Fill	CY	116,600	98,300	99,600	122,900
Marsh Creation	CY	1,371,000	2,218,000	4,863,000	6,156,000
Bedding Material	TN	487,300	528,200	595,200	746,400
400 lb. Riprap	TN	444,200	478,700	545,500	692,000
1000lb. RipRap	TN	12,100	13,500	13,400	19,200
Geotextile	SY	179,900	218,500	290,100	368,100
Geogrid	SY	179,900	218,500	290,100	368,100
36" Culvert Pipe	LF	3,000	3,130	5,220	7,830
36" Flared End Section	EA	104	156	260	390
Striping	AC	75	75	75	75
Clearing & Grubbing	AC	15	15	15	15
Road Removal	SY	270	270	270	270
9" Cement Treated Sand Shell Base	SY	270	270	270	270
3.5" Asphaltic Concrete Binder Course	SY	270	270	270	270
1.5" Asphaltic Concrete Wearing Course	SY	270	270	270	270
Remove & Dispose of Articulated Concrete Mat	SY	950	950	950	950
Install Articulated Concrete Mat	SY	950	950	950	950
Dewatering	LS	1	1	1	1
Real Estate Costs	LS	1	1	1	1

Table 3

Location 2
30 Pipe Siphon

		5,000 cfs	10,000cfs
Excavation	CY	1,506,800	2,237,300
Berm Fill	CY	116,600	98,300
Marsh Creation	CY	1,390,000	2,139,000
Bedding Material	TN	326,500	363,700
400 lb. Riprap	TN	256,400	324,500
1000lb. RipRap	TN	12,100	13,500
Geotextile	SY	123,500	149,300
Geogrid	SY	123,500	149,300
Striping	AC	75	75
Clearing & Grubbing	AC	15	15
36" Culvert Pipe	LF	2,100	3,130
36" Flared End Section	EA	104	156
Road Removal	SY	1,210	1,210
9" Cement Treated Sand Shell Base Sand Shell Base	SY	1,210	1,210
3.5" Asphaltic Concrete Binder Course	SY	1,210	1,210
1.5" Asphaltic Concrete Wearing Course Concrete Wearing Course	SY	1,210	1,210
Remove & Dispose of Articulated Concrete Mat	SY	1,880	1,880
Install Articulated Concrete Mat	SY	1,880	1,880
Dewatering	LS	1	1
Real Estate Costs	LS	1	1

Table 4

Location 3
15’ x 15’ Box Culverts

		3 5,000 cfs	3 10,000 cfs	10 15,000 cfs	10 35,000 cfs
Excavation	CY	2,081,200	2,562,600	3,377,300	5,241,500
Fill	CY	2,080,500	2,561,500	3,370,500	524,500
Berms for Marsh Creation	CY	912,900	1,215,000	2,144,000	3,766,000
Bedding Material	TN	264,300	269,800	271,700	279,200
400 lb. Riprap	TN	268,000	272,700	273,500	284,300
1000lb. RipRap	TN	4,700	6,100	7,700	11,800
Geotextile	SY	197,800	199,700	201,500	202,500
Geogrid	SY	197,800	199,700	201,500	202,500
Striping	AC	35	35	35	35
Clearing & Grubbing	AC	8	10	13	19
Road Removal	SY	725	725	1,130	1,130
9" Cement Treated Sand Shell Base	SY	725	725	1,130	1,130
3.5" Asphaltic Concrete Binder Course	SY	725	725	1,130	1,130
1.5" Asphaltic Concrete Wearing Course	SY	725	725	1,130	1,130
Remove & Dispose of Articulated Concrete Mat	SY	610	610	940	940
Install Articulated Concrete Mat	SY	610	610	940	940
Dewatering	LS	1	1	1	1
Real Estate Costs	LS	1	1	1	1

Table 5

Location 3
30 Pipe Siphon

		5,000 cfs	10,000cfs
Excavation	CY	2,114,300	2,575,800
Fill	CY	2,114,300	2,575,800
Berms for Marsh Creation	CY	912,900	1,215,500
Bedding Material	TN	266,900	268,400
400 lb. Riprap	TN	268,300	269,500
1000lb. RipRap	TN	8,800	9,000
Geotextile	SY	262,300	263,100
Geogrid	SY	262,300	263,100
Striping	AC	35	35
Clearing & Grubbing	AC	8	10
Road Removal	SY	1,370	1,370
9" Cement Treated Sand Shell Base Sand Shell Base	SY	1,370	1,370
3.5" Asphaltic Concrete Binder Course	SY	1,370	1,370
1.5" Asphaltic Concrete Wearing Course Concrete Wearing Course	SY	1,370	1,370
Remove & Dispose of Articulated Concrete Mat	SY	0	0
Install Articulated Concrete Mat	SY	0	0
Dewatering	LS	1	1
Real Estate Costs	LS	1	1

3155 Table 6

PLAN - LOCATION 2- 5,000cfs
SCALE: 1" = 1000'
1000'
0
1000'
RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION
N
US Army Corps of Engineers
NEW ORLEANS DISTRICT
FEASIBILITY
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI 63103-2833
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE:
PLOT DATE:
SIZE:
FILE NAME:
DATE:
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 2
PLAN
SHEET IDENTIFICATION
C-01


PLAN - LOCATION 2- 15,000cfs
SCALE: 1" = 1000'
1000'
0
1000'
RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION
N
US Army Corps of Engineers
NEW ORLEANS DISTRICT
FEASIBILITY
MARK
DESCRIPTION
DATE
APPR.
DESIGNED BY:
DWN BY:
CKD BY:
SUBMITTED BY:
PLOT SCALE:
PLOT DATE:
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FILE NAME:
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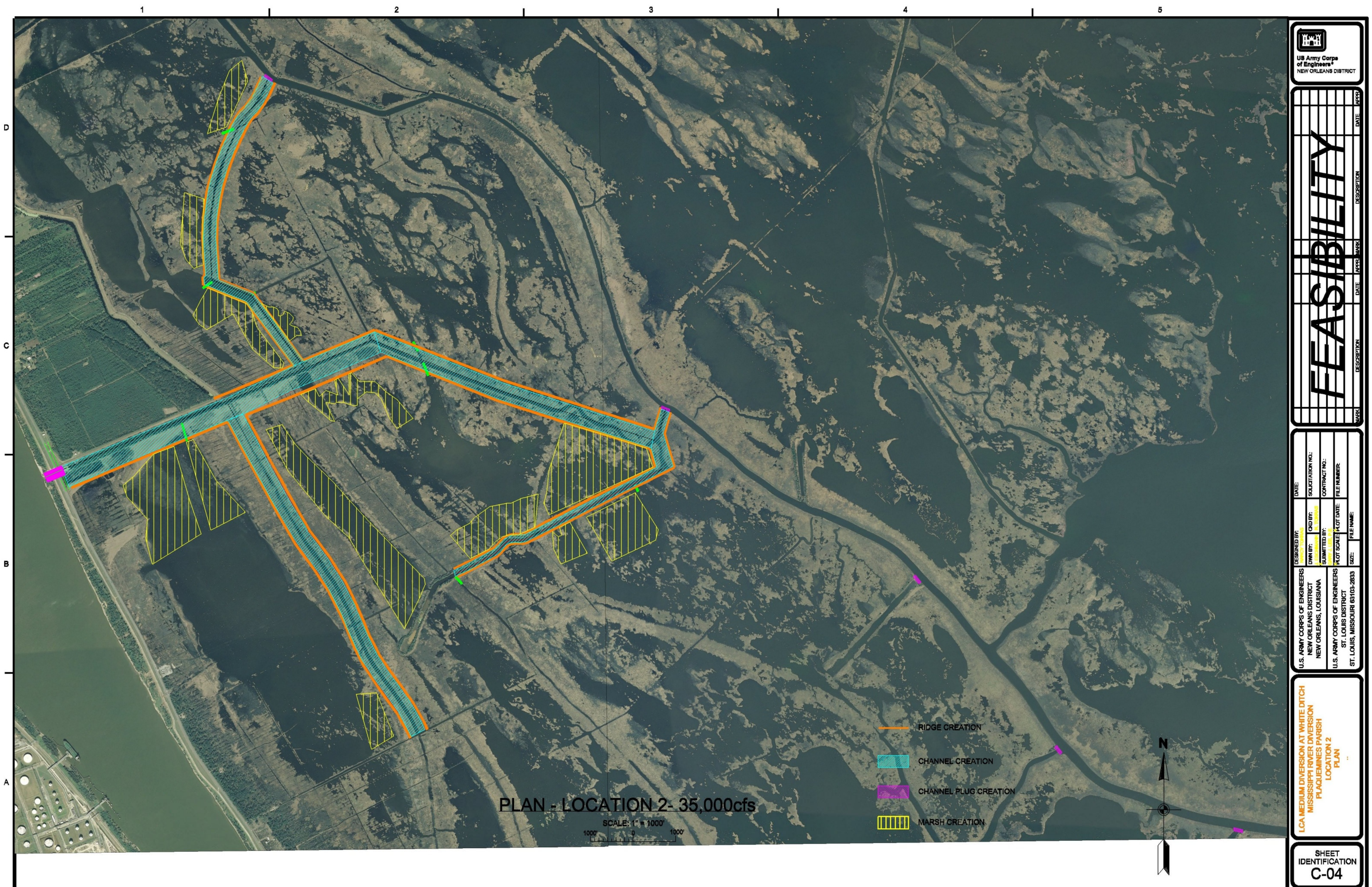
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI 63103-2833
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 2
PLAN
SHEET IDENTIFICATION
C-03



PLAN - LOCATION 2- 35,000cfs
SCALE: 1" = 1000'
1000'
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1000'
RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION
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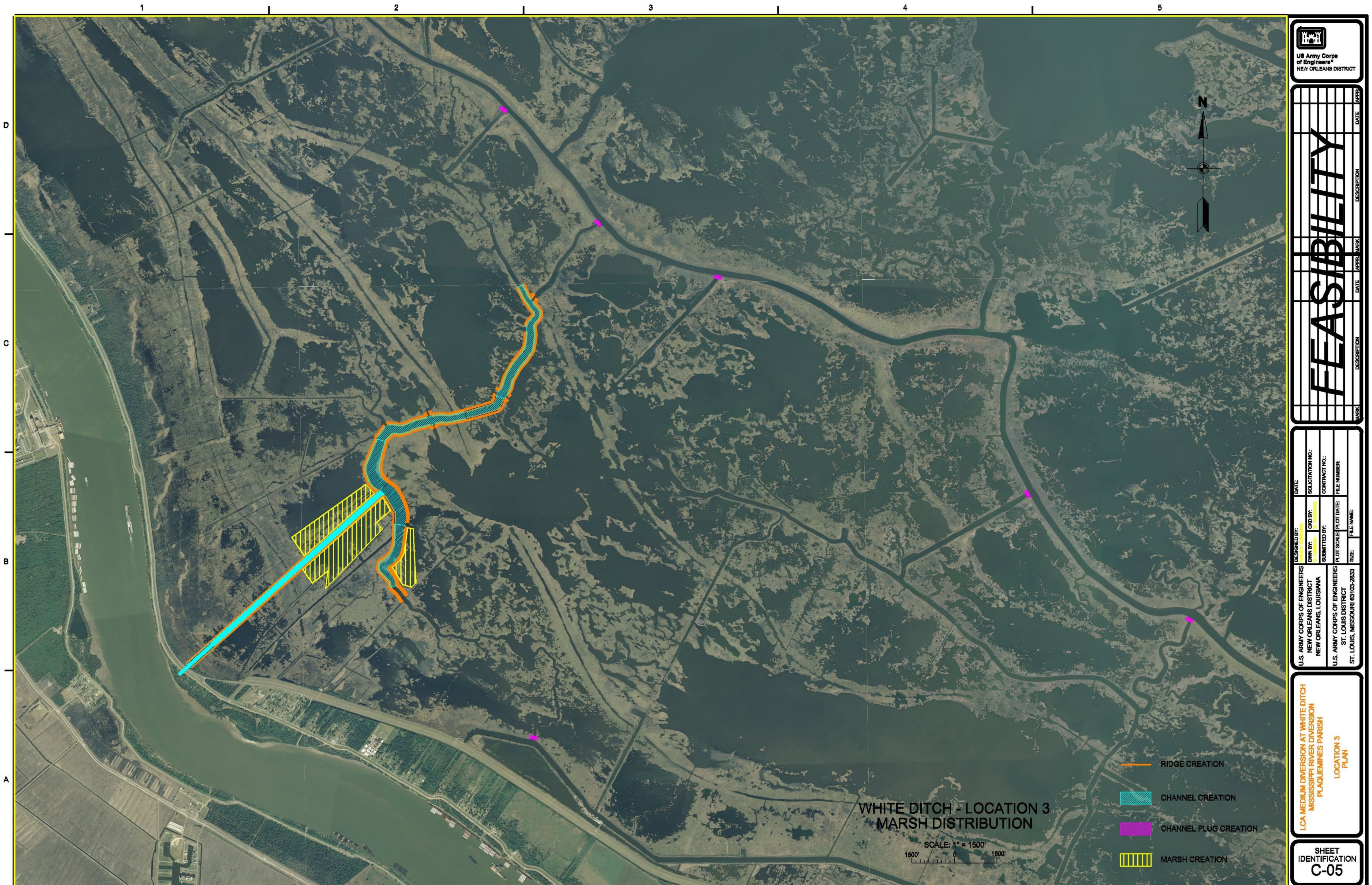
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI 63103-2833
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 2
PLAN
SHEET IDENTIFICATION
C-04



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US Army Corps of Engineers
NEW ORLEANS DISTRICT
FEASIBILITY
WHITE DITCH - LOCATION 3
MARSH DISTRIBUTION
SCALE: 1" = 1500'
1500'
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RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
U.S. ARMY CORPS OF ENGINEERS
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ST. LOUIS, MISSOURI 63103-2833
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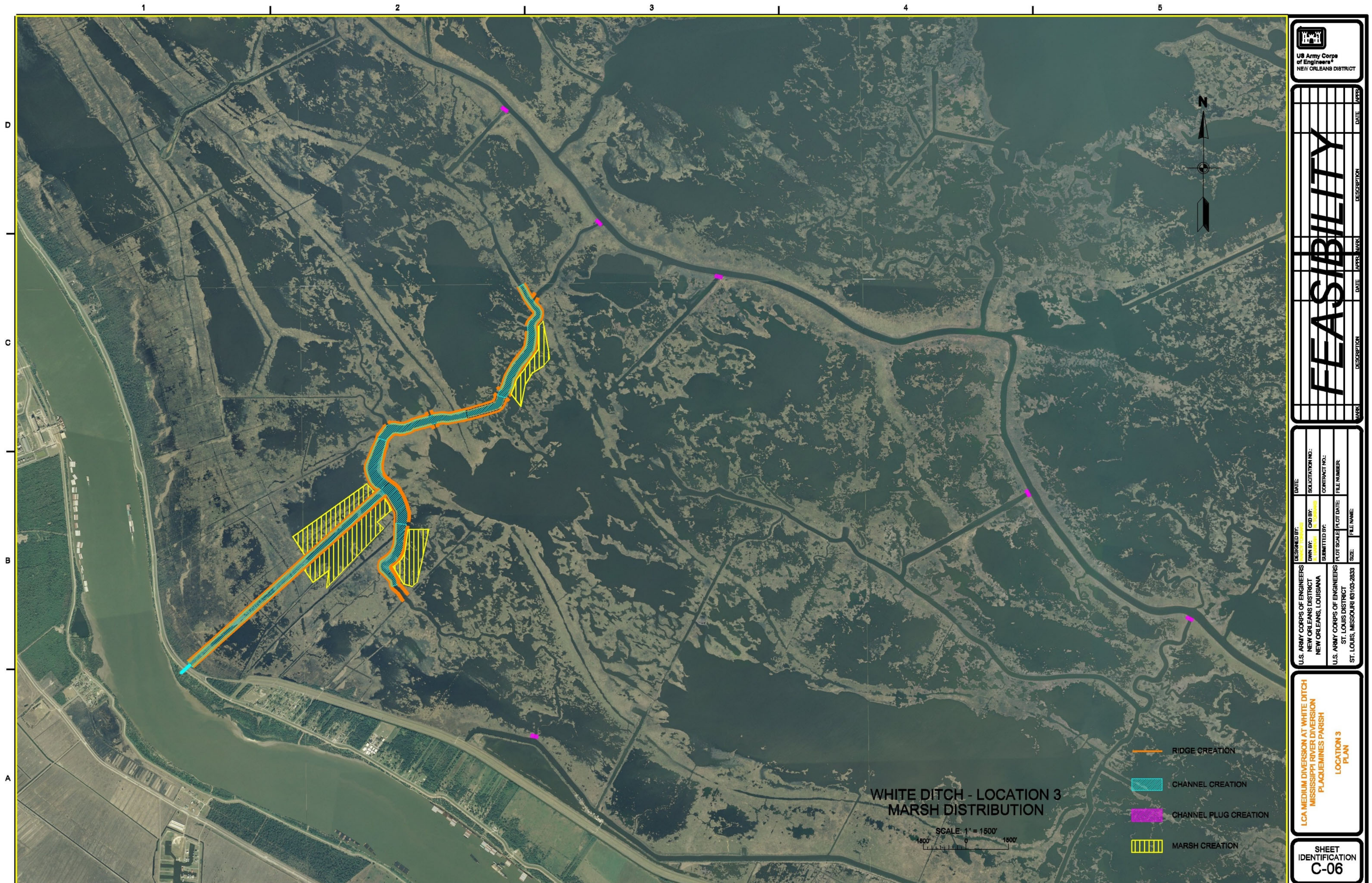
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 3
PLAN
SHEET
IDENTIFICATION
C-05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MARSH DISTRIBUTION
SCALE: 1" = 1500'
RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION
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FEASIBILITY
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U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
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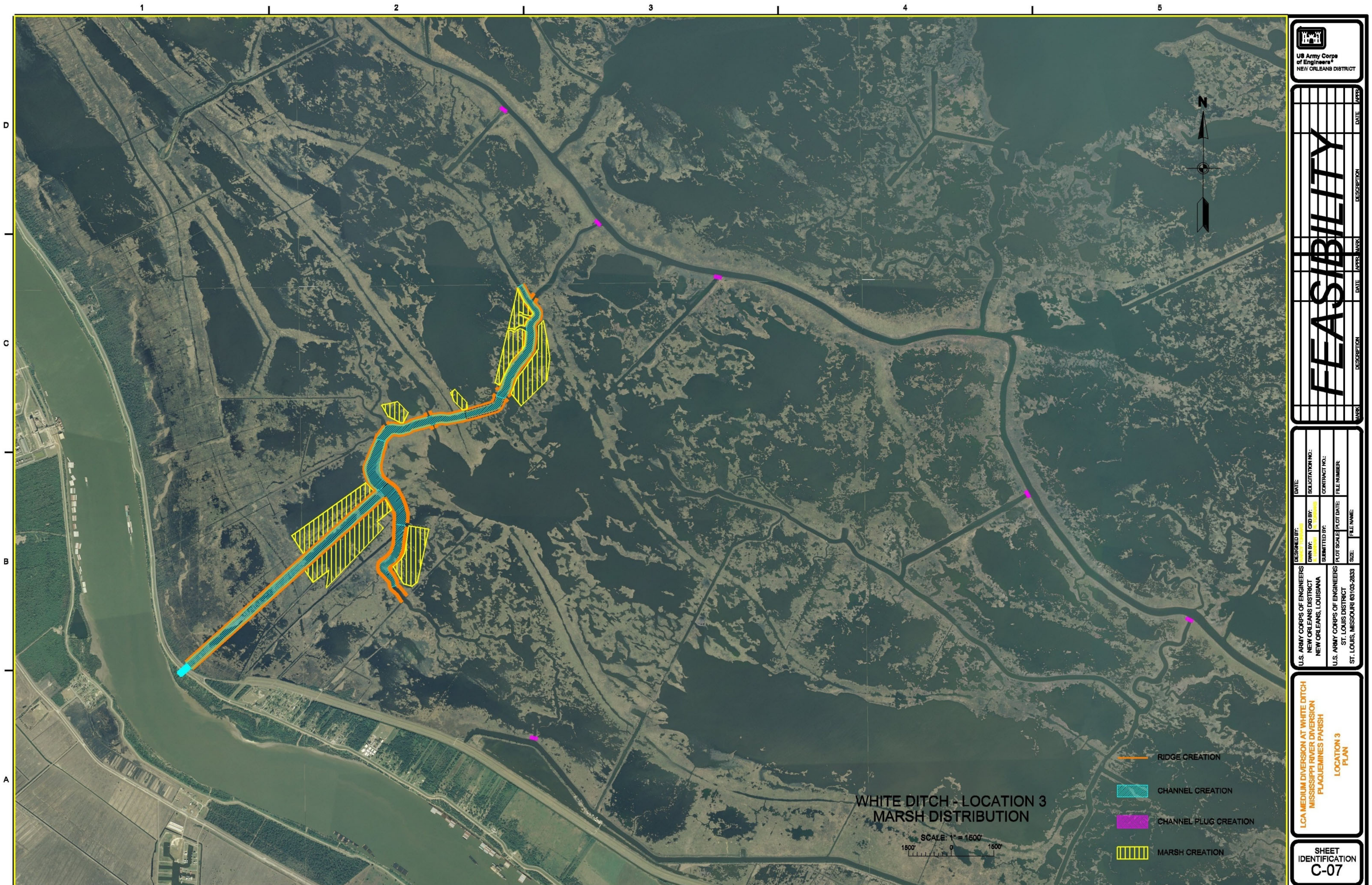
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 3
PLAN
SHEET IDENTIFICATION
C-06



WHITE DITCH - LOCATION 3
MARSH DISTRIBUTION
SCALE: 1" = 1500'
RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION
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US Army Corps of Engineers
NEW ORLEANS DISTRICT
FEASIBILITY
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U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI 63103-2833
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 3
PLAN
SHEET IDENTIFICATION
C-07


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NEW ORLEANS DISTRICT
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NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI 63103-2833
DESIGNED BY: NANCY TOKRAKS
DWN BY: K. HANNAH
CKD BY: N. TOKRAKS
SUBMITTED BY:
PLOT SCALE:
PLOT DATE:
SIZE:
FILE NAME:
DATE:
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER:
LCA MEDIUM DIVERSION AT WHITE DITCH
MISSISSIPPI RIVER DIVERSION
PLAQUEMINES PARISH
LOCATION 3
PLAN
SHEET IDENTIFICATION
C-08
WHITE DITCH - LOCATION 3
MARSH DISTRIBUTION
SCALE: 1" = 1500'
1500'
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1500'
RIDGE CREATION
CHANNEL CREATION
CHANNEL PLUG CREATION
MARSH CREATION

L8. Structural Design Criteria

L8.1 FOUNDATION RECOMMENDATIONS

L8.1.1 General

Development of this proposed diversion project would require various proposed features to accomplish the intended purpose. Among those would be a variety of structures. A description of the foundations for each structural feature will be shown below. The pile founded structures would incorporate the use of steel H-piles and sheet piles, precast prestressed concrete (PPC) piles, timber piles, and steel pipe piles where indicated on the drawings. Preliminary assumptions of pile sizes, spacing, and pile tip elevations were based on the design of similar structures found in the vicinity. Verification of the pile assumptions, along with any adjustments, was accomplished with the use of pile capacity curves that were developed for similar soils. A more accurate determination of soil properties was not possible due to the absence of reliable borings; therefore pile tip elevations may be adjusted in the next stage of design. All cast-in-place concrete structure monoliths exposed to lateral loadings were analyzed using the COE CASE program “CPGA” (X0080), Pile Group Analysis Program to determine adequacy of pile pattern assumptions. All designs were performed in accordance with applicable COE and technical publications, and industry codes. All structures will be constructed using conventional construction equipment and techniques. The contractor will be required to provide dewatering systems (where necessary) in order to construct foundations in a near dry atmosphere. The contractor will also be required to provide a system of shoring or open excavation to safely facilitate construction procedures.

L8.1.2 Description of Feature Foundations

a. Project Feature 3-15’x15’ Gated Box Culverts. – The proposed concrete monolithic structures at this location will be supported on a combination of steel HP14x73 piles, 12”x12” PPC piles, and 14”x14” PPC piles. Location, spacing, and pile tip elevations of the piling is shown on drawings S-102, and S-103. A 4” stabilization slab will be placed between the concrete substructures and the soil foundation to act as a stable working surface during construction. A steel sheet pile seepage cut-off wall will be placed around the perimeter of the concrete substructures. The pile tip elevations of the cut-off walls are shown on drawing S-201.

b. Project Feature 10-15’x15’ Gated Box Culverts. – The proposed concrete monolithic structures at this location will be supported on a combination of steel HP14x73 piles, 12”x12” PPC piles, and 14”x14” PPC piles. Location, spacing, and pile tip elevations of the piling is shown on drawings S-111, S-112, and S-113. A 4” stabilization slab will be placed between the concrete substructures and the soil foundation to act as a stable working surface during construction. A steel sheet pile seepage cut-off wall will be placed around the perimeter of the concrete substructures. The pile tip elevations of the cut-off walls are shown on drawing S-210.

c. Project Feature 4,000' Gated Weir. – The proposed concrete monolithic structures at this location will be supported on 18"x18" PPC piles. Location, spacing, and pile tip elevations of the piling is shown on drawing S-220. A 4" stabilization slab will be placed between the concrete substructures and the soil foundation.

d. Project Feature 3,000' Gated Weir. – The proposed concrete monolithic structures at this location will be supported on 18"x18" PPC piles. Location, spacing, and pile tip elevations of the piling is shown on drawing S-230. A 4" stabilization slab will be placed between the concrete substructures and the soil foundation.

e. Project Feature 2,000' Gated Weir. – The proposed concrete monolithic structures at this location will be supported on 18"x18" PPC piles. Location, spacing, and pile tip elevations of the piling is shown on drawing S-240. A 4" stabilization slab will be placed between the concrete substructures and the soil foundation.

f. Project Feature 19-6' Dia. Pipe Siphon. – The substructures for this proposed feature will be 16 inch diameter steel pipe piles located at the intake end of the siphon which will provide a support system for the 6' diameter pipes, and 16 inch dia. steel pipe piles located at the riverward end of the excavated inlet channel which will support a protective dolphin and floating boom system. The support system for the 6' diameter pipes, and the protective dolphins will be supported with both vertical and battered pipe piles. The pile tip elevation of the vertical pipe piles for the 6' dia. pipe support system will be El.-90.0, and the pile tip elevation for the battered pipe piles will be El.-85.0. The pile tip elevation of the vertical pipe piles for the protective dolphins will be El.-80.0, and the pile tip elevation for the battered pipe piles will be El.-85.0. It is assumed the bedding system for the 6' diameter pipe will be determined at a later design stage. Location and pile tip elevations for the pipe piling is shown on drawing S-250.

g. Project Feature 30-6' Dia. Pipe Siphon. – The substructures for this proposed feature will be 16 inch diameter steel pipe piles located at the intake end of the siphon, which will provide a support system for the 6' diameter pipes, and 16 inch dia. steel pipe piles located at the riverward end of the excavated inlet channel which will support a protective dolphin and floating boom system. The support system for the 6' diameter pipes, and the protective dolphins will be supported with both vertical and battered pipe piles. The pile tip elevation of the vertical pipe piles for the 6' dia. pipe support system will be El.-90.0, and the pile tip elevation for the battered pipe piles will be El.-85.0. The pile tip elevation of the vertical pipe piles for the protective dolphins will be El.-80.0, and the pile tip elevation for the battered pipe piles will be El.-85.0. It is assumed the bedding system for the 6' diameter pipe will be determined at a later design stage. Location and pile tip elevations for the pipe piling is shown on drawing S-260.

L8.2 STRUCTURAL DESIGN FOR DIVERSION FACILITY

L8.2.1 General

The general physical configuration of structures for this proposed diversion project were based on a variety of considerations, among them hydraulic requirements, similar structures performing the same function, and utilizing existing designs from other projects. All concrete structures will be reinforced and cast-in-place. Concrete and structural steel member sizes were assumed based on similar structures of equivalent size with similar loadings, therefore, no stress analyses were performed in this design phase.

L8.2.2 Description of Structural Features

a. Project Feature 3-15’x15’ Gated Box Culverts. – The proposed structures at this location will be a series of reinforced cast-in-place concrete box culverts constructed monolithically in conjunction with inflow, roller gate, bulkhead, and T-wall monoliths. These structures will be located under an existing earth levee. There will be three box culvert barrels, each 15 feet high and 15 feet wide (inside dimensions). The flow line elevation inside the barrels will be El.-15.0. The box culverts base slab will be 4.0 feet thick, the top slab will be 3.0 feet thick, the interior vertical walls will be 2.5 feet thick, and the exterior vertical walls will be 3.0 feet thick. The length of the box culverts will be 160.0 feet. The concrete inflow monoliths on the upstream end of the structure will be comprised of a 4.0 foot thick base slab and two 3.0 foot thick vertical guidewalls providing a length of 150.0 feet. The upstream end of the inflow monoliths will flare from 56.0 to 96.0 feet in width. The roller gate monolith will be 59.0 feet long and 56.0 feet wide. The concrete bulkhead monolith on the downstream end of the structure will also be comprised of a 4.0 foot thick base slab and two 3.0 foot thick vertical guidewalls providing a length of 95.0 feet and a width of 56.0 feet. The concrete T-walls which retain the earth embankment, will be located at the downstream end of the bulkhead monolith, on both sides of the channel. Two T-walls will be located on each side of the channel, and oriented 55 degrees from the centerline of the channel. Each T-wall will be 36.0 feet long, with a top of stem elevation of El.+6.0. All the T-wall bases will be 3.0 feet thick, and the vertical stem thicknesses will vary. The foundation elevation of the T-walls nearest the bulkhead monolith will be El.-23.0, and the remaining T-walls will be founded at El.-15.0. The inflow channel bottom will be El.-16.0, with a width of 96.0 feet and side slopes of 1 vert. on 3 horiz. The outflow channel bottom will transition from El.-16.0 at the bulkhead monolith to El.-20.0, 100.0 feet from the concrete structure with a width of 50.0 feet and side slopes of 1 vert. on 3 horz. Vertical slots and structural steel roller guides will be provided in the concrete walls at each end of the barrels for the placement of a bulkhead, when required. A 15 foot high and 15 foot wide fabricated structural steel roller gate will be located at the upstream end of each barrel. A flush bottom closure for the gates will be accomplished by providing a steel sill beam assembly at El. -15.0. Vertical slots will be provided in the concrete sidewalls for the installation of structural steel roller guides. A concrete platform will be located at El.+17.5 to support the roller gate operators. A machinery building will be located adjacent to the support platform, also at El.+17.5. A 2.0 foot thick vertical concrete seepage cut-off wall extending from the top of the box culverts toEl.+13.0 will be located on the roller gate monolith near the centerline of the earth levee. A 17.0 foot wide and 34.0 foot long timber pile supported concrete bulkhead storage slab will be located on the landside of the levee.

b. Project Feature 10-15'x15' Gated Box Culverts. – The proposed structures at this location will be a series of reinforced cast-in-place concrete box culverts constructed monolithically in conjunction with inflow, roller gate, bulkhead, and T-wall monoliths. These structures will be located under an existing earth levee. There will be ten box culvert barrels, each 15 feet high and 15 feet wide (inside dimensions). The flow line elevation inside the barrels will be El.-15.0. The box culverts base slab will be 4.0 feet thick, the top slab will be 3.0 feet thick, the interior vertical walls will be 2.5 feet thick, and the exterior vertical walls will be 3.0 feet thick. The length of the box culverts will be 160.0 feet. The concrete inflow monoliths on the upstream end of the structure will be comprised of a 4.0 foot thick base slab and two 3.0 foot thick vertical guidewalls providing a length of 150.0 feet. The upstream end of the inflow monoliths will flare from 178.5 to 218.5 feet in width. The roller gate monolith will be 59.0 feet long and 178.5 feet wide. The concrete bulkhead monolith on the downstream end of the structure will also be comprised of a 4.0 foot thick base slab and two 3.0 foot thick vertical guidewalls providing a length of 95.0 feet and a width of 178.5 feet. The concrete T-walls which retain the earth embankment, will be located at the downstream end of the bulkhead monolith, on both sides of the channel. Two T-walls will be located on each side of the channel, and oriented 55 degrees from the centerline of the channel. Each T-wall will be 36.0 feet long, with a top of stem elevation of El.+6.0. All the T-wall bases will be 3.0 feet thick, and the vertical stem thicknesses will vary. The foundation elevation of the T-walls nearest the bulkhead monolith will be El.-23.0, and the remaining T-walls will be founded at El.-15.0. The inflow channel bottom will be El.-16.0, with a width of 218.5 feet and side slopes of 1 vert. on 3 horiz. The outflow channel bottom will transition from El.-16.0 at the bulkhead monolith to El.-20.0, 100.0 feet from the concrete structure with a width of 172.5 feet and side slopes of 1 vert. on 3 horz. Vertical slots and structural steel roller guides will be provided in the concrete walls at each end of the barrels for the placement of a bulkhead, when required. A 15 foot high and 15 foot wide structural steel roller gate will be located at the upstream end of each barrel. A flush bottom closure for the gates will be accomplished by providing a steel sill beam assembly at El.-15.0. Vertical slots will be provided in the concrete sidewalls for the installation of structural steel roller guides. A concrete platform will be located at El.+17.5 to support the roller gate operators. A machinery building will be located adjacent to the support platform, also at El.+17.5. A 2.0 foot thick vertical concrete seepage cut-off wall extending from the top of the box culverts toEl.+13.0 will be located on the roller gate monolith near the centerline of the earth levee. A 17.0 foot wide and 34.0 foot long timber pile supported concrete bulkhead storage slab will be located on the landside of the levee.

c. Project Feature 4,000' Gated Weir. - The proposed structure at this location will be a reinforced cast-in-place concrete fresh water diversion control structure incorporating vertical lift gates, a rail mounted gantry crane and crane bridge, and a highway vehicle bridge. The 3.5 thick substructure base slab will be founded at El.-5.5, extend 4,007.0 feet, and will be parallel to the vehicle, and gantry crane bridges. The upstream end of the base slab will include an elevated spillway with a top elevation of El.+8.0. The remaining portion of the base slab will serve as a stilling basin with a top of slab elevation of El.-2.0. The stilling basin will include two rows of baffle blocks located near the mid point of the stilling basin. The top elevation of the baffle blocks will be El.+3.0. Concrete divider walls will be located parallel to flow at 22.0 feet on center to form 182 gate bays, which will contain the vertical lift gates. The divider walls will be 3.0 feet thick and are approx. 45.0 feet long. The divider walls will also provide a support foundation for the vehicle, and gantry crane bridges. The bridges will extend 43.5 feet beyond each end of the substructure for a total length of 4094.0 feet. The gantry crane bridge will be located toward the upstream end of the structure, above the spillway, with a top elevation of El.+20.0. The gantry crane bridge will be constructed of 4.0 feet deep reinforced cast-in-place T-beams. A steel crane rail will be installed on each T-beam. The highway vehicle bridge will provide two 12.0 foot driving lanes, with a top of deck elevation of El.+19.0 and total bridge width of 28.0 feet. The bridge deck and supporting beams will be reinforced cast-in-place concrete. The top elevation of the divider walls supporting the bridge beams will be El.+15.5. The vertical orientation of the lift gates will be made possible with the use of the gantry crane. When the lift gates are in their lowest position they will rest on the spillway at El.+8.0, and the top of the gates will be at El.+15.0. When the gates are at their highest position the bottom of the gate will be at El.+16.0, and the top of the gates will be at El.+23.0. The lift gates will be fabricated from structural steel and utilize steel rollers. Vertical slots will be provided in the concrete divider walls for the structural steel lift gate guides. Also, provisions will be made for installation of dogging devices in the divider walls in order to retain the lift gates in an open position.

d. Project Feature 3,000’ Gated Weir. - The proposed structure at this location will be a reinforced cast-in-place concrete fresh water diversion control structure incorporating vertical lift gates, a rail mounted gantry crane and crane bridge, and a highway vehicle bridge. The 3.5 thick substructure base slab will be founded at El.-5.5, extend 2.995.0 feet, and will be parallel to the vehicle, and gantry crane bridges. The upstream end of the base slab will include an elevated spillway with a top elevation of El.+8.0. The remaining portion of the base slab will serve as a stilling basin with a top of slab elevation of El.-2.0. The stilling basin will include two rows of baffle blocks located near the mid point of the stilling basin. The top elevation of the baffle blocks will be El.+3.0. Concrete divider walls will be located parallel to flow at 22.0 feet on center to form 136 gate bays, which will contain the vertical lift gates. The divider walls will be 3.0 feet thick and are approx. 45.0 feet long. The divider walls will also provide a support foundation for the vehicle, and gantry crane bridges. The bridges will extend 43.5 feet beyond each end of the substructure for a total length of 3,082.0 feet. The gantry crane bridge will be located toward the upstream end of the structure, above the spillway, with a top elevation of El.+20.0. The gantry crane bridge will be constructed of 4.0 feet deep reinforced cast-in-place T-beams. A steel crane rail will be installed on each T-beam. The highway vehicle bridge will provide two 12.0 foot driving lanes, with a top of deck elevation of El.+19.0 and total bridge width of 28.0 feet. The bridge deck and supporting beams will be reinforced cast-in-place concrete. The top elevation of the divider walls supporting the bridge beams will be El.+15.5. The vertical orientation of the lift gates will be made possible with the use of the gantry crane.

When the lift gates are in their lowest position they will rest on the spillway at El.+8.0, and the top of the gates will be at El.+15.0. When the gates are at their highest position the bottom of the gate will be at El.+16.0, and the top of the gates will be at El.+23.0. The lift gates will be fabricated from structural steel and utilize steel rollers. Vertical slots will be provided in the concrete divider walls for the structural steel lift gate guides. Also, provisions will be made for installation of dogging devices in the divider walls in order to retain the lift gates in an open position.

e. Project Feature 2,000’ Gated Weir. - The proposed structure at this location will be a reinforced cast-in-place concrete fresh water diversion control structure incorporating vertical lift gates, a rail mounted gantry crane and crane bridge, and a highway vehicle bridge. The 3.5 thick substructure base slab will be founded at El.-5.5, extend 2.005.0 feet, and will be parallel to the vehicle, and gantry crane bridges. The upstream end of the base slab will include an elevated spillway with a top elevation of El.+8.0. The remaining portion of the base slab will serve as a stilling basin with a top of slab elevation of El.-2.0. The stilling basin will include two rows of baffle blocks located near the mid point of the stilling basin. The top elevation of the baffle blocks will be El.+3.0. Concrete divider walls will be located parallel to flow at 22.0 feet on center to form 91 gate bays, which will contain the vertical lift gates. The divider walls will be 3.0 feet thick and are approx. 45.0 feet long. The divider walls will also provide a support foundation for the vehicle, and gantry crane bridges. The bridges will extend 43.5 feet beyond each end of the substructure for a total length of 2,092.0 feet. The gantry crane bridge will be located toward the upstream end of the structure, above the spillway, with a top elevation of El.+20.0. The gantry crane bridge will be constructed of 4.0 feet deep reinforced cast-in-place T-beams. A steel crane rail will be installed on each T-beam. The highway vehicle bridge will provide two 12.0 foot driving lanes, with a top of deck elevation of El.+19.0 and total bridge width of 28.0 feet. The bridge deck and supporting beams will be reinforced cast-in-place concrete. The top elevation of the divider walls supporting the bridge beams will be El.+15.5. The vertical orientation of the lift gates will be made possible with the use of the gantry crane. When the lift gates are in their lowest position they will rest on the spillway at El.+8.0, and the top of the gates will be at El.+15.0. When the gates are at their highest position the bottom of the gate will be at El.+16.0, and the top of the gates will be at El.+23.0. The lift gates will be fabricated from structural steel and utilize steel rollers. Vertical slots will be provided in the concrete divider walls for the structural steel lift gate guides. Also, provisions will be made for installation of dogging devices in the divider walls in order to retain the lift gates in an open position.

f. Project Feature 19-6’ Dia. Pipe Siphons. - The proposed fresh water diversion control structure at this location will be comprised of multiple components. The major component of this structure will be 19-6’ dia. steel discharge pipes spaced at 10.0 feet on center, and will transport water over an existing levee. The approx. elevation of the top of the levee is El.+15.0. The pipes will be soil founded at various elevations on the landside of the levee. The pipes on the riverside of the levee at the water intake point will be supported with a pile founded structural steel component. The discharge pipe support structure will be located approx. 90.0 feet riverward from the centerline of the existing levee. An inlet channel will be excavated between the waterway and the pipe support structure. The flow line elevation of the discharge pipes at the support structure will be El.-10.0. The inlet end of the discharge pipes will be fabricated as a horizontal line with a bottom elevation of El.-12.5. The pipe support structure will be supported with 16 inch dia. steel pipe piles placed in pairs between the discharge pipes. The riverward pile will be placed vertical, and the landward pile will be battered toward the levee. The support structure will be constructed of various sized structural steel members fastened to 24 inch dia. steel pipe sleeves. The pipe sleeves will be fastened over the end of the pipe piles. The pipe piles located at each end of the support structure will be battered either upstream or downstream depending on the location. Another component of this structure will be a system comprised of dolphins and floating booms, designed to restrain or deflect floating debris at the riverward end of the excavated inlet channel. A total of seven dolphins will be required and spaced at approximately 40.0 feet on center. Each dolphin will be attached to a cluster of three 16 inch dia. steel pipe piles. Two of the piles adjacent to the floating boom will be oriented in a vertical position, the third pile will be battered away from the boom. The top elevation of the vertical piles will be El.+14.0, and the top elevation of the battered piles will be El.+10.0. The upper portion of the dolphins will be a system constructed of structural steel members fastened to 24 inch dia. steel pipe sleeves. The pipe sleeves will be fastened over the end of the pipe piles. A floating boom placed horizontally will extend between every two dolphins. The booms will be constructed of watertight 24 inch steel pipe filled with foam, and fastened to the dolphins in a manner to allow the booms to rise and fall with the surrounding water elevation changes. A platform will be provided on top of two dolphins to support solar powered lanterns and storage batteries. The elevation of the top of the platform will be El.+12.5. One lantern will be located at each end of the dolphin group.

g. Project Feature 30-6' Dia. Pipe Siphons. - The proposed fresh water diversion control structure at this location will be comprised of multiple components. The major component of this structure will be 19-6' dia. steel discharge pipes spaced at 10.0 feet on center, and will transport water over an existing levee. The approx. elevation of the top of the levee is El.+15.0. The pipes will be soil founded at various elevations on the landside of the levee. The pipes on the riverside of the levee at the water intake point will be supported with a pile founded structural steel component. The discharge pipe support structure will be located approx. 90.0 feet riverward from the centerline of the existing levee. An inlet channel will be excavated between the waterway and the pipe support structure. The flow line elevation of the discharge pipes at the support structure will be El.-10.0. The inlet end of the discharge pipes will be fabricated as a horizontal line with a bottom elevation of El.-12.5. The pipe support structure will be supported with 16 inch dia. steel pipe piles placed in pairs between the discharge pipes. The riverward pile will be placed vertical, and the landward pile will be battered toward the levee. The support structure will be constructed of various sized structural steel members fastened to 24 inch dia. steel pipe sleeves. The pipe sleeves will be fastened over the end of the pipe piles. The pipe piles located at each end of the support structure will be battered either upstream or downstream depending on the location. Another component of this structure will be a system comprised of dolphins and floating booms, designed to restrain or deflect floating debris at the riverward end of the excavated inlet channel. A total of ten dolphins will be required and spaced at approximately 40.0 feet on center. Each dolphin will be attached to a cluster of three 16 inch dia. steel pipe piles. Two of the piles adjacent to the floating boom will be oriented in a vertical position, the third pile will be battered away from the boom. The top elevation of the vertical piles will be El.+14.0, and the top elevation of the battered piles will be El.+10.0. The upper portion of the dolphins will be a system constructed of structural steel members fastened to 24 inch dia. steel pipe sleeves. The pipe sleeves will be fastened over the end of the pipe piles. A floating boom placed horizontally will extend between every two dolphins. The booms will be constructed of watertight 24 inch steel pipe filled with foam, and fastened to the dolphins in a manner to allow the booms to rise and fall with the surrounding water elevation changes. A platform will be provided on top of three dolphins to support solar powered lanterns and storage batteries. The elevation of the top of the platforms will be El.+12.5. One lantern will be located at each end of the dolphin group, and one at the mid-point.

L9. Electrical and Mechanical Requirements

L9.1 ELECTRICAL SOURCES AND SUPPLY REQUIREMENTS

L9.1.1 General

Development of this proposed diversion project will require various proposed structural features to accomplish the intended purpose. All the structural features will require either a single or multiple type of electrical power source depending on the operational requirements at each site. The ability to furnish electrical power to each structural feature from an off site location has not been determined at this time, and will be investigated in another design stage. The possible electrical requirements at each feature site have been presented below.

L9.1.2 Electrical Requirements Per Site

a. Project Feature 3-15’x15’ Gated Box Culverts. – An electrical power supply will be required to operate the roller gate operators. Whether the operators will be electrically or hydraulically operated has not been determined at this time. In either case an electrical power source will be required for the operator motors, or for the electrical motors driving the hydraulic pumps for the operators. In addition, a power source will be required for the machinery building lighting, and switchboard equipment in the building.

b. Project Feature 10-15’x15’ Gated Box Culverts. – An electrical power supply will be required to operate the roller gate operators. Whether the operators will be electrically or hydraulically operated has not been determined at this time. In either case an electrical power source will be required for the operator motors, or for the electrical motors driving the hydraulic pumps for the operators. In addition, a power source will be required for the machinery building lighting, and switchboard equipment in the building.

c. Project Feature 4,000' Gated Weir. – An electrical power supply will be required to operate the movable gantry crane. The power supply will operate the drive motors which move the crane, the lifting hoist motors which position the lift gates, the jib crane motor, and the motor which operates the clamshell bucket.

d. Project Feature 3,000' Gated Weir. – An electrical power supply will be required to operate the movable gantry crane. The power supply will operate the drive motors which move the crane, the lifting hoist motors which position the lift gates, the jib crane motor, and the motor which operates the clamshell bucket.

e. Project Feature 2,000' Gated Weir. – An electrical power supply will be required to operate the movable gantry crane. The power supply will operate the drive motors which move the crane, the lifting hoist motors which position the lift gates, the jib crane motor, and the motor which operates the clamshell bucket.

f. Project Feature 19-6' Dia. Pipe Siphon. – Operation of the siphon will not require an electrical power source. In the event a decision is made, at a later date, to provide exterior lighting or a lighted maintenance building, an electrical power source may be required.

g. Project Feature 30-6' Dia. Pipe Siphon. – Operation of the siphon will not require an electrical power source. In the event a decision is made, at a later date, to provide exterior lighting or a lighted maintenance building, an electrical power source may be required.

h. Electric Power Source(s). – Electric power source(s) can be either commercial utility electric power or diesel engine generators. Location of commercial utility power and the cost to supply this power will be compared to the cost of a diesel engine generator set, including estimated O&M costs to determine the recommended source of the required electrical power.

L9.2 SOLAR POWER SUPPLY SYSTEMS

L9.2.1 General

The only project features that would incorporate a solar power system will be the two siphon structures mentioned above. The siphon features will include protective dolphins placed in the waterway. Warning lanterns will be mounted on top of the dolphins and powered with electrical storage batteries which will be charged with solar panels. Exterior lighting and a maintenance building are not proposed to be included in this project at this time, but in the event they are included, solar power may be provided in lieu of extending a conventional power supply to the sites.

L9.3 ELECTRICAL AND MECHANICAL DESIGN FOR DIVERSION FACILITY

L9.3.1 General

The size and type of electrical and mechanical components for the project features were selected based on a variety of considerations, among them hydraulic requirements, similar features performing the same function, and utilizing existing designs from other projects.

L9.3.2 Electrical/Mechanical Requirements Per Site

a. Project Feature 3-15’x15’ Gated Box Culverts. – Regulation of flow thru the culverts will be controlled with the use of three 15’x15’ fabricated structural steel roller gates. The gates will be raised/lowered with the use of a gate hoist supplied by a known and acceptable gate manufacturer. Selection of either electric motor operated or hydraulically operated gate hoists will be determined in a later project design stage. Two fabricated structural steel bulkheads approximately 15 feet square will be provided and stored on site when not in use. The bulkheads will be fitted with rollers, and vertical steel roller guides will be cast in slots in the concrete walls.

b. Project Feature 10-15’x15’ Gated Box Culverts. – Regulation of flow thru the culverts will be controlled with the use of ten 15’x15’ fabricated structural steel roller gates. The gates will be raised/lowered with the use of a gate hoist supplied by a known and acceptable gate manufacturer. Selection of either electric motor operated or hydraulically operated gate hoists will be determined in a later project design stage. Two fabricated structural steel bulkheads approximately 15 feet square will be provided and stored on site when not in use. The bulkheads will be fitted with rollers, and vertical steel roller guides will be cast in slots in the concrete walls.

c. Project Feature 4,000’ Gated Weir. – Regulation of flow thru the weir structure will be controlled by the operational use of one hundred eighty two fabricated structural steel vertical lift gates. The gates will be approx. 19.0 feet wide and 7.0 feet high. The gates will be fitted with steel rollers, and vertical steel roller guides will be cast in slots in the concrete divider walls. Dogging devices will be attached to the gates to lock them in a raised position. The gates will be raised with the use of a fabricated structural steel lifting beam, connected with steel cables to a movable rail mounted gantry crane. The crane size and lifting capacity to be determined during a later design phase. The gantry crane assembly will include a jib crane, and clamshell bucket suspended from a boom with a 180 degree swing capability.

d. Project Feature 3,000’ Gated Weir. – Regulation of flow thru the weir structure will be controlled by the operational use of one hundred thirty eight fabricated structural steel vertical lift gates. The gates will be approx. 19.0 feet wide and 7.0 feet high. The gates will be fitted with steel rollers, and vertical steel roller guides will be cast in slots in the concrete divider walls. Dogging devices will be attached to the gates to lock them in a raised position. The gates will be raised with the use of a fabricated structural steel lifting beam, connected with steel cables to a movable rail mounted gantry crane. The crane size and lifting capacity to be determined during a later design phase. The gantry crane assembly will include a jib crane, and clamshell bucket suspended from a boom with a 180 degree swing capability.

e. Project Feature 2,000’ Gated Weir. – Regulation of flow thru the weir structure will be controlled by the operational use of ninety one fabricated structural steel vertical lift gates. The gates will be approx. 19.0 feet wide and 7.0 feet high. The gates will be fitted with steel rollers, and vertical steel roller guides will be cast in slots in the concrete divider walls. Dogging devices will be attached to the gates to lock them in a raised position. The gates will be raised with the use of a fabricated structural steel lifting beam, connected with steel cables to a movable rail mounted gantry crane. The crane size and lifting capacity to be determined during a later design phase. The gantry crane assembly will include a jib crane, and clamshell bucket suspended from a boom with a 180 degree swing capability.

L10. Construction Procedures

The MRT levee protects the project area from Mississippi River floods. A temporary levee will be in place, with the appropriate level of protection, when the levee is breached for construction to protect the evacuation route. Appropriate erosion control measures will be in place for the duration of the construction.

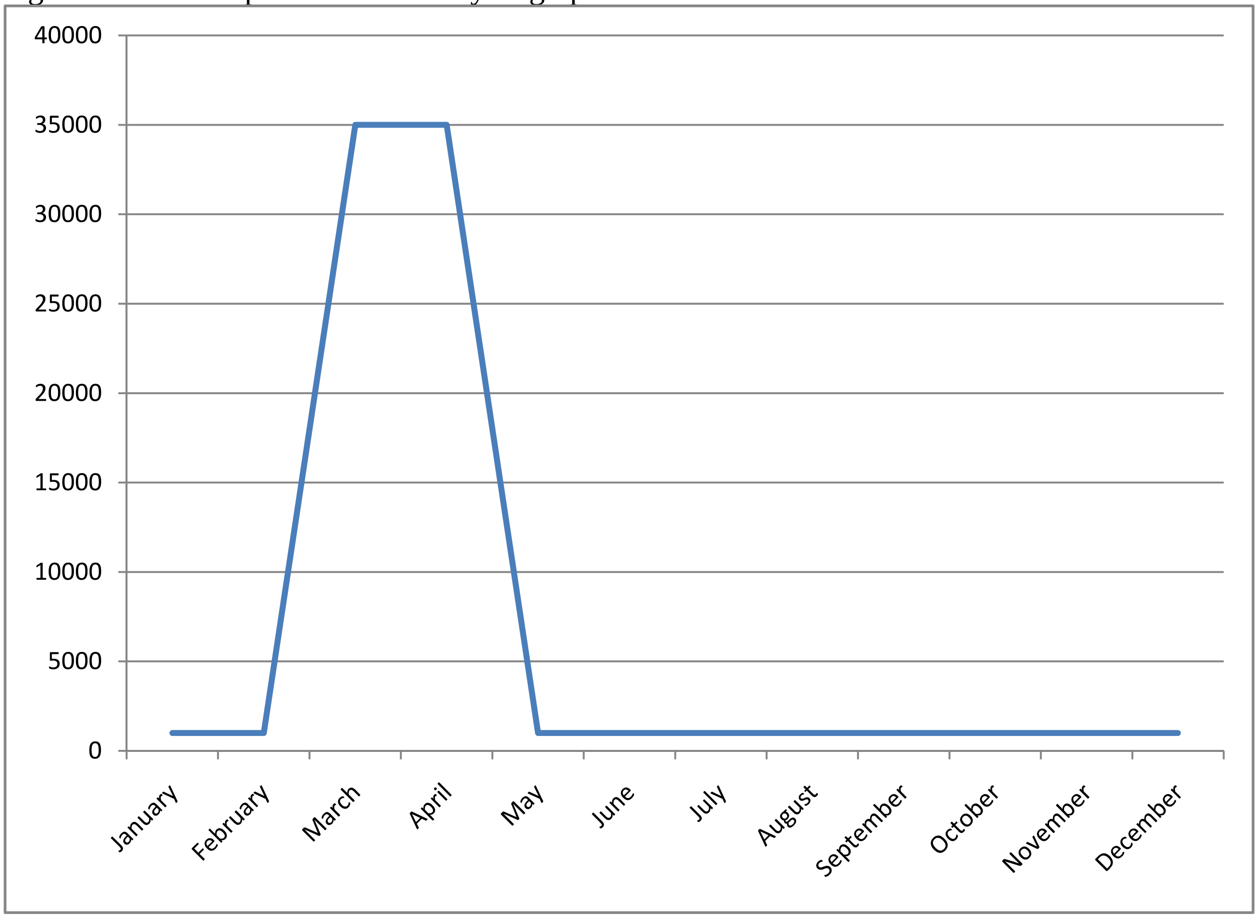
Highway 39 is the emergency evacuation route for areas south of the diversion site. Continued access to the project area during construction will be necessary to ensure the population will not be isolated. Temporary detours of Highway 39 will be constructed, with appropriate safety measures in place. Secondary road detours will be made to allow local residents access to their property during the construction of the project.

L11. Operations and Maintenance

L11.1 Operations

Operations for the diversion are yet to be determined. It is assumed that there will be some type of seasonal pulse in the spring of the year lasting from possibly two weeks to three months depending on conditions. For this pulse, water will be gradually introduced so as to minimize scour without affecting the sediment load. The current proposed operations are to have a March and April pulse of the maximum amount of water possible (up to 35,000cfs). Figure L11.1 shows the proposed hydrograph of the diversion structure.

Figure L11.1 – Proposed diversion hydrograph



The operation of this structure will be closely tied to the operation of the Caernarvon Diversion as well other diversions along the Mississippi River. Interrelated operations between these different diversions are critical to provide benefits to the different coastal marshes and not create undesired impacts to the Mississippi River such as induced shoaling.

The diversion will be driven based off of the head differential between the Mississippi River and the coastal marsh where we are diverting water. The outfall of the diversion is in an estuary and assumed to have an average stage equal to sea level (0.00 NAD88) throughout the course of the year. Therefore, the river stage will typically be the head that the diversion can utilize. Figure 11.2 shows the average stage of the river at the Alliance, LA gage. The Alliance, LA gage is approximately 5 miles upstream from the proposed diversion site and is assumed to have the same stage. Figure 11.3 shows the rating curve for the 10 – 15’x15’ Box Culvert Diversion.

Figure 11.2 – Average Mississippi River stage at Alliance, LA

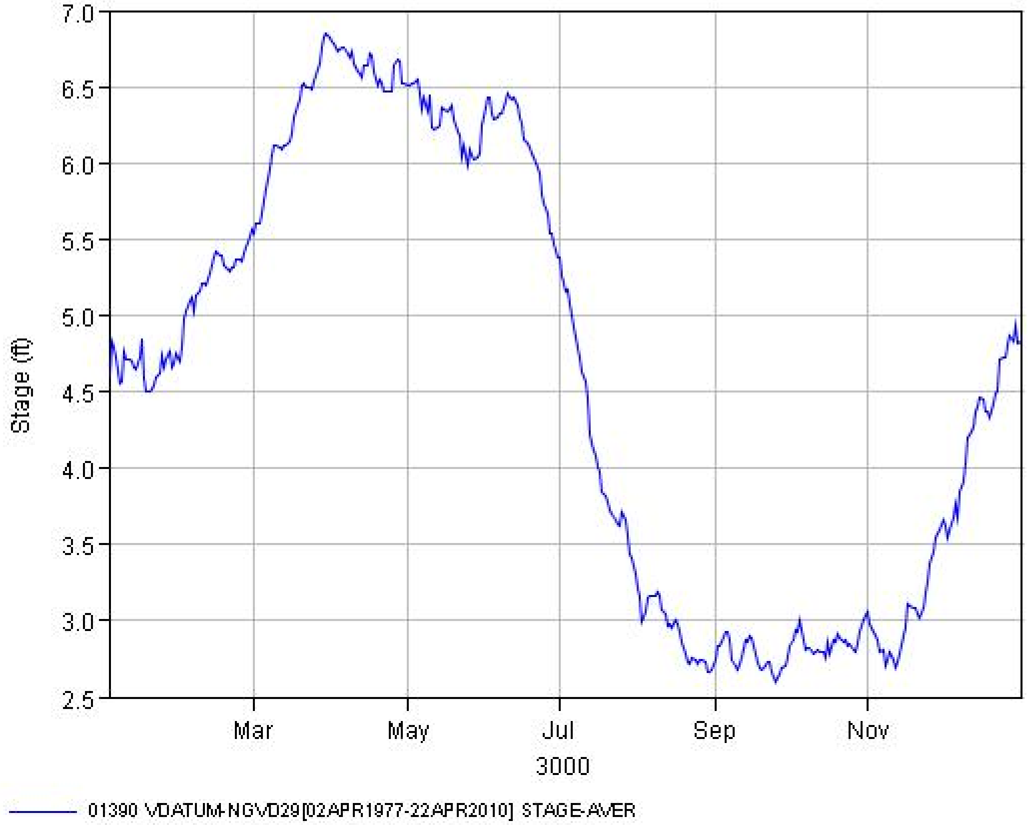
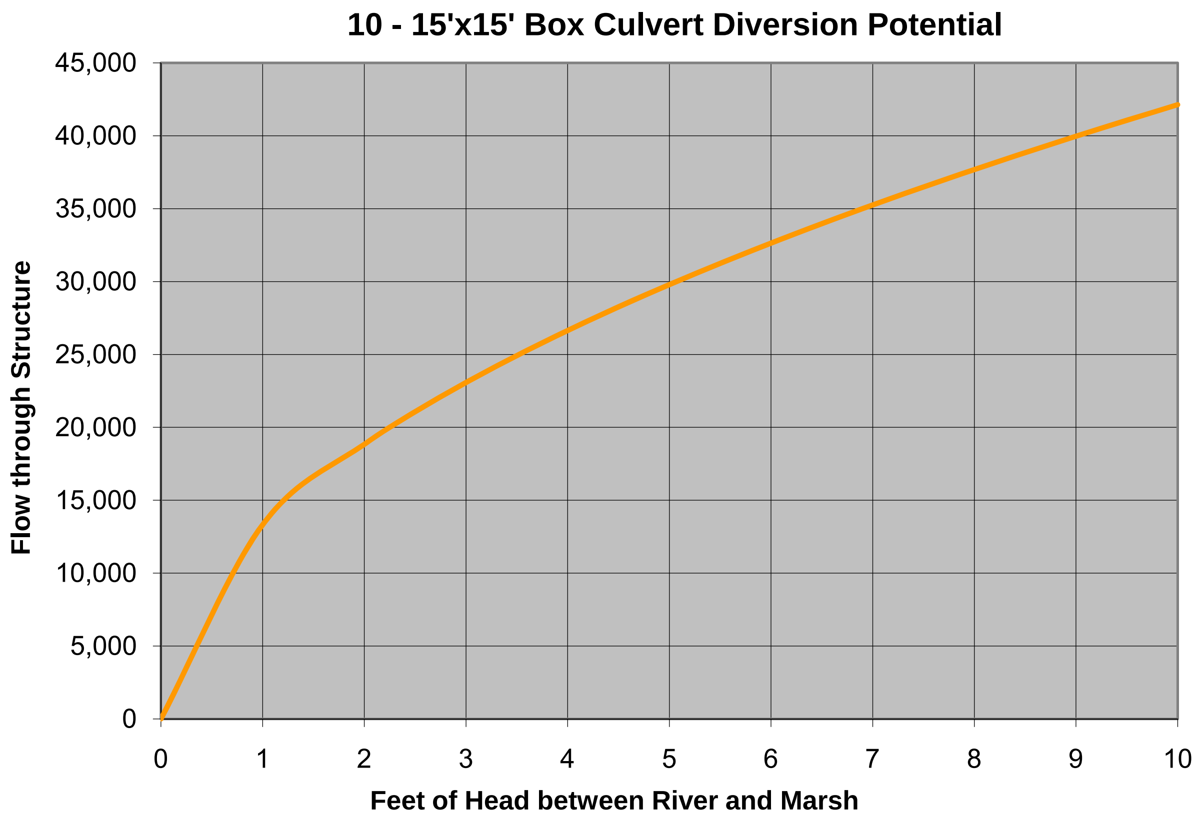


Figure 11.3 – Diversion Rating Curve



For more information operations of the diversion, please consult chapter 3.0 Plan Formulation of the White Ditch Feasibility Study.

L11.2 Maintenance

With the proposed diversion there will be needs for channel maintenance dredging, removal of sediment buildup in box culverts and sluice gate maintenance. It is estimated that there will need to be significant channel dredging every 10 years on the proposed channel enhancement features. Sediment removed from box culverts and dredged from channels shall be placed in sediment deficient areas near the dredge site. It is also assumed that there will be annual maintenance and lubrication needs provided to the sluice gates.

L12. Cost Estimates

L12.1 Basis of Cost Estimate

An initial array of alternatives was developed by the PDT. The initial array of alternatives included at Location 2 are:

- Alternative 2A: 30 pipe siphon with a 5,000 cfs outfall capacity
- Alternative 2B: 3 box culverts with a 5,000 cfs outfall capacity

- Alternative 2C: 30 pipe siphon with a 10,000 cfs outfall capacity
- Alternative 2D: 3 box culverts with a 10,000 cfs outfall capacity
- Alternative 2E: 10 box culverts with a 15,000 cfs outfall capacity
- Alternative 2F: 10 box culverts with a 35,000 cfs outfall capacity

The initial array of alternatives include at Location 3 are:

- Alternative 3A: 30 pipe siphon with a 5,000 cfs outfall capacity
- Alternative 3B: 3 box culverts with a 5,000 cfs outfall capacity
- Alternative 3C: 30 pipe siphon with a 10,000 cfs outfall capacity
- Alternative 3D: 3 box culverts with a 10,000 cfs outfall capacity
- Alternative 3E: 10 box culverts with a 15,000 cfs outfall capacity
- Alternative 3F: 10 box culverts with a 35,000 cfs outfall capacity

Each alternative consists of a structure paired with an appropriately sized outfall channel to convey a desired flow of fresh water and sediment into the weakened marsh area.

The preliminary cost estimates for the initial array of alternatives are unit price estimates based on preliminary design and associated quantity take-offs with price data from recent bid results, historical costs, and the expertise of the district's cost estimators and engineers. Appropriate contingencies are applied. The price level for these cost estimates is November 2009. The cost estimates for the initial array of alternatives can be found in Annex 3.

The final array of alternatives included four alternatives at Location 3. The alternatives were selected from the initial array of alternatives and had to meet the project goals outlined in the main report. The final alternatives chosen are:

- Alternative 3B: 3 box culverts with a 5,000 cfs outfall capacity
- Alternative 3D: 3 box culverts with a 10,000 cfs outfall capacity
- Alternative 3E: 10 box culverts with a 15,000 cfs outfall capacity
- Alternative 3F: 10 box culverts with a 35,000 cfs outfall capacity

The preliminary cost estimates for the final array of alternatives are also based on further refined preliminary design and associated quantity take-offs with price data from recent bid results, historical costs, and the expertise of the district's cost estimators and engineers. Appropriate contingencies are applied. The price level for these cost estimates is December 2009. The cost estimates for the final array of alternatives can be found in Annex 3. In addition to the four final alternatives, the cost estimates for the siphons at Location 3 were included. These estimates were included for quantity clarification purposes only.

L12.2 DETAILED ESTIMATE

The tentatively selected plan for the White Ditch Marsh Restoration project is Alternative 3F, 10 each, sized 15 feet x 15 feet box culverts, with an outfall capacity of 35,000 cfs. The selected plan involves excavating a section of levee and road to construct the 10 box culvert structure, replacing the levee and road on top of the structure, and excavating an outfall channel system to convey 35,000 cfs of fresh water and sediment to the damaged marsh. The structure also has ten sluice gates with hydraulic operators that will be used to regulate the flow of fresh water and sediment through the structure.

The preferred alternative cost estimate is a detailed estimate based on the expertise of the district's cost estimators and engineers. The cost estimate for the recommended plan was prepared utilizing the MCACES software. The MCACES estimate is included in Annex 3. The estimated costs were based upon an analysis of each line item evaluating quantity, production rate, and time, together with the appropriate equipment, labor, and material costs. Appropriate contingencies are applied. The price level for this cost estimate is January 2010.

The detailed estimate meets the requirements and recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects.
- ER 1110-2-1302, Civil Works Cost Engineering.
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.

The detailed estimate assumes that the marsh and main outfall excavation will be completed by two small dredges and the side berms will be formed by several amphibious excavators. The detailed estimate also assumes that all construction elements associated with the box culvert will be completed on land.

Planning, Engineering and Design costs and Construction Management costs are included in the detailed estimates. These costs are calculated as a percentage rate of the construction cost. The rates are 17.5% for planning, engineering and design, which includes engineering and design during construction, and 10% for construction management. The planning, engineering, and design rate was calculated based on percentages for Engineering, Project Management, Estimating, Construction, and Planning & Environmental Compliance. The construction management rate is based on average expenditures for construction management.

A plan construction schedule was developed based on the production rates used in the detailed estimate and the expertise of the district's cost estimators and engineers. The plan construction schedule was used in the Cost and Schedule Risk Analysis discussed below. The anticipated construction duration based on the plan schedule is four years and one month. The plan construction schedule is included in Annex 3.

The Total Project Cost table was developed based on the detailed estimate, the completed cost and schedule risk analysis, and the civil works work breakdown structure (CWWBS) elements included in the detailed estimate. Those elements are:

- 01 LANDS AND DAMAGES
- 02 RELOCATIONS
- 15 FLOODWAY CONTROLS AND DIVERSION STRUCTURES
- 30 PLANNING, ENGINEERING & DESIGN
- 31 CONSTRUCTION MANAGEMENT

The Total Project Cost table shows the effective price level for the detailed estimate of January 2010, the Budget Year effective price level of October 2010, and the Fully Funded Project Cost with a construction midpoint date of April 2014. Escalation for the price level years is based on the Army Corps of Engineers Engineering Manual (EM) 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS) revised 30 September 2009. The Total Project Cost table is included in Annex 3.

L12.3 Contingencies

Contingencies are based on a Cost Rick Analysis using Crystal Ball software. Results of this analysis are discussed in the Risk Analysis Section below.

L12.4 Risk Analysis

A cost risk analysis was performed for this project in accordance with ER 1110-2-1302 paragraph 7.3.2 and ER 1110-2-1302, appendix B, paragraph 4. The results of the cost risk analysis are shown in the Project Cost and Schedule Risk Analysis Report included in Annex 3.

ANNEX 1

Quantifying Benefits of Freshwater Flow Diversions to Coastal Marshes

Quantifying Benefits of Freshwater Flow Diversion to Coastal Marshes: Theory[a] and Applications[b]

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Keywords: wetland, Louisiana, accretion, uncertainty, organic, inorganic, coastal restoration, operation,

Abstract

The combination of relative sea level rise and river/marsh disconnection has created a deficit of available soil and accompanying land loss in a large portion of coastal Louisiana. The U.S. Congress recently charged the U.S. Army Corps of Engineers, State of Louisiana, and other federal and local agencies with restoring the coastal wetlands of Louisiana and Mississippi. Many alternative combinations of restoration measures have been proposed, and assessment of the advantages and disadvantages of these efforts must be made to determine the optimal design. One technique being applied for coastal restoration is the reconnection of rivers to coastal marshes through flow diversions.

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[a] Based on material from McKay, S.K., J.C. Fischenich, and S.J. Smith. (2008). "Quantifying Benefits of Flow Diversion to Coastal Marshes. I: Theory." In draft for submission to Ecological Engineering.
[b] Based on material from McKay, S.K., J.C. Fischenich, and R. Paille. (2008). "Quantifying Benefits of Flow Diversion to Coastal Marshes. II: Application to Louisiana Coastal Protection and Restoration." In draft for submission to Ecological Engineering.

Freshwater flow diversions offer significant nutrient and sediment inputs to marshes that induce both organic and inorganic accumulation of soil. Boustany (2007) presented a screening level model for assessing both the nutrient and sediment benefits of flow diversion over long time scales. This paper has presented the adaptation of Boustany's (2007) model to include daily variation in sediment processes in order to optimize diversion structure design and operation. The model was verified using an existing diversion to prove the ability of the model to track land evolution associated with flow diversion. This paper also demonstrates the application of the model to diversion operational and structural optimization.

Introduction

In the fall of 2005, Hurricanes Katrina and Rita awakened the United States public to the natural protection that coastal wetlands provide in reducing of the effects of hurricanes on coastal communities. In response to these catastrophic events, the U.S. Congress directed the U.S. Army Corps of Engineers (USACE) to "conduct a comprehensive hurricane protection analysis and design…to develop and present a full range of flood control, coastal restoration, and hurricane protection measures" (USACE, 2006). This paper focuses on interagency efforts to assess and weigh benefits of coastal restoration via freshwater flow diversion. The paper will focus on the development and adaptation of a screening level model to quantify the benefits of flow diversion to coastal marshes and will describe the assessment of various diversion operational and structural scenarios.

Coastal Marsh Accretion and Flow Diversion

The tidal marshes of coastal Louisiana are receding at alarming rates as high as 115 km^2/yr (Barras et al., 1994). Submergence of these valuable ecological assets (Figure 1) was once counteracted by vertical accretion due to the addition of freshwater, nutrient, and mineral inputs from riverine environments; however, eustatic sea level rise (ESLR) and basin subsidence now exceed the current rate of vertical accretion, and coastal marshes have been disconnected from their freshwater and sediment sources, distributary channels of the Mississippi and Atchafalya Rivers. ESLR has been attributed to global increase in ocean volume and has been estimated as 1.0-2.4 mm/yr (Church et al., 2001). Subsidence of the Mississippi delta has been attributed to multiple factors, namely: regional isostasy, faulting, sediment consolidation, and soil dewatering (Dokka et al., 2006). Previous researchers identified other potential sources of subsidence as groundwater and petroleum extraction (Morton et al., 2002); however, Dokka et al. (2006) renounce these hypotheses as unlikely due to the relative lack of groundwater extraction from the highly saltwater intruded groundwater table of most of southern Louisiana and the lack of coincidence between petroleum extraction and subsidence. The synergy of ESLR and basin subsidence has created an apparent local change in sea level known as Relative Sea Level Rise (RSLR) that has been measured in the Mississippi Delta at rates as high as 10 mm/yr (Snedden et al., 2007).

In addition to RSLR, the disconnection of coastal marshes from their sediment and nutrient source is equally disconcerting. Over geologic time scales, large-scale delta lobe switching has lead to alternating episodes of delta building and redistribution of sediment and nutrients throughout the coastal plain (Coleman, 1988; Coleman et al., 1998); however, in the last two centuries, the Mississippi River has been controlled by levees and other structures in order to maintain a consistent navigation channel for commerce and protect infrastructure against floods (Coleman et al., 1998; Parker et al., 2006). Presently, much of the sediment and nutrient load of the Mississippi River is discharged directly into the northern Gulf of Mexico through the birdsfoot delta, providing little benefit to protective delta building and contributing to an increasing zone of hypoxia near the river mouth (Mitsch et al., 2001). In addition to problems associated with fate of river sediment and nutrients, this disconnection starves coastal wetlands of historic nutrient and sediment inputs necessary for marsh sustainment. Although the relative importance of this multitude of factors has yet to be rigorously quantified throughout the Louisiana coastal plain, the combination of RSLR and river/marsh disconnection has led to high land loss rates and conversion of many freshwater marshes to shallow saltwater bays.

In recent years, freshwater flow diversions from river sources to coastal marshes have been offered as a tool for combating RSLR and disconnection of rivers and wetlands. In these diversions, river water is released into marshes to simulate flooding of a river onto its floodplain and increase hydrologic connectivity. Potential benefits have been observed from pulsing diversion discharges to simulate natural flood regimes (Day et al., 2003; Reyes et al., 2003; Snedden et al., 2007). Many studies have also shown that flow diversion is a plausible remedy to reconnect rivers to tidal marshes and deltas and induce organic and inorganic deposition (Parker et al., 2006; Snedden et al., 2007). An ancillary benefit of these flow diversions is potentially reduction of the nutrient loading to the Gulf of Mexico with associated reduction in the hypoxic zone (Lane et al., 1999; Mitsch et al., 2001).

Vertical accretion of marshes has been identified as highly dependent upon both inorganic and organic accumulation (Figure 2; Delaune et al., 1981; Nyman et al., 1993; Day et al., 1995; Reed, 1995; Foote and Reynolds, 1997; Nyman et al., 2006; Morris, 2007). Often accretion is only accounted for through sedimentation (e.g. Parker et al., 2006); however locations have been identified that depend more upon organic inputs than sediment inputs (Nyman et al., 2006). The characteristics of the receiving marsh and associated hydrologic connectivity are likely to influence whether inorganic or organic inputs control (Boustany, 2007). For instance, if a region is initially unvegetated, sediment inputs will be necessary to establish a soil platform for dense vegetative growth; however, once vegetation is well established, the vegetative inputs are likely to dominate while at the same time inducing higher retention of sediment in the process. This complex feedback system necessitates the inclusion of both inorganic (sediment) and organic (vegetative) inputs to any calculation of vertical accretion (Reed, 1995).

Vegetative accumulation in coastal marshes involves a delicate balance of above and belowground plant productivity (Gosselink, 1984; Edwards and Mills, 2005), salinity (Visser et al., 2004), nutrient availability (Delaune et al., 2005), flood frequency (Nyman et al., 2006), vegetation type (Gosselink, 1984), and seasonality (Visser et al., 2004), among other factors. Freshwater reintroduction has been shown to increase nutrient inputs to coastal marshes (Lane et al., 1999) and stimulate growth in these ecosystems (Cardoch et al., 2002), further causing vegetative inputs to contribute to accretion. In coastal Louisiana most marshes are nutrient limited (Nyman et al., 1990; Delaune et al., 2005), so the introduction of limiting nutrients such as nitrogen and phosphorous from flow diversion is a topic of great importance when considering flow diversion alternatives and benefits (Lane et al., 1999; Hyfield, 2004; Hyfield, 2008); however, excessive nutrient loading to coastal wetlands could potentially induce harmful water quality effects such as eutrophication (Delaune et al., 2005) or stimulation of invasive plant species (Carter and Bernard, 2007), so diversion of flow to coastal wetlands must be carefully balanced and planned.

The accretion of sediment on coastal marshes and deltas has also been studied extensively (Stumpf, 1983; Wang, 1997; Rybczyk and Cahoon, 2002; Reyes et al., 2003; Parker et al., 2006; Snedden et al., 2007). Relevant sedimentation processes have been identified as sediment loading from floods/diversions (Reed, 1995; Parker et al., 2006), sediment settling properties (Stumpf, 1983; Soulsby, 1997; Winterwerp and van Kesteren, 2004), tidal erosion (Stumpf, 1983; Wang et al., 1997), wind and storm induced erosion and deposition (Wang, 1997), sediment export through canals and bayous (Wang, 1997; Baustian and Turner, 2006), and vegetation induced settling (Gleason et al., 1979; Stumpf, 1983; Reed, 1995; Leonard and Luther, 1995).

Although flow diversions have proved useful for combating coastal land loss, the optimization of flow diversion locations and operation has been difficult due to the complexity in data needs of a coupled ecological and hydrodynamic model (Reyes et al., 2003; Delaune et al., 2003; Snedden et al., 2007). These complexities encourage the development of a simple, screening-level model that includes the effects of vegetation and sediment dynamics and allows for straightforward examination and optimization of flow diversion feasibility and operational benefits.

Boustany (2007) Landscape Evolution Model

Boustany (2007) developed a composite nutrient and sediment model to assess the feasibility of flow diversions and screen diversion alternatives under the Coastal Wetland Planning, Protection, and Restoration Act (CWPPRA; Boustany, Personal Communication). This model, herein referred to as the Boustany Model (BM), presents all benefits of flow diversion in terms of marsh area by assuming all nutrient and sediment benefits additive to the existing area and land change rate:

$$A_{i+1} = A_i + \delta_{nut} A_i + A_{sed}$$

Equation 1

Where A_i is the marsh area at time i, δ_{nut} is the fractional change in land area due to RSLR and river-marsh disconnection (value may be positive or negative) that has been adjusted to account for the benefits associated with nutrient addition, and A_{sed} is the area benefit of sediment addition.

The BM was developed to compare long term relative benefits of many flow diversion locations and was implemented with an annual time step to provide quick estimates of the potential benefits of diversions. The BM is sufficient for quick estimation of flow diversion benefits and initial screening of alternatives, but the LACPR program required greater temporal resolution in order to assess not only the relative benefits of diversion locations, but also the effects of diversion structure type, diversion operational regimes, and hydrologic variability. Ideally a detailed two- or three-dimensional model coupling nutrient and sediment processes would be used to account for the complex mechanisms governing coastal marsh accretion (Reyes et al., 2000; Dortch et al., 2007); however, the vast number of alternatives and short time scale of the LACPR report to Congress precluded development of such models for every alternative and marsh. As such, the BM was adapted to include processes deemed most critical to LACPR alternatives analysis. The following sections provide further details of the nutrient and sediment models implemented in the landscape evolution calculations, but the two major adaptations of the BM were:

- High temporal variability in sediment processes encouraged the refinement of the temporal resolution of the sediment model to include daily impacts of the diversion on the marsh.
- In order to maintain model simplicity, the BM required estimation of a number of parameters to account for nutrient and sediment processes (e.g. sediment retention and average annual suspended sediment concentration). The adaptation of the model has also included the calculation of many of these inputs in order to account for temporal variance, reduce data requirements, and minimize potential input errors.

Nutrient Benefits

Nutrient addition to coastal marshes has proven to be a source of vegetation stimulation and strengthening and biomass creation (Deegan et al., 2007). Boustany (2007) proposes a model that accounts for the ability of nutrients to stimulate vegetation to better resist erosional processes. This model determines the percent of the vegetated area that is strengthened from nutrient addition. This parameter is found by examining the annual nutrient requirements of the marsh relative to the nutrients loaded to the marsh.

The nutrients required by the marsh for vegetative growth are assumed to be the mass of the nutrients held in plant biomass. This quantity may be assessed by examining the rate of biomass production (annual primary productivity, P_r) and the percent of biomass containing these nutrients (γ). Since most Louisiana coastal marshes are nitrogen or phosphorous limited, Boustany proposes that the total concentration of nitrogen and phosphorous (*TNP*) be used to account for nutrient benefits.

$$LR_{req} = P_r \gamma_{TNP}$$

Equation 2

Where LR_{req} is the marsh required nutrient loading rate [$ML^{-2}T^{-1}$], P_r is primary productivity [$ML^{-2}T^{-1}$], and γ_{TNP} is the percent of plant biomass containing nitrogen and phosphorous [1].

The nutrient loading rate of the diversion to plant biomass, LR_{div}, may be calculated from the volumetric discharge of water to the marsh from the diversion, Q_{div} [L^3T^{-1}], the concentration of nutrients in the source water, C_{source} [ML^{-3}], the retention rate of nutrients in plant biomass, R_{nut} [1], and the vegetated marsh area, A_{veg} [L^2].

$$LR_{div} = \frac{Q_{div} C_{source}}{A_{veg}} R_{nut}$$

Equation 3

In addition to nutrient loading from the diversion, there is ambient nutrient loading to the marsh from other ongoing processes (e.g. atmospheric deposition, stormwater runoff, current plant decomposition, denitrification, etc.). These processes will be accounted for by a loading rate for background sources, $LR_{background}$. The net loading of nutrients to the marsh, LR_{net}, is therefore the sum of the background and diversion loading rates.

$$LR_{net} = LR_{div} + LR_{background}$$

Equation 4

From knowledge of the loading rates applied, LR_{net}, and required, LR_{req}, one may obtain the fraction of wetlands sustained by nutrient addition, E_s.

$$E_s = \frac{LR_{net}}{LR_{req}}$$

Equation 5

In this model, nutrients are assumed to be unable to freely construct land; however, they can reduce the loss rate by strengthening vegetated areas against erosion. This assumption produces conservative estimates of the organically-induced benefits of the diversion. For instance, in an environment with a low land loss rate, according to the model, the diversion could potentially reduce the land loss to zero; however, no land gain would be associated with organic inputs. The percentage of wetland sustained by nutrient addition serves as a reduction ratio to the land loss rate in the form of Equation 6.

$$\delta_{nut} = \begin{cases} \delta(1 - E_s) & For E_s < 1 \\ 0 & For E_s \geq 1 \end{cases}$$

Equation 6

Where δ is the land change rate prior to the diversion and δ_{nut} is the nutrient adjusted land change rate.

Sediment Benefits

The accumulation of diverted sediments is determined by a sediment budgeting model utilizing the input concentration of sediment from the source water and calculated hydrodynamics of the system to determine the quantity of diverted sediment retained in the marsh. As previously specified, the BM implemented sedimentation calculations on an annual timescale, and while this assumption is reasonable for preliminary screening of alternatives, further refinement is necessary for more detailed analyses of flow diversion benefits. The sediment model implemented herein relies on calculation of sediment inputs and sediment settling theory on a daily timescale over a single representative year and reapplies that year throughout the proposed project life cycle.

Sediment Input

In order to minimize costs and maximize benefits of flow diversion in coastal Louisiana, diversion structures often withdraw water from one of the region's major rivers (e.g.

Mississippi, Atchafalya, Calcasieu). These rivers are located throughout the coastal plain, carry large water and sediment loads, and serve as a virtually infinite source of diversion resources.

River discharge and suspended sediment concentration have often been shown to be positively correlated (Mossa, 1996; Snedden et al., 2007). The relationship between discharge and sediment load may be determined by analytical and partially analytical models (e.g. Meyer-Peter Muller, Einstein, Yang; Richardson et al., 2001) or by empirical models for a given set of observed discharge and sediment concentration values (Mossa, 1996; Snedden et al., 2007). In coastal Louisiana, there exists enough recorded sediment discharge data to generate empirical models of sediment concentration for some of the major rivers of the region. For this analysis, a power function was found to provide enough resolution in sediment concentration variation (Equation 7). Table 1 presents a number of sediment ratings of this form for coastal Louisiana.

$$Q_{s,river} = a_1 Q_{river}{}^{a_2}$$

Equation 7

Where $Q_{s,river}$ is sediment load (ton/da), Q_{river} is river discharge (cfs), a_1 is a dimensional coefficient, and a_2 is a dimensionless coefficient. From this sediment rating, flow-averaged suspended sediment concentration of the river, C_{river}, may be calculated $\left(C_{river} = Q_{s,river} / Q_{river} \right)$ and transformed to the desired units.

Regardless of the model defining this relationship, the sediment concentration has been shown to be highly dependent upon discharge; therefore, in order to capture the temporal variance in sediment discharge through a diversion, the sediment concentration must vary with river discharge at an appropriate time scale (Snedden et al., 2007). For the purposes of this analysis, daily variation in discharge provides sufficient temporal resolution for accurate calculation of sediment loading to marshes by diversions.

One of the purposes for adapting the BM is the desire to examine relative diversion structure operation. In order to do this, daily estimates of diversion discharge are also required. These daily diversion discharges, Q_{div}, are combined with the daily predictions of river suspended sediment concentration, C_{river}, to determine the mass loading rate of sediment to the marsh, $Q_{s,div}$ (Equation 8). This increase in temporal resolution allows for examination of diversion discharge operation such that sediment benefits may be maximized by coinciding diversion discharges with periods of high river suspended sediment concentration.

$$Q_{s,div} = Q_{div} C_{river}$$

Equation 8

Sediment Retention

After sediment laden water has been diverted to a coastal wetland, a portion of the sediment load is expected to settle from suspension and deposit. Sediment that remains in suspension is then subject to being transported outside the system boundaries. Sediment retention defines the fraction of diverted sediments retained within the coastal wetland.

Retention is dependent upon system properties such as: wetland geometry, diversion discharge, tidal velocities (Stumpf, 1983), wind and storm events (Wang, 1997), settling velocity of diverted sediments (Soulsby, 1997; Winterwerp and van Kesteren, 2004), vegetation coverage (Stumpf, 1983), and canal-induced sediment import/export (Wang, 1997). The approach taken by Boustany (2007) is to apply retention factors estimated for other sites (e.g. Wax Lake Outlet) or allow the analyst to choose a retention factor based on knowledge of the receiving area and best professional judgment. Building upon the suggestion of Stumpf (1983), an alternative to this approach is to use a simple calculation which includes effects of wetland geometry, sediment properties, and flow hydrodynamics at the site. The effects of vegetation and channels are ignored in this analysis in order to maintain model simplicity; however, vegetation would likely increase roughness, reduce turbulence, and induce greater sediment deposition leading to conservatively low estimates of sediment retention, while the influence of channels may serve as pathways to sediment export and thus produce non-conservatively high estimates of sediment retention.

Consider suspended sediments in a water body. The time required for a given particle to settle from the water surface to the bed is given as:

$$T = \frac{H}{W_{s,eff}}$$

Equation 9

Where T is the time required for sediment to completely settle, H is the local depth, and $W_{s,eff}$ is the effective settling velocity of a specific sediment class.

As the particle settles, it is also transported by tidal and diversion currents, so the distance traveled by the particle is:

$$X = U_{div} T = U_{div} \frac{H}{W_{s,eff}}$$

Equation 10

Where U is the diversion induced mean velocity. As the averaging timescale of the model is greater than the tidal period and net tidal flow is zero, Equation 10 neglects the influence of tidal velocities, and the net displacement of water within the marsh is described by the diversion flow.

For this analysis the wetland is assumed to have rectangular planform and cross-sectional geometries described by the average length (L), width (B), and depth (H). The fraction of sediment retained in the wetland then becomes a function of wetland length relative to transport distance prior to full deposition of the sediment fraction in question (Stumpf, 1983). If all diverted sediment is retained within the system, the retention factor is 1. Since this analysis takes a macroscopic view of the total sediment retained in the system and location of deposit is not considered, the retention factor becomes 1 if the length of the wetland is greater than the transport length, and the retention of a given sediment particle class, R_j, may be expressed as:

$$R_j = \min\left(\frac{L}{X}, 1\right)$$

Equation 11

Due to variation in fall velocity with sediment size, coarse particles may be retained while fines are flushed from the system; therefore, the combined retention of the entire grain size distribution must be made. Retention over all sediment classes may be expressed as:

$$R_T = \sum R_j f_j$$

Equation 12

Where R_T is the combined total retention factor and f_j is the mass fraction associated with each sediment class.

Fall Velocity

A key element of the sediment budgeting model presented is the calculation of the effective fall velocity of a given sediment size class, which is a function of the fall velocity of that sediment in a static body of water, W_s, and the turbulence of the flow. Fall velocity of sediment is dependent upon both sediment properties (shape, size, density, concentration, ability to flocculate) and fluid properties (viscosity, density, temperature, salinity). In the natural environment, turbulence is generated by flow over the sediment bed. The presence of turbulence acts to vertically mix suspended sediments, which reduces the effective settling velocity of suspended particles. The steady-state vertical flux balance at a point in the water column is given by:

$$W_s C + K_z \frac{dC}{dz} = 0$$

Equation 13

Where C is the suspended sediment concentration, K_z is the vertical diffusivity, and z is the vertical distance from the bed.

For the purposes of this tool to estimate retention, it is convenient to combine the terms in Equation 13 to define an effective settling velocity (Equation 14).

$$W_{s,eff} C = W_s C + K_z \frac{dC}{dz}$$

Equation 14

Vertical diffusivity varies with turbulent intensity and height above the bed. Rouse proposes that diffusivity varies parabolically with height above the bed in the form (Richardson et al., 2001):

$$K_z = \kappa u_* z\left(1 - \frac{z}{H}\right)$$

Equation 15

Where κ is the von Karman constant (~0.4) and u_* is the total friction velocity (a measure of turbulent intensity).

Given the sediment flux balance in Equation 13, the vertical concentration profile is:

$$C = C_a\left(\frac{z}{z_a}\frac{H - z_a}{H - z}\right)^{-b}$$

Equation 16

Where b is the Rouse parameter $\left(b = {W_s}/{\kappa u_*}\right)$ and z_a is a reference height above the bed with a known sediment condition, C_a.

The turbulent shear velocity is estimated from the depth-averaged velocity by the logarithmic boundary layer (law of the wall) (Kundu, 1990).

$$u_* = \frac{U\kappa}{\ln\left(\frac{H/3}{z_0}\right)}$$

Equation 17

Where U is the daily mean wetland velocity with both tidal and diversion related components and z_0 is the hydraulic roughness length.

For the diurnal tidal cycle of coastal Louisiana, the tide is assumed to have approximately sinusoidal periodicity. The mean instantaneous wetland velocity can then be determined by considering both tidal and diversion components (Figure 3).

$$U_i = U_{div} + U_{\max,tide} \sin\omega = \frac{Q_{div}}{HB} + U_{\max,tide} \sin\omega$$

Equation 18

Where U_i is the instantaneous mean velocity with tidal and diversion components and $U_{max,tide}$ is the maximum tidal velocity (or tidal amplitude), and ω is tide phase.

For the use in the flow diversion model, the velocity is integrated over the tidal cycle (0 to 2π) to obtain the daily mean velocity, U.

$$U = \frac{1}{2\pi}\left\{U_{div}\left(2\omega_1 - \omega_0 - \omega_2\right) + U_{\max,tide}\left(\cos(\omega_2) - 2\cos(\omega_1) + \cos(\omega_0)\right)\right\}$$

Equation 19

Where ω_0 is the tide phase at zero up-crossing $\left(\omega_0 = \sin^{-1}\left(-U_{div}/U_{\max,tide}\right)\right)$, ω_1 is the tide phase at zero down-crossing $\left(\omega_1 = \pi - \omega_0\right)$, and ω_2 is the completed tidal phase $\left(\omega_2 = \omega_0 + 2\pi\right)$ (Figure 3).

In order to estimate the shear velocity, the hydraulic roughness must also be estimated from local sediment grain size, form roughness, and vegetative coverage. In this analysis, a lumped parameter accounting for both grain size and form roughness is implemented based on marsh surface character (Table 2). Vegetative roughness is incredibly important in coastal marshes where emergent plants are encountered throughout the marsh, and although basing this parameter on bed material ignores the effects of vegetation, this will provide an estimate of sediment settling in open water and will therefore provide conservative estimates of settling in vegetated or partially vegetated marsh.

Combining Equation 13 – Equation 17, one may obtain an expression for the effective settling velocity of sediment in coastal marshes.

$$W_{s,eff} = W_s - bK_z\left(\frac{H - z_a}{z_a}\right)^{-b}\left(\frac{z}{H - z}\right)^{-b-1}\left(\frac{H}{(H - z)^2}\right)$$

Equation 20

For incorporation into the flow diversion model, vertical mixing has been computed at a height above the bed equal to 1/10 of water depth $\left(z = H/10\right)$ and z_a is approximated as 1/100 of the depth $\left(z_a = H/100\right)$. These values provide an estimate of the settling velocity of particles very near the bed that are assumed to settle. Insertion of these relations into Equation 20 yields:

$$W_{s,eff} = W_s - bK_z(99)^{-b}\left(\frac{1}{9}\right)^{-b-1}\left(\frac{0.81}{H}\right)$$

Equation 21

Where $K_z = 0.009\kappa u_* H$.

Net Sediment Benefit

By accounting for sediment loading to the marsh and sediment retention within the marsh, the mass loading rate of sediment retained in the marsh may be determined by:

$$Q_{s,net} = Q_{s,div} R_T$$

Equation 22

Where $Q_{s,net}$ is the net mass loading rate of sediment to the marsh.

This loading rate may then be used to calculate the net aerial sediment benefit due to flow diversion, A_{sed}, for a given time period.

$$A_{sed} = \frac{Q_{s,net}\,dt}{H\rho_{bd}}$$

Equation 23

Where dt is the time step (da) and ρ_{bd} is the average bulk density of the receiving area.

Bulk density in coastal marshes varies significantly with depth due to sediment consolidation. For our analysis, we assumed that the bulk density was a depth averaged value based on the depth of marsh being filled with sediment (i.e. flow depth, *H*). Bulk density profiles were obtained from literature (Nyman et al., 1990; Nyman et al., 1993; Delaune et al., 2003) and available data (Michael Channel, personal communication).

Application: Caernarvon Diversion and Breton Sound Estuary

In order to verify the ability of the model to account for landscape evolution due to flow diversion, the model was applied to an existing diversion structure and marsh, the Caernarvon Diversion to Upper Breton Sound Estuary (Figure 4). The Caernarvon Diversion is located on the east bank of the Mississippi River at river mile 81.5 (131.2 km) (approximately 12.5 river miles (20.1 km) downstream of New Orleans) and discharges Mississippi River water into Breton Sound through five 15-ft (4.57-m) box culverts with vertical lift gates (Lane et al., 1999; Snedden et al., 2007). The diversion was constructed between 1988 and 1991 and opened for operation in August of 1991 with goals of reducing the salinity in Breton Sound for commercial shell fisheries. An ancillary benefit of the diversion has been sediment and nutrient loading to the marsh and corresponding reduction in land loss (Snedden et al., 2007).

Upper Breton Sound is approximately 231 mi^2 (599 km^2) in area with a length of 18.8 mi (30.2 km) and a width of 12.3 mi (19.8 km). This estuary was historically an intermediate marsh, but due to RSLR and river/marsh disconnection, marsh salinity elevated to brackish conditions before the diversion became operational (Carter and Bernard, 2007). The current marsh is dominated by brackish species (e.g. *S. patens*) near the diversion and saline marsh species (e.g. *S. alterniflora*) far from the diversion (Snedden et al., 2007).

Breton Sound is hydrologically isolated from surrounding marshes by levees on both the eastern and western borders; therefore accounting for inflows and outflows to the marsh is relatively straightforward with water budgets for Upper Breton Sound revealing major hydrologic processes to be precipitation, evaporation, and freshwater diversion. Groundwater and stormwater inflows have been shown to be relatively small compared to precipitation and diversion (Hyfield, 2004).

In order to maximize the retention time of diverted water and induce desirable sediment settling and nutrient uptake, the State of Louisiana has initiated outfall management for the Caernarvon Diversion. Management actions have included restoration and backfilling of man-made canals, installation of control structures throughout the marsh (Carter and Bernard, 2007), and operational adjustment to test theories of marsh sedimentation processes (Snedden et al., 2007).

Snedden et al. (2007) have shown that a large majority (nearly 99%) of Caernarvon's discharge flows downmarsh through two major flow routes for low discharges. These authors indicate that below 3500 cfs, the diverted waters remain almost entirely in these canals. When diversion discharge exceeds this threshold value, diverted waters appear to exceed canal banks and flow over the marsh as sheet flow (Snedden et al., 2007). This indicates that large pulses of discharge may be more effective in distributing sediments throughout the estuary. These authors also applied a local river sediment rating based on near-surface suspended sediment concentrations of the Mississippi River approximately 5 mi (8 km) downstream of the Caernarvon structure at Belle Chase, Louisiana. By examining sediment loading rates through the diversion, these authors concluded that pulsing of discharges in phase with high river sediment concentrations not only induces sheet flow over the marsh, but also has the ability to load much greater quantities of sediment to the marsh (Snedden et al., 2007).

The Caernarvon Diversion provides an excellent test case for the model developed herein due to the variable discharge inputs and extensive knowledge of current system processes. Table 3 presents the inputs to the model for the Caernarvon Diversion and

Breton Sound. Many of these inputs have a significant amount of variability and have been presented with standard deviations in order to provide the reader with a scale of parameter uncertainty. When data was not available, parameters and ranges were estimated by best professional judgment. Since many of the input parameters contain a significant amount of uncertainty and forecasting land evolution in such a complex system is difficult, model uncertainty has been characterized by a Monte Carlo risk analysis. In this analysis, parameter uncertainty was estimated and assumed normal about the mean. Random errors were then introduced in each parameter for 10,000 calculations. Model results were computed with each set of randomly induced errors, and the range of area predictions was analyzed to determine 90% confidence intervals.

In order to apply the model to Breton Sound, the diversion and river hydrographs must be estimated to indicate marsh nutrient and sediment availability. The river hydrograph may be estimated by using a representative water year or by averaging flows for many years and determining mean daily discharges over a period of record. The diversion hydrograph may be estimated by applying historic operational records, assuming an input hydrograph, testing various operational theories (e.g. pulses timed with river discharge), or linking the discharge to the diversion structure type (e.g. diversion discharge dependence upon river stage using a weir equation). A sample representative diversion and river hydrograph are displayed (Figure 5) for operation of the Caernarvon structure in 1994. Both the diversion and river hydrographs for this year output very near average annual discharge volumes and the peak magnitudes of the hydrographs were well represented; therefore, for this analysis, the diversion and river hydrographs were assumed to be that of the 1994 calendar year for each year of the simulation.

Figure 6 presents the evolution of land area within Upper Breton Sound from before the diversion was opened (1 November 1990) until the end of 2006 (31 December 2006). This figure shows the observed values of marsh area along with estimates by the current model with associated parameter uncertainty alongside the Boustany Model. The estimated future without project (FWOP) is presented to provide the reader with the magnitude of marsh area benefit the Caernarvon Diversion is providing Breton Sound. Vertical lines indicate the beginning of diversion operation and hurricanes making landfall in Louisiana. It is clear that hurricanes create significant perturbations to the system; however, hurricanes may provide both import and export to a given marsh depending upon the location of landfall and are, for the purpose of this screening level model, assumed to create no net import or export of sediment over a long planning horizon.

In addition to model verification at Caernarvon, readers may be interested in the benefits provided by nutrient and sediment components separately; therefore Figure 7 presents the model predictions with nutrient only and sediment only scenarios for the Caernarvon Diversion application.

Optimization of Implemented Diversion

The focus of LACPR has been the analysis of alternatives and the decision support framework associated with choosing diversion sites and quantities. The land evolution model has been applied as tool for assisting in this framework and has provided relative benefits of various flow diversion sites and scenarios. The utility of the tool, however, has not yet been fully exploited. Following the narrowing of alternatives, the land evolution model may then be used in the initial optimization of the selected diversions by examining different operational and structural scenarios. This type of analysis has not yet been conducted for each of the alternatives of the LACPR, but this section provides a sample of how these analyses might be conducted for a given diversion site. The model will be applied to an existing diversion (Caernarvon) to assess the land gain benefits of six operational and five structural scenarios with near equal annual discharge volumes.

As previously stated, the Caernarvon Diversion discharges Mississippi River water to Upper Breton Sound through five 15 ft box culverts with vertical lift gates which can be used to control diversion discharges to the marsh. For this analysis the diversion is merely used to demonstrate the ability of the land evolution model to provide relative benefits of different operational and structural conditions. Table 3 provides the model inputs used for these optimization exercises. For these analyses, the 1994 Mississippi River hydrograph was found to be representative of the average annual discharge volume, peak magnitude, and seasonality of flow in the river and has been used throughout the duration of the model simulations in these exercises.

Operational Optimization of Gate Structures

The continuous hydrographic inputs of the model provide a tool for optimizing gate-type diversion operation to obtain the greatest land evolution benefits. In this section, the model will be applied to demonstrate the operational benefits for the six approximately equal-volume discharge scenarios that follow (Figure 8). These annual hydrographs were chosen based on previous research indicating that pulsing and timing of diversions may be critical to land evolution (Day et al., 2003; Snedden et al., 2007).

1. Historic operation based on 2003 operational conditions (a "pulsed" diversion year with a large portion of the annual sediment load derived from two two-week pulses)
2. Simulated operation with a large pulse of one-month duration timed *in phase* with high river sediment discharges
3. Simulated operation with a large pulse of one-month duration timed *out of phase* with high river sediment discharges
4. Simulated operation with a small pulse of six-month duration timed *in phase* with high river sediment discharges
5. Simulated operation with a small pulse of six-month duration timed *out of phase* with high river sediment discharges
6. Constant diversion discharge

Each of the annual hydrographs was input to the model, and land evolution estimates were made for a 50 year time period starting at the arbitrary starting date of January 1, 2001 (Figure 9). These results indicate that, for the inputs considered, the magnitude and timing of the diversion discharges is critical to suppression of the land loss rate. Therefore, for this hypothetical diversion scenario at Caernarvon, the diversion of flows could be altered to be in phase with high river sediment discharges and should occur from later winter to early summer (February – June). These periods of high sediment discharge may not, however, align with other project goals of a given diversion (e.g. reduction of salinity for maintenance of commercial fisheries). This analysis indicates a time period over which the greatest land evolution benefits may be obtained, and diversion operation may be optimized within that timeframe to include multiple project goals.

Structure Selection

Not only will operational considerations impact diversion benefits, but structure type will also have a drastic impact on the selection and operation of a given diversion. For instance, a gate-type structure (such as the one at Caernarvon) may be controlled to achieve the desired water and sediment discharges, but the cost and maintenance may be high. Whereas a broad-crested weir may have low cost, but control of diversion discharges is relatively minimal. A siphon is a third common diversion structure that may require significant maintenance and operational effort, but the suspended sediment concentration of the diverted water may be higher and the size gradation of the sediment diverted may be significantly larger inducing more land gain on both accounts. This section will demonstrate the ability of the model to assess land evolution by applying the model to the Caernarvon Diversion for the following five hypothetical structural scenarios:

1. Gate structure with pulsed operation based on the 2003 hydrograph
2. 100-ft wide broad-crested weir
3. 200-ft wide broad-crested weir structure
4. 1 – 15 ft siphon with a single short duration (113 day) discharge event
5. 1 – 6 ft siphon with continuous operation throughout the year

The weir structures have been assumed to behave as theoretical broad-crested weirs (Equation 24) and the discharge was determined based on the Mississippi River stage for the representative hydrograph (1994). The weir elevations were adjusted to produce annual discharge volumes approximately equal to the average annual diversion discharge volume from 1991-2006.

$$Q_{div} = C_{weir} B_{weir} \left(z_{river} - z_{weir}\right)^{3/2}$$

Equation 24

Where C_{weir} is a weir coefficient (~4.37 $ft^{0.5}/s$), B_{weir} is the width of the weir (ft), z_{river} is the elevation of the river for a given flow rate (ft), z_{weir} is the elevation of the weir (ft) (White, 2003).

In order to calculate the discharge of the diversion by siphoning, Bernoulli’s equation was implemented (Equation 25). Frictional losses in the pipe were assumed negligible due to the qualitative nature of this analysis. As with the weir, the marsh elevation was optimized to produce annual discharge volumes approximately equal to the average annual diversion discharge volume from 1991-2006. Figure 10 presents diversion discharge hydrographs for the five scenarios considered.

$$Q_{div} = V_{siphon} A_{siphon} = \sqrt{2g\left(z_{river} - z_{marsh}\right)}\left(\frac{\pi d^2}{4}\right)$$

Equation 25

Where z_{marsh} is the elevation of the marsh and d is the pipe diameter.

The land evolution model was applied using these annual diversion hydrographs and the parameters from the Caernarvon Diversion (Table 3). The only alteration of the Caernarvon model inputs was the sediment rating curve and size fraction applied to the siphon calculations. A weir or gate structure diverts surface waters of the Mississippi River to the marsh, and the Belle Chase surface sediment rating presented in Table 1 was determined as such (Snedden et al., 2007), but a siphon could draw water from lower in the water column, producing a larger sediment concentration and a more coarse sediment size fraction. As such, the total sediment rating at Belle Chase was applied with an assumed size fraction distribution based on the observed fraction of silt and clay (f_{sand} = 0.12, f_{silt} = 0.44, f_{clay} = 0.44, f_{floc} = 0.3).

As evident by the land evolution calculations (Figure 11), the benefits of flow diversion are extremely sensitive to the size fraction and concentration of the river water diverted. Therefore, the choice of structure type from a land evolution perspective is overwhelmingly in favor of siphons which divert higher concentrations of coarser sediment. However, logistical difficulties associated with operation and maintenance of a siphon (e.g. maintaining head differential, priming the siphon, air intrusion) may eliminate this structure type from consideration in many instances. It is also important to note that the results presented herein likely offer overly optimistic benefits of siphon structures due to the exclusion of friction in the siphon and the use of the total suspended sediment rating at Belle Chase. Although the siphon will be able to draw water from lower in the Mississippi River water column than a gate or weir, in order to maintain appropriate pressure differential for flow to the marsh, the siphon inlet will likely be required to draw in the upper half of the water column where suspended sediment concentrations are lower. The land evolution benefits of a siphon may also be overshadowed by other project objectives which may be detrimentally impacted by high turbidity or suspended sediment concentrations, such as fisheries production and marsh vegetation stimulation.

Summary of Diversion Optimization

The purpose of this exercise was not to identify an operational condition or structural alternative that is ideal for all flow diversions in coastal Louisiana, but was instead to demonstrate the land evolution model's ability to maximize land gain benefits for various operational and structural alternatives. Land gain (or suppression of land loss) is often not the only objective in the large-scale, long-term projects of the LACPR, and many other factors may be included in the selection of a diversion operational or structural scheme, some of which include:

- Cost of diversion with both structural and operation/maintenance components
- Desire to control diversion releases
- Commercial fisheries impacts
- Public recreational land use patterns

Conclusions

This paper has presented the adaptation of a model for quantifying flow diversion benefits and demonstrated the model's ability to estimate the relative benefits of various flow diversion locations, structures, and operational regimes; however, the model results are limited due to the exclusion of a variety of important system processes. Some of the major assumptions and limitations of the model were:

- Benefits of flow diversion are independent (in reality the benefits are likely non-linearly coupled due to vegetation inducing sediment deposition and sedimentation increasing suitable habitat for vegetation)
- Nutrients serve as a reduction in land loss, not a source of land gain benefits (Deposition of particulate organic matter neglected)
- Spatial uniformity - vegetation, roughness, bulk density, and other parameters are highly heterogeneous in coastal marshes
- Temporal resolution is only represented intra-annually, not contiuously
- Rectangular wetland geometry
- No vegetative component to settling/roughness
- Organic accumulation is not considered as a function of time even through biomass production is highly seasonal
- No habitat switching with time
- Canals are not accounted for as a sediment loss mechanism
- Sheetflow was assumed for all diversion flow rates
- No sediment resuspension due to rainfall, tidal flows, waves, or hurricanes
- Uniform distribution of sedimentation.
- Nutrient recycling neglected

Although these assumptions significantly limit the model's ability to quantify the benefits of flow diversion, approximations had to be made due to the time and resource constraints under which the model was developed. Further refinement of model processes and algorithms are recommended and should address the above limitations specifically focusing on the following:

- Temporal distribution of nutrient benefits to account for seasonality and storage
- Nutrients as a source of benefit, not just a source of loss reduction. Refer to the organic accumulation models of Blum et al. (1978), Mitsch and Reeder (1991), and Reyes et al. (2000) for examples of organic benefit frameworks
- Nutrient retention calculations inclusive of marsh nutrient cycling processes (e.g. denitrification, burial)
- Division of nutrients – nutrients should be divided into individual components (e.g. nitrogen and phosphorous) due to marsh limitation to a single nutrient
- Salinity is roughly covered in the model by the adjustment of bulk density and primary productivity, but the parameter is not explicitly covered and habitat switching is not tracked
- Spatial complexity/geometry improvements
- Inclusion of coastal currents and erosion, major storm events, and wind erosion
- Better methods of accounting for hydraulic resistance

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Figures

Figure 1. Typical coastal Louisiana marsh community with a patchwork of dense vegetation and open water

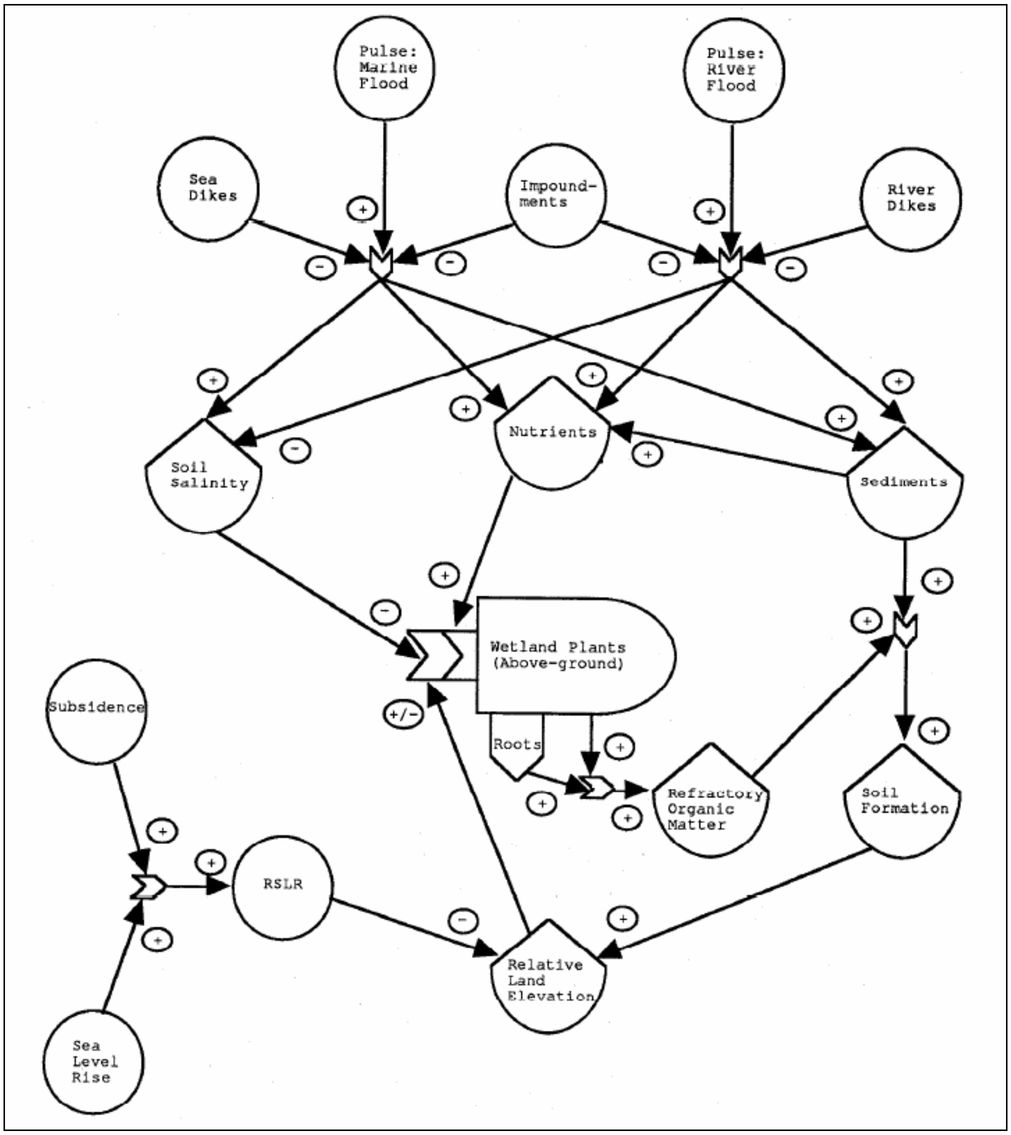


Figure 2. Conceptual model of coastal Louisiana marsh accretionary processes (from Day et al., 1995)

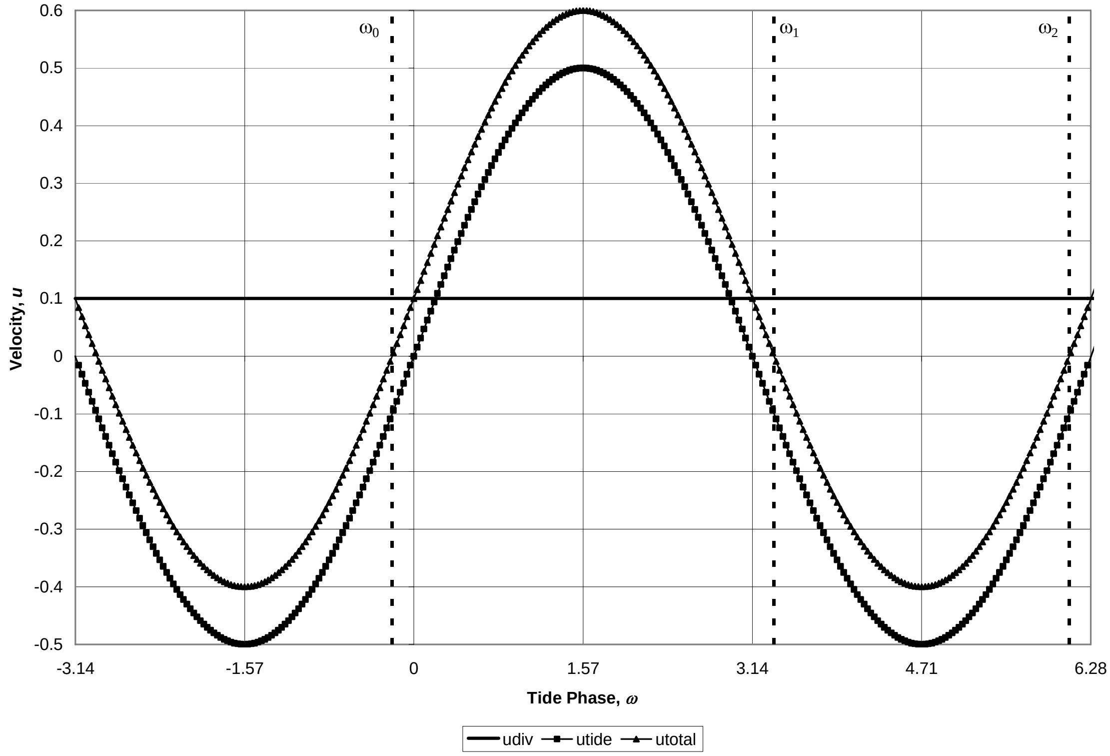


Figure 3. Wetland velocity with diversion and tidal components

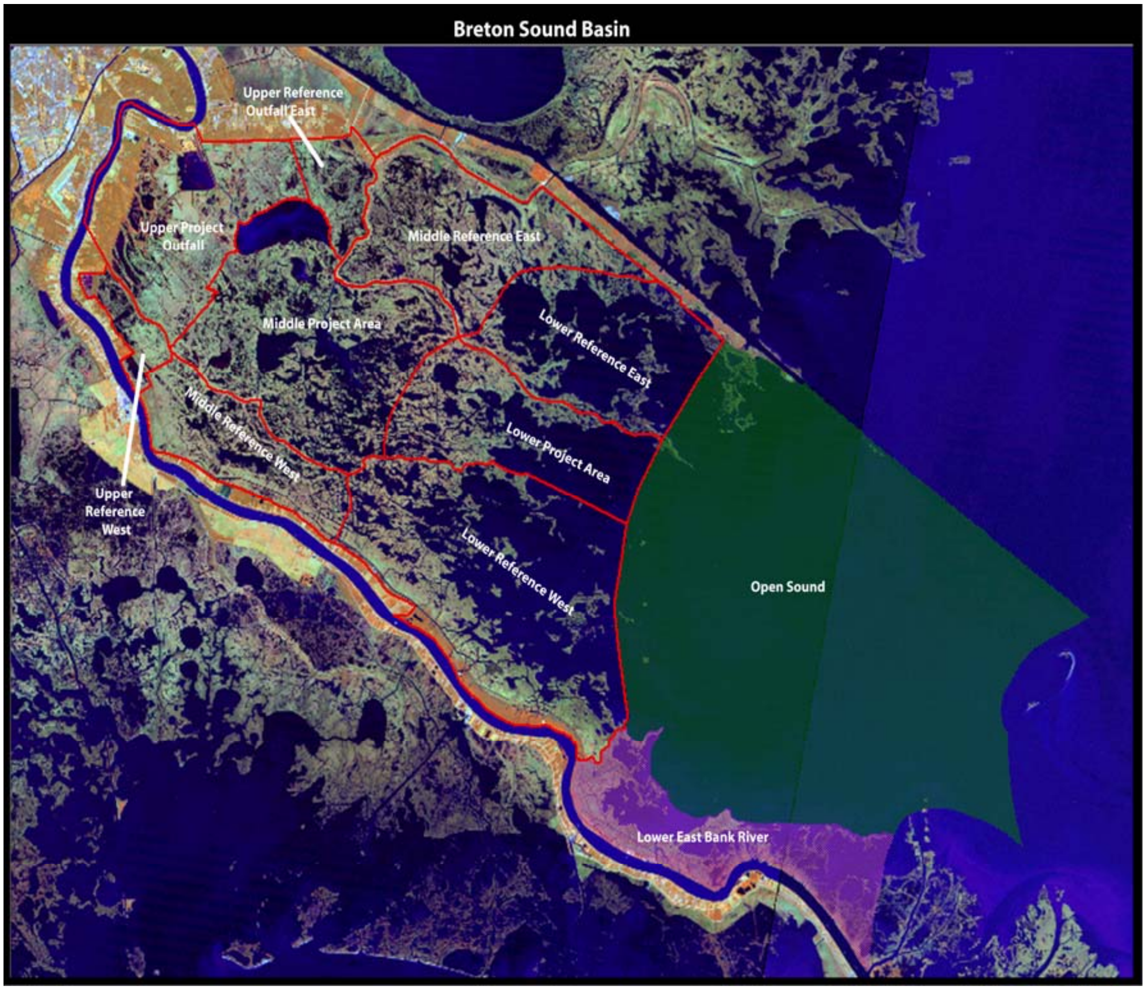


Figure 4. Aerial view of Breton Sound displaying Caernarvon Diversion and project division areas for tracking land evolution. In this analysis only the following areas were considered to be directly influenced by the Caernarvon Diversion in order to maintain relative uniformity in conditions: Upper Reference Outfall East, Upper Project Outfall, Upper Reference West, Middle Reference West, and Middle Project Area.

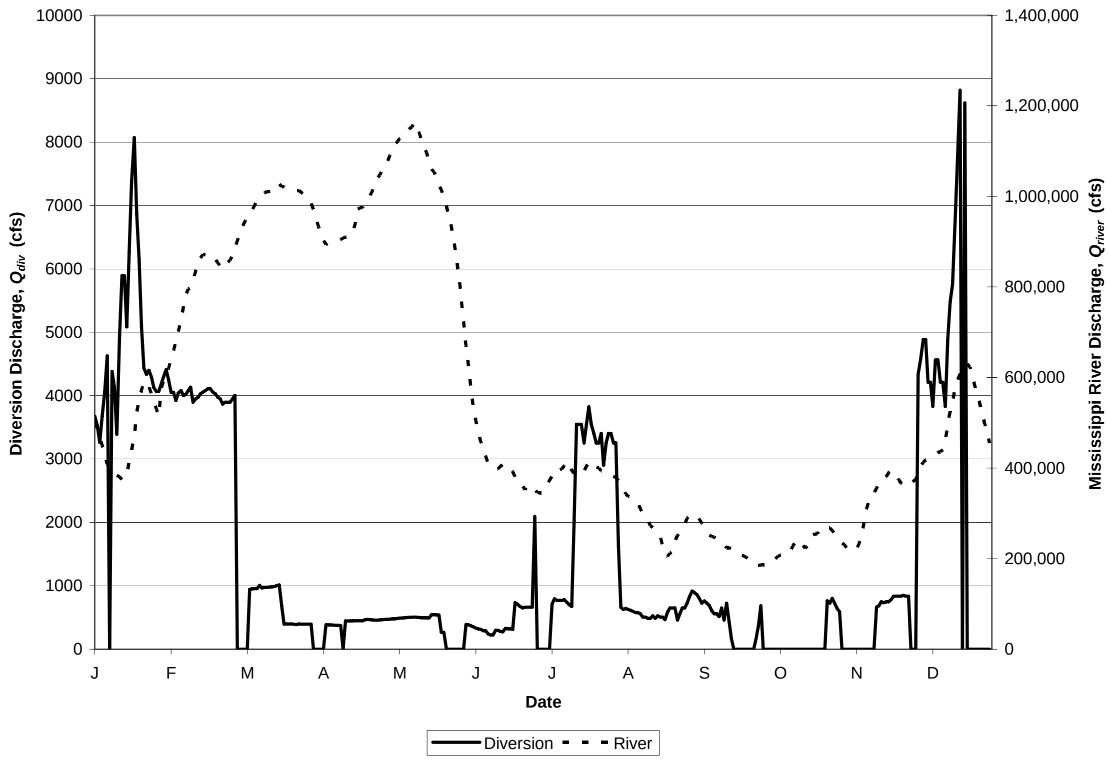


Figure 5. Representative diversion and river hydrographs for land evolution forecasting associated with the Caernarvon Diversion (1994 hydrographs)

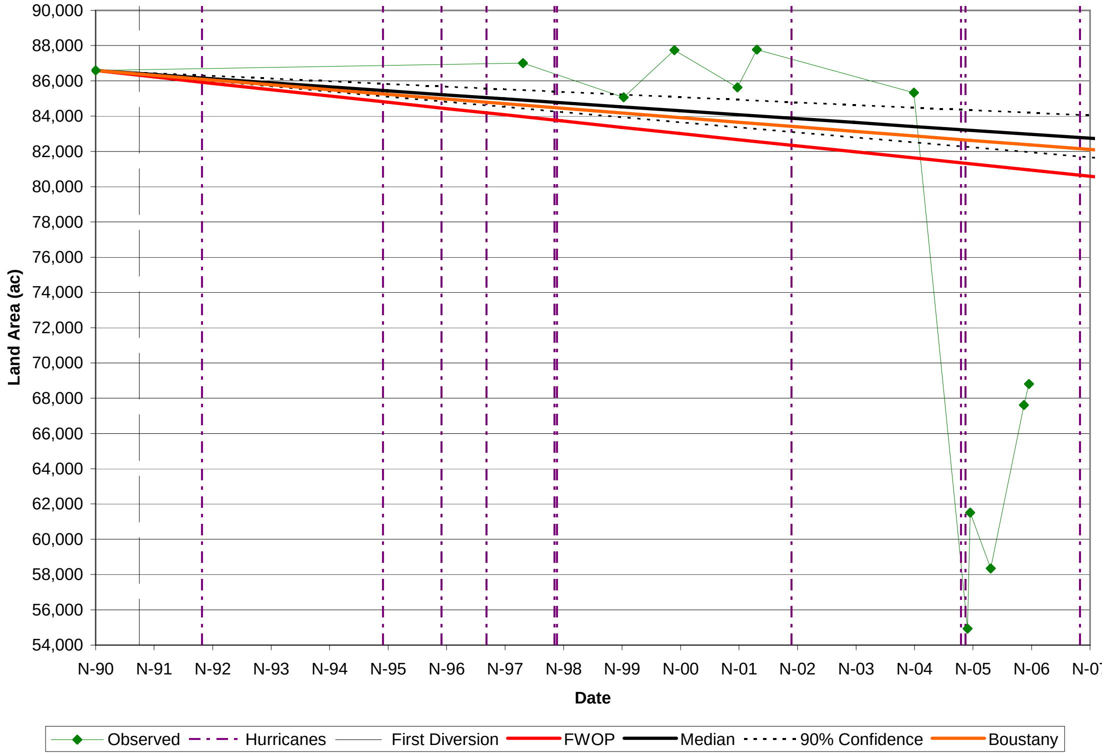


Figure 6. Marsh area prediction for the Caernarvon Diversion from 1990-2006 with observed acreages, model predictions with parameter uncertainty bounds, as well as the Boustany Model predictions

Figure 7. Marsh area prediction for the Caernarvon Diversion from 1990-2040 with isolated nutrient and sediment benefits

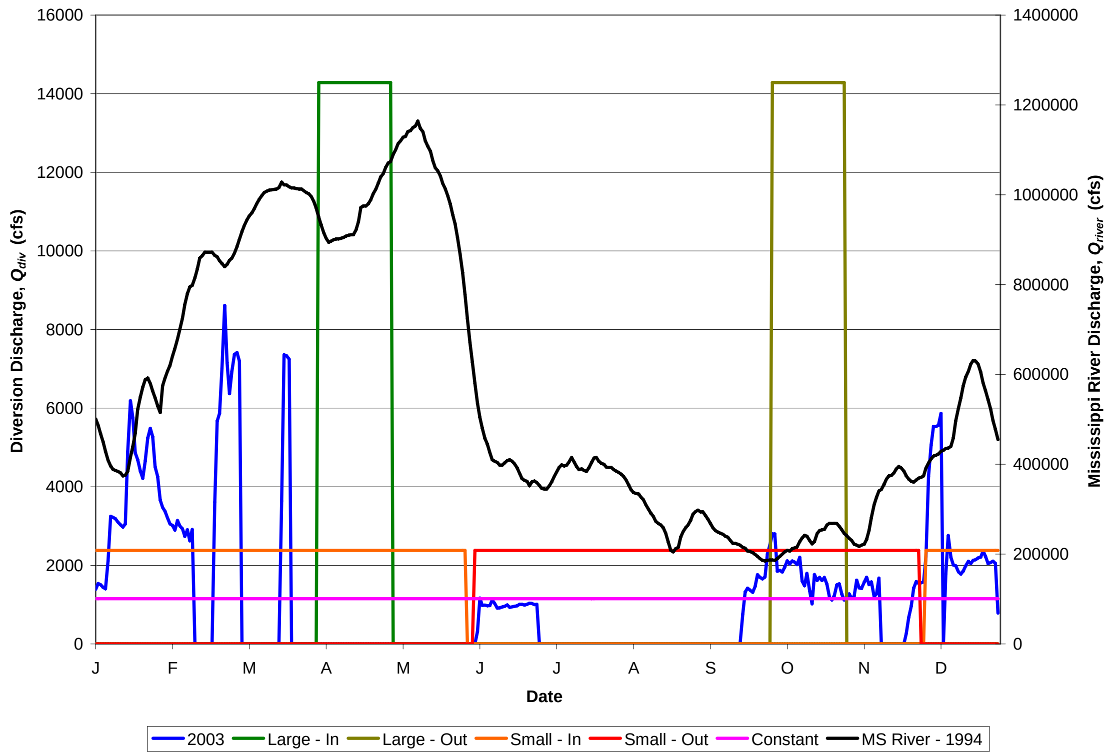


Figure 8. Hydrographs considered in Caernarvon Diversion operational optimization

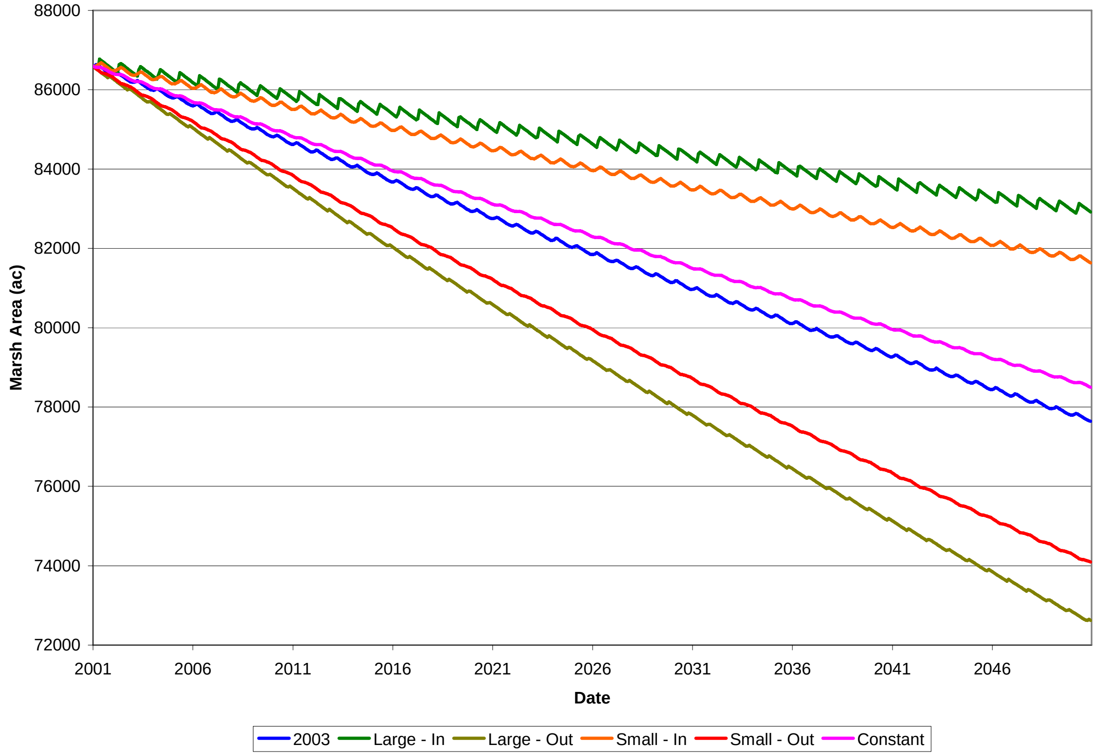


Figure 9. Land evolution predictions for multiple operational scenarios at the Caernarvon Diversion

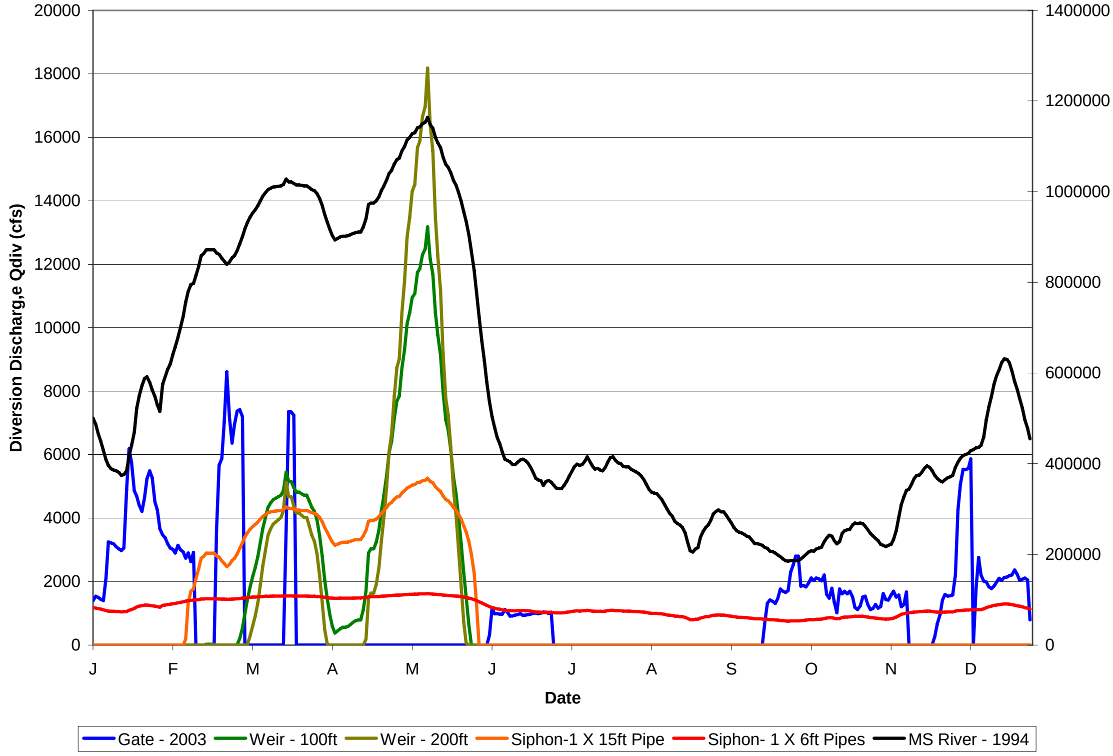


Figure 10. Calculated hydrographs for various structure types at the Caernarvon Diversion

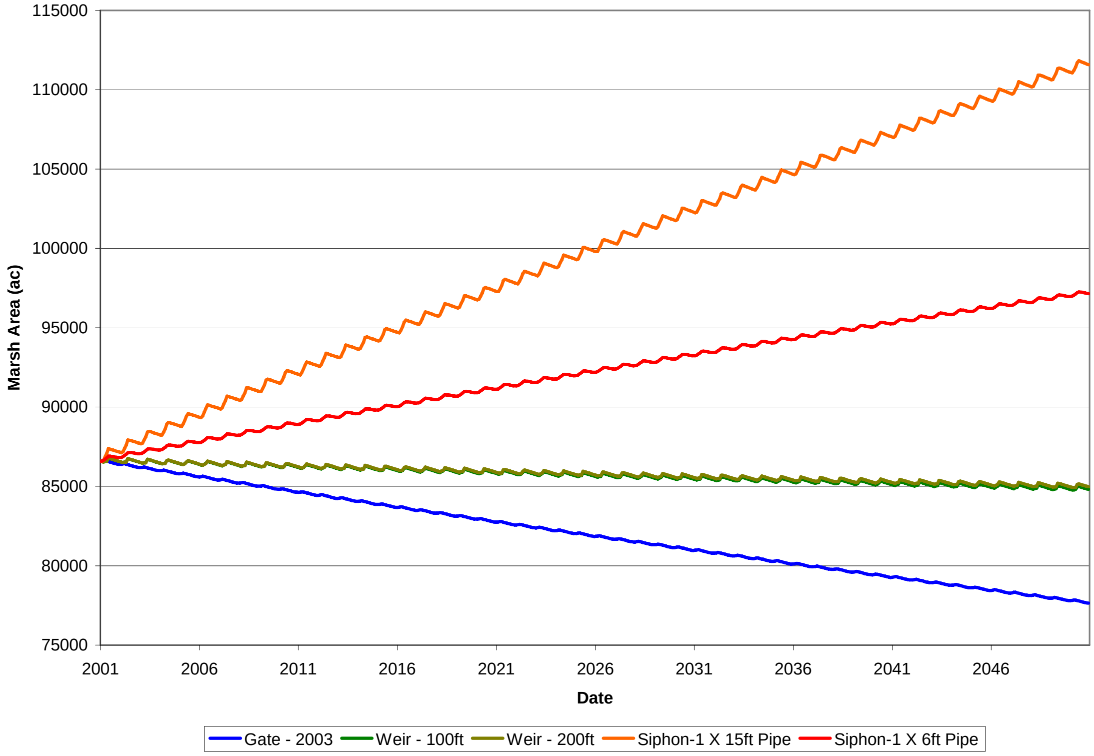


Figure 11. Land evolution predictions for various structure types at the Caernarvon Diversion

Tables

Table 1. Sediment Ratings for Rivers on the Louisiana Coastal Plain

River	Gauge Location	a_1	a_2	R^2
Mississippi	Belle Chase Surface*	3.205E-07	2.000	0.6648
	Belle Chase	1.237E-08	2.320	0.7302
	Tarbert - 1949-1975	1.192E-04	1.702	0.7945
	Tarbert - 1975-2007	7.096E-03	1.342	0.7689
	St. Francisville	6.501E-04	1.507	0.7357
Atchafalaya	Melville	4.941E-06	1.937	0.7764
	Simmesport	8.286E-04	1.563	0.8138

All ratings developed from suspended sediment concentrations and water discharges from USGS Website except "Belle Chase Surface"

*Surface concentrations of suspended sediment at Belle Chase and Tarbert's Landing Discharges (Snedden et al., 2007)

Table 2. Hydraulic roughness height as a function of bed material grain size

Channel Boundary	**Roughness Height, z_0[1]**		
	ft	**mm**	**m**
Mud	6.6E-04	0.2	2.0E-04
Mud/Sand	2.3E-03	0.7	7.0E-04
Silt/Sand	1.6E-04	0.05	5.0E-05
Sand (unrippled)	1.3E-03	0.4	4.0E-04
Sand (rippled)	2.0E-02	6	6.0E-03
Sand/Shell	9.8E-04	0.3	3.0E-04
Sand/Gravel	9.8E-04	0.3	3.0E-04
Mud/Sand/Gravel	9.8E-04	0.3	3.0E-04
Gravel	9.8E-03	3	3.0E-03

[1]Adapted from Soulsby (1983, Table 5.4)

Table 3. System properties and land evolution model parameters for the Caernarvon Diversion to Breton Sound Estuary

Parameter	Best Estimate	Approximate Standard Deviation
General System Properties		
Initial Land Area (ac)#	86,591	-
Project Area (ac)#	148,018	-
Average Water Depth, H (ft)*	3	0.5
Average Water Width, B (ft)	65,000#	1,000*
Maximum Tidal Velocity, $U_{tide,max}$ (ft/s)*	0.6	0.1
Roughness Height, z_o (ft)*	0.005	0.0005
Land Loss Rate (%/y)[1]	-0.42	0.042
Bulk Density, ρ_{bd} (g/cm^3)	0.26	-
Sediment Rating of Surface Concentrations of the Mississippi River at Belle Chase[2]		
Coefficient	3.205E-07	3.21E-08
Exponent	2.000	-
Size Fraction of Belle Chase Rating[2]		
Sand	0.01	0.0017
Silt	0.63	0.1050
Clay	0.36	-
Floc Fraction*	0.3	0.0667

Parameter	Best Estimate	Approximate Standard Deviation
Approximate Fall Velocity[3] (m/s)		
Sand	1.00E-02	8.33E-04
Silt	3.00E-04	2.50E-05
Clay	7.00E-06	5.83E-07
Floc Fraction	2.00E-04	4.00E-05
Marsh Nutrient Requirements		
Plant Productivity Rate, P_r (g/m^{2}yr)[*]	4,150	415
Percent of N and P in Plant Biomass, γ_{TNP}(%)[4]	0.72	0.072[*]
Nutrient Loading to Marsh		
Background Concentration of N and P, $C_{background}$ (mg/L)[5]	0.34	0.034[*]
Sourcewater Concentration of N and P, C_{source} (mg/L)[#]	2.28	0.5[*]
Nutrient Retention, R_{nut} (%)[*]	50	10

[1]Land loss rate calculated from observed marsh acreage from 1978-1990

[2]Data for rating and size fraction from Snedden et al. (2007)

[3]Calculated from method of Soulsby (1997)

[4]Foote and Reynolds (1997)

[5]Hyfield (2004)

[#]Available data

[*]Best professional judgment

Symbols

b = Rouse parameter
d = Diameter of siphon
f_i = Sediment size fraction i
g = Acceleration due to gravity
u_* = Shear velocity
x = Longitudinal or down-marsh coordinate
y = Horizontal or cross-marsh coordinate
z = Vertical coordinate
z_0 = Hydraulic roughness length
z_a = Reference depth
z_{river} = River stage
z_{marsh} = Marsh Elevation
z_{weir} = Weir Elevation
A = Marsh area
A_{veg} = Vegetated area of receiving area
A_{nut} = Total aerial nutrient benefit from flow diversion
A_{sed} = Total aerial sediment benefit from flow diversion
A_{siphon} = Cross-sectional area of siphon
B = Average marsh width
B_{weir} = Weir width
C = Suspended sediment concentration
C_a = Suspended sediment concentration at reference elevation z_a
C_{river} = Suspended sediment concentration of river
C_{source} = Nutrient concentration of source water
C_{weir} = Theoretical weir coefficient
E_{sus} = Percent of wetland sustained by nutrient loading
H = Average marsh depth
K_z = Vertical diffusivity
L = Average marsh length
LR_{req} = Marsh required nutrient loading rate
LR_{div} = Loading rate of nutrients from the flow diversion
$LR_{background}$ = Background loading rate of nutrients from preexisting marsh sources
LR_{net} = Net loading rate of nutrients from diversion and background sources (=LR_{div} - $LR_{background}$)
P_r = Primary Production
Q_{div} = Volumetric water discharge through diversion
$Q_{s,river}$ = Sediment discharge of river
$Q_{s,div}$ = Sediment discharge of diversion
$Q_{s,net}$ = Rate of sediment discharged to and retained in marsh
R_i = Sediment retention of size fraction i
R_T = Total sediment retention factor
T = Time required for particle settling
U = Daily mean velocity with tidal and diversion related components
U_i = Instantaneous mean velocity with tidal and diversion related components

U_{div} = Diversion induced velocity (= Q_{div} / HB)
$U_{max,tide}$ = Maximum tidal velocity (tidal velocity amplitude)
V_{siphon} = Velocity of flow in siphon
W_s = Natural settling velocity
$W_{s,eff}$ = Effective settling velocity due to natural settling and turbulence
X = Transport distance of suspended sediment
δ = Land change rate (% / time)
δ_{nut} = Nutrient suppressed land change rate (% / time)
γ_{nut} = Percent of plant biomass made up of nutrients
κ = von Karman's constant (0.4)
ω = Tide phase
ω_0 = Tide phase of the up-crossing zero velocity
ω_1 = Tide phase of the down-crossing zero velocity (=$\omega_0 + \pi$)
$\omega_2 = \omega_0 + 2\pi$

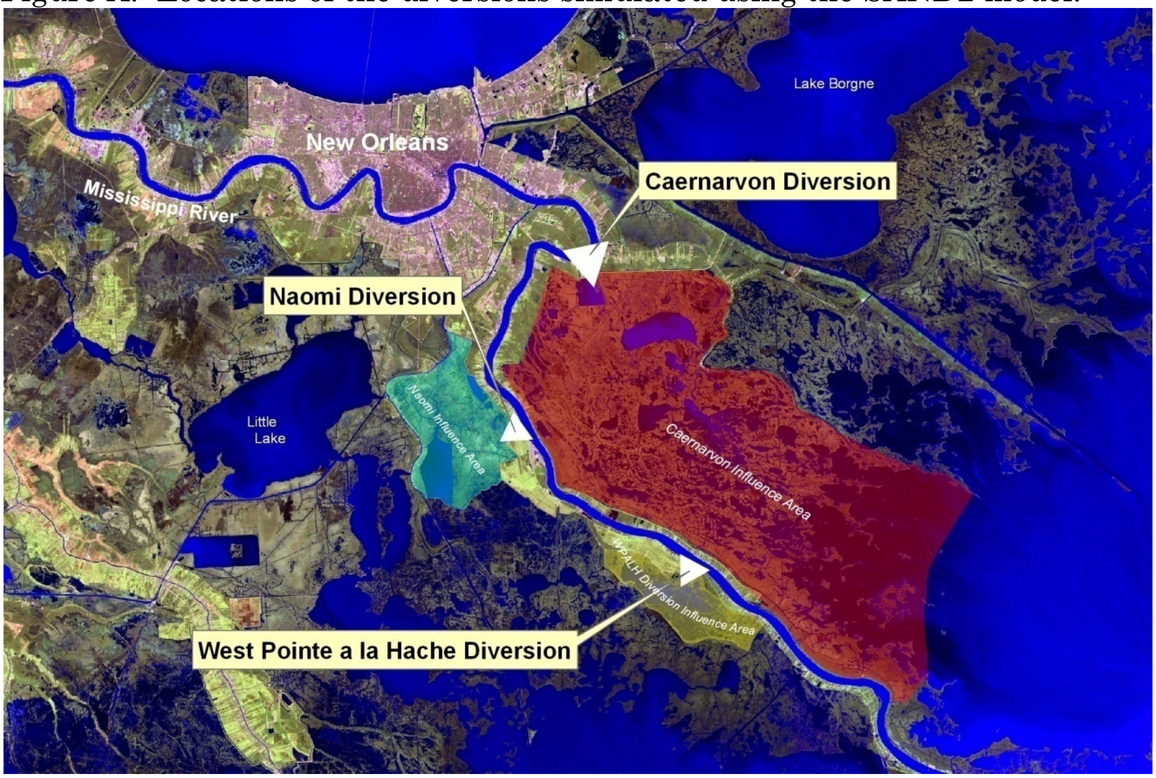
ANNEX 2

ERDC-SAND2 Model Verification

ERDC-SAND2 Model Verification

Verification of the SAND2 model was conducted by simulating the effects of the freshwater diversions (siphons) at Naomi and West Pointe a la Hache, both of which began operating in 1993 (Figure A), and the larger Caernarvon Freshwater Diversion Project, which began operating in 1991.

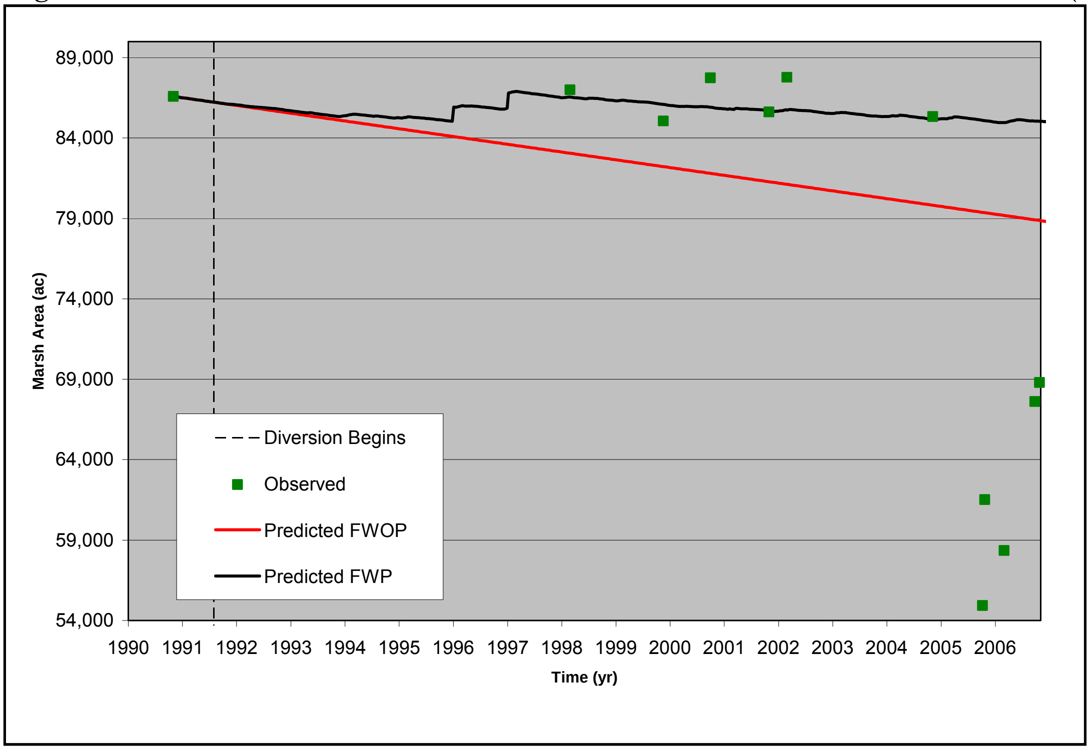
Figure A. Locations of the diversions simulated using the SAND2 model.



Daily discharge information from each of these diversions was used as input into the SAND2 model. Wetland acreages from the respective influence areas, from 1956 to 1990 were used to determine pre-diversion wetland loss rates. The SAND2 model was then used to predict post-operation wetland acreages. Those predicted acreages were then compared to post-operation observed wetland acreages to verify model results.

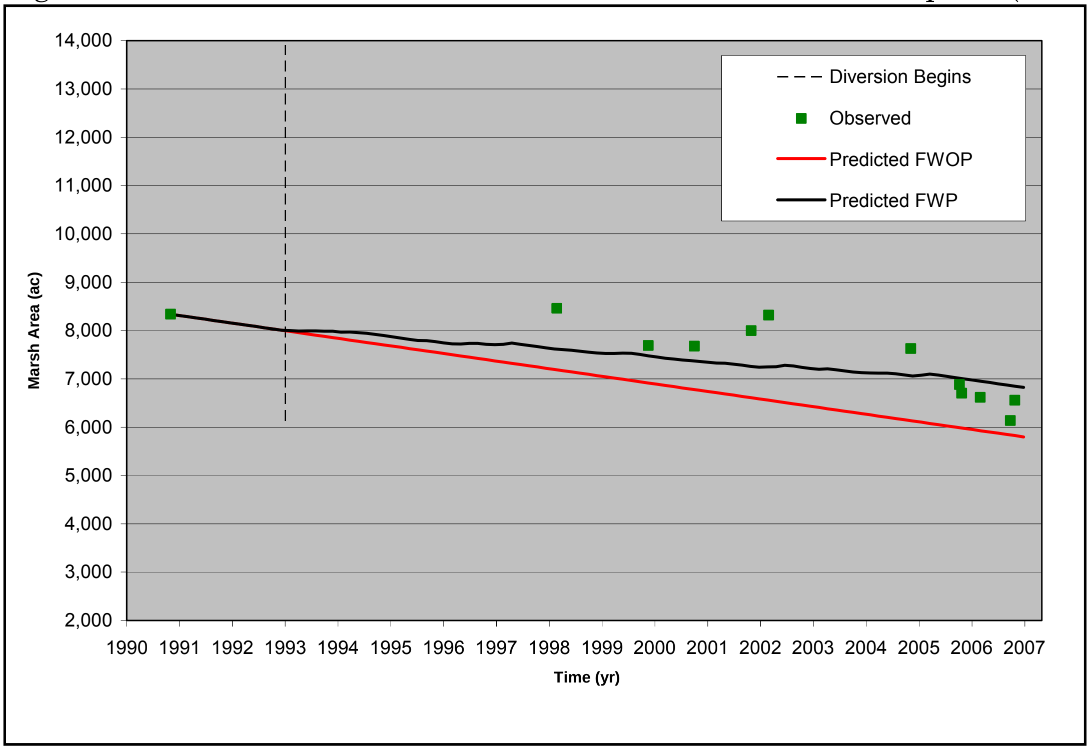
The SAND2 model did a reasonably good job forecasting Caernarvon benefits until 2005 when Hurricane Katrina caused severe marsh loss in the influence area. Because the model does not incorporate effects of major storm impacts, the model-predicted acreages differed dramatically from observed acreages following Katrina (Figure B).

Figure B. SAND2 simulation of the Caernarvon Freshwater Diversion (1991-2006).



Compared to the 8,000 cubic feet per second (cfs) design maximum discharge for the Caernarvon Diversion structure, the maximum discharge of the 2 siphons is roughly 2,000 cfs. Although the SAND2 model did a fairly good job predicting the effects of the West Pointe a la Hache Siphon (Figure C), the predicted results tended to underestimate actual observed wetland acreages.

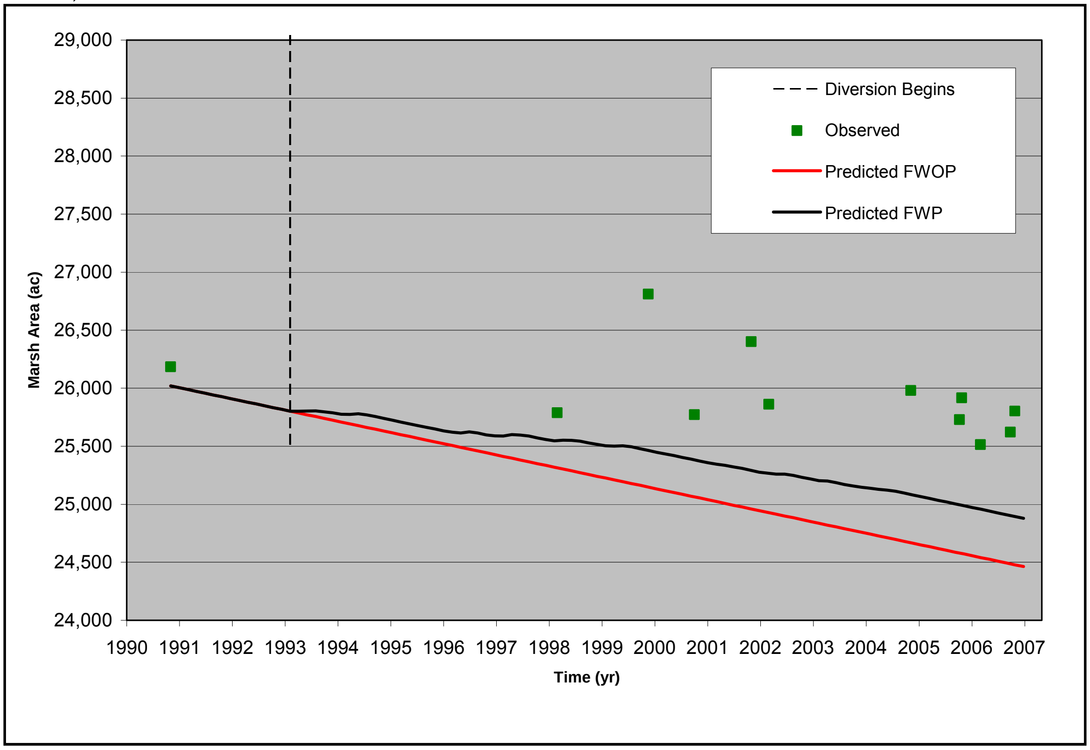
Figure C. SAND2 simulation of the West Pointe a la Hache Siphon (1993-2007).



Likewise, the SAND2 results also underestimated wetland acreage in the area influenced by the Naomi Freshwater Diversion Siphon (Figure D). The underestimate for the Naomi Siphon may be related in part to the large and relatively deep open water included within the siphon's influence area. Exclusion of this area, or a reduction in the influence area size, may have improved the accuracy of model results. This issue highlights the influence of project area selection on model results. Ideally, a hydrologic model or other systematic method to determining the project area (diversion influence area) is needed to achieve the best model results. Unfortunately, there was not sufficient time to conduct model runs to determine the potential ARTM diversion influence areas for each freshwater introduction measure. Instead, influence area polygons were determined using best professional judgment.

The SAND2 verification work, and other work with the SAND2 model indicates that it is most applicable in interior marsh systems. When applied to open bays or large lakes, it appears to substantially overestimate land-building. This may be related to resuspension and export of deposited sediments, a process that the model does not address. The ARTM measures, however, are all generally interior locations which are handled well by the SAND2 model. Unfortunately, no examples of freshwater introductions without sediment are available to verify the application of the SAND2 model for nutrient-only situations.

Figure D. SAND2 simulation of the Naomi Freshwater Diversion Siphon (1993-2006).



ANNEX 3

MCASES Cost Analysis

For Internal Use Only

F I N A L   R E P O R T

USACE WHITE DITCH EVALUATION AND DESIGN

HYDRODYNAMIC AND SALINITY TRANSPORT MODELING

Prepared for

USACE

June 4, 2010

URS

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Appendices

Appendix A Discussion of Bay Gardene Tide Gage Datum

The White Ditch project area is located in the Breton Sound estuary and covers the area extending north and south from just south of Belair, Louisiana to the coastline of Louisiana and extending east and west from the Mississippi River to the Oak River. This area extends about 50 km in the NW-SE directions and about 30 km in the SW-NE direction. Subsidence, erosion, channelization, saltwater intrusion, storm damage and the absence of fresh water, sediments and nutrients from the Mississippi River have all caused significant adverse impacts to the White Ditch project area resulting in extensive wetland loss and ecosystem degradation. There is an existing siphon at the mouth of White Ditch that was built in 1963 and has not been in operation since 1991, except for two brief episodes.

The absence of a supply of fresh water, sediment, and nutrients has caused the marsh to degrade. This degradation coupled with the subsidence and a sea level rise rate of approximately 1.04 cm per year has led to an increase in saltwater intrusion. The additional influx of saltwater from the Gulf of Mexico through the vast canal network in the project area has further damaged the marsh vegetation. In August and September of 2005 Louisiana was hit by hurricanes Katrina and Rita. These hurricanes brought high winds and high tidal surges and destroyed thousands of acres of already weakened marsh. In September of 2008 hurricanes Ike and Gustav also hit the Gulf coast. While they did not make direct landfall in the project area, the tidal surges from these storms caused the loss of additional marsh acreage.

The White Ditch area is part of the Breton Sound estuary system. Breton Sound estuary is located in southern Louisiana, between Breton Sound Bay and approximately the last 85 miles of the Mississippi River before it discharges into the Gulf of Mexico. The estuary consists of about 430 square miles (1,100 km2) of fresh and brackish coastal wetlands that are made up of shallow water ponds, lakes, bays, and a man-made canal system (Figure 1). The major rivers in the estuary are the Oak River (also known as River aux Chenes) and Bayou Terra aux Boeufs. The larger water bodies are Big Mar, Lake Leary, Spanish Lake, Grand Lake, and Little Lake.

On the northern edge of Breton Sound estuary is the Caernarvon freshwater diversion structure. It is located on the east bank of a Mississippi River oxbow at river mile 81.5. The diversion structure began operating in 1991 as a means for establishing optimal salinity conditions for oyster production, and can also be used to prevent saltwater intrusion during storms or droughts.

The USACE is investigating alternative designs for a fresh water diversion from the Mississippi River to the White Ditch project area. Two alternative locations (Locations 2 and 3) are proposed for the diversion near White Ditch and are shown in Figure 2. Location 2 uses a modification of the existing siphon at White Ditch. Location 3 is located farther to the south. At both alternative locations, different channel depths and widths are considered for different peak diversion flow rates, ranging from 5,000 to 100,000 cfs. Location 2 also includes culverts located throughout the modified channels to provide connectivity with the marsh areas.

The alternatives are evaluated in terms of their impact on water depths and salinities throughout the study area. A hydrodynamic and salinity model has been developed to quantify the impacts of each alternative and evaluate the effects of diversion flow operations on the water depth and salinity. The results of the hydrodynamic and salinity model simulations were post-processed and used as input for the Wetland Value Assessment model to quantify the environmental benefits of the diversion. In addition to assessing environmental benefits such as the impacts on plant and animal communities in the project area, the stage data was also used to estimate potential flooding impacts for each alternative.

This report describes the hydrodynamic and salinity modeling analyses used to evaluate alternative designs and flow rates. The application of the wetland value assessment and other analyses were conducted by the USACE and are reported separately.

There were a number of existing data sets available to support the configuration, calibration and application of the hydrodynamic and salinity transport model. In addition to the existing data sets, a bathymetric survey and a field measurement program were conducted prior to the modeling analysis in order to provide site-specific data. Each of these data sets is briefly described below.

2.1 BATHYMETRY

There was sparse existing data within the coverage area, and the resolution and precision of any available data was insufficient for model use. Digital Elevation Model (DEM) and contoured elevation coverages were available at http://atlas.lsu.edu/rasterdown.htm for portions of the modeled area (Figure 3), however the elevation values available in these datasets did not contain the resolution necessary for use in the model.

2.2 TIDE STAGE

Real-time tide data were downloaded from http://waterdata.usgs.gov/nwis for three U.S. Geological Survey (USGS) stations. Station locations include: Northeast Bay Gardene (Station ID: 7374527), Black Bay near Snake Island (Station ID: 7374526) and Cow Bell at American Bay (Station ID: 73745258). Tide data were also obtained from http://tidesonline.nos.noaa.gov/ for the National Oceanic and Atmospheric Administration (NOAA) Station Pilot East (Station ID: 8761305). Station locations are shown in Figure 4. Time series plots of sample portions of the tide data are shown in Figure 5.

A review of the tide gages revealed that there were no suitable gage locations in the proximity of the White Ditch area. The closest gages were Cow Bell at American Bay and Northeast Bay Gardene. Data from the Bay Gardene station was chosen for use in the modeling analysis since it provided the widest date range of available data with the fewest data gaps.

A plot of the monthly average water elevations for the period 2000-2009 for the Bay Gardene station is shown in Figure 6. The data show that the stage tends to be higher in the fall, which corresponds to the period when the winds are predominantly from the Southeast.

2.3 METEOROLOGICAL DATA

Wind data are available from various stations in the project area. The wind data were collected by NOAA from 1999 through 2009 (http://www.ncdc.noaa.gov/oa/ncdc.html). Louisiana wind station locations include: Grand Isle (Station Number 8762417), Pilot East (Station Number 8760922) and Shell Beach (Station Number 8761305). The locations of these stations are shown in Figure 7. Hourly data was available from the Pilot East station and was downloaded for the time period of 3/25/2004 through 7/23/2009. A wind rose based on data collected at the Pilot East station during the year 2008 is shown in Figure 8.

Rainfall data were obtained from the NOAA Port Sulfer Station (Station 167471) and from a Belle Chasse station. Station Locations are shown in Figure 7. The data included a daily sum of rainfall in inches for 1/1/2004 through 8/27/2009 for Port Sulfur and 9/28/2006 through 8/20/2009 for Belle Chasse. Annual and seasonal rainfall patterns are shown in Figure 9 for the Belle Chasse data set.

There were no daily evaporation data available from stations near the project area. In order to provide some information for evaporation rates, data in the literature was reviewed. A study conducted by Cooke et al. (2008) provided measured data at a variety of stations in Louisiana. The nearest station for which summer evaporation rates were available was Houma. The data indicate some daily fluctuations do occur, ranging between 2 and 8 mm/day, with an average rate on the order of 5 mm/day.

2.4 SALINITY

Salinity data are available from the USGS and were obtained from the website: http://waterdata.usgs.gov. Data from three Louisiana stations including Northeast Bay Gardene (Station ID 7374527), Black Bay near Snake Island (Station ID 7374526), and Cow Bell at American Bay (Station ID 73745258) were obtained. The station locations are shown in Figure 4. The monthly average salinities for 2009 for the Bay Gardene station are shown in Figure 10a.

Another salinity data set was available from Strategic Online Natural Resources Information System (SONRIS). This data set included hourly or monthly salinity measurements and stations were located throughout the Breton Sound with varying periods of record). Station locations are shown in Figure 10b, and average, max and minimum salinity values at stations with sufficient data are shown in the table in Figure 10b. The average salinity is lowest in the spring and is controlled by Freshwater from the Caernarvon Diversion and the Mississippi River, which are the two freshwater sources for this area.

2.5 CAERNARVON FLOWS

On the northern edge of Breton Sound estuary is the Caernarvon freshwater diversion structure. It is located on the east bank of a Mississippi River oxbow at river mile 81.5. The diversion structure began operating in 1991 as a means for establishing optimal salinity conditions for oyster production, and can also be used to prevent saltwater intrusion during storms or droughts. The 23-meter-wide structure has the capacity to divert up to about 8,000 cfs (226 m^3/s) of Mississippi River water into the Breton Sound estuary, and has been managed at many different discharge rates since its commencement.

The US Army Corps of Engineers (USACE), New Orleans District, manages the Caernarvon Freshwater Diversion Project and provided daily flow data in cfs from 1992 through 2009. The seasonal flows from the diversion are shown in Figure 11.

Based on discussions with local land managers, it is believed that the flow from the diversion followed two dominant paths form the diversion. The main one is to the south through the Bayou Mandeville area. The second one is directed to the west, through the Delacroix Canal, and ultimately merges with the Oaks River. It is believed that about 20 to 30 percent of the diversion flows went through the western path until Hurricane Katrina impacted the area. After Katrina, many of the smaller channels to the west were clogged with debris, and it is believed that only 5 to 10 percent of the diversion flow now flows westward.

2.6 BATHYMETRIC SURVEY DATA

The USACE conducted a bathymetric survey of the White Ditch area to support both the modeling analysis and the alternative designs. The survey transects are shown in Figure 12. The surveyed cross-sections are shown in a sequence of plots in Figures 13 and 14. These data provide information on the channel depths and widths, the lake depths, elevations of ridges bounding the channels as well as the characteristics of the inter-tidal and land areas.

2.7 URS FIELD INVESTIGATION

The White Ditch field investigation was conducted from July 20 through July 23, 2009 to collect necessary calibration data for the CMS-Flow hydrodynamic model of the study area. The field investigation was conducted by two crews of URS field staff operating from airboats hired for the project. The field crews were accompanied by William Terry of the U.S. Army Corps of Engineers (USACE) St. Louis District Office for most of the field investigation. A detailed report of the field program, its implementation and an analysis of the data were provided to the USACE as a deliverable on 9/28/2009 (URS, 2009). The two data sets explicitly used in the modeling analysis, the water elevations and the salinity data, are summarized here.

The study area and sampling stations are shown in Figure 15. Measurements of flow velocity, temperature, salinity and turbidity were collected periodically between July 21 and 23, 2009 at the primary stations (N1, N2, N3, S1, S2, and S3). Water level measurements were collected at stations N3 and S3 from July 20 to July 23, 2009 using temporary staff gauges and recording pressure transducers that were installed at these locations.

Less frequent flow velocity, temperature and salinity measurements were collected at the secondary locations (Oak River Channel, N4, N5, N6, S4, S5, S6, S7, S8, S9, S10, and S11). Water depth measurements were collected at each of the primary and secondary locations, and at additional field locations (S12-S33) shown on Figure 16.

2.7.1 Water Level

Staff gauges and recording pressure transducers were installed at locations S3 and N3 to measure water level fluctuations within the study area. The transducers used were Micro-Diver Dataloggers (Model DI601) manufactured by the Schlumberger Corporation. The data loggers were initially programmed to collect pressure measurements every five minutes in the units of feet of water. The sample interval was changed to 30 seconds after approximately 24 hours.

Staff gauges constructed of 1-inch diameter PVC pipe were also installed at locations S3 and N3. Periodic measurements of the water level at each staff gauge were recorded. The measured stage data collected at the two stations are shown in Figure 17. When compared to the tides at the Bay Gardene Station, it is evident that there is a significant loss of tidal amplitude as the tides propagate into the White Ditch area.

2.7.2 Salinity

Salinity data (as well as temperature and turbidity measurements) were collected at each primary location and other select locations (shown on Figure 15) using a HydroLab Quanta system. The median, maximum and minimum salinity at each station are shown in Figure 18. The SONRIS salinity data are also shown in Figure 10b, and although the data represent different time periods, they show a general trend in the salinity patterns. The trends show a basic low to high salinity gradient from offshore to the NW as well as a high to low gradient from the east bank of the Mississippi River to the NE. The general gradients, even those in the White Ditch area, point towards the Caernarvon Diversion, indicating that it is a significant source of freshwater in the area.

Salinity measurements were also made at surface and bottom – the data indicate a very minor difference between top and bottom – less than 0.5 ppt.

A conceptual model for the analysis has been developed based on the project goals and the data summary. The key points considered in developing the conceptual model are discussed below:

- The area of interest is large with a network of inter-connecting channels and lakes with varying widths and depths. The land elevations and tide ranges indicate that the tidal flows will be contained to the channels during lower tide stages but may inundate the land segments during higher tide stages.
- The proposed Alternatives include relatively high flow rates, up to 100,000 cfs that will likely flood the land areas, at least in the vicinity of the discharge.
- The salinities are controlled by rainfall and evaporation and freshwater from the Caernarvon Diversion and the Mississippi River. The effects of the Mississippi river are inherent in the salinity data at the USGS gages near the southern extent of the study area.
- Salinity transport in the White Ditch area will also be affected by wind driven circulation.
- The time scale for salinity to reach steady state is relatively large for ambient conditions (including Caernarvon), on the order of one month but will be shorter for high-flow White Ditch diversions
- The proposed Alternatives include culverts to route freshwater to the White Ditch area and therefore these structures will require representation in the modeling analysis.
- The salinity data available from the field study indicate that there is very little vertical stratification, indicating the depth-averaged modeling is suitable

The components of the conceptual model that were developed based on the above considerations are described below:

- The model boundaries should extend from the Mississippi River levees from the northwest and southwest to the Mississippi River-Gulf Outlet (MRGO) channel to the northeast and to the general vicinity of the Bay Gardene USGS station to the southeast. This domain includes the majority of the area influenced by the Caernarvon Diversion, which is important to properly represent its influence on the White Ditch area.
- The details of the intricate network of channels will need resolution in the model grid. The most detailed resolution should focus on White Ditch area but at least include large conveyance channels in the area to the east of the Oak River. This component will require grid cell dimension on the order of 10 to 30 meters in the White Ditch area.
- The model needs to include a simulation of tides, winds, diversion discharges, rainfall and evaporation and salinity transport.
- The simulations will require the representation of significant wetting and drying of land segments throughout the area, especially during larger White Ditch diversion flows
- The modeling analysis needs to represent the location and conveyance of culverts on the flow
- A 2D depth-average model is suitable for the analysis

4.1 MODEL SELECTION

A number of hydraulic models were considered for use in simulating the White Ditch diversion alternatives. The candidate models are listed below and organized into finite element and finite volume categories. In general, the finite element models have unstructured meshing capabilities that allow for the efficient detailed resolution of small features, However, they are difficult to implement in projects with large areas of wetting and drying, often requiring excessive bathymetric and topographic smoothing to achieve a stable solution.

finite element models

ADCIRC – unstructured mesh
no salinity, poor wetting and drying

FESWMS – unstructured mesh,
no salinity, poor wetting and drying

RMA2 – unstructured mesh, salinity transport
poor wetting and drying

finite volume models

CMS– salinity transport, good wetting and drying
rectilinear mesh

EFDC – salinity transport, good wetting and drying
curvilinear mesh

FVCOM – unstructured mesh, good wetting and drying
commercial availability

POM– salinity transport, good wetting and drying
curvilinear mesh

The finite difference models typically will not have any stability problems when considering wetting and drying, but often do not have the benefits of unstructured meshes since they typically use rectilinear or curvilinear structured meshes. The FVCOM model is unique in that it is a finite volume model that uses an unstructured mesh and therefore can realize the mesh generation benefits often associated with finite elements. However, the model is relatively new and limited to research applications. Non-research applications are occurring but model documentation and general industrial familiarity with the model are not mature. The remaining three finite volume models (CMS, EFDC and POM) all have similar capabilities and are suitable for the project.

Of those three, CMS is supported by the USACE and therefore was selected for the project. CMS-Flow is a process-based 2D depth-averaged hydrodynamic, sediment transport and morphology model developed by the USACE for application in and around inlets and channels. It is accessible via the Surfacewater Modeling System (SMS) graphical user interface (Militello, 2004; Buttolph, 2006).

4.2 MODEL DOMAIN AND GRID GENERATION

The model domain is shown in Figure 19. The domain includes all of the white ditch area as well as an extensive portion of Breton Sound. A primary reason for including the larger portion of Breton Sound was the potential influence of the diversion peak flows on the east of the Oaks River. Also, the channels providing flow pathways from the Caernarvon Diversion to the White Ditch area required inclusion since the Caernarvon Diversion flows provided a significant portion of the freshwater to the White Ditch area (the other freshwater source being rainfall).

To provide bathymetric data for the model grid, a project-specific bathymetric and topographic data set was developed. This data was then used to set the bottom elevation of the cells in the model grid. Initial experiments with the model indicated that the grid resolution in the White Ditch area would need to be on the order of 10 to 30 meters. This level of resolution would provide sufficient resolution of the channel features but allow for reasonable simulation times on high-end workstations. Therefore, the bathymetric and topographic data should have a minimum resolution of 10 meters in the White Ditch area.

The area bathymetry and topography were developed from existing bathymetric data, land/water boundary data and results from the project field survey. It was determined early in the bathymetric data development that existing bathymetric data were limited to areas above MSL and sets did not provide sufficient precision or resolution for direct use in the grid generation. Therefore the following approach was used to develop the bathymetric and topographic data set.

1. Acquire the most recent land/water boundary data
2. Update the land/water boundary data for Post Katrina conditions
3. Divide the land/water boundaries into small polygons representing channels, lakes, land segments and other features
4. Assign depth/elevation to each polygon
5. Convert the polygons to a 10 meter grid and export
6. Import the 10 meter grid into SMS and use to populate the CMS grid

Several datasets of land and water polygons were obtained for use in developing the bathymetric dataset; one from the Louisiana GIS Digital Map Compilation DVD (2007) and one from the ESRI Streetmap dataset. The land/water polygon data from the LA GIS Digital Map Compilation DVD was used to start the bathymetric data processing. This polygon data represents pre-Katrina conditions and is shown in Figure 20 overlaying post-Katrina aerial images. It is clear that there were some significant changes in the land mass as a result of Katrina in the White Ditch area, especially in the NW region. These changes were confirmed in a USGS study, the results of which are shown in Figure 21. Therefore, in order to update the land/water polygons, polygons from the ESRI dataset were merged with the LA GIS data and subsequently modified to best reflect the post-Katrina conditions. Additional digitizing was conducted so that the final set of polygons reflected the land and water boundaries as depicted in the most current aerial photography available for the area. Additional reviews of the polygon data set indicated that not all of the canals in the study area were completely represented in the processing up to this point. Canals not represented were digitized and canal water body connections that were inaccurate were modified. The final set of polygons is shown in Figures 22a and 22b.

The next step is to assign depth values to each of the polygons in the data set. As pointed out in Section 2, there was no comprehensive bathymetric data set available. In order to assign depths, information from the project bathymetric survey and NOAA nautical chart data were used. The first step was to set the land elevation. For this purpose, all of the survey data was pooled and sorted to identify the distribution and range. The distribution of the data is shown in Figure 23. There is a distinctive break in the distribution at elevation 0 ft (NAVD 88) that is likely representative of MSL, where the channel and lake banks are steepest. Assuming that most of the inter-tidal zones and land segments lie at or above 0 ft elevation, the data was filtered to eliminate values below 0 feet, and then resorted. The results are also shown in Figure 23, and indicate that the median land elevation is 1 foot NAVD 88. This value was adopted as the land elevation and all land polygons were assigned a depth of one foot.

In order to assign depth values to the canals and lakes, the survey data transects were processed and used to develop a suitable average depth for each cross-section. Each transect cross-section was clipped so that the only the portion below MSL remained. Then the hydraulic radius of the cross-section was calculated. Then the cross-section effective depth was calculated so that it would yield the same hydraulic radius as the original cross-section. This value was then assigned to the center point of the cross-section transect and used to assign depth values in the canal and lake polygons. The effective depths and their locations, as obtained by this procedure, are shown in Figure 24. The effective depth data did not provide sufficient information to assign depths to all canal and lake polygons. Therefore a generalized template for canal and lake depths was developed and used to assign the depths to the remaining polygons. A review of Figure 24 indicates that there is a general increase in the canal and lake depths from the NW to the SE. A template, shown in Figure 25, was developed using this trend.

After completing the depth assignments to each polygon, the depth data were interpolated from the polygons to a point grid. The point grid consisted of 10 m spacing in the White Ditch area and expanded to 50 m spacing to the east of the Oak River and to the SE. The 50 m resolution was necessary to keep the file size manageable and still provide sufficient resolution of key features. A view of the bathymetric data as reflected by the point grid is shown in Figure 26. An enlarged portion of the point grid data is shown in Figure 27, where the points are color coded by the assigned depths.

The point grid bathymetry dataset was imported into SMS, triangulated, and the depths were interpolated on to the CMS grid. Based on trials in the focus area near White Ditch, a 20 meter resolution was determined to be optimal for areas in the vicinity of the proposed diversion.

The grid was designed with 20 meter spacing in the White Ditch area with the cell spacing expanding to the SE and SW. In these regions of grid expansion, the grid was allowed to increase to a maximum grid cell size of 500 meters in order to keep the number of cells as low as possible and help manage simulation run time while still providing detailed resolution in the White Ditch study area. The final grid is shown in Figure 28. The green cells are 'inactive' and represent areas protected by levees or that are above 4 feet elevation. These cells are not used in the model simulations and are a by-product of the inherent CMS rectangular grid structure. A QAQC process was performed in order to ensure canal connections and other components necessary for accurate flow simulation were correctly implemented. Cell properties were adjusted manually where appropriate. The final grid contains 866,791 active cells in 992 Columns and 569 Rows. The bathymetry as represented in the final grid is shown in Figures 29 and 30. After some initial testing, a time step of 1.5 seconds was found to provide numerically stable solutions, and the model simulations (including salinity transport) were determined to take about two days (48 hours) in order to simulate a one month period on an HP Workstation Z400 with an Intel 2.93 Ghz Xeon Quad processor and 8gb DD3 SDRam.

4.3 BOUNDARY CONDITIONS

The boundary conditions required for the White Ditch model simulations included:

1. Offshore tide elevation
2. Offshore salinity values
3. Flow boundaries (flow rate and salinity)
4. Rainfall and Evaporation
5. Wind Forcing

The location of each boundary application (for White Ditch location 3) is shown in Figure 31. Note that during the model calibration, it was found that the salinity calibration was sensitive to both the total flow rate from the Caernarvon Diversion as well as the split between the amounts assumed to flow through the Delacroix Canal to the west and the through Bayou Mandeville to the south. Therefore, the grid was modified slightly in the region of the Caernarvon Diversion so that the flow splits could be assigned directly.

The hydrodynamic and salinity calibration were conducted simultaneously. This was necessary because it was learned in the preliminary salinity calibration simulations that the salinity calibration was sensitive to the total flow and flow split assumed for the Caernarvon Diversion. Since these flow rates may influence the tidal response in the white ditch area, it was necessary to conduct the hydrodynamic and salinity calibration simultaneously.

The hydrodynamic calibration period was selected to coincide with the period for which the stage data was available from the project field program, namely the four day period July 20 through July 24th. Preliminary testing with the model indicated that the tidal flows required a relatively short spin-up period, on the order of one-week, but it was found that the salinity simulations required a much longer spin-up period.

The salinity calibration focused on the same period for data comparison, July 20th through July 24th, for which salinity data was available from the project field program. After some preliminary testing with the model, it was found that a two-month spin-up was required to eliminate the effects of the initial conditions on the solution.

For the calibration simulation, the model was configured with measured wind, tide, rainfall, evaporation, salinity and Caernarvon flow data corresponding to the calibration period. For the evaporation, the average value of 5 mm/day adopted from the Cooke et al. (2008) study was used. The tide, wind and Caernarvon flow data are shown in Figure32. For the Caernarvon diversion flows, freshwater was assumed, and the corresponding salinity was assigned a value of zero. The initial salinity in the grid domain was set to 7.0 ppt which was an approximate average value of the calibration data.

The key calibration parameters are:

1. Bottom Fiction (Manning's n)
2. Lateral Dispersion
3. Fresh Water flow and flow split from Caernarvon

The calibration simulations indicated that the hydrodynamic calibration was most sensitive to the bottom friction, with a minor sensitivity to the Carnarvon flow splits. The salinity calibration was most sensitive to the Caernarvon Diversion flow rate and flow split, with a lower level of sensitivity to the lateral dispersion.

An initial range for the lateral dispersion was obtained by considering the length scales of the water bodies in the White Ditch area and the length-scale dependent dispersion values from data summarized by Fischer (1979). For this analysis, a length scale was developed by taking the square-root of the area of each of the polygons used to represent each water body and then selecting the median value. The median value is approximately 300 meters, for which the associated dispersion coefficient is 10 m^2/s.

During some initial sensitivity simulations, it was found that the stage calibration was difficult to obtain using a reasonable range of values to the friction and dispersion parameters. Eventually, the difficulty was traced to the gage Datum of the Bay Gardene stage data used as a boundary condition on the southeast boundary of the grid. After some investigation and discussions with USGS staff familiar with the gage it was determined that there was some uncertainty in the gage datum, and therefore an adjustment to the gage data was developed. More details of the investigation are discussed in Appendix A. The adjustment to the gage data consisted of a shift in the stage that was based on some sensitivity of the calibration to the measured stage data. Figure 33 shows the results of the sensitivity analysis for the cases of no shift, a 0.5 foot shift and a one foot shift in the Bay Gardene stage data. For the 0.5 and 1.0 shifts, the simulated response shows a much smaller tide range. This is caused by the inundation of the land segments when the water elevations are higher. The inundation dampens the tide signal causing the lower tide range. The 1.0 shift for the Bay Gardene data was adopted for the modeling calibration and all subsequent alternatives analysis simulations.

The rational for adjusting the Carnarvon total flow is that the model grid domain does not contain the entire area influenced by the diversion flow. Therefore, only a portion of the flow actually drains through the region covered by the model grid. The remaining portion of the flow drains towards the MRGO channel that is not represented in the model grid. Thus, it is appropriate to reduce the Carnarvon flow rates so that they better represent the flow entering the area covered by the model gird. The “best” reduction level was determined via the salinity calibration.

It was also found that the salinity calibration was sensitive, albeit to a smaller degree, to the assumed split of the Caernarvon flow to the west and the south. As discussed in Section 2, historically the portion flowing to the west, directly towards the White Ditch area, was about 20 to 30 percent. However, it is believed by local land managers that after Hurricane Katrina, the percentage flowing directly to the west is lower, due to blockage of many of the smaller canals, and is currently about 5 to 10 percent.

After assigning the dispersion value, a sequence of final calibration simulations were completed in which the bottom friction and the total flow and flow split for the Caernarvon were systematically altered. The final calibration was obtained with the following parameter values:

- Manning’s n: 0.021
- Dispersion Coefficient: 10 m^2/s
- Amount of Measured Caernarvon Flow applied: 58.2%
- Amount of Applied Caernarvon Flow directed to the west: 5%

The final stage calibration is shown in Figure 34. The simulated stage calibration indicates that the model represents the measured tide amplitude reduction and phase shifts at stations S3 and N3. A typical time series of the salinity response in the White Ditch area is shown in Figure 35. The decrease in the salinity values for all but the most offshore station from the initial conditions and the asymptotic characteristic of the final values are evident in the time series data. The values for station 39 increase, because it is closest to the offshore boundary and less influenced by the freshwater flow from the Caernarvon diversion. The influence of the tidal excursion is also most evident at this station.

The final salinity calibration results are shown in Figure 36 and represent the time-averaged salinity values over the last four days of the simulation, which correspond to the time period of the measured values obtained during the project field program. The spatial gradients and the actual salinity levels are well represented in the simulated results. The largest discrepancy occurs in the southern station (Simulated Salinity Point 37) where the model results slightly under-predict the salinity levels.

6.1 ALTERNATIVES ANALYSIS

The calibrated CMS hydrodynamic and salinity transport model was configured to simulate the impacts of 12 alternative diversion designs. The alternatives are located in either of two locations referred to as Location 2 and Location 3 as indicated in Figure 2. The USACE initially considered another location (Location 1) but that location was discarded and not considered for modeling evaluation.

The alternative design at Location 2 is connected to the Mississippi River with a box culvert and consists of two main outfall channels and three distribution channels, as indicated in Figure 37. Culverts are distributed along the channels to enhance the connectivity to the wetlands, and plugs are placed at some junctures to control the flow. There is a short final outfall channel connecting the second main outfall channel and the Oak River

The configuration for Location 3 is shown in Figure 38. At this location, there is one main outfall channel connected to a second channel with a natural alignment. Ridges align the channels and some plugs are included.

At each alternative location, six design diversion flow rates were considered. For each flow rate a different channel cross-sectional area was used and therefore a flow-specific model grid was configured for each of the six different flow capacities at each of the two locations (for a total of 12 grids). Flow capacities for the twelve unique grid configurations are shown in Table A.

For each alternative location and flow rate, the channels were represented in the model grid by adjusting the grid cell elevations within the footprint of each channel. Examples of cross-sections for the 5000 cfs capacity flow rate at Location 2 are shown in Figure 39 and shown for the 5000 cfs capacity flow rate at Location 3 in Figures 40a – 40c. In general the cross-section widths and depths increased as the design flow rates increased. An example of the 35,000 cfs flow-rate grid at Location 2 is shown in Figure 41. The corresponding grid for the 35,000 cfs flow-rate grid is shown in Figure 42.

The boundary conditions locations and implementation for these alternatives grids were identical to those used in the model calibration grid (i.e. existing conditions grid) except for the addition of the White Ditch diversion flow. A flow rate boundary condition cell string was created at the beginning of the main diversion channel for application of the diversion flow rate in the model simulations.

The evaluation of the alternatives was implemented in three phases:

1. Preliminary Evaluation/Initial Screening
2. Sea-level Rise Simulations
3. Long-term Simulations of the 35,000 cfs Flow Rate at Location 3

Each of these evaluations is described below.

6.2 PRELIMINARY EVALUATION/INITIAL SCREENING

A preliminary evaluation of the alternatives was conducted with a 29 day simulation. These simulations provided evaluations of the impact of the diversion flow on water elevations and salinity levels through-out the White Ditch area. For these simulations, the Caernarvon

Diversion flow was set to 8000 cfs and the water elevations for the Bay Gardene station for the period of July 2009 were used at the offshore boundary.

Instantaneous plots of the salinity distribution during the start-up of the diversions are shown in Figure 43 for Location 2 and in Figure 44 for Location 3. The freshwater flow through the diversion channels and culverts into the wetlands is evident in the sequence of plots.

As the simulations were completed, the model results were processed and delivered to the USACE for subsequent analysis. The main post-processing for these simulations were maps of the time-averaged salinity and water depth over the last week of simulation, during which conditions were quasi-steady, and varying only due to tidal effects. An example of the average salinity conditions for Location 2 35,000 flow-rate design conditions is shown in Figure 45. The corresponding plot of the time-average water depths is shown in Figure 46.

6.3 SEA LEVEL RISE SIMULATIONS

Twelve 90-day sea-level rise simulations were configured and are described in Table B. For these simulations, the existing no project conditions were used and there was no flow simulated from White Ditch. As indicated in Table B, both the Caernarvon flow rate and tide (sea) level were varied. Each sea-level rise was implemented by adding the rise to the water elevation time series used at the offshore boundary condition. The water elevations for the Bay Gardene station for the period of June through August were used for these simulations. Details of the sea-level rise scenarios designated in Table B are listed in Table C.

6.4 LONG TERM SIMULATIONS AT LOCATION 3

Seven additional alternatives were completed using the 35000 cfs capacity grid at Location 3. Three simulations represented a 90 day period using the Bay Gardene water elevation data for June – August, 2009 at the offshore boundary conditions. The diversion flows were steady at 10000, 15000, and then 35000 cfs, respectively. The flow at the Caernarvon Diversion was 1200 cfs. The results of these simulations were delivered to the USACE for further evaluation.

The remaining four simulations were 17 months long and were completed using the Location 3 35000 cfs flow capacity model grid. These model runs simulated conditions beginning during a Spring season and continuing through the Summer of the following year. Flow rates at both the White Ditch diversion and the Caernarvon diversion were varied throughout the simulation period. The flow conditions for each scenario are shown in Table D.

The 17 months of simulation time was divided into eight consecutive simulations. The first seven (a through g) each simulated two months time and the eighth simulation (h) simulated the final three-month period. The labels a through h at the top of Table D indicates the simulation period. For simulations 1 and 2, the simulations were started at period d, using the solutions at the end of the previous 90 day simulations.

Tide inputs for these long term simulations were taken from measured data at Bay Gardene Station for the entire year 2009. Data from March through December 2009 were used for the initial ten months of simulation, and then data from January through July 2009 were used during the last seven months of simulation.

Time series plots of salinity at seven observation locations within the model grid are shown for simulation 3 in Figure 47a and simulation 4 in Figure 47b. The impact of the high White Ditch Diversion flow rates during period a and f and g are very evident in the time series and the response time of the salinity levels in the White Ditch area can be inferred from these time series. A plot of the time-averaged salinity over the final three months of simulation period (Simulation 3h) for long-term Simulation 3 is shown in Figure 48.

The CMS Flow model was successfully configured and calibrated for the White Ditch area for simulations of tide, flow and salinity. The model was subsequently used to evaluate various alternative designs and operational scenarios for the White Ditch diversion.

During the calibration and implementation of the CMS Flow model, a number of assumptions and data limitations were identified that were required in order to complete the modeling analysis within the project schedule. In anticipation of a need for additional modeling analysis, it is recommended that additional data collection be completed to reduce the number of assumptions and limitations. The data categories are:

1. Additional bathymetric and topographic data
2. Additional water level and salinity data
3. Flow measurements geared towards verifying westward flow patterns from the Caernarvon Diversion
4. Better understanding of rainfall and evaporation runoff from the land segments

Each of these topics is discussed below.

Bathymetric and topographic data

The original survey data focused on the areas adjacent to the proposed diversion. Scheduling considerations and access rights prevent survey data collection from areas to the northwest, southeast and across the Oaks River area. Aerial images since the impact of Hurricane Katrina have provided suitable data for delineating the dense network of canals, streams and lakes, but the water depths and land elevations are not well documented. For the development of the existing model, assumptions for the water depths and land elevations were made based on the spatial patterns derived from the available project surveys. It is recommended that additional data, similar to the survey data collected as part of this project, also be collected. The ridge along the Oaks River north and south of the previous survey area should also be surveyed, as this is an important feature in the project area, controlling flows from the project area into the Oaks River.

Another area for survey data collection is along the canals that connect the Caernarvon Diversion to the Oaks River. During the model calibration it was found that Caernarvon Diversion flow westward to the Oaks River area had a strong impact on the salinity in the project area. Thus, an improved delineation of the flow-ways would enhance the reliability of the model.

Additional Water Level and Salinity Data

The model calibration data set consisted of a few days of continuous water elevations at two stations in the central area of the project. Salinity data consisted of point measurements at about eight stations around the central project area. Although this data set did provide reasonable constraints of water elevation and salinity, a more rigorous model calibration could be made if continuous water elevation and salinity data could be obtained. It is recommended that continuous monitoring of water elevation and salinity be made at stations spanning the entire project area, and in the vicinity of the flow-ways connecting the Caernarvon Diversion flows to the Oaks River. At least three stations would be located in the projected area, one each in the north, central and southern portion of the project area. An additional station should be located east of the Oaks River, in one of the major flow-ways connecting the Caernarvon Diversion flows to the Oaks River. Measurements should be made for at least two weeks (a complete spring-neap tide cycle), and preferably over a month or more to collect data under a larger variety of conditions. Consideration should be given to collecting data during high and low Caernarvon Diversion flows.

The need for sensor maintenance during deployment in a marine environment should be considered in identifying station locations.

All water elevation sensors should be surveyed so that they can be referenced to the same vertical datum of the bathymetric and topographic survey data.

Flow measurements for verifying westward flow patterns from the Caernarvon Diversion

During the model calibration, it was found that the simulated salinities in the project area were sensitive to assumptions as to the total amount of Caernarvon Diversion flow that traveled westward and south-westward towards the Oaks River and project area. At that time, only antidotal estimates of the flow rates were available, mainly from observations of persons familiar with the area. Thus, additional data collection to establish the flow rates would be very useful in enhancing the model calibration. Flow measurements should be made at 2 to 5 stations in flow-ways connecting the Caernarvon Diversion to the Oaks River. Measurements should be made every 1 to 2 hours over a 24-hour period. (or 12-hour period if access is not feasible at night). At least one set of flow measurements should be collected during a spring tide and one during a neap tide.

Better understanding of rainfall and evaporation runoff from the land segments

Another model parameter that affected the salinity in the project area was the rainfall and evaporation rates. During the model calibration, assumption of the rainfall water balance (evaporation, direct run-off and infiltration and groundwater discharge) had to be made. It is recommended that two or three pressure gages be installed in shallow wells to provide continuous water table surface elevation and salinity data during the same period that the continuous surface water measurements are being recorded. The well should be able to be installed using a hand auger due to the shallow depths. The pressure sensors should also be surveyed to provide the data referenced to the same vertical datum as the bathymetric and topographic data. The installation of automatic rainfall gages and pan evaporation measurement systems should considered at each of the well locations.

Buttolph, A. M.; Reed, C. W.; Kraus, N. C.; Ono, N.; Larson, M.; Camenen, B.; Hanson, H.; Wamsley, T. and Zundel, A. K., 2006. Two-Dimensional Depth-Averaged Circulation Model CMS-M2D: Version 3.0, Report 2, Sediment Transport and Morphology Change. Coastal and Hydraulics Laboratory Technical Report ERDC/CHL-TR-06-7. Vicksburg, MS: US Army Engineer Research and Development Center.

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Fischer, H., List, J., Koh, R., Imberger, J., Brooks, N., Mixing in Inland and Coastal Waters, (Academic Press, Inc., Orlando) 1979.

Militello, A., Reed, C.W., Zundel, A.K., and Kraus, N.C. 2004. Two-Dimensional Depth-Averaged Circulation Model M2D: Version 2.0, Report 1, Technical Documentation and User's Guide, ERDC/CHL TR-04-2, U.S. Army Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.

URS, White Ditch Filed Program Results, 2009, Submitted to the USACE.

TABLES

Table A. Grid Configurations and Flow Capacities.

	Flow Rate (cfs)
Location 2	5,000 cfs
	10,000 cfs
	15,000 cfs
	35,000 cfs
	70,000 cfs
	100,000 cfs
Location 3	5,000 cfs
	10,000 cfs
	15,000 cfs
	35,000 cfs
	70,000 cfs
	100,000 cfs

Table B. No Project Simulations Boundary Conditions.

Simulation ID	Caernarvon Flow (cfs)	Sea Level Rise Scenario
2000	8,000	2009 Low
2500	2,800	2009 Low
3000	200	2009 Low
3500	8,000	2065 Low
4000	2,800	2065 Low
4500	200	2065 Low
5000	8,000	2065 Moderate
5500	2,800	2065 Moderate
6000	200	2065 Moderate
6500	8,000	2065 High
7000	2,800	2065 High
7500	200	2065 High

Table C. Sea Level Rise Scenarios.

Scenario			
Year	Low feet	Intermediate feet	High feet
2009	0	0	0
2015	0.2	0.2	0.3
2020	0.3	0.4	0.5
2025	0.5	0.6	0.8
2030	0.7	0.8	1.1
2035	0.8	1	1.4
2040	1	1.2	1.8
2045	1.2	1.4	2.1
2050	1.3	1.6	2.5
2055	1.5	1.8	2.9
2060	1.7	2.1	3.3
2065	1.8	2.3	3.7

Table D. Boundary Condition Inputs for Long-Term Simulations at Location 3.

Simulation	Model Run By	Flow Input Location	a		b		c		d		e		f		g		h		
			March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July
Simulation 1	USACE	White Ditch							1000	1000	1000	1000	1000	1000	1000	35000	1000	1000	1000
		Caernarvon							500	450	750	1750	2600	3000	2000	1500	1050	950	1000
Simulation 2	USACE	White Ditch							0	0	0	0	0	0	0	35000	0	0	0
		Caernarvon							500	450	750	1750	2600	3000	2000	1500	1050	950	1000
Simulation 3	URS	White Ditch	35000	0	0	0	0	0	0	0	0	0	15000	20000	35000	0	0	0	0
		Caernarvon	2000	1500	1050	950	1000	650	500	450	750	1750	500	500	500	1500	1050	950	1000
Simulation 4	URS	White Ditch	35000	1000	1000	1000	1000	1000	1000	1000	1000	1000	15000	20000	35000	1000	1000	1000	1000
		Caernarvon	2000	1500	1050	950	1000	650	500	450	750	1750	500	500	500	1500	1050	950	1000

Table E. Time Period and Naming Convention for Long-term Simulations at Location 3.

	Total Hours	Begin Month	End Month
SIM 3a, 4a	1464	March	April
SIM 3b, 4b	1464	May	June
SIM 3c, 4c	1488	July	August
SIM 1d, 2d, 3d, 4d	1464	September	October
SIM 1e, 2e, 3e, 4e	1464	November	December
SIM 1f, 2f, 3f, 4f	1416	January	February
SIM 1g, 2g, 3g, 4g	1464	March	April
SIM 1h, 2h, 3h, 4h	2208	May	July

FIGURES

Figure 1. Study Area.

Figure 2. Alternative Locations.

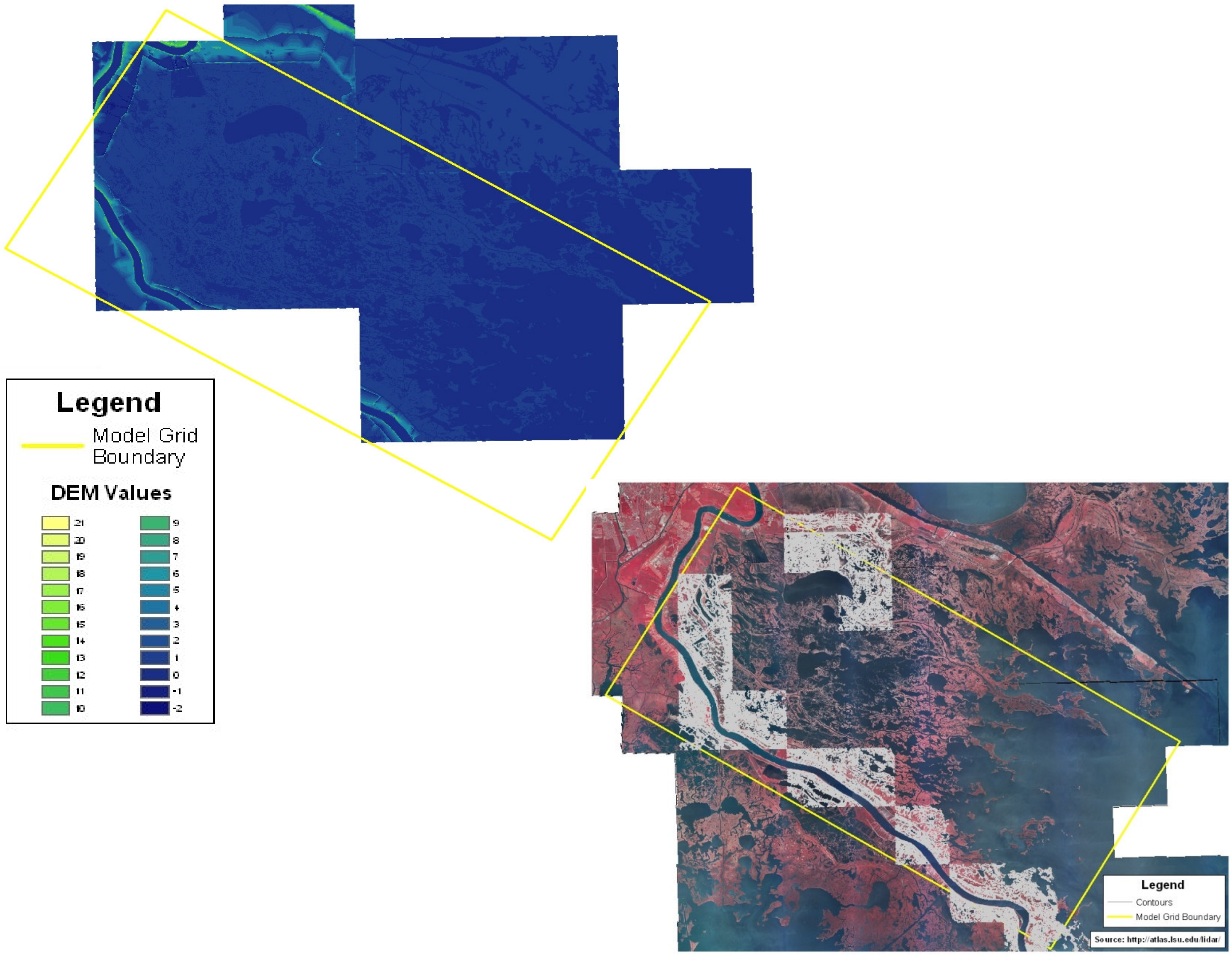


Figure 3. Existing DEM and Contour Data.

Figure 4. Station Locations.

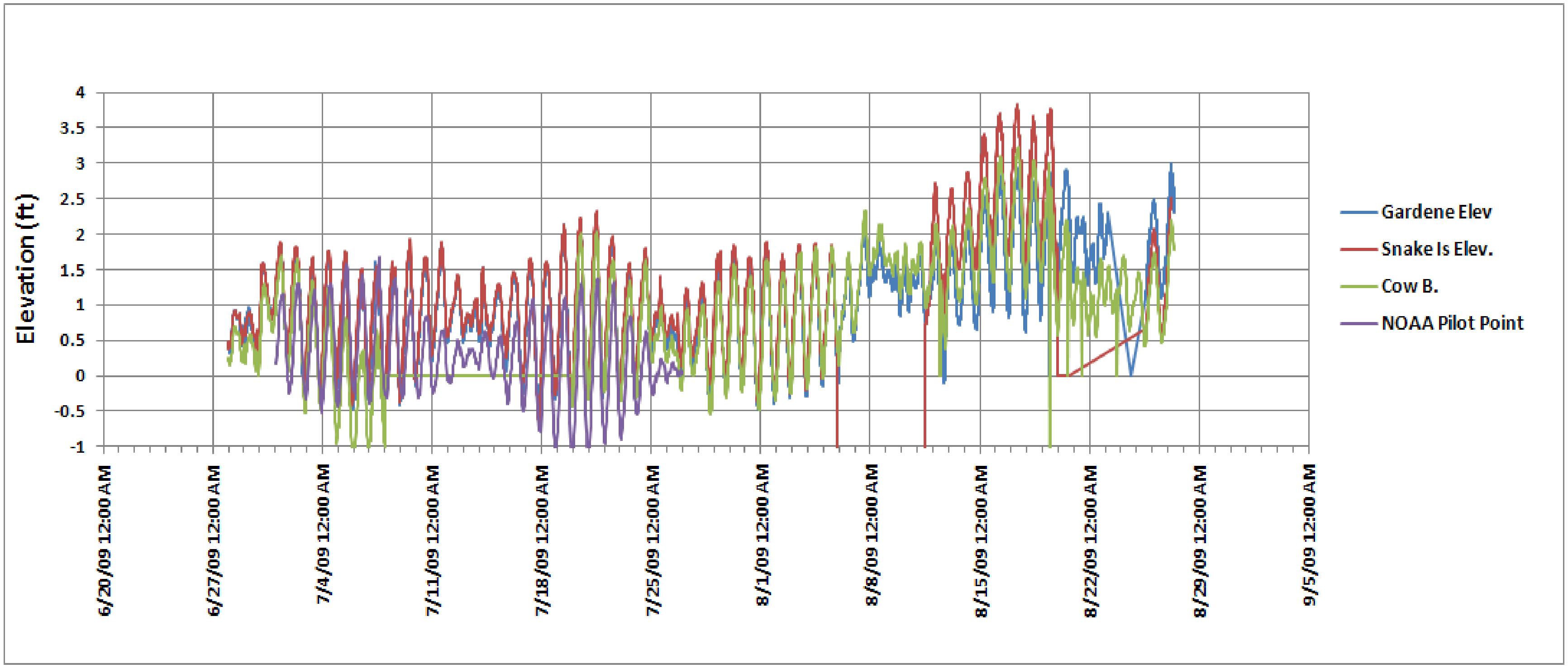


Figure 5. Sample Tide Record.

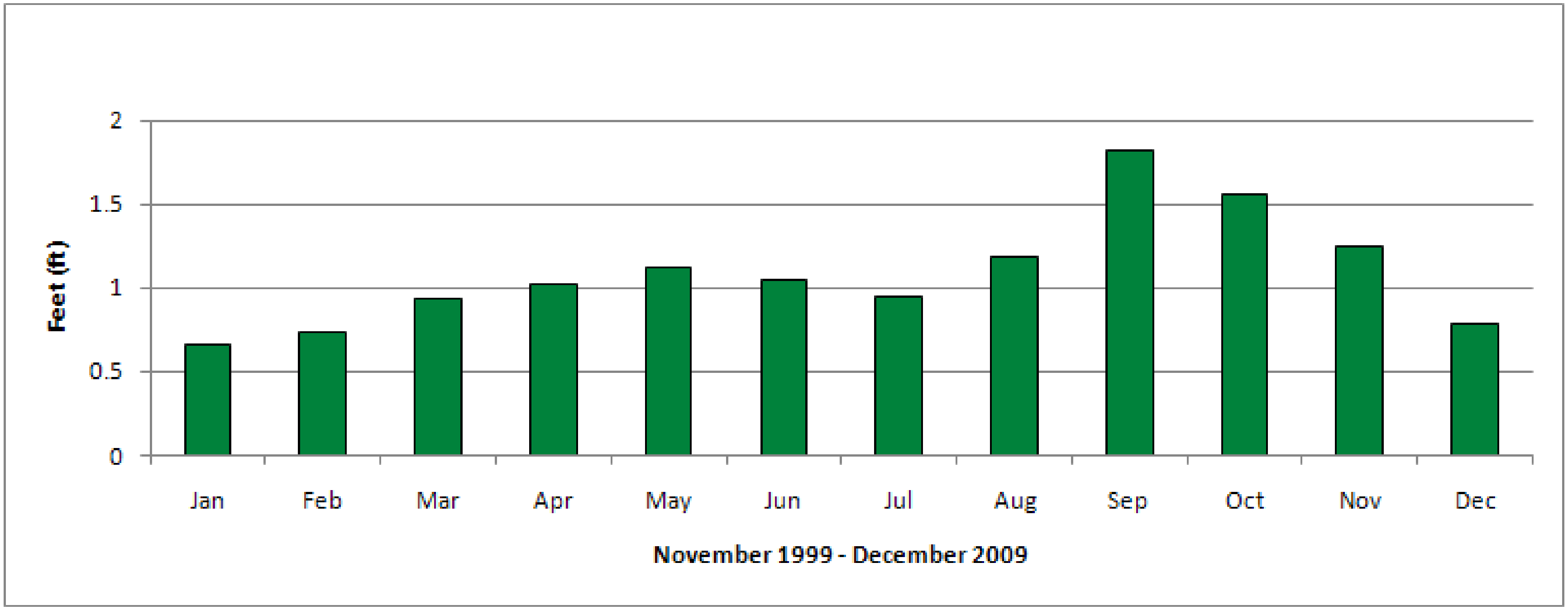


Figure 6. Monthly Average Tide Stage at the Bay Gardene Station for Period 2000–2009.

Figure 7. Wind and Rainfall Station Locations.

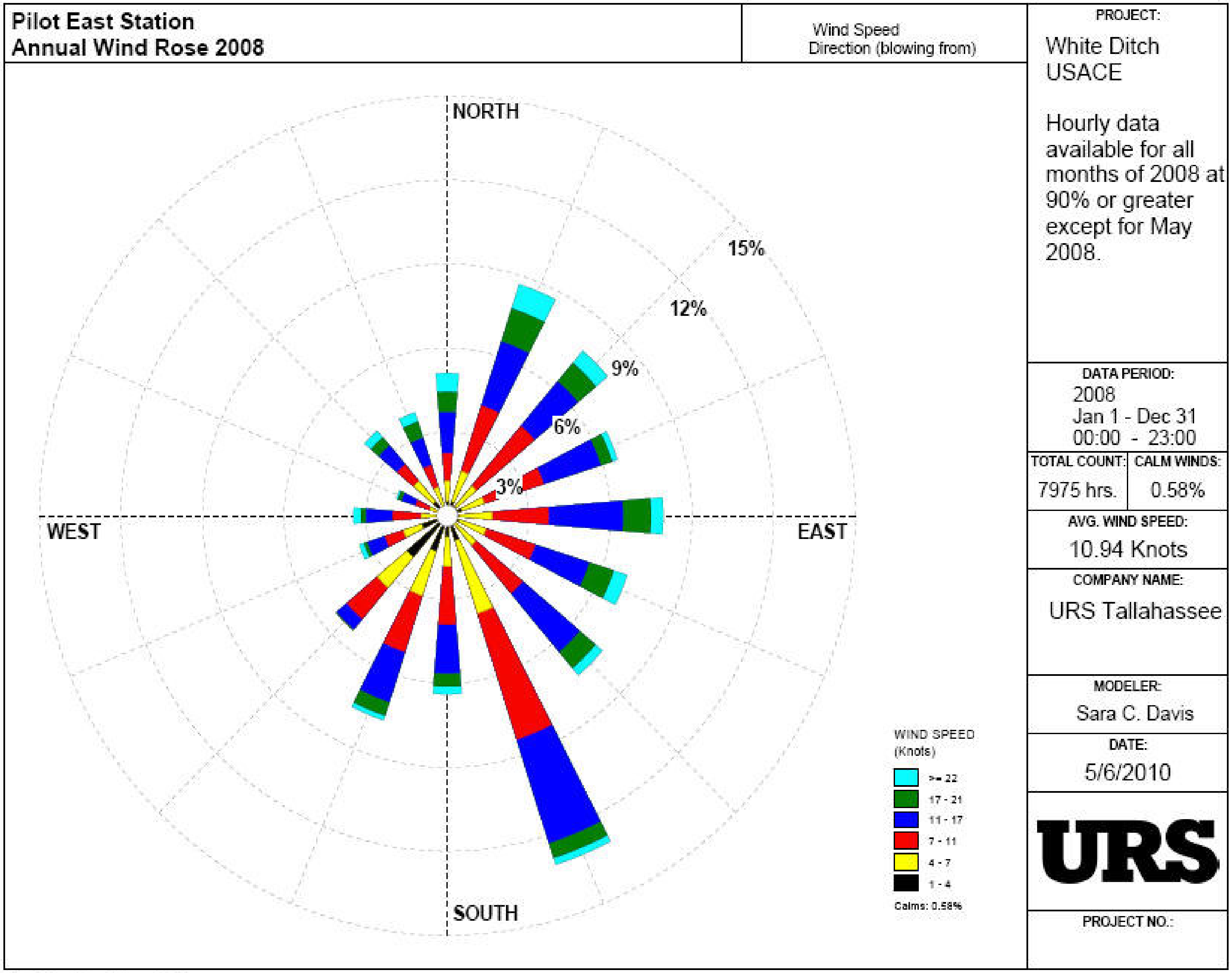
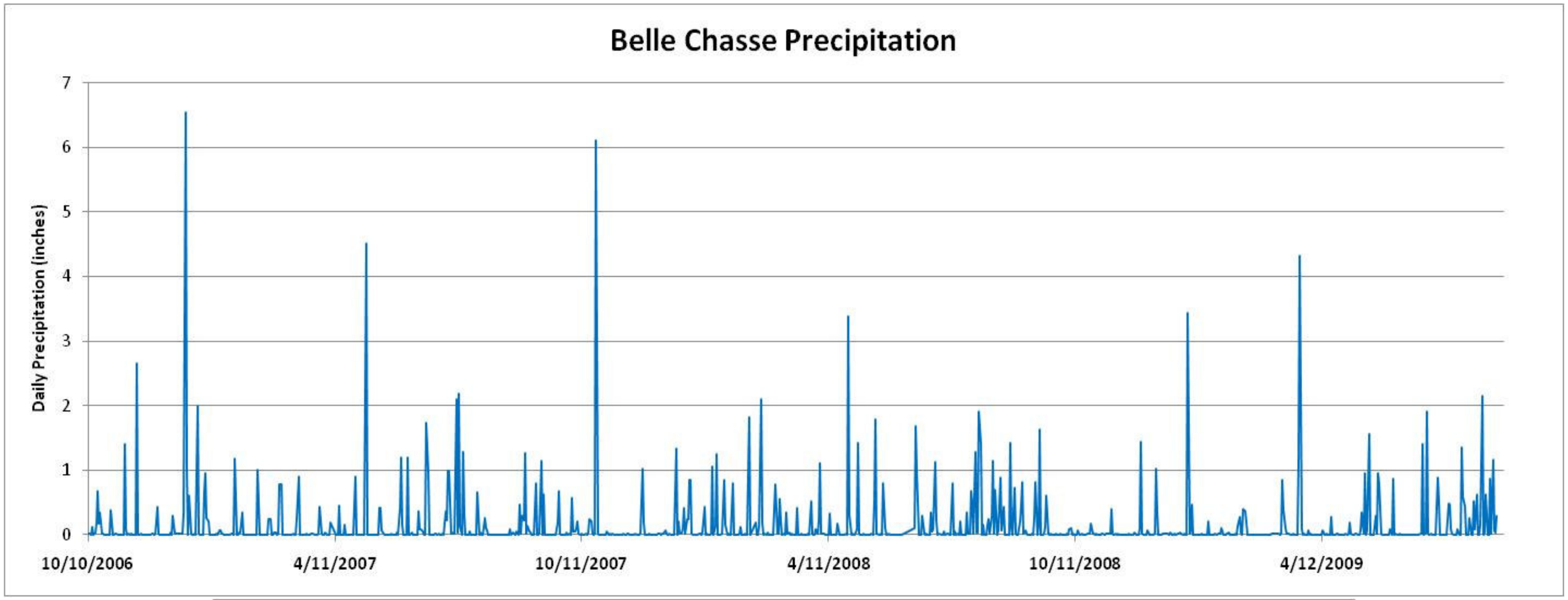


Figure 8. Pilot East 2008 Wind Rose.



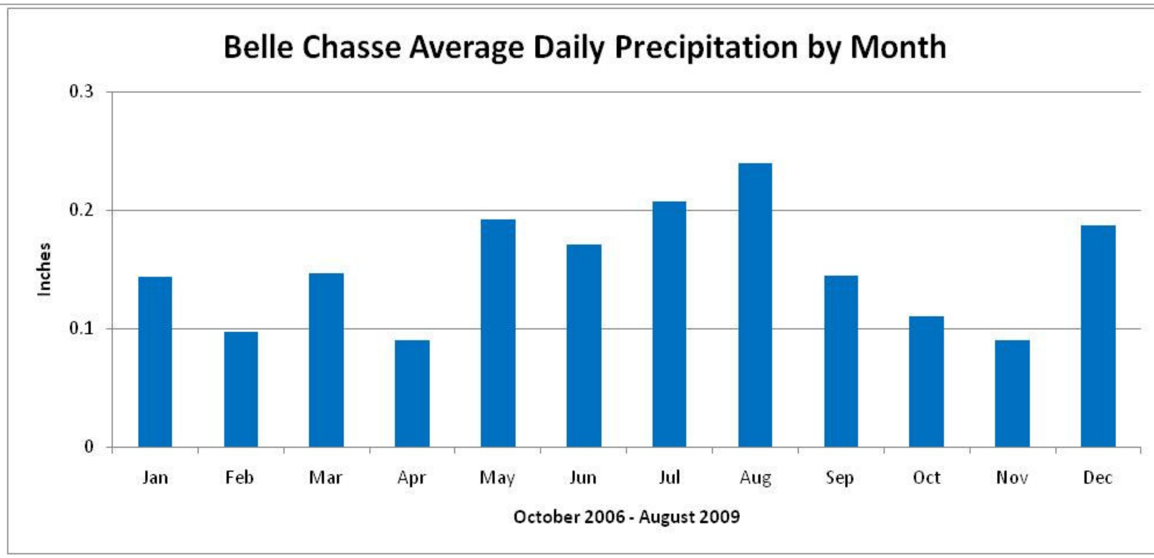


Figure 9. Belle Chasse Rainfall Data.

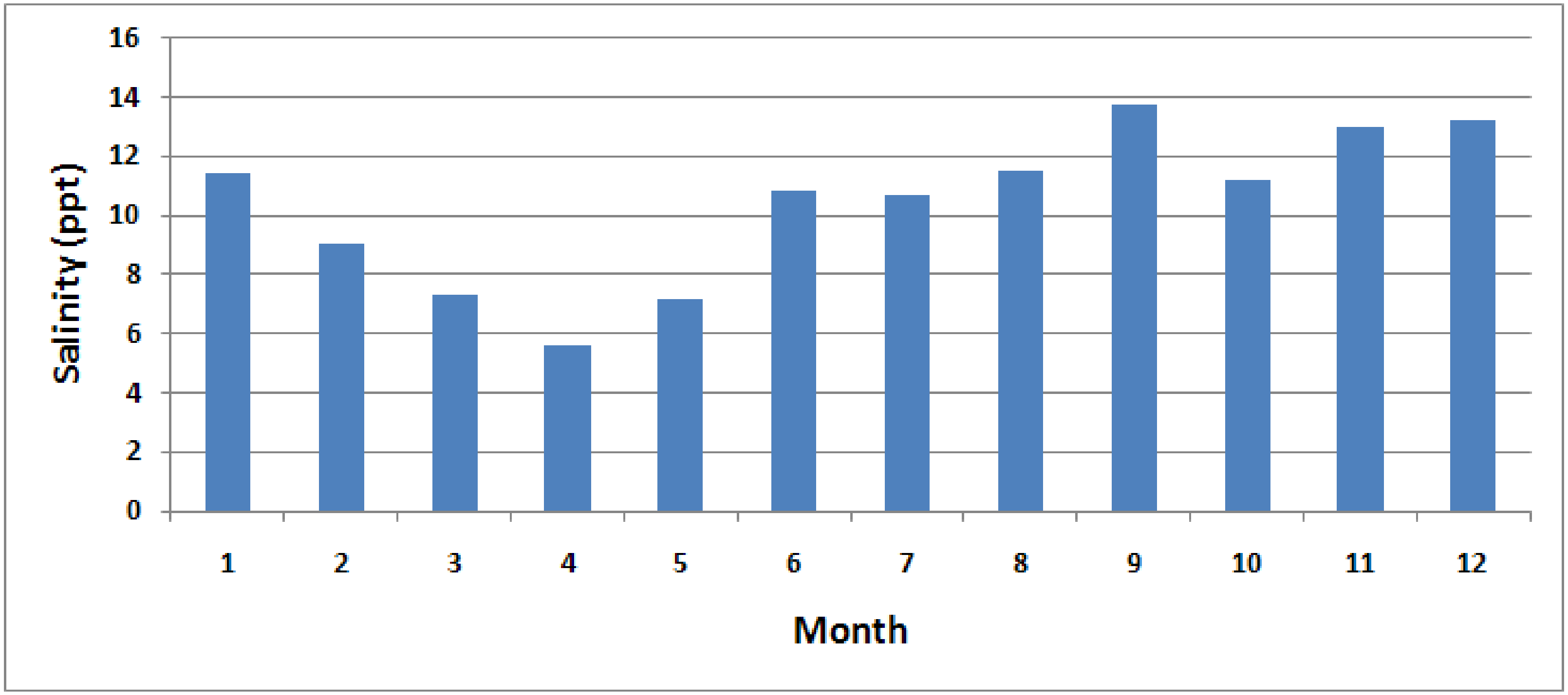
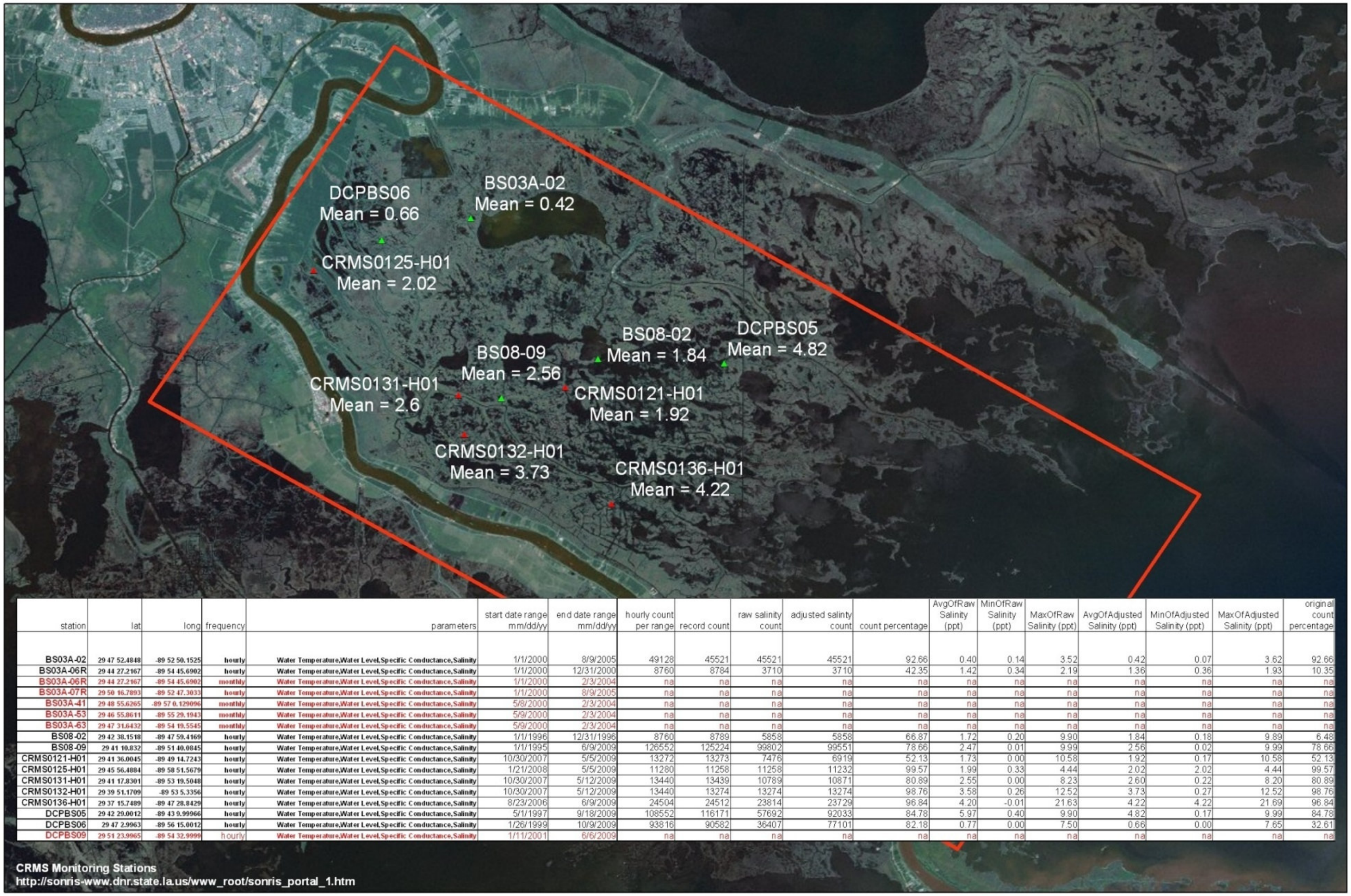


Figure 10a. Monthly Average Salinity at the Bay Gardene Station for Year 2009.



station	lat	long	frequency	parameters	start date range mm/dd/yy	end date range mm/dd/yy	hourly count per range	record count	raw salinity count	adjusted salinty count	count percentage	AvgOfRaw Salinity (ppt)	MinOfRaw Salinity (ppt)	MaxOfRaw Salinity (ppt)	AvgOfAdjusted Salinity (ppt)	MinOfAdjusted Salinity (ppt)	MaxOfAdjusted Salinity (ppt)	original count percentage
BS03A-02	29 47 52.4848	-89 52 50.1525	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/1/2000	8/9/2005	49128	45521	45521	45521	92.66	0.40	0.14	3.52	0.42	0.07	3.62	92.66
BS03A-06R	29 44 27.2167	-89 54 45.6902	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/1/2000	12/31/2000	8760	8784	3710	3710	42.35	1.42	0.34	2.19	1.36	0.36	1.93	10.35
BS03A-06R	29 44 27.2167	-89 54 45.6902	monthly	Water Temperature,Water Level,Specific Conductance,Salinity	1/1/2000	2/3/2004	na	na	na	na	na	na	na	na	na	na	na	na
BS03A-07R	29 50 16.7893	-89 52 47.3033	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/1/2000	8/9/2005	na	na	na	na	na	na	na	na	na	na	na	na
BS03A-41	29 48 55.6265	-89 57 0.129096	monthly	Water Temperature,Water Level,Specific Conductance,Salinity	5/8/2000	2/3/2004	na	na	na	na	na	na	na	na	na	na	na	na
BS03A-53	29 46 55.8611	-89 55 29.1943	monthly	Water Temperature,Water Level,Specific Conductance,Salinity	5/9/2000	2/3/2004	na	na	na	na	na	na	na	na	na	na	na	na
BS03A-63	29 47 31.6432	-89 54 19.5545	monthly	Water Temperature,Water Level,Specific Conductance,Salinity	5/9/2000	2/3/2004	na	na	na	na	na	na	na	na	na	na	na	na
BS08-02	29 42 38.1518	-89 47 59.4169	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/1/1996	12/31/1996	8760	8789	5858	5858	66.87	1.72	0.20	9.90	1.84	0.18	9.89	6.48
BS08-09	29 41 10.832	-89 51 40.0845	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/1/1995	6/9/2009	126552	125224	99802	99551	78.66	2.47	0.01	9.99	2.56	0.02	9.99	78.66
CRMS0121-H01	29 41 36.0045	-89 49 14.7243	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	10/30/2007	5/5/2009	13272	13273	7476	6919	52.13	1.73	0.00	10.58	1.92	0.17	10.58	52.13
CRMS0125-H01	29 45 56.4884	-89 58 51.5679	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/21/2008	5/5/2009	11280	11258	11258	11232	99.57	1.99	0.33	4.44	2.02	2.02	4.44	99.57
CRMS0131-H01	29 41 17.8301	-89 53 19.5048	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	10/30/2007	5/12/2009	13440	13439	10789	10871	80.89	2.55	0.00	8.23	2.60	0.22	8.20	80.89
CRMS0132-H01	29 39 51.1709	-89 53 5.3356	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	10/30/2007	5/12/2009	13440	13274	13274	13274	98.76	3.58	0.26	12.52	3.73	0.27	12.52	98.76
CRMS0136-H01	29 37 15.7489	-89 47 28.8429	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	8/23/2006	6/9/2009	24504	24512	23814	23729	96.84	4.20	-0.01	21.63	4.22	4.22	21.69	96.84
DCPBS05	29 42 29.0012	-89 43 9.99966	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	5/1/1997	9/18/2009	108552	116171	57692	92033	84.78	5.97	0.40	9.90	4.82	0.17	9.99	84.78
DCPBS06	29 47 2.9963	-89 56 15.0012	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/26/1999	10/9/2009	93816	90582	36407	77101	82.18	0.77	0.00	7.50	0.66	0.00	7.65	32.61
DCPBS09	29 51 23.9965	-89 54 32.9999	hourly	Water Temperature,Water Level,Specific Conductance,Salinity	1/11/2001	6/6/2009	na	na	na	na	na	na	na	na	na	na	na	na

Figure 10b. SONRIS Salinity Data.

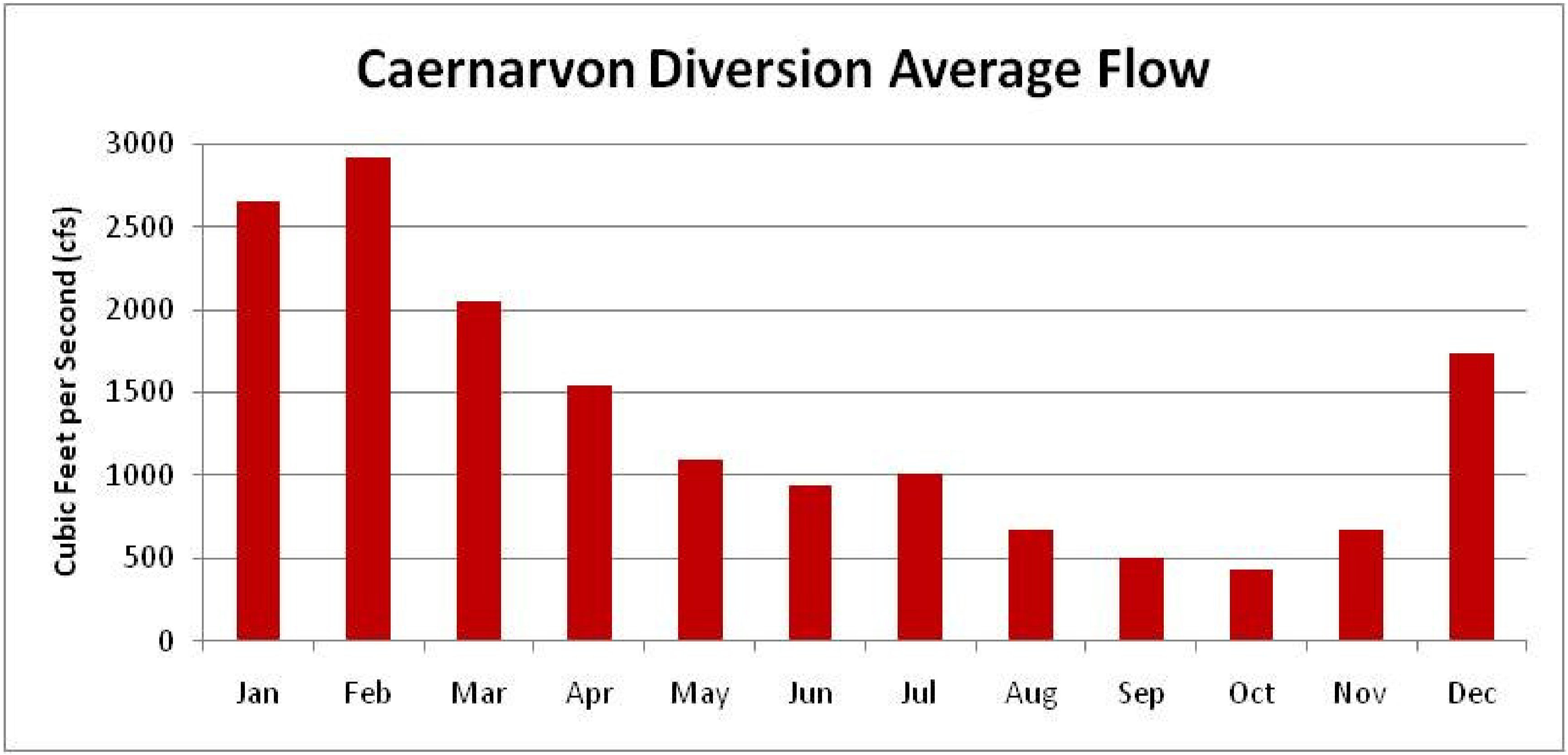


Figure 11. Seasonal Flows from Caernarvon Freshwater Diversion.

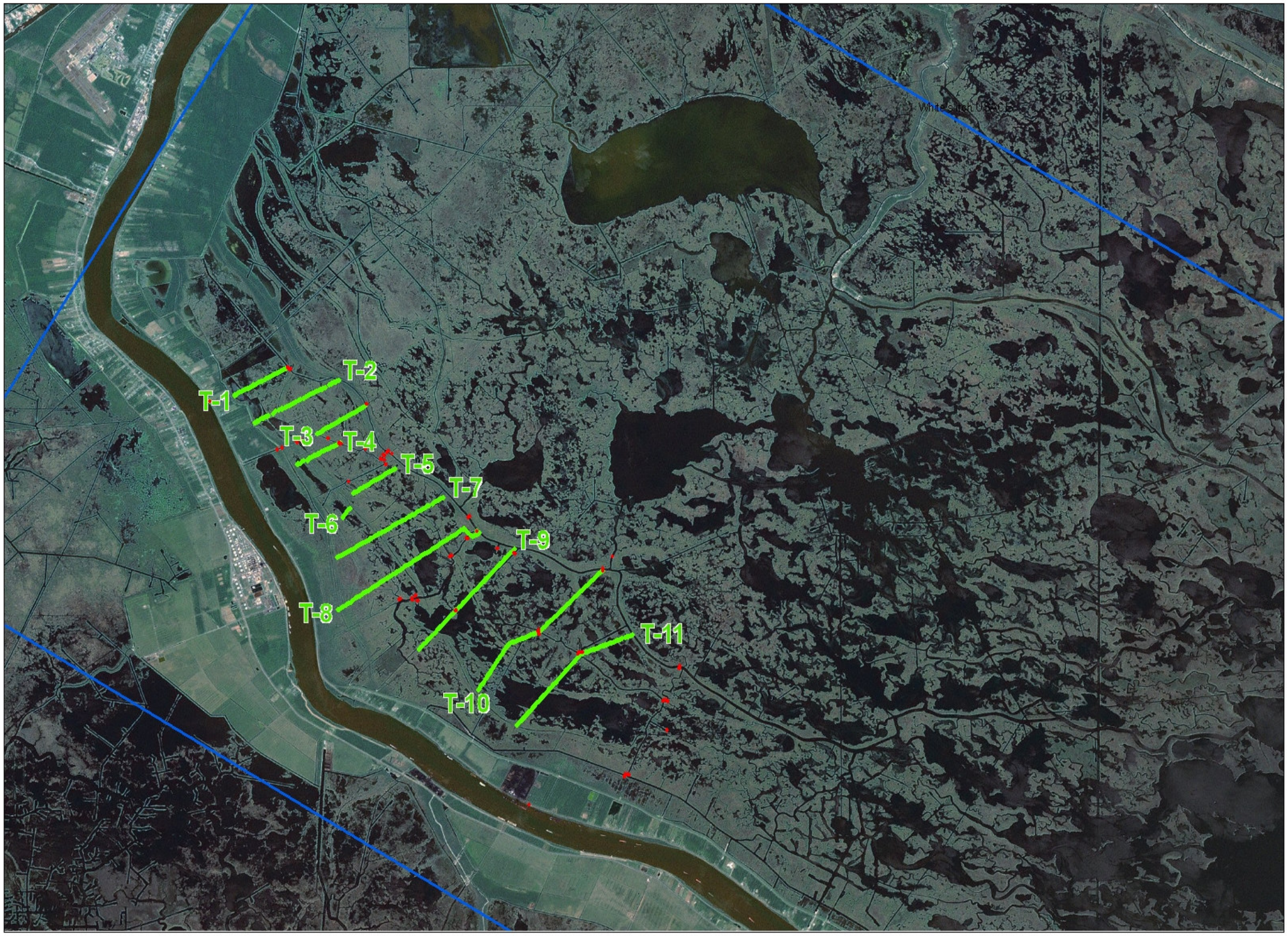


Figure 12. Transect Locations.

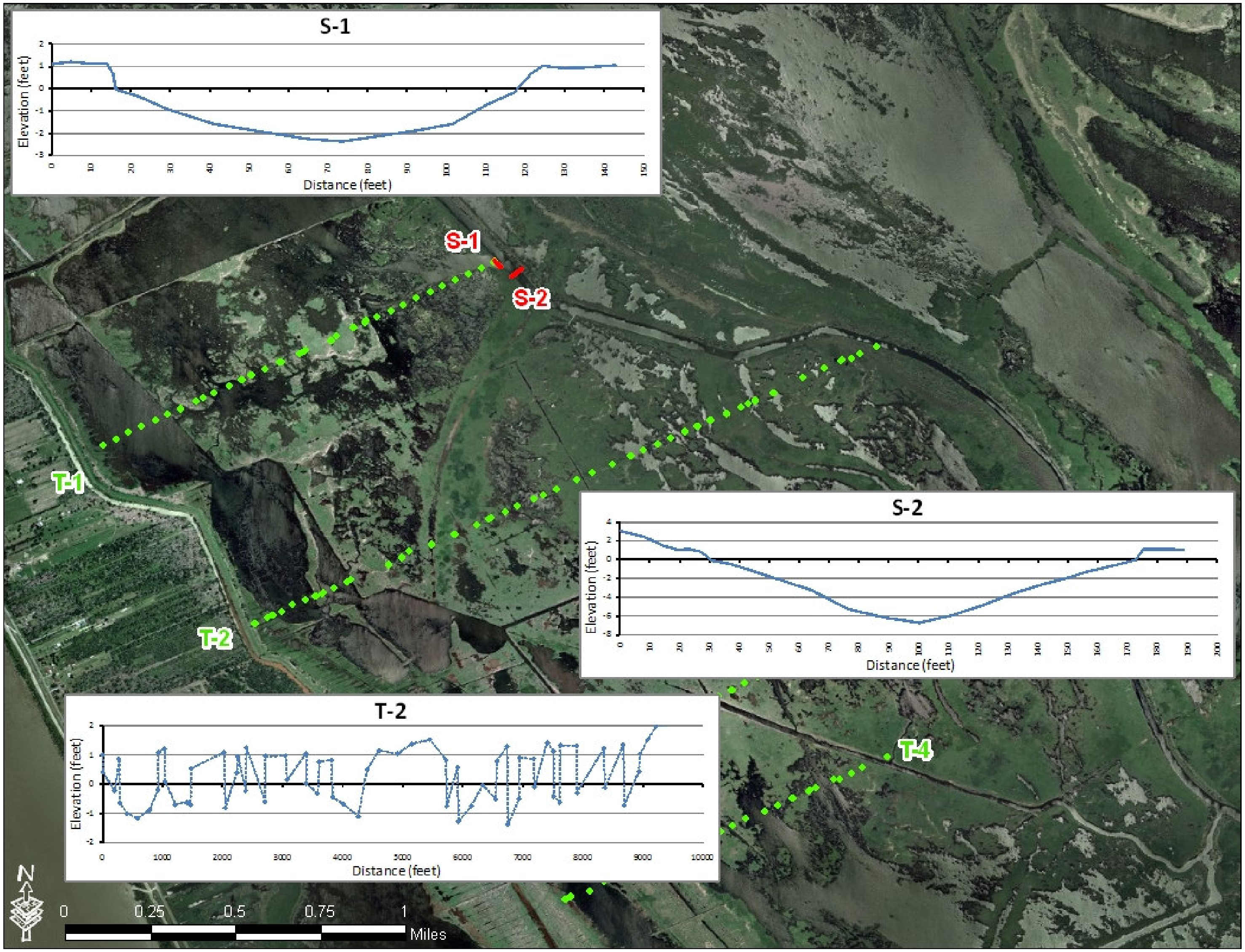


Figure 13. Sample of the Surveyed Cross-Sections.

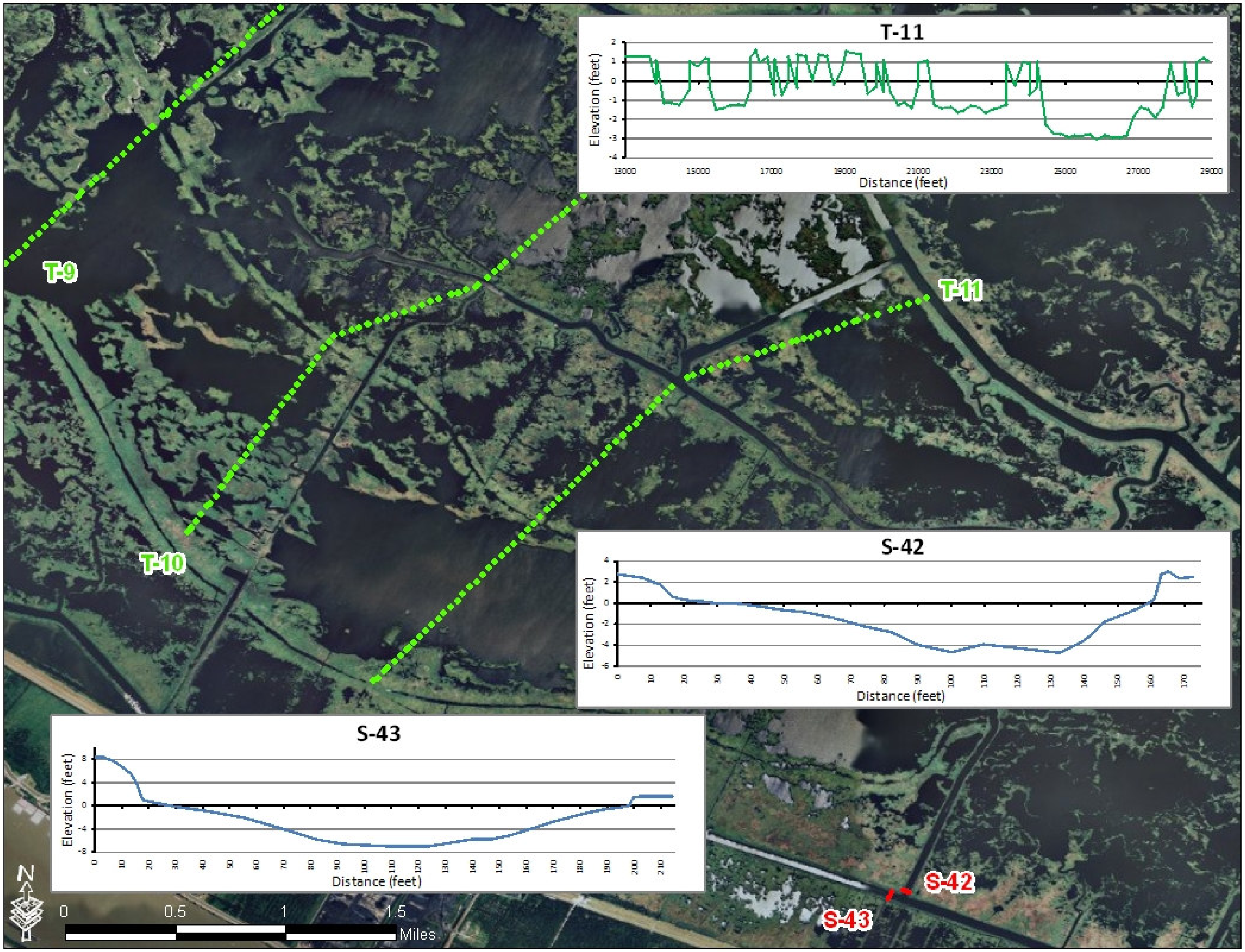


Figure 14. Sample of the Surveyed Cross-Sections.

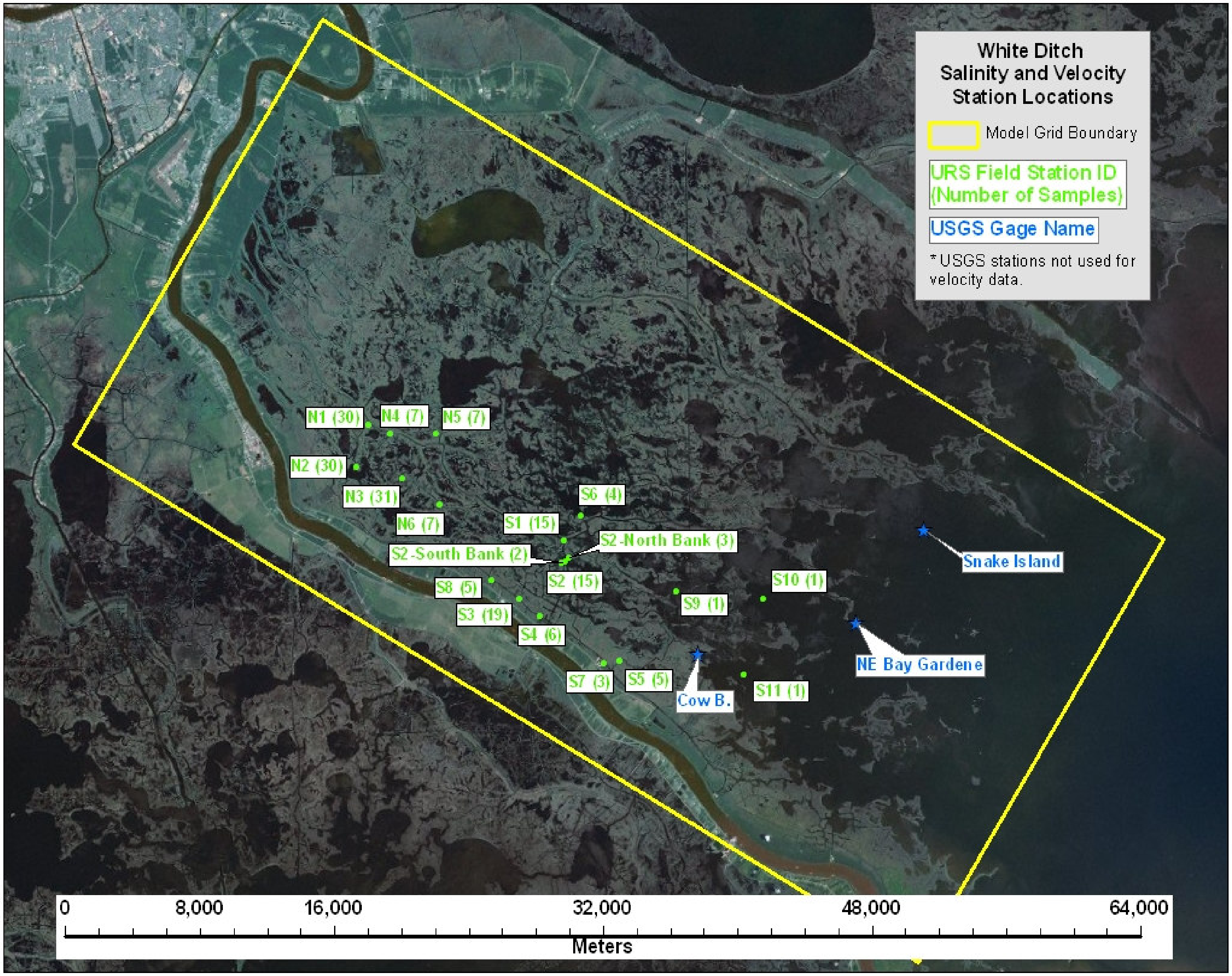


Figure 15. Salinity and Velocity Sampling Stations.

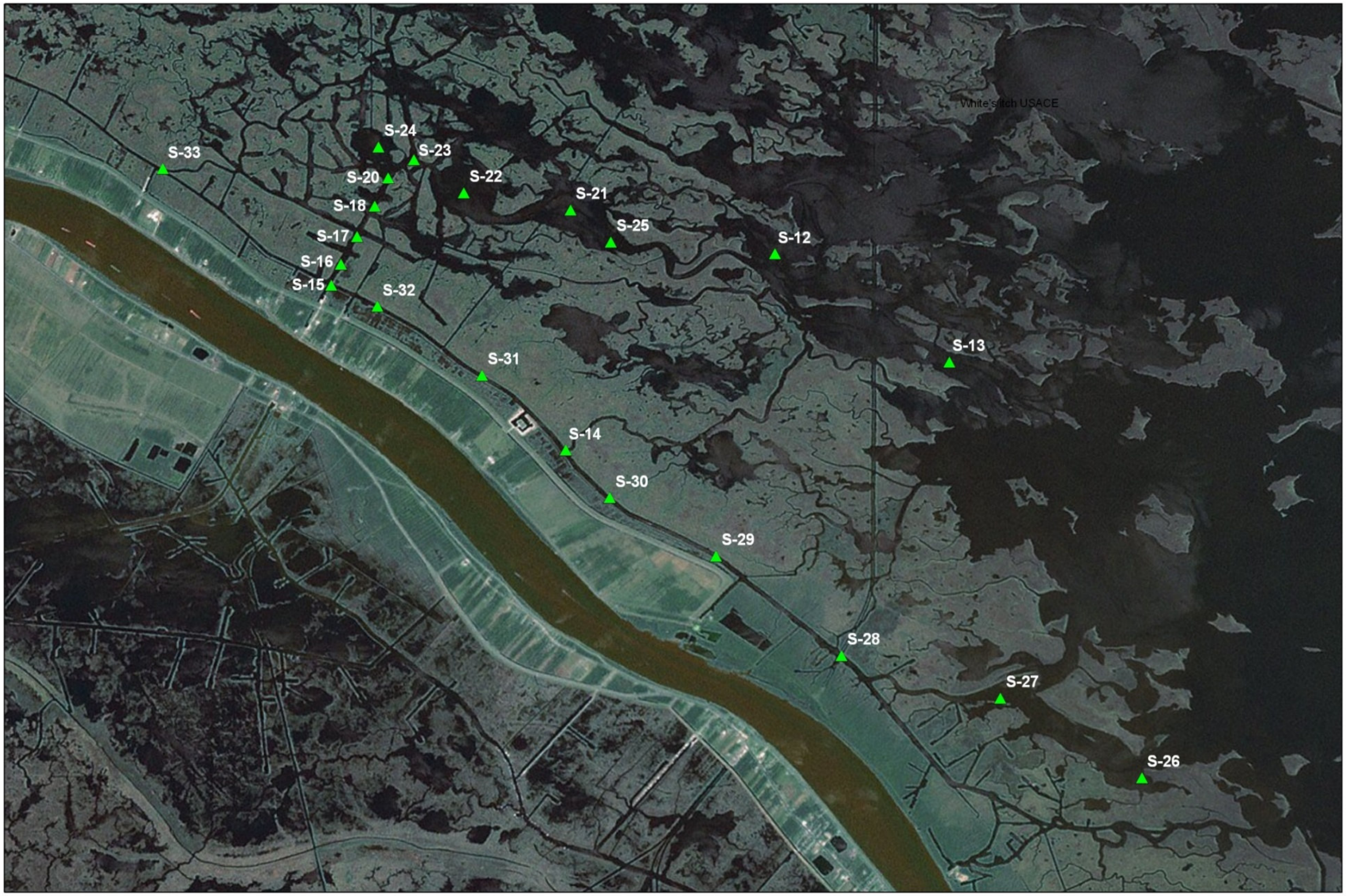


Figure 16. Additional URS Field Locations.

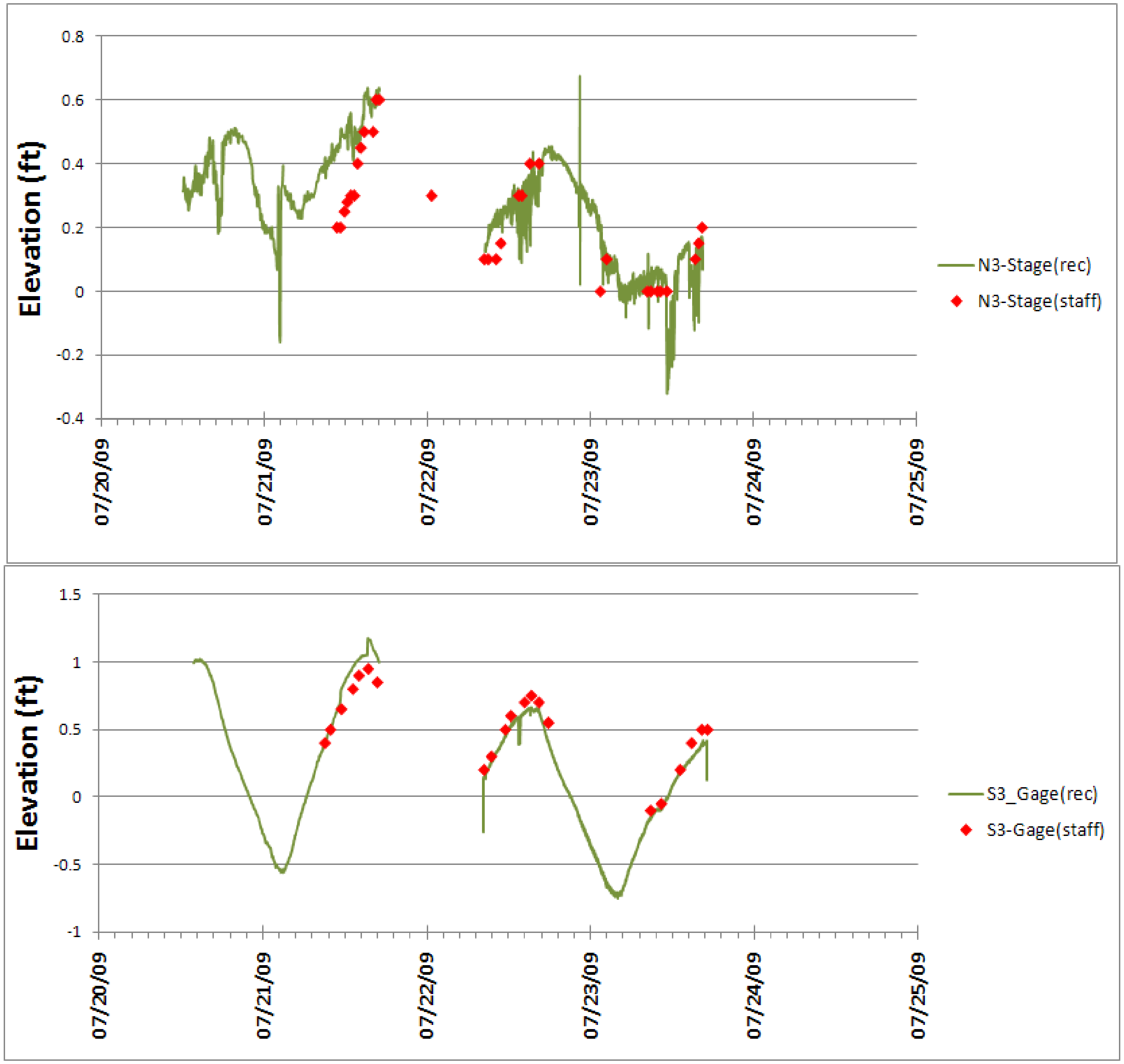


Figure 17. Measured Stage Data.

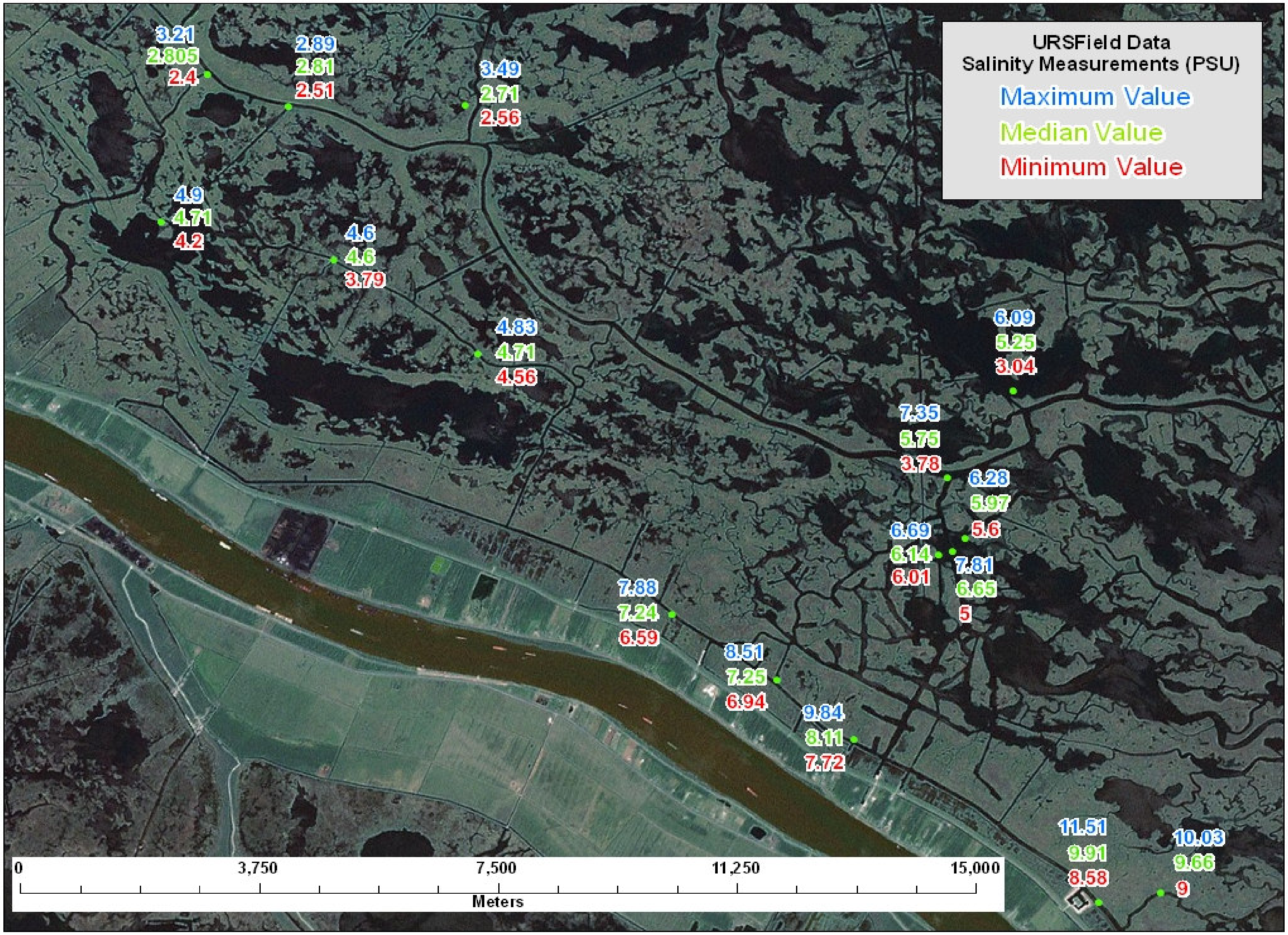


Figure 18. Salinity Sampling Results.

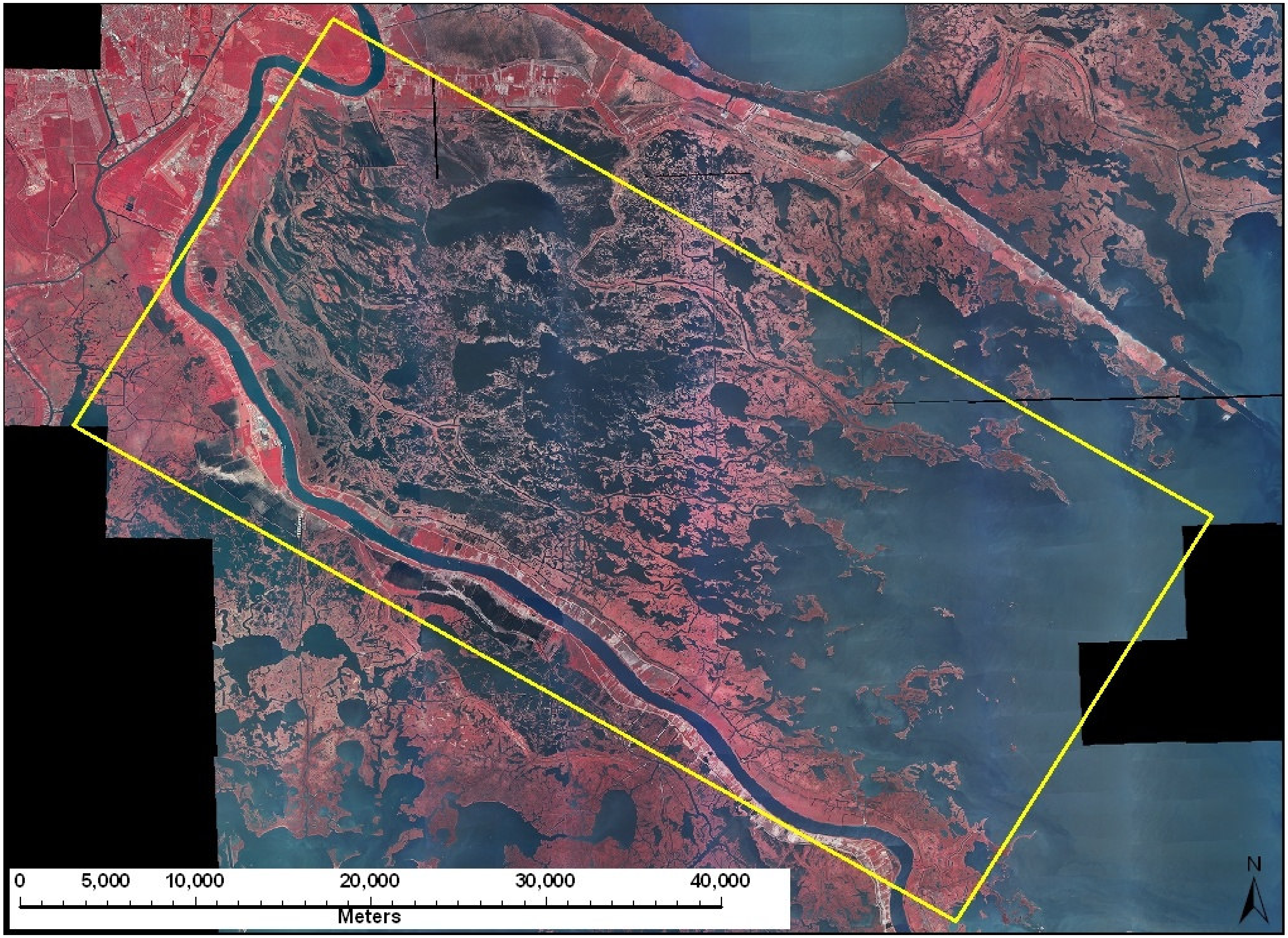


Figure 19. Model Domain.

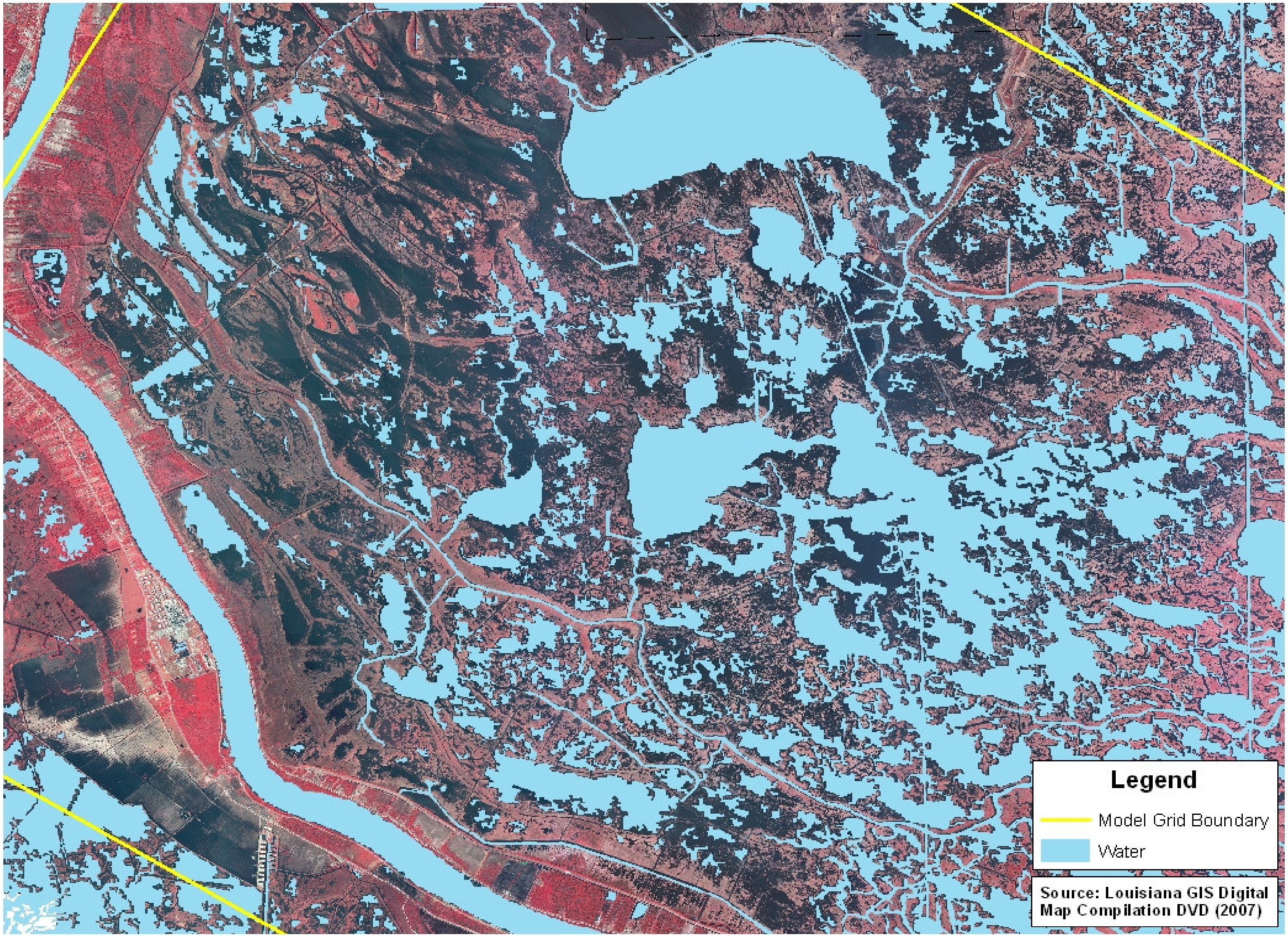


Figure 20. Water Polygon Data from the LA GIS Digital Map Compilation DVD.

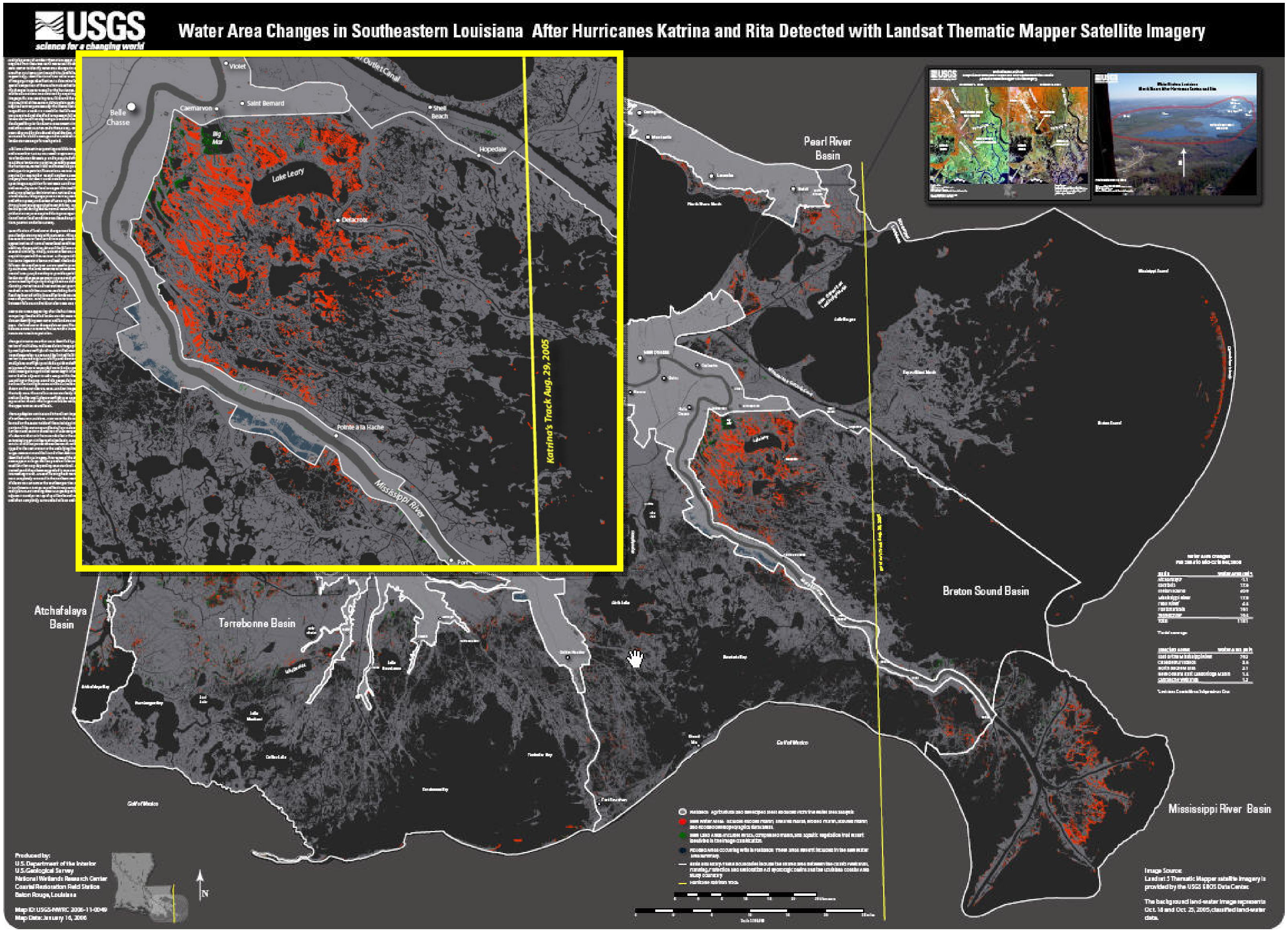


Figure 21. USGS Water Area Changes Study Results.

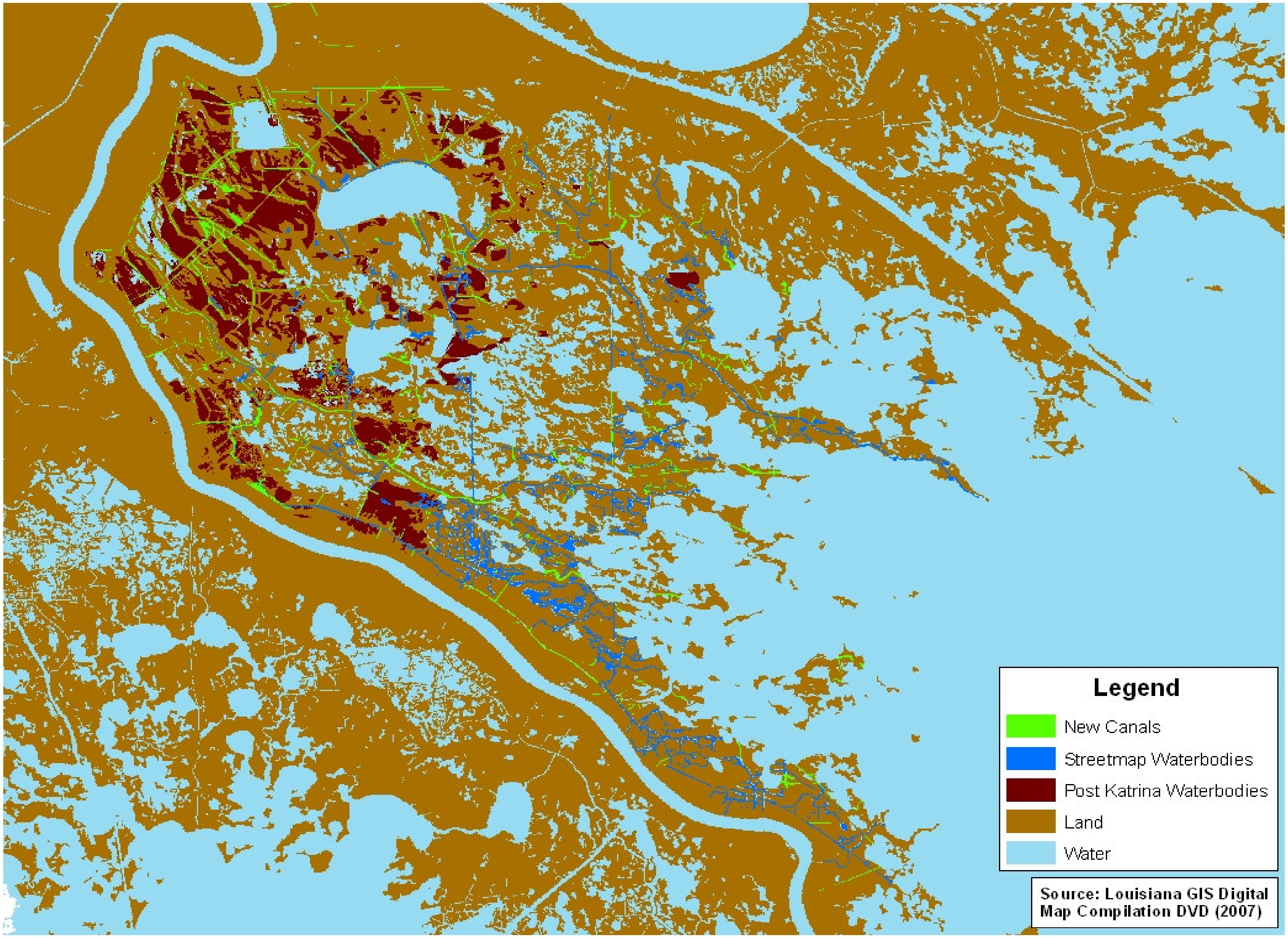


Figure 22a. Final Polygon Set.

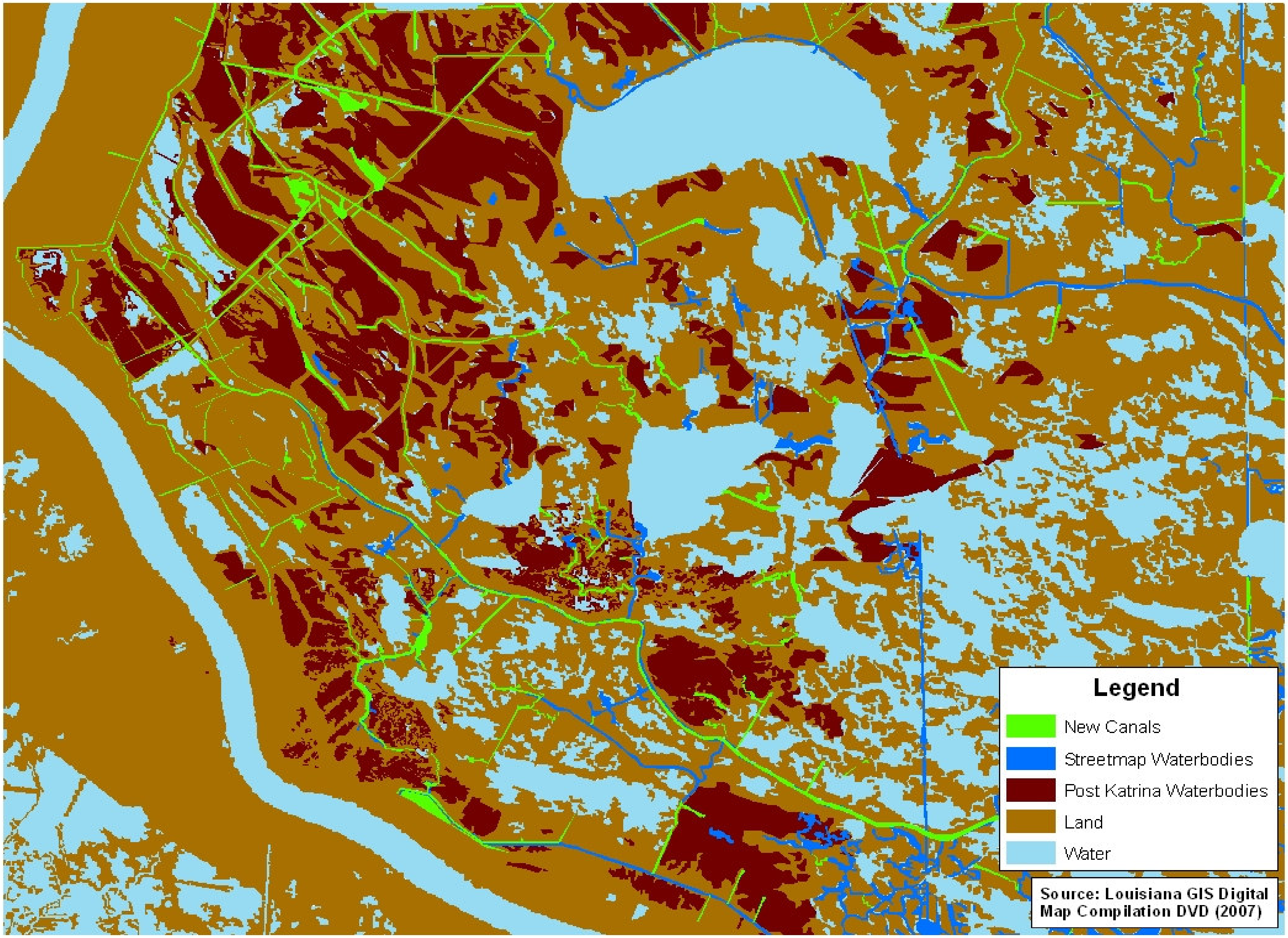


Figure 22b. Final Polygon Set in White Ditch Study Area.

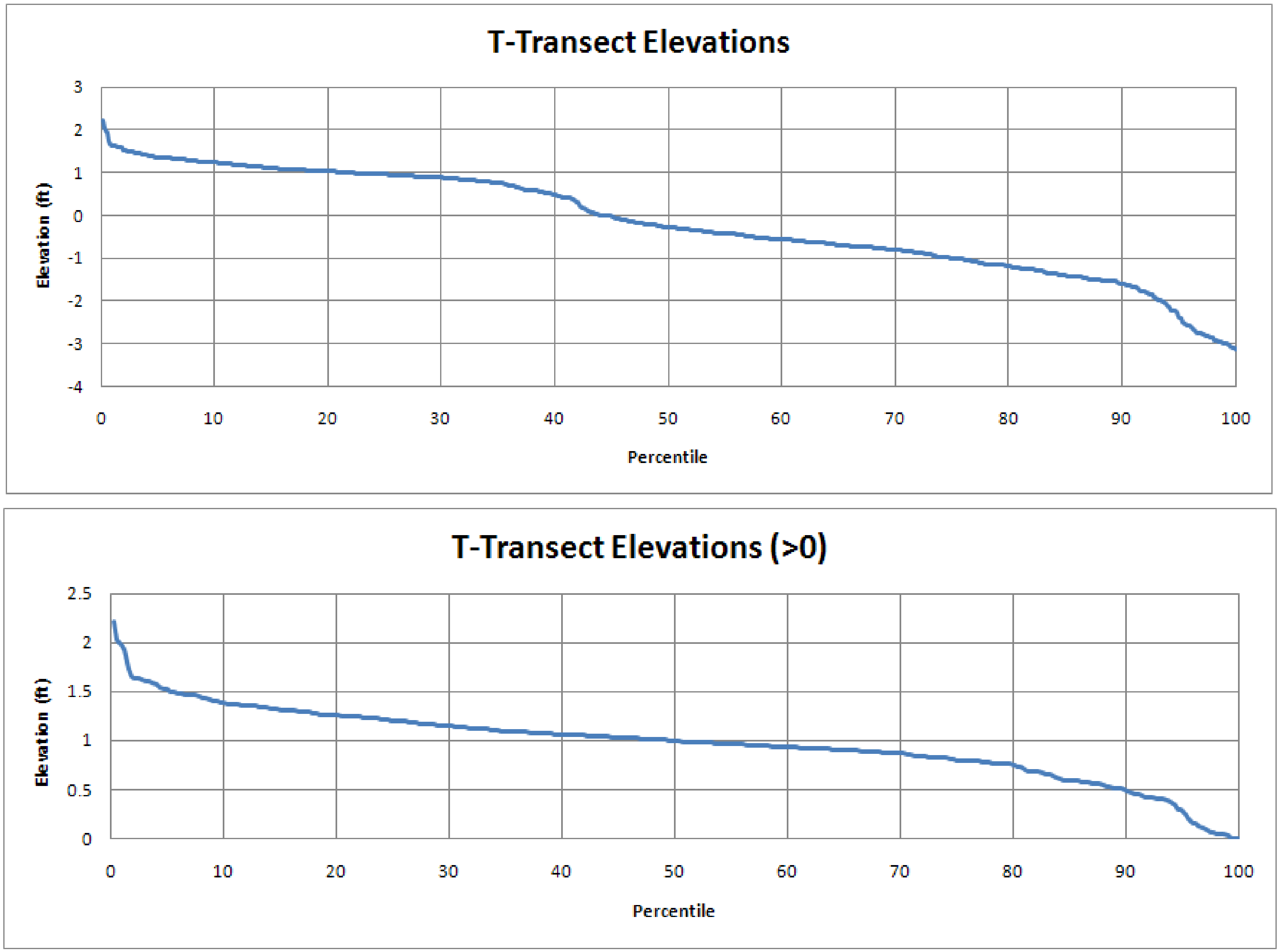


Figure 23. Survey Data Distribution.

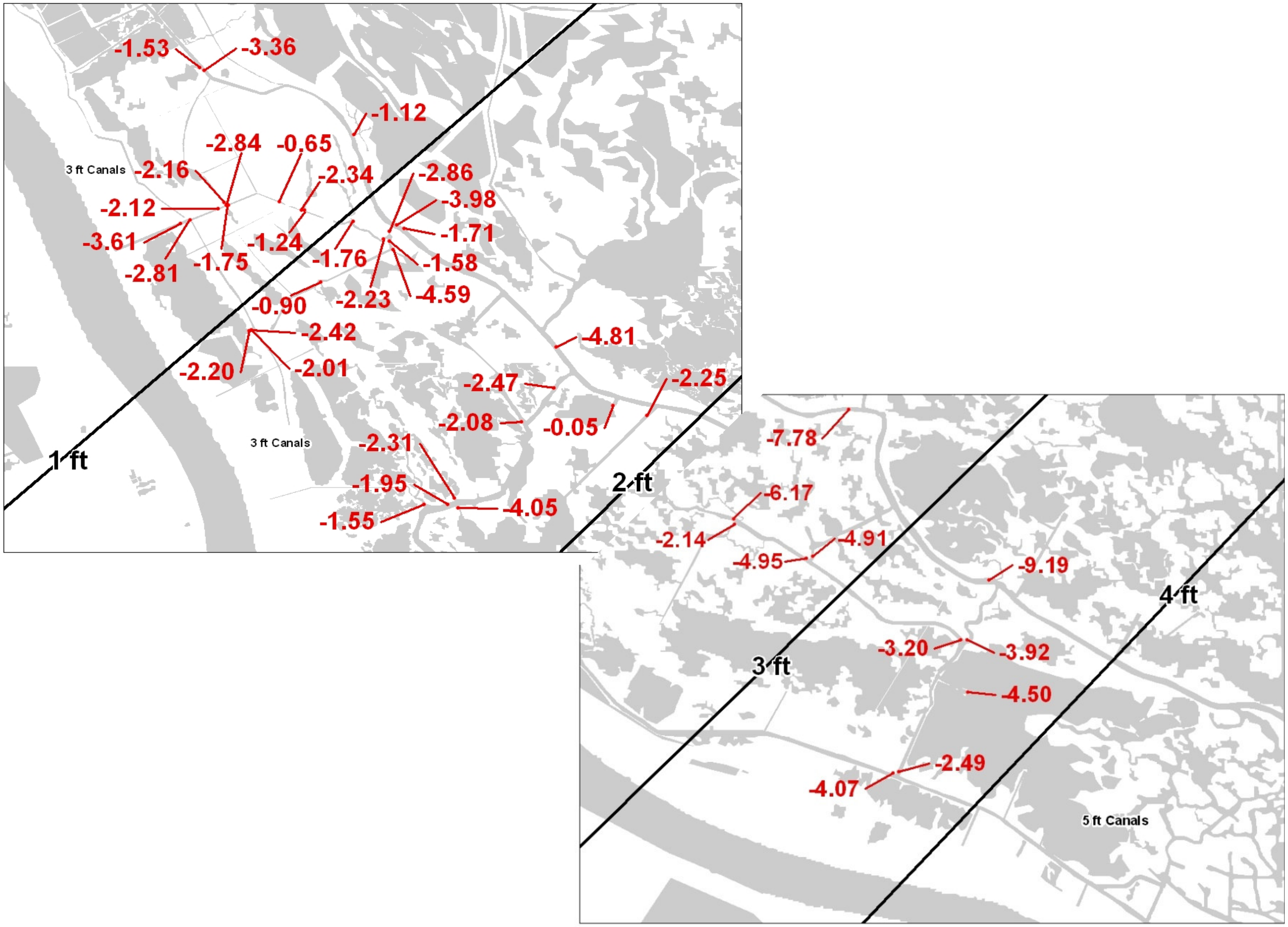


Figure 24. Effective Depths and Locations from Cross-Section Transect Data.

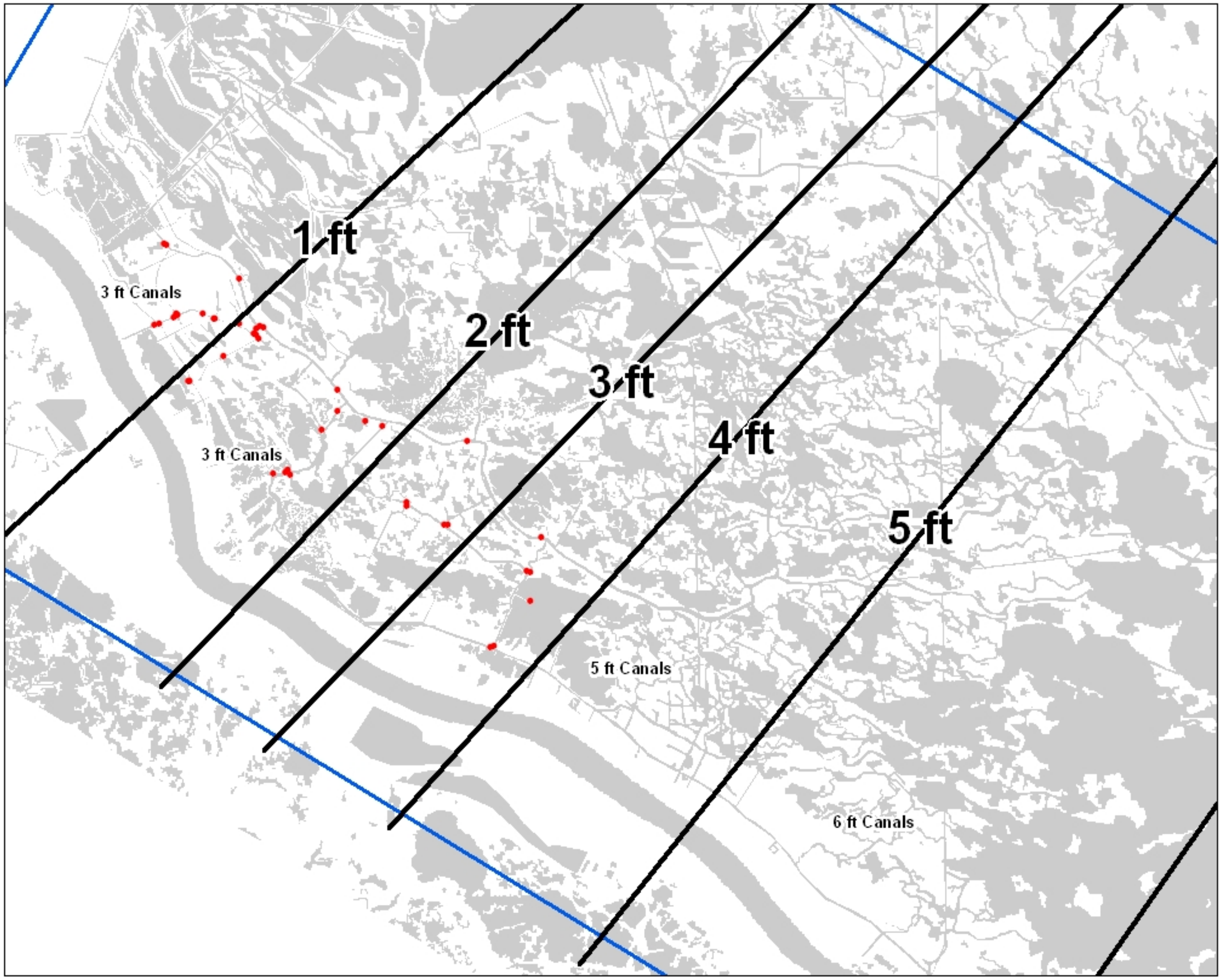


Figure 25. Template of Water Body Depths.

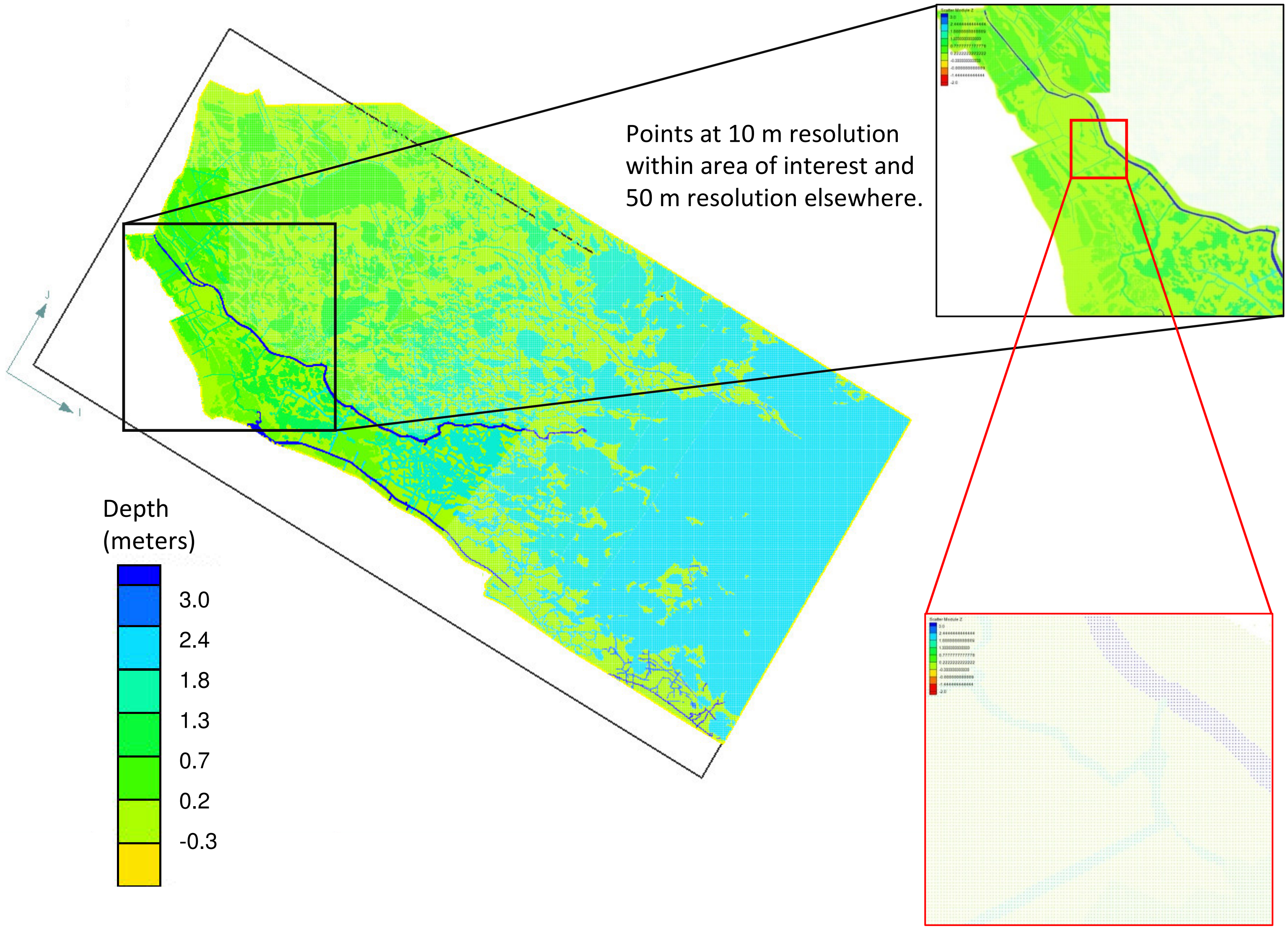


Figure 26. Scatter Set Used for Grid Generation.

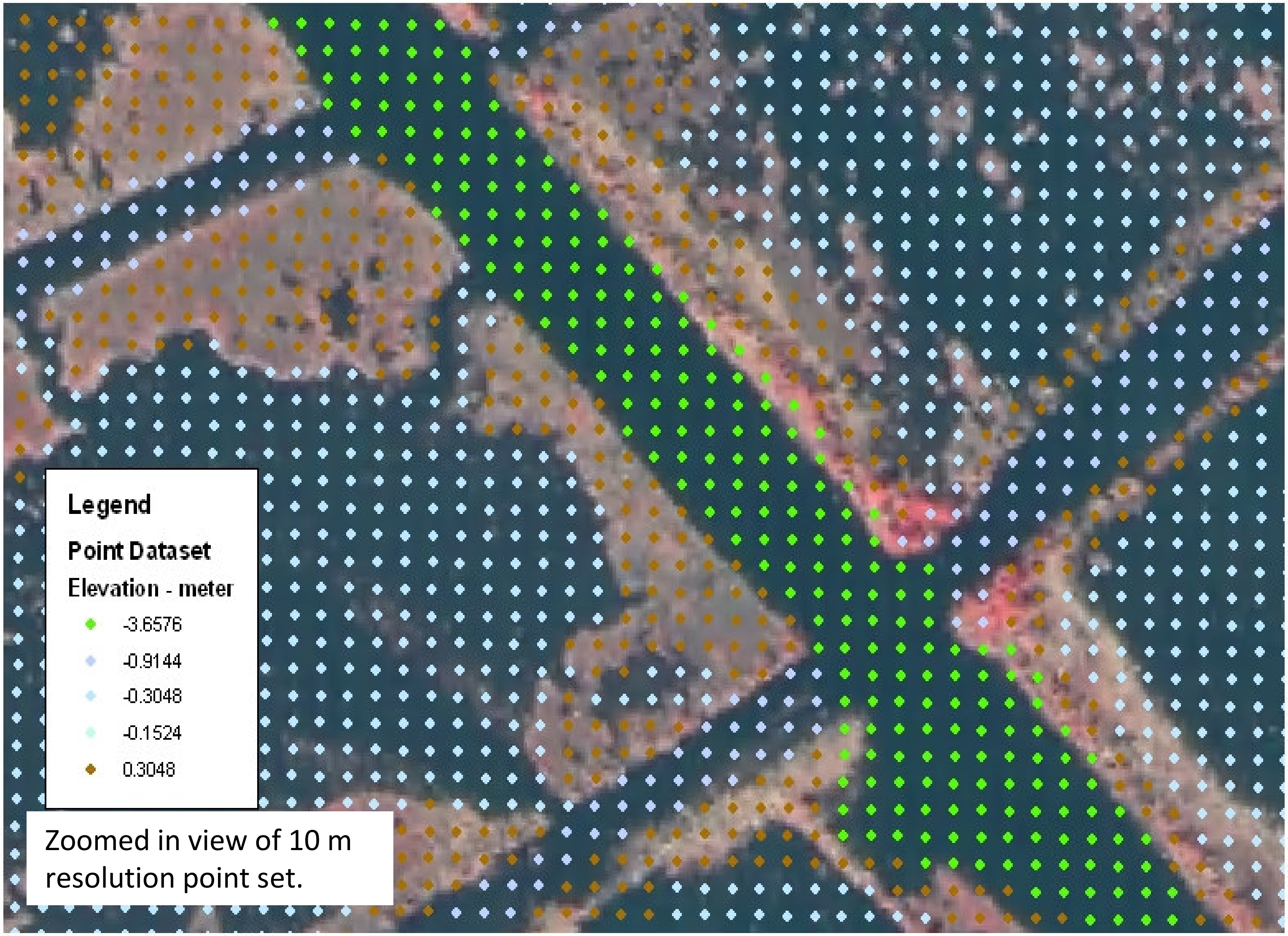


Figure 27. Enlarged Portion of Point Grid Data.

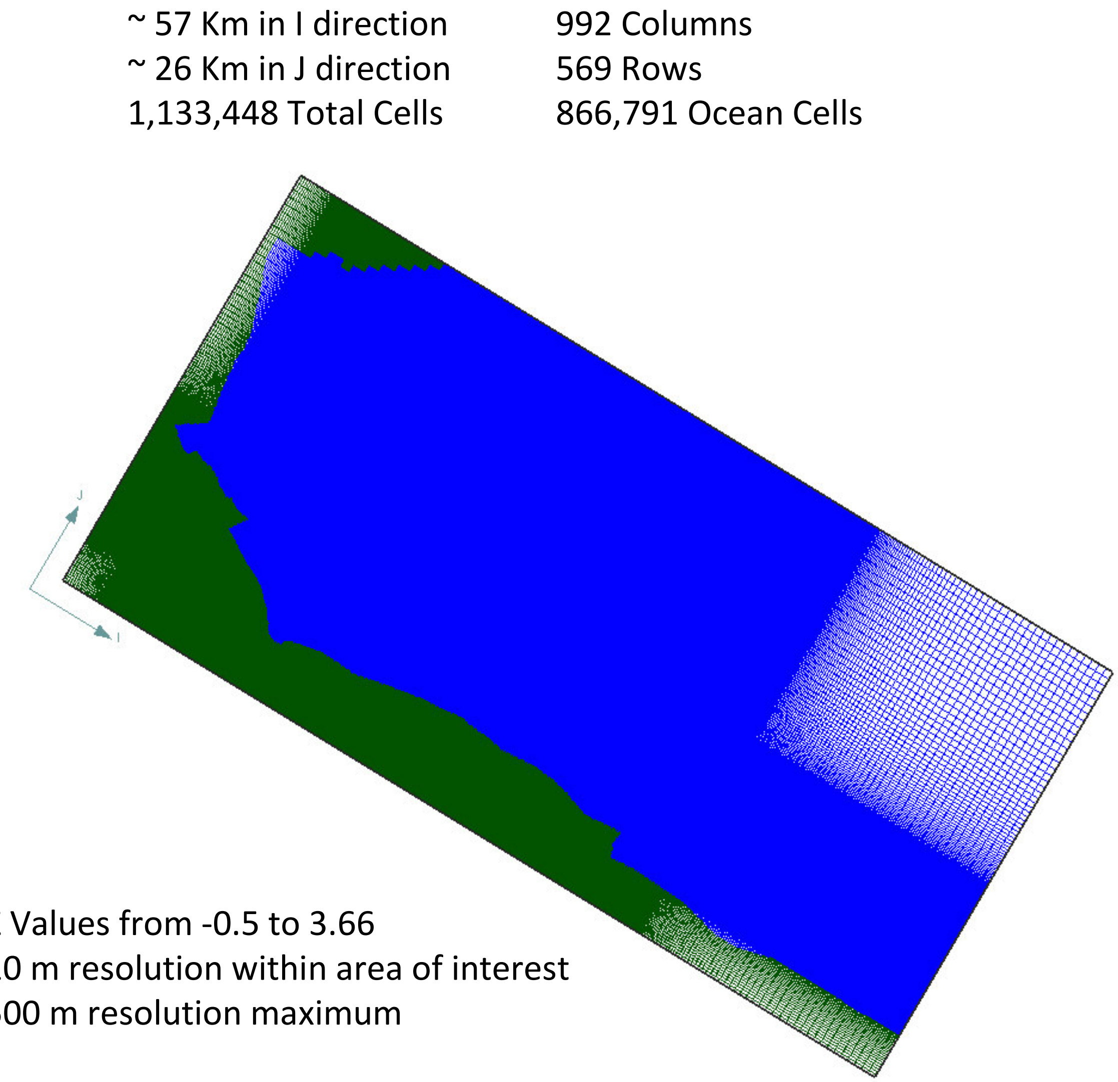


Figure 28. Final Grid and Grid Information.

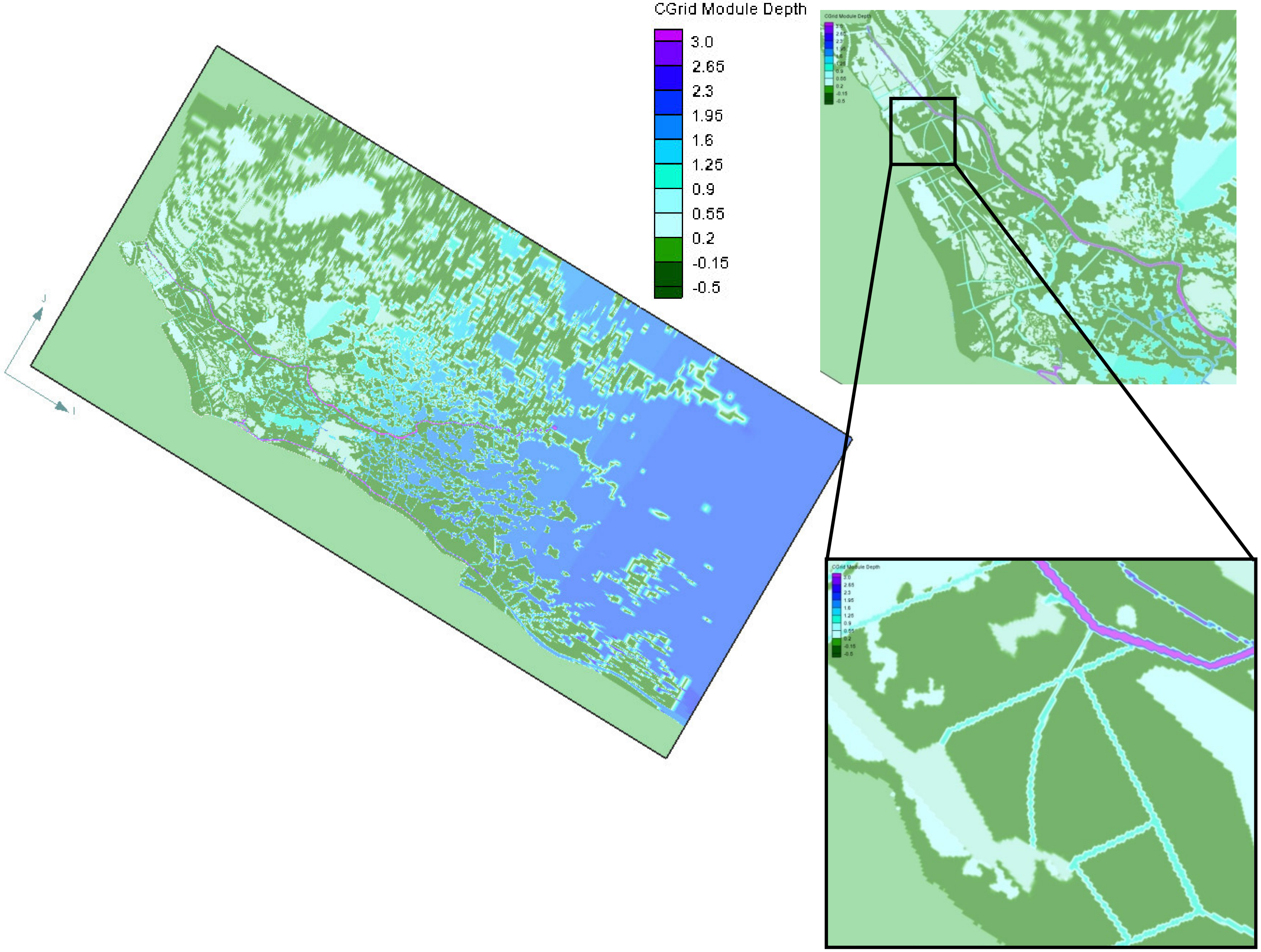


Figure 29. Depth Contours.

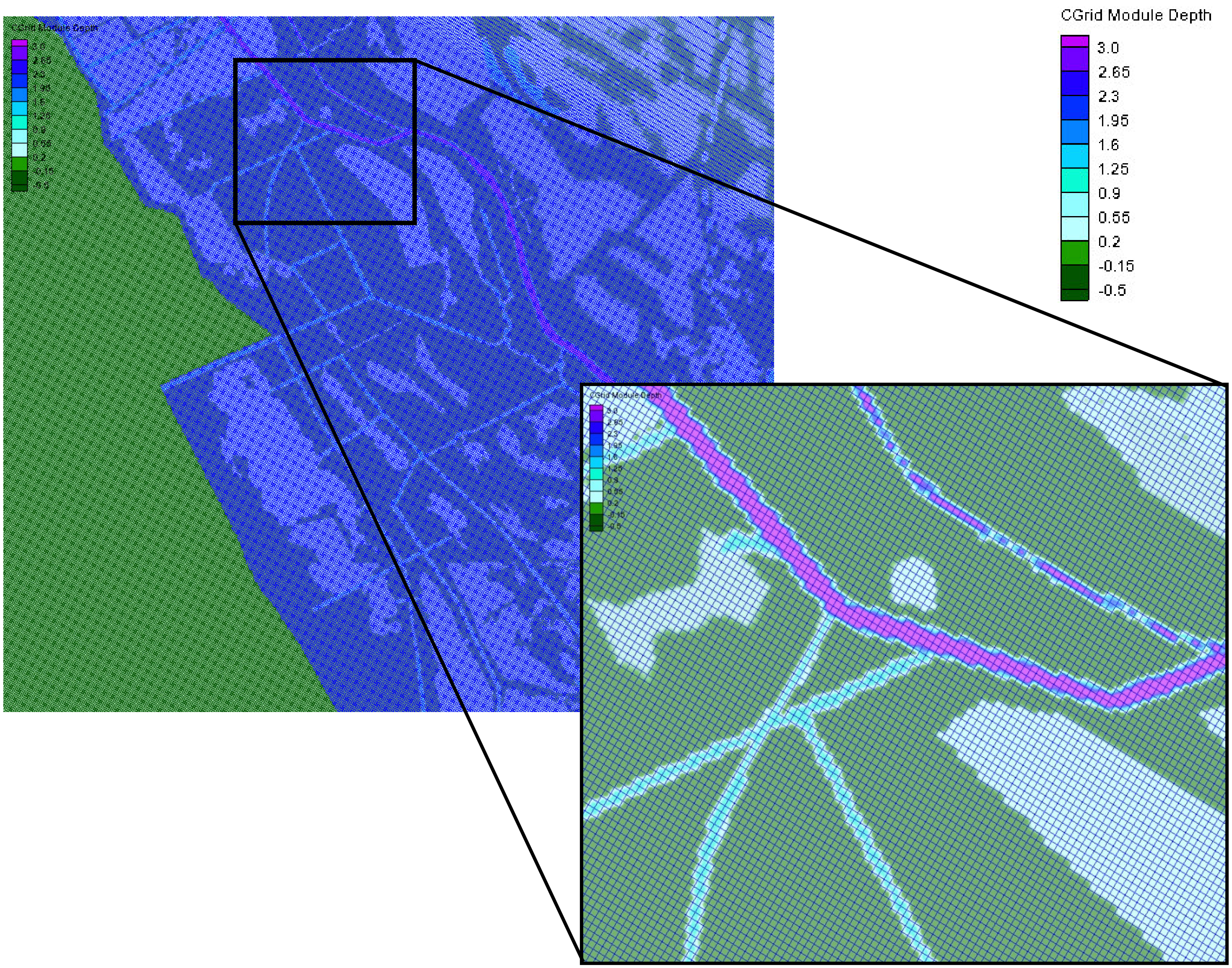


Figure 30. Grid Cell Resolution in area of interest (top) and showing number of cells in canals and rivers (right).

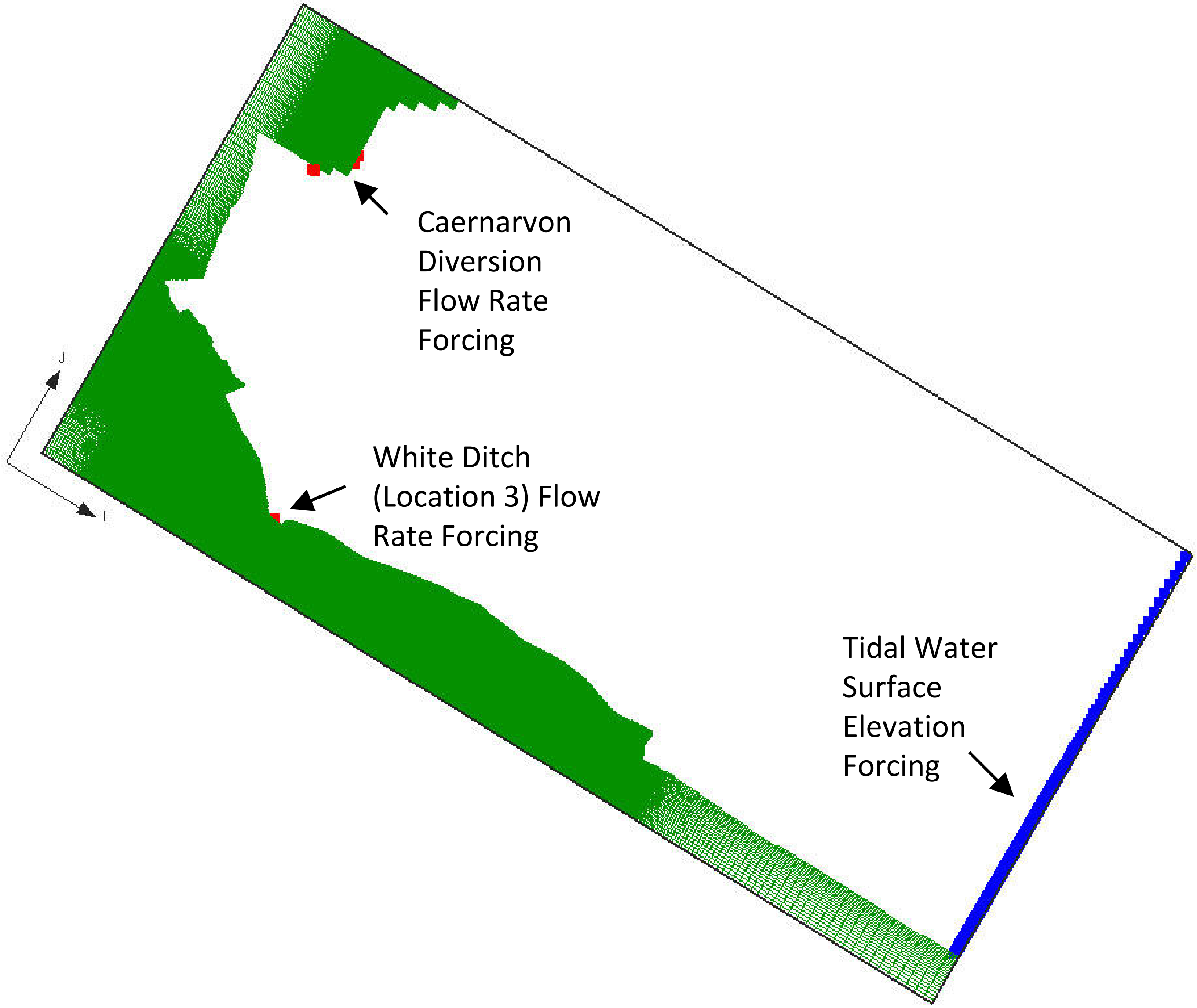


Figure 31. Grid with Boundary Cellstring Locations.

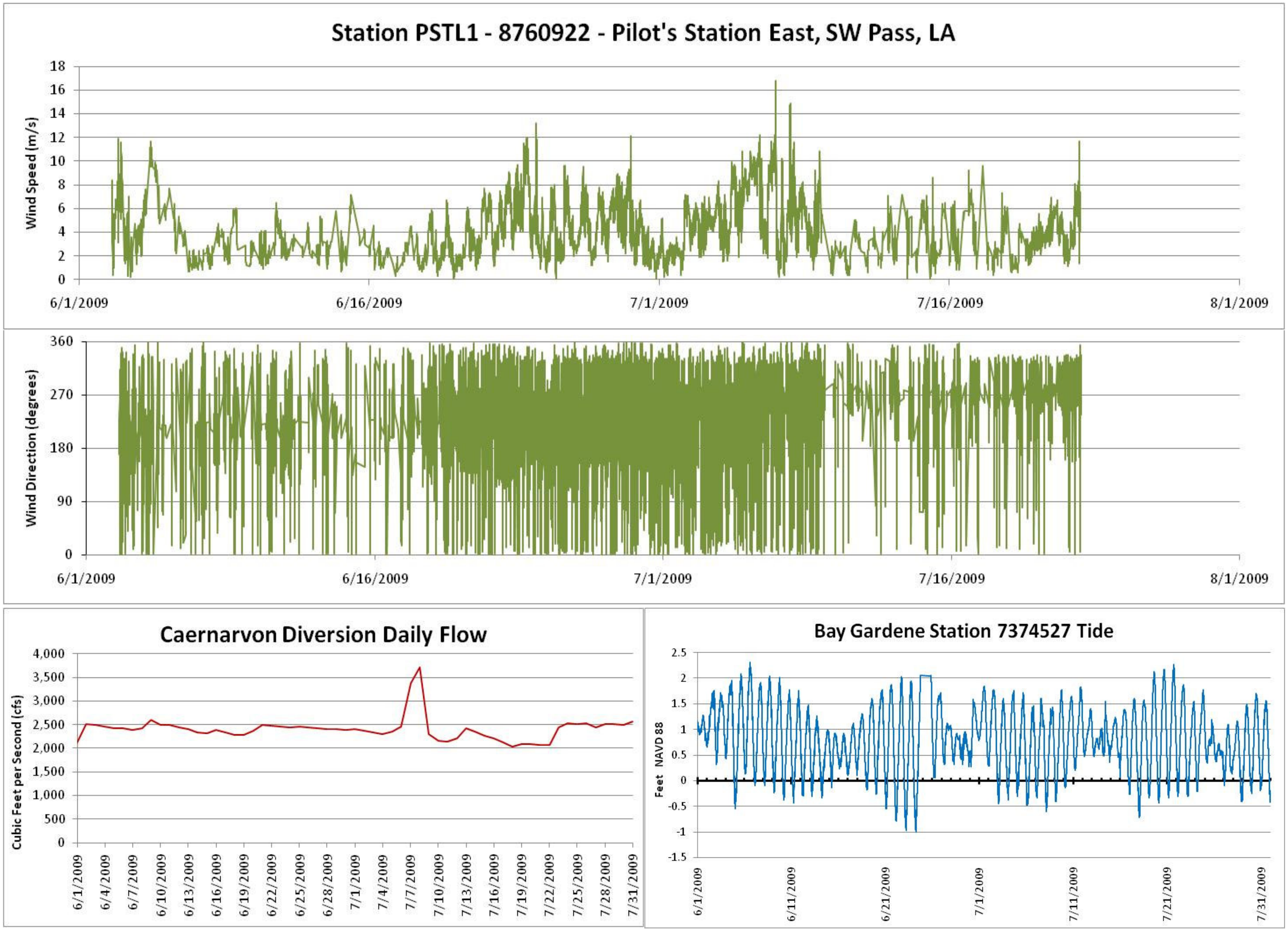


Figure 32. Boundary Input Data.

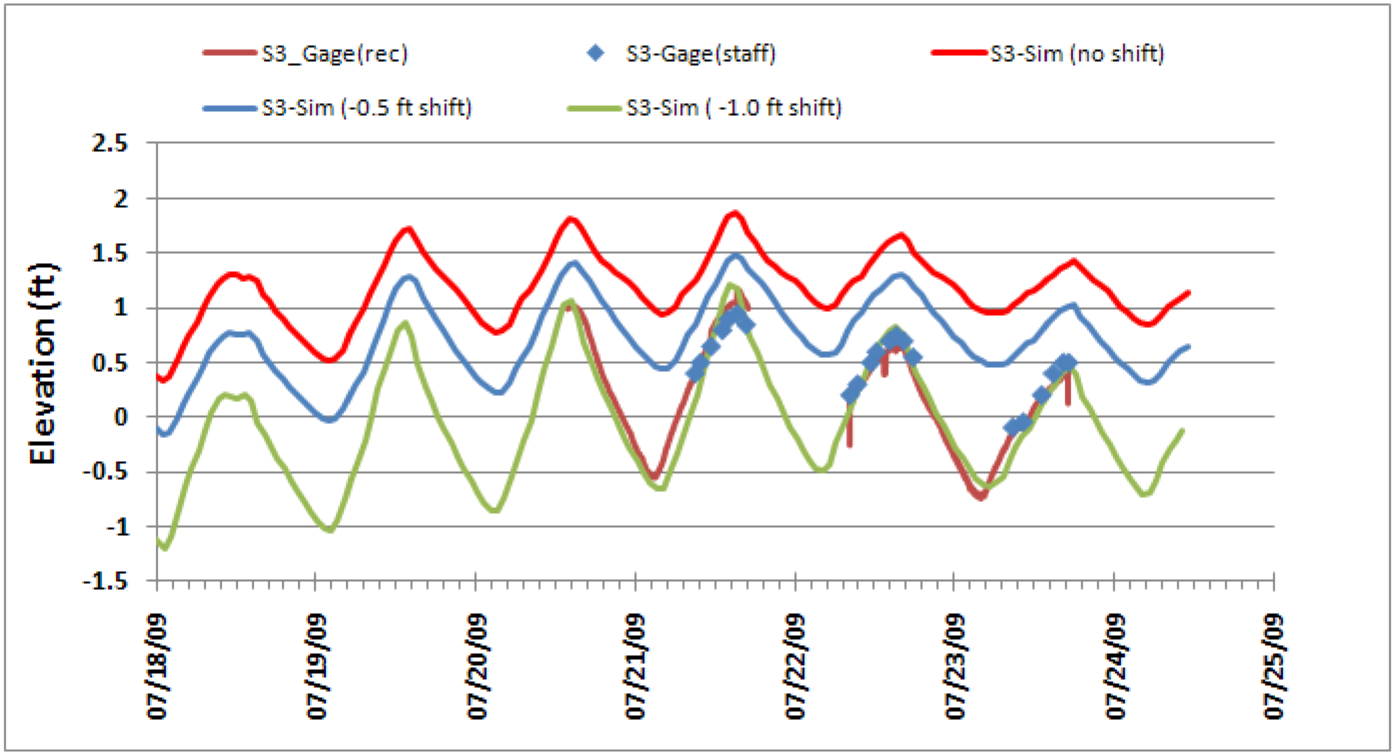


Figure 33. Sensitivity of the Tide Calibration to the Datum Shifts in the Bay Gardene Stage Data.

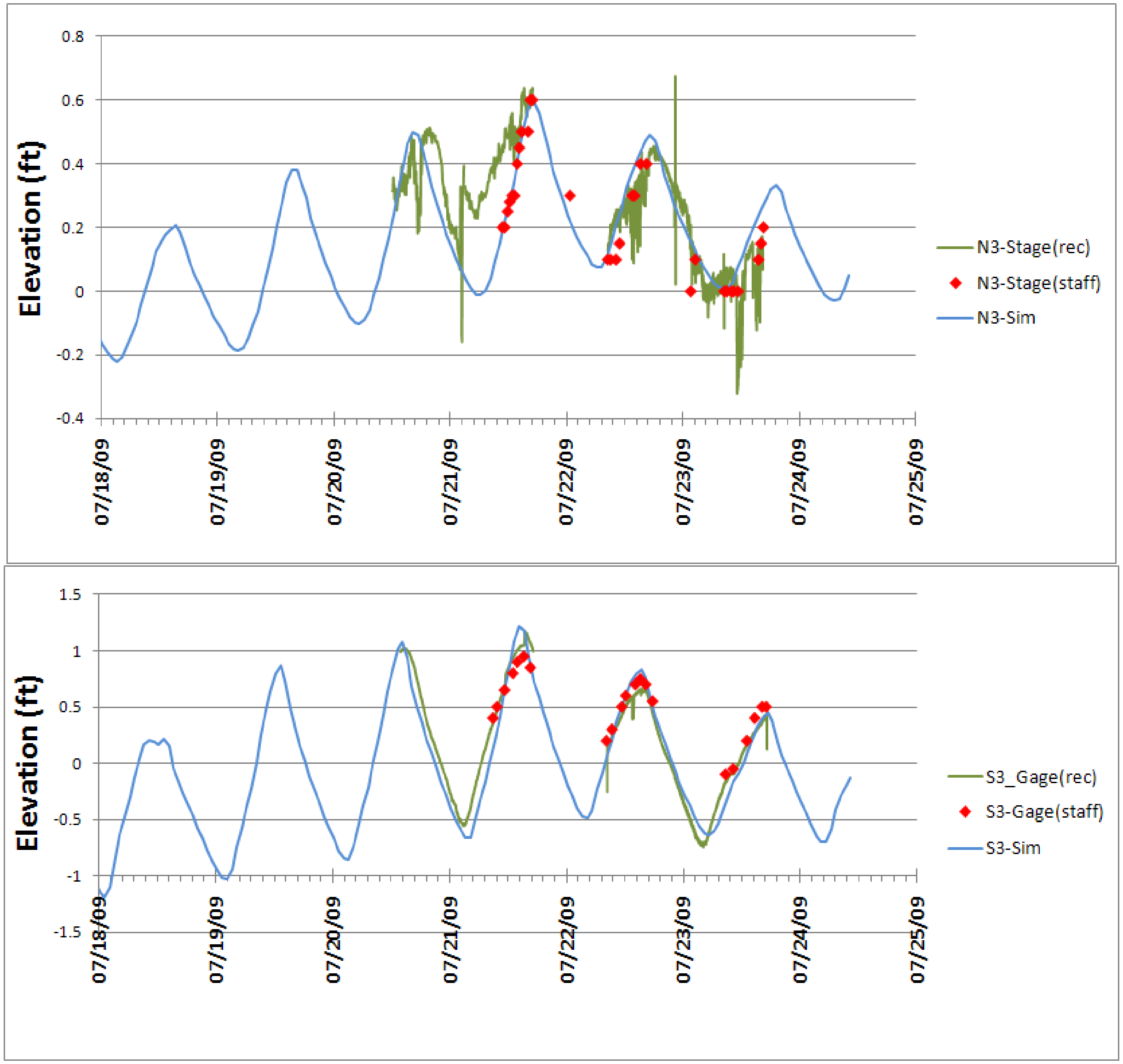


Figure 34. Final Stage Calibration.

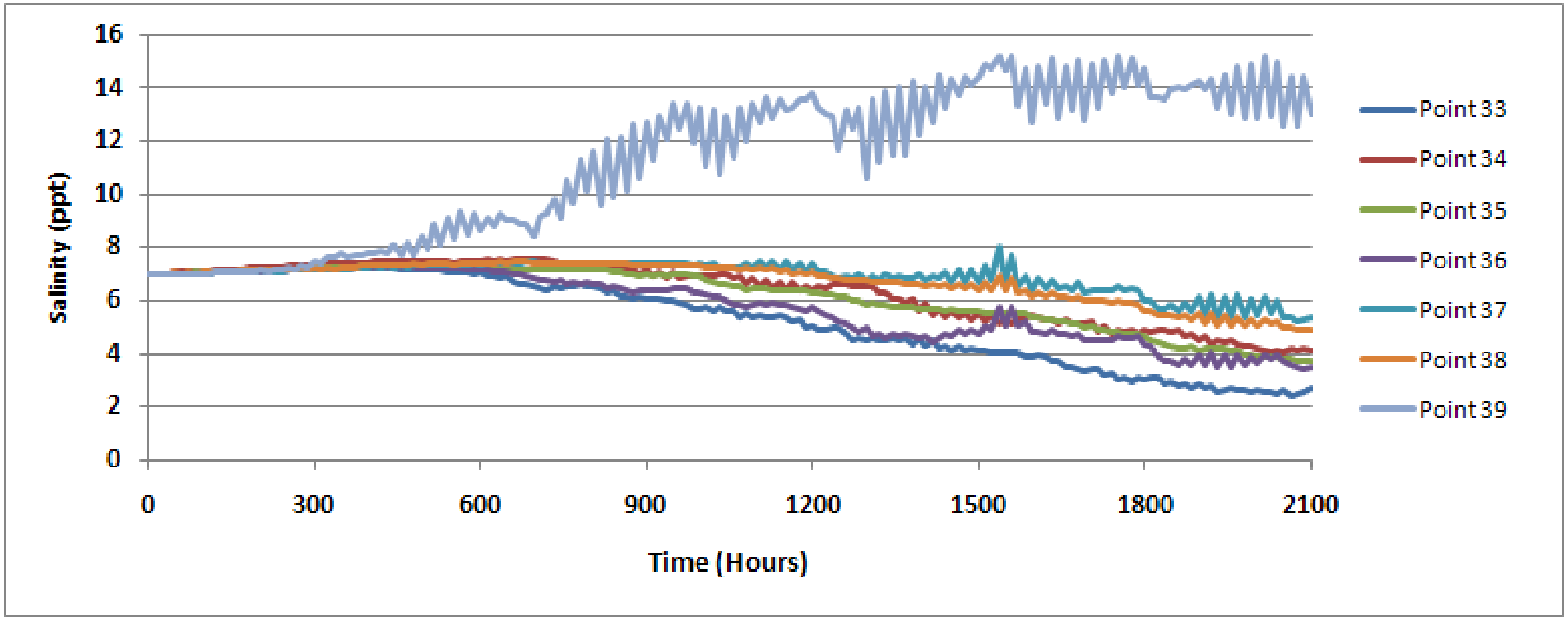


Figure 35. Typical Response of Salinity During a Calibration Simulation (Point locations are shown on Figure 36).

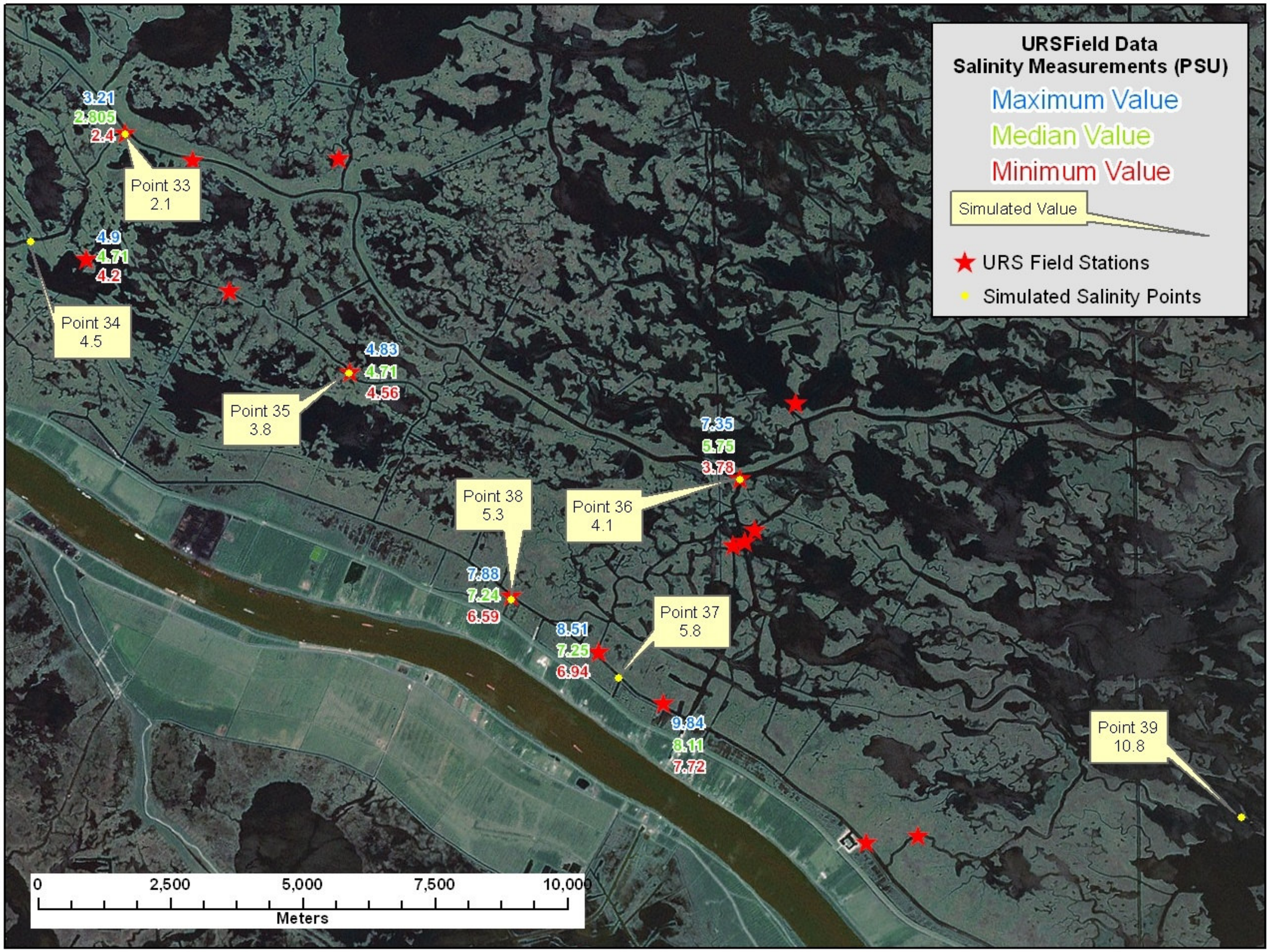


Figure 36. Final Salinity Calibration (all values in ppt).

Figure 37. Location 2.

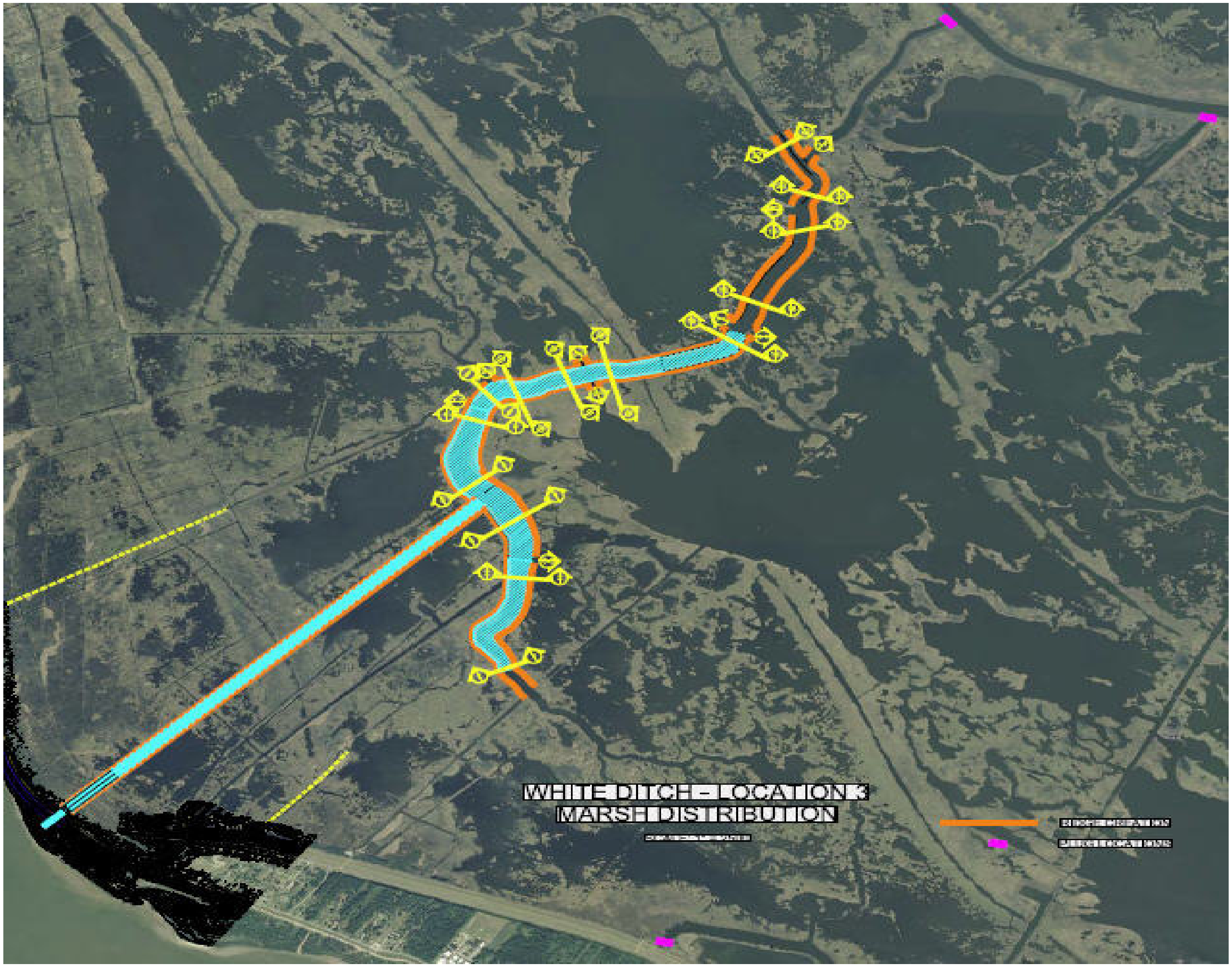


Figure 38. Location 3.

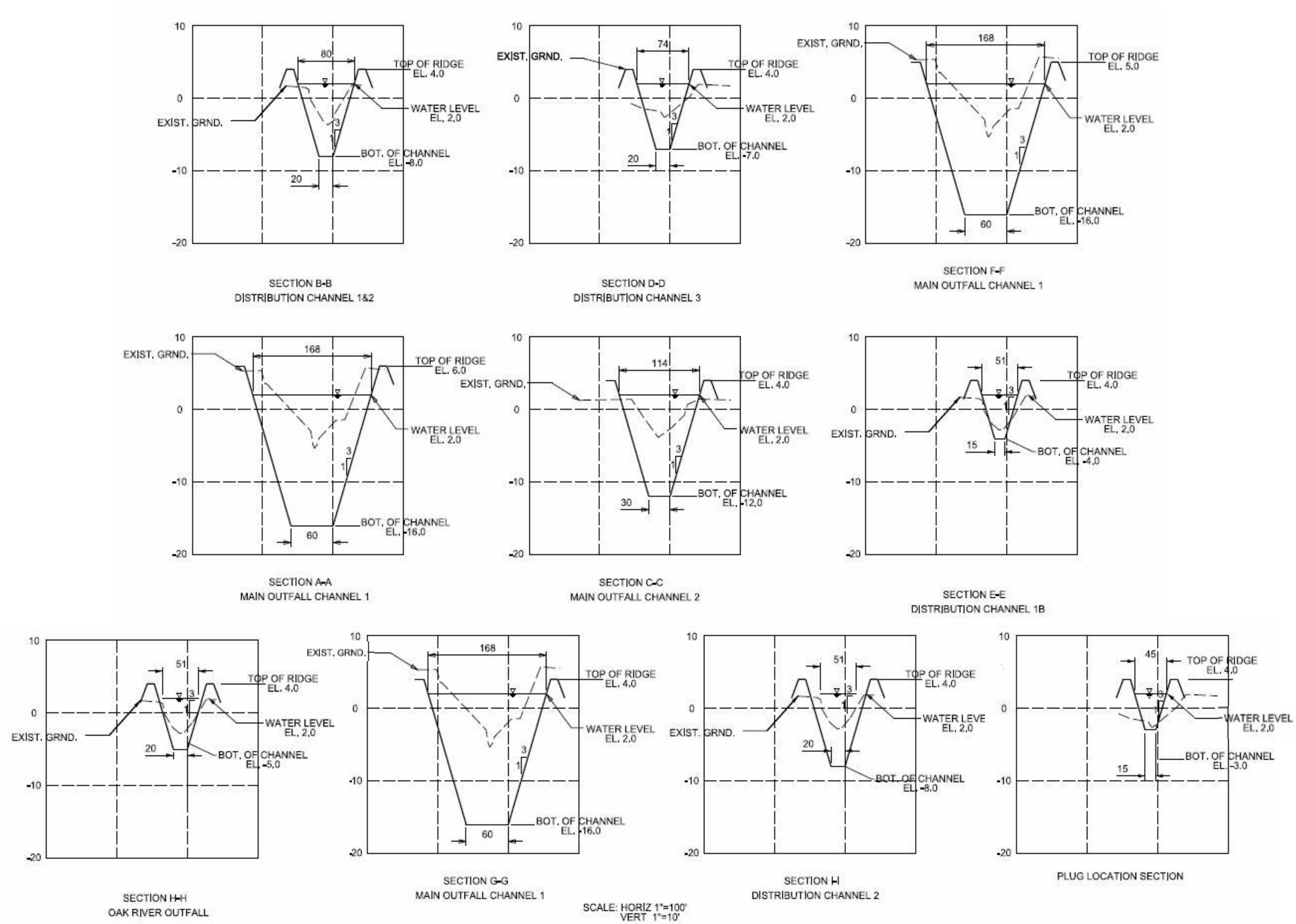


Figure 39. Location 2 5000 cfs Capacity Cross-Sections.

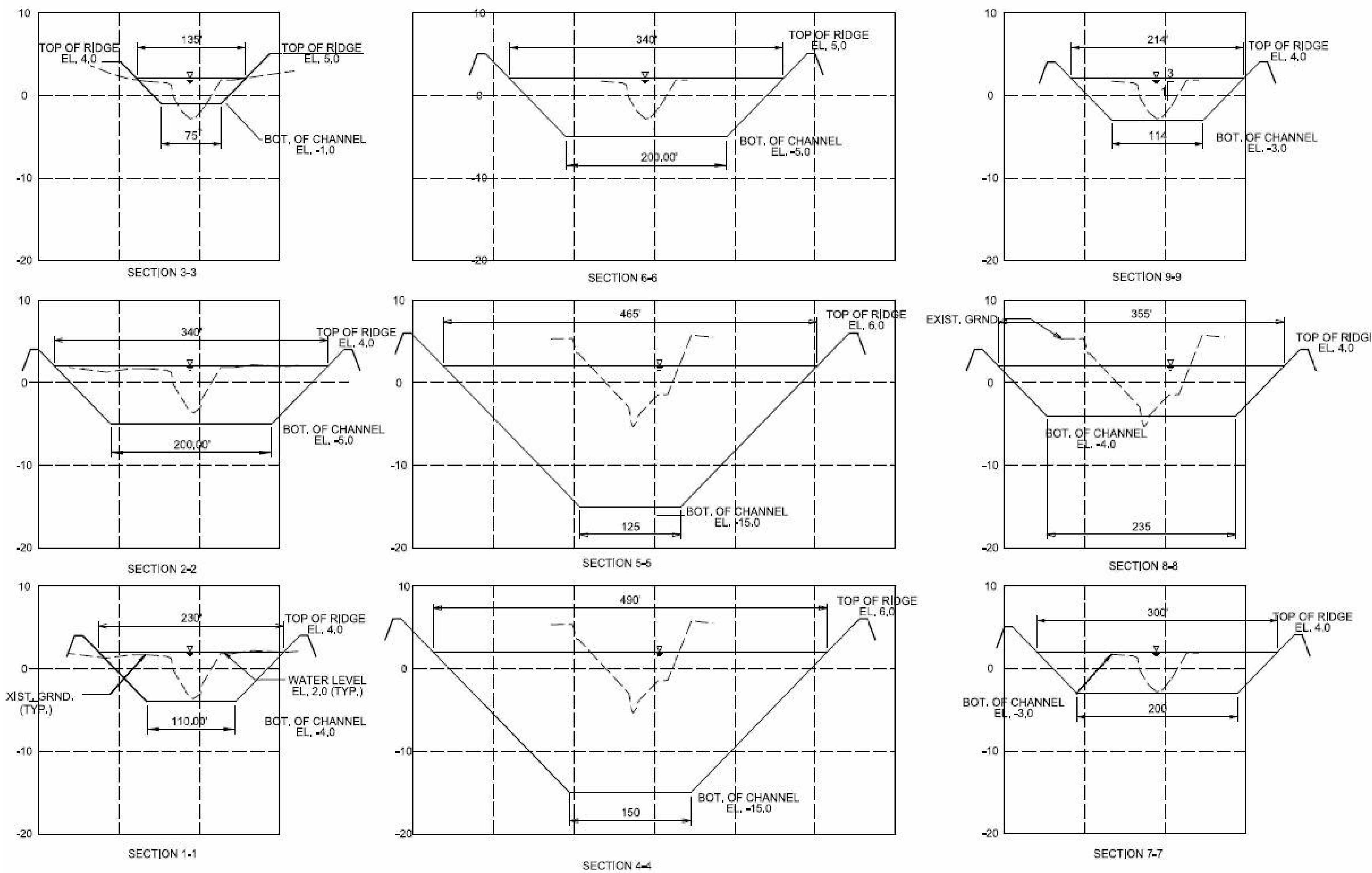


Figure 40a. Location 3 5000 cfs Capacity Cross-Sections.

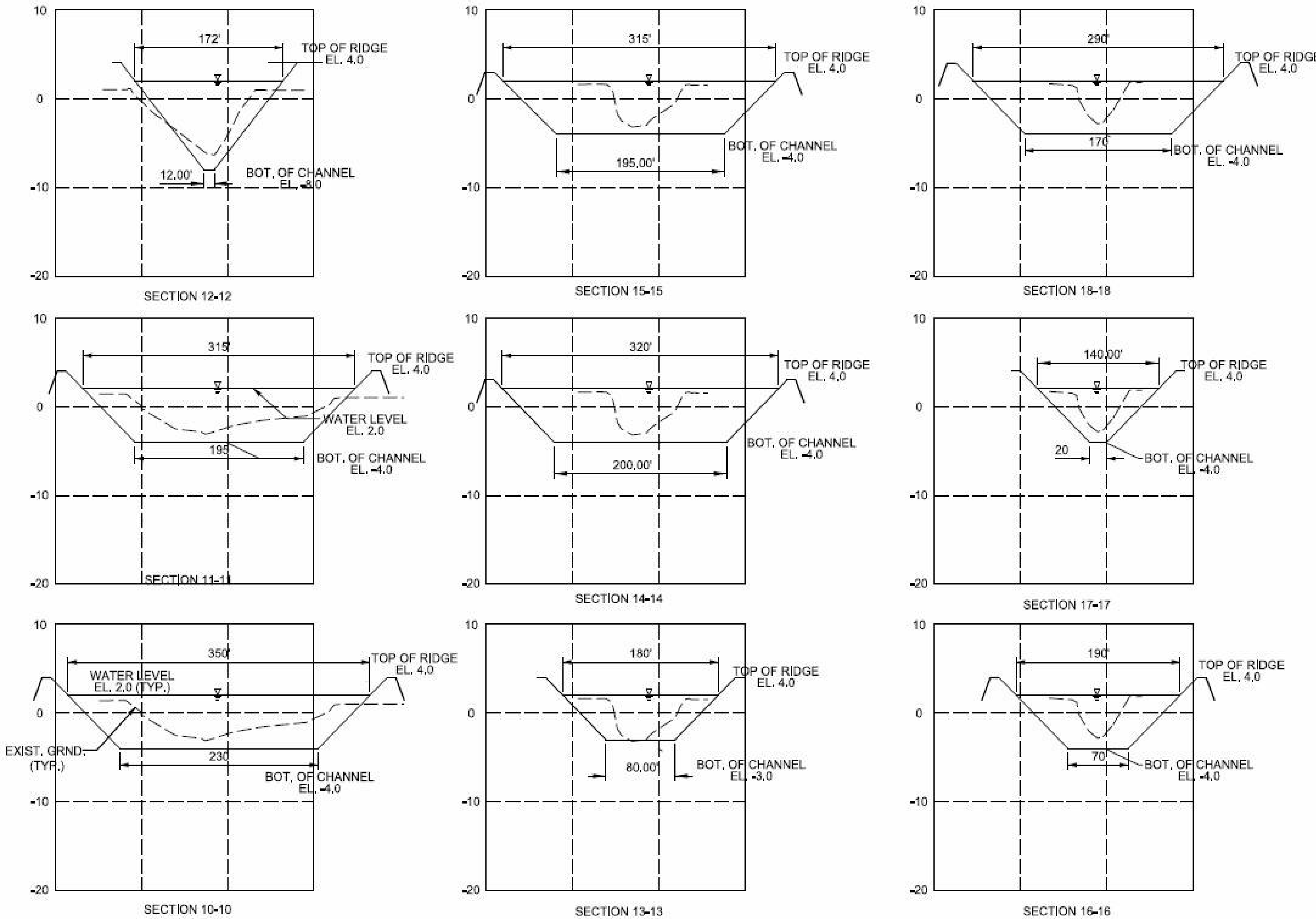


Figure 40b. Location 3 5000 cfs Capacity Cross-Sections.

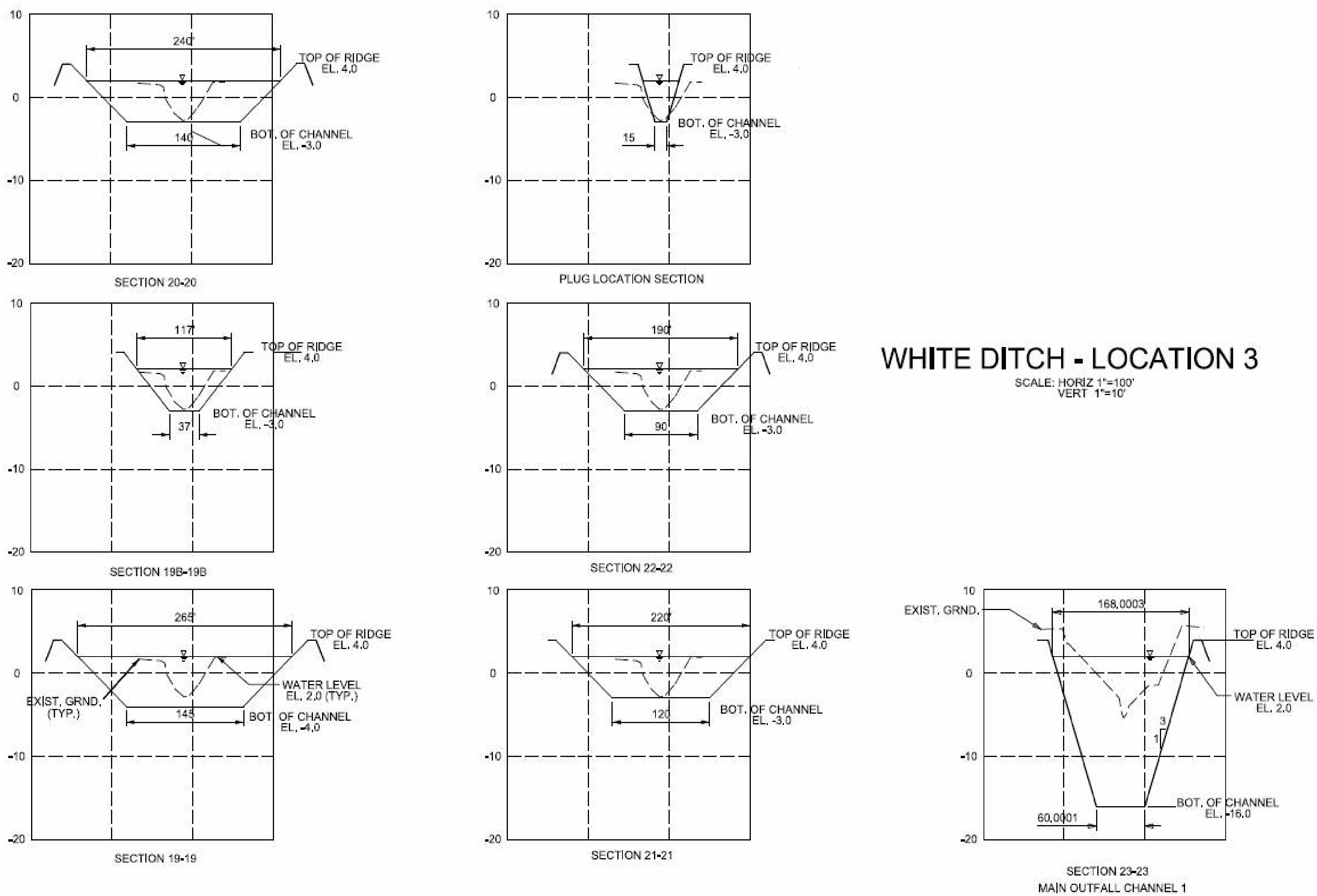


Figure 40c. Location 3 5000 cfs Capacity Cross-Sections.

Figure 41. 35,000 cfs Capacity Alternative 2 Depth Contours.

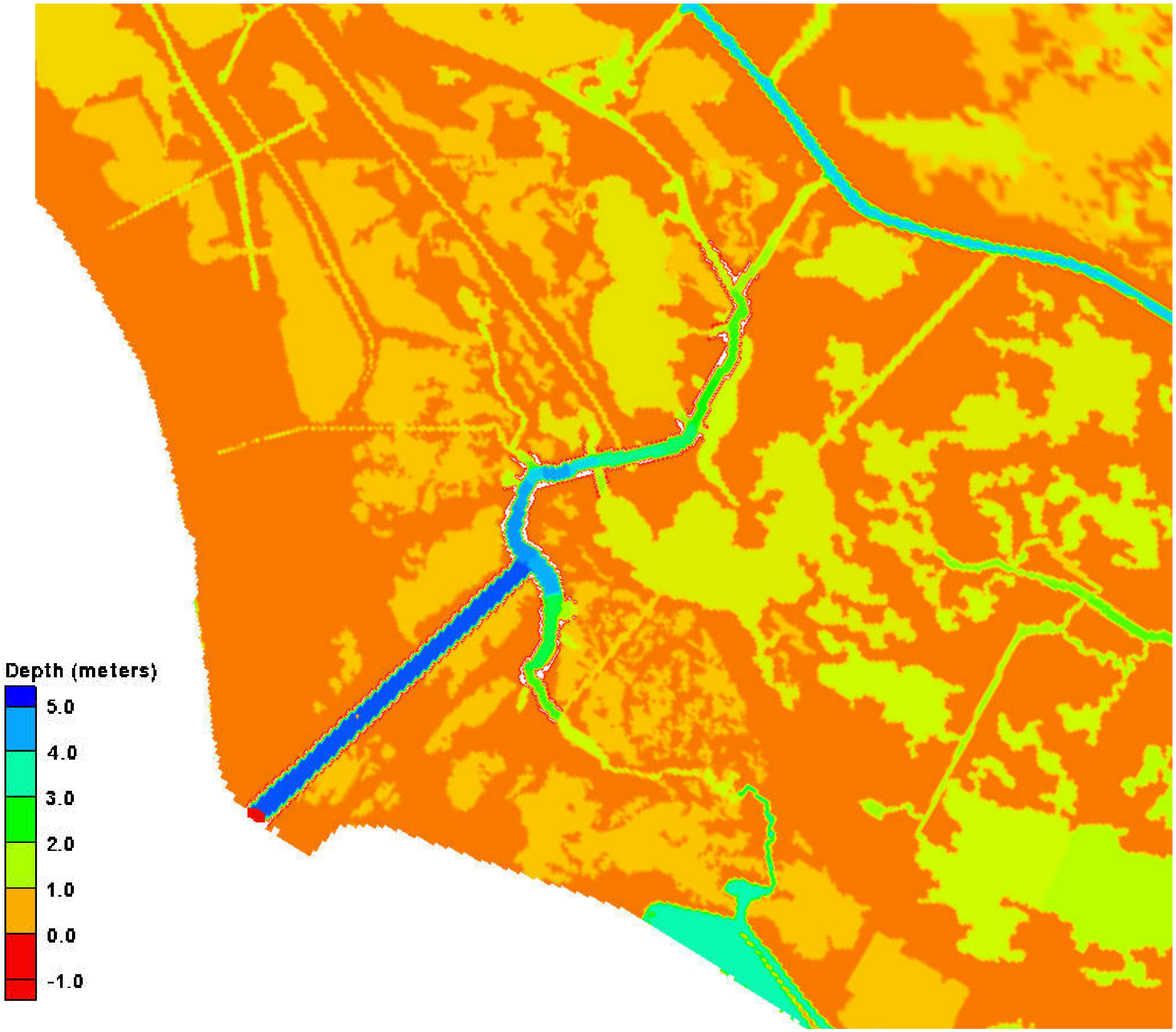


Figure 42. 35,000 cfs Capacity Alternative 3 Depth Contours.

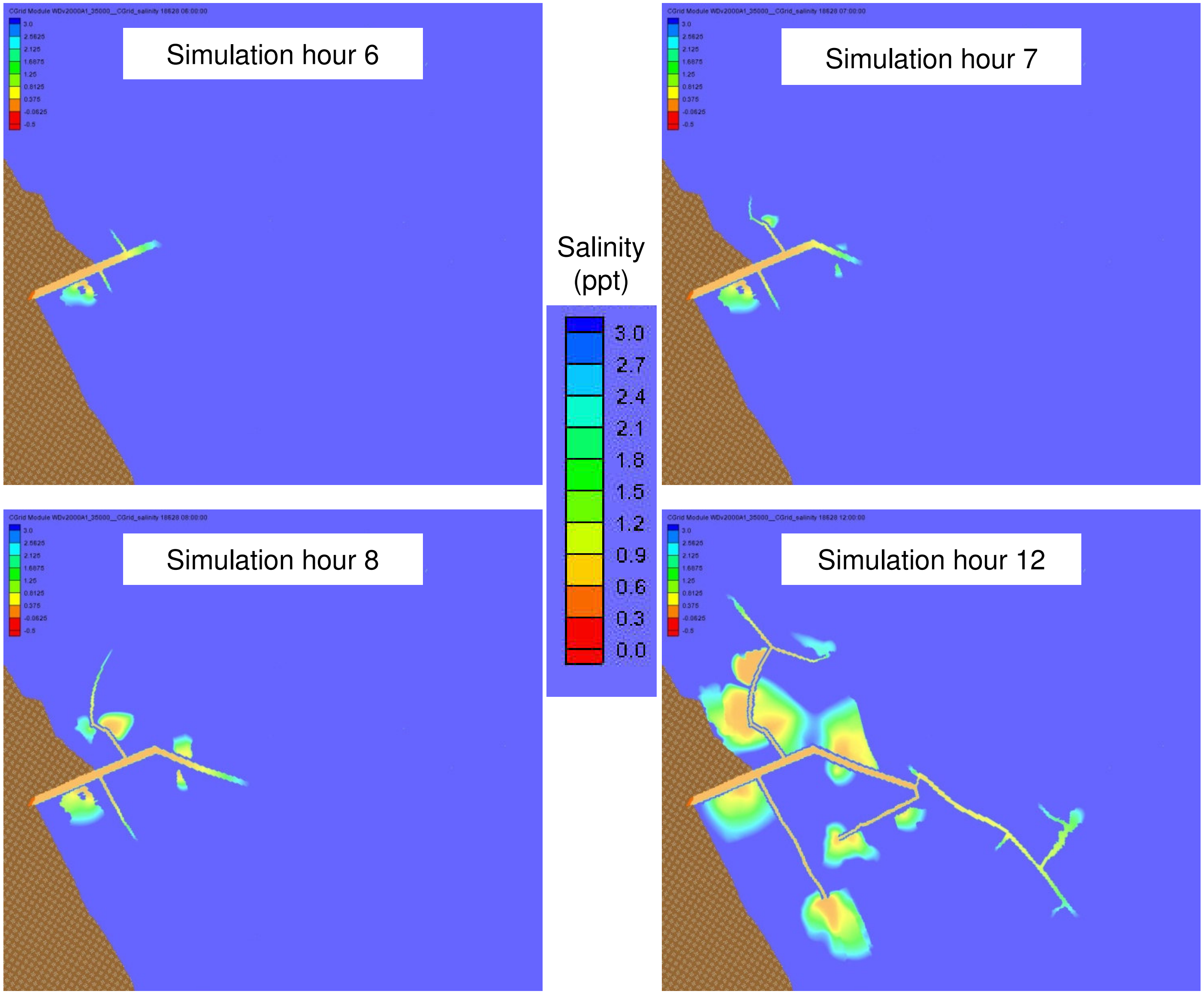


Figure 43. Sequence of Salinity Distributions at Location 2 with 35,000 cfs Capacity Grid.

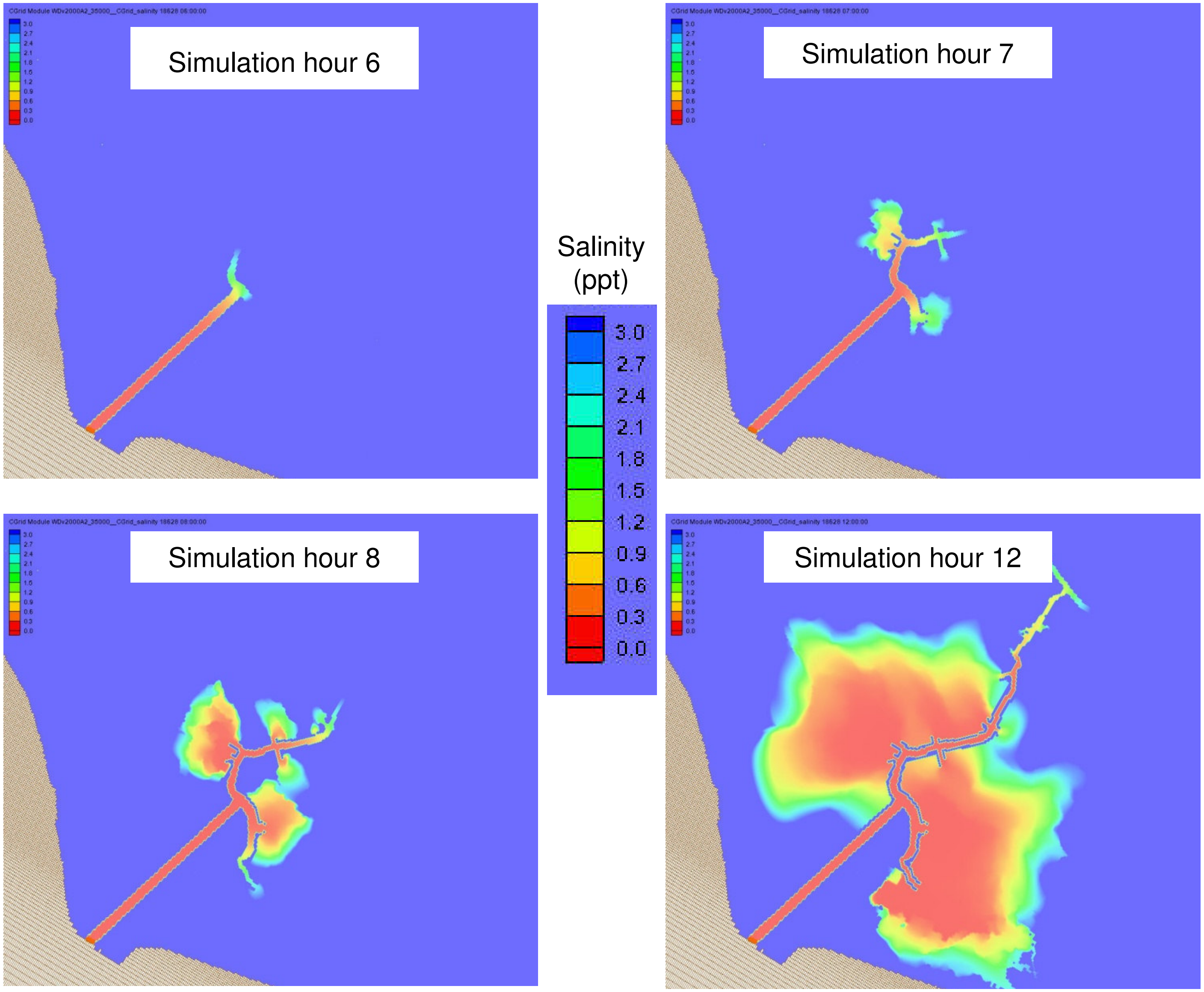


Figure 44. Sequence of Salinity Distributions at Location 3 with 35,000 cfs Capacity Grid.

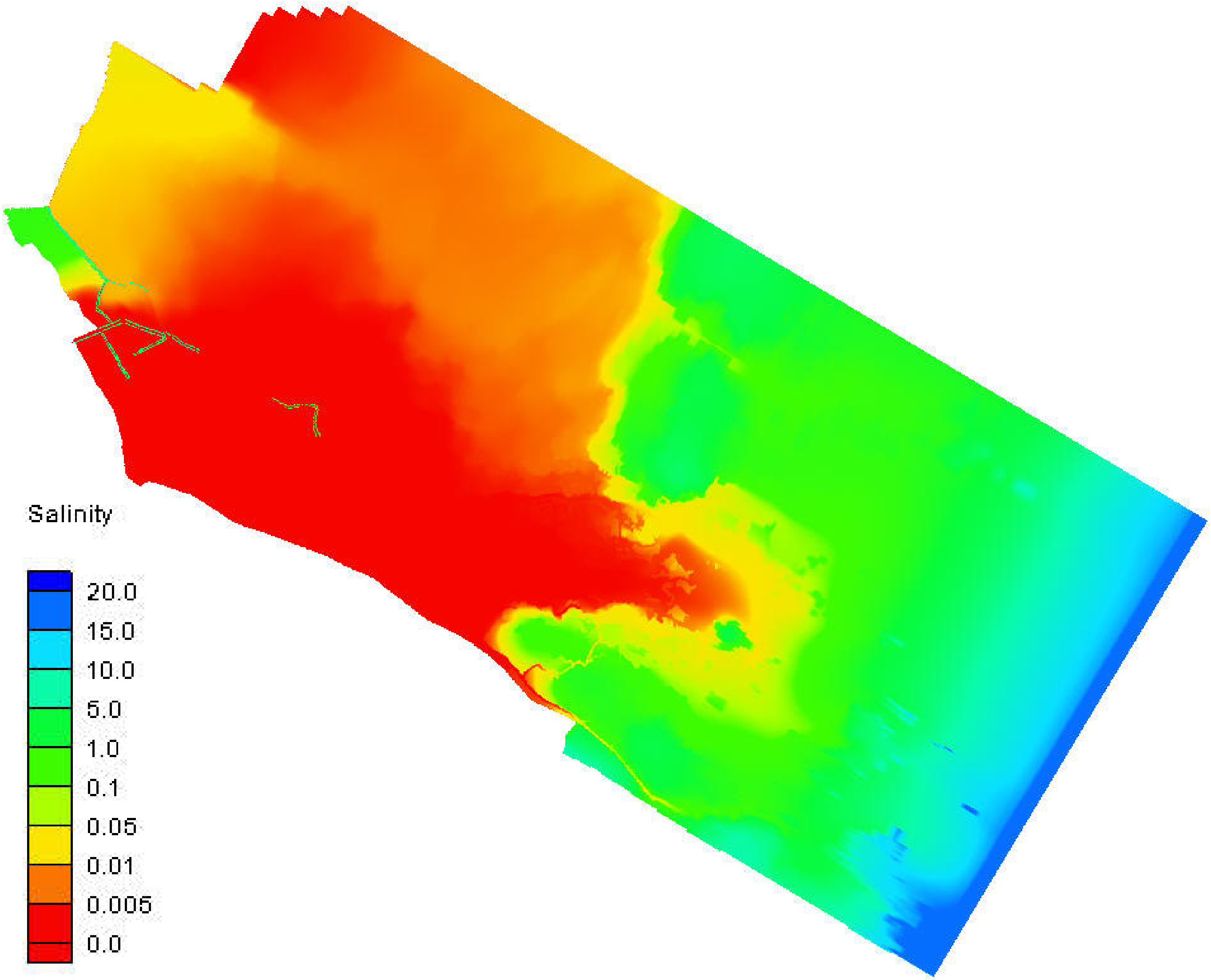


Figure 45. Time-averaged Salinities for Final 7 days of the Simulation at Location 2.

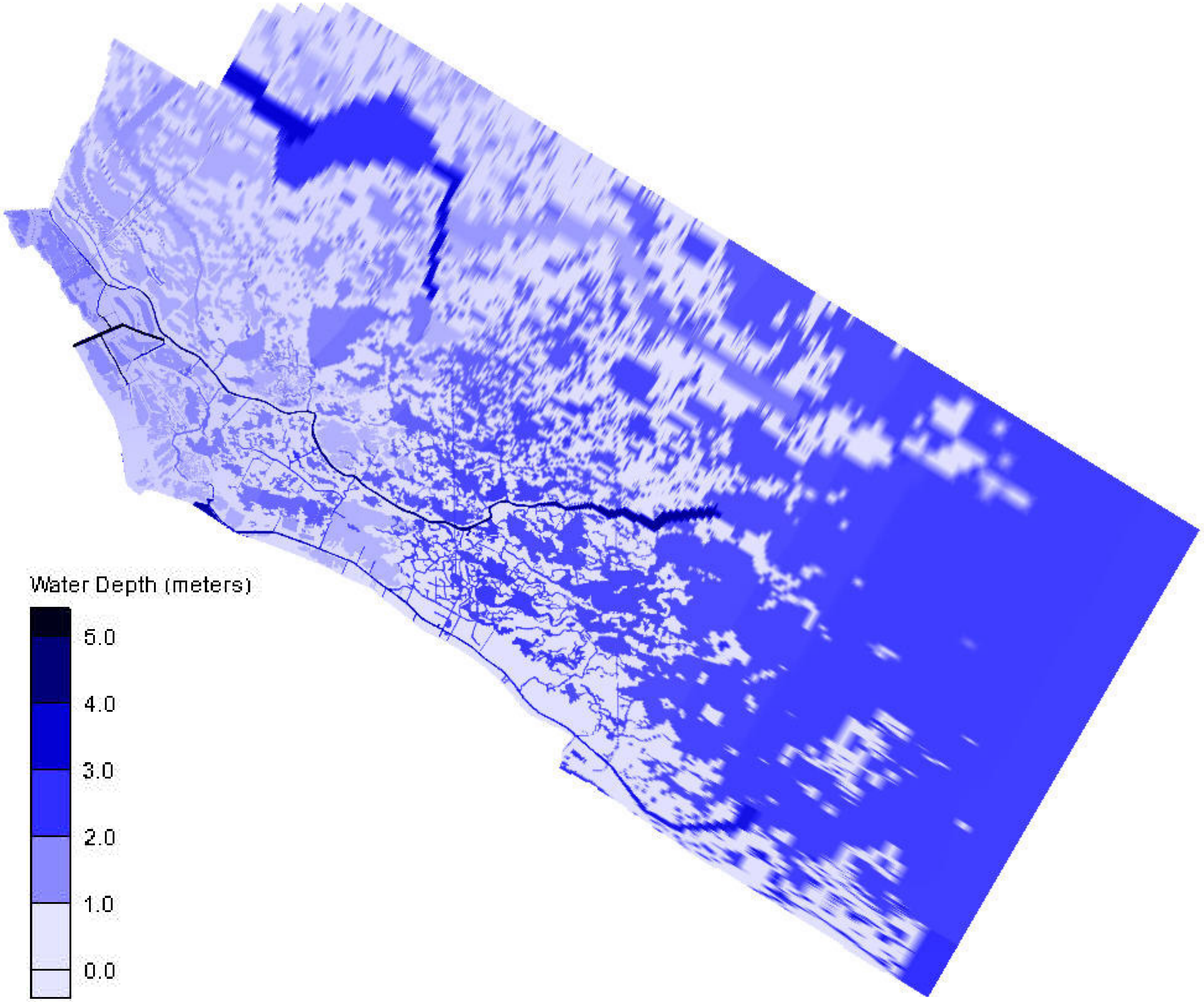


Figure 46. Time-averaged Water Depths for Final 7 days of the Simulation at Location 2.

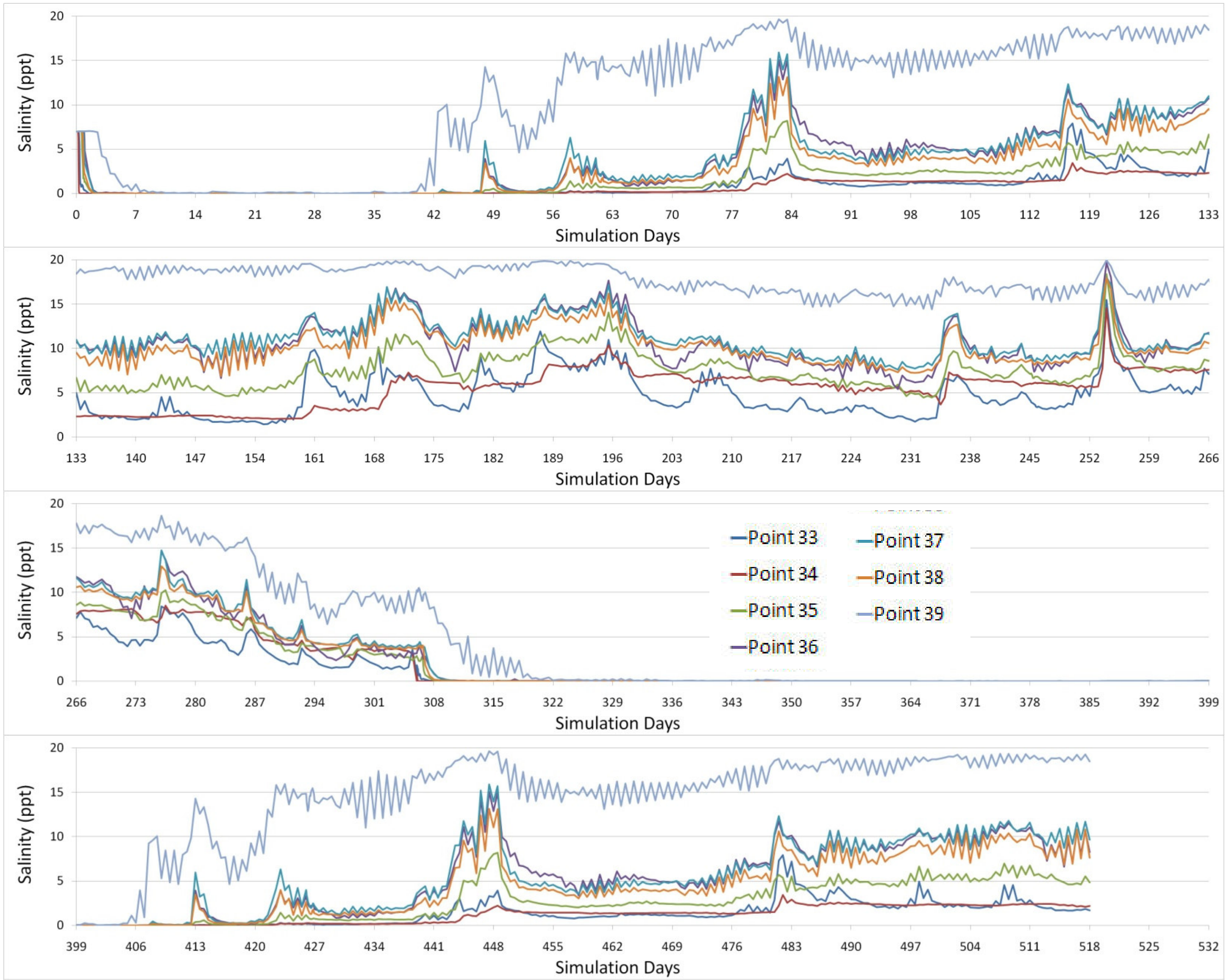


Figure 47a. Simulation 3 Salinity Time Series Results at Points throughout the White Ditch Area (Point Locations shown on Figure 36).

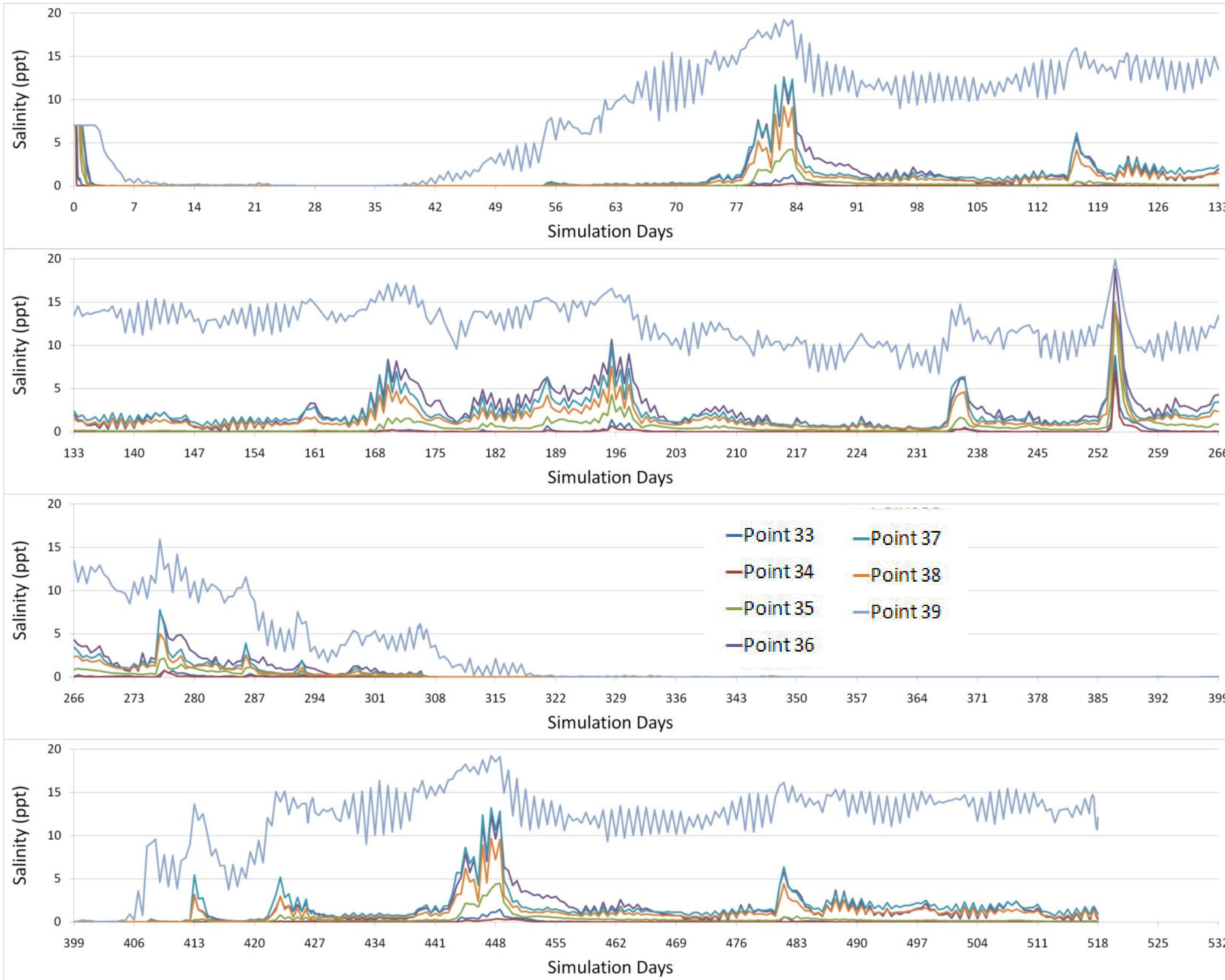


Figure 47b. Simulation 4 Salinity Time Series Results at Points throughout the White Ditch Area (Point Locations shown on Figure 36).

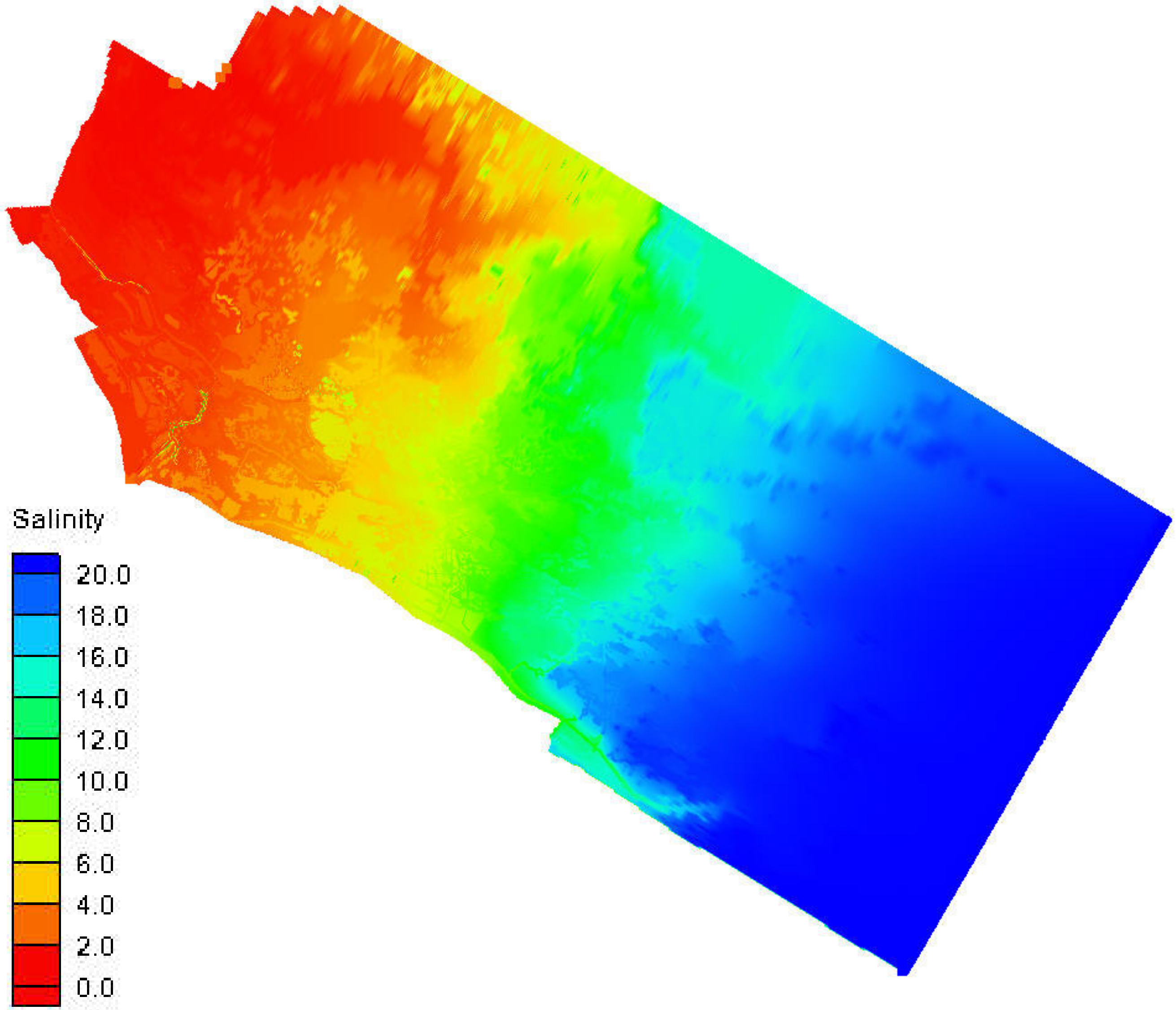


Figure 48. Time-averaged Salinity Distribution for Long-term Simulation 3.

Appendix A

Discussion of Bay Gardene Tide Gage Datum

The White Ditch hydrodynamic and salinity model developed by URS uses the USGS Bay Gardene tide data for the offshore water elevation boundary condition. During the model calibration it was not possible to obtain a tidal calibration to measured data in the White Ditch area without shifting the reported elevation of the tide data. The shift used was approximately 1 foot downward.

The Bay Gardene tide data is reported as NAVD 88 and the mean tide elevation for one or more year period is approximately one foot. The typical spring tide range is about 2 feet. The local survey data in the White Ditch are indicates that the median land elevation (based on numerous survey points on transects across the area) is about 1 foot. Thus during the rising tide, it is expected that the land will be inundated and during a falling tide the inundated areas would become dry. This was reproduced in the model simulations, but it causes a severe attenuation of the tide range in the White Ditch area, so much so that there was no possibility of matching the measured tide range in the area with adjustments to the friction or mixing parameters.

Local knowledge of the area, based on discussion with airboat operators who spend a significant amount of time in the area indicate that during normal tides the land areas do not become submerged, even at high tides. The only exception is during the month of September when high offshore water levels associate with predominant southeasterly winds causes a setup in the White Ditch area. In order to reconcile some of these findings an investigation of the tidal datum for the Bay Gardene gage was made. The findings of this investigation are summarized as follows:

- The USGS indicates that the gage was reset with the last year and there is larger than normal uncertainty in the accuracy of the gage datum (NAVD88)
- NOAA is not aware of or is not using the datum data that the USGS generated (no MSL to NAVD 88 info). NOAA has no published website Benchmark Page and they do not publish a NAVD to MSL conversion for the Bay Gardene gage.
- The NOAA VDATUM software quotes the uncertainty of datum conversions in the east Louisiana and Mississippi area as 17.1 cm (65% chance that actual area is below this level)
- Discussion with Garron Ross of USGS (referred to by Scott Beddingfield) indicates that there is a good degree of uncertainty in the tidal benchmark at Bay Gardene and that the USGS plans to re-survey it using a state-of-the-art GPS system in the near future, possibly publishing it in Summer 2010. The current gage was remounted about a year ago, and an expedient method of establishing the gage datum was used. Mr. Ross also pointed out that the Bay Gardene data of summer 2009 is still provisional, and noted that there was a sudden 0.5 foot shift in the data back in January.

These findings indicate that there is sufficient uncertainty in the Bay Gardene gage datum to allow for some adjustment of the stage levels in the modeling analysis.