NEXTera® ENERGY POINT BEACH

July 29, 2013

NRC 2013-0075

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266 and 50-301
Renewed License Nos. DPR-24 and DPR-27

Response to Request for Additional Information from July 22, 2013, Regulatory Conference to Discuss Inspection Report 05000266/2013011 and 05000301/2013011, Preliminary Yellow Finding

References:

1) U.S. Nuclear Regulatory Commission, Point Beach Nuclear Plant, Units 1 and 2 NRC Integrated Inspection Report 05000266/2013011 and 05000301/2013011; Preliminary Yellow Finding, dated June 18, 2013. (ML13169A212)

2) Point Beach letter NRC 2013-0054, Response to Inspection Report 05000266/2013011 and 05000301/2013011Preliminary Yellow Finding, dated June 28, 2013 (ML13179A333)

3) Point Beach letter NRC 2013-0069, Supporting Documentation for July 22, 2013 Regulatory Conference to Discuss Inspection Report 050000266/2013011 and 05000301/2013011, Preliminary Yellow Finding, dated July 15, 2013 (M13197A118)

On June 18, 2013, the Nuclear Regulatory Commission (NRC) provided NextEra Energy Point Beach, LLC (NextEra) with the results of the Temporary Instruction (TI) 2515-187, "Inspection of Near-Term Task Force Recommendation 2.3 Flooding Walk Downs," conducted at the Point Beach Nuclear Plant (PBNP) during the first quarter of 2013. The results of the TI included a performance deficiency related to the PBNP implementation of certain procedures intended to mitigate postulated flooding events (Reference 1). The Reference 1 letter further informed NextEra that NRC had preliminarily determined that the significance of the identified performance deficiency was yellow.

On June 28, 2013, NextEra requested a Regulatory Conference to discuss the significance determination (Reference 2). On July 15, 2013, NextEra provided a summary of the updated wave run-up analysis and an explanation of the results which clearly demonstrate that the safety significance of the performance deficiency is very low (Reference 3).

The updated analysis and results were discussed at the July 22, 2013, Regulatory Conference during which NRC requested additional information. The responses to the additional information requests are contained in the Enclosure to this letter.

NextEra maintains that using the updated external flooding analysis and Probabilistic Risk Assessment (PRA) models are the best available information to assess the safety significance of the subject performance deficiency. As discussed in the enclosure to this letter, the results show that the Turbine Building is only impacted by postulated flood frequencies in the range of E-06/yr resulting in a change in core damage frequency (ΔCDF) of 1.E-08/yr. Consequently, the safety significance of the performance deficiency is very low, with margin.

This letter contains no new Regulatory Commitments and no revisions to existing Regulatory Commitments.

If you have any questions or require additional information, please contact Mr. Ron Seizert, Licensing Supervisor at (920)755-7500.

Very truly yours,

Larry Meyer
Site Vice President
NextEra Energy Point Beach, LLC

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Point Beach Nuclear Plant, USNRC
Resident Inspector, Point Beach Nuclear Plant, USNRC
Branch Chief, Plant Support, Division of Reactor Safety, Region III, USNRC

ENCLOSURE

NEXTERA ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION UPDATED FLOODING ANALYSIS AND SIGNIFICANCE DETERMINATION

Summary

The external flooding analysis for Point Beach Nuclear Plant (PBNP) contained in the station's Individual Plant Examination of External Events (IPEEE) is dominated by conservative estimations and assumptions. The cumulative effect of these conservative assumptions results in overestimating the impact of external flooding events, including wave run-up.

NextEra developed an updated storm surge/wave run-up analysis utilizing more recent and best-available information and modeling which provides a more reliable analytical basis for assessing the associated safety significance of the postulated flooding event. The application of this updated analysis shows that the identified performance deficiency is of very low safety significance, with margin.

During the July 22, 2013 Regulatory Conference to discuss the significance determination of the performance deficiency as described in Reference 1, and the updated analysis and results that were provided in Reference 3, the NRC requested additional information. This Enclosure contains the NRC requests and the NextEra responses.

Attachment 2 is an updated safety significance determination evaluation. The results show that the Turbine Building is only impacted by postulated flood frequencies in the range of E-06/yr resulting in a change in core damage frequency (ΔCDF) of 1.E-08/yr. Consequently, the safety significance of the performance deficiency is very low, with margin.

Request 1:
The Wave Run-Up Calculation references a draft FEMA document. Is it appropriate to use the draft FEMA document?

Response 1:
The Draft FEMA (2012) Report was only used as a supporting document and not for any of the run-up calculations. However, the Draft FEMA (2012) Report has since been issued final. ENERCON has reviewed the final issued FEMA (2012) Report. There are no changes in that final report that impact the results or conclusions of ENERCON's total run-up calculation.

Request 2:
Are the values in Point Beach Final Safety Analysis Report (FSAR) Table 2.5-1 average values or maximum values?

Response 2:
The wave heights listed in Point Beach Nuclear Plant (PBNP) Final Safety Analysis Report (FSAR) Table 2.5-1 are maximum deep water wave heights (not mean wave heights) for the "Full Year" and "Ice-Free Period" for each recurrence frequency that is listed.

The information contained in FSAR Table 2.5-1 is based on Sargent & Lundy report, "Maximum Deep Water Waves & Beach Run-up at Point Beach," dated January 14, 1967. The Sargent & Lundy report was prepared to support the preliminary safety analysis for Point Beach and provided an evaluation review of probable wave conditions and wave run-up for recurrence frequencies up to 1 in 500 years.

FSAR 2012 Section 2.5 Hydrology (Page 2.5-2) states: *"The predicted magnitude of deep water wave heights is shown in Table 2.5-1."* The Sargent & Lundy report, Section II, (page 4) states: *"...the following maximum deep water waves are calculated:..."* The list of calculated values includes 23.5' as the maximum calculated deep water wave occurring once each 500 years.

Request 3:
Provide copy of the Bathymetry/topography calculation that defines site topography in the updated analysis.

Response 3:
ENERCON Calculation FPL-076-CALC-001, "Bathymetry and Topography Data Processing (DELFT3D Domain)," is included as Attachment 1. Citations in this document, *i.e.*, "(NOAA, 1996)," refer to references in that calculation. (The input data for the calculation is not included in Attachment 1 due to its volume.)

Discussion:
The site topography used in the analysis is the combination of a June 2013 site survey and publicly available National Oceanic and Atmospheric Administration (NOAA) and United States Geological Survey (USGS) information. The best available and most recent data were used directly for development of the model. The purpose of the bathymetry and topography calculation (FPL-076-CALC-001) is to convert the raw data into a format that can be imported into the DELFT3D software. A brief summary of each data source follows.

1 Lake Michigan Bathymetry
Bathymetric data was obtained from the NOAA National Geophysical Data Center (NGDC) website (NOAA, 1996) as an ASCII grid file. The data were published in 1996 and are the best available bathymetric data for Lake Michigan.

2 Site-Specific Topography
From June 12-14, 2013, a survey team from AECOM, led by a Registered Land Surveyor in the State of Wisconsin, performed a topographic survey at PBNP specifically for this analysis (NEE, 2013a). The survey included the general area and specific features around the Circulating Water Pump House (CWPH), bounding the land areas and features which would potentially be affected by wave action from Lake Michigan and extending into a bathymetric survey of the lake by taking actual depth measurements as far as safety would allow. This survey provided a much higher resolution (smaller grid size) for the immediate site area than publicly available. An image of the CAD drawing file is located on page 17 of 48 in the attached calculation.

3 General Topography

The general topography is included for completeness of the model. The 1/3-arc second (~10 meter resolution) National Elevation Datasets (NEDs) were downloaded from the USGS National Map website (USGS, 2011). The NEDs were published in 2011 and are the best available elevation data.

Request 4:

Provide insights on acceptability and validation of DELFT3D software. Has NRC reviewed it or has another federal agency approved or used it?

Response 4:

DELFT3D has undergone extensive development and is used worldwide.

DELFT3D is a suite of integrated modules that simulate a host of processes: two- and three-dimensional hydrodynamic flows, sediment transport, waves, water quality, morphological development, and ecology. The model was developed over decades by Deltares, an independent applied research institute in the Netherlands. Through development, it showed good agreement against laboratory data (*e.g.,* Henrotte, 2008) and field measurements (*e.g.,* Booij *et al.,* 1999; Elias, 1999; Luijendijk, 2001) and is now an open-source software. Internationally, DELFT3D has been used for tsunami and storm surge analysis for power plants in the United Arab Emirates, Turkey, the Netherlands, and Canada (Lake Huron) by Rizzo Associates, Inc.

The DELFT3D software has been internally verified by ENERCON

ENERCON maintains a 10 CFR 50 Appendix B Quality Assurance program for safety related nuclear projects. The DELFT3D software has been internally verified under this program.

DELFT3D has been applied and validated by governmental agencies in the United States.

- In their validations, the U.S. Naval Research Laboratory (NRL) found "*in general, DELFT3D has been shown to be robust and accurate in predicting nearshore wave heights and flows*." NRL has performed surf prediction, wave modeling, and circulation/flow analyses across the country with DELFT3D (NRL, 2002; 2006; 2008; 2009).
- DELFT3D has been selected to replace the Navy Standard Surf Model (NSSM) for official Navy use (Rogers/NRL, 2009).
- The U. S. Army Corps of Engineers (USACE) hindcasted a winter storm (*i.e.,* modeled waves and currents) along Long Island with DELFT3D (USACE, 2004).

DELFT3D has been used in five site evaluations submitted to the NRC.

- South Texas Project, Units 3 and 4 (Texas), for Combined License Application (COLA) and FSAR for breach and wave modeling
- Turkey Point (Florida), Units 6 and 7, for COLA tsunami wave analysis
- Turkey Point (Florida), Units 3 and 4, for the post-Fukushima flood hazard re-evaluation
- Nine Mile Point (New York) for nearshore wave heights and periods
- Victoria County (Texas) Station Early Site Permit Application, for Cooling Basin Breach Analysis

Additionally, questions were asked at the July 22, 2013 Regulatory Conference about the conservatisms that were included as DELFT3D model inputs. A summary of the most important inputs and outputs of the wave setup and incident run-up calculation, which add conservatisms, are provided below. This information is included to show that the DELFT3D model inputs were selected to obtain results that had the greatest impact at the site.

- The deep-water wave height (23.5 feet) was determined from the maximum 500-year event in the PBNP FSAR (2012), Section 2.5, "Hydrology", which states *"...only waves of lesser height actually need to be considered in the runup of the beach."* Use of 23.5' deep-water wave height is conservative and leads to a higher wave run-up.
- Multiple deep-water wave directions were prescribed to determine the most critical value (120 °, with respect to north, 0 °). Only water levels from the critical wave direction were used in subsequent calculations.
- The maximum sustained easterly wind, as determined by the Sargent & Lundy Runup Report (1967) and UFSAR (PBNP, 2012) were used in DELFT3D. The inclusion of wind in the DELFT3D wave setup calculations is a conservative approach, since wind setup had already been included in the starting still water levels (*e.g.,* worst-case Individual Plant Examination for External Events (IPEEE) scenario, 587 feet IGLD 1955).
- Depths near the seaward edge of the discharge flumes were increased (made deeper) up to three meters to produce larger waves (and, thus, higher water levels) near PBNP.
- The Manning's coefficient for bottom roughness (n) was set at 0.02, which is the suggested value from USACE (2012). That value corresponds to a sandy lake bottom. Although most of Lake Michigan is covered with sand, this is still a conservative approximation, since other bottom irregularities would have a higher n value and corresponding decreased wave set-up.
- The wind drag coefficient (0.0028) was a suggested value from "FEMA Great Lakes Coastal Guidelines, Appendix D.3" and is conservative. This makes the wave heights greater near PBNP.
- Run-up did not account for infiltration and was assumed to be uninterrupted by rundown. No barrier effects or reduction factors due to surface roughness are considered to interrupt run-up. These assumptions are conservative.

Based on the above conservatisms and the use of best available and most recent topography and bathymetry, the external water levels calculated at the Turbine Building are concluded to be the highest levels for leakage analysis.

As previously indicated, DELFT3D has been used by a number of federal agencies including its use in submittals to the NRC.

Request 5:
IPEEE Table 5.2.5-2 is titled, "Mean Lake Level Hazard Curve For Point Beach." Are the values in the table mean or maximum values? What is the result of using starting lake level values shifted to the 95th percentile level to assess the range of potential water levels in the turbine building? What is impact on statistical uncertainty around the results from the Point Beach deterministic evaluation? What is the trend in Lake Michigan level during the past 20 years?

Response 5:
Table 5.2.5-2 of the IPEEE is entitled, "Mean Lake Level Hazard Curve for Point Beach." The basis of these data is the USACE study (Revised Report on Great Lakes Open-Coast Flood Levels) performed in 1988. The study states that the listed levels are based on an analysis of the maximum instantaneous levels recorded each year. Given this clarification, the "still water elevation" values in Table 3 of the safety significance determination provided in Attachment 2 of NRC 2013-0069 are not actually mean lake levels, but represent recorded data of maximum yearly lake levels.

The lake level frequency analysis in the IPEEE is based on the TAP A-45 report (NUREG/CR-4458). Both of these documents used a statistical approach to determine the frequency of flooding on Lake Michigan. Re-calculating the wave run-up with a deterministic approach is consistent with the previously used approach.

Based on industry guidance for PRA (*e.g.,* EPRI TR-105396, "PSA Applications Guide"), best-estimate models and data should be used to accurately reflect the plant. This guidance further defines best-estimate as the point estimate of a parameter utilized in a computation which is not biased by conservatism or optimism. Generally, the mean value of a parameter is considered to be the best estimate.

However, a sensitivity case was performed using a 95th percentile curve to represent the annual flood frequency, rather than the values in the IPEEE. The results of that sensitivity case show that even using the 95th percentile curve, the ΔCDF is only 3E-08/yr. The base ΔCDF resulting from using the IPEEE annual flood frequency curve is 1E-8/yr. These values are both of very low safety significance. NextEra has concluded that the flood frequency that impacts equipment in the Turbine Building is in the range of E-06/yr.

Additionally, questions were asked at the July 22, 2013 Regulatory Conference related to the trend in Lake Michigan water level data during the last 20 years. A review of Lake Michigan water levels over the last two decades since the PBNP IPEEE actually shows that the level has been steadily lowering.

Request 6 (Equipment-Specific Questions):
Engineering Evaluation, EC 279398, documents the flood elevations at which equipment that is credited in the Point Beach PRA is assumed to be lost. The measurements of the most limiting subcomponents were considered accurate within ½". The recorded values are rounded down to the next closest ½". The following are the equipment-specific questions and responses with respect to the flood failure elevations.

Request 6.1:
1A-05 and 2A-05 (4.16 kV Vital Switchgear) have wires that are routed to the contact stabs which dip below the elevation of the stabs on the block. Therefore, these wires will be wetted at a lower flood elevation than that stated in the engineering evaluation. Why does the evaluation use the height of the lowest stab instead of the wire bundle height?

Response 6.1:
This response is not limited to just those conductors questioned in the 4.16 kV Vital Switchgear. It includes other conductors that are the subject of subsequent questions.

The photos contained in EC 279398 which show the elevations of electrical equipment subject to potential submergence depict several insulated cables and internal wires that may be routed below the postulated water elevation stated in the engineering evaluation. As discussed in greater detail below, these low voltage insulated conductors are not subject to electrical failure due to a postulated short duration immersion in flood water. Previous industry experience with insulation failures due to immersion in water has been noted when immersion durations are on the order of many years of continuous or intermittent immersion, and is more prevalent in higher voltages than those carried by the conductors in question. As a result, the insulated conductors will not be impacted during the duration of a flooding event.

Based upon inspection of the photos contained in EC 279398, all of the subject cables and internal wires are considered low voltage conductors, typically carrying 125VDC, 120VAC, or 480VAC. EPRI Report, "Plant Support Engineering: Aging Management Program Development Guidance for AC and DC Low-Voltage Power Cable Systems for Nuclear Plants," contains guidance regarding cable wetting or submergence. Excerpts from Section 6 of this document, "Actions for Low-Voltage Power Cables in Wet Environments," are provided below:

"The insulation of low-voltage power cable subjected to long-term wetting may deteriorate over time. Insulated Cable Engineers Association manufacturing standards required insulation stability testing to be performed by manufacturers to prove stability of cable insulation under wet conditions, so that no significant deterioration should occur for an extended period unless the conditions of the soil or water are particularly aggressive. In low-voltage cables, the thickness of insulation and jacketing that are used is driven by mechanical protection capabilities rather than by voltage withstand. Therefore, the voltage stress in the insulation is quite low by comparison to that of medium-voltage cable, and no electrically driven failure mechanism such as water treeing is expected to occur. Failures have occurred, possibly due to long-term chemical deterioration of jackets and insulations, but failures are more often due to installation or post-installation damage."

The cables have their protective jackets intact until entering the various boxes, and are routed in protective metal conduits when low in the building structure. The jacketing, conduits, and enclosures prevent post-installation damage to the wire insulation. Similarly, the jacketing on the cables protects the individual conductor insulation from being damaged during installation while pulling the cable thorough the conduits. In the case of the cable bundle for the auxiliary contact connection block on the 4 kV breakers, the bundle is enclosed in a protective braided metal sheath. This provides protection while ensuring flexibility of the bundle to accommodate relative motion of the breaker components.

As noted in the EPRI Report guidance, the thickness of the insulation on low voltage conductors is dictated by mechanical protection capabilities, not dielectric requirements. Therefore, even if some damage to the individual conductor insulation is present, it is highly unlikely that it would lead to grounding of the conductor upon immersion in water.

Continuing with the EPRI Report:

"Rain and drain conditions will not adversely affect jacketed cables. Water takes a number of months to years to migrate into the jacket. Low-voltage power cables are not susceptible to

water treeing because the voltage stresses in the insulation are too low to induce the electrochemical/electromechanical degradation mechanisms involved. Other water-related degradation mechanisms may exist; however, manufacturers' water stability tests indicate that water-related degradation should not occur."

PBNP operating experience supports the conclusions in the EPRI Report. The only significant cable failures due to water submergence that have occurred at PBNP were associated with medium voltage cables where the electrical stresses are sufficient to cause water treeing over an extended period of time. For example, a failure of an underground cable from transformer 1X-04 occurred in 2008 due to long term periodic wetting. This cable had been in service since original plant construction (more than 35 years). Prior to performing improvements to reduce and mitigate water intrusion in electrical manholes, numerous low voltage cables at PBNP had been exposed to numerous periods of water submergence, with no failures.

Internal wiring at PBNP is typically type SIS switchboard wire, which is rated for dry or wet environments. Underwriters Laboratories Standard UL 44, "THERMOSET-INSULATED WIRES AND CABLES," provides testing requirements for this cable type, which includes a dielectric withstand test in water. Section 36.1 of UL 44 states:

"The insulation shall enable a finished wire or cable capable to withstand for 60 s without breakdown the application of the test potential indicated in Table 36.1 under the following conditions. The wire or cable shall be immersed in tap water at room temperature for not less than 6 h, following which it shall be subjected to the voltage test while still immersed. The dielectric voltage-withstand test shall be conducted before the insulation-resistance test…."

The dielectric test voltage for 600V type SIS wire is a minimum of 3,000V, which far exceeds the actual voltages in use.

Although the wiring in the EC 278398 photos may be routed below the maximum postulated flood elevation; this wiring is rated for wet environments and will not fail upon being submerged during a flooding event. Therefore, the elevations included in the subject engineering evaluation (height of lowest exposed electrical device) remain valid. There is no need to postulate any increase in failure probability of equipment due to wetted insulated conductors.

Request 6.2:
In the C-78 DC Power Transfer Control Panel there is at least one wire that drops from the lowest terminal block to the bottom of the panel (~6" above the floor), and will be wetted at a lower flood elevation than that stated in the engineering evaluation. Why does the evaluation use the height of the terminal block rather than the wire elevation?

Response 6.2:
As discussed in detail in the response to question 6.1, low voltage insulated wires and cables such as those seen in the C-78 power transfer control panel are not subject to electrical failure from direct immersion in water for the periods of interest in a flooding event.

Request 6.3:
The local control panel (C-62) for P-35A, Electric Fire Pump, rests on a very low concrete base (~1" high). The flood vulnerability of P-35A is discussed in the evaluation; however, C-62 is not. Are there components in C-62 that are vulnerable to wetting at low flood elevations?

Response 6.3:
As stated in the evaluation, the Electric Fire Pump was included in the engineering evaluation *"for completeness of information,"* and was not the subject of any of the other three documents (PRA internal flooding notebook, IPEEE, or Flooding Vulnerability Report).

The higher elevation of the vulnerable components in the control panel for the pump were known to the preparer and verifier of the engineering evaluation to be well above the elevation of the pump motor windings. As a result, discussion of the control cabinet was inadvertently omitted from the evaluation.

The vulnerable components (*i.e.,* un-insulated exposed electrical conductors) are more than 31" above the 7' elevation floor slab (19" above the 8' plant elevation). This is bounded by the lower elevation of the pump motor windings, which are listed as 12" above the 8' elevation in the evaluation.

Request 6.4:
In the photographs that are included in the engineering evaluation of D-01 and D-02, 125V DC Distribution Panels, the lowest cables dip below the 12.5" listed in the evaluation, and will be wetted at a lower flood elevation than that stated in the evaluation. Why does the evaluation use a height of 12.5" rather than the wire elevation?

Response 6.4:
As discussed in detail in the response to question 6.1, low voltage insulated wires and cables such as those seen in the D-01 and D-02 DC panels are not subject to electrical failure from direct immersion in water for the periods of interest in a flooding event.

Request 6.5:
In the photograph that is included in the engineering evaluation of the junction box on K-3B, Service Air Compressor, there are several wires running along the bottom of the box at ~10.5" above the floor level. Why does the evaluation use a height of 12.5" rather than the wire elevation?

Response 6.5:
As discussed in detail in the response to question 6.1, low voltage insulated wires and cables such as those seen in K-3B terminal box are not subject to electrical failure from direct immersion in water for the period of interest in a flooding event.

The bottom location(s) on the terminal strips are unused. The first (lowest) terminal strip used is located at 12½".

Request 6.6:
In the photograph that is included in the engineering evaluation of C-61, Control Panel for P-35B Diesel Fire Pump, there are cables ~11" above the floor. The Pumphouse floor is at the plant 7' elevation, not the 8' elevation. Yet the evaluation concludes that a flood vulnerability height of 16" should be used. How is this justified?

Response 6.6:
The evaluation did not consider insulated conductors to be vulnerable to shorting or grounding as a result of direct immersion in water. This is why the elevation of the lowest [bare] terminal lugs were used rather than the lowest wire in the various cabinets and enclosures. The basis for this is discussed in greater detail in the response to question 6.1.

The 16" value stated in the summary spreadsheet at the back of Engineering Evaluation 279398 is in error. As stated in the evaluation: "... the lowest un-insulated terminal strips in the DFP control panel (C-61), which are slightly more than 16" above the 7' floor. Therefore, a value of 16" should be used for flood risk assessments".

The intent of the evaluation was that the vulnerable elevation is 16" above the 7' elevation, not the 8' elevation. However, when this was transcribed into the spreadsheet summary at the end of the evaluation, an error occurred that indicated the elevation is ">16" above the 8' plant elevation. The entries in the spreadsheet summary were to all be referenced to the 8' plant elevation, and the one foot correction for this component was not made. Additionally, the FSAR describes the elevation as 4.5" above the 8' plant elevation. Further review of the photographs confirmed that the lowest vulnerable component in the cabinet is at least 16.5" above the 7' floor elevation. Therefore, the entry in the spreadsheet should have been 4.5" rather than ">16".

The error has been documented in the corrective action program, and two independent reviews were immediately performed to determine the extent of condition. Both reviewers concluded that all other entries in the spreadsheet for equipment located in the Pumphouse were correctly adjusted for the difference in floor elevations. The engineering evaluation will be amended to correct this error via the corrective action program.

Additionally, the actual flood vulnerability elevation for C-62 is reflected in the revised PRA model by including the failure of P-35B, Diesel Fire Pump at a flood water elevation range of 4" to <8". This correction results in a revised ΔCDF of 1.E-08/yr as compared to the ΔCDF of 7.E-09/yr determined with the Diesel Fire Pump failure at a flood water elevation range of 12.5" to <17". The Updated Point Beach External Flood Safety Significance Determination is included as Attachment 2. This update did not materially change the result of the safety significance of the performance deficiency, which remains very low.

Request 6.7:
The engineering evaluation describes the D-63 and D-64 panels as having been modified to install insulating end caps on the exposed bus bars to prevent them from being wetted from water up to 18" deep. However, no photographs were included. There are conduits entering these cabinets from the sides, suggesting that there are wires or cables in the conduits that might be wetted at lower elevations. Are these conduits sealed to prevent wetting of the wires or cables in them?

Response 6.7:
As discussed in greater detail in the response to question 6.1, insulated internal wires and cables are not subject to failure due to direct immersion from the postulated flooding. Therefore, although the wiring in the side entry conduits could be wetted, this would not cause electrical failure.

The modification that installed the panels specifically assessed the potential for water intruding into the cabinets and made provisions to protect exposed electrical conductors that are below the potential flood elevation. Sealing of the conduits and other penetrations to prevent flooding impact was determined to not be necessary.

Per CRN 261586 (ECN 15158) and 206911 (ECN 14483), field verification showed the D-63 and D-64 main bus bar elevations to be approximately ½" below the centerline of the P-38A and P-38B pump motor windings. A Raychem insulated heat shrink end cap and heat shrink tubing were installed on the bottom of each exposed bus bar. This provides protection up to the P-38A and P-38B pump motor winding centerline height.

CRN 261586 states:

"Raychem environmental qualification testing results included in EDR-5389, Rev. 0 and EDR-5336, Rev. 5, concluded that the end caps and sleeve tubing (respectively) used in this modification are environmentally qualified for a LOCA accident environment…The test samples were also subject to 24 hours submergence in tap water at room temperature, +/-25°C at least 12 inches below the water surface with a DC voltage applied of 500 volts for 1 minute. This test is similar to conditions expected during a LOCA accident condition in this application…The Raychem end cap and tubing sleeve will not be subjected to a harsh environment as described by DG-G11 "Environmental Qualification Service Conditions". Therefore, the end cap and tubing sleeve are acceptable for use in this installation."

Request 6.8:
A walkdown of the 1 and 2P-29 Turbine Driven Auxiliary Feedwater Pumps found that there are junction boxes associated with the 1-MS-2082 and 2-MS-2082 valves (trip and throttle valves) that are located ~6" above the floor. These junction boxes do not appear to have been addressed in the evaluation. Please provide information on the content of these boxes and the potential consequences of their being wetted.

Response 6.8:
These boxes were not specifically addressed because they were not included in the three documents that were being reconciled, and because previous efforts had confirmed that there are no exposed energized electrical components within the boxes. These boxes were verified to contain direct runs of insulated wires, with no terminal blocks, splices, or other potentially exposed conductors.

As discussed in detail in the response to question 6.1, low voltage insulated wires are not subject to electrical failure due to direct immersion for the periods of time being considered for flooding events.

Attachments

Attachment 1: FPL-076-CALC-001, "Bathymetry and Topography Data Processing (DELFT3D Domain"

Attachment 2: "Updated Point Beach External Flood Safety Significance Determination"

ATTACHMENT 1

NEXTERA ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT

BATHYMETRY AND TOPOGRAPHY DATA PROCESSING (DELFT3D Domain)

48 Pages Follow

ENERCON	CALCULATION COVER SHEET	CALC. NO. FPL-076-CALC-001
		REV. 0
		PAGE NO. 1 of 48

Title:	Bathymetry and Topography Data Processing (DELFT3D Domain)	Client: NextEra Energy (NEE)
		Project: FPLPB025

Item	Cover Sheet Items	Yes	No
1	Does this calculation contain any assumptions that require confirmation? (If **YES**, identify the assumptions)_____		X
2	Does this calculation serve as an "Alternate Calculation"? (If **YES**, identify the design verified calculation.) **Design Verified Calculation No.**_____		X
3	Does this calculation supersede an existing calculation? (If **YES**, identify the superseded calculation.) **Superseded Calculation No.**_____		X

Scope of Revision: **Initial issue**

Revision Impact on Results:

Not Applicable to Revision 0.

Study Calculation	☐	**Final Calculation**	☒
Safety-Related	☒	**Non-Safety Related**	☐

(Print Name and Sign)

Originator:	Mandy Searle	Mandy Searle Mandy Searle	**Date:** 7/11/2013
Design Verifier:	Justin Pistininzi	Justin D. Pistininzi	**Date:** 7/11/2013
Approver:	Paul Martinchich		**Date:** 7/11/2013

ENERCON	CALCULATION REVISION STATUS SHEET	CALC. NO. FPL-076-CALC-001 REV. 0 PAGE NO. 2 of 48

CALCULATION REVISION STATUS

REVISION	DATE	DESCRIPTION
0	July 11, 2013	Initial Issue

PAGE REVISION STATUS

PAGE NO.	REVISION	PAGE NO.	REVISION
All pages	0		

Appendix/Attachment REVISION STATUS

Attachment NO.	PAGE NO.	REVISION NO.	Attachment NO.	PAGE NO.	REVISION NO.
Attachment - A	All Pages	0			

ENERCON	CALCULATION DESIGN VERIFICATION PLAN AND SUMMARY SHEET	CALC. NO. FPL-076-CALC-001 REV. 0 PAGE NO. 3 of 48

Calculation Design Verification Plan:

Apply CSP Number 3.01, Revision 6, Section 4.5.a, Design Review Method and to include at a minimum:

1. Review and verify the design inputs, references and tables to ensure that the Calculation Results, as they conform to the design methodology, are correct.

(Print Name and Sign for Approval – mark "N/A" if not required)

Approver: Paul Martinchich	**Date:** 7/11/13

Calculation Design Verification Summary:

After reviewing this calculation and all related documents for Revision 0, I have come to the following conclusions:

1. The methodology, design inputs and approach are appropriate for the derivation of all calculated results.
2. The results of the Calculation are reasonable based on verified input values.
3. The report text and general flow of the document is clear and concise.

Based on the above summary, the calculation is determined to be acceptable.

(Print Name and Sign)

Design Verifier: Justin Pistininzi Justin D. Pistininzi	**Date:** 7/11/2013
Others: N/A	

ENERCON	CALCULATION DESIGN VERIFICATION CHECKLIST	CALC. NO. FPL-076-CALC-001
		REV. 0
		PAGE NO. 4 of 48

Item	Cover Sheet Items	Yes	No	N/A
1	Design Inputs - Were the design inputs correctly selected, referenced (latest revision), consistent with the design basis and incorporated in the calculation?	X		
2	Assumptions – Were the assumptions reasonable and adequately described, justified and/or verified, and documented?	X		
3	Quality Assurance – Were the appropriate QA classification and requirements assigned to the calculation?	X		
4	Codes, Standard and Regulatory Requirements – Were the applicable codes, standards and regulatory requirements, including issue and addenda, properly identified and their requirements satisfied?	X		
5	Construction and Operating Experience – Has applicable construction and operating experience been considered?			X
6	Interfaces – Have the design interface requirements been satisfied, including interactions with other calculations?	X		
7	Methods – Was the calculation methodology appropriate and properly applied to satisfy the calculation objective?	X		
8	Design Outputs – Was the conclusion of the calculation clearly stated, did it correspond directly with the objectives and are the results reasonable compared to the inputs?	X		
9	Radiation Exposure – Has the calculation properly considered radiation exposure to the public and plant personnel?			X
10	Acceptance Criteria – Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished?	X		
11	Computer Software – Is a computer program or software used, and if so, are the requirements of CSP 3.02 met?	X		

COMMENTS:

(Print Name and Sign)

Design Verifier: Justin Pistininzi Justin D. Pistininzi **Date:** 7/11/2013

Others: N/A

TABLE OF CONTENTS

1. Purpose and Scope

This calculation is performed under NextEra Energy (NEE) Contract Order 02306247, to evaluate wave runup and related inundation effects due to surge in Lake Michigan at the Point Beach Plant (PBN)

The purpose of this calculation is to compile Lake Michigan bathymetry and near site topography and survey data into a tab delimited xyz text file (.xyz). The output files are referenced to a horizontal datum in the World Geodetic System of 1984 (WGS84) geographic coordinate system (GCS) and a vertical datum referenced to Lake Michigan low water datum (LWD) at the International Great Lakes Datum of 1985 (IGLD85) with units in meters.

The files will be created using publically available bathymetric data from the National Oceanic and Atmospheric Administration (NOAA) and topographic data from the United State Geological Survey (USGS). The latest site survey completed in June 2013 will also be used to obtain site elevation information. The following output files from this calculation will be utilized in FPL-076-CALC-003 "DELFT3D Model:"

1. Lake Michigan bathymetric points,
2. Near site topographic elevation points,
3. Site survey elevation points,
4. Site survey contours denoted as point features,
5. Lake Michigan shoreline denoted as point features,
6. Additional elevation points in discharge canals.

2. Summary of Results and Conclusions

The text delimited xyz file (.xyz), referenced to WGS84 GCS meters-IGLD85, is based on available bathymetric data from the National Oceanic and Atmospheric Administration (NOAA, 1996), United States Geological Survey (USGS) National Elevation Datasets (NED) (USGS, 2011), and site survey elevation points (NEE, 2013a). Spacing of bathymetric data is approximately 90 meters; spacing for the NEDs is 10 meters; and spacing for the site survey is variable, between one to ten meters. Thus, the output text files (.xyz format) containing bathymetry and topographic elevations are appropriate for use as input for calculation FPL-076-CALC-003 "DELFT3D Model". The input files, output text files and references are included on a DVD in Attachment 1.

3. References

The references are available in Attachment A (on DVD).

3.1 **AECOM, 2013**, "RE: Topographic Survey," e-mail correspondence from AECOM to ENERCON, June 20, 2013.

3.2 **Deltares, 2011**, "DELFT3D-RGFGRID User Manual," Version 4.00, Revision 15423, 2600 MH Delft, The Netherlands.

3.3 **ENERCON, 2012**, ENERCON Services Inc. (ENERCON), "ENERCON QA Master File: ArcGIS Desktop Version 10.1," Murrysville, PA (Pittsburgh Office), 2012.

3.4 **ESRI, 2012**, Environmental Systems Research Institute (ESRI), "ArcGIS Desktop 10.1," Computer Program, ESRI: Redlands, California, 2012.

3.5 **NGS, 2013**, National Geodetic Survey (NGS), NGS Data Sheet: LSC 7 B 81, PID: PM0368, received in e-mail correspondence from AECOM to ENERCON, June 17, 2013.

3.6 **NGS, 2012**, National Geodetic Survey (NGS), "DYNAMIC_HT," NGS Geodetic Tool Kit Website, http://www.ngs.noaa.gov/TOOLS/DYNHT/dynamic_ht.pdf, Accessed June 2013.

3.7 **NEE, 2013a**, NextEra Energy (NEE), "Topography Survey Data of CWPH Area for External Flooding Analysis," Design Information Transmittal (DIT) PBNP Engineering Evaluation EC 279589, Source of Information: AECOM, PO 02306247, July 9, 2013.

3.8 **NEE, 2013b**, NextEra Energy (NEE), "FW: Plant Datum," e-mail correspondence from NextEra to ENERCON, June 24, 2013.

3.9 **NOAA, 2013a**, National Oceanic and Atmospheric Administration (NOAA), "Great Lakes Low Water Datums," Tides and Currents Website, http://tidesandcurrents.noaa.gov/gldatums.shtml, Accessed June 2013.

3.10 **NOAA, 2013b**, National Oceanic and Atmospheric Administration (NOAA), "Great Lakes Water Dashboard – Water Level Data Detail," Great Lakes Environmental Research Laboratory (GLERL) Website, http://www.glerl.noaa.gov/data/now/wlevels/dbd/levels2.html, Accessed June 2013.

3.11 **NOAA, 1999**, National Oceanic and Atmospheric Administration (NOAA), "Bathymetry of the Lake Erie and Lake Saint Clair," National Geodetic Data Center Website, http://www.ngdc.noaa.gov//mgg/greatlakes/erie.html, Accessed June 2013.

3.12 **NOAA, 1996**, National Oceanic and Atmospheric Administration (NOAA), "Bathymetry of Lake Michigan," National Geodetic Data Center (NGDC) Website, http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html?dbase=grdglb, Accessed June 2013.

3.13 **NOAA, 1995**, National Oceanic and Atmospheric Administration (NOAA), "Establishment of International Great Lakes Datum (1985)," The Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, NOAA Tides and Currents Website, http://tidesandcurrents.noaa.gov/publications/Establishment_of_International_Great_Lakes_Datum_1985.pdf, Accessed June 2013.

3.14 **NOAA, 1985**, National Oceanic and Atmospheric Administration (NOAA), "Orthometric Height Determinination Using GPS Observations and the Integrated Geodesy Adjustment Model," NOAA Technical Report NOS 110 NGS 32, NGS Publication Website, http://www.ngs.noaa.gov/PUBS_LIB/TRNOS110NGS32.PDF, Accessed June 2013.

3.15 **USACE, 1992**, United States Army Corps of Engineers (USACE), "Brochure on the International Great Lakes Datum of 1985 (IGLD85)," USACE Website, http://www.lre.usace.army.mil/Portals/69/docs/GreatLakesInfo/docs/IGLD/BrochureOnTheInternationalGreatLakesDatum1985.pdf, Accessed June 2013.

3.16 **USGS, 2011**, United States Geological Survey (USGS), "1/3-Arc Second National Elevation Dataset (NED)," NED grid n45w088_1, USGS National View Website, http://viewer.nationalmap.gov/viewer, Accessed June 2013.

3.17 **USGS, 2010a**, United States Geological Survey (USGS), "Two Creeks, Wisconsin," 7.5-minute Quadrangle, USGS Website, http://store.usgs.gov/b2c_usgs/usgs/maplocator/(xcm=r3standardpitrex_prd&layout=6_1_61_48&uiarea=2&ctype=areaDetails&carea=%24ROOT)/.do, Accessed June 2013.

3.18 **USGS, 2010b**, United States Geological Survey (USGS), "NHDH0406," National Hydrography Dataset, USGS National Hydrology Dataset Viewer Website, http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd, Accessed June 2013.

4. Assumptions

4.1 Lake Michigan LWD, established by NOAA, is set to 176.0 meters-IGLD85 (NOAA, 2013a). It is assumed the LWD is the average water level (established at the Lake Michigan master gauging station at Harbor Beach, Michigan) which is considered constant at all locations around Lake Michigan (NOAA, 2013b).

4.2 The site survey (NEE, 2013a), delivered in CAD (.dwg) and microstation (.dgn), does not include ground elevation along the discharge flumes. For the purposes of this calculation, the contours lines provided in the file will connect across the discharge flume area. Since the discharge flume area is considered an obstruction for wave action in the DELFT3D coastal modeling software, it is assumed bathymetry within this area is negligible.

5. Design Inputs

The following are the digital file inputs that were utilized for this calculation:

5.1 Lake Michigan Bathymetry, Gridded Bathymetric Data (ASCII): *Michigan_lld* (NOAA, 1996). The NOAA Lake Michigan bathymetric data is the best bathymetry available at the time of this calculation. The grid data is in North American Datum of 1983 (NAD83) GCS, referenced to IGLD85 vertical datum at 176.0 meters LWD.

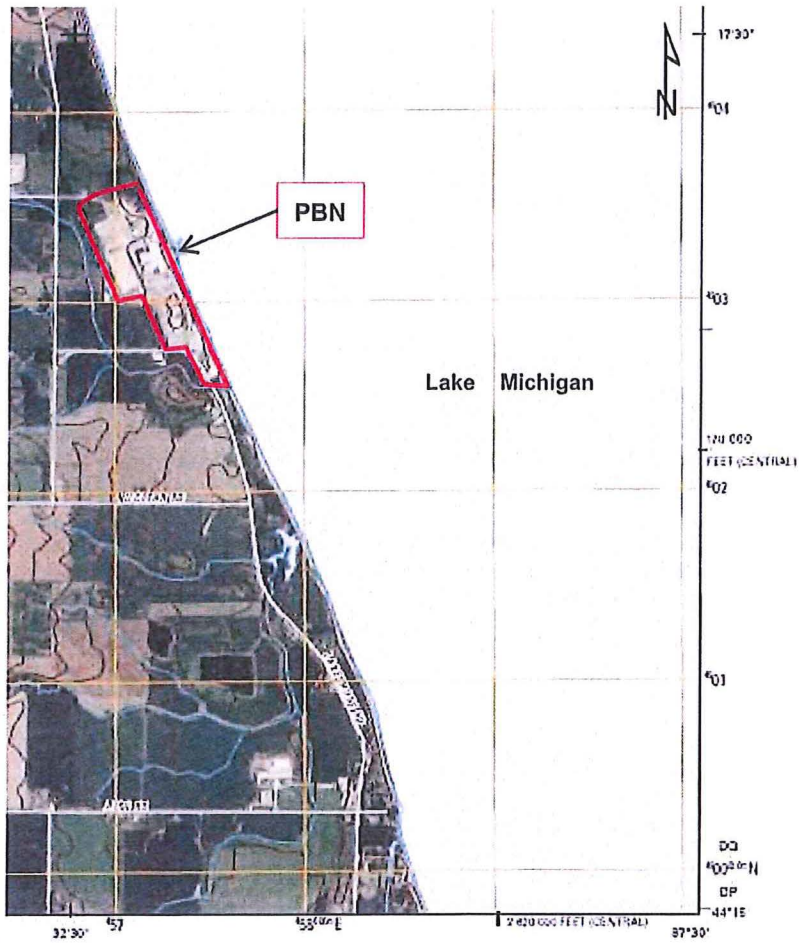
5.2 National Elevation Dataset from the USGS, 1/3-arc second (10 meters) grid: *n45w088_13* (USGS, 2011). The NED is in the NAD83 GCS, referenced to the North American Vertical Datum of 1988 (NAVD88) with units in meters.

5.3 Topographic Survey of PBN by AECOM (NEE, 2013a), with elevation points in a "Point, Northing, Easting, Elevation, Description" format and a CAD file containing contours and breaklines (G60302156_PBNP_Topo.dwg). The horizontal coordinates are in the Wisconsin State County System of Manitowoc County, referenced to NAVD88 with units in feet (AECOM, 2013).

The input files are provided in Attachment A (on DVD).

6. Methodology

The location of the PBN was determined utilizing the USGS Two Creeks, WI Quadrangle referenced to NAD83 (USGS, 2010a). The latitude and longitude of the approximate center point of PBN, obtained from the Two Creeks, WI Quadrangle (USGS, 2010), is 44° 16' 52.0" North, 87° 32' 12" West. The plant location, as shown on Figure 1, was used to obtain the required bathymetry and topography data.



a

Figure 1. Location of PBN on Two Creeks, WI Quadrangle (USGS, 2010a)

The output from this calculation will be used as input for the DELFT3D coastal modeling software. The DELFT3D modeling software user's manual states that if the user wants to use spherical coordinates, the coordinates system of the data must be in WGS84 (Deltares, 2011). Thus, the bathymetry and topography will be converted to the WGS84 to meet the criteria.

The ESRI ArcGIS Desktop 10.1 software (ESRI, 2012a) was utilized to create tab delimited xyz text files (.xyz) containing longitude (x), latitude (y), and height (z). Topography and bathymetry will be in the WGS84 GCS at IGLD85 vertical datum in meters at LWD for Lake Michigan. Table 1 provides a summary of the topographic and bathymetric data used as input.

Table 1. Summary of topographic and bathymetric data used as input

Area	Data Type	Source	Horizontal Resolution	Coordinate System	Vertical/ Tidal Datum	Vertical Units
Lake Michigan	Bathymetry, ASCII grid (.asc)	NOAA, 1996	~90 meters	NAD83	LWD-IGLD85	meters
Site grid	1/3-arc second NED (.flt)	USGS, 2011	10 meters	NAD83	NAVD88	meters
Site Survey	Topography (P,N,E,EL,D.txt and G60302156_BPNP_topo.dwg)	NEE, 2013a	Spot elevation, feet	Wisconsin System – Manitowoc County	NAVD88	feet

Due to the localized settings for subsequent calculations using the output files from this calculation, all topographic and bathymetric data will be clipped to a user-defined mask (shown on Figure 2). The mask is approximately 2,535 square miles, extending from 86° 35' 13.07" and 87° 53' 51.52" West to 43° 59' 49.88" and 44° 33' 28.92" North.

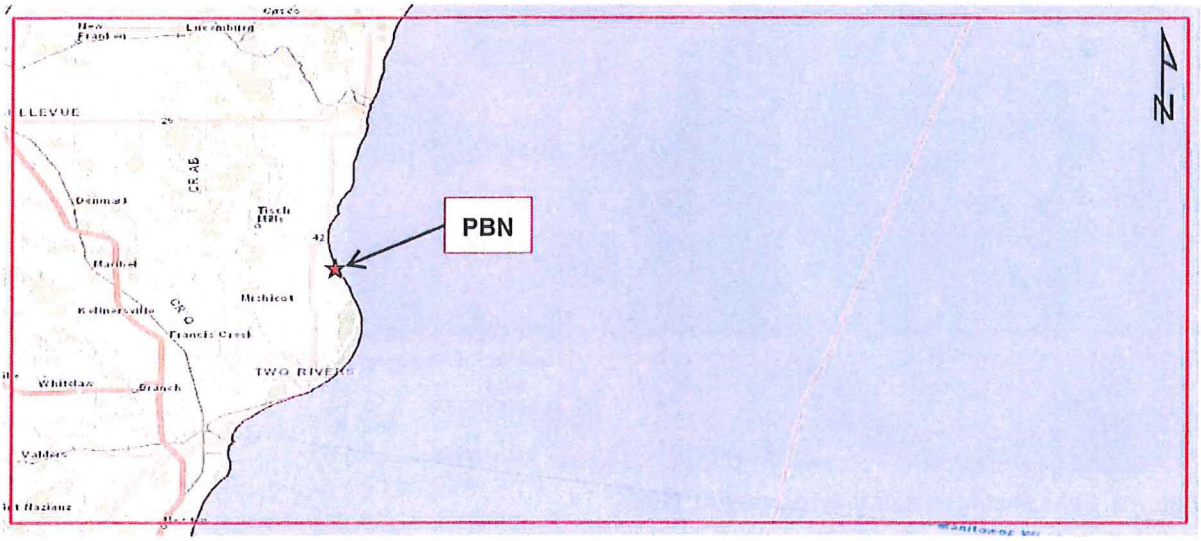


Figure 2. Mask Area for bathymetric and Topographic Data

6.1 Lake Michigan Bathymetry

Lake Michigan bathymetry (shown on Figure 3) was obtained from NOAA's NGDC website as an ASCII grid file (.asc) with an approximately 90 meter resolution (NOAA, 1996). The bathymetry is referenced to the IGLD85 vertical datum at 176.0 meters LWD. The LWD is defined as the geopotential elevation (geopotential

difference) for each of the Great Lakes and the corresponding sloping surfaces of the St. Mary's, St. Clair, Detroit, Niagara, and St. Lawrence Rivers to which are referred the depths shown on the navigational charts and authorized depths for navigation projects (NOAA, 1995).

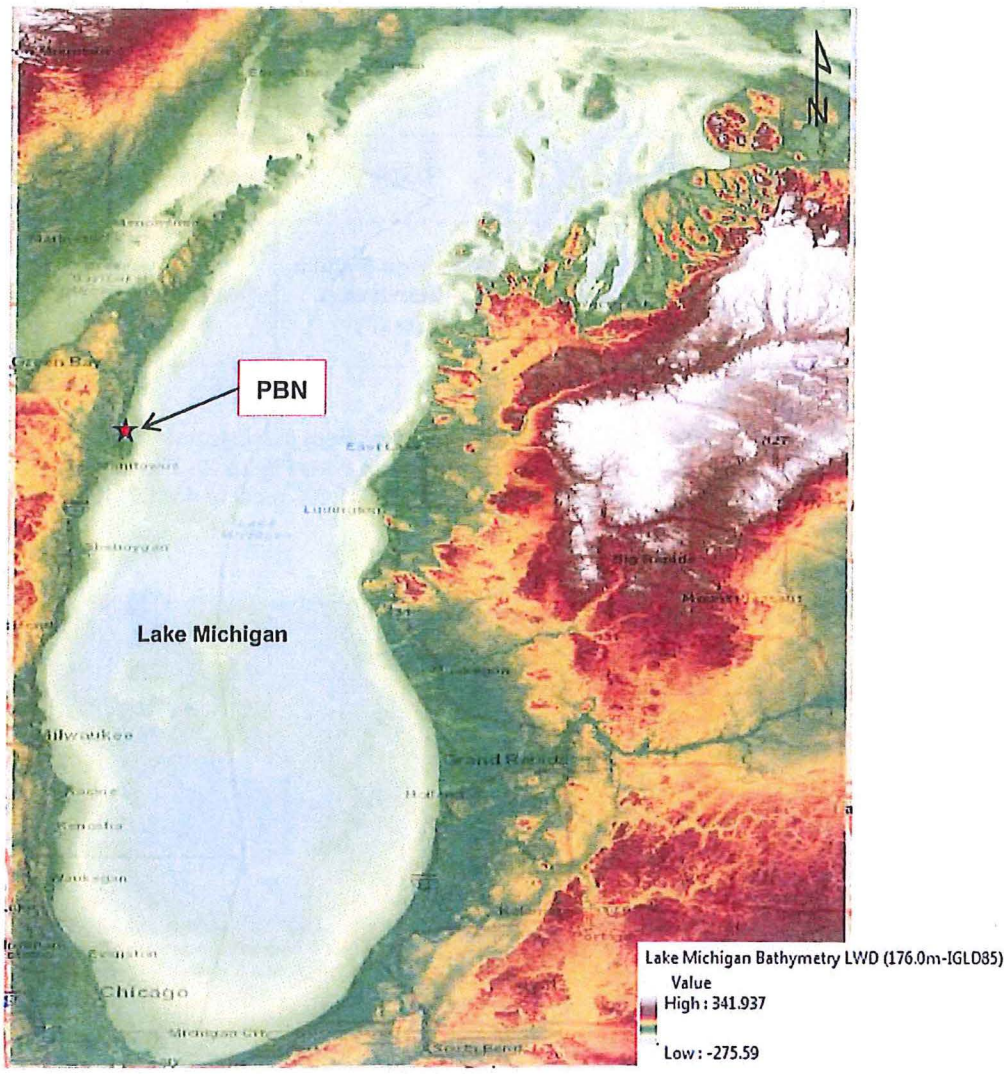


Figure 3. Lake Michigan Bathymetry (NOAA, 1996)

The following outlines the steps to re-project bathymetry binary float file (.asc) to the WGS84 GCS (horizontal), referenced to 176.0 meters-LWD IGLD85 (vertical), then exported to a tab delimited xyz file that

can be used in the DELFT3D modeling software. The detailed processing using the ESRI ArcGIS Desktop 10.1 SP1 (ESRI, 2012) and Microsoft Access[1] is described under Calculations, Section 7.0 of this calculation.

1. Clip Lake Michigan bathymetry to a mask (extent to which the data will be clipped).
2. Convert raster to points, where each point represents elevation in 176.0 meters-LWD IGLD85
3. Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.
4. Convert elevation to sounding data (values are expressed as positive downward from the reference plane 176.0 m-IGLD85), per DELFT3D user's manual (Deltares, 2011).
5. Export X-Y-Z data to a tab delimited xyz text file using Microsoft Access.

6.2 Topography - Digital Elevation Model

The 1/3-arc second NEDs were obtained from the USGS with an approximate 10 meter resolution (USGS, 2011). The NEDs are in NAD83 GCS and referenced to the NAVD88 in meters. One NED (shown on Figure 4) covers the PBN site area.

[1] Microsoft Access (version 10.4.6029.1000) is only used to export data into the correct format.

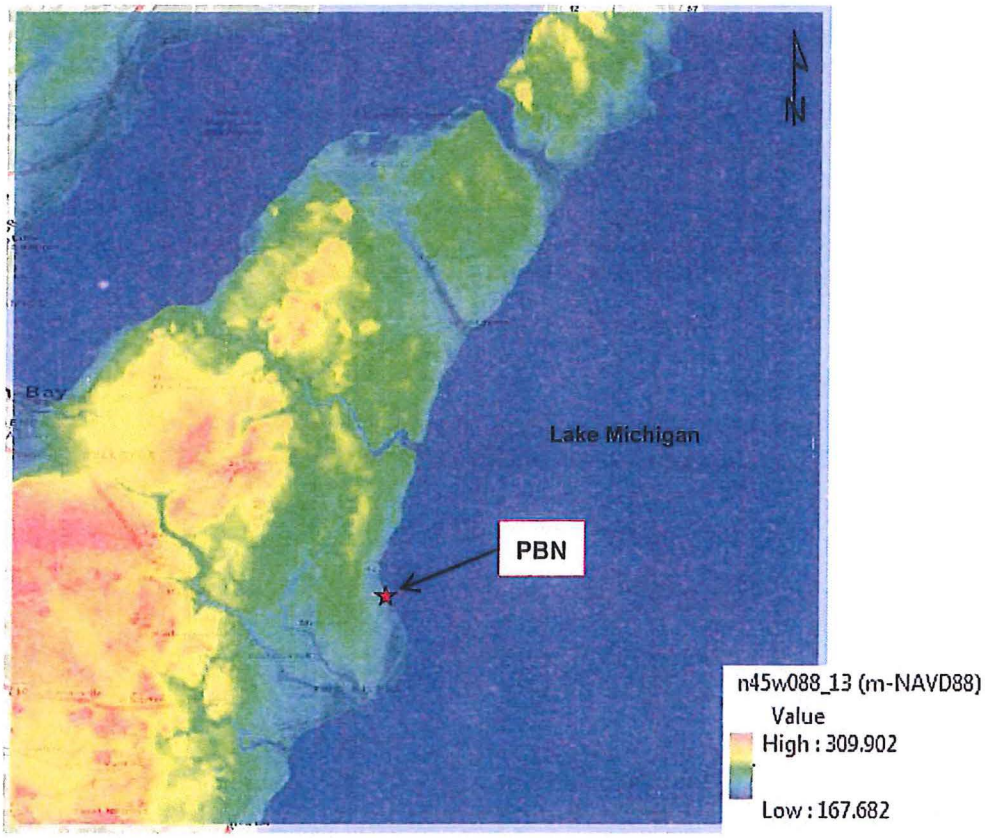


Figure 4. 1/3-arc Second NED (USGS, 2011)

The following outlines the steps to re-project the NED grid files to the WGS84 GCS (horizontal), referenced to 176.0 meters-LWD IGLD85 (vertical), then exported to a text delimited xyz file that can be used in DELFT3D modeling software (Deltares, 2011). The detailed processing using the ESRI ArcGIS Desktop 10.1 SP1 (ESRI, 2012) and Microsoft Access[2] is described under Calculations, Section 7.0 of this calculation.

1. Clip to shoreline within the mask (extent to which the data will be clipped).
2. Convert vertical datum from NAVD88 to 176.0 m-LWD IGLD85 using the National Geodetic Survey (NGS) monument 'LSC B 81' (NGS, 2013) for vertical adjustment.
3. Convert raster to points, where each point represents elevation in meters-NAVD88.
4. Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.
5. Convert elevation to sounding data (values are expressed as negative upward from the reference plane 176.0 m-IGLD85), per DELFT3D user's manual (Deltares, 2011).
6. Export X-Y-Z data to tab delimited xyz text file using Microsoft Access.

---

[2] Ibid.

The shoreline within the mask area will also be clipped and converted to a point feature class. The elevation of the points will be at 0 m-LWD at IGLD85.

7. Clip shoreline (USGS, 2010b) to mask (extent to which the data will be clipped).
8. Convert shoreline feature to points.
9. Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.
10. Add elevation points (z) at 0 m-LWD IGLD85.
11. Export X-Y-Z data to tab delimited xyz text file using Microsoft Access.

6.3 Topography – Site Survey

A site survey of the discharge canals and near-shore bathymetry located along the shoreline of PBN was completed in June 2013 (NEE, 2013a). The survey included a text file of the elevations in a "Point, Northing, Easting, Elevation, Description" text format (shown on Figure 5) and a CAD drawing showing contours and structures (shown on Figure 6). The horizontal coordinates are in the Wisconsin State County System of Manitowoc County, referenced to NAVD88 with units in feet (AECOM, 2013).

Survey Point Data PNEELD format.txt - Notepad

File Edit Format View Help

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60,369751.9360,265822.5360,590.4730,TPT MAG
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106,369732.5960,265860.3990,592.6260,EOC1
107,369712.2150,265869.5100,594.2700,EOC1
108,369713.2840,265849.8520,593.4470,EOC1
109,369699.3810,265846.3760,594.0090,EOC1
110,369699.0030,265845.6660,594.0350,EOC1
111,369713.8710,265839.2930,593.0590,EOC1
112,369730.8060,265832.0800,591.9880,EOC1
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143,369794.0600,265854.1300,589.2150,XYZ
144,369785.0630,265839.3050,589.2110,XYZ
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149,369780.6540,265795.9540,589.0640,XYZ
150,369763.7990,265801.7520,590.0260,XYZ
151,369745.5860,265809.2800,591.0420,XYZ
152,369724.6920,265818.6570,592.3190,XYZ
153,369704.0590,265828.4430,593.5620,XYZ
154,369687.4860,265835.3860,594.6090,XYZ
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157,369663.3250,265862.2790,596.1900,EOB3
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Note:
1st column = P = Point ID
2nd column = N = Northing
3rd column = E = Easting
4th column = EL = Elevation (ft-NAVD88)
5th column = D = Description of point

Figure 5. Snapshot of the survey elevation points in "P,N,E,EL,D" text format (NEE, 2013a)

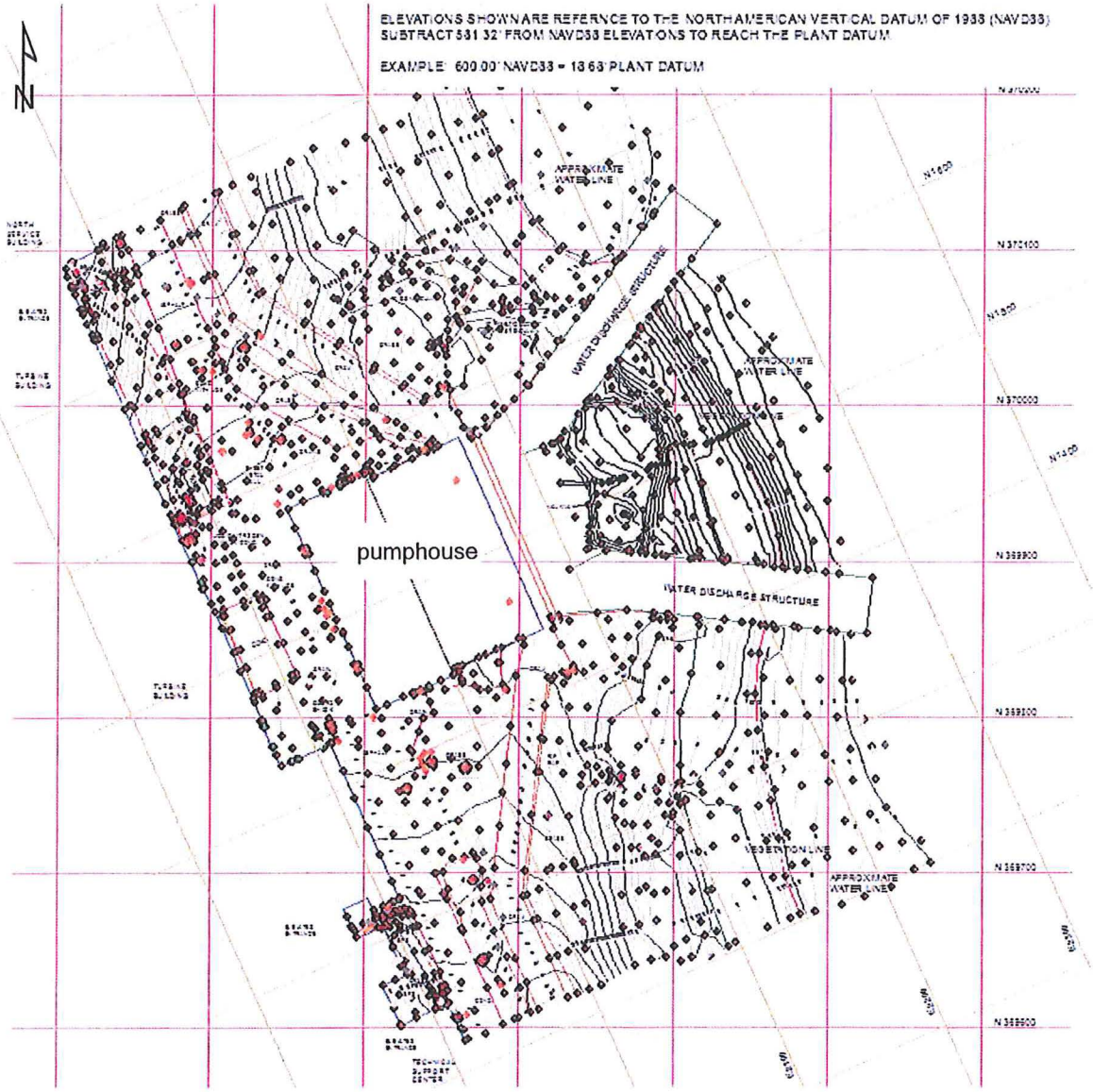

Figure 6. Site Survey, CAD Drawing file (NEE, 2013a)

The following outlines the steps to re-project the survey elevations points to the WGS84 GCS (horizontal), referenced to 176.0 meters-LWD IGLD85 (vertical), then exported to a text delimited xyz file that can be used in the DELFT3D modeling software (Deltares, 2011). The detailed processing using the ESRI ArcGIS Desktop 10.1 SP1 (ESRI, 2012) and Microsoft Access[3] is described under Calculations, Section 7.0 of this calculation.

[3] Ibid.

1. Import survey elevation points (NEE, 2013a) using Add XY dialog tool and create a shapefile.
2. Query only XYZ data so only ground elevation (ID as XYZ) is used.[4]
3. Convert site survey contour lines (NEE, 2013a) to point feature shapefile.
4. Add points to the contour feature points along the discharge flumes[5].
5. Add longitude (x) and latitude (y) in WGS84 GCS to attribute tables in decimal degrees.
6. Convert NAVD88 to 176.0 m-LWD IGLD85 using the National Geodetic Survey (NGS) monument 'LSC B 81' (NGS, 2013) for vertical adjustment.
7. Convert elevation to sounding data (values are expressed as negative upward from the reference plane 176.0 m-IGLD85), per DELFT3D user's manual (Deltares, 2011).
8. Export X-Y-Z data to tab delimited xyz text file using Microsoft Access.

The height of the jersey barrier and the discharge canals will be included at the end of this calculation in IGLD55, NAVD88 and LWD IGLD85. These will be included as the input parameters to calculation FPL-076-CALC-003 "DELF3D Model."

The input files are provided in Attachment A (on DVD).

7. Calculations

7.1 Lake Michigan Bathymetry

7.1.1 Clip Lake Michigan bathymetry to a mask.

The Clip (Data Management) tool was utilized to clip the bathymetry data to the shoreline within the mask area. The Output Coordinates in the Environmental Settings were set to WGS84. Figures 7 and 8 show the Clip tool input parameters and the resulting clipped bathymetric grid in WGS84, respectively.

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[4] The survey point file includes elevations for top of wall, buildings, manholes, base of light pole, electric pedestal, etc. In order to eliminate discrepancy, only XYZ ground points were used for the model.

[5] The survey file does not show contour lines within the discharge flumes. The DELFT3D software cannot read this area, so the points are added to the point feature file to eliminate discrepancy in the software (see Assumption 4.2).

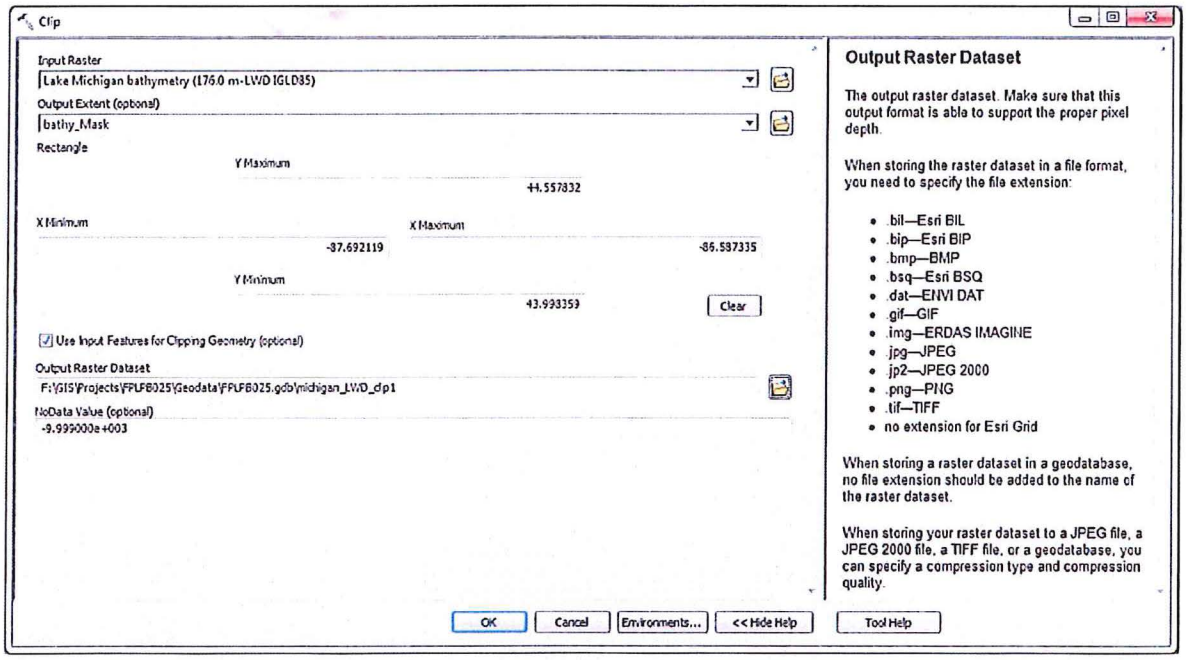

Figure 7. Clip (Data Management) Tool Input Parameters

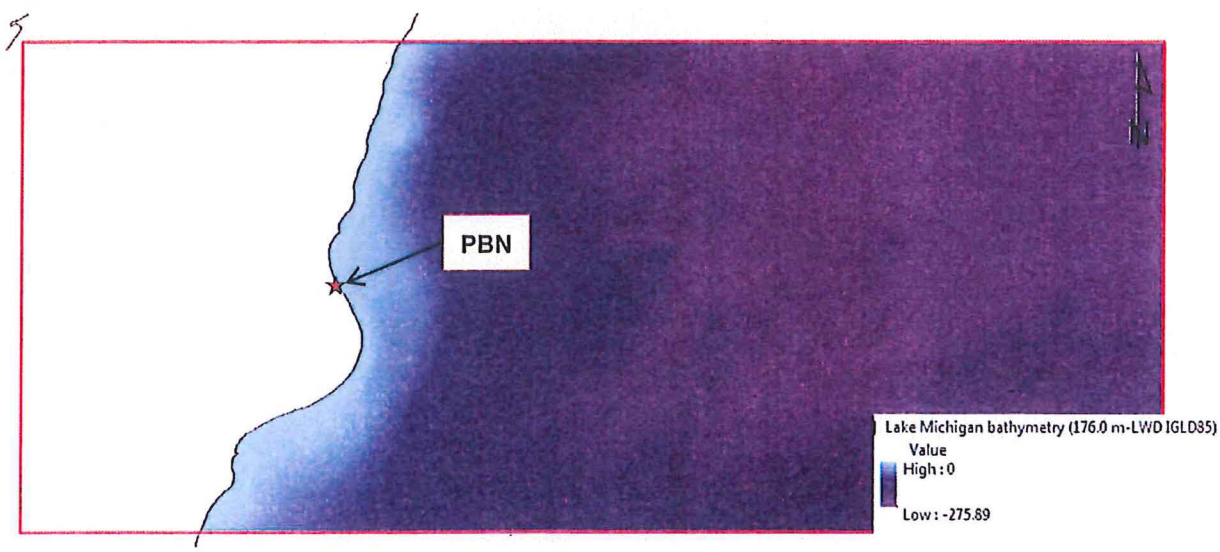

Figure 8. Point features of the Lake Michigan bathymetry, 176.0 m-LWD IGLD85

7.1.2 Convert raster to points, where each point represents elevation in 176.0 meters-LWD IGLD85.

The Raster to Points tool was utilized to convert the ASCII grid file to point feature file. When converting a raster to point, each cell in the input raster converts to a point in the output. That is, each new point is

positioned at the center of the cell it represents. The Raster to Point tool input parameters and the resulting output point feature file is shown on Figures 9 and 10, respectively.

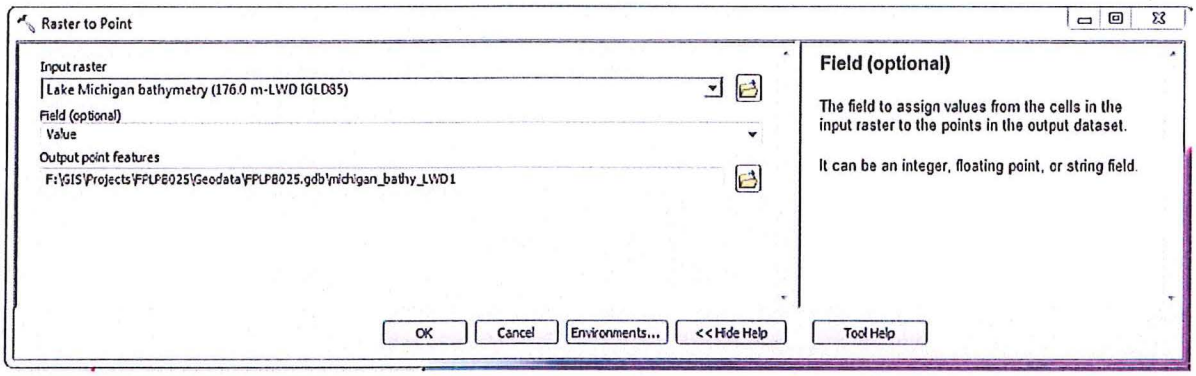

Figure 9. Raster to Points Input Parameters

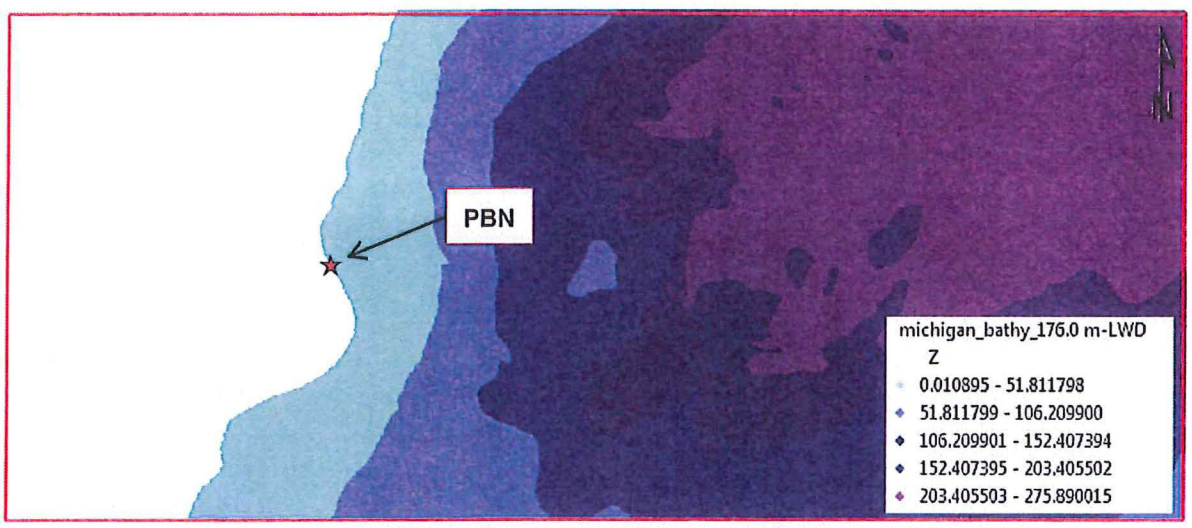

Figure 10. Point Feature of the Lake Michigan bathymetry, 176.0 m-LWD IGLD85

7.1.3 Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.

The Add XY Coordinates tool was utilized to add the longitude (x) and latitude (y) coordinates to the point feature file. The coordinates were set to the WGS84 GCS. Figures 11 and 12 show the Add XY Coordinates tool input parameters and the associated Environmental Settings, respectively.

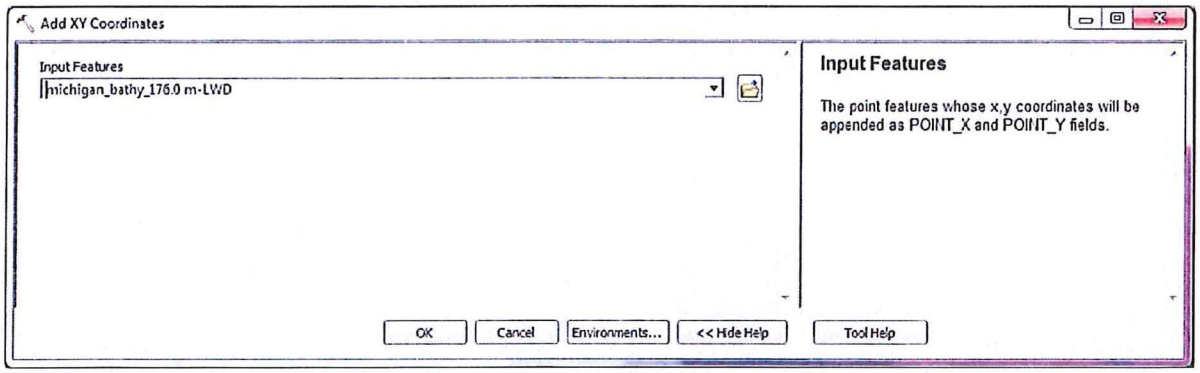

Figure 11. Add XY Coordinates Input Parameters

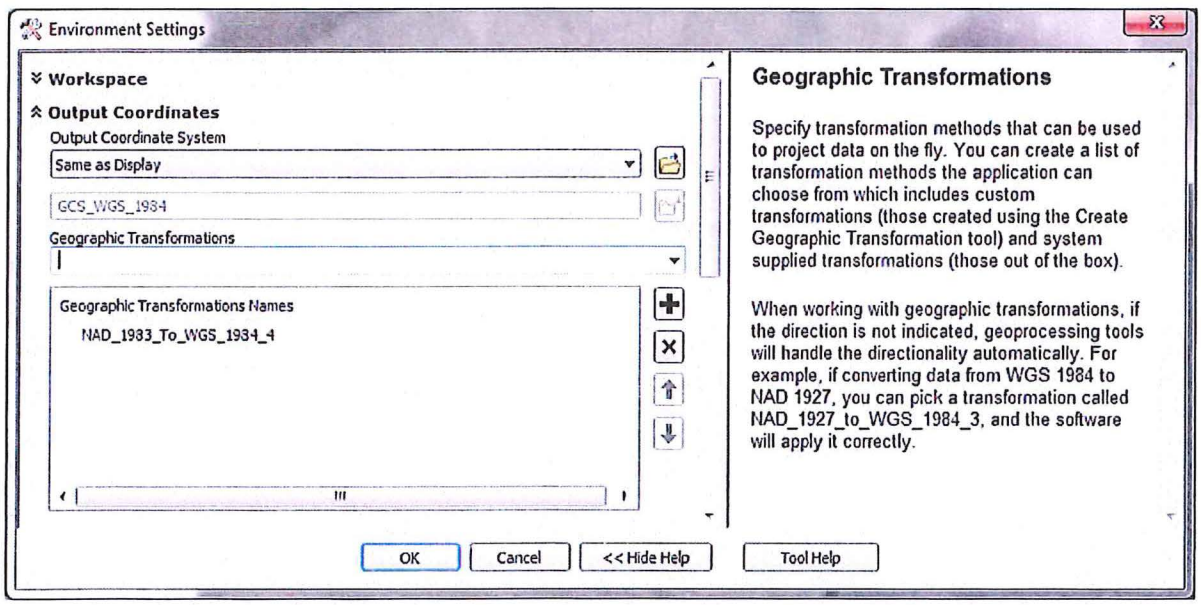

Figure 12. Environmental Settings, Add XY Coordinate Tool

7.1.4 Convert elevation to sounding data (values are expressed as positive downward from the reference plane 176.0 m-LWD IGLD85), per DELFT3D user's manual (Deltares, 2011).

Per DELFT3D User's Manual (Deltares, 2011), the bathymetry was converted to sounding data so that positive units indicate values below the reference plane and negative units indicate values above the reference plane. Since the bathymetry is referenced to 176.0 m-LWD IGLD85, all bathymetric values will be positive below the 176.0 m-IGLD85 elevation, which is at elevation 0 m for the bathymetric data.

The Field Calculator dialog tool was used to convert the bathymetric depths to a positive value by multiplying the elevation field ('Z') by -1. Figure 13 shows the Field Calculator dialog conversion.

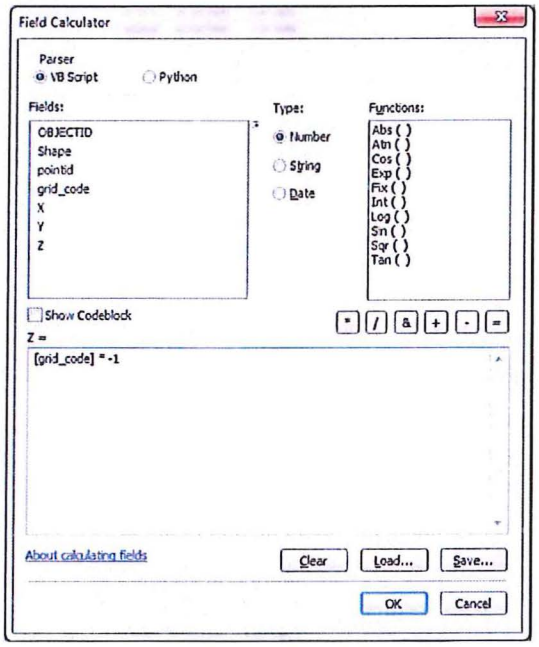

Figure 13. Field Calculator Tool, Convert Units to Negative Value

7.1.5 Export X-Y-Z data to a tab delimited xyz text file using Microsoft Access.

The X-Y-Z data was exported from Microsoft Access as a tab delimited xyz text file due to the fact ArcGIS Desktop 10.1 software does not have the functionality to export to the correct format. This was achieved by importing the associated database file (.dbf) in Microsoft Access and exporting to a tab delimited xyz text file. Three files were exported at approximately 8.3 MB in size. A snapshot of the output tab delimited xyz text file is shown in Figure 14.

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-87.477505	44.170008	27.610305
-87.476672	44.170008	28.110305
-87.475839	44.170008	28.510192
-87.475005	44.170008	29.010192
-87.474172	44.170008	29.410202
-87.473339	44.170008	29.810195
-87.472505	44.170008	30.210205
-87.471672	44.170008	30.610198
-87.470839	44.170008	31.010192
-87.470005	44.170008	31.310195
-87.469172	44.170008	31.710205
-87.468339	44.170008	32.010101
-87.467505	44.170008	32.310104
-87.466672	44.170008	32.610107
-87.465839	44.170008	32.910110
-87.465005	44.170008	33.210113
-87.464172	44.170008	33.510101
-87.463339	44.170008	33.810104
-87.462505	44.170008	34.010101
-87.461672	44.170008	34.309997
-87.460839	44.170008	34.610000
-87.460005	44.170008	35.009994
-87.459172	44.170008	35.410003
-87.458339	44.170008	35.910003
-87.457505	44.170008	36.410003
-87.456672	44.170008	36.910003
-87.455839	44.170008	37.509994
-87.455005	44.170008	38.110000
-87.454172	44.170008	38.709899
-87.453339	44.170008	39.309890
-87.452505	44.170008	40.009887
-87.451672	44.170008	40.709899
-87.450839	44.170008	41.409896
-87.450005	44.170008	42.109893
-87.449172	44.170008	42.809890
-87.448339	44.170008	43.409896
-87.447505	44.170008	44.109802
-87.446672	44.170008	44.709808
-87.445839	44.170008	45.309799
-87.445005	44.170008	45.909805
-87.444172	44.170008	46.609802
-87.443339	44.170008	47.209808
-87.442505	44.170008	47.809799
-87.441672	44.170008	48.509704
-87.440839	44.170008	49.109703
-87.440005	44.170008	49.809700
-87.439172	44.170008	50.409706
-87.438339	44.170008	51.009704
-87.437505	44.170008	51.609703
-87.436672	44.170008	52.109703
-87.435839	44.170008	52.609703

Note:
1st column = X = Longitude
2nd column = Y = Latitude
3rd column = Z = depth below/above reference (0) plane
(+ down from plane, - up from plane)

Figure 14. Snapshot of Final Bathymetry Tab Delimited XYZ Text File

Output files are provided on a DVD in Attachment A.

7.2 Topography – Digital Elevation Model

7.2.1 Clip to shoreline within the mask area.

The Clip (Data Management) tool was utilized to clip the DEM binary float grid to the shoreline within the mask area. The Output Coordinates in the Environmental Settings were set to WGS84. Figures 15 and 16 show the Clip tool input parameters and the resulting clipped bathymetric grid in WGS84, respectively.

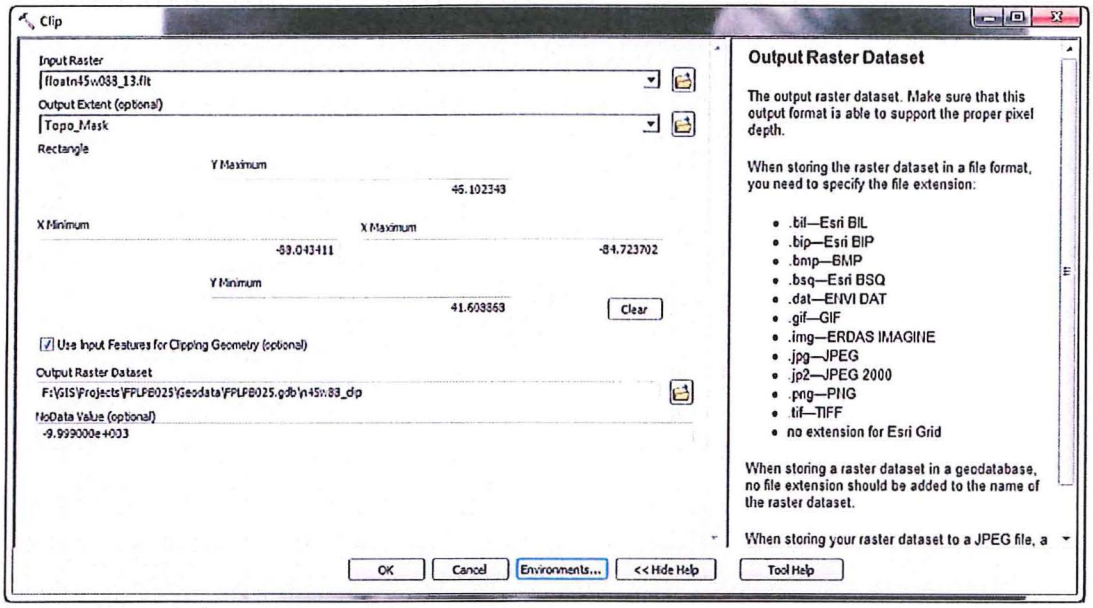

Figure 15. Clip (Data Management) Input Parameters

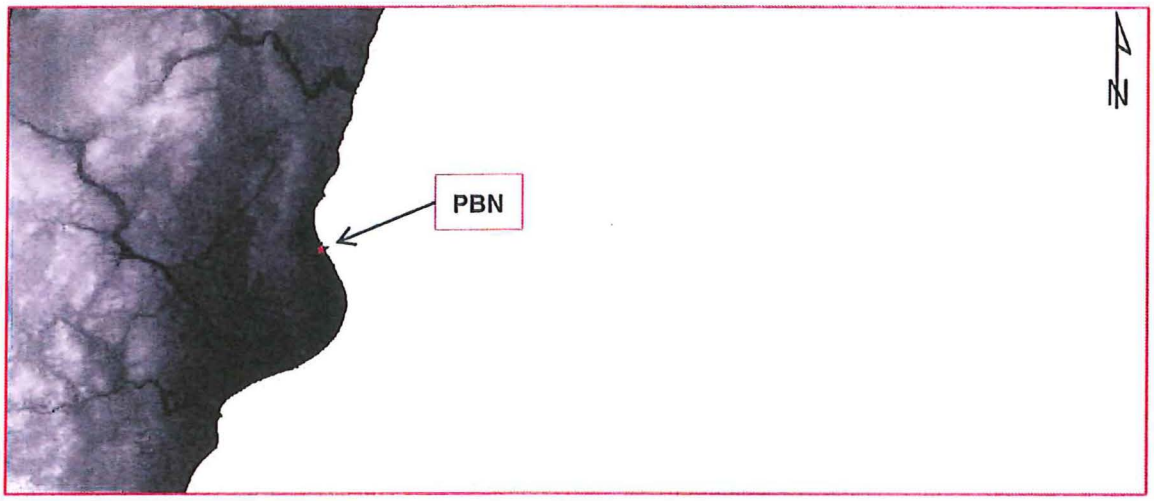

Figure 16. 1/3-arc Second DEM Clip to Mask

7.2.2 Convert NAVD88 to 176.0 m-LWD IGLD85 using the National Geodetic Survey (NGS) monument 'LSC B 81' (NGS, 2013) for vertical adjustment.

Converting the DEM binary float grid vertical datum from m-NAVD88 to 176.0 m-LWD IGLD85 is a two-step process. First, the data is converted from NAVD88 to IGLD85. Then the LWD of 176.0 (NOAA, 2013) is added to IGLD85 to obtain the LWD IGLD85 height for Lake Michigan.

According to the article "Establishment of International Great Lakes Datum (1985)" published by the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, "the development of the NAVD (1988) was to include vertical control networks of the U.S., Canada and Mexico, as well as International Great Lakes Datum data. For NAVD (1988), a minimum-constraint adjustment was performed also holding fixed the primary benchmark at Pointe-au-Pere/Rimouski. Therefore, IGLD (1985) and NAVD (1988) are one and the same. The only difference between IGLD (1985) and NAVD (1988) is that the IGLD (1985) bench mark elevations are published as dynamic heights[6] and the NAVD (1988) elevations are published as Helmert orthometric heights[7]" (NOAA, 1995, p. 13).

The benchmark LSC 7 B 81 (NGS, 2013) was used as the vertical benchmark for the site survey as indicated in an e-mail from AECOM to ENERCON, dated June 20, 2013 (AECOM, 2013). According to benchmark LSC 7 B 81, the difference between the established NAVD88 height and the dynamic height is 0.027 m (0.09 ft). The Raster Calculator tool was utilized to convert NAVD88 to IGLD85 using a difference of 0.027 m.

The IGLD85 LWD for Lake Michigan is 176.0 meters (NOAA, 2013a), which is the reference plane for the bathymetric dataset (NOAA, 1996)[8]. The IGLD85 datum could also be considered as a height equivalent above mean sea level, based on the adopted elevation at Rimouski, Quebec, Canada (Rimouski) (NOAA, 1999). Figure 17 shows the reference point for IGLD85 at Rimouski with the associated vertical and horizontal relationship to the Great Lakes-St Lawrence River System (NOAA, 1992).

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[6] The dynamic height of a benchmark is the height of a reference latitude of the geopotential surface through that benchmark. In general, the dynamic height is computed from the geopotential height. [Geopotential_ht = ortho_ht * (gravity + (4.24E-5 * ortho_ht))] Dynamic height is then obtained by dividing the adjusted NAVD88 geopotential heigth of a benchmark by the normal gravity, G, computed on the GRS80 ellipsoid at 45° North. [G = 980.6199 gal] (NGS, 2012).

[7] Orthometric height is the difference between ellipsoidal heights, h, and geoidal heights, N. [H = h - N] (NOAA, 1985).

[8] 176.0 m-ILGD85 = 0 m Lake Michigan LWD for the dataset. That is, data below the 176.0 meters if negative and data above is positive in the dataset (NOAA, 1996).

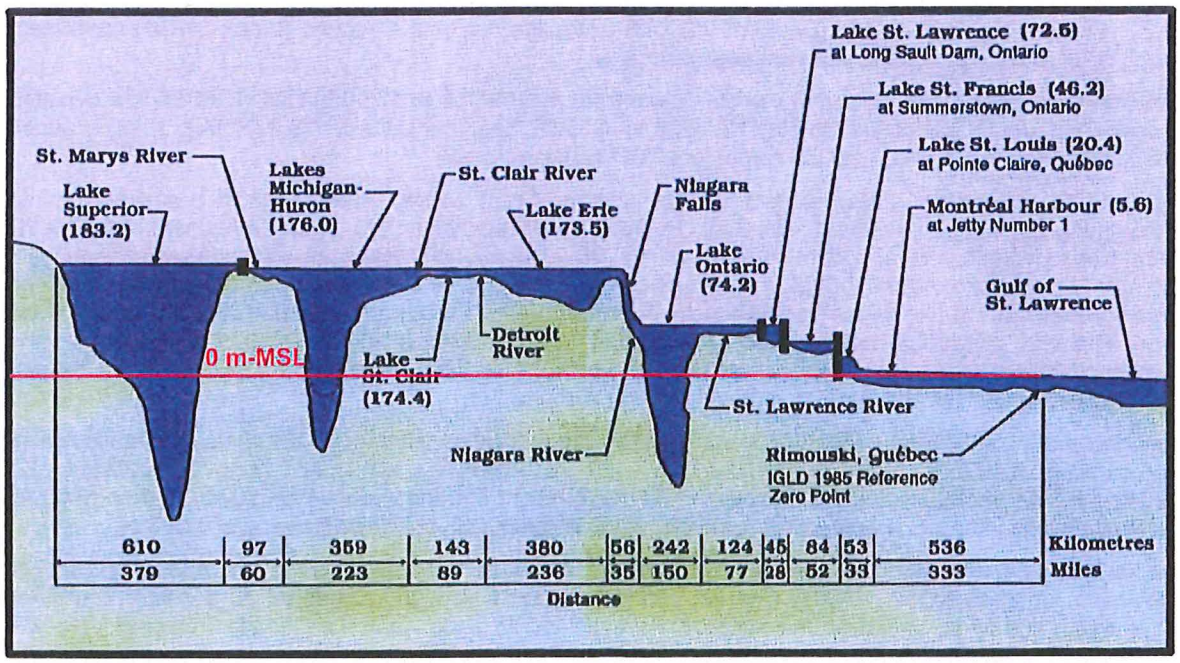

Figure 17. Great Lakes System Profile: Vertical and Horizontal Relationships (NOAA, 1992)

To convert to LWD at IGLD85 for Lake Michigan, 176.0 m was subtracted from the DEM binary float grid file. The elevation at 176.0 m becomes the 0 m elevation point for which the data below that reference point becomes negative and data above is positive. For example, the maximum elevation in the DEM grid file is 315.83 meters-NAVD88. To convert to LWD at IGLD85, the dynamic height of 0.027 m and the LWD of 176.0 m was subtracted from the data. So, an elevation of 315.83 m-NAVD88 would equate to 139.80 m-LWD IGLD85 (315.83 – 0.027 – 176.0). Thus, the maximum height in the clipped DEM dataset is 139.80 meters above LWD (176.0 m-IGLD85).

The Raster Calculator was used to subtract the dynamic height of 0.027 m and the LWD of 176.0 m from the DEM binary float grid. The output coordinates were set in the Environmental Settings to convert from NAD83 to WGS84. Figures 18 and 19 show the Raster Calculator tool input parameters and the associated Environmental Settings, respectively.

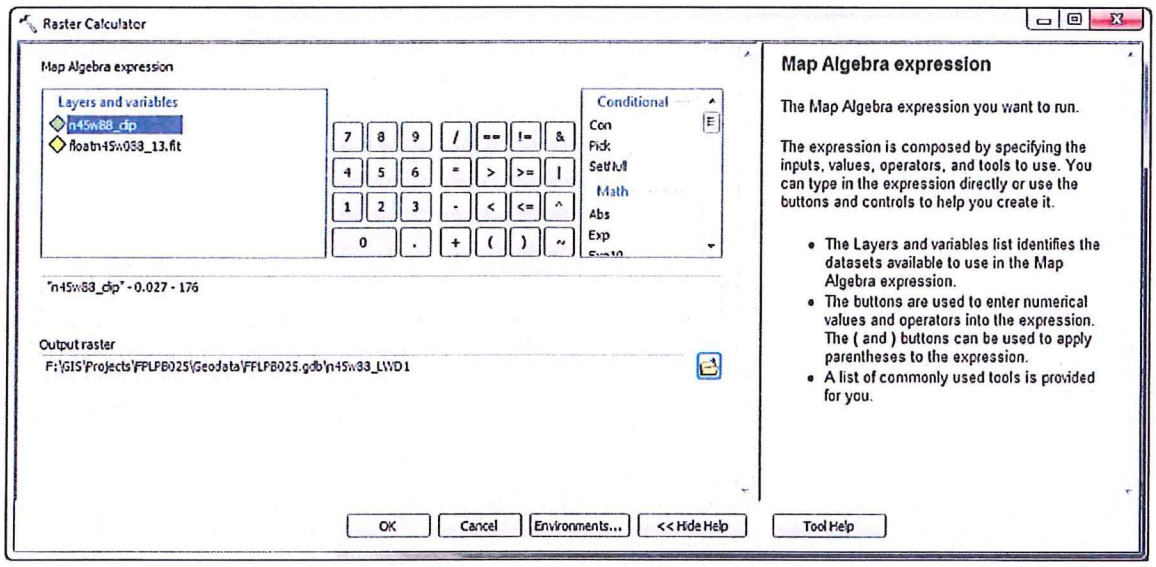

Figure 18. Raster Calculator Tool Input Parameters

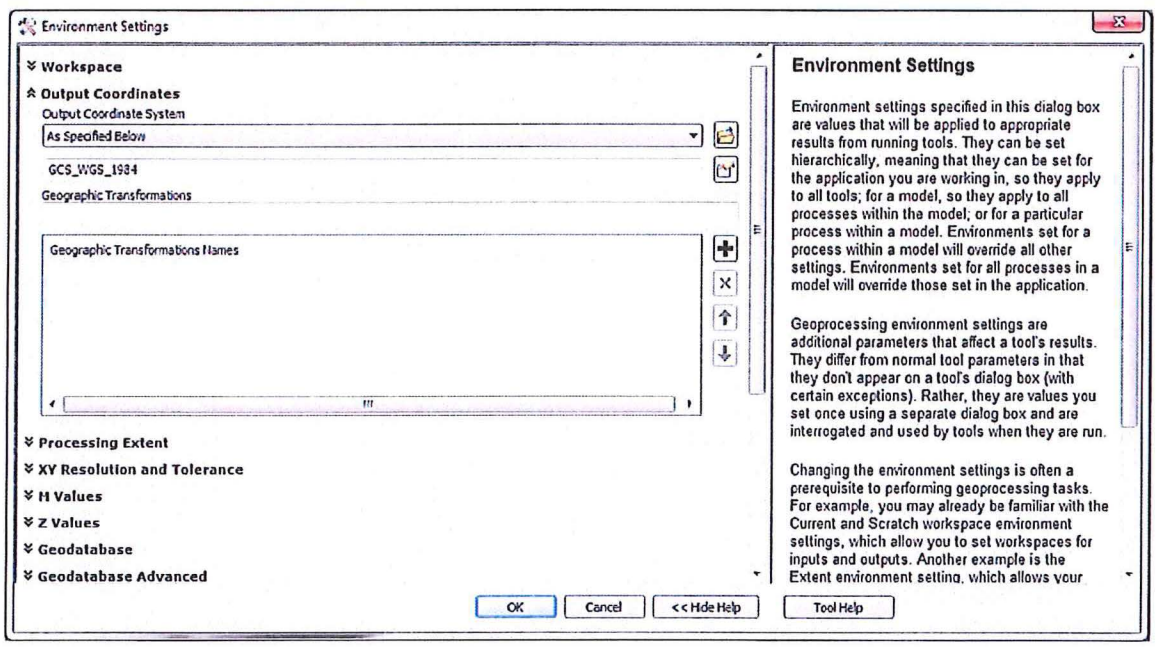

Figure 19. Environmental Setting Parameters, Raster Calculator Tool

7.2.3 Convert raster to points, where each point represents elevation in meters-NAVD88.

The Raster to Points tool was utilized to convert the DEM binary float grid to a point feature file, where each point represented the ground elevation in m-NAVD88. The Raster to Point tool input parameters and the resulting output point feature file is shown on Figures 20 and 21, respectively.

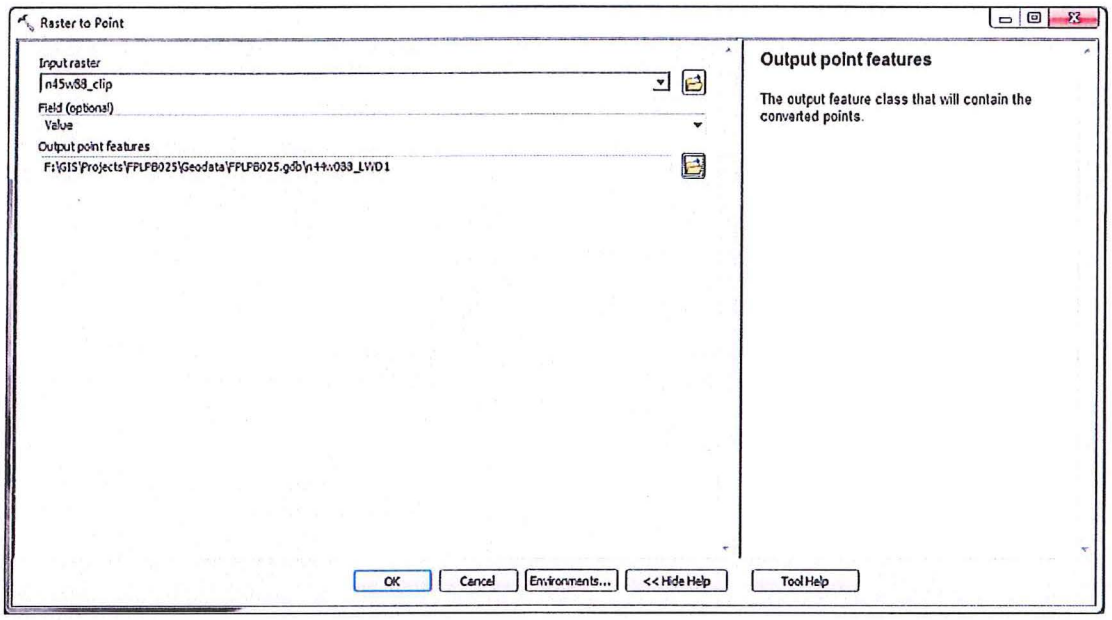

Figure 20. Raster to Point Tool Input Parameters

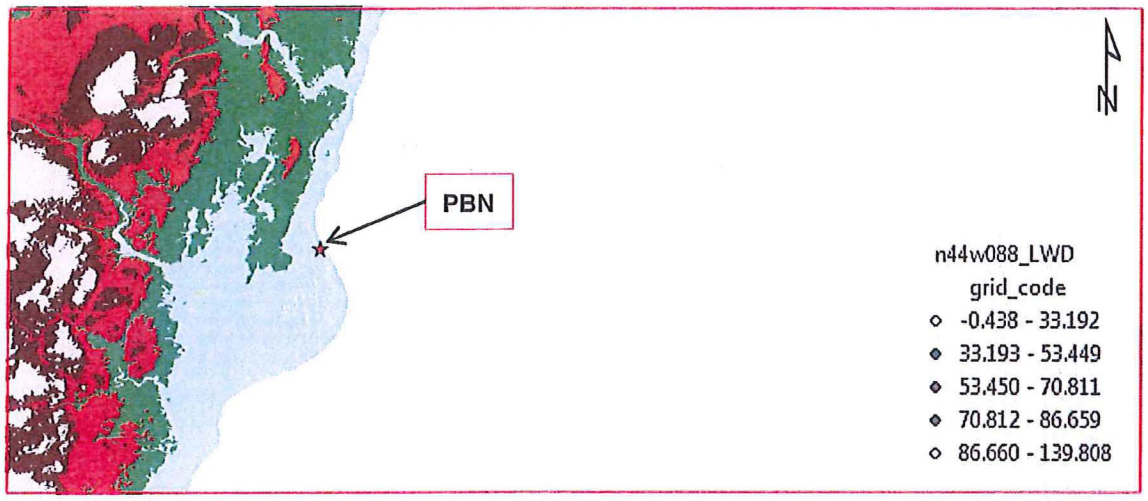

Figure 21. Topographic Feature Points

7.2.4 Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.

The Add XY Coordinates tool was utilized to add the longitude (x) and latitude (y) coordinates to the DEM point feature file. The coordinates were set to the WGS84 GCS. Figures 22 and 23 show the Add XY Coordinates tool input parameters and the associated Environmental Settings.

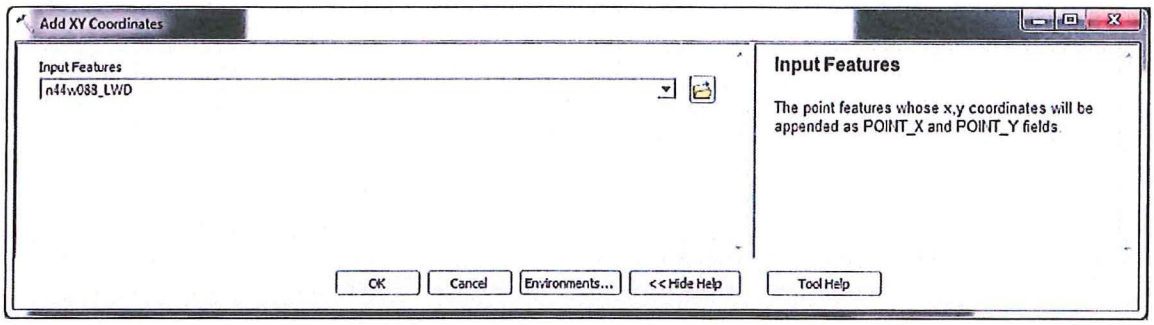

Figure 22. Add XY Tool Input Parameters

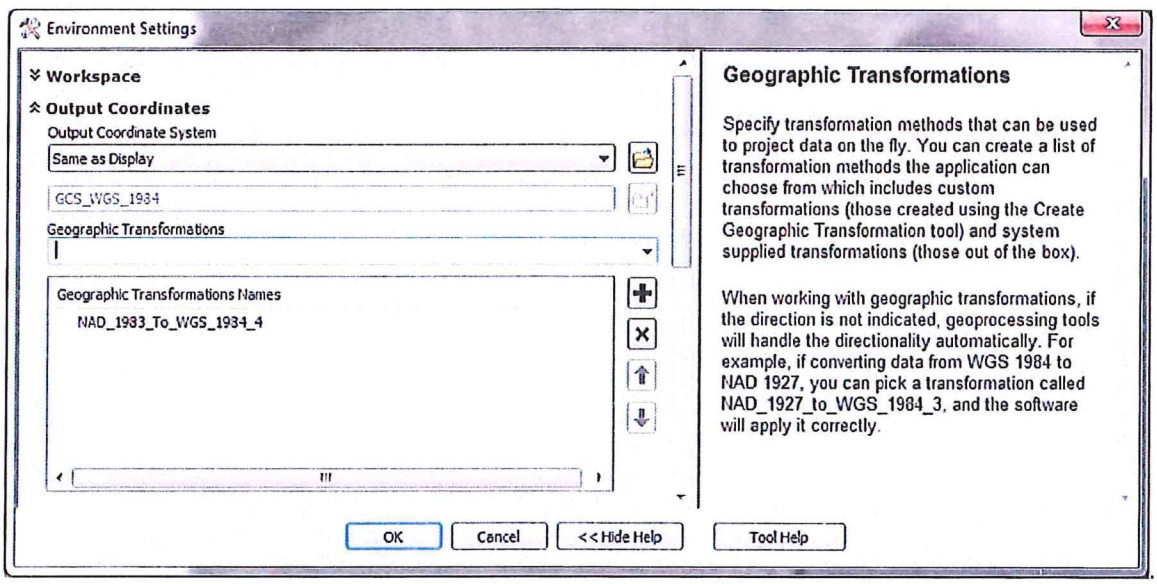

Figure 23. Environmental Settings, Add XY Tool

7.2.5 Convert elevation to sounding data (values are expressed as negative upward from the reference plane 176.0 m-IGLD85), per DELFT3D user's manual (Deltares, 2011).

Per DELFT3D User's Manual (Deltares, 2011), the bathymetry was converted to sounding data so that positive units indicate values below the reference plane and negative units indicate values above the reference plane.

The Field Calculator dialog tool was utilized to convert the elevation points ('Z') to a negative value by multiplying the elevation field by -1. Figure 24 shows the Field Calculator dialog conversion.

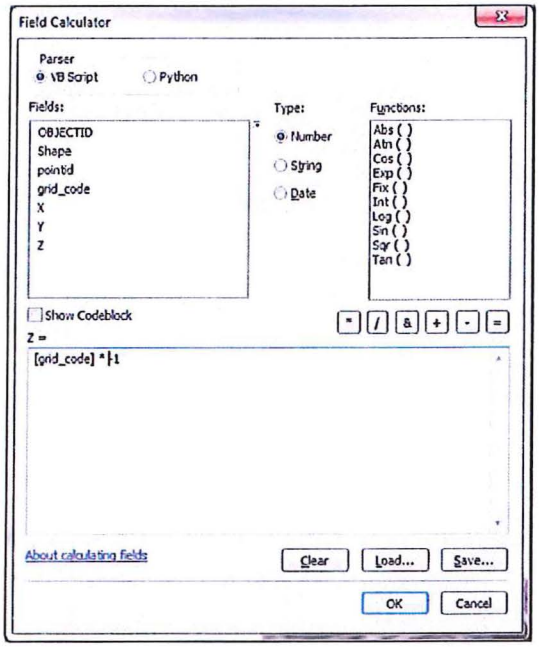

Figure 24. Field Calculator Tool, Convert Units to Negative Value

7.2.6 Export X-Y-Z data to tab delimited xyz text file using Microsoft Access.

The X-Y-Z data was exported from Microsoft Access as a tab delimited xyz text file due to the fact ArcGIS Desktop 10.1 software does not have the functionality to export to the correct format. This was achieved by importing the associated database file (.dbf) in Microsoft Access and exporting to a tab delimited xyz text file. Five files were exported at approximately 147 MB in size. A snapshot of a file output tab delimited xyz text file is shown in Figure 25.

-87.898107	44.557739	-19.943740
-87.898015	44.557739	-19.948852
-87.897922	44.557739	-20.028244
-87.897829	44.557739	-20.016403
-87.897737	44.557739	-19.795486
-87.897644	44.557739	-19.331100
-87.897552	44.557739	-19.164810
-87.897459	44.557739	-19.094299
-87.897366	44.557739	-18.847503
-87.897274	44.557739	-18.760726
-87.897181	44.557739	-18.834915
-87.897089	44.557739	-18.829376
-87.896996	44.557739	-18.982971
-87.896903	44.557739	-18.974380
-87.896811	44.557739	-18.998840
-87.896718	44.557739	-18.901214
-87.896626	44.557739	-18.897232
-87.896533	44.557739	-18.928619
-87.896440	44.557739	-18.888565
-87.896348	44.557739	-18.893600
-87.896255	44.557739	-18.938903
-87.896163	44.557739	-19.093765
-87.896070	44.557739	-19.308959
-87.895977	44.557739	-19.083297
-87.895885	44.557739	-19.223388
-87.895792	44.557739	-19.212142
-87.895700	44.557739	-19.262908
-87.895607	44.557739	-19.364288
-87.895515	44.557739	-19.426071
-87.895422	44.557739	-19.515838
-87.895329	44.557739	-19.694305
-87.895237	44.557739	-19.865661
-87.895144	44.557739	-19.994338
-87.895052	44.557739	-20.079086
-87.894959	44.557739	-20.193313
-87.894866	44.557739	-20.291305
-87.894774	44.557739	-20.366012
-87.894681	44.557739	-20.555053
-87.894589	44.557739	-20.666976
-87.894496	44.557739	-20.878356
-87.894403	44.557739	-21.099380
-87.894311	44.557739	-21.134475
-87.894218	44.557739	-21.044479
-87.894126	44.557739	-21.039321
-87.894033	44.557739	-21.062896
-87.893940	44.557739	-21.122833
-87.893848	44.557739	-21.164932
-87.893755	44.557739	-21.228317
-87.893663	44.557739	-21.391174
-87.893570	44.557739	-21.540512
-87.893477	44.557739	-21.711364

Note:
1st column = X = Longitude
2nd column = Y = Latitude
3rd column = Z = depth below/above reference (0) plane
(+ down from plane, - up from plane)

Figure 25. Snapshot of Final Topographic Tab Delimited XYZ Text File

7.2.7 Clip shoreline (USGS, 2013) to mask (extent to which the data will be clipped).

The Clip (Data Management) tool was utilized to clip the shoreline to the mask area. Figure 26 shows the clipped shoreline.

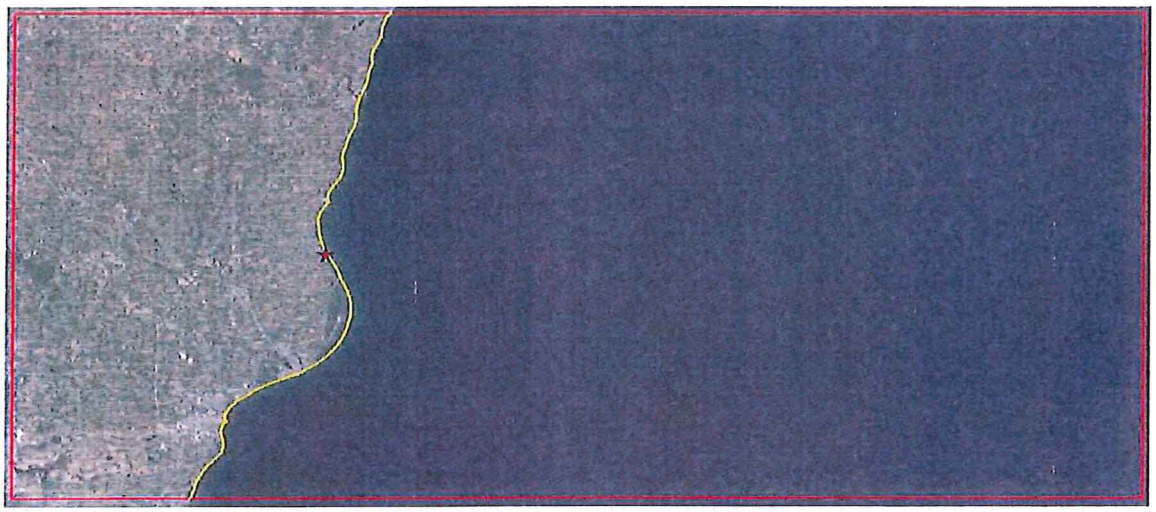

Figure 26. Shoreline Clipped within Mask

7.2.8 Convert features to points at every 10 feet intervals.

The Features to Points tool was utilized to convert the shoreline to points. Figure 27 shows the point features class.

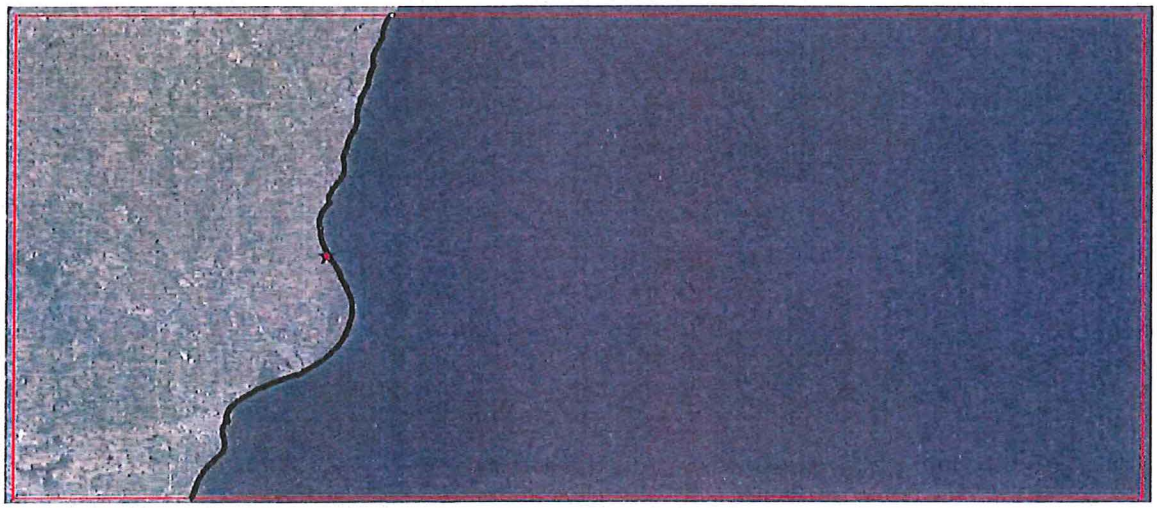

Figure 27. Shoreline Feature Points (0 m-LWD IGLD85)

7.2.9 Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.

The Add XY Coordinates tool was utilized to add the longitude (x) and latitude (y) coordinates to the DEM point feature file. The coordinates were set to the WGS84 GCS. Figures 28 and 29 show the Add XY Coordinates tool input parameters and the associated Environmental Settings.

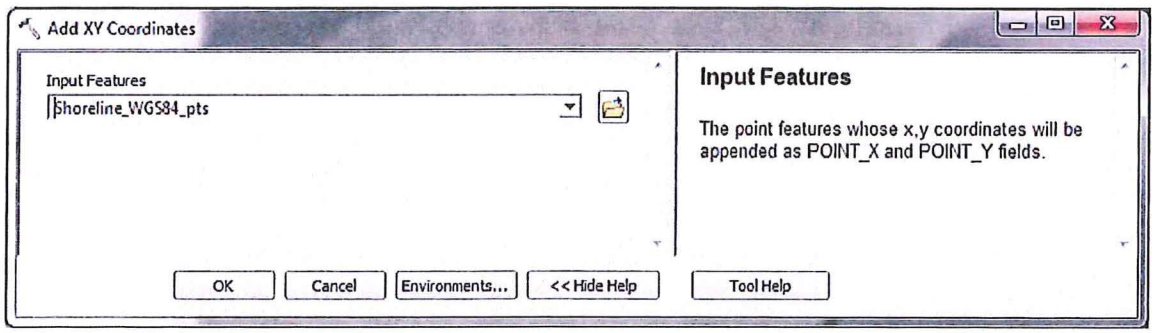

Figure 28. Add XY Coordinates Tool Input Parameters

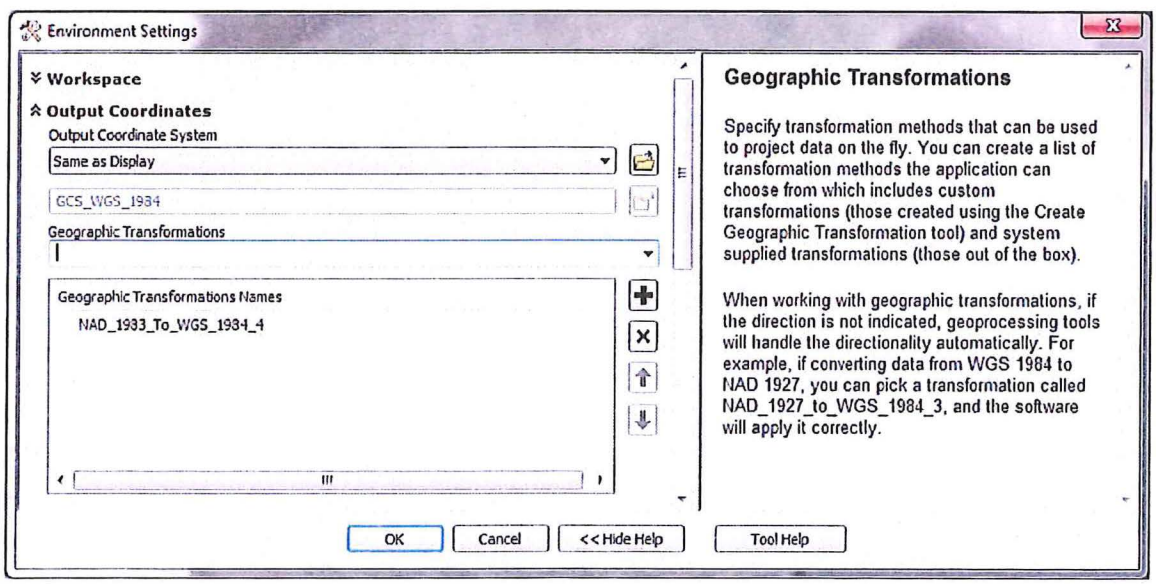

Figure 29. Environmental Settings, Add XY Coordinates Tool

7.2.10 Add elevation points (z) at 0 m-LWD IGLD85.

The elevation 'Z' was added to the attribute table as a double type numerical field. The Field Calculator was utilized to denote a 0 elevation for all the attributes.

7.2.11 Export X-Y-Z data to tab delimited xyz text file using Microsoft Access.

The X-Y-Z data was exported from Microsoft Access as a tab delimited xyz text file due to the fact ArcGIS Desktop 10.1 software does not have the functionality to export to the correct format. This was achieved by importing the associated database file (.dbf) in Microsoft Access and exporting to a tab delimited xyz text file. Five files were exported at approximately 713 KB in size. A snapshot of a file output tab delimited xyz text file is shown in Figure 30.

```
-87.691853 43.998814  0.000000
-87.691838 43.998839  0.000000
-87.691822 43.998864  0.000000
-87.691806 43.998889  0.000000
-87.691791 43.998914  0.000000
-87.691775 43.998939  0.000000
-87.691759 43.998964  0.000000
-87.691744 43.998989  0.000000
-87.691728 43.999014  0.000000
-87.691712 43.999039  0.000000
-87.691697 43.999064  0.000000
-87.691681 43.999089  0.000000
-87.691664 43.999114  0.000000
-87.691647 43.999138  0.000000
-87.691629 43.999162  0.000000
-87.691611 43.999186  0.000000
-87.691593 43.999211  0.000000
-87.691575 43.999235  0.000000
-87.691558 43.999259  0.000000
-87.691540 43.999283  0.000000
-87.691522 43.999308  0.000000
-87.691504 43.999332  0.000000
-87.691486 43.999356  0.000000
-87.691468 43.999380  0.000000
-87.691448 43.999403  0.000000
-87.691429 43.999427  0.000000
-87.691409 43.999451  0.000000
-87.691390 43.999474  0.000000
-87.691370 43.999498  0.000000
-87.691350 43.999521  0.000000
-87.691331 43.999545  0.000000
-87.691311 43.999568  0.000000
-87.691292 43.999592  0.000000
-87.691272 43.999615  0.000000
-87.691256 43.999640  0.000000
-87.691242 43.999665  0.000000
-87.691229 43.999691  0.000000
-87.691215 43.999717  0.000000
-87.691201 43.999742  0.000000
-87.691188 43.999768  0.000000
-87.691174 43.999793  0.000000
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-87.691147 43.999845  0.000000
-87.691133 43.999870  0.000000
-87.691119 43.999896  0.000000
-87.691107 43.999922  0.000000
-87.691095 43.999948  0.000000
-87.691083 43.999974  0.000000
-87.691072 44.000000  0.000000
-87.691060 44.000026  0.000000
-87.691048 44.000052  0.000000
```

Note:
1st column = X = Longitude
2nd column = Y = Latitude
3rd column = Z = depth below/above reference (0) plane
(+ down from plane, - up from plane)

Figure 30. Snapshot of Final Shoreline Tab Delimited XYZ Text File

Output files are provided on a DVD in Attachment A.

7.3 Topography – Site Survey

7.3.1 Import elevation points using Add XY dialog tool and create a shapefile.

The Add XY Data tool as utilized to import the survey elevation points. The Coordinate System was set to NAD_1983_HARB_WISCRS_Manitowoc_County_Feet, with the Z Coordinate System set as NAVD 1988. Figures 31 and 31 show the Add XY Data tool input parameters and the resulting shapefile, respectively.

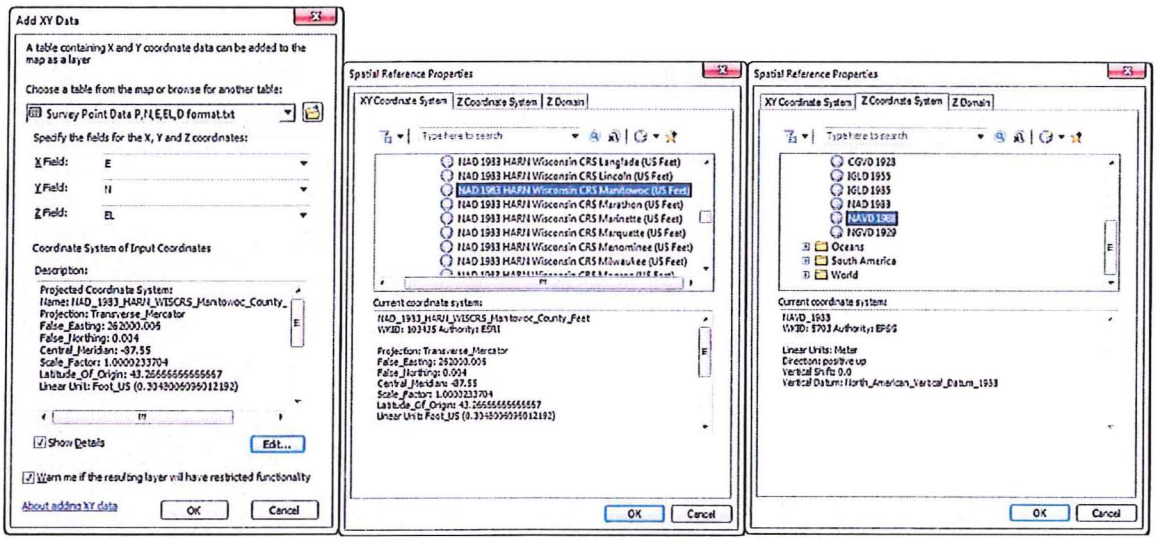


Figure 31. Add XY Data Tool Input Parameters for Survey Elevation Points

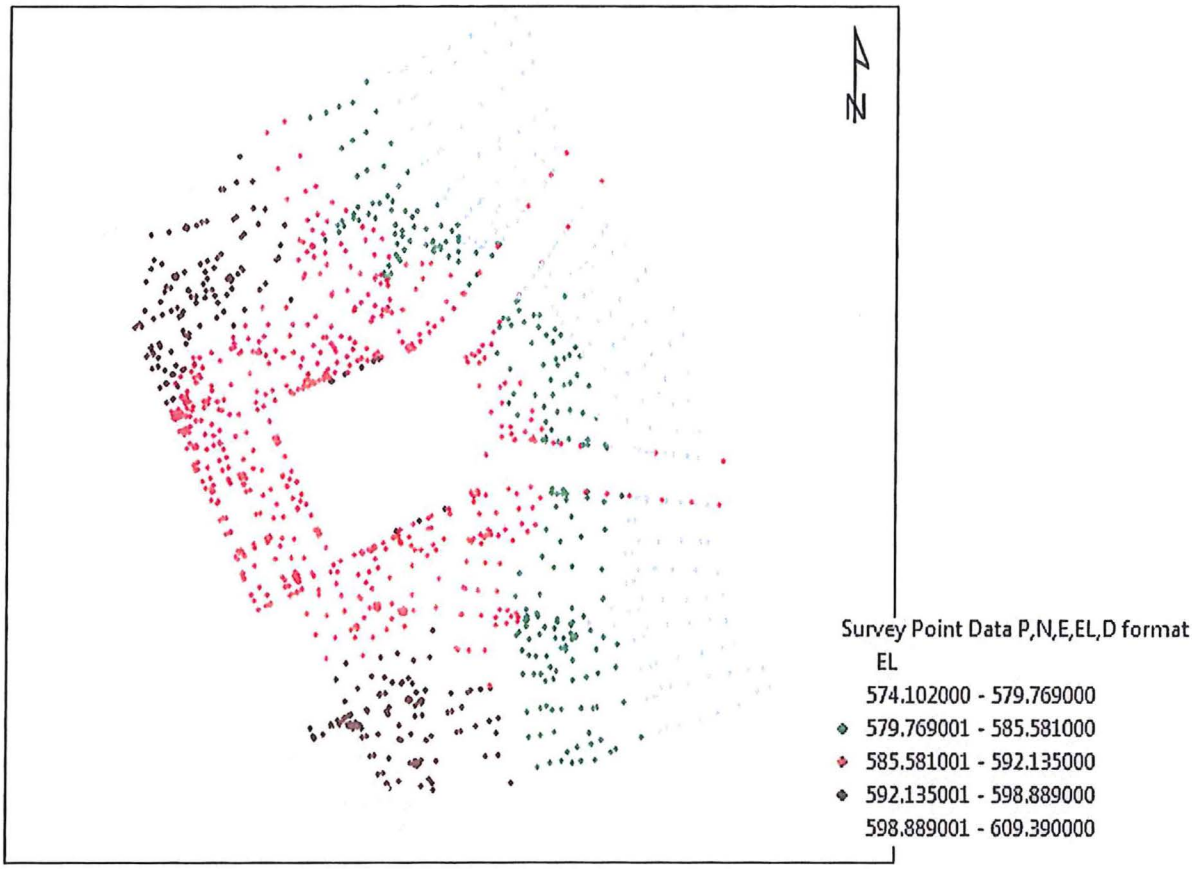


Figure 32. Survey Points as a Shapefile, Referenced to ft-NAVD88

7.3.2 Query only XYZ data so only ground elevation (ID as XYZ) is used.[9]

Since the ground survey elevation will be used in the DELFT3D modeling software (Deltares, 2011), the survey point feature dataset was queried to only use those points. The Query Builder dialog tool was utilized to query the points designated as 'XYZ' in the description field. Figures 33 and 34 show the Query Builder input parameters and the resulting dataset, respectively.

[9] The survey point file includes elevations for top of wall, buildings, manholes, base of light pole, electric pedestal, etc. In order to eliminate discrepancy, only XYZ ground points were used for the model.

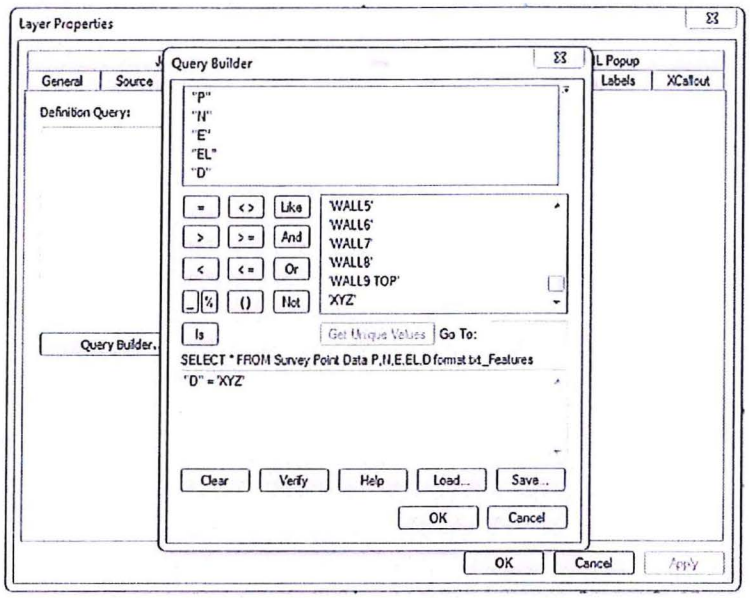


Figure 33. Query Builder Tool, XYZ data

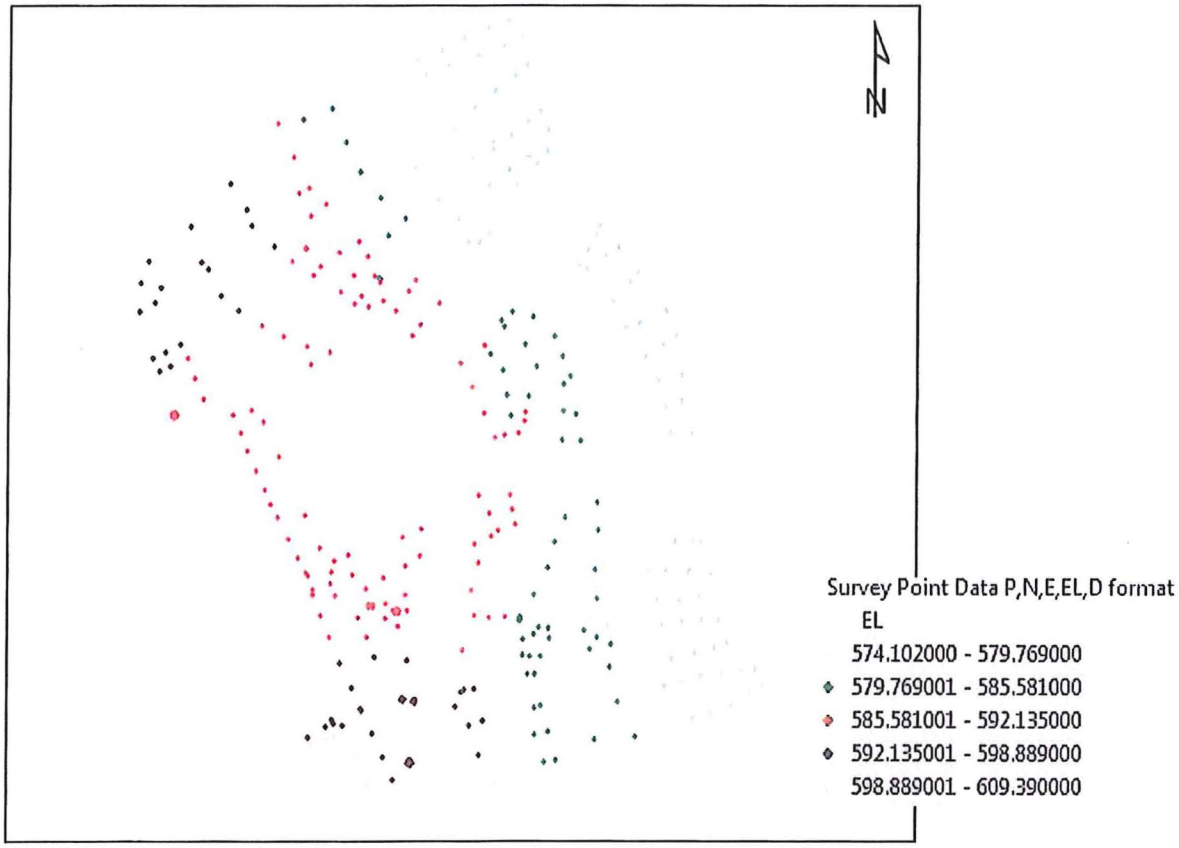


Figure 34. XYZ Survey Elevation Points, Referenced to ft-NAVD88

7.3.3 Convert site survey contour lines (NEE, 2013a) to point feature shapefile.

The contour lines were queried in the Drawing Layers tab under the CAD file Layer Properties. The Features to Points tool was utilized to convert the contour lines into point features. Figure 36 shows the resulting contour point features.

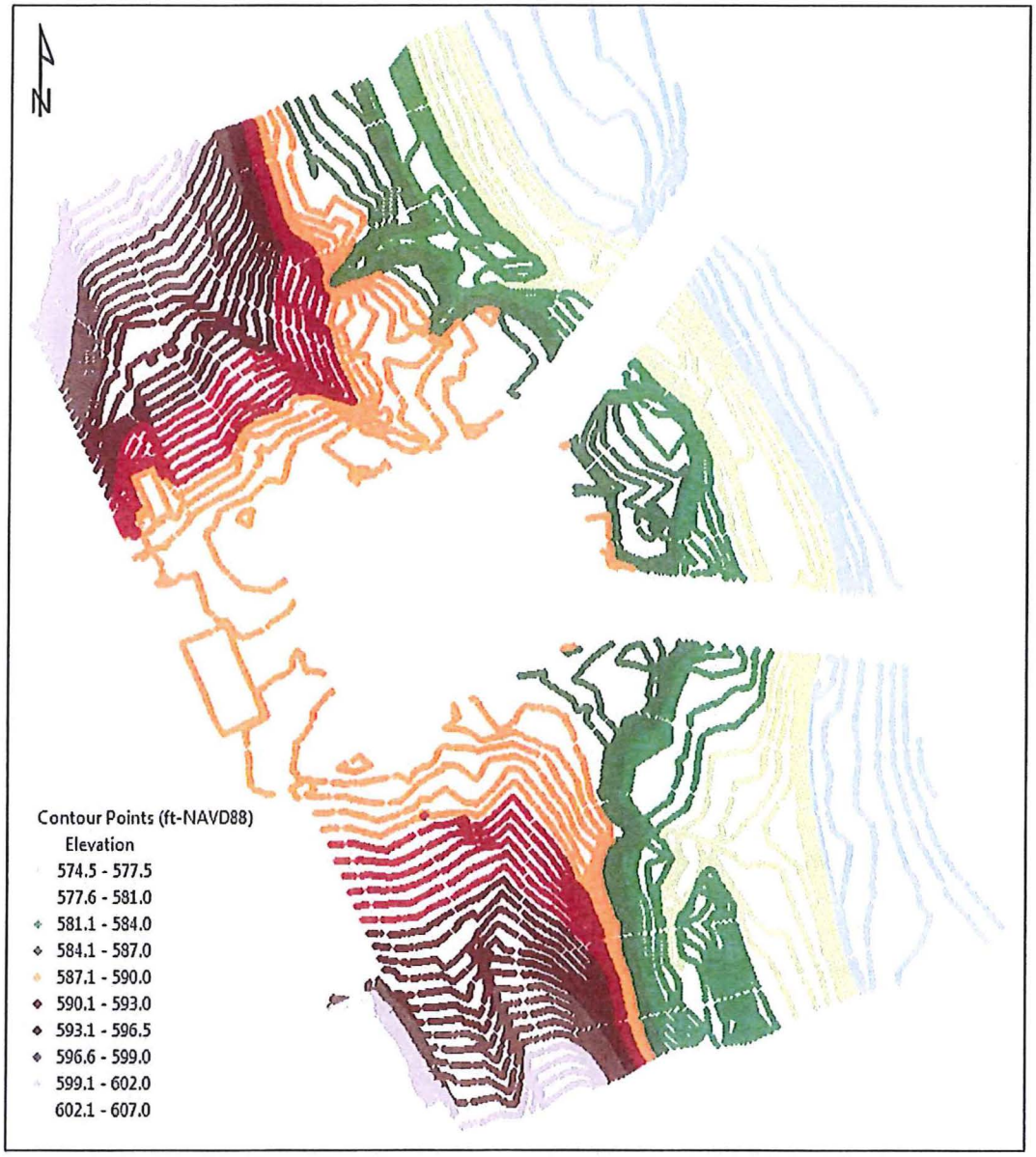


Figure 35. Site Survey Contours Shown as Point Features

7.3.4 Add points to the contour feature points along the discharge flumes[10].

To eliminate discrepancy between the discharge flume area that does not designate elevation and the contoured area within the DELFT3D modeling software, contour lines were connected within both discharge canals. The contour lines were then converted to points utilizing the Points to Features tool. Figure 36 shows the contour lines and the point feature class within the discharge canals.

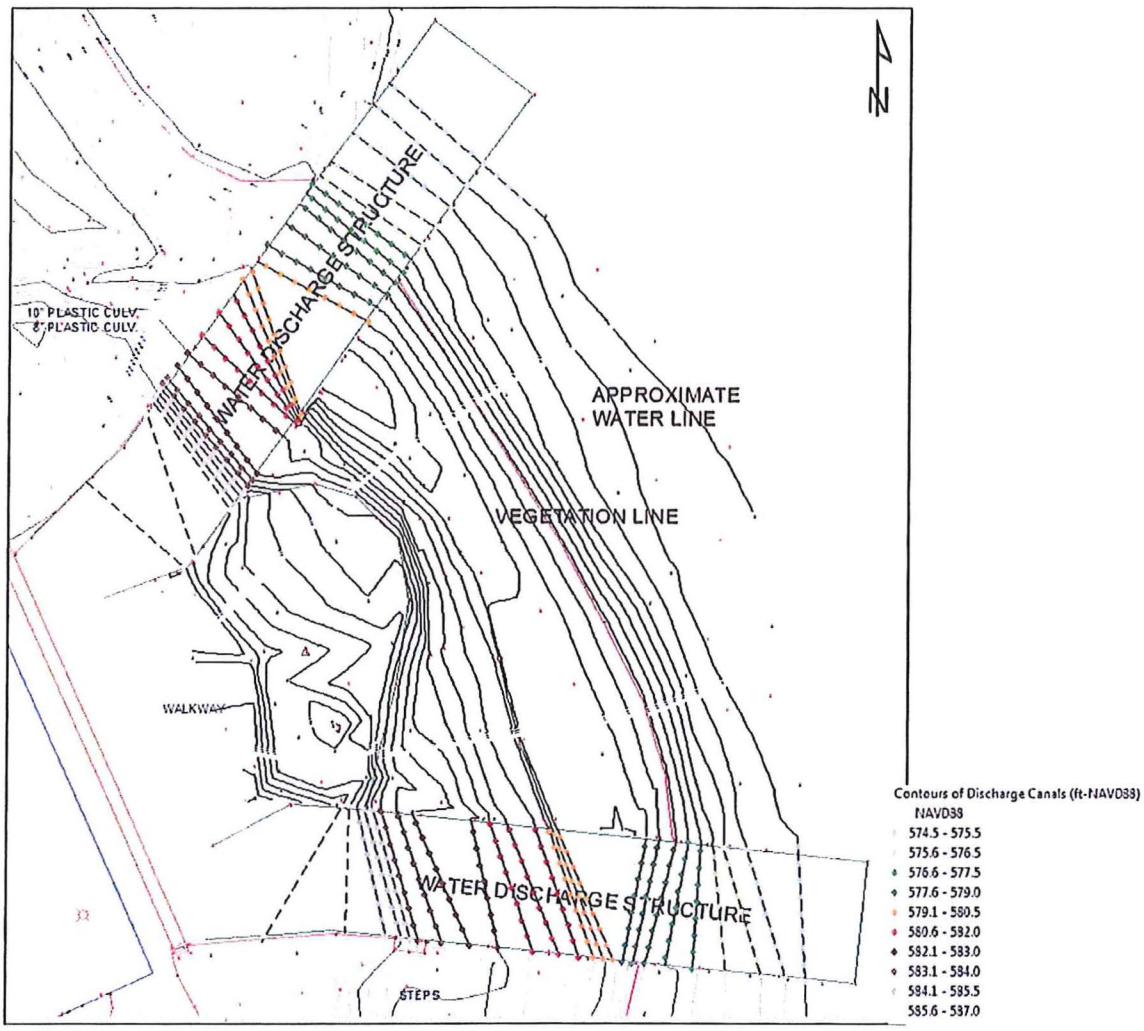


Figure 36. Contours of Discharge Canals

[10] The survey file does not show contour lines within the discharge flumes. The DELFT3D software cannot read this area, so the points are added to the point feature file to eliminate discrepancy in the software (see Assumption 4.2).

7.3.5 Add longitude (x) and latitude (y) in WGS84 GCS to the attribute table in decimal degrees.

The Add XY Coordinates tool was utilized to add the longitude (x) and latitude (y) coordinates to the survey elevation point feature file. The coordinates were set to the WGS84 GCS. Figures 37 and 38 show the Add XY Coordinates tool input parameters and the associated Environmental Settings.

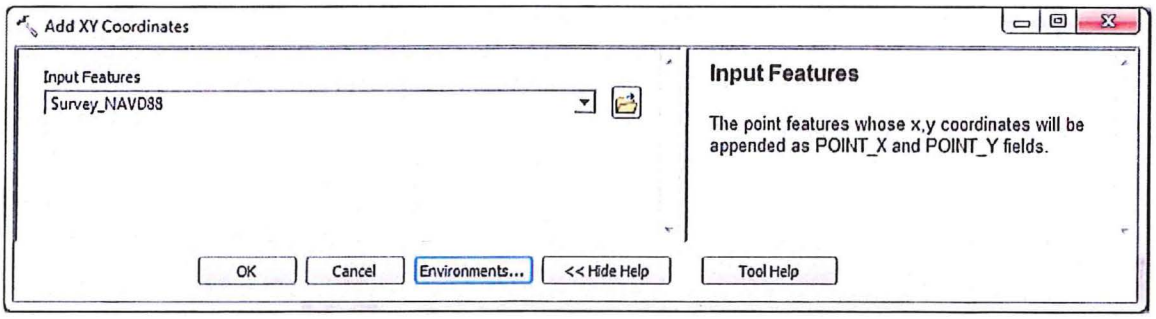


Figure 37. Add XY Coordinates Tool Input Parameters

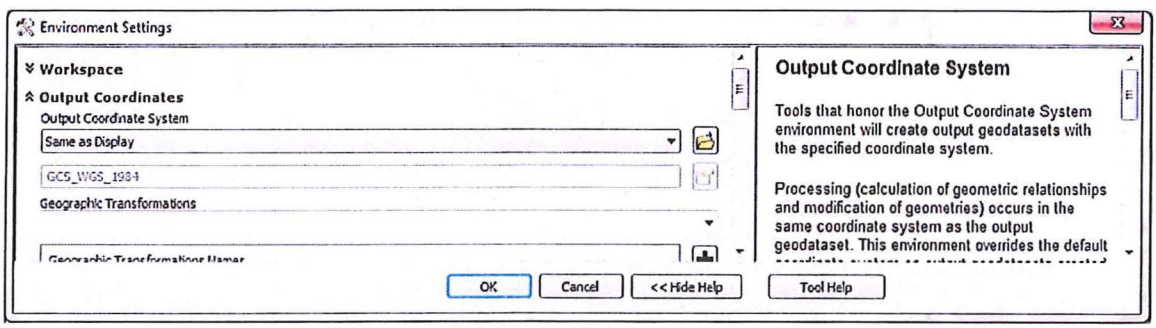


Figure 38. Environment Settings, Add XY Coordinates Tool

7.3.6 Convert NAVD88 to 176.0 m-LWD IGLD85 using the National Geodetic Survey (NGS) monument 'LSC B 81' (NGS, 2013) for vertical adjustment.

Converting the survey elevation point feature vertical datum from m-NAVD88 to 176.0 m-LWD IGLD85 is a two-step process. First, the data is converted from NAVD88 to IGLD85. Then the LWD of 176.0 (NOAA, 2013) is added to IGLD85 to obtain the LWD IGLD85 height for Lake Michigan. See Section 7.2.2 for a detailed description of converting the vertical datum NAVD88 to 176.0 m-LWD IGLD85.

An attribute field 'Z' was added to the survey elevation point feature dataset as a double numeric type. The Field Calculator dialog tool was utilized to convert from ft-NAVD88 to m-LWD IGLD85. Figure 39 shows the Field Calculator input parameters.

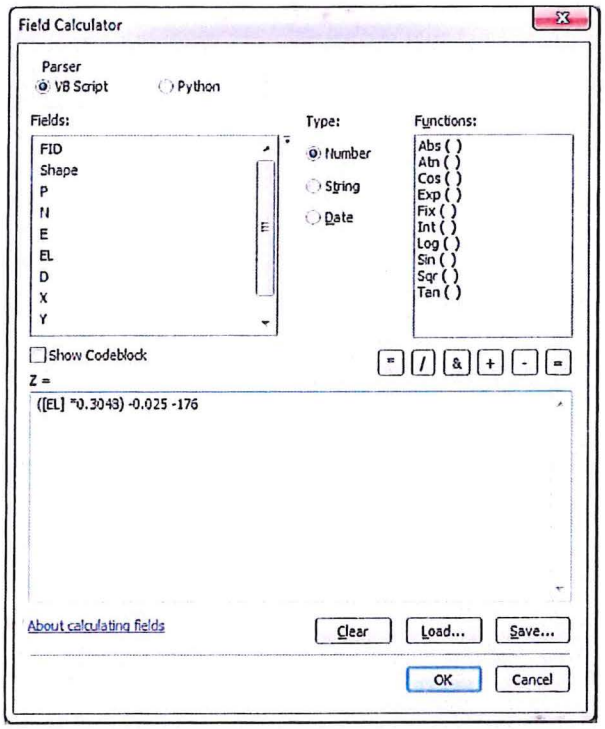


Figure 39. Field Calculator, Conversion from ft-NAVD88 to m-LWD IGLD85

7.3.7 Convert elevation to sounding data (values are expressed as negative upward from the reference plane 176.0 m-IGLD85), per DELFT3D user's manual (Deltares, 2011).

Per DELFT3D User's Manual (Deltares, 2011), the bathymetry was converted to sounding data so that positive units indicate values below the reference plane and negative units indicate values above the reference plane.

The Field Calculator dialog tool was utilized to convert the elevation points ('Z') to a negative value by multiplying the elevation field by -1. Figures 40 shows the Field Calculator dialog conversion.

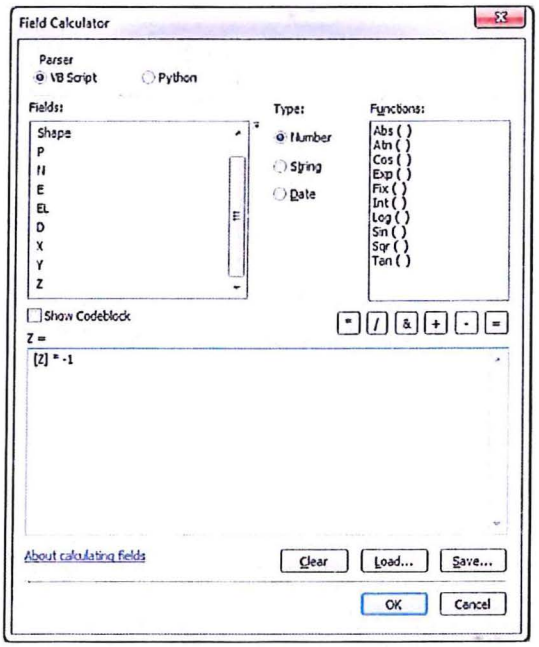


Figure 40. Field Calculator Tool, Convert Units to Negative Value

7.3.8 Export X-Y-Z data to tab delimited xyz text file using Microsoft Access.

The X-Y-Z data was exported from Microsoft Access as a tab delimited xyz text file due to the fact ArcGIS Desktop 10.1 software does not have the functionality to export to the correct format. This was achieved by importing the associated database file (.dbf) in Microsoft Access and exporting to a tab delimited xyz text file. One file was exported at approximately 13 KB in size. A snapshot of a file output tab delimited xyz text file is shown in Figure 41.

-87.535319	44.281026	-3.828640
-87.535330	44.281025	-3.820106
-87.535330	44.281033	-3.752440
-87.535319	44.281033	-3.794198
-87.535168	44.281142	-3.283048
-87.535216	44.281121	-3.403749
-87.535284	44.281093	-3.567732
-87.535340	44.281068	-3.566512
-87.535311	44.280915	-4.564428
-87.535337	44.280959	-4.196839
-87.535366	44.281005	-3.895392
-87.535437	44.281054	-3.463795
-87.535506	44.281056	-3.521707
-87.535484	44.281010	-3.814924
-87.535455	44.280960	-4.124601
-87.535419	44.280902	-4.513831
-87.535382	44.280846	-4.892697
-87.535355	44.280800	-5.211823
-87.535193	44.280550	-6.764169
-87.535219	44.280589	-6.576412
-87.535252	44.280640	-6.309408
-87.535283	44.280691	-5.973213
-87.535318	44.280744	-5.582764
-87.535351	44.280795	-5.241998
-87.535220	44.280823	-5.222186
-87.535226	44.280824	-5.207251
-87.535227	44.280819	-5.222796
-87.535223	44.280818	-5.245046
-87.535219	44.280820	-5.211823
-87.535190	44.280815	-5.571792
-87.535184	44.280814	-5.619036
-87.535183	44.280819	-5.580936
-87.535189	44.280819	-5.561124
-87.535108	44.280578	-6.783981
-87.535206	44.280676	-6.110983
-87.535199	44.280672	-6.108240
-87.535190	44.280678	-5.965288
-87.535196	44.280684	-5.950353
-87.535204	44.280683	-6.009484
-87.535207	44.280677	-6.132014
-87.535209	44.280909	-4.848501
-87.535239	44.280984	-4.323331
-87.535277	44.281001	-4.089244
-87.535210	44.281020	-3.886857
-87.535216	44.281055	-3.583581
-87.535277	44.281036	-3.774386
-87.535449	44.281106	-3.181855
-87.535523	44.281097	-3.233976
-87.535507	44.281067	-3.429962
-87.535450	44.281079	-3.351933
-87.535382	44.281100	-3.309566

Note:
1st column = X = Longitude
2nd column = Y = Latitude
3rd column = Z = depth below/above reference (0) plane
(+ down from plane, - up from plane)

Figure 41. Snapshot of Final Survey Tab Delimited XYZ Text File

7.3.9 The following elevations will be used when examining wave runup in the DELFT3D modeling.

Based on client provided data (NEE, 2013b), the height of the jersey barriers are at an elevation 589.3 ft-IGLD55. Based on site survey (NEE, 2013a) the top of the northern discharge wall is at 588.55 ft-NAVD88 and the top of the southern discharge wall is at 588.16 ft-NAVD88.

To convert from ft-LWD at IGLD85 to ft-IGLD55, add 576.47 feet. This is based on the following calculation:

[Starting elevation LWD IGLD85] + [low water datum for Lake Michigan] + [dynamic height (NGS, 2012) between NAVD88 and IGLD85] - [elevation difference between NAVDD88 and IGLD55 (NEE, 2013a)] = elevation in IGLD55

0 ft-LWD + 577.5 ft +0.09 ft -1.12 ft = 576.47 ft IGLD55

For example, the top elevation of the jersey barriers is at 12.83 ft-LWD IGLD85, thus 576.47 ft would be added to obtain the top elevation at ft-IGLD55:

12.83 ft-LWD IGLD85 + 576.47 ft = 589.30 ft-IGLD55

Table 2 provides the conversions for the jersey barriers and the discharge wall in IGLD55, NAVD88, and m-LWD in IGLD85.

Table 2. Vertical Datum Conversion for Jersey Barriers and Discharge Canals

Structure	ft-IGLD55 (m)	ft-NAVD88 (m)	ft-LWD IGLD85 (m)
Top Elevation of Jersey Barrier	589.30 (179.62)	590.42 (179.96)	12.83 (3.91)
Maximum Elevation of Northern Discharge Wall	587.13 (178.96)	588.25 (179.30)	10.66 (3.25)
Maximum Elevation of Northern Discharge Wall	587.04 (178.93)	588.16 (179.27)	10.57 (3.22)

Output files are provided on a DVD in Attachment A.

Attachment A

File Name	Revision	Reference	Input	Output
Michigan_lld (.asc grid) (NOAA, 1996)	NA		X	
Floatn45w088_13 (.flt) (USGS, 2011)	NA		X	
Survey Point Data P,N,E,EL,D format.txt (NEE, 2013a)	0		X	
G60302156_PBNP_Topo.dwg (NEE, 2013a)	0		x	
AECOM, 2013	NA	X		
Deltares, 2011.pdf	NA	X		
ENERCON, 2012.pdf	0	X		
ESRI, 2012.pdf	NA	X		
NGS, 2013.pdf	X	X		
NGS, 2012.pdf	NA	X		
NEE, 2013a.pdf	NA	X		
NEE, 2013b.pdf	NA	X		
NOAA, 2013a.pdf	NA	X		
NOAA, 2013b.pdf	NA	X		
NOAA, 1999.pdf	NA	X		
NOAA, 1996.pdf	NA	X		
NOAA, 1995.pdf	NA	X		
NOAA, 1985.pdf	NA	X		
USACE, 1992.pdf	NA	X		
USGS, 2010a.pdf	NA	X		
USGS, 2010b.pdf	NA	X		
USGS, 2011.pdf	NA	X		
Michigan1.xyz	0			X
Michigan2.xyz	0			X
Michigan3.xyz	0			X
Topo1.xyz	0			X

Topo2.xyz	0			X
Topo3.xyz	0			X
Topo4.xyz	0			X
Shoreline0m.xyz	0			X
Survey_points.xyz	0			X
Survey_contour.xyz	0			X
Discharge_points.xyz	0			X

ATTACHMENT 2

NEXTERA ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT

UPDATED POINT BEACH EXTERNAL FLOOD SAFETY SIGNIFICANCE DETERMINATION

Performance Deficiency

The licensee failed to maintain external flood mitigation features, procedures, processes, and relevant descriptions in the CLB that address maximum wave run-up.

Executive Conclusion

The safety significance of this issue is assessed to be very low for Units 1 and 2. Table 4 provides the core damage frequency with and without barriers as well as the change in core damage frequency with and without the barriers. The basis of this conclusion is that a detailed wave run-up analysis results in a calculated water level much lower than the water levels previously evaluated in the IPEEE. This analysis confirms that the IPEEE analysis was conservative for the 1E-06 frequency event.

Background

The IPEEE response to GL 88-20 evaluated external flood hazards for Point Beach. This evaluation was based in part on the analysis for external flood events conducted in conjunction with the NRC's TAP A-45 study. In order to evaluate the safety significance of this issue, the data provided in the IPEEE was used in conjunction with our updated analyses to evaluate the change in core damage frequency (CDF) and large early release frequency (LERF). For the purpose of this evaluation the "change" being considered is the plant with and without the barrier protection to 589.2 IGLD 1955, as described in the IPEEE report.

To perform this evaluation, some simplifying conservative assumptions are made:

1) At the time of the identification of this issue, PC 80 Part 7 (Lake Water Level Determination) directed the plant to install concrete Jersey Barriers if the Lake Michigan mean level was greater than or equal to a plant elevation of +0.5 feet (580.7 ft IGLD 1955. This elevation is 6.5 feet below the floor of the CWPH and 7.5 feet below the floor of the Turbine Building). For the purposes of this evaluation, no credit is given to these barriers since the barriers would have been partially effective.
2) The water level on site reaches the same height, inside and outside of the turbine building during the event providing margin.
3) Above 589.2 ft IGLD 1955 (+9 ft), the impact of the flood is the same with and without barriers. While the flow rate into buildings would be lower with barriers than without, the extended duration assumed for this flood would result in the same

impact with or without the barriers providing margin.

4) Below 588.2 ft IGLD 1955 (+8 ft), there is no impact from the flood (with or without barriers).

5) It is assumed that the reason for the high lake water level is a storm that results in a dual-unit loss of offsite power (LOOP) which is conservative and provides margin.

Risk Assessment

PBNP PRA Model Rev. 5.02 was used for this assessment. The following directory paths were used for the computer files used in this assessment:

Since this evaluation will be applying the frequency of the external flood outside of the PRA model, all initiators in the internal events model were set to 0.0 with the exception of the weather-centered LOOP initiator (INIT-T1W). By doing this, the value being quantified is the conditional core damage probability (CCDP), i.e., the core damage probability assuming the initiator (external flood in this case) occurs. The following flags were used in all runs discussed in this evaluation:

The following steps were taken to evaluate the significance of this issue:

1) Run CAFTA cases (average T&M) for Units 1 and 2 with an E-10 truncation limit with flags set to account for the postulated equipment failures. The results of the cases representing the CCDPs for the five bins comprising varying depths of water are shown in Table 1. For simplicity, only the maximum CCDP for each bin will be carried through the rest of this calculation.

2) The results of the calculated water level based on the still water elevation based on still water lake elevation are shown in Table 2.

3) The results of the curve-fit of the flood exceedance frequencies from Table 5.2.5-2 of the IPEEE are presented in Table 3. Note that due to the data, two curve fits are presented. The first curve fit represents still water elevations ≤585.1 ft IGLD 1955 and the second curve fit represents still water elevations >585.1 ft IGLD 1955.

4) The information on Tables 1, 2, and 3 are combined into Table 4 which calculates the CDF with and without barriers along with a ΔCDF that represents the worst case value applicable to Unit 1 and Unit 2. Note that based upon previous evaluations and the very small CDF values, values for LERF were not calculated. Due to the nature of the initiating event, it is judged that there is no unique challenge to LERF. Thus, the ΔLERF for this evaluation is judged to be well below 1E-09/yr.

The final calculation of ΔCDF for this issue is determined to be 1E-08/yr, which is of very low safety significance, with margin.

Margin

The flood consequence evaluation is considered to be bounding and conservative for the following reasons:

1) All equipment affected by the flood is assumed to be failed at time zero. In actuality, there would be a relatively slow progression of the postulated flood throughout the plant and

equipment would likely fail at various times.

2) There is no assumed duration for the flood, which necessitates the assumption that the water level throughout the plant is equalized. It is highly unlikely that water inside the buildings would remain at those levels for an extended time since the cause of the water would eventually stop and normal drainage would occur.

3) No credit for flood mitigation actions taken in response to rising water levels throughout the plant has been modeled. Due to the relatively slow progression of the postulated flood, there should be time for the plant to respond to the rising water level and to protect and/or realign equipment that may be in danger.

4) No credit for recovery actions taken in response to equipment issues in the plant has been modeled. It is expected that some equipment may be able to be recovered and that other means to provide decay heat removal could be used, e.g., pumper trucks, B.5.b equipment, and portable generators.

5) The concrete barriers installed at a lake level of 580.7 IGLD 1955, in accordance with PC 80 Part 7, are assumed to be ineffective in limiting the quantity of water.

Table 1
Maximum Conditional Core Damage Probability vs. Water Level Range Bins

Bin	Range of Water Level (inches) (2,3)	Equipment Assumed Failed (1,5)	CCDP (max) (4)
1	0 to <4	Offsite power assumed lost, Offsite Power Transformers (1X-01/03, 2X-01/03), RHR Pumps (1/2P-10A/B), RHR Pump Suction from Containment Sump B (1/2SI-851A/B)	**4.25E-05**
2	4 to <8	Charging Pumps (1CV-2A/B/C and 2CV-2A/B/C), Station Battery Chargers (D-07/D-08/D-09) Diesel Fire Pump (P-35B)	**4.83E-3**
3	8 to ≤12	A Train Emergency Diesel Generators (G-01, G-02), G-01/G-02 EDG Alarm & Electrical Panels (C-34/C-35), G-01/G-02 EDG DC Power Transfer Control Panels (C-78/C-79), 4.16 KV Switchgear (1/2A-03/04), 4.16 KV Vital Switchgear A Train (1/2A-05), 1/2HX-11A, B RHR HX Shell Side Inlet Valves (1/2CC-738A/B), Non-Safety Related 480V MCCs (B-33, B-43), Steam Generator Feedwater Pump Seal Water Injection Pumps (1/2P-99A/B) Electric Fire Pump (P-35A)	**7.70E-03**
4	>12 to <17	480 V Vital MCCs A Train (1/2B-32), Safeguards Batteries (D-01, D-02), Service Air Compressor (K-3B) Instrument Air Compressors (K-2A/B) Turbine Driven Auxiliary Feedwater Pump (2P-29)	**9.00E-02**
5	≥17 to ≤24	Condensate Pumps (1/2P-25A/B), Feedwater Pumps (1/2P-28A/B), Service Water Pumps (P-32A/B/C/D/E/F), DC Distribution Panels (D-63, D-64), Stand-by Steam Generator Pumps (P-38A/B), Turbine Driven Auxiliary Feedwater Pump (1P-29), Motor Driven Auxiliary Feedwater Pumps (1/2P-53), Service Air Compressor (K-3A), Safety Injection Pumps (1/2-P15A/B)	**1.00**

Notes:

(1) "Equipment Assumed Failed" for each range of water levels greater than 588.2 feet is based on the elevation of the limiting vulnerable subcomponent.

(2) "Range of Water Level" is based on inches of water on the turbine building floor.

(3) "Range of Water Level" 0 inches equals 588.2 IGLD 1955.

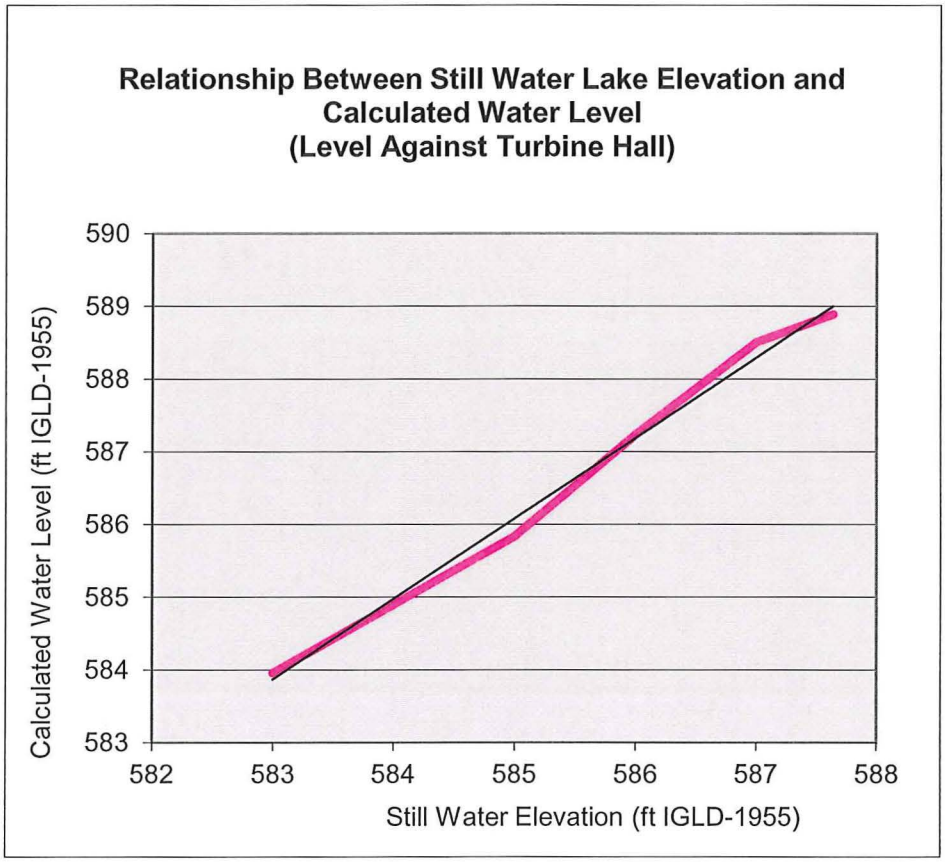
(4) The maximum CCDP from either unit is used in the downstream calculations.

(5) Equipment failures at the water level elevations have been validated against the most recent walkdowns as documented in EC279398. Note that AR 1891921 (ENG EVAL EC 279398 FLOODING VULNERABILITY HEIGHT ERROR) identified an error in that EC with regard to the failure height of the Diesel Fire Pump. For this reason, the Diesel Fire Pump was moved from Bin 4 to Bin 2 above.

Table 2
Calculated Water Level Based on Still Water Lake Elevation

Still Water Elevation to Calculated Water Level Relationship

Still Water Lake Elevation (ft. IGLD-1955)	Calculated Water Level (ft. IGLD-1955) *
587.64	588.89
587.00	588.51
586.00	587.24
585.00	585.84
583.00	583.96



NOTES:

* Calculated Water Level is taken from Table 7-3 of Enercon Calculation FPL-076-CALC-004

Table 3
Annual Frequency Based on Still Water Elevation
[Derived from Information in IPEEE]

Flood Frequency - Curve Fit Equations

		Frequency - Curve Fit (per yr)	
Annual Frequency (per yr)	**Still Water Elevation** (ft IGLD-1955) from IPEEE Table 5.2.5-2	**IPEEE StillWaterFREQ1**	**IPEEE StillWaterFREQ2**
3.69E-02	582.5	3.7E-02	
2.53E-04	585.1	2.7E-04	4.8E-04
3.45E-07	588.0		4.1E-07
8.25E-11	591.0		2.9E-10

Note where two values are provided, IPEEE Still Water FREQ2 was used.

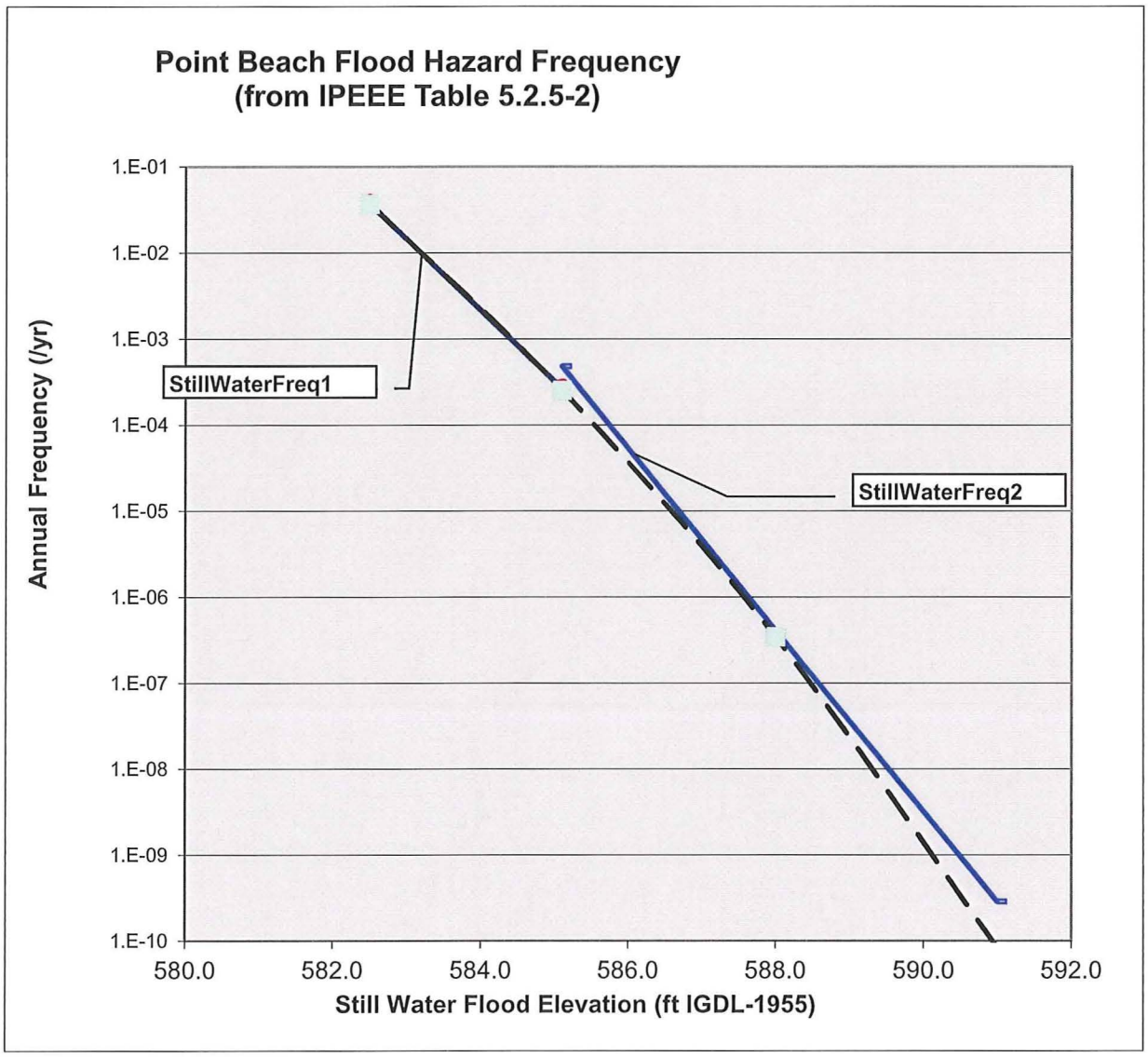


Table 4
ΔCDF Calculation With and Without Barriers

					Without Barriers		With Barriers		
Bin	IPEEE Flood Frequency	IPEEE Incremental Flood Frequency	Still Water Lake Elevation	Effective Water Level (Range) (1)	CCDP	CDF	CCDP	CDF	ΔCDF
	per yr	*per yr*	*ft (IGLD-1955)*	*inches*		*per yr*		*per yr*	*per yr*
1	5.6E-06	2.9E-06	586.93	0 to <4	4.25E-05	1.23E-10	0.00E+00	0.00E+00	1.23E-10
2	2.7E-06	1.4E-06	587.23	4 to <8	4.83E-03	6.71E-09	0.00E+00	0.00E+00	6.71E-09
3	1.3E-06	6.7E-07	587.53	8 to ≤12	7.70E-03	5.15E-09	0.00E+00	0.00E+00	5.15E-09
4	6.2E-07	3.8E-07	587.83	>12 to <17	9.00E-02	3.38E-08	9.00E-02	3.38E-08	0.00E+00
5	2.5E-07	2.5E-07	588.21	≥17 to ≤24	1.00E+00	2.48E-07	1.00E+00	2.48E-07	0.00E+00
					CDF Total	**2.93E-07**	**CDF Total**	**2.81E-07**	**1.E-08**

Notes:

(1) Effective water level is the level of water in the turbine building.