

APPENDIX A
SUBSURFACE CONDITIONS

SUBSURFACE CONDITIONS

Available Data

The subsurface conditions near the outlet of Pretty Lake have been interpreted from historical explorations, whose location is shown in Figure 4-8 and 4-9. The data at this location is limited to geotechnical borings drilled in 1999 by Virginia Department of Transportation (VDOT) for the Shore Drive Bridge with the objective of identifying the sand bearing stratum to estimate pile tip elevations. The data only includes Standard Penetration Test (SPT) blow counts. Note that the superimposed bridge pile tip elevations shown in Figure 4-8 are based on pile design length of 70 feet. The as-built pile lengths may vary according to encountered subsurface conditions. Even though the data is limited, different soil parameters were still derived using published correlations for preliminary site characterization, and conceptual design of alternative flood mitigation systems.

During March 2012, three cone penetration tests (CPTs) were conducted to validate the stratigraphic profiles used to evaluate the foundation concepts. Figures 4-8 and 4-9 present interpreted subsurface conditions at the basin outlet. Locations of the CPT soundings are included on the plan view of Figure 4-8 and 4-9. The CPT logs are provided in Appendix A.

The regional geology and subsurface conditions are described in the Section 4. In summary, the stratigraphic units identified the subsurface at the basin outlet are:

- Artificial Fill: 5 to 15 feet of sandy material related to construction of the Shore Drive Bridge and waterfront development.
- Quaternary Alluvium: 60 to 70 feet of sand and fine-grained deposits. The upper subunit is comprised of sandy sediment approximately 25 to 55 feet thick. The upper sand unit has soft, fine-grained layers that are 5 to 15 feet thick and laterally discontinuous. The lower unit is comprised of soft to firm clay or silt that is approximately 15 to 30 feet thick.
- Yorktown Formation: Approximately 45 to 50 feet thick silty sand deposits. A stiff to very stiff clay unit was encountered from El. -140 to -186 feet in CPT C-3.

Design Subsurface Profiles for Concept Evaluation

To evaluate possible flood mitigation systems at Pretty Lake, it was necessary to idealize the subsurface conditions, and determine soil properties that will govern the selection of an appropriate flood mitigation system. Based on the available data and published correlations between different soil parameters, the following were interpreted:

- Two idealized soil profiles representing an upper and lower bound of expected stratigraphy;
- Design strength parameters including undrained shear strength and friction angles;
- Ultimate bearing capacity values for the upper and lower boundary profiles based on a continuous strip footing with a unit width;
- Active and passive earth pressure coefficients. A drained condition was assumed for the clay and silt layer.

Idealized Stratigraphy

The subsurface condition was idealized into two profiles. The first profile is located inside the channel where the silt and clay layer is thinnest. This profile represents an upper bound of expected design strength parameters. This profile comprises of about 30 feet of loose sand overlying 20 feet of medium dense to dense sand. Below this layer is a 5 feet layer of soft silt and clay layer. The bottom layer comprises of a 65 feet medium dense to dense silty sand layer.

The second profile is located below the southwest abutment of Shore Drive bridge. This profile represents a lower bound of expected design strength parameters. The profile comprises of a 30 feet layer of loose sand overlying a 25 feet layer of medium dense to dense sand. The clay and silt layer at this location is about 20 feet. The bottom layer comprises of medium dense to dense silty sand.

Based on the soil description and the blow counts, each layer was assigned a total unit weight (Table A-1). The total unit weights were used to estimate an effective stress profile as shown in Figures A-1 and A-2.

Table A-1. Total Unit Weights

Soil layer	Total Unit Weight (pcf)	
	Profile 1	Profile 2
Loose sand	105	105
Medium dense to dense sand	115	115
Silt and Clay	105	110
Medium dense to dense silty sand	120	120

Design Strength Parameters

The strength properties for the sand layers were obtained by estimating friction angle (ϕ) profiles based on SPT blow counts (N-values). The N-values were corrected for rod length, fines content, and overburden pressure using the correlation provided by Liao and Whitman (1986). The correlations provided by Peck et al. (1974) and the American Petroleum Institute (API) (2000) were then used to estimate ϕ from corrected N-values. The API method resulted in considerably higher ϕ values as shown in Figures A-3 and A-4. Therefore, the mean ϕ values for each layer was calculated based on Peck et al. (1974) and used as an upper bound profile. Two standard deviations were subtracted from the mean value to calculate the lower bound ϕ profile. The upper and lower design ϕ values for each profile are shown in Table A-2.

Since no strength data is available for the clay and silt layer, the undrained shear strength of this layer was conservatively assumed to be 500 psf and 250 psf for an upper and lower bound values, respectively.

Table A-2. Idealized Friction Angles

Soil Layer	Effective Stress Friction Angle (degrees)					
	Profile 1			Profile 2		
	Upper Bound	Lower Bound	COV (%)	Upper Bound	Lower Bound	COV (%)
Loose sand	30	27	5	29	26	5
Medium dense to dense sand	36	33	4	37	30	9
Medium dense to dense silty sand	35	32	4	35	32	5

Active and Passive Earth Pressure Coefficients

Active (k_a) and passive (k_p) earth pressure coefficients were calculated for the two idealized profiles. This can be used to conceptually design flood mitigation alternatives where lateral earth pressure loadings are expected behind the structure such as a retaining or sheet pile wall. The pressure at which the soil fails as the wall moves away from the retained soil is called active earth pressure, whereas the pressure at which the soil fails as the wall moves into the retained soil is called passive pressure. Active and passive earth pressure coefficients were calculated according to Rankine's and Coulomb's theories (Figures A-5 to A-8). Rankine's k_a and k_p were determined based on a frictionless wall where the interface friction (δ) between the retaining structure and the soil is neglected. Coulomb's k_a and k_p were calculated for a steel and concrete wall by varying the value of δ . For a steel wall, δ was equal to $\phi - 5^\circ$, whereas for a concrete wall, δ was equal to $0.58 \cdot \phi$.

Ultimate Bearing Capacity

Since some flood mitigation alternatives may be supported on shallow foundations, ultimate bearing capacity values, based on a continuous strip footing with unit width, were calculated. For each profile, lower and upper bound bearing capacity values were determined from the mean and lower bound friction angles, respectively (Figures A-9 and A-10). Further, ultimate bearing capacity values for the clay and silt layer were estimated based on both drained and undrained conditions. For a drained condition, the upper bound effective stress friction angle was assumed to be 33° degrees. The lower bound effective stress friction angle was obtained by applying a 7% Coefficient of Variation (COV) based on Duncan (2000) recommendations. Tables A-3 and A-4 summarize the bearing capacity factors, which were used to calculate the ultimate bearing capacity. The bearing capacity factors were based on correlations provided by Meyerhof (1963).

Table A-3. Bearing Capacity Factors – Profile 1

Bearing Capacity Factor	Loose Sand		Medium Dense to Dense to Dense Sand		Silt and Clay			Medium Dense to Dense Silty Sand	
	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Undrained	Upper Bound	Lower Bound
N _c	30	24	51	39	39	26	5	46	35
N _q	18	13	38	26	26	15	1	33	23
N _γ	16	10	44	26	26	11	0	37	22
COV (%)	5	-	4	-	7	-	-	4	-

Table A-4. Bearing Capacity Factors – Profile 2

Bearing Capacity Factor	Loose Sand		Medium Dense to Dense to Dense Sand		Silt and Clay			Medium Dense to Dense Silty Sand	
	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Undrained	Upper Bound	Lower Bound
N _c	28	22	56	30	39	26	5	46	35
N _q	16	12	43	18	26	15	1	33	23
N _γ	13	8	53	16	26	11	0	37	22
COV (%)	5	-	9	-	7	-	-	5	-

SEEPAGE AND LATERAL PILE ANALYSES

Seepage and lateral pile analyses were performed with information provided for the Pretty Lake Coastal Flooding Mitigation Flood Wall and Gate at varying flood wall tip elevations. Seepage analyses were performed for flood wall tip elevations of El. -17.0, -30.0, -70.0, and -81.4 feet to qualitatively evaluate the increase in seepage rates caused by shortening the flood gate sheet pile tip elevation. To qualitatively understand the impact of shortening the flood gate pile tip elevation on pile head deflection, lateral pile analyses were performed using pile tip elevations of El. -22.0, -31.0, and -81.4 feet. The flood gate and gate dimensions, tip elevation, and specifics were taken from S-101, S-201, S-401, S-501, and S-502 of “Pretty Lake Coastal Flooding Mitigation” design drawings by Moffatt and Nichol dated March, 2012. Geotechnical information from 2012 Fugro CPTs and 1999 VDOT borings was used to idealize apparent subsurface stratigraphy beneath Little Creek. The subsurface condition was idealized as follows:

Table A-5. Soil Parameters Used in Seepage and Lateral Pile Analyses

Elevation (ft)		Layer Description	Effective Unit Weight (pcf)	Friction Angle (degrees)	Undrained Shear Strength (ksf)
Top of Layer	Bottom of Layer				
-15	-19	Sand	41	35	
-19	-23	Stiff Clay	34		1.3
-23	-35	Sand	41	37	
-35	-60	Soft Clay	34		0.7
-60	-135	Sand	51	36	

SHEET PILE SEEPAGE ANALYSIS

Analytical background

Seepage analysis was performed to evaluate the change in seepage rate under different sheet pile tip elevations. For every tip elevation, an equivalent hydraulic conductivity was determined based on CPTs C-1 and C-3. Hydraulic conductivity values were determined from CPT data using correlations provided by Robertson et al. (1986). The resulting equivalent hydraulic conductivity was used with the mathematical solution developed by Harr (1962) as a simple method of determining seepage under a single row of sheet piles. Seepage analyses were performed for flood wall tip elevations of El. -17.0, -30.0, -70.0, and -81.4 feet. The El. -17 feet flood wall tip elevation case represents an assumed subsurface condition where the interbedded clay unit is continuous and the termination depth of the flood wall is in that clay unit. For evaluating the El. -17.0 and -30.0 feet flood wall tip elevations, the underlying clay layer at approximately El. -40 ft is assumed to be impermeable. For the El. -70.0 and -81.4 feet flood wall tip elevation cases, an impermeable layer is assumed to exist below the sand layer.

Seepage was determined under an extreme flood event where the head difference between both sides of the flood wall was estimated to be eight feet. In this scenario, a flood event would result in higher water levels to the east of Shore Drive and the proposed flood wall than the west side.

Results and recommendation

The results show significant difference between seepage rates of a sheet pile wall installed above and below the interbedded, predominately fine-grained layer. It is therefore not recommended to shore up the sheet pile wall above the thick fine-grained layer beginning at El. -35 to -40 ft. The following table provides results of the seepage analyses. Due to the limited geotechnical data and consequently simplified analytical procedure, the results are to be evaluated comparatively, and not as site-representative seepage rates.

Table A-6. Seepage Rate Summary

Elevation of Sheet Pile Wall Tip (ft)	Seepage Rate (ft²/s)
-17.0	0.927
-30.0	0.875
-70.0	0.002
-81.4	0.003

LATERAL PILE RESPONSE

Lateral pile analyses were performed to evaluate the lateral response of the foundation system with varying sheet pile wall tip elevations. The analyses were conducted using the commercially available software LPILE v. 5.0 (Ensoft, Inc., 2004). Lateral pile deflections were estimated under an extreme flood event estimated to be about eight feet of head difference between both sides of the flood wall. The hydrostatic load per pile was estimated and used as a model input for the pile head lateral load.

At the location of the flood gate, most of the hydrostatic load due to the extreme event will be applied to the flood gate. LPILE models cannot model the foundation system-flood gate connection. Further, LPILE models cannot model the hydrostatic load translation and distribution on the steel pipe pile and sheet pile structure, which is governed by relative stiffness and requires advanced soil structure interaction modeling. Therefore, three relatively simplified models were developed to estimate pile head deflection under three sheet pile tip elevations. The deepest tip elevation is based on a termination depth in the competent sand layer at elevation El. -81.4 feet. The shallower elevations are based on a pile termination depth in the upper sand layer and the interbedded clay layer. A 60-inch diameter steel pipe pile of 3/4" thickness was used in the pile model.

MODEL DESCRIPTION

Three simplified LPILE models were used to determine the impact on different pile tip elevations on the pile lateral response. The first model assumes a rigid connection between the flood wall and the pile. The modeled boundary condition assumes no pile head rotation. Hydrostatic load due to the extreme flood event is modeled as a distributed load on the flood gate, and the pile head deflection at elevation -10 feet is computed. Conservatively, the load is applied entirely to the steel pipe pile (i.e. the sheet pile wall is assumed to support no load). The second pile model extends the pile top to the elevation of the resultant hydrostatic load (elevation +3.7 feet). The boundary condition allows for both translation and rotation of the pile head (pinned condition). The pile head deflection at El. -10 feet is then computed. Conservatively, the hydrostatic load is applied entirely to the steel pipe pile. Lastly, the third pile model applies an equivalent moment at the pile head (El. -10 feet) due to the resultant

hydrostatic load (at El. 3.7 feet). The boundary condition allows for both translation and rotation of the pile head (pinned condition).

The LPILE pile models are simplified with inherent limitations. Some of the limitations that are not accounted for in the pile models include structural evaluation of the flood gate, hydrostatic load translation from the flood gate to the foundation system, relative lateral load distribution between the supporting sheet pile and steel pipe pile, variation in pile cap stiffness and deflection of the sheet pile.

Summary of Results

The results of the three models based on a tip elevation of El. 81.4 feet indicate that the point of fixity is El. -55 feet below the pile head for models 1 and 2 and El. -40 feet below the pile head for model 3. Consequently, sheet pile structures shallower than the point of fixity will result in considerable deflection as confirmed by our models. Piles with shallower tip elevations encountered excessive pile head deflection under the selected extreme load event. This produced computational errors in our model’s predictions as demonstrated in the table below.

Table A-7. Pile Head Deflection Summary

Elevation of Sheet Pile Wall Tip (ft)	Pile Head Deflection (inches)		
	Model 1	Model 2	Model 3
-22.0	N/A	N/A	N/A
-31.0	N/A	N/A	N/A
-81.4	0.22	0.18	0.08

REFERENCES

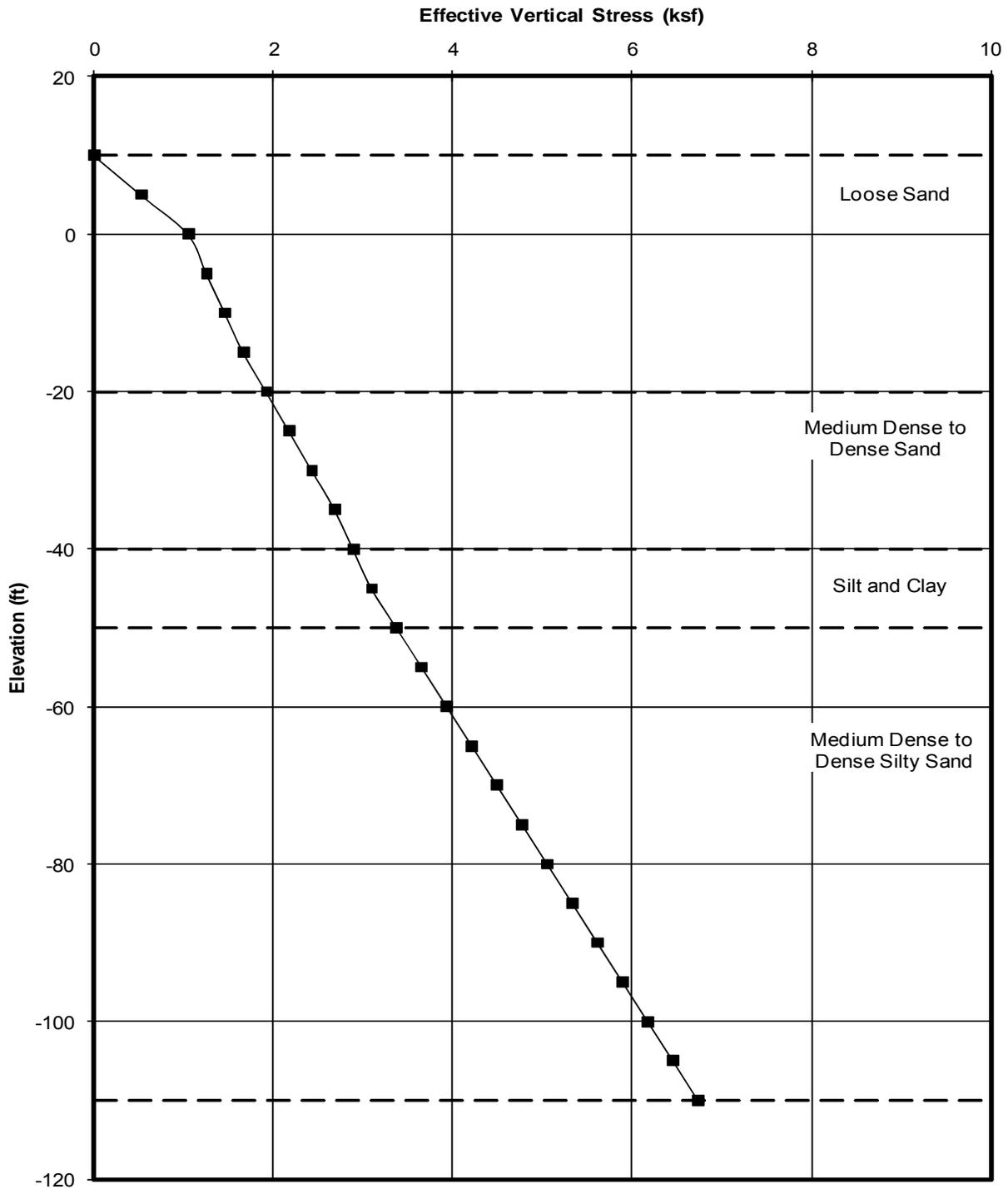
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Duncan, J. M. (2000), “Factors of Safety and Reliability in Geotechnical Engineering,” *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, Vol. 126, No. 4, pp. 307-316.

Liao, S. C., and Whitman, R. V. (1986), “Overburden Correction Factors for SPT,” *Journal of Geotechnical Engineering*, ASCE, Vol. 112, No. 3, pp. 373-377.

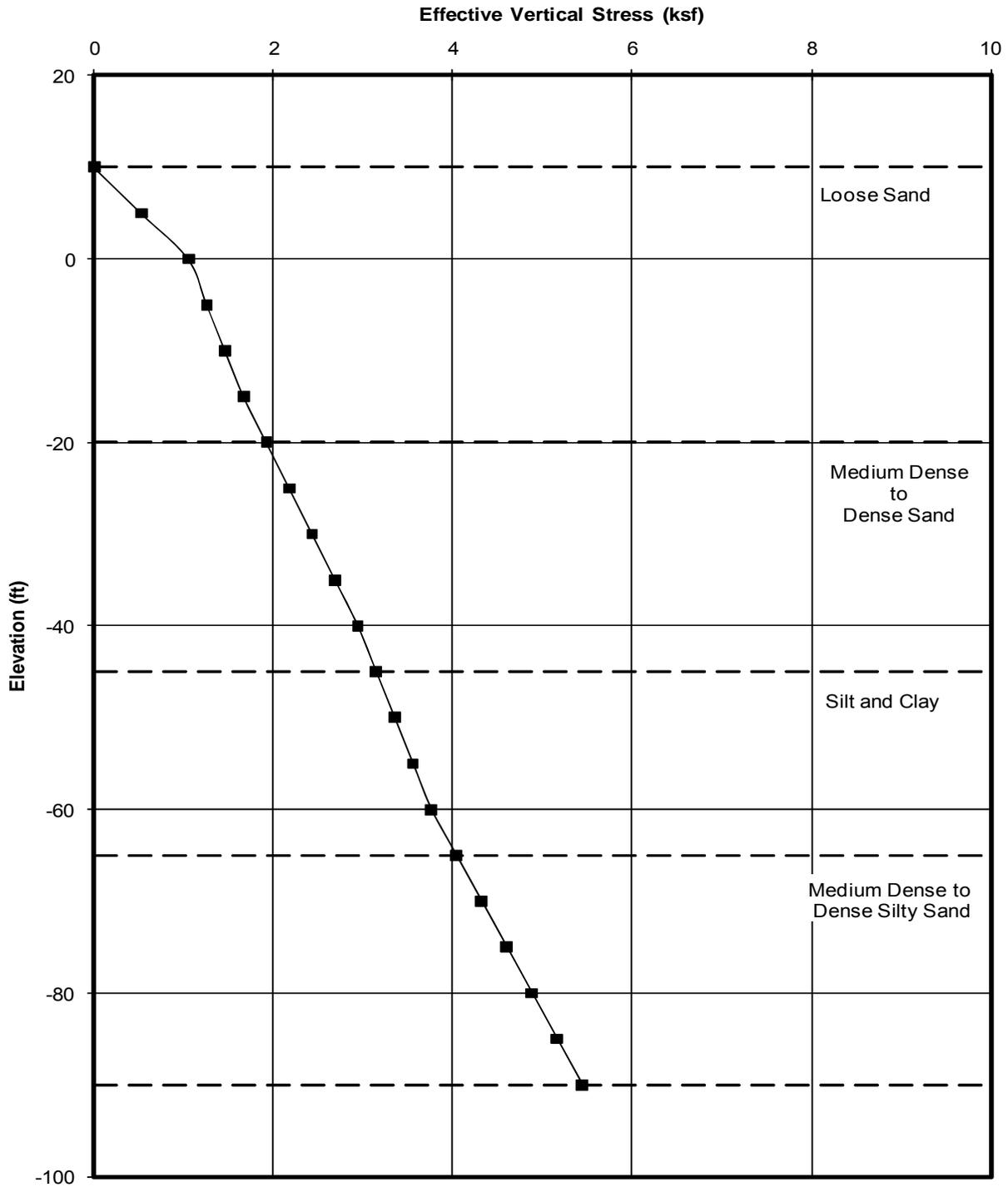
Meyerhof, G. G. (1963), “Some Recent Research on the Bearing Capacity of Foundations,” *Canadian Geotechnical Journal*, Vol. 1, No. 4, pp. 57-64.

Peck, R. B., Hanson, W. E., and Thornburn, T. H. (1974), “*Foundation Engineering*,” 2nd Edition, John Wiley, New York.



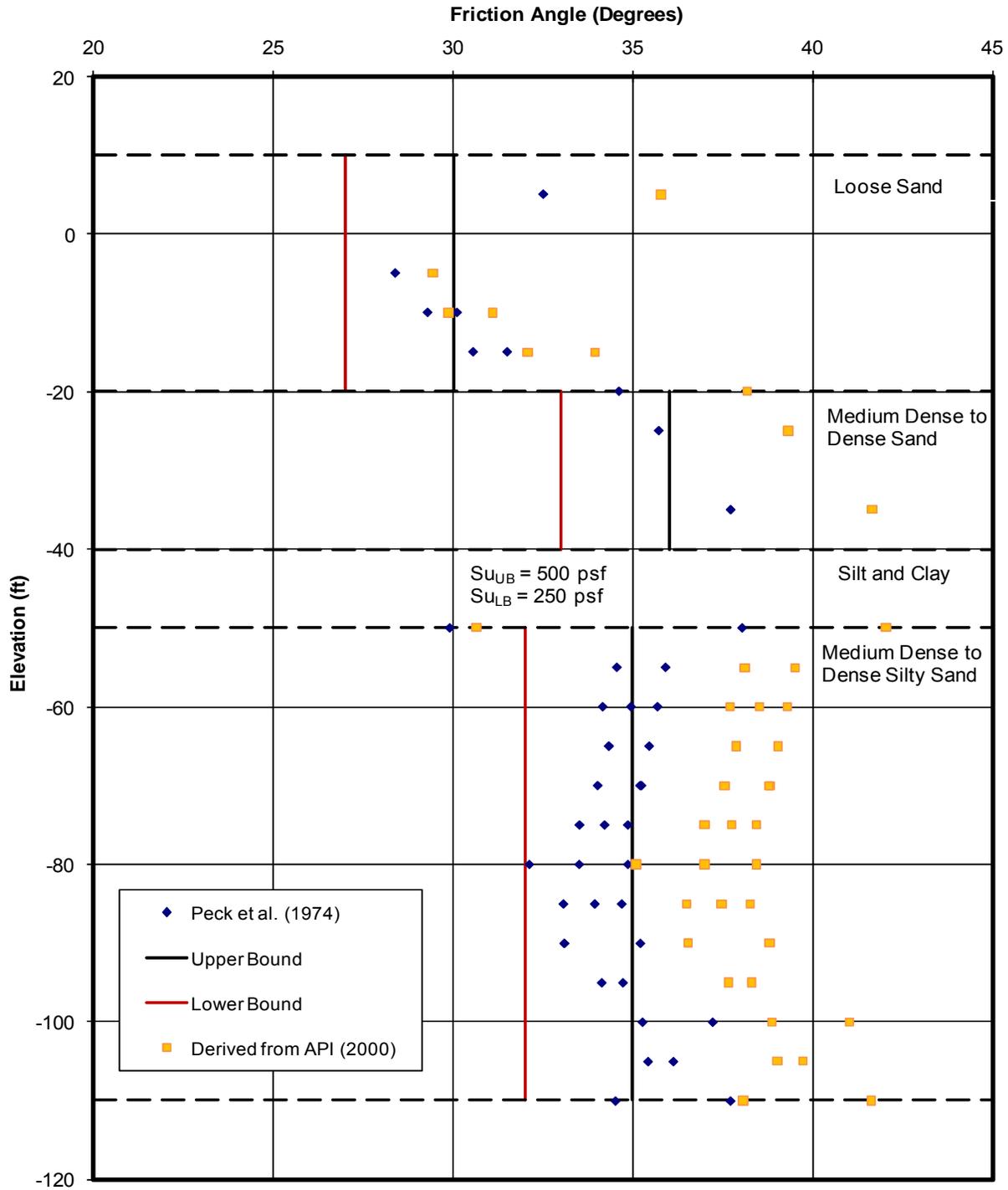
EFFECTIVE STRESS - PROFILE 1
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE A-1



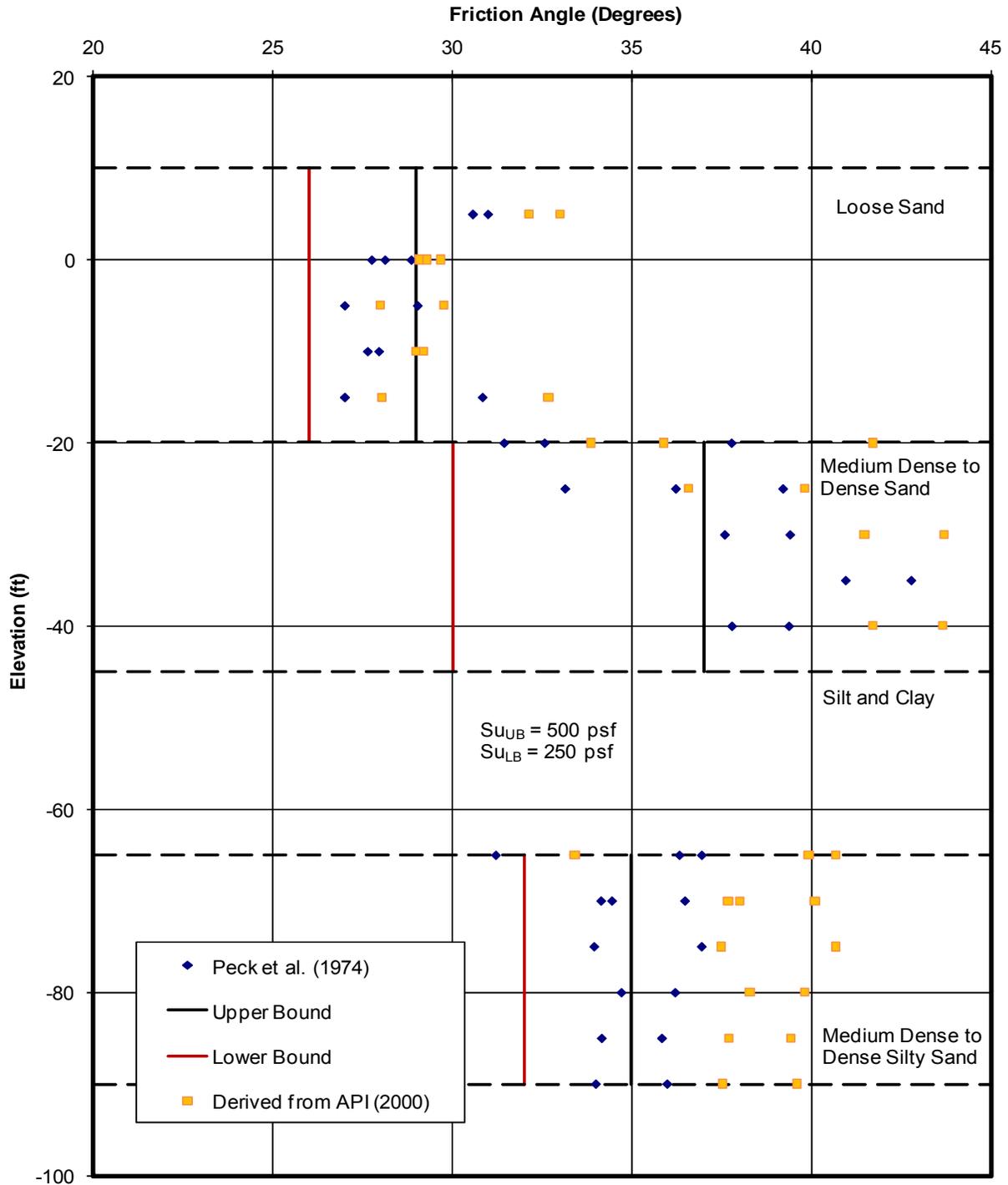
EFFECTIVE STRESS - PROFILE 2
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE A-2



DESIGN STRENGTH PARAMETERS - PROFILE 1
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE A-3



DESIGN STRENGTH PARAMETERS - PROFILE 2
 City-wide Coastal Flooding Study
 Norfolk, Virginia

FIGURE A-4

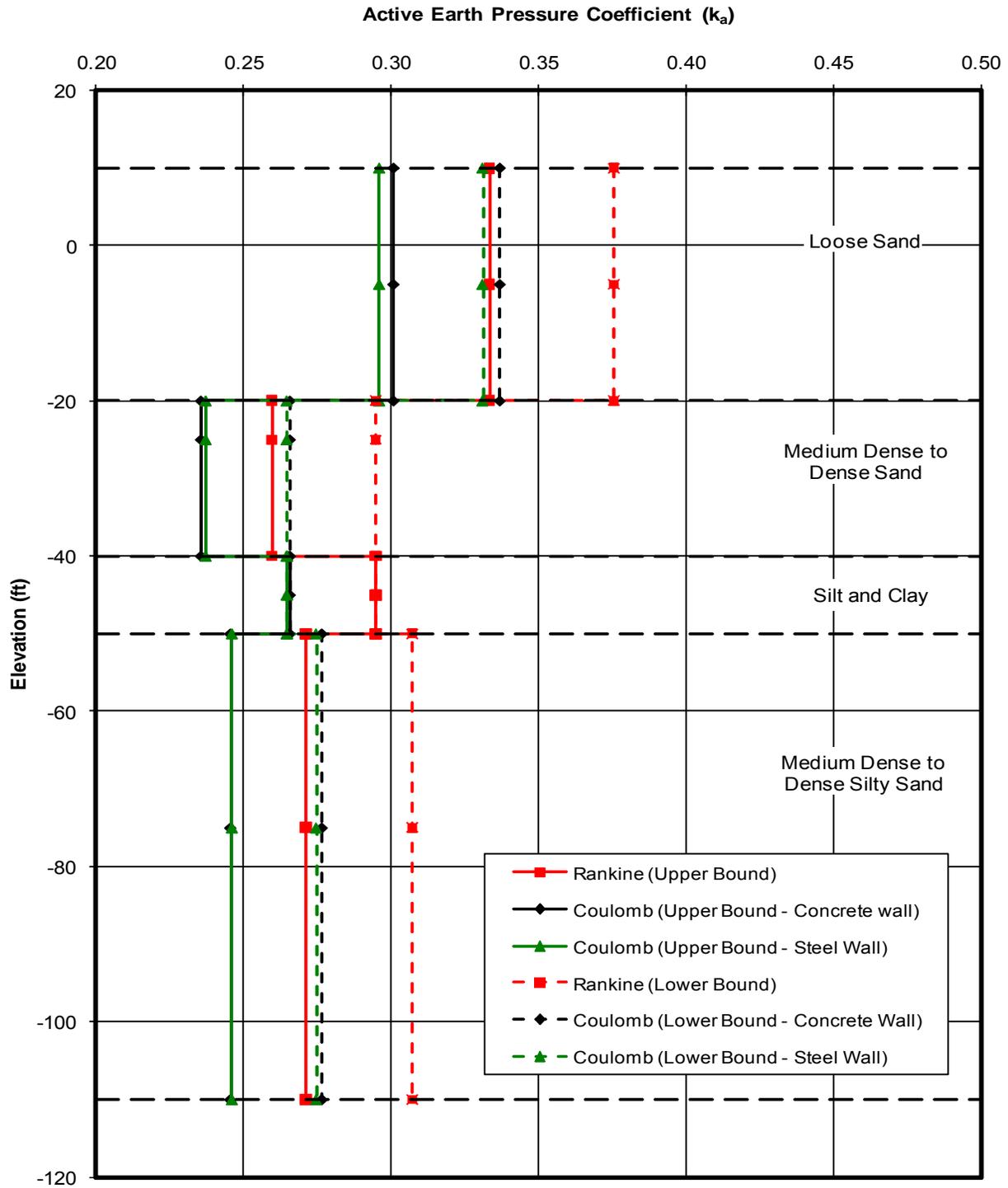
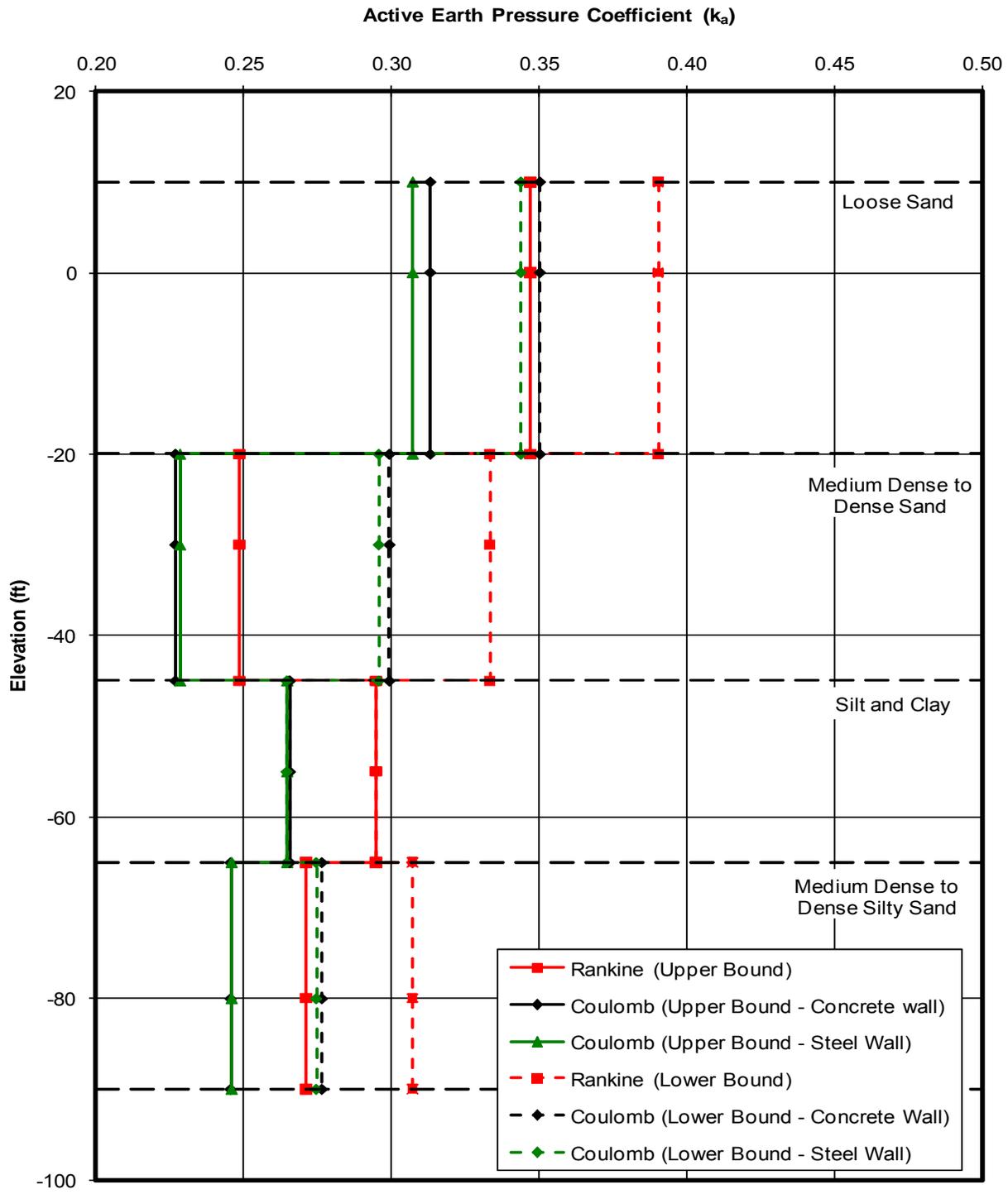
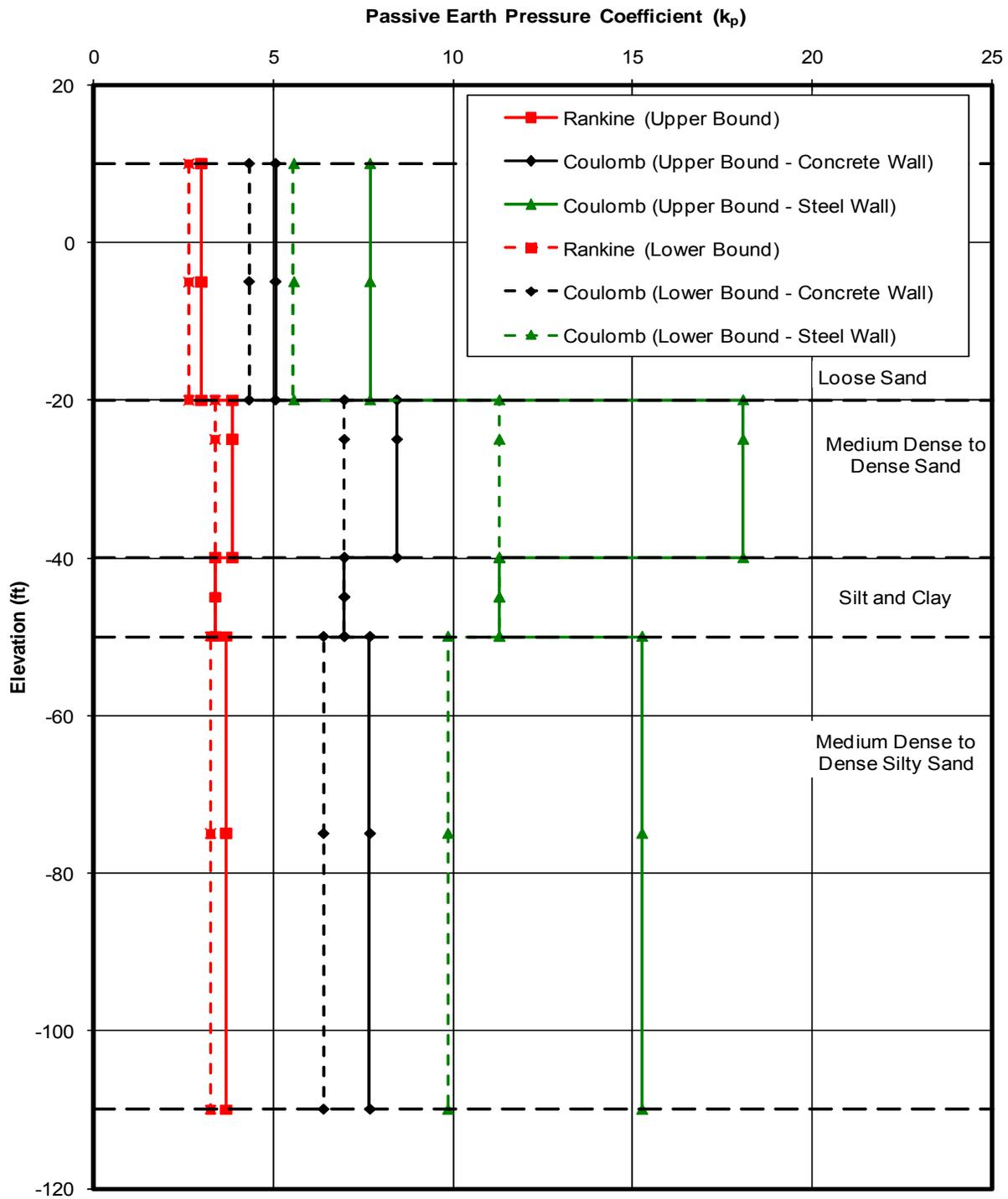


FIGURE A-5

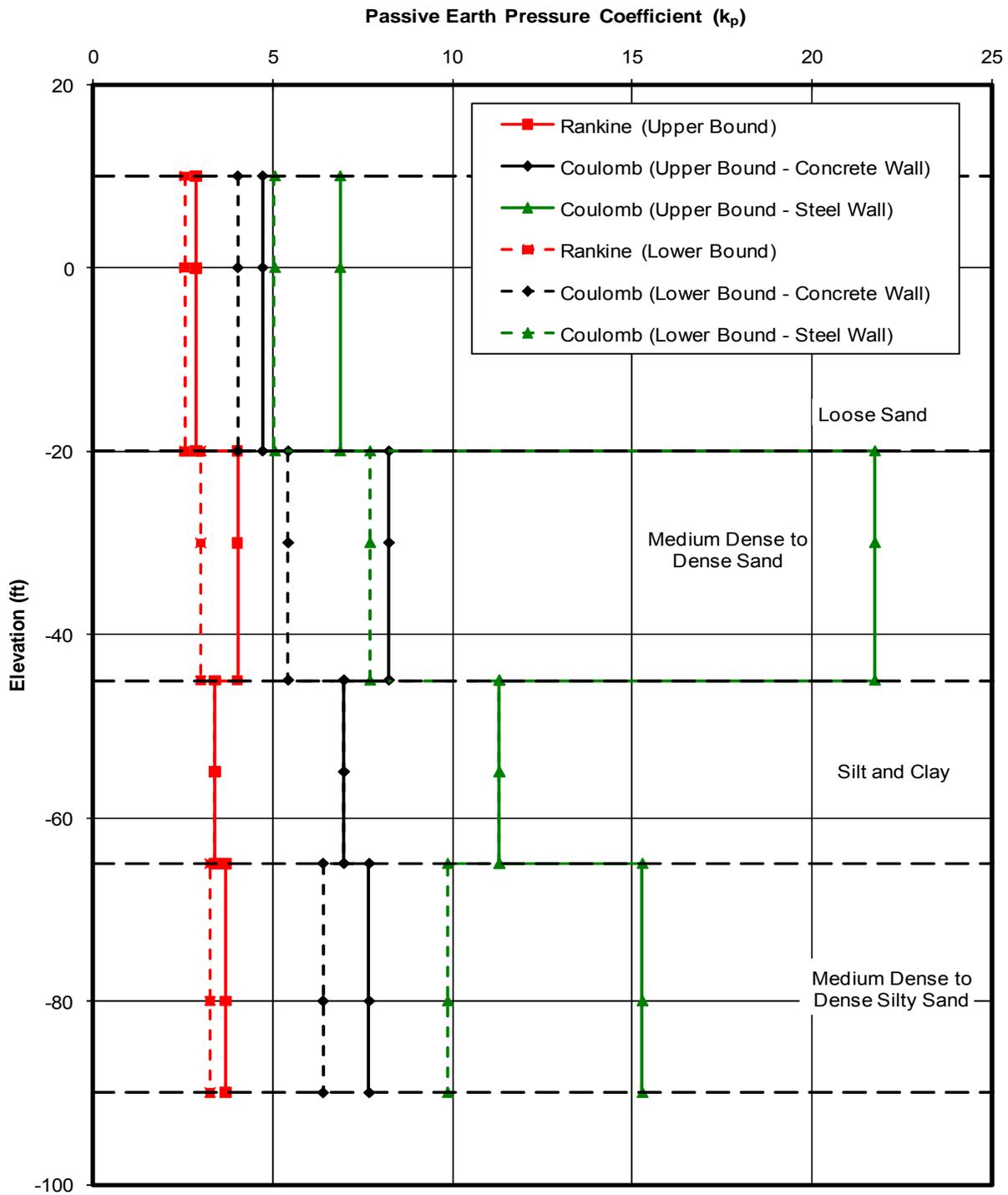


ACTIVE EARTH PRESSURE COEFFICIENT - PROFILE 2
 City-wide Coastal Flooding Study
 Norfolk, Virginia

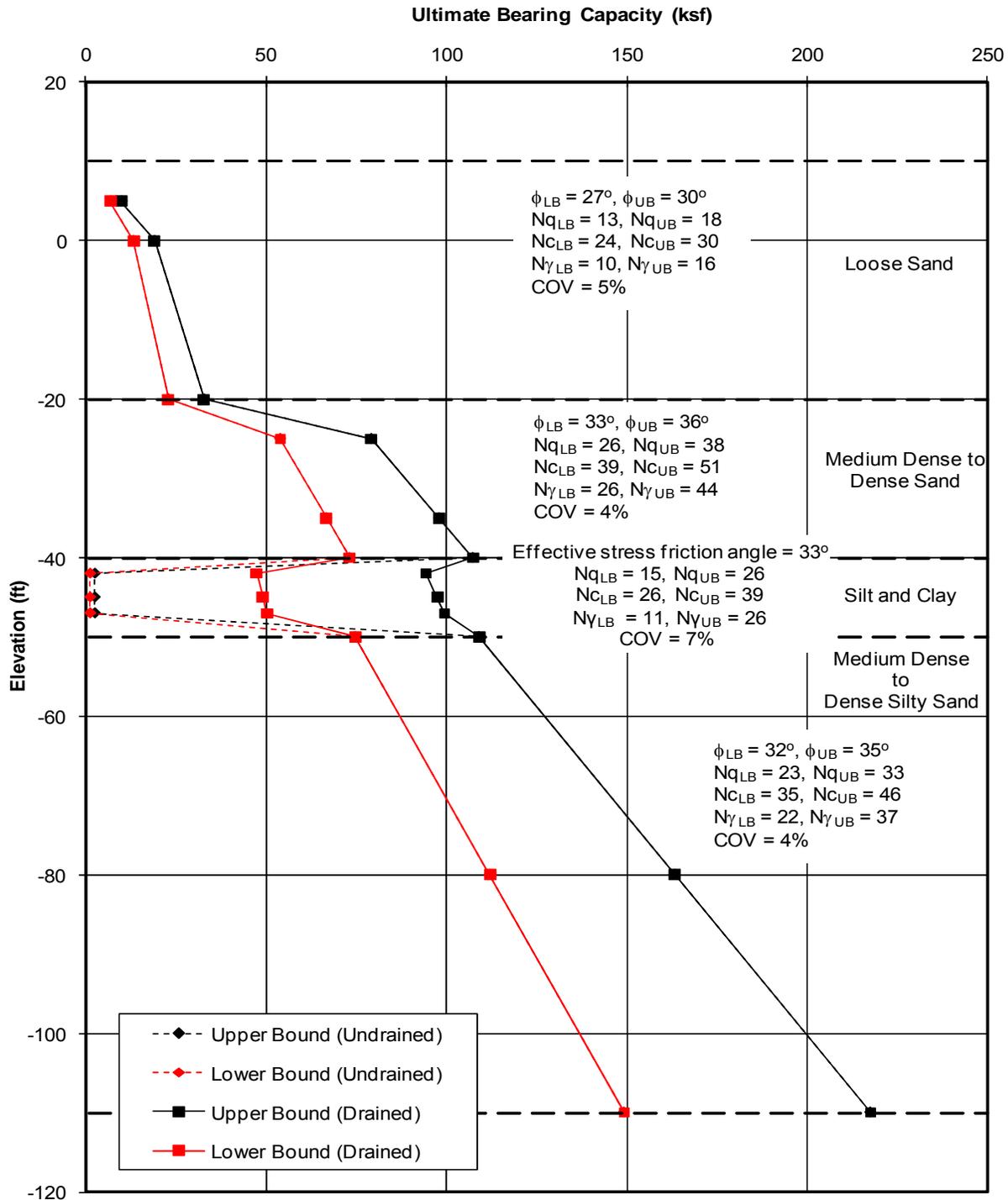
FIGURE A-6



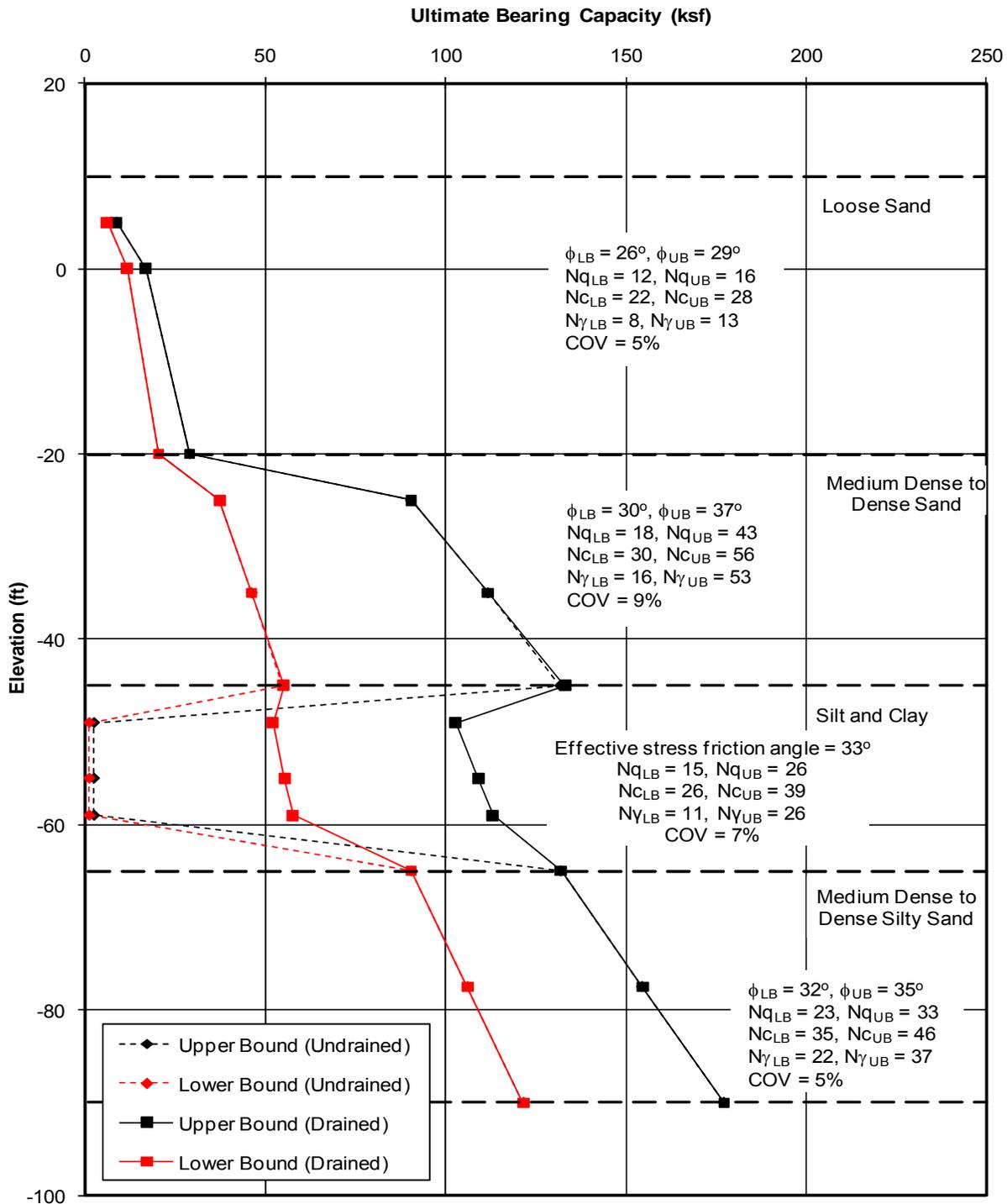
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 Norfolk, Virginia



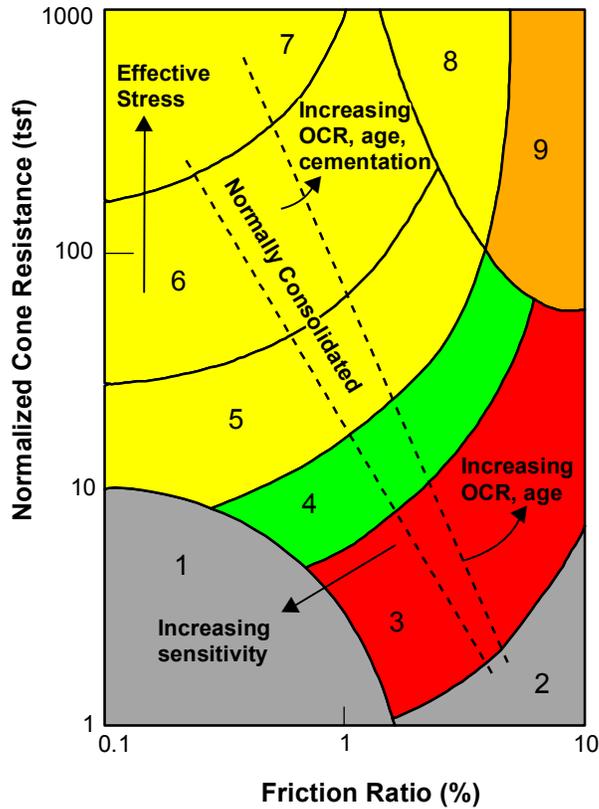
PASSIVE EARTH PRESSURE COEFFICIENT - PROFILE 2
 City-wide Coastal Flooding Study
 Norfolk, Virginia



ULTIMATE BEARING CAPACITY - PROFILE 1
 City-wide Coastal Flooding Study
 Norfolk, Virginia



ULTIMATE BEARING CAPACITY - PROFILE 2
 City-wide Coastal Flooding Study
 Norfolk, Virginia

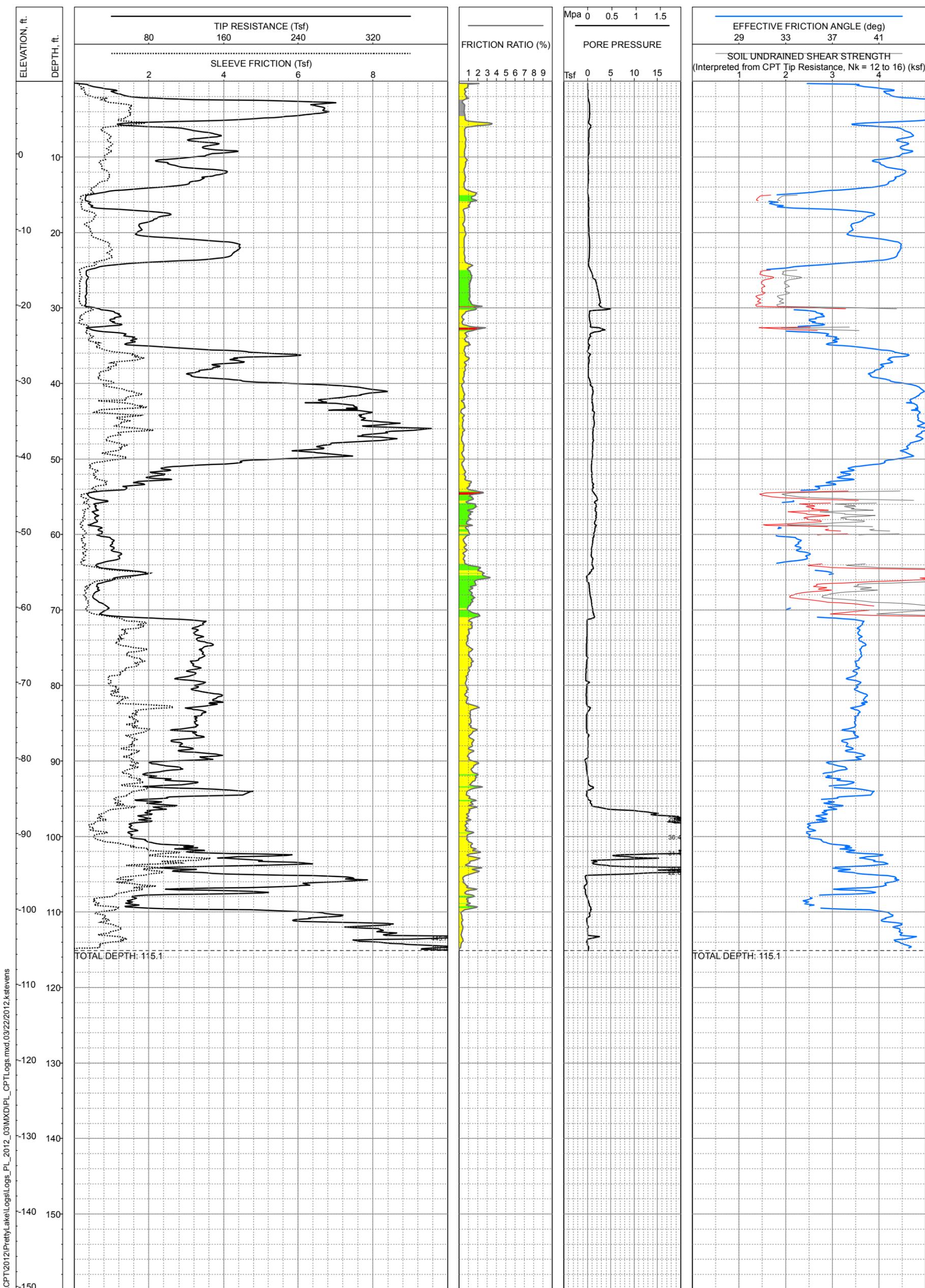


Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay to Silty Clay	CL-CH
4	Clayey Silt to Silty Clay	MH-CL
5	Silty Sand to Sandy Silt	SM-ML
6	Sand to Silty Sand	SP-SM
7	Gravelly Sand to Sand	GP-SP
8	Sand to Clayey Sand	SP-SC
9	Very Stiff Fine-grained*	CH-CL

*overconsolidated or cemented

**CPT CORRELATION CHART
ROBERTSON, 1990**

CPT SOIL BEHAVIOR TYPE KEY
City-wide Coastal Flooding Study
Norfolk, Virginia

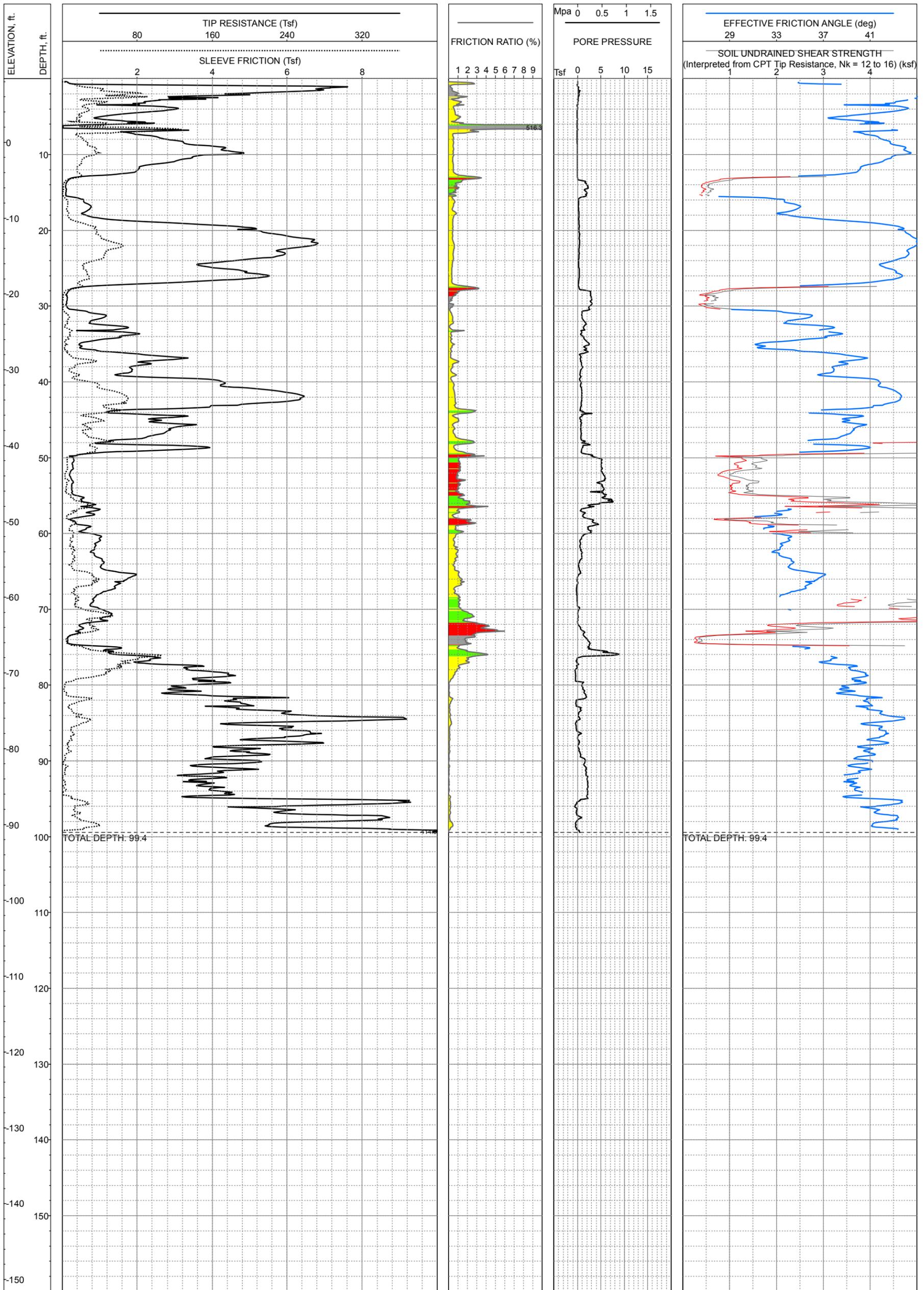


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LOCATION: N: 3,504,356, E: 12,157,609 (State Plane Virginia South Zone, NAD 83, feet)
SURFACE EL: 9.6 ft (NAVD88)
COMPLETION DEPTH: 115.1ft
TEST DATE: 3/1/2012

EXPLORATION METHOD: CPT
PERFORMED BY: Fugro
REVIEWED BY: KSmith
Soil behavior type based on Robertson (1990)

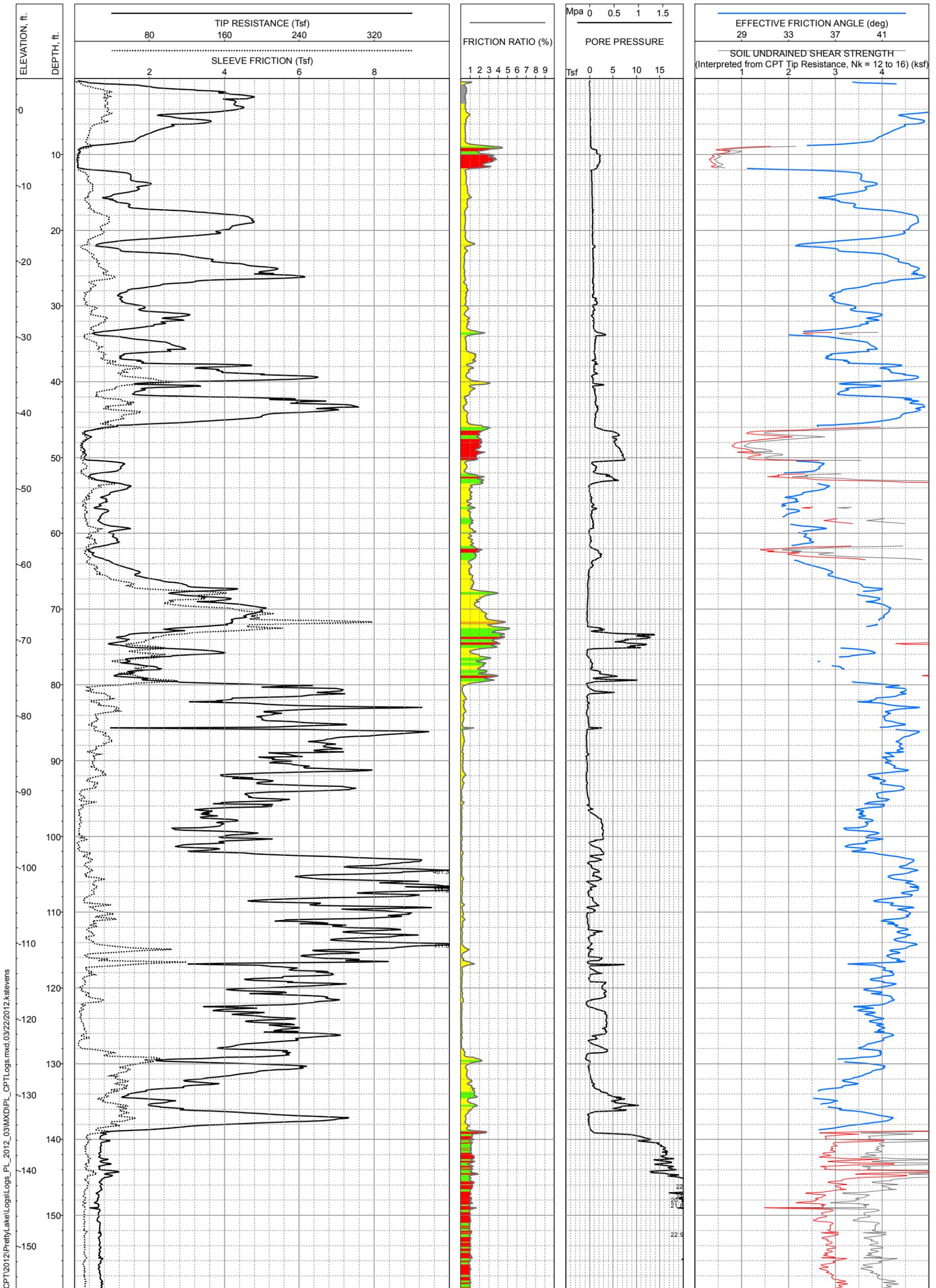
LOG OF CPT NO: C-1
Pretty Lake Area
Norfolk, Virginia



LOCATION: N: 3,504,964, E: 12,157,747 (State Plane Virginia South Zone, NAD 83, feet)
 SURFACE EL: 8.4 ft (NAVD88)
 COMPLETION DEPTH: 99.4ft
 TEST DATE: 3/2/2012

EXPLORATION METHOD: CPT
 PERFORMED BY: Fugro
 REVIEWED BY: KSmith
 Soil behavior type based on Robertson (1990)

LOG OF CPT NO: C-2
 Pretty Lake Area
 Norfolk, Virginia



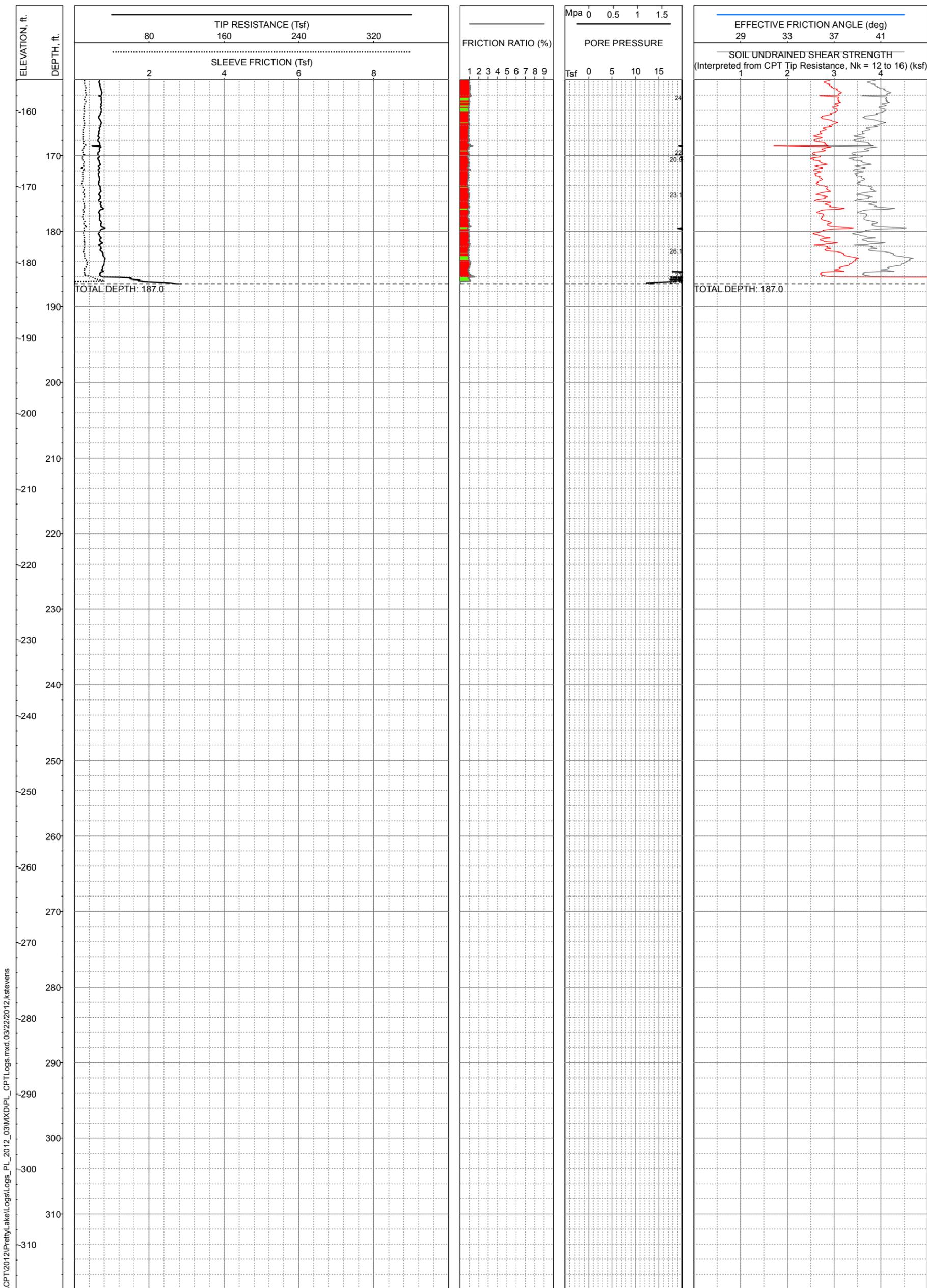
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 SURFACE EL: 4.1 ft (NAVD88)
 COMPLETION DEPTH: 187.0ft
 TEST DATE: 3/2/2012

EXPLORATION METHOD: CPT
 PERFORMED BY: Fugro
 REVIEWED BY: KSmith
 Soil behavior type based on Robertson (1990)

LOG OF CPT NO: C-3
 Pretty Lake Area
 Norfolk, Virginia

FIGURE A-14a

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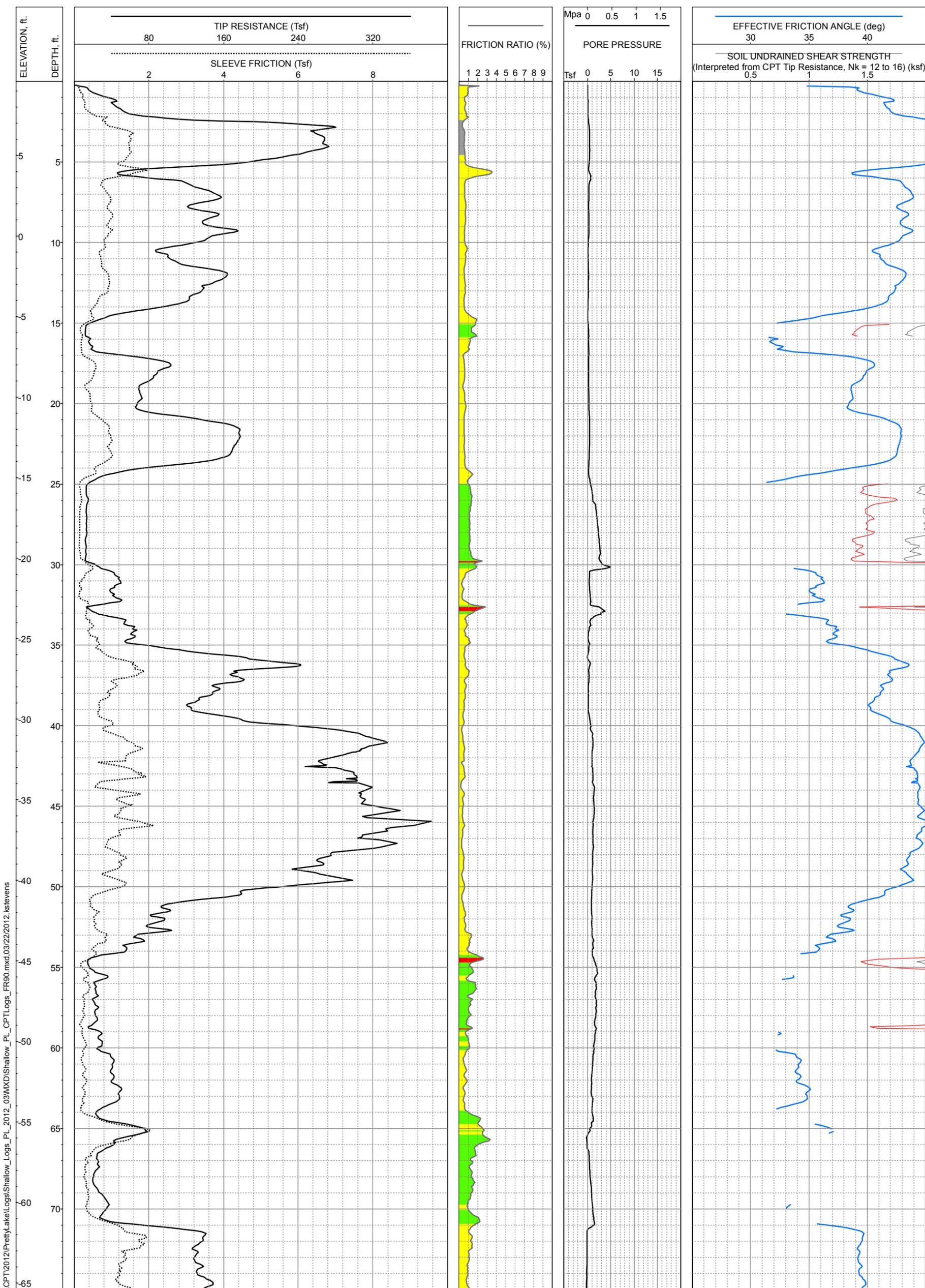


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LOCATION: N: 3,504,765, E: 12,157,694 (State Plane Virginia South Zone, NAD 83, feet)
SURFACE EL: 4.1 ft (NAVD88)
COMPLETION DEPTH: 187.0ft
TEST DATE: 3/2/2012

EXPLORATION METHOD: CPT
PERFORMED BY: Fugro
REVIEWED BY: KSmith
Soil behavior type based on Robertson (1990)

LOG OF CPT NO: C-3
Pretty Lake Area
Norfolk, Virginia

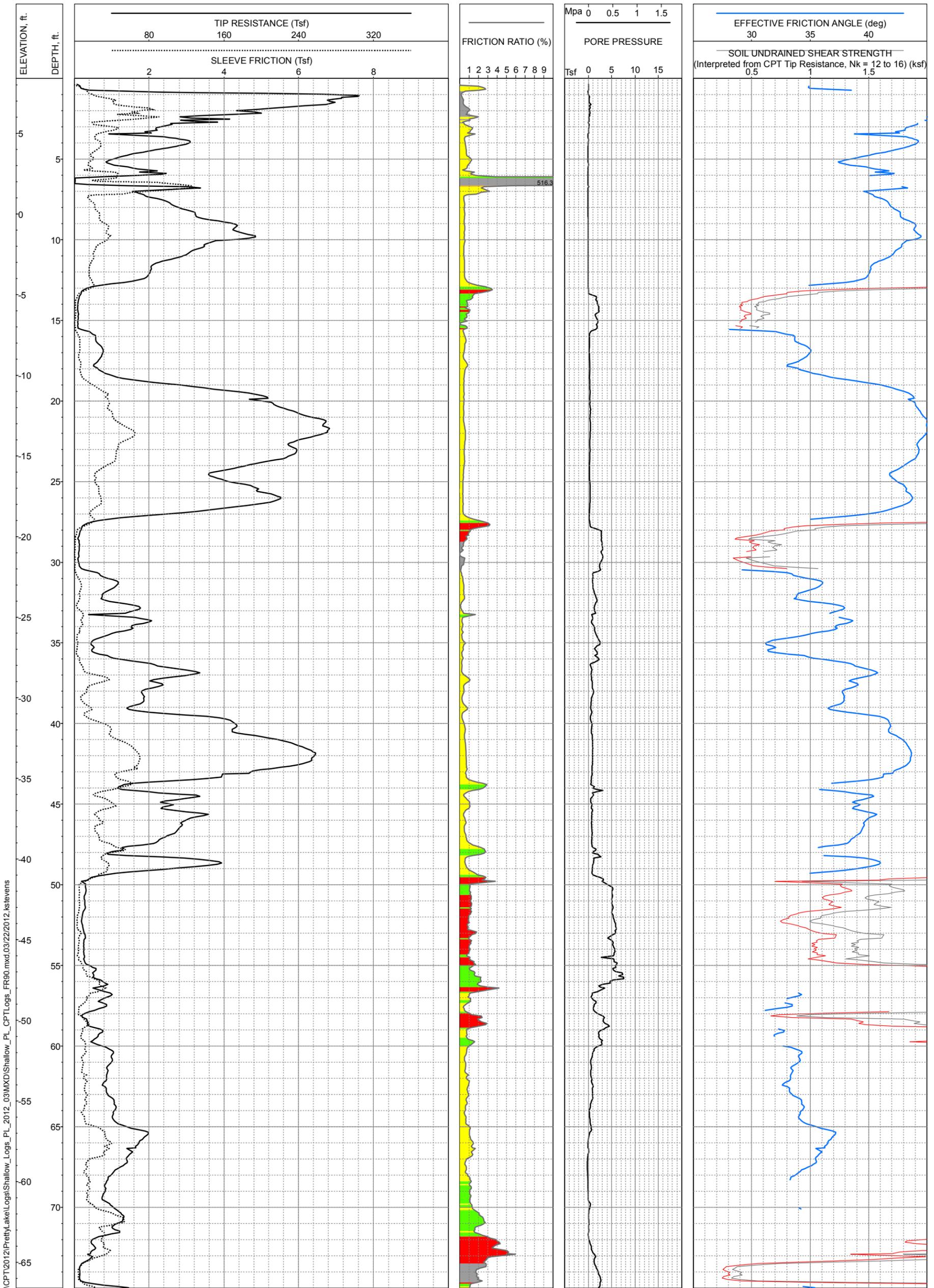


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LOCATION: N: 3,504,356, E: 12,157,609 (State Plane Virginia South Zone, NAD 83, feet)
 SURFACE EL: 9.6 ft (NAVD88)
 COMPLETION DEPTH: 115.1ft
 TEST DATE: 3/1/2012

EXPLORATION METHOD: CPT
 PERFORMED BY: Fugro
 REVIEWED BY: KSmith
 Soil behavior type based on Robertson (1990)

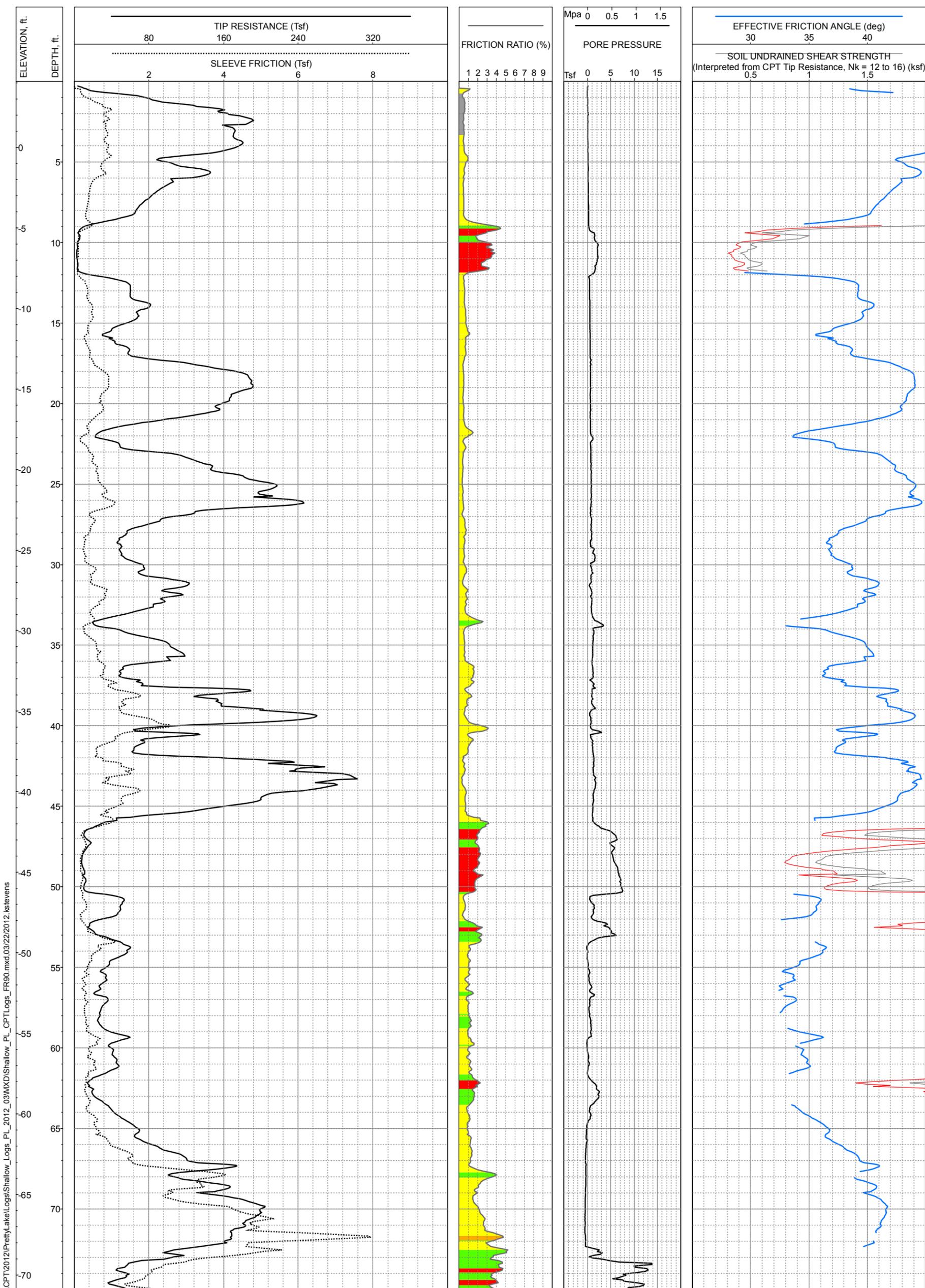
SHALLOW LOG (UPPER 75 FT) OF CPT NO: C-1
 Pretty Lake Area
 Norfolk, Virginia



LOCATION: N: 3,504,964, E: 12,157,747 (State Plane Virginia South Zone, NAD 83, feet)
 SURFACE EL: 8.4 ft (NAVD88)
 COMPLETION DEPTH: 99.4ft
 TEST DATE: 3/2/2012

EXPLORATION METHOD: CPT
 PERFORMED BY: Fugro
 REVIEWED BY: KSmith
 Soil behavior type based on Robertson (1990)

SHALLOW LOG (UPPER 75 FT) OF CPT NO: C-2
 Pretty Lake Area
 Norfolk, Virginia



LOCATION: N: 3,504,765, E: 12,157,694 (State Plane Virginia South Zone, NAD 83, feet)
 SURFACE EL: 4.1 ft (NAVD88)
 COMPLETION DEPTH: 187.0ft
 TEST DATE: 3/2/2012

EXPLORATION METHOD: CPT
 PERFORMED BY: Fugro
 REVIEWED BY: KSmith
 Soil behavior type based on Robertson (1990)

SHALLOW LOG (UPPER 75 FT) OF CPT NO: C-3
 Pretty Lake Area
 Norfolk, Virginia

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APPENDIX B
MODELING RESULTS

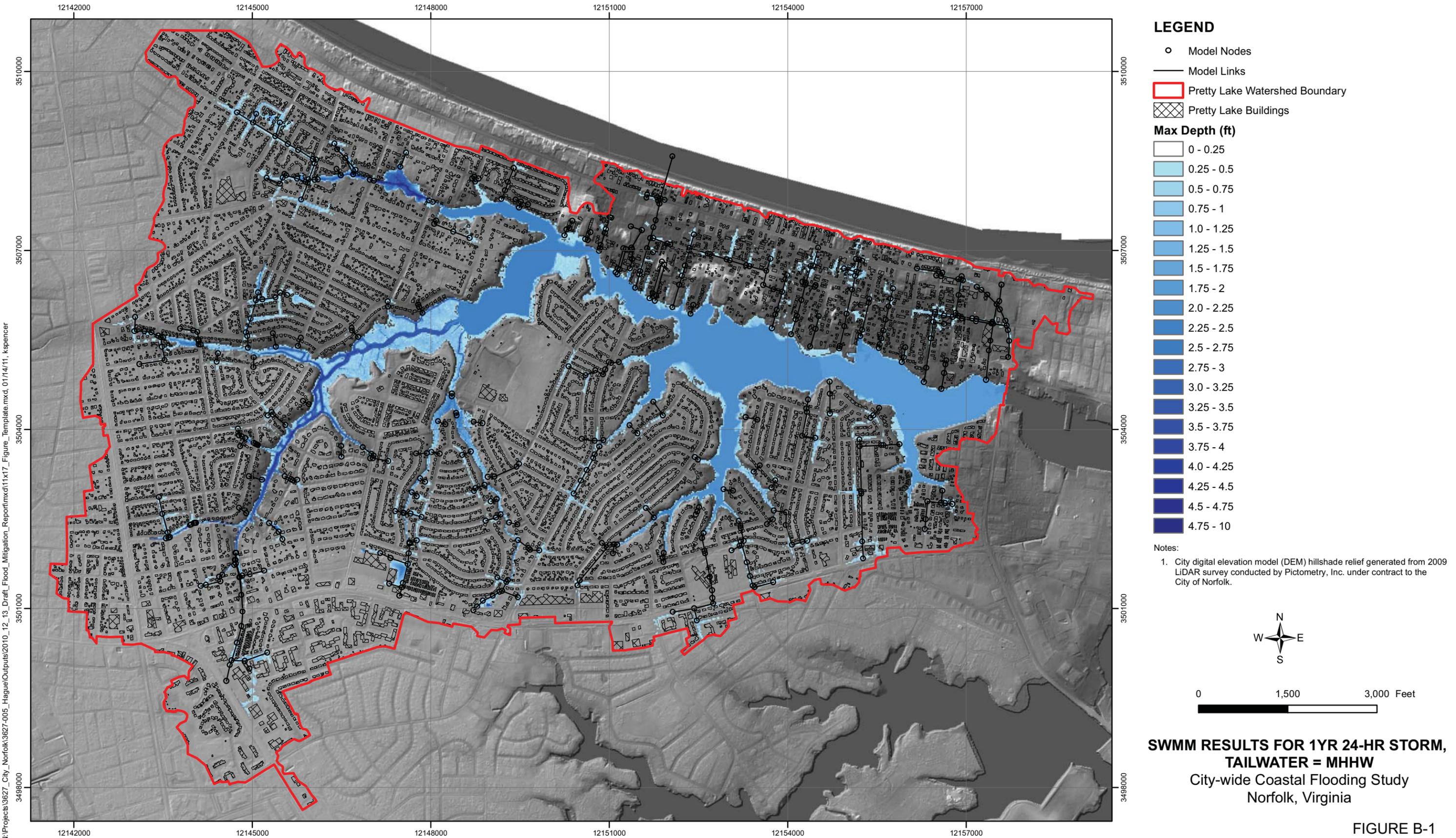
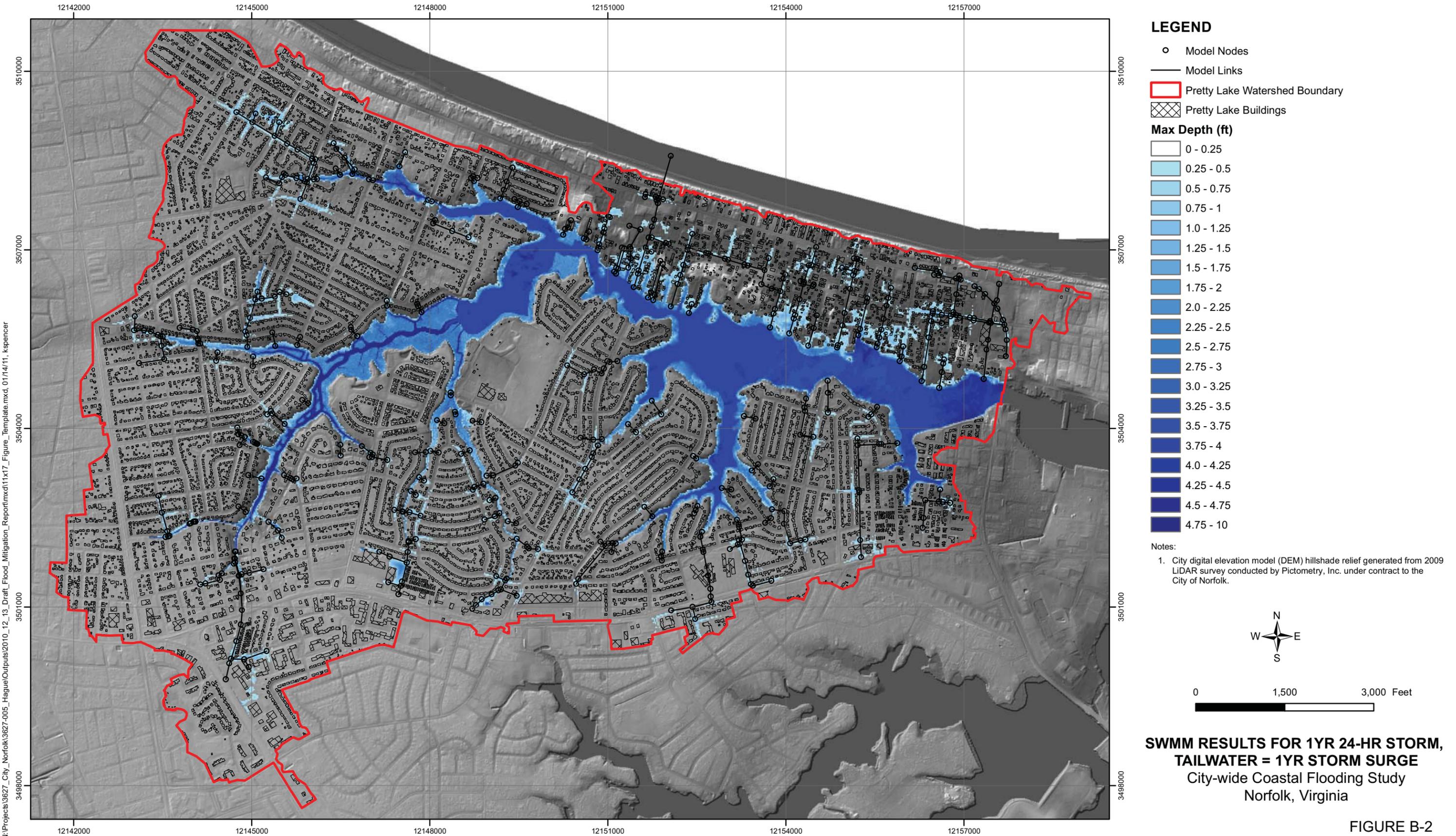
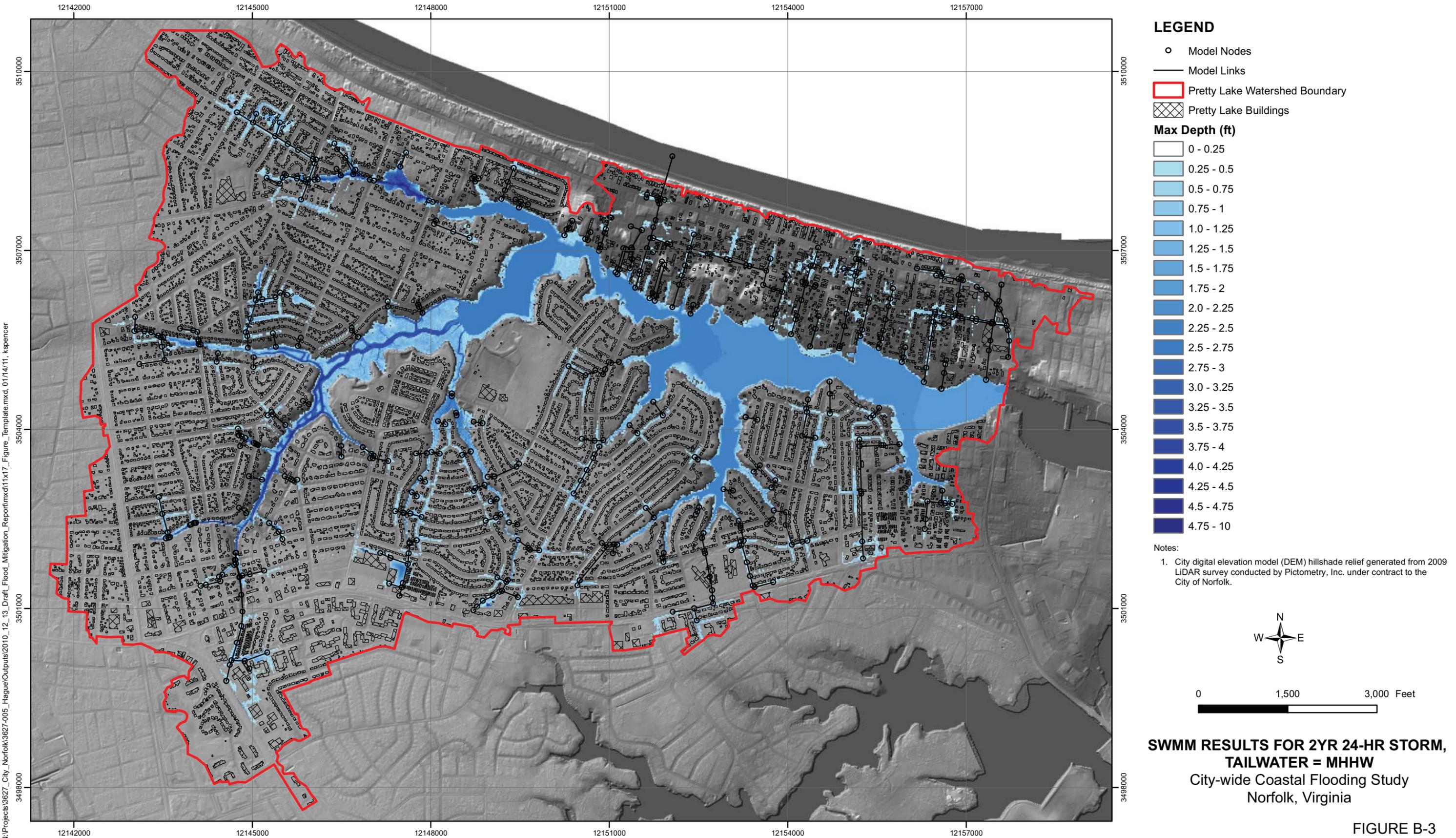


FIGURE B-1



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FIGURE B-2



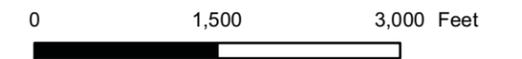
LEGEND

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 2YR 24-HR STORM,
TAILWATER = MHHW**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-3

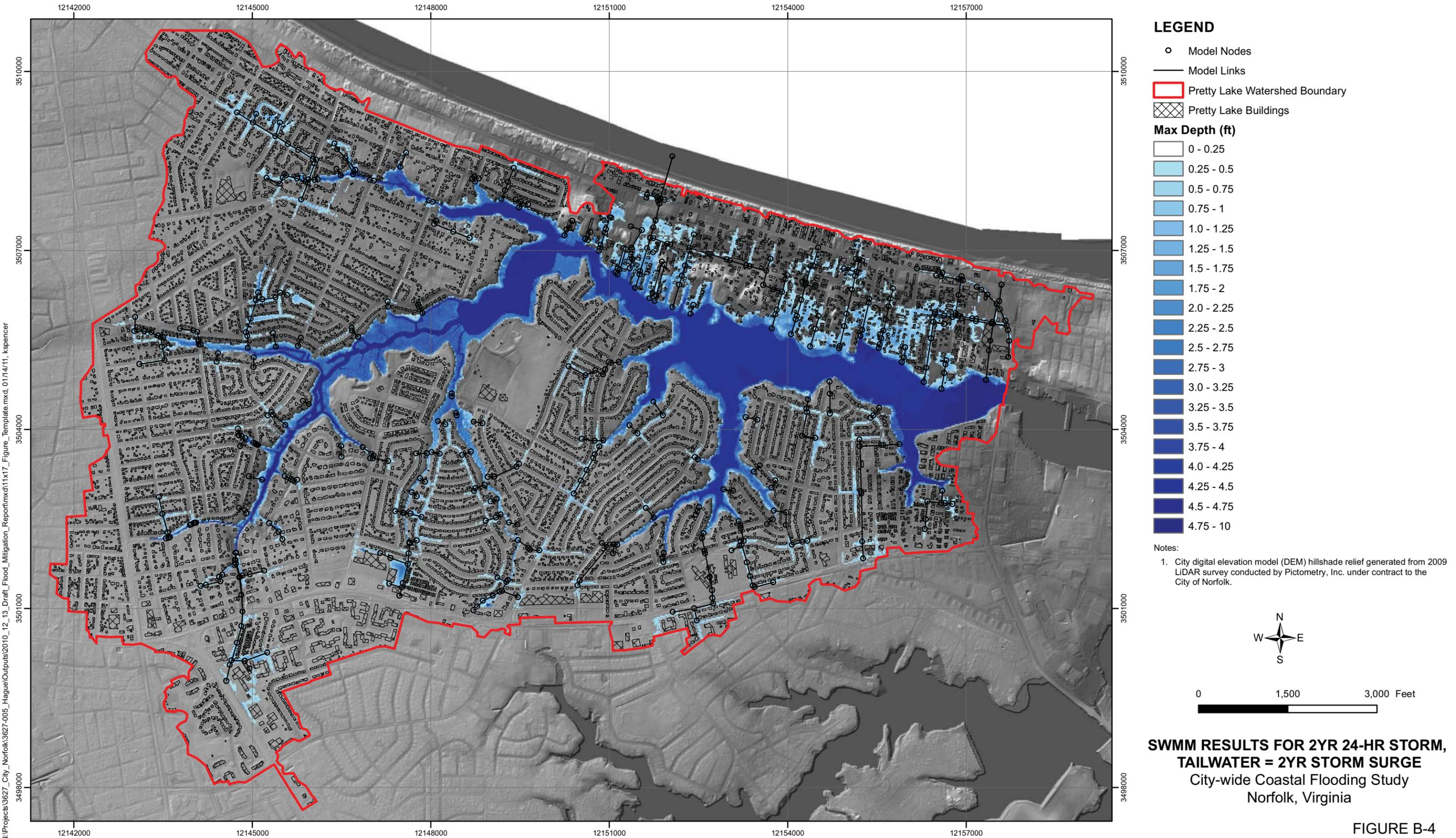


FIGURE B-4

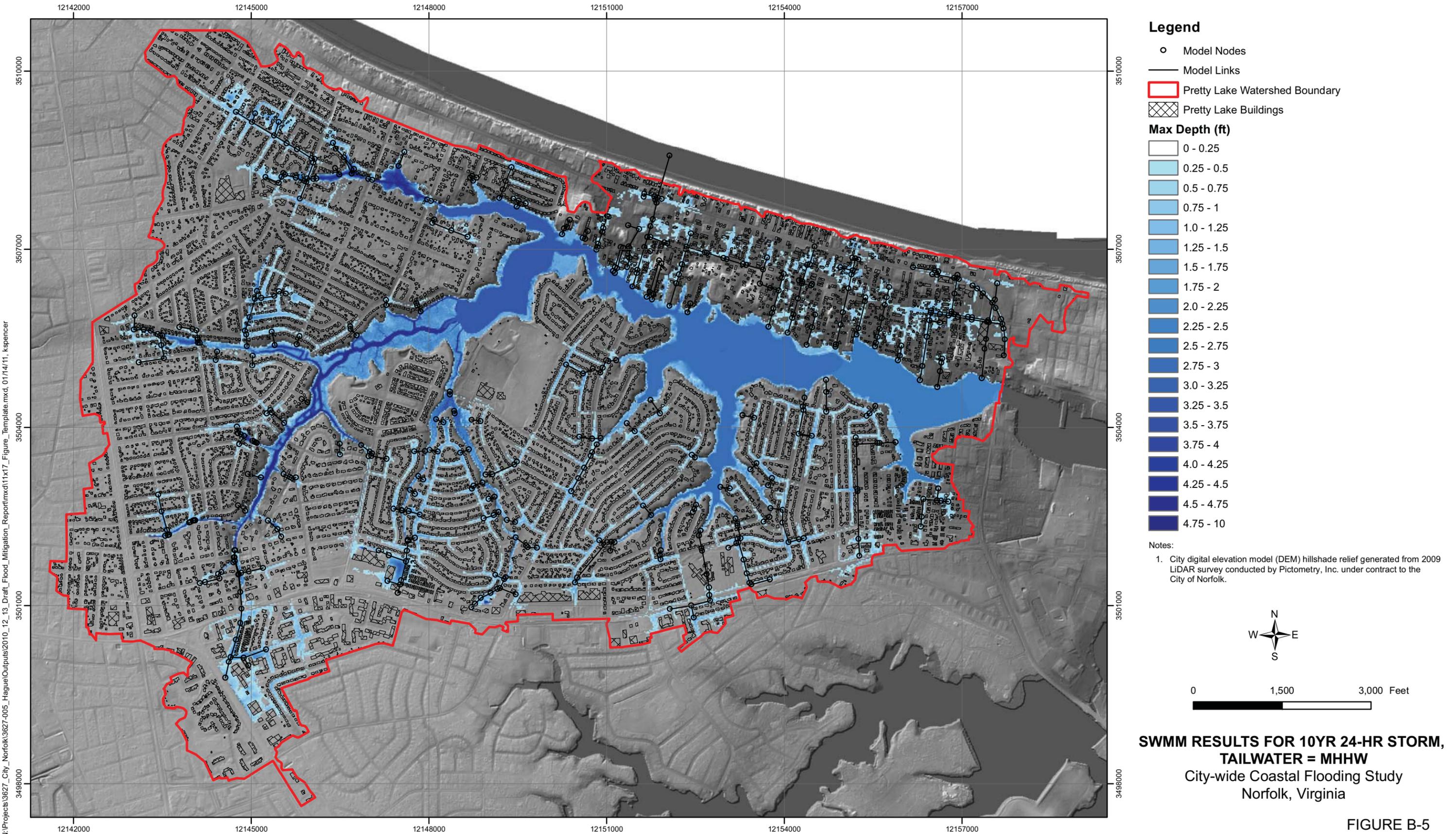
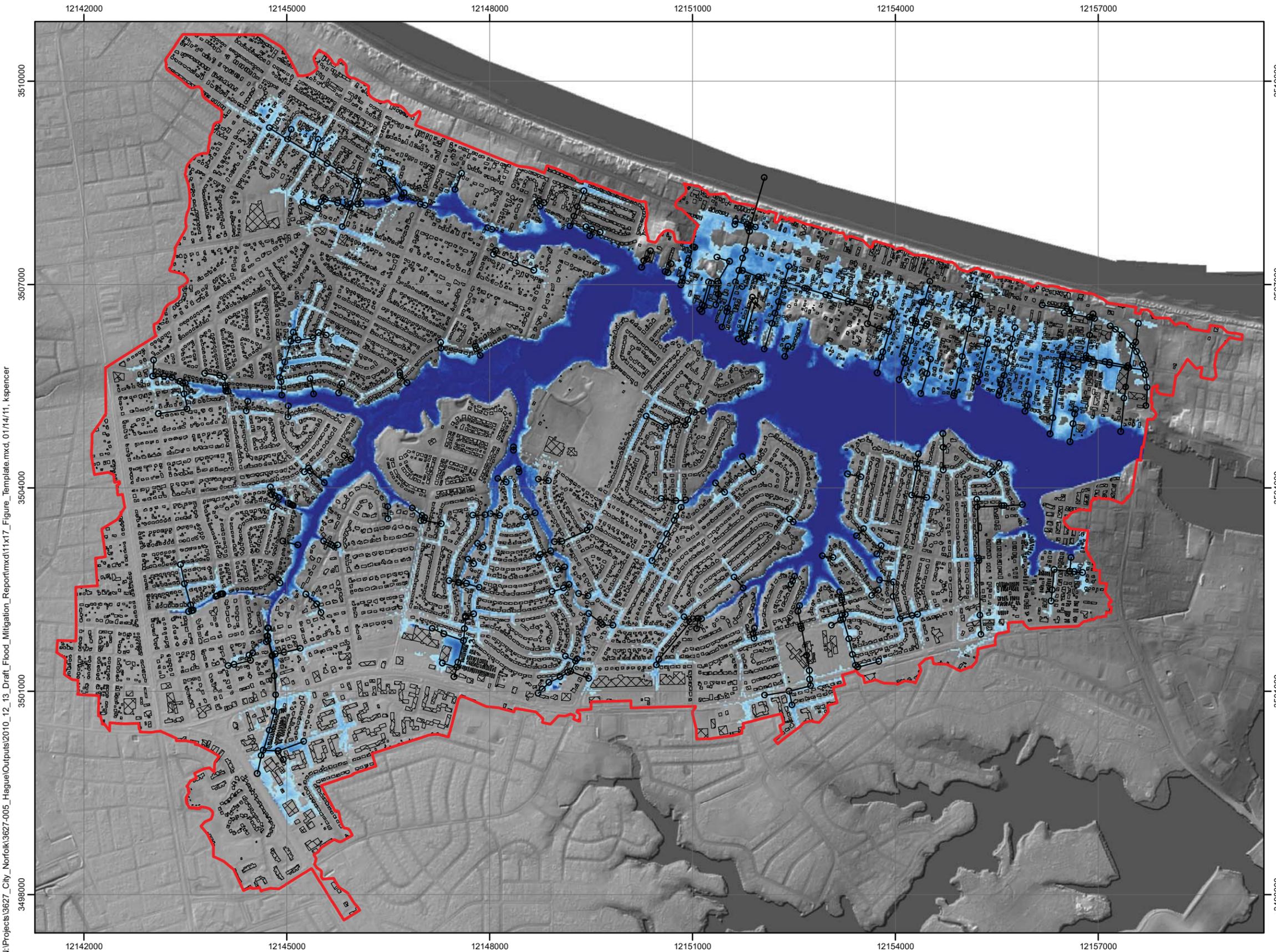


FIGURE B-5



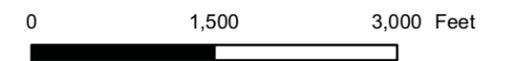
Legend

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

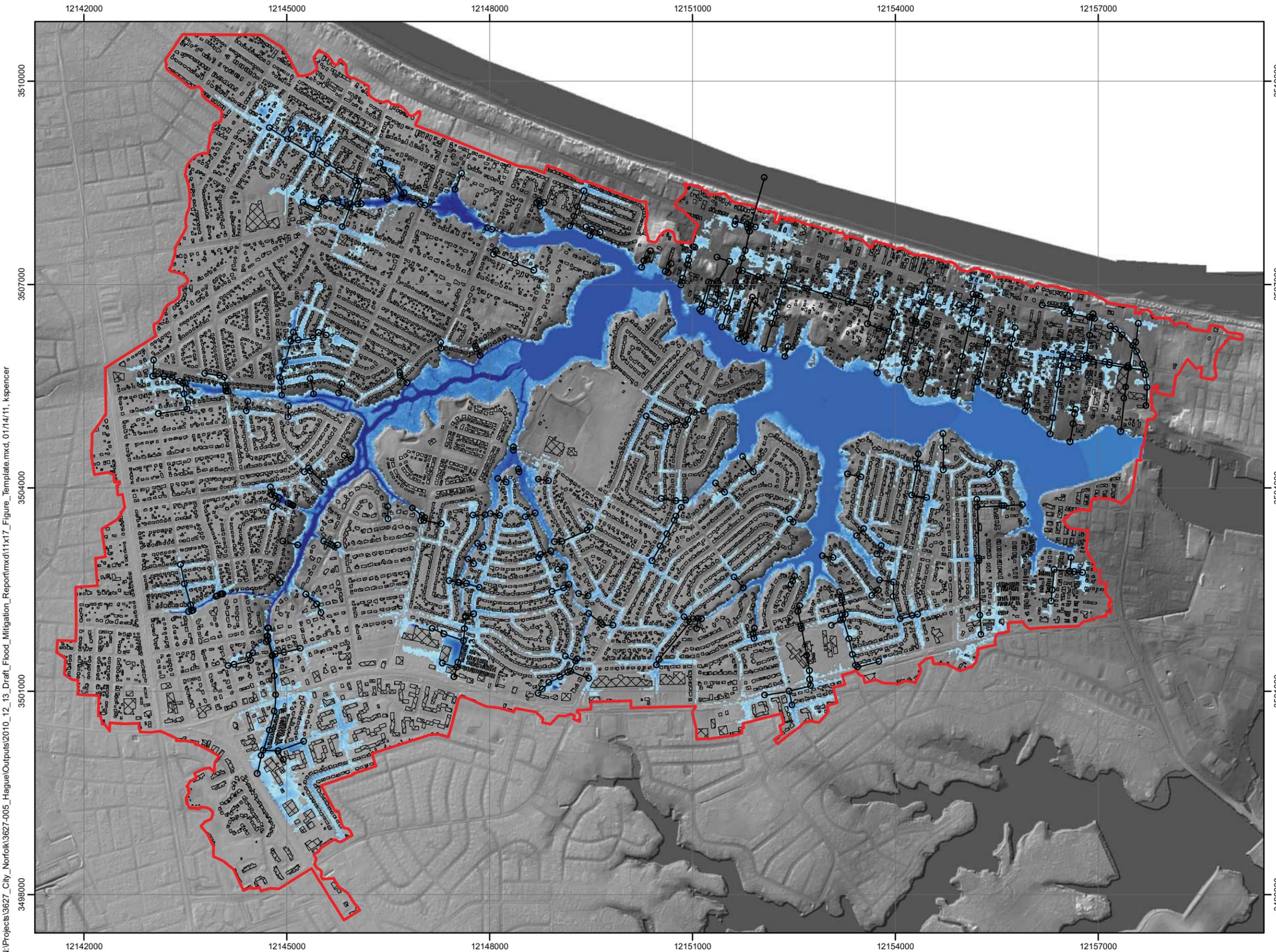
Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
TAILWATER = 10YR STORM SURGE**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-6

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd, 01/14/11, kspencer



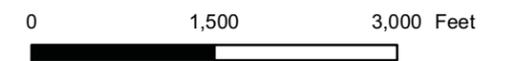
Legend

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = MHHW**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-7

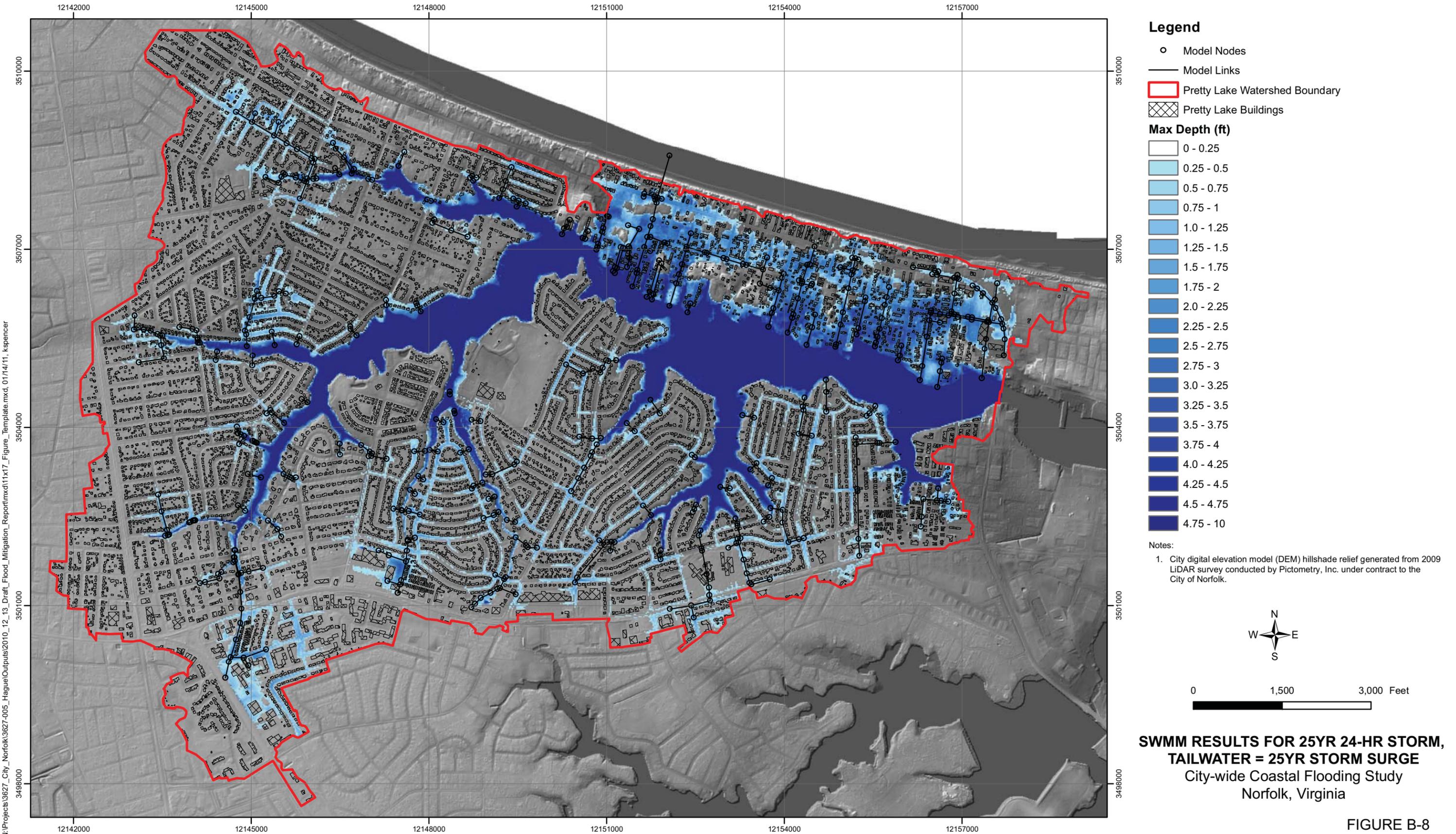


FIGURE B-8

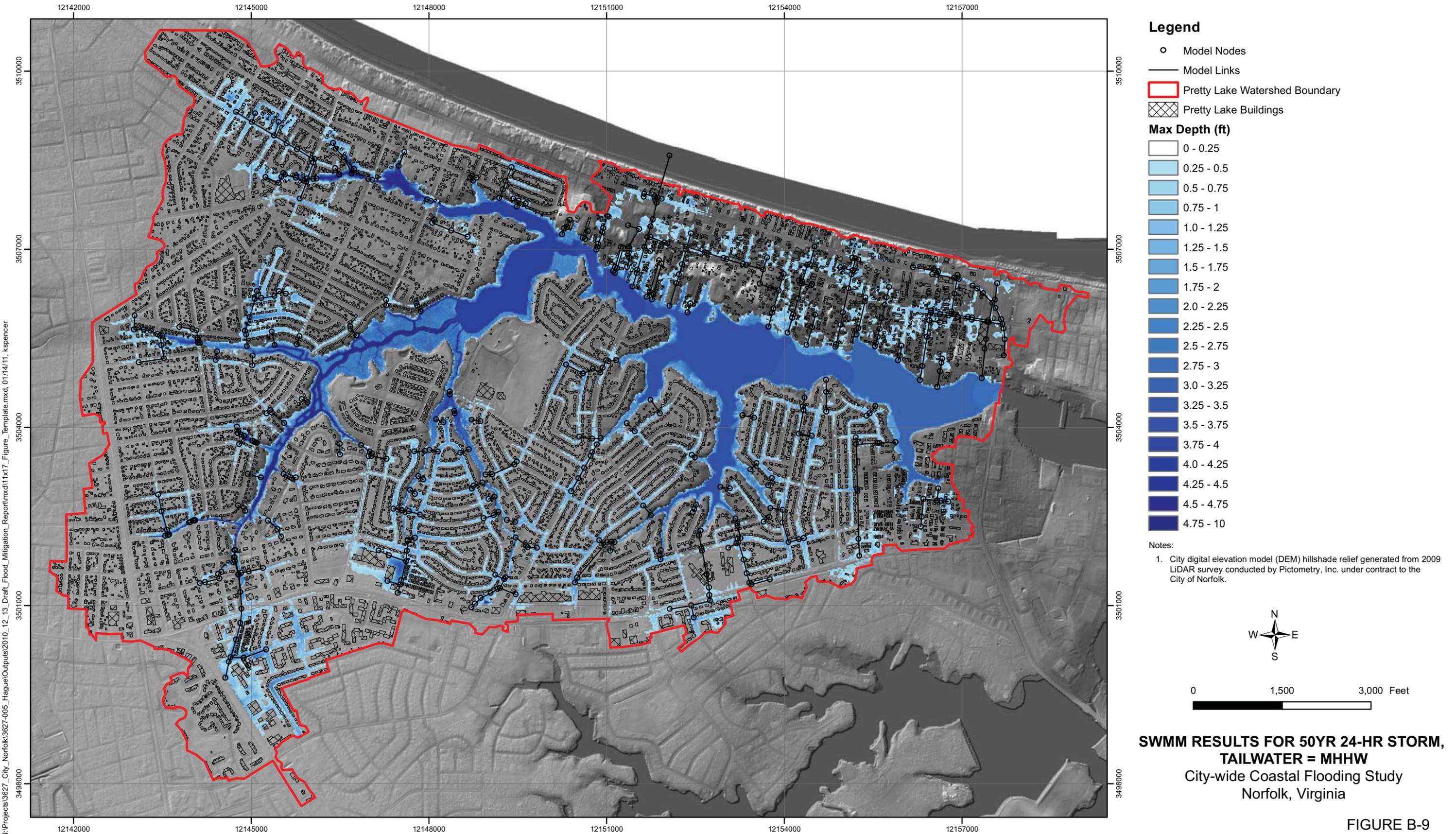


FIGURE B-9

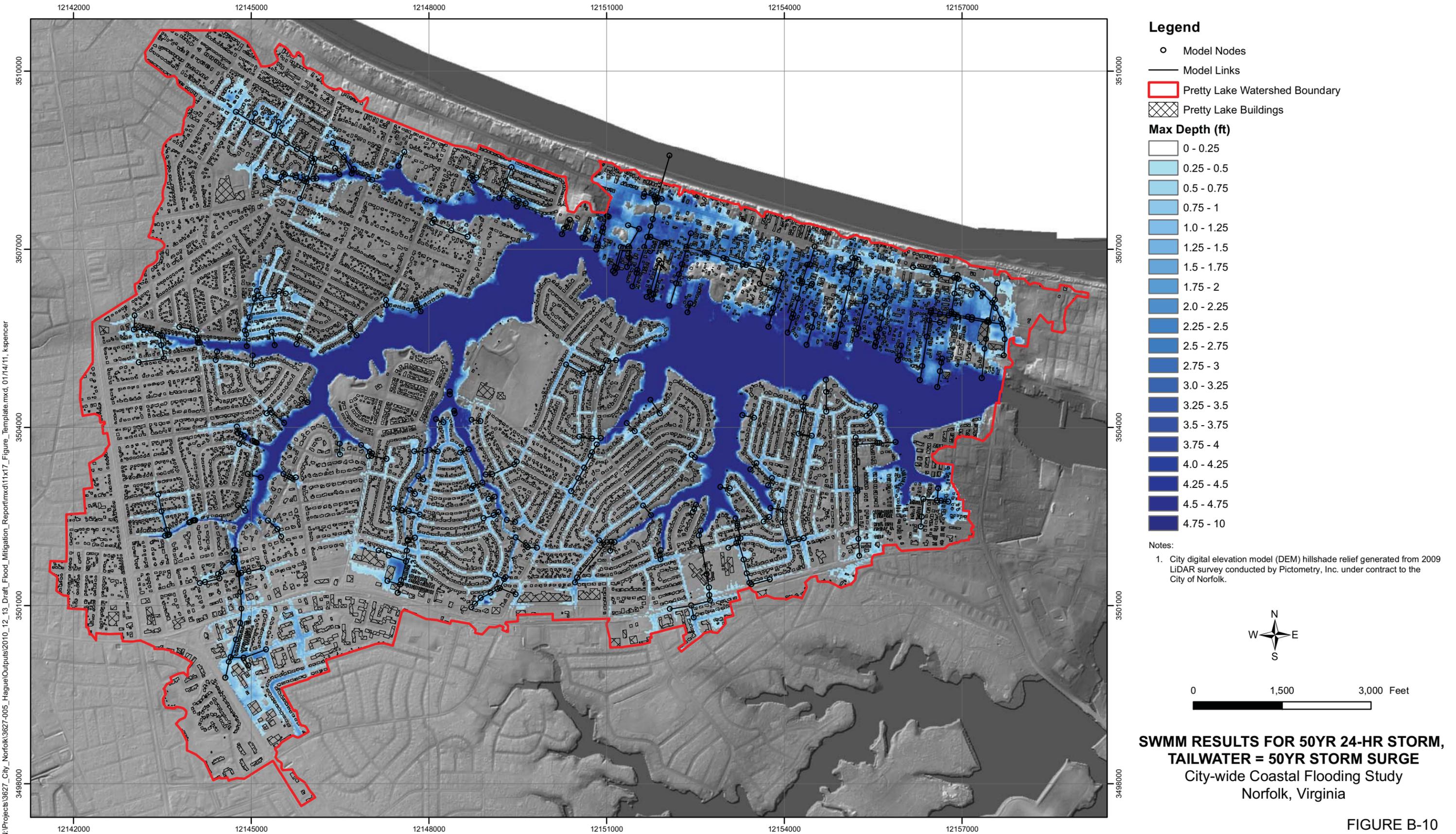
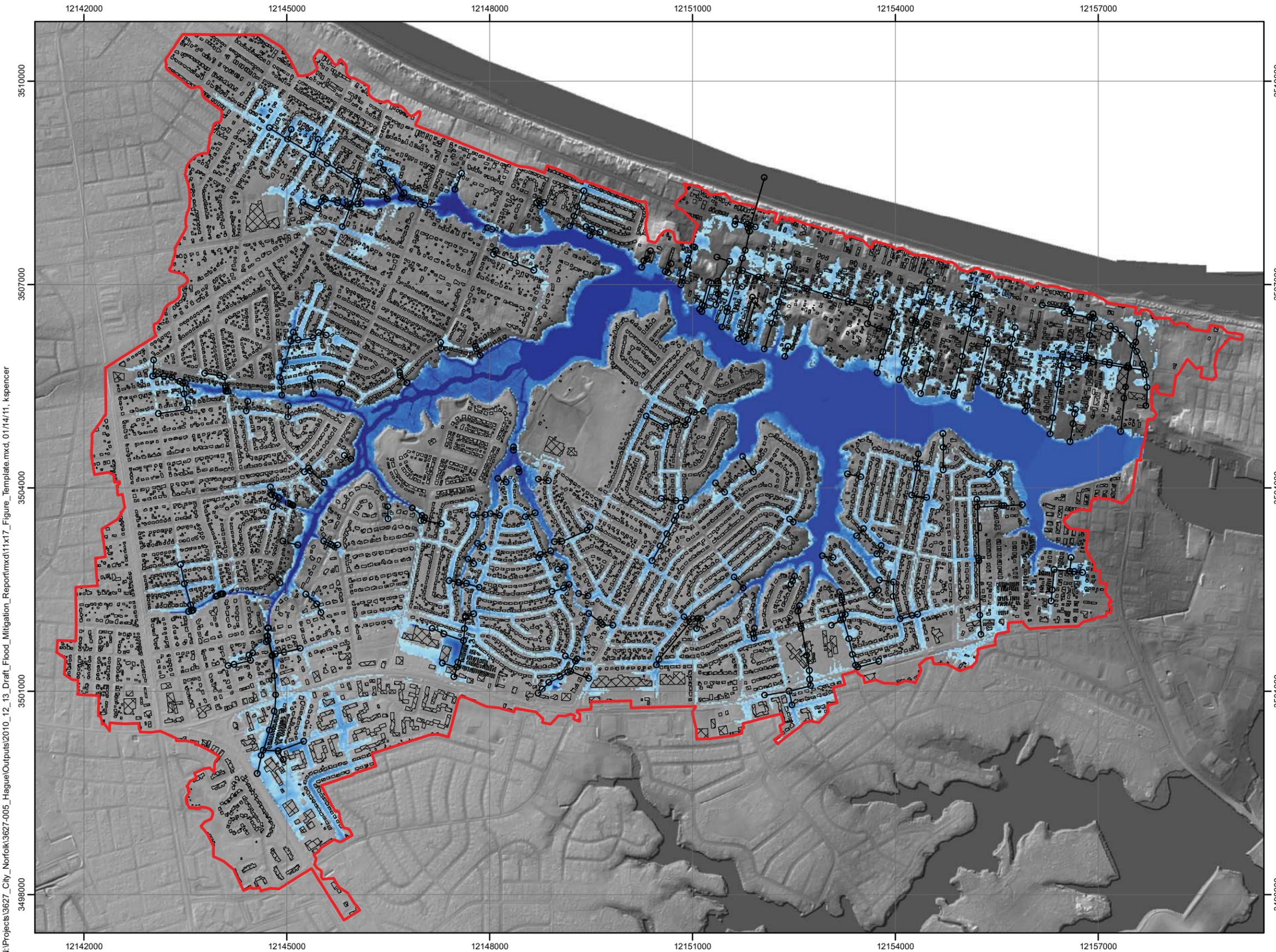


FIGURE B-10



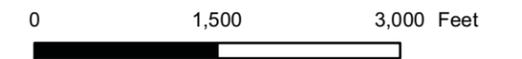
Legend

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

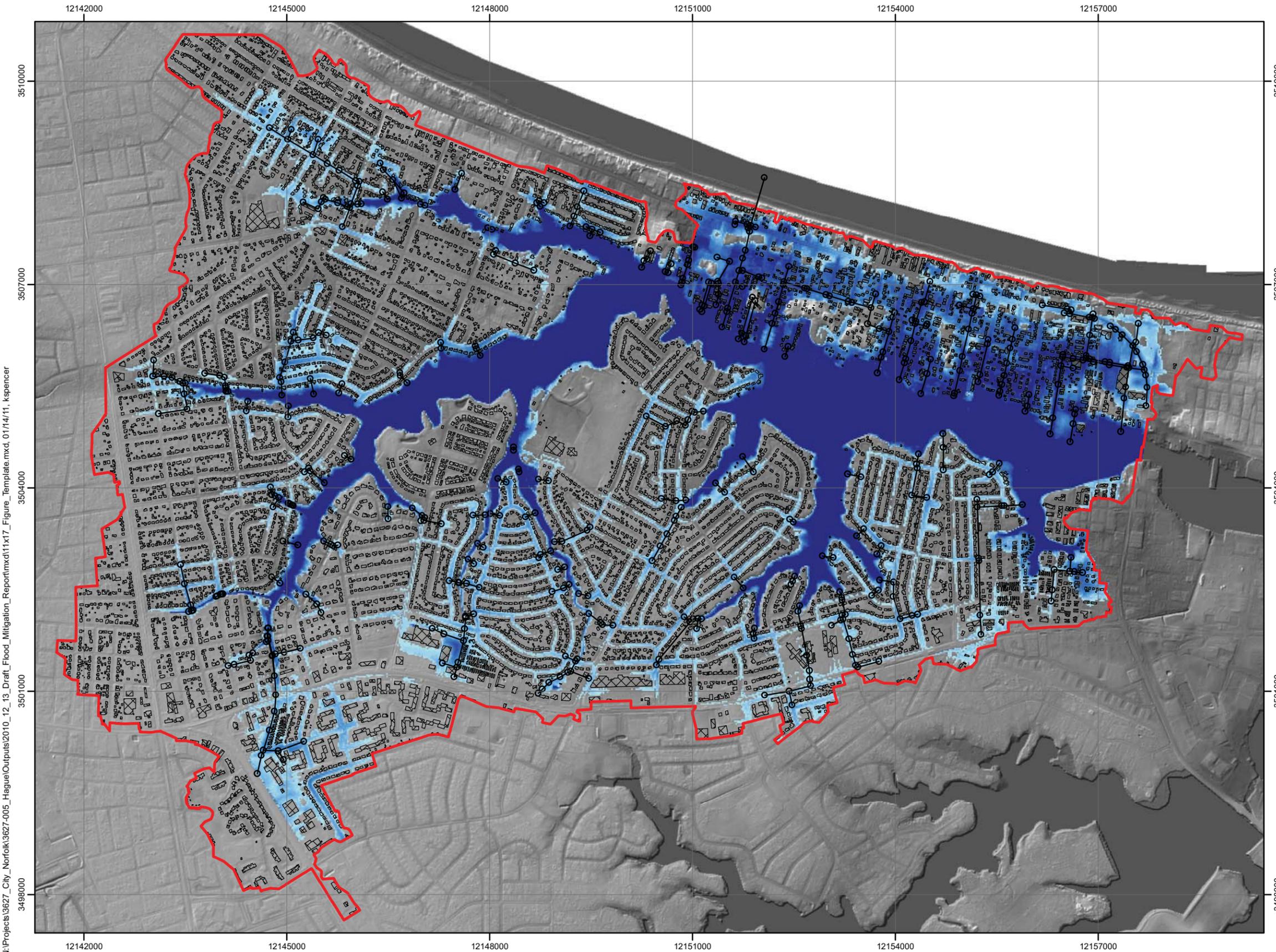
Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = MHHW**
City-wide Coastal Flooding Study
Norfolk, Virginia



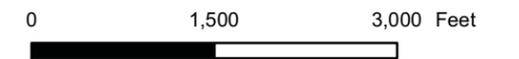
Legend

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▣ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = 100YR STORM SURGE**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-12

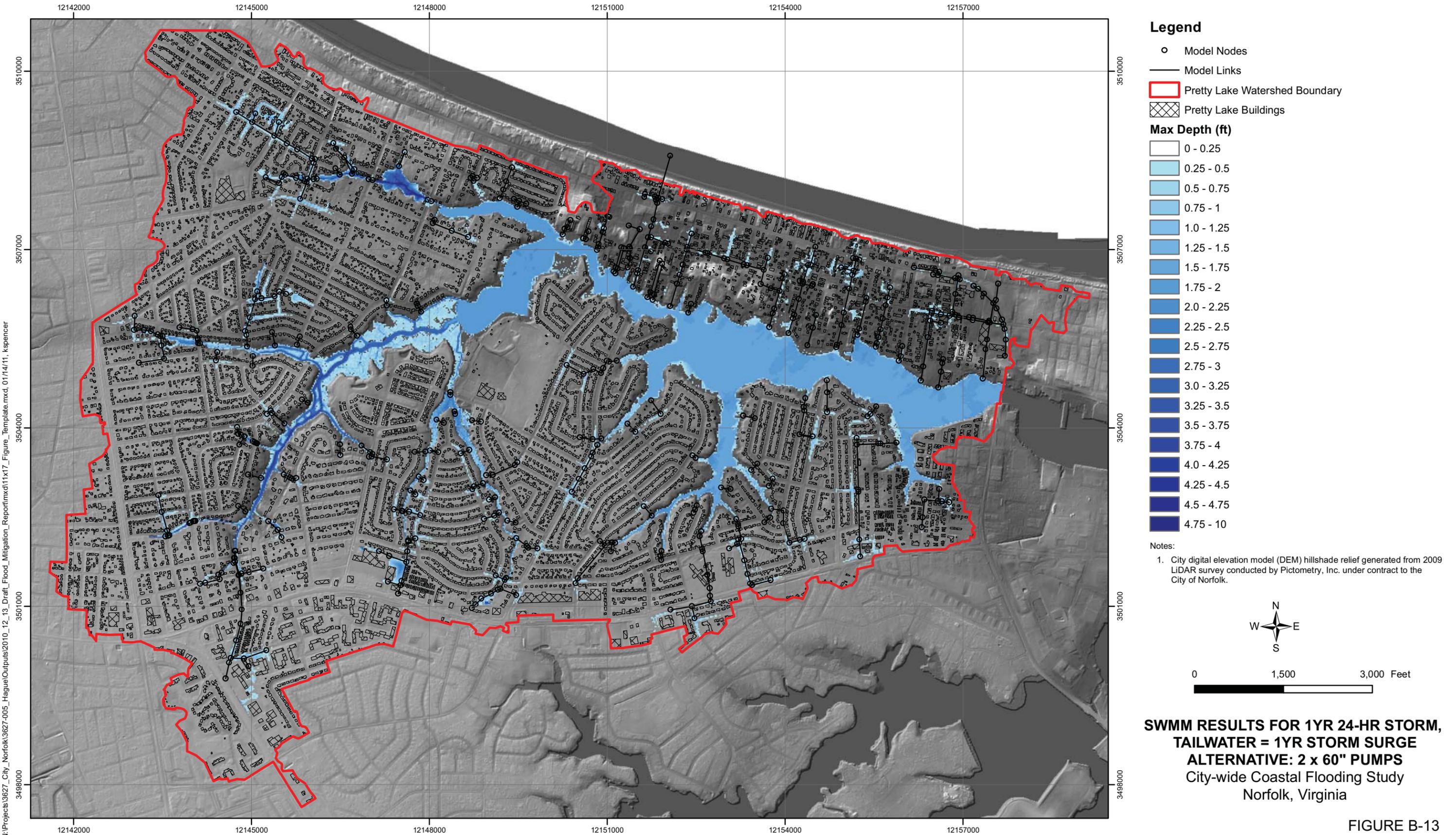


FIGURE B-13

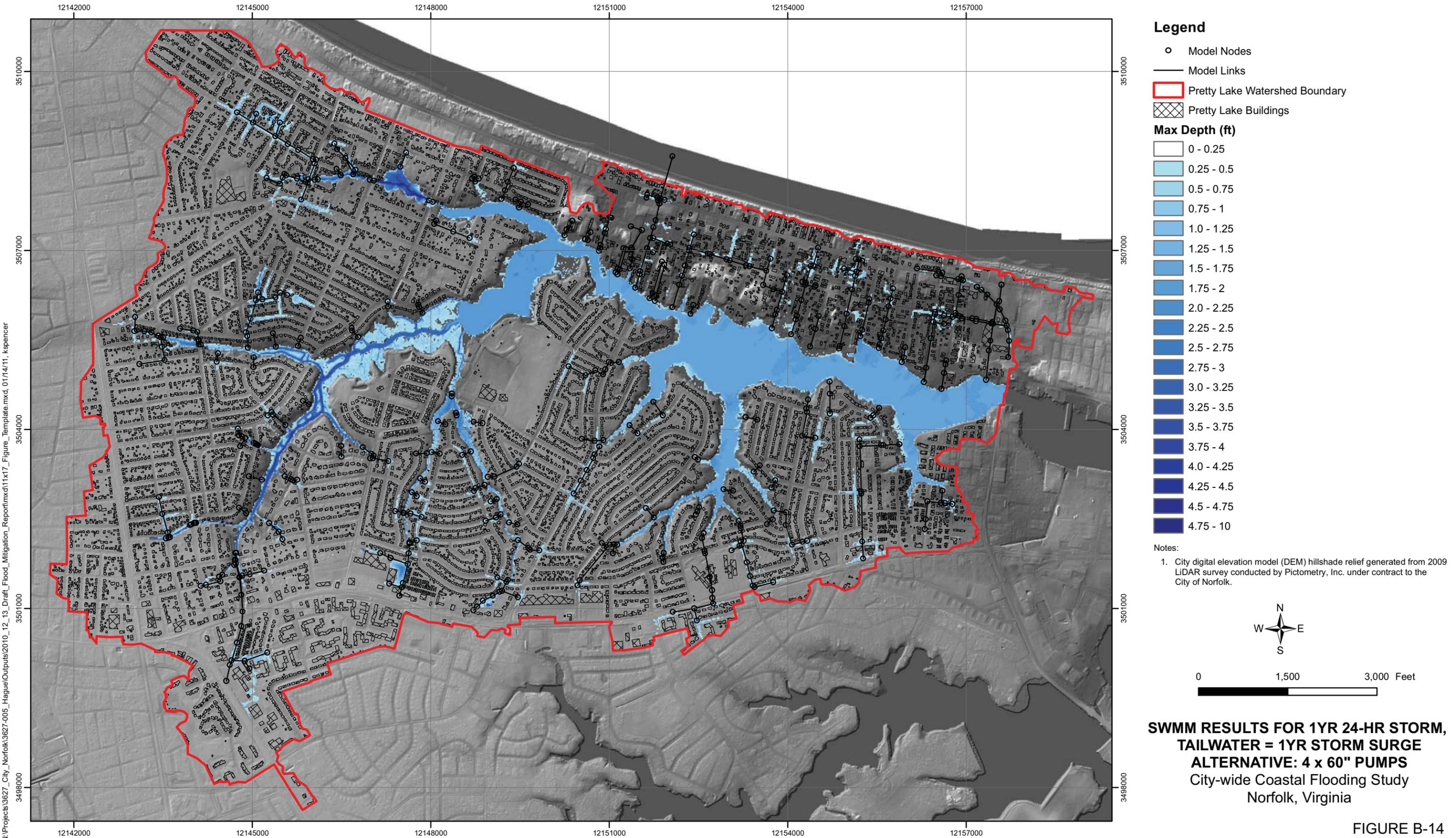


FIGURE B-14

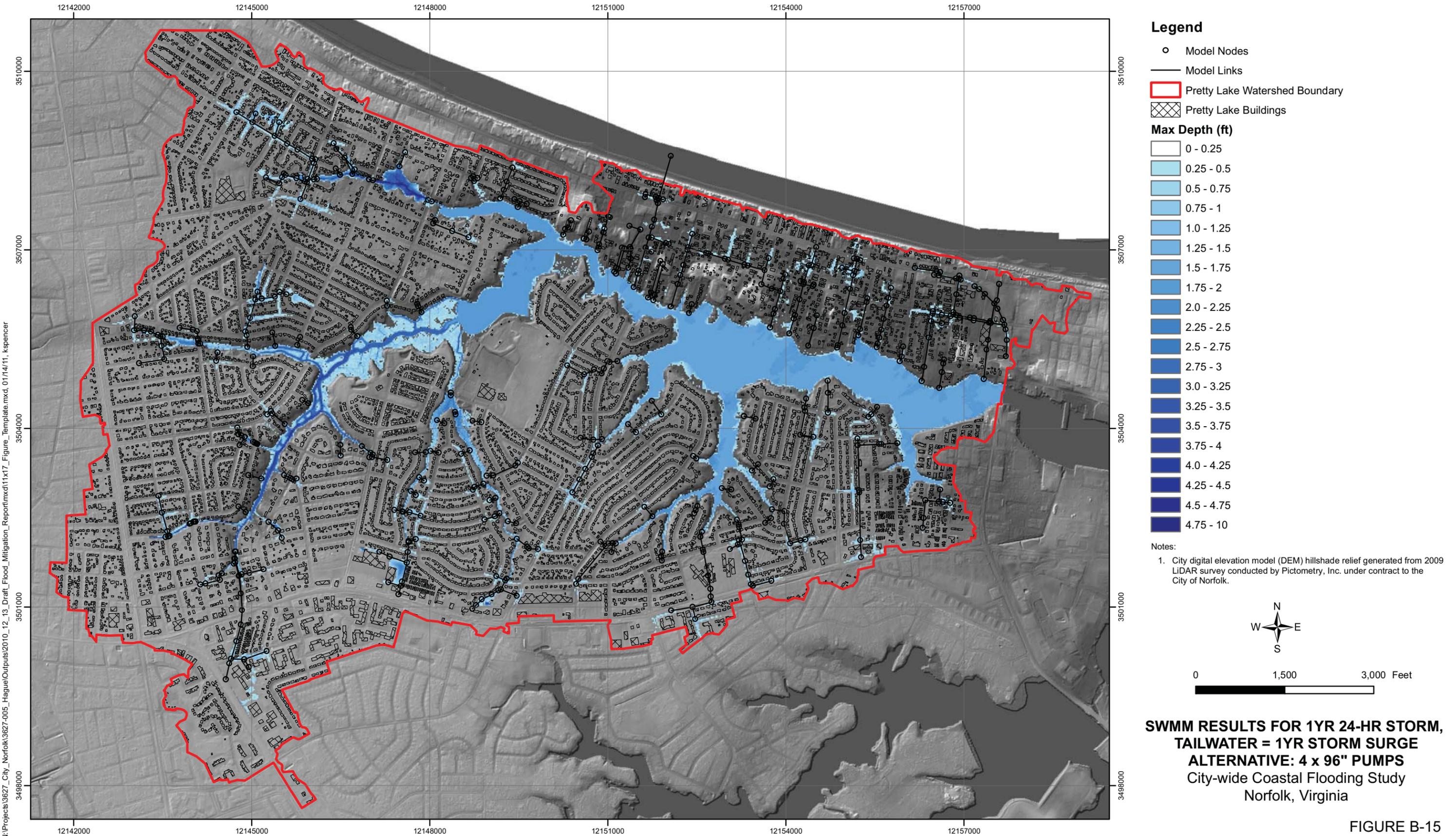


FIGURE B-15

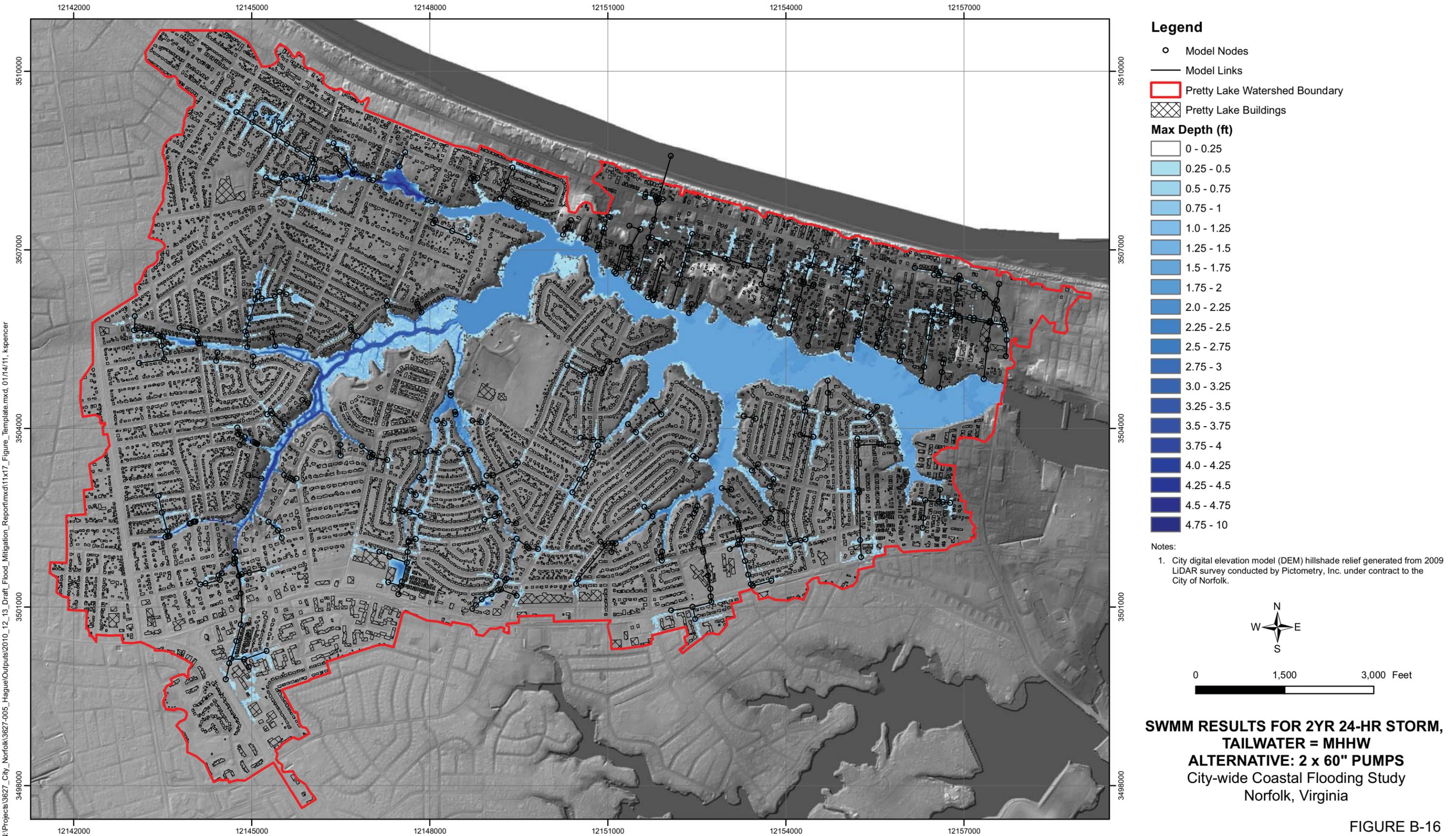
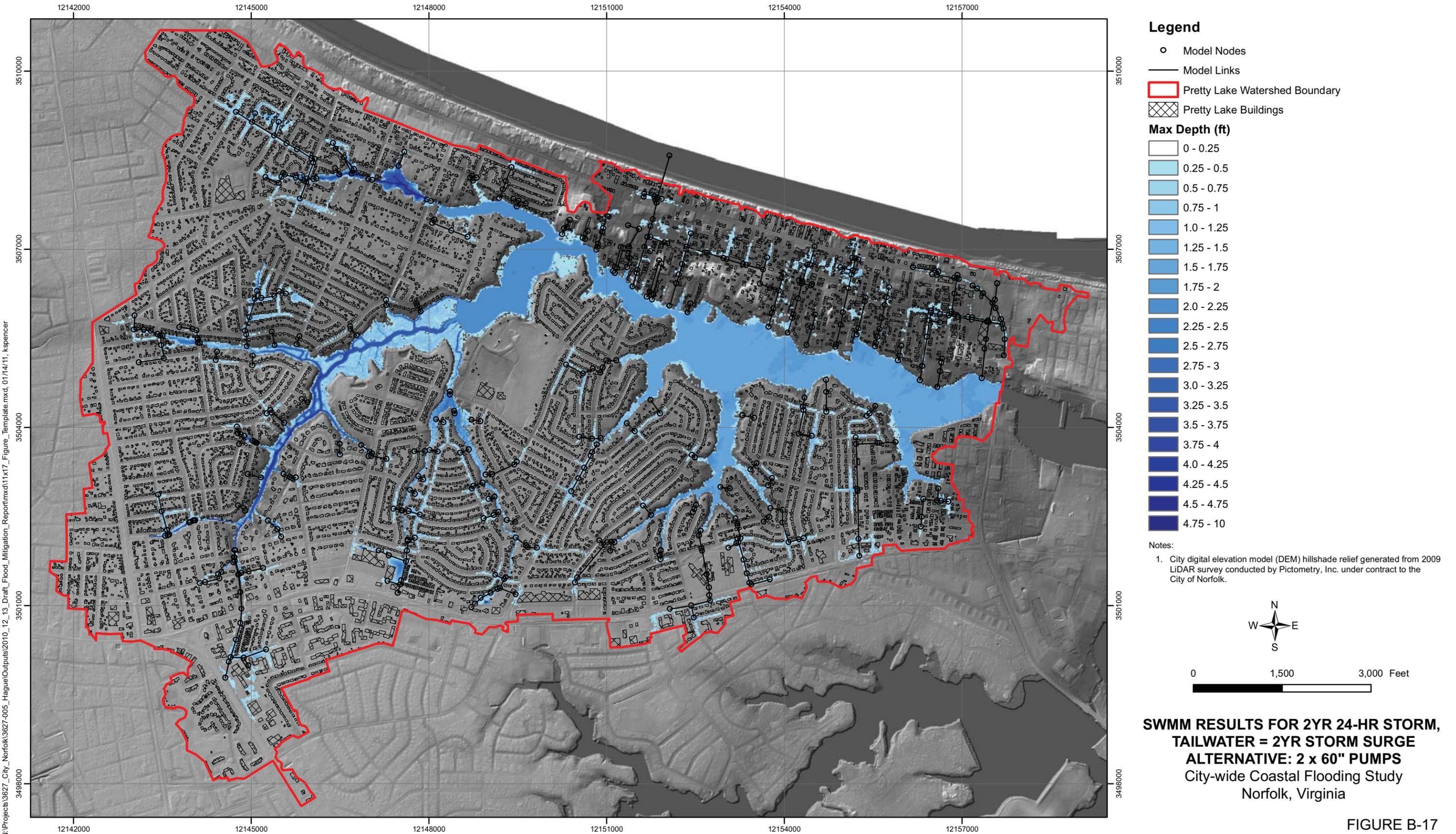


FIGURE B-16



**SWMM RESULTS FOR 2YR 24-HR STORM,
TAILWATER = 2YR STORM SURGE
ALTERNATIVE: 2 x 60" PUMPS**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-17

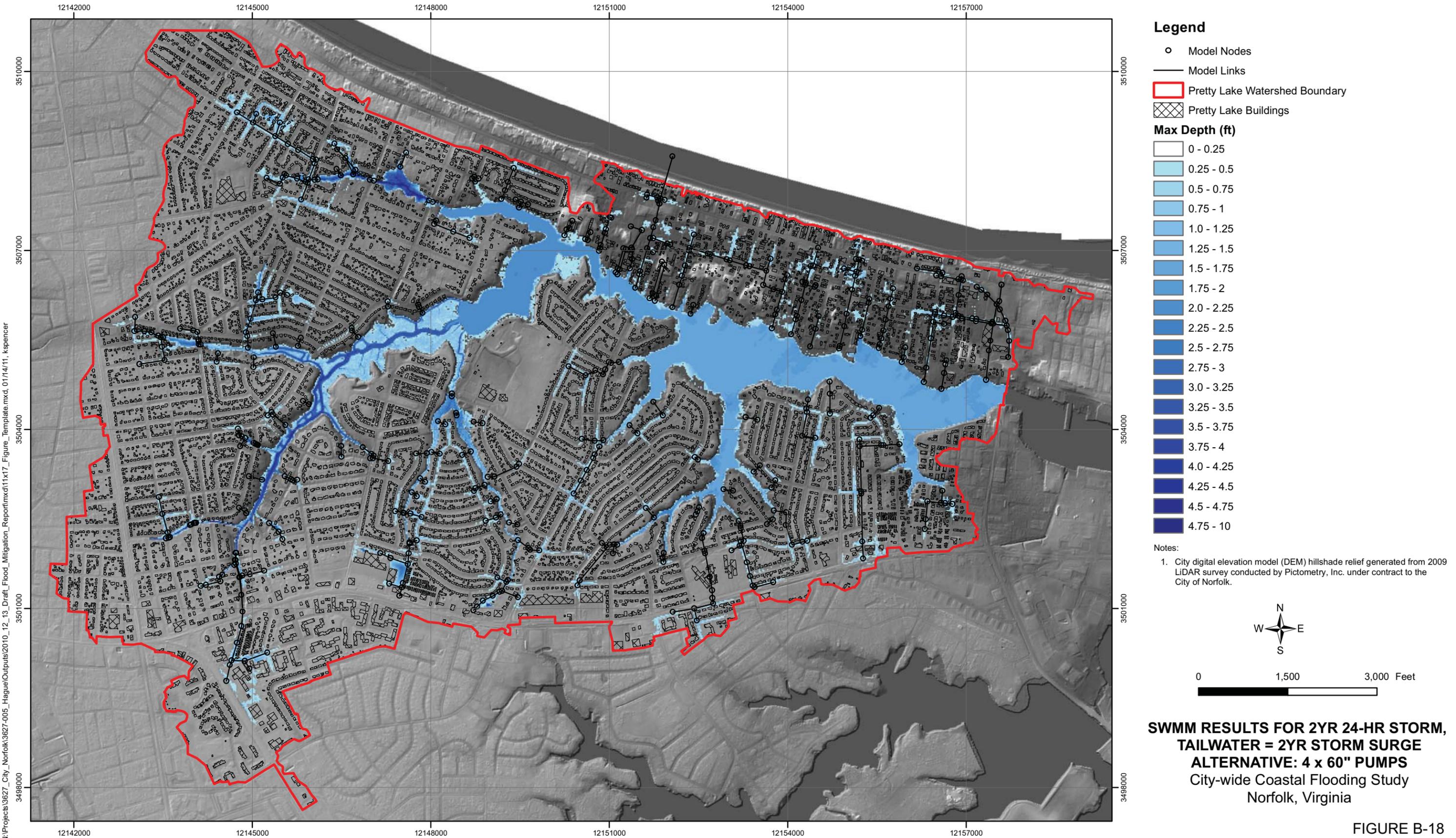


FIGURE B-18

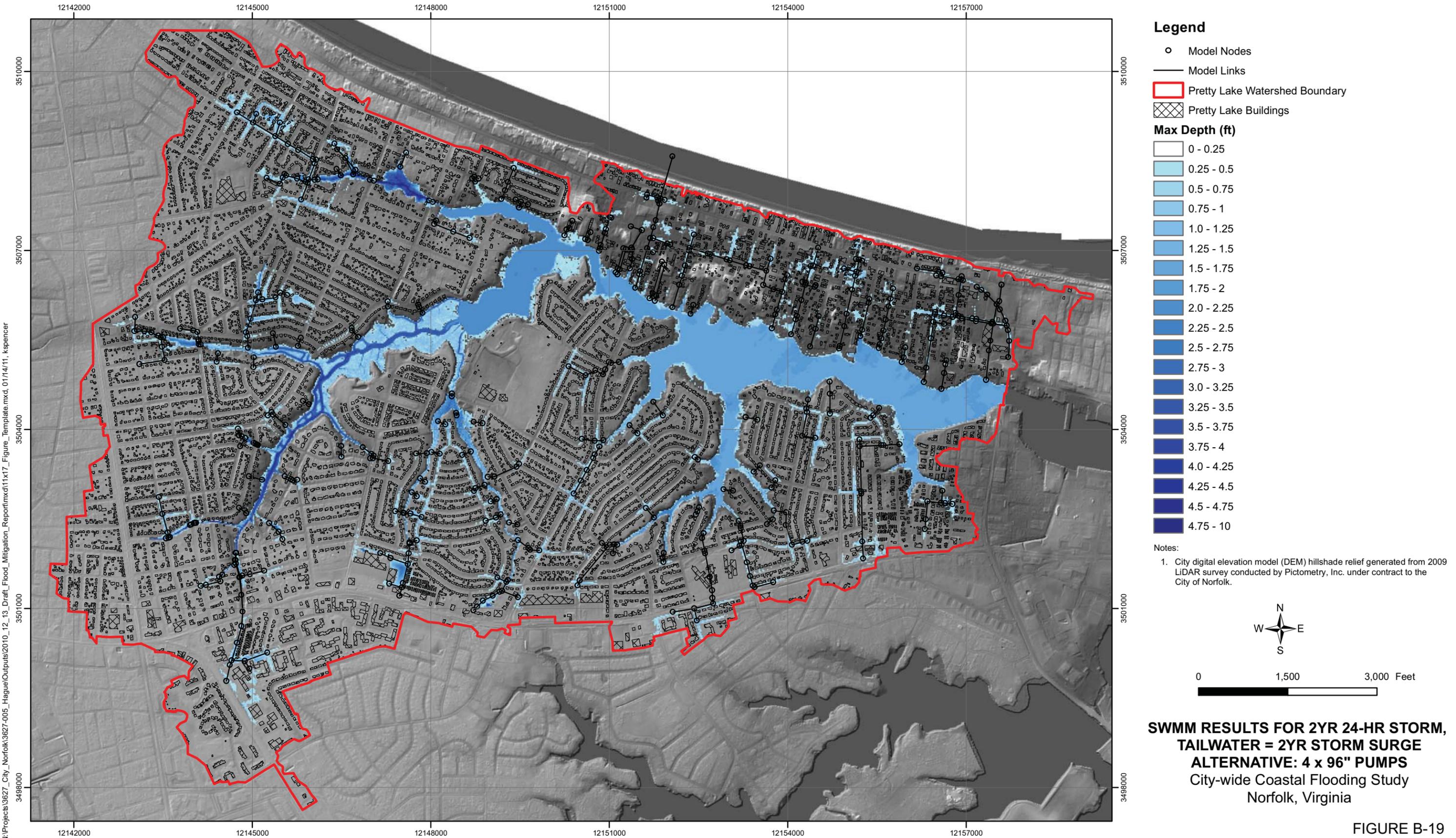


FIGURE B-19

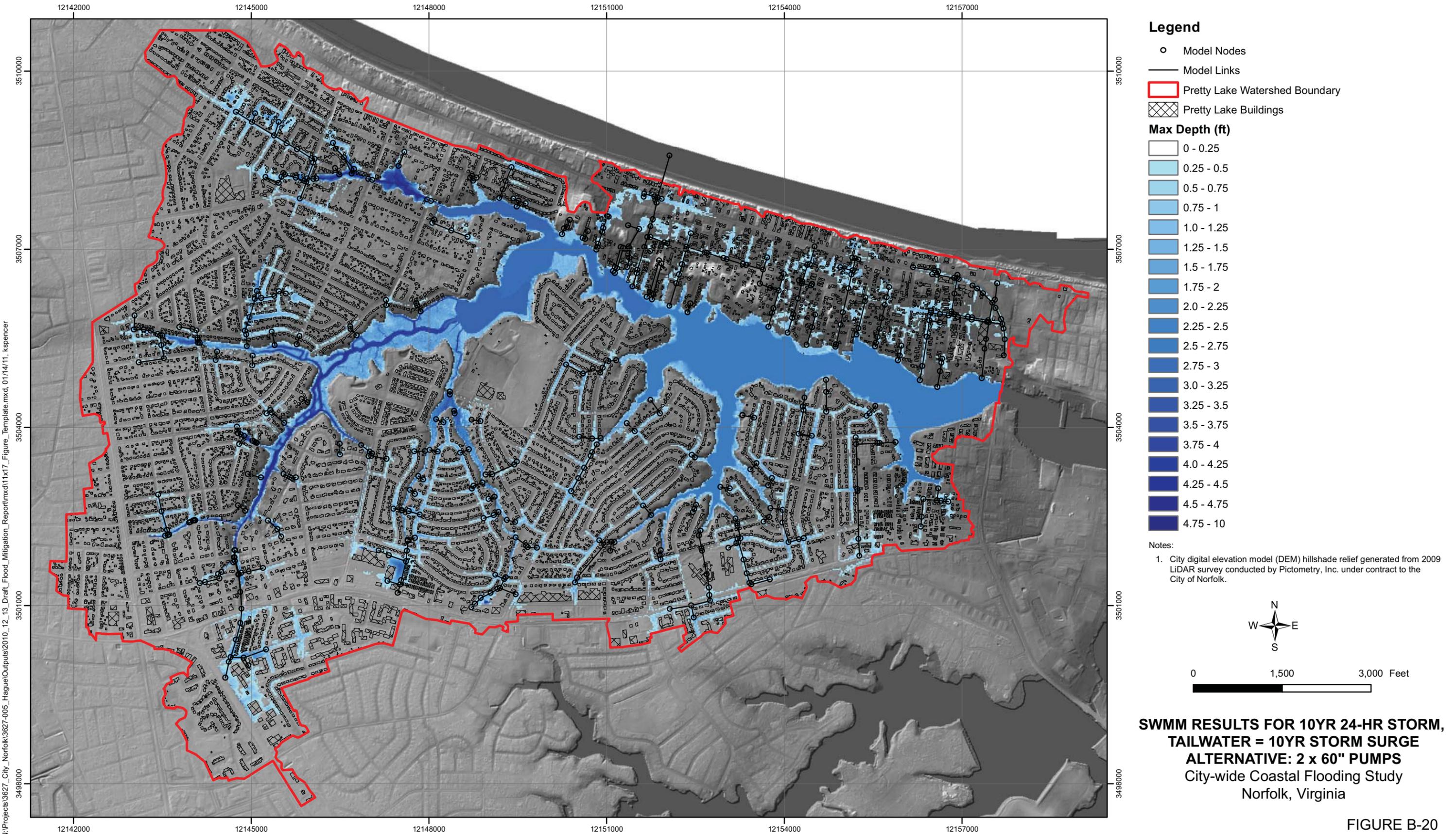


FIGURE B-20

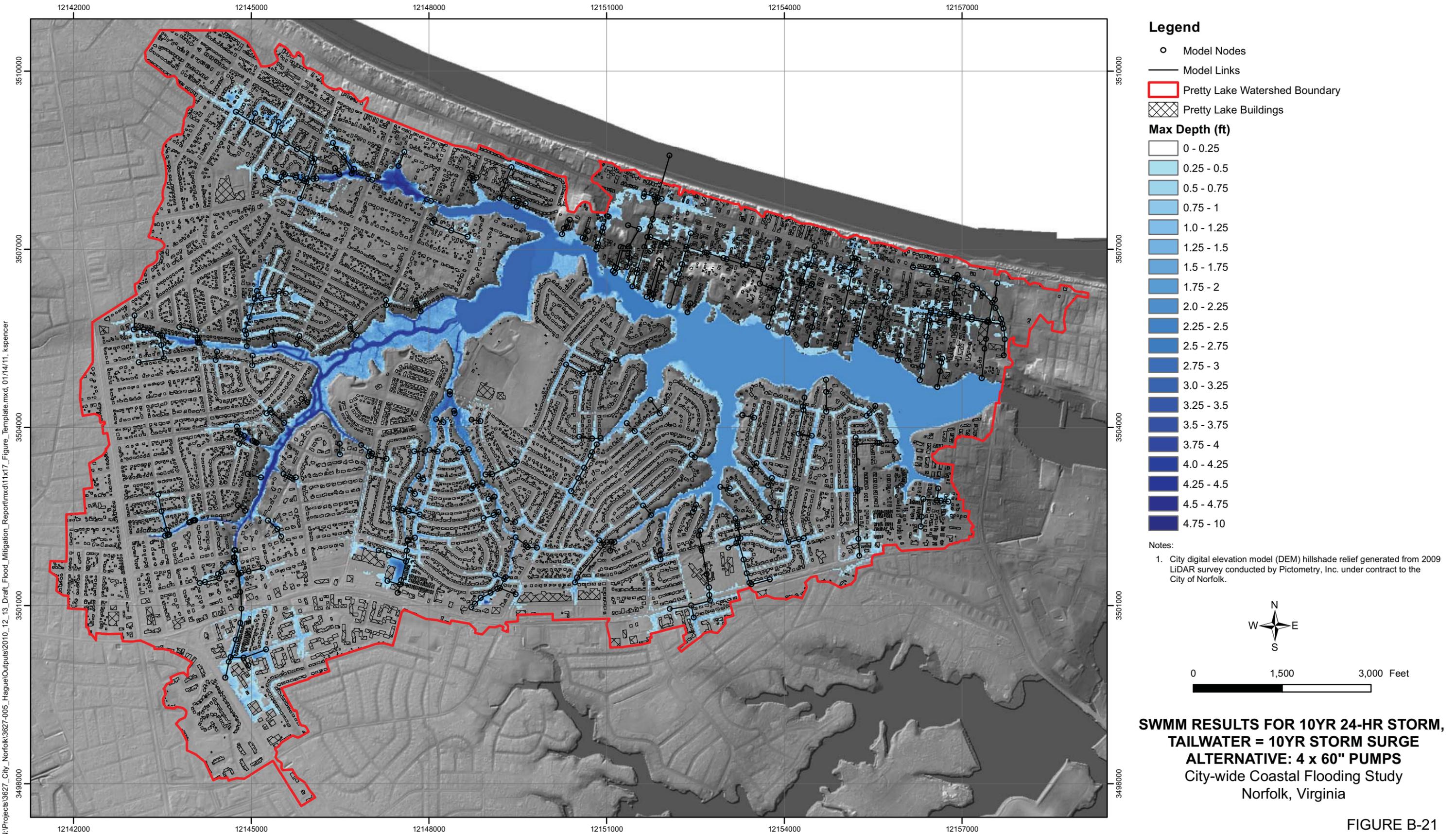


FIGURE B-21

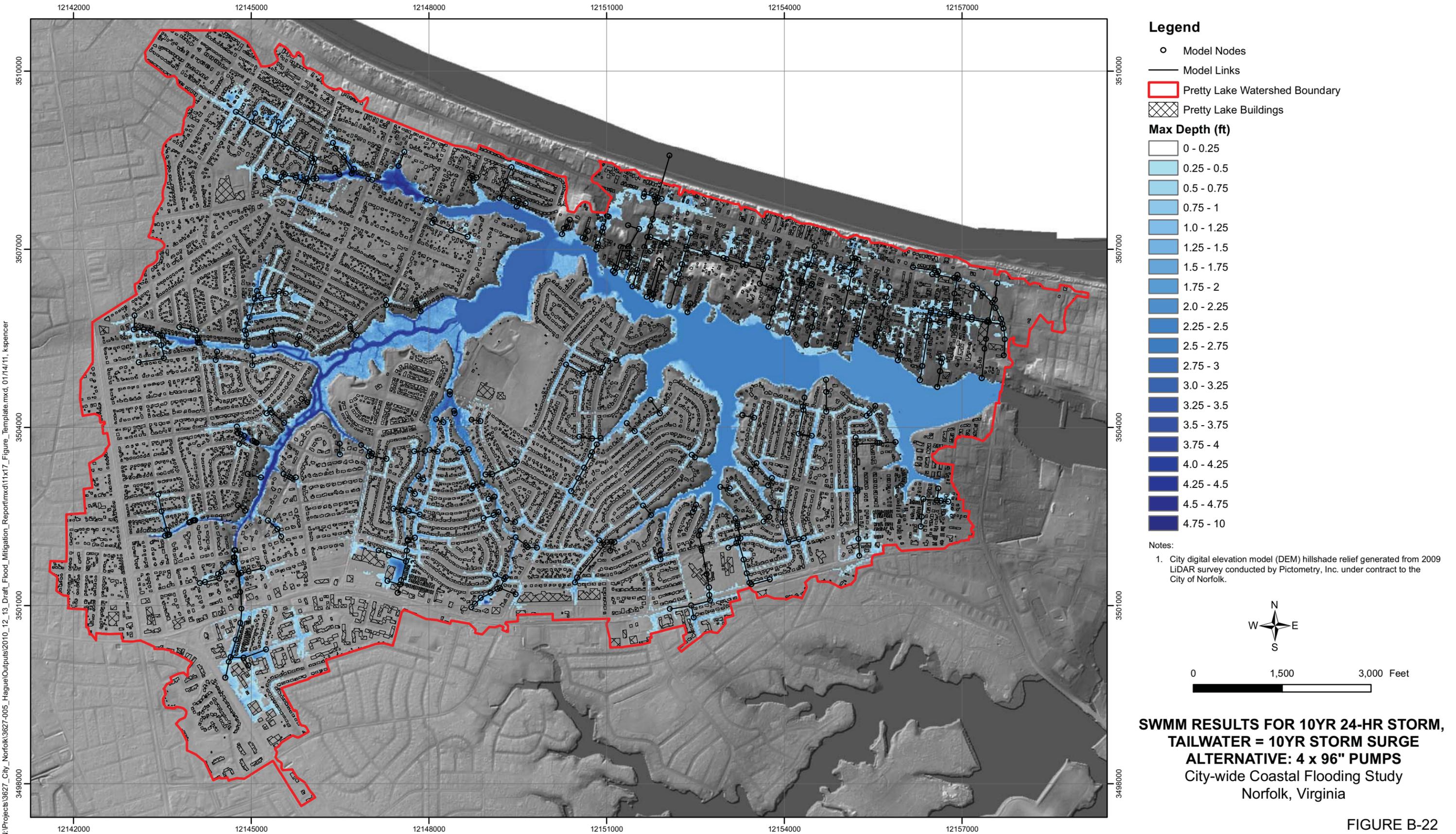
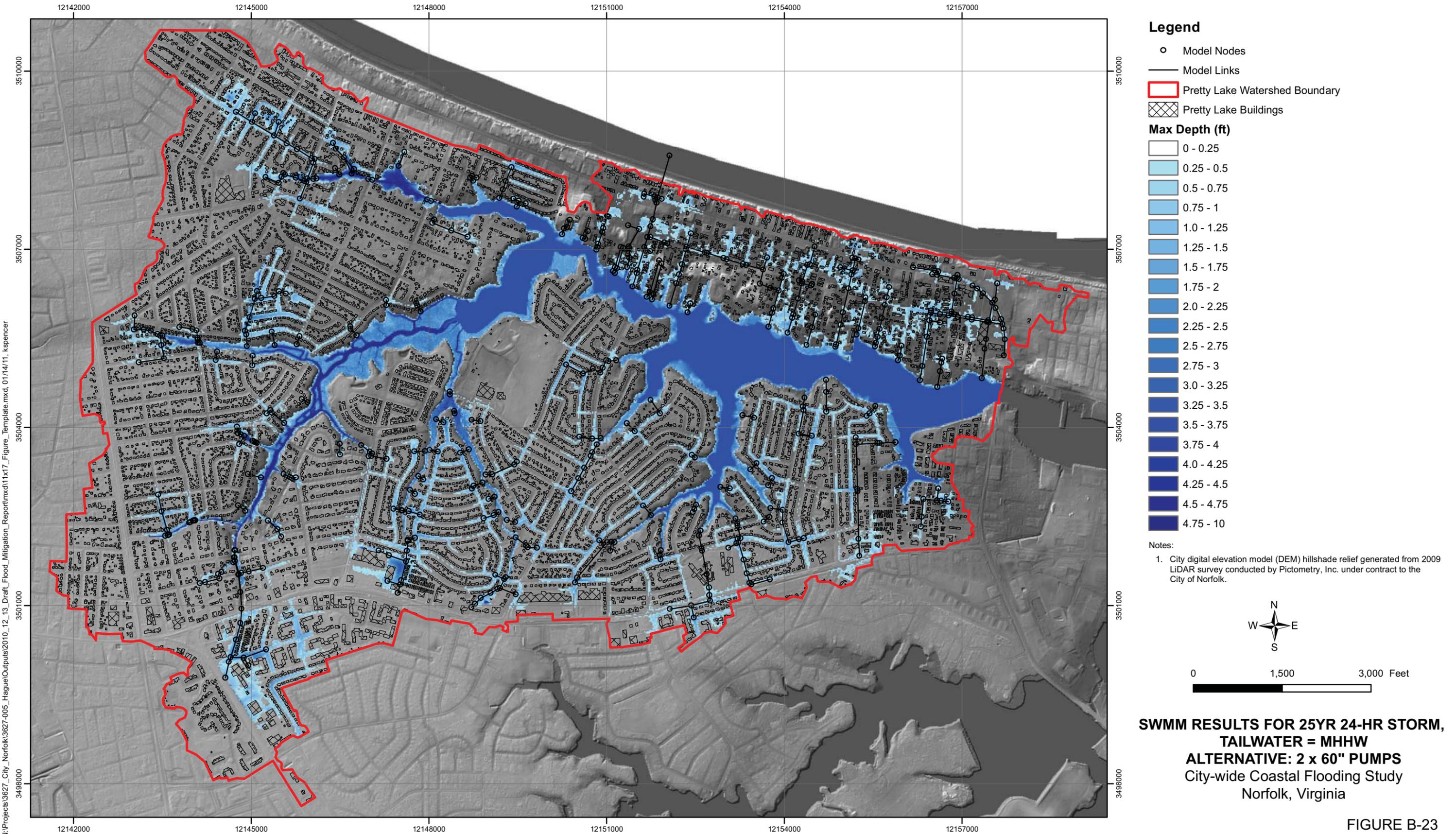


FIGURE B-22



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: 2 x 60" PUMPS**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-23

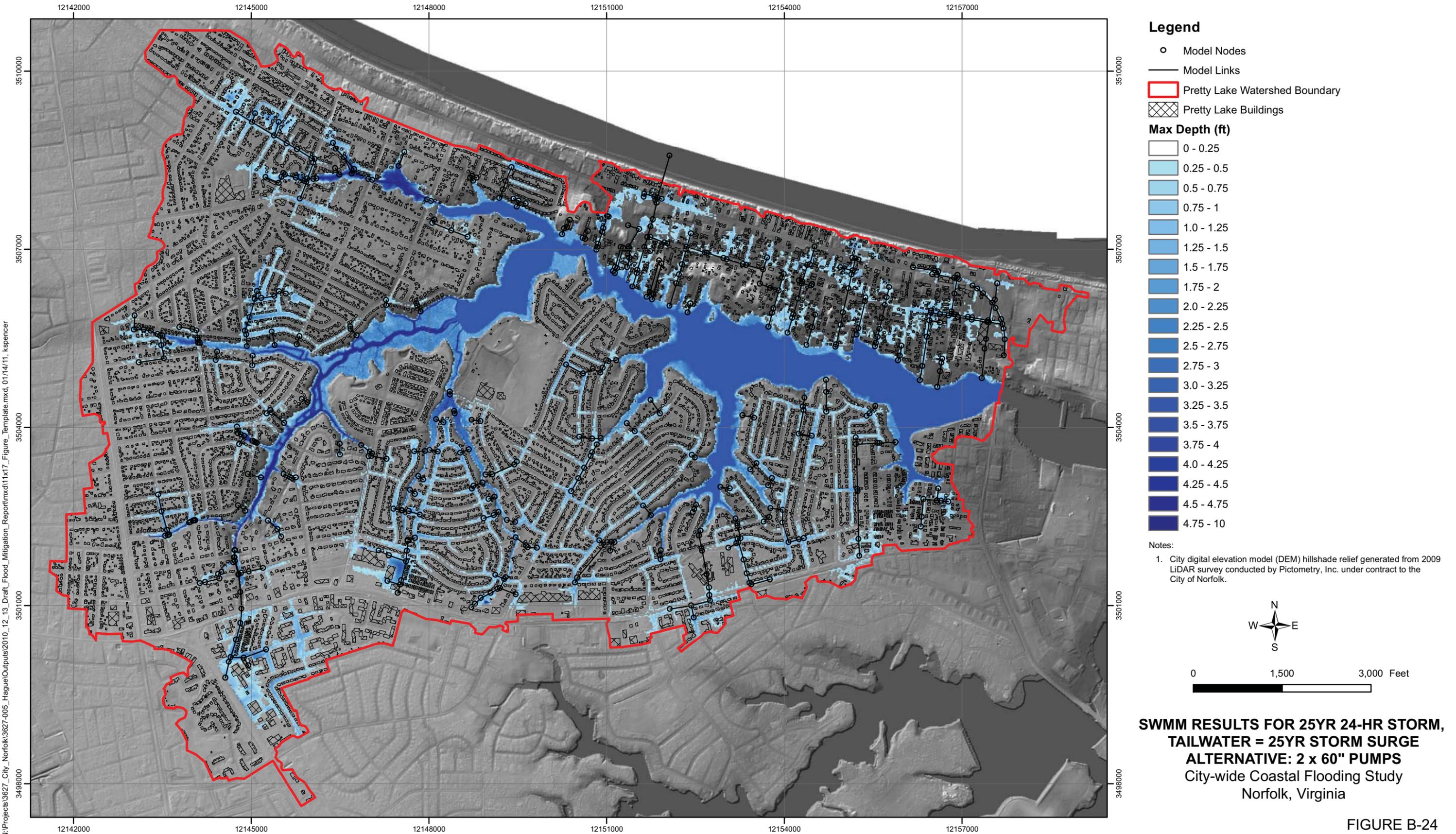


FIGURE B-24

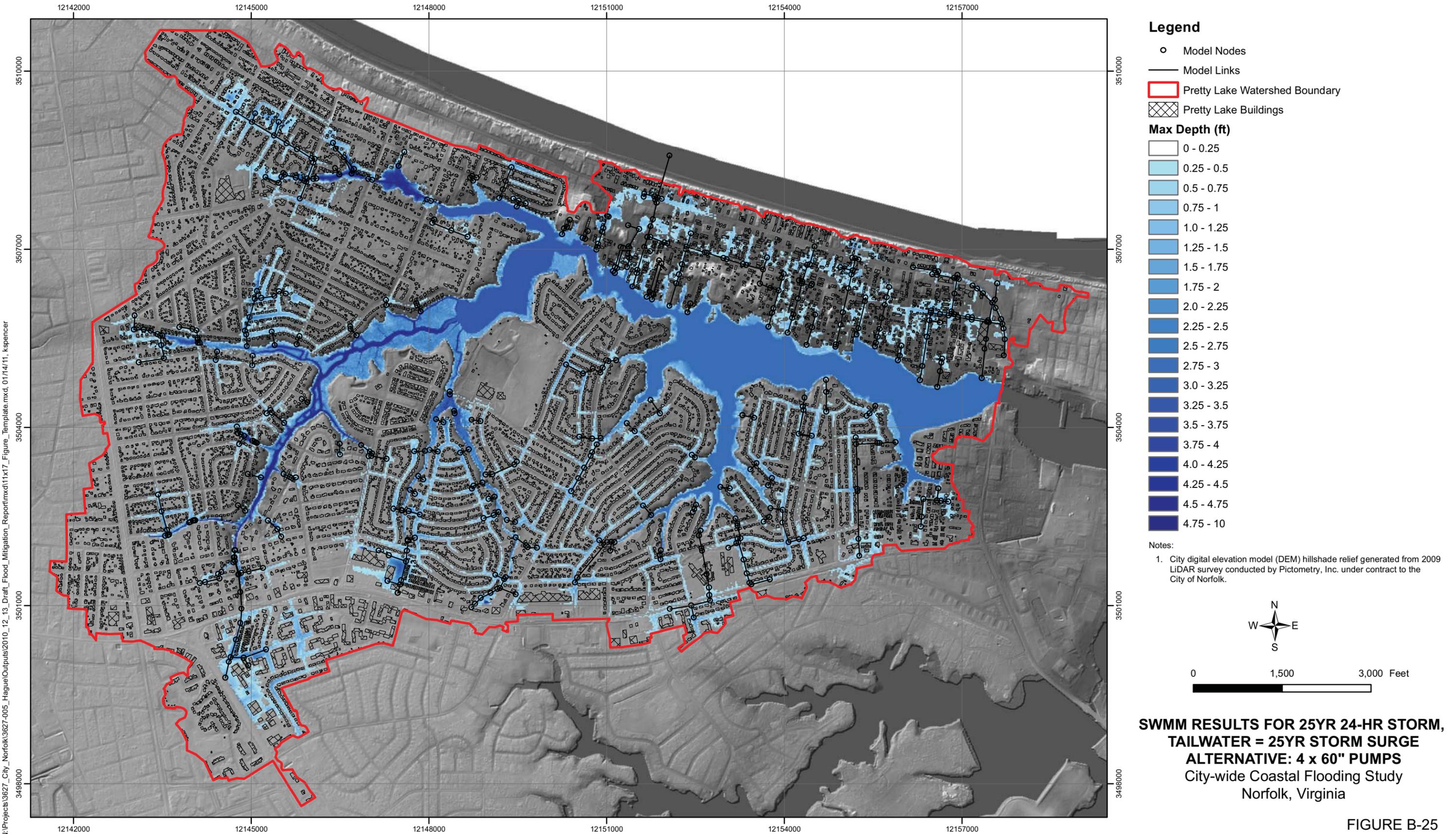


FIGURE B-25

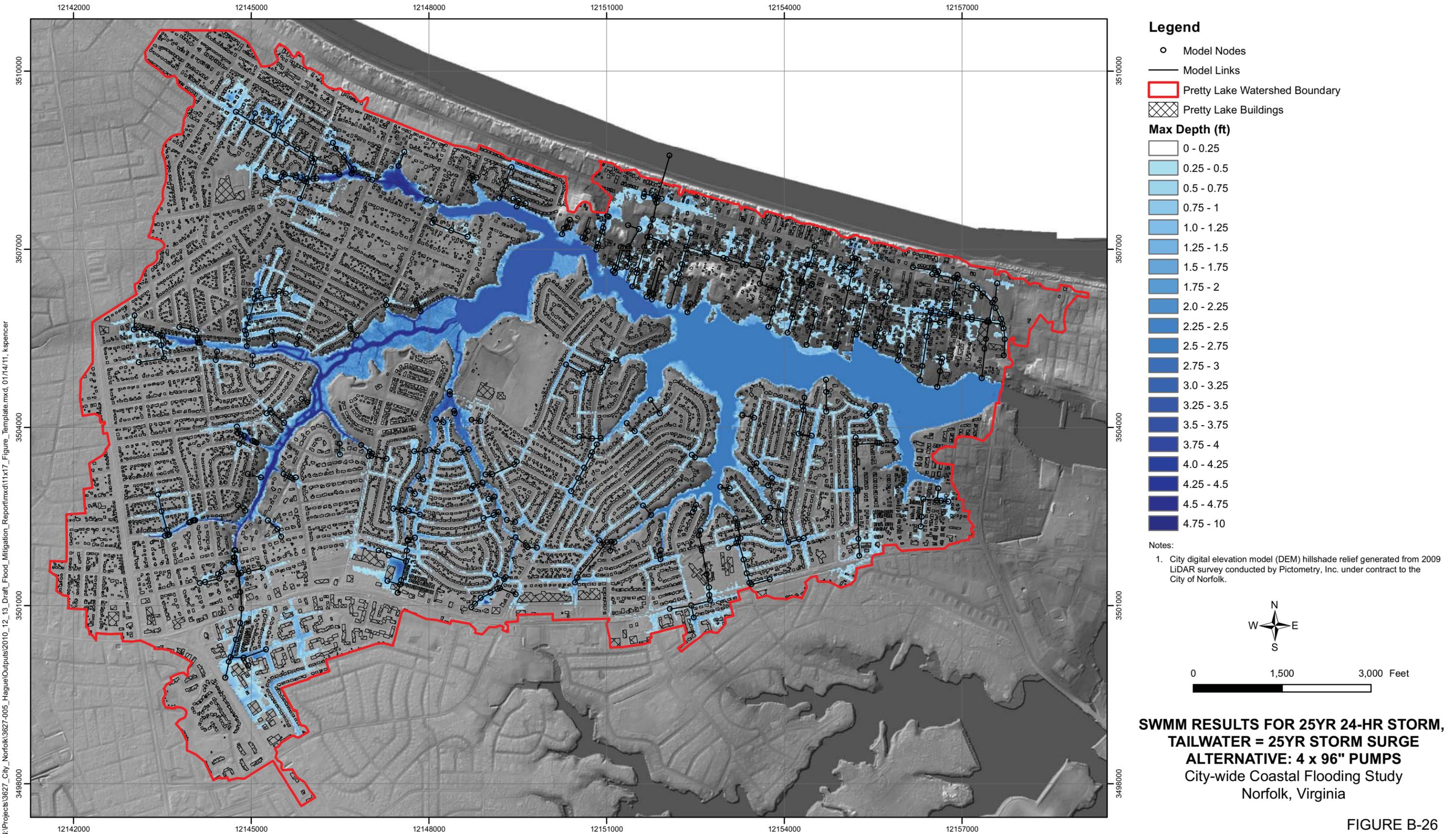


FIGURE B-26

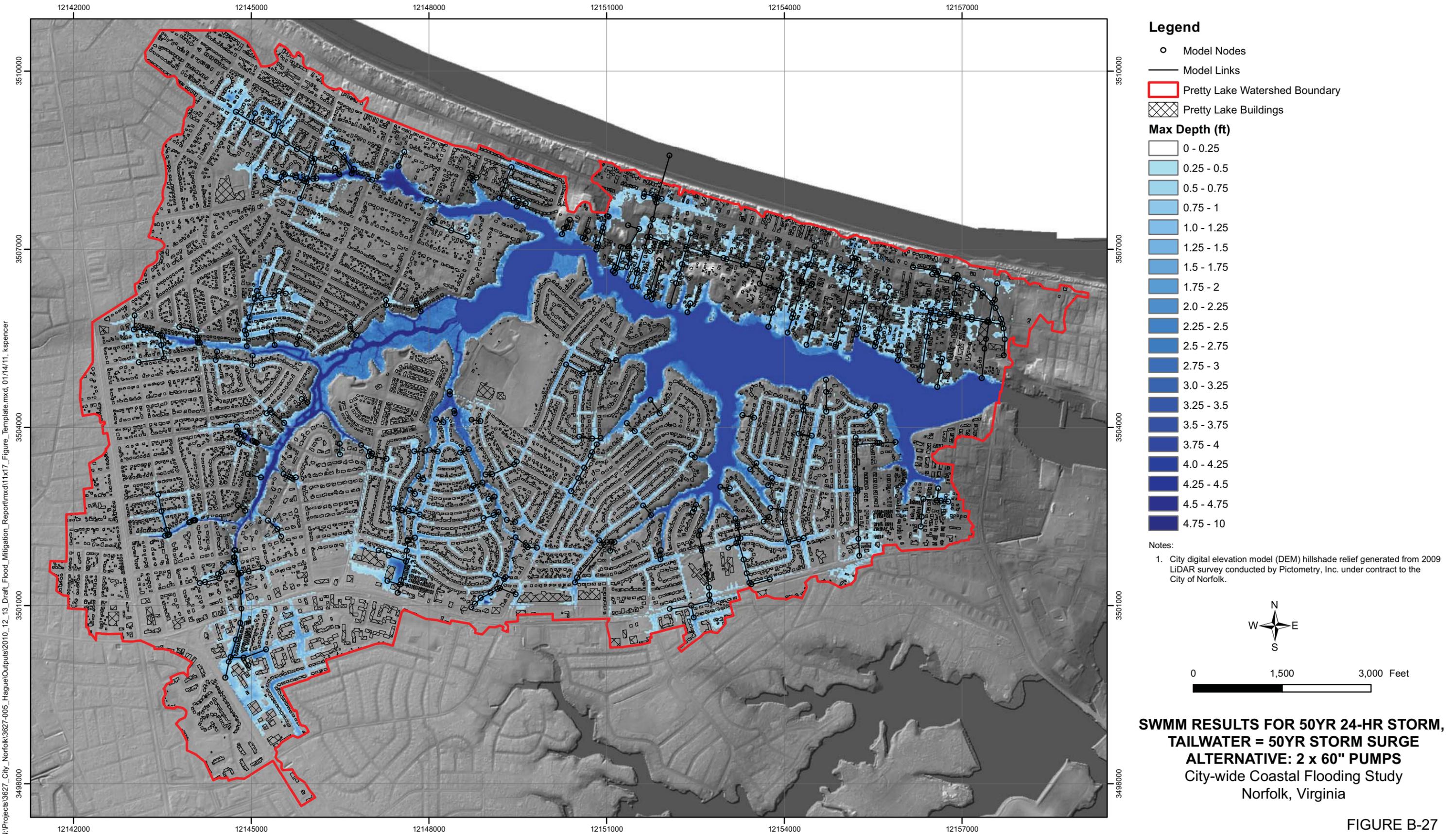


FIGURE B-27

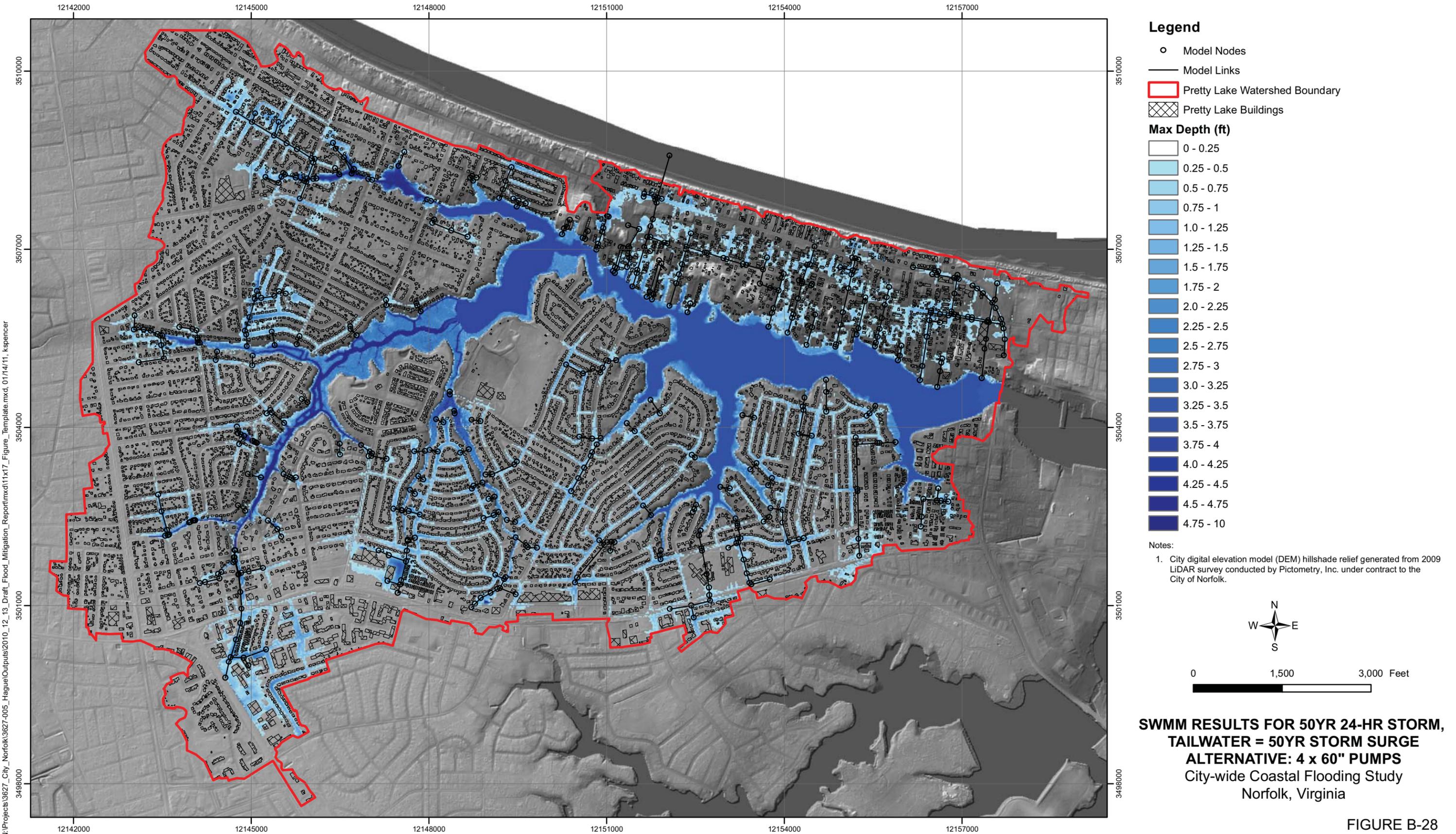


FIGURE B-28

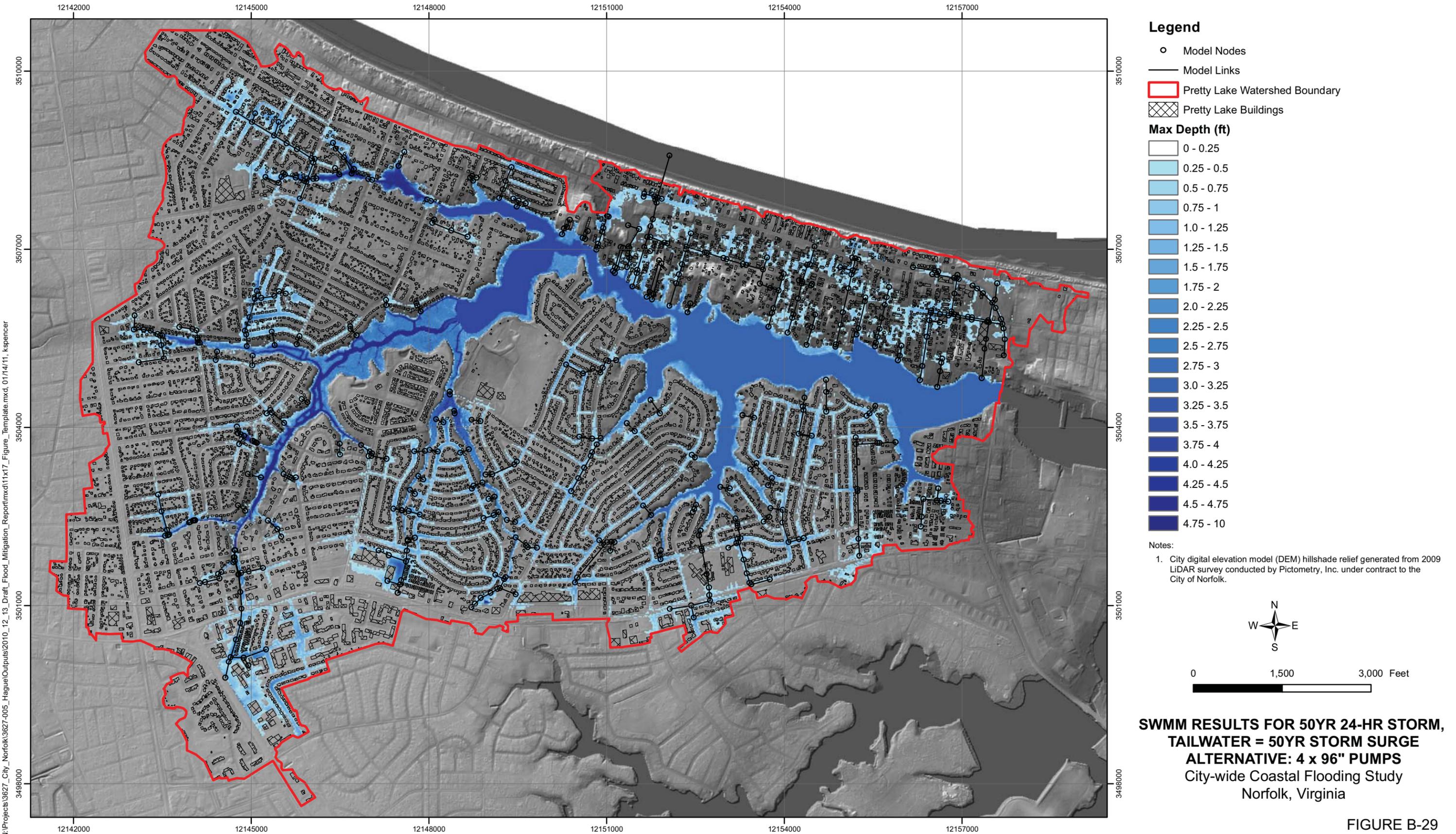


FIGURE B-29

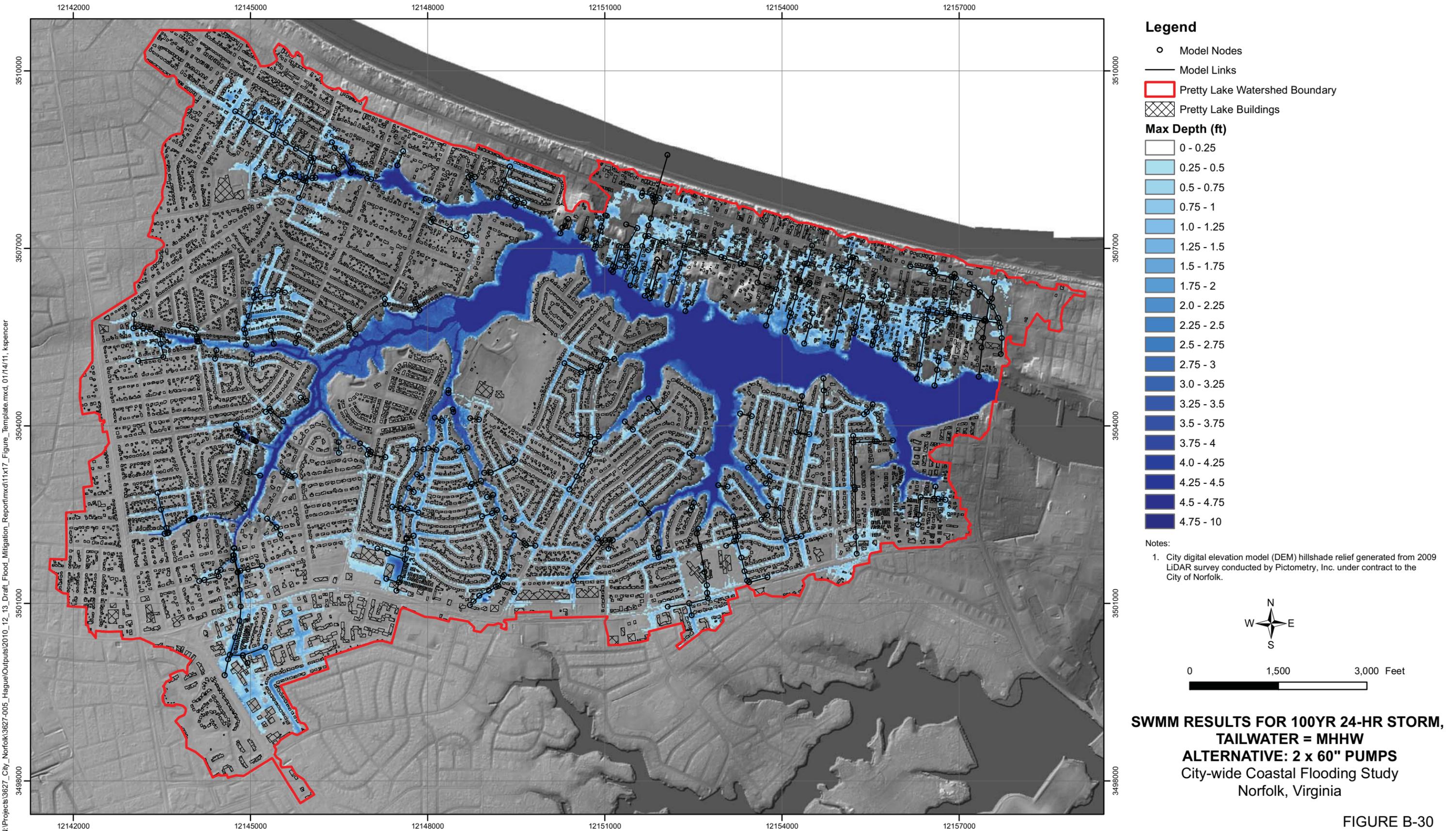
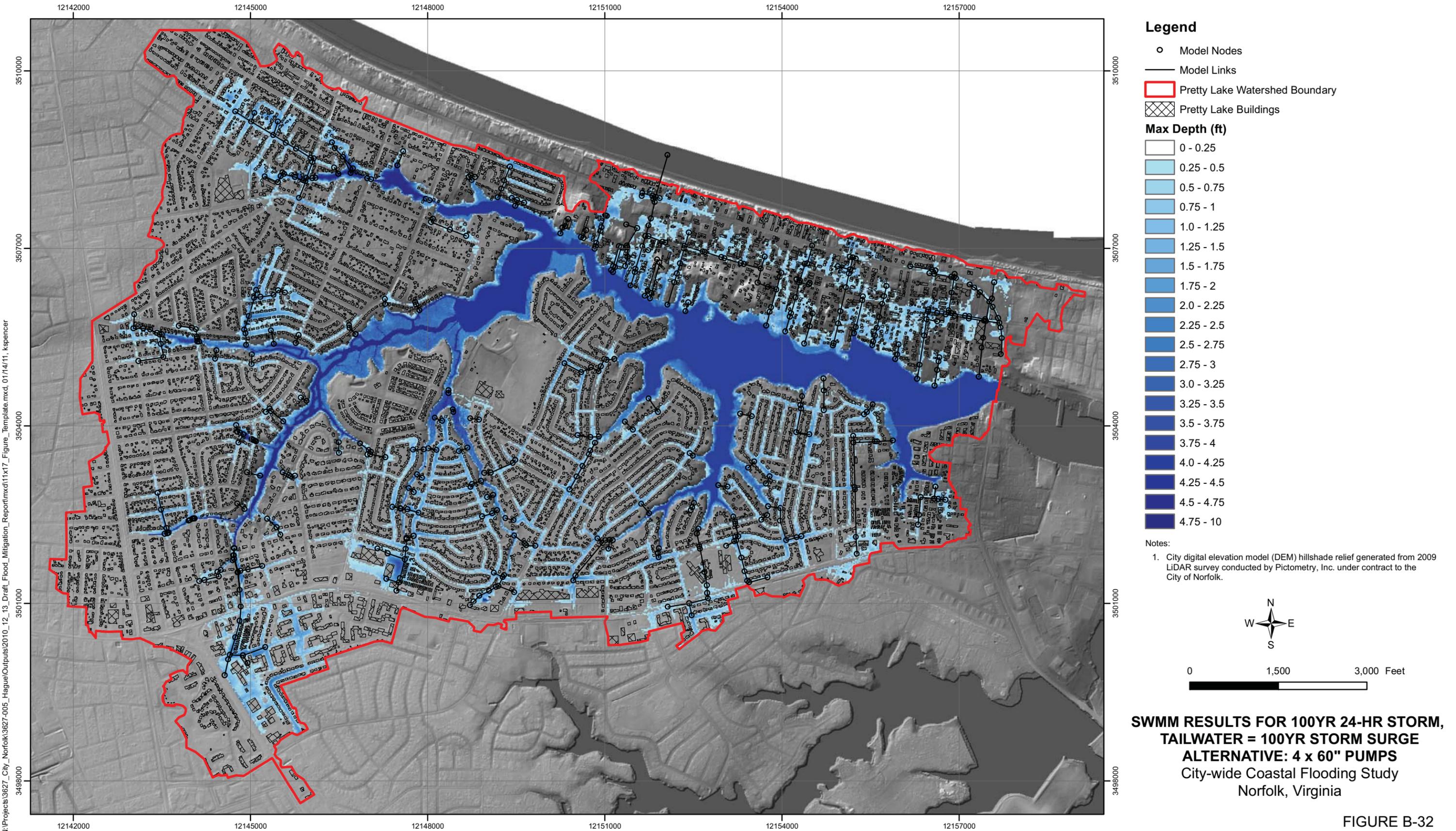


FIGURE B-30



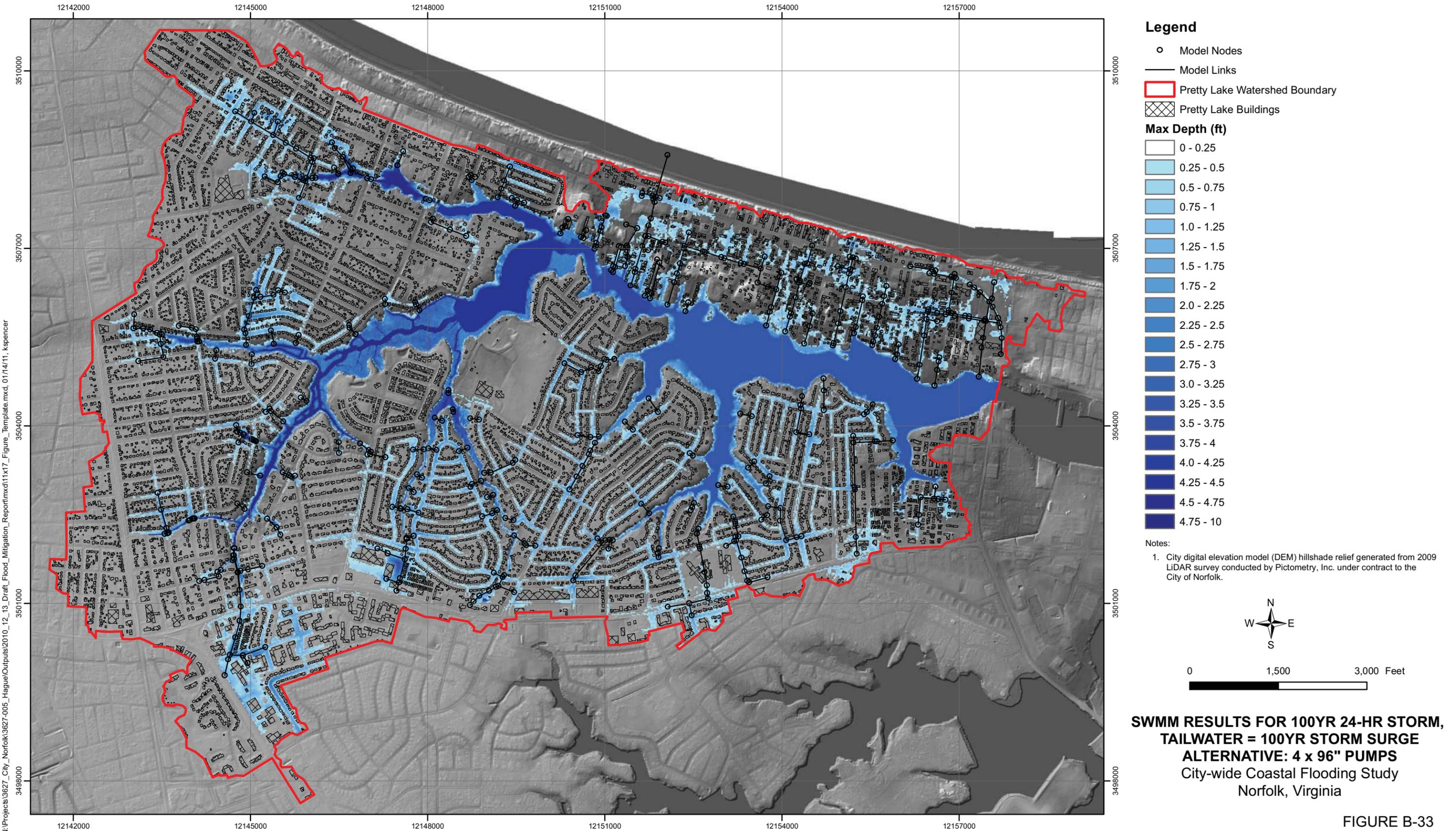
FIGURE B-31



**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = 100YR STORM SURGE
ALTERNATIVE: 4 x 60" PUMPS**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-32

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**SWMM RESULTS FOR 100YR 24-HR STORM,
TAILWATER = 100YR STORM SURGE
ALTERNATIVE: 4 x 96" PUMPS**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-33

N:\Projects\3627_City_Norfolk\3627-005_Hague\Outputs\2010_12_13_Draft_Flood_Mitigation_Report\mxd\11x17_Figure_Template.mxd, 01/14/11, kspencer

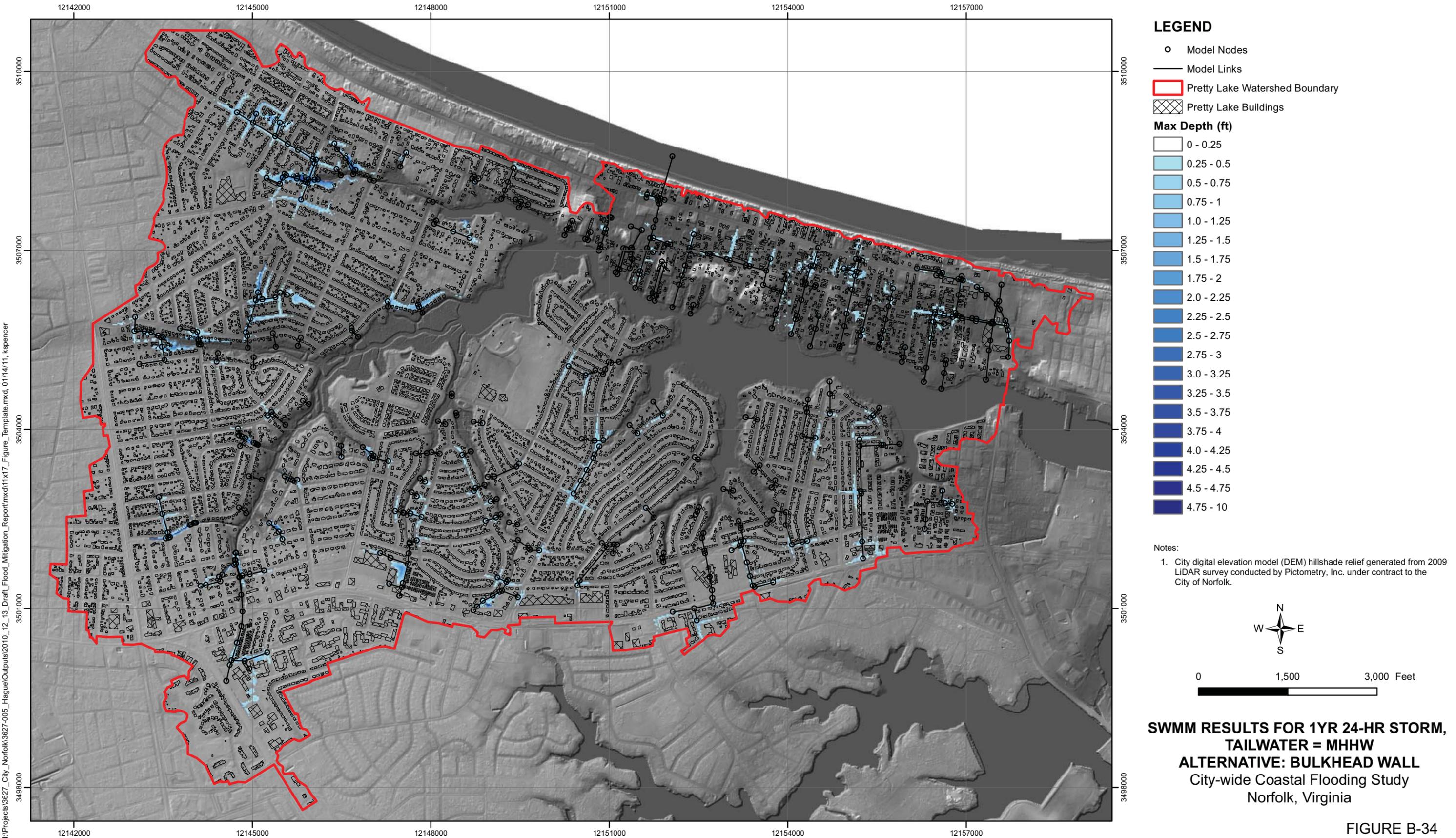


FIGURE B-34

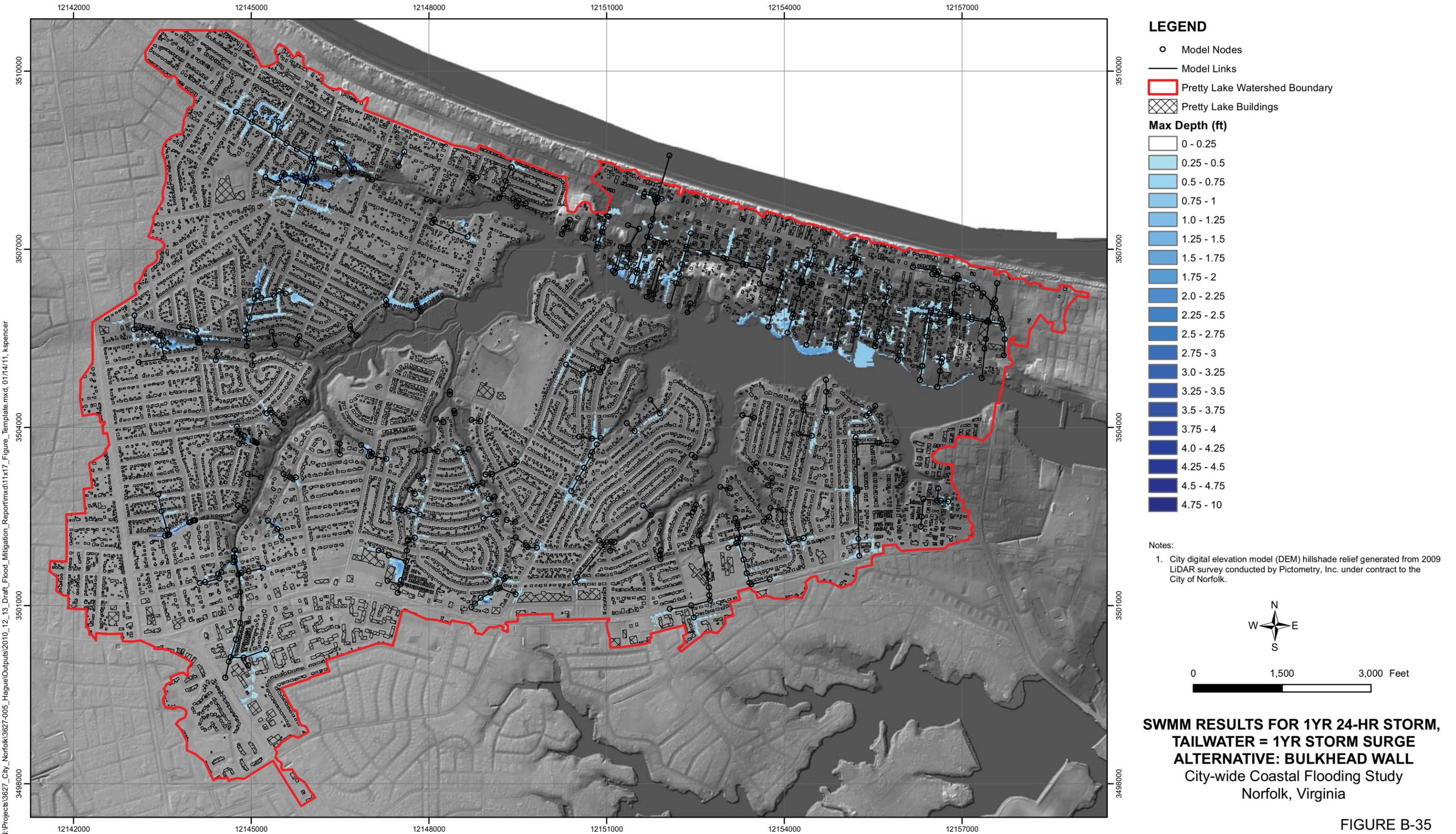
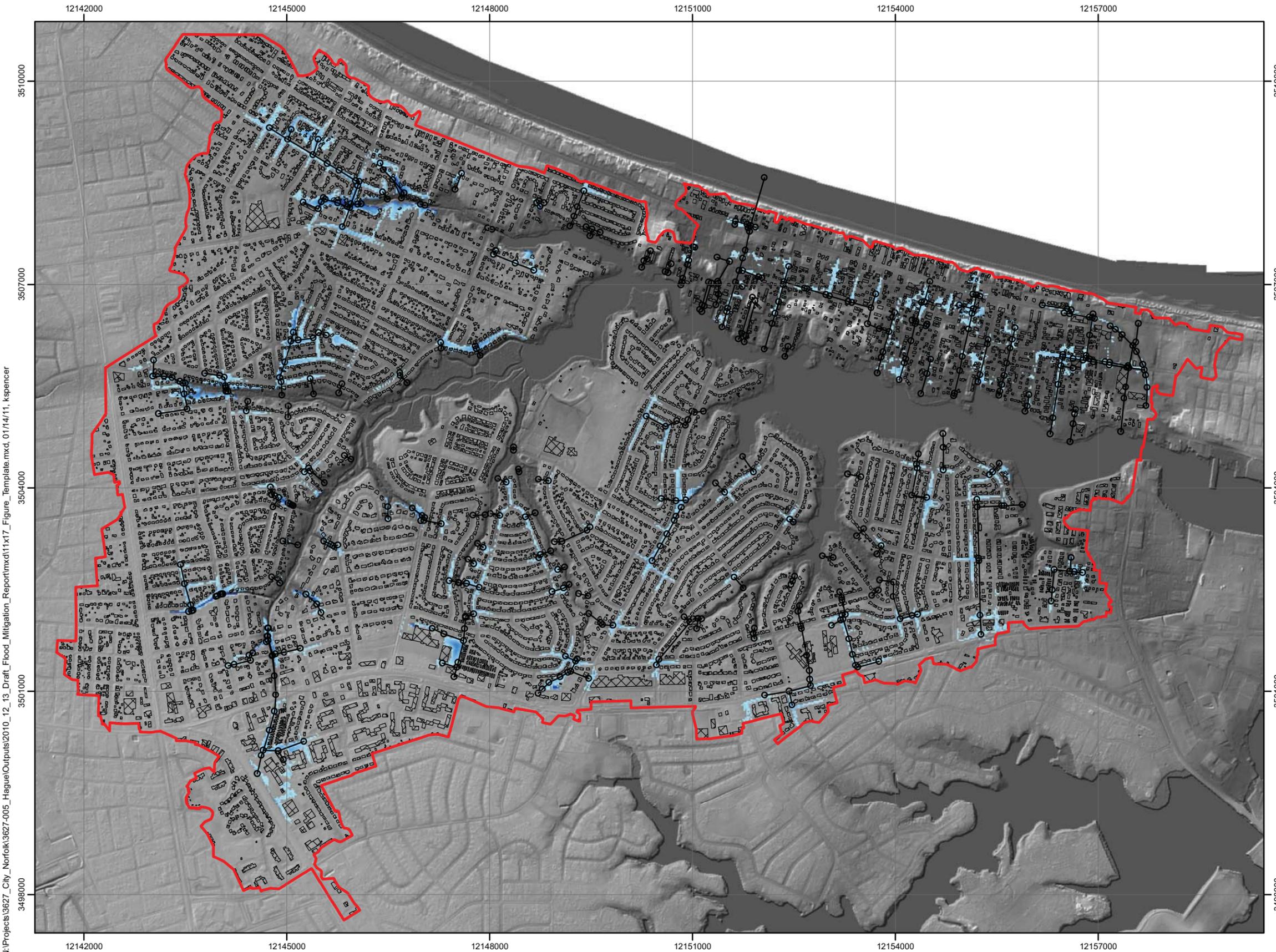


FIGURE B-35



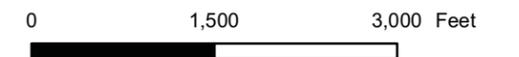
LEGEND

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 2YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-36

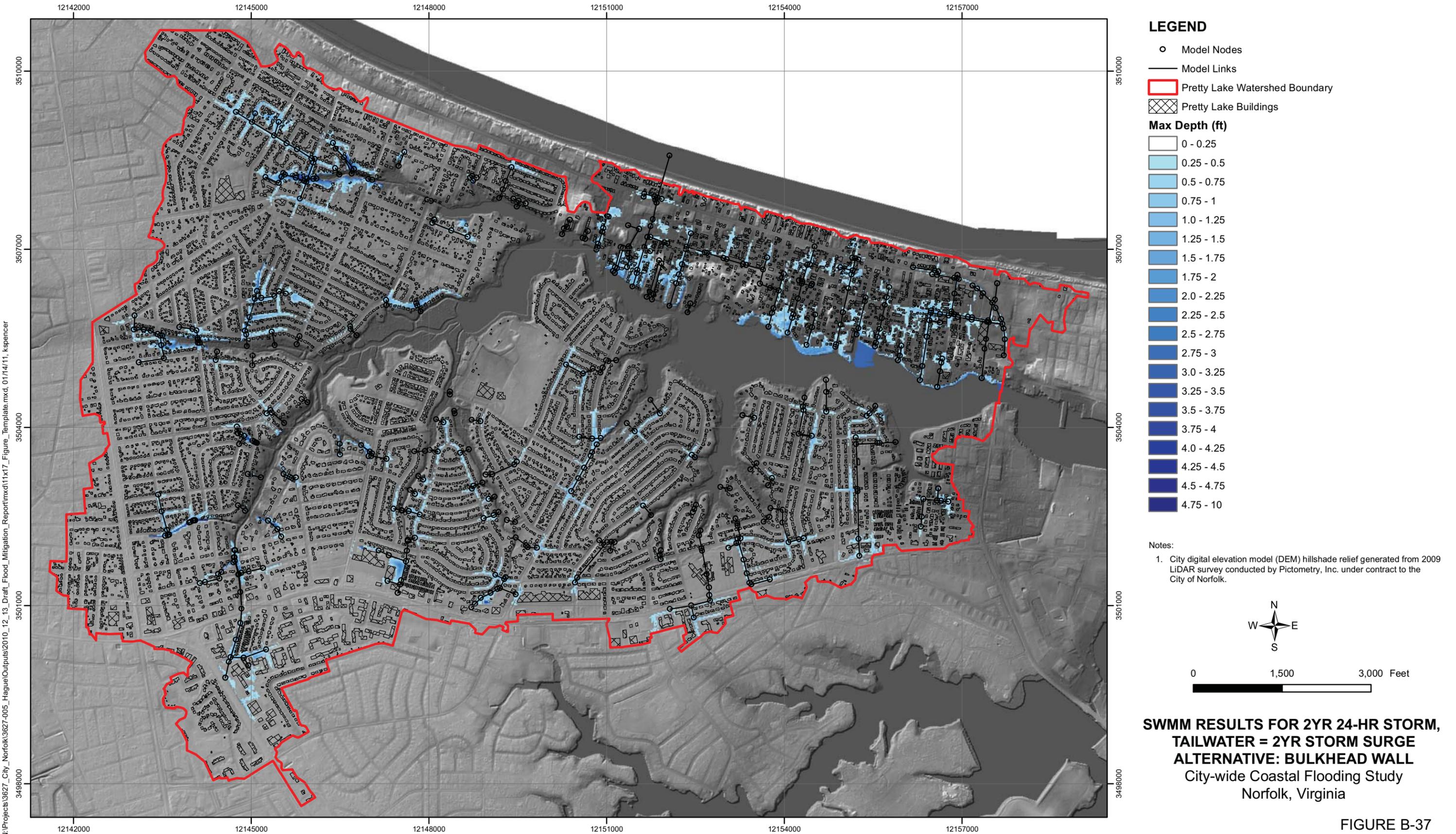
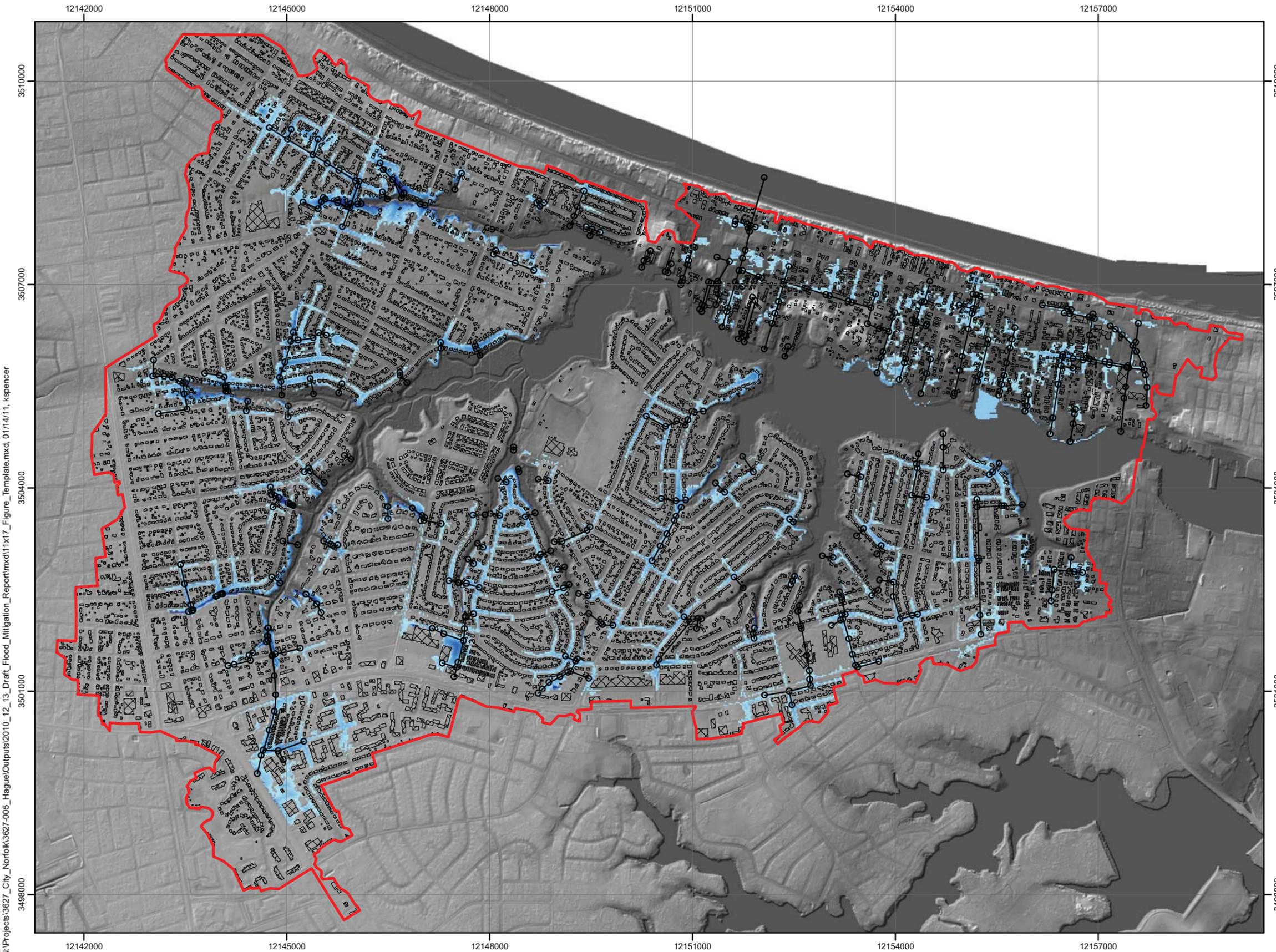


FIGURE B-37



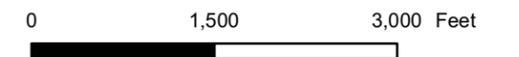
LEGEND

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
TAILWATER = MHHW
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-38

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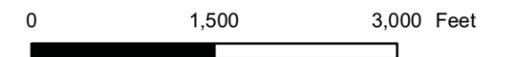
LEGEND

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 10YR 24-HR STORM,
TAILWATER = 10YR STORM SURGE
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

FIGURE B-39

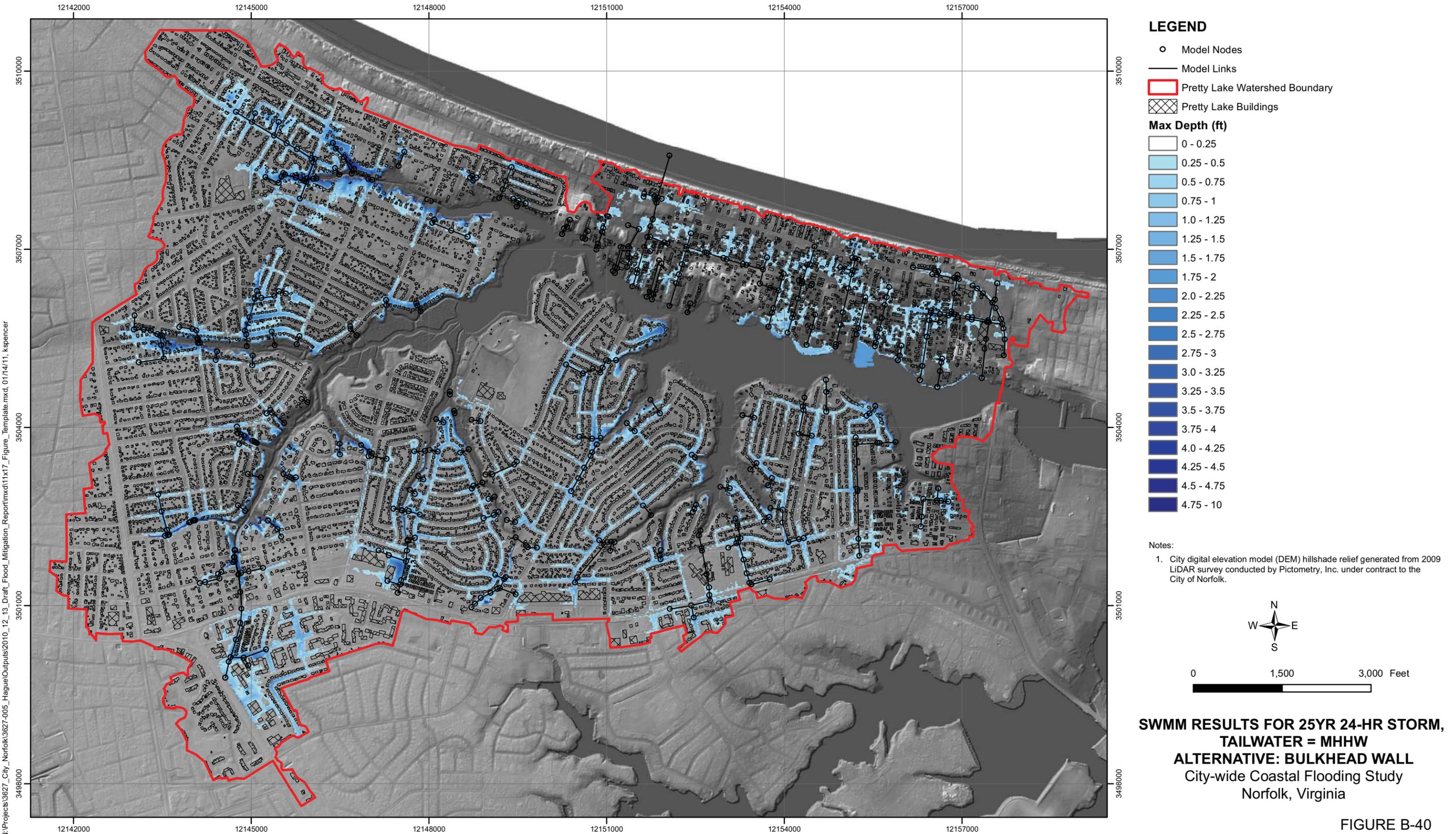
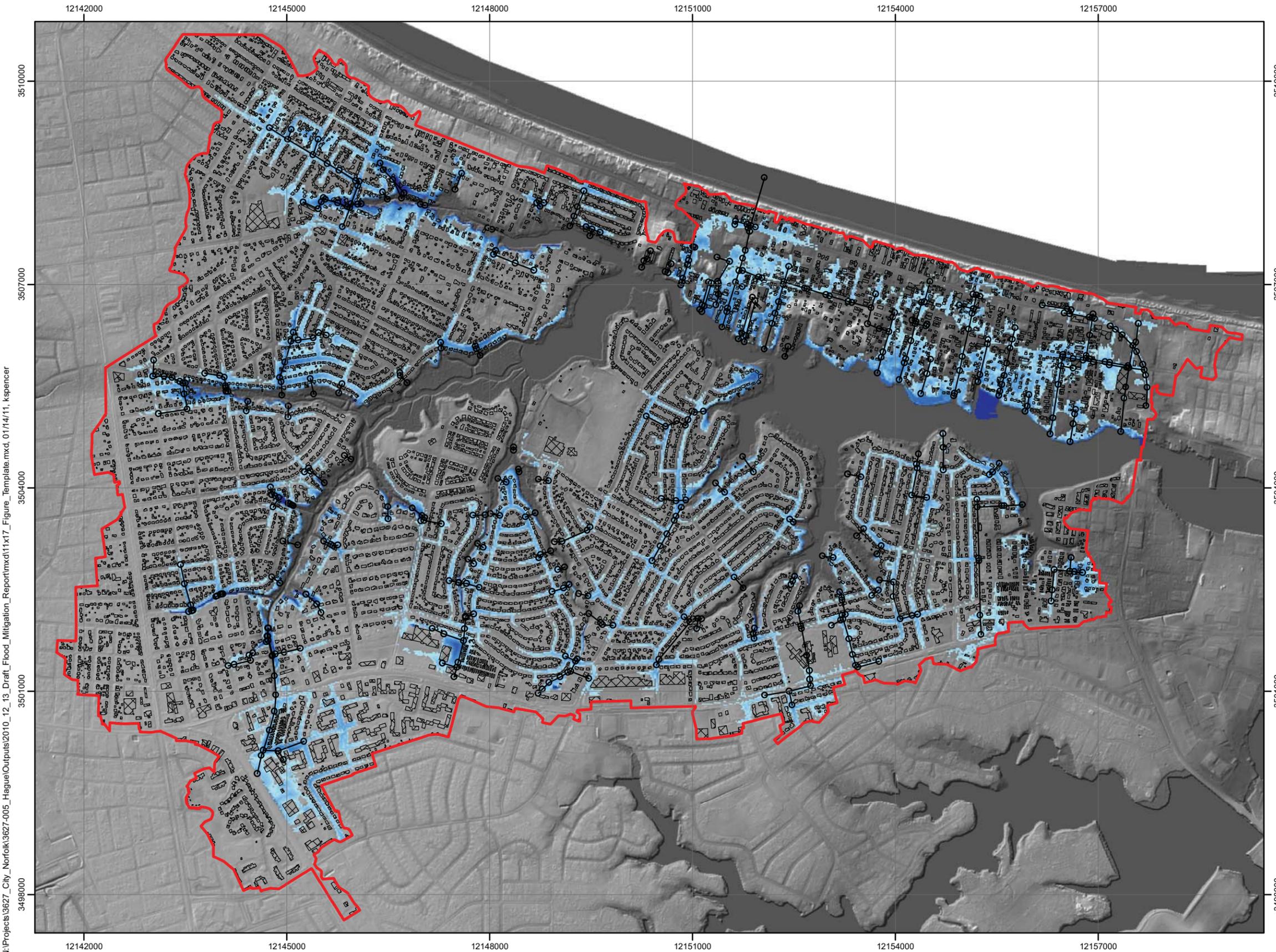


FIGURE B-40



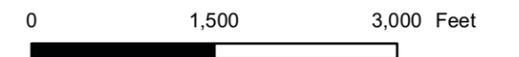
LEGEND

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

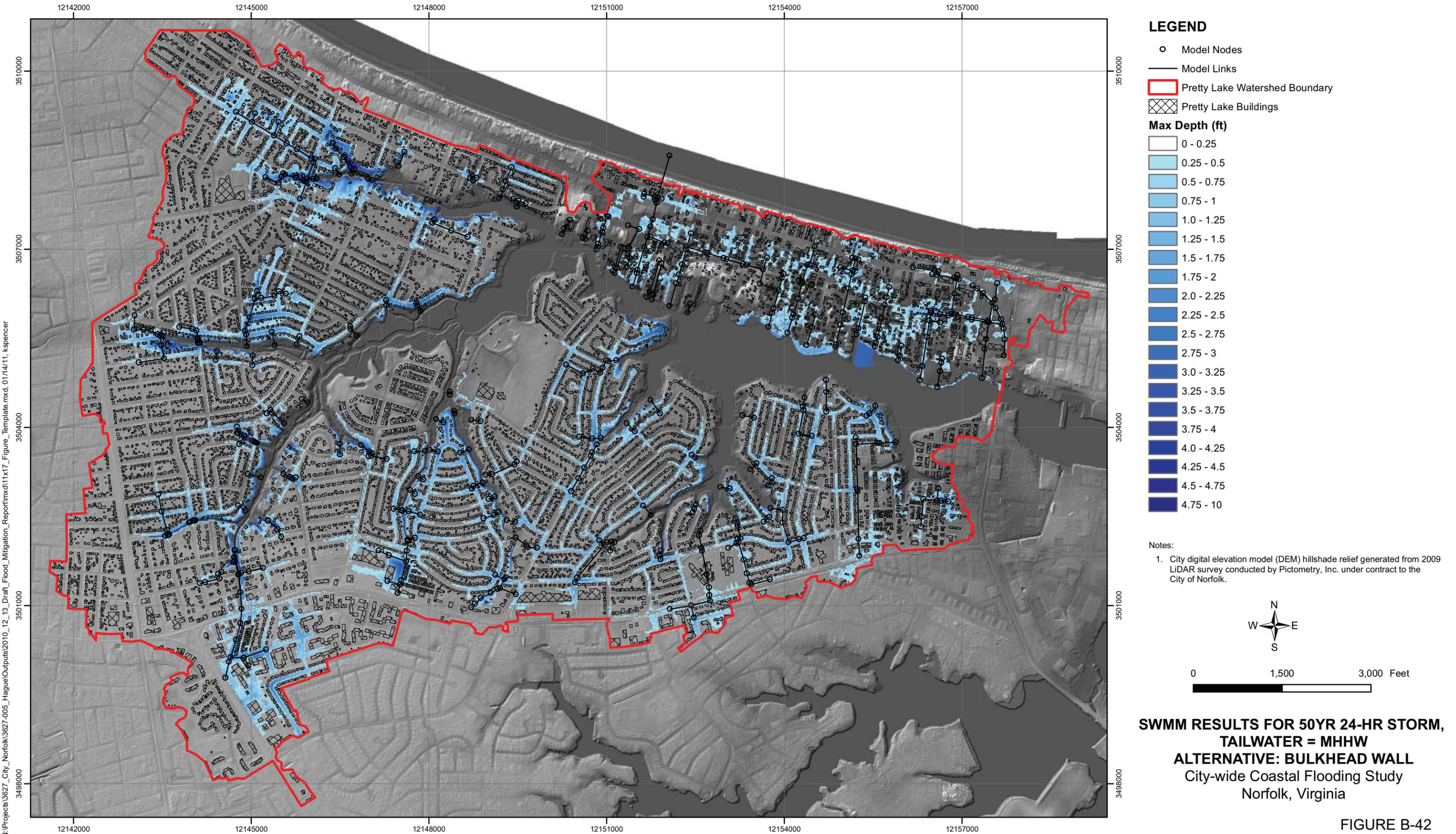
Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

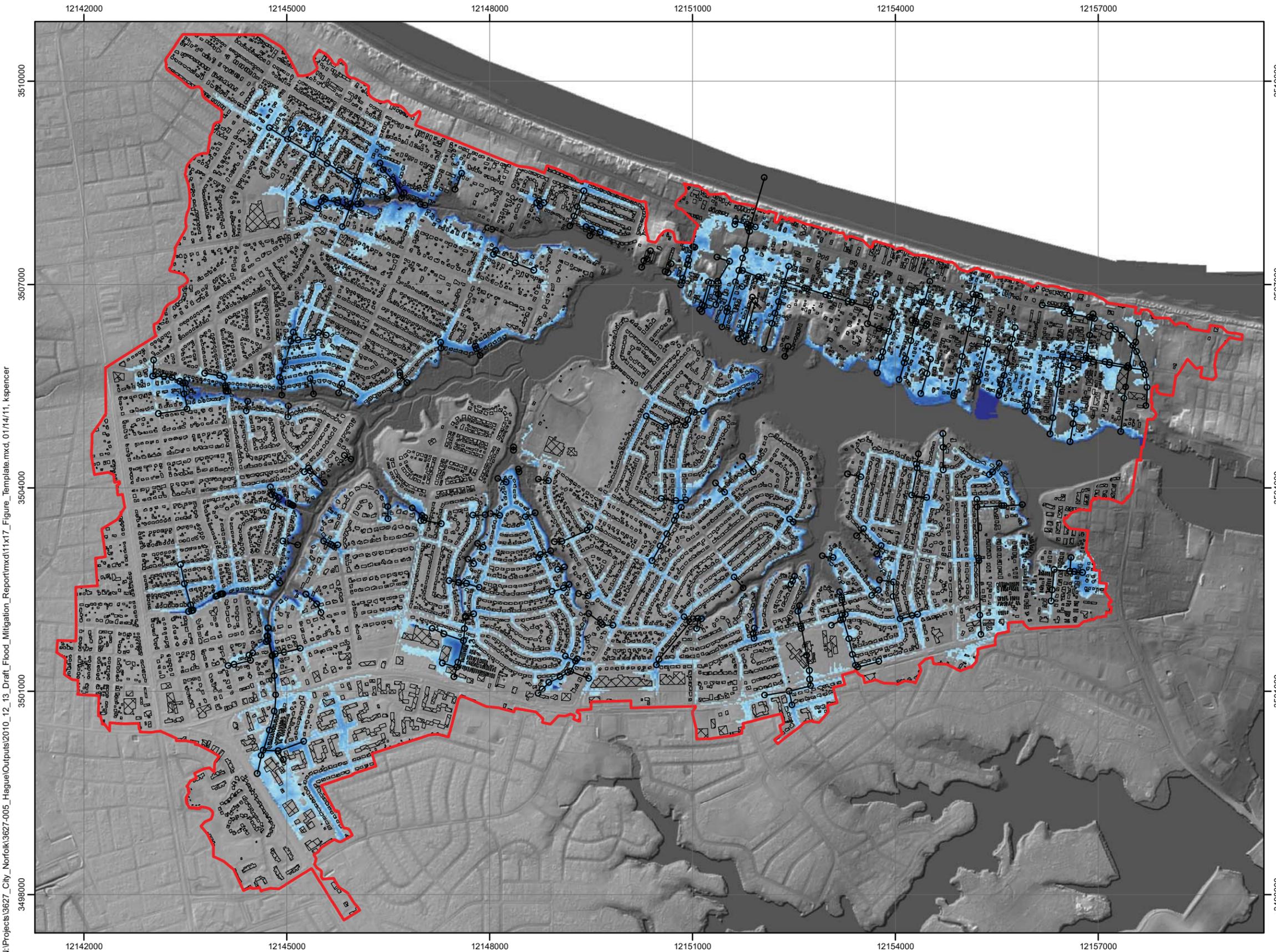
Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 25YR 24-HR STORM,
TAILWATER = 25YR STORM SURGE
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia



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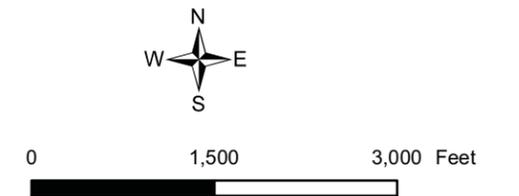
LEGEND

- Model Nodes
- Model Links
- ▭ Pretty Lake Watershed Boundary
- ▨ Pretty Lake Buildings

Max Depth (ft)

- 0 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1.0 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- 2.0 - 2.25
- 2.25 - 2.5
- 2.5 - 2.75
- 2.75 - 3
- 3.0 - 3.25
- 3.25 - 3.5
- 3.5 - 3.75
- 3.75 - 4
- 4.0 - 4.25
- 4.25 - 4.5
- 4.5 - 4.75
- 4.75 - 10

Notes:
1. City digital elevation model (DEM) hillshade relief generated from 2009 LIDAR survey conducted by Pictometry, Inc. under contract to the City of Norfolk.



**SWMM RESULTS FOR 50YR 24-HR STORM,
TAILWATER = 50YR STORM SURGE
ALTERNATIVE: BULKHEAD WALL**
City-wide Coastal Flooding Study
Norfolk, Virginia

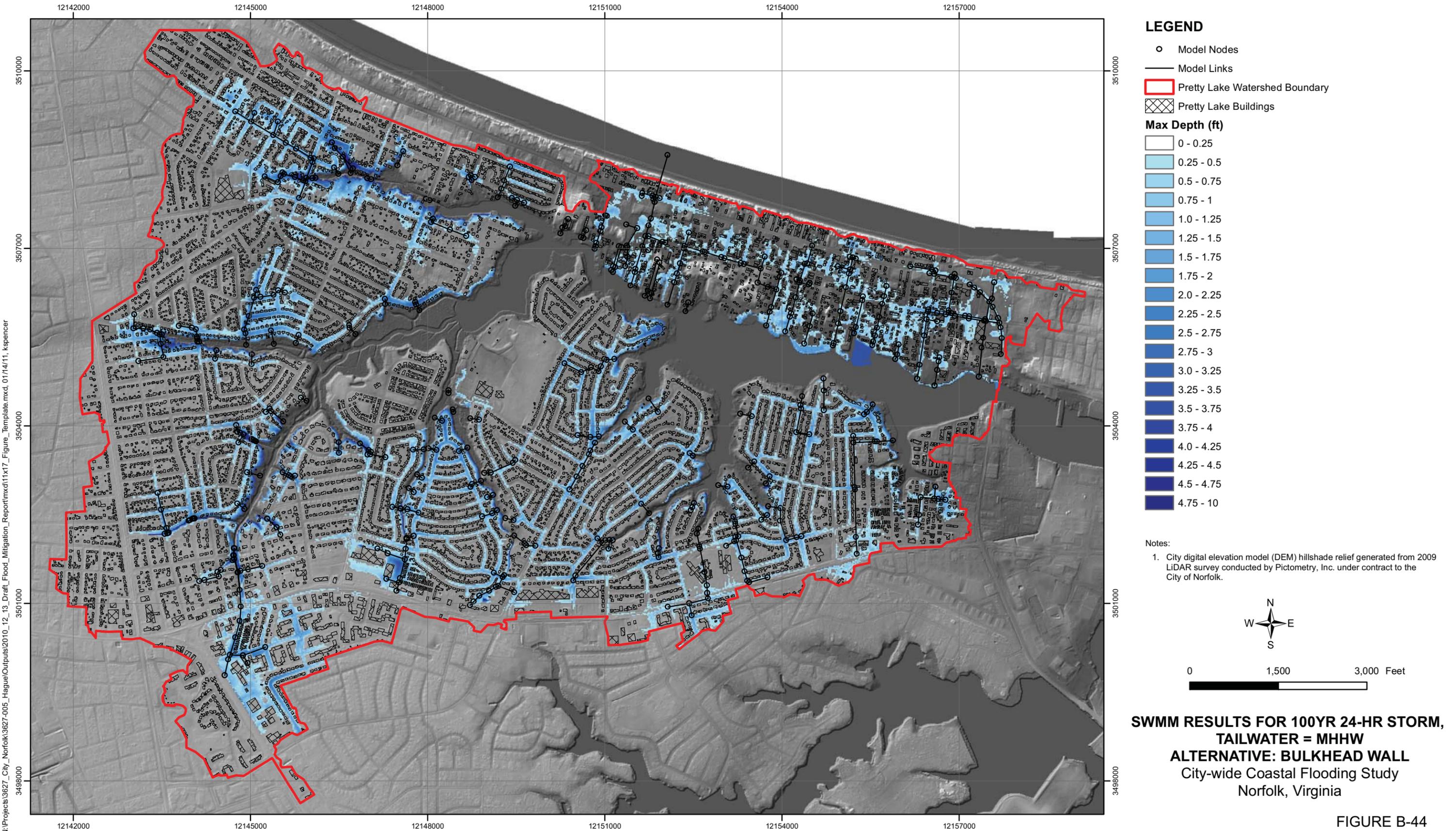


FIGURE B-44

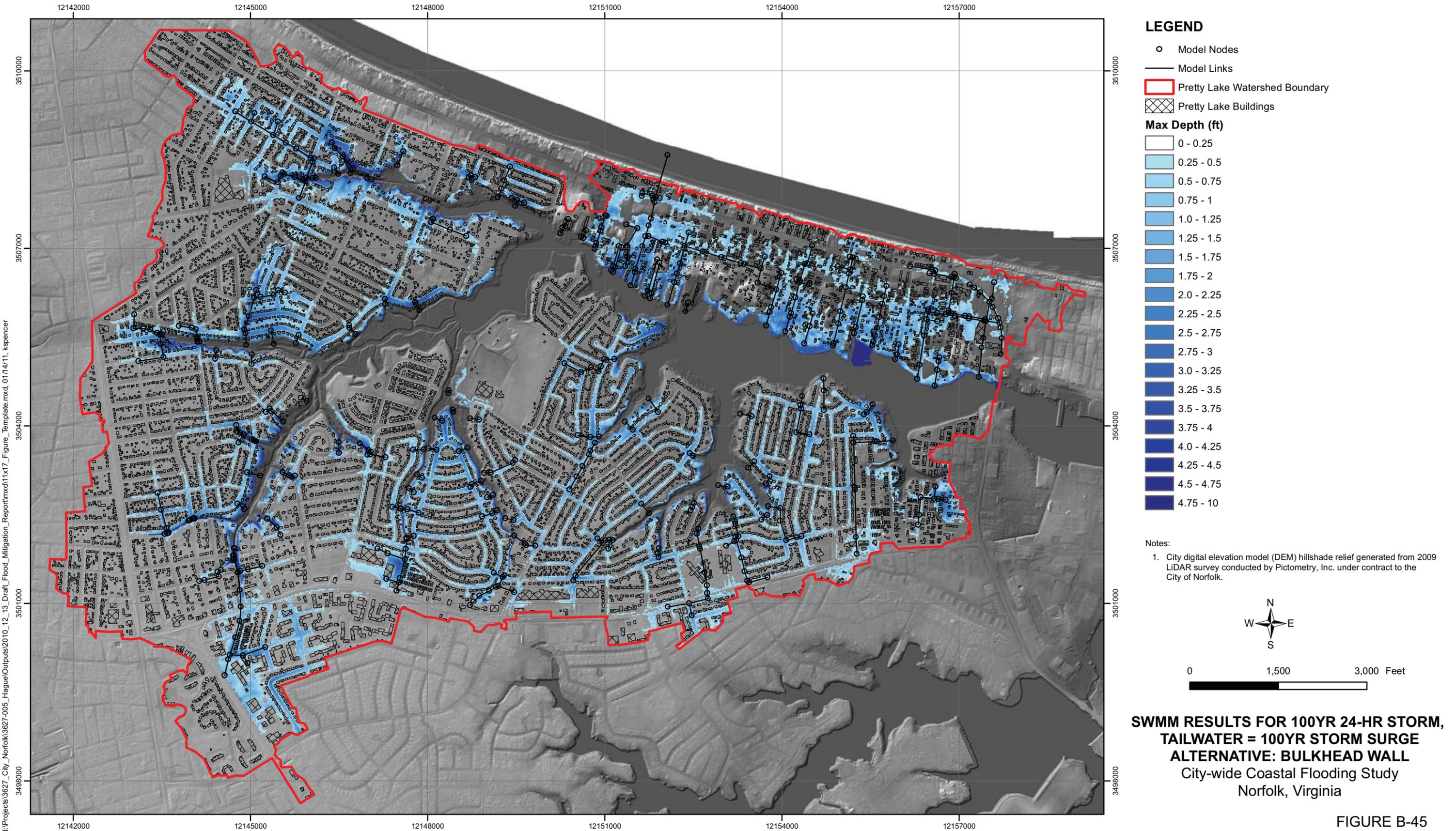


FIGURE B-45

APPENDIX C

OPINION OF PROBABLE COST AND OPERATIONAL COST

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 1a Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN	JOB ORDER NUMBER 6822-06	
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$27,700,000		
10 Year Surge with Rain			\$34,900,000		
25 Year Surge with Rain			\$36,200,000		
50 Year Surge with Rain			\$37,400,000		
100 Year Surge with Rain			\$38,400,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
City of Norfolk Norfolk, Virginia		ESTIMATED BY	CATEGORY CODE NUMBER		
PROJECT TITLE		Moffatt & Nichol			
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 2 Year Event @ ELEV +4.2'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	0.00	LF/VLF	\$250.00	\$0	
Road Raise (4-Lane Road)	0.00	LF/VLF	\$450.00	\$0	
Utility Relocation	0	LF	\$300.00	\$0	
Elevating Homes along North Side of Dunning Ave	0	EA	\$70,000.00	\$0	
Sliding Gate					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	56,400	SF	\$28.50	\$1,607,400	
Treat Embedded Interlocks	13,000	LF	\$7.25	\$94,250	
30" DIA Steel Pipe End Piles	320	LF	\$363.00	\$116,160	
Special Sheet Fabrication	480	LF	\$42.50	\$20,400	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Gate Assembly</u>					
Framed Steel Gate	65	Tons	\$10,125.00	\$658,125	
Flanged Steel Wheel Assembly	6	EA	\$3,120.00	\$18,720	
Rail	150	LF	\$298.00	\$44,700	
Capstan & Cabling	1	LS	\$193,500.00	\$193,500	
UHMW Rollers	12	EA	\$2,587.00	\$31,044	
Pocket Seal	35	LF	\$4,650.00	\$162,750	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
City of Norfolk Norfolk, Virginia		ESTIMATED BY	CATEGORY CODE NUMBER		
PROJECT TITLE		Moffatt & Nichol			
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 2 Year Event @ ELEV +4.2'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<u>Common Costs</u>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<u>Site Work</u>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<u>Power</u>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 2 Year Event @ ELEV +4.2'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Sales Tax for Electrical		1	LS	\$173,859.00	\$173,859
SUBTOTAL					\$14,679,117
Overhead & Profit		15%			\$2,201,868
Mobilization/Demobilization		10%			\$1,467,912
Difficult Waterside Conditions		est - lump sum			\$1,000,000
Erosion/Sediment Control		5%			\$733,956
Traffic Control		2%			\$293,582
Surveying/Engineering/Construction Observation		12%			\$1,761,494
Subtotal with Mark-ups					\$22,137,929
Contingency		25%			\$5,534,482
Subtotal					\$27,672,411
TOTAL					\$27,672,411
				SAY	\$27,700,000

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 10 Year Event @ ELEV +5.6'		Moffatt & Nichol			
		STATUS OF DESIGN		JOB ORDER NUMBER	
				6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	1,650.00	LF/VLF	\$250.00	\$412,500	
Road Raise (4-Lane Road)	1,100.00	LF/VLF	\$450.00	\$495,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Sliding Gate					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	61,100	SF	\$28.50	\$1,741,350	
Treat Embedded Interlocks	14,000	LF	\$7.25	\$101,500	
30" DIA Steel Pipe End Piles	340	LF	\$363.00	\$123,420	
Special Sheet Fabrication	520	LF	\$42.50	\$22,100	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Gate Assembly</u>					
Framed Steel Gate	65	Tons	\$10,125.00	\$658,125	
Flanged Steel Wheel Assembly	6	EA	\$3,120.00	\$18,720	
Rail	150	LF	\$298.00	\$44,700	
Capstan & Cabling	1	LS	\$193,500.00	\$193,500	
UHMW Rollers	12	EA	\$2,587.00	\$31,044	
Pocket Seal	35	LF	\$4,650.00	\$162,750	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 10 Year Event @ ELEV +5.6'		Moffatt & Nichol			
		STATUS OF DESIGN		JOB ORDER NUMBER	
				6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<u>Common Costs</u>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<u>Site Work</u>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<u>Power</u>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk					
Norfolk, Virginia		ESTIMATED BY		CATEGORY CODE NUMBER	
PROJECT TITLE		Moffatt & Nichol			
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise		STATUS OF DESIGN		JOB ORDER NUMBER	
For 10 Year Event @ ELEV +5.6'				6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Sales Tax for Electrical	1	LS	\$173,859.00	\$173,859	
SUBTOTAL				\$18,661,777	
Overhead & Profit	15%			\$2,799,267	
Mobilization/Demobilization	10%			\$1,866,178	
Difficult Waterside Conditions	est - lump sum			\$1,000,000	
Erosion/Sediment Control	5%			\$933,089	
Traffic Control	2%			\$373,236	
Surveying/Engineering/Construction Observation	12%			\$2,239,413	
Subtotal with Mark-ups				\$27,872,959	
Contingency	25%			\$6,968,240	
Subtotal				\$34,841,199	
TOTAL				\$34,841,199	
				SAY \$34,900,000	

		Opinion of Probable Cost		DATE PREPARED	
				17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 25 Year Event @ ELEV +6.4'		Moffatt & Nichol			
		STATUS OF DESIGN		JOB ORDER NUMBER	
				6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Site Civil					
Road Raise (2-Lane Road)	2,970.00	LF/VLF	\$250.00	\$742,500	
Road Raise (4-Lane Road)	1,980.00	LF/VLF	\$450.00	\$891,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Sliding Gate					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	61,100	SF	\$28.50	\$1,741,350	
Treat Embedded Interlocks	14,000	LF	\$7.25	\$101,500	
30" DIA Steel Pipe End Piles	340	LF	\$363.00	\$123,420	
Special Sheet Fabrication	520	LF	\$42.50	\$22,100	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Gate Assembly</u>					
Framed Steel Gate	65	Tons	\$10,125.00	\$658,125	
Flanged Steel Wheel Assembly	6	EA	\$3,120.00	\$18,720	
Rail	150	LF	\$298.00	\$44,700	
Capstan & Cabling	1	LS	\$193,500.00	\$193,500	
UHMW Rollers	12	EA	\$2,587.00	\$31,044	
Pocket Seal	35	LF	\$4,650.00	\$162,750	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY	CATEGORY CODE NUMBER		
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 25 Year Event @ ELEV +6.4'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 25 Year Event @ ELEV +6.4'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Sales Tax for Electrical		1	LS	\$173,859.00	\$173,859
SUBTOTAL					\$19,387,777
Overhead & Profit		15%			\$2,908,167
Mobilization/Demobilization		10%			\$1,938,778
Difficult Waterside Conditions		est - lump sum			\$1,000,000
Erosion/Sediment Control		5%			\$969,389
Traffic Control		2%			\$387,756
Surveying/Engineering/Construction Observation		12%			\$2,326,533
Subtotal with Mark-ups					\$28,918,399
Contingency		25%			\$7,229,600
Subtotal					\$36,147,999
TOTAL					\$36,147,999
					SAY \$36,200,000

		Opinion of Probable Cost		DATE PREPARED	
				17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 50 Year Event @ ELEV +7.0'		STATUS OF DESIGN		JOB ORDER NUMBER	
				6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	3,960.00	LF/VLF	\$250.00	\$990,000	
Road Raise (4-Lane Road)	2,640.00	LF/VLF	\$450.00	\$1,188,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Sliding Gate					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	65,800	SF	\$28.50	\$1,875,300	
Treat Embedded Interlocks	15,000	LF	\$7.25	\$108,750	
30" DIA Steel Pipe End Piles	360	LF	\$363.00	\$130,680	
Special Sheet Fabrication	560	LF	\$42.50	\$23,800	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Gate Assembly</u>					
Framed Steel Gate	65	Tons	\$10,125.00	\$658,125	
Flanged Steel Wheel Assembly	6	EA	\$3,120.00	\$18,720	
Rail	150	LF	\$298.00	\$44,700	
Capstan & Cabling	1	LS	\$193,500.00	\$193,500	
UHMW Rollers	12	EA	\$2,587.00	\$31,044	
Pocket Seal	35	LF	\$4,650.00	\$162,750	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY	CATEGORY CODE NUMBER		
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 50 Year Event @ ELEV +7.0'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 50 Year Event @ ELEV +7.0'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Sales Tax for Electrical		1	LS	\$173,859.00	\$173,859
SUBTOTAL					\$20,082,437
Overhead & Profit		15%			\$3,012,366
Mobilization/Demobilization		10%			\$2,008,244
Difficult Waterside Conditions		est - lump sum			\$1,000,000
Erosion/Sediment Control		5%			\$1,004,122
Traffic Control		2%			\$401,649
Surveying/Engineering/Construction Observation		12%			\$2,409,892
Subtotal with Mark-ups					\$29,918,710
Contingency		25%			\$7,479,677
Subtotal					\$37,398,387
TOTAL					\$37,398,387
				SAY	\$37,400,000

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 100 Year Event @ ELEV +7.6'		STATUS OF DESIGN		JOB ORDER NUMBER	
				6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	4,950.00	LF/VLF	\$250.00	\$1,237,500	
Road Raise (4-Lane Road)	3,300.00	LF/VLF	\$450.00	\$1,485,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Sliding Gate					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	65,800	SF	\$28.50	\$1,875,300	
Treat Embedded Interlocks	15,000	LF	\$7.25	\$108,750	
30" DIA Steel Pipe End Piles	360	LF	\$363.00	\$130,680	
Special Sheet Fabrication	560	LF	\$42.50	\$23,800	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Gate Assembly</u>					
Framed Steel Gate	65	Tons	\$10,125.00	\$658,125	
Flanged Steel Wheel Assembly	6	EA	\$3,120.00	\$18,720	
Rail	150	LF	\$298.00	\$44,700	
Capstan & Cabling	1	LS	\$193,500.00	\$193,500	
UHMW Rollers	12	EA	\$2,587.00	\$31,044	
Pocket Seal	35	LF	\$4,650.00	\$162,750	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY	CATEGORY CODE NUMBER		
Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 100 Year Event @ ELEV +7.6'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1a - Tidal Barrier with Steel Gate, 2 - 60" Dia. Pumps, and Road Raise For 100 Year Event @ ELEV +7.6'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
		QUANTITY		ENGINEERING ESTIMATE	
ITEM DESCRIPTION		NUMBER	UNIT	UNIT COST	TOTAL
Sales Tax for Electrical		1	LS	\$173,859.00	\$173,859
SUBTOTAL					\$20,626,937
Overhead & Profit		15%			\$3,094,041
Mobilization/Demobilization		10%			\$2,062,694
Difficult Waterside Conditions		est - lump sum			\$1,000,000
Erosion/Sediment Control		5%			\$1,031,347
Traffic Control		2%			\$412,539
Surveying/Engineering/Construction Observation		12%			\$2,475,232
Subtotal with Mark-ups					\$30,702,790
Contingency		25%			\$7,675,697
Subtotal					\$38,378,487
TOTAL					\$38,378,487
				SAY	\$38,400,000

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
			ESTIMATED BY Moffatt & Nichol		
PROJECT TITLE Pretty Lake - Alternative 1b Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise			STATUS OF DESIGN		
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$29,900,000		
10 Year Surge with Rain			\$37,600,000		
25 Year Surge with Rain			\$39,200,000		
50 Year Surge with Rain			\$40,600,000		
100 Year Surge with Rain			\$41,900,000		

		Opinion of Probable Cost		DATE PREPARED	
				17-Jan-11	
ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY	CATEGORY CODE NUMBER		
Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 2 Year Event @ ELEV +4.2'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	0.00	LF/VLF	\$250.00	\$0	
Road Raise (4-Lane Road)	0.00	LF/VLF	\$450.00	\$0	
Utility Relocation	0	LF	\$300.00	\$0	
Elevating Homes along North Side of Dunning Ave	0	EA	\$70,000.00	\$0	
Obermeyer Gate w/ Bulkhead (Pretty Lake is 475 LF)					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	51,700	SF	\$28.50	\$1,473,450	
Treat Embedded Interlocks	12,000	LF	\$7.25	\$87,000	
30" DIA Steel Pipe End Piles	300	LF	\$363.00	\$108,900	
Special Sheet Fabrication	600	LF	\$42.50	\$25,500	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Dam Assembly</u>					
Gate with Operating System - 12.3' High x 50 LF	615	SF	\$4,000.00	\$2,460,000	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 2 Year Event @ ELEV +4.2'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 2 Year Event @ ELEV +4.2'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
ITEM DESCRIPTION		QUANTITY		ENGINEERING ESTIMATE	
		NUMBER	UNIT	UNIT COST	TOTAL
Sales Tax for Electrical		1	LS	\$173,859.00	\$173,859
SUBTOTAL					\$15,886,918
Overhead & Profit		15%			\$2,383,038
Mobilization/Demobilization		10%			\$1,588,692
Difficult Waterside Conditions		est - lump sum			\$1,000,000
Erosion/Sediment Control		5%			\$794,346
Traffic Control		2%			\$317,738
Surveying/Engineering/Construction Observation		12%			\$1,906,430
Subtotal with Mark-ups					\$23,877,162
Contingency		25%			\$5,969,291
Subtotal					\$29,846,453
TOTAL					\$29,846,453
				SAY	\$29,900,000

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.	IDENTIFICATION NUMBER		
		ESTIMATED BY Moffatt & Nichol	CATEGORY CODE NUMBER		
PROJECT TITLE Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 10 Year Event @ ELEV +5.6'		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
		ITEM DESCRIPTION		QUANTITY	
NUMBER	UNIT			UNIT COST	TOTAL
Site Civil					
Road Raise (2-Lane Road)	1,650.00	LF/VLF	\$250.00	\$412,500	
Road Raise (4-Lane Road)	1,100.00	LF/VLF	\$450.00	\$495,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Obermeyer Gate w/ Bulkhead (Pretty Lake is 475 LF) -					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	56,400	SF	\$28.50	\$1,607,400	
Treat Embedded Interlocks	13,000	LF	\$7.25	\$94,250	
30" DIA Steel Pipe End Piles	320	LF	\$363.00	\$116,160	
Special Sheet Fabrication	520	LF	\$42.50	\$22,100	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Dam Assembly</u>					
Gate with Operating System - 13.7' High x 50 LF	685	SF	\$4,000.00	\$2,740,000	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

ITEM DESCRIPTION		QUANTITY		ENGINEERING ESTIMATE	
		NUMBER	UNIT	UNIT COST	TOTAL
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
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VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
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PROJECT TITLE		Moffatt & Nichol			
Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 25 Year Event @ ELEV +6.4'		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		TOTAL
	NUMBER	UNIT	UNIT COST		
Site Civil					
Road Raise (2-Lane Road)	2,970.00	LF/VLF	\$250.00		\$742,500
Road Raise (4-Lane Road)	1,980.00	LF/VLF	\$450.00		\$891,000
Utility Relocation	2,750	LF	\$300.00		\$825,000
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00		\$2,100,000
Obermeyer Gate w/ Bulkhead (Pretty Lake is 475 LF)					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	56,400	SF	\$28.50		\$1,607,400
Treat Embedded Interlocks	13,000	LF	\$7.25		\$94,250
30" DIA Steel Pipe End Piles	320	LF	\$363.00		\$116,160
Special Sheet Fabrication	520	LF	\$42.50		\$22,100
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25		\$1,225,500
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50		\$91,625
Tremie Concrete Base	150	CY	\$985.00		\$147,750
<u>Dam Assembly</u>					
Gate with Operating System - 15.1' High x 50 LF	725	SF	\$4,000.00		\$2,900,000
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00		\$688,500
Top Slab	180	CY	\$630.00		\$113,400
Handrail	830	LF	\$178.00		\$147,740
Pump Stations					
60" pumps	3	EA	\$1,380,000.00		\$4,140,000
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00		\$28,000
Misc 60" Pipe Sections	3	EA	\$8,000.00		\$24,000
Concrete Headwall	1	EA	\$80,000.00		\$80,000
Flapgates	3	EA	\$19,200.00		\$57,600
Brick Enclosure for Generator	1	EA	\$450,000.00		\$450,000
Aesthetic Features of Pump Station	1	LS	\$150,000.00		\$150,000

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		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
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Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
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Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 50 Year Event @ ELEV +7.0'		Moffatt & Nichol			
		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION		QUANTITY		ENGINEERING ESTIMATE	
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Site Civil					
Road Raise (2-Lane Road)	3,960.00	LF/VLF	\$250.00	\$990,000	
Road Raise (4-Lane Road)	2,640.00	LF/VLF	\$450.00	\$1,188,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Obermeyer Gate w/ Bulkhead (Pretty Lake is 475 LF)					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	61,100	SF	\$28.50	\$1,741,350	
Treat Embedded Interlocks	14,000	LF	\$7.25	\$101,500	
30" DIA Steel Pipe End Piles	340	LF	\$363.00	\$123,420	
Special Sheet Fabrication	520	LF	\$42.50	\$22,100	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Dam Assembly</u>					
Gate with Operating System - 15.1' High x 50 LF	755	SF	\$4,000.00	\$3,020,000	
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Concrete Fascia	8,100	SF	\$85.00	\$688,500	
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Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
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ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO.		IDENTIFICATION NUMBER	
PROJECT TITLE Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 100 Year Event @ ELEV +7.6'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	4,950.00	LF/VLF	\$250.00	\$1,237,500	
Road Raise (4-Lane Road)	3,300.00	LF/VLF	\$450.00	\$1,485,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Obermeyer Gate w/ Bulkhead (Pretty Lake is 475 LF)					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	61,100	SF	\$28.50	\$1,741,350	
Treat Embedded Interlocks	14,000	LF	\$7.25	\$101,500	
30" DIA Steel Pipe End Piles	340	LF	\$363.00	\$123,420	
Special Sheet Fabrication	520	LF	\$42.50	\$22,100	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Dam Assembly</u>					
Gate with Operating System - 15.7' High x 50 LF	795	SF	\$4,000.00	\$3,180,000	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

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City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY	CATEGORY CODE NUMBER		
Alt. 1b - Tidal Barrier with Obermeyer Gate, 2 - 60" Dia. Pumps, and Road Raise For 100 Year Event @ ELEV +7.6'		Moffatt & Nichol			
		STATUS OF DESIGN	JOB ORDER NUMBER		
			6822-06		
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Electrical					
Dominion Power Installation Costs	1	LS	\$100,000.00	\$100,000	
<i>Common Costs</i>					
Line Truck	20	DY	\$283.25	\$5,665	
Backhoe	10	DY	\$395.52	\$3,955	
Scissors Lift	40	DY	\$265.20	\$10,608	
<i>Site Work</i>					
Trench & Backfill	400	LF	\$1.96	\$784	
Pole, Foundation & Flood It	6	EA	\$1,223.02	\$7,338	
Quasite Handhole	3	EA	\$607.04	\$1,821	
<i>Power</i>					
Switchboard	1	LS	\$74,231.00	\$74,231	
400A 208V service panel W/MCB	1	EA	\$4,475.00	\$4,475	
100A 30ckt 208v 3 phase panel	6	EA	\$2,090.00	\$12,540	
225A 42 ckt 208v 3 phase panel	2	EA	\$3,400.00	\$6,800	
100-225A 3P 208v CB	4	EA	\$998.00	\$3,992	
20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

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ACTIVITY AND LOCATION		CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER			
City of Norfolk Norfolk, Virginia					
PROJECT TITLE		ESTIMATED BY		CATEGORY CODE NUMBER	
Alt. 1c - Tidal Barrier with Inflatable Dam, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 100 Year Event @ ELEV +7.6'		STATUS OF DESIGN		JOB ORDER NUMBER	
				6822-06	
ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
Site Civil					
Road Raise (2-Lane Road)	4,950.00	F/VL	\$250.00	\$1,237,500	
Road Raise (4-Lane Road)	3,300.00	F/VL	\$450.00	\$1,485,000	
Utility Relocation	2,750	LF	\$300.00	\$825,000	
Elevating Homes along North Side of Dunning Ave	30	EA	\$70,000.00	\$2,100,000	
Inflatable Dam w/ Bulkhead (Pretty Lake is 475 LF)					
<u>Piling: Steel</u>					
Install AZ 14 Steel Sheet Piles	61,100	SF	\$28.50	\$1,741,350	
Treat Embedded Interlocks	14,000	LF	\$7.25	\$101,500	
30" DIA Steel Pipe End Piles	340	LF	\$363.00	\$123,420	
Special Sheet Fabrication	520	LF	\$42.50	\$22,100	
<u>Site Work: Excavation & Fill</u>					
Gravel Base	38,000	CY	\$32.25	\$1,225,500	
<u>Concrete: Gate Base Slab</u>					
Precast Concrete Gate Base	50	CY	\$1,832.50	\$91,625	
Tremie Concrete Base	150	CY	\$985.00	\$147,750	
<u>Dam Assembly</u>					
Rubber Dam - 15.7' High x 111 LF	1,765	SF	\$3,000.00	\$5,294,700	
Dam Operating System	1	LS	\$248,000.00	\$248,000	
<u>Finish Work</u>					
Concrete Fascia	8,100	SF	\$85.00	\$688,500	
Top Slab	180	CY	\$630.00	\$113,400	
Handrail	830	LF	\$178.00	\$147,740	
Pump Stations					
60" pumps	3	EA	\$1,380,000.00	\$4,140,000	
Support Structure - piles,header,rods, etc.	1	EA	\$28,000.00	\$28,000	
Misc 60" Pipe Sections	3	EA	\$8,000.00	\$24,000	
Concrete Headwall	1	EA	\$80,000.00	\$80,000	
Flapgates	3	EA	\$19,200.00	\$57,600	
Brick Enclosure for Generator	1	EA	\$450,000.00	\$450,000	
Aesthetic Features of Pump Station	1	LS	\$150,000.00	\$150,000	

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Alt. 1c - Tidal Barrier with Inflatable Dam, 2 - 60" Dia. Pumps, and Road Raise		Moffatt & Nichol			
For 100 Year Event @ ELEV +7.6'		STATUS OF DESIGN		JOB ORDER NUMBER	
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ITEM DESCRIPTION	QUANTITY		ENGINEERING ESTIMATE		
	NUMBER	UNIT	UNIT COST	TOTAL	
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Backhoe	10	DY	\$395.52	\$3,955	
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20A 1P 120v Circuit Breaker	42	EA	\$53.30	\$2,239	
Surge Arrestor (SPD) 208V 10-Mode NEMA 4x box	2	EA	\$9,849.00	\$19,698	
4" GRS Conduit	1500	LF	\$49.80	\$74,700	
3/4" GRS Conduit	2500	LF	\$7.93	\$19,825	
1/2" GRS Conduit	5000	LF	\$7.14	\$35,700	
4" GRS Fittings	100	EA	\$455.00	\$45,500	
3/4" GRS Fittings	200	EA	\$42.95	\$8,590	
1/2" GRS Fittings	200	EA	\$35.45	\$7,090	
# 500 kcmil XHHW	7500	LF	\$14.10	\$105,750	
#4/0 AWG THWN	1500	LF	\$6.86	\$10,290	
#8 THWN Copper	1500	LF	\$0.91	\$1,365	
#12 THWN Copper	25000	LF	\$0.50	\$12,500	
# 500 kcmil cable connector	18	EA	\$160.00	\$2,880	
GFI Receptacle W/ Box & Cover	25	EA	\$107.09	\$2,677	
Duplex Receptacle W/Box & Cover	80	EA	\$60.82	\$4,866	
Motor Connection	3	EA	\$9,203.13	\$27,609	
VFD Drive	3	EA	\$150,000.00	\$450,000	
2500 KW Standby Generator - natural gas	2	EA	\$1,245,875.00	\$2,491,750	
Paralleling Switchgear	1	LS	\$429,800.00	\$429,800	
150 KVA Dry Transformer	1	EA	\$15,452.00	\$15,452	
30kVA UPS owner purchase (including commissioning)	1	EA	\$40,000.00	\$40,000	
Annunciator	1	LS	\$14,200.00	\$14,200	
Insurance & Taxes for Electrical	1	LS	\$159,404.00	\$159,404	

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ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER			
PROJECT TITLE Alt. 1c - Tidal Barrier with Inflatable Dam, 2 - 60" Dia. Pumps, and Road Raise For 100 Year Event @ ELEV +7.6'		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN		JOB ORDER NUMBER 6822-06	
ITEM DESCRIPTION		QUANTITY		ENGINEERING ESTIMATE	
		NUMBER	UNIT	UNIT COST	TOTAL
Sales Tax for Electrical		1	LS	\$173,859.00	\$173,859
SUBTOTAL					\$24,910,638
Overhead & Profit		15%		\$3,736,596	
Mobilization/Demobilization		10%		\$2,491,064	
Difficult Waterside Conditions		est - lump sum		\$1,000,000	
Erosion/Sediment Control		5%		\$1,245,532	
Traffic Control		2%		\$498,213	
Surveying/Engineering/Construction Observation		12%		\$2,989,277	
Subtotal with Mark-ups					\$36,871,319
Contingency		25%		\$9,217,830	
Subtotal					\$46,089,149
TOTAL					\$46,089,149
				SAY	\$46,100,000

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 2a Tidal Barrier with Steel Gate, 4 - 60" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN	JOB ORDER NUMBER 6822-06	
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$39,800,000		
10 Year Surge with Rain			\$46,900,000		
25 Year Surge with Rain			\$48,200,000		
50 Year Surge with Rain			\$49,500,000		
100 Year Surge with Rain			\$50,500,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 2b Tidal Barrier with Obermeyer Gate, 4 - 60" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN		JOB ORDER NUMBER 6822-06
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$41,800,000		
10 Year Surge with Rain			\$49,400,000		
25 Year Surge with Rain			\$51,000,000		
50 Year Surge with Rain			\$52,500,000		
100 Year Surge with Rain			\$53,800,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 2c Tidal Barrier with Inflatable Dam, 4 - 60" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN		JOB ORDER NUMBER 6822-06
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$45,300,000		
10 Year Surge with Rain			\$53,300,000		
25 Year Surge with Rain			\$55,100,000		
50 Year Surge with Rain			\$56,700,000		
100 Year Surge with Rain			\$57,600,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 3a Tidal Barrier with Steel Gate, 4 - 96" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN		JOB ORDER NUMBER 6822-03
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$74,300,000		
10 Year Surge with Rain			\$81,500,000		
25 Year Surge with Rain			\$82,800,000		
50 Year Surge with Rain			\$84,000,000		
100 Year Surge with Rain			\$85,000,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 3b Tidal Barrier with Obermeyer Gate, 4 - 96" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN		JOB ORDER NUMBER 6822-06
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$76,500,000		
10 Year Surge with Rain			\$84,100,000		
25 Year Surge with Rain			\$85,700,000		
50 Year Surge with Rain			\$87,200,000		
100 Year Surge with Rain			\$88,500,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 3c Tidal Barrier with Inflatable Dam, 4 - 96" Dia. Pumps, and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN		JOB ORDER NUMBER 6822-06
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$79,900,000		
10 Year Surge with Rain			\$90,400,000		
25 Year Surge with Rain			\$92,200,000		
50 Year Surge with Rain			\$93,800,000		
100 Year Surge with Rain			\$94,100,000		

		Opinion of Probable Cost		DATE PREPARED 17-Jan-11	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia			CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER		
PROJECT TITLE Pretty Lake - Alternative 4 Bulkhead Wall, Earthen Berm and Road Raise			ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER
			STATUS OF DESIGN		JOB ORDER NUMBER 6822-06
Summary					
Scenario			Opinion of Probable Cost		
2 Year Surge with Rain			\$55,500,000		
10 Year Surge with Rain			\$94,700,000		
25 Year Surge with Rain			\$117,400,000		
50 Year Surge with Rain			\$154,500,000		
100 Year Surge with Rain			\$189,700,000		

		Opinion of Probable Cost		DATE PREPARED 20-Dec-10	
ACTIVITY AND LOCATION City of Norfolk Norfolk, Virginia		CONSTRUCTION CONTRACT NO. IDENTIFICATION NUMBER			
PROJECT TITLE Pretty Lake - Alternative 5 Buyout 20% Damage Level		ESTIMATED BY Moffatt & Nichol		CATEGORY CODE NUMBER	
		STATUS OF DESIGN Conceptual		JOB ORDER NUMBER 6822-06	
Summary					
Scenario			Opinion of Probable Cost		
2 - Year Storm Event			\$50,366,925		
10 - Year Storm Event			\$174,241,900		
25 - Year Storm Event			\$265,390,650		
50 - Year Storm Event			\$356,736,888		
100 - Year Storm Event			\$473,696,563		

		Opinion of Probable Cost		DATE PREPARED 7-Dec-10	
ACTIVITY AND LOCATION			CONSTRUCTION CONTRACT IDENTIFICATION NUMBER		
PROJECT TITLE			ESTIMATED BY		
Pretty Lake - Steel Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)			Moffatt & Nichol		
			STATUS OF DESIGN		
		Quantities	Price	Unit	Total Price
Bulkhead & Gate					
Inspections (Completed Every 5 Years)		10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)		3	\$400,000	EACH	\$1,200,000.00
Major Repairs (Years 25 & 40)		2	\$1,250,000	EACH	\$2,500,000.00
Operational Cost per Event (8 Events per Year)		400	\$500	EACH	\$200,000.00
Pump Station					
Maintenance Cost Per Generator Per Year (2 Gen Sets)		100	\$2,000	EACH	\$200,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)		20	\$40,000	EACH	\$800,000.00
Maintenance Cost Per Pump (Per Year Per Pump)		100	\$40,000	EACH	\$4,000,000.00
Replacement of Pumps (Year 30)		2	\$690,000	EACH	\$1,380,000.00
Operational Cost per Pump Per Event Per Pump Per Year		100	\$785	EACH	\$78,500.00
Operation Cost (City Employees - 2 Employees per Event)		19200	\$25	HOUR	\$480,000.00
Total					\$11,588,500.00

		Opinion of Probable Cost		DATE PREPARED 7-Dec-10	
ACTIVITY AND LOCATION			CONSTRUCTION CONTRACT IDENTIFICATION NUMBER		
PROJECT TITLE			ESTIMATED BY		
Pretty Lake - Obermeyer Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)			Moffatt & Nichol		
			STATUS OF DESIGN		
			JOB ORDER NUMBER		
		Quantities	Price	Unit	Total Price
Bulkhead & Gate					
Inspections (Completed Every 5 Years)		10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)		3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)		2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)		1	\$984,000	EACH	\$984,000.00
Operational Cost per Event (8 Events per Year)		400	\$500	EACH	\$200,000.00
Pump Station					
Maintenance Cost Per Generator Per Year (2 Gen Sets)		100	\$2,000	EACH	\$200,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)		20	\$40,000	EACH	\$800,000.00
Maintenance Cost Per Pump (Per Year Per Pump)		100	\$40,000	EACH	\$4,000,000.00
Replacement of Pumps (Year 30)		2	\$690,000	EACH	\$1,380,000.00
Operational Cost per Pump Per Event Per Pump Per Year		100	\$785	EACH	\$78,500.00
Operation Cost (City Employees - 2 Employees per Event)		19200	\$25	HOUR	\$480,000.00
Total					\$11,772,500.00

		Opinion of Probable Cost		DATE PREPARED 7-Dec-10	
ACTIVITY AND LOCATION			CONSTRUCTION CONTRACT IDENTIFICATION NUMBER		
PROJECT TITLE			ESTIMATED BY		
Pretty Lake - Inflatable Gate with Steel Bulkhead & Pumpstation with 2 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)			Moffatt & Nichol		
			STATUS OF DESIGN		
			JOB ORDER NUMBER		
		Quantities	Price	Unit	Total Price
Bulkhead & Gate					
Inspections (Completed Every 5 Years)		10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)		3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)		2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)		1	\$2,200,000	EACH	\$2,200,000.00
Operational Cost per Event (8 Events per Year)		400	\$500	EACH	\$200,000.00
Pump Station					
Maintenance Cost Per Generator Per Year (2 Gen Sets)		100	\$2,000	EACH	\$200,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)		20	\$40,000	EACH	\$800,000.00
Maintenance Cost Per Pump (Per Year Per Pump)		100	\$40,000	EACH	\$4,000,000.00
Replacement of Pumps (Year 30)		2	\$690,000	EACH	\$1,380,000.00
Operational Cost per Pump Per Event Per Pump Per Year		100	\$785	EACH	\$78,500.00
Operation Cost (City Employees - 2 Employees per Event)		19200	\$25	HOUR	\$480,000.00
Total					\$12,988,500.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Pretty Lake - Steel Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$400,000	EACH	\$1,200,000.00
Major Repairs (Years 25 & 40)	2	\$1,250,000	EACH	\$2,500,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$690,000	EACH	\$2,760,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$785	EACH	\$157,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Total				\$18,047,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Pretty Lake - Obermeyer Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$984,000	EACH	\$984,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$690,000	EACH	\$2,760,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$785	EACH	\$157,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Total				\$18,231,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY
Pretty Lake - Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 60" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	Moffatt & Nichol
	CATEGORY CODE NUMBER
	STATUS OF DESIGN
	JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$2,200,000	EACH	\$2,200,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$690,000	EACH	\$2,760,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$785	EACH	\$157,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Total				\$19,447,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
PROJECT TITLE	ESTIMATED BY Moffatt & Nichol
Pretty Lake - Inflatable Gate with Steel Bulkhead & Pumpstation with 4 - 96" Pumps Operational & Maintenance Costs (Anticipated Service Life of 50 Years)	CATEGORY CODE NUMBER
	STATUS OF DESIGN JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$1,975,000	EACH	\$7,900,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$1,245	EACH	\$249,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Total				\$22,479,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
	ESTIMATED BY: Moffatt & Nichol CATEGORY CODE NUMBER
PROJECT TITLE	STATUS OF DESIGN: JOB ORDER NUMBER:

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$984,000	EACH	\$984,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$1,975,000	EACH	\$7,900,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$1,245	EACH	\$249,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Total				\$23,463,000.00



Opinion of Probable Cost

DATE PREPARED
7-Dec-10

ACTIVITY AND LOCATION	CONSTRUCTION CONTRACT IDENTIFICATION NUMBER
	ESTIMATED BY: Moffatt & Nichol CATEGORY CODE NUMBER
PROJECT TITLE	STATUS OF DESIGN: JOB ORDER NUMBER

	Quantities	Price	Unit	Total Price
Bulkhead & Gate				
Inspections (Completed Every 5 Years)	10	\$75,000	EACH	\$750,000.00
Minor Repairs (Years 15, 35, 45)	3	\$300,000	EACH	\$900,000.00
Major Repairs (Years 25 & 40)	2	\$1,000,000	EACH	\$2,000,000.00
Replacement of Rubber Dam (Year 30)	1	\$2,200,000	EACH	\$2,200,000.00
Operational Cost per Event (8 Events per Year)	400	\$500	EACH	\$200,000.00
Pump Station				
Maintenance Cost Per Generator Per Year (4 Gen Sets)	200	\$2,000	EACH	\$400,000.00
Operational Cost for Generator Per Event (Once Every 5 Yr)	40	\$40,000	EACH	\$1,600,000.00
Maintenance Cost Per Pump (Per Year Per Pump)	200	\$40,000	EACH	\$8,000,000.00
Replacement of Pumps (Year 30)	4	\$1,975,000	EACH	\$7,900,000.00
Operational Cost per Pump Per Event (8 Events per Year)	200	\$1,245	EACH	\$249,000.00
Operation Cost (City Employees - 2 Employees per Event)	19200	\$25	Hour	\$480,000.00
Total				\$24,679,000.00

APPENDIX D

BENEFIT/COST RATIO CALCULATIONS

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
		0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
	0.500	2	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
	0.100	10	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
	0.040	25	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
	0.020	50	\$63,169,593	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
	0.010	100					\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,323				
		0.50	\$4,573,605	\$4,052,464	\$2,025,827	\$2,025,827	
	0.500	2	\$22,364,184	\$13,468,894	\$5,387,558	\$7,413,384	
	0.100	10	\$33,481,476	\$27,922,830	\$1,675,370	\$9,088,754	
	0.040	25	\$47,289,764	\$40,385,620	\$807,712	\$9,896,467	7.00% INTEREST RATE
	0.020	50	\$63,169,593	\$55,229,679	\$552,297	\$10,448,763	50 YEARS
	0.010	100					\$144,200,733 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,933				
		0.49	\$3,417,403	\$2,929,168	\$1,435,582	\$1,435,582	
	0.500	2	\$0	\$1,708,702	\$683,481	\$2,119,063	
	0.100	10	\$0	\$0	\$0	\$2,119,063	
	0.040	25	\$0	\$0	\$0	\$2,119,063	7.00% INTEREST RATE
	0.020	50	\$0	\$0	\$0	\$2,119,063	50 YEARS
	0.010	100					\$29,244,652 PRESENT WORTH

2 - 60" Pumps and Inflatable Dam			
\$33,300,000	PRESENT WORTH PROJECT COST	\$260,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,588,194	PRESENT WORTH O&M COSTS	\$36,888,194	PRESENT WORTH TOTAL PROJECT COST
		0.79	B/C RATIO

2 - 60" Pumps and Obermeyer Gate			
\$29,900,000	PRESENT WORTH PROJECT COST	\$236,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,256,976	PRESENT WORTH O&M COSTS	\$33,156,976	PRESENT WORTH TOTAL PROJECT COST
		0.88	B/C RATIO

2 - 60" Pumps and Steel Gate			
\$27,700,000	PRESENT WORTH PROJECT COST	\$232,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,201,773	PRESENT WORTH O&M COSTS	\$30,901,773	PRESENT WORTH TOTAL PROJECT COST
		0.95	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,323				
0.500	2	0.50	\$4,573,605	\$4,052,464	\$2,025,827	\$2,025,827	
0.100	10	0.4	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,731	
0.040	25	0.06	\$33,481,476	\$21,751,197	\$1,305,072	\$6,249,803	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$7,057,515	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$7,609,812	50 YEARS
							\$105,021,089 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,933				
0.500	2	0.49	\$3,417,403	\$2,929,168	\$1,435,582	\$1,435,582	
0.100	10	0.4	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,716	
0.040	25	0.06	\$0	\$6,171,633	\$370,298	\$4,958,014	
0.020	50	0.02	\$0	\$0	\$0	\$4,958,014	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$0	\$0	\$4,958,014	50 YEARS
							\$68,424,297 PRESENT WORTH

2 - 60" Pumps and Inflatable Dam			
\$41,300,000	PRESENT WORTH PROJECT COST	\$260,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,588,194	PRESENT WORTH O&M COSTS	\$44,888,194	PRESENT WORTH TOTAL PROJECT COST
1.52 B/C RATIO			

2 - 60" Pumps and Obermeyer Gate			
\$37,600,000	PRESENT WORTH PROJECT COST	\$236,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,256,976	PRESENT WORTH O&M COSTS	\$40,856,976	PRESENT WORTH TOTAL PROJECT COST
1.67 B/C RATIO			

2 - 60" Pumps and Steel Gate			
\$34,900,000	PRESENT WORTH PROJECT COST	\$232,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,201,773	PRESENT WORTH O&M COSTS	\$38,101,773	PRESENT WORTH TOTAL PROJECT COST
1.80 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM		DATE: 27-Apr-11			
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
	0.500	2	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
	0.100	10	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
	0.040	25	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
	0.020	50	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
	0.010	100	\$63,169,593	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM		DATE: 27-Apr-11			
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,323				
	0.500	2	\$4,573,605	\$4,052,464	\$2,025,827	\$2,025,827	
	0.100	10	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,731	
	0.040	25	\$12,936,003	\$11,478,461	\$688,708	\$5,633,439	
	0.020	50	\$47,289,764	\$30,112,884	\$602,258	\$6,235,697	7.00% INTEREST RATE
	0.010	100	\$63,169,593	\$55,229,679	\$552,297	\$6,787,993	50 YEARS
							\$93,679,374 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM		DATE: 27-Apr-11			
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,933				
	0.500	2	\$3,417,403	\$2,929,168	\$1,435,582	\$1,435,582	
	0.100	10	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,716	
	0.040	25	\$20,545,473	\$16,444,369	\$986,662	\$5,574,378	
	0.020	50	\$0	\$10,272,736	\$205,455	\$5,779,833	7.00% INTEREST RATE
	0.010	100	\$0	\$0	\$0	\$5,779,833	50 YEARS
							\$79,766,011 PRESENT WORTH

2 - 60" Pumps and Inflatable Dam			
\$43,100,000	PRESENT WORTH PROJECT COST	\$260,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,588,194	PRESENT WORTH O&M COSTS	\$46,688,194	PRESENT WORTH TOTAL PROJECT COST
		1.71	B/C RATIO

2 - 60" Pumps and Obermeyer Gate			
\$39,200,000	PRESENT WORTH PROJECT COST	\$236,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,256,976	PRESENT WORTH O&M COSTS	\$42,456,976	PRESENT WORTH TOTAL PROJECT COST
		1.88	B/C RATIO

2 - 60" Pumps and Steel Gate			
\$36,200,000	PRESENT WORTH PROJECT COST	\$232,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,201,773	PRESENT WORTH O&M COSTS	\$39,401,773	PRESENT WORTH TOTAL PROJECT COST
		2.02	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,323				
0.500	2	0.50	\$4,573,605	\$4,052,464	\$2,025,827	\$2,025,827	
0.100	10	0.4	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,731	
0.040	25	0.06	\$12,936,003	\$11,478,461	\$688,708	\$5,633,439	
0.020	50	0.02	\$16,050,214	\$14,493,109	\$289,862	\$5,923,301	7.00% INTEREST RATE
0.010	100	0.01	\$39,609,904	\$39,609,904	\$396,099	\$6,319,400	50 YEARS
							\$87,212,438 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,933				
0.500	2	0.49	\$3,417,403	\$2,929,168	\$1,435,582	\$1,435,582	
0.100	10	0.4	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,716	
0.040	25	0.06	\$20,545,473	\$16,444,369	\$986,662	\$5,574,378	
0.020	50	0.02	\$31,239,550	\$25,892,511	\$517,850	\$6,092,229	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$15,619,775	\$156,198	\$6,248,426	50 YEARS
							\$86,232,947 PRESENT WORTH

2 - 60" Pumps and Inflatable Dam			
\$44,100,000	PRESENT WORTH PROJECT COST	\$260,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,588,194	PRESENT WORTH O&M COSTS	\$47,688,194	PRESENT WORTH TOTAL PROJECT COST
		1.81	B/C RATIO

2 - 60" Pumps and Obermeyer Gate			
\$39,200,000	PRESENT WORTH PROJECT COST	\$236,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,256,976	PRESENT WORTH O&M COSTS	\$42,456,976	PRESENT WORTH TOTAL PROJECT COST
		2.03	B/C RATIO

2 - 60" Pumps and Steel Gate			
\$37,400,000	PRESENT WORTH PROJECT COST	\$232,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,201,773	PRESENT WORTH O&M COSTS	\$40,601,773	PRESENT WORTH TOTAL PROJECT COST
		2.12	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 100 yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 100 yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,323				
0.500	2	0.50	\$4,573,605	\$4,052,464	\$2,025,827	\$2,025,827	
0.100	10	0.4	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,731	
0.040	25	0.06	\$12,936,003	\$11,478,461	\$688,708	\$5,633,439	
0.020	50	0.02	\$16,050,214	\$14,493,109	\$289,862	\$5,923,301	7.00% INTEREST RATE
0.010	100	0.01	\$21,497,001	\$18,773,607	\$187,736	\$6,111,037	50 YEARS
							\$84,336,873 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 2-60" PUMPS - 100 yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,933				
0.500	2	0.49	\$3,417,403	\$2,929,168	\$1,435,582	\$1,435,582	
0.100	10	0.4	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,716	
0.040	25	0.06	\$20,545,473	\$16,444,369	\$986,662	\$5,574,378	
0.020	50	0.02	\$31,239,550	\$25,892,511	\$517,850	\$6,092,229	7.00% INTEREST RATE
0.010	100	0.01	\$41,672,592	\$36,456,071	\$364,561	\$6,456,789	50 YEARS
							\$89,108,512 PRESENT WORTH

2 - 60" Pumps and Inflatable Dam			
\$46,100,000	PRESENT WORTH PROJECT COST	\$260,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,588,194	PRESENT WORTH O&M COSTS	\$49,688,194	PRESENT WORTH TOTAL PROJECT COST
1.79 B/C RATIO			

2 - 60" Pumps and Obermeyer Gate			
\$41,900,000	PRESENT WORTH PROJECT COST	\$236,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,256,976	PRESENT WORTH O&M COSTS	\$45,156,976	PRESENT WORTH TOTAL PROJECT COST
1.97 B/C RATIO			

2 - 60" Pumps and Steel Gate			
\$38,400,000	PRESENT WORTH PROJECT COST	\$232,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,201,773	PRESENT WORTH O&M COSTS	\$41,601,773	PRESENT WORTH TOTAL PROJECT COST
2.14 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,866				
0.500	2	0.50	\$4,573,605	\$4,052,736	\$2,025,963	\$2,025,963	
0.100	10	0.4	\$22,364,184	\$13,468,894	\$5,387,558	\$7,413,520	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$9,088,890	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$9,896,602	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$10,448,899	50 YEARS
							\$144,202,608 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,390				
0.500	2	0.49	\$3,417,403	\$2,928,896	\$1,435,449	\$1,435,449	
0.100	10	0.4	\$0	\$1,708,702	\$683,481	\$2,118,930	
0.040	25	0.06	\$0	\$0	\$0	\$2,118,930	
0.020	50	0.02	\$0	\$0	\$0	\$2,118,930	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$0	\$0	\$2,118,930	50 YEARS
							\$29,242,814 PRESENT WORTH

4 - 60" Pumps and Inflatable Dam			
\$45,300,000	PRESENT WORTH PROJECT COST	\$389,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,368,490	PRESENT WORTH O&M COSTS	\$50,668,490	PRESENT WORTH TOTAL PROJECT COST
0.58 B/C RATIO			

4 - 60" Pumps and Obermeyer Gate			
\$41,800,000	PRESENT WORTH PROJECT COST	\$365,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,037,272	PRESENT WORTH O&M COSTS	\$46,837,272	PRESENT WORTH TOTAL PROJECT COST
0.62 B/C RATIO			

4 - 60" Pumps and Steel Gate			
\$39,800,000	PRESENT WORTH PROJECT COST	\$361,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,982,069	PRESENT WORTH O&M COSTS	\$44,782,069	PRESENT WORTH TOTAL PROJECT COST
0.65 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,866				
0.500	2	0.50	\$4,573,605	\$4,052,736	\$2,025,963	\$2,025,963	
0.100	10	0.4	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,867	
0.040	25	0.06	\$33,481,476	\$21,751,197	\$1,305,072	\$6,249,939	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$7,057,651	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$7,609,948	50 YEARS
							\$105,022,963 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,390				
0.500	2	0.49	\$3,417,403	\$2,928,896	\$1,435,449	\$1,435,449	
0.100	10	0.4	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,583	
0.040	25	0.06	\$0	\$6,171,633	\$370,298	\$4,957,881	
0.020	50	0.02	\$0	\$0	\$0	\$4,957,881	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$0	\$0	\$4,957,881	50 YEARS
							\$68,422,459 PRESENT WORTH

4 - 60" Pumps and Inflatable Dam			
\$53,300,000	PRESENT WORTH PROJECT COST	\$389,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,368,490	PRESENT WORTH O&M COSTS	\$58,668,490	PRESENT WORTH TOTAL PROJECT COST
		1.17	B/C RATIO

4 - 60" Pumps and Obermeyer Gate			
\$49,400,000	PRESENT WORTH PROJECT COST	\$365,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,037,272	PRESENT WORTH O&M COSTS	\$54,437,272	PRESENT WORTH TOTAL PROJECT COST
		1.26	B/C RATIO

4 - 60" Pumps and Steel Gate			
\$46,900,000	PRESENT WORTH PROJECT COST	\$361,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,982,069	PRESENT WORTH O&M COSTS	\$51,882,069	PRESENT WORTH TOTAL PROJECT COST
		1.32	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$63,169,593	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,866				
0.500	2	0.50	\$4,573,605	\$4,052,736	\$2,025,963	\$2,025,963	
0.100	10	0.4	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,867	
0.040	25	0.06	\$12,936,003	\$11,478,461	\$688,708	\$5,633,575	
0.020	50	0.02	\$47,289,764	\$30,112,884	\$602,258	\$6,235,832	7.00% INTEREST RATE
0.010	100	0.01	\$63,169,593	\$55,229,679	\$552,297	\$6,788,129	50 YEARS
							\$93,681,249 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,390				
0.500	2	0.49	\$3,417,403	\$2,928,896	\$1,435,449	\$1,435,449	
0.100	10	0.4	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,583	
0.040	25	0.06	\$20,545,473	\$16,444,369	\$986,662	\$5,574,245	
0.020	50	0.02	\$0	\$10,272,736	\$205,455	\$5,779,700	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$0	\$0	\$5,779,700	50 YEARS
							\$79,764,173 PRESENT WORTH

4 - 60" Pumps and Inflatable Dam

\$55,100,000	PRESENT WORTH PROJECT COST	\$389,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,368,490	PRESENT WORTH O&M COSTS	\$60,468,490	PRESENT WORTH TOTAL PROJECT COST
1.32 B/C RATIO			

4 - 60" Pumps and Obermeyer Gate

\$51,000,000	PRESENT WORTH PROJECT COST	\$365,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,037,272	PRESENT WORTH O&M COSTS	\$56,037,272	PRESENT WORTH TOTAL PROJECT COST
1.42 B/C RATIO			

4 - 60" Pumps and Steel Gate

\$48,200,000	PRESENT WORTH PROJECT COST	\$361,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,982,069	PRESENT WORTH O&M COSTS	\$53,182,069	PRESENT WORTH TOTAL PROJECT COST
1.50 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
	0.500	2	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
	0.100	10	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
	0.040	25	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
	0.020	50	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
	0.010	100	\$63,169,593	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,866				
	0.500	2	\$4,573,605	\$4,052,736	\$2,025,963	\$2,025,963	
	0.100	10	\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,867	
	0.040	25	\$12,936,003	\$11,478,461	\$688,708	\$5,633,575	
	0.020	50	\$16,050,214	\$14,493,109	\$289,862	\$5,923,437	7.00% INTEREST RATE
	0.010	100	\$63,169,593	\$39,609,904	\$396,099	\$6,319,536	50 YEARS
							\$87,214,313 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,390				
	0.500	2	\$3,417,403	\$2,928,896	\$1,435,449	\$1,435,449	
	0.100	10	\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,583	
	0.040	25	\$20,545,473	\$16,444,369	\$986,662	\$5,574,245	
	0.020	50	\$31,239,550	\$25,892,511	\$517,850	\$6,092,095	7.00% INTEREST RATE
	0.010	100	\$0	\$15,619,775	\$156,198	\$6,248,293	50 YEARS
							\$86,231,109 PRESENT WORTH

4 - 60" Pumps and Inflatable Dam			
\$56,700,000	PRESENT WORTH PROJECT COST	\$389,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,368,490	PRESENT WORTH O&M COSTS	\$62,068,490	PRESENT WORTH TOTAL PROJECT COST
		1.39 B/C RATIO	

4 - 60" Pumps and Obermeyer Gate			
\$52,500,000	PRESENT WORTH PROJECT COST	\$365,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,037,272	PRESENT WORTH O&M COSTS	\$57,537,272	PRESENT WORTH TOTAL PROJECT COST
		1.50 B/C RATIO	

4 - 60" Pumps and Steel Gate			
\$49,500,000	PRESENT WORTH PROJECT COST	\$361,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,982,069	PRESENT WORTH O&M COSTS	\$54,482,069	PRESENT WORTH TOTAL PROJECT COST
		1.58 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 100yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
		0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.500	2		\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
		0.40	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.100	10		\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
		0.06	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
0.040	25		\$63,169,593				\$173,841,588 PRESENT WORTH
0.020	50						
0.010	100						
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 100yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,866				
		0.50	\$4,573,605	\$4,052,736	\$2,025,963	\$2,025,963	
0.500	2		\$10,020,918	\$7,297,261	\$2,918,905	\$4,944,867	
		0.4	\$11,478,461	\$11,478,461	\$688,708	\$5,633,575	
0.100	10		\$12,936,003	\$14,493,109	\$289,862	\$5,923,437	7.00% INTEREST RATE
		0.06	\$16,050,214	\$18,773,607	\$187,736	\$6,111,173	50 YEARS
0.040	25		\$21,497,001				\$84,338,748 PRESENT WORTH
0.020	50						
0.010	100						
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-60" PUMPS - 100yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,390				
		0.49	\$3,417,403	\$2,928,896	\$1,435,449	\$1,435,449	
0.500	2		\$12,343,266	\$7,880,335	\$3,152,134	\$4,587,583	
		0.4	\$20,545,473	\$16,444,369	\$986,662	\$5,574,245	
0.100	10		\$31,239,550	\$25,892,511	\$517,850	\$6,092,095	7.00% INTEREST RATE
		0.06	\$36,456,071	\$36,456,071	\$364,561	\$6,456,656	50 YEARS
0.040	25		\$41,672,592				\$89,106,674 PRESENT WORTH
0.020	50						
0.010	100						

4 - 60" Pumps and Inflatable Dam	
\$57,600,000 PRESENT WORTH PROJECT COST	\$389,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,368,490 PRESENT WORTH O&M COSTS	\$62,968,490 PRESENT WORTH TOTAL PROJECT COST
1.42 B/C RATIO	

4 - 60" Pumps and Obermeyer Gate	
\$52,500,000 PRESENT WORTH PROJECT COST	\$365,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$5,037,272 PRESENT WORTH O&M COSTS	\$57,537,272 PRESENT WORTH TOTAL PROJECT COST
1.55 B/C RATIO	

4 - 60" Pumps and Steel Gate	
\$50,500,000 PRESENT WORTH PROJECT COST	\$361,000 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$4,982,069 PRESENT WORTH O&M COSTS	\$55,482,069 PRESENT WORTH TOTAL PROJECT COST
1.61 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
		0.50		\$6,981,632	\$3,490,118	\$3,490,118	
0.500	2		\$7,991,008				
		0.40		\$15,177,596	\$6,071,038	\$9,561,156	
0.100	10		\$22,364,184				
		0.06		\$27,922,830	\$1,675,370	\$11,236,526	
0.040	25		\$33,481,476				
		0.02		\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.020	50		\$47,289,764				50 YEARS
		0.01		\$55,229,679	\$552,297	\$12,596,535	\$173,841,588 PRESENT WORTH
0.010	100		\$63,169,593				
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,810				
		0.50		\$4,052,806	\$2,025,998	\$2,025,998	
0.500	2		\$4,573,802				
		0.4		\$13,468,993	\$5,387,597	\$7,413,595	
0.100	10		\$22,364,184				
		0.06		\$27,922,830	\$1,675,370	\$9,088,965	
0.040	25		\$33,481,476				
		0.02		\$40,385,620	\$807,712	\$9,896,677	7.00% INTEREST RATE
0.020	50		\$47,289,764				50 YEARS
		0.01		\$55,229,679	\$552,297	\$10,448,974	\$144,203,636 PRESENT WORTH
0.010	100		\$63,169,593				
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 2yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,446				
		0.49		\$2,928,826	\$1,435,415	\$1,435,415	
0.500	2		\$3,417,206				
		0.4		\$1,708,603	\$683,441	\$2,118,856	
0.100	10		\$0				
		0.06		\$0	\$0	\$2,118,856	
0.040	25		\$0				
		0.02		\$0	\$0	\$2,118,856	7.00% INTEREST RATE
0.020	50		\$0				50 YEARS
		0.01		\$0	\$0	\$2,118,856	\$29,241,795 PRESENT WORTH
0.010	100		\$0				

4 - 96" Pumps and Inflatable Dam			
\$79,900,000	PRESENT WORTH PROJECT COST	\$494,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,817,569	PRESENT WORTH O&M COSTS	\$86,717,569	PRESENT WORTH TOTAL PROJECT COST
0.34 B/C RATIO			

4 - 96" Pumps and Obermeyer Gate			
\$76,500,000	PRESENT WORTH PROJECT COST	\$470,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,486,351	PRESENT WORTH O&M COSTS	\$82,986,351	PRESENT WORTH TOTAL PROJECT COST
0.35 B/C RATIO			

4 - 96" Pumps and Steel Gate			
\$74,300,000	PRESENT WORTH PROJECT COST	\$450,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,210,336	PRESENT WORTH O&M COSTS	\$80,510,336	PRESENT WORTH TOTAL PROJECT COST
0.36 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,810				
0.500	2	0.50	\$4,573,802	\$4,052,806	\$2,025,998	\$2,025,998	
0.100	10	0.4	\$10,020,418	\$7,297,110	\$2,918,844	\$4,944,842	
0.040	25	0.06	\$33,481,476	\$21,750,947	\$1,305,057	\$6,249,899	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$7,057,611	7.00% INTEREST RATE
0.010	100	0.01	\$55,229,679	\$55,229,679	\$552,297	\$7,609,908	50 YEARS
							\$105,022,406 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 10yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,446				
0.500	2	0.49	\$3,417,206	\$2,928,826	\$1,435,415	\$1,435,415	
0.100	10	0.4	\$12,343,766	\$7,880,486	\$3,152,194	\$4,587,609	
0.040	25	0.06	\$0	\$6,171,883	\$370,313	\$4,957,922	
0.020	50	0.02	\$0	\$0	\$0	\$4,957,922	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$0	\$0	\$4,957,922	50 YEARS
							\$68,423,026 PRESENT WORTH

4 - 96" Pumps and Inflatable Dam			
\$90,400,000	PRESENT WORTH PROJECT COST	\$494,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,817,569	PRESENT WORTH O&M COSTS	\$97,217,569	PRESENT WORTH TOTAL PROJECT COST
		0.70	B/C RATIO

4 - 96" Pumps and Obermeyer Gate			
\$84,100,000	PRESENT WORTH PROJECT COST	\$470,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,486,351	PRESENT WORTH O&M COSTS	\$90,586,351	PRESENT WORTH TOTAL PROJECT COST
		0.76	B/C RATIO

4 - 96" Pumps and Steel Gate			
\$81,500,000	PRESENT WORTH PROJECT COST	\$450,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,210,336	PRESENT WORTH O&M COSTS	\$87,710,336	PRESENT WORTH TOTAL PROJECT COST
		0.78	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
0.500	2	0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.100	10	0.40	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
0.040	25	0.06	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.020	50	0.02	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
0.010	100	0.01	\$63,169,593	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,810				
0.500	2	0.50	\$4,573,802	\$4,052,806	\$2,025,998	\$2,025,998	
0.100	10	0.4	\$10,020,418	\$7,297,110	\$2,918,844	\$4,944,842	
0.040	25	0.06	\$12,929,730	\$11,475,074	\$688,504	\$5,633,346	
0.020	50	0.02	\$47,289,764	\$30,109,747	\$602,195	\$6,235,541	7.00% INTEREST RATE
0.010	100	0.01	\$63,169,593	\$55,229,679	\$552,297	\$6,787,838	50 YEARS
							\$93,677,228 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 25yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,446				
0.500	2	0.49	\$3,417,206	\$2,928,826	\$1,435,415	\$1,435,415	
0.100	10	0.4	\$12,343,766	\$7,880,486	\$3,152,194	\$4,587,609	
0.040	25	0.06	\$20,551,746	\$16,447,756	\$986,865	\$5,574,475	
0.020	50	0.02	\$0	\$10,275,873	\$205,517	\$5,779,992	7.00% INTEREST RATE
0.010	100	0.01	\$0	\$0	\$0	\$5,779,992	50 YEARS
							\$79,768,203 PRESENT WORTH

4 - 96" Pumps and Inflatable Dam			
\$92,200,000	PRESENT WORTH PROJECT COST	\$494,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,817,569	PRESENT WORTH O&M COSTS	\$99,017,569	PRESENT WORTH TOTAL PROJECT COST
0.81 B/C RATIO			

4 - 96" Pumps and Obermeyer Gate			
\$85,700,000	PRESENT WORTH PROJECT COST	\$470,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,486,351	PRESENT WORTH O&M COSTS	\$92,186,351	PRESENT WORTH TOTAL PROJECT COST
0.87 B/C RATIO			

4 - 96" Pumps and Steel Gate			
\$84,000,000	PRESENT WORTH PROJECT COST	\$450,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,210,336	PRESENT WORTH O&M COSTS	\$90,210,336	PRESENT WORTH TOTAL PROJECT COST
0.88 B/C RATIO			

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
	0.500	2	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
	0.100	10	\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
	0.040	25	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
	0.020	50	\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
	0.010	100	\$63,169,593	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
							\$173,841,588 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,810				
	0.500	2	\$4,573,802	\$4,052,806	\$2,025,998	\$2,025,998	
	0.100	10	\$10,020,418	\$7,297,110	\$2,918,844	\$4,944,842	
	0.040	25	\$12,929,730	\$11,475,074	\$688,504	\$5,633,346	
	0.020	50	\$15,981,365	\$14,455,547	\$289,111	\$5,922,457	7.00% INTEREST RATE
	0.010	100	\$63,169,593	\$39,575,479	\$395,755	\$6,318,212	50 YEARS
							\$87,196,039 PRESENT WORTH
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 50yr SURGE							
PROJ NO:		DESIGNER: JDM			DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,446				
	0.500	2	\$3,417,206	\$2,928,826	\$1,435,415	\$1,435,415	
	0.100	10	\$12,343,766	\$7,880,486	\$3,152,194	\$4,587,609	
	0.040	25	\$20,551,746	\$16,447,756	\$986,865	\$5,574,475	
	0.020	50	\$31,308,399	\$25,930,073	\$518,601	\$6,093,076	7.00% INTEREST RATE
	0.010	100	\$0	\$15,654,199	\$156,542	\$6,249,618	50 YEARS
							\$86,249,392 PRESENT WORTH

4 - 96" Pumps and Inflatable Dam			
\$93,800,000	PRESENT WORTH PROJECT COST	\$494,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,817,569	PRESENT WORTH O&M COSTS	\$100,617,569	PRESENT WORTH TOTAL PROJECT COST
		0.86	B/C RATIO

4 - 96" Pumps and Obermeyer Gate			
\$87,200,000	PRESENT WORTH PROJECT COST	\$470,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,486,351	PRESENT WORTH O&M COSTS	\$93,686,351	PRESENT WORTH TOTAL PROJECT COST
		0.92	B/C RATIO

4 - 96" Pumps and Steel Gate			
\$84,000,000	PRESENT WORTH PROJECT COST	\$450,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,210,336	PRESENT WORTH O&M COSTS	\$90,210,336	PRESENT WORTH TOTAL PROJECT COST
		0.96	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 100yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,972,256				
		0.50	\$7,991,008	\$6,981,632	\$3,490,118	\$3,490,118	
0.500	2		\$22,364,184	\$15,177,596	\$6,071,038	\$9,561,156	
		0.40	\$33,481,476	\$27,922,830	\$1,675,370	\$11,236,526	
0.100	10		\$47,289,764	\$40,385,620	\$807,712	\$12,044,239	7.00% INTEREST RATE
		0.06	\$55,229,679	\$55,229,679	\$552,297	\$12,596,535	50 YEARS
0.040	25		\$63,169,593				\$173,841,588 PRESENT WORTH
0.020	50						
0.010	100						
0.99							

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 100yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$3,531,810				
		0.50	\$4,573,802	\$4,052,806	\$2,025,998	\$2,025,998	
0.500	2		\$10,020,418	\$7,297,110	\$2,918,844	\$4,944,842	
		0.4	\$11,475,074	\$11,475,074	\$688,504	\$5,633,346	
0.100	10		\$12,929,730	\$14,455,547	\$289,111	\$5,922,457	7.00% INTEREST RATE
		0.06	\$15,981,365	\$18,528,329	\$185,283	\$6,107,740	50 YEARS
0.040	25		\$21,075,294				\$84,291,376 PRESENT WORTH
0.020	50						
0.010	100						
0.99							

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 4-96" PUMPS - 100yr SURGE							
PROJ NO: DESIGNER: JDM DATE: 27-Apr-11							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$2,440,446				
		0.49	\$3,417,206	\$2,928,826	\$1,435,415	\$1,435,415	
0.500	2		\$12,343,766	\$7,880,486	\$3,152,194	\$4,587,609	
		0.4	\$20,551,746	\$16,447,756	\$986,865	\$5,574,475	
0.100	10		\$31,308,399	\$25,930,073	\$518,601	\$6,093,076	7.00% INTEREST RATE
		0.06	\$36,701,349	\$36,701,349	\$367,013	\$6,460,089	50 YEARS
0.040	25		\$42,094,299				\$89,154,056 PRESENT WORTH
0.020	50						
0.010	100						

4 - 96" Pumps and Inflatable Dam			
\$94,100,000	PRESENT WORTH PROJECT COST	\$494,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,817,569	PRESENT WORTH O&M COSTS	\$100,917,569	PRESENT WORTH TOTAL PROJECT COST
		0.88	B/C RATIO

4 - 96" Pumps and Obermeyer Gate			
\$88,500,000	PRESENT WORTH PROJECT COST	\$470,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,486,351	PRESENT WORTH O&M COSTS	\$94,986,351	PRESENT WORTH TOTAL PROJECT COST
		0.94	B/C RATIO

4 - 96" Pumps and Steel Gate			
\$85,000,000	PRESENT WORTH PROJECT COST	\$450,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,210,336	PRESENT WORTH O&M COSTS	\$91,210,336	PRESENT WORTH TOTAL PROJECT COST
		0.98	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 2-yr Bulkhead - SURGE				DATE:		27-Apr-11
PROJ NO:		DESIGNER: JDM				DATE:		27-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$5,435,078					
		0.50		\$6,713,043	\$3,355,850	\$3,355,850		
0.500	2		\$7,991,008					
		0.40		\$15,177,596	\$6,071,038	\$9,426,889		
0.100	10		\$22,364,184					
		0.06		\$27,922,830	\$1,675,370	\$11,102,259		
0.040	25		\$33,481,476					
		0.02		\$40,385,620	\$807,712	\$11,909,971		
0.020	50		\$47,289,764					
		0.01		\$55,229,679	\$552,297	\$12,462,268		
0.010	100		\$63,169,593					
		0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WOI
\$171,988,595

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 2-yr Bulkhead - SURGE				DATE:		27-Apr-11
PROJ NO:		DESIGNER: JDM				DATE:		27-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$4,763,445					
		0.50		\$5,529,936	\$2,764,415	\$2,764,415		
0.500	2		\$6,296,428					
		0.4		\$14,330,306	\$5,732,122	\$8,496,538		
0.100	10		\$22,364,184					
		0.06		\$27,922,830	\$1,675,370	\$10,171,907		
0.040	25		\$33,481,476					
		0.02		\$40,385,620	\$807,712	\$10,979,620		
0.020	50		\$47,289,764					
		0.01		\$55,229,679	\$552,297	\$11,531,917		
0.010	100		\$63,169,593					
		0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WOI
\$159,149,055

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 2-yr Bulkhead - SURGE				DATE:		27-Apr-11
PROJ NO:		DESIGNER: JDM				DATE:		27-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION		
0.990	1		\$671,633					
		0.49		\$1,183,107	\$579,839	\$579,839		
0.500	2		\$1,694,580					
		0.4		\$847,290	\$338,916	\$918,756		
0.100	10		\$0					
		0.06		\$0	\$0	\$918,756		
0.040	25		\$0					
		0.02		\$0	\$0	\$918,756		
0.020	50		\$0					
		0.01		\$0	\$0	\$918,756		
0.010	100		\$0					

7.00% INTEREST RATE
50 YEARS
PRESENT WOI
\$12,679,512

Bulkhead/Berm Options

\$55,500,000	PRESENT WORTH PROJECT COST	\$277,500	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$3,829,707	PRESENT WORTH O&M COSTS	\$59,329,707	PRESENT WORTH TOTAL PROJECT COST
		0.21	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 10-yr Bulkhead - SURGE		DESIGNER: JDM		DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	SUMMATION
1.000	1		\$5,435,078			
		0.50		\$6,713,043	\$3,355,850	\$3,355,850
0.500	2		\$7,991,008			
		0.40		\$15,177,596	\$6,071,038	\$9,426,889
0.100	10		\$22,364,184			
		0.06		\$27,922,830	\$1,675,370	\$11,102,259
0.040	25		\$33,481,476			
		0.02		\$40,385,620	\$807,712	\$11,909,971
0.020	50		\$47,289,764			
		0.01		\$55,229,679	\$552,297	\$12,462,268
0.010	100		\$63,169,593			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$171,988,595

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 10-yr Bulkhead - SURGE		DESIGNER: JDM		DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	SUMMATION
1.000	1		\$4,763,445			
		0.50		\$5,529,936	\$2,764,415	\$2,764,415
0.500	2		\$6,296,428			
		0.4		\$10,248,966	\$4,099,587	\$6,864,002
0.100	10		\$14,201,505			
		0.06		\$23,841,491	\$1,430,489	\$8,294,491
0.040	25		\$33,481,476			
		0.02		\$40,385,620	\$807,712	\$9,102,204
0.020	50		\$47,289,764			
		0.01		\$55,229,679	\$552,297	\$9,654,500
0.010	100		\$63,169,593			
0.99						

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$133,239,311

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE - 10-yr Bulkhead - SURGE		DESIGNER: JDM		DATE: 27-Apr-11		
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	SUMMATION
0.990	1		\$671,633			
		0.49		\$1,183,107	\$579,839	\$579,839
0.500	2		\$1,694,580			
		0.4		\$4,928,630	\$1,971,452	\$2,551,291
0.100	10		\$8,162,679			
		0.06		\$4,081,339	\$244,880	\$2,796,172
0.040	25		\$0			
		0.02		\$0	\$0	\$2,796,172
0.020	50		\$0			
		0.01		\$0	\$0	\$2,796,172
0.010	100		\$0			

7.00% INTEREST RATE
50 YEARS
PRESENT WORTH \$38,589,256

Bulkhead/Berm Options	
\$94,700,000 PRESENT WORTH PROJECT COST	\$473,500 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$6,534,653 PRESENT WORTH O&M COSTS	\$101,234,653 PRESENT WORTH TOTAL PROJECT COST
0.38 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 25-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY	RETURN	INTERVAL	DAMAGES	AVERAGE	EXPECTED ANNUAL DAMAGES	INTERVAL	SUMMATION		
%	PERIOD			DAMAGES					
1.000	1		\$5,435,078						
		0.50		\$6,713,043	\$3,355,850		\$3,355,850		
0.500	2		\$7,991,008						
		0.40		\$15,177,596	\$6,071,038		\$9,426,889		
0.100	10		\$22,364,184						
		0.06		\$27,922,830	\$1,675,370		\$11,102,259		
0.040	25		\$33,481,476						
		0.02		\$40,385,620	\$807,712		\$11,909,971	7.00% INTEREST RATE	
0.020	50		\$47,289,764					50 YEARS	
		0.01		\$55,229,679	\$552,297		\$12,462,268	PRESENT WORTH	
0.010	100		\$63,169,593						
0.99									

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 25-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY	RETURN	INTERVAL	DAMAGES	AVERAGE	EXPECTED ANNUAL DAMAGES	INTERVAL	SUMMATION		
%	PERIOD			DAMAGES					
1.000	1		\$4,763,445						
		0.50		\$5,529,936	\$2,764,415		\$2,764,415		
0.500	2		\$6,296,428						
		0.4		\$10,248,966	\$4,099,587		\$6,864,002		
0.100	10		\$14,201,505						
		0.06		\$16,983,727	\$1,019,024		\$7,883,025		
0.040	25		\$19,765,950						
		0.02		\$33,527,857	\$670,557		\$8,553,583	7.00% INTEREST RATE	
0.020	50		\$47,289,764					50 YEARS	
		0.01		\$55,229,679	\$552,297		\$9,105,879	PRESENT WORTH	
0.010	100		\$63,169,593						
0.99									

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 25-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY	RETURN	INTERVAL	BENEFITS	AVERAGE	EXPECTED ANNUAL BENEFITS	INTERVAL	SUMMATION		
%	PERIOD			BENEFITS					
0.990	1		\$671,633						
		0.49		\$1,183,107	\$579,839		\$579,839		
0.500	2		\$1,694,580						
		0.4		\$4,928,630	\$1,971,452		\$2,551,291		
0.100	10		\$8,162,679						
		0.06		\$10,939,103	\$656,346		\$3,207,637		
0.040	25		\$13,715,526						
		0.02		\$6,857,763	\$137,155		\$3,344,793	7.00% INTEREST RATE	
0.020	50		\$0					50 YEARS	
		0.01		\$0	\$0	\$0	\$3,344,793	PRESENT WORTH	
0.010	100		\$0						

Bulkhead/Berm Options			
\$117,400,000	PRESENT WORTH PROJECT COST	\$587,000	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$8,101,038	PRESENT WORTH O&M COSTS	\$125,501,038	PRESENT WORTH TOTAL PROJECT COST
		0.37	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 50-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY	RETURN	INTERVAL	DAMAGES	AVERAGE	EXPECTED ANNUAL DAMAGES	INTERVAL	SUMMATION		
%	PERIOD			DAMAGES					
1.000	1		\$5,435,078						
		0.50		\$6,713,043	\$3,355,850		\$3,355,850		
0.500	2		\$7,991,008						
		0.40		\$15,177,596	\$6,071,038		\$9,426,889		
0.100	10		\$22,364,184						
		0.06		\$27,922,830	\$1,675,370		\$11,102,259		
0.040	25		\$33,481,476						
		0.02		\$40,385,620	\$807,712		\$11,909,971	7.00% INTEREST RATE	
0.020	50		\$47,289,764					50 YEARS	
		0.01		\$55,229,679	\$552,297		\$12,462,268	\$171,988,595 PRESENT WORTH	
0.010	100		\$63,169,593						
0.99									

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 50-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY	RETURN	INTERVAL	DAMAGES	AVERAGE	EXPECTED ANNUAL DAMAGES	INTERVAL	SUMMATION		
%	PERIOD			DAMAGES					
1.000	1		\$4,763,445						
		0.50		\$5,529,936	\$2,764,415		\$2,764,415		
0.500	2		\$6,296,428						
		0.4		\$10,248,966	\$4,099,587		\$6,864,002		
0.100	10		\$14,201,505						
		0.06		\$16,983,727	\$1,019,024		\$7,883,025		
0.040	25		\$19,765,950						
		0.02		\$22,925,105	\$458,502		\$8,341,528	7.00% INTEREST RATE	
0.020	50		\$26,084,259					50 YEARS	
		0.01		\$44,626,926	\$446,269		\$8,787,797	\$121,278,154 PRESENT WORTH	
0.010	100		\$63,169,593						
0.99									

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 50-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY	RETURN	INTERVAL	BENEFITS	AVERAGE	EXPECTED ANNUAL BENEFITS	INTERVAL	SUMMATION		
%	PERIOD			BENEFITS					
0.990	1		\$671,633						
		0.49		\$1,183,107	\$579,839		\$579,839		
0.500	2		\$1,694,580						
		0.4		\$4,928,630	\$1,971,452		\$2,551,291		
0.100	10		\$8,162,679						
		0.06		\$10,939,103	\$656,346		\$3,207,637		
0.040	25		\$13,715,526						
		0.02		\$17,460,515	\$349,210		\$3,556,848	7.00% INTEREST RATE	
0.020	50		\$21,205,505					50 YEARS	
		0.01		\$10,602,752	\$106,028		\$3,662,875	\$50,550,412 PRESENT WORTH	
0.010	100		\$0						

Bulkhead/Berm Options			
\$154,500,000	PRESENT WORTH PROJECT COST	\$772,500	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$10,661,077	PRESENT WORTH O&M COSTS	\$165,161,077	PRESENT WORTH TOTAL PROJECT COST
		0.31	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 100-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION			
1.000	1		\$5,435,078						
		0.50		\$6,713,043	\$3,355,850	\$3,355,850			
0.500	2		\$7,991,008						
		0.40		\$15,177,596	\$6,071,038	\$9,426,889			
0.100	10		\$22,364,184						
		0.06		\$27,922,830	\$1,675,370	\$11,102,259			
0.040	25		\$33,481,476						
		0.02		\$40,385,620	\$807,712	\$11,909,971		7.00% INTEREST RATE	
0.020	50		\$47,289,764					50 YEARS	
		0.01		\$55,229,679	\$552,297	\$12,462,268		PRESENT WORTH	\$171,988,595
0.010	100		\$63,169,593						
0.99									

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 100-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION			
1.000	1		\$4,763,445						
		0.50		\$5,529,936	\$2,764,415	\$2,764,415			
0.500	2		\$6,296,428						
		0.4		\$10,248,966	\$4,099,587	\$6,864,002			
0.100	10		\$14,201,505						
		0.06		\$16,983,727	\$1,019,024	\$7,883,025			
0.040	25		\$19,765,950						
		0.02		\$22,925,105	\$458,502	\$8,341,528		7.00% INTEREST RATE	
0.020	50		\$26,084,259					50 YEARS	
		0.01		\$29,542,036	\$295,420	\$8,636,948		PRESENT WORTH	\$119,196,327
0.010	100		\$32,999,812						
0.99									

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE - 100-yr Bulkhead - SURGE				DATE:		27-Apr-11	
PROJ NO:		DESIGNER: JDM							
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION			
0.990	1		\$671,633						
		0.49		\$1,183,107	\$579,839	\$579,839			
0.500	2		\$1,694,580						
		0.4		\$4,928,630	\$1,971,452	\$2,551,291			
0.100	10		\$8,162,679						
		0.06		\$10,939,103	\$656,346	\$3,207,637			
0.040	25		\$13,715,526						
		0.02		\$17,460,515	\$349,210	\$3,556,848		7.00% INTEREST RATE	
0.020	50		\$21,205,505					50 YEARS	
		0.01		\$25,687,643	\$256,876	\$3,813,724		PRESENT WORTH	\$52,632,240
0.010	100		\$30,169,781						

Bulkhead/Berm Options			
\$189,700,000	PRESENT WORTH PROJECT COST	\$948,500	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$13,090,008	PRESENT WORTH O&M COSTS	\$202,790,008	PRESENT WORTH TOTAL PROJECT COST
		0.26	B/C RATIO

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$5,435,078		
		0.50		\$6,713,043	\$3,355,850
0.500	2		\$7,991,008		
		0.40		\$15,177,596	\$6,071,038
0.100	10		\$22,364,184		
		0.06		\$27,922,830	\$1,675,370
0.040	25		\$33,481,476		
		0.02		\$40,385,620	\$807,712
0.020	50		\$47,289,764		
		0.01		\$55,229,679	\$552,297
0.010	100		\$63,169,593		
		0.99			

7.00% INTEREST RATE
50 YEARS
\$171,988,595 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$2,924,079		
		0.50		\$3,748,376	\$1,873,813
0.500	2		\$4,572,673		
		0.4		\$10,869,581	\$4,347,832
0.100	10		\$17,166,489		
		0.06		\$22,276,316	\$1,336,579
0.040	25		\$27,386,144		
		0.02		\$33,947,024	\$678,940
0.020	50		\$40,507,904		
		0.01		\$48,157,487	\$481,575
0.010	100		\$55,807,070		
		0.99			

7.00% INTEREST RATE
50 YEARS
\$120,325,117 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$2,510,999		
		0.49		\$2,964,667	\$1,452,981
0.500	2		\$3,418,335		
		0.4		\$4,308,015	\$1,723,206
0.100	10		\$5,197,695		
		0.06		\$5,646,514	\$338,791
0.040	25		\$6,095,332		
		0.02		\$6,438,596	\$128,772
0.020	50		\$6,781,860		
		0.01		\$7,072,192	\$70,722
0.010	100		\$7,362,523		

7.00% INTEREST RATE
50 YEARS
\$51,262,474 PRESENT WORTH

Pretty Lake Buyout 20% Damage Level 2yr	
\$50,366,925 PRESENT WORTH PROJECT COST	\$554,036 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$7,646,113 PRESENT WORTH O&M COSTS	\$58,013,038 PRESENT WORTH TOTAL PROJECT COST
0.88 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$5,435,078		
		0.50		\$6,713,043	\$3,355,850
0.500	2		\$7,991,008		
		0.40		\$15,177,596	\$6,071,038
0.100	10		\$22,364,184		
		0.06		\$27,922,830	\$1,675,370
0.040	25		\$33,481,476		
		0.02		\$40,385,620	\$807,712
0.020	50		\$47,289,764		
		0.01		\$55,229,679	\$552,297
0.010	100		\$63,169,593		
		0.99			

7.00% INTEREST RATE
50 YEARS
\$171,988,595 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$1,943,308		
		0.50		\$2,194,889	\$1,097,225
0.500	2		\$2,446,471		
		0.4		\$6,413,889	\$2,565,556
0.100	10		\$10,381,307		
		0.06		\$14,294,172	\$857,650
0.040	25		\$18,207,036		
		0.02		\$23,866,695	\$477,334
0.020	50		\$29,526,355		
		0.01		\$36,382,149	\$363,821
0.010	100		\$43,237,944		
		0.99			

7.00% INTEREST RATE
50 YEARS
\$73,993,895 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$3,491,771		
		0.49		\$4,518,154	\$2,214,343
0.500	2		\$5,544,537		
		0.4		\$8,763,707	\$3,505,483
0.100	10		\$11,982,877		
		0.06		\$13,628,658	\$817,720
0.040	25		\$15,274,440		
		0.02		\$16,518,925	\$330,378
0.020	50		\$17,763,409		
		0.01		\$18,847,529	\$188,475
0.010	100		\$19,931,649		

7.00% INTEREST RATE
50 YEARS
\$97,383,570 PRESENT WORTH

Pretty Lake Buyout 20% Damage Level 10yr			
\$174,241,900	PRESENT WORTH PROJECT COST	\$1,916,661	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$26,451,351	PRESENT WORTH O&M COSTS	\$200,693,251	PRESENT WORTH TOTAL PROJECT COST
	0.49 B/C RATIO		

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE							
PROJ NO: DESIGNER: JDM							DATE: 27-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$5,435,078				
		0.50		\$6,713,043	\$3,355,850	\$3,355,850	
0.500	2		\$7,991,008				
		0.40		\$15,177,596	\$6,071,038	\$9,426,889	
0.100	10		\$22,364,184				
		0.06		\$27,922,830	\$1,675,370	\$11,102,259	
0.040	25		\$33,481,476				
		0.02		\$40,385,620	\$807,712	\$11,909,971	7.00% INTEREST RA
0.020	50		\$47,289,764				50 YEARS
		0.01		\$55,229,679	\$552,297	\$12,462,268	\$171,988,595 PRESENT WO
0.010	100		\$63,169,593				
		0.99					

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE							
PROJ NO: DESIGNER: JDM							DATE: 27-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION	
1.000	1		\$1,652,770				
		0.50		\$1,805,826	\$902,733	\$902,733	
0.500	2		\$1,958,883				
		0.4		\$4,572,395	\$1,828,958	\$2,731,691	
0.100	10		\$7,185,908				
		0.06		\$9,812,117	\$588,727	\$3,320,418	
0.040	25		\$12,438,327				
		0.02		\$17,244,843	\$344,897	\$3,665,315	7.00% INTEREST RA
0.020	50		\$22,051,358				50 YEARS
		0.01		\$28,140,275	\$281,403	\$3,946,717	\$54,467,646 PRESENT WO
0.010	100		\$34,229,192				
		0.99					

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE							
PROJ NO: DESIGNER: JDM							DATE: 27-Apr-11
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION	
0.990	1		\$3,782,308				
		0.49		\$4,907,217	\$2,405,022	\$2,405,022	
0.500	2		\$6,032,125				
		0.4		\$10,605,201	\$4,242,080	\$6,647,102	
0.100	10		\$15,178,276				
		0.06		\$18,110,713	\$1,086,643	\$7,733,745	
0.040	25		\$21,043,149				
		0.02		\$23,140,777	\$462,816	\$8,196,561	7.00% INTEREST RA
0.020	50		\$25,238,406				50 YEARS
		0.01		\$27,089,403	\$270,894	\$8,467,455	\$116,857,193 PRESENT WO
0.010	100		\$28,940,401				

Pretty Lake Buyout 20% Damage Level 25yr

\$265,390,650	PRESENT WORTH PROJECT COST	\$2,919,297	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$40,288,479	PRESENT WORTH O&M COSTS	\$305,679,129	PRESENT WORTH TOTAL PROJECT COST
	0.38	B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$5,435,078		
		0.50		\$6,713,043	\$3,355,850
0.500	2		\$7,991,008		
		0.40		\$15,177,596	\$6,071,038
0.100	10		\$22,364,184		
		0.06		\$27,922,830	\$1,675,370
0.040	25		\$33,481,476		
		0.02		\$40,385,620	\$807,712
0.020	50		\$47,289,764		
		0.01		\$55,229,679	\$552,297
0.010	100		\$63,169,593		
		0.99			

7.00% INTEREST RATE
50 YEARS
\$171,988,595 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES SUMMATION
1.000	1		\$1,539,669		
		0.50		\$1,667,008	\$833,338
0.500	2		\$1,794,347		
		0.4		\$3,627,275	\$1,450,910
0.100	10		\$5,460,202		
		0.06		\$7,065,767	\$423,946
0.040	25		\$8,671,331		
		0.02		\$12,448,830	\$248,977
0.020	50		\$16,226,329		
		0.01		\$21,438,017	\$214,380
0.010	100		\$26,649,704		
		0.99			

7.00% INTEREST RATE
50 YEARS
\$43,769,760 PRESENT WORTH

**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT: CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE		DESIGNER: JDM		DATE: 27-Apr-11	
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS SUMMATION
0.990	1		\$3,895,409		
		0.49		\$5,046,035	\$2,473,057
0.500	2		\$6,196,661		
		0.4		\$11,550,321	\$4,620,128
0.100	10		\$16,903,982		
		0.06		\$20,857,063	\$1,251,424
0.040	25		\$24,810,145		
		0.02		\$27,936,790	\$558,736
0.020	50		\$31,063,435		
		0.01		\$33,791,662	\$337,917
0.010	100		\$36,519,889		

7.00% INTEREST RATE
50 YEARS
\$127,536,302 PRESENT WORTH

Pretty Lake Buyout 20% Damage Level 50yr	
\$356,736,888 PRESENT WORTH PROJECT COST	\$3,924,106 ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$54,155,588 PRESENT WORTH O&M COSTS	\$410,892,476 PRESENT WORTH TOTAL PROJECT COST
0.31 B/C RATIO	

**EXPECTED ANNUAL DAMAGES
EXISTING CONDITIONS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE				DATE:		27-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$5,435,078					
		0.50		\$6,713,043	\$3,355,850	\$3,355,850		
0.500	2		\$7,991,008					
		0.40		\$15,177,596	\$6,071,038	\$9,426,889		
0.100	10		\$22,364,184					
		0.06		\$27,922,830	\$1,675,370	\$11,102,259		
0.040	25		\$33,481,476					
		0.02		\$40,385,620	\$807,712	\$11,909,971	7.00% INTEREST RATE	
0.020	50		\$47,289,764				50 YEARS	
		0.01		\$55,229,679	\$552,297	\$12,462,268	\$171,988,595 PRESENT WORTH	
0.010	100		\$63,169,593					
		0.99						

**EXPECTED ANNUAL DAMAGES
RESIDUAL DAMAGES WITH PROJECT**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE				DATE:		27-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	DAMAGES	AVERAGE DAMAGES	EXPECTED ANNUAL DAMAGES INTERVAL	EXPECTED ANNUAL DAMAGES SUMMATION		
1.000	1		\$1,109,896					
		0.50		\$1,201,163	\$600,461	\$600,461		
0.500	2		\$1,292,429					
		0.4		\$2,827,981	\$1,131,192	\$1,731,654		
0.100	10		\$4,363,533					
		0.06		\$5,508,522	\$330,511	\$2,062,165		
0.040	25		\$6,653,511					
		0.02		\$9,495,602	\$189,912	\$2,252,077	7.00% INTEREST RATE	
0.020	50		\$12,337,693				50 YEARS	
		0.01		\$16,418,100	\$164,181	\$2,416,258	\$33,346,165 PRESENT WORTH	
0.010	100		\$20,498,507					
		0.99						

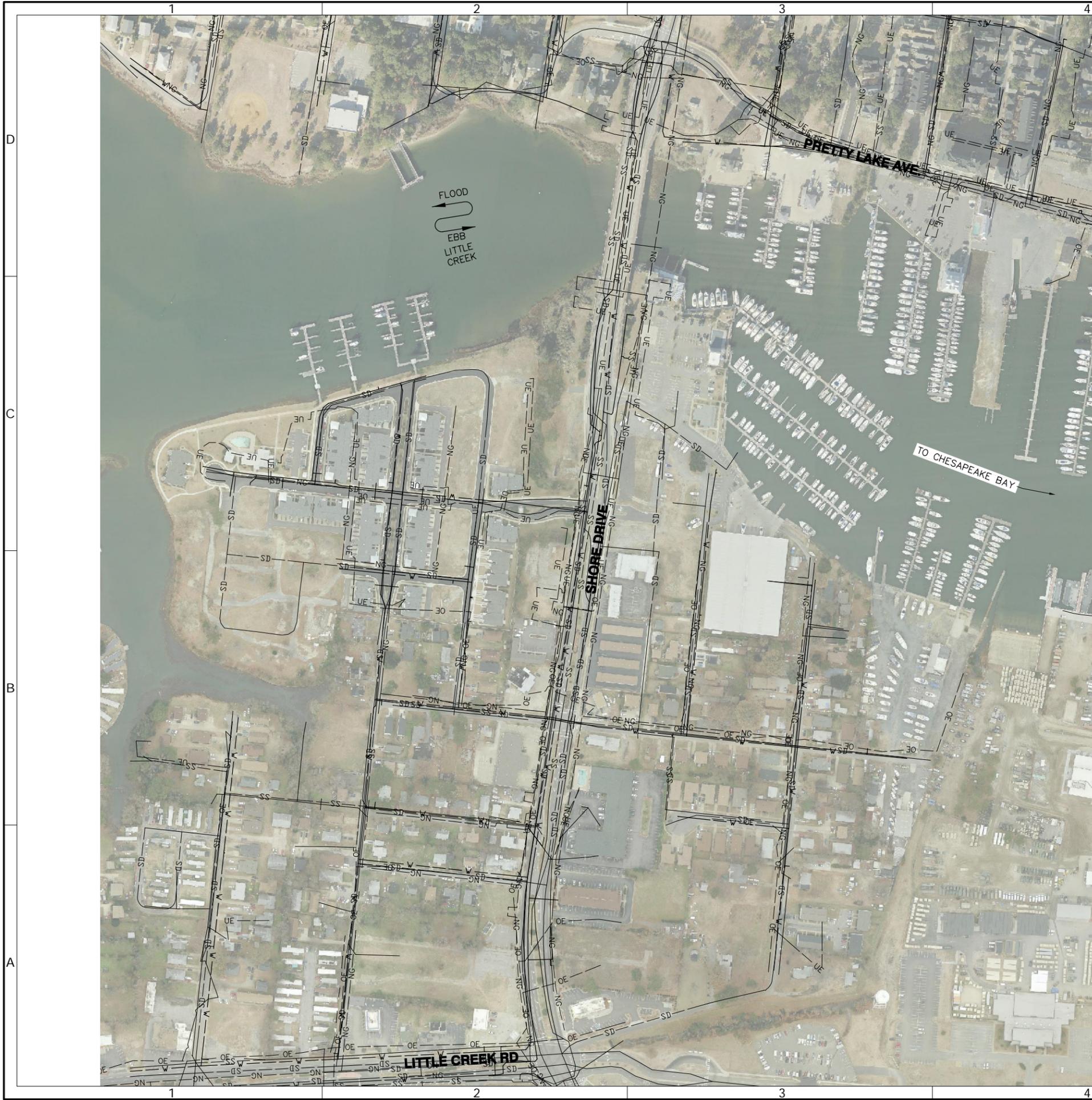
**EXPECTED ANNUAL DAMAGES
NET BENEFITS**

PROJECT:		CITY OF NORFOLK - PRETTY LAKE -20% Buyout - SURGE				DATE:		27-Apr-11
PROJ NO:		DESIGNER: JDM						
FREQUENCY %	RETURN PERIOD	INTERVAL	BENEFITS	AVERAGE BENEFITS	EXPECTED ANNUAL BENEFITS INTERVAL	EXPECTED ANNUAL BENEFITS SUMMATION		
0.990	1		\$4,325,182					
		0.49		\$5,511,880	\$2,701,367	\$2,701,367		
0.500	2		\$6,698,579					
		0.4		\$12,349,615	\$4,939,846	\$7,641,213		
0.100	10		\$18,000,651					
		0.06		\$22,414,308	\$1,344,858	\$8,986,072		
0.040	25		\$26,827,965					
		0.02		\$30,890,018	\$617,800	\$9,603,872	7.00% INTEREST RATE	
0.020	50		\$34,952,071				50 YEARS	
		0.01		\$38,811,578	\$388,116	\$9,991,988	\$137,896,887 PRESENT WORTH	
0.010	100		\$42,671,086					

Pretty Lake Buyout 20% Damage Level 100yr			
\$473,696,563	PRESENT WORTH PROJECT COST	\$5,210,662	ANNUAL OPERATION & MAINTENANCE (O&M) COSTS
\$71,911,027	PRESENT WORTH O&M COSTS	\$545,607,589	PRESENT WORTH TOTAL PROJECT COST
		0.25	B/C RATIO

APPENDIX E

PRELIMINARY (10% LEVEL) DESIGN PLANS AND SECTIONS



- LEGEND:**
- SD — STORM PIPES
 - SS — SANITARY SEWER
 - W — WATER
 - UE — UNDERGROUND ELECTRIC
 - OE — OVERHEAD ELECTRIC
 - NG — NATURAL GAS



PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Mark	Description	Date	Appr.

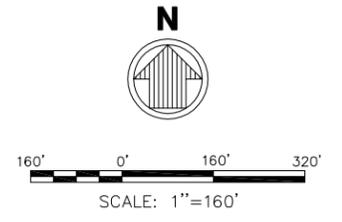
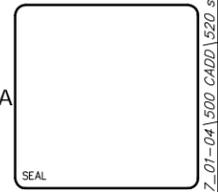
PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

EXISTING UTILITIES PLAN

Designed by: RJ	Date: MAR, 2012	Rev.:
Dwn by: BA	M&N 7607-02	
Reviewed by:	Drawing code:	
Submitted by: MOFFATT & NICHOL	Drawing Scale: NONE	
	Plot scale: 1:1 (0 SHEET)	

moffatt & nichol
800 WORLD TRADE CENTER
NORFOLK, VA 23510
757-628-8222

PREPARED FOR:
CLIENT OF PUBLIC WORKS
DEPARTMENT OF PUBLIC WORKS
ENVIRONMENTAL STORM WATER
MANAGEMENT DIVISION



DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

Sheet Reference Number:
V-102
Sheet - of -



LEGEND:
 ● BORING LOCATION

NOTE:
 1. BORINGS BY VDOT DATED 1999.



PRELIMINARY
 NOT TO BE USED FOR CONSTRUCTION

Mark	Description	Date	Appr.

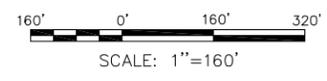
PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA
 SOIL BORING LOCATION PLAN

Date: MAR, 2012 Drawn by: RJ Designated by: RJ Own by: BA Reviewed by:	Rev: - Project No: 7607-02 Drawing code: Drawing Scale: NONE Plot scale: 1:1 (0 SHEET)
--	--

800 WORLD TRADE CENTER
 NORFOLK, VA 23510
 757-628-8222

moffatt & nichol

PREPARED FOR:
 CLIENT OF PUBLIC WORKS
 DEPARTMENT OF ENVIRONMENTAL STORM WATER
 MANAGEMENT DIVISION



DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING

SEAL

Sheet Reference Number:
GR-101
 Sheet - of -

CONCRETE AND REINFORCING STEEL:

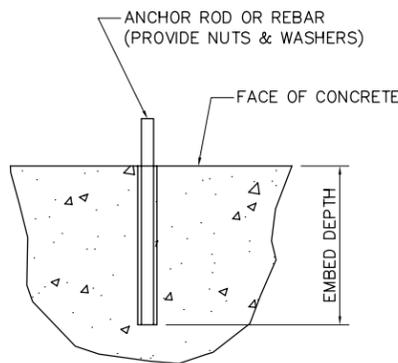
- ALL CONCRETE WORK SHALL BE PERFORMED IN ACCORDANCE WITH CURRENT ACI 301, UNLESS OTHERWISE NOTED.
- ALL CONCRETE SHALL BE NORMAL WEIGHT AND MARINE GRADE, UON.
- ALL DETAILING, FABRICATION, AND ERECTION OF REINFORCING STEEL SHALL CONFORM TO THE ACI MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES, ACI 315.
- ALL GROUT IS TO BE NON-METALLIC AND NONSHRINK (UON).
- MATERIALS SHALL CONFORM TO THE FOLLOWING, UNLESS OTHERWISE NOTED:
 - CONCRETE STRENGTH 28 DAY @ RELEASE
 - CAST-IN-PLACE CONCRETE 5000 PSI -
 - GROUT 8000 PSI -
 - PRESTRESSED CONCRETE PILES 6000 PSI 4000 PSI
 - REINFORCING STEEL
 - ALL MILD REINFORCING STEEL FOR CAST-IN-PLACE CONCRETE SHALL CONFORM TO ASTM A706 GRADE 60 AND SHALL BE HOT DIP GALVANIZED AFTER FABRICATION.
 - MILD STEEL SPIRALS SHALL CONFORM TO ASTM A82, GALVANIZED.
 - GALVANIZED REINFORCING STEEL SHALL COMPLY WITH ASTM A767/A767M, CLASS COATING.
 - ALL REINFORCING BAR SPLICES SHALL BE CLASS "B" TENSION LAP SPLICES, IN ACCORDANCE WITH ACI 318, CHAPTER 12 (UON).
 - PRESTRESSING STEEL FOR PRESTRESSED CONCRETE SHALL BE 7-WIRE, LOW RELAXATION STRANDS CONFORMING TO ASTM A416, GRADE 270, UNCOATED.
 - ALL MECHANICAL COUPLERS, HARDENED NUTS FOR REINFORCING STEEL SHALL DEVELOP 125 PERCENT OF YIELD STRENGTH IN TENSION FOR THE REINFORCING SIZE INDICATED AND SHALL BE COATED IN ACCORDANCE WITH THE SAME REQUIREMENTS AS REINFORCING BARS.
- CHAMFER ALL EXPOSED EXTERNAL CORNERS OF CONCRETE WITH 3/4", 45° CHAMFERS UNLESS OTHERWISE NOTED.
- MINIMUM CONCRETE COVER FOR REINFORCING SHALL BE 3" UNLESS OTHERWISE NOTED.
- ALL HORIZONTAL AND VERTICAL CONSTRUCTION JOINTS SHALL BE KEYED. ROUGHEN SURFACE OF HORIZONTAL CONSTRUCTION JOINTS TO 1/4" AMPLITUDE.

STRUCTURAL AND MISCELLANEOUS STEEL:

- ALL STEEL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE CURRENT AISC CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES.
- ALL WELDING SHALL CONFORM TO THE REQUIREMENTS OF CURRENT AWS D1.1
- STEEL MATERIALS SHALL CONFORM TO THE FOLLOWING, UNLESS OTHERWISE NOTED:
 - STRUCTURAL CARBON STEEL ASTM A36, A572, UON
 - MISC PLATES, BARS, AND SHAPES ASTM A36
 - W-SHAPES ASTM A992
 - STEEL SHEET PILES ASTM A572, GRADE 50
 - PIPE PILES ASTM A252, GRADE 3, fy = 50 KSI
 - SHEAR STUDS AWS D1.1 CLAUSE 7, STUD WELDING
- ALL STEEL SHAPES, PLATES, FASTENERS AND ALL OTHER STEEL HARDWARE SHALL BE HOT DIP GALVANIZED AFTER ASSEMBLY EXCEPT FOR PIPE PILES, STEEL SHEET PILES, GATE STRUCTURAL AND STAINLESS STEEL SHAPES AND HARDWARE, UNLESS OTHERWISE NOTED.
- STEEL PIPE PILE COMBINATION WALL SHALL HAVE THE FOLLOWING MINIMUM PROPERTIES:
 - SECTION MODULUS 236.5 IN.^3/FT
 - MOMENT OF INERTIA 6670 IN.^4/FT
 - WALL THICKNESS 3/4" NOMINAL
 - SYSTEM WIDTH 9'-9 5/8"
 - SYSTEM DEPTH 60" (MAXIMUM)
 - YIELD STRENGTH 50 KSI
- STEEL SHEET PILE CUTOFF WALL SHALL HAVE THE FOLLOWING MINIMUM PROPERTIES:
 - SECTION MODULUS 48.4 IN.^3/FT
 - MOMENT OF INERTIA 437.3 IN.^4/FT
 - WALL THICKNESS 1/2" NOMINAL
 - YIELD STRENGTH 50 KSI
- STEEL PIPE PILES, PIPE PILE COMBINATION WALL & GATE STRUCTURE SHALL BE COATED WITH 16 MIL COAL TAR EPOXY.
- STEEL PIPE PILE AND COMBINATION WALL INTERLOCKS/CONNECTORS SHALL BE SEALED.
- STRUCTURAL CARBON STEEL FASTENERS SHALL CONFORM TO THE REQUIREMENTS OF ASME/ANSI B 18.2.2 AND ASTM A325.
- ANCHOR BOLTS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F1554 GRADE 105, UNLESS OTHERWISE NOTED.
- ALL DAMAGED GALVANIZED FINISH SHALL BE FIELD TREATED WITH TWO COATS OF HIGH ZINC OXIDE PAINT, COLD GALVANIZING COMPOUNDS, OR APPROVED EQUAL CONFORMING TO ASTM A780. ALL EXPOSED THREADED SURFACES SHALL BE PAINTED WITH TWO COATS OF HIGH ZINC DUST OXIDE PAINT AFTER INSTALLATION.

INSTALLATION OF MISCELLANEOUS DRILLED DOWEL & ANCHOR BOLTS:

- DOWEL AND ANCHOR BOLT EMBEDMENT AND HOLE DIAMETER SHALL BE PER MANUFACTURER'S RECOMMENDATIONS TO DEVELOP 150% OF THE DOWEL OR ANCHOR BOLT TENSILE CAPACITY.
- FOLLOW EPOXY MANUFACTURER'S RECOMMENDATIONS FOR THE INSTALLATION.
- DRILLED HOLES SHALL HAVE ROUGHENED INTERIOR SURFACE AS PER MANUFACTURER'S RECOMMENDATIONS.
- CONTRACTOR SHALL LOCATE REINFORCEMENT PRIOR TO DRILLING ANCHOR HOLES, SO AS NOT TO DAMAGE THE REINFORCING STEEL.
- THE CONTRACTOR SHALL PREPARE A TEMPLATE AND DRILL REQUIRED HOLES.
- VACUUM DUST FROM BOTTOM AND SIDES OF HOLE USING A NOZZLE OF SMALL TUBING THAT WILL REACH THE BOTTOM OF THE HOLE. INSPECT ALL HOLES WITH A LIGHT TO MAKE CERTAIN ALL DUST IS REMOVED.
- FOLLOW MANUFACTURER'S RECOMMENDATIONS FOR THE MIXING AND APPLICATION OF EPOXY.
- SUBMIT MANUFACTURER'S DATA SHEET AND RECOMMENDATIONS FOR APPROVAL
- THE ANCHOR RODS OR REBARS SHALL DEVELOP THE FOLLOWING MINIMUM ALLOWABLE CAPACITIES. EMBEDMENT DEPTHS SHALL BE AS REQUIRED TO ACHIEVE SPECIFIED CAPACITIES.



CONCRETE ANCHOR INSTALLATION SCHEDULE *			
ROD DIA (IN)	MIN ALLOWABLE CAPACITY (LBS)	REBAR SIZE NO.	MIN ALLOWABLE CAPACITY (LBS)
3/8"	2500	#4	4600
1/2"	3300	#5	6900
5/8"	7500	#6	11200
3/4"	12900	#7	15400
7/8"	16000	#8	18200
1"	17900	#9	21000
1 1/4"	35200	#10	24200
-	-	#11	30900

* BASED ON fc = 4000 PSI

REFERENCES

- ACI 318-08/318R-08 – AMERICAN CONCRETE INSTITUTE "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE AND COMMENTARY"
- ACI 301 – AMERICAN CONCRETE INSTITUTE "SPECIFICATION FOR STRUCTURAL CONCRETE FOR BUILDINGS"
- IBC – INTERNATIONAL CODE COUNCIL "INTERNATIONAL BUILDING CODE, 2006 EDITION."
- ASCE 7-05 – AMERICAN SOCIETY OF CIVIL ENGINEERS, "MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES"
- AISC – AMERICAN INSTITUTE OF STEEL CONSTRUCTION "MANUAL OF STEEL CONSTRUCTION"
- AASHTO – AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS, "STANDARD SPECIFICATION FOR HIGHWAY BRIDGES"
- UFC 4-152-01 – "DESIGN: PIERS AND WHARVES"
- UFC 4-159-03 – "DESIGN: MOORINGS"
- AWS D1.1 – AMERICAN WELDING SOCIETY "STRUCTURAL WELDING CODE-STEEL", 2010 EDITION
- PCI – PRECAST/ PRESTRESSED CONCRETE INSTITUTE "DESIGN HANDBOOK – 6TH EDITION"



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

STRUCTURAL NOTES

Date: MAR 2012 M&M Project No. 7607-02 Drawing code:	Rev: - Drawing Scale: NONE Plot scale: 1:1 (0 SHEET)
Designed by: BA Drawn by: BA Reviewed by:	Submitted by: MOFFATT & NICHOL

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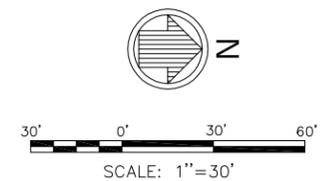
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DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

SOUTH-EAST OVERLAND FLOOD WALL - SHEET 1 OF 2

	Designed by: BJ Drawn by: BA Reviewed by:	Date: MAR, 2012 M&N Project No.: 7607-02 Drawing code:	Rev. - Drawing Scale: NONE Plot scale: 1:1 (0 SHEET)
	800 WORLD TRADE CENTER NORFOLK, VA 23510 757-628-8222	Submitted by: MOFFATT & NICHOL ENVIRONMENTAL STORM WATER MANAGEMENT DIVISION	PREPARED FOR: CITY OF NORFOLK DEPARTMENT OF PUBLIC WORKS ENVIRONMENTAL STORM WATER MANAGEMENT DIVISION

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S-103
Sheet - of -



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

SOUTH-EAST OVERLAND FLOOD WALL - SHEET 2 OF 2

Designed by: BJ	Check: MAR, 2012	Rev. -
Dwn by: BA	M&N Project No. 7607-02	
Reviewed by:	Drawing code:	
Submitted by: MOFFATT & NICHOL	Drawing Scale: NONE	
	Plot scale: 1:1 (0 SHEET)	

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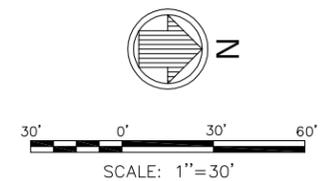
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MATCH LINE STA 4+25



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

EAST OVERLAND FLOOD WALL - SHEET 2 OF 2

Date: MAR, 2012 M&M Project No. 7607-02 Drawing code:	Rev: - Drawing Scale: NONE Plot scale: 1:1 (0 SHEET)
Designed by: BJ Drawn by: BA Reviewed by:	Submitted by: MOFFATT & NICHOL

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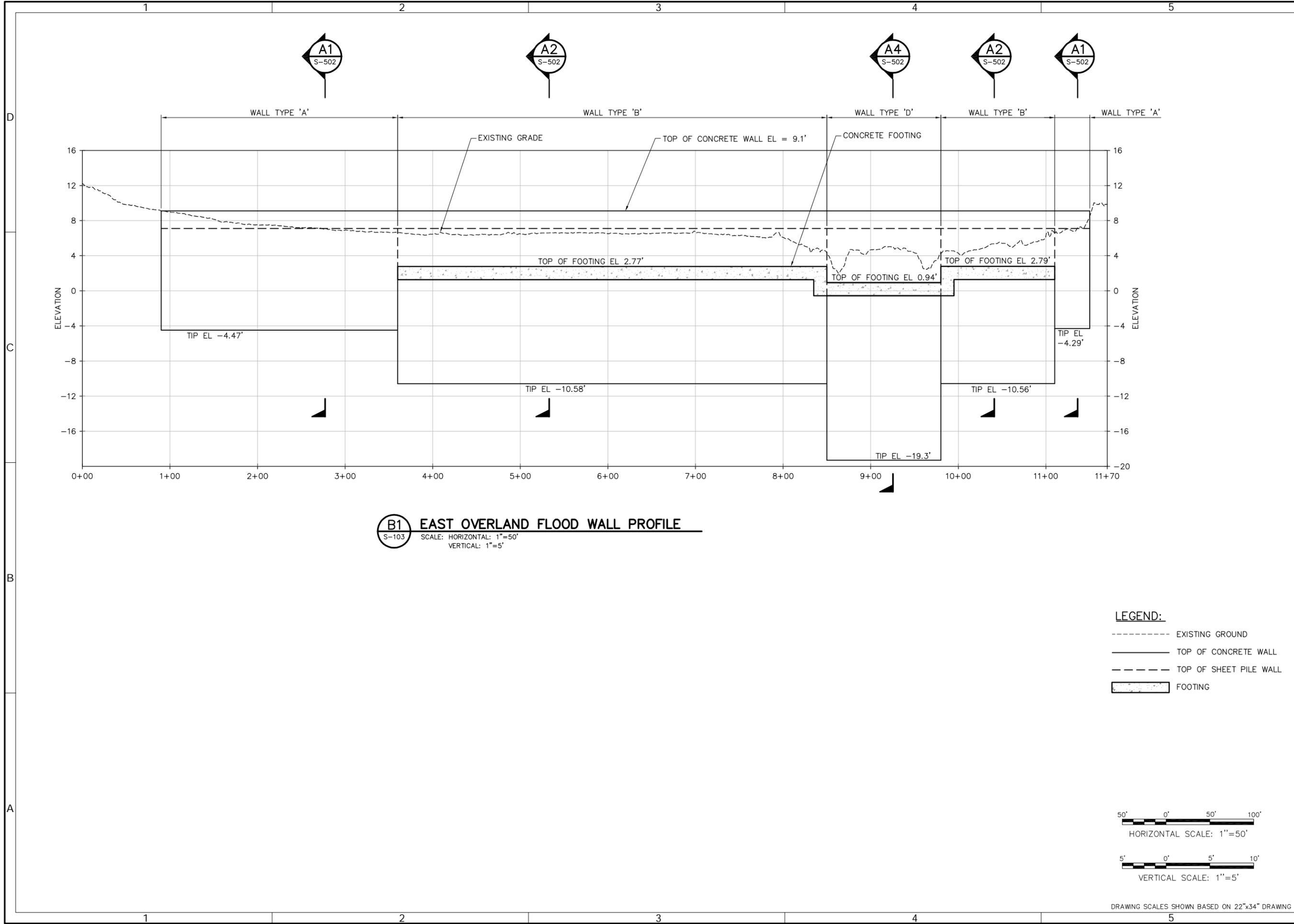
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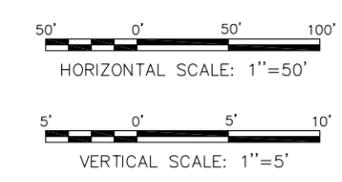
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B1 EAST OVERLAND FLOOD WALL PROFILE
 S-103 SCALE: HORIZONTAL: 1"=50'
 VERTICAL: 1"=5'

- LEGEND:**
- EXISTING GROUND
 - TOP OF CONCRETE WALL
 - TOP OF SHEET PILE WALL
 - ▨ FOOTING



DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

EAST OVERLAND FLOOD WALL PROFILE

Date: MAR, 2012 M&N Project No. 7607-02 Drawing code:	Rev: - Drawing Scale: NONE Plot scale: 1:1 (0 SHEET)
Designed by: BA Drawn by: BA Reviewed by:	Submitted by: MOFFATT & NICHOL Client: PUBLIC WORKS DEPARTMENT OF ENVIRONMENTAL STORM WATER MANAGEMENT DIVISION

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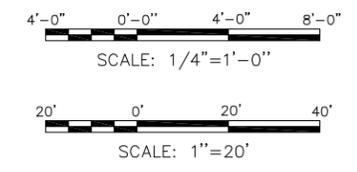
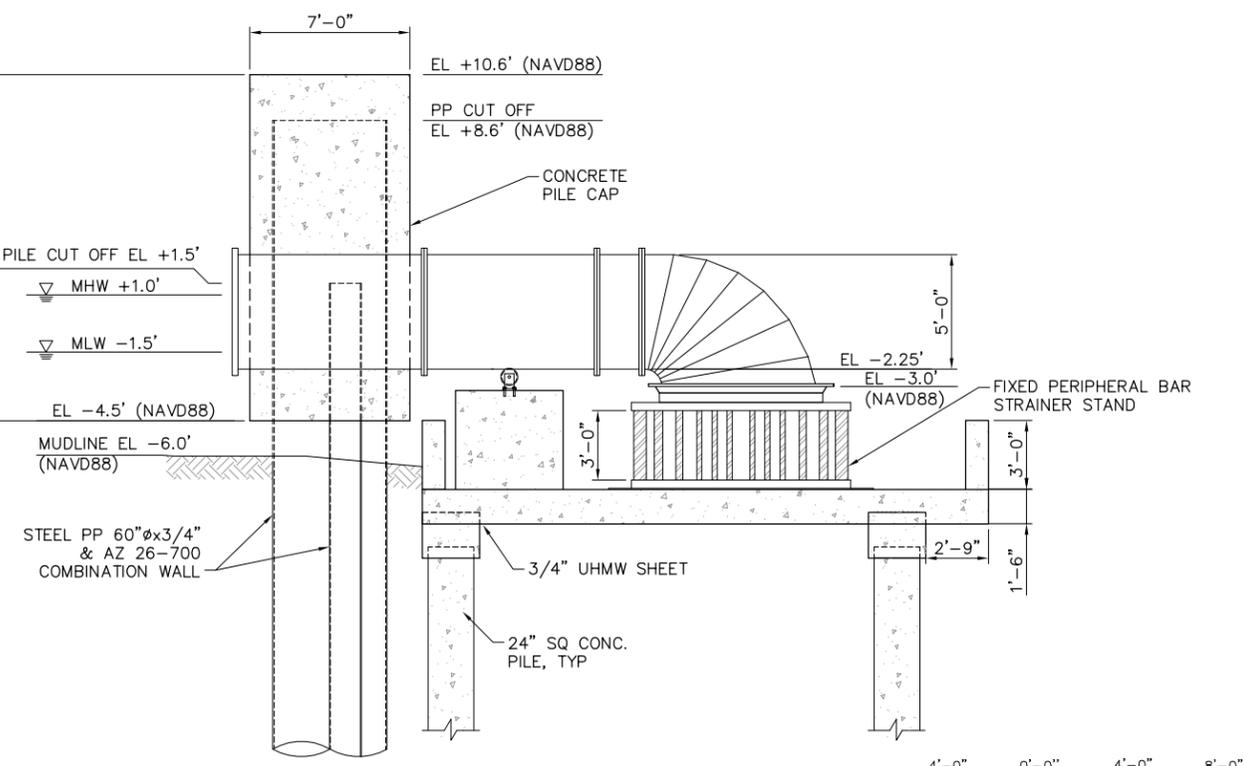
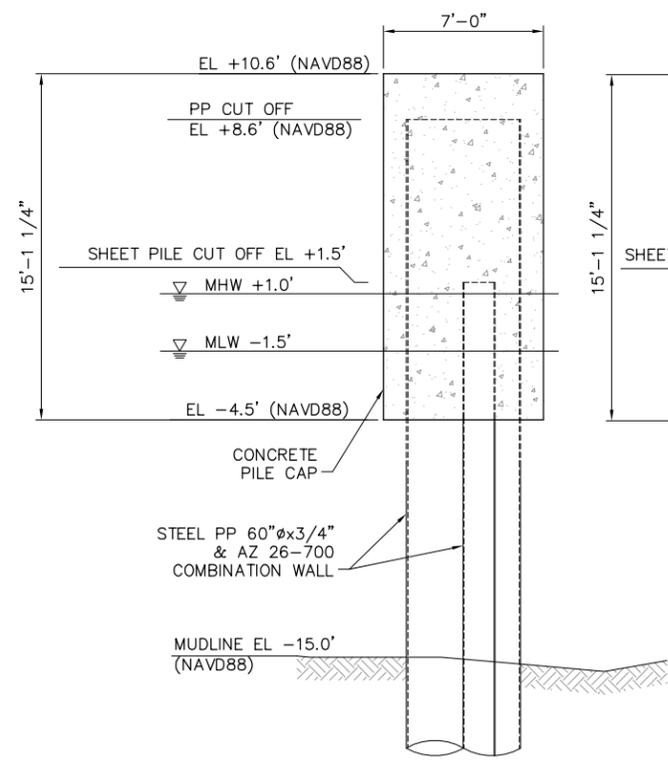
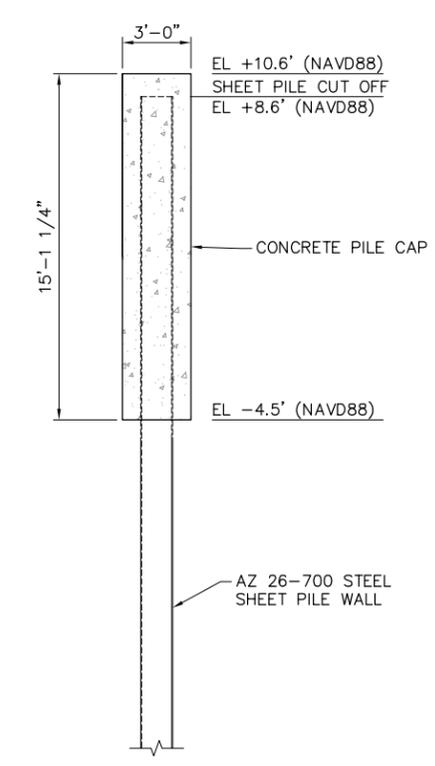
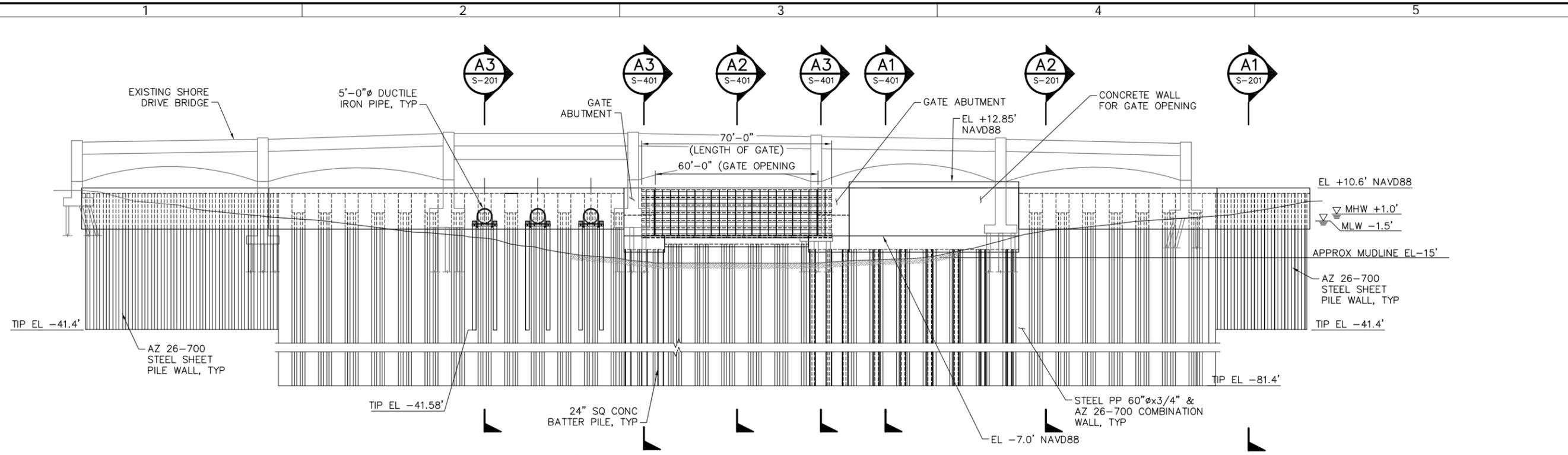
PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA
ELEVATION VIEW OF FLOOD WALL

Designed by: MR/LEG
Dwn by: BA
Reviewed by: MOTT & NICHOL

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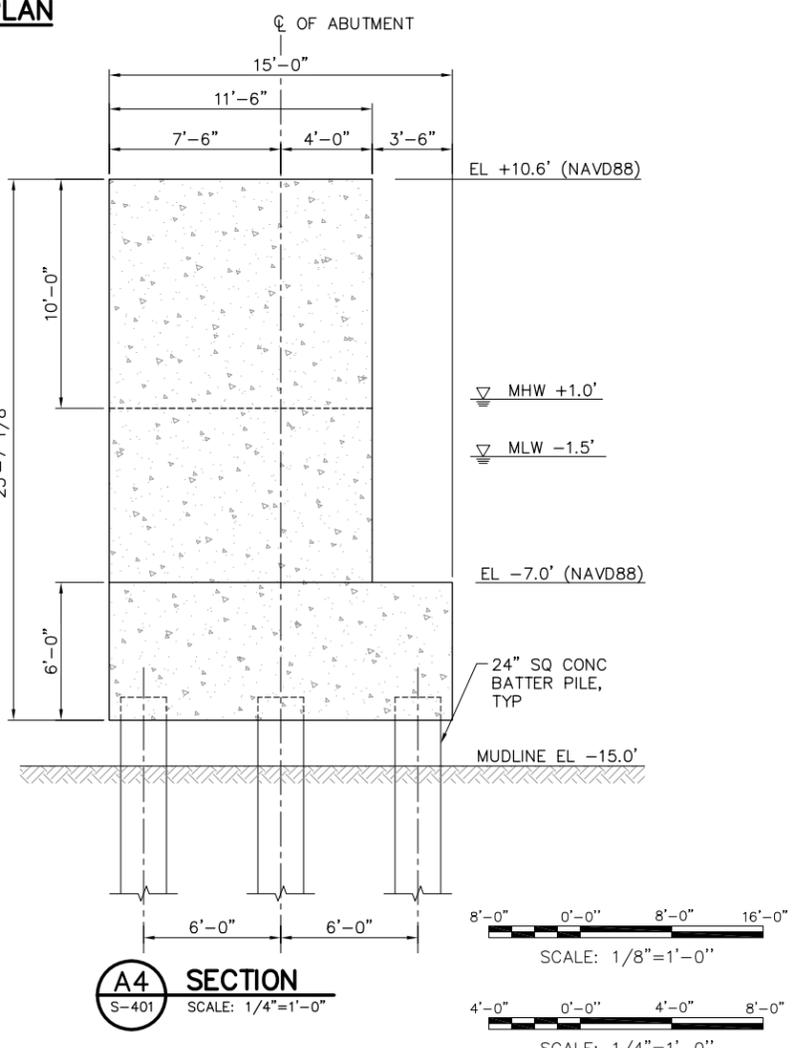
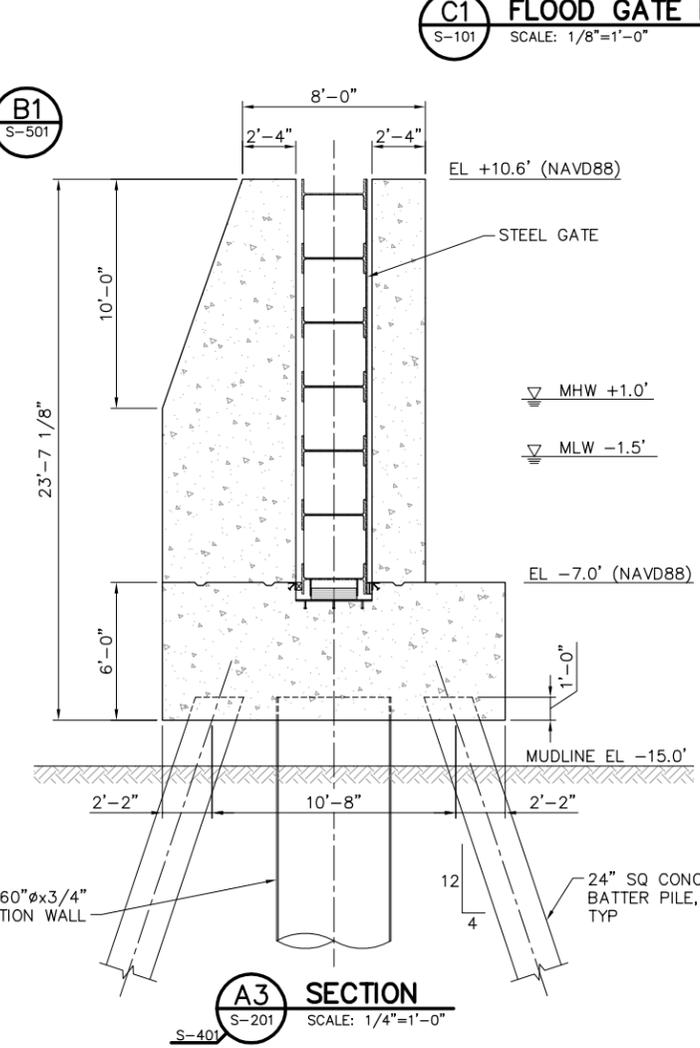
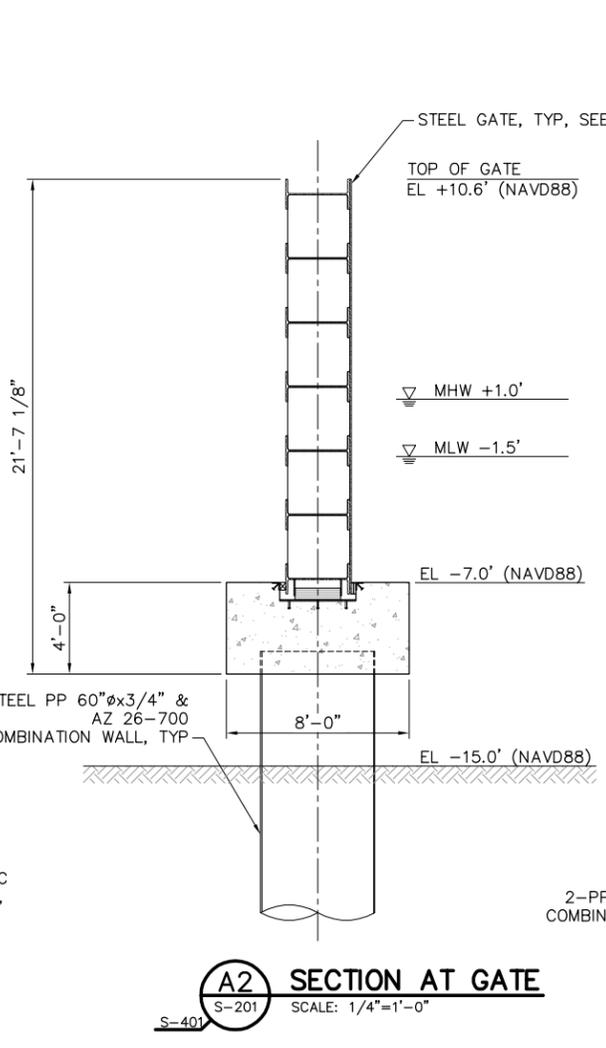
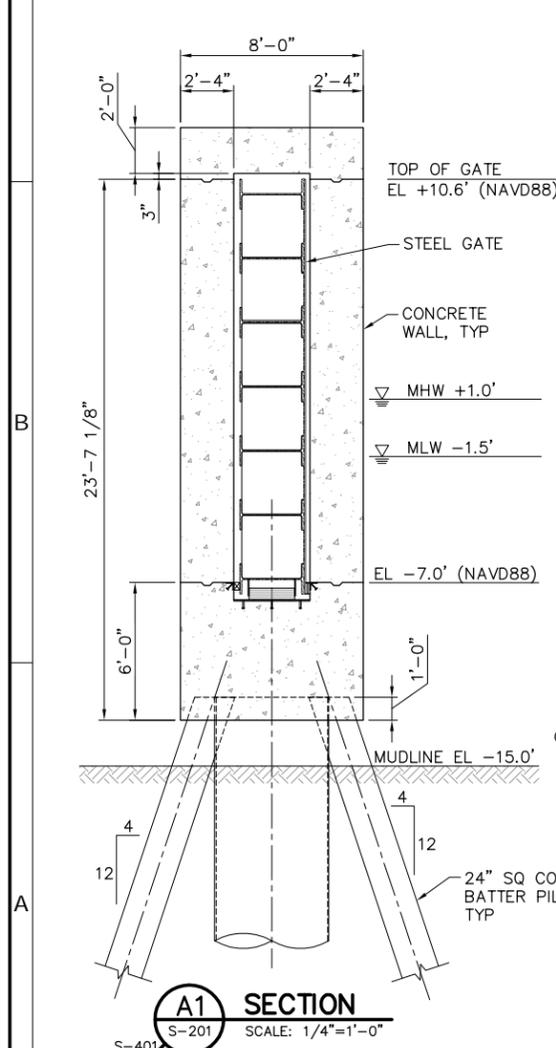
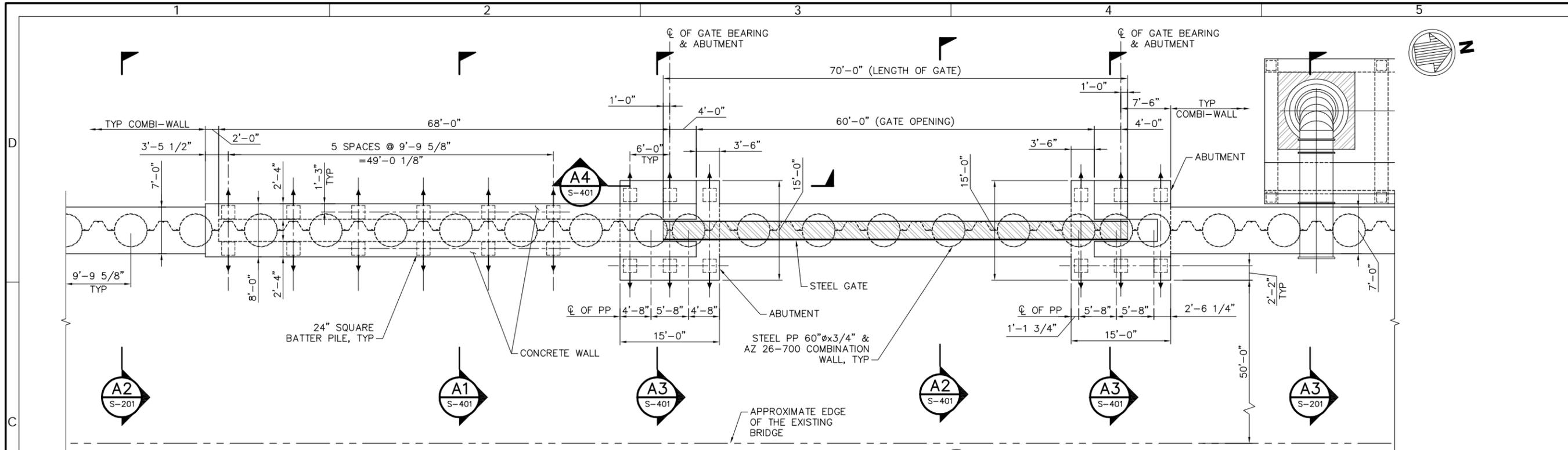
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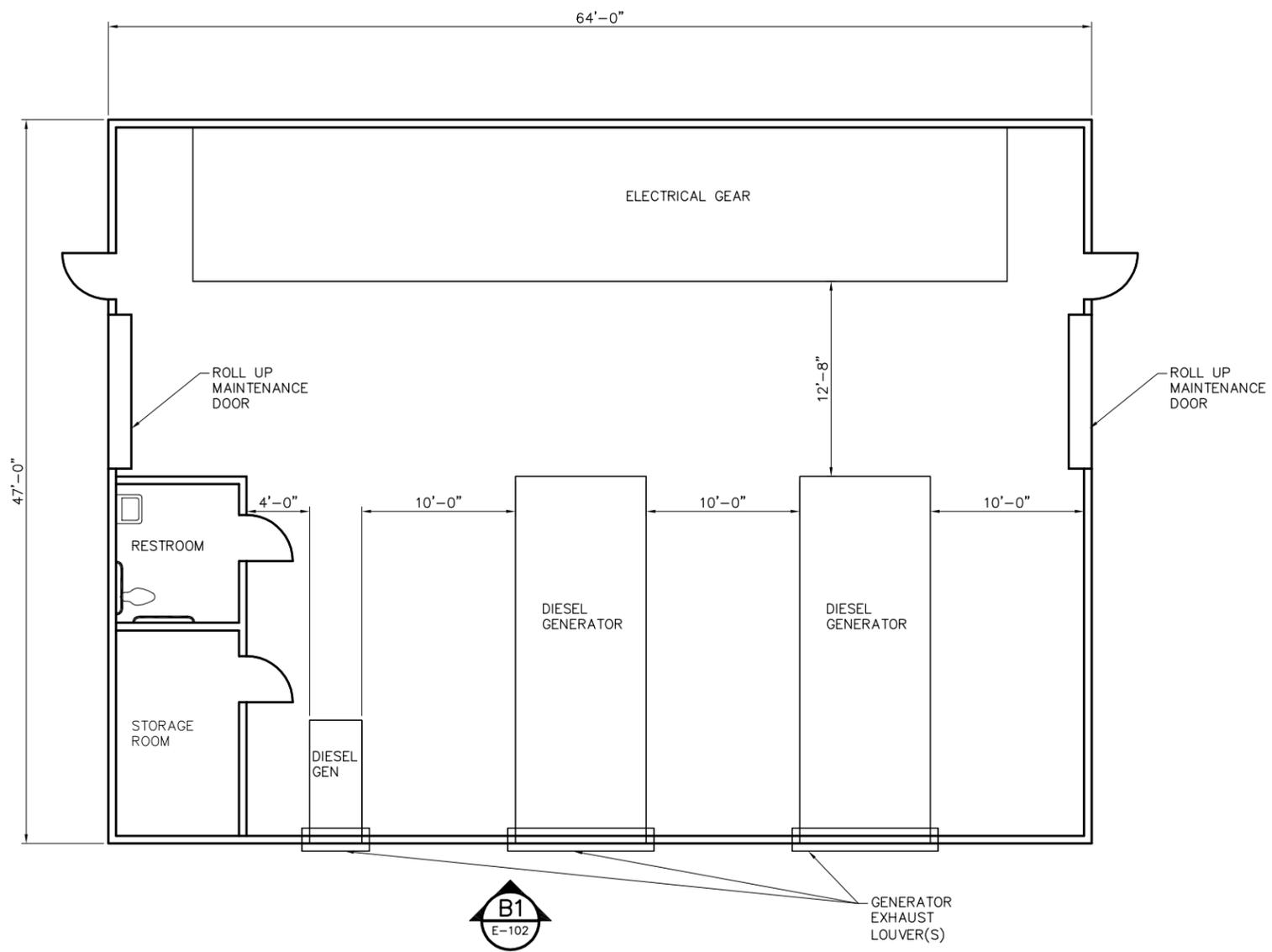
PARTIAL FLOOD GATE WALL PLAN

800 WORLD TRADE CENTER NORFOLK, VA 23510 757-628-8222 moffatt & nichol	DESIGNED BY: MR DRAWN BY: BA CHECKED BY: BA REVIEWED BY:	DATE: MAR, 2012 M&N PROJECT NO.: 7607-02 DRAWING CODE:	PREPARED FOR: OFFICE OF PUBLIC WORKS DEPARTMENT OF PUBLIC WORKS ENVIRONMENTAL STORM WATER MANAGEMENT DIVISION
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Sheet Reference Number:
S-401
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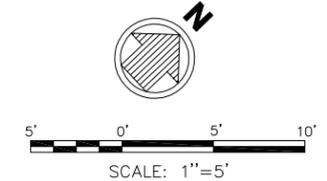


B1
E-101

B1
E-102

B1 GENERATOR BUILDING ELECTRICAL PLAN
SCALE: 1"=5'

GENERATOR EXHAUST LOUVER(S)



DRAWING SCALES SHOWN BASED ON 22"x34" DRAWING



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

GENERATOR BUILDING ELECTRICAL PLAN

Designed by: R.C.	Drawn by: J.W.	Reviewed by: J.W.	Submitted by: MOFFATT & NICHOL
Date: MAR, 2012	Proj. No: 7607-02	Drawing code:	Drawing Scale: NONE
Rev.:			Plot scale: 1:1 (0 SHEET)

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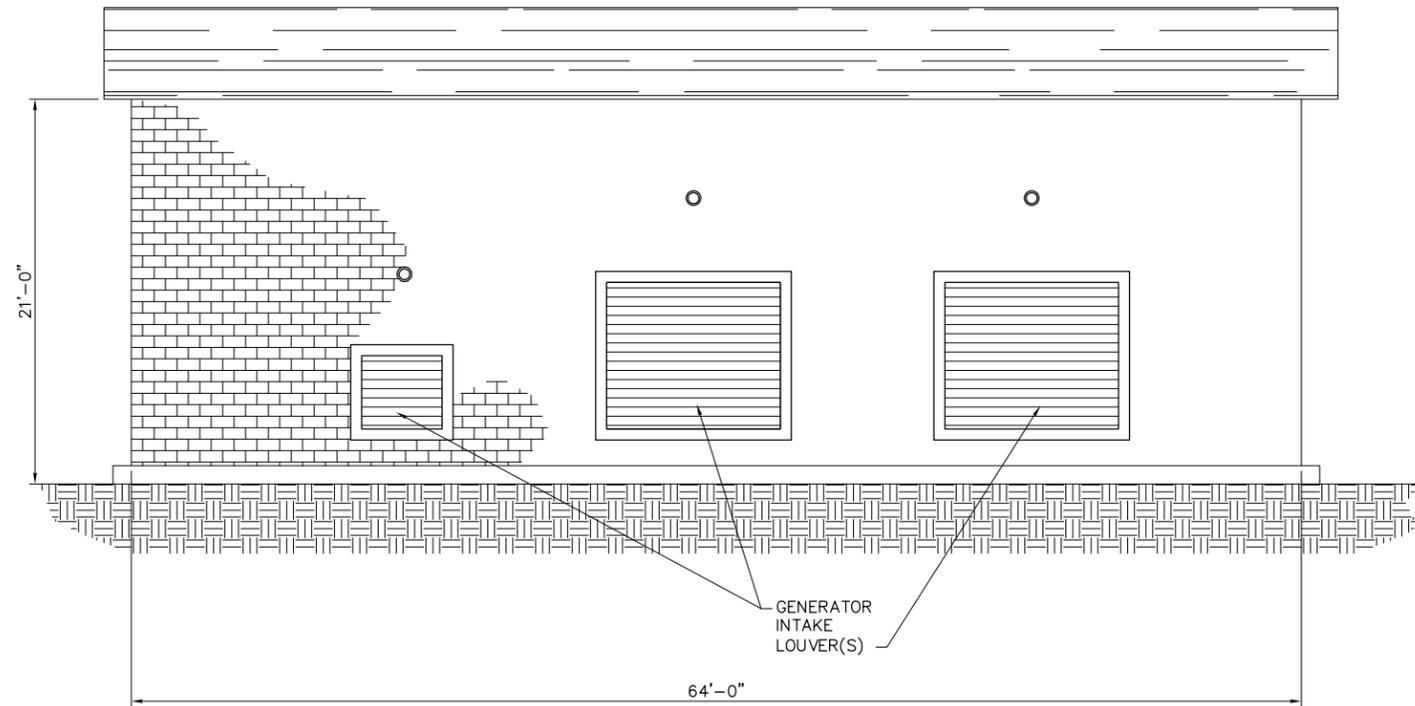
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B1 GENERATOR BUILDING ELEVATION
E-101 SCALE: 1" = 5'



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA

GENERATOR BUILDING ELEVATION

Designed by: R.C.	Drawn by: R.C.	Checked by: JW	Submitted by: MOFFATT & NICHOL
Date: MAR, 2012	Project No: 7607-02	Reviewed by: JW	Client: CITY OF NORFOLK DEPARTMENT OF PUBLIC WORKS ENVIRONMENTAL STORM WATER MANAGEMENT DIVISION
Rev. -	Drawing code:	Drawing Scale: NONE	Plot scale: 1:1 (0 SHEET)

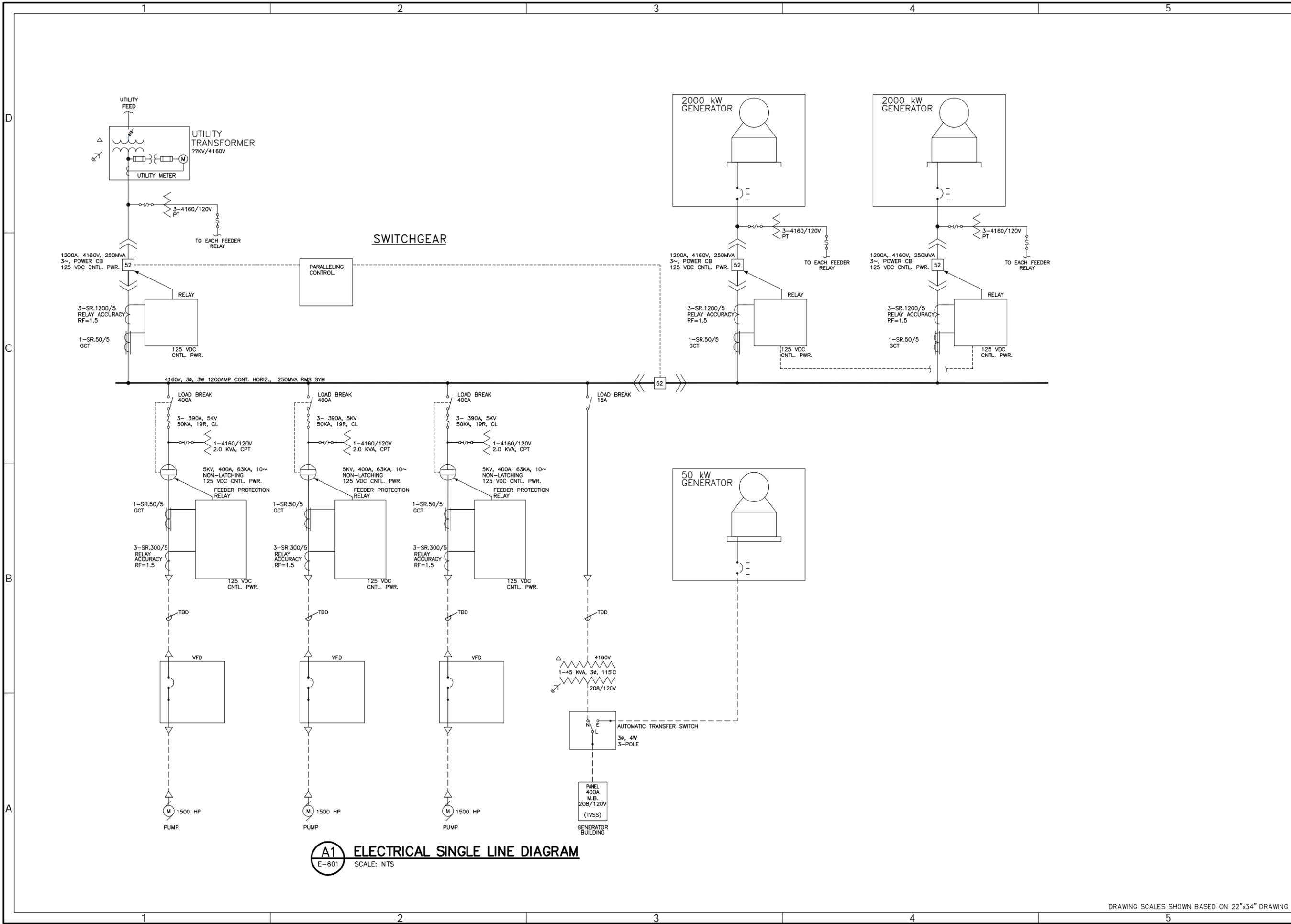
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A1 ELECTRICAL SINGLE LINE DIAGRAM
E-601 SCALE: NTS



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PRETTY LAKE COASTAL FLOODING MITIGATION, NORFOLK, VA
ELECTRICAL SINGLE LINE DIAGRAM

Designed by: R.C.	Rev: -
Dwn by: R.C.	Date: MAR, 2012
Reviewed by: J.W.	M&N Project No. 7607-02
Submitted by: MOFFATT & NICHOL	Drawing code: -
MOFFATT & NICHOL	Drawing Scale: NONE
	Plot scale: 1:1 (0 SHEET)

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