Cashie River at Windsor Flood Mitigation Study

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List of Acronyms

ALE – Annual Loss Estimate

BC – Benefit/Cost Ratio

CFS – Cubic Feet per Second

ESP – ESP Associates, Inc.

FEMA – Federal Emergency Management Agency

FFE – Finished Floor Elevation

FIMAN – Flood Inundation Mapping Alert Network

FRIS – Flood Risk Information System

HEC-RAS – Hydraulic Engineering Center River Analysis System

HEC-HMS – Hydraulic Engineering Center Hydrologic Modeling System

HUC – Hydrologic Unit Code

NCDOT – North Carolina Department of Transportation

NCEM – North Carolina Emergency Management

NCFMP – North Carolina Floodplain Mapping Program

NCSU – North Carolina State University

NOAA – National Oceanic and Atmospheric Administration

USACE – United States Army Corps of Engineers

USGS – United States Geologic Survey

WSEL – Water Surface Elevation

Executive Summary

The Town of Windsor, North Carolina, located on the banks of the Cashie River, has a history of flooding with significant impacts during major events Tropical Storm Julia and Hurricane Matthew. As a result of this, the Town of Windsor and Bertie County jointly applied for and received a grant from the Golden LEAF Foundation, which received funds from the Disaster Recovery Act of 2016 (DRA-16). The grant was used to fund a flood mitigation study conducted by North Carolina State University (NCSU). The study analyzed the existing conditions of the Cashie River just upstream and downstream of the Town of Windsor as well as the flooding and monetary impacts of multiple improvement alternatives. The study was completed in 2018, with the conclusion being that more analysis was required and that the benefit cost analysis completed should be further refined.

The goal of this study is to further enhance the modeling of the existing conditions and a select set of mitigation alternatives developed in 2018, and to provide a more refined benefits cost analysis incorporating long term (30- and 50-yr) life cycles.

Mitigation Strategies and Scenarios

Eight strategies for flood mitigation were developed by North Carolina State University (NCSU) in coordination with stakeholders for the initial analysis, completed in 2018. For the updated study, nine strategies were assessed. The insert Table ES.1 show these nine scenarios along with costs and benefits associated with each. Direct losses include estimates of losses based on structural damage and loss of property and contents. Indirect losses include estimates for items such as temporary relocation, lost income and wages, lost sales, and lost rent.

Analysis and Findings

In order to provide a high-level comparison of the mitigation scenarios analyzed, a series of tables ranking the scenarios using different criteria are provided.

Table ES.1

Mitigation Scenario	Description	Time Horizon	Implementation Costs	Benefits: Direct Losses Avoided	Benefits: Direct & Indirect Losses Avoided	Benefit Cost Ratio: Direct	Benefit Cost Ratio: Direct & Indirect
1	Lower Hoggards Mill Reservoir Cashie River Reservoir	30-yr	$ 16,403,025	$ 827,234	$ 4,596,513	0.05	0.28
		50-yr	$ 16,403,025	$ 1,378,724	$ 7,660,856	0.08	0.47
2	Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir	30-yr	$ 29,812,658	$ 956,357	$ 5,597,526	0.03	0.19
		50-yr	$ 29,812,658	$ 1,593,928	$ 9,329,210	0.05	0.31
3	Raise York St to elevation of 8.25' to 8.0' Raise Water St to elevation of 10.0'	30-yr	$ 3,667,385	$ 40,244	$ 1,359,033	0.01	0.37
		50-yr	$ 3,667,385	$ 67,073	$ 2,265,054	0.02	0.62
3b	Raise York St to elevation of 8.25' to 8.0' (no Water St levee)	30-yr	$ 2,584,580	$ 40,914	$ 1,361,511	0.02	0.53
		50-yr	$ 2,584,580	$ 68,191	$ 2,269,185	0.03	0.88
4	Raise York St to elevation of 10.5' to 10.0' Raise Water St to elevation of 10.0'	30-yr	$ 5,148,458	$ 177,869	$ 2,407,097	0.03	0.47
		50-yr	$ 5,148,458	$ 296,449	$ 4,011,828	0.06	0.78
4b	Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	30-yr	$ 4,065,653	$ 175,707	$ 2,399,178	0.04	0.59
		50-yr	$ 4,065,653	$ 292,845	$ 3,998,630	0.07	0.98
5	Combination of Alt 2 and Alt 4: Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir Raise York St to elevation of 10.5' to 10.0' Raise Water St to elevation of 10.0'	30-yr	$ 34,961,115	$ 1,041,752	$ 6,800,991	0.03	0.19
		50-yr	$ 34,961,115	$ 1,736,254	$ 11,334,985	0.05	0.32
5b	Combination of Alt 2 and Alt 4b: Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir Raise York St to elevation of 10.5' to 10.0'	30-yr	$ 33,878,310	$ 1,041,575	$ 6,800,755	0.03	0.20
		50-yr	$ 33,878,310	$ 1,735,958	$ 11,334,591	0.05	0.33
6	Lower Hoggards Mill Reservoir Raise York St to elevation of 10.5' to 10.0'	30-yr	$ 8,303,633	$ 299,547	$ 2,779,980	0.04	0.33
		50-yr	$ 8,303,633	$ 499,246	$ 4,633,300	0.06	0.56

Table ES.2 shows the estimates of the number of buildings that will be removed from flood risk at the modeled 50-, 100-, 200-, and 500-year recurrence interval level with the mitigation scenario implemented.

Mitigation Alternative	50-yr Building Count Reduction	100-yr Building Count Reduction	200-yr Building Count Reduction	500-yr Building Count Reduction
Alternative 5	42	80	110	214
Alternative 5b	42	80	109	207
Alternative 2	26	56	77	169
Alternative 4	24	43	65	0
Alternative 6	24	40	54	25
Alternative 1	14	37	53	141

Table ES.2: Greatest Reduction in Impacted Structures

Table ES.3 ranks the alternatives by estimated cost to implement (lowest to highest). Of these, only Alternatives 4, 6, and 1 also made the list for the top six for building count reduction.

Mitigation Alternative	Initial Cost
Alternative 3b	$2,584,580
Alternative 3	$3,667,385
Alternative 4b	$4,065,653
Alternative 4	$5,148,458
Alternative 6	$8,303,633
Alternative 1	$16,403,025
Alternative 2	$29,812,658
Alternative 5b	$33,878,310
Alternative 5	$34,961,115

Table ES.3: Cost to Implement

Tables ES.4 and ES.5 show the top 7 alternatives for highest direct losses avoided and best direct benefit to cost (BC) ratio.

Mitigation Alternative	50-Year Benefit
Alternative 5	$1,736,254
Alternative 5b	$1,735,958
Alternative 2	$1,593,928
Alternative 1	$1,378,724
Alternative 6	$499,246
Alternative 4	$296,449
Alternative 4b	$292,845

Table ES.4: Highest Direct Losses Avoided (Top 7 Alternatives)

Mitigation Alternative	50-Year Benefit / Cost
Alternative 1	0.08
Alternative 4b	0.07
Alternatives 6 and 4	0.06
Alternatives 2, 5, and 5b	0.05

Table ES.5: Highest Benefit to Cost Ratio (Top 7 Alternatives)

Conclusions

Results from this analysis support the conclusion reached in the previous study: that the proposed alternatives appear unfavorable for implementation. Typically, when benefit cost ratios reach values equal to or greater than "1.0" a proposed project will be considered for construction; benefit cost ratios calculated for this project range from 0.01 to 0.08 (0.19 to 0.98 when indirect damages are included). However, it is noted that the Town of Windsor has indicated that further buyouts and mitigation actions are planned that were not included in this analysis. Assuming those actions would remove homes from damages for the frequency events analyzed, the benefit cost ratios for the considered alternatives would be further reduced. Similar studies have reached the conclusion that targeted building-level mitigation of the most at-risk buildings yield favorable benefit/cost ratios.

For a digital copy of this report and associated Appendices, please visit https://rebuild.nc.gov.

1. Hydrologic Modeling

ESP Associates, Inc. (ESP) was provided with the final report for the 2018 NCSU study (dated June 8, 2018) as well as the supporting HEC-HMS version 4.2.1 model. **Figure 1** below shows the HEC-HMS model as received.

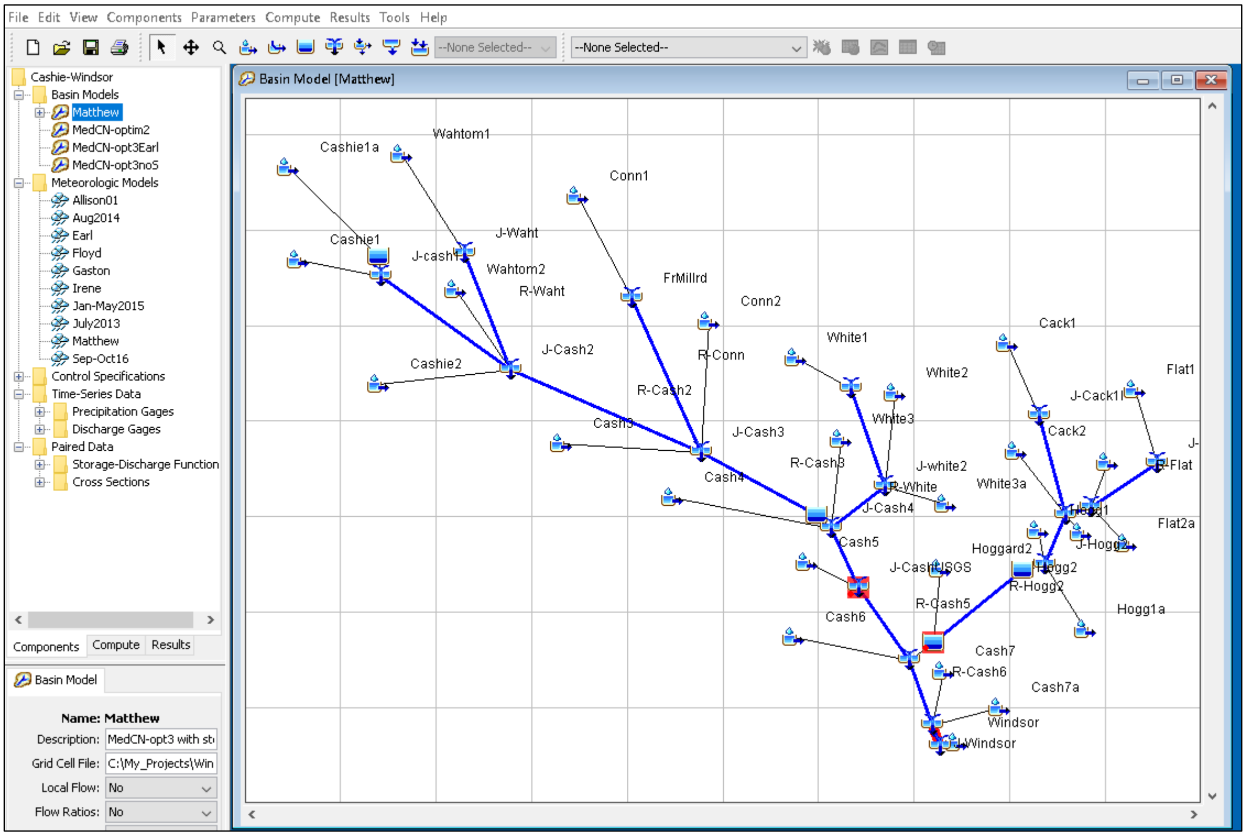

Figure 1: HEC-HMS model as received

The previous study's model files were reviewed, updated, and edited as necessary at the start of this analysis. The review and revisions made to the files are provided in detail in Appendix A. The model was then used to generate flows in order to evaluate associated flooding across a wide range of storm events.

The 20-, 10-, 4-, 2-, 1-, 0.5-, 0.2-, and 0.1-percentexceedeance storms were modeled to provide a wide range of flooding conditions, which should effectively show the impacts of the mitigation alternatives and allow for calculation of average annual loss. To model these events, the NOAA Atlas 14 Volume 2: Ohio River Basin and Surrounding States (orb) grid files were obtained from the NOAA website. The ArcGIS tool 'Zonal Statistics' was used to determine the mean precipitation value of the USGS HUC 10 named "Headwaters Cashie River"/ HUC 10 ID: 0301010707. To apply the averaged Atlas 14 rainfall data, the data was input to HEC-HMS as the point rainfall data of a SCS Type 3 storm. **Table 1** below provides the rainfall values used in the HEC-HMS modeling.

Table 1: Atlas 14 Rainfall Data Used in HEC-HMS Modeling

Event	20 PCT	10PCT	4 PCT	2 PCT	1 PCT	0.5 PCT	0.2 PCT	0.1 PCT
Rainfall (in.)	4.654	5.549	6.891	8.056	9.349	10.795	12.973	14.853

The majority of the HEC-HMS model covers areas upstream of Windsor. It is noted that the downstream limit of the modeling occurs at the King Street bridge, though the hydraulic modeling continues further downstream of King St. A tributary that combines with the Cashie River approximately 1 mile downstream of the King St. bridge is not included in the hydrologic modeling. This tributary could increase flows in the Cashie River downstream of Windsor, thus increasing the tailwater of the Cashie River at Windsor, however, it is likely the effect of this tributary is relatively minor and the addition of this basin to the hydrologic modeling was outside the scope of this study. **Figure 2** below shows the basins included in the HEC-HMS model.

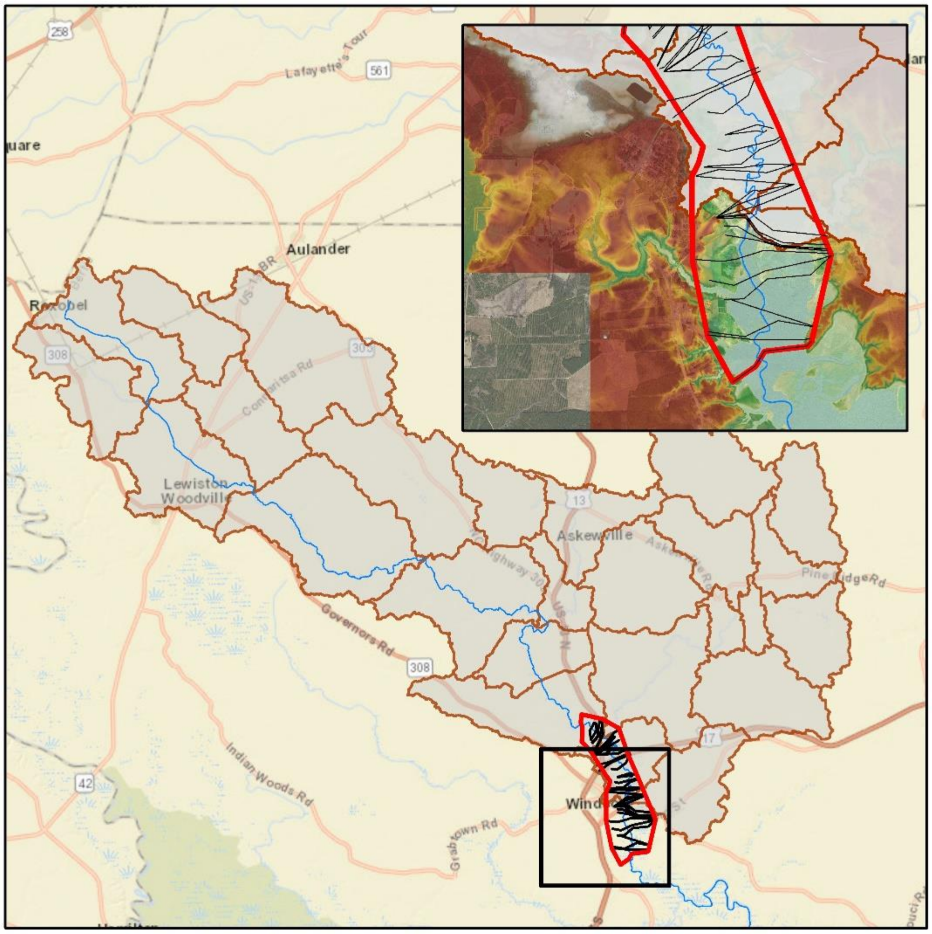

Figure 2: Study HEC-HMS Basins, Inset showing 2014 Terrain

Results from two junctions, "J-Hogg" and "JKing", in the HEC-HMS model were selected for use in the hydraulic model. A third junction, "J-Windsor" is present within the spatial limits of the hydraulic modeling but was not used. This junction is located just downstream of JKing and adds flow from the basin named "Windsor". **Figure 3** below shows the downstream end of the HEC-HMS model. The basin Windsor is approximately 158 acres, and generally located over the Cashie River just upstream of the King St. bridge. The J-Windsor junction was not included in the hydraulic modeling since the basin adds very little flow, and the routing reach connecting elements JKing and J-Windsor actually retains more flow than is added by the small basin. The recurrence interval flows used in the hydraulic model are shown in **Table 2**.

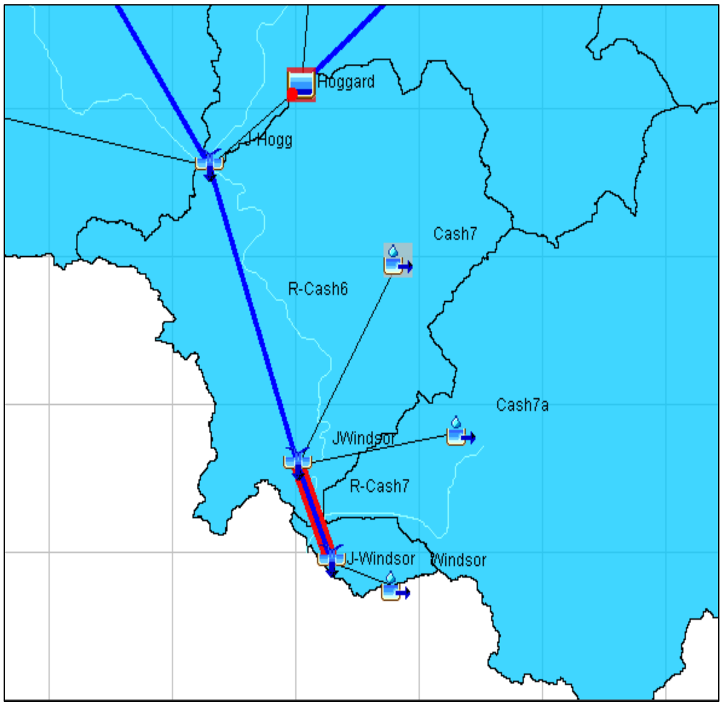

Figure 3: HEC-HMS at Downstream End

Table 2: Flows Used in Hydraulic Modeling

RS	HEC -HMS Node	Storm Event							
		20 PCT	10PCT	4 PCT	2 PCT	1 PCT	0.5 PCT	0.2 PCT	0.1 PCT
		Flow Used in Hydraulic Model (CFS)							
161247	J-Hogg	2120	3880	6810	9380	12280	15520	20430	24680
155648	J-King	2270	4080	7060	9690	12650	15970	20990	25350

2. Hydraulic Modeling

Hydraulic models were obtained from multiple sources for the updated study. NCSU provided five HEC-RAS version 5.0.3 models. The existing condition HEC-RAS model used for the 2018 NCSU study was obtained from NC Floodplain Mapping Program (NCFMP). All geometries applied in the previous models were reviewed for accuracy and relevance. Duplicate geometries were discovered and removed. The model was converted from HEC-RAS version 5.0.3 to the most recent approved version, which is HEC-RAS version 5.0.7. The effective model flows and geometry were run in each version to ensure no major discrepancies would result from the version update. No discrepancies were noted. The model was updated with the most recent lidar topographic data and several cross sections were adjusted to match the lidar elevations and current land use conditions. Roughness coefficients of the channel were also adjusted to match current land uses.

King Street crosses the Cashie River within the Town of Windsor; the bridge was replaced around 2010 for being "structurally deficient" according to NCDOT. To support the design and construction of the bridge, a 'no-rise' model and report were created and subsequently approved in 2005. The project is titled CTP Project B-4434 by

NCDOT. The model and report were obtained to support the study. **Figure 4** below shows the area included in the hydraulic model.

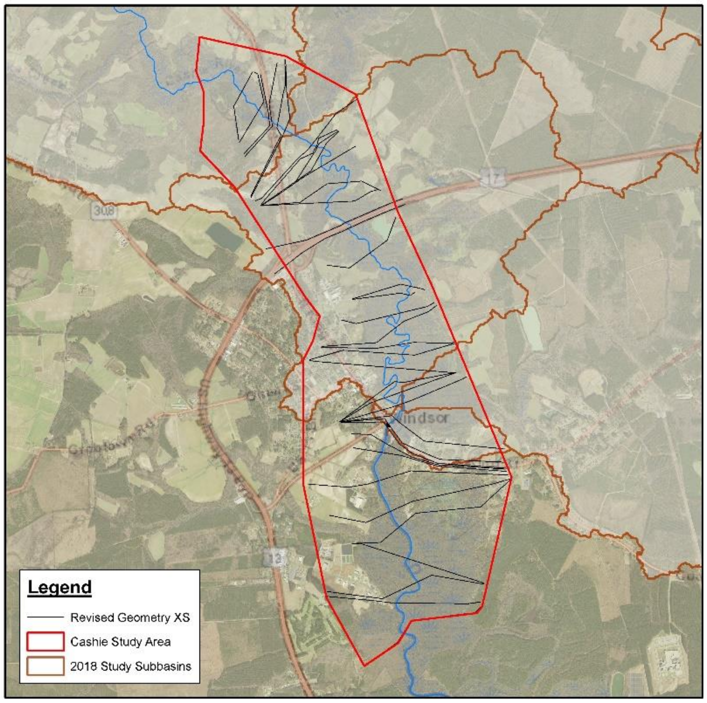

Figure 4: Hydraulic Model Area

The recurrence interval flows calculated using the HEC-HMS hydrologic model were run through the updated geometry and reviewed. The downstream water elevation (i.e. boundary condition) for each model run were tailored to the HEC-HMS output flow specific to each return interval storm that was modeled. The results were deemed reasonable, and ready for use as the baseline for analysis of the mitigation alternatives discussed in the 2018 study.

A thorough explanation of the hydraulic model development is provided in **Appendix A**.

3. Alternatives Analysis

Review of Alternatives from 2018 Study

The 2018 flood mitigation study conducted by North Carolina State University proposed eight mitigation strategies to improve flood conditions on the Cashie River. The initial scope of this study indicated that four of the previously evaluated alternatives and a combination of all four alternatives together would be selected for further analysis. **Figure 5** shows a portion of a figure from the 2018 Study detailing the mitigation alternatives proposed as part of the study, with the highlighted items indicating those which were selected for further analysis as part of this study.

Flood Mitigation Alternative
NO CONTROLS - Hurricane Matthew
Existing Hoggard's Mill Pond
Lower Hoggard's Mill
Lower and Upper Hoggard's Mill
Lower Hoggard's Mill and Cashie River
Lower, Upper Hoggard's Mill and Cashie River
Raise York St to 8 FT, Water St to 10 FT
Raise York St to 10 FT, Water St to 10 FT
Increase King St Bridge Span and Deck Elevation

Figure 5: A Portion of Table 13 from the Final Report of the 2018 NCSU Study (dated June 8, 2018)

Updated Alternatives Assessment

Ultimately, it was determined that in order to fully analyze the alternatives, nine modeling scenarios would be assessed. Two of these alternatives incorporate only detention to the system, four model only different levee configurations, and three alternatives are composed of a combination of detention and levees.

To assist in clarity, once the final alternatives to be modeled were selected, names were associated with each alternative. **Table 3** details the alternative names and their associated projects.

Table 3: Flood Mitigation Alternatives Naming Scheme and Details

Alternative Name	Mitigation Strategies	Description	Deviance from 2018 Study
Alt 1	Detention	Lower Hoggards Mill Reservoir Cashie River Reservoir	For the largest storm event, the 0.1% Event, additional reservoir storage discharge curves were added to the elements representing the propsosed reservoirs in HEC-HMS. For the largest event, the reservoir stage was exceeding the values present in the table, and the model would fail. Additional values were extrapolated based on the curve present in the model provided.
Alt 2	Detention	Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir	For the largest storm event, the 0.1% Event, additional reservoir storage discharge curves were added to the elements representing the propsosed reservoirs in HEC-HMS. For the largest event, the reservoir stage was exceeding the values present in the table, and the model would fail. Additional values were extrapolated based on the curve present in the model provided.
Alt 3	Levees	Raise York St to elevation of 8.25' to 8.0' Raise Water St to elevation of 10.0'	York St levee proposed at universally 8.0' elevation in 2018 Study
Alt 3b	Levees	Raise York St to elevation of 8.25' to 8.0' (no Water St levee)	York St levee proposed at universally 8.0' elevation in 2018 Study No analysis without Water St completed
Alt 4	Levees	Raise York St to elevation of 10.5' to 10.0' Raise Water St to elevation of 10.0'	York St levee proposed at universally 10.0' elevation in 2018 Study
Alt 4b	Levees	Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	York St levee proposed at universally 10.0' elevation in 2018 Study No analysis without Water St completed
Alt 5	Levees and Detention	Combination of Alt 2 and Alt 4: Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir Raise York St to elevation of 10.5' to 10.0' Raise Water St to elevation of 10.0'	No combined reservoir and levee anlalysis completed Elevations of levees differing from 2018 study
Alt 5b	Levees and Detention	Combination of Alt 2 and Alt 4b: Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	No combined reservoir and levee anlalysis completed Elevations of levees differing from 2018 study
Alt 6	Levees and Detention	Lower Hoggards Mill Reservoir Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	No combined reservoir and levee anlalysis completed Elevations of levees differing from 2018 study

Hydrologic and Hydraulic Assessment

The potential for three dry detention facilities were identified in the 2018 study (see **Figures 6 and 7**). As shown above in **Table 3**, five of the nine alternatives analyzed included combinations of the three detention facilities. These alternatives result in reduction of peak discharges along the Cashie River for the largest events analyzed. The other four alternatives utilizing levees only had no impact on the peak flows modeled along the Cashie River. The results of the flow comparisons for each alternative and existing condition obtained from the hydrologic modeling are provided below in **Table 4** and the accompanying bar charts in **Figure 8**.

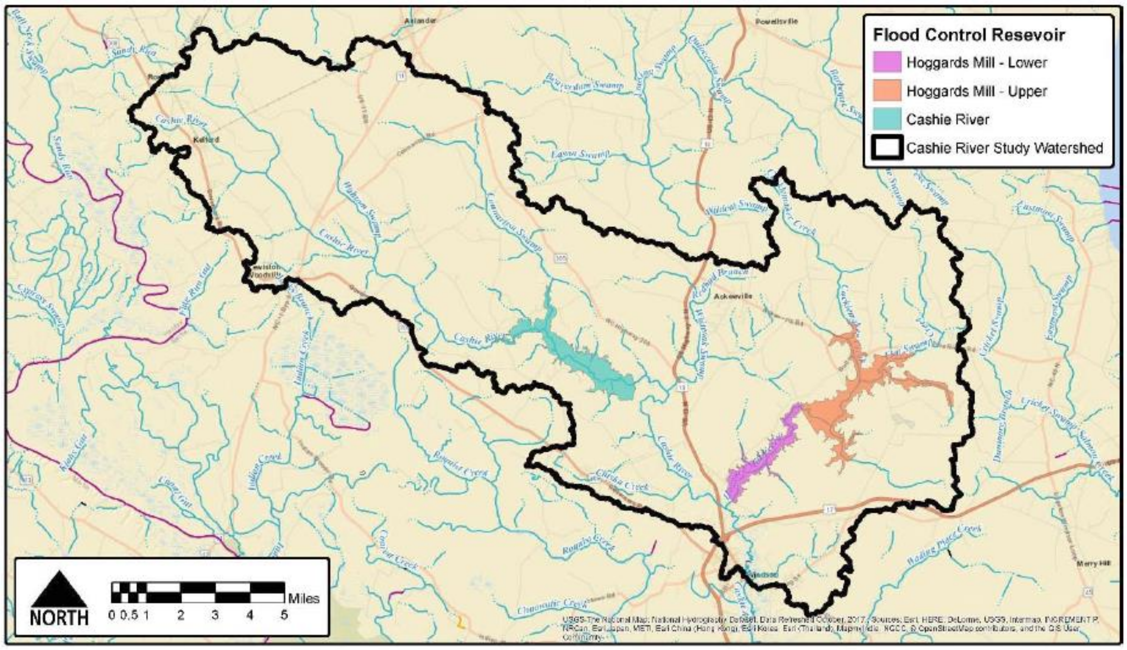

Figure 6: Reservoir Location Graphic from the 2018 Study

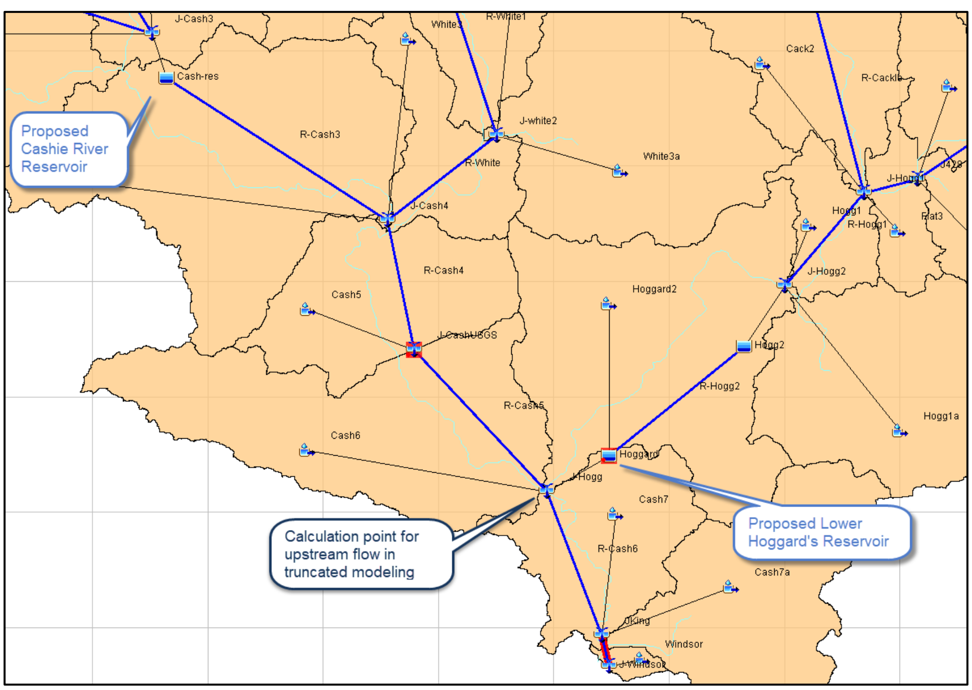

Figure 7: HEC-HMS Geometry Layout

Table 4: Flows Comparison Between Existing Conditions and Alternatives

RS	Storm Event							
	20 PCT	10PCT	4 PCT	2 PCT	1 PCT	0.5 PCT	0.2 PCT	0.1 PCT
	Flow Used in Existing Conditions Alternatives 3, 3b, 4, and 4b Hydraulic Model (CFS)							
161247	2,125	3,878	6,805	9,384	12,277	15,524	20,431	24,682
155648	2,272	4,076	7,061	9,694	12,649	15,969	20,993	25,349
	Flow Used in Alternative 1 Model (CFS)							
161247	2,183	3,806	6,277	8,199	10,082	11,942	14,338	15,954
155648	2,330	3,993	6,537	8,538	10,514	12,482	15,048	16,824
	Flow Used in Alternatives 2, 5, and 5b (CFS)							
161247	2,065	3,528	5,692	7,372	9,003	10,559	12,627	14,166
155648	2,193	3,702	5,946	7,705	9,430	11,096	13,333	15,028
	Flow Used in Alternative 6 Model (CFS)							
161247	2,275	4,051	6,934	9,416	12,153	15,173	19,621	23,311
155648	2,418	4,242	7,186	9,726	12,528	15,625	20,194	23,990
	Percent Difference in Flows for Existing Conditions vs. Alternative 1 Hydraulic Model (CFS)							
161247	3%	-2%	-8%	-13%	-18%	-23%	-30%	-35%
155648	3%	-2%	-7%	-12%	-17%	-22%	-28%	-34%
	Percent Difference in Flows for Existing Conditions vs. Alternatives 2, 5, and 5b Hydraulic Model (CFS)							
161247	-3%	-9%	-16%	-21%	-27%	-32%	-38%	-43%
155648	-3%	-9%	-16%	-21%	-25%	-31%	-36%	-41%
	Percent Difference in Flows for Existing Conditions vs. Alternative 6 Hydraulic Model (CFS)							
161247	7%	5%	2%	0%	-1%	-3%	-6%	-9%
155648	6%	4%	2%	0%	-1%	-3%	-5%	-8%

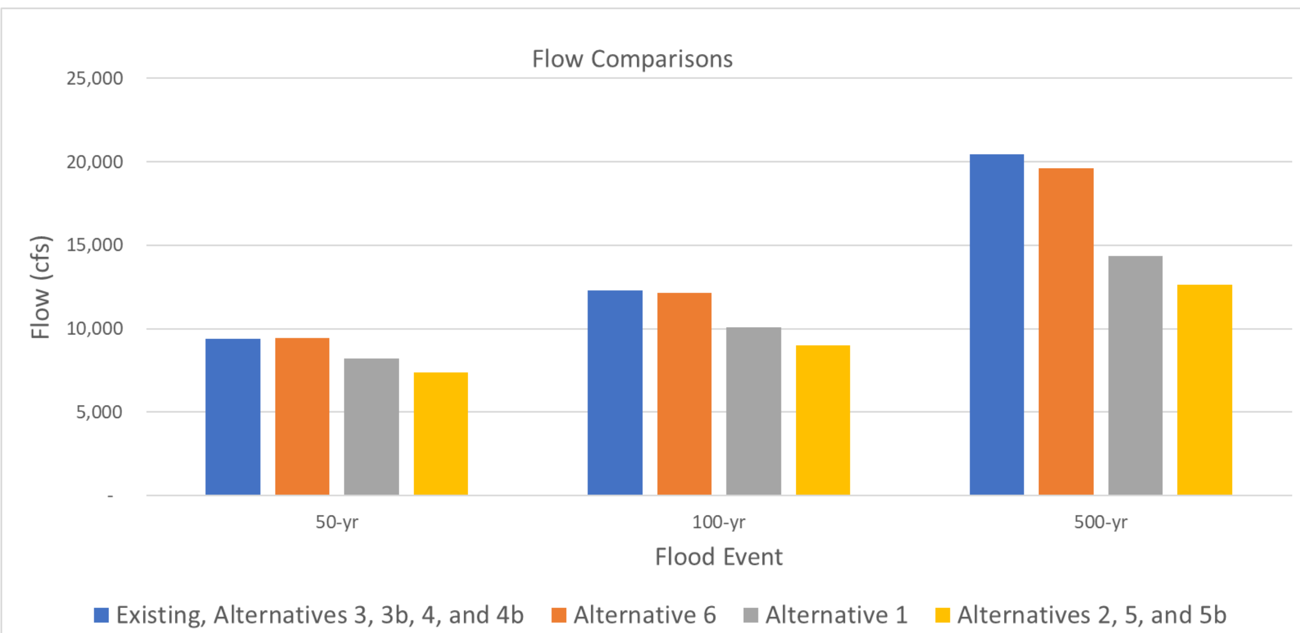

Figure 8: Flow Comparisons for Alternatives

As shown above, the hydrologic impact of the reservoirs varied by storm event and configuration.

Detention Only Alternatives

The 2018 study proposed several detention options to limit the flow reaching the Windsor area. For this study, two detention options were selected for further analysis and to update benefit cost assessments. These two studies were incorporated into several alternatives, with Alternative 1 and Alternative 2 consisting of only proposed reservoirs (no levees). It is noted that the structures proposed at the reservoirs were completed with a cursory analysis. If these scenarios are further pursued, more detailed analysis needs to be performed that includes the design of dam outlet works.

Alternative 1 – Lower Hoggard's Mill Reservoir and Cashie River Reservoir

Alternative 1 consists of two proposed reservoirs: the Lower Hoggards Mill Reservoir located along Hoggard Mill Creek and the Cashie River Reservoir located along the Cashie River. The primary mitigation method of the reservoirs is flow reduction, which is assessed in HEC-HMS.

Following the hydrologic analysis of the reservoirs, flows were compiled for input into HEC-RAS. The construction of the reservoirs impacted the timing such that flows increased for the smallest event, the 20 percent event, for Alternative 1, which resulted in a slightly higher tailwater computed for this event. For the remaining events, the tailwater was reduced as shown in **Table 5**.

Table 5: Tailwater Conditions for Alternative 1

Profile	Tailwater Elevation (ft) - Existing Conditions	Tailwater Elevation (ft) - Alt 1	Difference
20 PCT	1.65	1.67	0.02
10PCT	2.45	2.41	-0.04
4 PCT	3.89	3.64	-0.25
2 PCT	5.06	4.56	-0.5
1 PCT	6.25	5.4	-0.85
0.5 PCT	7.46	6.19	-1.27
0.2 PCT	9.05	7.14	-1.91
0.1 PCT	10.26	7.75	-2.51

Changes in water surface were negligible for small storms (20% and 10% exceedance); water surface elevations were increasingly lower than existing conditions for larger storm events. Alternative 1 reduces the water surface elevation by approximately 2.5 feet in the 0.1 percent event. The full range of water surface elevation impacts resulting from Alternative 1 are provided in **Appendix B**.

Alternative 2 – Upper Hoggard's Mill Reservoir, Lower Hoggard's Mill Reservoir, and Cashie River Reservoir

Alternative 2 consists of three proposed reservoirs: the Upper Hoggards Mill and the Lower Hoggards Mill Reservoirs located along Hoggard Mill Creek, and the Cashie River Reservoir located along the Cashie River.

Table 6 provides the tailwater conditions used as the boundary condition for Alternative 2.

Table 6: Tailwater Conditions for Alternative 2

Profile	Tailwater Elevation (ft) - Existing Conditions	Tailwater Elevation (ft) - Alt 2	Difference
20 PCT	1.65	1.62	-0.03
10PCT	2.45	2.27	-0.18
4 PCT	3.89	3.36	-0.53
2 PCT	5.06	4.18	-0.88
1 PCT	6.25	4.95	-1.30
0.5 PCT	7.46	5.64	-1.82
0.2 PCT	9.05	6.51	-2.54
0.1 PCT	10.26	7.13	-3.13

Changes in water surface were again negligible for small storms; water surface elevations were increasingly lower than existing conditions for larger storms. Alternative 2 reduces the water surface elevation by approximately 3.1 feet in the 0.1 percent event. The full range of water surface elevation impacts resulting from Alternative 2 are provided in **Appendix B**.

Levee Only Alternatives

The 2018 study proposed two alternatives incorporating levees at York Street and Water Street. These alternatives were selected for further analysis as part of this study. Alternatives 3, 3b, 4, and 4b of this study incorporate various levee schemes for flood mitigation.

Levee points, which restrict overbank flow until the elevation of the levee is overtopped were added to HEC-RAS to model the levees. **Figure 9** shows a levee point applied to a cross section to model the York Street levee.

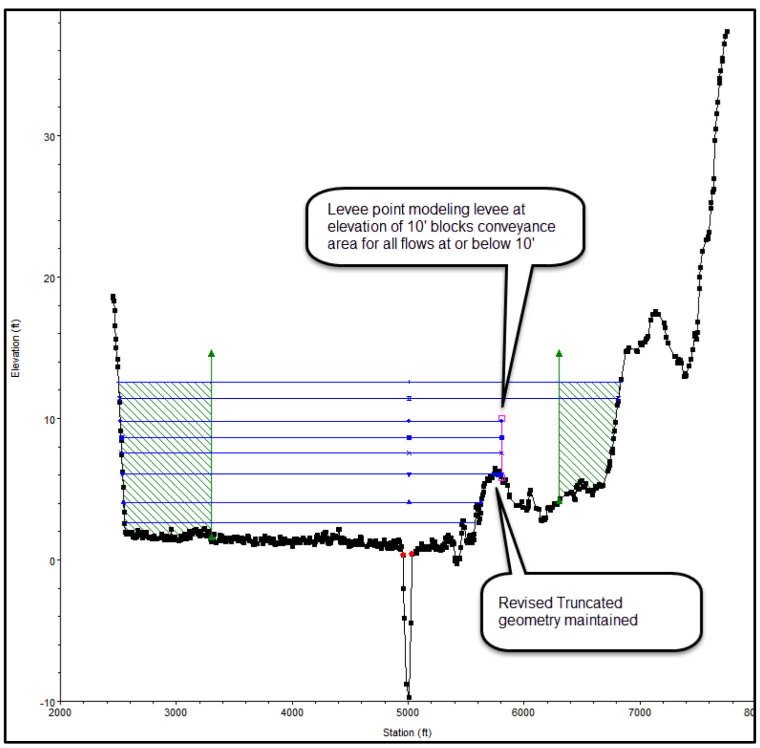

Figure 9: HEC-RAS Levee Modeling Method

The 2018 study alternatives proposed tide gates in combination with levees. With the current modeling method of the Cashie River at Windsor, tide gates are not able to be modeled independently. However, with the levee methodology used in the analysis the water surface results effectively represent a scenario including tide gates. This is because if the Cashie River is at an elevation lower than the proposed levee, water is not allowed a flow path through the Town, as shown in **Figure 9**. Once the levee is overtopped water will convey through the town as indicated during higher events shown in **Figure 9**, which use the full cross sectional area in the hydraulic model. The final floodplain mapping was clipped along York Street and Water Street based upon the levee conditions stated in each respective alternative; if a levee was proposed along the street it was assumed that backwater conditions would not be present in the drainage ditch beneath the levee, instead assuming a tide gate was present. For alternatives that do not include a levee at Water Street, backwater is incorporated into the mapping from the Cashie River at Water Street – southeast of the intersection of Sutton Drive and Water Street.

It is noted that in large levee systems with tide gates that frequently receive large and drawn-out storm events, pumps are typically incorporated behind the levees to remove accumulation of rainfall behind the levees. Potential pump systems or localized rainfall within Windsor are not considered in the 2018 study or this updated study.

Alternative 3 – Raise York St to Approximately 8 feet, Raise Water St to Approximately 10 feet

The alternative "Raise York Street to 8 ft, Water Street to 10ft" from the previous study was selected for further analysis. The 2018 study alternative proposed a uniform 8 feet levee at York Street. It was discovered that the north end of the levee overtopped by a small amount for events greater than and equal to the 2 percent event. An 8-foot levee was overtopped by approximately 1 inch at the northern end in the 2 percent event. Therefore, a graded levee was proposed for this analysis. **Figure 10** shows the proposed schematic for the York Street levee for Alternatives 3, with a York Street levee ranging in elevation from 8.25 feet on the north end to 8.0 feet on the south end.

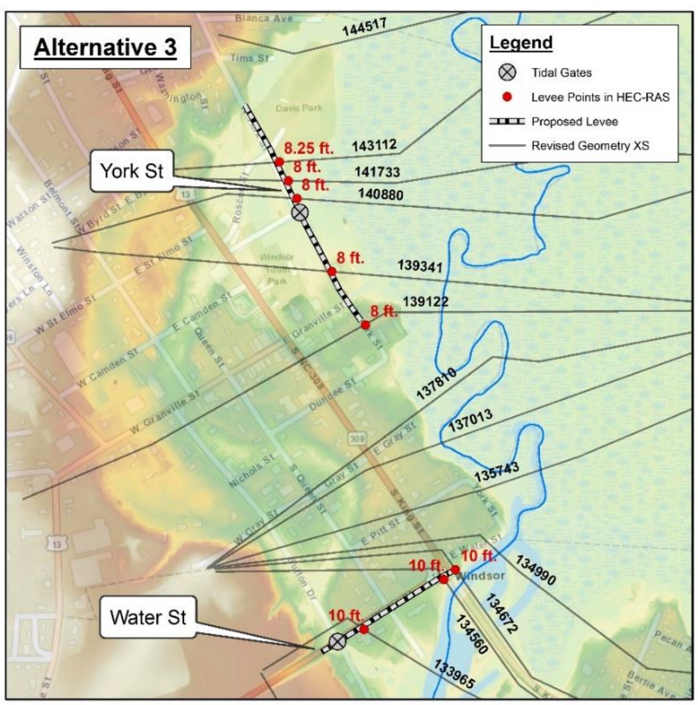

Figure 10: Alternative 3: 8.25' – 8.0' York St Levee, 10' Water St Levee

Water surface elevations between the existing conditions analysis and Alternative 3 generally remain unchanged, with results differing by less than an inch across the entire model reach. Water is prevented from spilling over into the town due to the levees during lower frequency events.

Alternative 3b – Raise York St to Approximately 8 feet (no Water St levee)

Following evaluation of the results of Alternative 3, it was discovered that the additional level of protection offered by the Water Street levee in combination with the York Street levee was uncertain. It was desired to see if effects were different with a single levee than the combined Water Street and York Street levees, therefore Alternative 3b was created. Upon review of the modeling results, adjustments were deemed necessary. Again, a graded levee at York St. with elevation 8.25 at the north end to 8 feet at the south end was applied for this alternative.

Figure 11 shows the proposed schematic for the York Street levee for Alternative 3b. No Water Street levee or tide gate at Water Street is incorporated into this alternative; however, the York Street levee remains unchanged from Alternative 3. The mapping and subsequent benefit cost analysis for this updated study assume backwater effects are present from the Cashie River at Water Street – southeast of the intersection of Sutton Drive and Water Street.

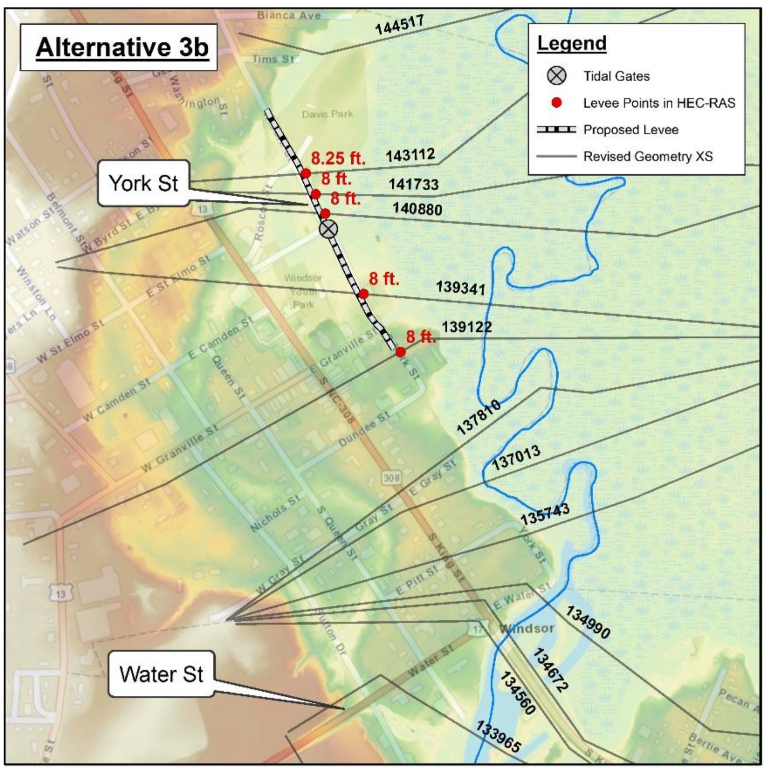

Figure 11: Alternative 3b: 8.25' – 8.0' York St Levee

Water surface elevations between the existing conditions analysis and Alternative 3b generally remain unchanged, with results differing by less than an inch across the entire model reach. Water is prevented from spilling over into the town due to the levees during lower frequency events.

Alternative 4 – Raise York St to Approximately 10 feet, Raise Water St to Approximately 10 feet

The alternative "Raise York Street to 10 ft, Water Street to 10 ft" from the previous study was selected for further analysis in this updated study. For the 2018 study alternative, the York Street levee was proposed to be at a uniform elevation of 10 feet. It was discovered that the north end of the levee overtopped by a small amount for events greater than and equal to the 0.5 percent event (overtopped by 4 inches in the 0.5 percent event). Therefore, a graded levee was proposed for this analysis. **Figure 12** shows the proposed schematic for the York Street levee for Alternative 4 with the York Street levee ranging from 10.5 feet on the north end to 10.0 feet on the south end. In order to tie-in to the existing ground elevations the York Street levee was also extended in this analysis as compared to the previous study, continuing west along Dundee Street until an elevation of 10 feet is reached on existing grade.

The Water Street levee proposed in the 2018 study was maintained for this updated study, with elevations universally at 10.0 feet for the extent of the proposed levee.

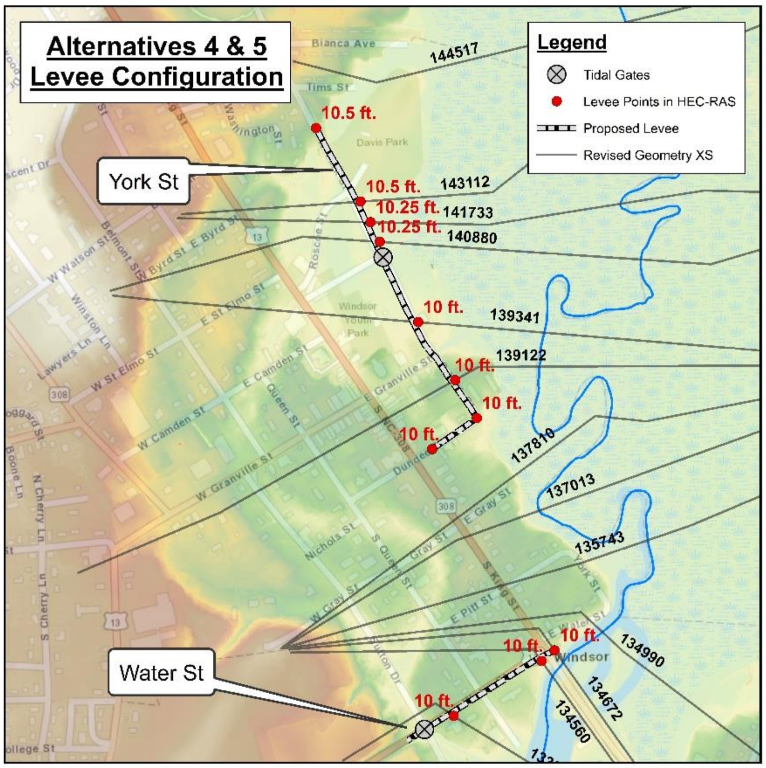

Figure 12: Alternative 4 and Alternative 5: 10.5' – 10.0' York St Levee, 10' Water St Levee

Water surface elevations between the existing conditions analysis and Alternative 4 generally remain unchanged, with results differing by less than an inch across the entire model reach. Water is prevented from spilling over into the town due to the levees during lower frequency events.

Alternative 4b – Raise York St to Approximately 10 feet (no Water St levee)

Following evaluation of the results of Alternative 4, it was discovered that the additional level of protection offered by the Water Street levee in combination with the York Street levee was uncertain. It was desired to see if effects were different with a single levee then the combined Water Street and York Street levees, therefore Alternative 4b was created. Again, a graded levee at York St. with elevation 10.5 at the north end to 10 feet at the south end was applied for this alternative. In order to tie-in to the existing ground elevations the York Street levee was also extended in this analysis as compared to the previous study, continuing west along Dundee Street until an elevation of 10 feet is reached on existing grade.

Figure 13 below shows the proposed schematic for the York Street levee for Alternative 4b. No Water Street levee is incorporated into this alternative; however, the York Street levee remains unchanged from Alternative 4. The mapping and subsequent benefit cost analysis for this updated study assume backwater effects are present from the Cashie River at Water Street – southeast of the intersection of Sutton Drive and Water Street.

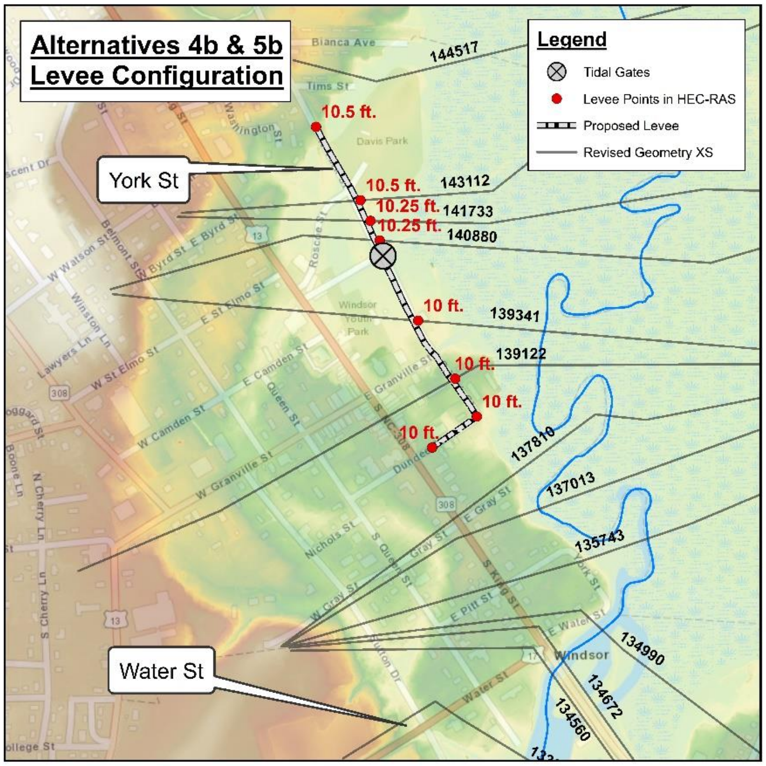

Figure 13: Alternative 4B and Alternative 5B: 10.5' – 10.0' York St Levee

Water surface elevations between the existing conditions analysis and Alternative 4b generally remain unchanged, with results differing by less than an inch across the entire model reach. Water is prevented from spilling over into the town due to the levees during lower frequency events.

Combined Detention and Levee Alternatives

For the four flood mitigation alternatives selected from the 2018 study for further analysis, two were composed of reservoirs and two were composed of levees. Alternatives 5, 5b, and 6 of this analysis investigate the impacts of combinations of levees and reservoirs.

Alternative 5 – Combination of Alt 2 and Alt 4: Upper Hoggard's Mill, Lower Hoggard's Mill, and Cashie River Reservoirs; Raise York Street to Approximately 10 feet, Raise Water Street to Approximately 10 feet

Alternative 5 consists of three proposed reservoirs: the Upper Hoggards Mill and the Lower Hoggards Mill Reservoirs located along Hoggard Mill Creek, and the Cashie River Reservoir located along the Cashie River combined with the two highest levee configurations.

To analyze this flood mitigation configuration the reduced flows computed in HEC-HMS, discussed previously, were incorporated into the hydraulic model. The levee points representing the levees at Water and York Street, discussed in the reporting of Alternative 4, were added to the cross section geometry. **Figure 12** provided previously displays the levee configuration proposed in this alternative.

For Alternative 5, water surface elevation reductions at the King Street bridge were negligible for the 20 percent event; water surface elevations were increasing lower than existing conditions for larger storm events. Alternative 5 reduces the water surface elevation by approximately 3.1 feet in the 0.1 percent event. The primary source of these reductions are the flow decreases resulting from the reservoir. These reductions in water surface elevation are similar to those seen in Alternative 2 – the mitigation alternative consisting only of the three reservoirs. **Appendix B** contains a table displaying the full range of water surface elevation impacts resulting from Alternative 5. Additional improvements are realized through the levee configuration by restricting overflow from entering the town, however, the mapping and subsequent benefit cost analysis for this updated study assume backwater effects are present from the Cashie River at Water Street – southeast of the intersection of Sutton Drive and Water Street.

Alternative 5b – Combination of Alt 2 and Alt 4: Upper Hoggard's Mill, Lower Hoggard's Mill, and Cashie River Reservoirs; Raise York Street to Approximately 10 feet, (No Water Street levee)

Alternative 5b consists of three proposed reservoirs: the Upper Hoggards Mill and the Lower Hoggards Mill Reservoirs located along Hoggard Mill Creek, and the Cashie River Reservoir located along the Cashie River combined with the highest York Street levee configuration. This configuration is identical to Alternative 5, with regards to all aspects except the Water Street levee. The Water Street levee is not included in this alternative.

To analyze this flood mitigation configuration the reduced flows computed in HEC-HMS, discussed previously, were incorporated into the revised truncated geometry. The levee points then discussed in the Alternative 4 reporting for the York Street levee were added to the cross section geometry. **Figure 13** provided previously displays the levee configuration proposed in this alternative.

For Alternative 5b, water surface elevation reductions at the King Street bridge were negligible for the 20 percent event; water surface elevations were increasingly lower than existing conditions for larger storm events. Alternative 5b reduces the water surface elevation by approximately 3.1 feet in the 0.1 percent event. The primary source of these reductions are the flow decreases resulting from the reservoir. These reductions in water surface elevation are similar to those seen in Alternative 2 and Alternative 5. **Appendix B** contains a table displaying the full range of water surface elevation impacts resulting from Alternative 5b. Additional improvements are realized through the levee configuration by restricting overflow from entering the town, however, the mapping and subsequent benefit cost analysis for this updated study assume backwater effects are present from the Cashie River at Water Street – southeast of the intersection of Sutton Drive and Water Street.

Alternative 6 – Lower Hoggard's Mill Reservoir and Raise York Street to Approximately 10 feet (No Water Street levee)

Alternative 6 consists of a single proposed reservoir: the Lower Hoggards Mill Reservoir located along Hoggard Mill Creek, combined with the highest York Street levee configuration. The Water Street levee is not included in this alternative. Alternative 6 was not initially considered, but was requested following a community meeting.

Table 7 provides the tailwater conditions used as the boundary condition for Alternative 6.

The Water Street levee was included in the hydraulic modeling in the same fashion as Alternative 4b.

Table 7: Tailwater Conditions for Alternative 6

Profile	Tailwater Elevation (ft) - Existing Conditions	Tailwater Elevation (ft) - Alt 2	Difference
20 PCT	1.65	1.7	0.05
10PCT	2.45	2.53	0.08
4 PCT	3.89	3.95	0.06
2 PCT	5.06	5.07	0.01
1 PCT	6.25	6.21	-0.04
0.5 PCT	7.46	7.34	-0.12
0.2 PCT	9.05	8.82	-0.23
0.1 PCT	10.26	9.9	-0.36

For Alternative 6, water surface elevation changes at the King Street bridge were negligible for the 20, 10, 4, and 2 percent events; water surface elevations were increasingly lower than existing conditions for larger storm events. For the 1, 0.5, 0.2, and 0.1 percent events water surface elevations at the King Street bridge are reduced from half of an inch to a quarter foot, respectively. **Appendix B** contains a table displaying the full range of water surface elevation impacts resulting from Alternative 6.

Benefit Cost Ratios

Damage Estimations

A primary goal of this study was to perform more detailed analyses of the benefit cost ratios for the alternatives selected from the 2018 study. To develop the updated benefit/cost ratios the hydrologic and hydraulic modeling was assessed and adjusted as previously discussed. Next, inundation mapping for each modeled recurrence interval event was created and manually adjusted as needed to reflect the proposed conditions. The inundation mapping and associated water surface elevation grids were used as the basis for determination of the flood damages associated with the existing conditions and the nine alternatives included in the analysis. **Figure 14** below depicts an example inundation map. Select maps for each alternative can be found in **Appendix D**.

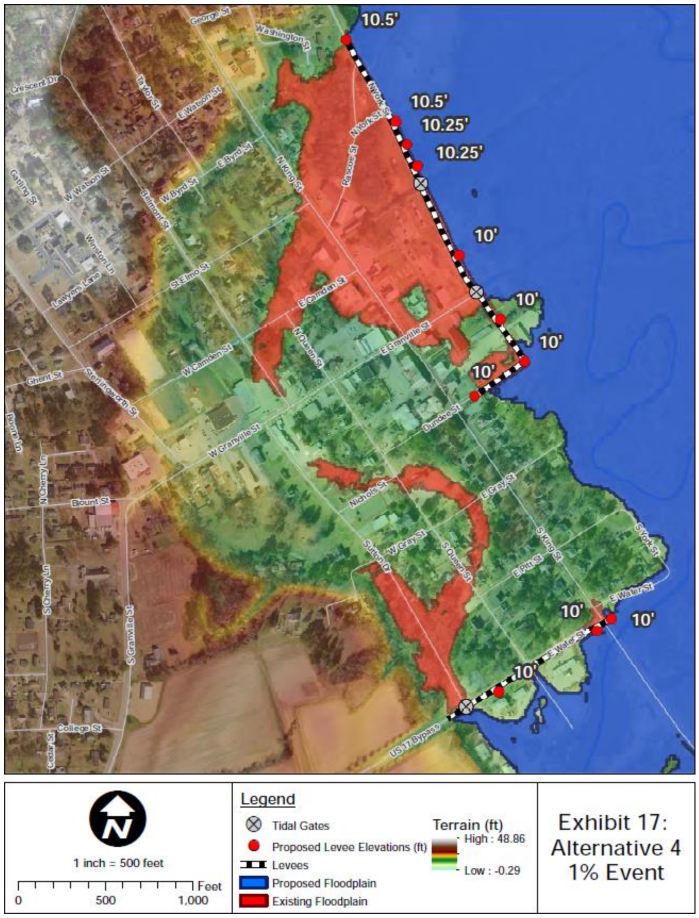

Figure 14: Example Inundation Map

North Carolina Emergency Management (NCEM) created and maintains a statewide building footprint layer. This spatial polygon file was used as the base spatial dataset for flood damage computations. The dataset contains the primary data used for the damages estimation including: spatial extent, building type, replacement value, and finished floor elevation (FFE). Prior to use, the dataset was carefully reviewed and any buildings that were no longer present were removed. The Town of Windsor has acquired, demolished and elevated a number of buildings using hazard mitigation funding. Information regarding the mitigation actions completed to date were provided by Town officials and were incorporated into the analysis by removing acquired buildings and updating FFEs for elevated buildings. The base buildings dataset used for the benefit cost analysis is a compilation of the updated information from Windsor and the large-scale dataset maintained by NCEM.

The buildings layer was compared to the multi-recurrence flood inundation raster mapping using NCEM's iRISK workflow and tools. This toolset was developed to compute direct and indirect damages to structures based on the associated water surface elevation (WSEL). The tool is used for providing statewide building risk assessments as shown on North Carolina's Flood Risk Information System (FRIS) and Flood Inundation Mapping Alert Network (FIMAN) websites. Damage calculations for buildings are based on depth-damage curves obtained from the United States Army Corps of Engineers and are specific to structure type, foundation, and occupancy type. Direct impacts consider the value of structures and associated contents, while indirect impacts consider items such as displacement and relocation costs, lost rent, lost wages, lost income, and more. For this analysis, both direct damages only as well as direct + indirect damages were considered. It is important to note that many of the building footprint attributes, such as contents value, are approximate and may be based on generalized assumptions. As such, the damage estimates performed as part of this analysis, although considered appropriate for this level of study, should be used for planning-level purposes only. A more detailed analysis to confirm building and contents value within a specified area of interest may likely produce different damage estimate results.

Once the project frequency flood elevations were associated with the building footprints, the iRISK toolset was used to estimate damages for each of the project frequency events presented below. As the building dataset and associated attributes used for damage calculations (including building values) was initially developed in 2010, an adjustment, obtained from the Bureau of Labor Statistics, of 29% was applied to convert the damages into December 2021 dollars. The analysis included the full extent of the hydraulic model used in this study, thus extending both upstream and downstream of Windsor, as depicted in **Exhibit 3**, located within **Appendix D**. **Table 8** provides a summary of the estimated building-level direct (structural and contents) damages for existing conditions and all alternatives for the analyzed flood events.

Table 8: Direct Damage Estimates

Annual Chance Event	Existing	Alt 1	Alt 2	Alt 3	Alt 3b	Alt 4	Alt 4b	Alt 5	Alt 5b	Alt 6
20%	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
10%	$ 2,679	$ 2,025	$ 2,025	$ 2,192	$ 2,192	$ 2,192	$ 2,192	$ 1,538	$ 1,538	$ 2,192
4%	$ 20,384	$ 12,467	$ 6,951	$ 12,208	$ 12,208	$ 12,208	$ 12,208	$ 4,629	$ 4,629	$ 13,869
2%	$ 155,131	$ 84,658	$ 41,690	$ 88,529	$ 88,529	$ 88,529	$ 88,529	$ 27,122	$ 27,122	$ 89,952
1%	$ 551,297	$ 234,113	$ 137,398	$ 547,028	$ 551,297	$ 275,873	$ 280,139	$ 77,143	$ 77,143	$ 268,221
0.50%	$ 1,430,289	$ 519,853	$ 316,900	$ 1,435,540	$ 1,430,289	$ 797,137	$ 814,627	$ 159,500	$ 159,500	$ 742,889
0.20%	$ 4,828,228	$ 1,138,202	$ 681,047	$ 4,845,524	$ 4,828,843	$ 4,845,373	$ 4,830,440	$ 348,097	$ 349,524	$ 4,215,009
0.10%	$10,268,043	$ 1,769,581	$ 1,111,289	$10,268,043	$10,268,043	$10,268,079	$10,268,079	$ 612,101	$ 614,151	$ 8,528,998

Another important aspect of risk analysis is annualized loss (ALE), which takes into account the probability of an event when determining the damages experienced from a flood of a certain magnitude. For this study, 30-year and 50-year time horizons were considered in defining the costs of damages to structures affected by flooding events. Annualized loss for structures impacted by project frequency events were determined as described on pages 20 and 21 in Federal Emergency Management Agency's (FEMA) "Guidance for Flood Risk Analysis and Mapping, Flood Risk Assessments, May 2016", as shown in **Figure 15** below.

$$
\begin{aligned}
\underline{\text{Annualized Loss}} \quad = \quad & (10\% - 4\%) * (\text{Loss } 10\% + \text{Loss } 4\%) / 2 + \\
& (4\% - 2\%) * (\text{Loss } 4\% + \text{Loss } 2\%) / 2 + \\
& (2\% - 1\%) * (\text{Loss } 2\% + \text{Loss } 1\%) / 2 + \\
& (1\% - 0.2\%) * (\text{Loss } 1\% + \text{Loss } 0.2\%) / 2 + \\
& 0.2\% * \text{Loss } 0.2\%
\end{aligned}
$$

Figure 15: Annualized Loss Calculations

Once an annualized loss is determined, that value can be multiplied by the time frame of interest, in this case 30 and 50 years, to determine a loss estimate for the timeframe.

Project Cost Estimation

As part of the 2018 Study, cost estimations for each of the nine proposed alternatives were computed. The line-item costs used in the 2018 study were maintained in the cost estimating for this updated analysis. In the previous study, cost estimations were provided for each individual flood mitigation element, for example the "Raise York

St to 8 FT, Water St to 10 FT" included separate pricing tables for the York Street eight-foot levee and the Water Street ten-foot levee. The pricing tables were used to obtain the quantities for several of the various items included in the alternatives. For example, the quantities for each of the three proposed reservoirs, spillway and outlet structures for the reservoirs, land acquisition needs, tide gates, and the compacted fill estimates for the ten-foot Water Street levee were all taken directly from the tables within the report of the 2018 Study. The amount of new roadway that would need to be built as part of raising the road was re-calculated for each of the levee alternatives. New fill estimates were created for the York Street levee using GIS to better represent the slightly higher levee in areas and the extension of the levee to tie-in to existing ground. As the cost estimates for the previous study were developed in 2018, an adjustment, obtained from the Bureau of Labor Statistics, of 11% was applied to convert the costs into December 2021 dollars.

Detailed cost estimate tables are provided in **Appendix C**; a summary table is provided in **Table 9**. Cost estimates for the updated alternatives were not significantly different than those from the 2018 Study. It is noted that the cost estimates used in the 2018 Study nor this updated study provide a significant level of detail, however, large contingencies are placed upon the base costs which are anticipated to cover any increase in costs associated with the high-level nature of these cost estimates. Should these projects receive further study additional efforts including detailed survey of existing conditions and geotechnical analyses will be necessary.

Table 9: Cost Estimate Comparison

Alternative	Deviance from 2018 Study	2018 Study Cost	Updated 2021 Costs	Difference
Alternative 1	For the largest storm event, the 0.1% Event, additional reservoir storage discharge curves were added to the elements representing the propsosed reservoirs in HEC-HMS. For the largest event, the reservoir stage was exceeding the values present in the table, and the model would fail. Additional values were extrapolated based on the curve present in the model provided. Adjustment to December 2021 dollars.	$ 14,780,000	$ 16,403,025	$ 1,623,025
Alternative 2	For the largest storm event, the 0.1% Event, additional reservoir storage discharge curves were added to the elements representing the propsosed reservoirs in HEC-HMS. For the largest event, the reservoir stage was exceeding the values present in the table, and the model would fail. Additional values were extrapolated based on the curve present in the model provided. Adjustment to December 2021 dollars.	$ 26,860,200	$ 29,812,658	$ 2,952,458
Alternative 3	York St levee proposed at universally 8.0' elevation in 2018 Study. Adjustment to December 2021 dollars.	$ 3,570,000	$ 3,667,385	$ 97,385
Alternative 3b	York St levee proposed at universally 8.0' elevation in 2018 Study No analysis without Water St completed. Adjustment to December 2021 dollars.	-	$ 2,584,580	-
Alternative 4	York St levee proposed at universally 10.0' elevation in 2018 Study. Adjustment to December 2021 dollars.	$ 5,250,000	$ 5,148,458	$ (101,543)
Alternative 4b	York St levee proposed at universally 10.0' elevation in 2018 Study No analysis without Water St completed. Adjustment to December 2021 dollars.	-	$ 4,065,653	-
Alternative 5	No combined reservoir and levee anlalysis completed Elevations of levees differing from 2018 study. Adjustment to December 2021 dollars.	-	$ 34,961,115	-
Alternative 5b	No combined reservoir and levee anlalysis completed. Elevations of levees differing from 2018 study. Adjustment to December 2021 dollars.	-	$ 33,878,310	-
Alternative 6	No combined reservoir and levee anlalysis completed Elevations of levees differing from 2018 study. Adjustment to December 2021 dollars.	-	$ 8,303,633	-

Benefit Cost Compilation and Review

The difference in estimated damages between the baseline and a mitigation alternative represents the annualized losses avoided (benefit) by employing each respective mitigation option. Additional potential benefits associated with the detention alternatives such as water supply or recreation were not considered. Those potential benefits often reduce the available flood storage which is the purpose of this study.

Table 10 shows the estimated annualized and 30-/50-yr timeframe losses (direct damages only), project costs, losses avoided (benefits) over 30- and 50-yr timeframes, and resulting benefit cost ratios for the considered alternatives. It is important to note that these values represent only damages resulting from flooding on the mainstem of the Cashie River; flood damages from other flooding sources in the basin are not accounted for in this analysis.

Table 10: Detailed Benefit Cost Ratios

Annual Chance Event	Existing	Alt 1	Alt 2	Alt 3	Alt 3b	Alt 4	Alt 4b	Alt 5	Alt 5b	Alt 6
	Annualized Losses (December 2021 Dollars)									
20%	$ 134	$ 101	$ 101	$ 110	$ 110	$ 110	$ 110	$ 77	$ 77	$ 110
10%	$ 692	$ 435	$ 269	$ 432	$ 432	$ 432	$ 432	$ 185	$ 185	$ 482
4%	$ 1,755	$ 971	$ 486	$ 1,007	$ 1,007	$ 1,007	$ 1,007	$ 318	$ 318	$ 1,038
2%	$ 3,532	$ 1,594	$ 895	$ 3,178	$ 3,199	$ 1,822	$ 1,843	$ 521	$ 521	$ 1,791
1%	$ 4,954	$ 1,885	$ 1,136	$ 4,956	$ 4,954	$ 2,683	$ 2,737	$ 592	$ 592	$ 2,528
0.50%	$ 9,388	$ 2,487	$ 1,497	$ 9,422	$ 9,389	$ 8,464	$ 8,468	$ 761	$ 764	$ 7,437
0.20%	$ 7,548	$ 1,454	$ 896	$ 7,557	$ 7,548	$ 7,557	$ 7,549	$ 480	$ 482	$ 6,372
0.10%	$ 10,268	$ 1,770	$ 1,111	$ 10,268	$ 10,268	$ 10,268	$ 10,268	$ 612	$ 614	$ 8,529
Annualized Losses Over 30- and 50- Year Timespan (December 2021 Dollars)										
30-yr Loss	$ 1,148,131	$ 320,897	$ 191,774	$ 1,107,887	$ 1,107,217	$ 970,262	$ 972,424	$ 106,379	$ 106,556	$ 848,584
50-yr Loss	$ 1,913,552	$ 534,828	$ 319,623	$ 1,846,479	$ 1,845,361	$ 1,617,103	$ 1,620,707	$ 177,298	$ 177,594	$ 1,414,306
Annualized Losses Avoided (Benefits) Over 30- and 50- Year Timespan (December 2021 Dollars)										
30-yr Losses Avoided	-	$ 827,234	$ 956,357	$ 40,244	$ 40,914	$ 177,869	$ 175,707	$ 1,041,752	$ 1,041,575	$ 299,547
50-yr Losses Avoided	-	$ 1,378,724	$ 1,593,928	$ 67,073	$ 68,191	$ 296,449	$ 292,845	$ 1,736,254	$ 1,735,958	$ 499,246
Project Cost (December 2021 Dollars)										
Project Cost	-	$ 16,403,025	$ 29,812,658	$ 3,667,385	$ 2,584,580	$ 5,148,458	$ 4,065,653	$ 34,961,115	$ 33,878,310	$ 8,303,633
Benefit Cost Ratios										
30Y BC Ratio	**-**	**0.05**	**0.03**	**0.01**	**0.02**	**0.03**	**0.04**	**0.03**	**0.03**	**0.04**
50Y BC Ratio	**-**	**0.08**	**0.05**	**0.02**	**0.03**	**0.06**	**0.07**	**0.05**	**0.05**	**0.06**

As seen in **Table 10**, the component ALE values for the more frequent events are not significant, indicating flood damages are limited during smaller events where the levee only alternatives provide benefit. Although damages from the largest, less frequent events can be substantially mitigated using detention alternatives, the losses avoided are not significant enough to overcome the high initial cost to implement, even over 50-years. It is noted that even if all flood damages were mitigated (30- and 50-year loss values equal to $0), none of the analyzed alternatives would produce a BC ratio of 1.0.

Table 11 provides estimated benefit cost ratios from the 2018 Study. The study did not analyze recurrence interval events as this study did, but instead focused on a single event – Hurricane Matthew. Because of this, the benefit cost ratios calculated in **Table 11** do not represent an annualized cost assessment, as is typically done in these types of assessments, but remains a reasonable point of comparison for this updated study. The benefit cost ratios computed in this updated study are in general agreement with those computed using the costs and damages detailed in the 2018 NCSU Study for the detention only alternatives, however, benefit cost ratios computed in this updated study are lower in alternatives that incorporate levees.

Table 11: 2018 Study Benefit Cost Ratios – Hurricane Matthew Event

Project Name from 2018 Study	Updated Study Alternative Name	Deviance from 2018 Study	Costs Reported in 2018 Study	Damages Reported (2018 Study)	Damages Avoided (2018 Study)	BC Ratio
				Hurricane Matthew		
Existing Conditions	-	-	-	$ 1,388,475	-	-
Lower Hoggard's Mill & Cashie River	Alt 1	Extended stage-storage table values	$ 14,780,000	$ 333,179	$ 1,055,296	**0.07**
Lower, Upper Hoggard's Mill, &	Alt 2	Extended stage-storage table values	$ 26,860,200	$ 228,517	$ 1,159,958	**0.04**
Raise York St to 8', Water St to 10'	Alt 3	York Street graded up to 8.25' along N Side	$ 3,570,000	$ 1,190,225	$ 198,250	**0.06**
Raise York St to 10', Water St to 10'	Alt 4	York Street graded up to 10.5' along N Side	$ 5,250,000	$ 767,476	$ 620,999	**0.12**

Table 12 further summarizes the benefit cost ratios computed in the updated study and how they compare to the previous study.

Table 12: Benefit Cost Summary Table

Alternative	Description	Hurricane Matthew B/C Ratio	30-yr Direct B/C Ratio	30-yr Direct + Indirect B/C Ratio	50-yr B/C Ratio	50-yr Direct + Indirect B/C Ratio
Alternative 1	Lower Hoggards Mill Reservoir Cashie River Reservoir	0.07	0.05	0.28	0.08	0.47
Alternative 2	Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir	0.04	0.03	0.19	0.05	0.31
Alternative 3	Raise York St to elevation of 8.25' to 8.0' Raise Water St to elevation of 10.0'	0.06	0.01	0.37	0.02	0.62
Alternative 3b	Raise York St to elevation of 8.25' to 8.0' (no Water St levee)	-	0.02	0.53	0.03	0.88
Alternative 4	Raise York St to elevation of 10.5' to 10.0' Raise Water St to elevation of 10.0'	0.12	0.03	0.47	0.06	0.07
Alternative 4b	Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	-	0.04	0.59	0.07	0.98
Alternative 5	Combination of Alt 2 and Alt 4: Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir Raise York St to elevation of 10.5' to 10.0' Raise Water St to elevation of 10.0'	-	0.03	0.19	0.05	0.32
Alternative 5b	Combination of Alt 2 and Alt 4b: Lower Hoggards Mill Reservoir Upper Hoggards Mill Reservoir Cashie River Reservoir Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	-	0.03	0.20	0.05	0.33
Alternative 6	Lower Hoggards Mill Reservoir Raise York St to elevation of 10.5' to 10.0' (no Water St levee)	-	0.04	0.33	0.06	0.56

Engineering Certification

Work performed for this planning level analysis of flood mitigation strategies for the Tar River basin within North Carolina was completed by ESP Associates, Inc. for North Carolina Emergency Management. This planning level study included no detailed design. All calculations, analyses, and cost estimates included in the study and contained in this report and associated appendices are conceptual and are not to be used for design or construction.

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Service: Engineering and Land Surveying

APPENDIX A –

ADDITIONAL TECHNICAL INFORMATION

2018 NCSU Study Review and Revisions

The following information is provided to document ESP's review, findings, and revisions from the 2018 NCSU study.

The 2018 report states that calibration for the model was completed using Tropical Storm Nicole, though the event is not present in the modeling received by ESP. The optimization trial present in the HEC-HMS model provided utilizes the basin model titled "MedCN-opt3noS" and storm event "Earl". Nearly all events present in the model received use the basin model titled "MedCN-opt3noS", with the notable exception being the model run titled "Matthew" which uses the basin file "Matthew".

HEC-HMS changes input parameters between versions, therefore, version 4.2.1 was held in the updates completed. To create the recurrence interval model runs, the basin file "MedCN-opt3noS" was used as the baseline. The conclusion to use this basin file stems from the fact that this was the basin file selected in the optimization run, this was the basin file used in most model runs present, and by comparing the parameters of this basin model and others to the conditions seen via aerial and elevation data in the area.

The model was reviewed using engineering judgement and the data available. The parameters included were generally deemed reasonable and acceptable for use in the recurrence storm interval modeling with the exception of one item. The HEC-HMS model was set up in US Customary Units, however, within the program, there exist additional locations where the units must be selected by the user. It was noted that the Cross Sections input, which are used in the Muskingum-Cunge hydrologic stream routing calculations, were set to meters rather than feet. The values within the model were plotted against a sampling of cross sections taken from a 2014 NCFMP terrain file. Based upon the comparison, it was determined that the data was intended to be set to the units of feet rather than meters. Although calibration appears to have occurred using the stream routing reaches set to meters, it was decided that the data should be corrected for the updated modeling. Comparisons were made to the results of the storm event Matthew (using basin file "Matthew") and for the 20 Percent and 100 Percent recurrence interval storms (using basin file "MedCN-opt3noS"). The comparisons of results from the use of meters and feet are shown in below. Asterisks within the first column of the second table indicate the elements used in the hydraulic model (J-Hogg and Jking).

HEC-HMS Results Comparison of Matthew Using Routing Units of Meters versus Feet

Matthew Event Comparison
Basin: Matthew
Storm Event: Matthew

HEC-HMS Element	Flows Using Routing Units: Meters (cfs)	Flows Using Routing Units: Feet (cfs)	Diff (ft - m)	Percent Difference
Cashie	9,398	10,350	951	10%
Hogg2	4,653	4,623	-31	1%
Hoggard	3,299	3,253	-46	1%
J428	1,297	1,297	0	0%
J-Cash2	4,090	4,102	12	0%
J-Cash3	9,649	10,584	935	9%
J-Cash4	12,551	13,654	1,103	8%
J-CashUSGS	12,707	13,334	627	5%
J-Hogg	16,465	17,032	567	3%
J-Hogg1	3,996	3,952	-44	1%
J-Hogg2	4,653	4,623	-31	1%
J-white2	1,618	1,617	-2	0%
JWindsor	16,984	17,547	564	3%
J-Windsor	16,938	17,463	525	3%
R-Cackle	703	703	0	0%
R-Cash1	1,747	1,752	5	0%
R-Cash2	4,026	4,068	43	1%
R-Cash3	9,398	10,350	951	10%
R-Cash4	12,255	12,864	610	5%
R-Cash5	12,569	13,175	605	5%
R-Cash6	16,288	16,824	536	3%
R-Cash7	16,938	17,463	525	3%
R-Conn	2,175	2,184	10	0%
R-Flat	488	488	0	0%
R-Hogg1	3,830	3,823	-7	0%
R-Hogg2	4,224	4,232	8	0%
R-Waht	1,056	1,057	1	0%
R-White	1,573	1,608	34	2%
R-White1	459	459	0	0%

HEC-HMS Results Comparison of 20 PCT and 1 PCT Event Using Routing Units of Meters versus Feet

Recurrence Interval Comparison
Basin: MedCN-opt3noS
Storm Events: 20 Percent Event and 1 Percent Event

HEC-HMS Element	20 PCT Flows Using Routing Units: Meters (cfs)	20 PCT Flows Using Routing Units: Feet (cfs)Routing Units: Feet	Diff (ft - m)	Percent Difference	1 PCT Flows Using Routing Units: Meters (cfs)	1 PCT Flows Using Routing Units: Feet (cfs)Routing Units: Feet	Diff (ft - m)	Percent Difference
Cash-res	1,166	844	-322	32%	6,753	7,844	1,092	15%
Hoggard	1,619	1,609	-9	1%	4,341	4,202	-139	3%
Hogg2	1,748	1,802	55	3%	4,638	4,587	-51	1%
***Jking**	3,146	2,272	-875	32%	12,348	12,649	301	2%
J-Cack1l	232	232	0	0%	586	586	0	0%
J-CashUSGS	1,574	1,098	-476	36%	8,717	9,057	340	4%
J-cash1	306	306	0	0%	2,192	2,192	0	0%
J-Cash2	433	417	-16	4%	3,544	3,569	25	1%
J-Cash3	1,166	844	-322	32%	6,753	7,844	1,092	15%
J-Cash4	1,493	1,121	-372	28%	8,744	9,636	892	10%
J-Flat	155	155	0	0%	398	398	0	0%
***J-Hogg**	2,913	2,125	-788	31%	11,957	12,277	320	3%
J-Hogg1	1,807	1,783	-25	1%	4,581	4,404	-178	4%
J-Hogg2	1,748	1,802	55	3%	4,638	4,587	-51	1%
J-Waht	139	139	0	0%	748	748	0	0%
J-white1	89	89	0	0%	341	341	0	0%
J-white2	300	302	2	1%	1,183	1,180	-3	0%
J-Windsor	3,126	2,268	-858	32%	12,311	12,587	276	2%
R-Cackle	232	231	0	0%	586	586	0	0%
R-Cash1	294	288	-6	2%	2,120	2,148	28	1%
R-Cash2	426	396	-29	7%	3,286	3,471	185	5%
R-Cash3	1,150	792	-358	37%	6,708	7,524	817	11%
R-Cash4	1,456	1,040	-416	33%	8,389	8,718	329	4%
R-Cash5	1,556	1,089	-467	35%	8,589	8,911	322	4%
R-Cash6	2,888	2,107	-781	31%	11,799	12,072	272	2%
R-Cash7	3,126	2,268	-858	32%	12,311	12,587	276	2%
R-Conn	306	306	0	0%	1,543	1,550	7	0%
R-Flat	154	151	-3	2%	396	397	0	0%
R-Hogg1	1,531	1,588	56	4%	4,083	4,048	-35	1%
R-Hogg2	1,328	1,316	-11	1%	3,603	3,476	-127	4%

HEC-HMS Element	20 PCT Flows Using Routing Units: Meters (cfs)	20 PCT Flows Using Routing Units: Feet (cfs)Routing Units: Feet	Diff (ft - m)	Percent Difference	1 PCT Flows Using Routing Units: Meters (cfs)	1 PCT Flows Using Routing Units: Feet (cfs)Routing Units: Feet	Diff (ft - m)	Percent Difference
R-Waht	138	138	0	0%	745	745	1	0%
R-White	299	299	0	0%	1,134	1,172	38	3%
R-White1	89	89	0	0%	341	341	0	0%

The hydraulic modeling files of the 2018 NCSU study were provided to ESP at the commencement of the study. Five HEC-RAS version 5.0.3 models were provided. Within the models, the same plans typically occurred and re-occurred. The understanding of ESP was that model copies were made through the modeling process, rather than plan additions which resulted in duplicate plans between models, however, the data within was not matching. For example, the model titled "Demo Old Bertie" contained a geometry titled "Rev_Truc" which modeled the King St. bridge as titled "Alternative #2" within the report, but the same geometry (Revised_Truc) within the model titled "CashieRatWindsor_FIMAN" shows an existing conditions bridge as shown in the NCDOT No-Rise B4434 project.

To create the updated Revised Conditions geometry, which will be used as the baseline for the mitigation analysis later in the study, the geometry "Revised_Truc" (renamed "Revised_Trunc") in the model "Demo Old Bertie" was selected as the starting point.

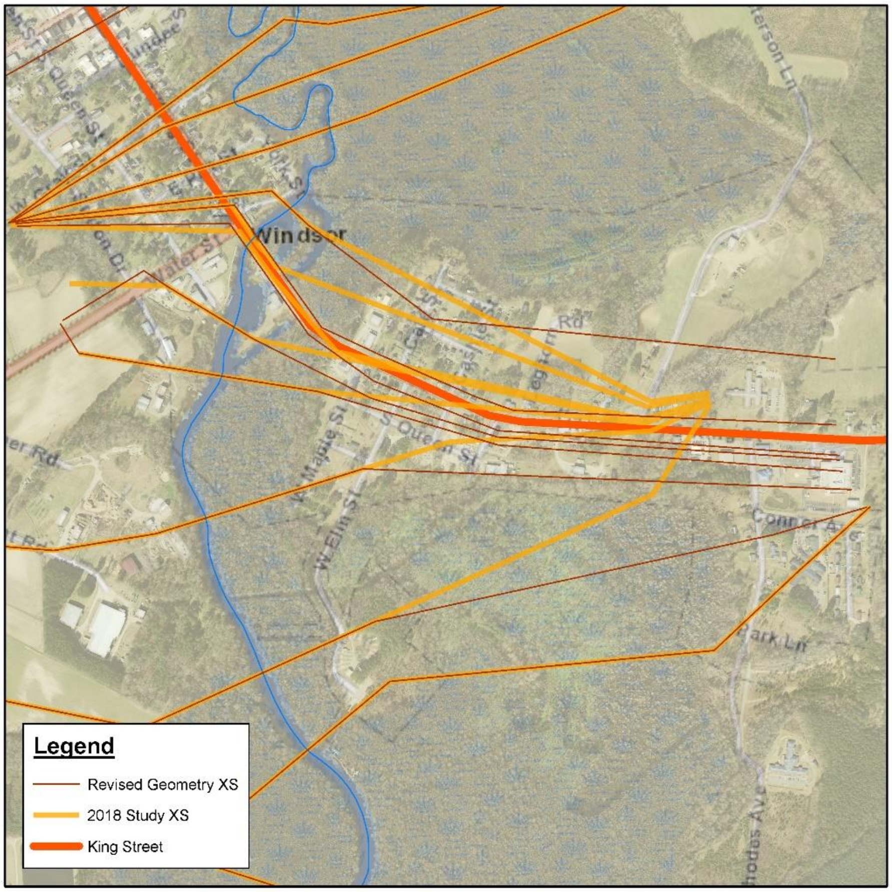
The model was first converted from HEC-RAS version 5.0.3 to the most recent approved version, which is HEC-RAS version 5.0.7. The effective model flows and geometry were run in each version to ensure no major discrepancies would result from the version update. Results of the effective model run in the truncated area of interest for each version are shown in the table below. No major inconsistencies were noted.

Comparison of Results Between HEC-RAS Versions

	10-Year Event			100-Year Event		
RS	Version 5.0.3	Version 5.0.7	Difference	Version 5.0.3	Version 5.0.7	Difference
161247	11.41	11.41	0.00	15.15	15.16	0.01
159058	10.42	10.42	0.00	14.26	14.27	0.01
158066	10.13	10.14	0.01	14.05	14.05	0.00
157519	9.89	9.89	0.00	13.58	13.59	0.01
157478	Bridge	Bridge	-	Bridge	Bridge	-
157417	9.29	9.29	0.00	12.93	12.93	0.00
157129	9.21	9.21	0.00	12.94	12.94	0.00
156783	9.14	9.15	0.01	12.89	12.89	0.00

	10-Year Event			100-Year Event		
RS	Version 5.0.3	Version 5.0.7	Difference	Version 5.0.3	Version 5.0.7	Difference
155648	8.65	8.65	0.00	12.47	12.47	0.00
155452	8.57	8.57	0.00	12.44	12.44	0.00
155432	Bridge	Bridge	-	Bridge	Bridge	-
155413	8.53	8.53	0.00	12.01	12.01	0.00
155180	8.57	8.57	0.00	12	12	0.00
154057	8.47	8.47	0.00	11.89	11.89	0.00
152015	8.26	8.26	0.00	11.65	11.65	0.00
150927	8.15	8.15	0.00	11.53	11.53	0.00
149400	7.77	7.77	0.00	11.05	11.05	0.00
148039	7.41	7.41	0.00	10.73	10.73	0.00
145812	6.73	6.73	0.00	10.09	10.09	0.00
145399	6.6	6.6	0.00	9.94	9.94	0.00
144517	6.43	6.43	0.00	9.77	9.77	0.00
143112	6.17	6.17	0.00	9.54	9.54	0.00
141733	5.93	5.93	0.00	9.34	9.34	0.00
140880	5.84	5.84	0.00	9.26	9.26	0.00
139341	5.68	5.68	0.00	9.13	9.13	0.00
137810	5.5	5.5	0.00	8.97	8.97	0.00
137013	5.41	5.41	0.00	8.87	8.87	0.00
135743	5.31	5.31	0.00	8.75	8.75	0.00
134991	5.19	5.19	0.00	8.57	8.57	0.00
134643	4.81	4.81	0.00	8.47	8.47	0.00
134616	Bridge	Bridge	-	Bridge	Bridge	-
134589	4.62	4.62	0.00	8.04	8.04	0.00
133965	4.61	4.61	0.00	7.97	7.97	0.00
133595	4.56	4.56	0.00	7.91	7.91	0.00
132451	4.43	4.43	0.00	7.76	7.76	0.00
131238	4.33	4.33	0.00	7.6	7.6	0.00
130585	4.26	4.26	0.00	7.55	7.55	0.00
129224	4.17	4.17	0.00	7.43	7.43	0.00
128238	4.09	4.09	0.00	7.34	7.34	0.00
126929	3.99	3.99	0.00	7.19	7.19	0.00
125625	3.9	3.9	0.00	7.08	7.08	0.00

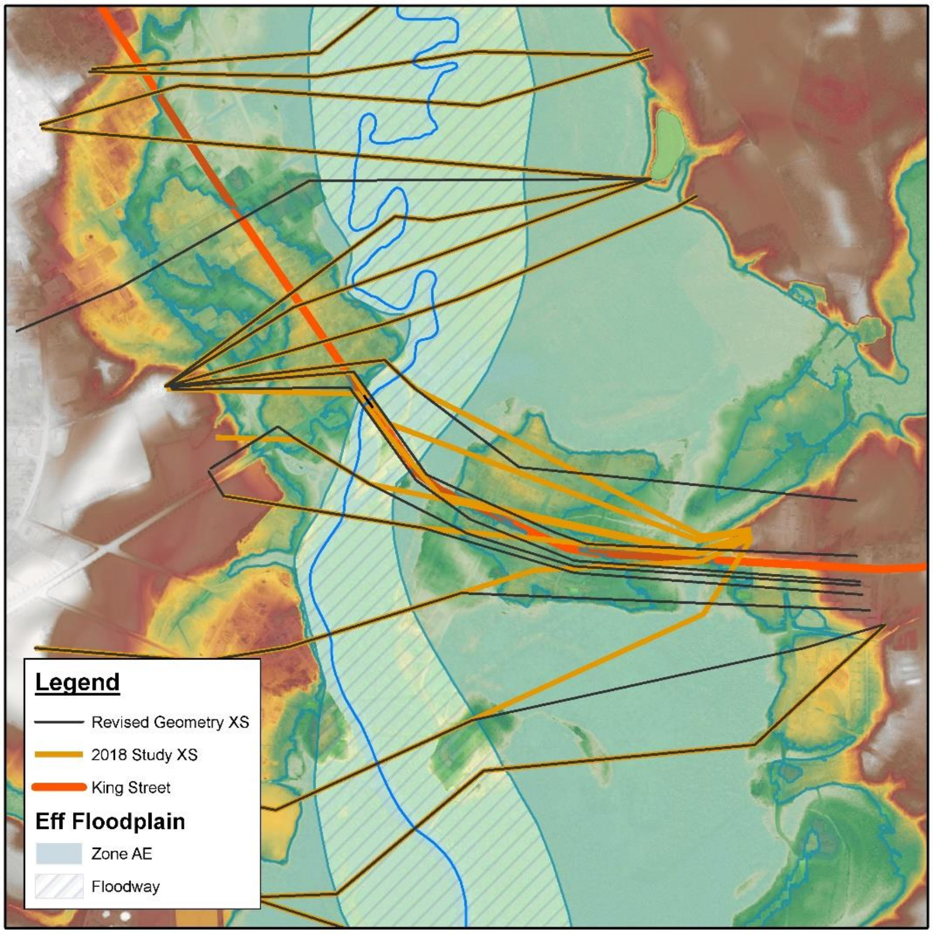
Next, the bridge at King Street was reviewed and corrected. It is noted that in the geometries modeling the existing bridge in the 2018 study, the bridge width is incorrectly entered as 35-feet rather than the 60-feet shown in the B4434 approved report and modeling, as well as through aerial confirmation. In the 2018 study the effective cross sections were maintained in the revised conditions geometry. The distance between these cross sections is approximately 50-feet, which is sufficient to model the bridge present when the effective model was created as the old bridge is approximately 40-feet wide. However, with the current bridge geometry, which includes wider driving lanes and additional sidewalks on each side of the road, the cross sections bounding the bridge needed to be moved. To account for this, the effective cross sections 134643 and 134589 were removed, and replaced with cross sections 134672 and 134560, respectively as shown in the figure below.



2018 Study Cross Sections and Updated Cross Sections at King St

Next, the existing King Street bridge was added to the model using the NCDOT No-Rise model as the basis. The NCDOT model is not georeferenced, therefore, the bridge was shifted until the bridge alignment visually matched that of the NCDOT model. The invert of the NCDOT model was used in the revised geometry as well, as per bridge measurements, the alignment of the NCDOT cross section upstream of the King St. bridge matched the updated cross section location in this study.

Cross section alignment revisions were also made to cross sections bounding King St. The effective cross section alignment crossed the road in the left overbank causing model results upstream of the road to be reflected downstream of the road, which would produce incorrect mapping products.   In addition to the direct bounding cross sections of King St., (eff. RS 134563 and 133965) cross sections 134991, 134672, 133595, 132451, and 131238 were adjusted to align more appropriately with King Street. These cross sections were maintained along the Cashie mainstem, but were adjusted in the left overbank as shown in the figure below.



2018 Study Cross Sections and Updated Cross Sections at King Street

To accurately model the mitigation alternatives proposed in the 2018 study, some cross section geometry adjustments were also necessary. Adjustments were made to the right overbank of two cross sections just downstream of the King Street bridge. These cross sections were also adjusted on the left overbank as previously noted to accurately depict overbank flows and bridge hydraulics. No adjustments were made along the stream centerline; therefore, the stream stationing remains the same as the effective modeling. The final adjustment made to accurately depict the alternatives was the addition of a cross section near the south end of York Street, between effective cross sections 139341 and 139122. The new cross section is located at river station 137810. Overbanks for this cross section were obtained from the 2014 lidar in the area; the channel geometry was interpolated from the bounding cross sections.

Next, the current QL2 LiDAR (fly date noted as 20141231) obtained from the North Carolina Spatial Data Download website was incorporated into the geometry. For the majority of the model, the data between the modeled channel banks was held as this data is assumed to be primarily based on surveyed elevations. The data on either side of the channel banks, which is based on LiDAR from 2001, was updated with the current LiDAR. The elevations between the effective model and the updated model was generally in agreement.

As noted, the data between the effective model's bank stations were generally held, however, at cross sections 161247, 159058, 158066, 157129, 156783, 155648, 155810, 152015, 150927, 149397, 148039, and 143112 - all located upstream of Windsor - the bank stations of the effective model were notably higher than the lidar elevations, therefore the bank stations were moved down to align with the current LiDAR. There was also a location where the right overbank limit of a cluster of cross sections ended on a hill. The elevation at this location was lower in the current terrain data, therefore some of the cross sections were extended to contain all of the recurrence events modeled. Cross sections 152015, 154057, and 155180 were slightly extended to obtain higher elevations within the model and contain all events.

Channel reach lengths were also adjusted for cross sections 150927, 149728, 1493967, and 148039 to match those calculated during the model revisions. It is assumed these discrepancies occurred as a result of the addition of US Route 17 to the model during the 2018 study. The cross section named 149400 was also renamed to 149397 to account for changes made to the alignment during the 2018 study.

The final revision to the 2018 study geometry was a select number of manning's roughness values. Cross sections 157519, 157417, 157129, 156783, 155648, 155452, and 155413 had roughness values of 10.0 present. Upon review of the alignment of these sections with the terrain and aerial, it seems that these were in the effective model to limit flow behind a large hill and through a pond. The values were changed to represent the land uses seen in the aerial and ineffective areas were added in to represent the pond and conveyance shadow behind the large hill.

Next, the recurrence interval run was set up in HEC-RAS. It is noted that in the 2018 study, a large portion of the Cashie River effective model downstream of Windsor was removed. The effective model ends at RS 51345 and the truncated model ends at RS 125625; this is a distance of 74,280 feet or approximately 14 river miles difference. The effective model uses a known water surface elevation of 1.18-feet as the boundary condition for each of the storm events (10-year, 50-year, 100-year, and 500-year). It appears that the 2018 study did not revise the boundary condition, and utilized the same known water surface elevation of 1.18 for all events. To establish new boundary conditions for the updated recurrence interval runs, the updated flows from HEC-HMS were input into the full effective geometry. The resulting water surface elevations were copied from cross section 125625 (the downstream cross section of the truncated model) and used as known water surface elevations for the recurrence interval runs using the truncated geometry, which will be the basis for the mitigation analysis. The table below shows the known water surface elevations used as the boundary conditions in the hydraulic modeling.

Known Water Surface Elevation Boundary Conditions use in Revised Modeling

Profile	20 PCT	10PCT	4 PCT	2 PCT	1 PCT	0.5 PCT	0.2 PCT	0.1 PCT
WSEL	1.65	2.45	3.89	5.06	6.25	7.46	9.05	10.26

The table below provides a summary of the three plans present in the hydraulic model provided.

<u>HEC-RAS Project Summary for Existing Conditions</u>

Plan	Geometry	Flow File	Description
Effective Multiple Run	Eff_Existing Conditions	Eff_Multiple	Effective conditions modeling as downloaded from North Carolina FRIS Website.
BC Multiple Run	Eff_Existing Conditions	Upd_Multiple_BC	Effective conditions geometry as downloaded from FRIS website, flows from updated HEC-HMS modeling incorporated to obtain water surface elevation for use as boundary condition in truncated model.
Revised_Truncated	Revised_Truncated	Upd_Multiple_Trunc	Model containing revised and truncated geometry as described in the memo. Flows obtained from updated HEC-HMS modeling.

The recurrence intervals calculated using HEC-HMS, as previously discussed, were run through the updated geometry and reviewed. The results were deemed reasonable, and ready for use as the baseline for analysis of the mitigation alternatives discussed in the 2018 study.

The storage discharge curves used for each reservoir alternative in the HEC-HMS modeling is shown in the table below. There were select values that were differing between the report summarizing the 2018 study and the HEC-HMS model provided as the final hydrologic model of the study. These were left as is and noted in the table below. The largest storm event, the 0.1 percent storm event, was also too large to model using the curves present in the HEC-HMS model – the stage would exceed those listed in the 2018 model and the model would fail. To remedy this, additional storage discharge curve values were added to the tables for the reservoirs. These data were created by viewing the discharge curves present in the model and extrapolating these to higher values. Data which was created using this method is denoted with a single asterisk in the table below.

Storage Discharge Curves Used in HEC-HMS Modeling

Reservoir Name	HEC-HMS Element Name	Stage (ft) *(Taken from 2018 Report)*	Storage (ac-ft)	Discharge (cfs)
Hoggard's Mill-Lower	Hoggard	0	0	0
		1	0.01	80
		2	4	225
		4	167	621
		6	511	1112
		8	1051	1663
		10	1854	2249
		12	2906	2849
		14	4197	3443
		16	5500**	3800**
		Unknown *	7000*	4000*
Hoggard's Mill-Upper	Hogg2	0	0	0
		2	26	112
		4	260	301
		6	742	524
		8	1501	758
		10	2611	985
		12	4083	1187
		14	7193	1350
		16	8672	1473
		Unknown *	10000*	1550*
		Unknown *	12000*	1600*
		Unknown *	14000*	1650*
Cashie River	Cash-res	0	0	0
		2	38	502
		4	337	1364
		6	880	2399
		8	1738	3495
		10	2990	4548
		12	4775	5455
		14	7068	6253
		16	10013	6943
		Unknown *	12000*	7200*
		Unknown *	15000*	7500*

**Indicates values were created by extrapolating previous data.*

***Indicates data not matching between final report and modeling provided.*

Impact on Flow from Proposed Reservoirs

It is notable that for Alternatives 1 and 6, slight increases in discharge are reported for lower recurrence interval events. This is a result of the impact on timing from the construction of reservoirs. Reservoirs are meant to retain water and slowly release, resulting in a lower but more drawn out peak flow. The Alternative 1 calculations report an increase of approximately 3% in the lowest event analyzed: the 5-year recurrence interval. The Alternative 6 calculations report increases of approximately 6%, 4%, 2%, and 0.4% for the 5-, 10-, 25- and 5-year recurrence intervals, respectively. As the associated detention structures are upstream of Windsor, it would be expected that discharges for all analyzed flood events would be decreased throughout the city. The increases along the Cashie River are due to the timing of the river systems within the area. For the higher frequency storms in the area, the Hoggard's Mill reach, peaks sooner than the Cashie River. Retaining flows on this stream lowers the peak inflow to the Cashie River where the two streams meet, but also increases the flow that is leaving Hoggard's Mill at the time the Cashie River currently peaks. This is one of the reasons the proposed Alternative 2, which includes retention on both stream reaches, is more significant than the alternatives proposing retention only on Hoggard's Mill.

Hydraulic Modeling of the Alternatives

The table below details the plans constructed in HEC-RAS to assess the existing conditions of the area and the nine mitigation strategies.

HEC-RAS Plan Structure

Plan	Geometry	Flow File	Description
Effective Multiple Run	Eff_Existing Conditions	Eff_Multiple	Effective conditions modeling as downloaded from North Carolina FRIS Website.
BC Multiple Run	Eff_Existing Conditions	Upd_Multiple_BC	Effective conditions geometry as downloaded from FRIS website, flows from updated HEC-HMS modeling incorporated to obtain water surface elevation for use as boundary condition in truncated model.
Revised_Truncated	Revised_Truncated	Upd_Multiple_Trunc	Model containing revised and truncated geometry as described in the memo. Flows obtained from updated HEC-HMS modeling.
Alternative 1	Revised_Truncated	Alt1_Flows	Model containing revised and truncated geometry as described in the memo. Flows obtained from updated HEC-HMS modeling, which includes routing through two proposed reservoirs.
Alternative 2	Revised_Truncated	Alt2_Flows	Model containing revised and truncated geometry as described in the memo. Flows obtained from updated HEC-HMS modeling, which includes routing through three proposed reservoirs.
Alternative 3	Alt3_8ftYorkSt_10ftWaterSt	Upd_Multiple_Trunc	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of two levees: raised York Street on the east side of town, and raised Water Street on the south side of town. Flows obtained from updated HEC-HMS modeling.
Alternative 3B	Alt3B_8ftYorkSt	Upd_Multiple_Trunc	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of a single levee - a raised York Street on the east side of town. Flows obtained from updated HEC-HMS modeling.

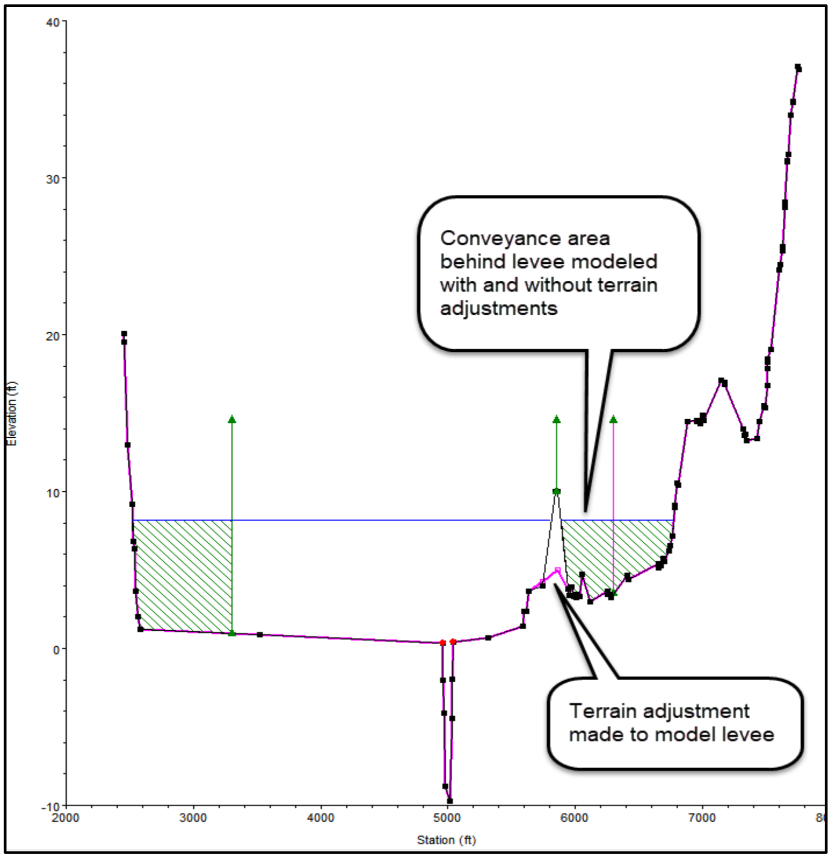
Alternative 4	Alt4_10ftYorkSt_10ftWaterSt	Upd_Multiple_Trunc	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of two levees: raised York Street on the east side of town, and raised Water Street on the south side of town. Flows obtained from updated HEC-HMS modeling.
Alternative 4B	Alt4B_10ftYorkSt	Upd_Multiple_Trunc	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of a single levee - a raised York Street on the east side of town. Flows obtained from updated HEC-HMS modeling.
Alternative 5	Alt4_10ftYorkSt_10ftWaterSt	Alt2_Flows	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of two levees: raised York Street on the east side of town, and raised Water Street on the south side of town. Flows obtained from updated HEC-HMS modeling, which include routing through three proposed reservoirs.
Alternative 5B	Alt4B_10ftYorkSt	Alt2_Flows	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of a single levee - a raised York Street on the east side of town. Flows obtained from updated HEC-HMS modeling, which include routing through three proposed reservoirs.
Alternative 6	Alt4B_10ftYorkSt	Alt6_Flows	Model containing revised and truncated geometry as described in the memo as the baseline, with the addition of a single levee - a raised York Street on the east side of town. Flows obtained from updated HEC-HMS modeling, which include routing through one proposed reservoir.
BC Alt 1 Run	Eff_Existing Conditions	Alt1_BC	Model containing revised and truncated geometry as described in the memo. Flows from updated HEC-HMS modeling incorporated to obtain water surface elevation for use as boundary condition in Alternative 1 model.

BC Alt 2 Run	Eff_Existing Conditions	Alt2_BC	Model containing revised and truncated geometry as described in the memo. Flows from updated HEC-HMS modeling incorporated to obtain water surface elevation for use as boundary condition in Alternative 2 model.
BC Alt 6 Run	Eff_Existing Conditions	Alt6_BC	Model containing revised and truncated geometry as described in the memo. Flows from updated HEC-HMS modeling incorporated to obtain water surface elevation for use as boundary condition in Alternative 6 model.

The first step in assessing the hydraulic implications of the reservoirs was to assess the impacts to the tailwater conditions. The same method used for the existing conditions hydraulics was used for the alternatives analysis.

To establish new boundary conditions for the updated recurrence interval runs, the updated flows from HEC-HMS were input into the full effective geometry. The resulting water surface elevations were copied from cross section 125625 (the downstream cross section of the truncated model) and used as known water surface elevations for the recurrence interval runs using the truncated geometry.

It is understood that for the 2018 study, incomplete modeling was used for the assessment of the levees. To model the levees, the ground elevation was raised at their proposed location. Steady state HEC-RAS is a basic program, and does not differentiate flow patterns for riverine flow. Instead, it places flow in any location possible based on elevations of hydraulic cross sections; meaning it will assign conveyance area to disconnected areas that riverine flow may not actually reach, as depicted in the figure below. This modeling scheme will typically result in lower water surface elevations, as conveyance area that may not be available in reality, is modeled as available.



HEC-RAS Modeling Method – 2018 Study

To model the levees using a simple HEC-RAS methodology (no lateral structures, split flows, or 2-dimensional areas) levee points were used in the program. This method allows a user to set a station and elevation of a proposed levee, where conveyance area will not be modeled on any overbank areas beyond this point, until the elevation specified is overtopped.

APPENDIX B –

WATER SURFACE ELEVATION RESULTS

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference	Existing Conditions	Alt 1	Difference
161247	6.98	7.05	0.07	8.91	8.84	-0.07	11.36	10.97	-0.39	13.11	12.37	-0.74	14.68	13.45	-1.23	16.02	14.55	-1.47	17.52	15.54	-1.98	18.77	16.25	-2.52
159058	6.27	6.34	0.07	8.19	8.12	-0.07	10.61	10.22	-0.39	12.35	11.63	-0.72	13.88	12.67	-1.21	15.12	13.76	-1.36	16.94	14.69	-2.25	18.22	15.37	-2.85
158066	6.12	6.19	0.07	8.04	7.97	-0.07	10.45	10.07	-0.38	12.22	11.48	-0.74	13.75	12.53	-1.22	15.00	13.63	-1.37	16.81	14.57	-2.24	18.09	15.25	-2.84
157519	5.96	6.03	0.07	7.80	7.73	-0.07	10.08	9.72	-0.36	11.75	11.05	-0.70	13.13	12.02	-1.11	14.19	13.04	-1.15	16.71	13.83	-2.88	17.99	14.83	-3.16
157478	Bridge - US 13																							
157417	5.35	5.42	0.07	7.15	7.08	-0.07	9.38	9.03	-0.35	11.01	10.33	-0.68	12.35	11.27	-1.08	13.51	12.26	-1.25	14.93	13.24	-1.69	15.89	13.77	-2.12
157129	5.26	5.32	0.06	7.06	6.99	-0.07	9.32	8.96	-0.36	10.96	10.28	-0.68	12.32	11.22	-1.10	13.51	12.23	-1.28	14.75	13.23	-1.52	15.84	13.77	-2.07
156783	5.17	5.24	0.07	6.98	6.91	-0.07	9.24	8.88	-0.36	10.89	10.20	-0.69	12.24	11.14	-1.10	13.42	12.16	-1.26	14.64	13.14	-1.50	15.77	13.68	-2.09
155648	4.90	4.96	0.06	6.61	6.54	-0.07	8.82	8.46	-0.36	10.47	9.78	-0.69	11.80	10.69	-1.11	12.93	11.72	-1.21	14.24	12.68	-1.56	15.47	13.19	-2.28
155452	4.87	4.94	0.07	6.54	6.47	-0.07	8.57	8.25	-0.32	10.39	9.43	-0.96	11.70	10.60	-1.10	12.81	11.62	-1.19	14.13	12.57	-1.56	15.38	13.07	-2.31
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.92	0.06	6.51	6.44	-0.07	8.51	8.20	-0.31	10.04	9.36	-0.68	11.09	10.18	-0.91	12.35	11.02	-1.33	14.12	12.00	-2.12	15.38	12.67	-2.71
155180	4.79	4.85	0.06	6.44	6.38	-0.06	8.49	8.17	-0.32	9.98	9.37	-0.61	11.09	10.19	-0.90	12.34	11.02	-1.32	14.10	11.99	-2.11	15.36	12.65	-2.71
154057	4.64	4.70	0.06	6.24	6.18	-0.06	8.26	7.94	-0.32	9.74	9.14	-0.60	10.98	10.08	-0.90	12.23	10.91	-1.32	14.01	11.88	-2.13	15.27	12.55	-2.72
152015	4.48	4.54	0.06	6.05	5.98	-0.07	8.05	7.73	-0.32	9.51	8.92	-0.59	10.78	9.89	-0.89	12.03	10.71	-1.32	13.80	11.68	-2.12	15.06	12.35	-2.71
150927	4.40	4.46	0.06	5.96	5.89	-0.07	7.95	7.63	-0.32	9.41	8.82	-0.59	10.67	9.78	-0.89	11.91	10.60	-1.31	13.67	11.56	-2.11	14.92	12.22	-2.70
149611	4.30	4.36	0.06	5.83	5.77	-0.06	7.80	7.49	-0.31	9.25	8.66	-0.59	10.49	9.62	-0.87	11.71	10.43	-1.28	13.46	11.37	-2.09	14.68	12.02	-2.66
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.30	0.05	5.75	5.69	-0.06	7.70	7.39	-0.31	9.13	8.55	-0.58	10.35	9.50	-0.85	11.56	10.29	-1.27	13.27	11.22	-2.05	14.48	11.86	-2.62
148039	4.10	4.15	0.05	5.58	5.52	-0.06	7.51	7.20	-0.31	8.95	8.37	-0.58	10.16	9.31	-0.85	11.35	10.09	-1.26	13.06	11.01	-2.05	14.27	11.66	-2.61
145812	3.76	3.82	0.06	5.20	5.14	-0.06	7.12	6.81	-0.31	8.55	7.98	-0.57	9.72	8.90	-0.82	10.88	9.66	-1.22	12.57	10.55	-2.02	13.75	11.19	-2.56
145399	3.67	3.72	0.05	5.07	5.01	-0.06	6.98	6.67	-0.31	8.41	7.84	-0.57	9.56	8.75	-0.81	10.71	9.50	-1.21	12.38	10.38	-2.00	13.54	11.01	-2.53
144517	3.51	3.56	0.05	4.89	4.83	-0.06	6.80	6.49	-0.31	8.23	7.66	-0.57	9.37	8.57	-0.80	10.50	9.31	-1.19	12.17	10.17	-2.00	13.32	10.81	-2.51
143112	3.27	3.32	0.05	4.66	4.60	-0.06	6.59	6.29	-0.30	8.04	7.47	-0.57	9.16	8.38	-0.78	10.29	9.10	-1.19	11.95	9.96	-1.99	13.09	10.59	-2.50
141733	3.05	3.10	0.05	4.44	4.38	-0.06	6.40	6.09	-0.31	7.85	7.28	-0.57	8.96	8.19	-0.77	10.07	8.90	-1.17	11.73	9.75	-1.98	12.85	10.37	-2.48
140880	2.93	2.98	0.05	4.33	4.27	-0.06	6.30	5.99	-0.31	7.76	7.19	-0.57	8.87	8.10	-0.77	9.97	8.81	-1.16	11.63	9.64	-1.99	12.74	10.27	-2.47
139341	2.66	2.70	0.04	4.06	4.00	-0.06	6.10	5.78	-0.32	7.59	7.02	-0.57	8.69	7.93	-0.76	9.79	8.63	-1.16	11.45	9.46	-1.99	12.56	10.09	-2.47
139122	2.62	2.67	0.05	4.03	3.97	-0.06	6.07	5.75	-0.32	7.56	6.98	-0.58	8.65	7.89	-0.76	9.75	8.59	-1.16	11.40	9.42	-1.98	12.51	10.05	-2.46
137810	2.42	2.46	0.04	3.85	3.79	-0.06	5.95	5.62	-0.33	7.46	6.88	-0.58	8.55	7.80	-0.75	9.64	8.49	-1.15	11.30	9.31	-1.99	12.40	9.94	-2.46
137013	2.32	2.37	0.05	3.73	3.67	-0.06	5.83	5.50	-0.33	7.34	6.76	-0.58	8.41	7.67	-0.74	9.49	8.36	-1.13	11.14	9.16	-1.98	12.23	9.79	-2.44
135743	2.22	2.26	0.04	3.58	3.51	-0.07	5.67	5.34	-0.33	7.18	6.61	-0.57	8.23	7.51	-0.72	9.29	8.18	-1.11	10.93	8.96	-1.97	12.00	9.59	-2.41
134990	2.16	2.20	0.04	3.47	3.41	-0.06	5.51	5.19	-0.32	7.00	6.44	-0.56	8.00	7.31	-0.69	9.01	7.95	-1.06	10.61	8.69	-1.92	11.78	9.30	-2.48
134672	2.08	2.12	0.04	3.26	3.21	-0.05	5.07	4.80	-0.27	6.90	6.35	-0.55	7.89	7.21	-0.68	8.89	7.84	-1.05	10.48	8.57	-1.91	11.69	9.18	-2.51
134606	Bridge - King St																							
134560	1.95	1.98	0.03	3.08	3.02	-0.06	4.80	4.52	-0.28	6.14	5.58	-0.56	7.44	6.52	-0.92	8.72	7.37	-1.35	10.37	8.38	-1.99	11.57	9.02	-2.55
133965	1.93	1.97	0.04	3.05	3.00	-0.05	4.79	4.50	-0.29	6.09	5.54	-0.55	7.36	6.46	-0.90	8.62	7.30	-1.32	10.27	8.29	-1.98	11.50	8.92	-2.58
133595	1.91	1.94	0.03	3.00	2.95	-0.05	4.72	4.44	-0.28	6.01	5.47	-0.54	7.27	6.37	-0.90	8.52	7.21	-1.31	10.17	8.19	-1.98	11.44	8.82	-2.62
132451	1.87	1.90	0.03	2.91	2.86	-0.05	4.56	4.29	-0.27	5.82	5.29	-0.53	7.07	6.18	-0.89	8.32	7.01	-1.31	9.97	7.99	-1.98	11.21	8.62	-2.59
131238	1.83	1.86	0.03	2.83	2.78	-0.05	4.45	4.18	-0.27	5.69	5.16	-0.53	6.92	6.04	-0.88	8.16	6.86	-1.30	9.79	7.83	-1.96	11.03	8.46	-2.57
130585	1.79	1.82	0.03	2.76	2.71	-0.05	4.36	4.09	-0.27	5.60	5.07	-0.53	6.83	5.95	-0.88	8.08	6.77	-1.31	9.71	7.75	-1.96	10.95	8.37	-2.58
129224	1.75	1.78	0.03	2.68	2.63	-0.05	4.24	3.97	-0.27	5.46	4.94	-0.52	6.69	5.81	-0.88	7.92	6.63	-1.29	9.55	7.60	-1.95	10.78	8.22	-2.56
128238	1.73	1.75	0.02	2.62	2.57	-0.05	4.15	3.89	-0.26	5.36	4.84	-0.52	6.58	5.71	-0.87	7.81	6.52	-1.29	9.43	7.49	-1.94	10.66	8.11	-2.55
126929	1.70	1.72	0.02	2.55	2.50	-0.05	4.02	3.77	-0.25	5.20	4.70	-0.50	6.39	5.54	-0.85	7.61	6.33	-1.28	9.20	7.29	-1.91	10.41	7.90	-2.51
125625	1.65	1.67	0.02	2.45	2.41	-0.04	3.89	3.64	-0.25	5.06	4.56	-0.50	6.25	5.40	-0.85	7.46	6.19	-1.27	9.05	7.14	-1.91	10.26	7.75	-2.51

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference	Existing Conditions	Alt 2	Difference
161247	6.98	6.90	-0.08	8.91	8.57	-0.34	11.36	10.51	-0.85	13.11	11.80	-1.31	14.68	12.91	-1.77	16.02	13.76	-2.26	17.52	14.95	-2.57	18.77	15.49	-3.28
159058	6.27	6.18	-0.09	8.19	7.84	-0.35	10.61	9.77	-0.84	12.35	11.06	-1.29	13.88	12.17	-1.71	15.12	13.00	-2.12	16.94	14.18	-2.76	18.22	14.65	-3.57
158066	6.12	6.03	-0.09	8.04	7.69	-0.35	10.45	9.62	-0.83	12.22	10.91	-1.31	13.75	12.05	-1.70	15.00	12.87	-2.13	16.81	14.07	-2.74	18.09	14.53	-3.56
157519	5.96	5.87	-0.09	7.80	7.46	-0.34	10.08	9.29	-0.79	11.75	10.51	-1.24	13.13	11.60	-1.53	14.19	12.33	-1.86	16.71	13.46	-3.25	17.99	13.81	-4.18
157478	Bridge - US 13																							
157417	5.35	5.26	-0.09	7.15	6.82	-0.33	9.38	8.61	-0.77	11.01	9.81	-1.20	12.35	10.87	-1.48	13.51	11.58	-1.93	14.93	12.68	-2.25	15.89	13.23	-2.66
157129	5.26	5.16	-0.10	7.06	6.73	-0.33	9.32	8.54	-0.78	10.96	9.75	-1.21	12.32	10.82	-1.50	13.51	11.54	-1.97	14.75	12.65	-2.10	15.84	13.21	-2.63
156783	5.17	5.08	-0.09	6.98	6.65	-0.33	9.24	8.46	-0.78	10.89	9.67	-1.22	12.24	10.75	-1.49	13.42	11.46	-1.96	14.64	12.58	-2.06	15.77	13.14	-2.63
155648	4.90	4.81	-0.09	6.61	6.29	-0.32	8.82	8.04	-0.78	10.47	9.26	-1.21	11.80	10.34	-1.46	12.93	11.02	-1.91	14.24	12.14	-2.10	15.47	12.67	-2.80
155452	4.87	4.79	-0.08	6.54	6.24	-0.30	8.57	7.87	-0.70	10.39	8.97	-1.42	11.70	9.93	-1.77	12.81	10.93	-1.88	14.13	12.05	-2.08	15.38	12.56	-2.82
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.77	-0.09	6.51	6.21	-0.30	8.51	7.82	-0.69	10.04	8.90	-1.14	11.09	9.91	-1.18	12.35	10.45	-1.90	14.12	11.35	-2.77	15.38	11.99	-3.39
155180	4.79	4.70	-0.09	6.44	6.14	-0.30	8.49	7.78	-0.71	9.98	8.89	-1.09	11.09	9.84	-1.25	12.34	10.46	-1.88	14.10	11.35	-2.75	15.36	11.98	-3.38
154057	4.64	4.55	-0.09	6.24	5.95	-0.29	8.26	7.56	-0.70	9.74	8.66	-1.08	10.98	9.61	-1.37	12.23	10.34	-1.89	14.01	11.24	-2.77	15.27	11.87	-3.40
152015	4.48	4.40	-0.08	6.05	5.76	-0.29	8.05	7.35	-0.70	9.51	8.45	-1.06	10.78	9.38	-1.40	12.03	10.15	-1.88	13.80	11.04	-2.76	15.06	11.67	-3.39
150927	4.40	4.32	-0.08	5.96	5.67	-0.29	7.95	7.25	-0.70	9.41	8.35	-1.06	10.67	9.28	-1.39	11.91	10.04	-1.87	13.67	10.92	-2.75	14.92	11.55	-3.37
149611	4.30	4.22	-0.08	5.83	5.55	-0.28	7.80	7.11	-0.69	9.25	8.20	-1.05	10.49	9.12	-1.37	11.71	9.88	-1.83	13.46	10.74	-2.72	14.68	11.36	-3.32
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.17	-0.08	5.75	5.47	-0.28	7.70	7.02	-0.68	9.13	8.09	-1.04	10.35	9.01	-1.34	11.56	9.75	-1.81	13.27	10.60	-2.67	14.48	11.21	-3.27
148039	4.10	4.02	-0.08	5.58	5.30	-0.28	7.51	6.83	-0.68	8.95	7.91	-1.04	10.16	8.83	-1.33	11.35	9.56	-1.79	13.06	10.41	-2.65	14.27	11.01	-3.26
145812	3.76	3.69	-0.07	5.20	4.93	-0.27	7.12	6.44	-0.68	8.55	7.52	-1.03	9.72	8.43	-1.29	10.88	9.14	-1.74	12.57	9.96	-2.61	13.75	10.54	-3.21
145399	3.67	3.60	-0.07	5.07	4.80	-0.27	6.98	6.30	-0.68	8.41	7.38	-1.03	9.56	8.28	-1.28	10.71	8.99	-1.72	12.38	9.80	-2.58	13.54	10.37	-3.17
144517	3.51	3.44	-0.07	4.89	4.62	-0.27	6.80	6.12	-0.68	8.23	7.20	-1.03	9.37	8.11	-1.26	10.50	8.81	-1.69	12.17	9.60	-2.57	13.32	10.17	-3.15
143112	3.27	3.21	-0.06	4.66	4.39	-0.27	6.59	5.91	-0.68	8.04	7.01	-1.03	9.16	7.92	-1.24	10.29	8.61	-1.68	11.95	9.39	-2.56	13.09	9.95	-3.14
141733	3.05	2.98	-0.07	4.44	4.17	-0.27	6.40	5.71	-0.69	7.85	6.82	-1.03	8.96	7.73	-1.23	10.07	8.42	-1.65	11.73	9.19	-2.54	12.85	9.74	-3.11
140880	2.93	2.86	-0.07	4.33	4.05	-0.28	6.30	5.61	-0.69	7.76	6.73	-1.03	8.87	7.65	-1.22	9.97	8.33	-1.64	11.63	9.09	-2.54	12.74	9.64	-3.10
139341	2.66	2.59	-0.07	4.06	3.78	-0.28	6.10	5.38	-0.72	7.59	6.54	-1.05	8.69	7.47	-1.22	9.79	8.16	-1.63	11.45	8.91	-2.54	12.56	9.46	-3.10
139122	2.62	2.56	-0.06	4.03	3.75	-0.28	6.07	5.35	-0.72	7.56	6.51	-1.05	8.65	7.44	-1.21	9.75	8.12	-1.63	11.40	8.87	-2.53	12.51	9.41	-3.10
137810	2.42	2.35	-0.07	3.85	3.56	-0.29	5.95	5.22	-0.73	7.46	6.40	-1.06	8.55	7.34	-1.21	9.64	8.02	-1.62	11.30	8.77	-2.53	12.40	9.31	-3.09
137013	2.32	2.26	-0.06	3.73	3.44	-0.29	5.83	5.09	-0.74	7.34	6.28	-1.06	8.41	7.22	-1.19	9.49	7.89	-1.60	11.14	8.63	-2.51	12.23	9.16	-3.07
135743	2.22	2.16	-0.06	3.58	3.29	-0.29	5.67	4.93	-0.74	7.18	6.12	-1.06	8.23	7.06	-1.17	9.29	7.73	-1.56	10.93	8.44	-2.49	12.00	8.96	-3.04
134990	2.16	2.11	-0.05	3.47	3.19	-0.28	5.51	4.79	-0.72	7.00	5.96	-1.04	8.00	6.89	-1.11	9.01	7.52	-1.49	10.61	8.20	-2.41	11.78	8.69	-3.09
134672	2.08	2.03	-0.05	3.26	3.02	-0.24	5.07	4.44	-0.63	6.90	5.47	-1.43	7.89	6.79	-1.10	8.89	7.42	-1.47	10.48	8.08	-2.40	11.69	8.57	-3.12
134606	Bridge - King St																							
134560	1.95	1.91	-0.04	3.08	2.84	-0.24	4.80	4.20	-0.60	6.14	5.13	-1.01	7.44	6.02	-1.42	8.72	6.78	-1.94	10.37	7.71	-2.66	11.57	8.37	-3.20
133965	1.93	1.89	-0.04	3.05	2.81	-0.24	4.79	4.17	-0.62	6.09	5.12	-0.97	7.36	5.97	-1.39	8.62	6.72	-1.90	10.27	7.63	-2.64	11.50	8.28	-3.22
133595	1.91	1.87	-0.04	3.00	2.77	-0.23	4.72	4.11	-0.61	6.01	5.05	-0.96	7.27	5.89	-1.38	8.52	6.63	-1.89	10.17	7.54	-2.63	11.44	8.18	-3.26
132451	1.87	1.83	-0.04	2.91	2.69	-0.22	4.56	3.98	-0.58	5.82	4.88	-0.94	7.07	5.71	-1.36	8.32	6.43	-1.89	9.97	7.34	-2.63	11.21	7.98	-3.23
131238	1.83	1.79	-0.04	2.83	2.62	-0.21	4.45	3.87	-0.58	5.69	4.76	-0.93	6.92	5.57	-1.35	8.16	6.29	-1.87	9.79	7.19	-2.60	11.03	7.82	-3.21
130585	1.79	1.75	-0.04	2.76	2.55	-0.21	4.36	3.78	-0.58	5.60	4.67	-0.93	6.83	5.48	-1.35	8.08	6.20	-1.88	9.71	7.10	-2.61	10.95	7.74	-3.21
129224	1.75	1.72	-0.03	2.68	2.47	-0.21	4.24	3.67	-0.57	5.46	4.54	-0.92	6.69	5.35	-1.34	7.92	6.06	-1.86	9.55	6.95	-2.60	10.78	7.59	-3.19
128238	1.73	1.69	-0.04	2.62	2.42	-0.20	4.15	3.59	-0.56	5.36	4.45	-0.91	6.58	5.25	-1.33	7.81	5.96	-1.85	9.43	6.85	-2.58	10.66	7.48	-3.18
126929	1.70	1.66	-0.04	2.55	2.36	-0.19	4.02	3.48	-0.54	5.20	4.31	-0.89	6.39	5.09	-1.30	7.61	5.78	-1.83	9.20	6.65	-2.55	10.41	7.28	-3.13
125625	1.65	1.62	-0.03	2.45	2.27	-0.18	3.89	3.36	-0.53	5.06	4.18	-0.88	6.25	4.95	-1.30	7.46	5.64	-1.82	9.05	6.51	-2.54	10.26	7.13	-3.13

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference	Existing Conditions	Alt 3	Difference
161247	6.98	6.98	0.00	8.91	8.92	0.01	11.36	11.36	0.00	13.11	13.11	0.00	14.68	14.68	0.00	16.02	16.02	0.00	17.52	17.52	0.00	18.77	18.77	0.00
159058	6.27	6.27	0.00	8.19	8.19	0.00	10.61	10.61	0.00	12.35	12.35	0.00	13.88	13.88	0.00	15.12	15.12	0.00	16.94	16.94	0.00	18.22	18.22	0.00
158066	6.12	6.12	0.00	8.04	8.04	0.00	10.45	10.46	0.01	12.22	12.23	0.01	13.75	13.75	0.00	15.00	15.00	0.00	16.81	16.82	0.01	18.09	18.09	0.00
157519	5.96	5.96	0.00	7.80	7.80	0.00	10.08	10.08	0.00	11.75	11.75	0.00	13.13	13.13	0.00	14.19	14.19	0.00	16.71	16.71	0.00	17.99	17.99	0.00
157478	Bridge - US 13																							
157417	5.35	5.35	0.00	7.15	7.15	0.00	9.38	9.39	0.01	11.01	11.02	0.01	12.35	12.35	0.00	13.51	13.51	0.00	14.93	14.93	0.00	15.89	15.89	0.00
157129	5.26	5.26	0.00	7.06	7.06	0.00	9.32	9.32	0.00	10.96	10.97	0.01	12.32	12.32	0.00	13.51	13.51	0.00	14.75	14.75	0.00	15.84	15.84	0.00
156783	5.17	5.17	0.00	6.98	6.98	0.00	9.24	9.24	0.00	10.89	10.90	0.01	12.24	12.24	0.00	13.42	13.42	0.00	14.64	14.64	0.00	15.77	15.77	0.00
155648	4.90	4.90	0.00	6.61	6.61	0.00	8.82	8.82	0.00	10.47	10.48	0.01	11.80	11.80	0.00	12.93	12.93	0.00	14.24	14.25	0.01	15.47	15.47	0.00
155452	4.87	4.87	0.00	6.54	6.54	0.00	8.57	8.58	0.01	10.39	10.40	0.01	11.70	11.70	0.00	12.81	12.81	0.00	14.13	14.13	0.00	15.38	15.38	0.00
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.86	0.00	6.51	6.51	0.00	8.51	8.52	0.01	10.04	10.05	0.01	11.09	11.09	0.00	12.35	12.35	0.00	14.12	14.12	0.00	15.38	15.38	0.00
155180	4.79	4.79	0.00	6.44	6.44	0.00	8.49	8.50	0.01	9.98	9.98	0.00	11.09	11.09	0.00	12.34	12.34	0.00	14.10	14.11	0.01	15.36	15.36	0.00
154057	4.64	4.64	0.00	6.24	6.24	0.00	8.26	8.27	0.01	9.74	9.75	0.01	10.98	10.98	0.00	12.23	12.23	0.00	14.01	14.01	0.00	15.27	15.27	0.00
152015	4.48	4.48	0.00	6.05	6.05	0.00	8.05	8.05	0.00	9.51	9.52	0.01	10.78	10.78	0.00	12.03	12.03	0.00	13.80	13.81	0.01	15.06	15.06	0.00
150927	4.40	4.40	0.00	5.96	5.96	0.00	7.95	7.95	0.00	9.41	9.42	0.01	10.67	10.67	0.00	11.91	11.91	0.00	13.67	13.67	0.00	14.92	14.92	0.00
149611	4.30	4.30	0.00	5.83	5.83	0.00	7.80	7.81	0.01	9.25	9.26	0.01	10.49	10.49	0.00	11.71	11.71	0.00	13.46	13.46	0.00	14.68	14.68	0.00
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.25	0.00	5.75	5.75	0.00	7.70	7.71	0.01	9.13	9.15	0.02	10.35	10.36	0.01	11.56	11.56	0.00	13.27	13.27	0.00	14.48	14.48	0.00
148039	4.10	4.10	0.00	5.58	5.58	0.00	7.51	7.52	0.01	8.95	8.96	0.01	10.16	10.16	0.00	11.35	11.35	0.00	13.06	13.06	0.00	14.27	14.27	0.00
145812	3.76	3.76	0.00	5.20	5.20	0.00	7.12	7.13	0.01	8.55	8.56	0.01	9.72	9.72	0.00	10.88	10.89	0.01	12.57	12.57	0.00	13.75	13.75	0.00
145399	3.67	3.67	0.00	5.07	5.07	0.00	6.98	6.99	0.01	8.41	8.42	0.01	9.56	9.56	0.00	10.71	10.71	0.00	12.38	12.39	0.01	13.54	13.54	0.00
144517	3.51	3.51	0.00	4.89	4.89	0.00	6.80	6.81	0.01	8.23	8.25	0.02	9.37	9.37	0.00	10.50	10.51	0.01	12.17	12.18	0.01	13.32	13.32	0.00
143112	3.27	3.27	0.00	4.66	4.66	0.00	6.59	6.61	0.02	8.04	8.06	0.02	9.16	9.16	0.00	10.29	10.29	0.00	11.95	11.95	0.00	13.09	13.09	0.00
141733	3.05	3.05	0.00	4.44	4.44	0.00	6.40	6.41	0.01	7.85	7.87	0.02	8.96	8.97	0.01	10.07	10.08	0.01	11.73	11.73	0.00	12.85	12.85	0.00
140880	2.93	2.93	0.00	4.33	4.33	0.00	6.30	6.32	0.02	7.76	7.79	0.03	8.87	8.87	0.00	9.97	9.98	0.01	11.63	11.63	0.00	12.74	12.74	0.00
139341	2.66	2.66	0.00	4.06	4.06	0.00	6.10	6.09	-0.01	7.59	7.58	-0.01	8.69	8.69	0.00	9.79	9.80	0.01	11.45	11.46	0.01	12.56	12.56	0.00
139122	2.62	2.62	0.00	4.03	4.03	0.00	6.07	6.07	0.00	7.56	7.56	0.00	8.65	8.65	0.00	9.75	9.75	0.00	11.40	11.41	0.01	12.51	12.51	0.00
137810	2.42	2.42	0.00	3.85	3.85	0.00	5.95	5.95	0.00	7.46	7.46	0.00	8.55	8.55	0.00	9.64	9.65	0.01	11.30	11.31	0.01	12.40	12.40	0.00
137013	2.32	2.32	0.00	3.73	3.73	0.00	5.83	5.83	0.00	7.34	7.34	0.00	8.41	8.42	0.01	9.49	9.50	0.01	11.14	11.15	0.01	12.23	12.23	0.00
135743	2.22	2.22	0.00	3.58	3.58	0.00	5.67	5.67	0.00	7.18	7.18	0.00	8.23	8.23	0.00	9.29	9.29	0.00	10.93	10.94	0.01	12.00	12.00	0.00
134990	2.16	2.16	0.00	3.47	3.47	0.00	5.51	5.51	0.00	7.00	7.00	0.00	8.00	8.00	0.00	9.01	9.02	0.01	10.61	10.62	0.01	11.78	11.78	0.00
134672	2.08	2.08	0.00	3.26	3.26	0.00	5.07	5.07	0.00	6.90	6.90	0.00	7.89	7.89	0.00	8.89	8.89	0.00	10.48	10.49	0.01	11.69	11.69	0.00
134606	Bridge - King St																							
134560	1.95	1.95	0.00	3.08	3.08	0.00	4.80	4.80	0.00	6.14	6.14	0.00	7.44	7.44	0.00	8.72	8.72	0.00	10.37	10.37	0.00	11.57	11.57	0.00
133965	1.93	1.93	0.00	3.05	3.05	0.00	4.79	4.79	0.00	6.09	6.09	0.00	7.36	7.36	0.00	8.62	8.62	0.00	10.27	10.27	0.00	11.50	11.50	0.00
133595	1.91	1.91	0.00	3.00	3.00	0.00	4.72	4.72	0.00	6.01	6.01	0.00	7.27	7.27	0.00	8.52	8.52	0.00	10.17	10.17	0.00	11.44	11.44	0.00
132451	1.87	1.87	0.00	2.91	2.91	0.00	4.56	4.56	0.00	5.82	5.82	0.00	7.07	7.07	0.00	8.32	8.32	0.00	9.97	9.97	0.00	11.21	11.21	0.00
131238	1.83	1.83	0.00	2.83	2.83	0.00	4.45	4.45	0.00	5.69	5.69	0.00	6.92	6.92	0.00	8.16	8.16	0.00	9.79	9.79	0.00	11.03	11.03	0.00
130585	1.79	1.79	0.00	2.76	2.76	0.00	4.36	4.36	0.00	5.60	5.60	0.00	6.83	6.83	0.00	8.08	8.08	0.00	9.71	9.71	0.00	10.95	10.95	0.00
129224	1.75	1.75	0.00	2.68	2.68	0.00	4.24	4.24	0.00	5.46	5.46	0.00	6.69	6.69	0.00	7.92	7.92	0.00	9.55	9.55	0.00	10.78	10.78	0.00
128238	1.73	1.73	0.00	2.62	2.62	0.00	4.15	4.15	0.00	5.36	5.36	0.00	6.58	6.58	0.00	7.81	7.81	0.00	9.43	9.43	0.00	10.66	10.66	0.00
126929	1.70	1.70	0.00	2.55	2.55	0.00	4.02	4.02	0.00	5.20	5.20	0.00	6.39	6.39	0.00	7.61	7.61	0.00	9.20	9.20	0.00	10.41	10.41	0.00
125625	1.65	1.65	0.00	2.45	2.45	0.00	3.89	3.89	0.00	5.06	5.06	0.00	6.25	6.25	0.00	7.46	7.46	0.00	9.05	9.05	0.00	10.26	10.26	0.00

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference	Existing Conditions	Alt 3b	Difference
161247	6.98	6.98	0.00	8.91	8.92	0.01	11.36	11.36	0.00	13.11	13.11	0.00	14.68	14.68	0.00	16.02	16.02	0.00	17.52	17.52	0.00	18.77	18.77	0.00
159058	6.27	6.27	0.00	8.19	8.19	0.00	10.61	10.61	0.00	12.35	12.35	0.00	13.88	13.88	0.00	15.12	15.12	0.00	16.94	16.94	0.00	18.22	18.22	0.00
158066	6.12	6.12	0.00	8.04	8.04	0.00	10.45	10.46	0.01	12.22	12.23	0.01	13.75	13.75	0.00	15.00	15.00	0.00	16.81	16.81	0.00	18.09	18.09	0.00
157519	5.96	5.96	0.00	7.80	7.80	0.00	10.08	10.08	0.00	11.75	11.75	0.00	13.13	13.13	0.00	14.19	14.19	0.00	16.71	16.71	0.00	17.99	17.99	0.00
157478	Bridge - US 13																							
157417	5.35	5.35	0.00	7.15	7.15	0.00	9.38	9.39	0.01	11.01	11.02	0.01	12.35	12.35	0.00	13.51	13.51	0.00	14.93	14.93	0.00	15.89	15.89	0.00
157129	5.26	5.26	0.00	7.06	7.06	0.00	9.32	9.32	0.00	10.96	10.97	0.01	12.32	12.32	0.00	13.51	13.51	0.00	14.75	14.75	0.00	15.84	15.84	0.00
156783	5.17	5.17	0.00	6.98	6.98	0.00	9.24	9.24	0.00	10.89	10.90	0.01	12.24	12.24	0.00	13.42	13.42	0.00	14.64	14.64	0.00	15.77	15.77	0.00
155648	4.90	4.90	0.00	6.61	6.61	0.00	8.82	8.82	0.00	10.47	10.48	0.01	11.80	11.80	0.00	12.93	12.93	0.00	14.24	14.24	0.00	15.47	15.47	0.00
155452	4.87	4.87	0.00	6.54	6.54	0.00	8.57	8.58	0.01	10.39	10.40	0.01	11.70	11.70	0.00	12.81	12.81	0.00	14.13	14.13	0.00	15.38	15.38	0.00
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.86	0.00	6.51	6.51	0.00	8.51	8.52	0.01	10.04	10.05	0.01	11.09	11.09	0.00	12.35	12.35	0.00	14.12	14.12	0.00	15.38	15.38	0.00
155180	4.79	4.79	0.00	6.44	6.44	0.00	8.49	8.50	0.01	9.98	9.98	0.00	11.09	11.09	0.00	12.34	12.34	0.00	14.10	14.10	0.00	15.36	15.36	0.00
154057	4.64	4.64	0.00	6.24	6.24	0.00	8.26	8.27	0.01	9.74	9.75	0.01	10.98	10.98	0.00	12.23	12.23	0.00	14.01	14.01	0.00	15.27	15.27	0.00
152015	4.48	4.48	0.00	6.05	6.05	0.00	8.05	8.05	0.00	9.51	9.52	0.01	10.78	10.78	0.00	12.03	12.03	0.00	13.80	13.80	0.00	15.06	15.06	0.00
150927	4.40	4.40	0.00	5.96	5.96	0.00	7.95	7.95	0.00	9.41	9.42	0.01	10.67	10.67	0.00	11.91	11.91	0.00	13.67	13.67	0.00	14.92	14.92	0.00
149611	4.30	4.30	0.00	5.83	5.83	0.00	7.80	7.81	0.01	9.25	9.26	0.01	10.49	10.49	0.00	11.71	11.71	0.00	13.46	13.46	0.00	14.68	14.68	0.00
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.25	0.00	5.75	5.75	0.00	7.70	7.71	0.01	9.13	9.15	0.02	10.35	10.35	0.00	11.56	11.56	0.00	13.27	13.27	0.00	14.48	14.48	0.00
148039	4.10	4.10	0.00	5.58	5.58	0.00	7.51	7.52	0.01	8.95	8.96	0.01	10.16	10.16	0.00	11.35	11.35	0.00	13.06	13.06	0.00	14.27	14.27	0.00
145812	3.76	3.76	0.00	5.20	5.20	0.00	7.12	7.13	0.01	8.55	8.56	0.01	9.72	9.72	0.00	10.88	10.88	0.00	12.57	12.57	0.00	13.75	13.75	0.00
145399	3.67	3.67	0.00	5.07	5.07	0.00	6.98	6.99	0.01	8.41	8.42	0.01	9.56	9.56	0.00	10.71	10.71	0.00	12.38	12.38	0.00	13.54	13.54	0.00
144517	3.51	3.51	0.00	4.89	4.89	0.00	6.80	6.81	0.01	8.23	8.25	0.02	9.37	9.37	0.00	10.50	10.50	0.00	12.17	12.17	0.00	13.32	13.32	0.00
143112	3.27	3.27	0.00	4.66	4.66	0.00	6.59	6.61	0.02	8.04	8.06	0.02	9.16	9.16	0.00	10.29	10.29	0.00	11.95	11.95	0.00	13.09	13.09	0.00
141733	3.05	3.05	0.00	4.44	4.44	0.00	6.40	6.41	0.01	7.85	7.87	0.02	8.96	8.96	0.00	10.07	10.07	0.00	11.73	11.73	0.00	12.85	12.85	0.00
140880	2.93	2.93	0.00	4.33	4.33	0.00	6.30	6.32	0.02	7.76	7.79	0.03	8.87	8.87	0.00	9.97	9.97	0.00	11.63	11.63	0.00	12.74	12.74	0.00
139341	2.66	2.66	0.00	4.06	4.06	0.00	6.10	6.09	-0.01	7.59	7.58	-0.01	8.69	8.69	0.00	9.79	9.79	0.00	11.45	11.45	0.00	12.56	12.56	0.00
139122	2.62	2.62	0.00	4.03	4.03	0.00	6.07	6.07	0.00	7.56	7.56	0.00	8.65	8.65	0.00	9.75	9.75	0.00	11.40	11.40	0.00	12.51	12.51	0.00
137810	2.42	2.42	0.00	3.85	3.85	0.00	5.95	5.95	0.00	7.46	7.46	0.00	8.55	8.55	0.00	9.64	9.64	0.00	11.30	11.30	0.00	12.40	12.40	0.00
137013	2.32	2.32	0.00	3.73	3.73	0.00	5.83	5.83	0.00	7.34	7.34	0.00	8.41	8.41	0.00	9.49	9.49	0.00	11.14	11.14	0.00	12.23	12.23	0.00
135743	2.22	2.22	0.00	3.58	3.58	0.00	5.67	5.67	0.00	7.18	7.18	0.00	8.23	8.23	0.00	9.29	9.29	0.00	10.93	10.93	0.00	12.00	12.00	0.00
134990	2.16	2.16	0.00	3.47	3.47	0.00	5.51	5.51	0.00	7.00	7.00	0.00	8.00	8.00	0.00	9.01	9.01	0.00	10.61	10.61	0.00	11.78	11.78	0.00
134672	2.08	2.08	0.00	3.26	3.26	0.00	5.07	5.07	0.00	6.90	6.90	0.00	7.89	7.89	0.00	8.89	8.89	0.00	10.48	10.48	0.00	11.69	11.69	0.00
134606	Bridge - King St																							
134560	1.95	1.95	0.00	3.08	3.08	0.00	4.80	4.80	0.00	6.14	6.14	0.00	7.44	7.44	0.00	8.72	8.72	0.00	10.37	10.37	0.00	11.57	11.57	0.00
133965	1.93	1.93	0.00	3.05	3.05	0.00	4.79	4.79	0.00	6.09	6.09	0.00	7.36	7.36	0.00	8.62	8.62	0.00	10.27	10.27	0.00	11.50	11.50	0.00
133595	1.91	1.91	0.00	3.00	3.00	0.00	4.72	4.72	0.00	6.01	6.01	0.00	7.27	7.27	0.00	8.52	8.52	0.00	10.17	10.17	0.00	11.44	11.44	0.00
132451	1.87	1.87	0.00	2.91	2.91	0.00	4.56	4.56	0.00	5.82	5.82	0.00	7.07	7.07	0.00	8.32	8.32	0.00	9.97	9.97	0.00	11.21	11.21	0.00
131238	1.83	1.83	0.00	2.83	2.83	0.00	4.45	4.45	0.00	5.69	5.69	0.00	6.92	6.92	0.00	8.16	8.16	0.00	9.79	9.79	0.00	11.03	11.03	0.00
130585	1.79	1.79	0.00	2.76	2.76	0.00	4.36	4.36	0.00	5.60	5.60	0.00	6.83	6.83	0.00	8.08	8.08	0.00	9.71	9.71	0.00	10.95	10.95	0.00
129224	1.75	1.75	0.00	2.68	2.68	0.00	4.24	4.24	0.00	5.46	5.46	0.00	6.69	6.69	0.00	7.92	7.92	0.00	9.55	9.55	0.00	10.78	10.78	0.00
128238	1.73	1.73	0.00	2.62	2.62	0.00	4.15	4.15	0.00	5.36	5.36	0.00	6.58	6.58	0.00	7.81	7.81	0.00	9.43	9.43	0.00	10.66	10.66	0.00
126929	1.70	1.70	0.00	2.55	2.55	0.00	4.02	4.02	0.00	5.20	5.20	0.00	6.39	6.39	0.00	7.61	7.61	0.00	9.20	9.20	0.00	10.41	10.41	0.00
125625	1.65	1.65	0.00	2.45	2.45	0.00	3.89	3.89	0.00	5.06	5.06	0.00	6.25	6.25	0.00	7.46	7.46	0.00	9.05	9.05	0.00	10.26	10.26	0.00

Appendix B
Water Surface Elevation Tables
Table 5: Alternative 4

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference	Existing Conditions	Alt 4	Difference
161247	6.98	6.98	0.00	8.91	8.92	0.01	11.36	11.36	0.00	13.11	13.11	0.00	14.68	14.69	0.01	16.02	16.02	0.00	17.52	17.52	0.00	18.77	18.77	0.00
159058	6.27	6.27	0.00	8.19	8.19	0.00	10.61	10.61	0.00	12.35	12.36	0.01	13.88	13.89	0.01	15.12	15.12	0.00	16.94	16.94	0.00	18.22	18.22	0.00
158066	6.12	6.12	0.00	8.04	8.04	0.00	10.45	10.46	0.01	12.22	12.23	0.01	13.75	13.76	0.01	15.00	15.00	0.00	16.81	16.82	0.01	18.09	18.09	0.00
157519	5.96	5.96	0.00	7.80	7.80	0.00	10.08	10.09	0.01	11.75	11.75	0.00	13.13	13.14	0.01	14.19	14.19	0.00	16.71	16.71	0.00	17.99	17.99	0.00
157478	Bridge - US 13																							
157417	5.35	5.35	0.00	7.15	7.15	0.00	9.38	9.39	0.01	11.01	11.02	0.01	12.35	12.36	0.01	13.51	13.52	0.01	14.93	14.93	0.00	15.89	15.89	0.00
157129	5.26	5.26	0.00	7.06	7.06	0.00	9.32	9.32	0.00	10.96	10.97	0.01	12.32	12.33	0.01	13.51	13.51	0.00	14.75	14.75	0.00	15.84	15.84	0.00
156783	5.17	5.17	0.00	6.98	6.98	0.00	9.24	9.24	0.00	10.89	10.90	0.01	12.24	12.25	0.01	13.42	13.43	0.01	14.64	14.64	0.00	15.77	15.77	0.00
155648	4.90	4.90	0.00	6.61	6.61	0.00	8.82	8.82	0.00	10.47	10.48	0.01	11.80	11.81	0.01	12.93	12.94	0.01	14.24	14.25	0.01	15.47	15.47	0.00
155452	4.87	4.87	0.00	6.54	6.54	0.00	8.57	8.58	0.01	10.39	10.40	0.01	11.70	11.71	0.01	12.81	12.82	0.01	14.13	14.14	0.01	15.38	15.38	0.00
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.86	0.00	6.51	6.51	0.00	8.51	8.52	0.01	10.04	10.05	0.01	11.09	11.10	0.01	12.35	12.37	0.02	14.12	14.12	0.00	15.38	15.38	0.00
155180	4.79	4.79	0.00	6.44	6.44	0.00	8.49	8.50	0.01	9.98	9.98	0.00	11.09	11.11	0.02	12.34	12.36	0.02	14.10	14.11	0.01	15.36	15.36	0.00
154057	4.64	4.64	0.00	6.24	6.24	0.00	8.26	8.27	0.01	9.74	9.75	0.01	10.98	10.99	0.01	12.23	12.25	0.02	14.01	14.01	0.00	15.27	15.27	0.00
152015	4.48	4.48	0.00	6.05	6.05	0.00	8.05	8.05	0.00	9.51	9.52	0.01	10.78	10.80	0.02	12.03	12.05	0.02	13.80	13.81	0.01	15.06	15.06	0.00
150927	4.40	4.40	0.00	5.96	5.96	0.00	7.95	7.95	0.00	9.41	9.42	0.01	10.67	10.68	0.01	11.91	11.93	0.02	13.67	13.67	0.00	14.92	14.92	0.00
149611	4.30	4.30	0.00	5.83	5.83	0.00	7.80	7.81	0.01	9.25	9.26	0.01	10.49	10.51	0.02	11.71	11.73	0.02	13.46	13.46	0.00	14.68	14.69	0.01
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.25	0.00	5.75	5.75	0.00	7.70	7.71	0.01	9.13	9.15	0.02	10.35	10.37	0.02	11.56	11.58	0.02	13.27	13.27	0.00	14.48	14.48	0.00
148039	4.10	4.10	0.00	5.58	5.58	0.00	7.51	7.52	0.01	8.95	8.96	0.01	10.16	10.18	0.02	11.35	11.38	0.03	13.06	13.06	0.00	14.27	14.27	0.00
145812	3.76	3.76	0.00	5.20	5.20	0.00	7.12	7.13	0.01	8.55	8.56	0.01	9.72	9.74	0.02	10.88	10.91	0.03	12.57	12.57	0.00	13.75	13.75	0.00
145399	3.67	3.67	0.00	5.07	5.07	0.00	6.98	6.99	0.01	8.41	8.42	0.01	9.56	9.58	0.02	10.71	10.74	0.03	12.38	12.39	0.01	13.54	13.54	0.00
144517	3.51	3.51	0.00	4.89	4.89	0.00	6.80	6.81	0.01	8.23	8.25	0.02	9.37	9.39	0.02	10.50	10.54	0.04	12.17	12.18	0.01	13.32	13.32	0.00
143112	3.27	3.27	0.00	4.66	4.66	0.00	6.59	6.61	0.02	8.04	8.06	0.02	9.16	9.19	0.03	10.29	10.32	0.03	11.95	11.95	0.00	13.09	13.09	0.00
141733	3.05	3.05	0.00	4.44	4.44	0.00	6.40	6.41	0.01	7.85	7.87	0.02	8.96	8.99	0.03	10.07	10.11	0.04	11.73	11.74	0.01	12.85	12.85	0.00
140880	2.93	2.93	0.00	4.33	4.33	0.00	6.30	6.32	0.02	7.76	7.79	0.03	8.87	8.90	0.03	9.97	10.01	0.04	11.63	11.63	0.00	12.74	12.74	0.00
139341	2.66	2.66	0.00	4.06	4.06	0.00	6.10	6.09	-0.01	7.59	7.58	-0.01	8.69	8.68	-0.01	9.79	9.78	-0.01	11.45	11.46	0.01	12.56	12.56	0.00
139122	2.62	2.62	0.00	4.03	4.03	0.00	6.07	6.07	0.00	7.56	7.56	0.00	8.65	8.65	0.00	9.75	9.75	0.00	11.40	11.41	0.01	12.51	12.51	0.00
137810	2.42	2.42	0.00	3.85	3.85	0.00	5.95	5.95	0.00	7.46	7.46	0.00	8.55	8.55	0.00	9.64	9.65	0.01	11.30	11.31	0.01	12.40	12.40	0.00
137013	2.32	2.32	0.00	3.73	3.73	0.00	5.83	5.83	0.00	7.34	7.34	0.00	8.41	8.42	0.01	9.49	9.50	0.01	11.14	11.15	0.01	12.23	12.23	0.00
135743	2.22	2.22	0.00	3.58	3.58	0.00	5.67	5.67	0.00	7.18	7.18	0.00	8.23	8.23	0.00	9.29	9.29	0.00	10.93	10.94	0.01	12.00	12.00	0.00
134990	2.16	2.16	0.00	3.47	3.47	0.00	5.51	5.51	0.00	7.00	7.00	0.00	8.00	8.00	0.00	9.01	9.02	0.01	10.61	10.62	0.01	11.78	11.78	0.00
134672	2.08	2.08	0.00	3.26	3.26	0.00	5.07	5.07	0.00	6.90	6.90	0.00	7.89	7.89	0.00	8.89	8.89	0.00	10.48	10.49	0.01	11.69	11.69	0.00
134606	Bridge - King St																							
134560	1.95	1.95	0.00	3.08	3.08	0.00	4.80	4.80	0.00	6.14	6.14	0.00	7.44	7.44	0.00	8.72	8.72	0.00	10.37	10.37	0.00	11.57	11.57	0.00
133965	1.93	1.93	0.00	3.05	3.05	0.00	4.79	4.79	0.00	6.09	6.09	0.00	7.36	7.36	0.00	8.62	8.62	0.00	10.27	10.27	0.00	11.50	11.50	0.00
133595	1.91	1.91	0.00	3.00	3.00	0.00	4.72	4.72	0.00	6.01	6.01	0.00	7.27	7.27	0.00	8.52	8.52	0.00	10.17	10.17	0.00	11.44	11.44	0.00
132451	1.87	1.87	0.00	2.91	2.91	0.00	4.56	4.56	0.00	5.82	5.82	0.00	7.07	7.07	0.00	8.32	8.32	0.00	9.97	9.97	0.00	11.21	11.21	0.00
131238	1.83	1.83	0.00	2.83	2.83	0.00	4.45	4.45	0.00	5.69	5.69	0.00	6.92	6.92	0.00	8.16	8.16	0.00	9.79	9.79	0.00	11.03	11.03	0.00
130585	1.79	1.79	0.00	2.76	2.76	0.00	4.36	4.36	0.00	5.60	5.60	0.00	6.83	6.83	0.00	8.08	8.08	0.00	9.71	9.71	0.00	10.95	10.95	0.00
129224	1.75	1.75	0.00	2.68	2.68	0.00	4.24	4.24	0.00	5.46	5.46	0.00	6.69	6.69	0.00	7.92	7.92	0.00	9.55	9.55	0.00	10.78	10.78	0.00
128238	1.73	1.73	0.00	2.62	2.62	0.00	4.15	4.15	0.00	5.36	5.36	0.00	6.58	6.58	0.00	7.81	7.81	0.00	9.43	9.43	0.00	10.66	10.66	0.00
126929	1.70	1.70	0.00	2.55	2.55	0.00	4.02	4.02	0.00	5.20	5.20	0.00	6.39	6.39	0.00	7.61	7.61	0.00	9.20	9.20	0.00	10.41	10.41	0.00
125625	1.65	1.65	0.00	2.45	2.45	0.00	3.89	3.89	0.00	5.06	5.06	0.00	6.25	6.25	0.00	7.46	7.46	0.00	9.05	9.05	0.00	10.26	10.26	0.00

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference	Existing Conditions	Alt 4b	Difference
161247	6.98	6.98	0.00	8.91	8.92	0.01	11.36	11.36	0.00	13.11	13.11	0.00	14.68	14.69	0.01	16.02	16.02	0.00	17.52	17.52	0.00	18.77	18.77	0.00
159058	6.27	6.27	0.00	8.19	8.19	0.00	10.61	10.61	0.00	12.35	12.35	0.00	13.88	13.89	0.01	15.12	15.12	0.00	16.94	16.94	0.00	18.22	18.22	0.00
158066	6.12	6.12	0.00	8.04	8.04	0.00	10.45	10.46	0.01	12.22	12.23	0.01	13.75	13.76	0.01	15.00	15.00	0.00	16.81	16.82	0.01	18.09	18.09	0.00
157519	5.96	5.96	0.00	7.80	7.80	0.00	10.08	10.08	0.00	11.75	11.75	0.00	13.13	13.14	0.01	14.19	14.19	0.00	16.71	16.71	0.00	17.99	17.99	0.00
157478	Bridge - US 13																							
157417	5.35	5.35	0.00	7.15	7.15	0.00	9.38	9.39	0.01	11.01	11.02	0.01	12.35	12.36	0.01	13.51	13.52	0.01	14.93	14.93	0.00	15.89	15.89	0.00
157129	5.26	5.26	0.00	7.06	7.06	0.00	9.32	9.32	0.00	10.96	10.97	0.01	12.32	12.33	0.01	13.51	13.51	0.00	14.75	14.75	0.00	15.84	15.84	0.00
156783	5.17	5.17	0.00	6.98	6.98	0.00	9.24	9.24	0.00	10.89	10.90	0.01	12.24	12.25	0.01	13.42	13.43	0.01	14.64	14.64	0.00	15.77	15.77	0.00
155648	4.90	4.90	0.00	6.61	6.61	0.00	8.82	8.82	0.00	10.47	10.48	0.01	11.80	11.81	0.01	12.93	12.94	0.01	14.24	14.25	0.01	15.47	15.47	0.00
155452	4.87	4.87	0.00	6.54	6.54	0.00	8.57	8.58	0.01	10.39	10.40	0.01	11.70	11.71	0.01	12.81	12.82	0.01	14.13	14.13	0.00	15.38	15.38	0.00
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.86	0.00	6.51	6.51	0.00	8.51	8.52	0.01	10.04	10.05	0.01	11.09	11.10	0.01	12.35	12.37	0.02	14.12	14.12	0.00	15.38	15.38	0.00
155180	4.79	4.79	0.00	6.44	6.44	0.00	8.49	8.50	0.01	9.98	9.98	0.00	11.09	11.10	0.01	12.34	12.35	0.01	14.10	14.10	0.00	15.36	15.36	0.00
154057	4.64	4.64	0.00	6.24	6.24	0.00	8.26	8.27	0.01	9.74	9.75	0.01	10.98	10.99	0.01	12.23	12.25	0.02	14.01	14.01	0.00	15.27	15.27	0.00
152015	4.48	4.48	0.00	6.05	6.05	0.00	8.05	8.05	0.00	9.51	9.52	0.01	10.78	10.79	0.01	12.03	12.05	0.02	13.80	13.80	0.00	15.06	15.06	0.00
150927	4.40	4.40	0.00	5.96	5.96	0.00	7.95	7.95	0.00	9.41	9.42	0.01	10.67	10.68	0.01	11.91	11.92	0.01	13.67	13.67	0.00	14.92	14.92	0.00
149611	4.30	4.30	0.00	5.83	5.83	0.00	7.80	7.81	0.01	9.25	9.26	0.01	10.49	10.51	0.02	11.71	11.73	0.02	13.46	13.46	0.00	14.68	14.69	0.01
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.25	0.00	5.75	5.75	0.00	7.70	7.71	0.01	9.13	9.15	0.02	10.35	10.37	0.02	11.56	11.58	0.02	13.27	13.27	0.00	14.48	14.48	0.00
148039	4.10	4.10	0.00	5.58	5.58	0.00	7.51	7.52	0.01	8.95	8.96	0.01	10.16	10.18	0.02	11.35	11.37	0.02	13.06	13.06	0.00	14.27	14.27	0.00
145812	3.76	3.76	0.00	5.20	5.20	0.00	7.12	7.13	0.01	8.55	8.56	0.01	9.72	9.74	0.02	10.88	10.91	0.03	12.57	12.57	0.00	13.75	13.75	0.00
145399	3.67	3.67	0.00	5.07	5.07	0.00	6.98	6.99	0.01	8.41	8.42	0.01	9.56	9.58	0.02	10.71	10.74	0.03	12.38	12.38	0.00	13.54	13.54	0.00
144517	3.51	3.51	0.00	4.89	4.89	0.00	6.80	6.81	0.01	8.23	8.25	0.02	9.37	9.39	0.02	10.50	10.53	0.03	12.17	12.17	0.00	13.32	13.32	0.00
143112	3.27	3.27	0.00	4.66	4.66	0.00	6.59	6.61	0.02	8.04	8.06	0.02	9.16	9.19	0.03	10.29	10.32	0.03	11.95	11.95	0.00	13.09	13.09	0.00
141733	3.05	3.05	0.00	4.44	4.44	0.00	6.40	6.41	0.01	7.85	7.87	0.02	8.96	8.99	0.03	10.07	10.11	0.04	11.73	11.73	0.00	12.85	12.85	0.00
140880	2.93	2.93	0.00	4.33	4.33	0.00	6.30	6.32	0.02	7.76	7.79	0.03	8.87	8.90	0.03	9.97	10.01	0.04	11.63	11.63	0.00	12.74	12.74	0.00
139341	2.66	2.66	0.00	4.06	4.06	0.00	6.10	6.09	-0.01	7.59	7.58	-0.01	8.69	8.68	-0.01	9.79	9.78	-0.01	11.45	11.45	0.00	12.56	12.56	0.00
139122	2.62	2.62	0.00	4.03	4.03	0.00	6.07	6.07	0.00	7.56	7.56	0.00	8.65	8.65	0.00	9.75	9.75	0.00	11.40	11.40	0.00	12.51	12.51	0.00
137810	2.42	2.42	0.00	3.85	3.85	0.00	5.95	5.95	0.00	7.46	7.46	0.00	8.55	8.55	0.00	9.64	9.64	0.00	11.30	11.30	0.00	12.40	12.40	0.00
137013	2.32	2.32	0.00	3.73	3.73	0.00	5.83	5.83	0.00	7.34	7.34	0.00	8.41	8.41	0.00	9.49	9.49	0.00	11.14	11.14	0.00	12.23	12.23	0.00
135743	2.22	2.22	0.00	3.58	3.58	0.00	5.67	5.67	0.00	7.18	7.18	0.00	8.23	8.23	0.00	9.29	9.29	0.00	10.93	10.93	0.00	12.00	12.00	0.00
134990	2.16	2.16	0.00	3.47	3.47	0.00	5.51	5.51	0.00	7.00	7.00	0.00	8.00	8.00	0.00	9.01	9.01	0.00	10.61	10.61	0.00	11.78	11.78	0.00
134672	2.08	2.08	0.00	3.26	3.26	0.00	5.07	5.07	0.00	6.90	6.90	0.00	7.89	7.89	0.00	8.89	8.89	0.00	10.48	10.48	0.00	11.69	11.69	0.00
134606	Bridge - King St																							
134560	1.95	1.95	0.00	3.08	3.08	0.00	4.80	4.80	0.00	6.14	6.14	0.00	7.44	7.44	0.00	8.72	8.72	0.00	10.37	10.37	0.00	11.57	11.57	0.00
133965	1.93	1.93	0.00	3.05	3.05	0.00	4.79	4.79	0.00	6.09	6.09	0.00	7.36	7.36	0.00	8.62	8.62	0.00	10.27	10.27	0.00	11.50	11.50	0.00
133595	1.91	1.91	0.00	3.00	3.00	0.00	4.72	4.72	0.00	6.01	6.01	0.00	7.27	7.27	0.00	8.52	8.52	0.00	10.17	10.17	0.00	11.44	11.44	0.00
132451	1.87	1.87	0.00	2.91	2.91	0.00	4.56	4.56	0.00	5.82	5.82	0.00	7.07	7.07	0.00	8.32	8.32	0.00	9.97	9.97	0.00	11.21	11.21	0.00
131238	1.83	1.83	0.00	2.83	2.83	0.00	4.45	4.45	0.00	5.69	5.69	0.00	6.92	6.92	0.00	8.16	8.16	0.00	9.79	9.79	0.00	11.03	11.03	0.00
130585	1.79	1.79	0.00	2.76	2.76	0.00	4.36	4.36	0.00	5.60	5.60	0.00	6.83	6.83	0.00	8.08	8.08	0.00	9.71	9.71	0.00	10.95	10.95	0.00
129224	1.75	1.75	0.00	2.68	2.68	0.00	4.24	4.24	0.00	5.46	5.46	0.00	6.69	6.69	0.00	7.92	7.92	0.00	9.55	9.55	0.00	10.78	10.78	0.00
128238	1.73	1.73	0.00	2.62	2.62	0.00	4.15	4.15	0.00	5.36	5.36	0.00	6.58	6.58	0.00	7.81	7.81	0.00	9.43	9.43	0.00	10.66	10.66	0.00
126929	1.70	1.70	0.00	2.55	2.55	0.00	4.02	4.02	0.00	5.20	5.20	0.00	6.39	6.39	0.00	7.61	7.61	0.00	9.20	9.20	0.00	10.41	10.41	0.00
125625	1.65	1.65	0.00	2.45	2.45	0.00	3.89	3.89	0.00	5.06	5.06	0.00	6.25	6.25	0.00	7.46	7.46	0.00	9.05	9.05	0.00	10.26	10.26	0.00

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference	Existing Conditions	Alt 5	Difference
161247	6.98	6.90	-0.08	8.91	8.57	-0.34	11.36	10.52	-0.84	13.11	11.80	-1.31	14.68	12.92	-1.76	16.02	13.77	-2.25	17.52	14.96	-2.56	18.77	15.49	-3.28
159058	6.27	6.18	-0.09	8.19	7.84	-0.35	10.61	9.77	-0.84	12.35	11.06	-1.29	13.88	12.18	-1.70	15.12	13.01	-2.11	16.94	14.18	-2.76	18.22	14.65	-3.57
158066	6.12	6.03	-0.09	8.04	7.69	-0.35	10.45	9.62	-0.83	12.22	10.91	-1.31	13.75	12.05	-1.70	15.00	12.87	-2.13	16.81	14.07	-2.74	18.09	14.53	-3.56
157519	5.96	5.87	-0.09	7.80	7.46	-0.34	10.08	9.29	-0.79	11.75	10.52	-1.23	13.13	11.60	-1.53	14.19	12.34	-1.85	16.71	13.46	-3.25	17.99	13.81	-4.18
157478	Bridge - US 13																							
157417	5.35	5.26	-0.09	7.15	6.82	-0.33	9.38	8.62	-0.76	11.01	9.82	-1.19	12.35	10.88	-1.47	13.51	11.59	-1.92	14.93	12.68	-2.25	15.89	13.23	-2.66
157129	5.26	5.16	-0.10	7.06	6.73	-0.33	9.32	8.54	-0.78	10.96	9.75	-1.21	12.32	10.83	-1.49	13.51	11.55	-1.96	14.75	12.66	-2.09	15.84	13.22	-2.62
156783	5.17	5.08	-0.09	6.98	6.65	-0.33	9.24	8.46	-0.78	10.89	9.68	-1.21	12.24	10.76	-1.48	13.42	11.47	-1.95	14.64	12.59	-2.05	15.77	13.14	-2.63
155648	4.90	4.81	-0.09	6.61	6.29	-0.32	8.82	8.05	-0.77	10.47	9.26	-1.21	11.80	10.35	-1.45	12.93	11.03	-1.90	14.24	12.15	-2.09	15.47	12.68	-2.79
155452	4.87	4.79	-0.08	6.54	6.24	-0.30	8.57	7.88	-0.69	10.39	8.97	-1.42	11.70	9.94	-1.76	12.81	10.94	-1.87	14.13	12.06	-2.07	15.38	12.57	-2.81
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.77	-0.09	6.51	6.21	-0.30	8.51	7.83	-0.68	10.04	8.91	-1.13	11.09	9.92	-1.17	12.35	10.46	-1.89	14.12	11.36	-2.76	15.38	12.01	-3.37
155180	4.79	4.70	-0.09	6.44	6.14	-0.30	8.49	7.78	-0.71	9.98	8.90	-1.08	11.09	9.85	-1.24	12.34	10.47	-1.87	14.10	11.37	-2.73	15.36	12.00	-3.36
154057	4.64	4.55	-0.09	6.24	5.95	-0.29	8.26	7.57	-0.69	9.74	8.67	-1.07	10.98	9.62	-1.36	12.23	10.35	-1.88	14.01	11.26	-2.75	15.27	11.89	-3.38
152015	4.48	4.40	-0.08	6.05	5.76	-0.29	8.05	7.35	-0.70	9.51	8.45	-1.06	10.78	9.39	-1.39	12.03	10.16	-1.87	13.80	11.06	-2.74	15.06	11.69	-3.37
150927	4.40	4.32	-0.08	5.96	5.67	-0.29	7.95	7.26	-0.69	9.41	8.35	-1.06	10.67	9.29	-1.38	11.91	10.06	-1.85	13.67	10.94	-2.73	14.92	11.57	-3.35
149611	4.30	4.22	-0.08	5.83	5.55	-0.28	7.80	7.12	-0.68	9.25	8.21	-1.04	10.49	9.14	-1.35	11.71	9.89	-1.82	13.46	10.76	-2.70	14.68	11.38	-3.30
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.17	-0.08	5.75	5.47	-0.28	7.70	7.02	-0.68	9.13	8.10	-1.03	10.35	9.02	-1.33	11.56	9.77	-1.79	13.27	10.63	-2.64	14.48	11.23	-3.25
148039	4.10	4.02	-0.08	5.58	5.30	-0.28	7.51	6.84	-0.67	8.95	7.92	-1.03	10.16	8.84	-1.32	11.35	9.58	-1.77	13.06	10.43	-2.63	14.27	11.03	-3.24
145812	3.76	3.69	-0.07	5.20	4.93	-0.27	7.12	6.45	-0.67	8.55	7.53	-1.02	9.72	8.44	-1.28	10.88	9.16	-1.72	12.57	9.99	-2.58	13.75	10.57	-3.18
145399	3.67	3.60	-0.07	5.07	4.80	-0.27	6.98	6.31	-0.67	8.41	7.39	-1.02	9.56	8.30	-1.26	10.71	9.01	-1.70	12.38	9.82	-2.56	13.54	10.40	-3.14
144517	3.51	3.44	-0.07	4.89	4.62	-0.27	6.80	6.13	-0.67	8.23	7.21	-1.02	9.37	8.12	-1.25	10.50	8.83	-1.67	12.17	9.63	-2.54	13.32	10.20	-3.12
143112	3.27	3.21	-0.06	4.66	4.39	-0.27	6.59	5.92	-0.67	8.04	7.02	-1.02	9.16	7.94	-1.22	10.29	8.63	-1.66	11.95	9.42	-2.53	13.09	9.99	-3.10
141733	3.05	2.98	-0.07	4.44	4.17	-0.27	6.40	5.72	-0.68	7.85	6.83	-1.02	8.96	7.75	-1.21	10.07	8.44	-1.63	11.73	9.22	-2.51	12.85	9.78	-3.07
140880	2.93	2.86	-0.07	4.33	4.05	-0.28	6.30	5.62	-0.68	7.76	6.74	-1.02	8.87	7.67	-1.20	9.97	8.35	-1.62	11.63	9.13	-2.50	12.74	9.68	-3.06
139341	2.66	2.59	-0.07	4.06	3.78	-0.28	6.10	5.38	-0.72	7.59	6.53	-1.06	8.69	7.46	-1.23	9.79	8.15	-1.64	11.45	8.91	-2.54	12.56	9.45	-3.11
139122	2.62	2.56	-0.06	4.03	3.75	-0.28	6.07	5.35	-0.72	7.56	6.51	-1.05	8.65	7.44	-1.21	9.75	8.12	-1.63	11.40	8.88	-2.52	12.51	9.42	-3.09
137810	2.42	2.35	-0.07	3.85	3.56	-0.29	5.95	5.22	-0.73	7.46	6.40	-1.06	8.55	7.34	-1.21	9.64	8.02	-1.62	11.30	8.77	-2.53	12.40	9.31	-3.09
137013	2.32	2.26	-0.06	3.73	3.44	-0.29	5.83	5.09	-0.74	7.34	6.28	-1.06	8.41	7.22	-1.19	9.49	7.89	-1.60	11.14	8.63	-2.51	12.23	9.17	-3.06
135743	2.22	2.16	-0.06	3.58	3.29	-0.29	5.67	4.93	-0.74	7.18	6.12	-1.06	8.23	7.06	-1.17	9.29	7.73	-1.56	10.93	8.45	-2.48	12.00	8.97	-3.03
134990	2.16	2.11	-0.05	3.47	3.19	-0.28	5.51	4.79	-0.72	7.00	5.96	-1.04	8.00	6.89	-1.11	9.01	7.52	-1.49	10.61	8.20	-2.41	11.78	8.70	-3.08
134672	2.08	2.03	-0.05	3.26	3.02	-0.24	5.07	4.44	-0.63	6.90	5.47	-1.43	7.89	6.79	-1.10	8.89	7.42	-1.47	10.48	8.09	-2.39	11.69	8.57	-3.12
134606	Bridge - King St																							
134560	1.95	1.91	-0.04	3.08	2.84	-0.24	4.80	4.20	-0.60	6.14	5.13	-1.01	7.44	6.02	-1.42	8.72	6.78	-1.94	10.37	7.71	-2.66	11.57	8.37	-3.20
133965	1.93	1.89	-0.04	3.05	2.81	-0.24	4.79	4.17	-0.62	6.09	5.12	-0.97	7.36	5.97	-1.39	8.62	6.72	-1.90	10.27	7.63	-2.64	11.50	8.28	-3.22
133595	1.91	1.87	-0.04	3.00	2.77	-0.23	4.72	4.11	-0.61	6.01	5.05	-0.96	7.27	5.89	-1.38	8.52	6.63	-1.89	10.17	7.54	-2.63	11.44	8.18	-3.26
132451	1.87	1.83	-0.04	2.91	2.69	-0.22	4.56	3.98	-0.58	5.82	4.88	-0.94	7.07	5.71	-1.36	8.32	6.43	-1.89	9.97	7.34	-2.63	11.21	7.98	-3.23
131238	1.83	1.79	-0.04	2.83	2.62	-0.21	4.45	3.87	-0.58	5.69	4.76	-0.93	6.92	5.57	-1.35	8.16	6.29	-1.87	9.79	7.19	-2.60	11.03	7.82	-3.21
130585	1.79	1.75	-0.04	2.76	2.55	-0.21	4.36	3.78	-0.58	5.60	4.67	-0.93	6.83	5.48	-1.35	8.08	6.20	-1.88	9.71	7.10	-2.61	10.95	7.74	-3.21
129224	1.75	1.72	-0.03	2.68	2.47	-0.21	4.24	3.67	-0.57	5.46	4.54	-0.92	6.69	5.35	-1.34	7.92	6.06	-1.86	9.55	6.95	-2.60	10.78	7.59	-3.19
128238	1.73	1.69	-0.04	2.62	2.42	-0.20	4.15	3.59	-0.56	5.36	4.45	-0.91	6.58	5.25	-1.33	7.81	5.96	-1.85	9.43	6.85	-2.58	10.66	7.48	-3.18
126929	1.70	1.66	-0.04	2.55	2.36	-0.19	4.02	3.48	-0.54	5.20	4.31	-0.89	6.39	5.09	-1.30	7.61	5.78	-1.83	9.20	6.65	-2.55	10.41	7.28	-3.13
125625	1.65	1.62	-0.03	2.45	2.27	-0.18	3.89	3.36	-0.53	5.06	4.18	-0.88	6.25	4.95	-1.30	7.46	5.64	-1.82	9.05	6.51	-2.54	10.26	7.13	-3.13

RS	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference	Existing Conditions	Alt 5b	Difference
161247	6.98	6.90	-0.08	8.91	8.57	-0.34	11.36	10.52	-0.84	13.11	11.80	-1.31	14.68	12.92	-1.76	16.02	13.77	-2.25	17.52	14.96	-2.56	18.77	15.49	-3.28
159058	6.27	6.18	-0.09	8.19	7.84	-0.35	10.61	9.77	-0.84	12.35	11.06	-1.29	13.88	12.18	-1.70	15.12	13.01	-2.11	16.94	14.18	-2.76	18.22	14.65	-3.57
158066	6.12	6.03	-0.09	8.04	7.69	-0.35	10.45	9.62	-0.83	12.22	10.91	-1.31	13.75	12.05	-1.70	15.00	12.87	-2.13	16.81	14.07	-2.74	18.09	14.53	-3.56
157519	5.96	5.87	-0.09	7.80	7.46	-0.34	10.08	9.29	-0.79	11.75	10.52	-1.23	13.13	11.60	-1.53	14.19	12.34	-1.85	16.71	13.46	-3.25	17.99	13.81	-4.18
157478	Bridge - US 13																							
157417	5.35	5.26	-0.09	7.15	6.82	-0.33	9.38	8.62	-0.76	11.01	9.82	-1.19	12.35	10.88	-1.47	13.51	11.59	-1.92	14.93	12.68	-2.25	15.89	13.23	-2.66
157129	5.26	5.16	-0.10	7.06	6.73	-0.33	9.32	8.54	-0.78	10.96	9.75	-1.21	12.32	10.83	-1.49	13.51	11.55	-1.96	14.75	12.66	-2.09	15.84	13.22	-2.62
156783	5.17	5.08	-0.09	6.98	6.65	-0.33	9.24	8.46	-0.78	10.89	9.68	-1.21	12.24	10.76	-1.48	13.42	11.47	-1.95	14.64	12.59	-2.05	15.77	13.14	-2.63
155648	4.90	4.81	-0.09	6.61	6.29	-0.32	8.82	8.05	-0.77	10.47	9.26	-1.21	11.80	10.35	-1.45	12.93	11.03	-1.90	14.24	12.15	-2.09	15.47	12.68	-2.79
155452	4.87	4.79	-0.08	6.54	6.24	-0.30	8.57	7.88	-0.69	10.39	8.97	-1.42	11.70	9.94	-1.76	12.81	10.94	-1.87	14.13	12.06	-2.07	15.38	12.57	-2.81
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	4.77	-0.09	6.51	6.21	-0.30	8.51	7.83	-0.68	10.04	8.91	-1.13	11.09	9.92	-1.17	12.35	10.46	-1.89	14.12	11.36	-2.76	15.38	12.01	-3.37
155180	4.79	4.70	-0.09	6.44	6.14	-0.30	8.49	7.78	-0.71	9.98	8.90	-1.08	11.09	9.85	-1.24	12.34	10.47	-1.87	14.10	11.37	-2.73	15.36	12.00	-3.36
154057	4.64	4.55	-0.09	6.24	5.95	-0.29	8.26	7.57	-0.69	9.74	8.67	-1.07	10.98	9.62	-1.36	12.23	10.35	-1.88	14.01	11.25	-2.76	15.27	11.89	-3.38
152015	4.48	4.40	-0.08	6.05	5.76	-0.29	8.05	7.35	-0.70	9.51	8.45	-1.06	10.78	9.39	-1.39	12.03	10.16	-1.87	13.80	11.06	-2.74	15.06	11.69	-3.37
150927	4.40	4.32	-0.08	5.96	5.67	-0.29	7.95	7.26	-0.69	9.41	8.35	-1.06	10.67	9.29	-1.38	11.91	10.06	-1.85	13.67	10.94	-2.73	14.92	11.57	-3.35
149611	4.30	4.22	-0.08	5.83	5.55	-0.28	7.80	7.12	-0.68	9.25	8.21	-1.04	10.49	9.14	-1.35	11.71	9.89	-1.82	13.46	10.76	-2.70	14.68	11.38	-3.30
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.17	-0.08	5.75	5.47	-0.28	7.70	7.02	-0.68	9.13	8.10	-1.03	10.35	9.02	-1.33	11.56	9.77	-1.79	13.27	10.62	-2.65	14.48	11.23	-3.25
148039	4.10	4.02	-0.08	5.58	5.30	-0.28	7.51	6.84	-0.67	8.95	7.92	-1.03	10.16	8.84	-1.32	11.35	9.58	-1.77	13.06	10.42	-2.64	14.27	11.03	-3.24
145812	3.76	3.69	-0.07	5.20	4.93	-0.27	7.12	6.45	-0.67	8.55	7.53	-1.02	9.72	8.44	-1.28	10.88	9.16	-1.72	12.57	9.98	-2.59	13.75	10.57	-3.18
145399	3.67	3.60	-0.07	5.07	4.80	-0.27	6.98	6.31	-0.67	8.41	7.39	-1.02	9.56	8.30	-1.26	10.71	9.01	-1.70	12.38	9.82	-2.56	13.54	10.40	-3.14
144517	3.51	3.44	-0.07	4.89	4.62	-0.27	6.80	6.13	-0.67	8.23	7.21	-1.02	9.37	8.12	-1.25	10.50	8.83	-1.67	12.17	9.62	-2.55	13.32	10.19	-3.13
143112	3.27	3.21	-0.06	4.66	4.39	-0.27	6.59	5.92	-0.67	8.04	7.02	-1.02	9.16	7.94	-1.22	10.29	8.63	-1.66	11.95	9.42	-2.53	13.09	9.98	-3.11
141733	3.05	2.98	-0.07	4.44	4.17	-0.27	6.40	5.72	-0.68	7.85	6.83	-1.02	8.96	7.75	-1.21	10.07	8.44	-1.63	11.73	9.22	-2.51	12.85	9.77	-3.08
140880	2.93	2.86	-0.07	4.33	4.05	-0.28	6.30	5.62	-0.68	7.76	6.74	-1.02	8.87	7.67	-1.20	9.97	8.35	-1.62	11.63	9.12	-2.51	12.74	9.67	-3.07
139341	2.66	2.59	-0.07	4.06	3.78	-0.28	6.10	5.38	-0.72	7.59	6.53	-1.06	8.69	7.46	-1.23	9.79	8.15	-1.64	11.45	8.90	-2.55	12.56	9.44	-3.12
139122	2.62	2.56	-0.06	4.03	3.75	-0.28	6.07	5.35	-0.72	7.56	6.51	-1.05	8.65	7.44	-1.21	9.75	8.12	-1.63	11.40	8.87	-2.53	12.51	9.41	-3.10
137810	2.42	2.35	-0.07	3.85	3.56	-0.29	5.95	5.22	-0.73	7.46	6.40	-1.06	8.55	7.34	-1.21	9.64	8.02	-1.62	11.30	8.77	-2.53	12.40	9.31	-3.09
137013	2.32	2.26	-0.06	3.73	3.44	-0.29	5.83	5.09	-0.74	7.34	6.28	-1.06	8.41	7.22	-1.19	9.49	7.89	-1.60	11.14	8.63	-2.51	12.23	9.16	-3.07
135743	2.22	2.16	-0.06	3.58	3.29	-0.29	5.67	4.93	-0.74	7.18	6.12	-1.06	8.23	7.06	-1.17	9.29	7.73	-1.56	10.93	8.44	-2.49	12.00	8.96	-3.04
134990	2.16	2.11	-0.05	3.47	3.19	-0.28	5.51	4.79	-0.72	7.00	5.96	-1.04	8.00	6.89	-1.11	9.01	7.52	-1.49	10.61	8.20	-2.41	11.78	8.69	-3.09
134672	2.08	2.03	-0.05	3.26	3.02	-0.24	5.07	4.44	-0.63	6.90	5.47	-1.43	7.89	6.79	-1.10	8.89	7.42	-1.47	10.48	8.08	-2.40	11.69	8.57	-3.12
134606	Bridge - King St																							
134560	1.95	1.91	-0.04	3.08	2.84	-0.24	4.80	4.20	-0.60	6.14	5.13	-1.01	7.44	6.02	-1.42	8.72	6.78	-1.94	10.37	7.71	-2.66	11.57	8.37	-3.20
133965	1.93	1.89	-0.04	3.05	2.81	-0.24	4.79	4.17	-0.62	6.09	5.12	-0.97	7.36	5.97	-1.39	8.62	6.72	-1.90	10.27	7.63	-2.64	11.50	8.28	-3.22
133595	1.91	1.87	-0.04	3.00	2.77	-0.23	4.72	4.11	-0.61	6.01	5.05	-0.96	7.27	5.89	-1.38	8.52	6.63	-1.89	10.17	7.54	-2.63	11.44	8.18	-3.26
132451	1.87	1.83	-0.04	2.91	2.69	-0.22	4.56	3.98	-0.58	5.82	4.88	-0.94	7.07	5.71	-1.36	8.32	6.43	-1.89	9.97	7.34	-2.63	11.21	7.98	-3.23
131238	1.83	1.79	-0.04	2.83	2.62	-0.21	4.45	3.87	-0.58	5.69	4.76	-0.93	6.92	5.57	-1.35	8.16	6.29	-1.87	9.79	7.19	-2.60	11.03	7.82	-3.21
130585	1.79	1.75	-0.04	2.76	2.55	-0.21	4.36	3.78	-0.58	5.60	4.67	-0.93	6.83	5.48	-1.35	8.08	6.20	-1.88	9.71	7.10	-2.61	10.95	7.74	-3.21
129224	1.75	1.72	-0.03	2.68	2.47	-0.21	4.24	3.67	-0.57	5.46	4.54	-0.92	6.69	5.35	-1.34	7.92	6.06	-1.86	9.55	6.95	-2.60	10.78	7.59	-3.19
128238	1.73	1.69	-0.04	2.62	2.42	-0.20	4.15	3.59	-0.56	5.36	4.45	-0.91	6.58	5.25	-1.33	7.81	5.96	-1.85	9.43	6.85	-2.58	10.66	7.48	-3.18
126929	1.70	1.66	-0.04	2.55	2.36	-0.19	4.02	3.48	-0.54	5.20	4.31	-0.89	6.39	5.09	-1.30	7.61	5.78	-1.83	9.20	6.65	-2.55	10.41	7.28	-3.13
125625	1.65	1.62	-0.03	2.45	2.27	-0.18	3.89	3.36	-0.53	5.06	4.18	-0.88	6.25	4.95	-1.30	7.46	5.64	-1.82	9.05	6.51	-2.54	10.26	7.13	-3.13

Table 9: Alternative 6

	20 Pct Event			10 Pct Event			4 Pct Event			2 Pct Event			1 Pct Event			0.5 Pct Event			0.2 Pct Event			0.1 Pct Event		
RS	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference	Existing Conditions	Alt 6	Difference
161247	6.98	7.17	0.19	8.91	9.08	0.17	11.36	11.46	0.10	13.11	13.13	0.02	14.68	14.62	-0.06	16.02	15.87	-0.15	17.52	17.36	-0.16	18.77	18.48	-0.29
159058	6.27	6.45	0.18	8.19	8.35	0.16	10.61	10.71	0.10	12.35	12.37	0.02	13.88	13.83	-0.05	15.12	14.98	-0.14	16.94	16.80	-0.14	18.22	17.95	-0.27
158066	6.12	6.30	0.18	8.04	8.20	0.16	10.45	10.55	0.10	12.22	12.25	0.03	13.75	13.69	-0.06	15.00	14.86	-0.14	16.81	16.68	-0.13	18.09	17.82	-0.27
157519	5.96	6.13	0.17	7.80	7.95	0.15	10.08	10.17	0.09	11.75	11.77	0.02	13.13	13.08	-0.05	14.19	14.06	-0.13	16.71	16.32	-0.39	17.99	17.72	-0.27
157478	Bridge - US 13																							
157417	5.35	5.52	0.17	7.15	7.29	0.14	9.38	9.47	0.09	11.01	11.04	0.03	12.35	12.30	-0.05	13.51	13.41	-0.10	14.93	14.89	-0.04	15.89	15.69	-0.20
157129	5.26	5.43	0.17	7.06	7.21	0.15	9.32	9.41	0.09	10.96	10.99	0.03	12.32	12.27	-0.05	13.51	13.40	-0.11	14.75	14.72	-0.03	15.84	15.63	-0.21
156783	5.17	5.34	0.17	6.98	7.13	0.15	9.24	9.33	0.09	10.89	10.91	0.02	12.24	12.19	-0.05	13.42	13.32	-0.10	14.64	14.62	-0.02	15.77	15.49	-0.28
155648	4.90	5.05	0.15	6.61	6.75	0.14	8.82	8.91	0.09	10.47	10.50	0.03	11.80	11.75	-0.05	12.93	12.83	-0.10	14.24	14.25	0.01	15.47	15.13	-0.34
155452	4.87	5.03	0.16	6.54	6.67	0.13	8.57	8.66	0.09	10.39	10.42	0.03	11.70	11.66	-0.04	12.81	12.72	-0.09	14.13	14.02	-0.11	15.38	15.04	-0.34
155432	Bridge - Hoggard Mill Rd																							
155413	4.86	5.01	0.15	6.51	6.64	0.13	8.51	8.59	0.08	10.04	10.07	0.03	11.09	11.05	-0.04	12.35	12.24	-0.11	14.12	13.85	-0.27	15.38	15.04	-0.34
155180	4.79	4.95	0.16	6.44	6.57	0.13	8.49	8.58	0.09	9.98	10.00	0.02	11.09	11.06	-0.03	12.34	12.23	-0.11	14.10	13.83	-0.27	15.36	15.02	-0.34
154057	4.64	4.79	0.15	6.24	6.37	0.13	8.26	8.35	0.09	9.74	9.76	0.02	10.98	10.94	-0.04	12.23	12.12	-0.11	14.01	13.73	-0.28	15.27	14.93	-0.34
152015	4.48	4.63	0.15	6.05	6.17	0.12	8.05	8.13	0.08	9.51	9.54	0.03	10.78	10.75	-0.03	12.03	11.92	-0.11	13.80	13.53	-0.27	15.06	14.72	-0.34
150927	4.40	4.55	0.15	5.96	6.08	0.12	7.95	8.03	0.08	9.41	9.43	0.02	10.67	10.63	-0.04	11.91	11.79	-0.12	13.67	13.40	-0.27	14.92	14.58	-0.34
149611	4.30	4.44	0.14	5.83	5.95	0.12	7.80	7.89	0.09	9.25	9.28	0.03	10.49	10.46	-0.03	11.71	11.60	-0.11	13.46	13.18	-0.28	14.68	14.36	-0.32
149546	Bridge - US Rte 17 Bypass																							
149397	4.25	4.39	0.14	5.75	5.87	0.12	7.70	7.78	0.08	9.13	9.16	0.03	10.35	10.33	-0.02	11.56	11.45	-0.11	13.27	13.01	-0.26	14.48	14.16	-0.32
148039	4.10	4.23	0.13	5.58	5.70	0.12	7.51	7.60	0.09	8.95	8.98	0.03	10.16	10.13	-0.03	11.35	11.25	-0.10	13.06	12.81	-0.25	14.27	13.95	-0.32
145812	3.76	3.89	0.13	5.20	5.32	0.12	7.12	7.21	0.09	8.55	8.58	0.03	9.72	9.70	-0.02	10.88	10.79	-0.09	12.57	12.32	-0.25	13.75	13.45	-0.30
145399	3.67	3.79	0.12	5.07	5.19	0.12	6.98	7.07	0.09	8.41	8.44	0.03	9.56	9.54	-0.02	10.71	10.61	-0.10	12.38	12.14	-0.24	13.54	13.25	-0.29
144517	3.51	3.63	0.12	4.89	5.00	0.11	6.80	6.89	0.09	8.23	8.26	0.03	9.37	9.35	-0.02	10.50	10.41	-0.09	12.17	11.92	-0.25	13.32	13.03	-0.29
143112	3.27	3.40	0.13	4.66	4.78	0.12	6.59	6.69	0.10	8.04	8.07	0.03	9.16	9.15	-0.01	10.29	10.20	-0.09	11.95	11.70	-0.25	13.09	12.80	-0.29
141733	3.05	3.17	0.12	4.44	4.56	0.12	6.40	6.50	0.10	7.85	7.89	0.04	8.96	8.95	-0.01	10.07	9.99	-0.08	11.73	11.49	-0.24	12.85	12.58	-0.27
140880	2.93	3.05	0.12	4.33	4.45	0.12	6.30	6.40	0.10	7.76	7.80	0.04	8.87	8.86	-0.01	9.97	9.89	-0.08	11.63	11.38	-0.25	12.74	12.47	-0.27
139341	2.66	2.77	0.11	4.06	4.18	0.12	6.10	6.18	0.08	7.59	7.60	0.01	8.69	8.64	-0.05	9.79	9.66	-0.13	11.45	11.21	-0.24	12.56	12.30	-0.26
139122	2.62	2.74	0.12	4.03	4.15	0.12	6.07	6.15	0.08	7.56	7.57	0.01	8.65	8.61	-0.04	9.75	9.62	-0.13	11.40	11.16	-0.24	12.51	12.25	-0.26
137810	2.42	2.53	0.11	3.85	3.98	0.13	5.95	6.04	0.09	7.46	7.47	0.01	8.55	8.51	-0.04	9.64	9.52	-0.12	11.30	11.06	-0.24	12.40	12.15	-0.25
137013	2.32	2.43	0.11	3.73	3.86	0.13	5.83	5.92	0.09	7.34	7.35	0.01	8.41	8.38	-0.03	9.49	9.37	-0.12	11.14	10.90	-0.24	12.23	11.98	-0.25
135743	2.22	2.32	0.10	3.58	3.70	0.12	5.67	5.76	0.09	7.18	7.20	0.02	8.23	8.20	-0.03	9.29	9.17	-0.12	10.93	10.69	-0.24	12.00	11.76	-0.24
134990	2.16	2.26	0.10	3.47	3.59	0.12	5.51	5.60	0.09	7.00	7.01	0.01	8.00	7.97	-0.03	9.01	8.89	-0.12	10.61	10.38	-0.23	11.78	11.55	-0.23
134672	2.08	2.17	0.09	3.26	3.37	0.11	5.07	5.15	0.08	6.90	6.92	0.02	7.89	7.85	-0.04	8.89	8.77	-0.12	10.48	10.25	-0.23	11.69	11.46	-0.23
134606	Bridge - King St																							
134560	1.95	2.03	0.08	3.08	3.18	0.10	4.80	4.87	0.07	6.14	6.16	0.02	7.44	7.39	-0.05	8.72	8.59	-0.13	10.37	10.13	-0.24	11.57	11.16	-0.41
133965	1.93	2.01	0.08	3.05	3.15	0.10	4.79	4.85	0.06	6.09	6.10	0.01	7.36	7.32	-0.04	8.62	8.50	-0.12	10.27	10.04	-0.23	11.50	11.13	-0.37
133595	1.91	1.99	0.08	3.00	3.11	0.11	4.72	4.79	0.07	6.01	6.02	0.01	7.27	7.23	-0.04	8.52	8.40	-0.12	10.17	9.93	-0.24	11.44	11.07	-0.37
132451	1.87	1.95	0.08	2.91	3.01	0.10	4.56	4.63	0.07	5.82	5.83	0.01	7.07	7.03	-0.04	8.32	8.20	-0.12	9.97	9.73	-0.24	11.21	10.84	-0.37
131238	1.83	1.90	0.07	2.83	2.93	0.10	4.45	4.51	0.06	5.69	5.70	0.01	6.92	6.88	-0.04	8.16	8.04	-0.12	9.79	9.55	-0.24	11.03	10.66	-0.37
130585	1.79	1.86	0.07	2.76	2.85	0.09	4.36	4.42	0.06	5.60	5.61	0.01	6.83	6.79	-0.04	8.08	7.95	-0.13	9.71	9.47	-0.24	10.95	10.58	-0.37
129224	1.75	1.82	0.07	2.68	2.77	0.09	4.24	4.30	0.06	5.46	5.47	0.01	6.69	6.65	-0.04	7.92	7.80	-0.12	9.55	9.31	-0.24	10.78	10.42	-0.36
128238	1.73	1.78	0.05	2.62	2.70	0.08	4.15	4.21	0.06	5.36	5.37	0.01	6.58	6.54	-0.04	7.81	7.69	-0.12	9.43	9.19	-0.24	10.66	10.29	-0.37
126929	1.70	1.75	0.05	2.55	2.63	0.08	4.02	4.08	0.06	5.20	5.21	0.01	6.39	6.35	-0.04	7.61	7.49	-0.12	9.20	8.97	-0.23	10.41	10.05	-0.36
125625	1.65	1.70	0.05	2.45	2.53	0.08	3.89	3.95	0.06	5.06	5.07	0.01	6.25	6.21	-0.04	7.46	7.34	-0.12	9.05	8.82	-0.23	10.26	9.90	-0.36

20 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	6.98	7.05	0.07	6.90	-0.08	6.98	0.00	6.98	0.00	6.98	0.00	6.98	0.00	6.90	-0.08	6.90	-0.08	7.17	0.19
159058	6.27	6.34	0.07	6.18	-0.09	6.27	0.00	6.27	0.00	6.27	0.00	6.27	0.00	6.18	-0.09	6.18	-0.09	6.45	0.18
158066	6.12	6.19	0.07	6.03	-0.09	6.12	0.00	6.12	0.00	6.12	0.00	6.12	0.00	6.03	-0.09	6.03	-0.09	6.30	0.18
157519	5.96	6.03	0.07	5.87	-0.09	5.96	0.00	5.96	0.00	5.96	0.00	5.96	0.00	5.87	-0.09	5.87	-0.09	6.13	0.17
157478	Bridge - US 13																		
157417	5.35	5.42	0.07	5.26	-0.09	5.35	0.00	5.35	0.00	5.35	0.00	5.35	0.00	5.26	-0.09	5.26	-0.09	5.52	0.17
157129	5.26	5.32	0.06	5.16	-0.10	5.26	0.00	5.26	0.00	5.26	0.00	5.26	0.00	5.16	-0.10	5.16	-0.10	5.43	0.17
156783	5.17	5.24	0.07	5.08	-0.09	5.17	0.00	5.17	0.00	5.17	0.00	5.17	0.00	5.08	-0.09	5.08	-0.09	5.34	0.17
155648	4.90	4.96	0.06	4.81	-0.09	4.90	0.00	4.90	0.00	4.90	0.00	4.90	0.00	4.81	-0.09	4.81	-0.09	5.05	0.15
155452	4.87	4.94	0.07	4.79	-0.08	4.87	0.00	4.87	0.00	4.87	0.00	4.87	0.00	4.79	-0.08	4.79	-0.08	5.03	0.16
155432	Bridge - Hoggard Mill Rd																		
155413	4.86	4.92	0.06	4.77	-0.09	4.86	0.00	4.86	0.00	4.86	0.00	4.86	0.00	4.77	-0.09	4.77	-0.09	5.01	0.15
155180	4.79	4.85	0.06	4.70	-0.09	4.79	0.00	4.79	0.00	4.79	0.00	4.79	0.00	4.70	-0.09	4.70	-0.09	4.95	0.16
154057	4.64	4.70	0.06	4.55	-0.09	4.64	0.00	4.64	0.00	4.64	0.00	4.64	0.00	4.55	-0.09	4.55	-0.09	4.79	0.15
152015	4.48	4.54	0.06	4.40	-0.08	4.48	0.00	4.48	0.00	4.48	0.00	4.48	0.00	4.40	-0.08	4.40	-0.08	4.63	0.15
150927	4.40	4.46	0.06	4.32	-0.08	4.40	0.00	4.40	0.00	4.40	0.00	4.40	0.00	4.32	-0.08	4.32	-0.08	4.55	0.15
149611	4.30	4.36	0.06	4.22	-0.08	4.30	0.00	4.30	0.00	4.30	0.00	4.30	0.00	4.22	-0.08	4.22	-0.08	4.44	0.14
149546	Bridge - US Rte 17 Bypass																		
149397	4.25	4.30	0.05	4.17	-0.08	4.25	0.00	4.25	0.00	4.25	0.00	4.25	0.00	4.17	-0.08	4.17	-0.08	4.39	0.14
148039	4.10	4.15	0.05	4.02	-0.08	4.10	0.00	4.10	0.00	4.10	0.00	4.10	0.00	4.02	-0.08	4.02	-0.08	4.23	0.13
145812	3.76	3.82	0.06	3.69	-0.07	3.76	0.00	3.76	0.00	3.76	0.00	3.76	0.00	3.69	-0.07	3.69	-0.07	3.89	0.13
145399	3.67	3.72	0.05	3.60	-0.07	3.67	0.00	3.67	0.00	3.67	0.00	3.67	0.00	3.60	-0.07	3.60	-0.07	3.79	0.12
144517	3.51	3.56	0.05	3.44	-0.07	3.51	0.00	3.51	0.00	3.51	0.00	3.51	0.00	3.44	-0.07	3.44	-0.07	3.63	0.12
143112	3.27	3.32	0.05	3.21	-0.06	3.27	0.00	3.27	0.00	3.27	0.00	3.27	0.00	3.21	-0.06	3.21	-0.06	3.40	0.13
141733	3.05	3.10	0.05	2.98	-0.07	3.05	0.00	3.05	0.00	3.05	0.00	3.05	0.00	2.98	-0.07	2.98	-0.07	3.17	0.12
140880	2.93	2.98	0.05	2.86	-0.07	2.93	0.00	2.93	0.00	2.93	0.00	2.93	0.00	2.86	-0.07	2.86	-0.07	3.05	0.12
139341	2.66	2.70	0.04	2.59	-0.07	2.66	0.00	2.66	0.00	2.66	0.00	2.66	0.00	2.59	-0.07	2.59	-0.07	2.77	0.11
139122	2.62	2.67	0.05	2.56	-0.06	2.62	0.00	2.62	0.00	2.62	0.00	2.62	0.00	2.56	-0.06	2.56	-0.06	2.74	0.12
137810	2.42	2.46	0.04	2.35	-0.07	2.42	0.00	2.42	0.00	2.42	0.00	2.42	0.00	2.35	-0.07	2.35	-0.07	2.53	0.11
137013	2.32	2.37	0.05	2.26	-0.06	2.32	0.00	2.32	0.00	2.32	0.00	2.32	0.00	2.26	-0.06	2.26	-0.06	2.43	0.11
135743	2.22	2.26	0.04	2.16	-0.06	2.22	0.00	2.22	0.00	2.22	0.00	2.22	0.00	2.16	-0.06	2.16	-0.06	2.32	0.10
134990	2.16	2.20	0.04	2.11	-0.05	2.16	0.00	2.16	0.00	2.16	0.00	2.16	0.00	2.11	-0.05	2.11	-0.05	2.26	0.10
134672	2.08	2.12	0.04	2.03	-0.05	2.08	0.00	2.08	0.00	2.08	0.00	2.08	0.00	2.03	-0.05	2.03	-0.05	2.17	0.09
134606	Bridge - King St																		
134560	1.95	1.98	0.03	1.91	-0.04	1.95	0.00	1.95	0.00	1.95	0.00	1.95	0.00	1.91	-0.04	1.91	-0.04	2.03	0.08
133965	1.93	1.97	0.04	1.89	-0.04	1.93	0.00	1.93	0.00	1.93	0.00	1.93	0.00	1.89	-0.04	1.89	-0.04	2.01	0.08
133595	1.91	1.94	0.03	1.87	-0.04	1.91	0.00	1.91	0.00	1.91	0.00	1.91	0.00	1.87	-0.04	1.87	-0.04	1.99	0.08
132451	1.87	1.90	0.03	1.83	-0.04	1.87	0.00	1.87	0.00	1.87	0.00	1.87	0.00	1.83	-0.04	1.83	-0.04	1.95	0.08
131238	1.83	1.86	0.03	1.79	-0.04	1.83	0.00	1.83	0.00	1.83	0.00	1.83	0.00	1.79	-0.04	1.79	-0.04	1.90	0.07
130585	1.79	1.82	0.03	1.75	-0.04	1.79	0.00	1.79	0.00	1.79	0.00	1.79	0.00	1.75	-0.04	1.75	-0.04	1.86	0.07
129224	1.75	1.78	0.03	1.72	-0.03	1.75	0.00	1.75	0.00	1.75	0.00	1.75	0.00	1.72	-0.03	1.72	-0.03	1.82	0.07
128238	1.73	1.75	0.02	1.69	-0.04	1.73	0.00	1.73	0.00	1.73	0.00	1.73	0.00	1.69	-0.04	1.69	-0.04	1.78	0.05
126929	1.70	1.72	0.02	1.66	-0.04	1.70	0.00	1.70	0.00	1.70	0.00	1.70	0.00	1.66	-0.04	1.66	-0.04	1.75	0.05
125625	1.65	1.67	0.02	1.62	-0.03	1.65	0.00	1.65	0.00	1.65	0.00	1.65	0.00	1.62	-0.03	1.62	-0.03	1.70	0.05

Appendix B
Water Surface Elevation Tables
Table 11: 10 Percent Event

10 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	8.91	8.84	-0.07	8.57	-0.34	8.92	0.01	8.92	0.01	8.92	0.01	8.92	0.01	8.57	-0.34	8.57	-0.34	9.08	0.17
159058	8.19	8.12	-0.07	7.84	-0.35	8.19	0.00	8.19	0.00	8.19	0.00	8.19	0.00	7.84	-0.35	7.84	-0.35	8.35	0.16
158066	8.04	7.97	-0.07	7.69	-0.35	8.04	0.00	8.04	0.00	8.04	0.00	8.04	0.00	7.69	-0.35	7.69	-0.35	8.20	0.16
157519	7.80	7.73	-0.07	7.46	-0.34	7.80	0.00	7.80	0.00	7.80	0.00	7.80	0.00	7.46	-0.34	7.46	-0.34	7.95	0.15
157478	Bridge - US 13																		
157417	7.15	7.08	-0.07	6.82	-0.33	7.15	0.00	7.15	0.00	7.15	0.00	7.15	0.00	6.82	-0.33	6.82	-0.33	7.29	0.14
157129	7.06	6.99	-0.07	6.73	-0.33	7.06	0.00	7.06	0.00	7.06	0.00	7.06	0.00	6.73	-0.33	6.73	-0.33	7.21	0.15
156783	6.98	6.91	-0.07	6.65	-0.33	6.98	0.00	6.98	0.00	6.98	0.00	6.98	0.00	6.65	-0.33	6.65	-0.33	7.13	0.15
155648	6.61	6.54	-0.07	6.29	-0.32	6.61	0.00	6.61	0.00	6.61	0.00	6.61	0.00	6.29	-0.32	6.29	-0.32	6.75	0.14
155452	6.54	6.47	-0.07	6.24	-0.30	6.54	0.00	6.54	0.00	6.54	0.00	6.54	0.00	6.24	-0.30	6.24	-0.30	6.67	0.13
155432	Bridge - Hoggard Mill Rd																		
155413	6.51	6.44	-0.07	6.21	-0.30	6.51	0.00	6.51	0.00	6.51	0.00	6.51	0.00	6.21	-0.30	6.21	-0.30	6.64	0.13
155180	6.44	6.38	-0.06	6.14	-0.30	6.44	0.00	6.44	0.00	6.44	0.00	6.44	0.00	6.14	-0.30	6.14	-0.30	6.57	0.13
154057	6.24	6.18	-0.06	5.95	-0.29	6.24	0.00	6.24	0.00	6.24	0.00	6.24	0.00	5.95	-0.29	5.95	-0.29	6.37	0.13
152015	6.05	5.98	-0.07	5.76	-0.29	6.05	0.00	6.05	0.00	6.05	0.00	6.05	0.00	5.76	-0.29	5.76	-0.29	6.17	0.12
150927	5.96	5.89	-0.07	5.67	-0.29	5.96	0.00	5.96	0.00	5.96	0.00	5.96	0.00	5.67	-0.29	5.67	-0.29	6.08	0.12
149611	5.83	5.77	-0.06	5.55	-0.28	5.83	0.00	5.83	0.00	5.83	0.00	5.83	0.00	5.55	-0.28	5.55	-0.28	5.95	0.12
149546	Bridge - US Rte 17 Bypass																		
149397	5.75	5.69	-0.06	5.47	-0.28	5.75	0.00	5.75	0.00	5.75	0.00	5.75	0.00	5.47	-0.28	5.47	-0.28	5.87	0.12
148039	5.58	5.52	-0.06	5.30	-0.28	5.58	0.00	5.58	0.00	5.58	0.00	5.58	0.00	5.30	-0.28	5.30	-0.28	5.70	0.12
145812	5.20	5.14	-0.06	4.93	-0.27	5.20	0.00	5.20	0.00	5.20	0.00	5.20	0.00	4.93	-0.27	4.93	-0.27	5.32	0.12
145399	5.07	5.01	-0.06	4.80	-0.27	5.07	0.00	5.07	0.00	5.07	0.00	5.07	0.00	4.80	-0.27	4.80	-0.27	5.19	0.12
144517	4.89	4.83	-0.06	4.62	-0.27	4.89	0.00	4.89	0.00	4.89	0.00	4.89	0.00	4.62	-0.27	4.62	-0.27	5.00	0.11
143112	4.66	4.60	-0.06	4.39	-0.27	4.66	0.00	4.66	0.00	4.66	0.00	4.66	0.00	4.39	-0.27	4.39	-0.27	4.78	0.12
141733	4.44	4.38	-0.06	4.17	-0.27	4.44	0.00	4.44	0.00	4.44	0.00	4.44	0.00	4.17	-0.27	4.17	-0.27	4.56	0.12
140880	4.33	4.27	-0.06	4.05	-0.28	4.33	0.00	4.33	0.00	4.33	0.00	4.33	0.00	4.05	-0.28	4.05	-0.28	4.45	0.12
139341	4.06	4.00	-0.06	3.78	-0.28	4.06	0.00	4.06	0.00	4.06	0.00	4.06	0.00	3.78	-0.28	3.78	-0.28	4.18	0.12
139122	4.03	3.97	-0.06	3.75	-0.28	4.03	0.00	4.03	0.00	4.03	0.00	4.03	0.00	3.75	-0.28	3.75	-0.28	4.15	0.12
137810	3.85	3.79	-0.06	3.56	-0.29	3.85	0.00	3.85	0.00	3.85	0.00	3.85	0.00	3.56	-0.29	3.56	-0.29	3.98	0.13
137013	3.73	3.67	-0.06	3.44	-0.29	3.73	0.00	3.73	0.00	3.73	0.00	3.73	0.00	3.44	-0.29	3.44	-0.29	3.86	0.13
135743	3.58	3.51	-0.07	3.29	-0.29	3.58	0.00	3.58	0.00	3.58	0.00	3.58	0.00	3.29	-0.29	3.29	-0.29	3.70	0.12
134990	3.47	3.41	-0.06	3.19	-0.28	3.47	0.00	3.47	0.00	3.47	0.00	3.47	0.00	3.19	-0.28	3.19	-0.28	3.59	0.12
134672	3.26	3.21	-0.05	3.02	-0.24	3.26	0.00	3.26	0.00	3.26	0.00	3.26	0.00	3.02	-0.24	3.02	-0.24	3.37	0.11
134606	Bridge - King St																		
134560	3.08	3.02	-0.06	2.84	-0.24	3.08	0.00	3.08	0.00	3.08	0.00	3.08	0.00	2.84	-0.24	2.84	-0.24	3.18	0.10
133965	3.05	3.00	-0.05	2.81	-0.24	3.05	0.00	3.05	0.00	3.05	0.00	3.05	0.00	2.81	-0.24	2.81	-0.24	3.15	0.10
133595	3.00	2.95	-0.05	2.77	-0.23	3.00	0.00	3.00	0.00	3.00	0.00	3.00	0.00	2.77	-0.23	2.77	-0.23	3.11	0.11
132451	2.91	2.86	-0.05	2.69	-0.22	2.91	0.00	2.91	0.00	2.91	0.00	2.91	0.00	2.69	-0.22	2.69	-0.22	3.01	0.10
131238	2.83	2.78	-0.05	2.62	-0.21	2.83	0.00	2.83	0.00	2.83	0.00	2.83	0.00	2.62	-0.21	2.62	-0.21	2.93	0.10
130585	2.76	2.71	-0.05	2.55	-0.21	2.76	0.00	2.76	0.00	2.76	0.00	2.76	0.00	2.55	-0.21	2.55	-0.21	2.85	0.09
129224	2.68	2.63	-0.05	2.47	-0.21	2.68	0.00	2.68	0.00	2.68	0.00	2.68	0.00	2.47	-0.21	2.47	-0.21	2.77	0.09
128238	2.62	2.57	-0.05	2.42	-0.20	2.62	0.00	2.62	0.00	2.62	0.00	2.62	0.00	2.42	-0.20	2.42	-0.20	2.70	0.08
126929	2.55	2.50	-0.05	2.36	-0.19	2.55	0.00	2.55	0.00	2.55	0.00	2.55	0.00	2.36	-0.19	2.36	-0.19	2.63	0.08
125625	2.45	2.41	-0.04	2.27	-0.18	2.45	0.00	2.45	0.00	2.45	0.00	2.45	0.00	2.27	-0.18	2.27	-0.18	2.53	0.08

4 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	11.36	10.97	-0.39	10.51	-0.85	11.36	0.00	11.36	0.00	11.36	0.00	11.36	0.00	10.52	-0.84	10.52	-0.84	11.46	0.10
159058	10.61	10.22	-0.39	9.77	-0.84	10.61	0.00	10.61	0.00	10.61	0.00	10.61	0.00	9.77	-0.84	9.77	-0.84	10.71	0.10
158066	10.45	10.07	-0.38	9.62	-0.83	10.46	0.01	10.46	0.01	10.46	0.01	10.46	0.01	9.62	-0.83	9.62	-0.83	10.55	0.10
157519	10.08	9.72	-0.36	9.29	-0.79	10.08	0.00	10.08	0.00	10.09	0.01	10.08	0.00	9.29	-0.79	9.29	-0.79	10.17	0.09
157478	Bridge - US 13																		
157417	9.38	9.03	-0.35	8.61	-0.77	9.39	0.01	9.39	0.01	9.39	0.01	9.39	0.01	8.62	-0.76	8.62	-0.76	9.47	0.09
157129	9.32	8.96	-0.36	8.54	-0.78	9.32	0.00	9.32	0.00	9.32	0.00	9.32	0.00	8.54	-0.78	8.54	-0.78	9.41	0.09
156783	9.24	8.88	-0.36	8.46	-0.78	9.24	0.00	9.24	0.00	9.24	0.00	9.24	0.00	8.46	-0.78	8.46	-0.78	9.33	0.09
155648	8.82	8.46	-0.36	8.04	-0.78	8.82	0.00	8.82	0.00	8.82	0.00	8.82	0.00	8.05	-0.77	8.05	-0.77	8.91	0.09
155452	8.57	8.25	-0.32	7.87	-0.70	8.58	0.01	8.58	0.01	8.58	0.01	8.58	0.01	7.88	-0.69	7.88	-0.69	8.66	0.09
155432	Bridge - Hoggard Mill Rd																		
155413	8.51	8.20	-0.31	7.82	-0.69	8.52	0.01	8.52	0.01	8.52	0.01	8.52	0.01	7.83	-0.68	7.83	-0.68	8.59	0.08
155180	8.49	8.17	-0.32	7.78	-0.71	8.50	0.01	8.50	0.01	8.50	0.01	8.50	0.01	7.78	-0.71	7.78	-0.71	8.58	0.09
154057	8.26	7.94	-0.32	7.56	-0.70	8.27	0.01	8.27	0.01	8.27	0.01	8.27	0.01	7.57	-0.69	7.57	-0.69	8.35	0.09
152015	8.05	7.73	-0.32	7.35	-0.70	8.05	0.00	8.05	0.00	8.05	0.00	8.05	0.00	7.35	-0.70	7.35	-0.70	8.13	0.08
150927	7.95	7.63	-0.32	7.25	-0.70	7.95	0.00	7.95	0.00	7.95	0.00	7.95	0.00	7.26	-0.69	7.26	-0.69	8.03	0.08
149611	7.80	7.49	-0.31	7.11	-0.69	7.81	0.01	7.81	0.01	7.81	0.01	7.81	0.01	7.12	-0.68	7.12	-0.68	7.89	0.09
149546	Bridge - US Rte 17 Bypass																		
149397	7.70	7.39	-0.31	7.02	-0.68	7.71	0.01	7.71	0.01	7.71	0.01	7.71	0.01	7.02	-0.68	7.02	-0.68	7.78	0.08
148039	7.51	7.20	-0.31	6.83	-0.68	7.52	0.01	7.52	0.01	7.52	0.01	7.52	0.01	6.84	-0.67	6.84	-0.67	7.60	0.09
145812	7.12	6.81	-0.31	6.44	-0.68	7.13	0.01	7.13	0.01	7.13	0.01	7.13	0.01	6.45	-0.67	6.45	-0.67	7.21	0.09
145399	6.98	6.67	-0.31	6.30	-0.68	6.99	0.01	6.99	0.01	6.99	0.01	6.99	0.01	6.31	-0.67	6.31	-0.67	7.07	0.09
144517	6.80	6.49	-0.31	6.12	-0.68	6.81	0.01	6.81	0.01	6.81	0.01	6.81	0.01	6.13	-0.67	6.13	-0.67	6.89	0.09
143112	6.59	6.29	-0.30	5.91	-0.68	6.61	0.02	6.61	0.02	6.61	0.02	6.61	0.02	5.92	-0.67	5.92	-0.67	6.69	0.10
141733	6.40	6.09	-0.31	5.71	-0.69	6.41	0.01	6.41	0.01	6.41	0.01	6.41	0.01	5.72	-0.68	5.72	-0.68	6.50	0.10
140880	6.30	5.99	-0.31	5.61	-0.69	6.32	0.02	6.32	0.02	6.32	0.02	6.32	0.02	5.62	-0.68	5.62	-0.68	6.40	0.10
139341	6.10	5.78	-0.32	5.38	-0.72	6.09	-0.01	6.09	-0.01	6.09	-0.01	6.09	-0.01	5.38	-0.72	5.38	-0.72	6.18	0.08
139122	6.07	5.75	-0.32	5.35	-0.72	6.07	0.00	6.07	0.00	6.07	0.00	6.07	0.00	5.35	-0.72	5.35	-0.72	6.15	0.08
137810	5.95	5.62	-0.33	5.22	-0.73	5.95	0.00	5.95	0.00	5.95	0.00	5.95	0.00	5.22	-0.73	5.22	-0.73	6.04	0.09
137013	5.83	5.50	-0.33	5.09	-0.74	5.83	0.00	5.83	0.00	5.83	0.00	5.83	0.00	5.09	-0.74	5.09	-0.74	5.92	0.09
135743	5.67	5.34	-0.33	4.93	-0.74	5.67	0.00	5.67	0.00	5.67	0.00	5.67	0.00	4.93	-0.74	4.93	-0.74	5.76	0.09
134990	5.51	5.19	-0.32	4.79	-0.72	5.51	0.00	5.51	0.00	5.51	0.00	5.51	0.00	4.79	-0.72	4.79	-0.72	5.60	0.09
134672	5.07	4.80	-0.27	4.44	-0.63	5.07	0.00	5.07	0.00	5.07	0.00	5.07	0.00	4.44	-0.63	4.44	-0.63	5.15	0.08
134606	Bridge - King St																		
134560	4.80	4.52	-0.28	4.20	-0.60	4.80	0.00	4.80	0.00	4.80	0.00	4.80	0.00	4.20	-0.60	4.20	-0.60	4.87	0.07
133965	4.79	4.50	-0.29	4.17	-0.62	4.79	0.00	4.79	0.00	4.79	0.00	4.79	0.00	4.17	-0.62	4.17	-0.62	4.85	0.06
133595	4.72	4.44	-0.28	4.11	-0.61	4.72	0.00	4.72	0.00	4.72	0.00	4.72	0.00	4.11	-0.61	4.11	-0.61	4.79	0.07
132451	4.56	4.29	-0.27	3.98	-0.58	4.56	0.00	4.56	0.00	4.56	0.00	4.56	0.00	3.98	-0.58	3.98	-0.58	4.63	0.07
131238	4.45	4.18	-0.27	3.87	-0.58	4.45	0.00	4.45	0.00	4.45	0.00	4.45	0.00	3.87	-0.58	3.87	-0.58	4.51	0.06
130585	4.36	4.09	-0.27	3.78	-0.58	4.36	0.00	4.36	0.00	4.36	0.00	4.36	0.00	3.78	-0.58	3.78	-0.58	4.42	0.06
129224	4.24	3.97	-0.27	3.67	-0.57	4.24	0.00	4.24	0.00	4.24	0.00	4.24	0.00	3.67	-0.57	3.67	-0.57	4.30	0.06
128238	4.15	3.89	-0.26	3.59	-0.56	4.15	0.00	4.15	0.00	4.15	0.00	4.15	0.00	3.59	-0.56	3.59	-0.56	4.21	0.06
126929	4.02	3.77	-0.25	3.48	-0.54	4.02	0.00	4.02	0.00	4.02	0.00	4.02	0.00	3.48	-0.54	3.48	-0.54	4.08	0.06
125625	3.89	3.64	-0.25	3.36	-0.53	3.89	0.00	3.89	0.00	3.89	0.00	3.89	0.00	3.36	-0.53	3.36	-0.53	3.95	0.06

2 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	13.11	12.37	-0.74	11.80	-1.31	13.11	0.00	13.11	0.00	13.11	0.00	13.11	0.00	11.80	-1.31	11.80	-1.31	13.13	0.02
159058	12.35	11.63	-0.72	11.06	-1.29	12.35	0.00	12.35	0.00	12.36	0.01	12.35	0.00	11.06	-1.29	11.06	-1.29	12.37	0.02
158066	12.22	11.48	-0.74	10.91	-1.31	12.23	0.01	12.23	0.01	12.23	0.01	12.23	0.01	10.91	-1.31	10.91	-1.31	12.25	0.03
157519	11.75	11.05	-0.70	10.51	-1.24	11.75	0.00	11.75	0.00	11.75	0.00	11.75	0.00	10.52	-1.23	10.52	-1.23	11.77	0.02
157478	Bridge - US 13																		
157417	11.01	10.33	-0.68	9.81	-1.20	11.02	0.01	11.02	0.01	11.02	0.01	11.02	0.01	9.82	-1.19	9.82	-1.19	11.04	0.03
157129	10.96	10.28	-0.68	9.75	-1.21	10.97	0.01	10.97	0.01	10.97	0.01	10.97	0.01	9.75	-1.21	9.75	-1.21	10.99	0.03
156783	10.89	10.20	-0.69	9.67	-1.22	10.90	0.01	10.90	0.01	10.90	0.01	10.90	0.01	9.68	-1.21	9.68	-1.21	10.91	0.02
155648	10.47	9.78	-0.69	9.26	-1.21	10.48	0.01	10.48	0.01	10.48	0.01	10.48	0.01	9.26	-1.21	9.26	-1.21	10.50	0.03
155452	10.39	9.43	-0.96	8.97	-1.42	10.40	0.01	10.40	0.01	10.40	0.01	10.40	0.01	8.97	-1.42	8.97	-1.42	10.42	0.03
155432	Bridge - Hoggard Mill Rd																		
155413	10.04	9.36	-0.68	8.90	-1.14	10.05	0.01	10.05	0.01	10.05	0.01	10.05	0.01	8.91	-1.13	8.91	-1.13	10.07	0.03
155180	9.98	9.37	-0.61	8.89	-1.09	9.98	0.00	9.98	0.00	9.98	0.00	9.98	0.00	8.90	-1.08	8.90	-1.08	10.00	0.02
154057	9.74	9.14	-0.60	8.66	-1.08	9.75	0.01	9.75	0.01	9.75	0.01	9.75	0.01	8.67	-1.07	8.67	-1.07	9.76	0.02
152015	9.51	8.92	-0.59	8.45	-1.06	9.52	0.01	9.52	0.01	9.52	0.01	9.52	0.01	8.45	-1.06	8.45	-1.06	9.54	0.03
150927	9.41	8.82	-0.59	8.35	-1.06	9.42	0.01	9.42	0.01	9.42	0.01	9.42	0.01	8.35	-1.06	8.35	-1.06	9.43	0.02
149611	9.25	8.66	-0.59	8.20	-1.05	9.26	0.01	9.26	0.01	9.26	0.01	9.26	0.01	8.21	-1.04	8.21	-1.04	9.28	0.03
149546	Bridge - US Rte 17 Bypass																		
149397	9.13	8.55	-0.58	8.09	-1.04	9.15	0.02	9.15	0.02	9.15	0.02	9.15	0.02	8.10	-1.03	8.10	-1.03	9.16	0.03
148039	8.95	8.37	-0.58	7.91	-1.04	8.96	0.01	8.96	0.01	8.96	0.01	8.96	0.01	7.92	-1.03	7.92	-1.03	8.98	0.03
145812	8.55	7.98	-0.57	7.52	-1.03	8.56	0.01	8.56	0.01	8.56	0.01	8.56	0.01	7.53	-1.02	7.53	-1.02	8.58	0.03
145399	8.41	7.84	-0.57	7.38	-1.03	8.42	0.01	8.42	0.01	8.42	0.01	8.42	0.01	7.39	-1.02	7.39	-1.02	8.44	0.03
144517	8.23	7.66	-0.57	7.20	-1.03	8.25	0.02	8.25	0.02	8.25	0.02	8.25	0.02	7.21	-1.02	7.21	-1.02	8.26	0.03
143112	8.04	7.47	-0.57	7.01	-1.03	8.06	0.02	8.06	0.02	8.06	0.02	8.06	0.02	7.02	-1.02	7.02	-1.02	8.07	0.03
141733	7.85	7.28	-0.57	6.82	-1.03	7.87	0.02	7.87	0.02	7.87	0.02	7.87	0.02	6.83	-1.02	6.83	-1.02	7.89	0.04
140880	7.76	7.19	-0.57	6.73	-1.03	7.79	0.03	7.79	0.03	7.79	0.03	7.79	0.03	6.74	-1.02	6.74	-1.02	7.80	0.04
139341	7.59	7.02	-0.57	6.54	-1.05	7.58	-0.01	7.58	-0.01	7.58	-0.01	7.58	-0.01	6.53	-1.06	6.53	-1.06	7.60	0.01
139122	7.56	6.98	-0.58	6.51	-1.05	7.56	0.00	7.56	0.00	7.56	0.00	7.56	0.00	6.51	-1.05	6.51	-1.05	7.57	0.01
137810	7.46	6.88	-0.58	6.40	-1.06	7.46	0.00	7.46	0.00	7.46	0.00	7.46	0.00	6.40	-1.06	6.40	-1.06	7.47	0.01
137013	7.34	6.76	-0.58	6.28	-1.06	7.34	0.00	7.34	0.00	7.34	0.00	7.34	0.00	6.28	-1.06	6.28	-1.06	7.35	0.01
135743	7.18	6.61	-0.57	6.12	-1.06	7.18	0.00	7.18	0.00	7.18	0.00	7.18	0.00	6.12	-1.06	6.12	-1.06	7.20	0.02
134990	7.00	6.44	-0.56	5.96	-1.04	7.00	0.00	7.00	0.00	7.00	0.00	7.00	0.00	5.96	-1.04	5.96	-1.04	7.01	0.01
134672	6.90	6.35	-0.55	5.47	-1.43	6.90	0.00	6.90	0.00	6.90	0.00	6.90	0.00	5.47	-1.43	5.47	-1.43	6.92	0.02
134606	Bridge - King St																		
134560	6.14	5.58	-0.56	5.13	-1.01	6.14	0.00	6.14	0.00	6.14	0.00	6.14	0.00	5.13	-1.01	5.13	-1.01	6.16	0.02
133965	6.09	5.54	-0.55	5.12	-0.97	6.09	0.00	6.09	0.00	6.09	0.00	6.09	0.00	5.12	-0.97	5.12	-0.97	6.10	0.01
133595	6.01	5.47	-0.54	5.05	-0.96	6.01	0.00	6.01	0.00	6.01	0.00	6.01	0.00	5.05	-0.96	5.05	-0.96	6.02	0.01
132451	5.82	5.29	-0.53	4.88	-0.94	5.82	0.00	5.82	0.00	5.82	0.00	5.82	0.00	4.88	-0.94	4.88	-0.94	5.83	0.01
131238	5.69	5.16	-0.53	4.76	-0.93	5.69	0.00	5.69	0.00	5.69	0.00	5.69	0.00	4.76	-0.93	4.76	-0.93	5.70	0.01
130585	5.60	5.07	-0.53	4.67	-0.93	5.60	0.00	5.60	0.00	5.60	0.00	5.60	0.00	4.67	-0.93	4.67	-0.93	5.61	0.01
129224	5.46	4.94	-0.52	4.54	-0.92	5.46	0.00	5.46	0.00	5.46	0.00	5.46	0.00	4.54	-0.92	4.54	-0.92	5.47	0.01
128238	5.36	4.84	-0.52	4.45	-0.91	5.36	0.00	5.36	0.00	5.36	0.00	5.36	0.00	4.45	-0.91	4.45	-0.91	5.37	0.01
126929	5.20	4.70	-0.50	4.31	-0.89	5.20	0.00	5.20	0.00	5.20	0.00	5.20	0.00	4.31	-0.89	4.31	-0.89	5.21	0.01
125625	5.06	4.56	-0.50	4.18	-0.88	5.06	0.00	5.06	0.00	5.06	0.00	5.06	0.00	4.18	-0.88	4.18	-0.88	5.07	0.01

1 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	14.68	13.45	-1.23	12.91	-1.77	14.68	0.00	14.68	0.00	14.69	0.01	14.69	0.01	12.92	-1.76	12.92	-1.76	14.62	-0.06
159058	13.88	12.67	-1.21	12.17	-1.71	13.88	0.00	13.88	0.00	13.89	0.01	13.89	0.01	12.18	-1.70	12.18	-1.70	13.83	-0.05
158066	13.75	12.53	-1.22	12.05	-1.70	13.75	0.00	13.75	0.00	13.76	0.01	13.76	0.01	12.05	-1.70	12.05	-1.70	13.69	-0.06
157519	13.13	12.02	-1.11	11.60	-1.53	13.13	0.00	13.13	0.00	13.14	0.01	13.14	0.01	11.60	-1.53	11.60	-1.53	13.08	-0.05
157478	Bridge - US 13																		
157417	12.35	11.27	-1.08	10.87	-1.48	12.35	0.00	12.35	0.00	12.36	0.01	12.36	0.01	10.88	-1.47	10.88	-1.47	12.30	-0.05
157129	12.32	11.22	-1.10	10.82	-1.50	12.32	0.00	12.32	0.00	12.33	0.01	12.33	0.01	10.83	-1.49	10.83	-1.49	12.27	-0.05
156783	12.24	11.14	-1.10	10.75	-1.49	12.24	0.00	12.24	0.00	12.25	0.01	12.25	0.01	10.76	-1.48	10.76	-1.48	12.19	-0.05
155648	11.80	10.69	-1.11	10.34	-1.46	11.80	0.00	11.80	0.00	11.81	0.01	11.81	0.01	10.35	-1.45	10.35	-1.45	11.75	-0.05
155452	11.70	10.60	-1.10	9.93	-1.77	11.70	0.00	11.70	0.00	11.71	0.01	11.71	0.01	9.94	-1.76	9.94	-1.76	11.66	-0.04
155432	Bridge - Hoggard Mill Rd																		
155413	11.09	10.18	-0.91	9.91	-1.18	11.09	0.00	11.09	0.00	11.10	0.01	11.10	0.01	9.92	-1.17	9.92	-1.17	11.05	-0.04
155180	11.09	10.19	-0.90	9.84	-1.25	11.09	0.00	11.09	0.00	11.11	0.02	11.10	0.01	9.85	-1.24	9.85	-1.24	11.06	-0.03
154057	10.98	10.08	-0.90	9.61	-1.37	10.98	0.00	10.98	0.00	10.99	0.01	10.99	0.01	9.62	-1.36	9.62	-1.36	10.94	-0.04
152015	10.78	9.89	-0.89	9.38	-1.40	10.78	0.00	10.78	0.00	10.80	0.02	10.79	0.01	9.39	-1.39	9.39	-1.39	10.75	-0.03
150927	10.67	9.78	-0.89	9.28	-1.39	10.67	0.00	10.67	0.00	10.68	0.01	10.68	0.01	9.29	-1.38	9.29	-1.38	10.63	-0.04
149611	10.49	9.62	-0.87	9.12	-1.37	10.49	-1.37	10.49	0.00	10.51	0.02	10.51	0.02	9.14	-1.35	9.14	-1.35	10.46	-0.03
149546	Bridge - US Rte 17 Bypass																		
149397	10.35	9.50	-0.85	9.01	-1.34	10.36	0.01	10.35	0.00	10.37	0.02	10.37	0.02	9.02	-1.33	9.02	-1.33	10.33	-0.02
148039	10.16	9.31	-0.85	8.83	-1.33	10.16	0.00	10.16	0.00	10.18	0.02	10.18	0.02	8.84	-1.32	8.84	-1.32	10.13	-0.03
145812	9.72	8.90	-0.82	8.43	-1.29	9.72	0.00	9.72	0.00	9.74	0.02	9.74	0.02	8.44	-1.28	8.44	-1.28	9.70	-0.02
145399	9.56	8.75	-0.81	8.28	-1.28	9.56	0.00	9.56	0.00	9.58	0.02	9.58	0.02	8.30	-1.26	8.30	-1.26	9.54	-0.02
144517	9.37	8.57	-0.80	8.11	-1.26	9.37	0.00	9.37	0.00	9.39	0.02	9.39	0.02	8.12	-1.25	8.12	-1.25	9.35	-0.02
143112	9.16	8.38	-0.78	7.92	-1.24	9.16	0.00	9.16	0.00	9.19	0.03	9.19	0.03	7.94	-1.22	7.94	-1.22	9.15	-0.01
141733	8.96	8.19	-0.77	7.73	-1.23	8.97	0.01	8.96	0.00	8.99	0.03	8.99	0.03	7.75	-1.21	7.75	-1.21	8.95	-0.01
140880	8.87	8.10	-0.77	7.65	-1.22	8.87	0.00	8.87	0.00	8.90	0.03	8.90	0.03	7.67	-1.20	7.67	-1.20	8.86	-0.01
139341	8.69	7.93	-0.76	7.47	-1.22	8.69	0.00	8.69	0.00	8.68	-0.01	8.68	-0.01	7.46	-1.23	7.46	-1.23	8.64	-0.05
139122	8.65	7.89	-0.76	7.44	-1.21	8.65	0.00	8.65	0.00	8.65	0.00	8.65	0.00	7.44	-1.21	7.44	-1.21	8.61	-0.04
137810	8.55	7.80	-0.75	7.34	-1.21	8.55	0.00	8.55	0.00	8.55	0.00	8.55	0.00	7.34	-1.21	7.34	-1.21	8.51	-0.04
137013	8.41	7.67	-0.74	7.22	-1.19	8.42	0.01	8.41	0.00	8.42	0.01	8.41	0.00	7.22	-1.19	7.22	-1.19	8.38	-0.03
135743	8.23	7.51	-0.72	7.06	-1.17	8.23	0.00	8.23	0.00	8.23	0.00	8.23	0.00	7.06	-1.17	7.06	-1.17	8.20	-0.03
134990	8.00	7.31	-0.69	6.89	-1.11	8.00	0.00	8.00	0.00	8.00	0.00	8.00	0.00	6.89	-1.11	6.89	-1.11	7.97	-0.03
134672	7.89	7.21	-0.68	6.79	-1.10	7.89	0.00	7.89	0.00	7.89	0.00	7.89	0.00	6.79	-1.10	6.79	-1.10	7.85	-0.04
134606	Bridge - King St																		
134560	7.44	6.52	-0.92	6.02	-1.42	7.44	0.00	7.44	0.00	7.44	0.00	7.44	0.00	6.02	-1.42	6.02	-1.42	7.39	-0.05
133965	7.36	6.46	-0.90	5.97	-1.39	7.36	0.00	7.36	0.00	7.36	0.00	7.36	0.00	5.97	-1.39	5.97	-1.39	7.32	-0.04
133595	7.27	6.37	-0.90	5.89	-1.38	7.27	0.00	7.27	0.00	7.27	0.00	7.27	0.00	5.89	-1.38	5.89	-1.38	7.23	-0.04
132451	7.07	6.18	-0.89	5.71	-1.36	7.07	0.00	7.07	0.00	7.07	0.00	7.07	0.00	5.71	-1.36	5.71	-1.36	7.03	-0.04
131238	6.92	6.04	-0.88	5.57	-1.35	6.92	0.00	6.92	0.00	6.92	0.00	6.92	0.00	5.57	-1.35	5.57	-1.35	6.88	-0.04
130585	6.83	5.95	-0.88	5.48	-1.35	6.83	0.00	6.83	0.00	6.83	0.00	6.83	0.00	5.48	-1.35	5.48	-1.35	6.79	-0.04
129224	6.69	5.81	-0.88	5.35	-1.34	6.69	0.00	6.69	0.00	6.69	0.00	6.69	0.00	5.35	-1.34	5.35	-1.34	6.65	-0.04
128238	6.58	5.71	-0.87	5.25	-1.33	6.58	0.00	6.58	0.00	6.58	0.00	6.58	0.00	5.25	-1.33	5.25	-1.33	6.54	-0.04
126929	6.39	5.54	-0.85	5.09	-1.30	6.39	0.00	6.39	0.00	6.39	0.00	6.39	0.00	5.09	-1.30	5.09	-1.30	6.35	-0.04
125625	6.25	5.40	-0.85	4.95	-1.30	6.25	0.00	6.25	0.00	6.25	0.00	6.25	0.00	4.95	-1.30	4.95	-1.30	6.21	-0.04

Table 15: 0.5 Percent Event

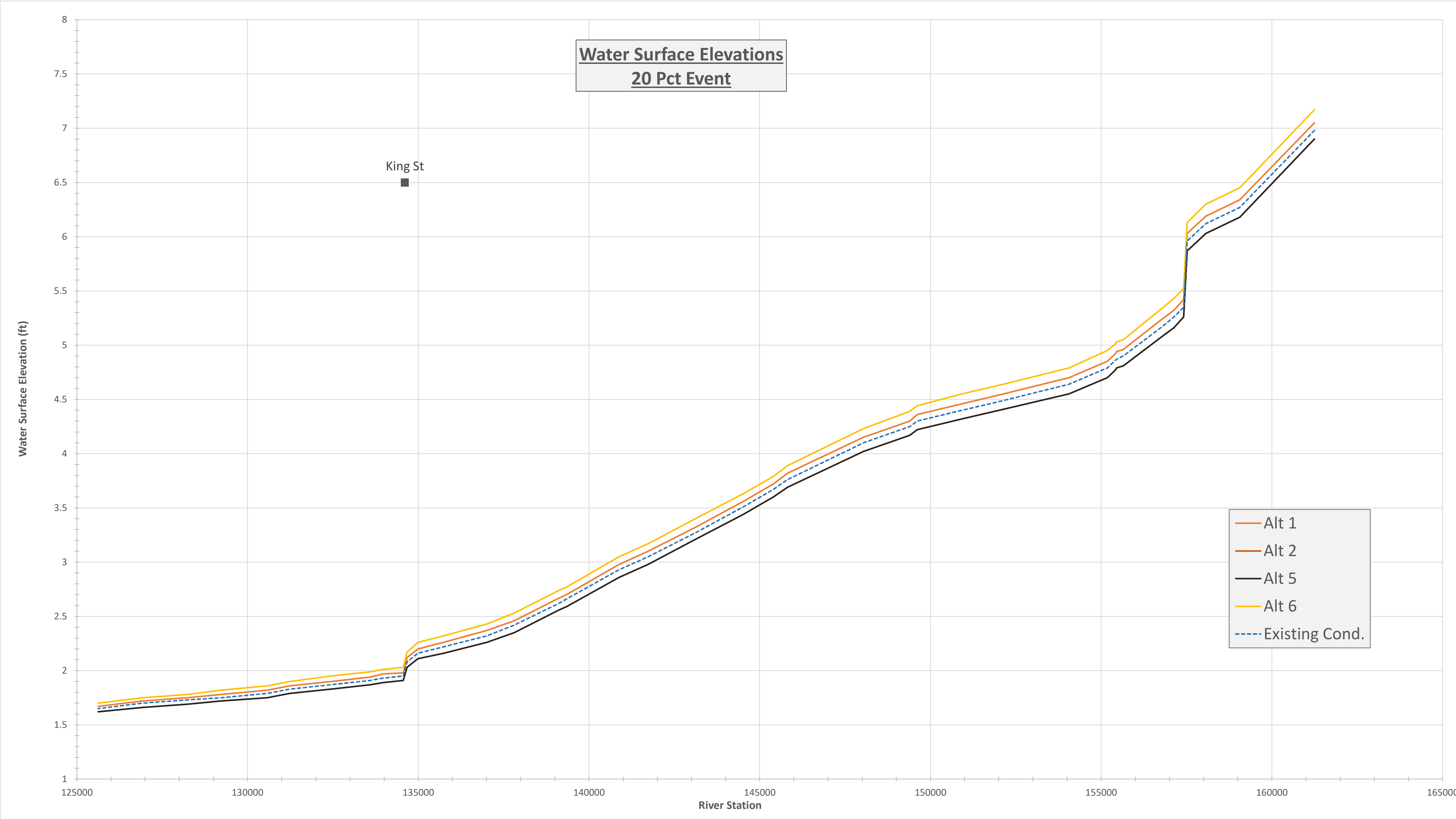
0.5 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	16.02	14.55	-1.47	13.76	-2.26	16.02	0.00	16.02	0.00	16.02	0.00	16.02	0.00	13.77	-2.25	13.77	-2.25	15.87	-0.15
159058	15.12	13.76	-1.36	13.00	-2.12	15.12	0.00	15.12	0.00	15.12	0.00	15.12	0.00	13.01	-2.11	13.01	-2.11	14.98	-0.14
158066	15.00	13.63	-1.37	12.87	-2.13	15.00	0.00	15.00	0.00	15.00	0.00	15.00	0.00	12.87	-2.13	12.87	-2.13	14.86	-0.14
157519	14.19	13.04	-1.15	12.33	-1.86	14.19	0.00	14.19	0.00	14.19	0.00	14.19	0.00	12.34	-1.85	12.34	-1.85	14.06	-0.13
157478	Bridge - US 13																		
157417	13.51	12.26	-1.25	11.58	-1.93	13.51	0.00	13.51	0.00	13.52	0.01	13.52	0.01	11.59	-1.92	11.59	-1.92	13.41	-0.10
157129	13.51	12.23	-1.28	11.54	-1.97	13.51	0.00	13.51	0.00	13.51	0.00	13.51	0.00	11.55	-1.96	11.55	-1.96	13.40	-0.11
156783	13.42	12.16	-1.26	11.46	-1.96	13.42	0.00	13.42	0.00	13.43	0.01	13.43	0.01	11.47	-1.95	11.47	-1.95	13.32	-0.10
155648	12.93	11.72	-1.21	11.02	-1.91	12.93	0.00	12.93	0.00	12.94	0.01	12.94	0.01	11.03	-1.90	11.03	-1.90	12.83	-0.10
155452	12.81	11.62	-1.19	10.93	-1.88	12.81	0.00	12.81	0.00	12.82	0.01	12.82	0.01	10.94	-1.87	10.94	-1.87	12.72	-0.09
155432	Bridge - Hoggard Mill Rd																		
155413	12.35	11.02	-1.33	10.45	-1.90	12.35	0.00	12.35	0.00	12.37	0.02	12.37	0.02	10.46	-1.89	10.46	-1.89	12.24	-0.11
155180	12.34	11.02	-1.32	10.46	-1.88	12.34	0.00	12.34	0.00	12.36	0.02	12.35	0.01	10.47	-1.87	10.47	-1.87	12.23	-0.11
154057	12.23	10.91	-1.32	10.34	-1.89	12.23	0.00	12.23	0.00	12.25	0.02	12.25	0.02	10.35	-1.88	10.35	-1.88	12.12	-0.11
152015	12.03	10.71	-1.32	10.15	-1.88	12.03	0.00	12.03	0.00	12.05	0.02	12.05	0.02	10.16	-1.87	10.16	-1.87	11.92	-0.11
150927	11.91	10.60	-1.31	10.04	-1.87	11.91	0.00	11.91	0.00	11.93	0.02	11.92	0.01	10.06	-1.85	10.06	-1.85	11.79	-0.12
149611	11.71	10.43	-1.28	9.88	-1.83	11.71	0.00	11.71	0.00	11.73	0.02	11.73	0.02	9.89	-1.82	9.89	-1.82	11.60	-0.11
149546	Bridge - US Rte 17 Bypass																		
149397	11.56	10.29	-1.27	9.75	-1.81	11.56	0.00	11.56	0.00	11.58	0.02	11.58	0.02	9.77	-1.79	9.77	-1.79	11.45	-0.11
148039	11.35	10.09	-1.26	9.56	-1.79	11.35	0.00	11.35	0.00	11.38	0.03	11.37	0.02	9.58	-1.77	9.58	-1.77	11.25	-0.10
145812	10.88	9.66	-1.22	9.14	-1.74	10.89	0.01	10.88	0.00	10.91	0.03	10.91	0.03	9.16	-1.72	9.16	-1.72	10.79	-0.09
145399	10.71	9.50	-1.21	8.99	-1.72	10.71	0.00	10.71	0.00	10.74	0.03	10.74	0.03	9.01	-1.70	9.01	-1.70	10.61	-0.10
144517	10.50	9.31	-1.19	8.81	-1.69	10.51	0.01	10.50	0.00	10.54	0.04	10.53	0.03	8.83	-1.67	8.83	-1.67	10.41	-0.09
143112	10.29	9.10	-1.19	8.61	-1.68	10.29	0.00	10.29	0.00	10.32	0.03	10.32	0.03	8.63	-1.66	8.63	-1.66	10.20	-0.09
141733	10.07	8.90	-1.17	8.42	-1.65	10.08	0.01	10.07	0.00	10.11	0.04	10.11	0.04	8.44	-1.63	8.44	-1.63	9.99	-0.08
140880	9.97	8.81	-1.16	8.33	-1.64	9.98	0.01	9.97	0.00	10.01	0.04	10.01	0.04	8.35	-1.62	8.35	-1.62	9.89	-0.08
139341	9.79	8.63	-1.16	8.16	-1.63	9.80	0.01	9.79	0.00	9.78	-0.01	9.78	-0.01	8.15	-1.64	8.15	-1.64	9.66	-0.13
139122	9.75	8.59	-1.16	8.12	-1.63	9.75	0.00	9.75	0.00	9.75	0.00	9.75	0.00	8.12	-1.63	8.12	-1.63	9.62	-0.13
137810	9.64	8.49	-1.15	8.02	-1.62	9.65	0.01	9.64	0.00	9.65	0.01	9.64	0.00	8.02	-1.62	8.02	-1.62	9.52	-0.12
137013	9.49	8.36	-1.13	7.89	-1.60	9.50	0.01	9.49	0.00	9.50	0.01	9.49	0.00	7.89	-1.60	7.89	-1.60	9.37	-0.12
135743	9.29	8.18	-1.11	7.73	-1.56	9.29	0.00	9.29	0.00	9.29	0.00	9.29	0.00	7.73	-1.56	7.73	-1.56	9.17	-0.12
134990	9.01	7.95	-1.06	7.52	-1.49	9.02	0.01	9.01	0.00	9.02	0.01	9.01	0.00	7.52	-1.49	7.52	-1.49	8.89	-0.12
134672	8.89	7.84	-1.05	7.42	-1.47	8.89	0.00	8.89	0.00	8.89	0.00	8.89	0.00	7.42	-1.47	7.42	-1.47	8.77	-0.12
134606	Bridge - King St																		
134560	8.72	7.37	-1.35	6.78	-1.94	8.72	0.00	8.72	0.00	8.72	0.00	8.72	0.00	6.78	-1.94	6.78	-1.94	8.59	-0.13
133965	8.62	7.30	-1.32	6.72	-1.90	8.62	0.00	8.62	0.00	8.62	0.00	8.62	0.00	6.72	-1.90	6.72	-1.90	8.50	-0.12
133595	8.52	7.21	-1.31	6.63	-1.89	8.52	0.00	8.52	0.00	8.52	0.00	8.52	0.00	6.63	-1.89	6.63	-1.89	8.40	-0.12
132451	8.32	7.01	-1.31	6.43	-1.89	8.32	0.00	8.32	0.00	8.32	0.00	8.32	0.00	6.43	-1.89	6.43	-1.89	8.20	-0.12
131238	8.16	6.86	-1.30	6.29	-1.87	8.16	0.00	8.16	0.00	8.16	0.00	8.16	0.00	6.29	-1.87	6.29	-1.87	8.04	-0.12
130585	8.08	6.77	-1.31	6.20	-1.88	8.08	0.00	8.08	0.00	8.08	0.00	8.08	0.00	6.20	-1.88	6.20	-1.88	7.95	-0.13
129224	7.92	6.63	-1.29	6.06	-1.86	7.92	0.00	7.92	0.00	7.92	0.00	7.92	0.00	6.06	-1.86	6.06	-1.86	7.80	-0.12
128238	7.81	6.52	-1.29	5.96	-1.85	7.81	0.00	7.81	0.00	7.81	0.00	7.81	0.00	5.96	-1.85	5.96	-1.85	7.69	-0.12
126929	7.61	6.33	-1.28	5.78	-1.83	7.61	0.00	7.61	0.00	7.61	0.00	7.61	0.00	5.78	-1.83	5.78	-1.83	7.49	-0.12
125625	7.46	6.19	-1.27	5.64	-1.82	7.46	0.00	7.46	0.00	7.46	0.00	7.46	0.00	5.64	-1.82	5.64	-1.82	7.34	-0.12

Table 16: 0.2 Percent Event

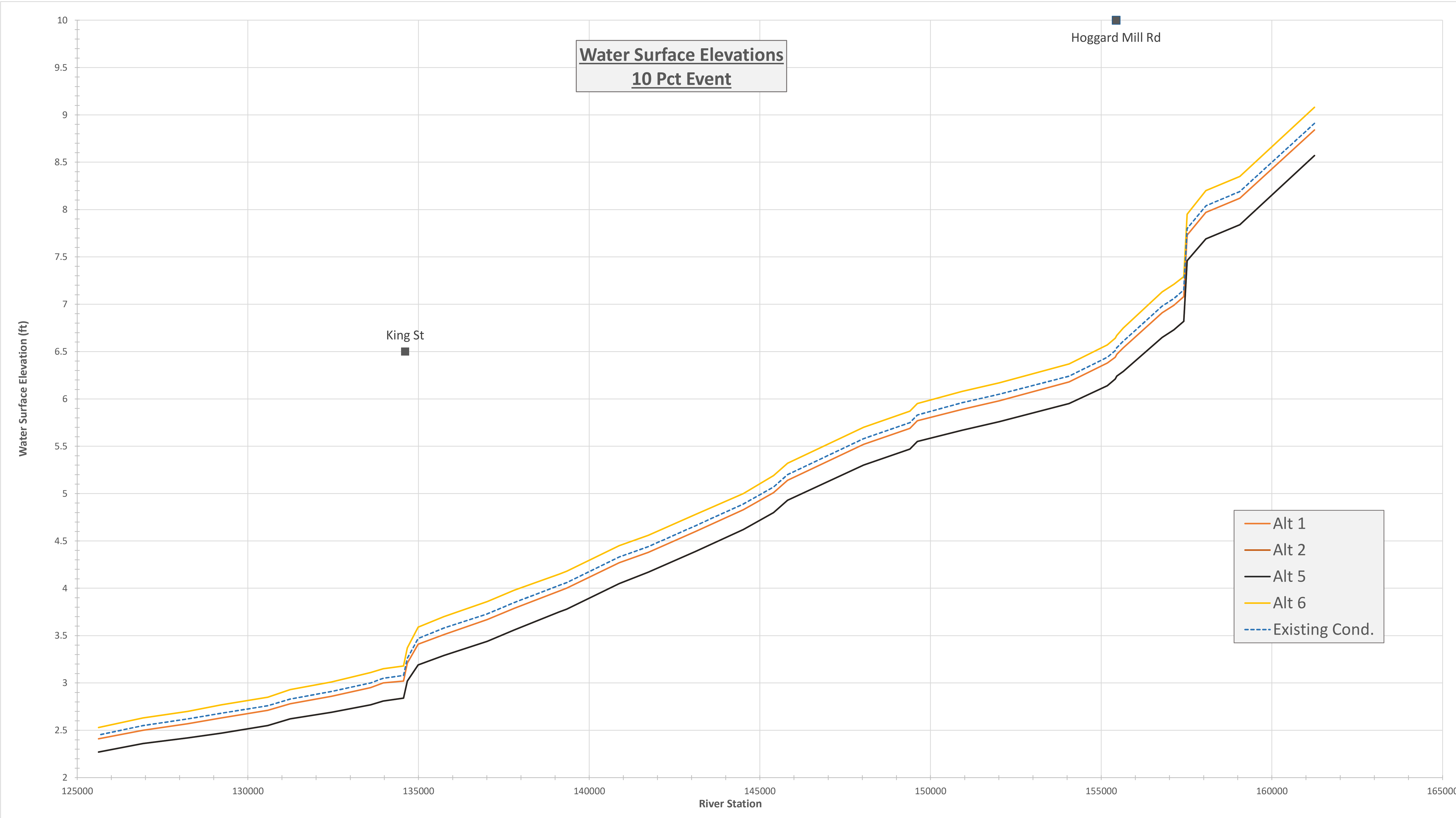
0.2 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	17.52	15.54	-1.98	14.95	-2.57	17.52	0.00	17.52	0.00	17.52	0.00	17.52	0.00	14.96	-2.56	14.96	-2.56	17.36	-0.16
159058	16.94	14.69	-2.25	14.18	-2.76	16.94	0.00	16.94	0.00	16.94	0.00	16.94	0.00	14.18	-2.76	14.18	-2.76	16.80	-0.14
158066	16.81	14.57	-2.24	14.07	-2.74	16.82	0.01	16.81	0.00	16.82	0.01	16.82	0.01	14.07	-2.74	14.07	-2.74	16.68	-0.13
157519	16.71	13.83	-2.88	13.46	-3.25	16.71	0.00	16.71	0.00	16.71	0.00	16.71	0.00	13.46	-3.25	13.46	-3.25	16.32	-0.39
157478	Bridge - US 13																		
157417	14.93	13.24	-1.69	12.68	-2.25	14.93	0.00	14.93	0.00	14.93	0.00	14.93	0.00	12.68	-2.25	12.68	-2.25	14.89	-0.04
157129	14.75	13.23	-1.52	12.65	-2.10	14.75	0.00	14.75	0.00	14.75	0.00	14.75	0.00	12.66	-2.09	12.66	-2.09	14.72	-0.03
156783	14.64	13.14	-1.50	12.58	-2.06	14.64	0.00	14.64	0.00	14.64	0.00	14.64	0.00	12.59	-2.05	12.59	-2.05	14.62	-0.02
155648	14.24	12.68	-1.56	12.14	-2.10	14.25	0.01	14.24	0.00	14.25	0.01	14.25	0.01	12.15	-2.09	12.15	-2.09	14.25	0.01
155452	14.13	12.57	-1.56	12.05	-2.08	14.13	0.00	14.13	0.00	14.14	0.01	14.13	0.00	12.06	-2.07	12.06	-2.07	14.02	-0.11
155432	Bridge - Hoggard Mill Rd																		
155413	14.12	12.00	-2.12	11.35	-2.77	14.12	0.00	14.12	0.00	14.12	0.00	14.12	0.00	11.36	-2.76	11.36	-2.76	13.85	-0.27
155180	14.10	11.99	-2.11	11.35	-2.75	14.11	0.01	14.10	0.00	14.11	0.01	14.10	0.00	11.37	-2.73	11.37	-2.73	13.83	-0.27
154057	14.01	11.88	-2.13	11.24	-2.77	14.01	0.00	14.01	0.00	14.01	0.00	14.01	0.00	11.26	-2.75	11.25	-2.76	13.73	-0.28
152015	13.80	11.68	-2.12	11.04	-2.76	13.81	0.01	13.80	0.00	13.81	0.01	13.80	0.00	11.06	-2.74	11.06	-2.74	13.53	-0.27
150927	13.67	11.56	-2.11	10.92	-2.75	13.67	0.00	13.67	0.00	13.67	0.00	13.67	0.00	10.94	-2.73	10.94	-2.73	13.40	-0.27
149611	13.46	11.37	-2.09	10.74	-2.72	13.46	0.00	13.46	0.00	13.46	0.00	13.46	0.00	10.76	-2.70	10.76	-2.70	13.18	-0.28
149546	Bridge - US Rte 17 Bypass																		
149397	13.27	11.22	-2.05	10.60	-2.67	13.27	0.00	13.27	0.00	13.27	0.00	13.27	0.00	10.63	-2.64	10.62	-2.65	13.01	-0.26
148039	13.06	11.01	-2.05	10.41	-2.65	13.06	0.00	13.06	0.00	13.06	0.00	13.06	0.00	10.43	-2.63	10.42	-2.64	12.81	-0.25
145812	12.57	10.55	-2.02	9.96	-2.61	12.57	0.00	12.57	0.00	12.57	0.00	12.57	0.00	9.99	-2.58	9.98	-2.59	12.32	-0.25
145399	12.38	10.38	-2.00	9.80	-2.58	12.39	0.01	12.38	0.00	12.39	0.01	12.38	0.00	9.82	-2.56	9.82	-2.56	12.14	-0.24
144517	12.17	10.17	-2.00	9.60	-2.57	12.18	0.01	12.17	0.00	12.18	0.01	12.17	0.00	9.63	-2.54	9.62	-2.55	11.92	-0.25
143112	11.95	9.96	-1.99	9.39	-2.56	11.95	0.00	11.95	0.00	11.95	0.00	11.95	0.00	9.42	-2.53	9.42	-2.53	11.70	-0.25
141733	11.73	9.75	-1.98	9.19	-2.54	11.73	0.00	11.73	0.00	11.74	0.01	11.73	0.00	9.22	-2.51	9.22	-2.51	11.49	-0.24
140880	11.63	9.64	-1.99	9.09	-2.54	11.63	0.00	11.63	0.00	11.63	0.00	11.63	0.00	9.13	-2.50	9.12	-2.51	11.38	-0.25
139341	11.45	9.46	-1.99	8.91	-2.54	11.46	0.01	11.45	0.00	11.46	0.01	11.45	0.00	8.91	-2.54	8.90	-2.55	11.21	-0.24
139122	11.40	9.42	-1.98	8.87	-2.53	11.41	0.01	11.40	0.00	11.41	0.01	11.40	0.00	8.88	-2.52	8.87	-2.53	11.16	-0.24
137810	11.30	9.31	-1.99	8.77	-2.53	11.31	0.01	11.30	0.00	11.31	0.01	11.30	0.00	8.77	-2.53	8.77	-2.53	11.06	-0.24
137013	11.14	9.16	-1.98	8.63	-2.51	11.15	0.01	11.14	0.00	11.15	0.01	11.14	0.00	8.63	-2.51	8.63	-2.51	10.90	-0.24
135743	10.93	8.96	-1.97	8.44	-2.49	10.94	0.01	10.93	0.00	10.94	0.01	10.93	0.00	8.45	-2.48	8.44	-2.49	10.69	-0.24
134990	10.61	8.69	-1.92	8.20	-2.41	10.62	0.01	10.61	0.00	10.62	0.01	10.61	0.00	8.20	-2.41	8.20	-2.41	10.38	-0.23
134672	10.48	8.57	-1.91	8.08	-2.40	10.49	0.01	10.48	0.00	10.49	0.01	10.48	0.00	8.09	-2.39	8.08	-2.40	10.25	-0.23
134606	Bridge - King St																		
134560	10.37	8.38	-1.99	7.71	-2.66	10.37	0.00	10.37	0.00	10.37	0.00	10.37	0.00	7.71	-2.66	7.71	-2.66	10.13	-0.24
133965	10.27	8.29	-1.98	7.63	-2.64	10.27	0.00	10.27	0.00	10.27	0.00	10.27	0.00	7.63	-2.64	7.63	-2.64	10.04	-0.23
133595	10.17	8.19	-1.98	7.54	-2.63	10.17	0.00	10.17	0.00	10.17	0.00	10.17	0.00	7.54	-2.63	7.54	-2.63	9.93	-0.24
132451	9.97	7.99	-1.98	7.34	-2.63	9.97	0.00	9.97	0.00	9.97	0.00	9.97	0.00	7.34	-2.63	7.34	-2.63	9.73	-0.24
131238	9.79	7.83	-1.96	7.19	-2.60	9.79	0.00	9.79	0.00	9.79	0.00	9.79	0.00	7.19	-2.60	7.19	-2.60	9.55	-0.24
130585	9.71	7.75	-1.96	7.10	-2.61	9.71	0.00	9.71	0.00	9.71	0.00	9.71	0.00	7.10	-2.61	7.10	-2.61	9.47	-0.24
129224	9.55	7.60	-1.95	6.95	-2.60	9.55	0.00	9.55	0.00	9.55	0.00	9.55	0.00	6.95	-2.60	6.95	-2.60	9.31	-0.24
128238	9.43	7.49	-1.94	6.85	-2.58	9.43	0.00	9.43	0.00	9.43	0.00	9.43	0.00	6.85	-2.58	6.85	-2.58	9.19	-0.24
126929	9.20	7.29	-1.91	6.65	-2.55	9.20	0.00	9.20	0.00	9.20	0.00	9.20	0.00	6.65	-2.55	6.65	-2.55	8.97	-0.23
125625	9.05	7.14	-1.91	6.51	-2.54	9.05	0.00	9.05	0.00	9.05	0.00	9.05	0.00	6.51	-2.54	6.51	-2.54	8.82	-0.23

Appendix B
Water Surface Elevation Tables
Table 17: 0.1 Percent Event

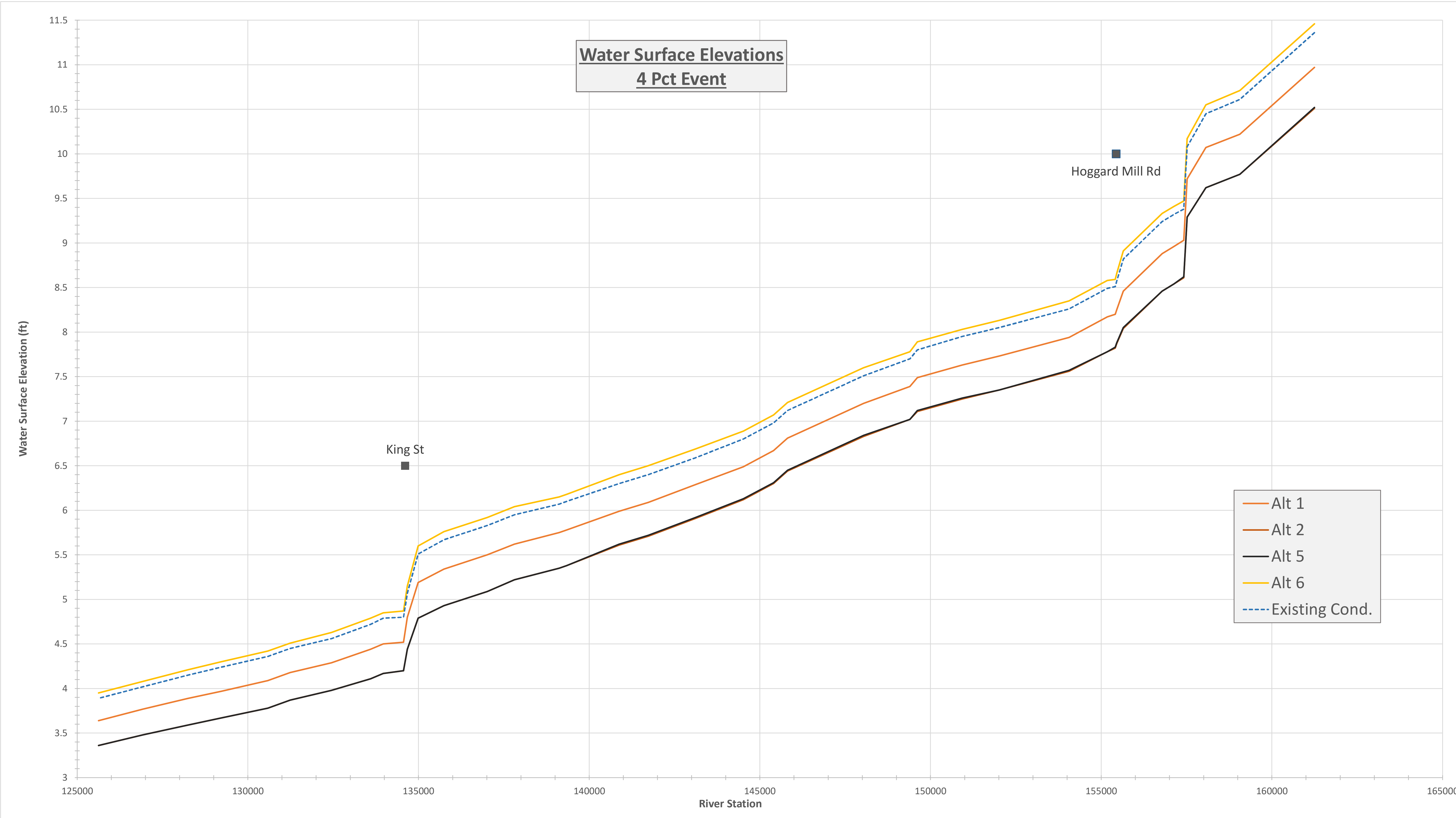
0.1 Pct Event																			
RS	Existing Conditions	Alt 1	Difference	Alt2	Difference	Alt 3	Difference	Alt 3b	Difference	Alt 4	Difference	Alt 4b	Difference	Alt 5	Difference	Alt 5b	Difference	Alt 6	Difference
161247	18.77	16.25	-2.52	15.49	-3.28	18.77	0.00	18.77	0.00	18.77	0.00	18.77	0.00	15.49	-3.28	15.49	-3.28	18.48	-0.29
159058	18.22	15.37	-2.85	14.65	-3.57	18.22	0.00	18.22	0.00	18.22	0.00	18.22	0.00	14.65	-3.57	14.65	-3.57	17.95	-0.27
158066	18.09	15.25	-2.84	14.53	-3.56	18.09	0.00	18.09	0.00	18.09	0.00	18.09	0.00	14.53	-3.56	14.53	-3.56	17.82	-0.27
157519	17.99	14.83	-3.16	13.81	-4.18	17.99	0.00	17.99	0.00	17.99	0.00	17.99	0.00	13.81	-4.18	13.81	-4.18	17.72	-0.27
157478	Bridge - US 13																		
157417	15.89	13.77	-2.12	13.23	-2.66	15.89	0.00	15.89	0.00	15.89	0.00	15.89	0.00	13.23	-2.66	13.23	-2.66	15.69	-0.20
157129	15.84	13.77	-2.07	13.21	-2.63	15.84	0.00	15.84	0.00	15.84	0.00	15.84	0.00	13.22	-2.62	13.22	-2.62	15.63	-0.21
156783	15.77	13.68	-2.09	13.14	-2.63	15.77	0.00	15.77	0.00	15.77	0.00	15.77	0.00	13.14	-2.63	13.14	-2.63	15.49	-0.28
155648	15.47	13.19	-2.28	12.67	-2.80	15.47	0.00	15.47	0.00	15.47	0.00	15.47	0.00	12.68	-2.79	12.68	-2.79	15.13	-0.34
155452	15.38	13.07	-2.31	12.56	-2.82	15.38	0.00	15.38	0.00	15.38	0.00	15.38	0.00	12.57	-2.81	12.57	-2.81	15.04	-0.34
155432	Bridge - Hoggard Mill Rd																		
155413	15.38	12.67	-2.71	11.99	-3.39	15.38	0.00	15.38	0.00	15.38	0.00	15.38	0.00	12.01	-3.37	12.01	-3.37	15.04	-0.34
155180	15.36	12.65	-2.71	11.98	-3.38	15.36	0.00	15.36	0.00	15.36	0.00	15.36	0.00	12.00	-3.36	12.00	-3.36	15.02	-0.34
154057	15.27	12.55	-2.72	11.87	-3.40	15.27	0.00	15.27	0.00	15.27	0.00	15.27	0.00	11.89	-3.38	11.89	-3.38	14.93	-0.34
152015	15.06	12.35	-2.71	11.67	-3.39	15.06	0.00	15.06	0.00	15.06	0.00	15.06	0.00	11.69	-3.37	11.69	-3.37	14.72	-0.34
150927	14.92	12.22	-2.70	11.55	-3.37	14.92	0.00	14.92	0.00	14.92	0.00	14.92	0.00	11.57	-3.35	11.57	-3.35	14.58	-0.34
149611	14.68	12.02	-2.66	11.36	-3.32	14.68	0.00	14.68	0.00	14.69	0.01	14.69	0.01	11.38	-3.30	11.38	-3.30	14.36	-0.32
149546	Bridge - US Rte 17 Bypass																		
149397	14.48	11.86	-2.62	11.21	-3.27	14.48	0.00	14.48	0.00	14.48	0.00	14.48	0.00	11.23	-3.25	11.23	-3.25	14.16	-0.32
148039	14.27	11.66	-2.61	11.01	-3.26	14.27	0.00	14.27	0.00	14.27	0.00	14.27	0.00	11.03	-3.24	11.03	-3.24	13.95	-0.32
145812	13.75	11.19	-2.56	10.54	-3.21	13.75	0.00	13.75	0.00	13.75	0.00	13.75	0.00	10.57	-3.18	10.57	-3.18	13.45	-0.30
145399	13.54	11.01	-2.53	10.37	-3.17	13.54	0.00	13.54	0.00	13.54	0.00	13.54	0.00	10.40	-3.14	10.40	-3.14	13.25	-0.29
144517	13.32	10.81	-2.51	10.17	-3.15	13.32	0.00	13.32	0.00	13.32	0.00	13.32	0.00	10.20	-3.12	10.19	-3.13	13.03	-0.29
143112	13.09	10.59	-2.50	9.95	-3.14	13.09	0.00	13.09	0.00	13.09	0.00	13.09	0.00	9.99	-3.10	9.98	-3.11	12.80	-0.29
141733	12.85	10.37	-2.48	9.74	-3.11	12.85	0.00	12.85	0.00	12.85	0.00	12.85	0.00	9.78	-3.07	9.77	-3.08	12.58	-0.27
140880	12.74	10.27	-2.47	9.64	-3.10	12.74	0.00	12.74	0.00	12.74	0.00	12.74	0.00	9.68	-3.06	9.67	-3.07	12.47	-0.27
139341	12.56	10.09	-2.47	9.46	-3.10	12.56	0.00	12.56	0.00	12.56	0.00	12.56	0.00	9.45	-3.11	9.44	-3.12	12.30	-0.26
139122	12.51	10.05	-2.46	9.41	-3.10	12.51	0.00	12.51	0.00	12.51	0.00	12.51	0.00	9.42	-3.09	9.41	-3.10	12.25	-0.26
137810	12.40	9.94	-2.46	9.31	-3.09	12.40	0.00	12.40	0.00	12.40	0.00	12.40	0.00	9.31	-3.09	9.31	-3.09	12.15	-0.25
137013	12.23	9.79	-2.44	9.16	-3.07	12.23	0.00	12.23	0.00	12.23	0.00	12.23	0.00	9.17	-3.06	9.16	-3.07	11.98	-0.25
135743	12.00	9.59	-2.41	8.96	-3.04	12.00	0.00	12.00	0.00	12.00	0.00	12.00	0.00	8.97	-3.03	8.96	-3.04	11.76	-0.24
134990	11.78	9.30	-2.48	8.69	-3.09	11.78	0.00	11.78	0.00	11.78	0.00	11.78	0.00	8.70	-3.08	8.69	-3.09	11.55	-0.23
134672	11.69	9.18	-2.51	8.57	-3.12	11.69	0.00	11.69	0.00	11.69	0.00	11.69	0.00	8.57	-3.12	8.57	-3.12	11.46	-0.23
134606	Bridge - King St																		
134560	11.57	9.02	-2.55	8.37	-3.20	11.57	0.00	11.57	0.00	11.57	0.00	11.57	0.00	8.37	-3.20	8.37	-3.20	11.16	-0.41
133965	11.50	8.92	-2.58	8.28	-3.22	11.50	0.00	11.50	0.00	11.50	0.00	11.50	0.00	8.28	-3.22	8.28	-3.22	11.13	-0.37
133595	11.44	8.82	-2.62	8.18	-3.26	11.44	0.00	11.44	0.00	11.44	0.00	11.44	0.00	8.18	-3.26	8.18	-3.26	11.07	-0.37
132451	11.21	8.62	-2.59	7.98	-3.23	11.21	0.00	11.21	0.00	11.21	0.00	11.21	0.00	7.98	-3.23	7.98	-3.23	10.84	-0.37
131238	11.03	8.46	-2.57	7.82	-3.21	11.03	0.00	11.03	0.00	11.03	0.00	11.03	0.00	7.82	-3.21	7.82	-3.21	10.66	-0.37
130585	10.95	8.37	-2.58	7.74	-3.21	10.95	0.00	10.95	0.00	10.95	0.00	10.95	0.00	7.74	-3.21	7.74	-3.21	10.58	-0.37
129224	10.78	8.22	-2.56	7.59	-3.19	10.78	0.00	10.78	0.00	10.78	0.00	10.78	0.00	7.59	-3.19	7.59	-3.19	10.42	-0.36
128238	10.66	8.11	-2.55	7.48	-3.18	10.66	0.00	10.66	0.00	10.66	0.00	10.66	0.00	7.48	-3.18	7.48	-3.18	10.29	-0.37
126929	10.41	7.90	-2.51	7.28	-3.13	10.41	0.00	10.41	0.00	10.41	0.00	10.41	0.00	7.28	-3.13	7.28	-3.13	10.05	-0.36
125625	10.26	7.75	-2.51	7.13	-3.13	10.26	0.00	10.26	0.00	10.26	0.00	10.26	0.00	7.13	-3.13	7.13	-3.13	9.90	-0.36



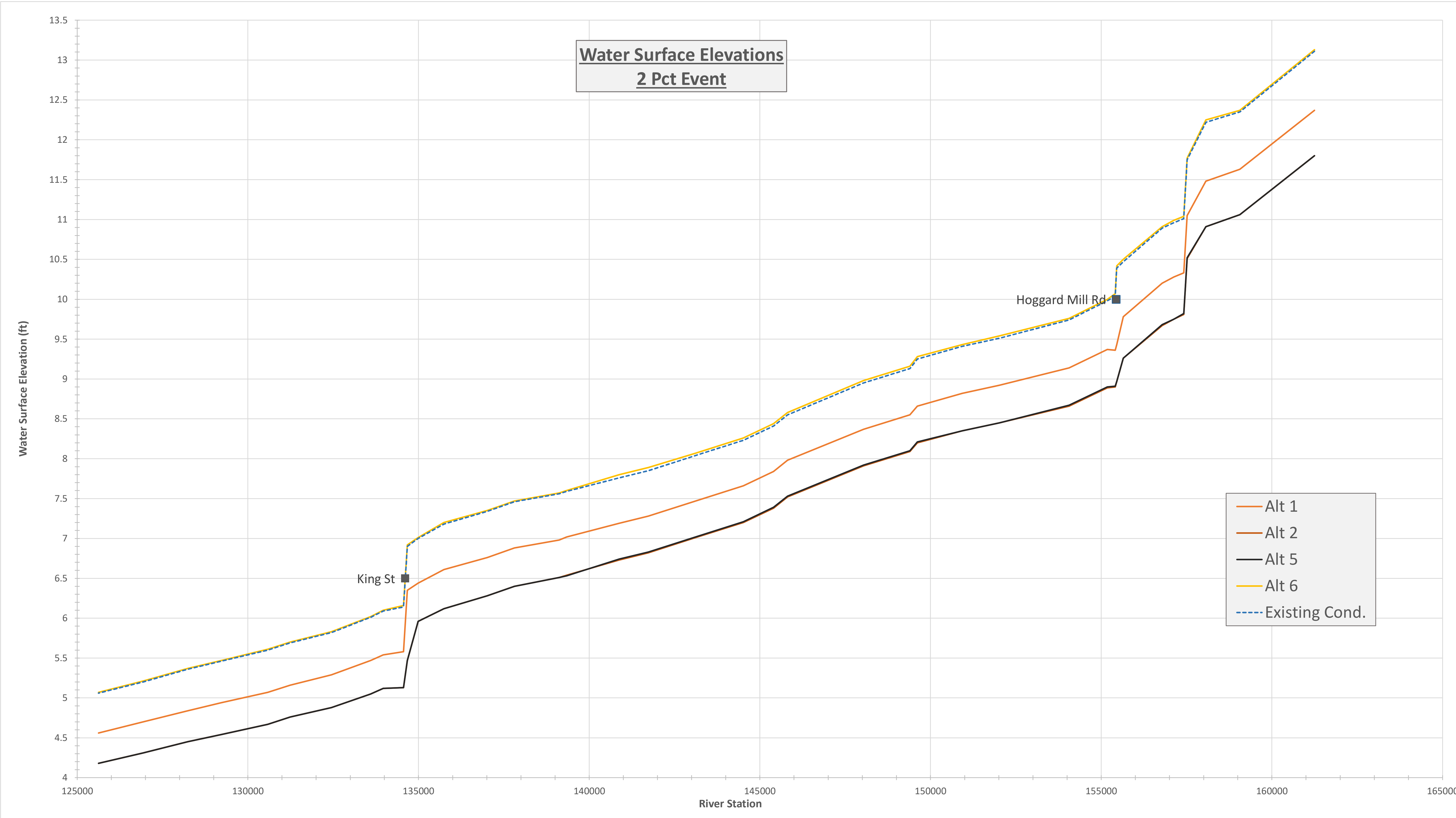
Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



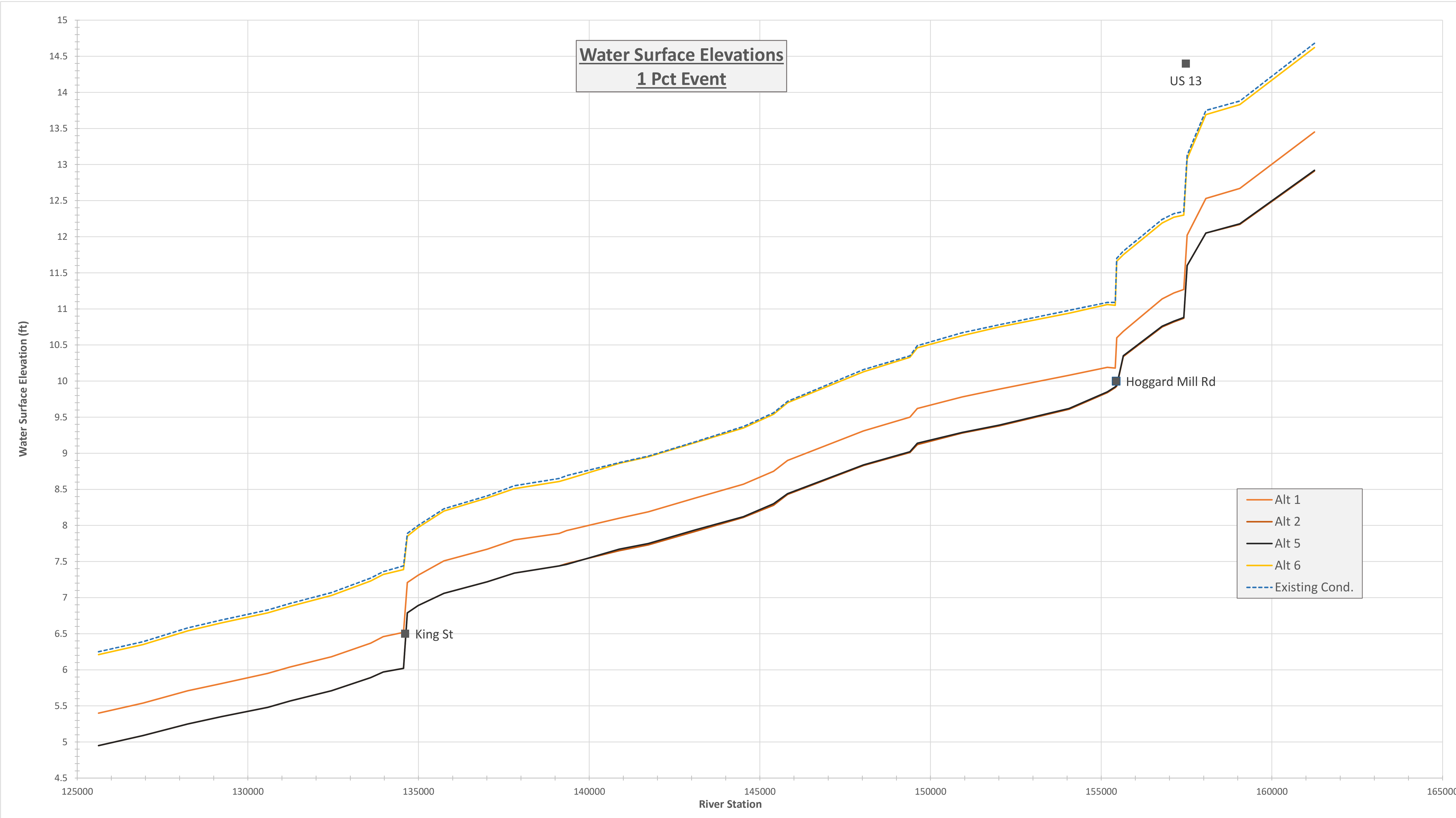
Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



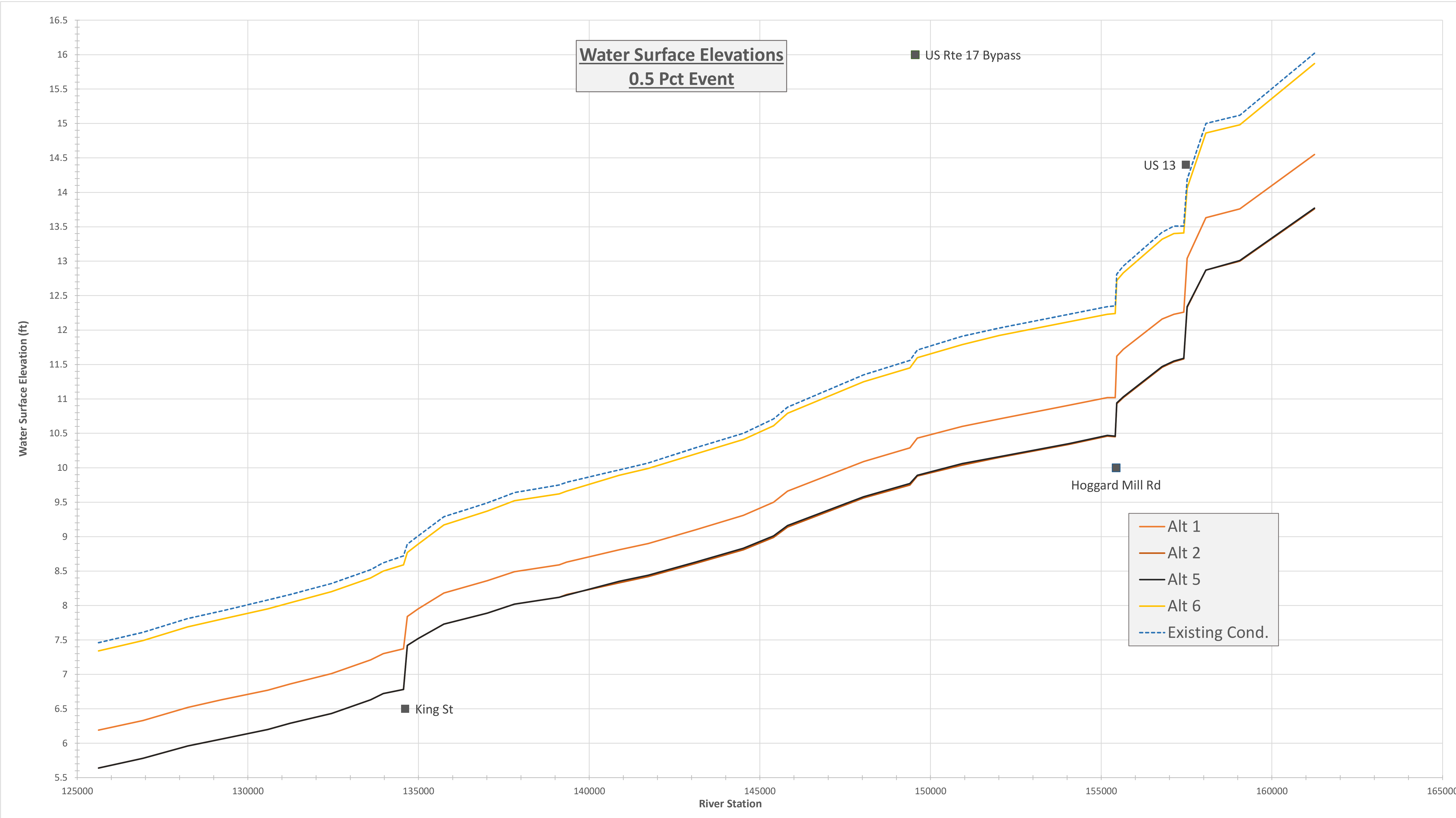
Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



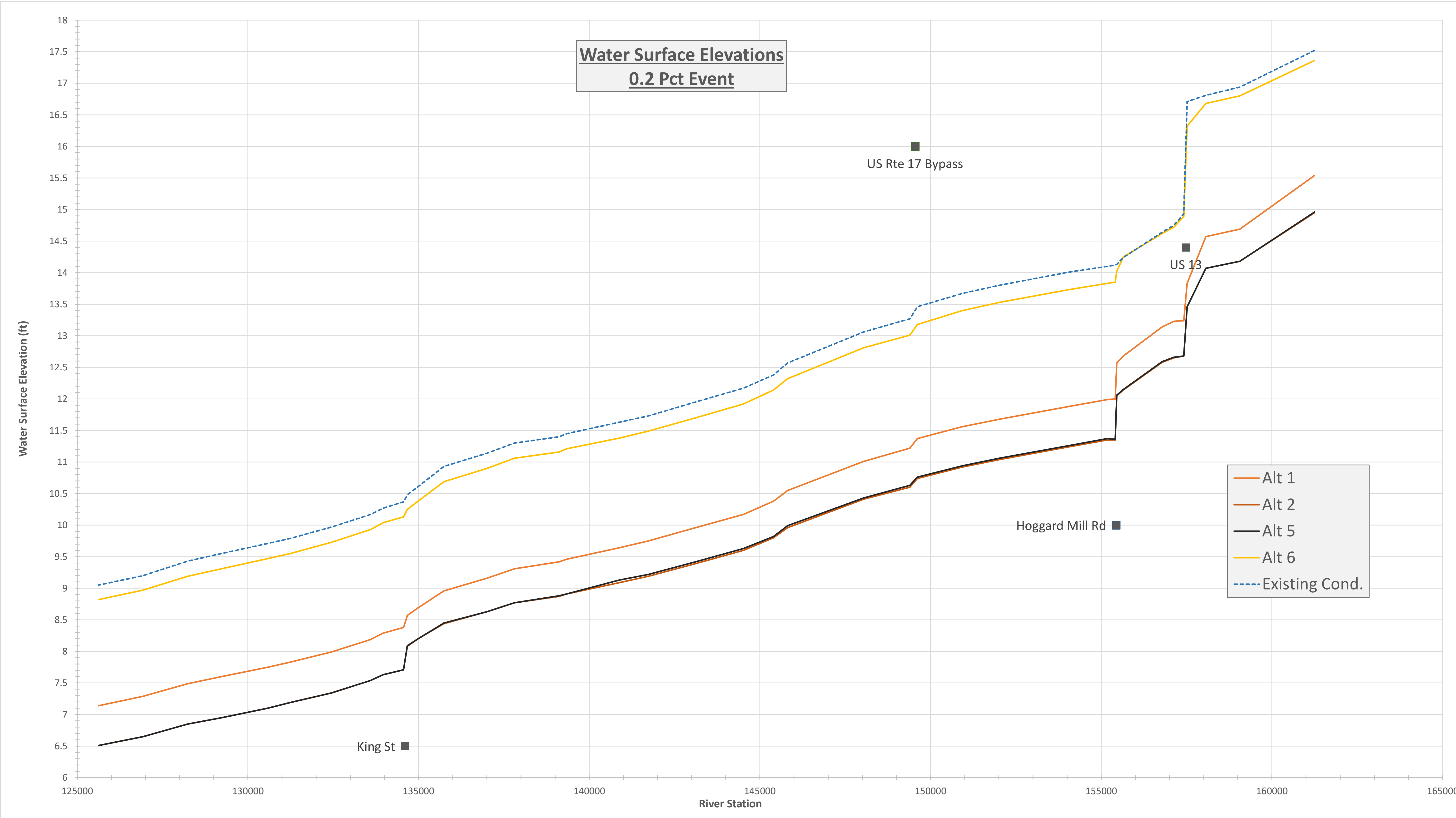
Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



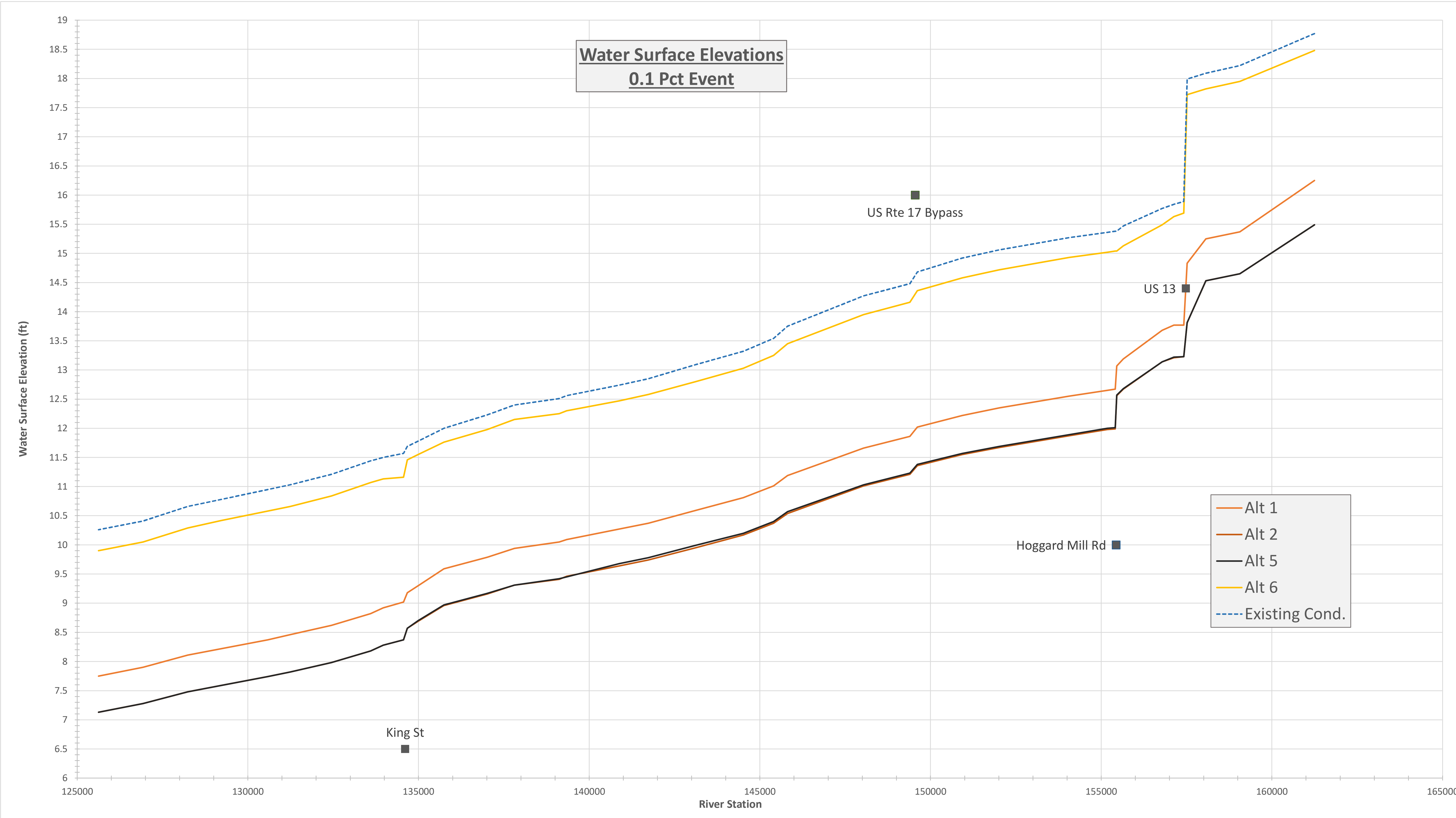
Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.



Alternatives 3, 3b, 4, and 4b are not included due to minimal WSEL impacts. Alternative 5b (not included) is similar to Alternative 5.

APPENDIX C –

COST ESTIMATES

Alternative 1
Lower Hoggards Mill Rsv, Cashie River Rsv
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	100,000	CY	Compacted Fill (Embankments)	$ 75.00	$ 7,500,000.00
2	2	EA	Spillways and Outlet Structures	$ 500,000.00	$ 1,000,000.00
Subtotal General Items				**$**	**8,500,000.00**
A.2 Land Acquisition					
1	3,000	AC	Land Acquisition	$ 600.00	$ 1,800,000.00
Subtotal Land Acquisition				**$**	**1,800,000.00**
				A. BASE BID TOTAL =	**$ 10,300,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 8,500,000.00**
Subtotal Land Acquisition					**$ 1,800,000.00**
Subtotal Construction Costs					**$ 10,300,000.00**
Engineering and Permitting (30% of General Items)					**$ 2,550,000.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 1,927,500.00**
				GRAND TOTAL	**$ 14,777,500.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 16,403,025.00**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 2
Lower Hoggards Mill Rsv, Upper Hoggards Mill Rsv, Cashie River Rsv
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	190,000	CY	Compacted Fill (Embankments)	$ 75.00	$ 14,250,000.00
2	3	EA	Spillways and Outlet Structures	$ 500,000.00	$ 1,500,000.00
Subtotal General Items				**$**	**15,750,000.00**
A.2 Land Acquisition					
1	4,800	AC	Land Acquisition	$ 600.00	$ 2,880,000.00
Subtotal Land Acquisition				**$**	**2,880,000.00**
				A. BASE BID TOTAL =	**$ 18,630,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 15,750,000.00**
Subtotal Land Acquisition					**$ 2,880,000.00**
Subtotal Construction Costs					**$ 18,630,000.00**
Engineering and Permitting (30% of General Items)					**$ 4,725,000.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 3,503,250.00**
				GRAND TOTAL	**$ 26,858,250.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 29,812,657.50**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 3
Raise York St: 8.25' to 8.0', Raise Water St: 10.0'
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	9,000	CY	Compacted Fill (Embankments)	$ 75.00	$ 675,000.00
2	3	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 600,000.00
3	0.55	MI	New Roadway Construction	$ 1,700,000.00	$ 935,000.00
Subtotal General Items				**$**	**2,210,000.00**
A.2 Land Acquisition					
Subtotal Land Acquisition				**$**	**-**
				A. BASE BID TOTAL =	**$ 2,210,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 2,210,000.00**
Subtotal Land Acquisition					**$ -**
Subtotal Construction Costs					**$ 2,210,000.00**
Engineering and Permitting (30% of General Items)					**$ 663,000.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 430,950.00**
				GRAND TOTAL	**$ 3,303,950.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 3,667,384.50**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 3b
Raise York St: 8.25' to 8.0' (no Water St levee)
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	7,500	CY	Compacted Fill (Embankments)	$ 75.00	$ 562,500.00
2	2	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 400,000.00
3	0.35	MI	New Roadway Construction	$ 1,700,000.00	$ 595,000.00
Subtotal General Items				**$**	**1,557,500.00**
A.2 Land Acquisition					
Subtotal Land Acquisition				**$**	**-**
				A. BASE BID TOTAL =	**$ 1,558,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 1,557,500.00**
Subtotal Land Acquisition					**$ -**
Subtotal Construction Costs					**$ 1,557,500.00**
Engineering and Permitting (30% of General Items)					**$ 467,250.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 303,700.00**
				GRAND TOTAL	**$ 2,328,450.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 2,584,579.50**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 4
Raise York St: 10.5' to 10.0', Raise Water St: 10.0'
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	17,500	CY	Compacted Fill (Embankments)	$ 75.00	$ 1,312,500.00
2	3	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 600,000.00
3	0.70	MI	New Roadway Construction	$ 1,700,000.00	$ 1,190,000.00
Subtotal General Items				**$**	**3,102,500.00**
A.2 Land Acquisition					
Subtotal Land Acquisition				**$**	**-**
				A. BASE BID TOTAL =	**$ 3,103,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 3,102,500.00**
Subtotal Land Acquisition					**$ -**
Subtotal Construction Costs					**$ 3,102,500.00**
Engineering and Permitting (30% of General Items)					**$ 930,750.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 605,000.00**
				GRAND TOTAL	**$ 4,638,250.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 5,148,457.50**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 4b
Raise York St: 10.5' to 10.0' (no Water St levee)
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	16,000	CY	Compacted Fill (Embankments)	$ 75.00	$ 1,200,000.00
2	2	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 400,000.00
3	0.50	MI	New Roadway Construction	$ 1,700,000.00	$ 850,000.00
Subtotal General Items				**$**	**2,450,000.00**
A.2 Land Acquisition					
Subtotal Land Acquisition				**$**	**-**
				A. BASE BID TOTAL =	**$ 2,450,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 2,450,000.00**
Subtotal Land Acquisition					**$ -**
Subtotal Construction Costs					**$ 2,450,000.00**
Engineering and Permitting (30% of General Items)					**$ 735,000.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 477,750.00**
				GRAND TOTAL	**$ 3,662,750.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 4,065,652.50**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 5

Lower Hoggards Mill Rsv, Upper Hoggards Mill Rsv, Cashie River Rsv, Raise York St: 10.5' to 10.0', Raise Water St: 10.0'

Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	207,500	CY	Compacted Fill (Embankments)	$ 75.00	$ 15,562,500.00
2	3	EA	Spillways and Outlet Structures	$ 500,000.00	$ 1,500,000.00
3	3	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 600,000.00
4	0.70	MI	New Roadway Construction	$ 1,700,000.00	$ 1,190,000.00
Subtotal General Items				**$**	**18,852,500.00**
A.2 Land Acquisition					
1	4,800	AC	Land Acquisition	$ 600.00	$ 2,880,000.00
Subtotal Land Acquisition				**$**	**2,880,000.00**
				A. BASE BID TOTAL =	**$ 21,733,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 18,852,500.00**
Subtotal Land Acquisition					**$ 2,880,000.00**
Subtotal Construction Costs					**$ 21,732,500.00**
Engineering and Permitting (30% of General Items)					**$ 5,655,750.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 4,108,250.00**
				GRAND TOTAL	**$ 31,496,500.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 34,961,115.00**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

Alternative 5b
Lower Hoggards Mill Rsv, Upper Hoggards Mill Rsv, Cashie River Rsv,
Raise York St: 10.5' to 10.0' (no Water levee)
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	206,000	CY	Compacted Fill (Embankments)	$ 75.00	$ 15,450,000.00
2	3	EA	Spillways and Outlet Structures	$ 500,000.00	$ 1,500,000.00
3	2	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 400,000.00
4	0.50	MI	New Roadway Construction	$ 1,700,000.00	$ 850,000.00
Subtotal General Items				**$**	**18,200,000.00**
A.2 Land Acquisition					
1	4,800	AC	Land Acquisition	$ 600.00	$ 2,880,000.00
Subtotal Land Acquisition				**$**	**2,880,000.00**
				A. BASE BID TOTAL =	**$ 21,080,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 18,200,000.00**
Subtotal Land Acquisition					**$ 2,880,000.00**
Subtotal Construction Costs					**$ 21,080,000.00**
Engineering and Permitting (30% of General Items)					**$ 5,460,000.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 3,981,000.00**
				GRAND TOTAL	**$ 30,521,000.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 33,878,310.00**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

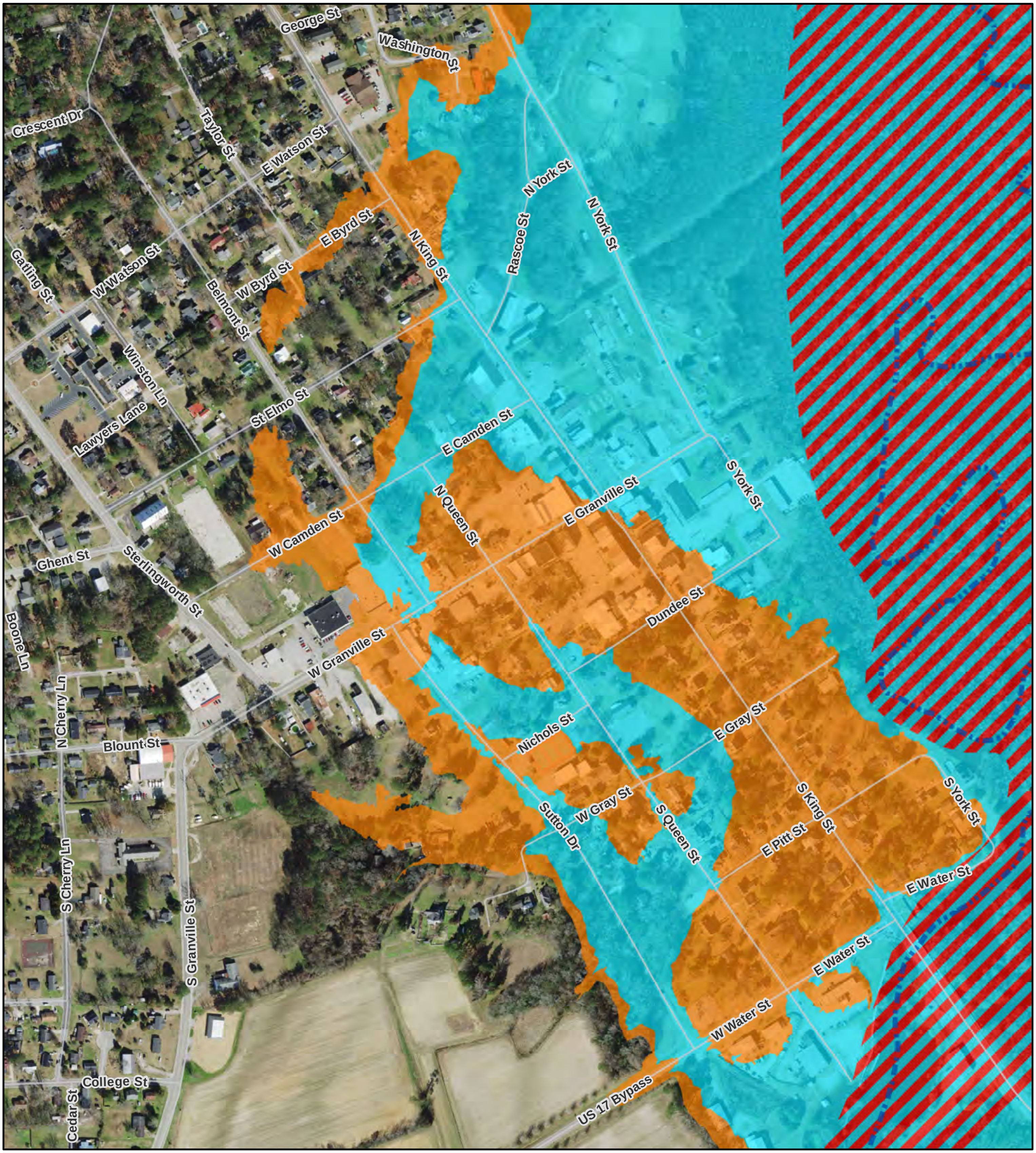
Alternative 6
Lower Hoggards Mill Rsv
Raise York St: 10.5' to 10.0' (no Water St levee)
Preliminary Opinion of Probably Costs

Item No.	QUAN.	UNIT	DESCRIPTION	COST PER UNIT	TOTAL COST
A. BASE ITEMS					
A.1 General Items					
1	36,000	CY	Compacted Fill (Embankments)	$ 75.00	$ 2,700,000.00
2	1	EA	Spillways and Outlet Structures	$ 500,000.00	$ 500,000.00
3	2	EA	Tide Gates and Backflow Preventers	$ 200,000.00	$ 400,000.00
4	0.50	MI	New Roadway Construction	$ 1,700,000.00	$ 850,000.00
Subtotal General Items				**$**	**4,450,000.00**
A.2 Land Acquisition					
1	1200	AC	Land Acquisition	$ 600.00	$ 720,000.00
Subtotal Land Acquisition				**$**	**720,000.00**
Total Project Construction Cost Summary					
Subtotal General Items					**$ 4,450,000.00**
Subtotal Land Acquisition					**$ 720,000.00**
Subtotal Construction Costs					**$ 5,170,000.00**
Engineering and Permitting (30% of General Items)					**$ 1,335,000.00**
Contingencies (15% of Construction Costs and Engineering and Permitting)					**$ 975,750.00**
				GRAND TOTAL	**$ 7,480,750.00**
				11% ADJUSTMENT TO DECEMBER 2021 $	**$ 8,303,632.50**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be liable to Owner or to a third party for any failure to accurately estimate the cost of the project, or any part thereof.

APPENDIX D –

EXHIBITS



1 inch = 500 feet

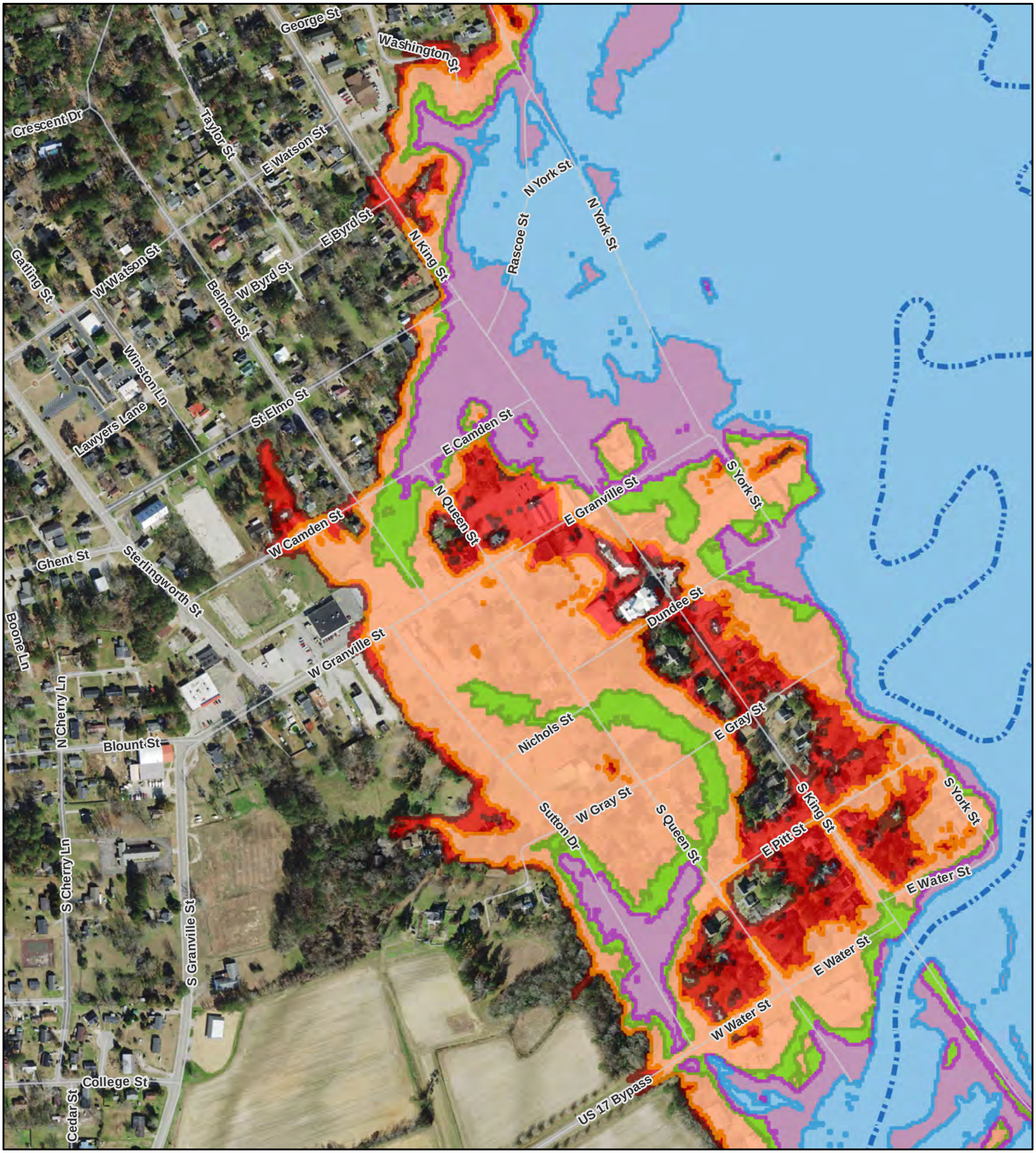
0 500 1,000 Feet

Legend

FEMA Effective Floodplains

- Floodway
- 1% Floodplain
- 0.2% Floodplain

Exhibit 1: Effective Floodplains



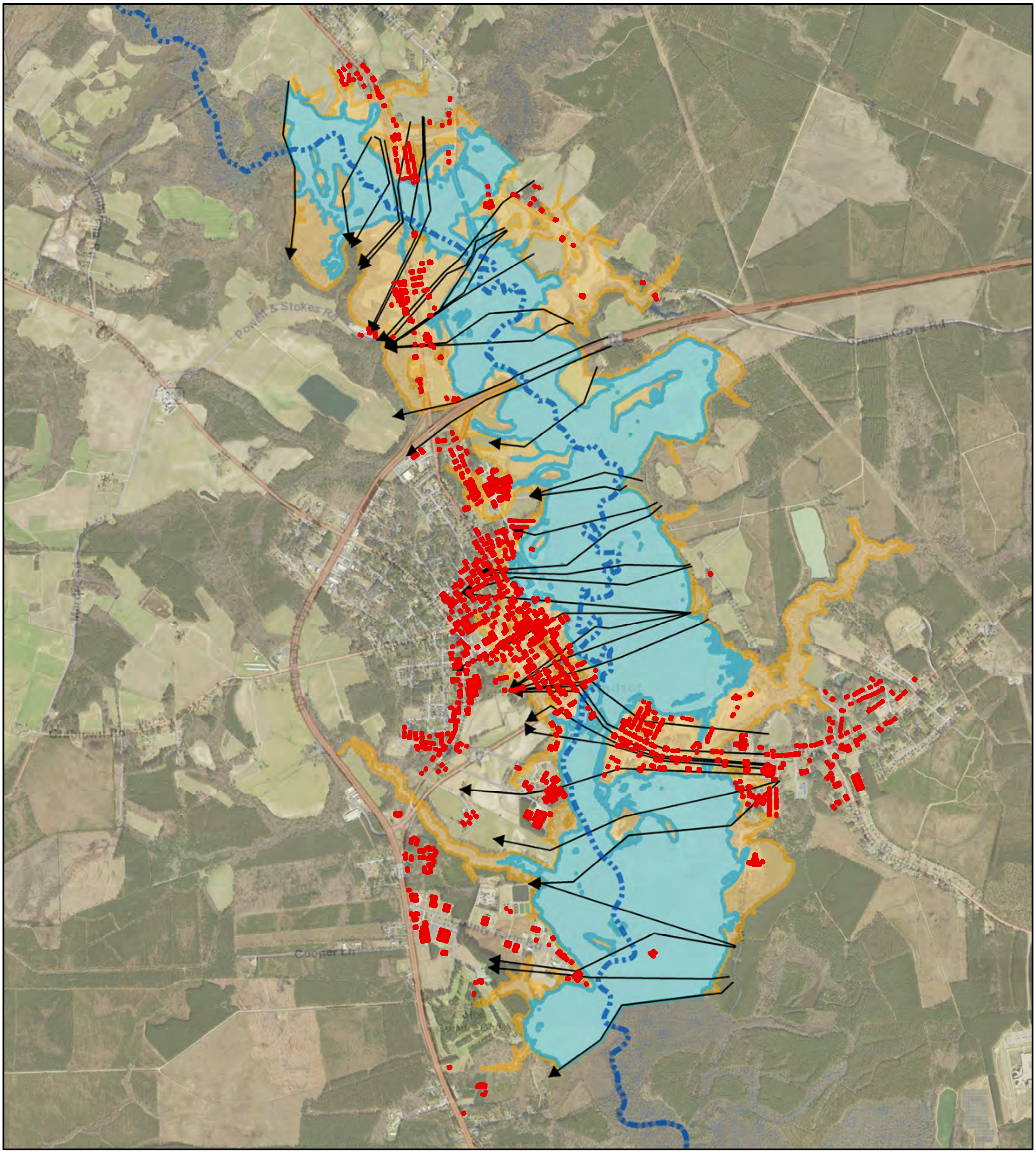
1 inch = 500 feet

0 500 1,000 Feet

Legend

- 10% Ex Floodplain
- 0.2% Ex Floodplain
- 2% Ex Floodplain
- 0.1% Ex Floodplain
- 1% Ex Floodplain

Exhibit 2: Existing Conditions Floodplains



N

1 inch = 3,000 feet

0 3,000 6,000 Feet

Legend

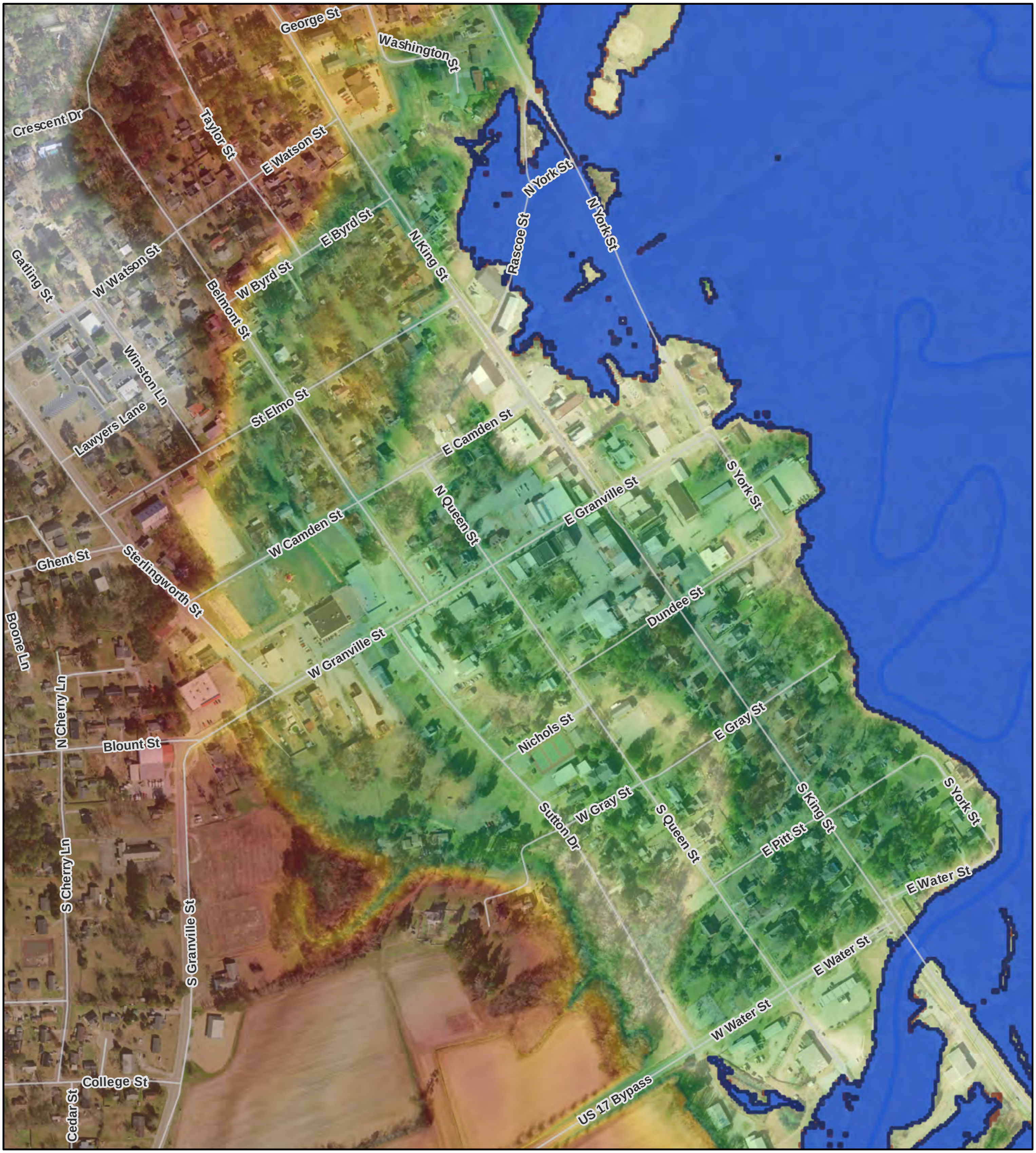
Hydraulic Modeling Cross Sections

Buildings Used in Analysis

10% Ex Floodplain

0.1% Ex Floodplain

Exhibit 3: Existing Conditions Floodplains



N

1 inch = 500 feet

0 500 1,000 Feet

Legend

Proposed Floodplain

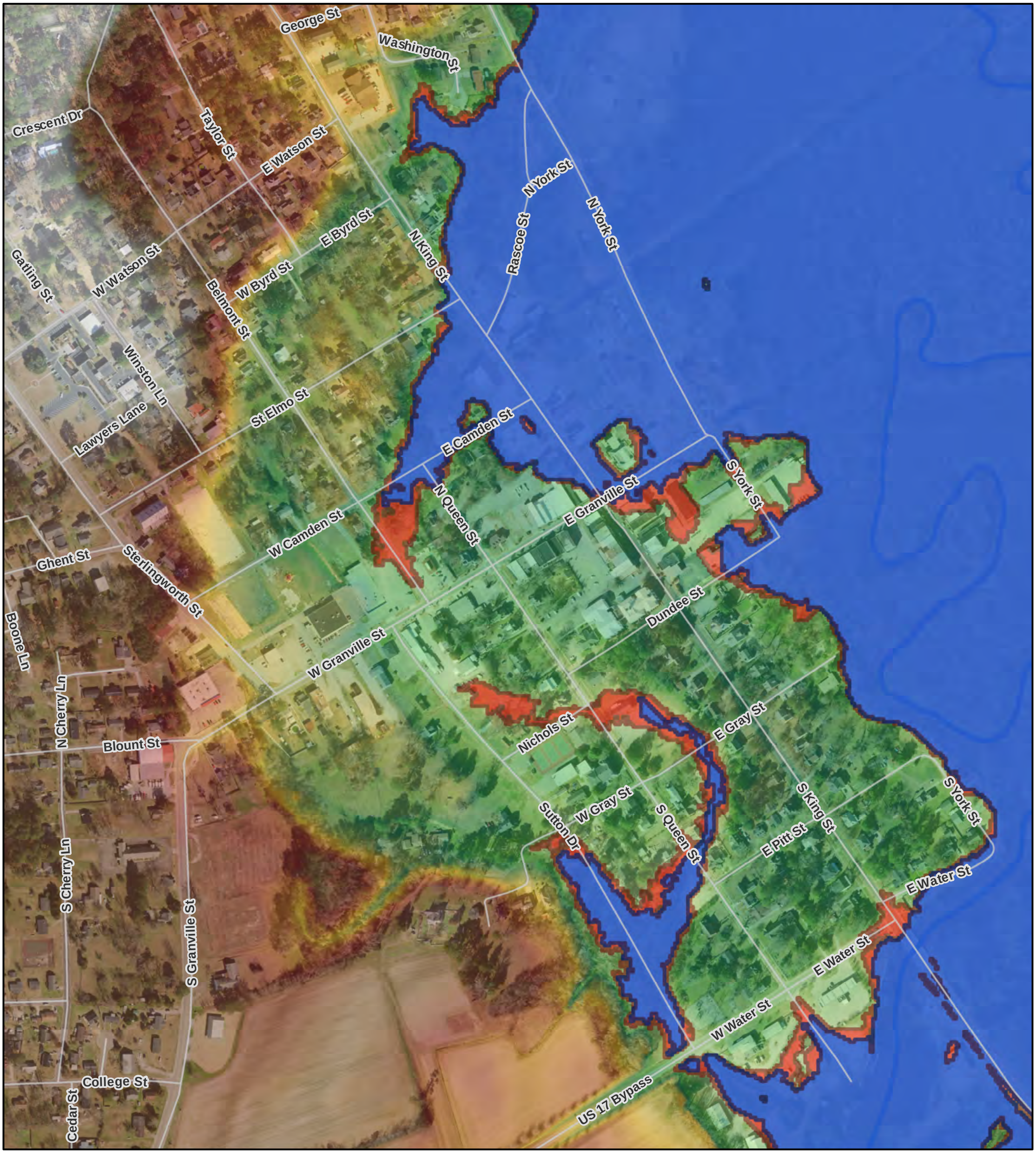
Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 4: Alternative 1 10% Event



N

1 inch = 500 feet

0 500 1,000 Feet

Legend

Proposed Floodplain

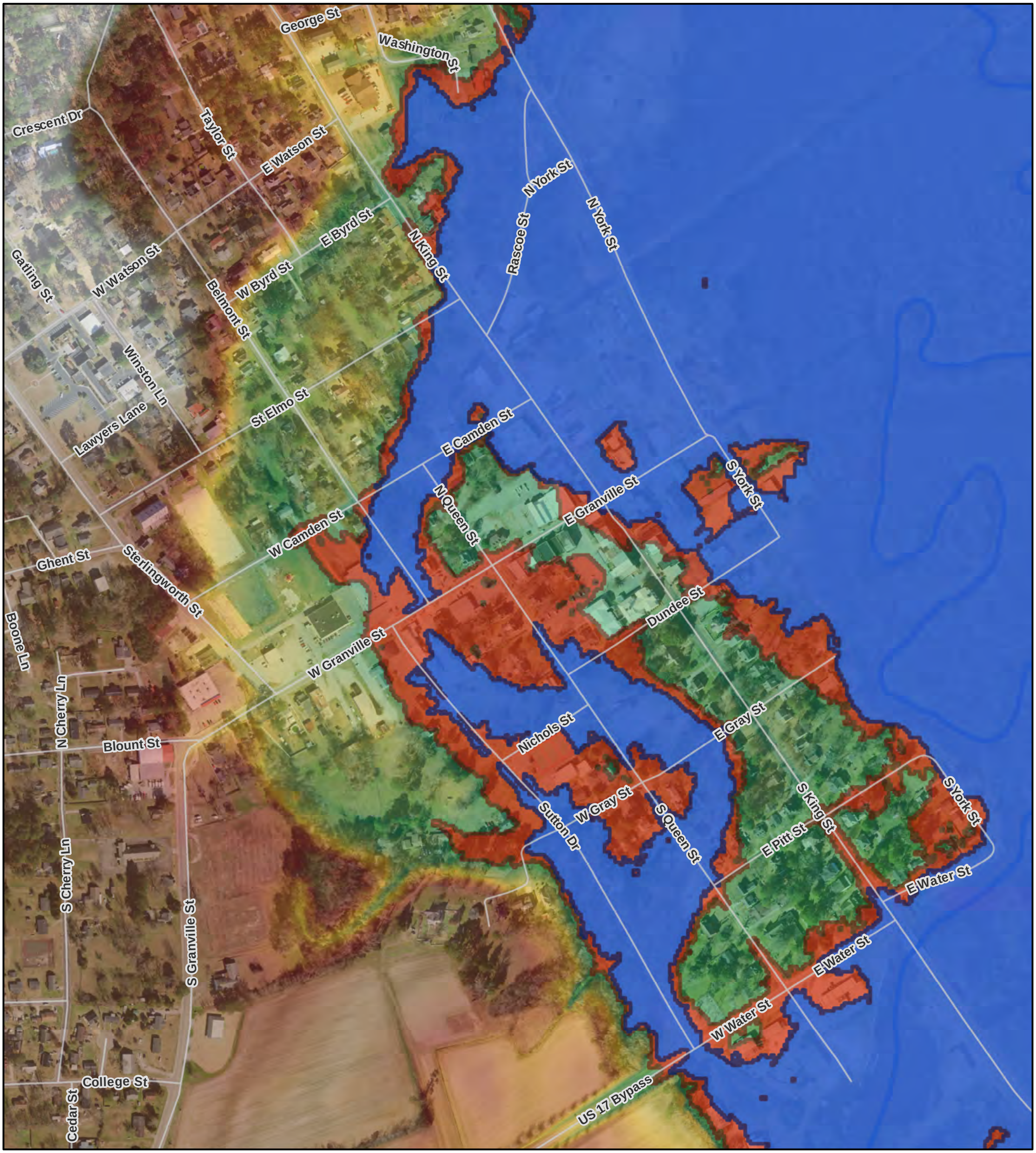
Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 5: Alternative 1 1% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

Proposed Floodplain

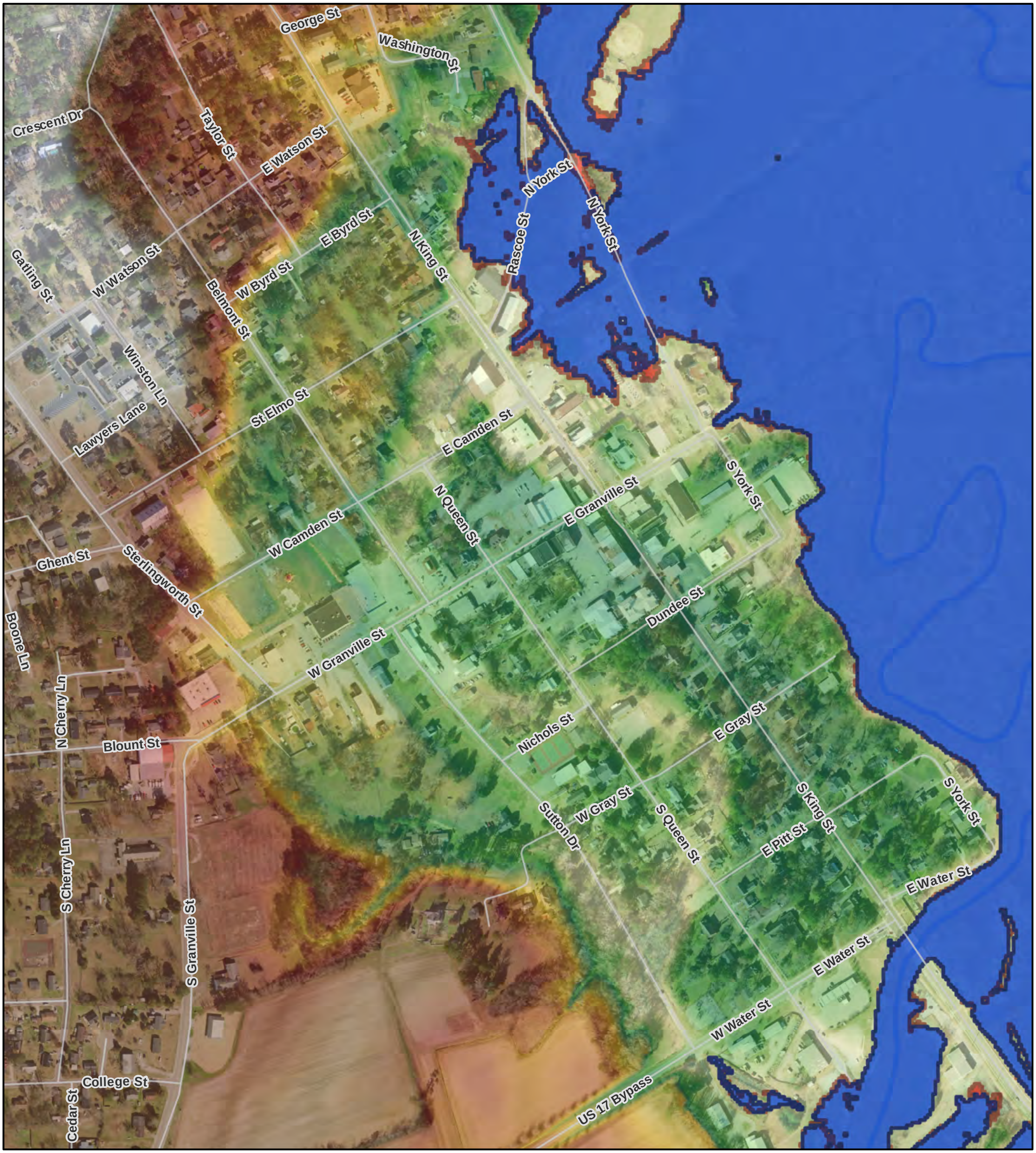
Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 6: Alternative 1 0.2% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

Proposed Floodplain

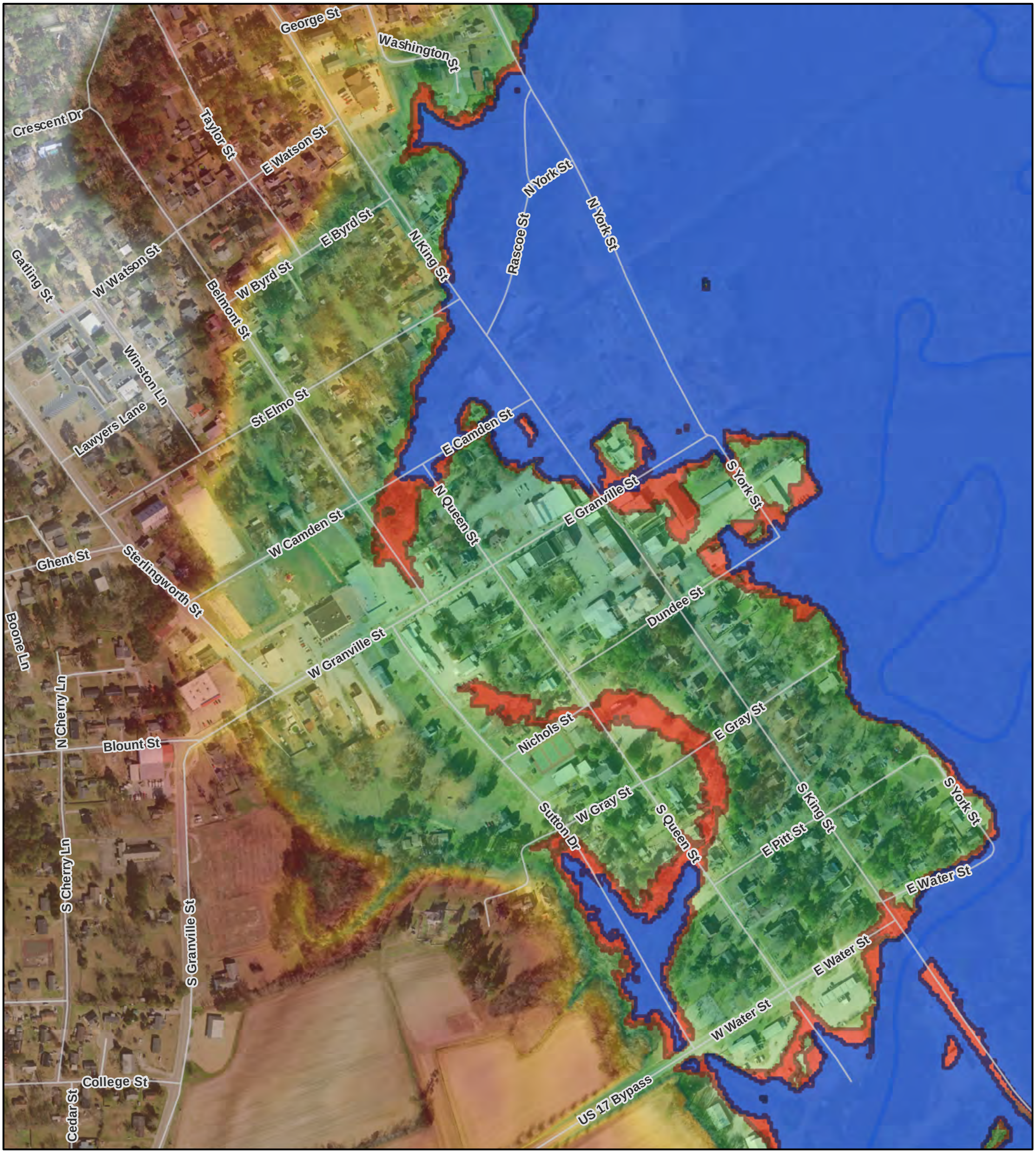
Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 7: Alternative 2 10% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

Proposed Floodplain

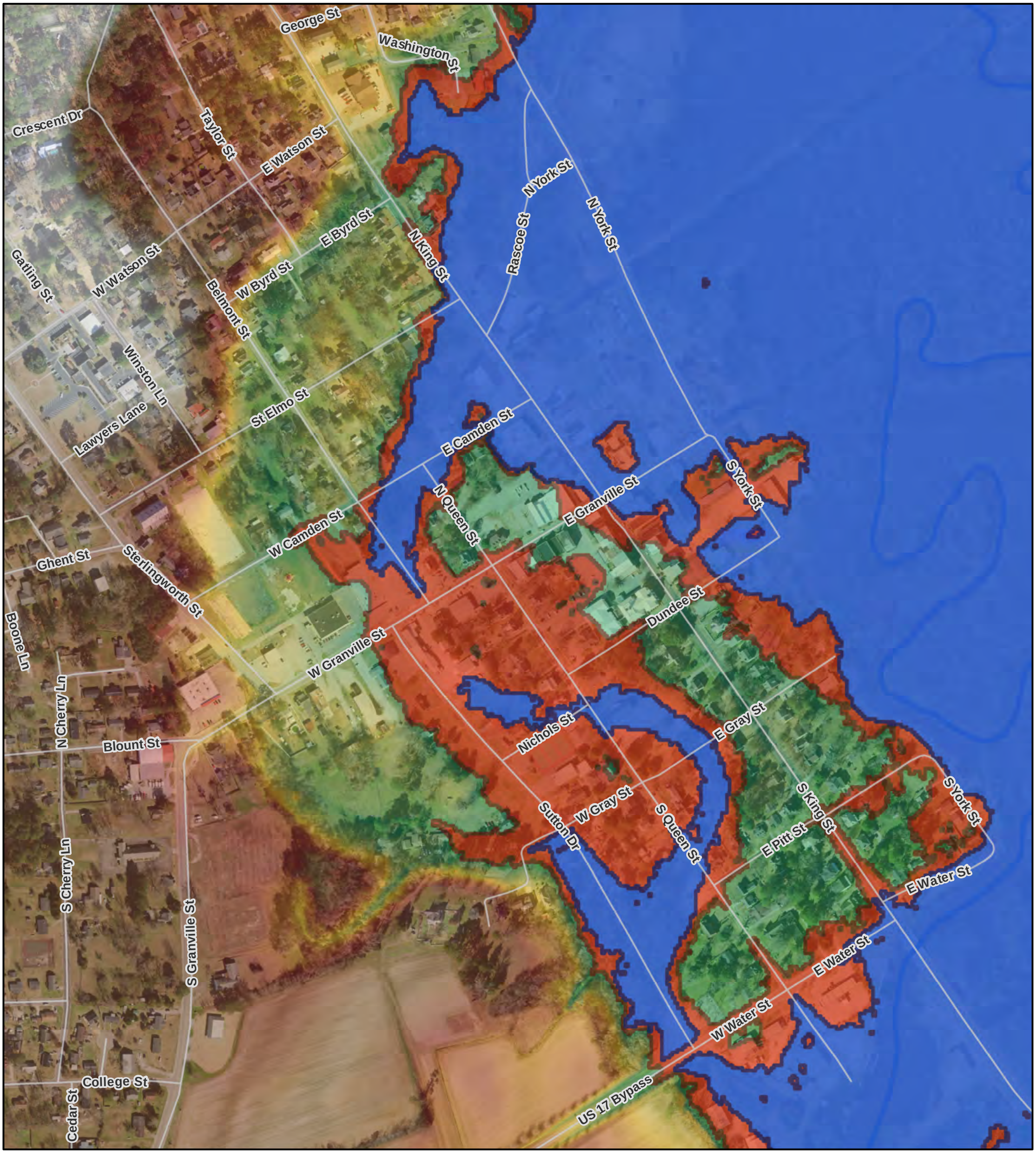
Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 8: Alternative 2 1% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

Proposed Floodplain

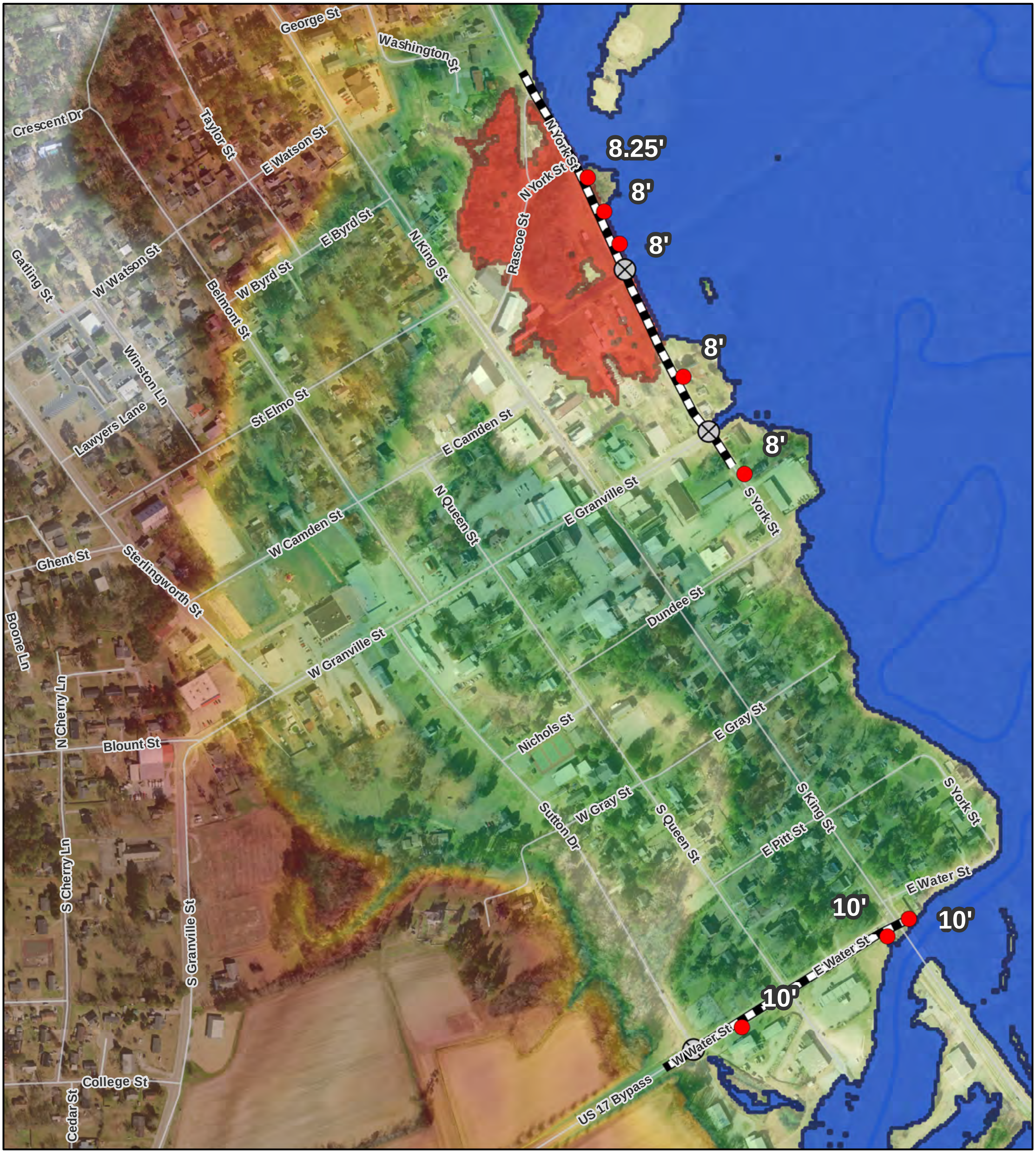
Existing Floodplain

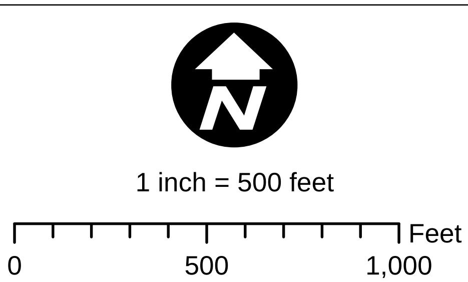
Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 9: Alternative 2 0.2% Event





Legend

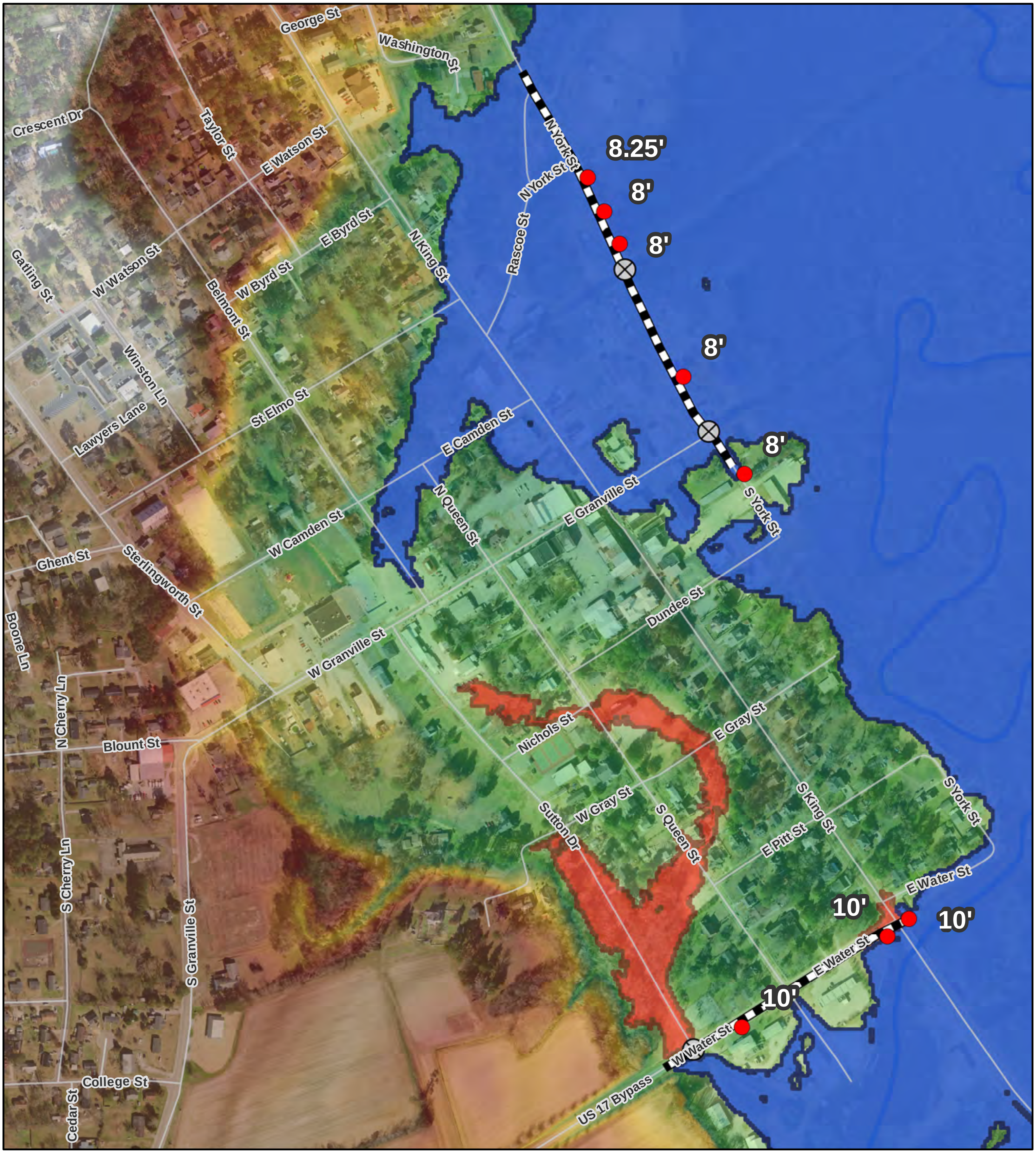
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 10: Alternative 3 10% Event



N

1 inch = 500 feet

0 500 1,000 Feet

Legend

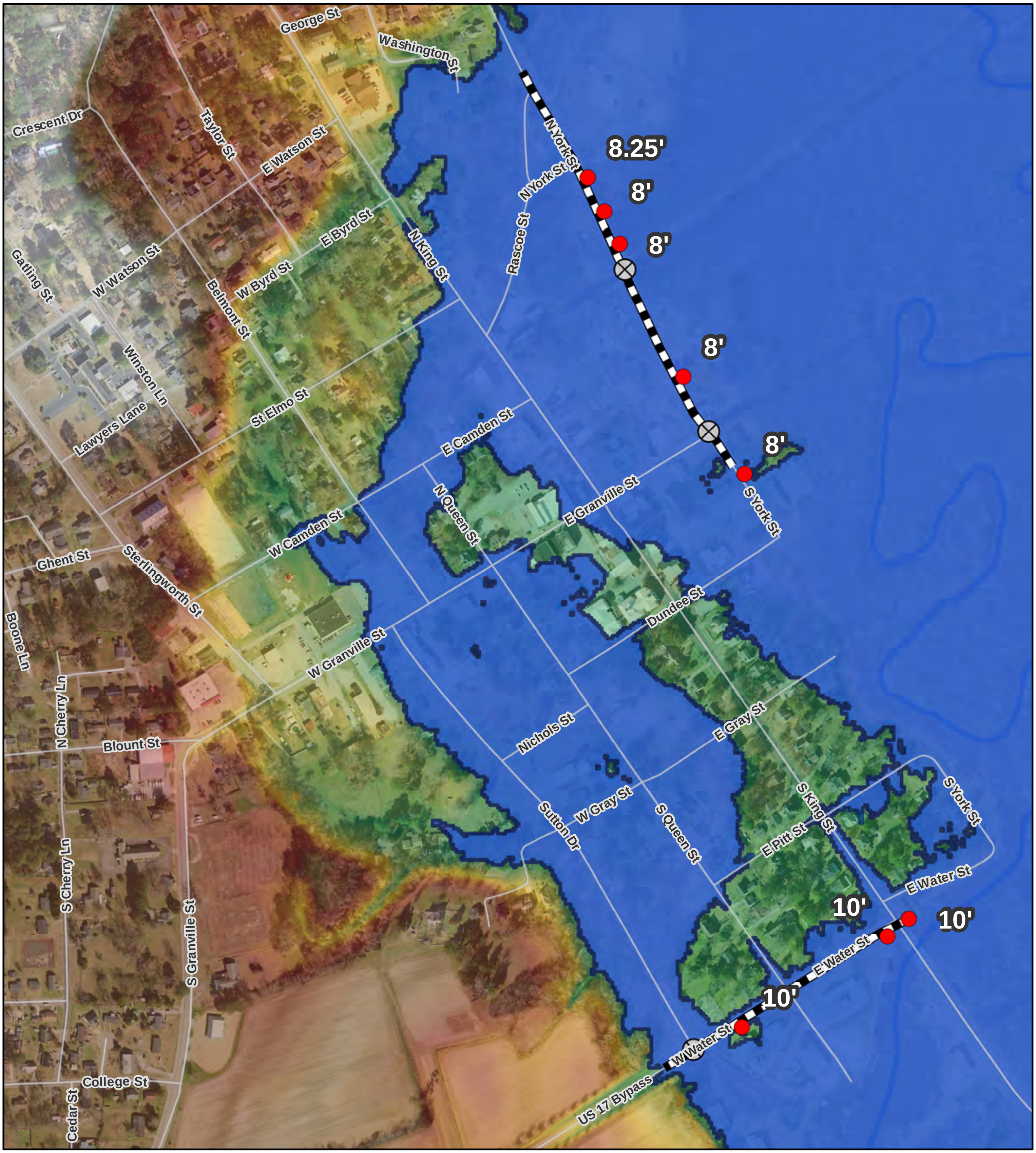
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 11: Alternative 3 1% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

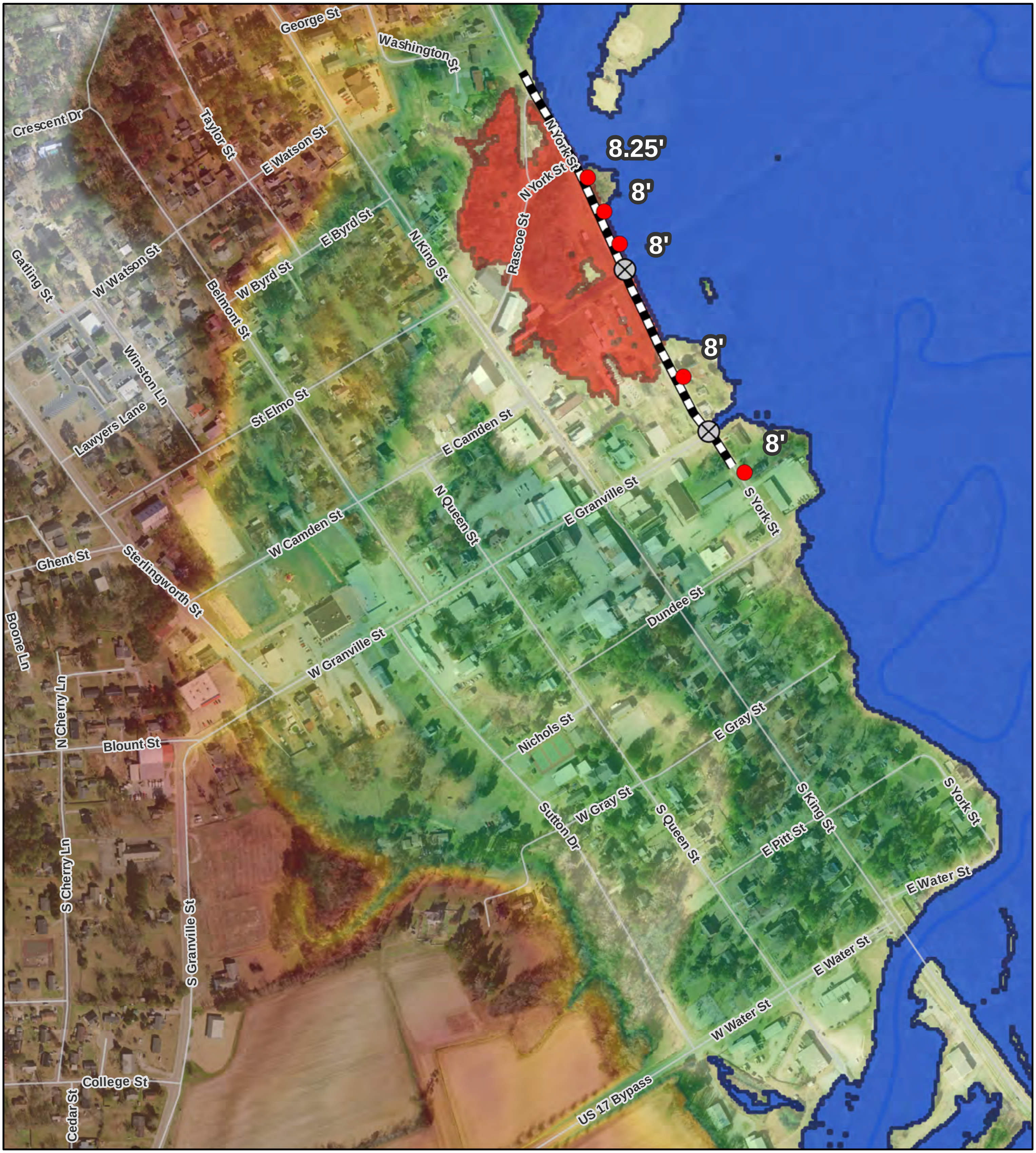
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 12: Alternative 3 0.2% Event



1 inch = 500 feet

0 500 1,000 Feet

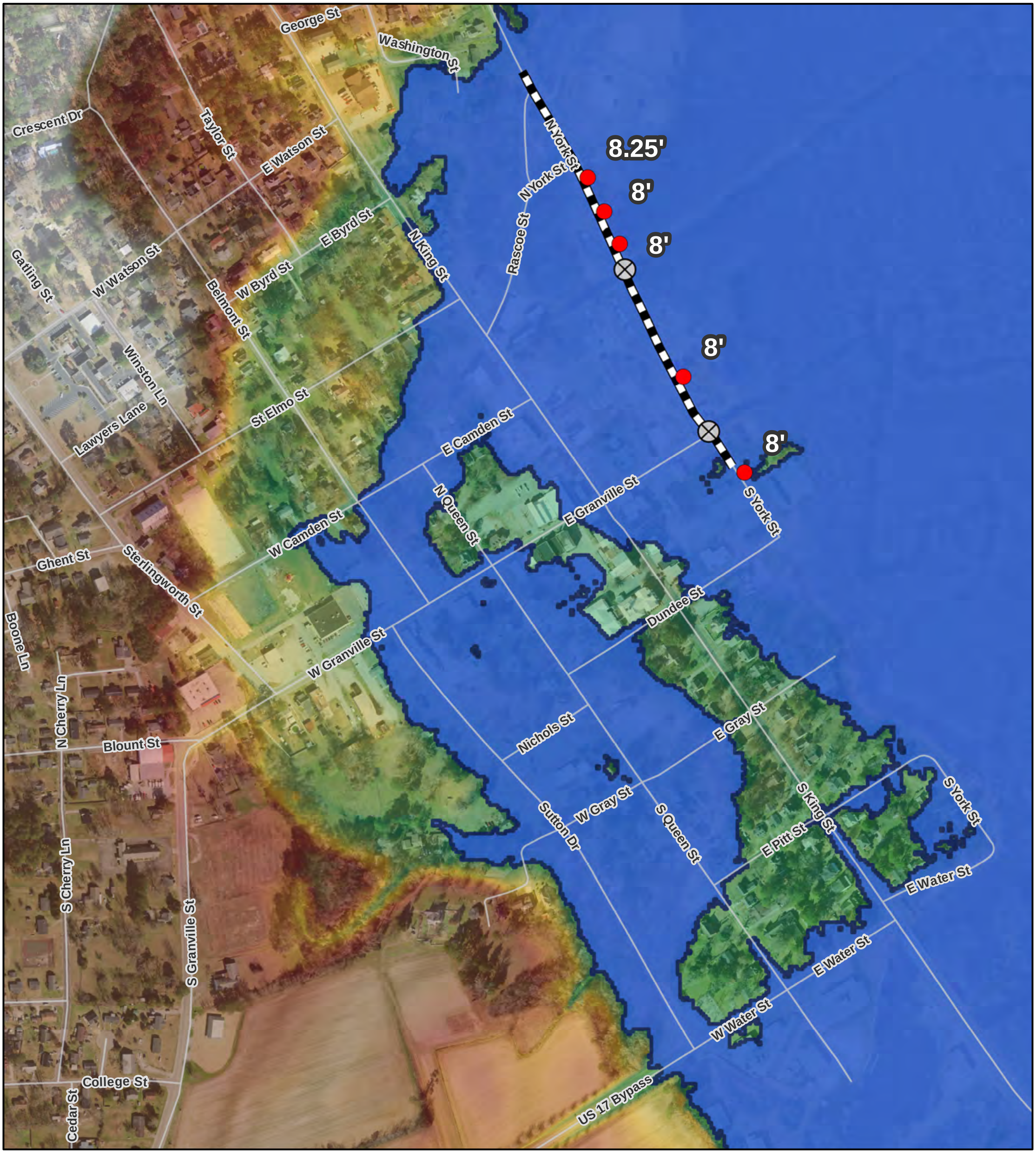
Legend

- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)
High : 48.86
Low : -0.29

Exhibit 13: Alternative 3b 10% Event

Exhibit 14: Alternative 3b 1% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

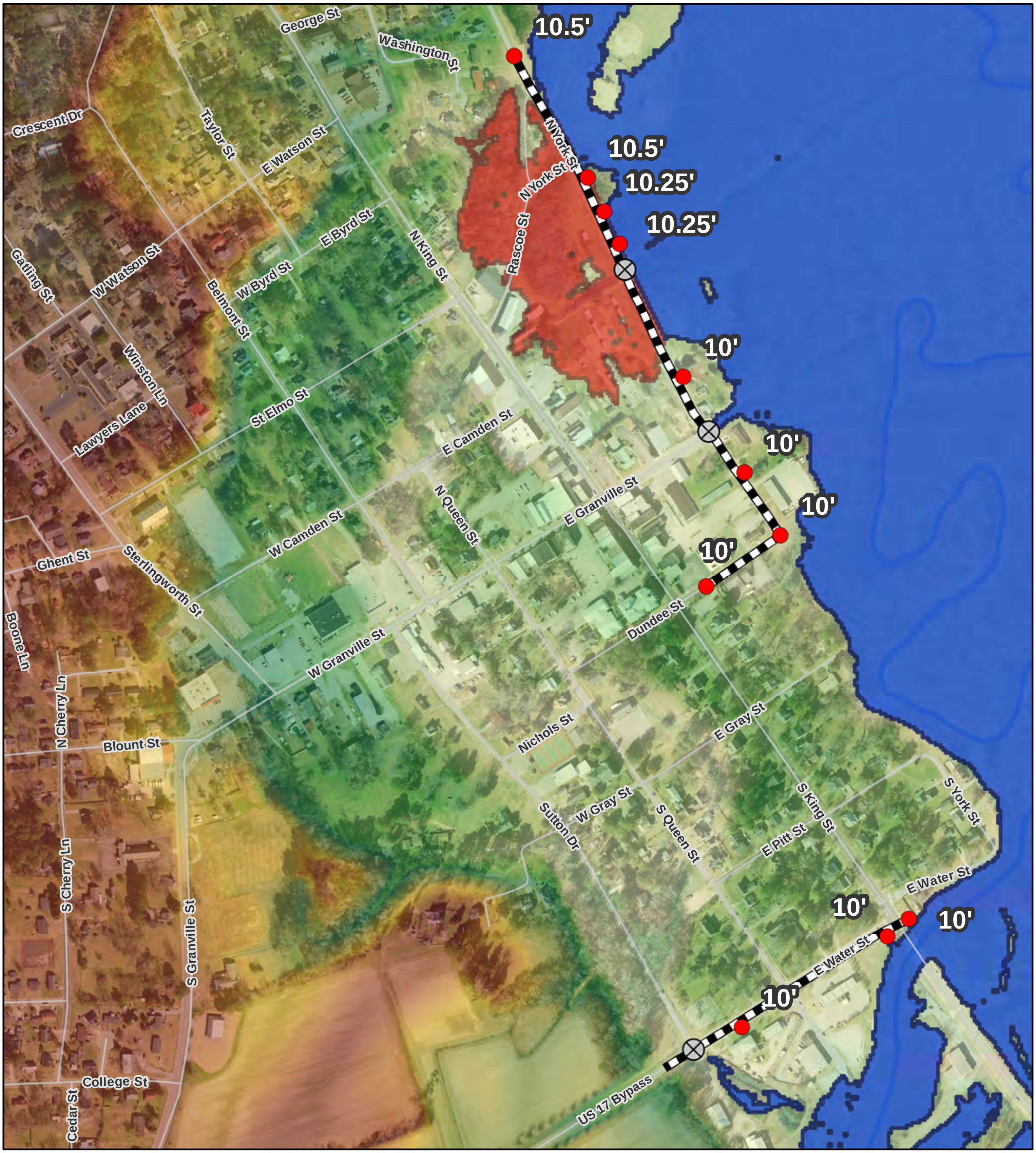
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 15: Alternative 3b 0.2% Event



N

1 inch = 500 feet

0 | 500 | 1,000 Feet

Legend

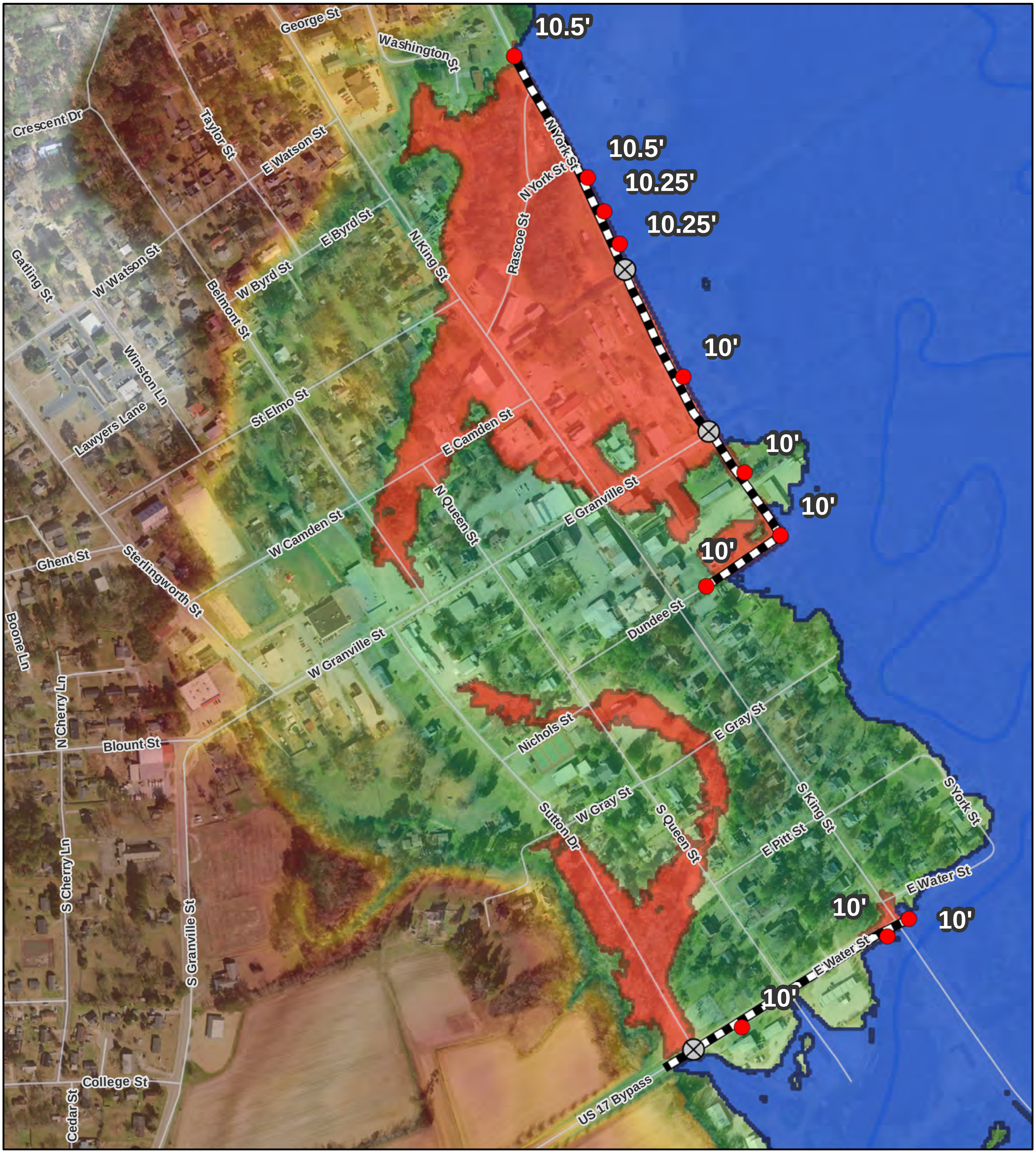
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 16: Alternative 4 10% Event



N

1 inch = 500 feet

0 500 1,000 Feet

Legend

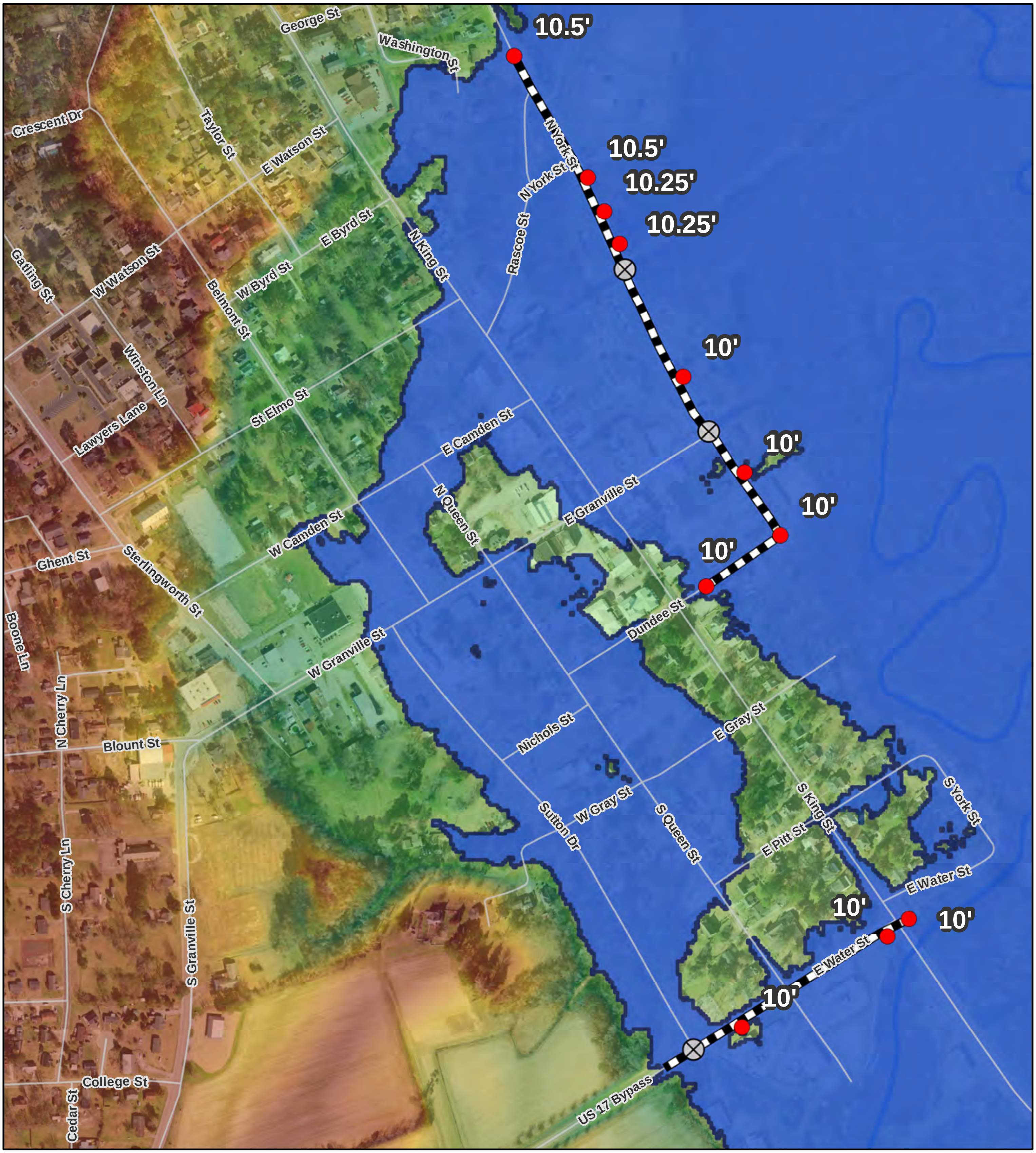
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 17: Alternative 4 1% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

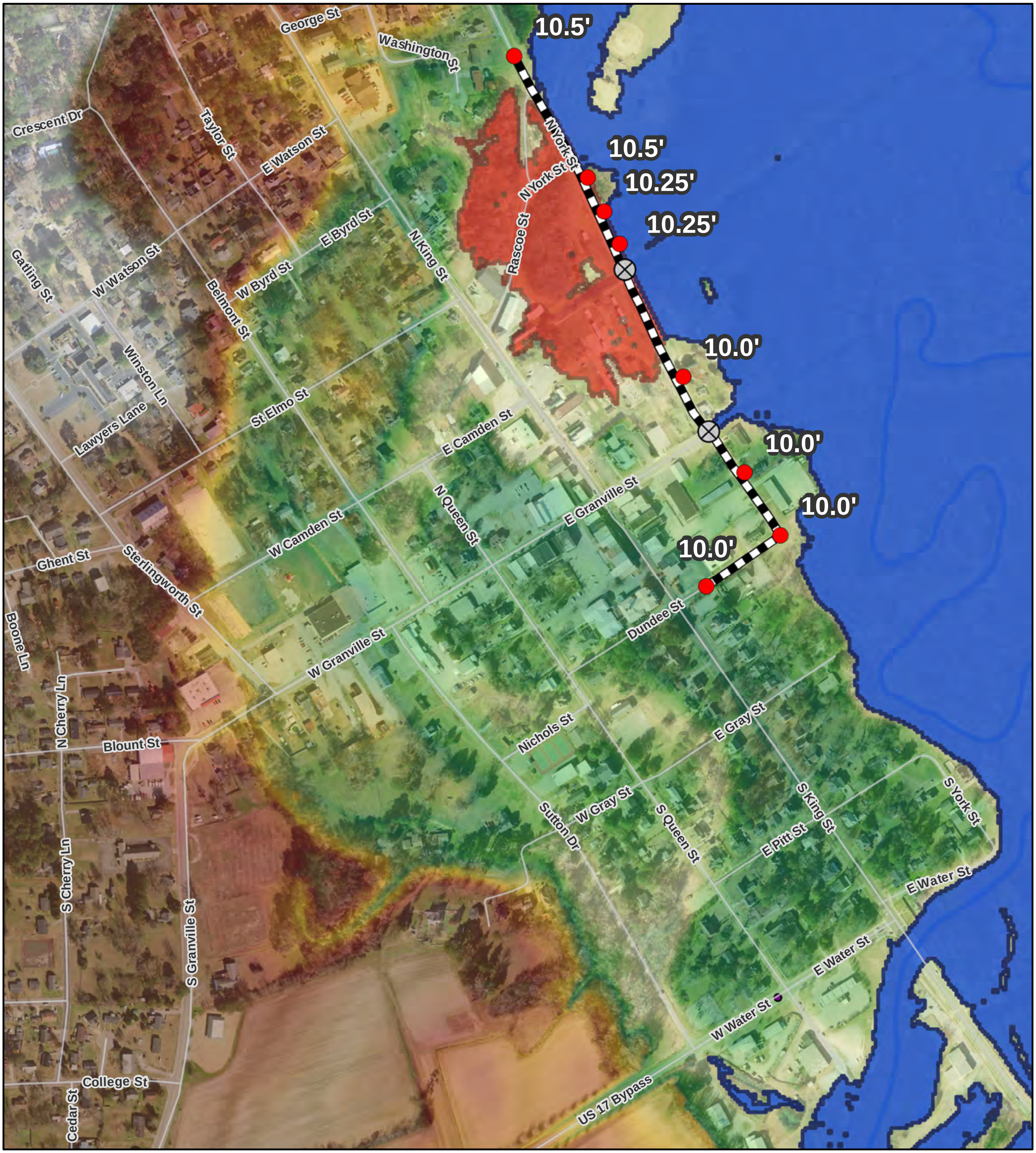
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 18: Alternative 4 0.2% Event



N

1 inch = 500 feet

0 500 1,000 Feet

Legend

Tidal Gates

Proposed Levee Elevations (ft)

Levees

Proposed Floodplain

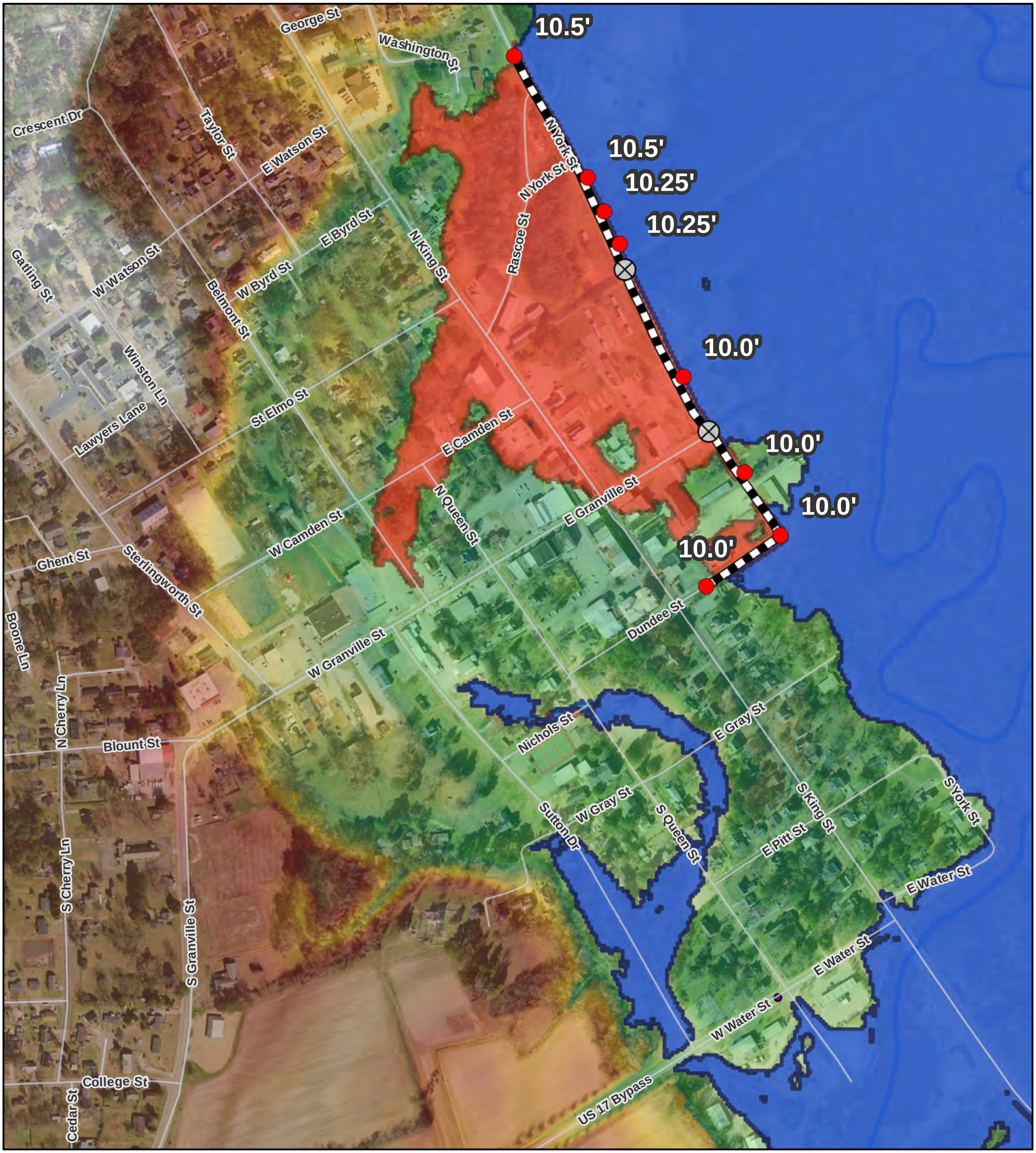
Existing Floodplain

Terrain (ft)

High : 49.4117

Low : -1.10647

Exhibit 19: Alternative 4b 10% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

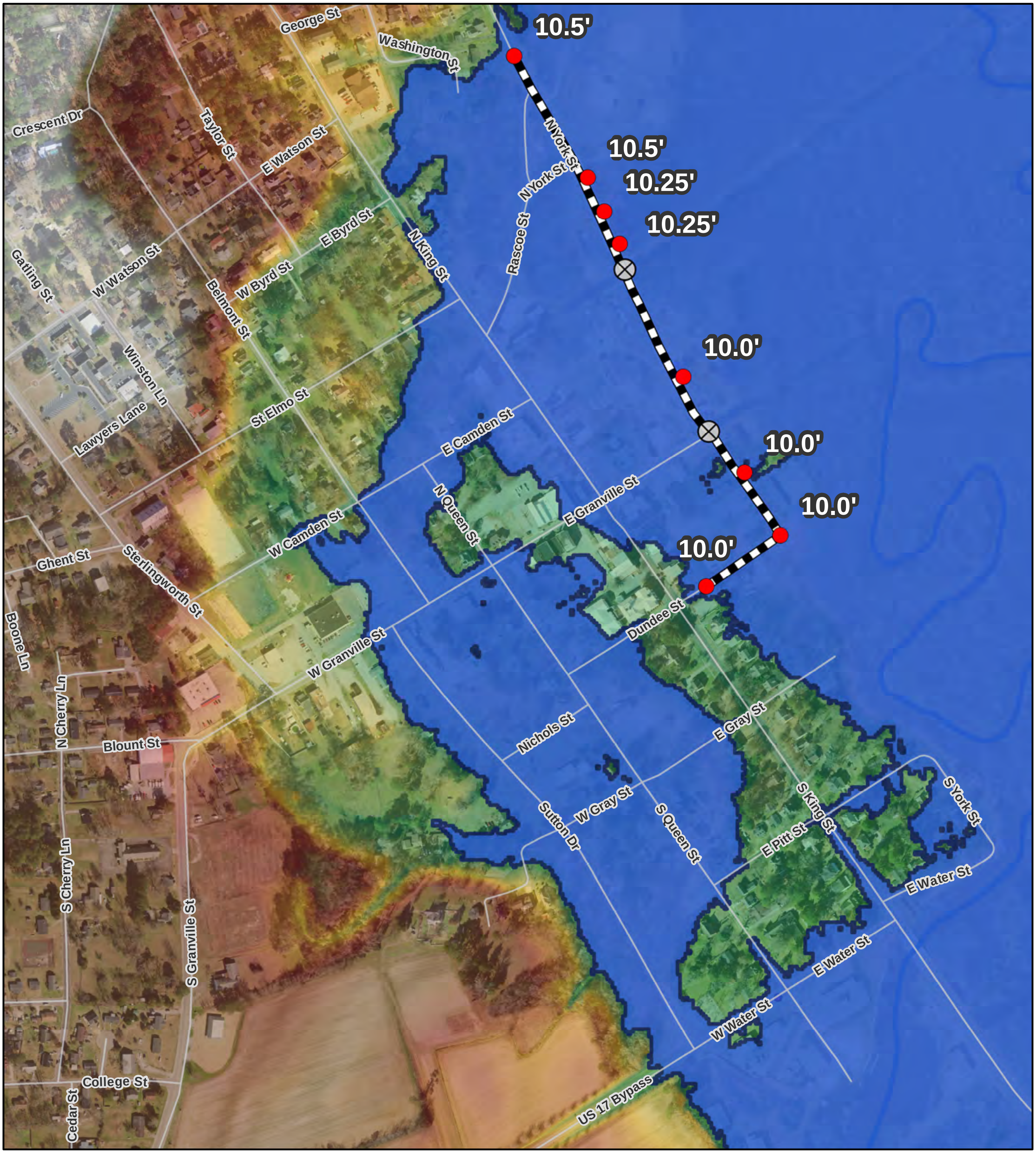
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 20: Alternative 4b 1% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

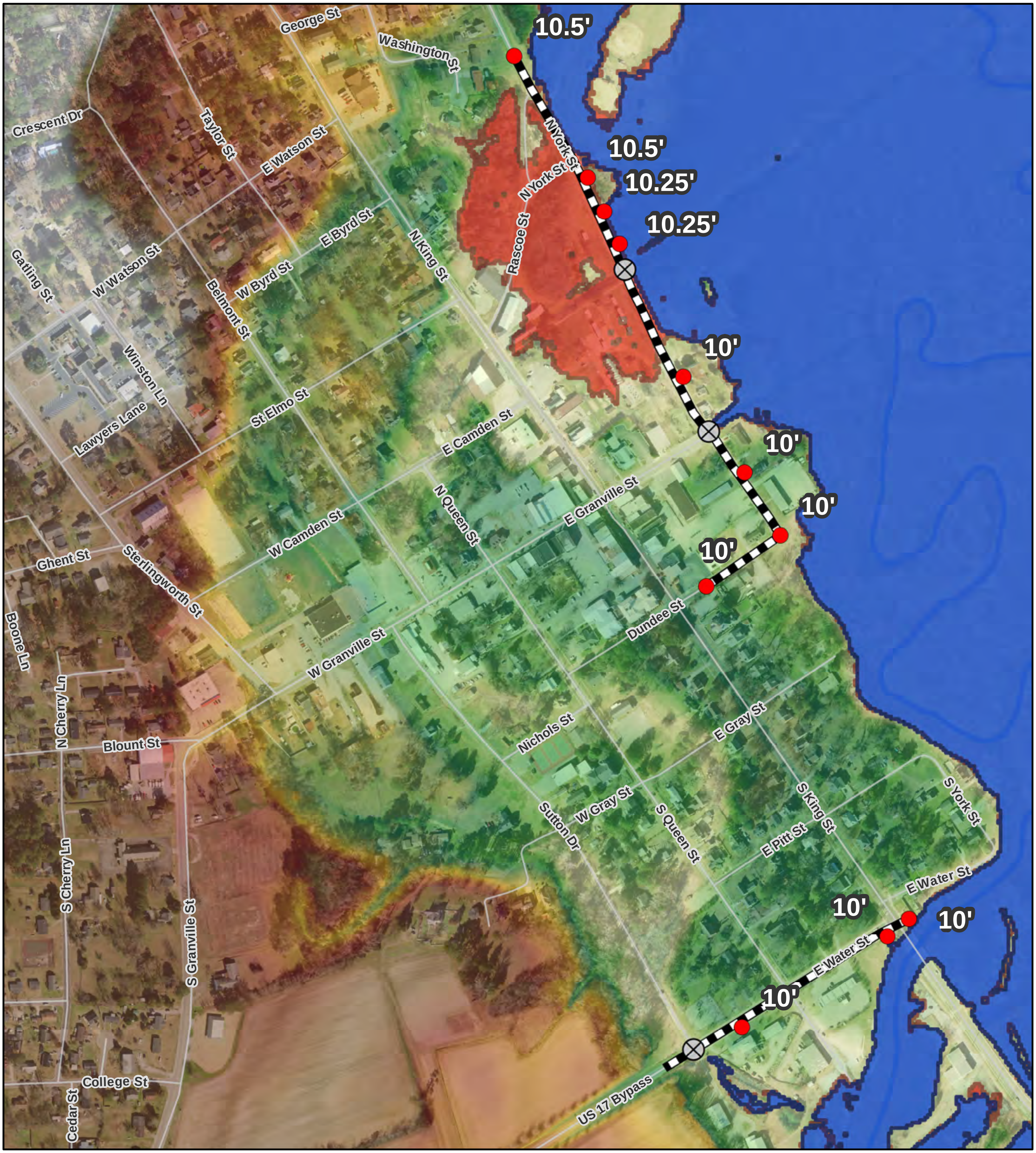
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 21: Alternative 4b 0.2% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

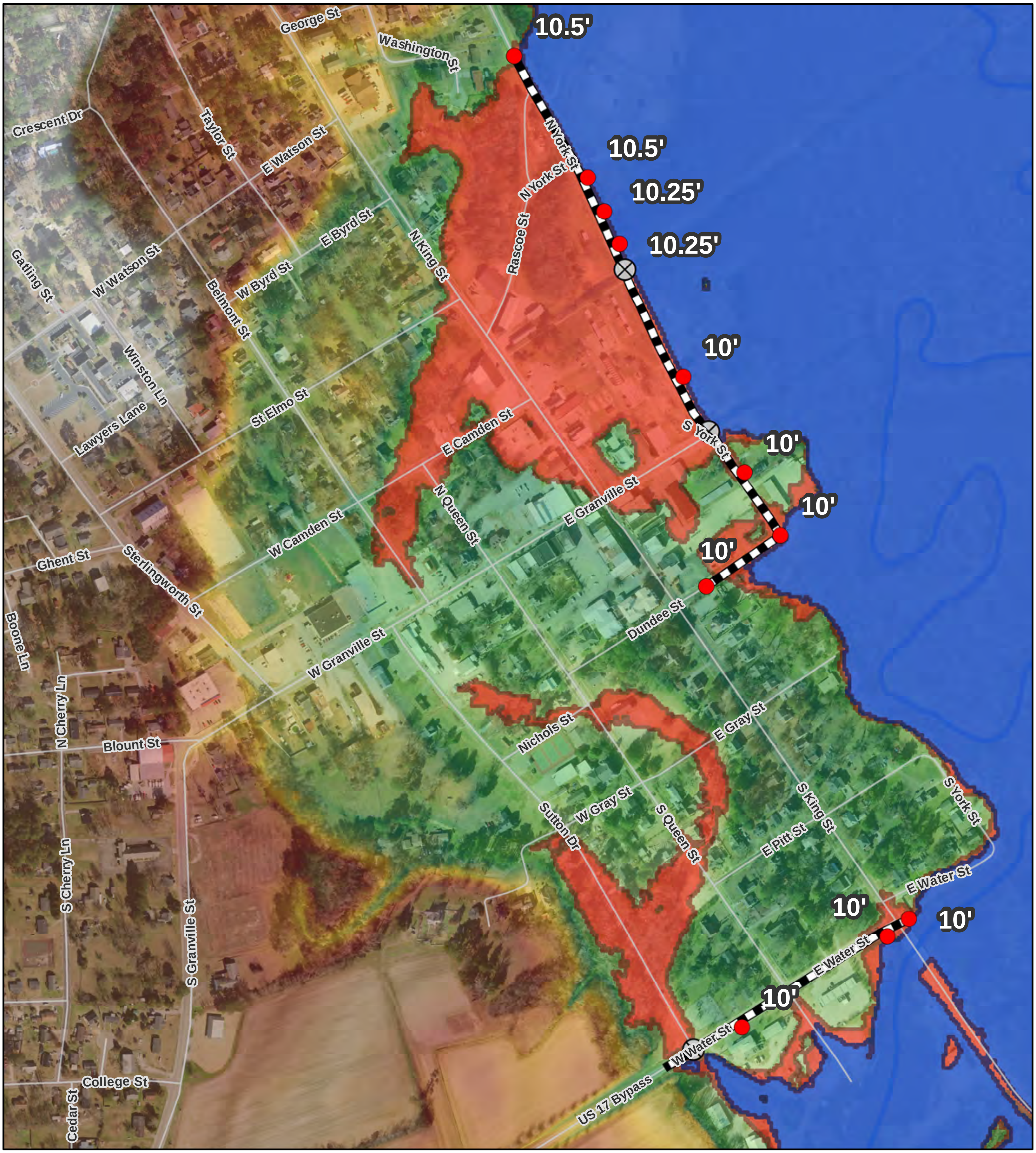
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 22: Alternative 5 10% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

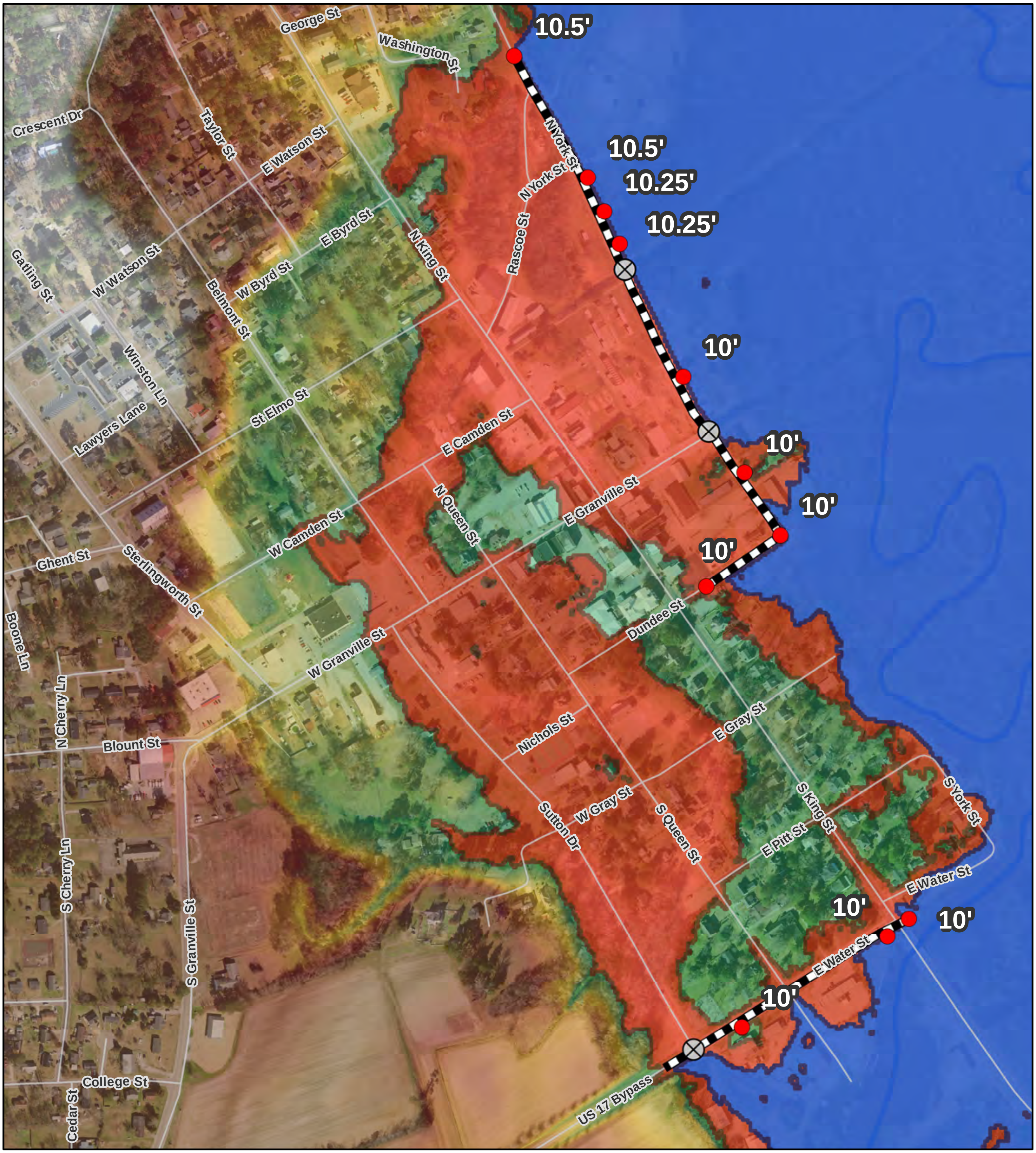
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

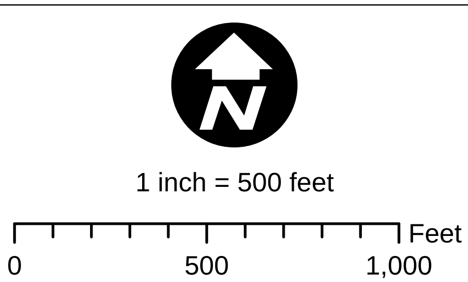
Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 23: Alternative 5 1% Event



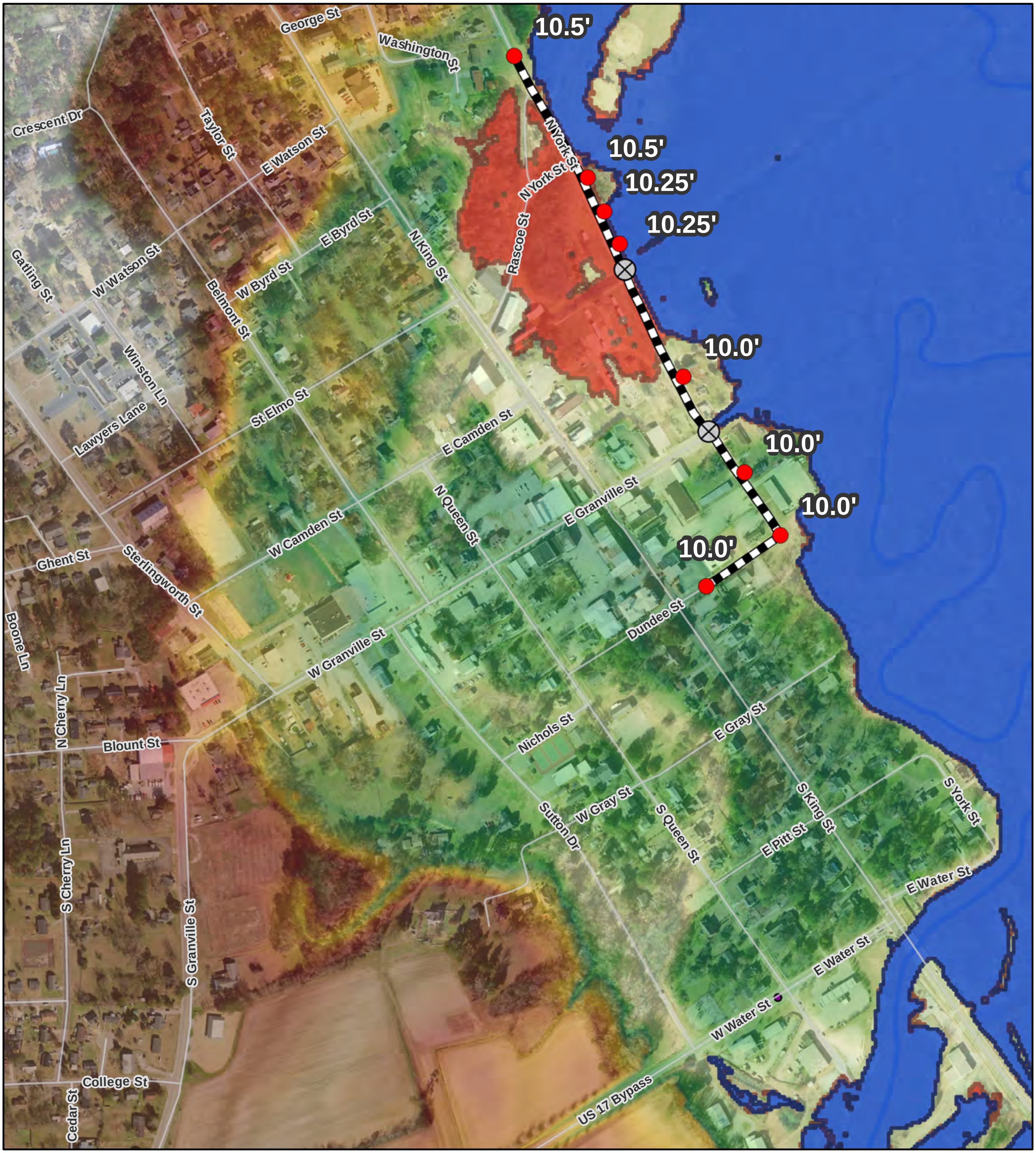


Legend

- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)
High : 48.86
Low : -0.29

Exhibit 24: Alternative 5 0.2% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

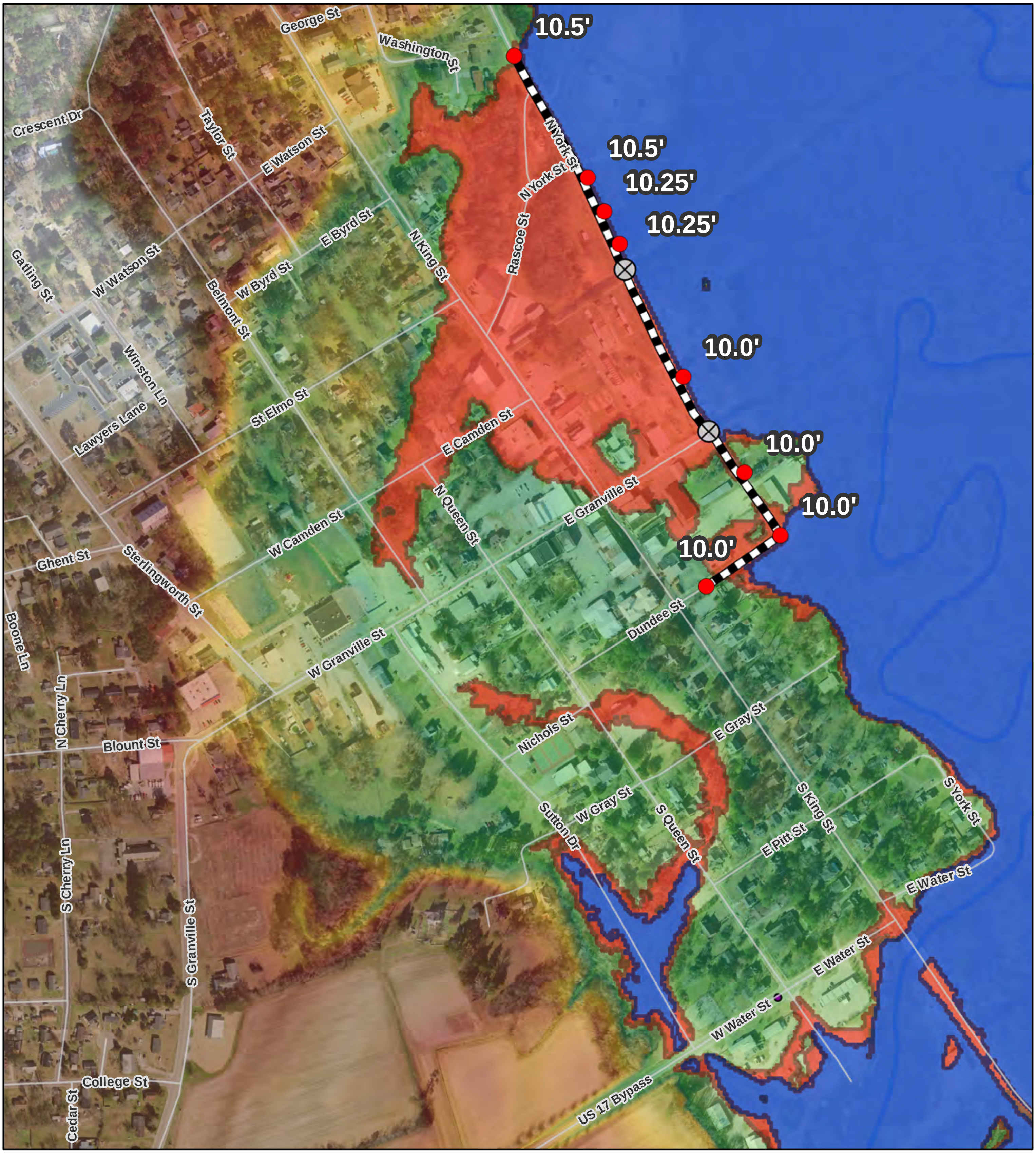
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 25: Alternative 5b 10% Event



1 inch = 500 feet

0 | 500 | 1,000 Feet

Legend

- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.86

Low : -0.29

Exhibit 26: Alternative 5b 1% Event

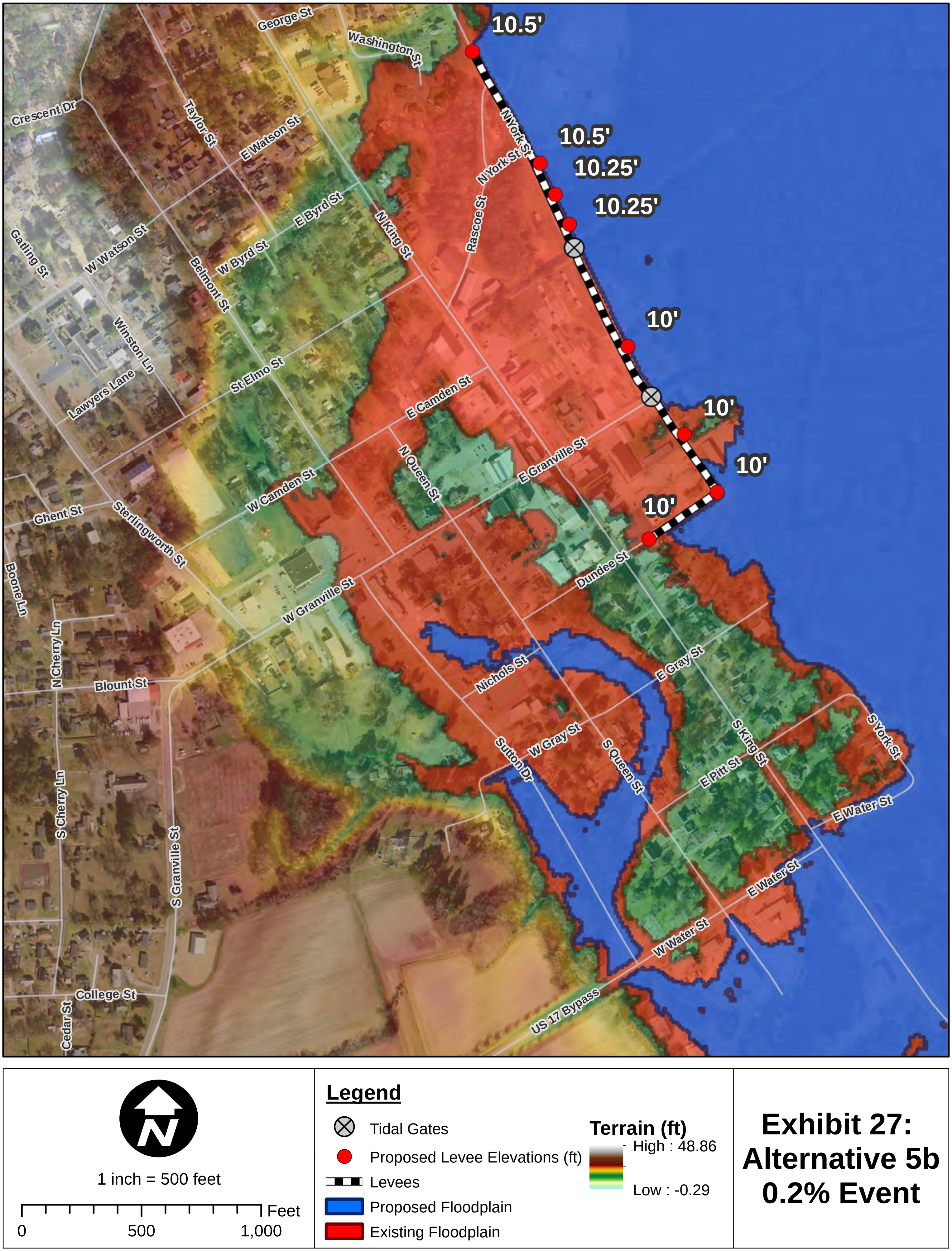
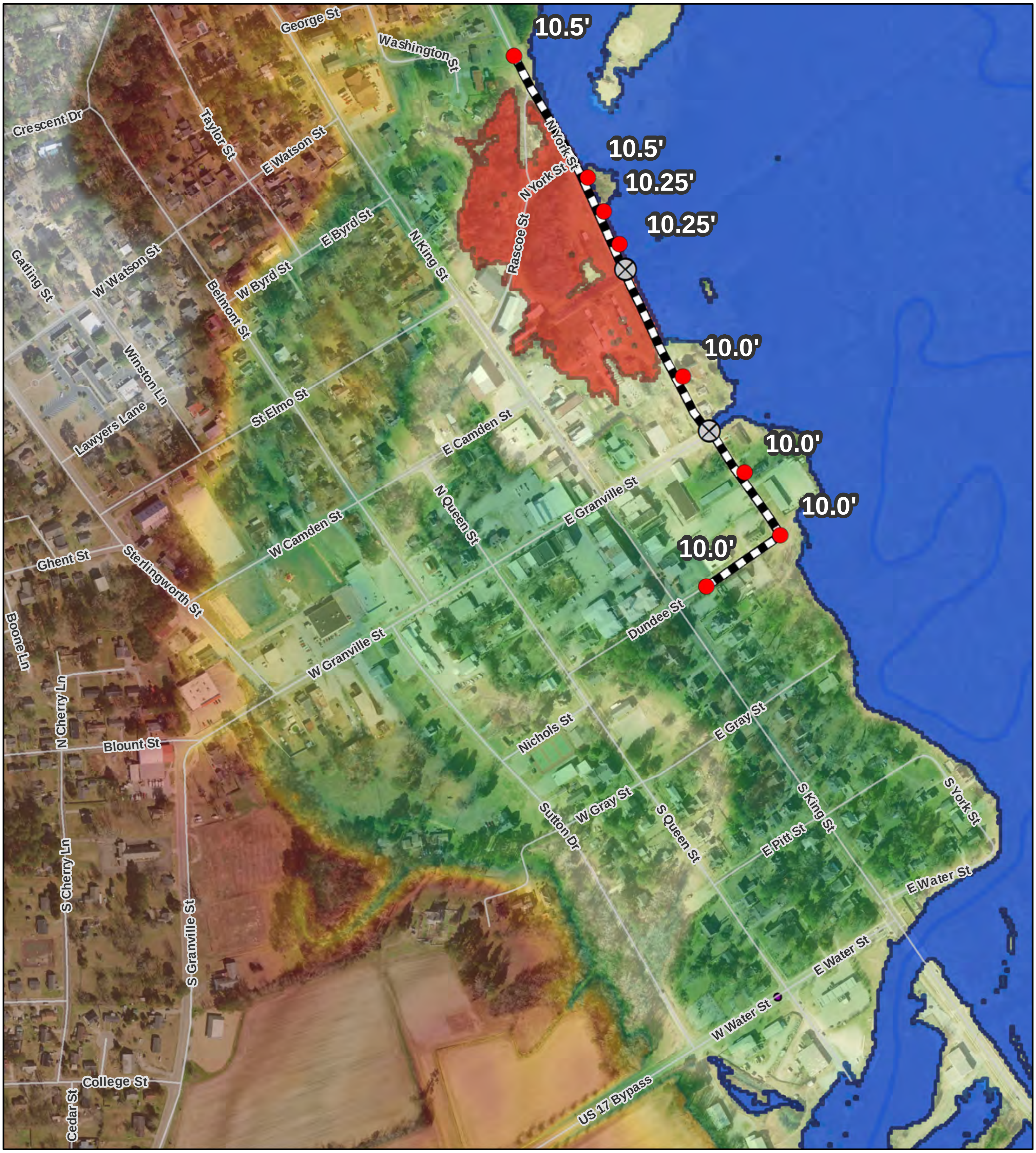
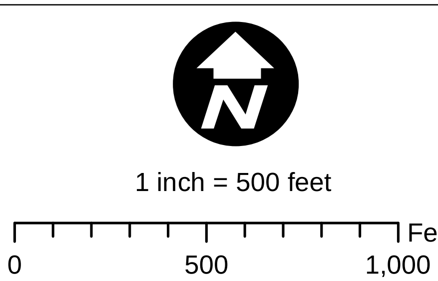


Exhibit 27: Alternative 5b 0.2% Event





Legend

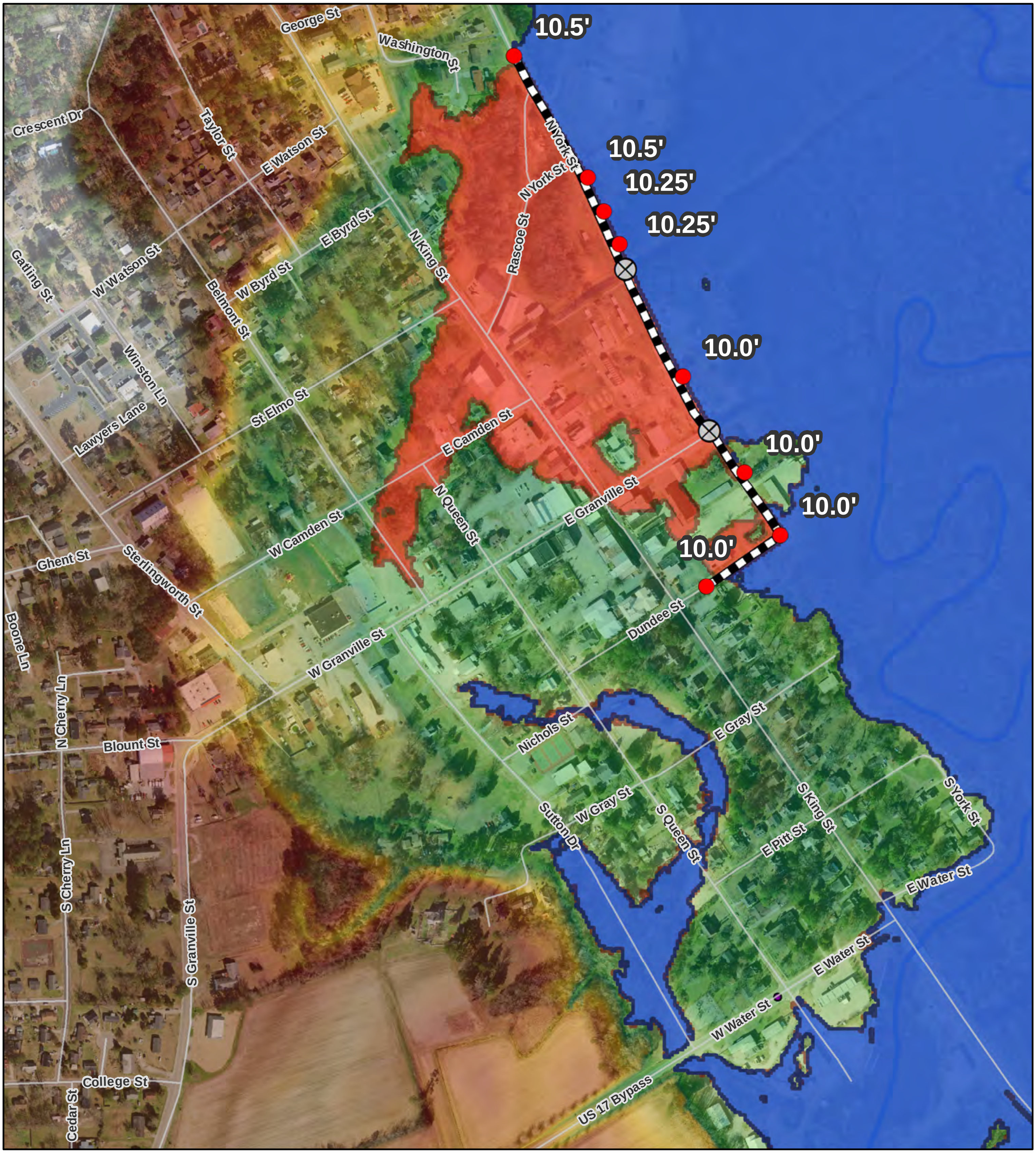
- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 48.8608

Low : -0.545

Exhibit 28: Alternative 6 10% Event



1 inch = 500 feet

0 500 1,000 Feet

Legend

Tidal Gates

Proposed Levee Elevations (ft)

Levees

Proposed Floodplain

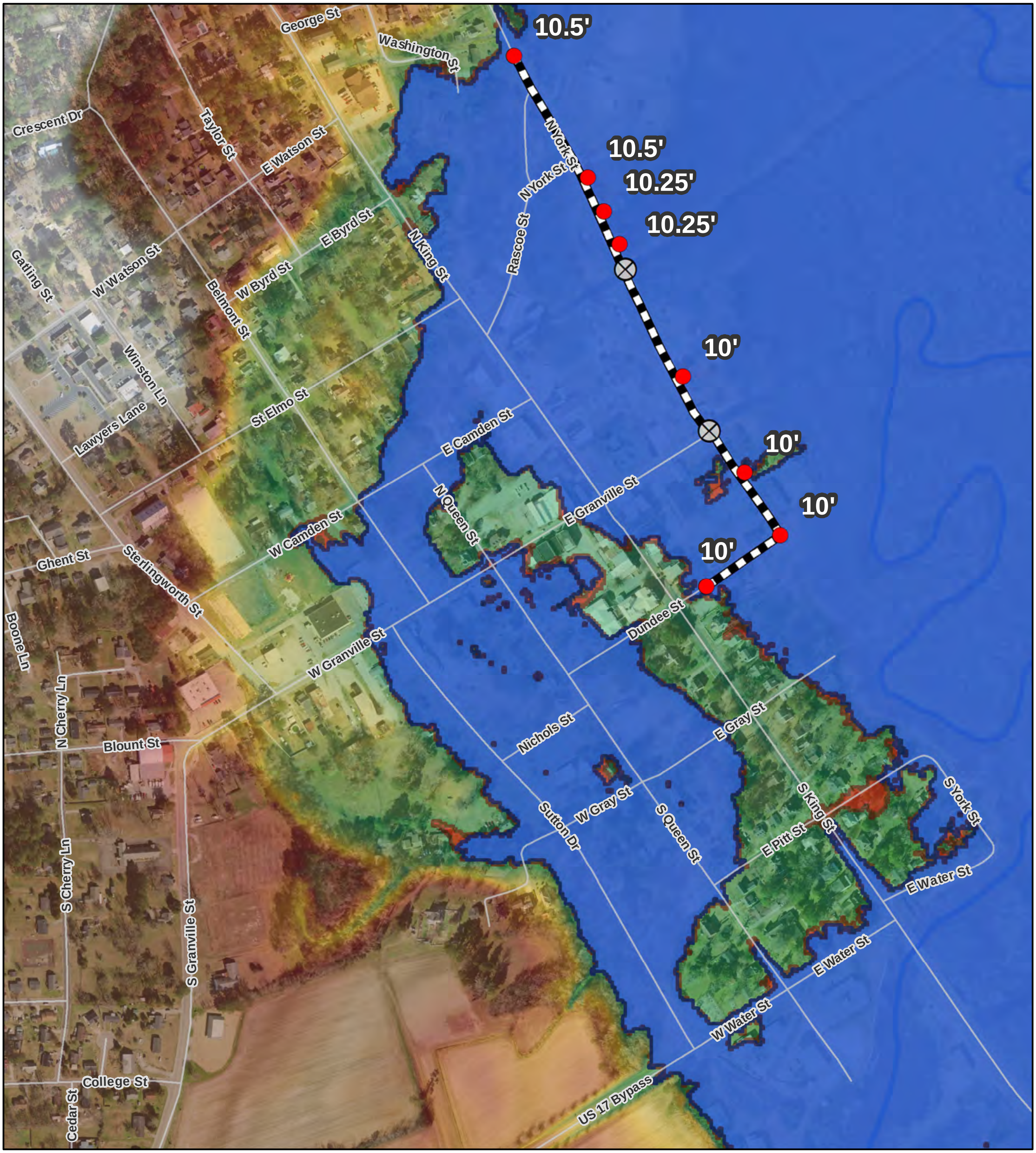
Existing Floodplain

Terrain (ft)

High : 49.4117

Low : -0.98053

Exhibit 29: Alternative 6 1% Event



N

1 inch = 500 feet

0 500 1,000 Feet

Legend

- Tidal Gates
- Proposed Levee Elevations (ft)
- Levees
- Proposed Floodplain
- Existing Floodplain

Terrain (ft)

High : 49.1767

Low : -1.10647

Exhibit 30: Alternative 6 0.2% Event