Final Report

Hydraulic Modeling Analysis

Spaulding Turnpike Improvements, Little Bay Bridges
Newington to Dover, New Hampshire

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TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

AECOM was contracted by Vanasse Hangen Brustlin, Inc. (VHB) to perform a hydraulic analysis for the proposed design of the Little Bay Bridges connecting Newington to Dover, New Hampshire. The hydraulic analysis was based on a continuation of a computer-based hydrodynamic model constructed by the University of New Hampshire (UNH), Department of Mechanical Engineering, Ocean Engineering Laboratory and bridge plans provided by VHB.

The UNH hydrodynamic model, which was constructed for the Environmental Impact Statement (EIS) prepared by VHB in December 2007, was verified and updated by AECOM to reflect the preferred alternative design. A temporary construction conditions model was also constructed by AECOM to assess the hydraulic impacts associated with temporary construction causeways and trestles. The hydrodynamic model was used to assess the hydraulic impacts of the proposed bridges design, quantified by changes to tidal water surface elevation and current velocities in the navigational channel.

The hydrodynamic modeling results predict minimal changes to the tidal heights in the Little Bay and Great Bay Estuaries. Table 1 contains a summary of the tidal height comparisons for the preferred alternative and temporary construction conditions models.

The preferred alternative model predicted changes between 0.00 and 0.02 feet (0.24 inches) when compared to existing conditions, depending on the tidal conditions (i.e. maximum high tide or minimum low tide) and the observation location within the model.

During temporary construction conditions, temporarily restricting the flow area through the Little Bay Bridges as a result of the temporary stone fill causeways at each abutment also result in minimal changes to the tidal heights. The temporary construction conditions model predicted changes between 0.00 feet (0.02 inches) and 0.03 feet (0.35 inches) when compared to existing conditions, depending on the tidal conditions and the observation location within the model.

While changes to the pier geometry for the preferred alternative model creates changes to the velocity magnitudes at the bridges when compared to existing conditions, these changes are slight when compared to the peak velocity magnitudes experienced at the bridge under existing conditions, which are predicted to be in the range of 10 to 12 ft/s in the existing conditions model. Focusing on the 200 foot wide navigational channel running through the center piers, the velocity magnitude increases by a maximum of only 5% for the preferred alternative.

The temporary construction conditions have more of an impact on velocities than the preferred alternative model due to the obstructions caused by the temporary stone fill causeways. However, the velocity magnitude increases by less than 10% though the navigational channel, with a maximum predicted velocity of 10.8 ft/s. Reducing the footprint of the temporary stone fill causeways will help reduce the impacts to the hydraulics during construction. The temporary access trestle was incorporated into the model based on assumptions made from a schematic drawing in the bridge plans provided by VHB. If the contractor utilizes a temporary access trestle or platform that causes an obstruction to the cross-sectional flow area under the bridges greater than what was assumed in the model, the temporary construction hydraulic impacts should be revisited.

Based on the results of the hydrodynamic models, the preferred alternative and temporary construction conditions will result in minimal changes to the hydraulics around the bridge and within the Great Bay Estuary.

Table 1. Tidal Height Comparison Summary

Modeled Scenario		Squamscot Marsh		Sandy Point		Pickering Brook		Lubberland Creek	
		Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)
Existing Conditions	Max High Tide	8.940	-	8.959	-	8.961	-	8.956	-
	Min Low Tide	1.828	-	1.548	-	1.427	-	1.497	-
Preferred Alternative	Max High Tide	8.957	**0.017**	8.976	**0.017**	8.978	**0.017**	8.972	**0.016**
	Min Low Tide	1.816	**-0.012**	1.532	**-0.016**	1.410	**-0.017**	1.481	**-0.016**
Temporary Construction (stone causeway with trestle)	Max High Tide	8.911	**-0.029**	8.930	**-0.029**	8.932	**-0.029**	8.927	**-0.029**
	Min Low Tide	1.833	**0.005**	1.553	**0.005**	1.433	**0.006**	1.502	**0.005**

Modeled Scenario		Adams Point		Durham Town Landing		Pomeroy Cove		Junction of Concheco & Salmon Falls River	
		Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)
Existing Conditions	Max High Tide	8.872	-	8.826	-	9.048	-	9.148	-
	Min Low Tide	1.448	-	1.484	-	1.027	-	1.203	-
Preferred Alternative	Max High Tide	8.887	**0.015**	8.840	**0.014**	9.045	**-0.003**	9.145	**-0.003**
	Min Low Tide	1.429	**-0.019**	1.464	**-0.020**	1.027	**0.000**	1.203	**0.000**
Temporary Construction (stone causeway with trestle)	Max High Tide	8.846	**-0.026**	8.801	**-0.025**	9.050	**0.003**	9.158	**0.010**
	Min Low Tide	1.454	**0.006**	1.491	**0.007**	1.021	**-0.006**	1.195	**-0.008**

1 INTRODUCTION

AECOM was contracted by Vanasse Hangen Brustlin, Inc. (VHB) to perform a hydraulic analysis for the proposed design of the Little Bay Bridges connecting Newington to Dover, New Hampshire. The hydraulic analysis was based on a continuation of a computer-based hydrodynamic model constructed by the University of New Hampshire (UNH), Department of Mechanical Engineering, Ocean Engineering Laboratory and bridge plans provided by VHB.

The UNH hydrodynamic model, which was constructed for the Environmental Impact Statement (EIS) prepared by VHB in December 2007, was verified and updated by AECOM to reflect the preferred alternative design. A temporary construction conditions model was also constructed by AECOM to assess the hydraulic impacts associated with temporary construction causeways and trestles. The hydrodynamic model was used to assess the hydraulic impacts of the proposed bridges design, quantified by changes to tidal water surface elevation and current velocities.

1.1 Project Location

The existing Little Bay Bridges connect Newington to Dover, New Hampshire and is a part of the Spaulding Turnpike that carries US Route 4 and NH Route 16 across the Little Bay. Figure 1 is a locus map showing the project location.

1.2 Project Description

The existing Little Bay Bridge is an important commuter route that serves approximately 70,000 vehicles per day. The bridge has experienced a steady increase in traffic volumes over the past 30 years, resulting in high levels of congestion on the bridge and along Spaulding Turnpike. The average daily traffic volume at the bridge is expected to increase to approximately 100,000 vehicles per day over the next 20 years (VHB, Inc., 2007).

In the December 2007 EIS, the UNH hydrodynamic model was used to assess potential adverse effects resulting from changes to the existing Little Bay Bridges proposed in various design alternatives considered for the Spaulding Turnpike improvements. The model was used to predict effects to marine resources and navigation in the Little Bay and Great Bay Estuaries by quantifying the changes to tidal water surface elevations and current velocity, using an existing conditions model as a baseline for comparison.

As a continuation of the previous modeling work performed by UNH, AECOM resurrected the existing conditions model and incorporated the latest preferred design alternative, including a temporary construction conditions model. The existing conditions model was verified by AECOM and used as the basis of comparison for the preferred design alternative model and the temporary construction conditions model. The development and results of each model are discussed in greater detail in the following sections.

1.2.1 Bridge Description

The existing Little Bay and General Sullivan Bridges are both supported by eight (8) piers in the Little Bay. Both sets of piers consist of granite faced walls that extend above the water level and have unreinforced rectangular concrete footings founded on bedrock (VHB, Inc., 2007). The preferred design alternative consists of rehabilitation of the General Sullivan Bridge and widening the Little Bay Bridges to the west toward the General Sullivan Bridge. An additional eight (8) piers will be required for the bridge widening. Each of the proposed piers will consist of three (3) drilled shafts with a minimum diameter of 98 inches drilled into a 96 inch diameter rock socket. A concrete strut connects the three (3) shafts on all but one (1) of the piers, but the strut is above the mean high water level, therefore, only the drilled shafts are represented in the model.

2 EXISTING CONDITIONS MODEL

The UNH existing conditions model was resurrected by AECOM and used as the baseline for comparison of tidal water surface elevations and current velocities to the preferred design alternative and temporary construction conditions models. The existing conditions model was verified by ensuring the previous modeling results could be accurately reproduced.

2.1 Model Description

According to the EIS, the Great Bay Estuary is the confluence of seven (7) major rivers with a total drainage area of approximately 930 square miles. The estuary originates in the Gulf of Maine, extending up the Piscataqua River into the Little Bay and eventually into the Great Bay. The estuary is made up of roughly 100 miles of shoreline.

The model boundaries include a tidal boundary at the mouth of the estuary in Portsmouth Harbor and seven (7) freshwater riverine boundaries: Salmon Falls River, Cocheco River, Bellamy River, Oyster River, Lamprey River, Squamscot River and Winnicut River. Figure 2 shows the model extent and each of the model boundaries. The model extends up to the first dam on each of the freshwater rivers. The entire modeled domain consists of 24.14 square miles.

2.1.1 Model Construction

The existing conditions model was constructed by UNH and was not modified by AECOM. A full description of the UNH model development is included in the EIS and summarized herein. The model was constructed with the following data sources:

- Bathymetry
    - National Oceanic and Atmospheric Administration's (NOAA) digital database, Marine Geophysical Custom Data from Geophysical Data System (GEODAS);
    - NOAA Chart 13285 (10th edition) for riverine bathymetry;

- Shorelines
    - National Geodetic Data Center (NGDC);
    - NOAA Chart 13285 (10th edition) for riverine bathymetry;

- Dam Locations
    - Global Positioning System (GPS) data;

- Calibration Data
    - UNH Center for Coastal and Ocean Mapping's tide station data collected at Adam's Point;

The model was constructed using the United States Army Corps of Engineers' (USACE) 2D hydrodynamic model called RMA2 Version 4.56. A summary of the finite element mesh used in the existing conditions model is included in Table 2, the bathymetry used in the model is shown on Figure 3 and the existing conditions finite element mesh used in the model is shown on Figure 4.

A 2D hydrodynamic model was chosen for this analysis because tides, which are very long waves and 2D in nature, dominate the hydrodynamics in the area. As stated in the EIS, freshwater flows account for only about 1% of the total estuarine volume at low tide and less than 2% of the tidal prism.

Table 2. Mesh Summary for Existing Conditions Model

Parameter	Value
Total Number of Elements	12,990
Number of Triangular Elements	3,037
Number of Quadrilateral Elements	9,953
Number of Nodes	41,434
Maximum Depth	-78.41 feet, MLLW
Minimum Depth	6.14 feet, MLLW
Modeled Area	24.14 square miles

2.1.2 Boundary Conditions

The existing conditions model was setup to run for a 90 hour period representing spring tide conditions. Figure 5 shows the tidal height time series used at the model's tidal boundary. The riverine boundaries had the following constant flows applied to them for the entire 90 hour run:

- Salmon Falls River, 36.8 cfs;
- Cocheco River, 21.8 cfs;
- Bellamy River, 16.3 cfs;
- Oyster River, 3.2 cfs;
- Lamprey River, 45.0 cfs;
- Squamscot River, 9.7 cfs;
- Winnicut River, 4.0 cfs.

The locations of the model's riverine and tidal boundaries are also shown on Figure 2. The boundary condition data was not verified as part of this study and the previously developed existing conditions boundary conditions were applied to the preferred alternative and temporary construction conditions models. The tidal boundary is located near the NOAA tide gage at Fort Point, New Hampshire. The tidal data shown in Figure 5 is consistent with the tidal characteristics shown at the NOAA gage. While not explicitly stated in the EIS, it is believed the NOAA data is the source of the boundary data. As shown on Figure 5, the initial stage of the tidal boundary (i.e. first nine hours) is slightly higher than the rest of the period to ensure a stable start to the model.

The EIS did not specify a datum for the tidal height elevations predicted by the previous model. From an inspection of data at the NOAA tide gage at Fort Point, New Hampshire, it appeared that the model's elevations were referenced to mean lower low water (MLLW). This also corresponds to the highest observable tide elevation mentioned in the EIS on page 3-334, which states that the NOAA 2005 maximum tide prediction at Hilton Park in Dover, New Hampshire was 4.1 feet in the North American Vertical Datum of 1988 (NAVD 88), which converts to roughly 9.1 feet MLLW, which is near the peak tidal height observed in the model. Furthermore, the depths shown on NOAA Chart 13285, which was used to obtain the bathymetry in the modeled domain, are listed in MLLW. Therefore, it was assumed that the elevations in the model and at the tidal boundary condition referred to MLLW and the results presented herein are relative to the assumed datum.

2.2 Existing Conditions Model Verification

The existing conditions model was resurrected by AECOM and rerun with an updated version of RMA2 (Version 4.58). The existing conditions model was verified by rerunning the model and comparing it to the original UNH model solution for tidal height and velocity. Both models utilized a time-step of 0.5 hour.

2.2.1 Tidal Height Verification

The EIS used eight (8) observation locations for tidal height within the entire estuarine system. These locations were approximated in the resurrected model by digitizing *Figure 4.10-2, Tidal Height Model Locations,* from the EIS and importing them into the model. Figure 6 shows the digitized observation locations. The tidal heights for each location were extracted from the original UNH existing conditions model solution and the AECOM existing conditions rerun. A summary of the tidal height comparison for the two (2) model runs are shown below in Table 3. The UNH existing conditions model was successfully resurrected as the tidal height data at the eight (8) observation points were a perfect match.

The exact coordinates of the observation points were not provided, therefore, the digitization of the observation points resulted in a slight variation of the tidal height data extracted from the model. Having the observation locations report values to within 0.003 feet of the EIS values was considered acceptable for the purposes of this study.

Table 3. Tidal Height Verification for Existing Conditions Model

Observation Location	UNH Model		AECOM Model		Delta (UNH - AECOM)	
	Max High (ft, MLLW)	Min Low (ft, MLLW)	Max High (ft, MLLW)	Min Low (ft, MLLW)	Max High (ft, MLLW)	Min Low (ft, MLLW)
Squamscot Marsh	8.940	1.828	8.940	1.828	0.000	0.000
Sandy Point	8.959	1.548	8.959	1.548	0.000	0.000
Pickering Brook	8.961	1.427	8.961	1.427	0.000	0.000
Lubberland Creek	8.956	1.497	8.956	1.497	0.000	0.000
Adams Point	8.872	1.448	8.872	1.448	0.000	0.000
Durham Town Landing	8.826	1.484	8.826	1.484	0.000	0.000
Pomeroy Cove	9.048	1.027	9.048	1.027	0.000	0.000
Junction of Cocheco and Salmon Falls Rivers	9.148	1.203	9.148	1.203	0.000	0.000

2.2.2 Velocity Verification

The RMA2 model computes vertically averaged velocity data in its hydrodynamic computations. For the EIS, the vertically averaged tidal currents were observed at 45 locations in the vicinity of the bridge, as shown on Figure 7. Similar to the tidal height observation locations, these 45 points had to be digitized from a figure in the EIS (*Figure 4.10-1, Current Velocity Model Data Locations*) as exact coordinates of each point were not provided. The maximum flood and ebb tidal velocities for the previous UNH existing conditions model solution were compared to the rerun existing conditions model. Table 4 shows the maximum flood and ebb velocities at each observation point for both models. The modeled velocity magnitude was successfully resurrected as the maximum flood and ebb velocities matched at all 45 points. Color contour plots of the existing conditions maximum flood and maximum ebb velocities have been provided in Figure 8 and Figure 9, respectively.

The velocity direction predicted by the resurrected existing conditions model was verified by comparing the UNH model results to the AECOM model results at each of the 45 observation locations for each modeled time step. Within the first few time-steps, there were direction differences of a few degrees as the model started up. From the modeled time of two (2) hours to the completion of the model run (i.e. 90 hours), the maximum difference between the original UNH model and the resurrected AECOM model did not exceed 0.16 degrees at any of the 45 observation locations.

Table 4. Velocity Verification for Existing Conditions Model

Observation Location	UNH Model		AECOM Model		Delta (UNH - AECOM)	
	Max Flood (ft/s)	Max Ebb (ft/s)	Max Flood (ft/s)	Max Ebb (ft/s)	Max Flood (ft/s)	Max Ebb (ft/s)
1	4.6	1.7	4.6	1.7	0.0	0.0
2	5.1	2.3	5.1	2.3	0.0	0.0
3	5.2	2.0	5.2	2.0	0.0	0.0
4	6.3	3.1	6.3	3.1	0.0	0.0
5	6.7	3.4	6.7	3.4	0.0	0.0
6	8.8	6.6	8.8	6.6	0.0	0.0
7	8.2	6.9	8.2	6.9	0.0	0.0
8	8.5	9.8	8.5	9.8	0.0	0.0
9	6.2	6.9	6.2	6.9	0.0	0.0
10	5.9	8.5	5.9	8.5	0.0	0.0
11	4.7	5.5	4.7	5.5	0.0	0.0
12	4.3	7.5	4.3	7.5	0.0	0.0
13	3.4	3.4	3.4	3.4	0.0	0.0
14	3.5	5.4	3.5	5.4	0.0	0.0
15	3.7	4.2	3.7	4.2	0.0	0.0
16	3.5	4.7	3.5	4.7	0.0	0.0
17	6.0	2.7	6.0	2.7	0.0	0.0
18	6.4	3.0	6.4	3.0	0.0	0.0
19	5.9	3.5	5.9	3.5	0.0	0.0
20	6.3	6.3	6.3	6.3	0.0	0.0
21	6.5	8.3	6.5	8.3	0.0	0.0
22	7.2	12.2	7.2	12.2	0.0	0.0
23	4.9	6.6	4.9	6.6	0.0	0.0
24	5.1	5.0	5.1	5.0	0.0	0.0
25	5.2	5.0	5.2	5.0	0.0	0.0
26	4.6	4.6	4.6	4.6	0.0	0.0
27	5.5	5.2	5.5	5.2	0.0	0.0
28	4.6	5.6	4.6	5.6	0.0	0.0
29	6.0	5.6	6.0	5.6	0.0	0.0
30	4.9	5.1	4.9	5.1	0.0	0.0
31	6.8	6.2	6.8	6.2	0.0	0.0
32	4.3	4.9	4.3	4.9	0.0	0.0
33	6.0	5.8	6.0	5.8	0.0	0.0
34	3.9	4.6	3.9	4.6	0.0	0.0
35	4.5	5.4	4.5	5.4	0.0	0.0
36	3.3	4.0	3.3	4.0	0.0	0.0
37	3.6	4.4	3.6	4.4	0.0	0.0
38	2.4	2.9	2.4	2.9	0.0	0.0
39	2.1	2.7	2.1	2.7	0.0	0.0
40	3.6	1.3	3.6	1.3	0.0	0.0
41	3.9	4.9	3.9	4.9	0.0	0.0
42	2.7	4.3	2.7	4.3	0.0	0.0
43	4.3	6.0	4.3	6.0	0.0	0.0
44	6.2	6.1	6.2	6.1	0.0	0.0
45	3.7	4.3	3.7	4.3	0.0	0.0

3 PREFERRED ALTERNATIVE MODEL

3.1 Model Description

The preferred design alternative consists of rehabilitation of the General Sullivan Bridge and widening the Little Bay Bridges to the west toward the General Sullivan Bridge. An additional eight (8) piers will be required for the bridge widening. Each of the proposed piers will consist of three (3) drilled shafts with a minimum diameter of 98 inches drilled into a 96 inch diameter rock socket. A concrete strut connects the three (3) shafts on all but one (1) of the piers, but the strut is above the mean high water level, therefore, only the drilled shafts are represented in the model.

3.1.1 Model Construction

VHB provided AECOM with MicroStation drawings of the proposed bridge design. The geo-referenced drilled shaft pier shapes were extracted from the drawings and imported into Surface-Water Modeling System (SMS) Version 8.1, a graphical user interface used to develop and execute RMA2 models.

To verify that the existing Little Bay Bridge and General Sullivan Bridge piers in the UNH model were consistent with the latest VHB drawings, these existing pier shapes were also exported from the drawings and imported into the model. The outlines of the existing bridge piers were consistent between the VHB drawings and UNH model.

The finite element mesh in the vicinity of the bridge was modified to account for the preferred alternative drilled shaft piers, which are represented by octagons in the mesh. The mesh for the rest of the modeled domain was unchanged. Table 5 contains a summary of the mesh used in the preferred alternative model. Figure 10 and Figure 11 show the preferred alternative model geometry at the bridge location.

The bathymetry for the preferred alternative model was the same as the existing conditions model, with the exception of the locations that are displaced by the new piers.

Table 5. Mesh Summary for Preferred Alternative Model

Parameter	Value
Total Number of Elements	14,476
Number of Triangular Elements	3,629
Number of Quadrilateral Elements	10,847
Number of Nodes	45,518
Maximum Depth	-78.41 feet, MLLW
Minimum Depth	6.14 feet, MLLW
Modeled Area	24.14 square miles

3.1.2 Boundary Conditions

The same riverine and tidal boundary conditions used in the existing conditions model were used for the preferred alternative model.

3.2 Model Results

3.2.1 Tidal Height Comparison

The maximum and minimum tidal heights at the eight (8) observation points for the preferred alternative model are summarized in Table 6. The six (6) observation points to the west of the Little Bay Bridges result in an increase in maximum tidal height and a decrease in minimum tidal height. The magnitude of change from the existing tidal elevations is no greater than 0.02 feet (0.24 inches) at these locations. The other two (2) observation locations located to the east of the bridges experience negligible changes in tidal heights (maximum change of 0.003 feet or 0.036 inches).

Table 6. Tidal Height Comparison for Preferred Alternative Model

Observation Location	Preferred Alternative		Existing Conditions		Delta (Preferred Alternative - Existing)	
	Max High (ft, MLLW)	Min Low (ft, MLLW)	Max High (ft, MLLW)	Min Low (ft, MLLW)	Max High (ft, MLLW)	Min Low (ft, MLLW)
Squamscot Marsh	8.957	1.816	8.940	1.828	0.017	-0.012
Sandy Point	8.976	1.532	8.959	1.548	0.017	-0.016
Pickering Brook	8.978	1.410	8.961	1.427	0.017	-0.017
Lubberland Creek	8.972	1.481	8.956	1.497	0.016	-0.016
Adams Point	8.887	1.429	8.872	1.448	0.015	-0.019
Durham Town Landing	8.840	1.464	8.826	1.484	0.014	-0.020
Pomeroy Cove	9.045	1.027	9.048	1.027	-0.003	0.000
Junction of Cocheco and Salmon Falls Rivers	9.145	1.203	9.148	1.203	-0.003	0.000

3.2.2 Velocity Comparison

The velocity magnitude comparison of the preferred alternative to existing conditions is summarized in Table 7. The maximum increase in velocity is 0.6 ft/s for the flood tide (at Point #7) and 1.1 ft/s for ebb tide (at Point #34). The maximum decrease in velocity is 1.0 ft/s for the flood tide (at Point #24) and 0.4 ft/s for ebb tide (at Point #6). Averaging the changes in velocities at each of the 45 observation locations yields an average decrease in velocity for flood tide (0.02 ft/s) and an average increase in velocity for ebb tide (0.14 ft/s).

There are four (4) observation locations that are positioned within the 200 foot wide navigational channel that runs underneath the Little Bay Bridges: Points #8, #20, #31 and #44. Each of these points experiences less than a 0.1 ft/s change when compared to the existing conditions maximum flood tide velocities. For the maximum ebb tide velocities, the velocity magnitude increases by 0.4 ft/s at Point #8 and 0.3 ft/s at Point #20, but there is no change in velocity for Points #31 and #44. The velocity increases at Point #8 and Point #20 correspond to a 4% and 5% increase, respectively, over the existing conditions velocity magnitudes for ebb tide.

The velocity direction predicted by the preferred alternative model was compared to the existing conditions model at each of the 45 observation locations for each modeled time step. In general, the average difference in velocity direction at each point was negligible (i.e. roughly 2 degrees on average).

Color contour plots of the existing conditions maximum flood and maximum ebb velocities have been provided in Figure 12 and Figure 13, respectively.

Table 7. Velocity Comparison for Preferred Alternative Model

Observation Location	Preferred Alternative		Existing Conditions		Delta (Pref. Alt. – Exist.)	
	Max Flood (ft/s)	Max Ebb (ft/s)	Max Flood (ft/s)	Max Ebb (ft/s)	Max Flood (ft/s)	Max Ebb (ft/s)
1	4.6	1.7	4.6	1.7	0.0	0.0
2	5.0	2.4	5.1	2.3	-0.1	0.1
3	5.4	2.1	5.2	2.0	0.2	0.1
4	6.2	3.1	6.3	3.1	-0.1	0.0
5	7.0	3.2	6.7	3.4	0.3	-0.2
6	8.7	6.3	8.8	6.6	-0.1	-0.3
7	8.8	7.2	8.2	6.9	0.6	0.3
8	8.6	10.2	8.5	9.8	0.1	0.4
9	6.6	7.2	6.2	6.9	0.4	0.3
10	5.9	8.6	5.9	8.5	0.0	0.1
11	4.9	5.6	4.7	5.5	0.2	0.1
12	4.3	7.7	4.3	7.5	0.0	0.2
13	3.5	3.3	3.4	3.4	0.1	-0.1
14	3.5	5.5	3.5	5.4	0.0	0.1
15	3.7	4.3	3.7	4.2	0.0	0.1
16	3.5	4.7	3.5	4.7	0.0	0.0
17	6.0	3.0	6.0	2.7	0.0	0.3
18	6.4	3.1	6.4	3.0	0.0	0.1
19	5.9	3.6	5.9	3.5	0.0	0.1
20	6.3	6.5	6.3	6.3	0.0	0.2
21	6.6	8.6	6.5	8.3	0.1	0.3
22	7.3	12.3	7.2	12.2	0.1	0.1
23	4.9	6.8	4.9	6.6	0.0	0.2
24	4.1	4.9	5.1	5.0	-1.0	-0.1
25	5.0	4.9	5.2	5.0	-0.2	-0.1
26	4.2	4.8	4.6	4.6	-0.4	0.2
27	5.4	5.2	5.5	5.2	-0.1	0.0
28	4.3	5.7	4.6	5.6	-0.3	0.1
29	5.8	5.5	6.0	5.6	-0.2	-0.1
30	5.2	5.8	4.9	5.1	0.3	0.7
31	6.7	6.2	6.8	6.2	-0.1	0.0
32	4.3	5.9	4.3	4.9	0.0	1.0
33	6.0	5.8	6.0	5.8	0.0	0.0
34	4.0	5.7	3.9	4.6	0.1	1.1
35	4.3	5.3	4.5	5.4	-0.2	-0.1
36	3.1	4.7	3.3	4.0	-0.2	0.7
37	3.8	4.1	3.6	4.4	0.2	-0.3
38	2.3	3.4	2.4	2.9	-0.1	0.5
39	1.9	2.5	2.1	2.7	-0.2	-0.2
40	3.6	1.3	3.6	1.3	0.0	0.0
41	3.9	4.7	3.9	4.9	0.0	-0.2
42	2.7	4.5	2.7	4.3	0.0	0.2
43	4.2	6.0	4.3	6.0	-0.1	0.0
44	6.3	6.1	6.2	6.1	0.1	0.0
45	3.8	4.3	3.7	4.3	0.1	0.0

4 TEMPORARY CONSTRUCTION CONDITIONS MODEL

4.1 Model Description

The preferred alternative model was modified to replicate temporary construction conditions at the Little Bay Bridges. On the latest plans provided by VHB, there are two (2) temporary construction structures shown: stone fill causeways at each abutment and trestles or work platforms along the new drilled shaft piers. The goal of this model was to determine the hydraulic impacts of the temporary construction structures in conjunction with the preferred alternative design.

4.1.1 Model Construction

The extents of the stone fill causeways and trestles were extracted from the plans provided by VHB. The existing conditions mesh was adjusted to account for the new shoreline around the abutments resulting from the stone fill causeways. According to the plans, the top of the causeways are to be 11 feet above mean water level. Using datum information provided at the NOAA tide gage at Fort Point, New Hampshire, this elevation was converted to MLLW, which was 15.69 feet. The elevations around the causeway were edited in the mesh to reflect the top elevation, 15.69 feet, with a slope of 1:1.5, as shown on the plans.

The VHB plans show an outline of the temporary trestles, but the notes on the plans indicate that the locations shown are schematic only and the detailed trestle design, if used, will be detailed by the contractor. Without a detailed trestle design, the schematic design shown on the plans was used in the temporary construction conditions model. On an earlier version of the plans provided by VHB (from July 2009), the profiles of the temporary trestles were shown. The trestle pier spacing shown on this plan sheet, which is included in Appendix C, was used to approximate the cross-sectional flow area obstruction caused by the trestle piers. Using an assumed trestle pier width of two (2) feet, the obstruction caused by the trestle piers was approximated to be 5%.

Using the United States Geological Survey's (USGS) "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains", a roughness value adjustment was determined based on the approximated obstruction value. The trestle piers were correlated to be a "minor effect of obstruction," which is detailed in the USGS paper to be an obstruction that occupies "less than 15% of the cross-sectional area and the spacing between obstructions is such that the sphere of influence around one (1) obstruction does not extend to the sphere of influence around another obstruction." To account for the obstructions caused by the trestle, the roughness value was increased by 0.005 in the model elements that fell within the trestle location shown on VHB's plans.

Figures 14 and 15 show the temporary construction conditions model geometry. On Figure 14, the existing conditions mesh boundary is shown as a reference to illustrate the causeway impact to the shoreline and the modified bathymetry around the causeways is also shown. The temporary construction conditions mesh and the outline of the temporary trestles as depicted within the model are shown on Figure 15. Table 8 contains a summary of the mesh used in the preferred alternative model.

4.1.2 Boundary Conditions

The same riverine and tidal boundary conditions used in the existing conditions model and preferred alternative model were used for the temporary construction conditions model. The initial water level was set to start at approximately the top elevation of the stone fill causeways, as the RMA2 model will not initiate with dry elements in the model.

Table 8. Mesh Summary for Temporary Construction Conditions Model

Parameter	Value
Total Number of Elements	14,306
Number of Triangular Elements	3,575
Number of Quadrilateral Elements	10,731
Number of Nodes	45,058
Maximum Depth	-78.41 feet, MLLW
Minimum Depth	15.69 feet, MLLW
Modeled Area	24.14 square miles

4.2 Model Results

4.2.1 Tidal Height Comparison

The maximum and minimum tidal heights at the eight (8) observation points for the temporary construction conditions model are summarized in Table 9. The six (6) observation points to the west of the Little Bay Bridges result in a decrease in maximum tidal height and a slight increase in minimum tidal height. The magnitude of change from the existing tidal elevations is no greater than 0.029 feet (0.35 inches) at these locations. The other two (2) observation locations located to the east of the bridges experience slight increases in maximum tidal height and decreases in minimum tidal height, with a maximum change of 0.01 feet (0.12 inches).

Table 9. Tidal Height Comparison for Temporary Construction Conditions Model

Observation Location	Temp. Construction Conditions		Existing Conditions		Delta (Temp. Construction – Exist.)	
	Max High (ft, MLLW)	Min Low (ft, MLLW)	Max High (ft, MLLW)	Min Low (ft, MLLW)	Max High (ft, MLLW)	Min Low (ft, MLLW)
Squamscot Marsh	8.911	1.833	8.940	1.828	-0.029	0.005
Sandy Point	8.930	1.553	8.959	1.548	-0.029	0.005
Pickering Brook	8.932	1.433	8.961	1.427	-0.029	0.006
Lubberland Creek	8.927	1.502	8.956	1.497	-0.029	0.005
Adams Point	8.846	1.454	8.872	1.448	-0.026	0.006
Durham Town Landing	8.801	1.491	8.826	1.484	-0.025	0.007
Pomeroy Cove	9.050	1.021	9.048	1.027	0.002	-0.006
Junction of Cocheco and Salmon Falls Rivers	9.158	1.195	9.148	1.203	0.010	-0.008

4.2.2 Velocity Comparison

The velocity magnitude comparison of the temporary construction conditions to existing conditions is summarized in Table 10. The addition of the stone fill causeways around the abutments result in decreased velocities at the observation points near the causeways in both flood and ebb tides. Points #1, #24 and #25 on the Dover side and Points #15, #16, #38 and #39 on the Newington side all experience velocity magnitude reductions due to the flow obstruction caused by the temporary causeways.

Due to the decreased flow around the abutments, velocity magnitude increases at various observation points under the bridges. Most notably, during flood tide, Point #7 experiences a 0.8 ft/s increase over the existing conditions velocity magnitude (a 10% increase). During ebb tide, the velocity magnitude increases by 1.1 ft/s at Points #32 and #34 and 1.0 ft/s at Point #8. On average, the 45 observation points experience a 0.10 ft/s decrease in velocity magnitude during flood tide and an increase of 0.09 ft/s during ebb tide.

Each of the four (4) observation locations that are positioned within the 200 foot wide navigational channel (Points #8, #20, #31 and #44) experiences an increase in maximum velocity magnitude during temporary construction conditions. During flood tide, the maximum increase is 0.3 ft/s, which is seen at Points #8 and #44. During ebb tide, the change in velocity magnitude over existing conditions increases as the points move from south to north: no increase at Point #44, 0.1 ft/s increase at Point #31, 0.5 ft/s increase at Point #20 and 1.0 ft/s at Point #8.

The velocity direction predicted by the temporary construction conditions model was compared to the existing conditions model at each of the 45 observation locations for each modeled time step. Around the stone fill causeways, the velocity direction changed due to the flow pattern imparted by the causeway obstructions. At the four (4) observation points located in the navigational channel, the average change in direction was less than 2.2 degrees.

Color contour plots of the existing conditions maximum flood and maximum ebb velocities have been provided in Figure 16 and Figure 17, respectively.

Table 10. Velocity Verification for Temporary Construction Conditions Model

Observation Location	Temp. Construction		Existing Conditions		Delta (Const. – Exist.)	
	Max Flood (ft/s)	Max Ebb (ft/s)	Max Flood (ft/s)	Max Ebb (ft/s)	Max Flood (ft/s)	Max Ebb (ft/s)
1	4.2	1.0	4.6	1.7	-0.4	-0.7
2	4.9	2.6	5.1	2.3	-0.2	0.3
3	5.4	2.5	5.2	2.0	0.2	0.5
4	6.4	3.4	6.3	3.1	0.1	0.3
5	7.2	3.4	6.7	3.4	0.5	0.0
6	8.9	6.7	8.8	6.6	0.1	0.1
7	9.0	7.6	8.2	6.9	0.8	0.7
8	8.8	10.8	8.5	9.8	0.3	1.0
9	6.8	7.6	6.2	6.9	0.6	0.7
10	6.1	9.0	5.9	8.5	0.2	0.5
11	5.1	5.8	4.7	5.5	0.4	0.3
12	4.4	7.9	4.3	7.5	0.1	0.4
13	3.5	3.4	3.4	3.4	0.1	0.0
14	3.3	5.6	3.5	5.4	-0.2	0.2
15	2.9	1.8	3.7	4.2	-0.8	-2.4
16	1.6	1.0	3.5	4.7	-1.9	-3.7
17	6.3	3.3	6.0	2.7	0.3	0.6
18	6.5	3.5	6.4	3.0	0.1	0.5
19	6.0	3.8	5.9	3.5	0.1	0.3
20	6.5	6.8	6.3	6.3	0.2	0.5
21	6.9	8.9	6.5	8.3	0.4	0.6
22	7.5	12.7	7.2	12.2	0.3	0.5
23	5.1	7.0	4.9	6.6	0.2	0.4
24	1.6	4.2	5.1	5.0	-3.5	-0.8
25	4.3	4.8	5.2	5.0	-0.9	-0.2
26	4.1	4.9	4.6	4.6	-0.5	0.3
27	5.3	5.3	5.5	5.2	-0.2	0.1
28	4.4	5.9	4.6	5.6	-0.2	0.3
29	5.9	5.6	6.0	5.6	-0.1	0.0
30	5.5	6.0	4.9	5.1	0.6	0.9
31	7.0	6.3	6.8	6.2	0.2	0.1
32	4.5	6.0	4.3	4.9	0.2	1.1
33	6.3	5.9	6.0	5.8	0.3	0.1
34	4.3	5.7	3.9	4.6	0.4	1.1
35	4.4	5.3	4.5	5.4	-0.1	-0.1
36	3.4	4.6	3.3	4.0	0.1	0.6
37	3.8	3.9	3.6	4.4	0.2	-0.5
38	0.9	2.7	2.4	2.9	-1.5	-0.2
39	0.6	1.3	2.1	2.7	-1.5	-1.4
40	3.6	1.9	3.6	1.3	0.0	0.6
41	3.9	4.9	3.9	4.9	0.0	0.0
42	2.6	4.6	2.7	4.3	-0.1	0.3
43	4.1	6.0	4.3	6.0	-0.2	0.0
44	6.6	6.1	6.2	6.1	0.4	0.0
45	4.1	4.3	3.7	4.3	0.4	0.0

5 RECOMMENDATIONS

The hydrodynamic modeling results predict minimal changes to the tidal heights in the Little Bay and Great Bay Estuaries. Table 11 contains a summary of the tidal height comparisons for the preferred alternative and temporary construction conditions models.

The preferred alternative model predicted changes between 0.00 and 0.02 feet (0.24 inches) when compared to existing conditions, depending on the tidal conditions (i.e. maximum high tide or minimum low tide) and the observation location within the model.

During temporary construction conditions, temporarily restricting the flow area through the Little Bay Bridges as a result of the temporary stone fill causeways at each abutment also result in minimal changes to the tidal heights. The temporary construction conditions model predicted changes between 0.002 feet (0.02 inches) and 0.029 feet (0.35 inches) when compared to existing conditions, depending on the tidal conditions and the observation location within the model.

While changes to the pier geometry for the preferred alternative model creates changes to the velocity magnitudes at the bridges when compared to existing conditions, these changes are slight when compared to the peak velocity magnitudes experienced at the bridge under existing conditions, which are predicted to be in the range of 10 to 12 ft/s in the existing conditions model. Focusing on the 200 foot wide navigational channel running through the center piers, the velocity magnitude increases by a maximum of only 5% for the preferred alternative.

The temporary construction conditions have more of an impact on velocities than the preferred alternative model due to the obstructions caused by the temporary stone fill causeways. However, the velocity magnitude increases by less than 10% though the navigational channel, with a maximum predicted velocity of 10.8 ft/s. Reducing the footprint of the temporary stone fill causeways will help reduce the impacts to the hydraulics during construction. The temporary access trestle was incorporated into the model based on assumptions made from a schematic drawing in the bridge plans provided by VHB. If the contractor utilizes a temporary access trestle of platform that causes an obstruction to the cross-sectional flow area under the bridges greater than what was assumed in the model, the temporary construction hydraulic impacts should be revisited.

Based on the results of the hydrodynamic models, the preferred alternative and temporary construction conditions will result in minimal changes to the hydraulics around the bridge and within the Great Bay Estuary.

Table 11. Tidal Height Comparison Summary

Modeled Scenario		Squamscot Marsh		Sandy Point		Pickering Brook		Lubberland Creek	
		Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)
Existing Conditions	Max High Tide	8.940	-	8.959	-	8.961	-	8.956	-
	Min Low Tide	1.828	-	1.548	-	1.427	-	1.497	-
Preferred Alternative	Max High Tide	8.957	**0.017**	8.976	**0.017**	8.978	**0.017**	8.972	**0.016**
	Min Low Tide	1.816	**-0.012**	1.532	**-0.016**	1.410	**-0.017**	1.481	**-0.016**
Temporary Construction (stone causeway with trestle)	Max High Tide	8.911	**-0.029**	8.930	**-0.029**	8.932	**-0.029**	8.927	**-0.029**
	Min Low Tide	1.833	**0.005**	1.553	**0.005**	1.433	**0.006**	1.502	**0.005**

Modeled Scenario		Adams Point		Durham Town Landing		Pomeroy Cove		Junction of Concheco & Salmon Falls River	
		Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)	Value (ft, MLLW)	Δ Existing (ft)
Existing Conditions	Max High Tide	8.872	-	8.826	-	9.048	-	9.148	-
	Min Low Tide	1.448	-	1.484	-	1.027	-	1.203	-
Preferred Alternative	Max High Tide	8.887	**0.015**	8.840	**0.014**	9.045	**-0.003**	9.145	**-0.003**
	Min Low Tide	1.429	**-0.019**	1.464	**-0.020**	1.027	**0.000**	1.203	**0.000**
Temporary Construction (stone causeway with trestle)	Max High Tide	8.846	**-0.026**	8.801	**-0.025**	9.050	**0.003**	9.158	**0.010**
	Min Low Tide	1.454	**0.006**	1.491	**0.007**	1.021	**-0.006**	1.195	**-0.008**

REFERENCES

1. Vanasse Hangen Brustlin, Inc., "Final Environmental Impact Statement, Spaulding Turnpike Improvements, NHS-027-1(37), 11238, Newington to Dover, New Hampshire," Volumes 1 to 3, December 2007.

2. Vanasse Hangen Brustlin, Inc., "Construction Plans, Bridge Improvements, NHS-027-1(37), 11238L, Bridge No. 201/204, Little Bay Bridge, SB Spaulding Turnpike, US Route 4, NH Route 16, Volume 2: Steel Superstructure Option," PPS&E Plans, November 2009.

3. Vanasse Hangen Brustlin, Inc., "Construction Plans, Bridge Improvements, NHS-027-1(37), 11238L, Bridge No. 201/204, Little Bay Bridge, SB Spaulding Turnpike, US Route 4, NH Route 16, Volume 2: Steel Superstructure Option," PPS&E Plans, July 2009.

4. National Oceanic and Atmospheric Administration, "COOPS/NGS Elevation Data Graphics, Elevation Information for Tide Station ID: 8423898, Fort Point, New Hampshire," Accessed February 22, 2010.

5. Arcement, Jr., G.J. and Schneider, V.R., "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains," United States Geological Survey, Water-supply Paper 2339, 1989.

6. Resource Management Associates, "Finite Element Method for Fluid Flow, Two-dimensional Hydrodynamics in the Horizontal Plane, RMA2 Version 4.58," Last modification date: September 15, 2009.

APPENDIX A: FIGURES

AECOM

Figure 1 - Project Locus Map
Little Bay Bridges

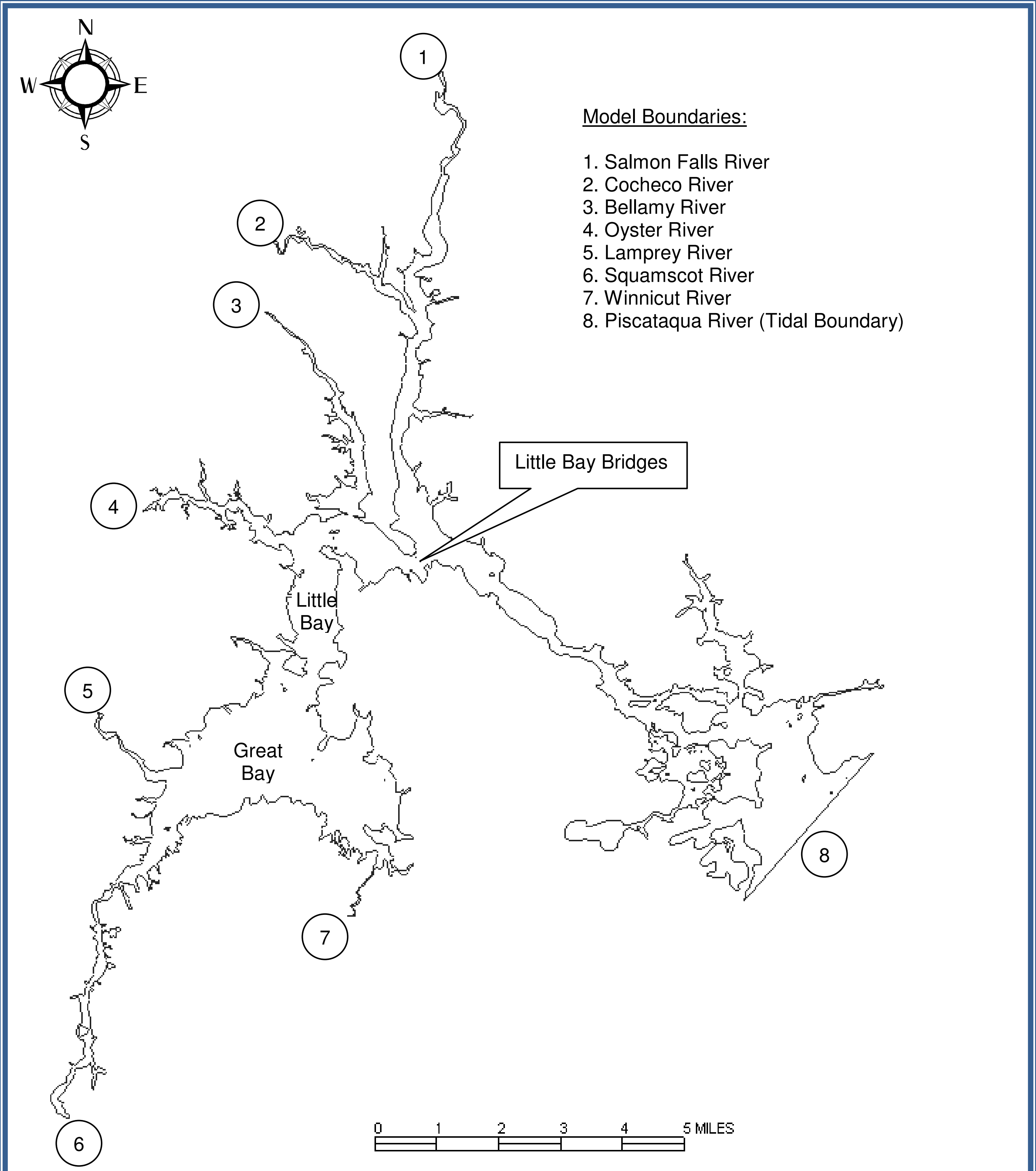

Figure 2. Model Extent

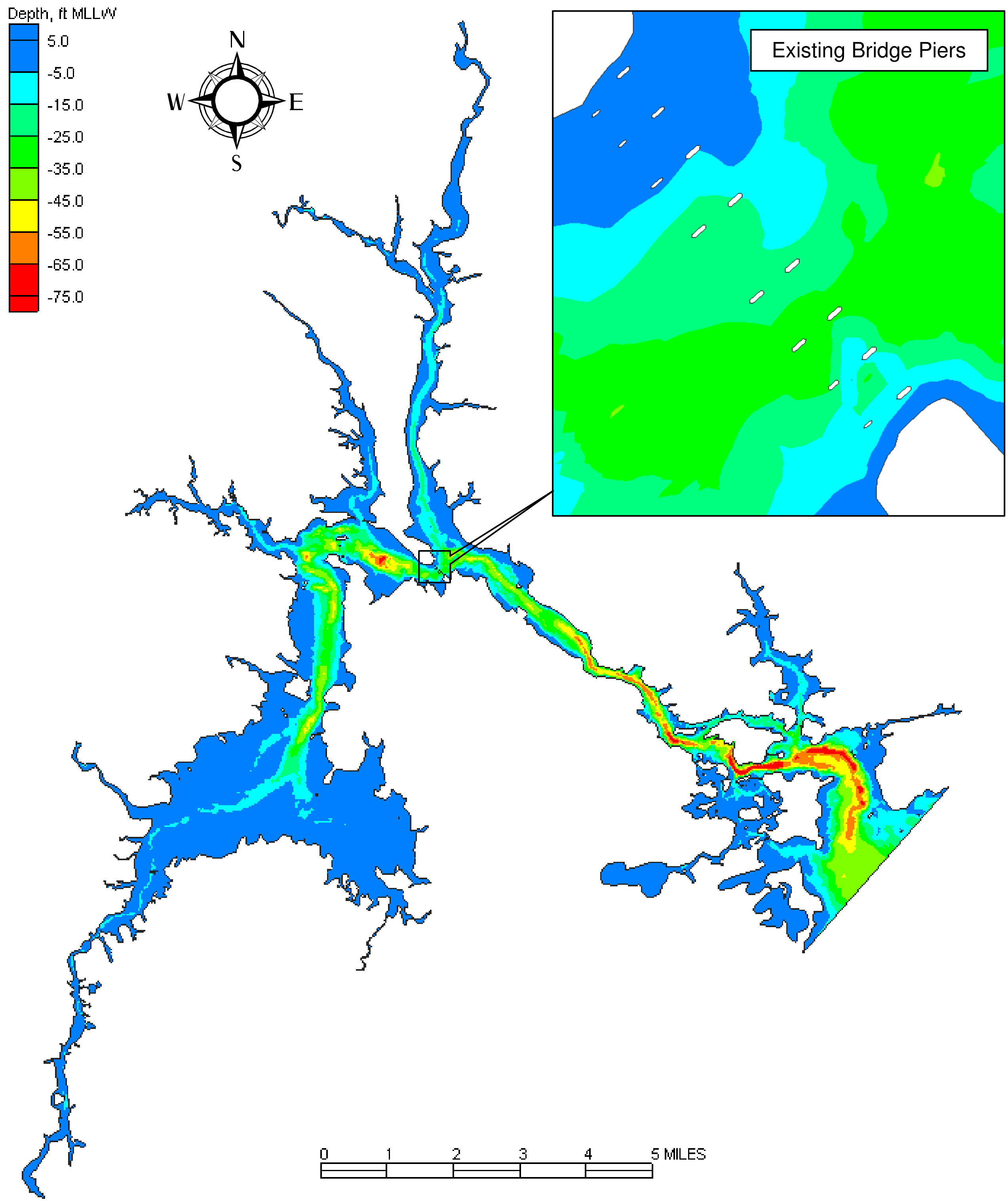

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Figure 3. Model Bathymetry

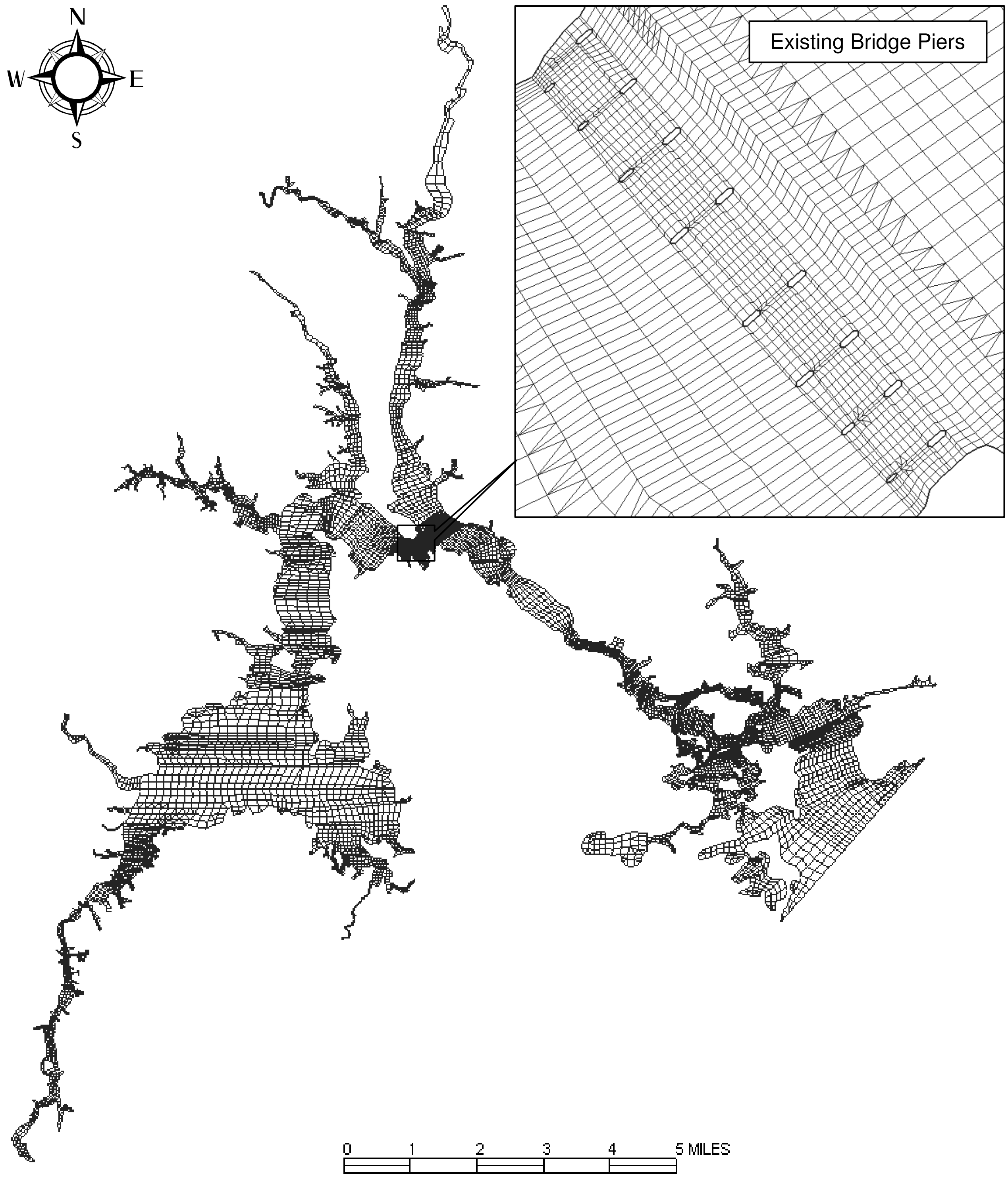
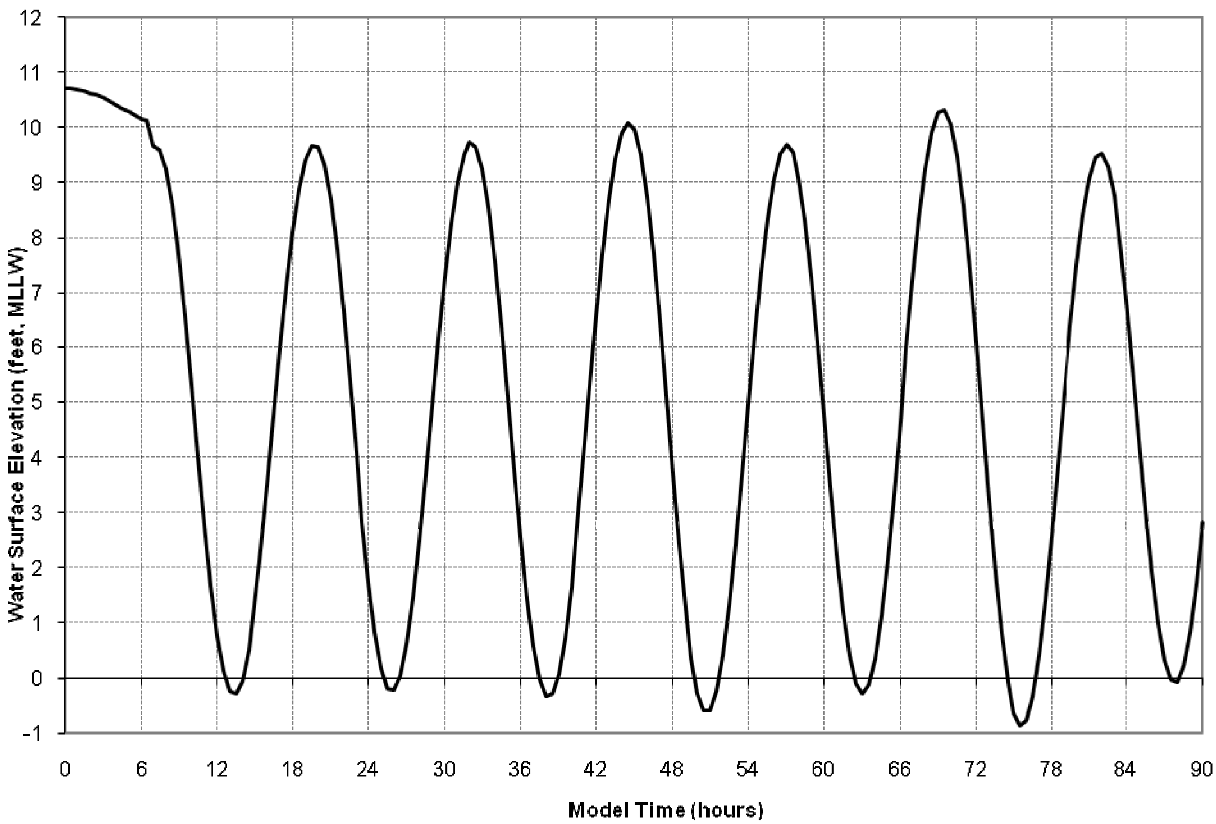


Figure 4. Existing Bridge Model Geometry with Mesh

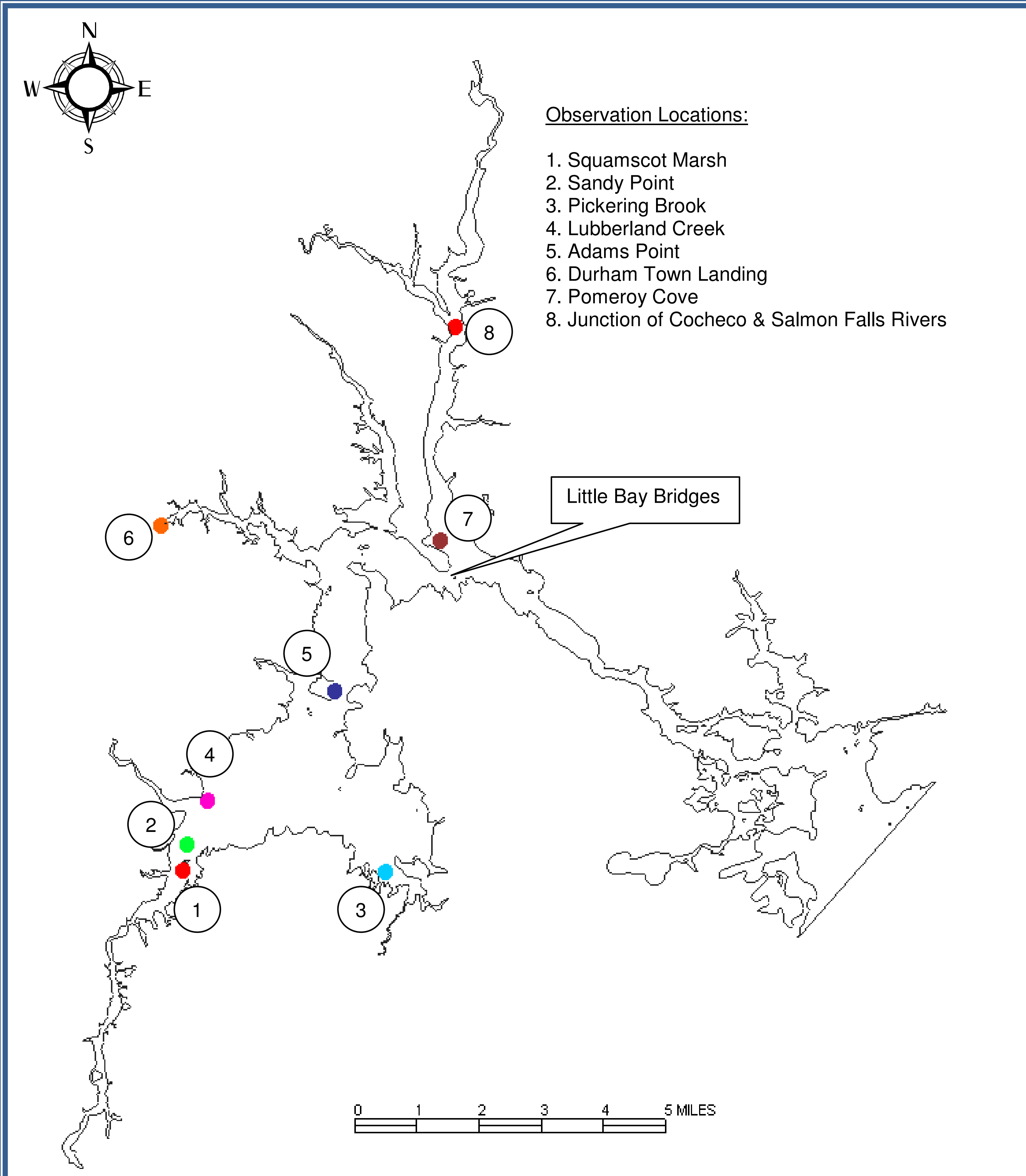


Tidal Boundary Statistics:

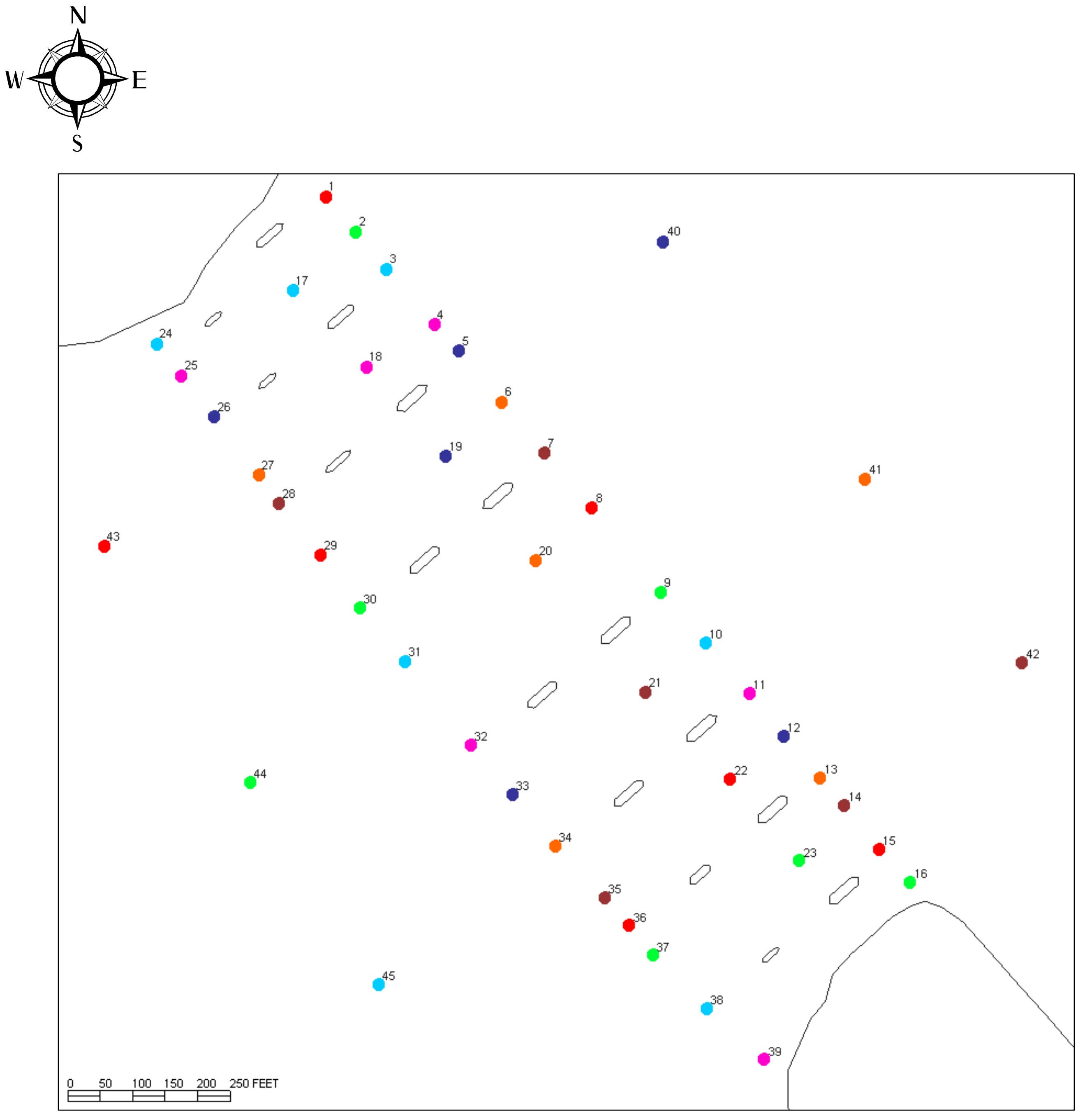
Maximum high tide: 10.32 feet at 69.5 hours
Minimum low tide: -0.87 feet at 75.5 hours
Mean tide level: 5.10 feet

AECOM

Figure 5. Tidal Boundary Time Series



AECOM **Figure 6. Tidal Height Observation Locations**



Note: Existing bridge pier configuration shown.

AECOM

Figure 7. Velocity Observation Locations

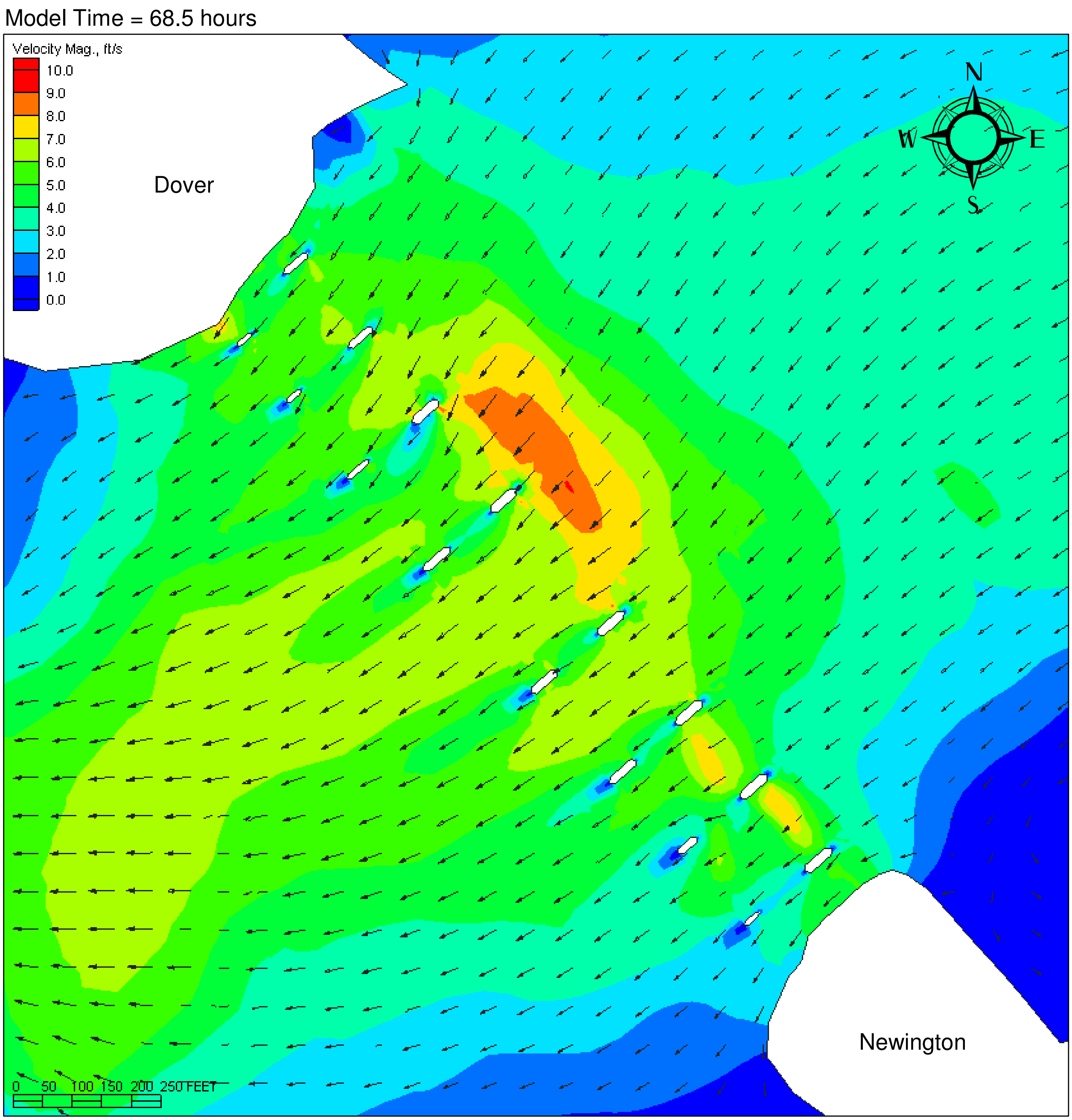


Figure 8. Maximum Flood Currents for Existing Conditions

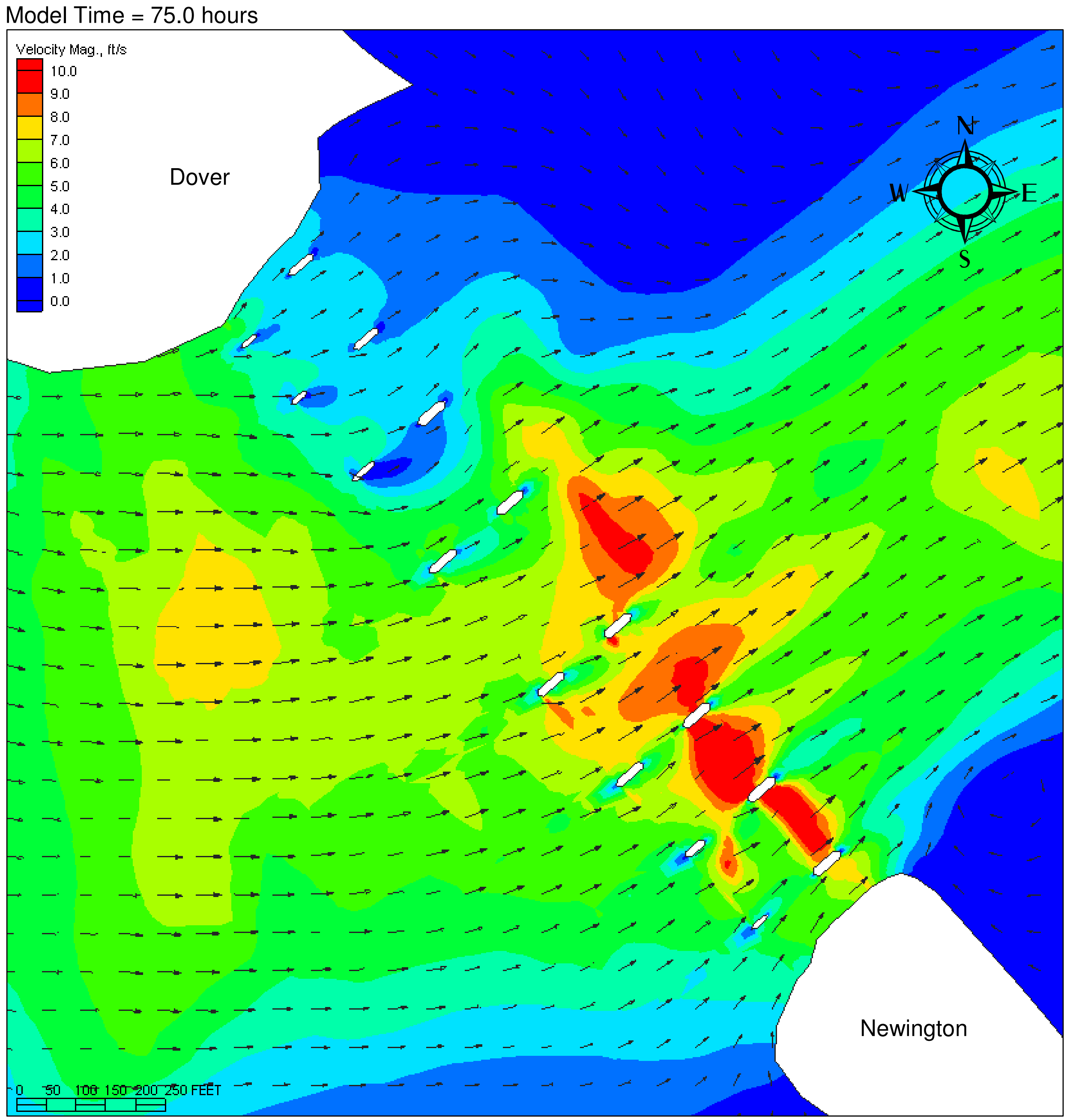


Figure 9. Maximum Ebb Currents for Existing Conditions

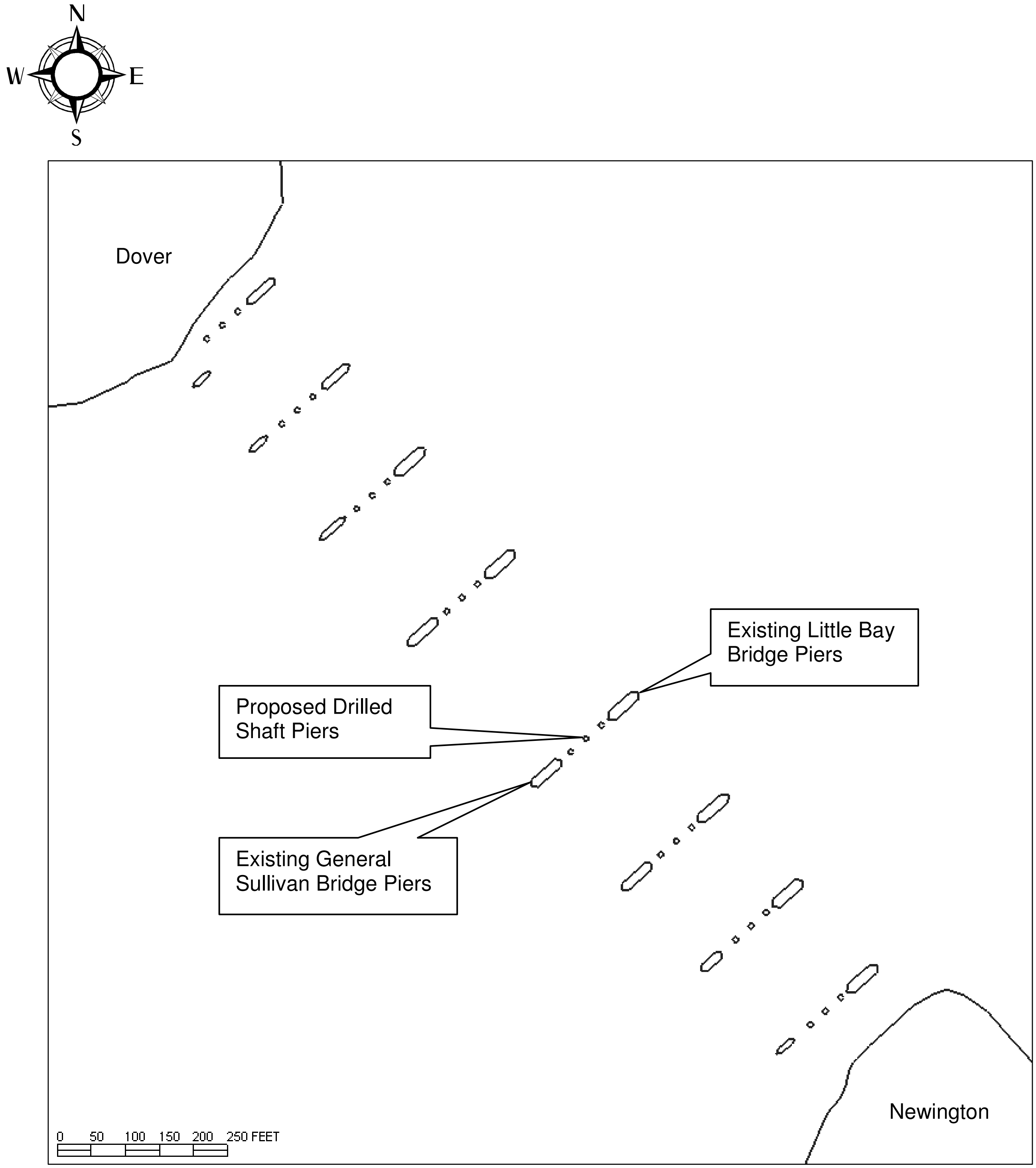


Figure 10. Preferred Alternative Model Geometry

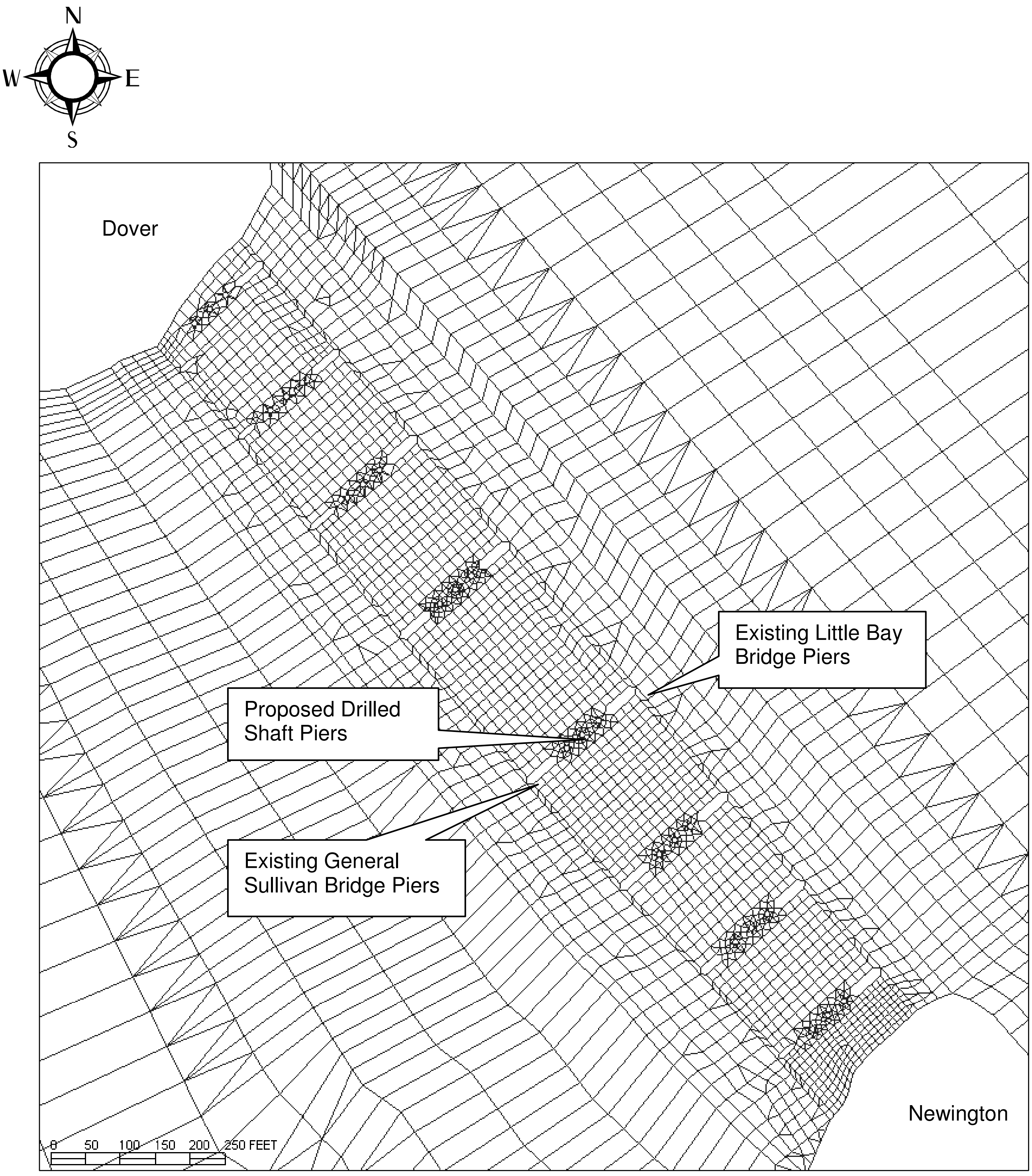


Figure 11. Preferred Alternative Model Geometry with Mesh

Model Time = 68.5 hours

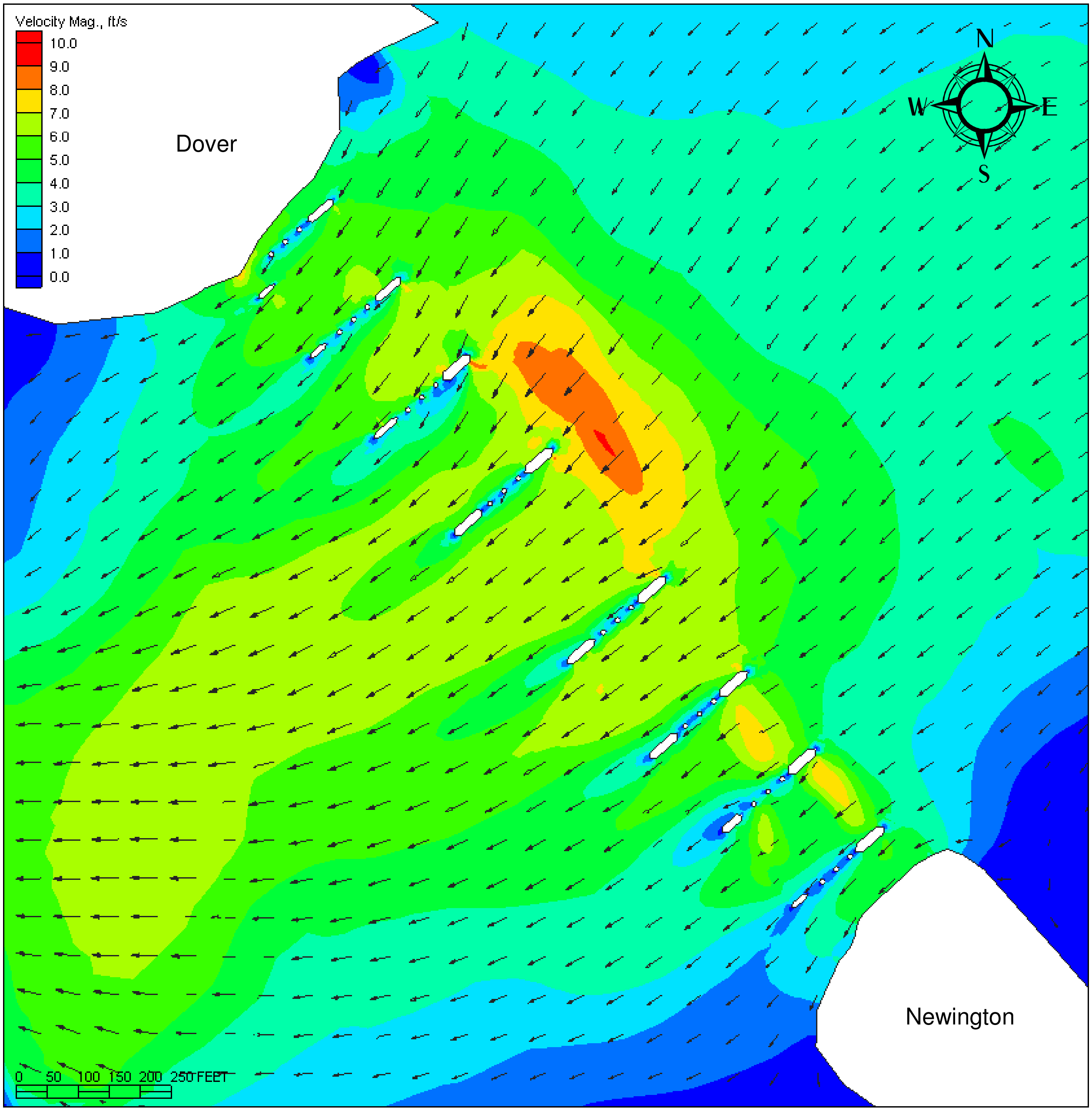
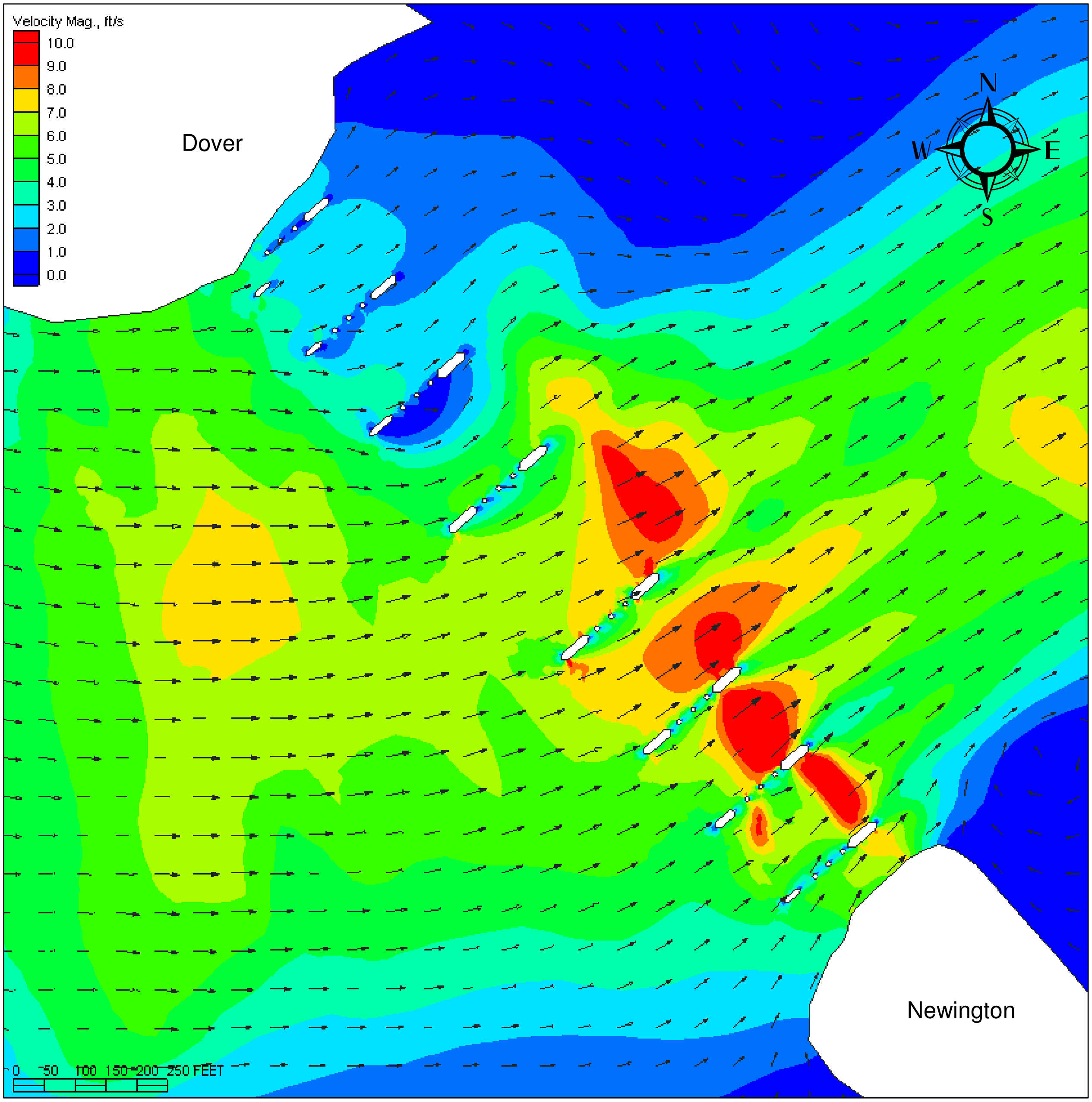


Figure 12. Maximum Flood Currents for Preferred Alternative

Model Time = 75.0 hours



AECOM **Figure 13. Maximum Ebb Currents for Preferred Alternative**

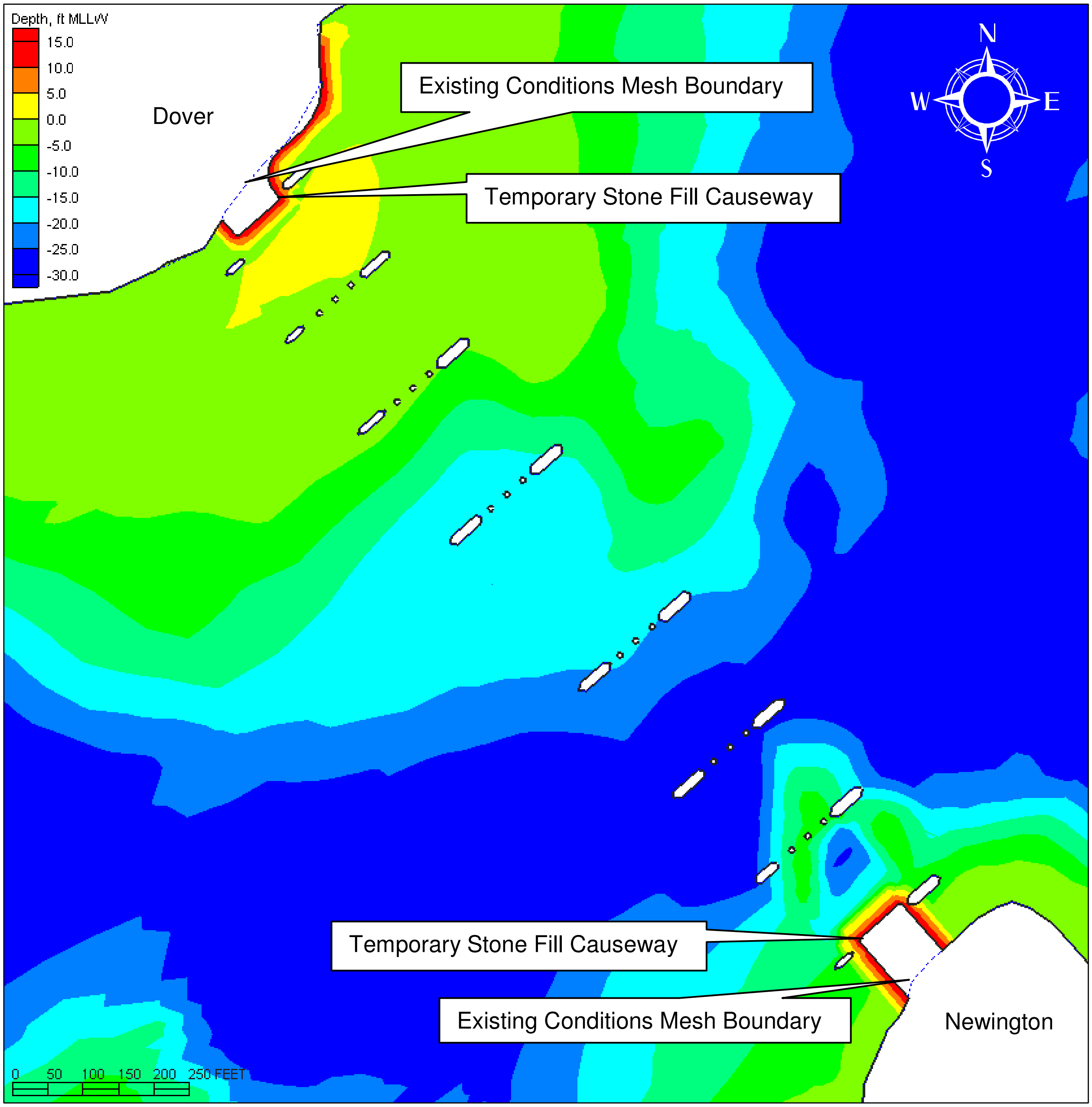


Figure 14. Temporary Construction Conditions Model Geometry

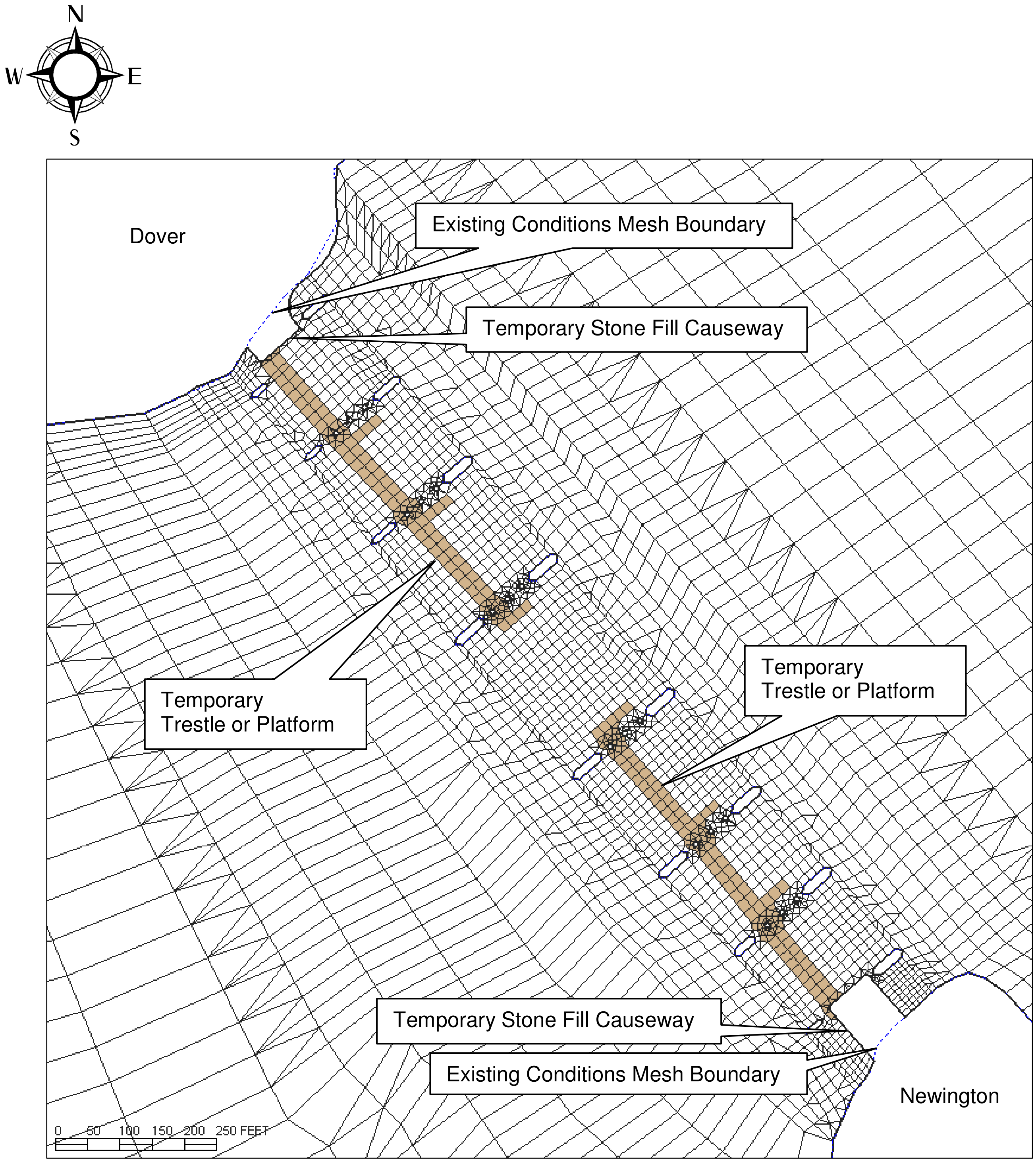


Figure 15. Temporary Construction Conditions Model Geometry with Mesh

Model Time = 68.5 hours

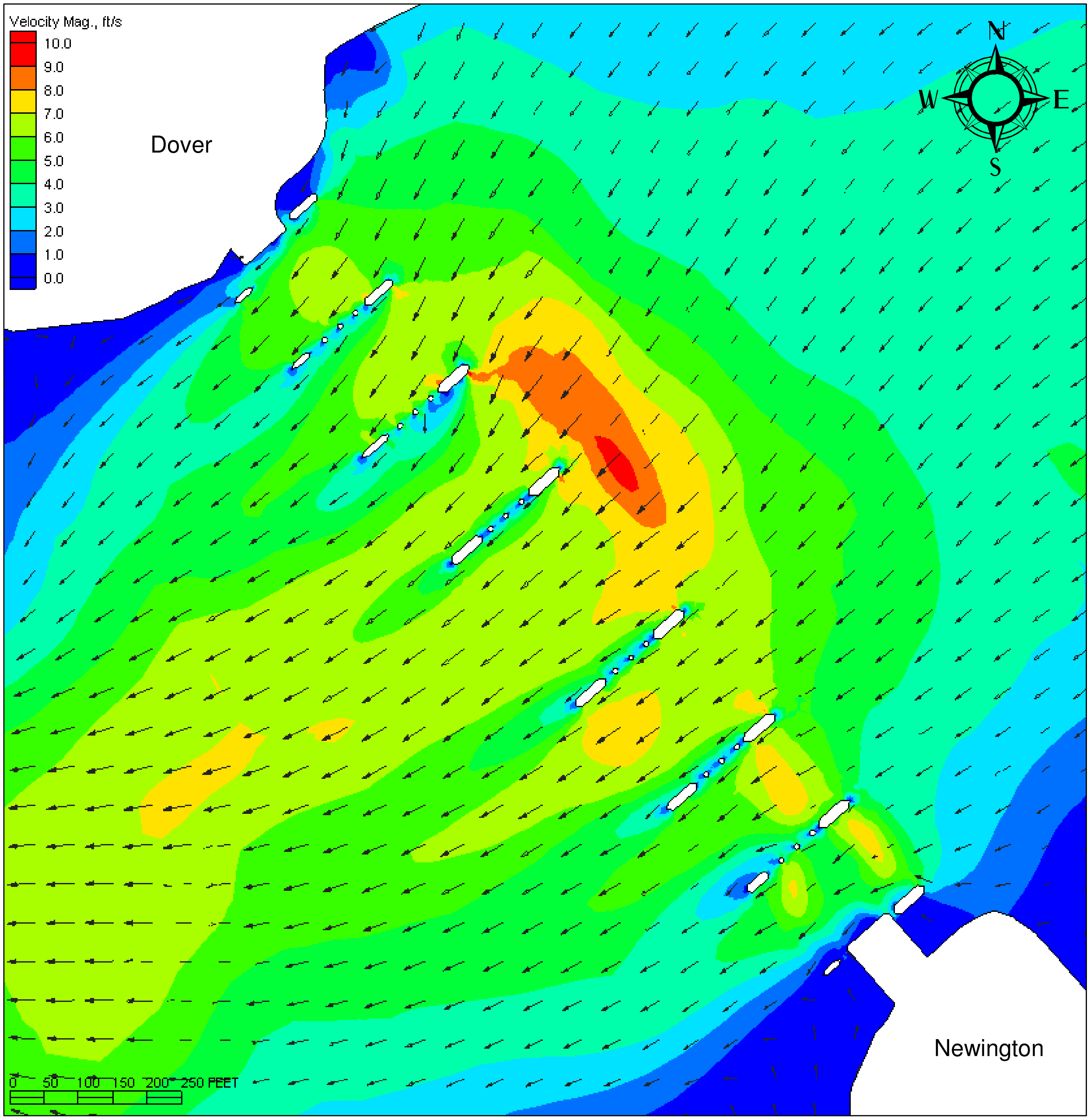


Figure 16. Maximum Flood Currents for Temporary Construction Conditions

Model Time = 75.0 hours

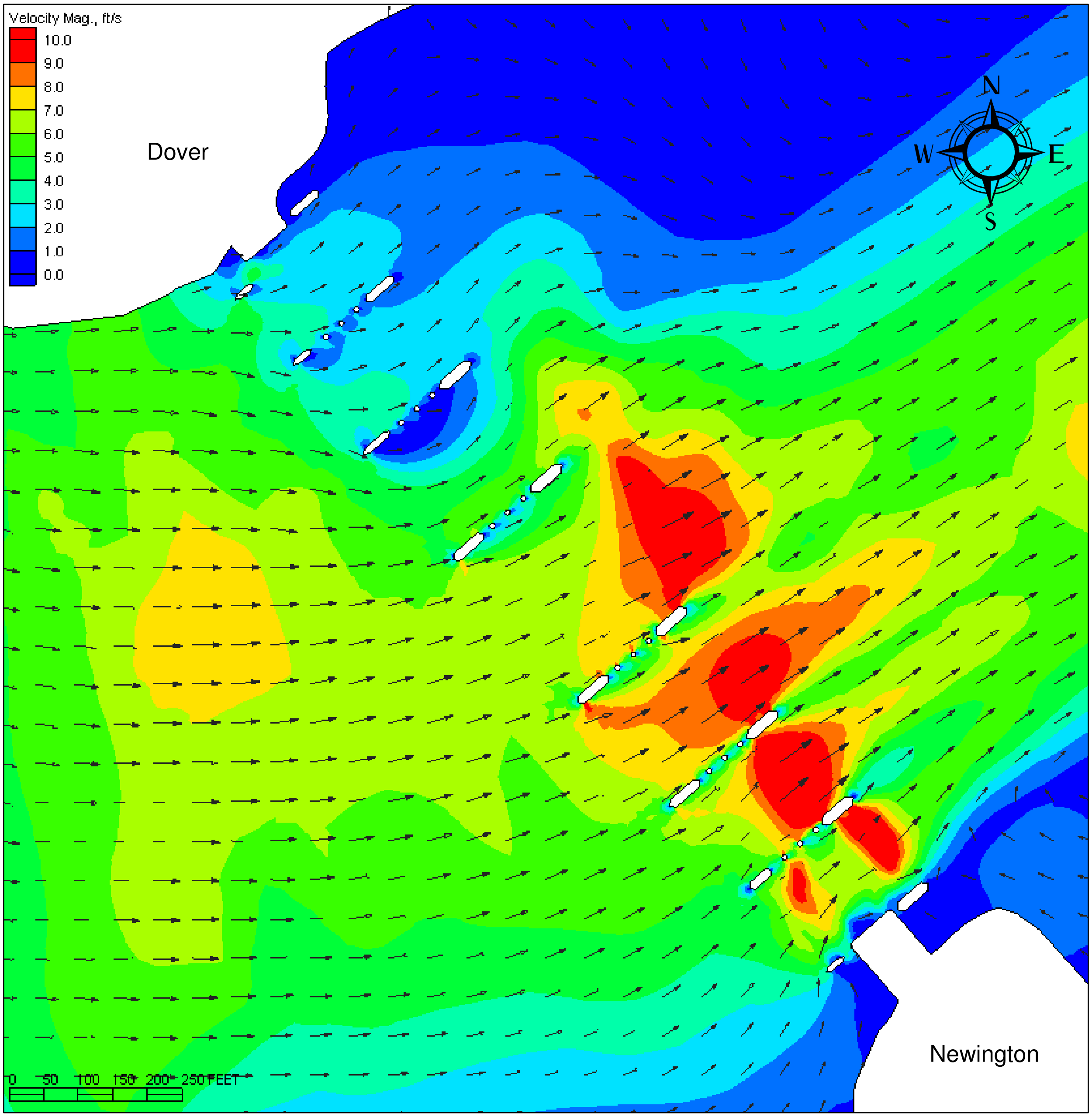


Figure 17. Maximum Ebb Currents for Temporary Construction Conditions

APPENDIX B: PLANS USED FOR THE PREFERRED ALTERNATIVE MODEL

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

CONSTRUCTION PLANS
BRIDGE IMPROVEMENTS

NHS-027-1(37)

11238L

BRIDGE NO. 201/024

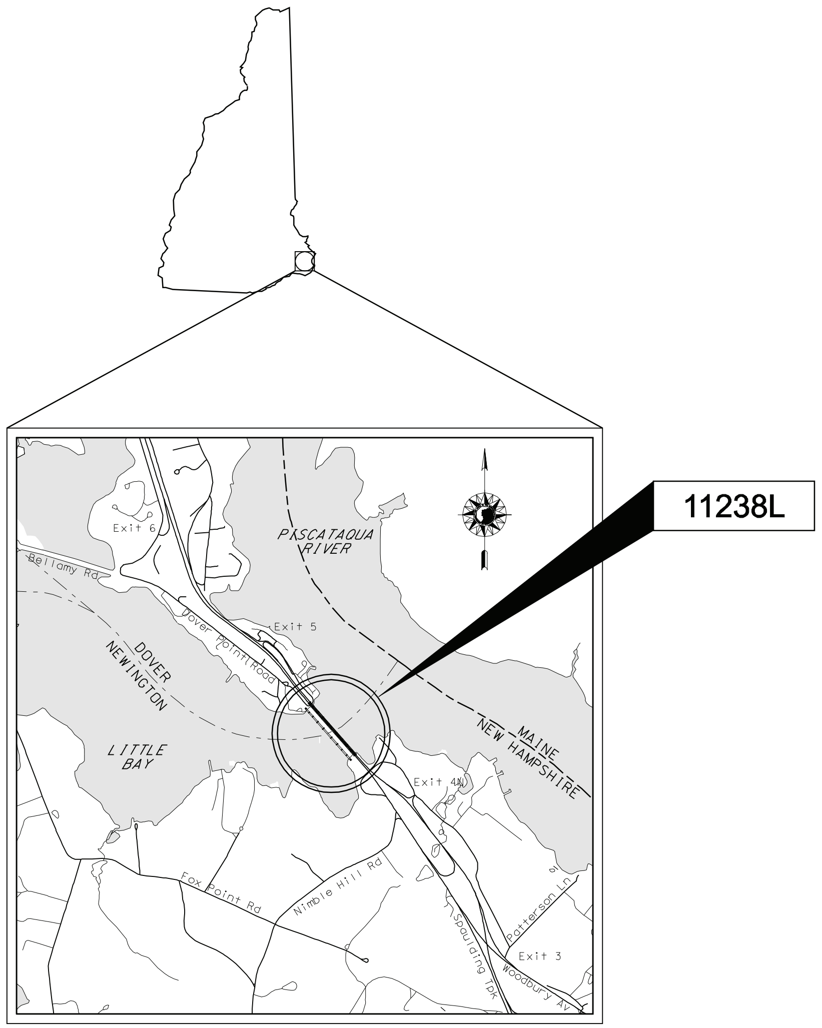
LITTLE BAY BRIDGE

SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16

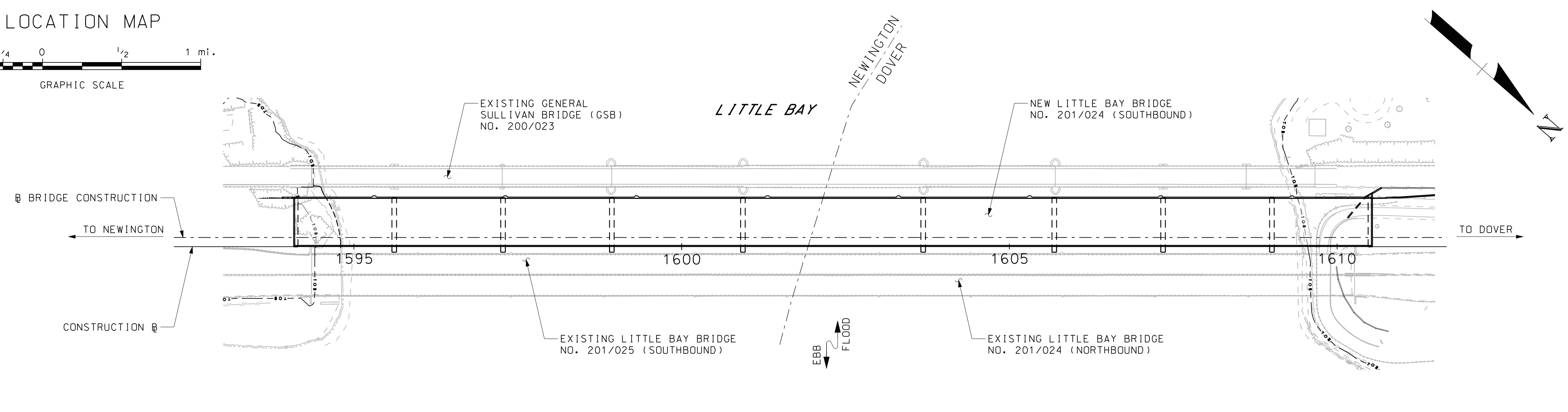
OVER LITTLE BAY

VOLUME 2
STEEL SUPERSTRUCTURE OPTION

PPS&E PLANS
NOVEMBER 2009



LOCATION MAP



PLAN
200 SCALE

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Ltitle01	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER — BRIDGE NO. 201/024 — STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

TITLE SHEET

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	SMH	11/09	CHECKED	KDW	11/09
	DRAWN	KDW	11/09	CHECKED	SMH	11/09
	QUANTITIES			CHECKED		
	ISSUE DATE					
	REV. DATE					

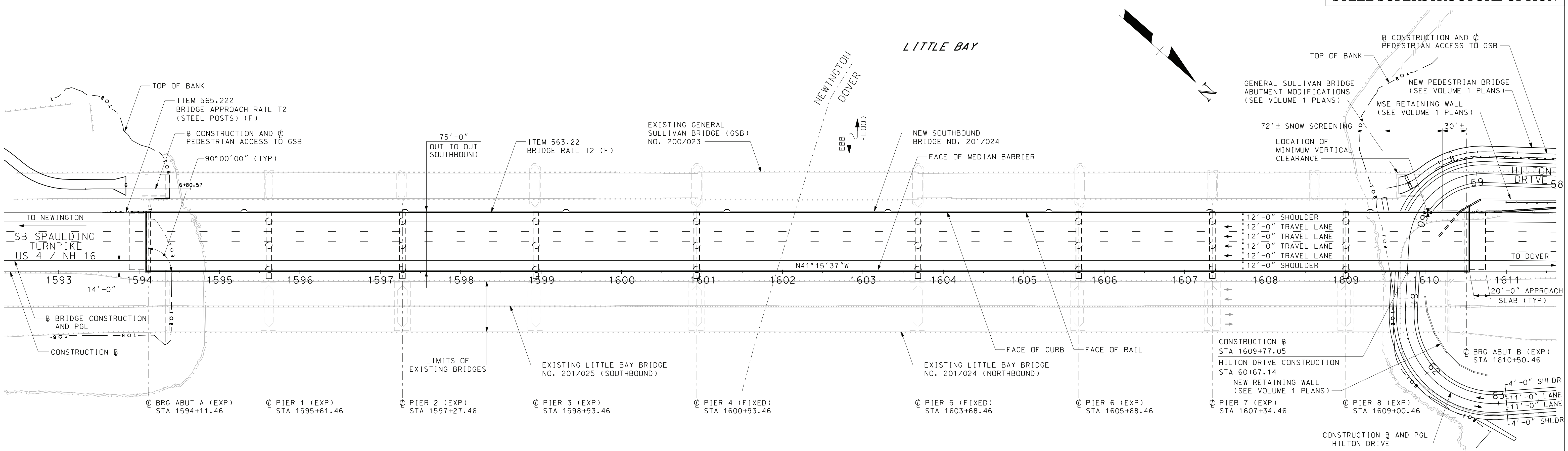
FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
NHS-027-1(37)		

BRIDGE SHEET 1 OF 76

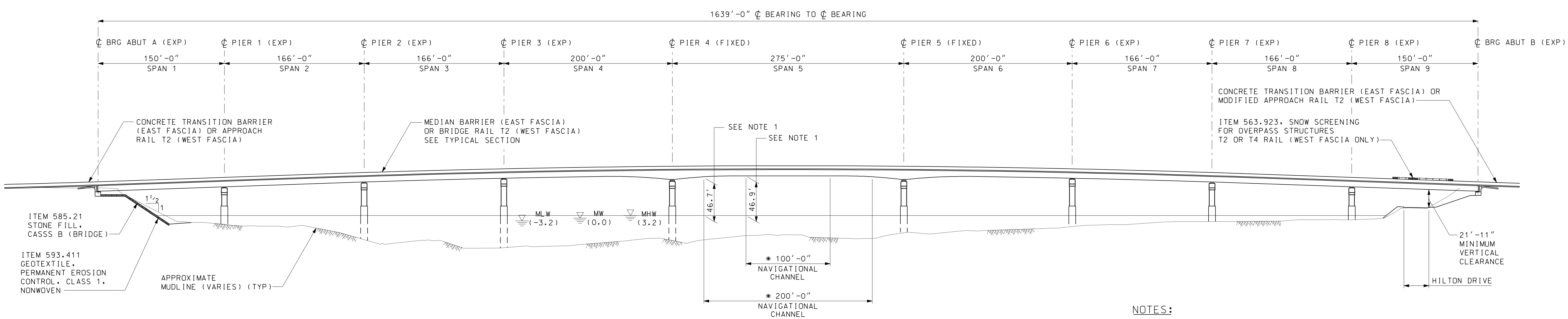
FILE NUMBER

\\vhb\proj\Bedford\52012.00\11238L\Brd\B01\PPSE\s11238Ltitle01.dgn

STEEL SUPERSTRUCTURE OPTION



GENERAL PLAN



ELEVATION

(EXISTING GENERAL SULLIVAN BRIDGE BEYOND AND LITTLE BAY BRIDGES IN FOREGROUND NOT SHOWN)

* EXISTING AND PROPOSED

NOTES:

1. PROPOSED VERTICAL NAVIGATIONAL CLEARANCE EQUALS OR EXCEEDS EXISTING.

2. SEE BRIDGE SHEET 3 FOR INDEX OF BRIDGE SHEETS.

60 0 60 120
SCALE IN FEET

VHB *Vanasse Hangen Brustlin, Inc.*

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lgenplan	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER | BRIDGE NO. 201/024 | STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

GENERAL PLAN AND ELEVATION

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	SMH	11/09	CHECKED	KDW	11/09
DRAWN	KDW	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		
ISSUE DATE					
REV. DATE					

FEDERAL PROJECT NO. NHS-027-1(37)

SHEET NO. | TOTAL SHEETS

BRIDGE SHEET 2 OF 76

FILE NUMBER

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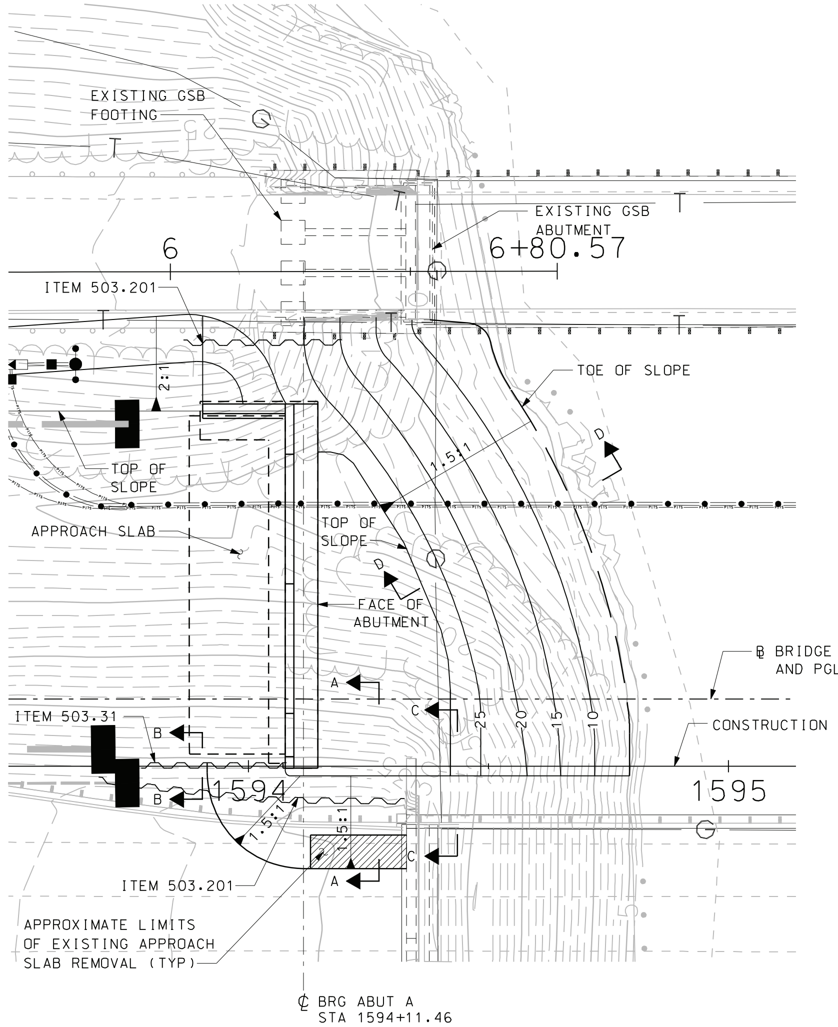
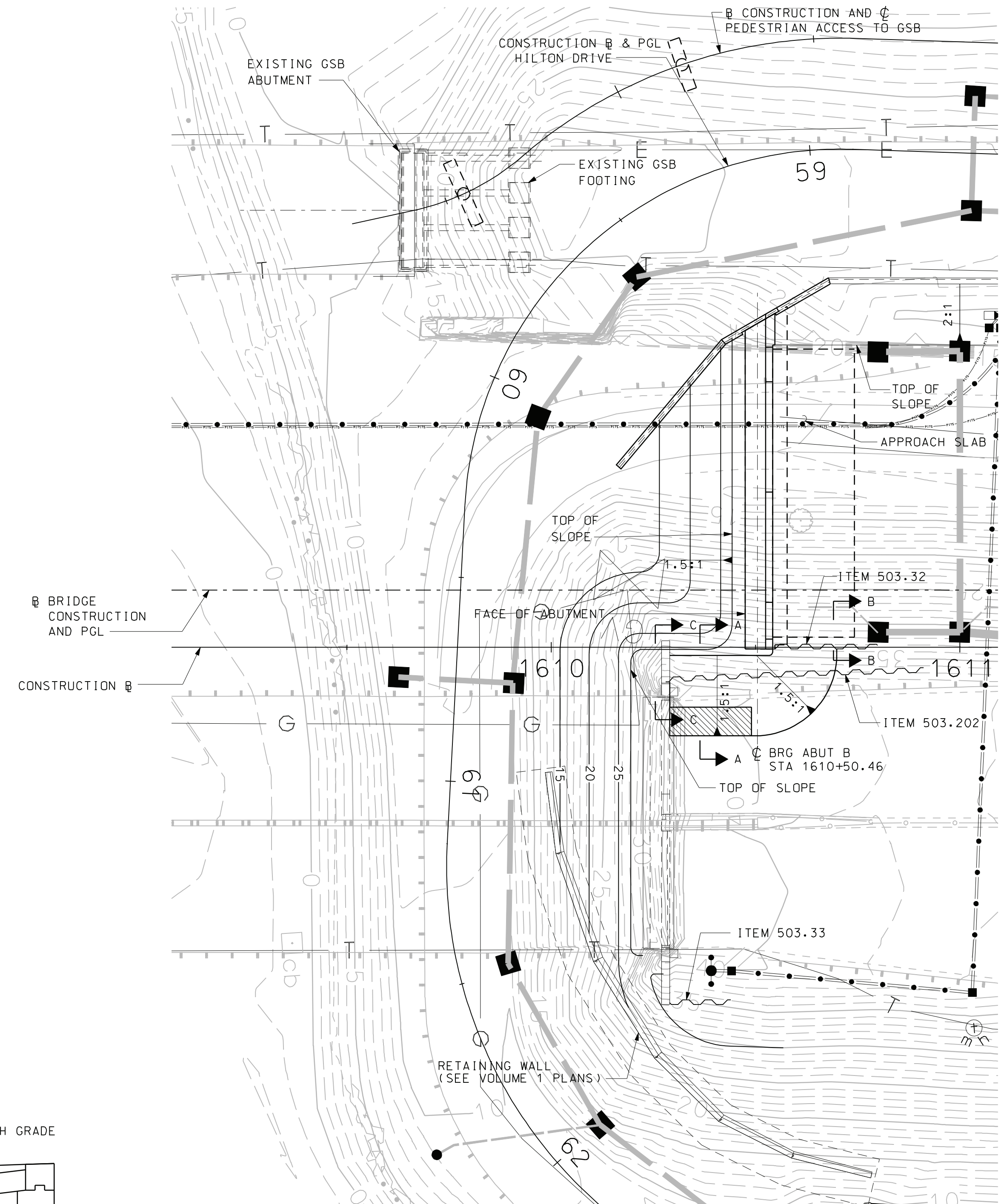
STEEL SUPERSTRUCTURE OPTION



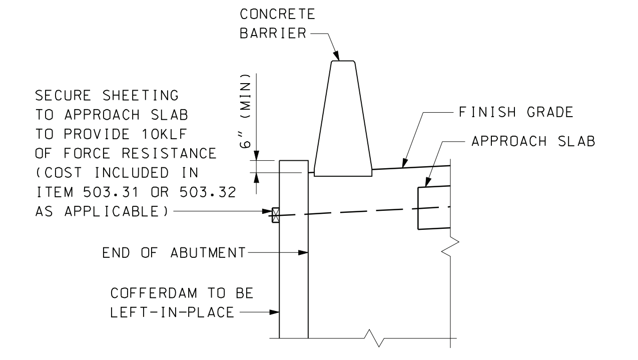
ABUTMENT A SITE PLAN DETAIL

SCALE: 1" = 20'



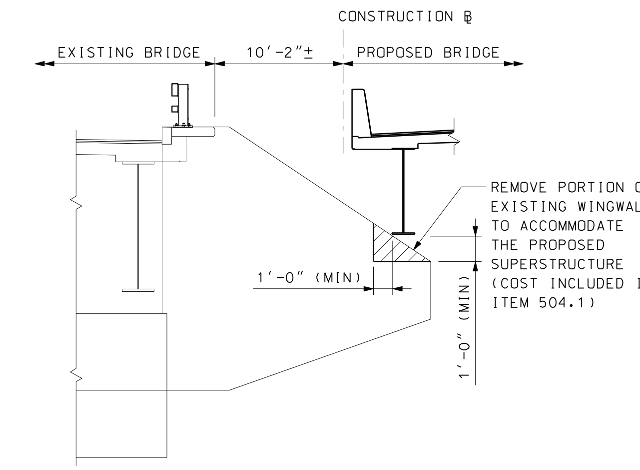
ABUTMENT B SITE PLAN DETAIL

SCALE: 1" = 20'



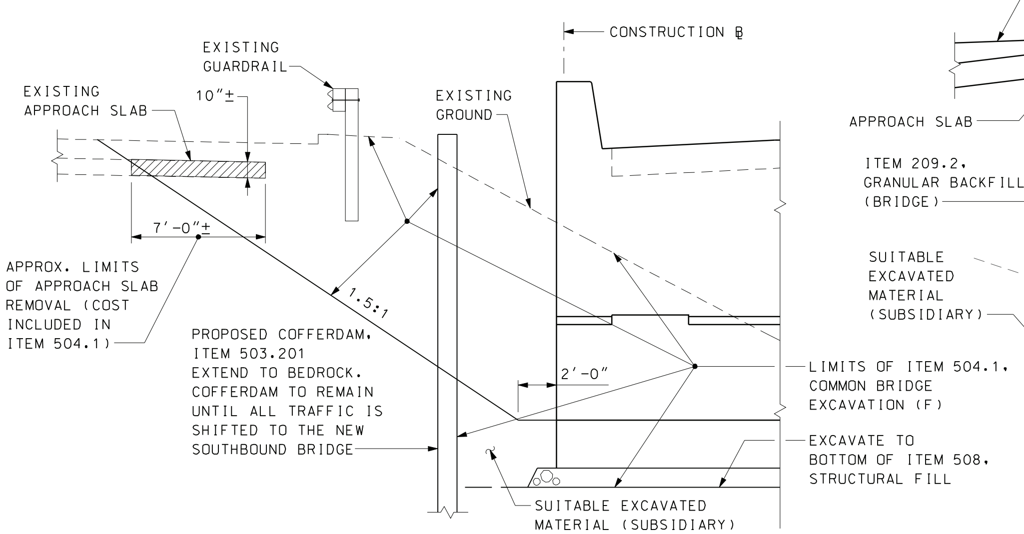
SECTION B-B

NOT TO SCALE
(ABUTMENT A SHOWN, ABUTMENT B SIMILAR, OPPOSITE HAND)



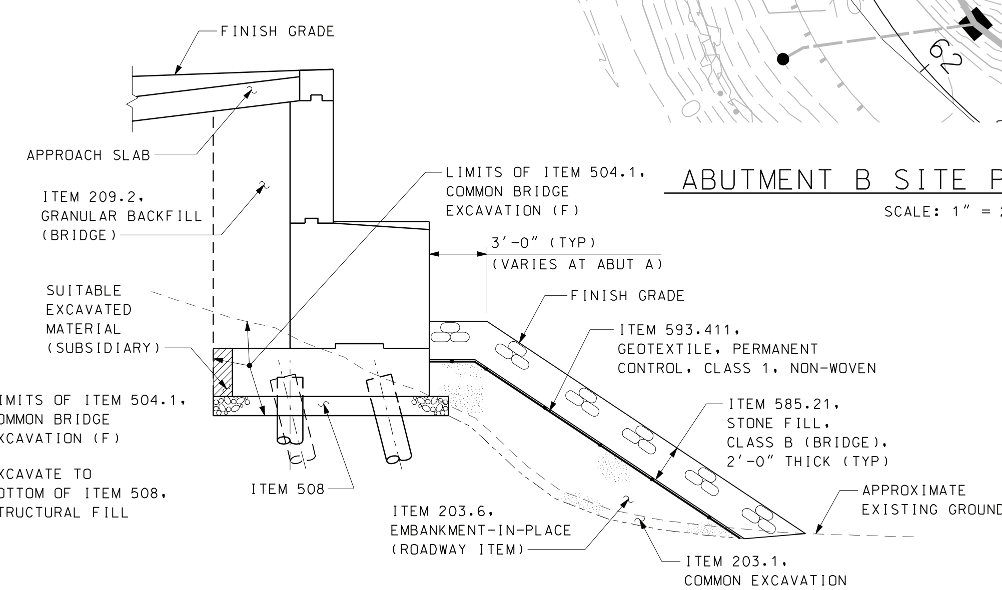
SECTION C-C

SCALE: 1" = 5'
(ABUTMENT A SHOWN, ABUTMENT B SIMILAR, OPPOSITE HAND)



SECTION A-A

SCALE: 1" = 5'
(ABUTMENT A SHOWN, ABUTMENT B SIMILAR, OPPOSITE HAND)



SECTION D-D

NOT TO SCALE

20 0 20 40
SCALE IN FEET

5 0 5 10
SCALE IN FEET

VHB *Vanasse Hangen Brustlin, Inc.*

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lsitedet	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER — BRIDGE NO. 201/024 — STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

ABUTMENT SITE PLAN DETAILS

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	JAW	11/09	CHECKED	LSG	11/09
	DRAWN	CLC	11/09	CHECKED	SMH	11/09
	QUANTITIES			CHECKED		
	ISSUE DATE					
	REV. DATE					

FEDERAL PROJECT NO. NHS-027-1(37)

BRIDGE SHEET 8 OF 76

FILE NUMBER

SHEET NO.

TOTAL SHEETS

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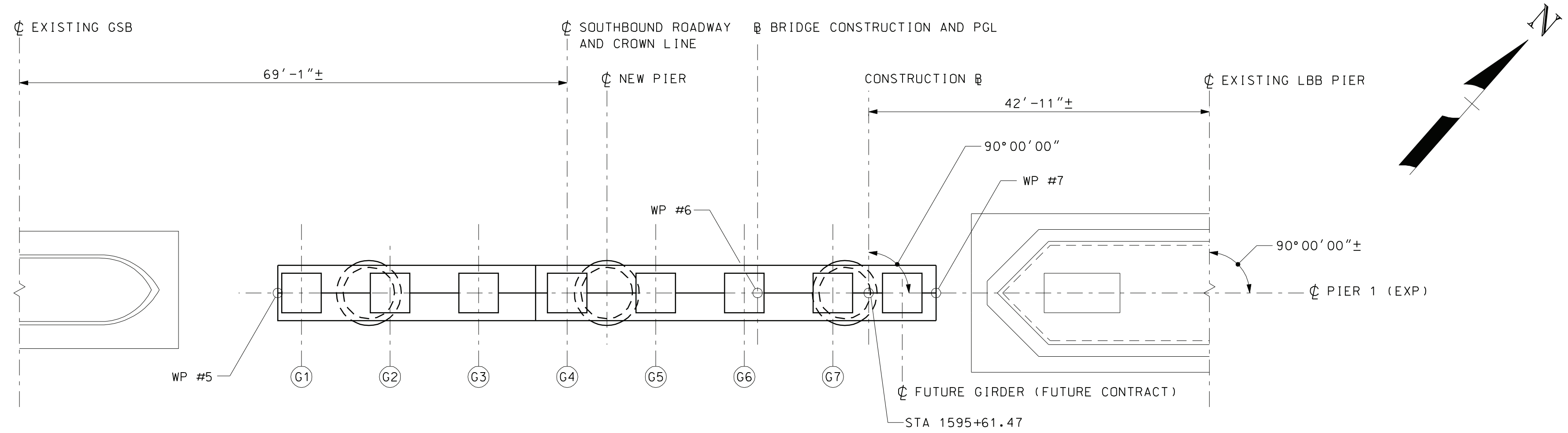
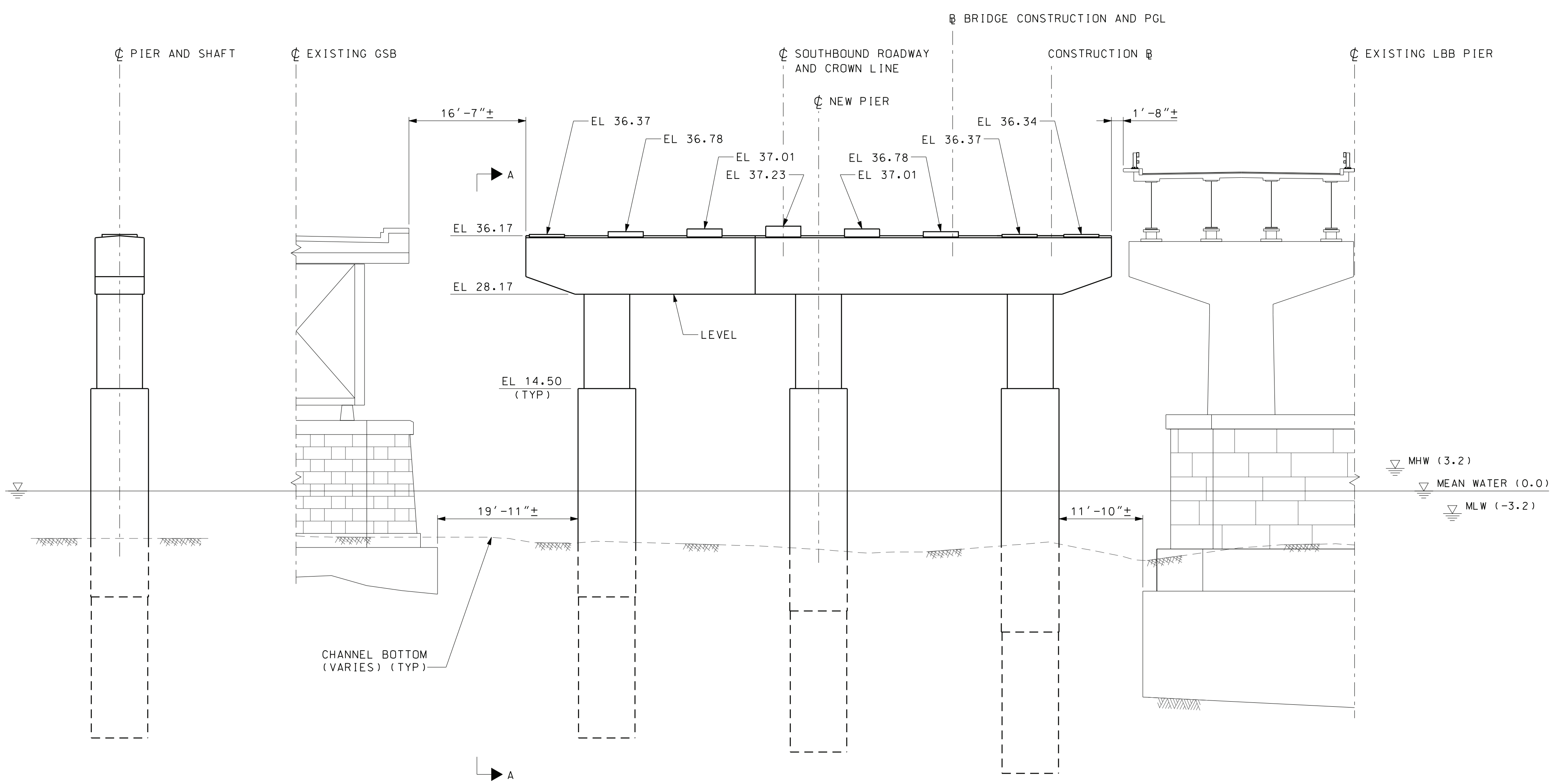
STEEL SUPERSTRUCTURE OPTION



PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"

ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER   BRIDGE NO. 201/024   STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 1 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 32 OF 76

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		

ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE	NHS-027-1(37)		

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

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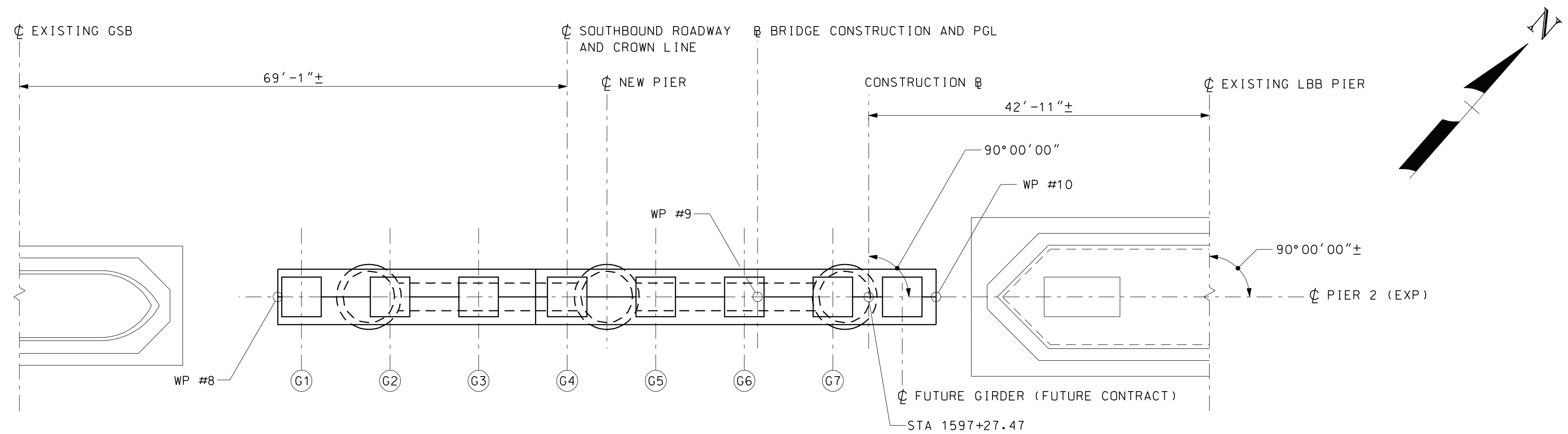
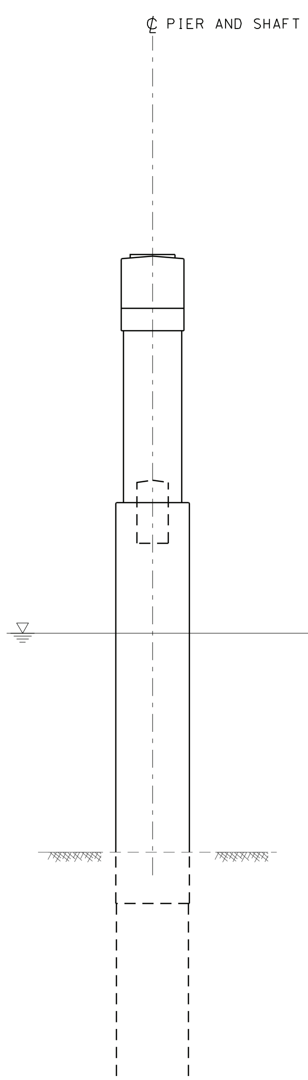
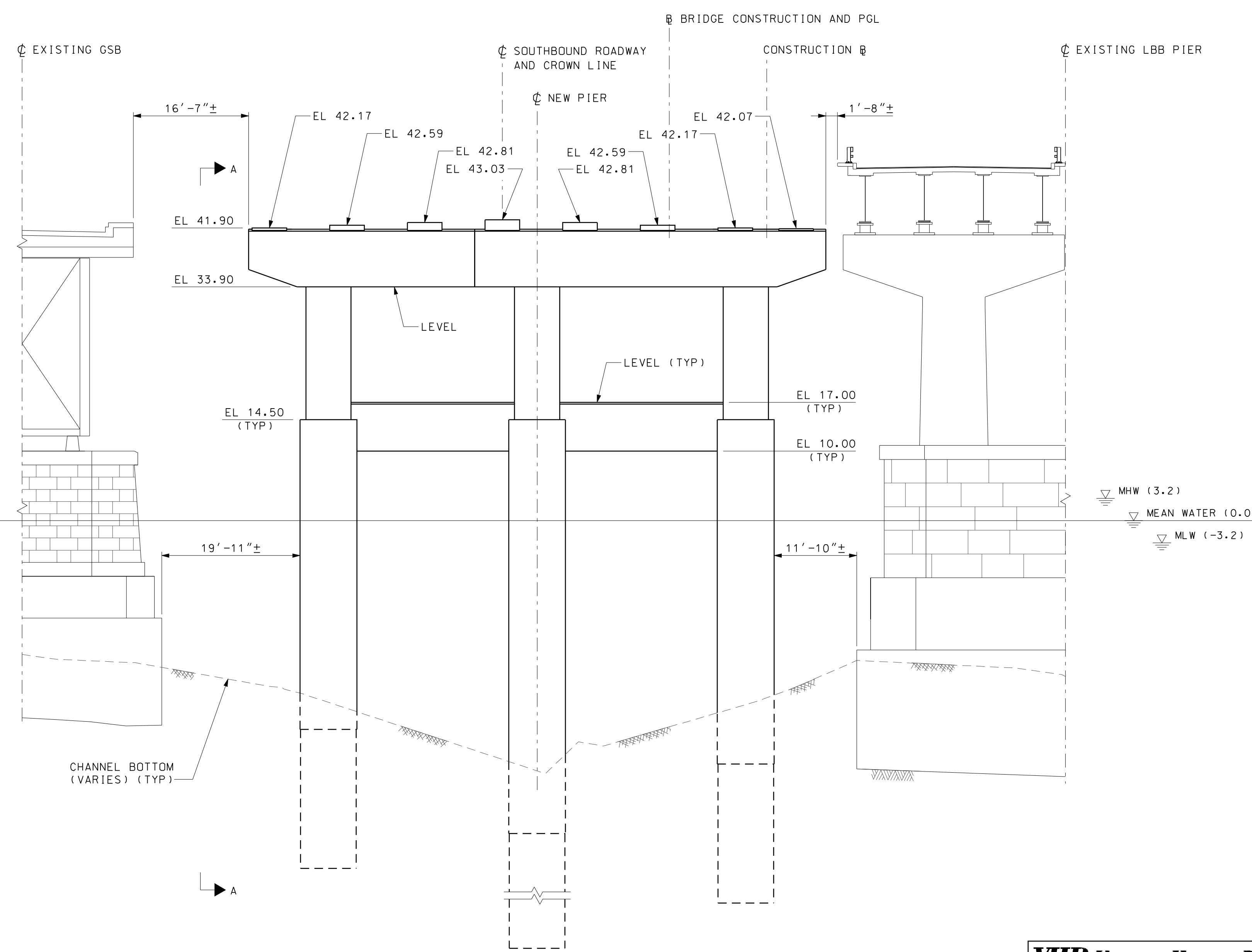


PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"



ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER | BRIDGE NO. 201/024 | STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 2 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 33 OF 76

FILE NUMBER

REVISIONS AFTER PROPOSAL

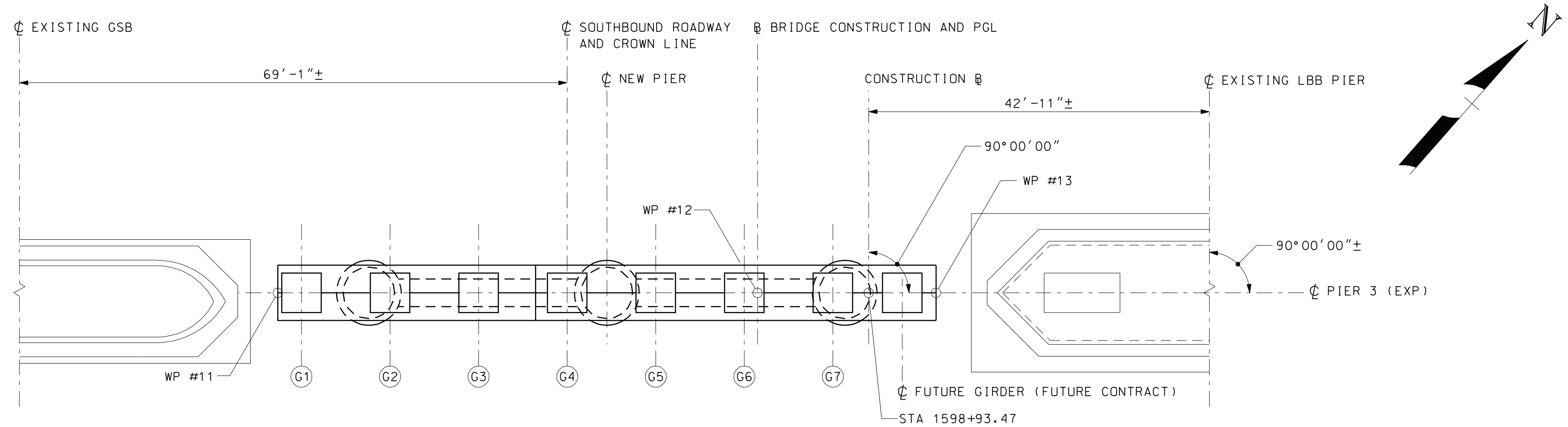
	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		
ISSUE DATE					
REV. DATE					

FEDERAL PROJECT NO. NHS-027-1(37) | SHEET NO. | TOTAL SHEETS

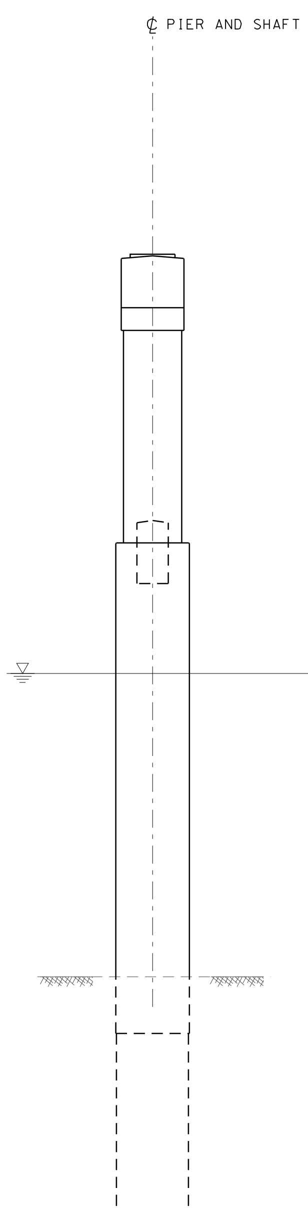
VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

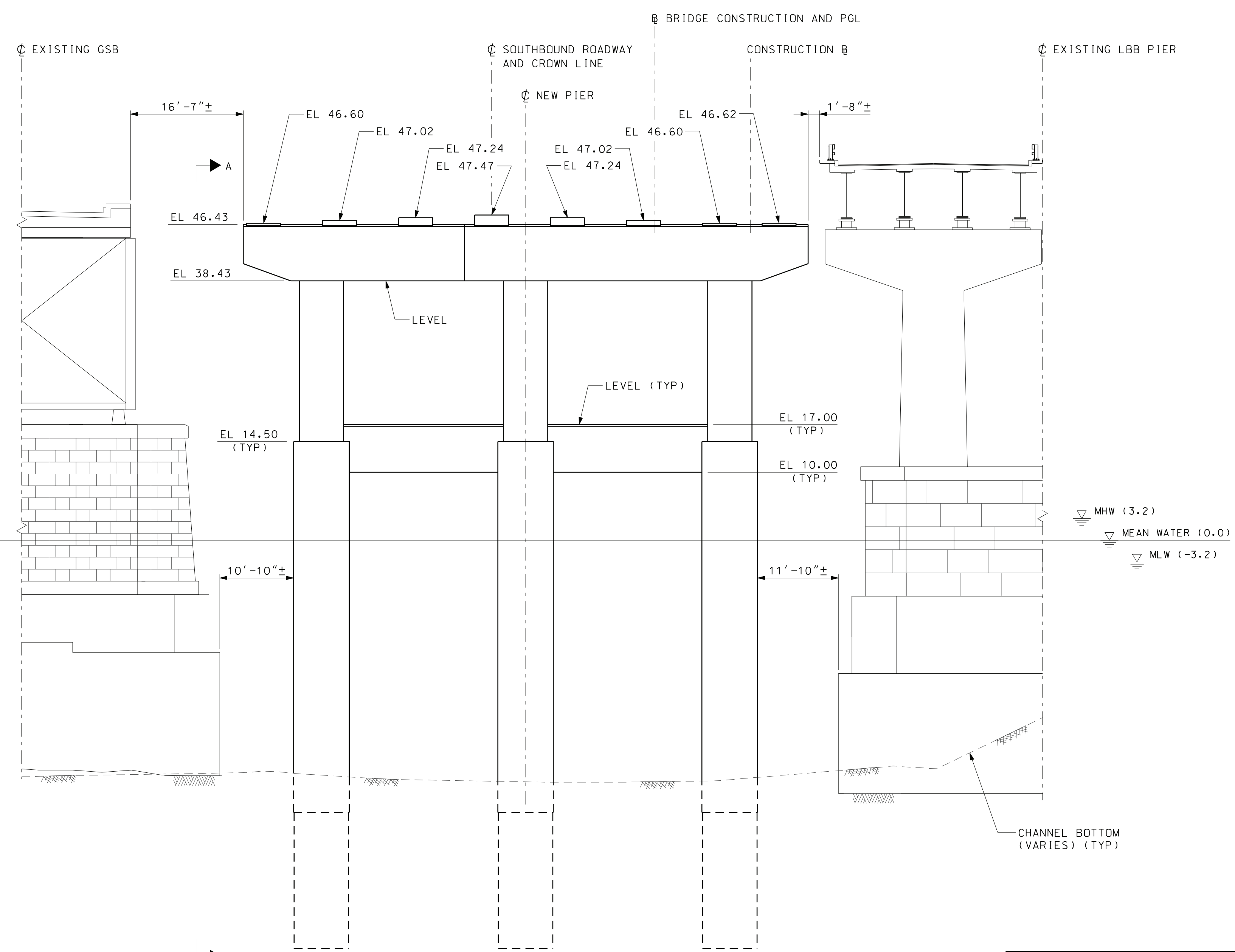
STEEL SUPERSTRUCTURE OPTION



PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"



ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

VHB *Vanasse Hangen Brustlin, Inc.*

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER BRIDGE NO. 201/024 STATE PROJECT 11238L
LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 3 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 34 OF 76
FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		

ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE	NHS-027-1(37)		

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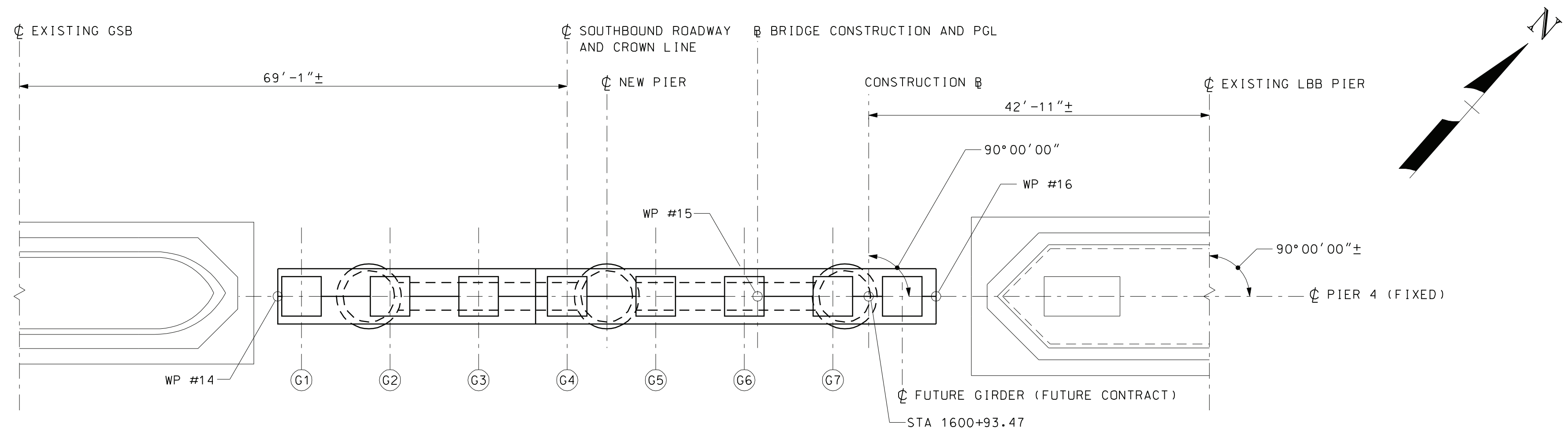
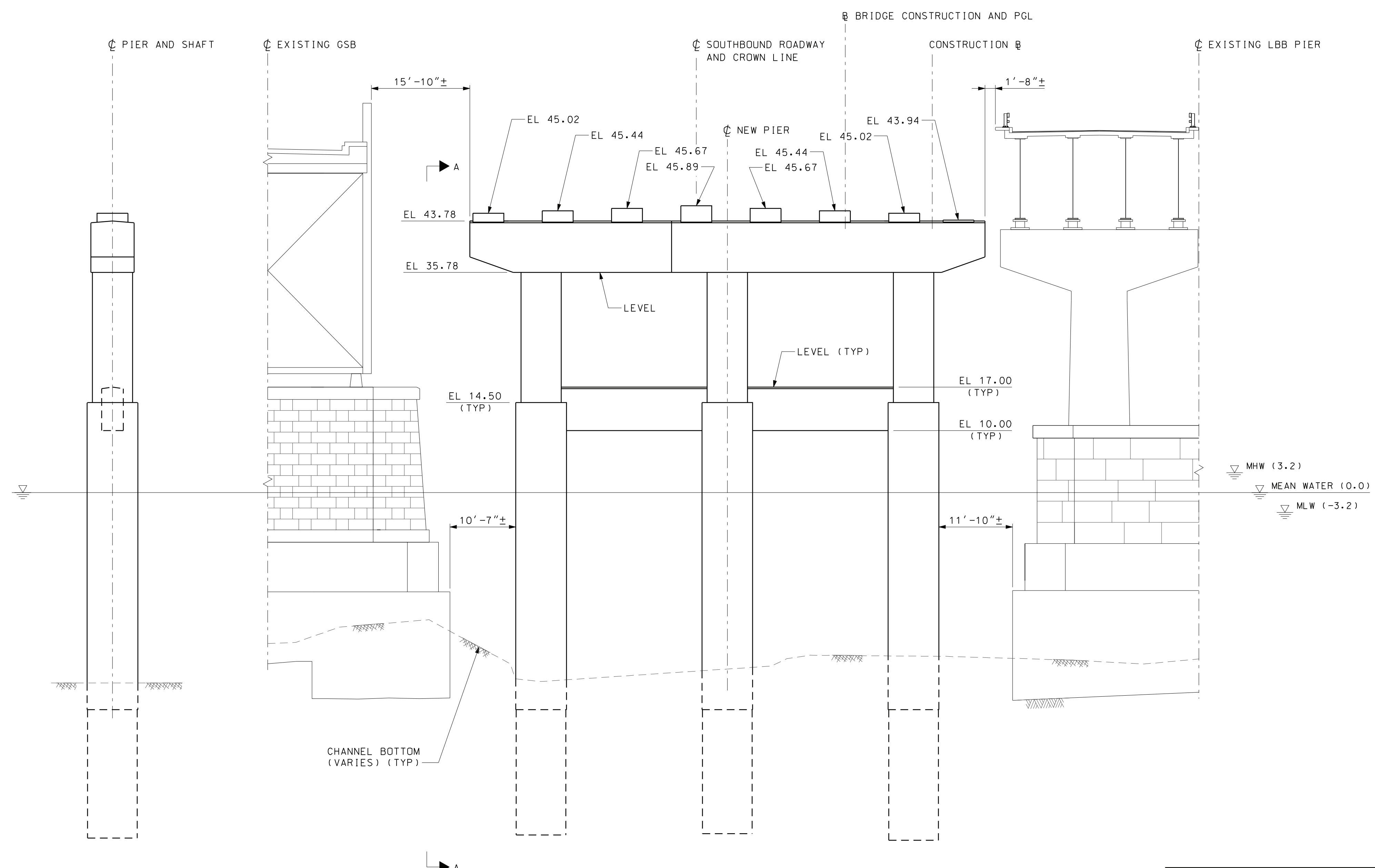
STEEL SUPERSTRUCTURE OPTION



PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"

ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER | BRIDGE NO. 201/024 | STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 4 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 35 OF 76

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		
ISSUE DATE					
REV. DATE					

FEDERAL PROJECT NO. NHS-027-1(37) | SHEET NO. | TOTAL SHEETS

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

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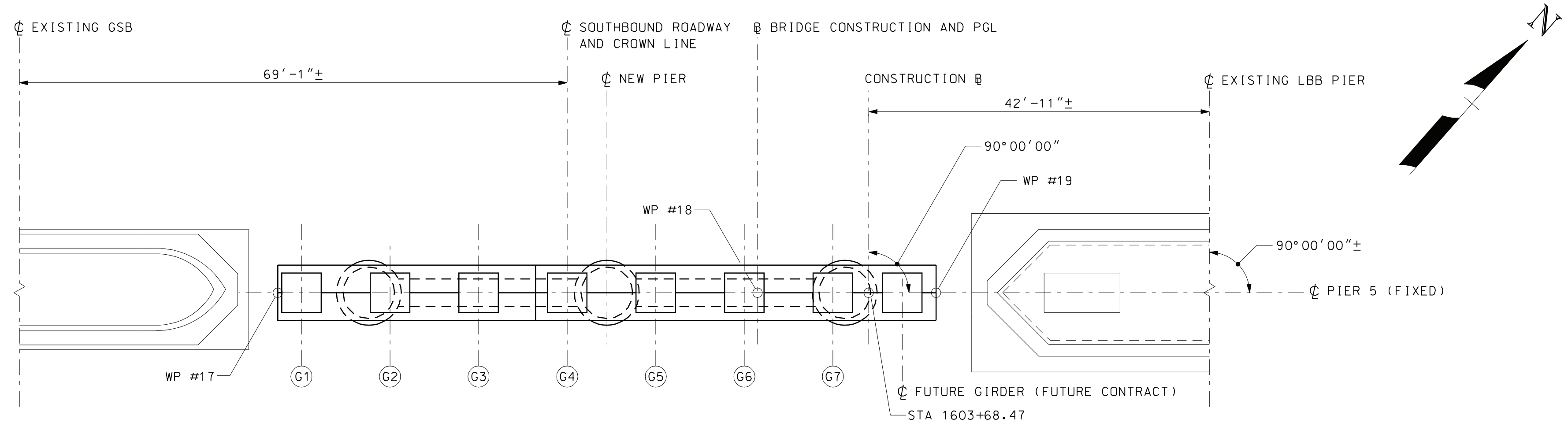
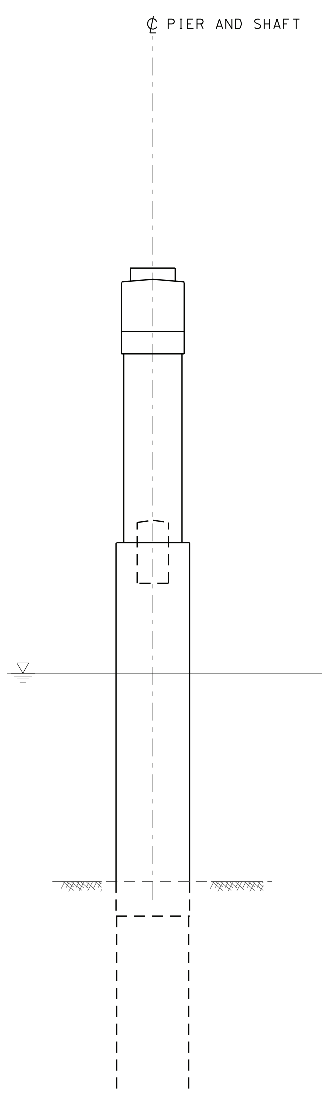
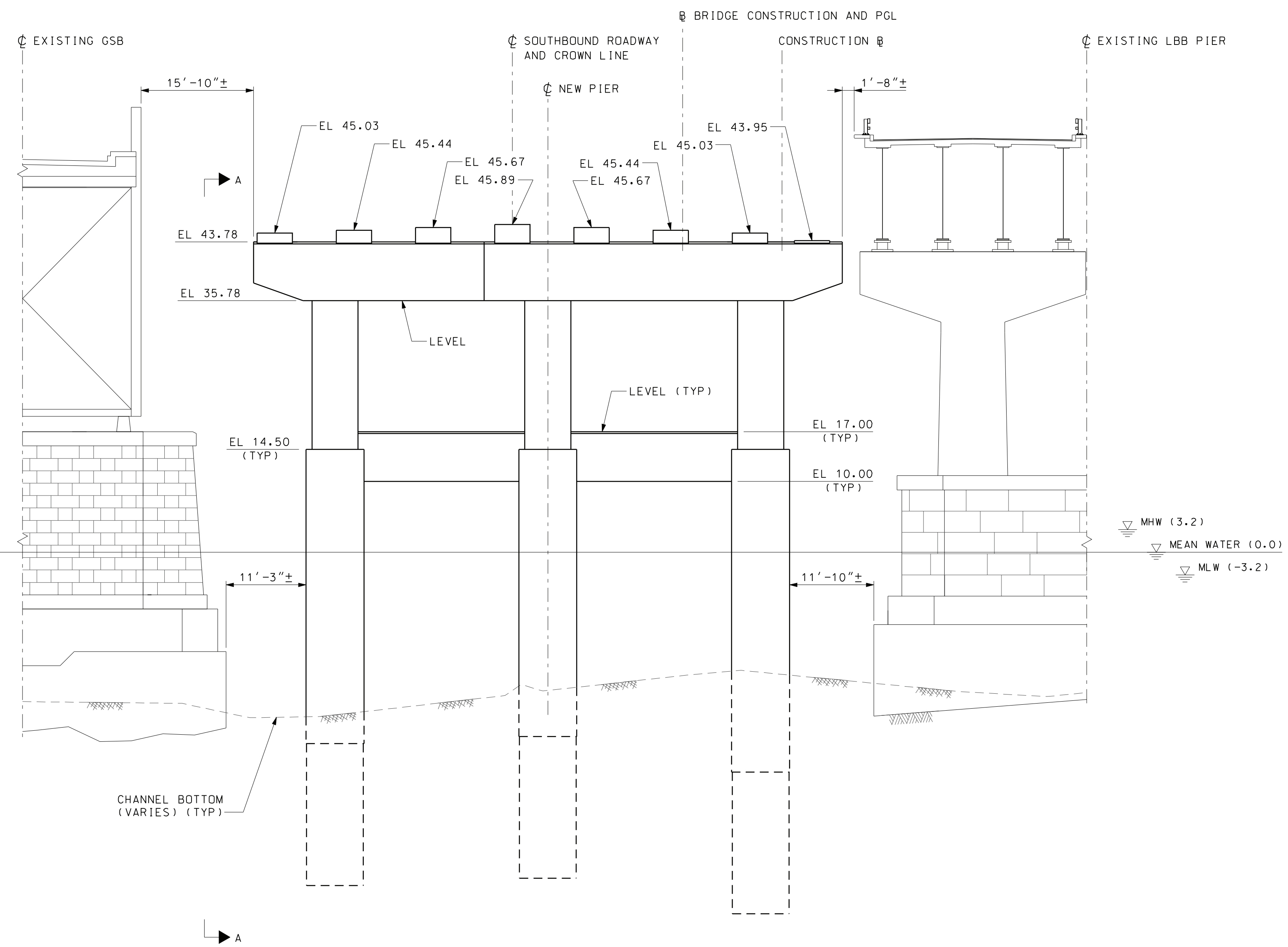
STEEL SUPERSTRUCTURE OPTION



PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"



ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER BRIDGE NO. 201/024 STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 5 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 36 OF 76

REVISIONS AFTER PROPOSAL		BY	DATE		BY	DATE
	DESIGNED	LSG	11/09	CHECKED	JAW	11/09
	DRAWN	CMD	11/09	CHECKED	SMH	11/09
	QUANTITIES			CHECKED		
	ISSUE DATE					
	REV. DATE					

FILE NUMBER

FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
NHS-027-1(37)		

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

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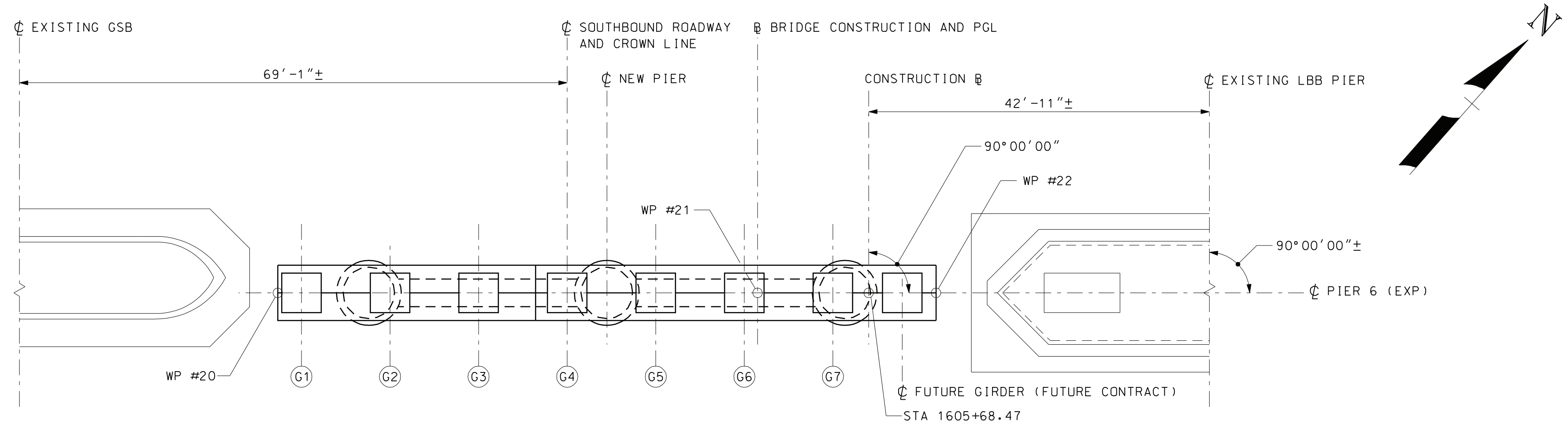
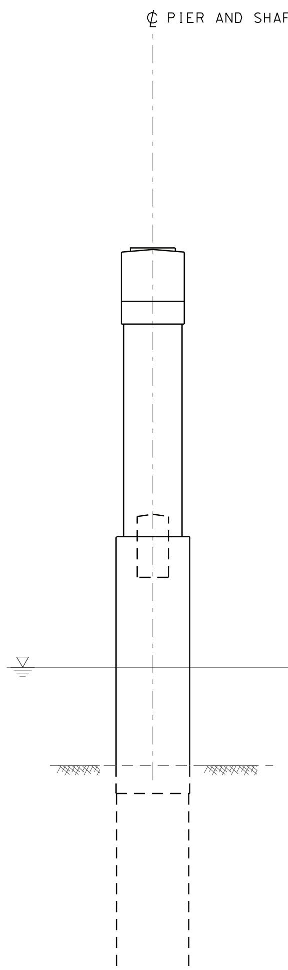
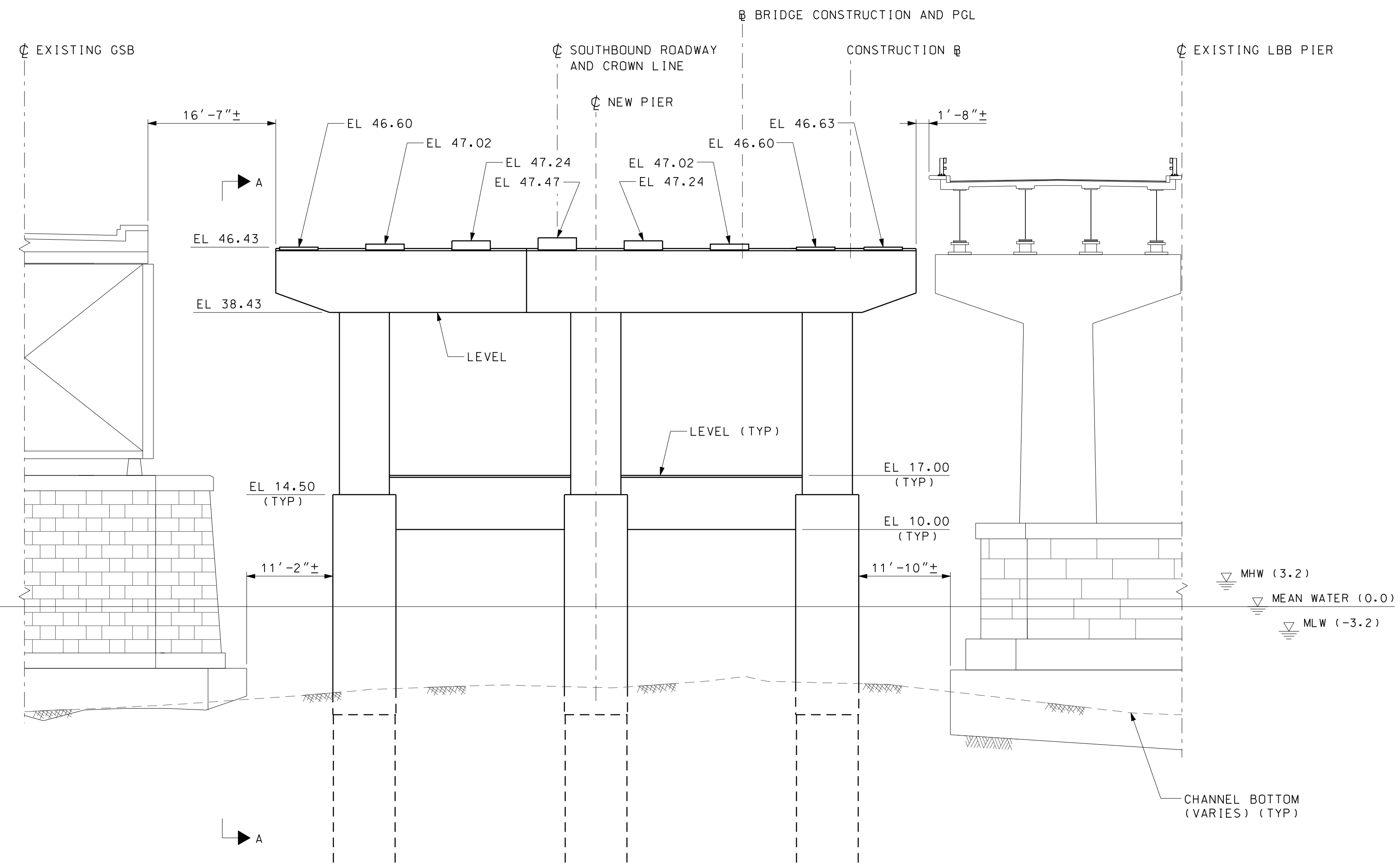
STEEL SUPERSTRUCTURE OPTION



PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"



ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER BRIDGE NO. 201/024 STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 6 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 37 OF 76

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		
ISSUE DATE					
REV. DATE					

FEDERAL PROJECT NO. NHS-027-1(37)

SHEET NO.

TOTAL SHEETS

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

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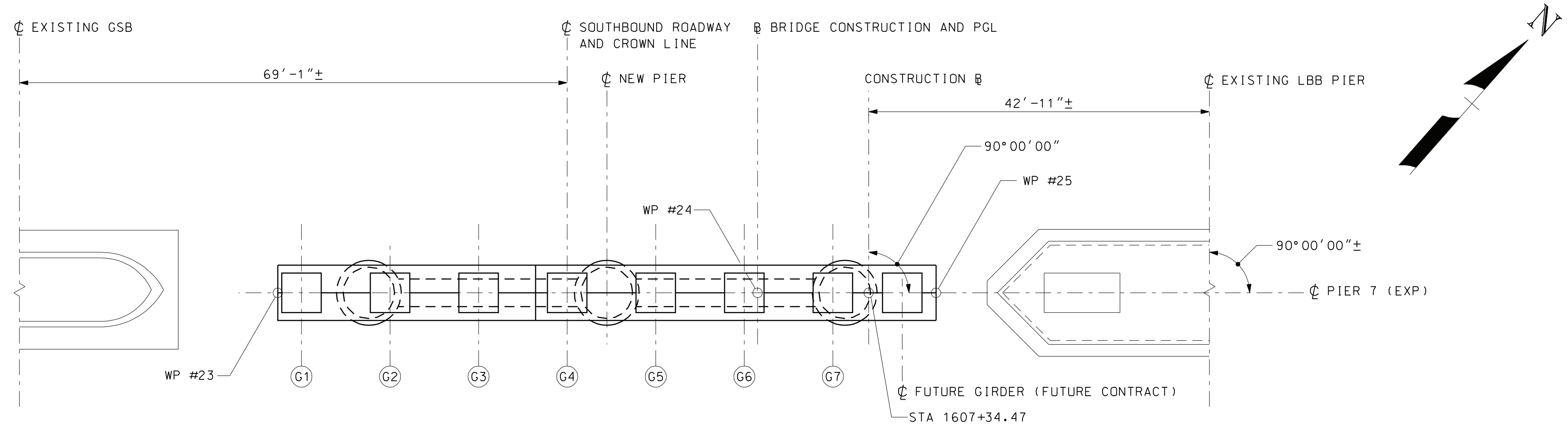
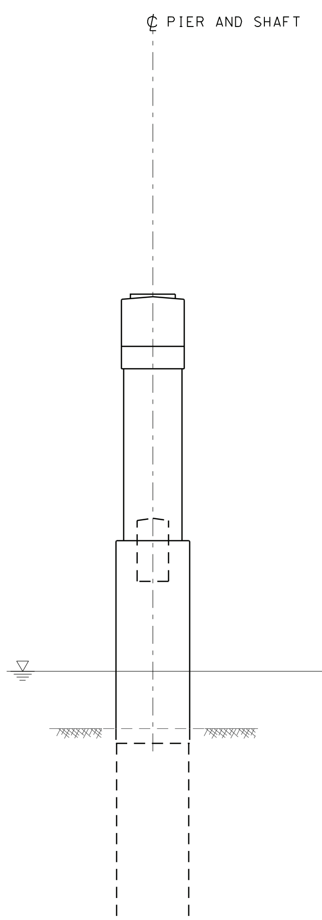
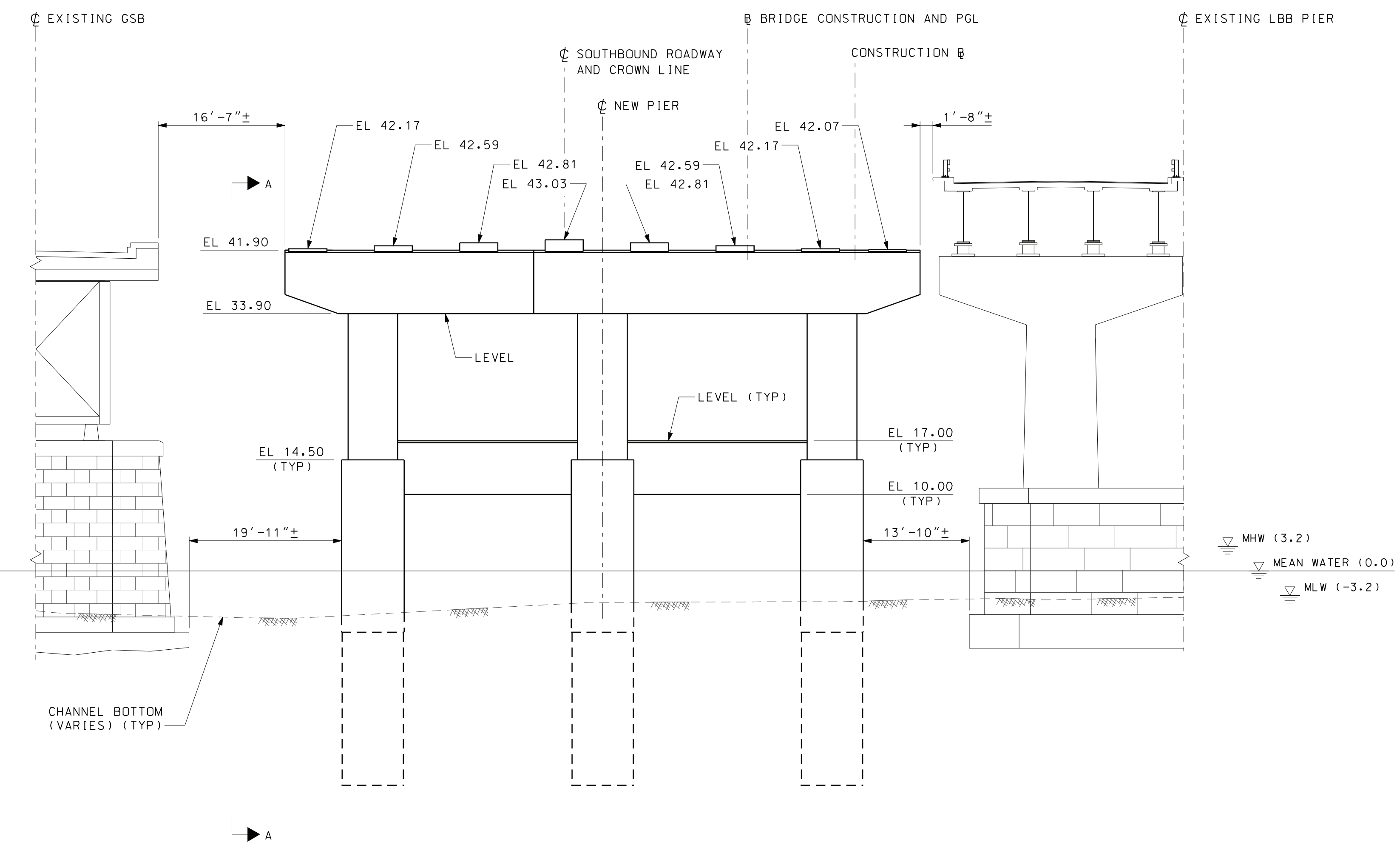
STEEL SUPERSTRUCTURE OPTION



PLAN
SCALE: 3/32" = 1'-0"





VIEW A-A
SCALE: 3/32" = 1'-0"

ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.
2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER | BRIDGE NO. 201/024 | STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 7 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 38 OF 76

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		

ISSUE DATE | REV. DATE | FEDERAL PROJECT NO. NHS-027-1(37) | SHEET NO. | TOTAL SHEETS

VHB *Vanasse Hangen Brustlin, Inc.*

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

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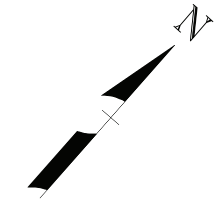
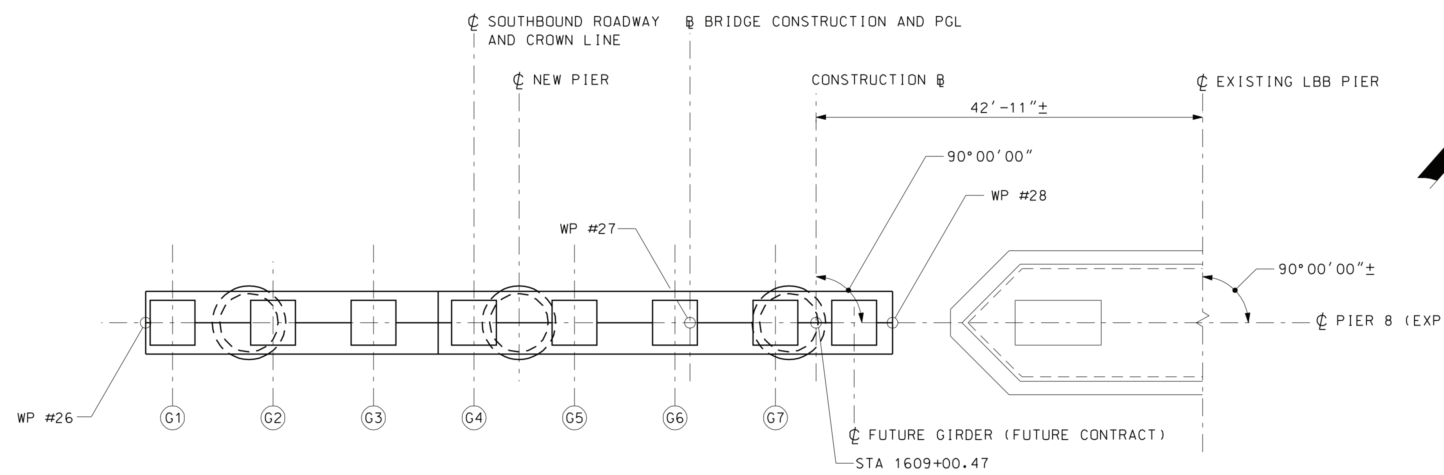
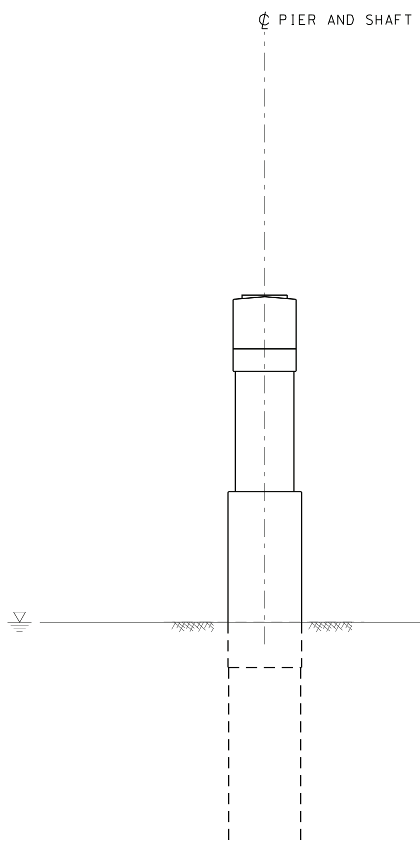
STEEL SUPERSTRUCTURE OPTION

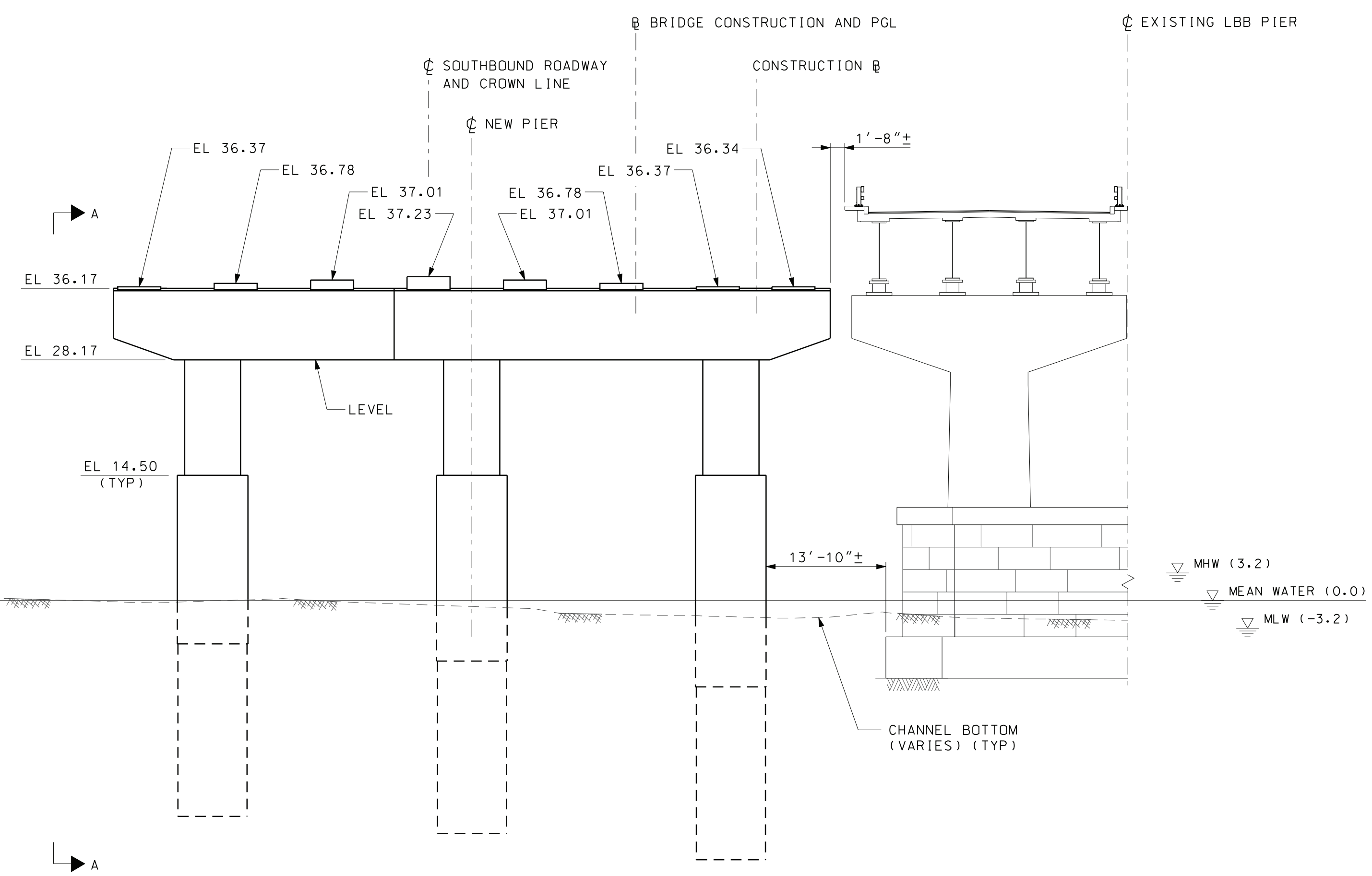




PLAN
SCALE: 3/32" = 1'-0"



VIEW A-A
SCALE: 3/32" = 1'-0"



ELEVATION
SCALE: 3/32" = 1'-0"

NOTES:

1. BEDROCK, MUDLINE, AND EXISTING FOUNDATION CONFIGURATION BASED ON LIMITED INFORMATION FROM EXISTING BRIDGE PLANS AND FROM BORINGS TAKEN BY NHDOT BETWEEN SEPTEMBER AND OCTOBER OF 2008. ACTUAL CONFIGURATION MAY VARY FROM THAT SHOWN.

2. SEE BRIDGE SHEET 40 FOR TYPICAL PIER DIMENSIONS AND DETAILS.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER | BRIDGE NO. 201/024 | STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

PIER 8 MASONRY PLAN AND ELEVATION

BRIDGE SHEET 39 OF 76

FILE NUMBER

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	LSG	11/09	CHECKED	JAW	11/09
DRAWN	CMD	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		

ISSUE DATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
REV. DATE	NHS-027-1(37)		

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det02	AS NOTED

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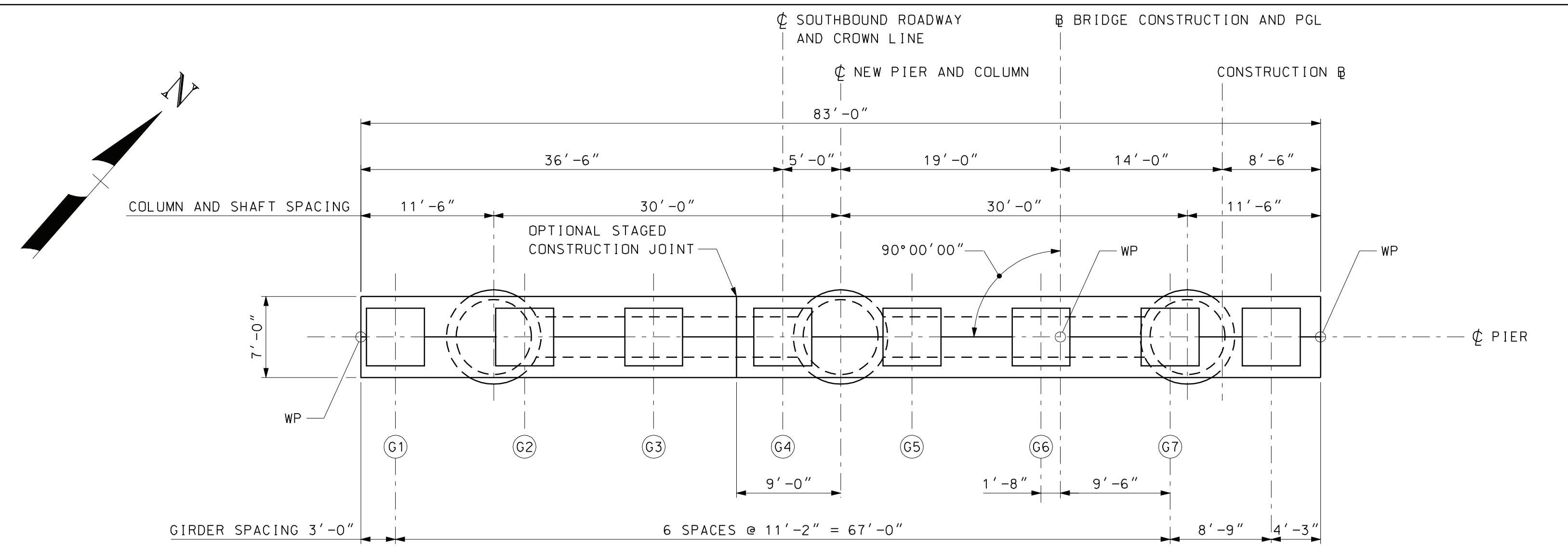
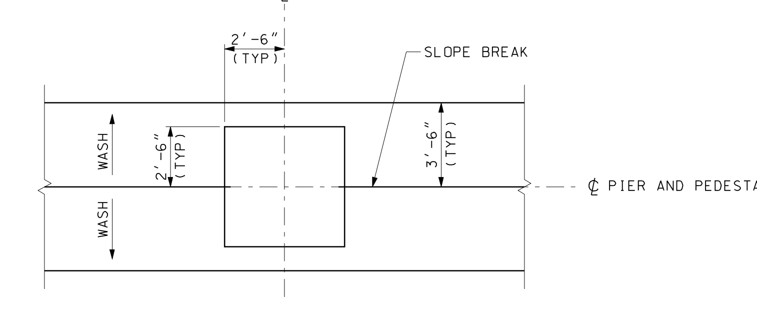
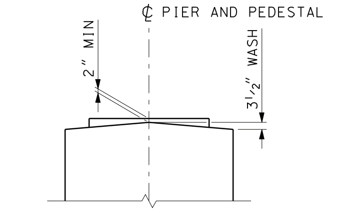
STEEL SUPERSTRUCTURE OPTION



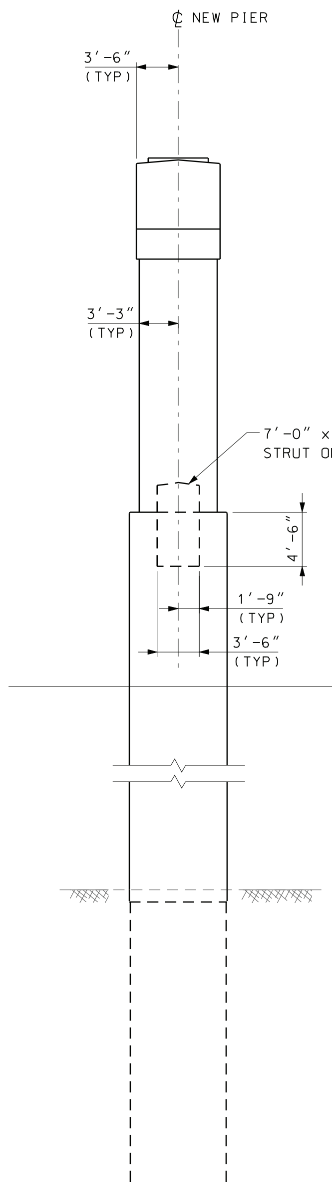
PLAN
SCALE: 1/8" = 1'-0"



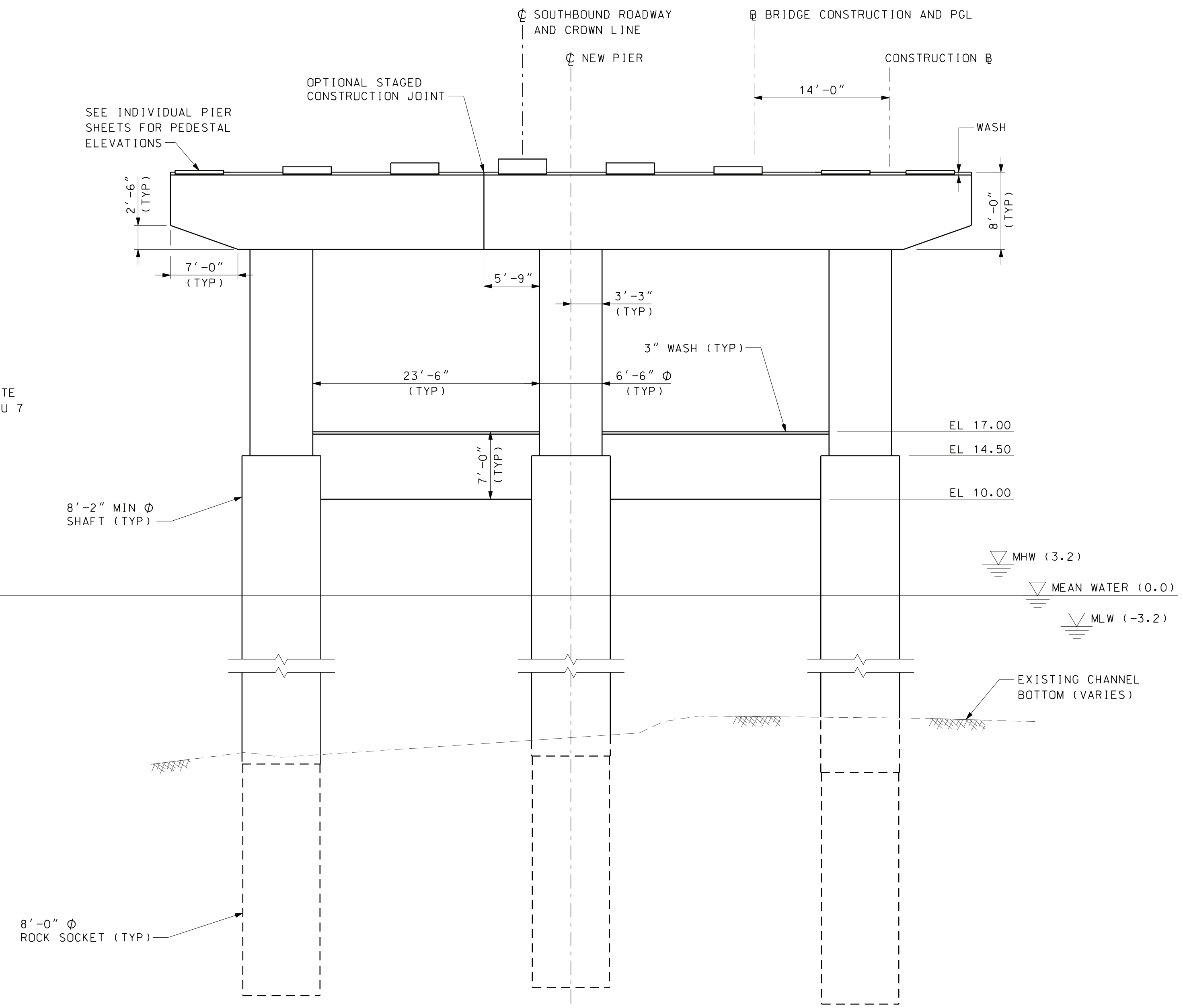
TYPICAL PEDESTAL PLAN
SCALE: 1/4" = 1'-0"



TYPICAL PEDESTAL DETAIL
SCALE: 1/4" = 1'-0"



END VIEW
SCALE: 1/8" = 1'-0"



ELEVATION
SCALE: 1/8" = 1'-0"

PLOT DATE	DRAWING NAME	SHEET SCALE
11/25/2009	11238Lpier_det01	AS NOTED

VHB *Vanasse Hangen Brustlin, Inc.*

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER — BRIDGE NO. 201/024 — STATE PROJECT 11238L

LOCATION SB SPAULDING TURNPIKE, US ROUTE 4, NH ROUTE 16 OVER LITTLE BAY

TYPICAL PIER MASONRY DETAILS

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	MAC/LSG	11/09	CHECKED	SMH/BOM	11/09
DRAWN	KDW	11/09	CHECKED	SMH	11/09
QUANTITIES			CHECKED		
ISSUE DATE					
REV. DATE					

FEDERAL PROJECT NO. NHS-027-1(37)

SHEET NO.

BRIDGE SHEET 40 OF 76

FILE NUMBER

TOTAL SHEETS

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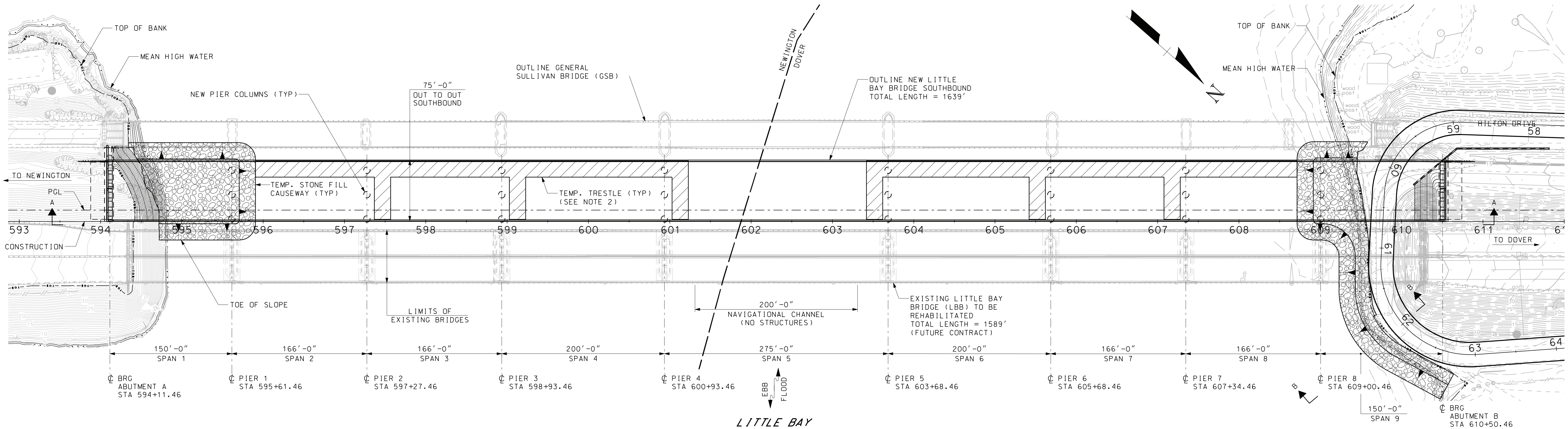
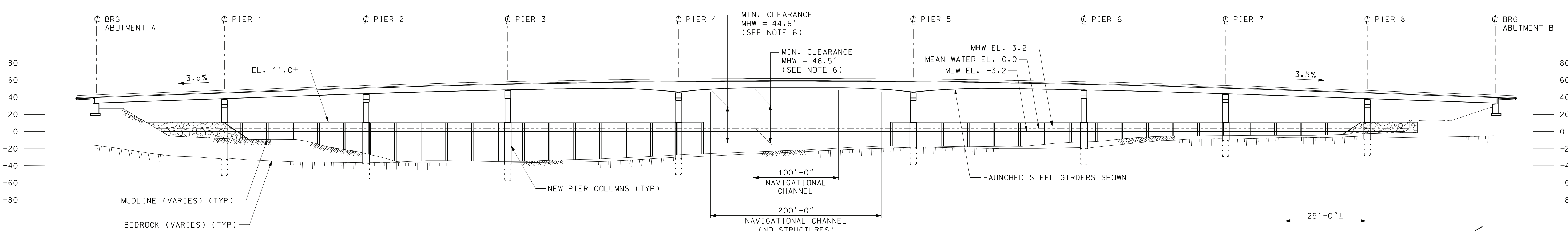
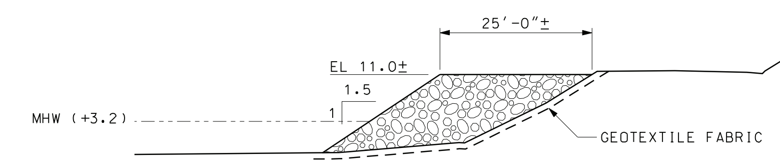
APPENDIX C: PLANS USED FOR THE TEMPORARY CONSTRUCTION CONDITIONS MODEL



GENERAL PLAN



SECTION A-A



SECTION B-B

SCALE: 1/16" = 1'-0"

NOTES:

1. ACCESS OVER LITTLE BAY SHALL BE OPEN STRUCTURES (TEMPORARY TRESTLES OR WORK PLATFORMS), BARGES OR TEMPORARY STONE FILL CAUSEWAY.
2. THE LOCATIONS OF TEMPORARY TRESTLES SHOWN ARE SCHEMATIC ONLY. ACTUAL TRESTLE LOCATIONS WILL BE DETAILED BY THE CONTRACTOR.
3. STONE FILL PLACED ON GEOTEXTILE FABRIC MAY BE USED BETWEEN THE EXISTING SHORES AND PIERS 1 AND 8 AS DETAILED ON THESE PLANS. AREA OF STONE BELOW MHW SHALL NOT EXCEED 30,000 SF.
4. MAINTAIN A MINIMUM 200' WIDE X 44' (ABOVE EL 3.2) CLEAR NAVIGATION CHANNEL THROUGH THE CONSTRUCTION AREA WITHIN THE REACH BETWEEN PIERS 4 AND 5. PROVIDE ALL PROTECTIVE MEASURES AS REQUIRED OR ORDERED TO INSURE THAT THE CHANNEL IS ADEQUATELY PROTECTED FROM FALLING CONSTRUCTION DEBRIS (SUBSIDIARY TO ITEM 500.02).
5. ALL COSTS FOR CONSTRUCTION ACCESS INCLUDING THE DESIGN, CONSTRUCTION, MAINTENANCE AND REMOVAL OF TEMPORARY ACCESS SHALL BE INCLUDED IN ITEM 500.02, ACCESS FOR BRIDGE CONSTRUCTION. SEE SECTION 500 SPECIAL PROVISION FOR ADDITIONAL INFORMATION.
6. PROPOSED VERTICAL NAVIGATIONAL CLEARANCE EQUALS OR EXCEEDS EXISTING.

60 0 60 120
SCALE IN FEET

VERTICAL DATUM NGVD 29

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VHB *Vanasse Hangen Brustlin, Inc.*

PLOT DATE	DRAWING NAME	SHEET SCALE
7/10/2009	11238accessPlan	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER BRIDGE NO. 201/024 AND 201/025 STATE PROJECT 11238

LOCATION US ROUTE 4, NH ROUTE 16 AND SPAULDING TURNPIKE OVER LITTLE BAY

TEMPORARY ACCESS FOR BRIDGE CONSTRUCTION

BRIDGE SHEET 1 OF 3

REVISIONS AFTER PROPOSAL

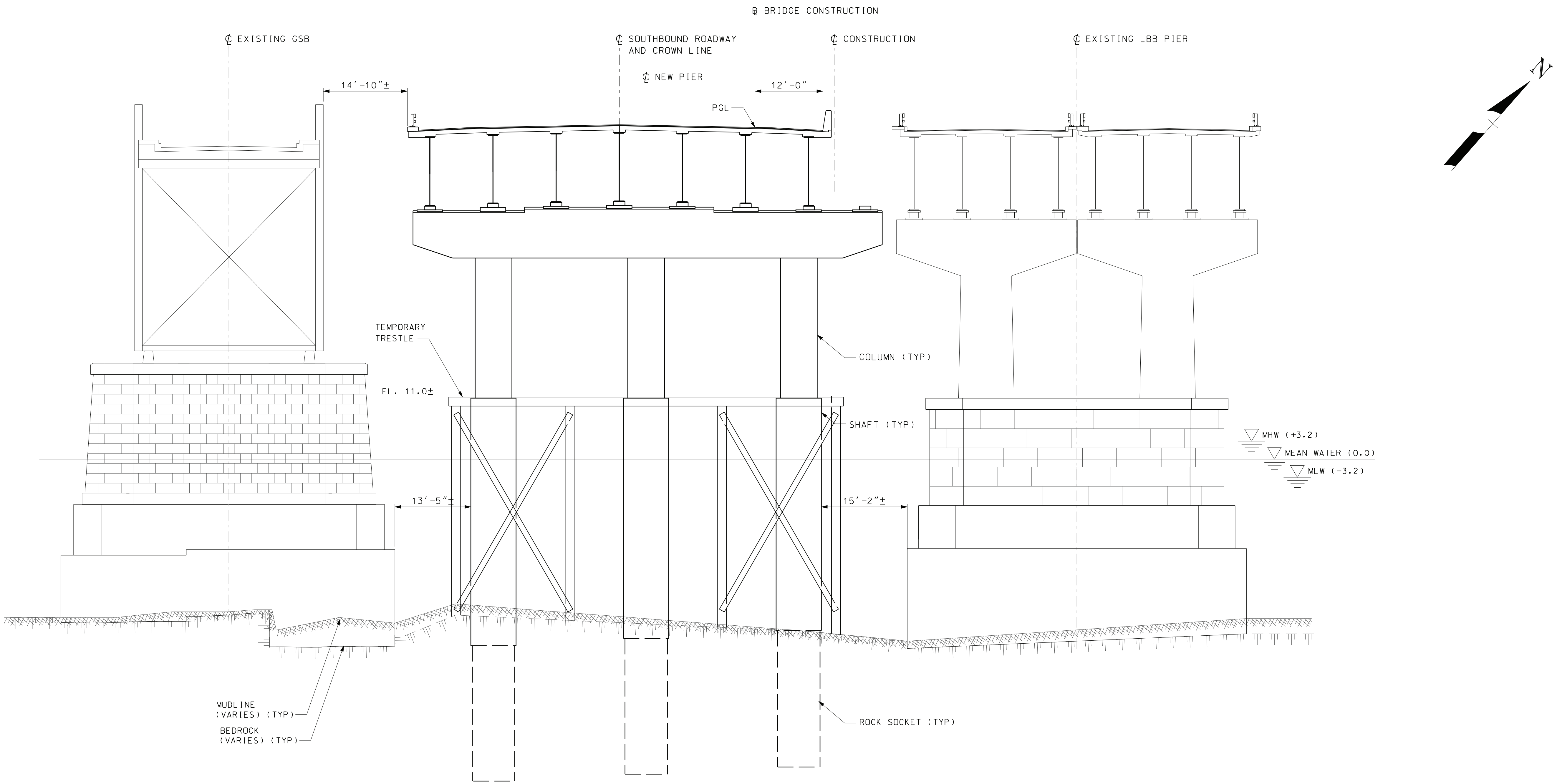
	BY	DATE		BY	DATE
DESIGNED	MJM	7/09	CHECKED	CDB	7/09
DRAWN	CMD	7/09	CHECKED	MJM	7/09
QUANTITIES			CHECKED		
ISSUE DATE					
REV. DATE					

FILE NUMBER

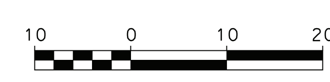
FEDERAL PROJECT NO. NHS-027-1(37)

SHEET NO.

TOTAL SHEETS



ELEVATION



STATE OF NEW HAMPSHIRE	
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN	
TOWN NEWINGTON-DOVER	BRIDGE NO. 201/024 AND 201/025 · STATE PROJECT 11238
LOCATION US ROUTE 4, NH ROUTE 16 AND SPAULDING TURNPIKE OVER LITTLE BAY	
TYPICAL TRESTLE SECTION	BRIDGE SHEET 2 OF 3
REVISIONS AFTER PROPOSAL	FILE NUMBER
DESIGNED MJM 5/09	CHECKED CDB 5/09
DRAWN KDW 5/09	CHECKED MJM 5/09
QUANTITIES	CHECKED
ISSUE DATE	FEDERAL PROJECT NO. NHS-027-1(37) · SHEET NO. · TOTAL SHEETS
REV. DATE	

VHB Vanasse Hangen Brustlin, Inc.

PLOT DATE	DRAWING NAME	SHEET SCALE
7/10/2009	ACCESSPIER	AS NOTED

VERTICAL DATUM NGVD 29

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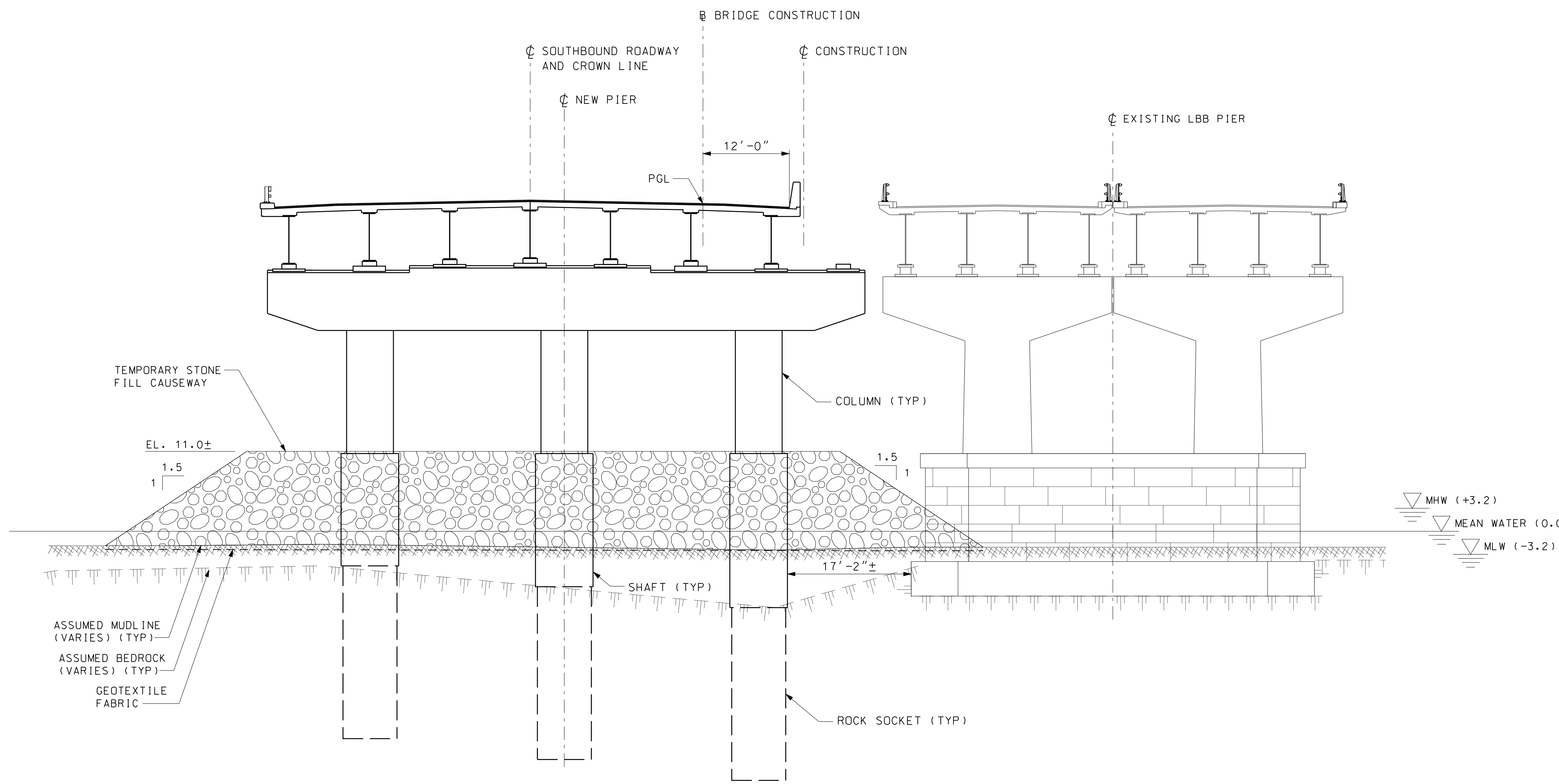

PIER 8 ELEVATION
(LOOKING UPSTATION)

10 0 10 20
SCALE IN FEET

VERTICAL DATUM NGVD 29

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VHB *Vanasse Hangen Brustlin, Inc.*

PLOT DATE	DRAWING NAME	SHEET SCALE
7/10/2009	11238PierSections-Piles	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN NEWINGTON-DOVER BRIDGE NO. 201/024 AND 201/025 STATE PROJECT 11238
LOCATION US ROUTE 4, NH ROUTE 16 AND SPAULDING TURNPIKE OVER LITTLE BAY

TYPICAL CAUSEWAY SECTION

REVISIONS AFTER PROPOSAL

	BY	DATE		BY	DATE
DESIGNED	MJM	5/09	CHECKED	CDB	5/09
DRAWN	KDW	5/09	CHECKED	MJM	5/09
QUANTITIES			CHECKED		

ISSUE DATE
REV. DATE

FEDERAL PROJECT NO. NHS-027-1(37)
SHEET NO.
TOTAL SHEETS
BRIDGE SHEET 3 OF 3
FILE NUMBER