Spinney Mill Road
Hydrodynamic Modeling & Conceptual Design Report

March 2026

SUBMITTED TO
Town of Arrowsic, Maine

PREPARED BY
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1. Introduction

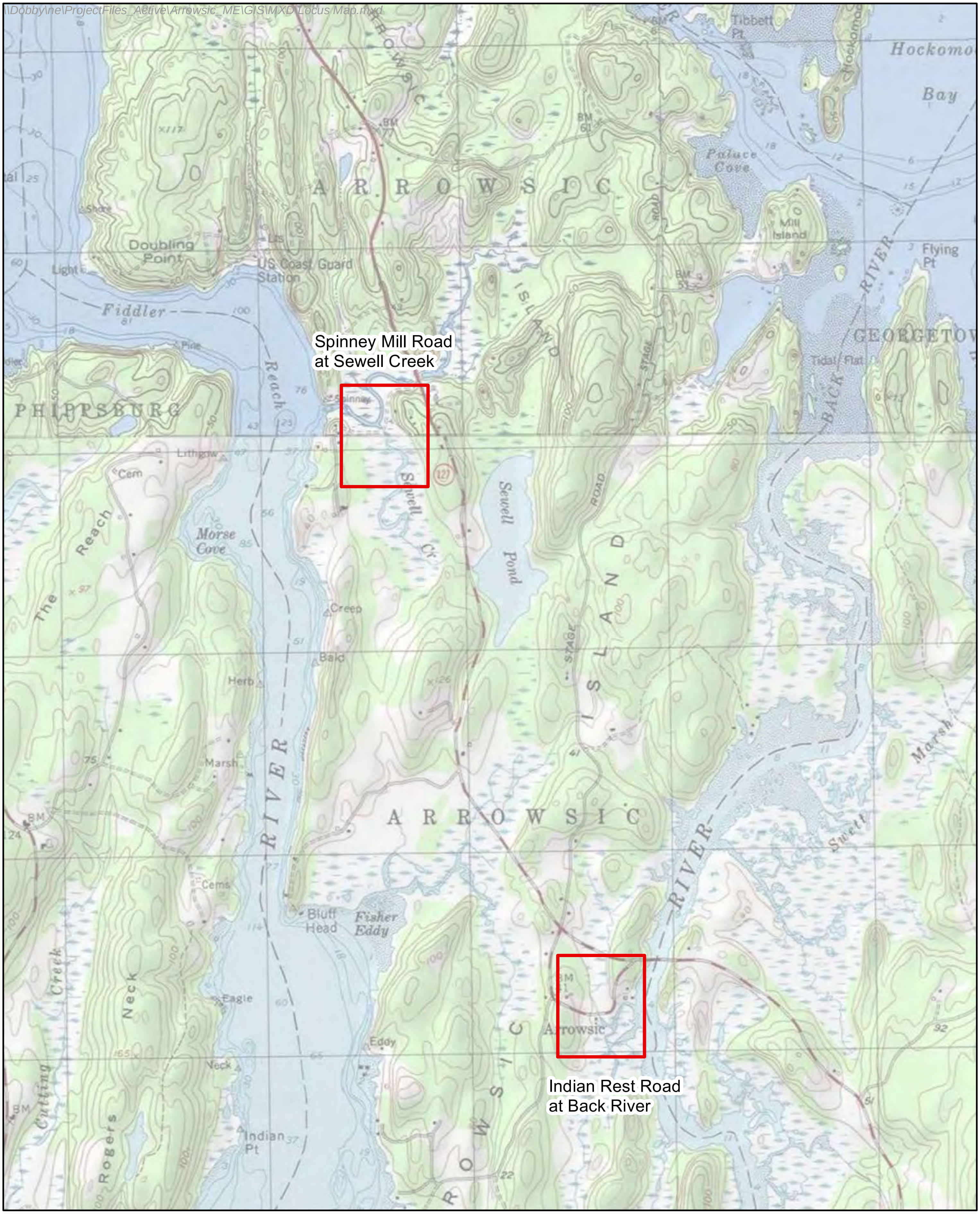
In 2024, Town of Arrowsic (the Town) and the Kennebec Estuary Land Trust (KELT) formed a partnership (the Partnership) and initiated a project to assess habitat resilience in community salt marshes and to produce conceptual designs for two tidal road crossings, one at Spinney Mill Road and Sewall Creek and the other at Indian Rest Road and an unnamed tributary to Back River. The project received funding from the Maine Infrastructure Adaptation Fund (MIAF)[1].

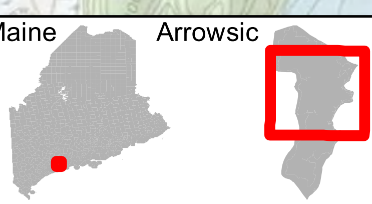
Both the Spinney Mill and the Indian Rest Road tidal crossings are town owned. Refer to Figure 1 for a locus map. Both crossings restrict tidal exchange and are frequently inundated by significant high tides and coastal storms. A separate project deliverable (Inter-Fluve 2026) reports on a companion evaluation of Indian Rest Road. This report summarizes the evaluation of Spinney Mill Road, describing data collection activities; hydrologic, hydraulic, and hydrodynamic modeling activities; and a conceptual design assessment for the Spinney Mill Road tidal crossing at Sewell Creek.

Spinney Mill Road provides the single access to eleven private residences. The existing crossing at Sewell Creek includes a relatively long approach embankment (0.25 miles) that currently overtops during higher spring tides (up to monthly, on average) and during coastal floods. The approach embankment will overtop much more often as sea level continues to rise. Overtopping cuts off access to the residences, making protection and resilience of this roadway a high priority for the Town. Refer to Figure 2 through Figure 6 for photos of the project area.

At the same time, the tidal restriction influences the health of the upstream marsh, and with an increasing degree of impact in the future. At present sea level, the extent of the upstream marsh area is approximately 50 acres. At future sea levels, with marsh migration potential, the marsh extent is anticipated to increase to over 70 acres. This is a notably-sized tidally-restricted marsh among tidal salt marshes in Maine, and is a notable conservation priority for the Town and local residents alike.

[1] This funding supports the current study.





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Feet
1 inch = 2,000 feet

Locus Map
Arrowsic, Maine

4/6/2026

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Figure 2. Photo of Sewell Creek and Spinney Mill Road, looking upstream.

Figure 3. Photo of Sewell Creek and Spinney Mill Road, looking downstream to the Kennebec River (upper left of photo).

Figure 4. Photo of Spinney Mill Road Crossing twin corrugated metal culverts. View of upstream end of culverts at mid tide.

Figure 5. Photo of Spinney Mill Road Crossing twin corrugated metal culverts. View of downstream end of culverts at low tide.

Figure 6. Photo of Spinney Mill road crossing the marsh, looking west.

Figure 7. Photo of Spinney Mill road crossing the marsh, looking east. Note numbers painted on the road to indicated depth over the center of the roadway during road overtopping events.

2. Goal and Objectives

On June 3, 2025, project stakeholders met to discuss the project including site characteristics, opportunities and constraints, and planning horizon. Project stakeholders identified a range of goals and objectives (below), which were discussed in greater detail at three follow-up meetings convened between September 2025 and February, 2026. The goal and objectives guided the technical work completed in the study.

The overarching ***Goal*** for the effort is the following:

- Sustain reliable access to the Spinney Mill peninsula to reduce community vulnerability to sea-level rise and coastal storm surges, mitigate factors leading to increased coastal hazards, and support community safety and well-being, while restoring and sustaining habitat for the native fish and wildlife that contribute to the vitality of the region.

In response to this goal, specific ***Objectives*** include the following:

- Enhance the safety and reliability of community access by reducing maintenance needs and providing road elevation above peak water levels during high tides for the 2100 planning horizon.
- Manage flooding patterns that may change as a result of project actions and avoid or mitigate potential impacts to property.
- Avoid or mitigate potential impacts to domestic infrastructure such as drinking water wells and septic systems.
- Ensure emergency services access evacuation access to the community under all conditions.
- Alleviate tidal restriction by constructing tidally transparent crossing structure(s) in alignment with the Maine Climate Council's "Commit to Manage" recommendation for the 2100 planning horizon. Under this scenario, preliminary considerations for structure sizing are based on the Highest Astronomical Tide (HAsT) plus 3.9 feet.
- Restore tidal wetlands to promote and sustain tidal salt marsh habitat, the coastal food web, and a natural flood buffering ecosystem.
- Prepare tidal wetlands to be resilient to projected sea-level rise, including marsh migration.
- Reduce potential for invasive freshwater plant species increase domination of the marsh by promoting unrestricted tidal flow.
- Capitalize on availability of funding for project implementation to maximum extent.
- Maintain scenic qualities that endear the area to residents and visitors.
- Comply with relevant Town plans, including Climate Action, Zoning, Fisheries, and Conservation/Master Plan.
- Foster public outreach and education regarding coastal resiliency and future planning to respond to rising sea levels and changing climate.

3. Data Collection

3.1 DESKTOP DATA REVIEW

As part of this work, Inter-Fluve reviewed background information provided by the Partnership. Background information included:

- Continuous (tidal) water level elevation, temperature, and salinity data collected in 2023-24 (detailed below) by the U.S. Fish and Wildlife Service Gulf of Maine Coastal Program (USFWS) and KELT
- Selected ground survey elevations in Sewall Creek and on the marsh platform by USFWS and KELT (December 2024). Refer to Section 3.2.1 of this report for a discussion of this data.
- Spinney Mill Road survey elevations by Island Surveys (PDF format only; John Wood, January 2024)
- GIS maps of project site

More specifically, the continuous water level elevation, temperature, and salinity monitoring by USFWS and KELT included:

- Downstream of Spinney Mill Road
  - 10/12/2023 – 11/10/2023 water level (NAVD88), temperature.
  - 4/20/2024 – 5/28/2024 water level (NAVD88), temperature, salinity
- Upstream of Spinney Mill Road monitoring
  - 10/12/2023 – 11/10/2023 water level (NAVD88), temperature
  - 4/20/2024 – 5/28/2024 water level (NAVD88), temperature, salinity
- Downstream of Sewall Pond
  - 4/20/2024 – 5/28/2024 water level (NAVD88), temperature

Additional data obtained from publicly available sources included:

- Flood Insurance Study for Sagadahoc County. 23023CV000A, July 16, 2015
- Flood Insurance Rate Map Panels 23023C 0218F and 0281F, July 16, 2015
- Remote topobathymetric data collected by the NOAA National Geodetic Survey (NGS) in 2022, transformed to units of feet[2]

[2] https://noaa-nos-coastal-lidar-pds.s3.amazonaws.com/dem/NCEI_ninth_Topobathy_2014_8483/MA_NH_ME/ncei19_n44x00_w070x00_2021v1.tif

3.2 SITE VISIT

To support the study, Inter-Fluve coordinated a site visit on June 3, 2025 to familiarize project staff with the project site and with local conditions. During the site visit, Inter-Fluve collected select spot elevations using RTK-DGPS survey equipment. Inter-Fluve used these spot elevations along the roadway to evaluate the quality and applicability of the 2022 NGS topobathymetric data, to provide information for verifying vertical datums and benchmarks, and to support hydraulic modeling work by measuring key elevations in the existing culverts and relevant roadway locations. Refer to Section 3.2.1 of this report for a discussion of this data.

Lastly, Inter-Fluve collected aerial drone photography in autumn 2025 at the site to assist in site interpretation. The photography included oblique images (Figure 2, Figure 3), and an orthophoto[3].

3.2.1 Topobathymetric Data Comparison

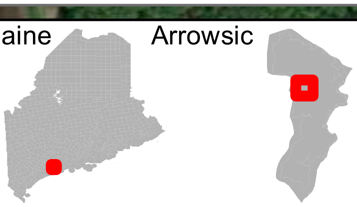
To evaluate the 2022 NGS topobathymetric LiDAR data for use in the study, we compared the data to elevations surveyed along the roadway by Inter-Fluve in 2025 and along the stream and in the marsh by USFWS in 2024. Figure 8 illustrates the comparison between the LiDAR data and the field survey. The comparison indicates that the surveyed road elevation data and a substantial portion of the marsh elevation data are consistent between the datasets. The most common comparison differences range from the LiDAR being 0.5 feet higher to 0.2 feet lower than the surveyed ground elevations. Differences can be explained by common limitations of the data collection methods.

In some locations on the marsh, the survey data indicates that the LiDAR data overestimates the elevation of the marsh surface. This is due to the difficulty in obtaining accurate LiDAR data in areas with dense vegetation. In some locations adjacent to the steep channel banks and road embankment, the comparison reveals largeer differences in elevation. In these areas, a small inconsistency in horizontal location can cause a larger difference in the elevation measurements, but do not impact analyses due to the localized nature.

Overall, the LiDAR data was found to provide a reasonable representation of the site terrain, including in key locations along the roadway. The data was accepted for use in the project analyses, without further post-processing or elevation adjustments.

[3] Orthophoto viewable at: [Spinney Mill Road Orthophoto]

On this figure, a positive value (RED) means that the field survey indicates that the ground is higher than the LiDAR dataset.
A negative value (BLUE) means that the field survey indicates that the ground is lower than the LiDAR dataset.



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0 250 500
Feet
1 inch = 367 feet

Field Survey vs LiDAR
Elevation Comparison
Spinney Mill Road
Arrowsic, Maine

3/26/2026

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3.3 GEOTECHNICAL EXPLORATION

As part of this project, Inter-Fluve coordinated a geotechnical exploration, conducted by Summit Geoengineering Services, Inc. (SGS) on June 3, 2025. The geotechnical exploration was conducted on the same day as the site visit (June 3, 2025). Refer to Appendix A for the exploration report which includes greater detail than summarized below.

During the exploration, SGS drilled three (3) borings and evaluated the material collected in those borings. From the subsurface exploration, the soil at this site generally consists of the following:

- Pavement - 3.5 to 5.5 inches thick
- Fill - 6.5 to 14.7 feet thick
- Saltmarsh Wetland - 9 to 29 feet thick
- Probable Glacial Marine Clay - 5 to 23 feet thick
- Probable Marine Sand - 11.5 to greater than 45.5 feet thick
- Probable Glacial Till - 2 feet thick
- Bedrock – 67.5 to greater than 74.5 feet below the ground surface.

Generally, the exploration confirmed expectations in terms of soil quality. Due to the notable organic/wetland and clay soils, foundation requirements for potential crossing or roadway construction alternatives will need to be carefully considered.

4. Tidal Hydrology

Inter-Fluve evaluated the tidal hydrology at the subject crossing using data observations specific to the project site. Inter-Fluve also processed the site-specific data to estimate tidal benchmark elevations and to develop synthetic tidal time series for typical tidal events and for a 10-year coastal storm surge event. This section of the report describes the data and analyses used to inform the hydrodynamic modeling effort described in Section 5.

In 2023 and 2024, USFWS and KELT installed several water level loggers to record tidal fluctuations along Sewell Creek both upstream and downstream of the project site (see Section 3.1 for a summary). Figure 9 illustrates the installation locations of loggers whose data were utilized in this study. Figure 10 presents the deployment dates for each of the loggers, and Figure 11 through Figure 15 present the recorded data.

From this data, a subset was selected to use in calibration of the hydrodynamic model (Figure 11 through Figure 16). The calibration period was selected during a timeframe when the water level data was available for the three locations simultaneously. The selected period is close to but slightly after the peak spring tide. This choice was made because the precipitation record indicates that no precipitation occurred during the period, enabling isolation of tidal flow from a potentially confounding rainfall runoff event.

Simultaneous data collected at the three gages during the selected calibration period is shown in Figure 16. The difference between the recorded water surface elevations upstream and downstream of Spinney Mill Road illustrate how the Spinney Mill Road crossing restricts the tide at present sea-level, affecting the tidal inundation depth and duration for Sewall Creek and the adjacent salt marsh.

The crossing reduces the peak tidal elevation and changes the timing and duration of inundation in the salt marsh. The restriction decreases the duration at higher tide levels and increases the duration at mid to lower tide levels. These patterns are expected to become more pronounced with increased future sea-level. The gage downstream of the Sewall Pond Dam indicates flat water surface elevation during low tide interval, this may be due to a residual pool at the gage or due to the water level dropping below the elevation of the gauge (i.e., a gauge out of water).

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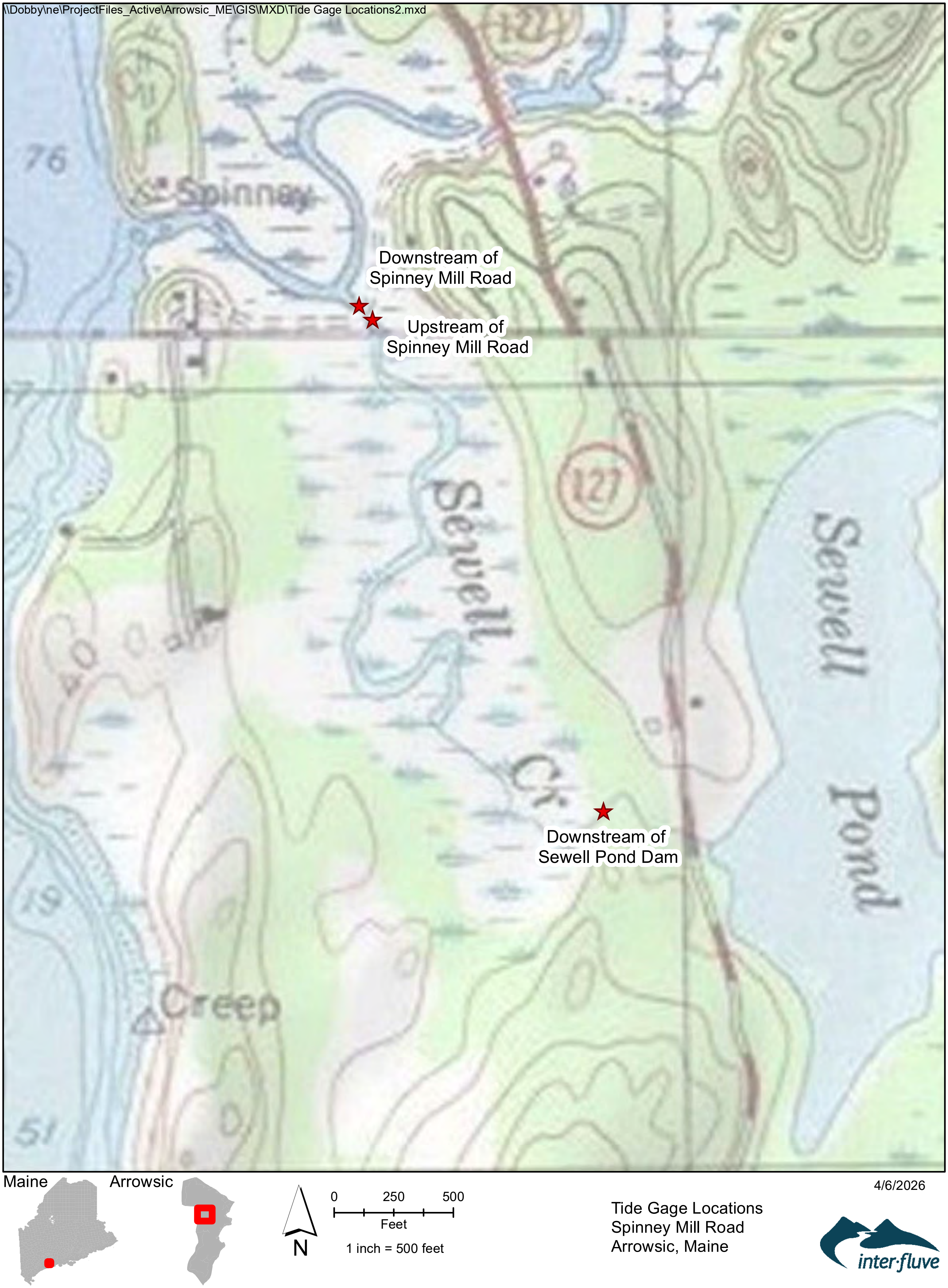

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Tide Gage Locations
Spinney Mill Road
Arrowsic, Maine

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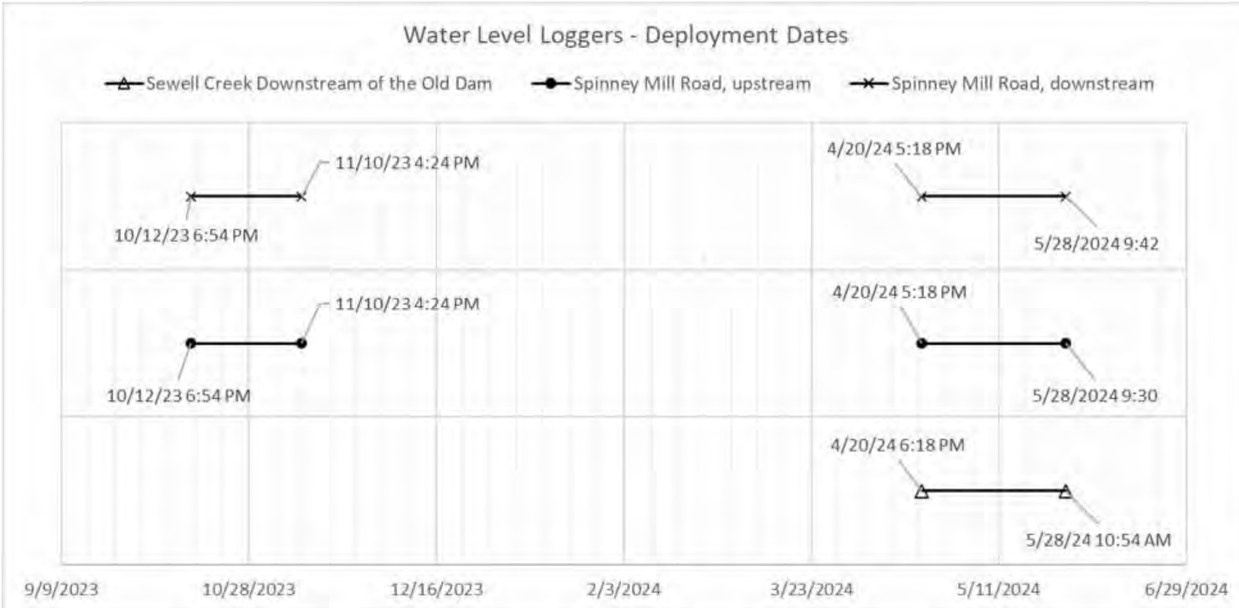


Figure 10. Water Level Logger Deployment Dates

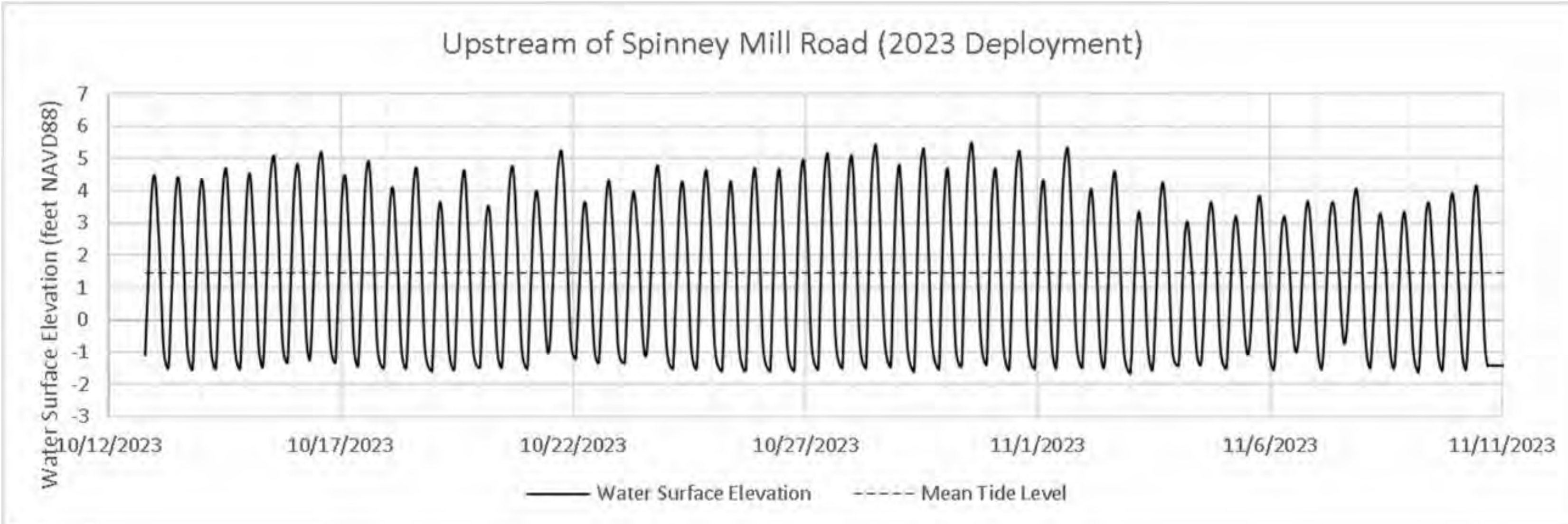


Figure 11. Tidal Gage Time Series. Upstream of Spinney Mill Road, 2023 Deployment.

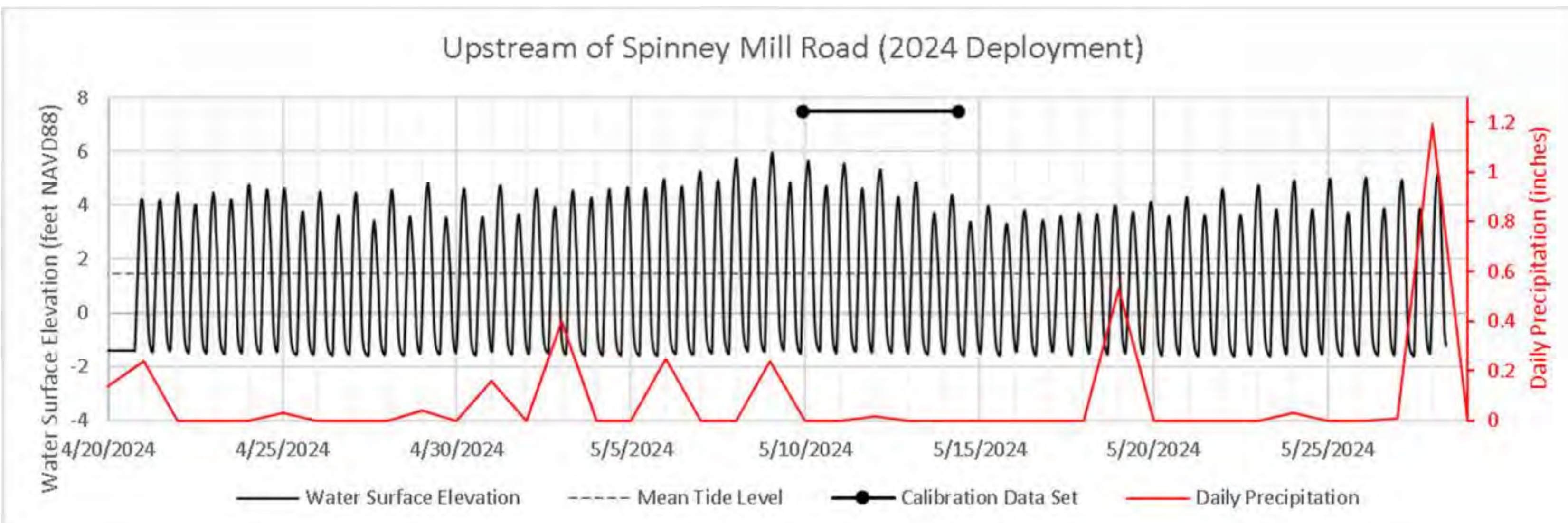


Figure 12. Tidal Gage Time Series. Upstream of Spinney Mill Road, 2024 Deployment.

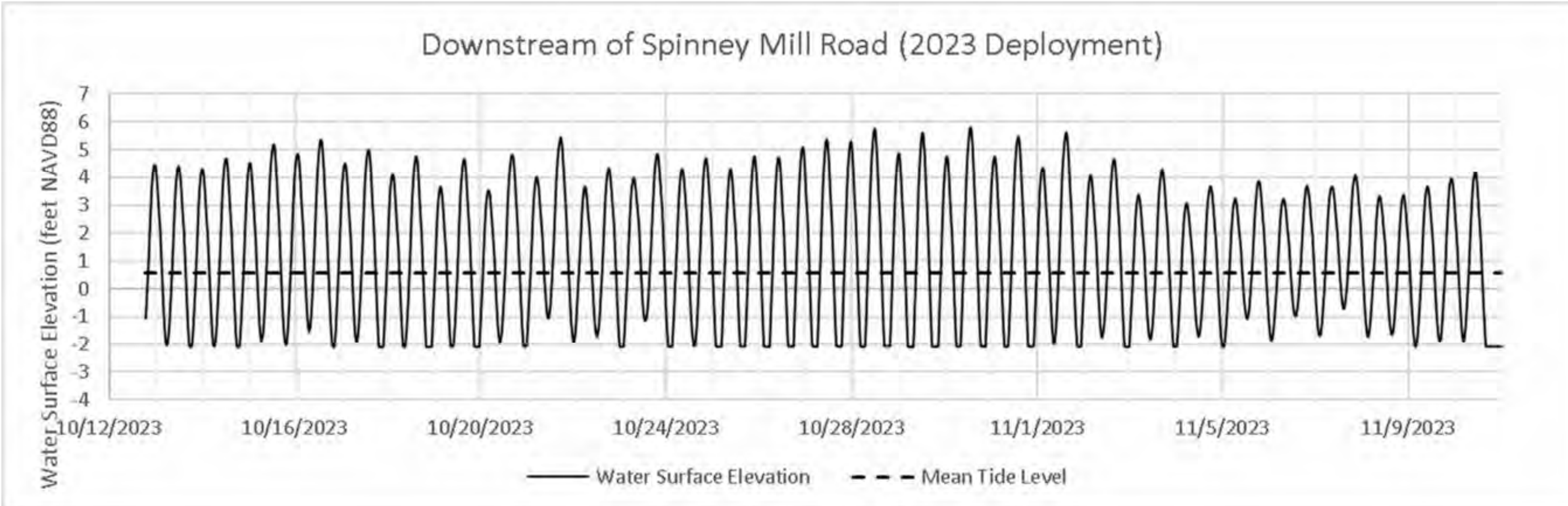


Figure 13. Tidal Gage Time Series. Downstream of Spinney Mill Road, 2023 Deployment.

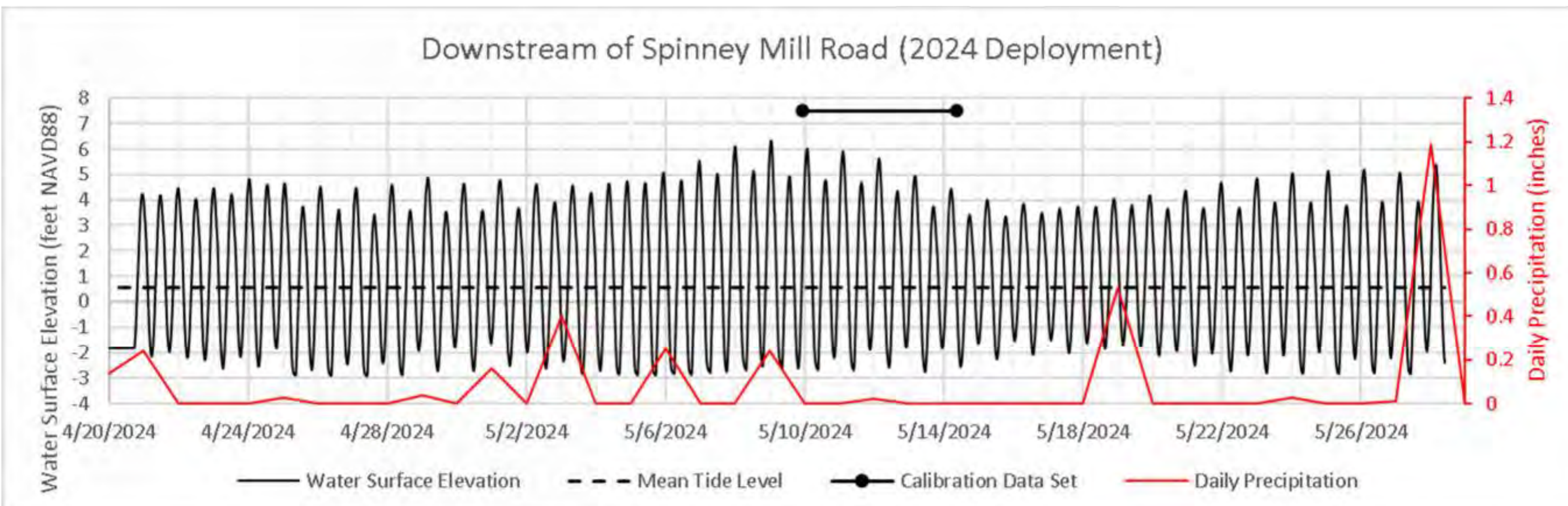


Figure 14. Tidal Gage Time Series. Downstream of Spinney Mill Road, 2024 Deployment.

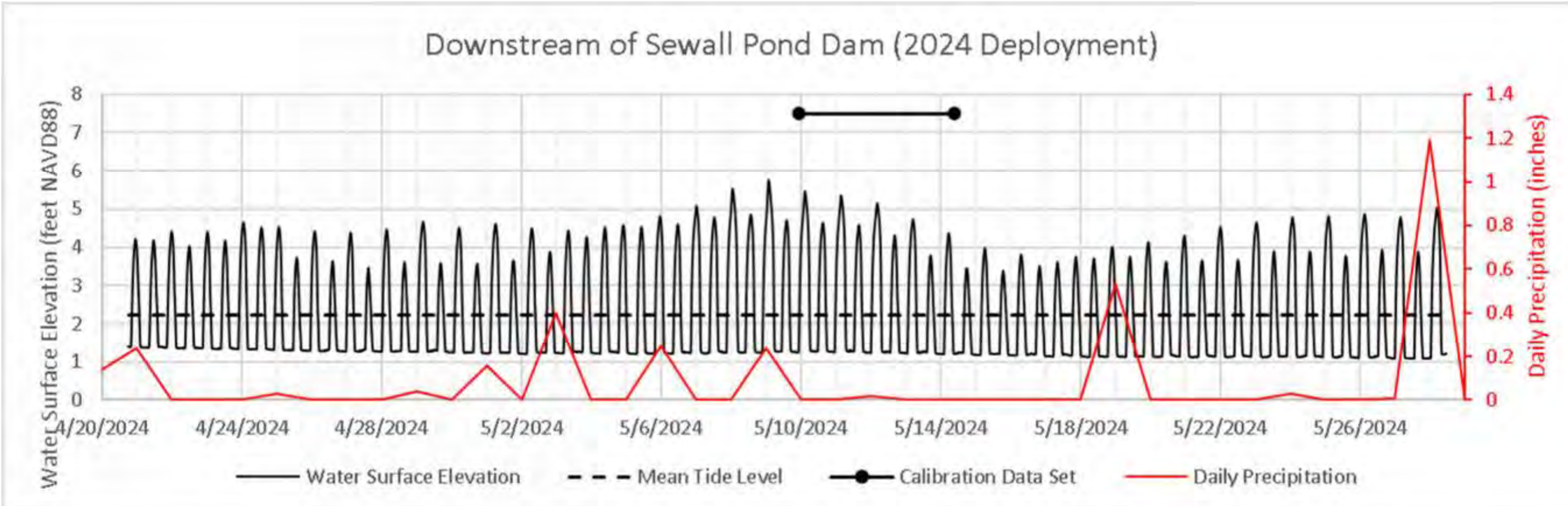


Figure 15. Tidal Gage Time Series. Downstream of Spinney Mill Road, 2024 Deployment.

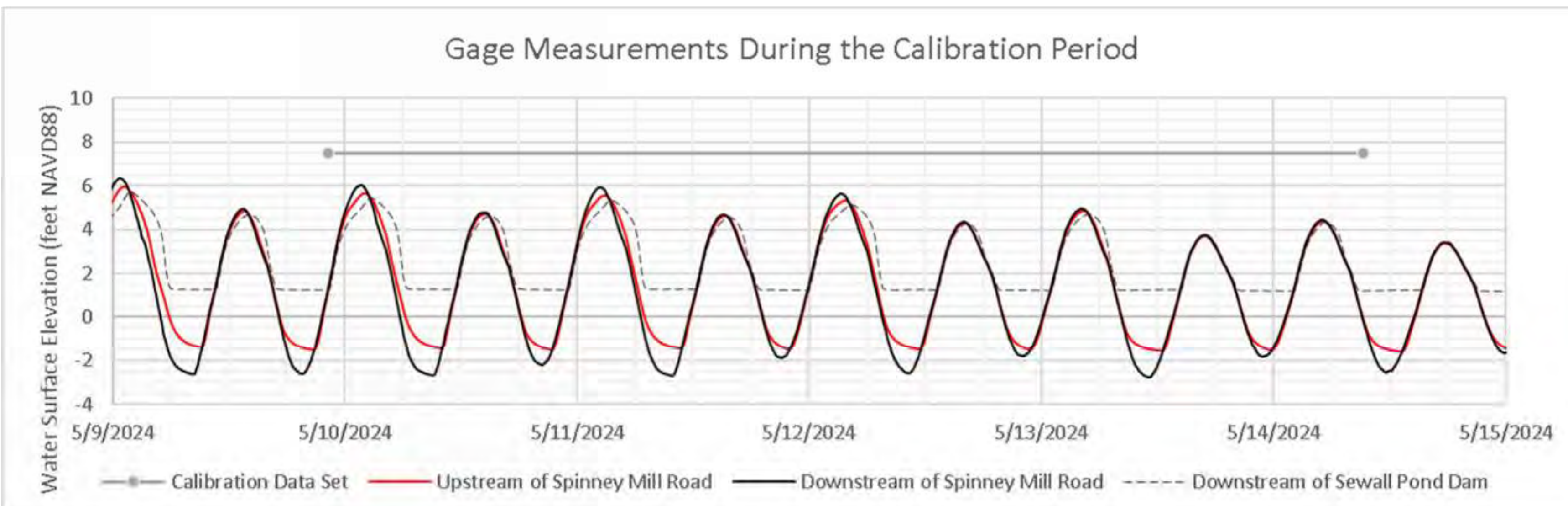


Figure 16. Tidal elevations at three gages during the calibration period.

4.1 TIDAL MEASUREMENTS

Inter-Fluve used the time series data to estimate benchmark tidal elevations at the placed tide gage locations. Inter-Fluve used the NOAA CO-OPS tidal datum calculator[4] to estimate the elevations with reference to the NAVD88 vertical datum and the NOAA reference station in Portland, Maine (Station 8418150). Table 1 summarizes the estimated tidal benchmarks elevations based on the collected data.

Table 1. Tidal Benchmark Elevations relative to NAVD88, feet.

Benchmark (Datum)	Downstream of Spinney Road (2023 Epoch)	Upstream of Spinney Road (2024 Epoch)	Downstream of Sewall Pond Dam (2024 Epoch)
MHHW	4.25	4.34	4.123
MHW	3.88	3.97	3.78
MTL	0.56	0.48	2.22
MLW	-2.77	-3.01	0.66
MLLW	-2.86	-3.23	0.76
Tide Range	6.65	6.98	3.13

**Mean higher high water (MHHW), Mean high water (MHW), Mean tide level (MTL), Mean low water (MLW), Mean lower low water (MLLW).*

4.2 HIGHEST ASTRONOMICAL TIDE

Inter-Fluve reviewed estimates of the highest astronomical tide (HAsT) for the study area. The Maine Geological Survey[5] estimates the HAsT at the project site at 6.1 feet NAVD88. NOAA estimates the HAsT at the Portland gage site at 6.7 feet NAVD88. Inter-Fluve reviewed the water level measurements downstream of Spinney Mill Road and observed the peak spring tide elevations in 2024 substantially exceeded the MGS HAsT estimate, which indictates that the MGS estimates are likely to be biased low. The peak water surface elevation measured downstream of Spinney Road during the brief 2024 deployment was 6.4 feet NAVD88. The actual HAsT at the project site is likely between 6.4 and 6.7 feet NAVD88. Therefore, for the purpose of modeling in this study, Inter-Fluve assumed a conservatively high value of 6.7 feet for the HAsT at the project site.

4.3 PLANNING HORIZON AND SEA LEVEL RISE ESTIMATES

In coordination with the Partnership, Inter-Fluve reviewed published estimates for predicted sea level rise at the project site. The Maine Coastwise guidelines (Moore et al. 2023) summarizes the estimates developed by NOAA and provides guidance for selecting design criteria consistent with the acceptable risk and recommended planning horizons for tidal crossings.

[4] https://access.co-ops.nos.noaa.gov/datumcalc/
[5] https://www.maine.gov/dacf/mgs/hazards/highest_tide_line/index.shtml

Following review of the risk categories with project stakeholders, the Medium Risk Consequence category was selected for the project with a 2100 planning horizon (see Section 2) with a resulting sea-level rise estimate of 3.9 feet[6]. This planning horizon best matches the recommendations of the the CoastWise guidelines and the Maine Climate Action Plan, where the planning horizon generally aligns with the anticipated durability of the infrastructure considered. This approach also aligns with the "Commit to Manage' recommendation of the Maine Climate Action Plan (Maine Climate Council 2024; MCC STS 2024) and the Town of Arrowsic Climate Action Plan (Arrowsic Climate Resilience Committee 2024).

After consultation with stakeholders regarding the potential significance of infrastructure upgrades (crossing size and road raise) associated with the 2100 planning horizon and associated sea-level rise estimate, a second planning horizon/sea-level rise case (1.9 feet at 2060[7]) was considered to provide contrast. Therefore, for the purpose of this work, Inter-Fluve has utilized two sea level rise scenarios corresponding to Medium Risk Consequence to advance through the project modeling and conceptual design phase:

- A rise of 1.9 feet by 2060
- A rise of 3.9 feet by 2100

4.4 TIDAL TIME SERIES

Inter-Fluve developed a synthetic time series to represent three progressively larger tide cycles to adapt and use as a downstream boundary condition in the hydrodynamic model. Figure 17 illustrates this time series for current day sea level and for projected sea level in 2060 and 2100.

Inter-Fluve also developed a synthetic time series to represent the 10-year coastal storm event. Inter-Fluve estimated the peak elevation of the 10-year storm surge event to be 6.9 feet NAVD88 under current sea level conditions using information provided in the effective Flood Insurance Study for Sagadahoc County. Inter-Fluve developed a time series for this event by applying a multiplier to measured tidal data to achieve the desired peak tide elevation for the future sea-level rise case.

[6] Corresponds with the Intermediate scenario, central estimate (50% probability of exceedance) based on the NOAA 2022 dataset.

[7] Corresponds with the Intermediate scenario, central estimate (50% probability of exceedance) based on the NOAA 2022 dataset.

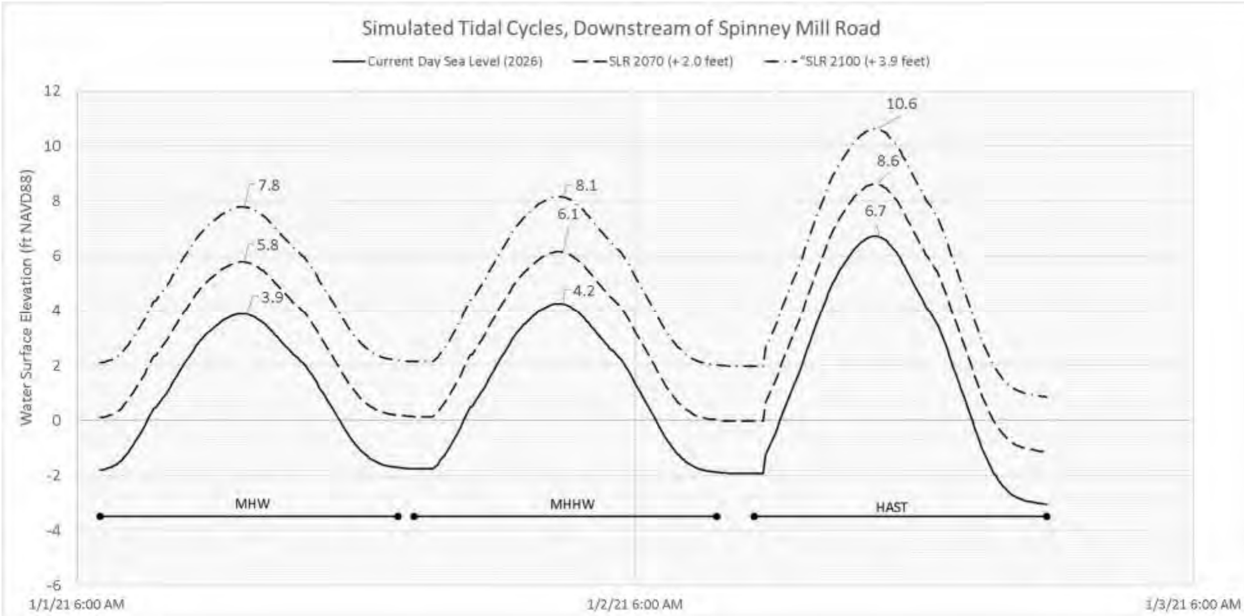


Figure 17. Simulated Tidal Cycle (MHW, MHHW, HAST).

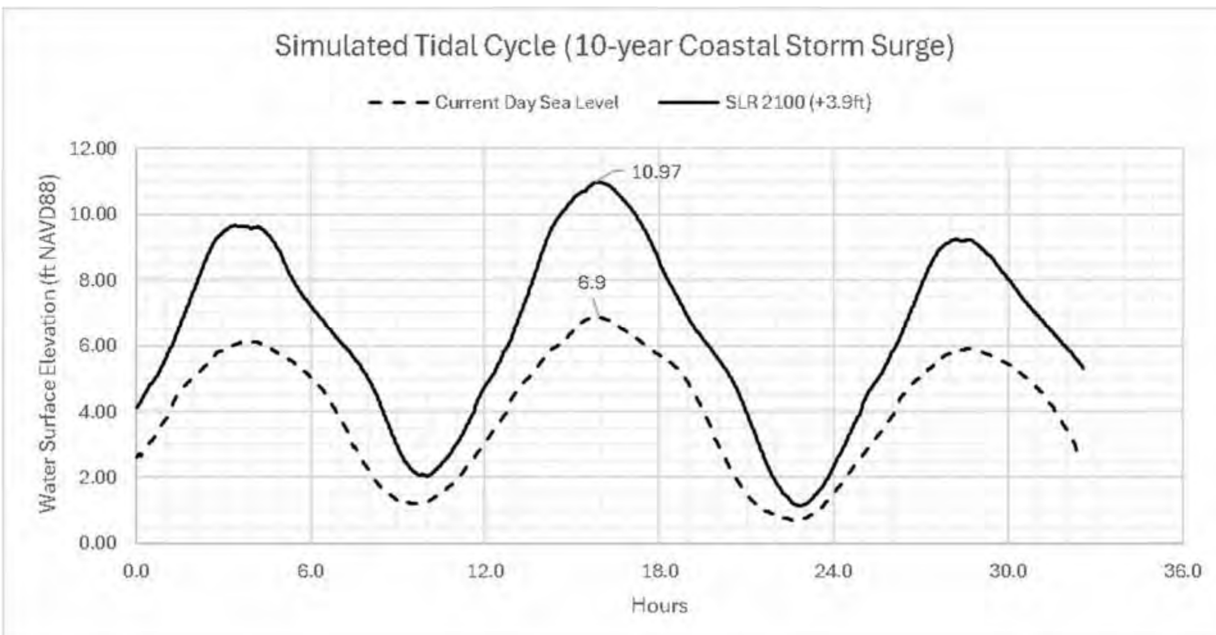


Figure 18. Simulated 10-year storm surge event (Current Day Sea Level and SLR 2100 (+3.9 feet).

5. Hydrodynamic Model

Inter-Fluve developed a two-dimensional (2-D) hydrodynamic model for the Spinney Mill Road tidal crossing site (the Subject Crossing) using data collected by the Partnership and supplemented with publicly available terrain data (e.g., LiDAR). Inter-Fluve developed the model to simulate hydrodynamic conditions along Sewell Brook under the existing condition, at present sea-level and at future estimated sea-levels.

The model was then used to simulate a range of modified crossing structure and road elevation cases to evaluate potential project alternatives. These results were used used to evaluate the restrictive transparency and vulnerability of the current crossing and to estimate the potential future transparency and resiliency of alternative crossing options.

Transparency, in this context, is the impact of a crossing on the ebb and flood of the tide. A restrictive crossing will affect the tide by reducing the tide range and affecting the duration of the tide. This impact affects the frequency and duration of inundation on the salt marsh, which has negative impacts to marsh ecology and resilience. A fully transparent crossing has no impact on the the ebb and flood of the tide.

Inter-Fluve developed the hydrodynamic model using the Bureau of Reclamation two-dimensional Sediment and River Hydraulics (SRH-2D) model, which is implemented through Aquaveo's Surface-water Modeling System (SMS; v 13.3.16) flow modeling system. The SRH-2D model is the 2D model approved by the Federal Highway Administration (FHWA), and is hence recommended for use by Maine DOT for bridge and culvert design when 2D modeling is required.

SMS is graphical user interface that is used to interact with the SRH-2D model. As stated on the SMS website, "*SRH-2D is a hydraulic model developed by the U.S. Bureau of Reclamation that incorporates very robust and stable numerical schemes with a seamless wetting-drying algorithm. The model uses a flexible mesh that may contain arbitrarily shaped cells, both quadrilateral and triangular elements, which promotes solution accuracy while minimizing computing demand. SRH-2D modeling applications include flows with in-stream structures, through bends, with perched rivers, with side channel and agricultural returns, and with braided channel systems. SRH-2D is well suited for modeling local flow velocities, eddy patterns, flow recirculation, lateral velocity variation, and flow over banks and levees*."[8]

This section of the report describes the development of the model inputs, the calibration, and the results.

5.1 MODEL DOMAIN

The model domain extends from a downstream limit at the confluence of Sewell Creek and the Kennebec River to an upstream limit at the small dam just downstream of Route 127. Refer to Figure 19.

[8] https://aquaveo.com/software/sms/models/srh-2d

The computational mesh consists of triangular and rectangular cells with side lengths ranging from four (4) feet up to twenty (20) feet within the footprint of inundation (Figure 20). Cell side lengths at the computational boundary reach ninety (90) feet. Small grid cells are located along topographical breaks and within the narrow channel to provide results at high resolution, balanced with computational demands and model run times.

5.2 EXISTING CONDITION TERRAIN

The topography and bathymetry that define the model terrain represent a mosaic of site-specific survey data and NGS topobathymetric data collected in 2022 in the project area.

5.3 MANNING'S "N" ROUGHNESS

The hydrodynamic model evaluates the movement of flow over the boundary layer at the land/water interface. The boundary layer has a roughness characteristic related to the material at the land/water interface. Figure 21 presents the land cover assumptions and the Manning's "n" value assigned to each land cover.

5.4 ROAD CROSSING STRUCTURES

The SRH-2D model can be used to calculate flow through bridge and culvert structures using the FHWA HY-8 model embedded in the computational domain. For the purpose of this analysis, the existing crossing was modeled as a perched, double, 7.25-foot diameter corrugated metal culverts through an embankment with the existing road profile. For evaluation of alternative replacement crossing sizes, proposed crossing sizes were simulated as standard box culverts up to the maximum size typically available (26-foot span) or breaches through the model terrain (for the 40-, 50, and 70-foot span alternatives). For the alternative replacement crossings, the road embankment was raised to prevent overtopping, so that all of the tidal flow is through the associated crossing. Table 2 lists the crossing structure sizes evaluated as part of this work.

Note that crossing spans evaluated in the rapid sizing analysis simulations are described by their average hydraulic span (i.e., the distance between vertical side walls). Subsequent detailed design for free-spanning structures will typically have sloping stone banks beneath the bridge deck, thus the actual bridge length will be greater than the average hydraulic span, while the width at the channel bottom will be less than the average hydraulic span. This pattern applies to the 40, 50, and 70 wide cases reported below.

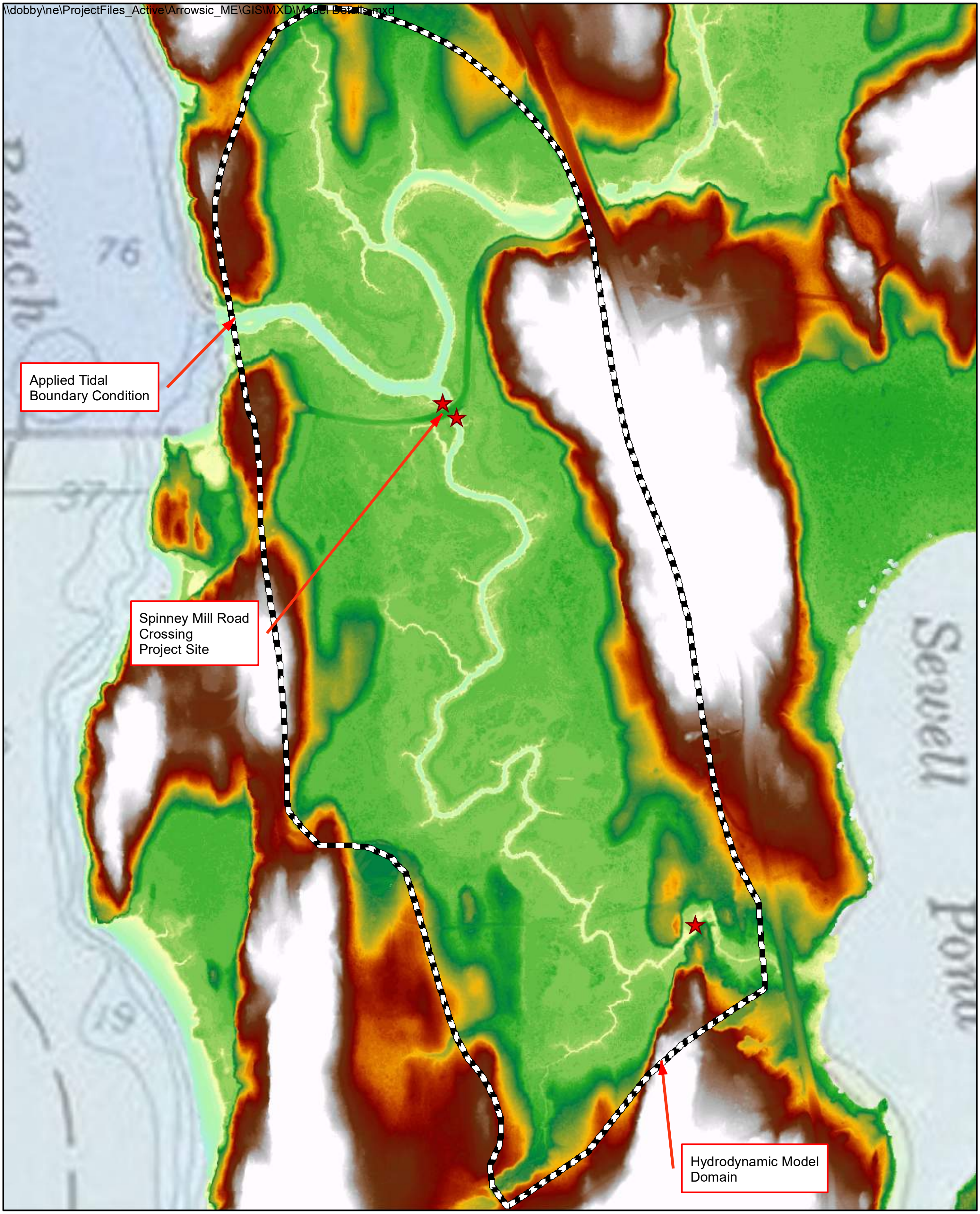
Table 2. Evaluated structure geometries.

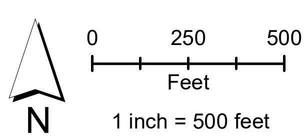
Nominal Opening	**Average Hydraulic Span**	**Computation Method**
Existing Conditions		
Existing Geometry, two corrugated metal culverts	7.5 feet circular diameter x 2	HY-8 embedded in SRH-2D
Alternative Proposed Conditions for Sizing Evaluation		
15-foot wide concrete box	15 feet	HY-8 embedded in SRH-2D
26-foot wide concrete box	26 feet	HY-8 embedded in SRH-2D
40-foot wide	45 feet	terrain modification to SRH-2D
50-foot wide	55 feet	terrain modification to SRH-2D
70-foot wide	75 feet	terrain modification to SRH-2D

5.5 BOUNDARY CONDITIONS

The hydrodynamic tidal boundary condition was established at the downstream limit of the model domain at the confluence of Sewell Creek and the Kennebec River. The tidal boundary condition was based on the tidal analyses of the data collected downstream of Spinney Mill Road as described in Section 3 of this report.

The freshwater hydrologic boundary condition was established at the upstream limit of the model domain at the outflow from Sewall Pond. A constant flow of 5.8 cfs was applied to represent outflow from Sewall Pond, which corresponds to average to above average spring outflow from the pond.





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Model Locus
Spinney Mill Road
Arrowsic, Maine

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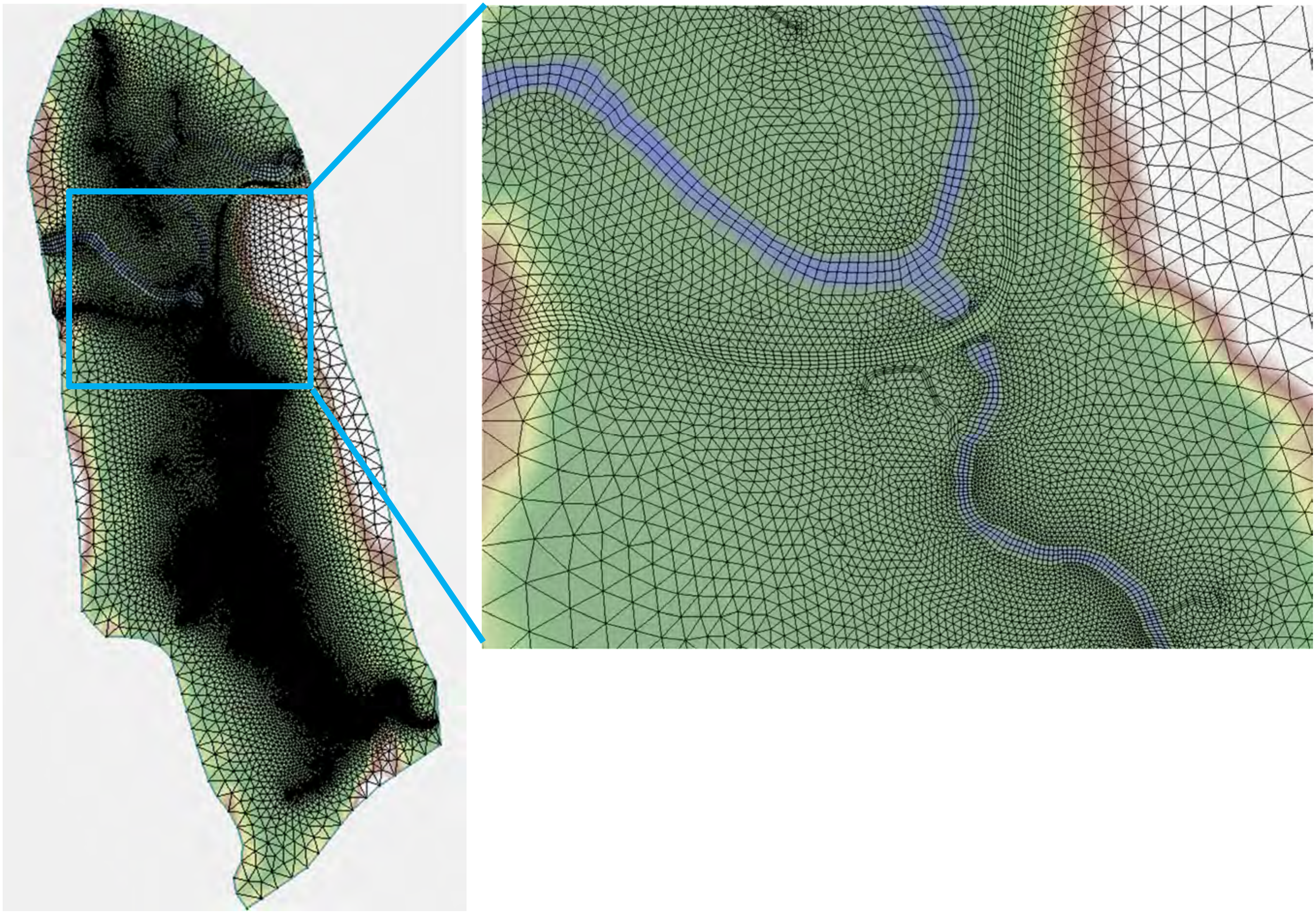
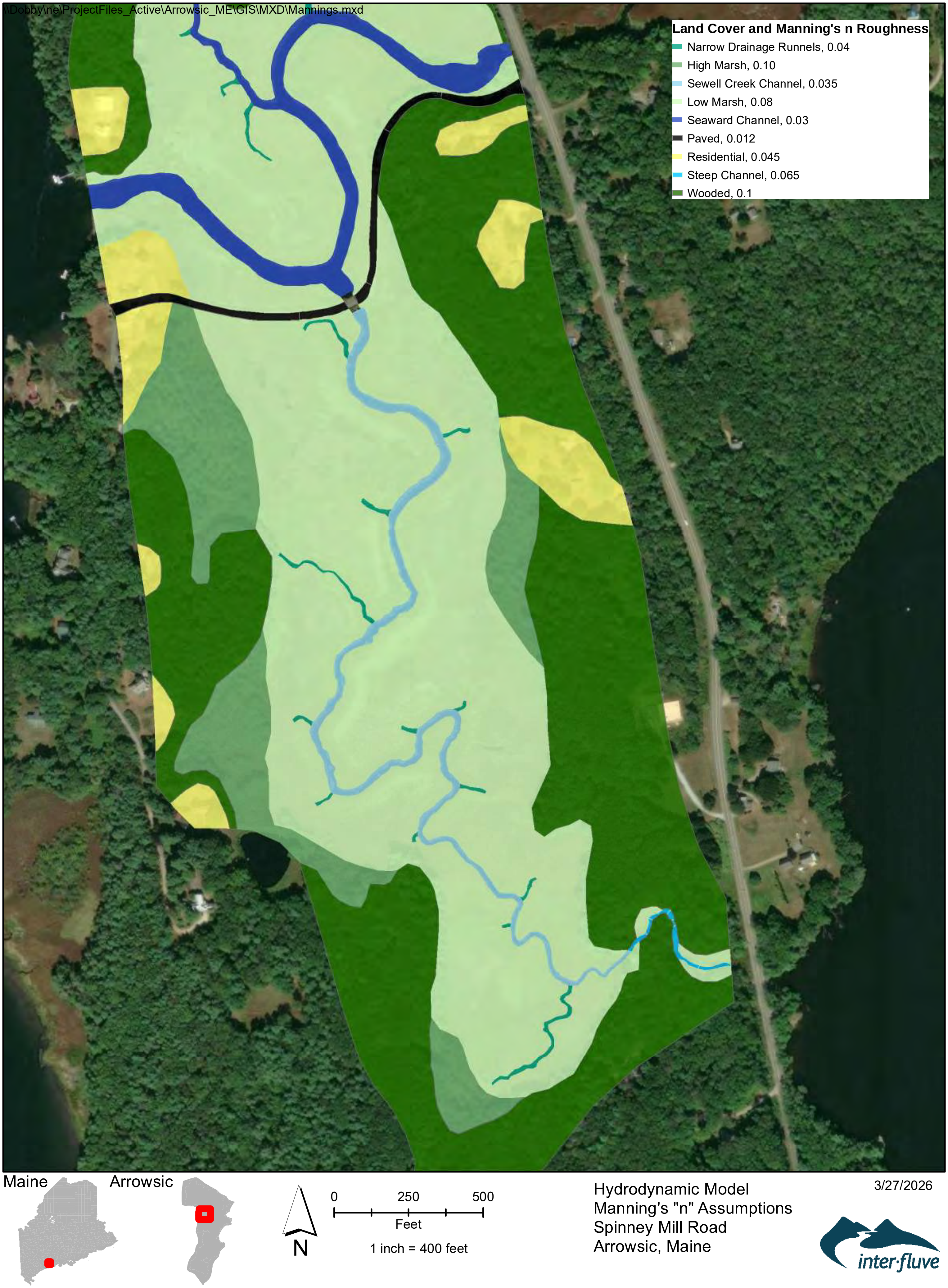


Figure 20. Two-dimensional model computational mesh.



Hydrodynamic Model
Manning's "n" Assumptions
Spinney Mill Road
Arrowsic, Maine

3/27/2026

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5.6 MODEL CALIBRATION

The existing conditions model was calibrated to observed tidal time series data collected in May 2024. During this period, water level logger data was available at three locations, downstream of Spinney Mill Road, upstream of Spinney Mill Road, and along Sewell Creek downstream of the Old Dam. The calibration time series included four complete tide cycles that captured the highest tide during the monitoring period unaffected by preceding precipitation.

Table 3. Calibration Time Series

	Start	End
Calibration Time Series	5/9/2024 22:18	5/14/2024 9:12

Calibration adjustments included:

- adjusting the Manning's "n" values for the underlying land cover to represent conditions during the calibration period,
- adding a constant value to the tidal elevations at the downstream boundary condition to compensate for the distance between the downstream boundary (the confluence with the Kennebec River) and the location of the water level logger (downstream of Spinney Mill Road).

Model calibration activities prioritized reproducing the elevation and timing of the mid-level and peak-tide portion of the tidal cycle. This emphasis was applied to reproduce as the upper half of the tide range is most important when evaluating inundation patterns, road overtopping potential, and evaluating alternative structure sizes, key considerations in this study.

The goodness-of-fit of the model calibration was evaluated by comparing simulated water surface elevations to observed water surface elevations at three locations: (1) immediately downstream of Spinney Mill Road, (2) immediately upstream of Spinney Mill Road, and (3) immediately downstream of the old dam downstream of Sewall Pond, at the upstream extent of the marsh. Figure 22, Figure 23, and Figure 24 compare the simulated water levels to the measured water levels, respectively. The root mean squared errors (RMSE) for the model fit during the mid to peak elevations in the tidal cycle were 0.19 feet, 0.19 feet, and 0.44 feet at these three locations, respectively.

Note that the model does not faithfully simulate the low tide conditions downstream of the old dam (Figure 24). This result indicates that the terrain model may not faithfully represent the elevation of the marsh surface at the monitoring station; the terrain model may be higher than the actual marsh surface.

At this location, the model also shows greater discrepancy at the higher high tide elevation in the calibration time series. The simulation represents more water reaching the calibration location earlier in the tide cycle than the observed data. It also allows the water to achieve a higher elevation. This result may indicate that the model is underestimating the roughness of the channel and the floodplain with respect to the calibration time period (spring). It may also indicate that the terrain model may not precisely represent the elevation of the marsh surface. Consistent with the findings relative to low tide, the results indicate that the terrain model may be higher than the actual marsh surface, although the comparison of the topobathymetric LiDAR to the surveyed elevations indicated reasonable agreement (Section 3.2.1).

For the purposes of the present study, the model calibration was deemed satisfactory. Additional efforts to further fine-tune the model calibration is possible in future project phases. Improvement of model calibration may require time instensive granular evaluation and adjustment of the topobathymetric LiDAR terrain which was outside the constrints of the current study.

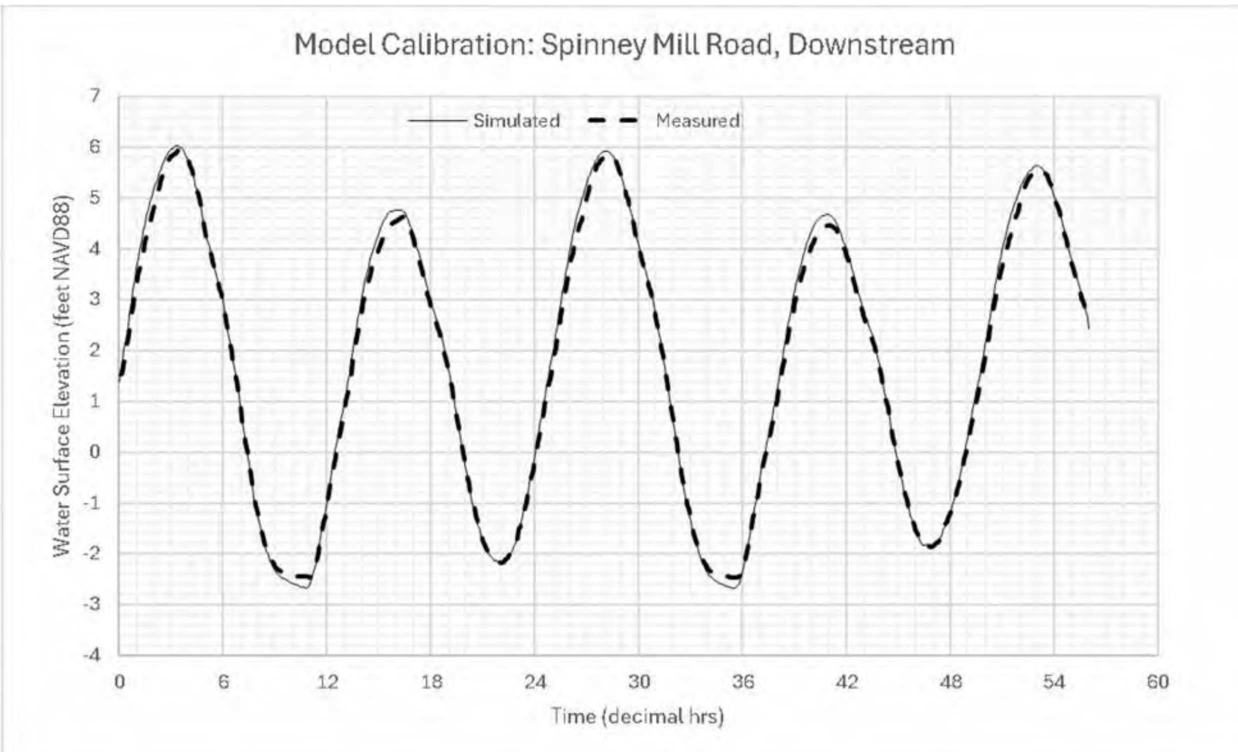

Figure 22. Model Calibration. Spinney Mill Road, Downstream.

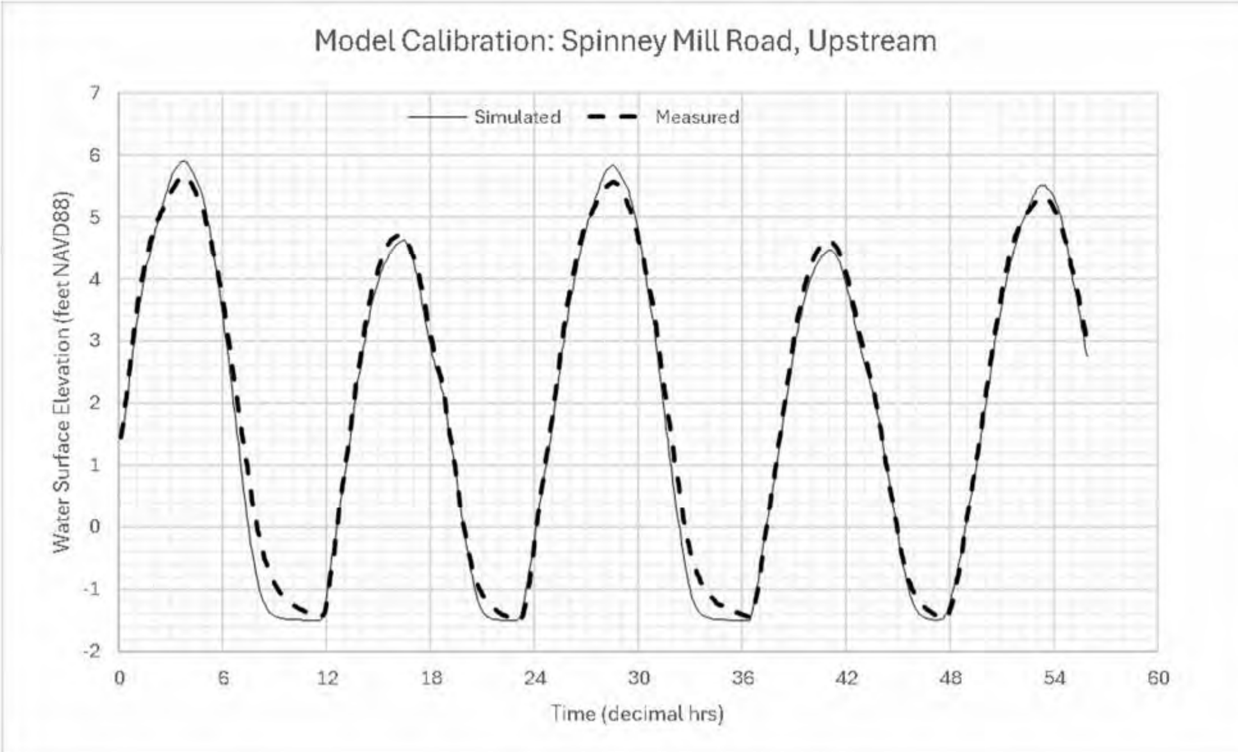

Figure 23. Model Calibration. Spinney Mill Road, Upstream.

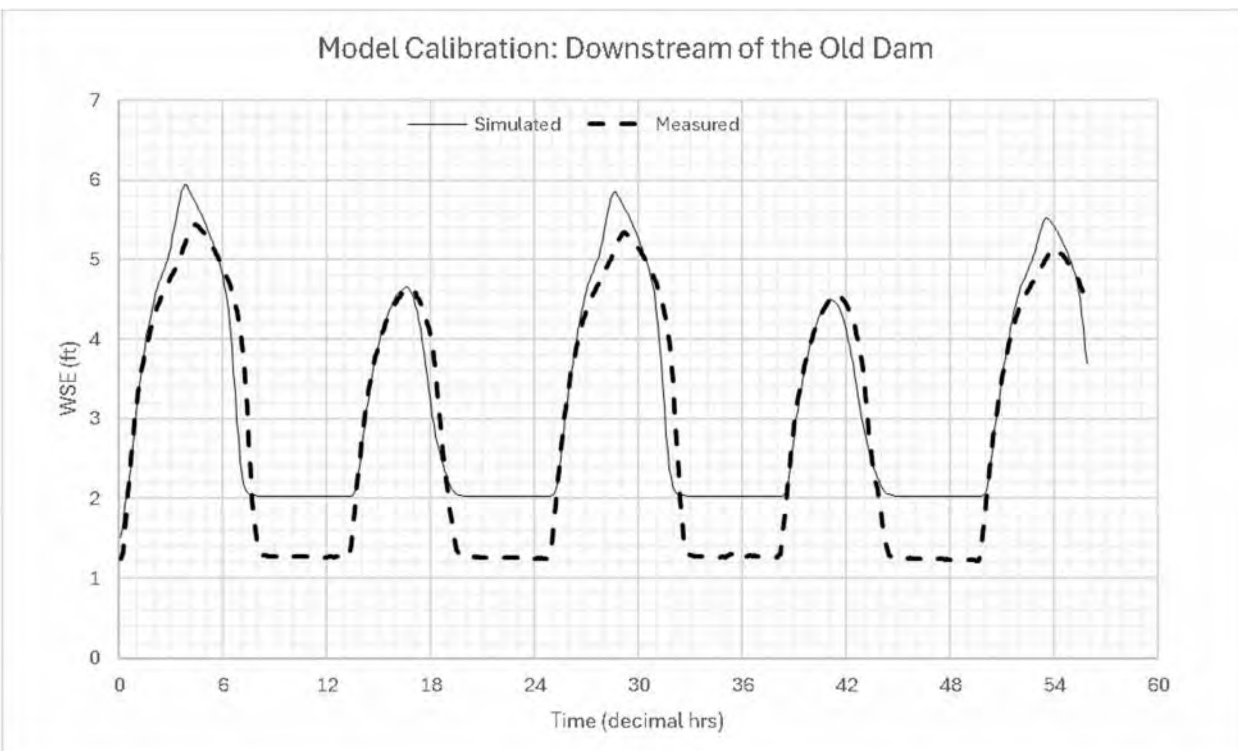

Figure 24. Model Calibration. Downstream of the old dam in Sewall Pond outlet, upstream end of marsh.

5.7 MODEL RESULTS

The calibrated hydrodynamic model was used to evaluate existing conditions at the subject crossing and to evaluate the tidal transparency of alternative crossing geometries during a range of tidal events including MHW, MHHW, and HAsT, along with the 10-year coastal storm surge event.

5.7.1 Model Scenarios

The calibrated model was used to simulate the performance of six (6) alternative crossing geometries under three (3) sea level conditions, during up to three (3) tidal conditions. Table 4 lists the model scenarios.

Table 4. Hydrodynamic Model Scenarios

Sea Level Condition	Tidal Condition	Geometry
Existing	MHW, MHHW, HAsT, 10-year	Existing
	MHW, MHHW, HAsT	15-foot
	MHW, MHHW, HAsT	26-foot
	MHW, MHHW, HAsT	40-foot
	MHW, MHHW, HAsT	50-foot
	MHW, MHHW, HAsT	70-foot
Sea Level in 2060	HAsT	Existing
	HAsT	15-foot
	HAsT	26-foot
	HAsT	40-foot
	HAsT	50-foot
	HAsT	70-foot
Sea Level in 2100	HAsT, 10-year	Existing
	HAsT	15-foot
	HAsT	26-foot
	HAsT	40-foot
	HAsT	50-foot
	HAsT	70-foot

5.7.2 Inundation Results

Appendix B presents the results of inundation modeling for the modeled scenarios. Model results indicated that for each sea-level rise case, the size of the opening has a moderate impact on the maximum extent of inundation for the simulated conditions, does affect the timing and duration.

As expected, the inundation footprints for future sea level conditions increase in extent. The inundation footprints of 2060 are larger than the footprints at current sea level. The inundation footprints of 2100 are projected to be larger than the footprints projected for 2060.

The largest change in inundation footprint between current sea level and projected sea level in 2100 is seen for the MHW. The inundation footprint for MHW in 2100 will resemble today's HAsT inundation footprint.

An additional notable result is that at present sea-level, even with an unrestrictive crossing the structure, the model results show MHHW tide is largely within the tidal channel, not inundating the marsh plain (Appendix B). This tidal elevation is often correlated with high marsh areas, and this result may help explain the vegetative conditions observed at the site today. This result is also promising for future marsh recovery and resilience, suggesting that marsh elevations may not be notably subsided, or may even be high relative to the tidal frame, implying a head start in keeping up with future sea-level rise.

5.7.3 Hydrographs

Figure 25 presents the model results for the existing crossing under the HAsT tidal event for three sea level conditions. Model results show that, as sea level rises, the existing crossing will have incrementally larger impacts on the elevation and duration of inundation in the salt marsh.

Appendix C presents the results of the simulated water levels for all the modeled scenarios.

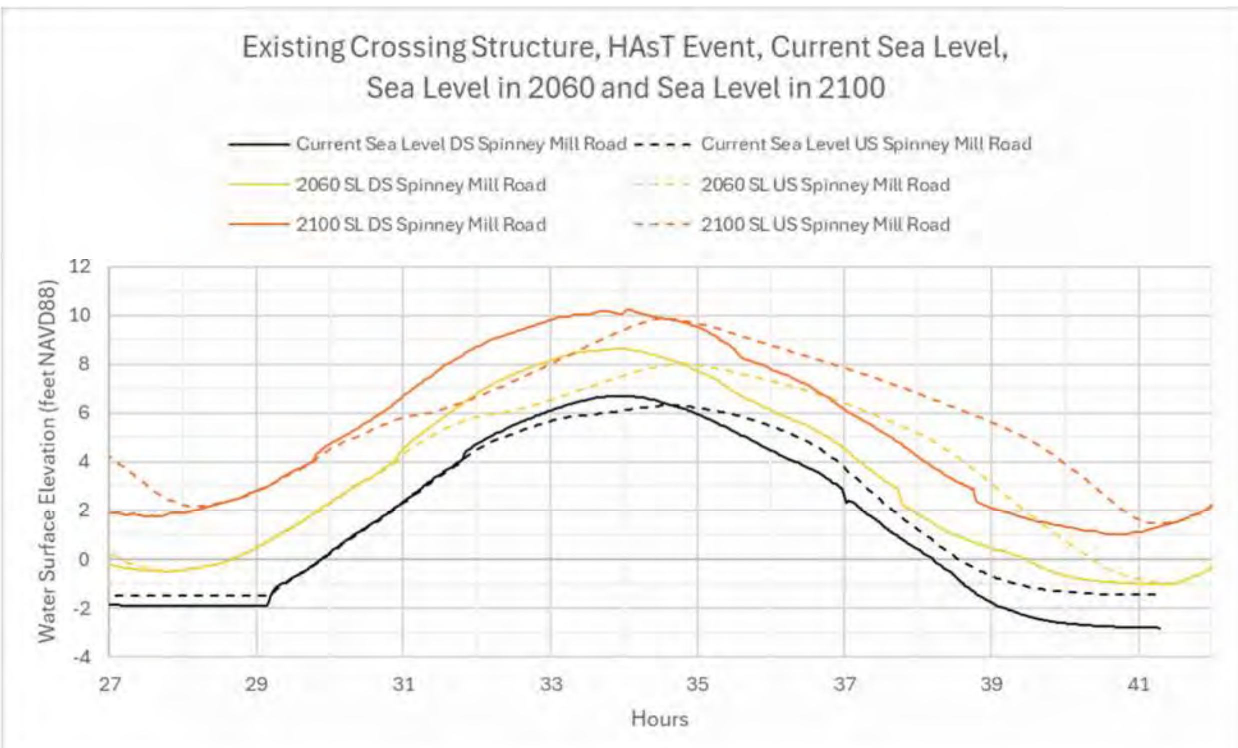

Figure 25. Model Results, Existing Crossing Structure, HAsT Event, for Three Sea Level Conditions

5.7.5 Tidal Transparency Discussion and Results

Objectives for the Spinney Mill Road crossing include maximizing the tidal transparency over the planning horizon (2100) to promote ecological resilience (Figure 26). Tidal transparency is achieved when the timing and water elevation of the peak tide match on either side of the crossing structure and the differences in water elevation on the running flood and ebb tides upstream and downstream of the crossing structure are as near to zero as practical. The difference in water elevation between the upstream and downstream sides of the crossing structure is referred to as "hydraulic" head differential (HHD).

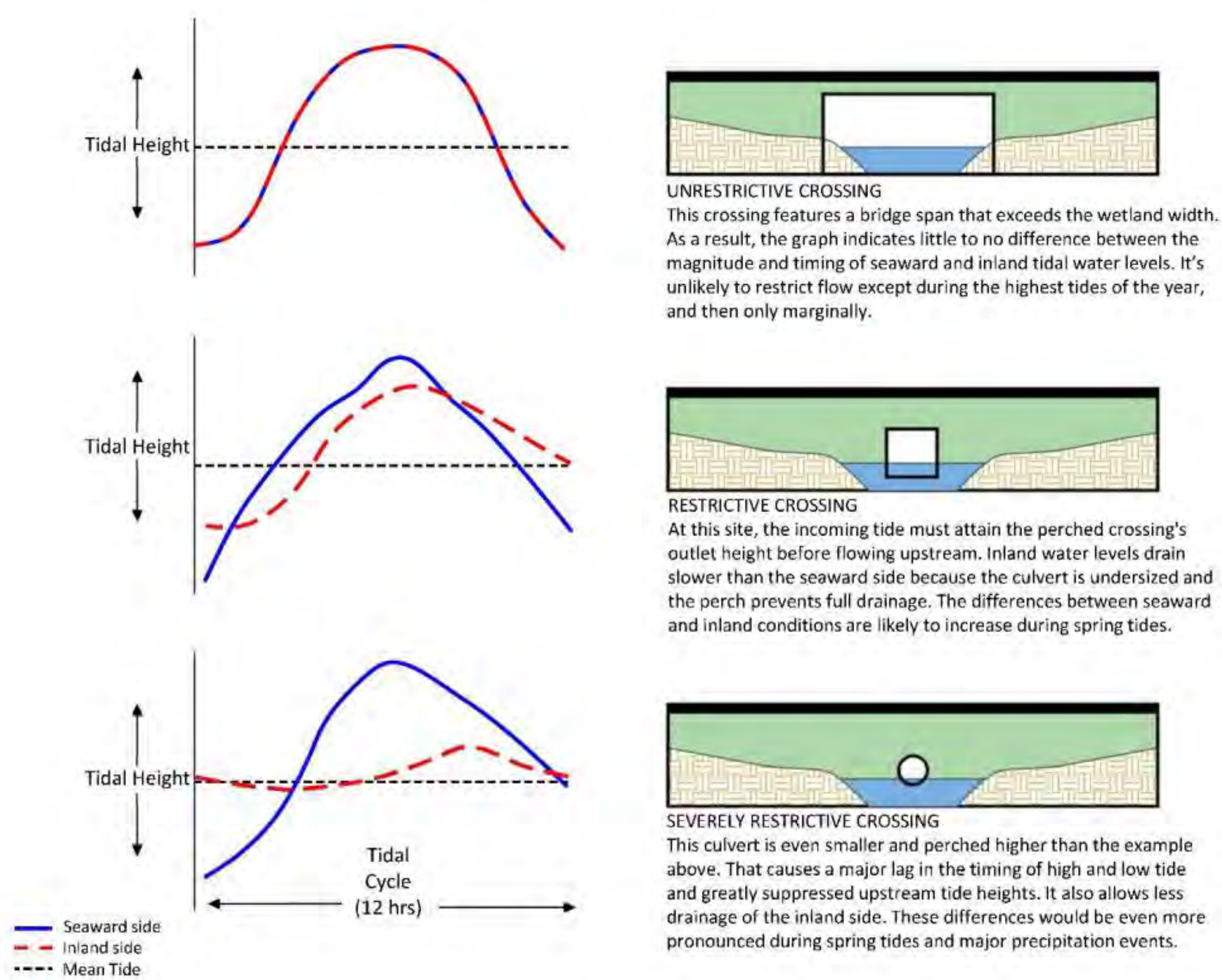

Figure 26. Definition sketches demonstrating degrees of tidal restriction. Sourced from CoastWise guidelines (Moore et al., 2023).

5.7.5.1 Sizing Metrics

Crossing structures should be sized to reduce or eliminate the hydraulic head differential upstream and downstream of the crossing structure. It is important to understand two hydraulic head differentials, the maximum instantaneous differential (IHHD) and the maximum peak differential (PHHD). The maximum instantaneous difference (IHHD) is calculated as the largest difference between upstream and downstream water levels during the continuous time series including the high and low tides, and the intervening flood and ebb running tides (Figure 27). The maximum IHHD typically occurs on the flood or ebb tides, at mid-tide or higher. The peak-to-peak difference (PHHD) is calculated as the difference between upstream and downstream peak water levels on a tidal cycle (Figure 27). A structure that is sized to accommodate the IHHD will be larger than a structure sized to accommodate the PHHD.

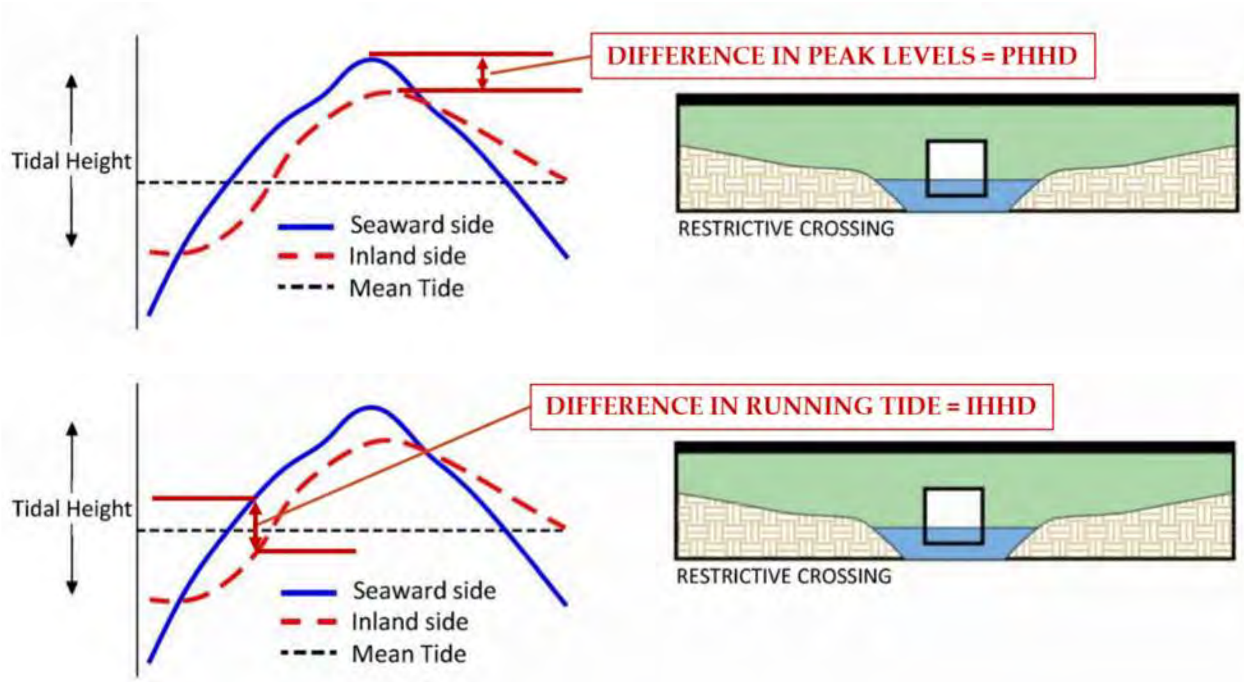

Figure 27. Definition sketches of crossing sizing metrics.

5.7.5.2 Crossing Transparency Results

Figure 28 summarizes the performance of the alternative crossing geometries with respect to sea level in 2100, while Figure 29 summarizes the performance with respect to sea level in 2060. Model results indicate that the effect on head differential diminishes as the hydraulic span of the crossing gets larger. Increasing the hydraulic span beyond the inflection points represented in the sizing charts results in diminishing incremental benefit to tidal transparency with increased size.

When reviewing the tidal transparency calculations, the CoastWise guidelines recommend looking for the inflection point in the sizing curves represented by Figure 28 and Figure 29 beyond which notable gains in transparency are not achieved even with substantial increases in structure size. In Figure 28, this inflection point occurs at the 40 foot nominal width case for the 2100 planning horizon. In Figure 29, this inflection point occurs between the 26 foot and the 40 foot nominal width case for the 2100 planning horizon. The CoastWise hydraulic head differential recommendations for an upstream marsh of this size are me by the 40 foot nominal size for the 2100 planning horizon, and are split between the 26 foot and 40 foot nominal widths for the 2060 planning horizon.

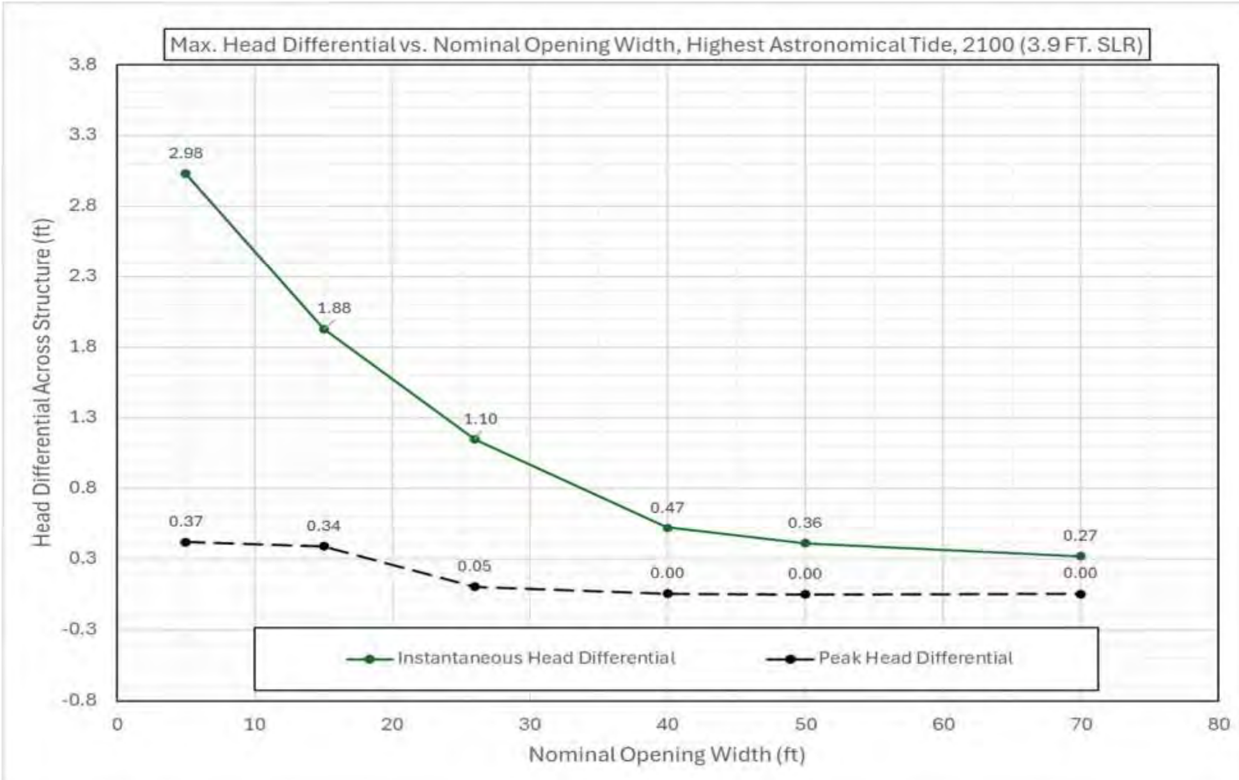

Figure 28. Alternative Crossing Geometry Sizing Results for 2100 sea levels.

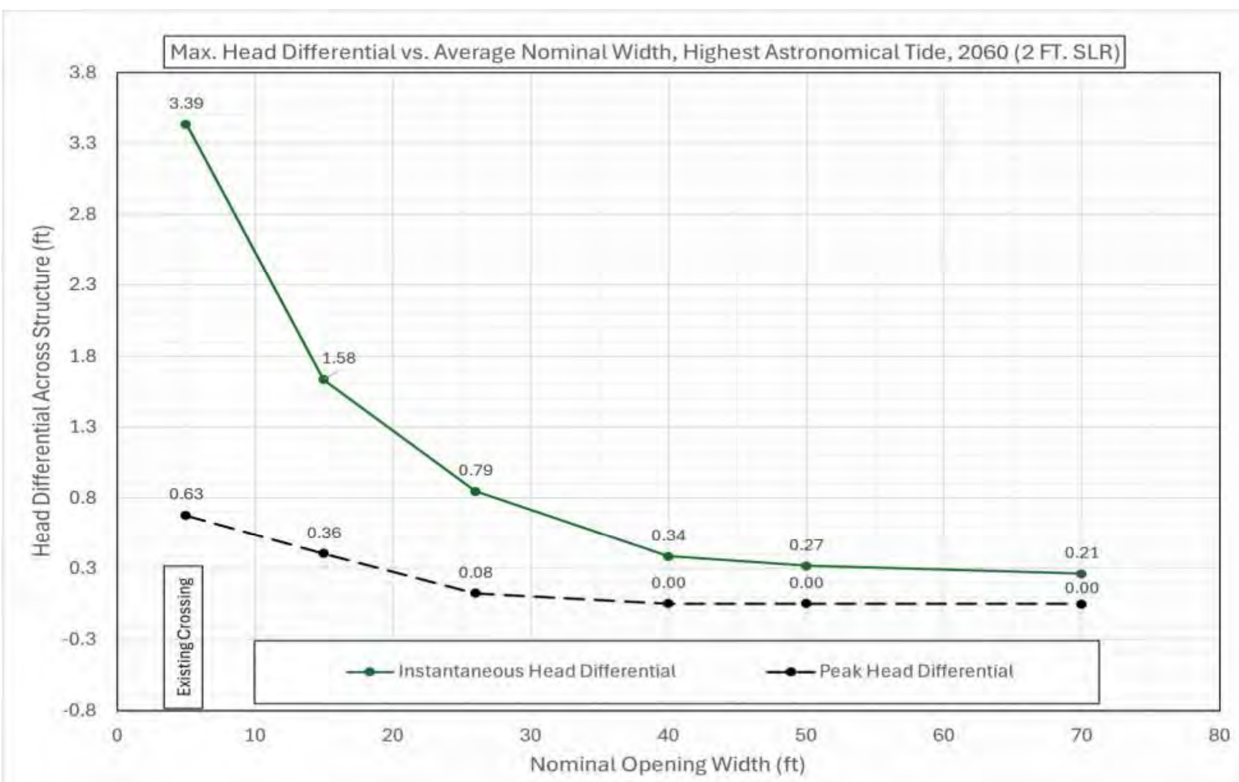

Figure 29. Alternative Crossing Geometry Sizing Results for 2060 sea levels.

6. Conceptual Design Assessment

To address the goals and objectives established for the project, in this section we review potential conceptual design alternatives for Spinney Mill Road. The performance and rough order of magnitude costs of the preliminary sizing alternatives discussed in Section 5.7 were reviewed with the advisory committee on January 13, 2026. Based on that review, three conceptual design alternatives were advanced and are described in this section (Table 5).

Other options were mentioned early in project discussions, but were not evaluated with this study. This included selective road realignment, which was considered infeasible due to private property considerations.

The following report discusses each of the alternatives. Concept design sheets for the three action alternatives are included in Appendix D, while cost opinions for the various action alternatives are included in Appendix E.

Table 5. List of Conceptual Design Alternatives.

Alternative	Comments
Alt. 0 - No Action	Maintains status quo.
Alt. 1 - Transparent and Resilient Crossing (2100)	Restoration of tidal hydrology through structure replacement and road raising at existing crossing. Targets 2100 planning horizon.
Alt. 2 - Transparent and Resilient Crossing (2060)	Restoration of tidal hydrology through structure replacement and road raising at existing crossing. Targets 2060 planning horizon.
Alt. 3 - Transparent and Resilient Crossing (Hybrid 2060/2100)	Restoration of tidal hydrology through structure replacement and road raising at existing crossing. Targets 2060 planning horizon for road raising with 2100 planning horizon for crossing structure.

6.1 ROAD ELEVATION CONSIDERATIONS

The CoastWise guidelines recommend targeting road elevations that exceed the projected Coastal Base Flood (CBF; 1 in 100-year coastal storm conditions) over the course of the planning horizon for the project. This conservative strategy, which adds the estimate of sea-level rise to the present-day base flood elevation, is recommended to ensure safe travel conditions over the life of the tidal road crossing, but is reliant on the projections of sea-level rise several decades into the future.

Current Maine DOT strategies vary from this approach. Maine DOT typically adds the sea-level rise estimate to the presently estimated HAsT elevation to set the minimum road elevation. They typically adopt the sea-level rise projection set by the Maine Climate Council for the "Commit to Manage" strategy at the 2100 planning horizon (3.9'). Often, this strategy results in a road elevation that is higher than the present day CBF elevation, but is less than the CBF elevation projected over the full planning horizon.

Maine DOT reasons that there is significant uncertainty in future sea-level rise projections approaching a planning horizon seventy-five years into the future. With a significantly large inventory of tidal crossings, they reason that obligating the resources to accommodate the uncertainty on top of the infrequently occurring CBF probability is impractical given current funding levels. Instead, they reason that if additional road raising is required decades into the future, they will be able to adapt road elevations again at that time.

As such, the Maine DOT strategy to setting road elevations integrates long-term resilience phasing elements. One primary nuance to this strategy, however, is to design the crossing structure with the long-term planning horizon in mind, correlated with the likely lifespan of the installed structure. At the present time, it is typically impractical to adapt crossing structures such as bridges or large culverts by increasing their top elevation several decades in the future without significant structural upgrades or replacement.

Although this crossing is not a Maine DOT facility, due to the potential increase in crossing size, the structure or bridge would fall under Maine DOT's jurisdiction from a inspection perspective, and depending on final size may also fall in their jurisdiction from a maintenance or even ownership perspective (Moore et al., 2023).

Combined with considering the potential cost to achieve a near-term road elevation complying with the CoastWise recommendation for this roadway, the conceptual design alternatives included herein were developed with a hybrid approach. The conceptual alternatives assume road elevation consistent with the Maine DOT strategy, but with structure elevation that that allows additional elevation of the road in the future if or as needed.

6.2 ROAD CONSTRUCTION CONSIDERATIONS

Due to the preponderance of weak soils beneath Spinney Mill Road, road raising will require careful geotechnical design and construction sequencing. Typically, with the addition of fill over soils such as these, substantial settlement may occur. One strategy to overcome this settlement prior to eventual road paving is to pre-load the road alignment with extra weight, intended to consolidate the deep soils. This strategy was recently employed on the Route 1 reconstruction project in Woolwich.

However, due to the single access nature of Spinney Mill Road, this is not anticipated to be a viable or cost-effective strategy. Instead, an alternative strategy that is likely favorable is to construct the raised road, but then allow for a period of settlement before repaving the road surface. When monitoring of settlement indicates that it has slowed or ceased, the final paving can occur. Based on the settlement pattern, fill may need to be added incrementally to achieve the final desired road elevation.

6.3 CROSSING STRUCTURE TYPE AND CONSTRUCTION CONSIDERATIONS

Crossing structure types considered include large concrete box culverts and small free-span bridges, commonly regarded as durable structure types in coastal and estuary environments with long planning horizons. Concrete box culverts are available up to span sizes of approximately 26 feet. Beyond that span size, the typical strategy entails a free span bridge deck with integral, pile supported abutments.

Similar to the discussion of road fill above, these structure types will also require careful geotechnical and foundation design. Due to the low strength soils, both are anticipated to require supporting piles driven to depth to mitigate settlement and ensuring safety of the traveling public. Although typically incrementally more expensive due to the larger span size, the bridge strategy may offer advantages during construction, including durations of impacts to regular travel along the road, water control, and sequencing.

6.4 CONCEPTUAL COST OPINION CONSIDERATIONS

Opinions of probable construction cost were developed for each of the Action Alternatives. It should be stressed that these cost opinions are intended at the present juncture primarily to enable relative comparison between options, with additional design development recommended to result in cost opinions that are suitable for advanced planning and fundraising.

According to the definitions developed by the American Association of Cost Engineering (AACE, 2016), the goal for the cost analysis fits in the range of Class 4 estimates, with a published accuracy range of -30% to +50%. The cost analysis includes construction costs only, in 2026 dollars. Project delivery costs for project management, permitting, geotechnical exploration, engineering design, construction contract administration and construction observation are not included, but may range from 15% to 25% of total construction costs. Adaptive management and operation and maintenance costs are also not included but should be considered in long-term project planning.

The cost opinions have been developed based on review of construction costs for similar items in past projects, consultations with vendors and construction contractors, and applicable reference cost data. The actual implemented cost may vary from these estimates based on market factors, detailed design development and possible optimization, and other factors. Refinement of designs, quantities and unit prices will occur in future detailed design phases.

The actual costs of implementation of the project may vary from the cost opinions due to heavy construction market fluctuations and other unforeseen factors. In particular, recent bid results (2019-2026) have seen substantial escalation and volatility in bid pricing, experienced before, during and after the COVID-19 pandemic. Conversations with construction contractors suggest costs may also escalate with increased stimulus and infrastructure spending and rising rates of inflation, especially on durable materials such as steel, labor market shortages, and subsequent developments in foreign trade policy. To account for potential variation, a 25% construction cost contingency has been included in the cost opinions.

6.5 ALTERNATIVE 0: NO ACTION

6.5.1 Overview

The "No Action" alternative will maintain the existing site configuration without notable improvements. Maintenance requirements would be perpetuated at existing or increased levels over time, while level of service may diminish in light of sea-level rise and other environmental stresses. The marsh will continue to evolve on a trajectory similar to that observable at the site today.

6.5.2 Effect on Tidal Restriction

The No Action alternative will not alleviate the tidal restriction at the site, which will be exacerbated with sea-level rise.

6.5.3 Effect on Tidal Inundation Patterns

The No Action alternative will not influence the current or future inundation patterns. The road presently overtops frequently in the current condition.

6.5.4 Marsh Restoration Considerations

The No Action alternative will not substantially contribute to the restoration of the historical tidal salt marsh.

6.5.5 Constructability and Impacts

Constructability considerations are not applicable to this alternative.

6.5.6 Estimated Initial and Long-Term Costs

Initial costs of this alternative are negligible. Anticipated moderate- to long-term costs include in-kind or upgraded structure replacement. Most typically, limited grant funding will be available for crossing replacement such as this, necessitating use of capital funds or bond measures to finance the work. Long-term maintenance costs may be significant.

6.5.7 Summary

The "no action" approach would maintain the existing site configuration without notable improvements. Maintenance of the facilities would be perpetuated at existing or increased levels over time as the infrastructure is subjected to increasing forces due to sea-level rise, increasing storm surges, and increasingly frequent overtopping events. Level of service may diminish in light of sea-level rise and other environmental stresses. The historical wetlands would continue to evolve on a trajectory similar to that observable at the site today.

The no action alternative presents the following advantages and drawbacks:

Advantages:

- Limited change to the local area, including unrestricted tidal inundation.
- Limited short-term costs.

Drawbacks:

- Ongoing tidal restriction and marsh degradation.
- Increasing road overtopping and flood damage risk, and increasing degradation of existing crossing structures.
- Escalating operation and maintenance costs.

Synthesis: *Provided the balance between advantages and drawbacks,* **the No Action alternative is not a feasible alternative to meet the stakeholder goals and objectives**.

6.6 ALTERNATIVE 1: TRANSPARENT AND RESILIENT CROSSING (2100)

6.6.1 Overview

Alternative 1 (Transparent and Resilient Crossing at 2100) would entail raising the roadway a minimum of 5 feet, and replace the existing culverts with a 45-foot average span crossing structure. This structure is most similar to the 40-foot nominal width scenario evaluated for the 2100 sea-level rise case in Section 5.7. As implemented, the bridge would result in an approximate 69-foot bridge span and an approximate 20 foot channel bottom width. This alternative is represented on Sheet 3 in Appendix D.

6.6.2 Effect on Tidal Restriction

This alternative was evaluated to achieve tidal transparency achieving CoastWise recommended criteria at the 2100 planning horizon, based on the future upstream tidal inundation area.

6.6.3 Effect on Tidal Inundation Patterns

This alternative will not change near term peak tidal or coastal storm inundation patterns, because the existing roadway overtops under these conditions also leading to full inundation of the marsh area. This effect would be similar over the full planning horizon if the current road was maintained in a status quo condition.

This alternative would optimize naturally occurring tidal inundation of the marsh area, supporting marsh restoration and future resiliency.

6.6.4 Marsh Restoration Considerations

By alleviating tidal restriction over the planning horizon, this alternative would provide substantial benefits for marsh restoration. Naturally occurring tidal inundation of the marsh area would be optimized, supporting marsh restoration and future resiliency.

6.6.5 Constructability and Impacts

This alternative has substantial constructability advantages due to the structure type. This includes limitation of traffic impacts due to the incremental nature of the construction, which also has benefits for factors such as construction sequencing and water control.

As this alternative includes the greatest increase in road elevation, impacts of added footprint of fill on the adjacent wetlands would be greatest among the alternatives.

6.6.6 Estimated Initial and Long-Term Costs

Initial costs of this alternative are the greatest among the conceptual design alternatives due to structure size and the greatest degree of road raising. The near-term construction cost opinion for this alternative is $5.2 million. See Appendix E for the detailed cost opinion for this alternative.

However, long-term maintenance costs will be the least among the alternatives due to the maximized resilience integrated in the alternative. Of the alternatives, this option may be most attractive to potential grant funders due to the long-term planning and resilience attributes of the alternative.

6.6.7 Summary

Alternative 1 (Transparent and Resilient Crossing at 2100) presents the following advantages and drawbacks:

Advantages:

- Greatest alleviation of tidal restriction and greatest support for marsh restoration and resiliency.
- Eliminated road overtopping and flood damage risk, and eliminated degradation of existing crossing structures.
- Minimized operation and maintenance costs.
- Notable potential constructability advantages.
- Attractive to grant funders due to long-term infrastructure resiliency planning and support for marsh restoration and resiliency.

Drawbacks:

- Greatest change to the local area relative to the present condition.
- Greatest short-term construction costs.

Synthesis: *Provided the balance between advantages and drawbacks,* **the Alternative 1 (Transparent and Resilient Crossing at 2100) best satisfies the stakeholder goals and objectives. This option has the greatest near-term cost, but may have comparable or lower long-term cost over the 2100 planning horizon, and may be most competitive for grant funding**.

6.7 ALTERNATIVE 2: TRANSPARENT AND RESILIENT CROSSING (2060)

6.7.1 Overview

Alternative 2 (Transparent and Resilient Crossing at 2060) would entail raising the roadway a minimum of 3 feet, and replace the existing culverts with a 26-foot concrete box crossing structure. This structure is most similar to the 26-foot nominal width scenario evaluated for the 2060 sea-level rise case in Section 5.7. This alternative was developed as a compromise alternative with a shorter planning horizon, in order to provide a contrast in reduced cost relative to Alternative 1. Alternative 2 meets transparency and resiliency objectives for the next few decades, but the benefits would be out of sync will the long-term assumed durability of the structure. This alternative is represented on Sheet 2 in Appendix D.

6.7.2 Effect on Tidal Restriction

This alternative was evaluated to improve tidal transparency substantially and achieve CoastWise recommended criteria for several decades, but may not fully meet these recommendations at the 2060 planning horizon (see Section 5.7.5.2), based on the future upstream tidal inundation area. Transparency performance would further diminish past the 2060 planning horizon.

6.7.3 Effect on Tidal Inundation Patterns

This alternative will not change near term peak tidal or coastal storm inundation patterns, because the existing roadway overtops under these conditions also leading to full inundation of the marsh area. This effect would be similar over the full planning horizon if the current road was maintained in a status quo condition.

This alternative would optimize naturally occurring tidal inundation of the marsh area, supporting marsh restoration and future resiliency over the shorter 2060 planning horizon.

6.7.4 Marsh Restoration Considerations

By alleviating tidal restriction over the shortened 2060 planning horizon, this alternative would provide substantial benefits for marsh restoration. Naturally occurring tidal inundation of the marsh area would be optimized, supporting marsh restoration and future resiliency over the shortened 2060 planning horizon. Support for marsh resiliency may diminish past the 2060 planning horizon.

6.7.5 Constructability and Impacts

This alternative has fewer constructability advantages than Alternative 1, primarily due to the massive structure type. The size and weight of the precast structure requires different types of construction equipment, greater degree of water control, increased traffic impacts, and more complex construction sequencing.

When compared to Alternative 1, this alternative has reduced increase in road elevation, hence impacts of added footprint of fill on the adjacent wetlands would be less.

6.7.6 Estimated Initial and Long-Term Costs

Initial costs of this alternative are the least among the conceptual design action alternatives due to structure size and the reduced degree of road raising. The near-term construction cost opinion for this alternative is $3.9 million, which is less than Alternatives 1 and 3. See Appendix E for the detailed cost opinion for this alternative.

However, long-term maintenance costs may be greater than Alternative 1 due to the lower road elevation, greater potential for overtopping during the decades to come, and the potential need to raise the road in the future. Of the alternatives, this option may be less attractive to potential grant funders due to the shorter planning and reduced resilience attributes of the alternative.

6.7.7 Summary

Alternative 2 (Transparent and Resilient Crossing at 2060) presents the following advantages and drawbacks:

Advantages:

- Alleviation of tidal restriction and support for marsh restoration and resiliency over the shortened 2060 planning horizon.
- Reduced road overtopping and flood damage risk, and eliminated degradation of existing crossing structures over the shortened 2060 planning horizon.
- Minimized operation and maintenance costs over the shortened 2060 planning horizon.
- Partially attractive to grant funders due to infrastructure resiliency planning and support for marsh restoration and resiliency over the shortened 2060 planning horizon.
- Least short-term construction costs among the action alternatives.

Drawbacks:

- Substantial change to the local area relative to the present condition.
- More challenging constructability compared to Alternatives 1 and 3.
- Planning horizon out of sync with infrastructure durability, and potential need for future adaptation.

***Synthesis*:** *Provided the balance between advantages and drawbacks,* **Alternative 2 (Transparent and Resilient Crossing at 2060) is a lower near-term cost option that satisfies several but not all of the stakeholder goals and objectives. Longer-term costs may exceed the other alternatives due to potentially required adaptation past the 2060 planning horizon, and may be less competitive for grant funding.**

6.8 ALTERNATIVE 3: TRANSPARENT AND RESILIENT CROSSING (HYBRID 2060/2100)

6.8.1 Overview

Alternative 3 - Transparent and Resilient Crossing (Hybrid 2060/2100) combines the crossing structure of Alternative 1 with the initial road raising of Alternative 2. This alternative was developed as a compromise alternative with the 2100 planning horizon for the less adaptable crossing structure, but less upfront cost for the more adaptable road elevation

Hence this alternative would entail raising the roadway a minimum of 3 feet, and replace the existing culverts with a 45-foot average span crossing structure. This structure is most similar to the 40-foot nominal width scenario evaluated for the 2100 sea-level rise case in Section 5.7. As implemented, the bridge would result in an approximate 69-foot bridge span and an approximate 20 foot channel bottom width. This alternative is represented on Sheet 4 in Appendix D.

6.8.2 Effect on Tidal Restriction

This alternative was evaluated to achieve tidal transparency achieving CoastWise recommended criteria at the 2100 planning horizon, based on the future upstream tidal inundation area.

6.8.3 Effect on Tidal Inundation Patterns

This alternative will not change near term peak tidal or coastal storm inundation patterns, because the existing roadway overtops under these conditions also leading to full inundation of the marsh area. This effect would be similar over the full planning horizon if the current road was maintained in a status quo condition.

This alternative would optimize naturally occurring tidal inundation of the marsh area, supporting marsh restoration and future resiliency.

6.8.4 Marsh Restoration Considerations

By alleviating tidal restriction over the planning horizon, this alternative would provide substantial benefits for marsh restoration. Naturally occurring tidal inundation of the marsh area would be optimized, supporting marsh restoration and future resiliency.

6.8.5 Constructability and Impacts

This alternative has substantial constructability advantages due to the structure type. This includes limitation of traffic impacts due to the incremental nature of the construction, which also has benefits for factors such as construction sequencing and water control.

When compared to Alternative 1, this alternative has reduced increase in road elevation, hence impacts of added footprint of fill on the adjacent wetlands would be less in the near term.

6.8.6 Estimated Initial and Long-Term Costs

Initial costs of this alternative are the least among the conceptual design action alternatives due to structure size and the reduced degree of road raising. The near-term construction cost opinion for

Initial costs of this alternative are the least among the conceptual design action alternatives due to structure size and the reduced degree of road raising. The near-term construction cost opinion for this alternative is $4.5 million, which is less than Alternative 1 and greater than Alternative 3. See Appendix E for the detailed cost opinion for this alternative.

However, long-term maintenance costs may be greater than Alternative 1 due to the lower road elevation, greater potential for overtopping during the decades to come, and the potential need to raise the road in the future. Of the alternatives, this option may be more attractive to potential grant funders due to the combined longer planning horizon with greater transparency and resiliency for the less adaptable infrastructure (bridge), reduced road construction cost, with acknowledgement of the potential need to further adapt the roadway in the future.

6.8.7 Summary

Alternative 3 (Transparent and Resilient Crossing Hybrid 2060/2100) presents the following advantages and drawbacks:

Advantages:

- Greatest alleviation of tidal restriction and greatest support for marsh restoration and resiliency.
- Reduced road overtopping and flood damage risk, and eliminated degradation of existing crossing structures over the shortened 2060 planning horizon.
- Minimized operation and maintenance costs over the hybrid 2060/2100 planning horizon.
- Attractive to grant funders due to infrastructure resiliency planning and support for marsh restoration and resiliency over the hybrid 2060/2100 planning horizons.
- Median short-term construction costs among the action alternatives.
- Notable potential constructability advantages

Drawbacks:

- Substantial change to the local area relative to the present condition.
- Potential need for future adaptation of road elevation.

Synthesis: *Provided the balance between advantages and drawbacks,* **Alternative 3 (Transparent and Resilient Crossing Hybrid 2060/2100) is a median near-term cost option that satisfies most of the stakeholder goals and objectives but will likely require adaptation of the roadway as part of a phased strategy. May be more competitive for grant funding than Alternative 2.**

6.9 CONCEPTUAL DESIGN ASSESSMENT SUMMARY

The conceptual design assessment alternatives are summarized in Table 6, in terms of synthesis and near-term construction cost.

Table 6. Summary of Conceptual Design Alternatives.

Alternative	Synthesis	Initial Construction Cost
Alt. 0 - No Action	The No Action alternative is not a feasible alternative to meet the stakeholder goals and objectives.	Not applicable, but with substantial ongoing maintenance, repair, and reduced level of service costs
Alt. 1 - Transparent and Resilient Crossing (2100)	Restoration of tidal hydrology through structure replacement and road raising at existing crossing. Targets 2100 planning horizon.	Alternative 1 (Transparent and Resilient Crossing at 2100) best satisfies the stakeholder goals and objectives. This option has the greatest near-term cost, but may have comparable or lower long-term cost over the 2100 planning horizon, and may be most competitive for grant funding.
Alt. 2 - Transparent and Resilient Crossing (2060)	Restoration of tidal hydrology through structure replacement and road raising at existing crossing. Targets 2060 planning horizon.	Alternative 2 (Transparent and Resilient Crossing at 2060) is a lower near-term cost option that satisfies several but not all of the stakeholder goals and objectives. Longer-term costs may exceed the other alternatives due to potentially required adaptation past the 2060 planning horizon, and may be less competitive for grant funding.
Alt. 3 - Transparent and Resilient Crossing (Hybrid 2060/2100)	Restoration of tidal hydrology through structure replacement and road raising at existing crossing. Targets 2060 planning horizon for road raising with 2100 planning horizon for crossing structure.	Alternative 3 (Transparent and Resilient Crossing Hybrid 2060/2100) is a median near-term cost option that satisfies most of the stakeholder goals and objectives but will likely require adaptation of the roadway as part of a phased strategy. May be more competitive for grant funding than Alternative 2.

7. References

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Inter-Fluve 2026. Indian Rest Road Assessment and Project Screening Technical Memorandum. March.

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MCC STS. 2024. Scientific Assessment of Climate Change and Its Effects in Maine - 2024 Update. A Report by the Scientific and Technical Subcommittee (STS) of the Maine Climate Council (MCC). Augusta, Maine. 268 pp.

Moore,S., M.Burke, M.Shultz, R.Hamilton, J.Aman, E.Bartow-Gillies, W.Bennett, R.Blunt, J.Carter, M.Craig, C.Enterline, J.Gabrielson, J.Bell, P.Taylor, and S.Widing. 2023. The Coast Wise Approach: Achieving Ecological Resilience and Climate-Ready Road Crossings in Tidal Environments. Maine Coastal Program.

Appendix A| Geotechnical Exploration Report

Summit Geotechnical Services, Inc.

Appendix B| Inundation Mapping

SRH-2D Model Results

Appendix C| Model Output Hydrographs

SRH-2D Model Results

Appendix D| Concept Designs

Drawings

Appendix E| Conceptual Design Option Cost Opinion Tables

Opinions of Cost for Conceptual Design Options

Appendix A| Geotechnical Exploration Report

Summit Geotechnical Services, Inc.

MEMORANDUM

Date: July 28, 2025

To: Mike Burke, Inter-Fluve

Project: Tidal Crossing Spinney Mill Road, Arrowsic, Maine

From: B. Peterlein, P.E., E. Dixon, E.I.

Reference: Subsurface Conditions and Geotechnical Considerations

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The following memo summarizes the subsurface conditions and geotechnical considerations for the tidal crossing on Spinney Mill Road in Arrowsic, Maine.

We understand that approximately a 1,000 foot stretch of Spinney Mill Road is subject to regular overtopping from tidal cycles. The project consists of an evaluation of road-raising and replacement of the existing culvert.

Summit Geoengineering Services, Inc. (SGS) observed the subsurface conditions on June 3, 2025 with the drilling of 3 borings. Two borings were on either side of the existing culvert, and the third boring was on the southern side of the area of interest.

The borings were completed by SGS using a trailer mounted AMS PowerProbe 9630 Pro-D drill rig. The borings were drilled to depths ranging from 67.5 feet to 74.5 feet, elevation ranging from -61.5 feet +/- to -67.5 feet +/-. Borings B-1 and B-3 were completed using 2-1/4 inch hollow stem augers. Boring B-2 was completed using 3 inch casing. Rod probing started at depths ranging from 22 to 32 feet below ground surface. Standard Penetration Tests (SPT) were performed continuously in Boring B-1 and in increments of 5 feet below the pavement in Borings B-2 and B-3. Soils were visually classified (*ASTM D2488*) using SPT split spoon sampling (*ASTM D1586*).

Undisturbed tube samples were collected in Boring B-2 at 15 feet and 30 feet. Field vanes were performed in the glacial marine in Boring B-2.

We understand the client survey located the boring locations; therefore, an approximate boring location plan is attached in *Appendix A*.

Laboratory Testing

Laboratory testing was performed at the following locations and depths:

LABORATORY TEST RESULTS				
Location	**Depth (ft)**	**Soil Type**	**Type of Test**	**Results**
B-1	10 to 12	Organic SILT, trace Clay	Moisture Content	100.4%
	12 to 14	Organic SILT, little Clay	Moisture Content	103.5%
	15 to 17	Organic SILT, little-some Clay	Moisture Content	84.9%
	17 to 19	Organic SILT, little-some Clay	Moisture Content	97.2%
	20 to 22	Clayey SILT, occasional Organics	Moisture Content	58.7%
	25 to 26.2	Organic SILT, little-some Clay	Moisture Content	85.3%
	26.2 to 26.6	Silty PEAT, occasional fibers	Moisture Content	264.4%
B-2	10 to 12	Organic SILT, little Sand	Moisture Content	77.1%
	15 to 17.5	Organic SILT, little-some fine Sand	Tube Opening Moisture Content 1-D Consolidation	γ_{sat} = 112 pcf MC = 37.8%
	20 to 22	Clayey SILT, little Sand	Moisture Content	47.4%
	30 to 32.5	Organic CLAY, some Silt	Tube Opening Moisture Content Atterberg Limit 1-D Consolidation	γ_{sat} = 93 pcf MC = 61.6% LL = 95 PI = 67
B-3	15 to 17	Silty PEAT, little Clay	Moisture Content	274.1%
	20 to 22	Organic SILT, little-some Clay	Moisture Content	149.2%

Detailed results of the laboratory testing can be found in *Appendix C*.

Subsurface Conditions

From the explorations, the soil at this site generally consists of the following:

- **Pavement** (3.5 to 5.5 inches thick)
- **Fill** (6.5 to 14.7 feet thick)
- **Saltmarsh Wetland** (9 to 29 feet thick)
- **Probable Glacial Marine Clay** (5 to 23 feet thick)
- **Probable Marine Sand** (11.5 to >45.5 feet thick)
- **Probable Glacial Till** (2 feet thick)

Pavement was encountered in all borings and is 3.5 to 5.5 inches thick.

The **fill** generally consists of sand with varying constituents of silt and gravel. An organic silt layer was observed in the fill in Boring B-1 that contained frequent woody fibers. Occasional wood pieces were observed. It is loose to dense and humid to saturated. It is 6.5 to 14.7 feet thick and is visually classified as SP, SP-SM, or SM in accordance with the Unified Soil Classification System (USCS). SPT-N values range from 11 blows per foot (bpf) to 63 bpf and average 22 bpf. Fill was observed in all borings.

The **saltmarsh wetland** generally consists of organic silt to silty peat with varying constituents of clay and sand. Occasional woody fibers were observed. It is very soft to soft and wet to saturated. It is 9 to 29 feet thick and is visually classified as OL, OH, ML, or PT in accordance with the USCS. SPT-N values range from weight of hammer (WH) to 5 bpf and average WH. Moisture contents ranged from 47.4% to 274.1%. The LL and PI for the organic clay sample at 30 feet below ground surface in Boring B-2 is 95 and 67, respectively. Field vanes performed in the saltmarsh wetland ranged from 1,350 psf to greater than 1,500 psf. Pocket penetrometers performed in the saltmarsh wetland ranged from 1 tsf to 1.25 tsf. Saltmarsh wetland was observed in all borings.

Probable glacial marine clay was observed in all borings based on blow counts, field vane values, and interpolation. It was observed starting at an approximate depth of 24 to 38 feet below ground surface (BGS) and is 5 to 23 feet thick. SPT-N values range from WH to 4 bpf and average WH. Field vanes in this layer ranged from 450 psf to 750 psf and averaged 560 psf.

Probable marine sand was observed in all borings, starting at a depth of 29 to 56 feet below ground surface, based on blow counts and is 11.5 to greater than 45.5 feet thick. SPT-N values range from 3 bpf to 14 bpf and average 9 bpf.

Probable glacial till was observed in Boring 2, starting at a depth of 71 feet below ground surface, based on blow counts and is 2 feet thick. SPT-N values range from 34 bpf to 35 bpf and average 35 bpf.

Detailed descriptions of the soil can be found in *Appendix B.*

Groundwater was measured or estimated at the following depths and elevations:

GROUNDWATER DEPTHS AND ELEVATIONS			
Location	Depth (ft +/-)	Elevation (ft +/-)	Reference
B-1	3.5	2.5	Observed in sample
B-2	5	1	Observed in sample
B-3	4	2	Observed on tooling after augering to 5'

Bedrock was encountered at the following depths and elevations:

BEDROCK DEPTHS AND ELEVATIONS		
Location	Depth (ft)	Elevation (ft +/-)*
B-1	67.5	-61.5
B-2	> 73	< -67
B-3	> 74.5	< -67.5

*Bedrock elevations were determined from solid stem probe refusal depths.

Probable bedrock was encountered in Boring B-1 at a depth of 67.5 feet (elevation -61.5 feet +/-).

Geotechnical Considerations

A geotechnical concern with raising the road is the presence of organic and soft clay soils. These soils will likely consolidate with a grade raise.

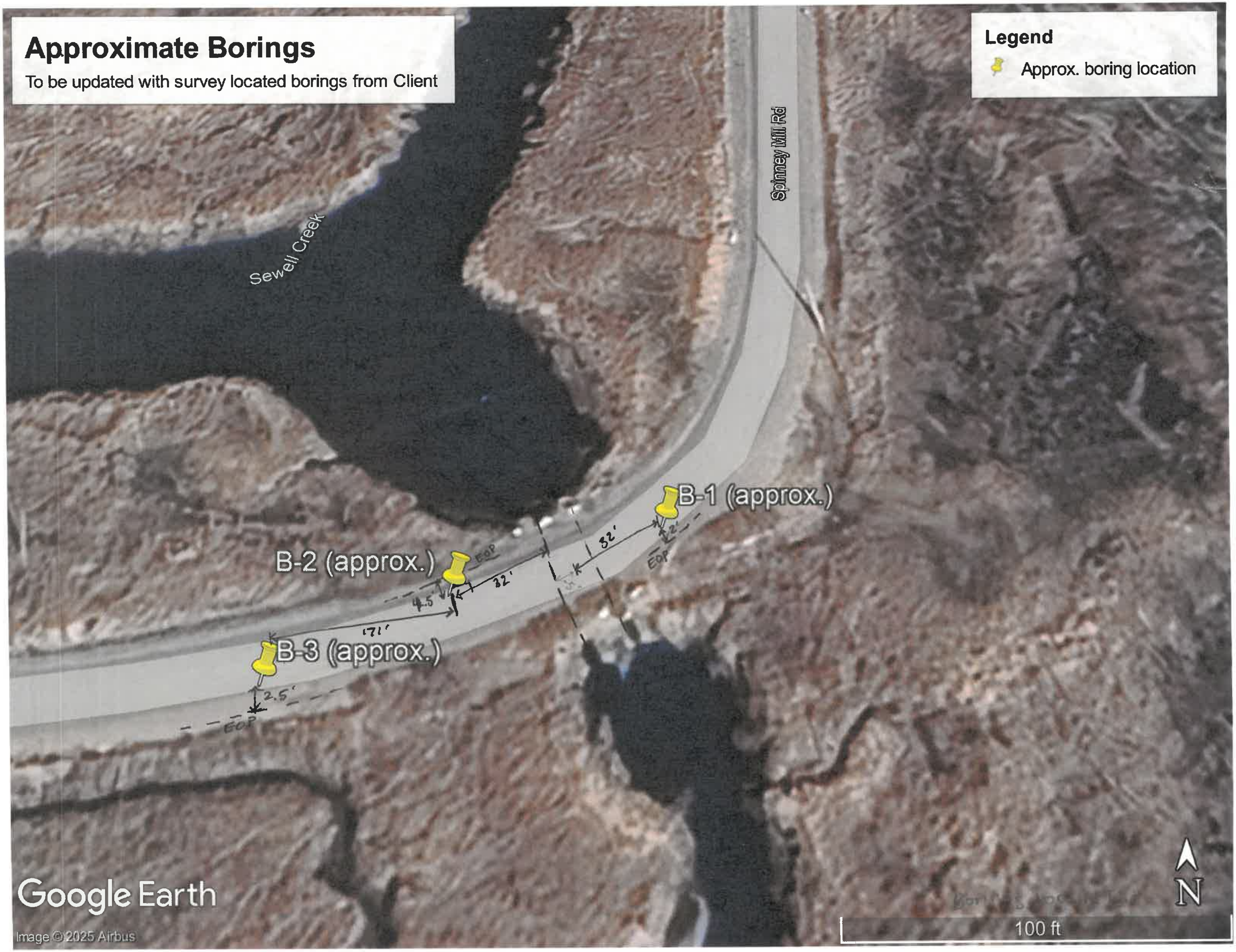
We understand the road is currently 16 to 20 feet wide and may be raised 4 feet. Preloading the roadway may be an option to raise the road and allow time for the organic and clay soils to consolidate, pending a settlement analysis. We understand that a portion of the road may have been built on sawdust. If a surcharge is used to shorten the preload duration, the sawdust might rebound after the surcharge is removed. The excavation of test pits would help to confirm the presence of sawdust underneath the existing roadway.

If the culvert is replaced with a bridge structure, the bridge may be able to be supported on deep timber piles driven into the marine sand until met with resistance, pending an analysis to confirm.

A logistical consideration with construction on the roadway will be to allow traffic through the area of interest during construction, since there is no outlet at the other end of the road. It is possible that the roadway can be left unpaved and allowed to settle while traffic is passing. Once settlement ceases or reaches an acceptable limit (considering keeping future settlement to within a defined tolerance) the road can be shimmed and paved. In order to estimate when the roadway can be shimmed and paved, settlement monitoring can be implemented.

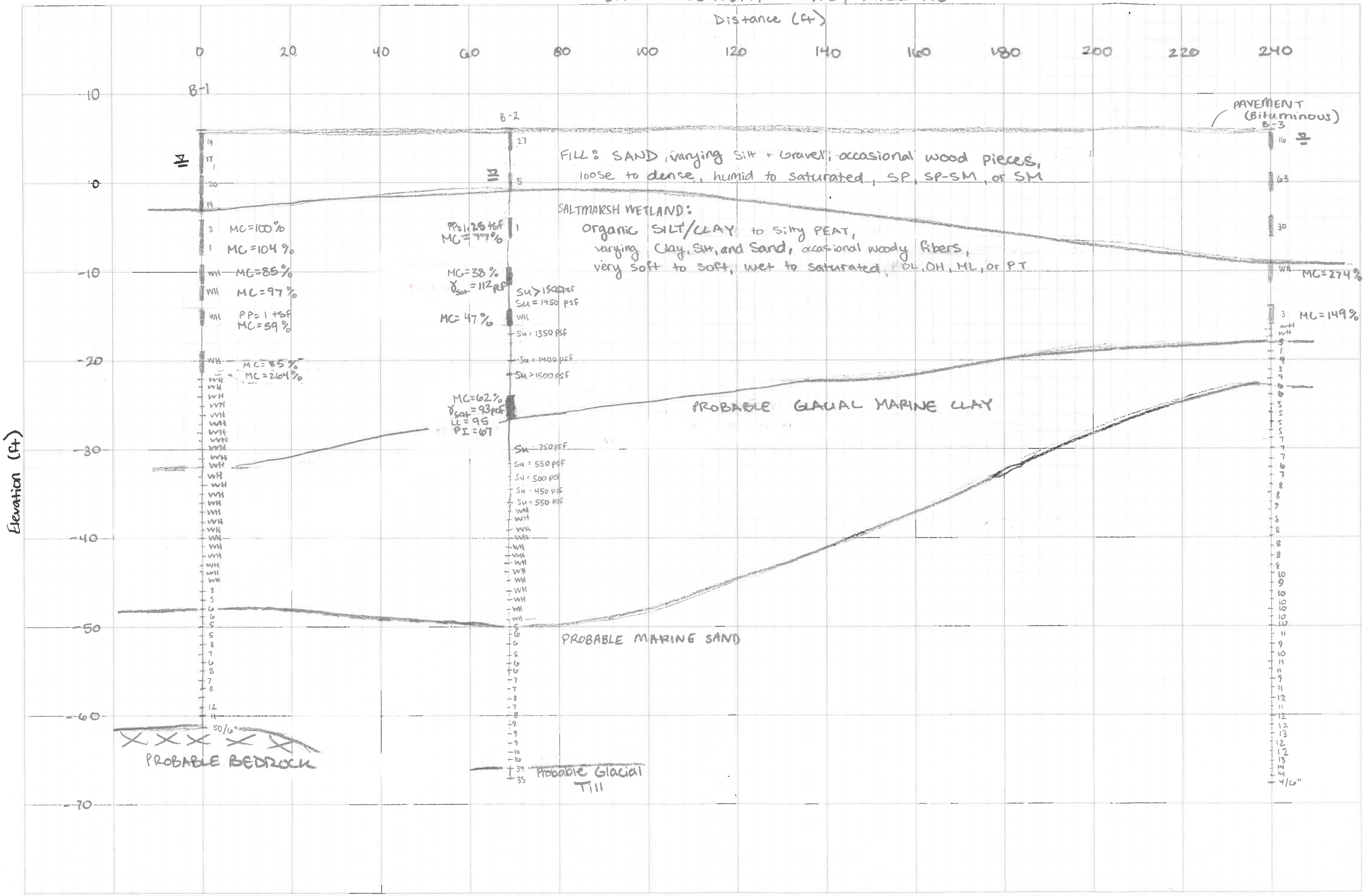
Appendix A

Exploration Location Plan



Approximate Borings
To be updated with survey located borings from Client
Legend
Approx. boring location
Sewell Creek
Spinney Mill Rd
B-1 (approx.)
B-2 (approx.)
B-3 (approx.)
32'
32'
171'
4.5'
2'
2.5'
EOP
EOP
EOP
Google Earth
Image © 2025 Airbus
100 ft
N

CROSS SECTION, SPINNEY MILL RD



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PROJECT TIDAL CROSSING IMPROVEMENT
PROJECT# 25102
SHEET 1 OF 1
DATE 06/09/2025
BY GJD CHK ELD

Appendix B

Exploration Logs

SUMMIT GEOENGINEERING SERVICES

SOIL BORING LOG

Boring #:	B-1		
Project:	Tidal Crossing Improvement	Project #:	25102
Location:	Spinney Mill Road	Sheet:	1 of 4
City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	3.5 feet	2.5 feet +/-	Observed in sample
6/3/2025	9.3 feet	- 3.3 feet +/-	Measured in 25 ft of Augers

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
						5" Bituminous Pavement		PAVEMENT
1	S-1	24/14	0.6 - 2.6	11		Dark brown SAND, some Gravel, trace-little Silt,		
				8		compact, damp, SP		
2				6				
				5				
3	S-2	24/7	2.6 - 4.6	7		Olive gray fine SAND, trace Silt & Gravel, compact,		
				10		moist, SP		
4				7		Gray Silty SAND, little Gravel, compact, wet, SM		
				8				FILL
5								
	S-3	24/13	5 - 7	3		Same as above, loose-compact, saturated, SM		
6				10		Dark brown Organic SILT, frequent woody fibers,		
				10		firm-stiff, saturated, ML-OL		
7				26		Wood in spoon tip		
	S-4	24/8	7 - 9	18		Gray Silty fine SAND, little-some Gravel, compact,		
8				7		saturated, SM		
				7				
9				7	-3+/-	Wood in spoon tip		
10								
	S-5	24/20	10 - 12	3		Dark brown Organic SILT, trace Sand & Clay, frequent	MC = 100.4%	
11				2		woody fibers, soft, saturated, OL		
				1				
12				1				
	S-6	24/20	12 - 14	1		Dark brown Organic SILT, little Clay, occasional woody	MC = 103.5%	
13				1		fibers, very soft, wet, OL to OH		
				WH				
14				WH				
15								
	S-7	24/24	15 - 17	WH		Brown to gray Organic SILT, little-some Clay, occasional	MC = 84.9%	SALTMARSH
16				WH		woody fibers, very soft, wet, OH		WETLAND
				WH				
17				WH				
	S-8	24/24	17 - 19	WH		Same as above, very soft, wet, OH	MC = 97.2%	
18				WH				
				WH				
19				3				
20								
	S-9	24/24	20 - 22	WH		Gray Clayey SILT, trace-little Sand, occasional drop stone	PP = 1 tsf	
21				WH		& Organics, very soft, wet, ML	MC = 58.7%	
				WH				
22				WH				

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES	**SOIL BORING LOG**		Boring #:	**B-1**
	Project:	Tidal Crossing Improvement	Project #:	25102
	Location:	Spinney Mill Road	Sheet:	2 of 4
	City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH			
Date	Depth	Elevation	Reference
6/3/2025	3.5 feet	2.5 feet +/-	Observed in sample
6/3/2025	9.3 feet	- 3.3 feet +/-	Measured in 25 ft of Augers

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
23								
24								
25								
	S-10	24/24	25 - 27	WH		Gray Organic SILT, little-some Clay, very soft, wet, OH	MC = 85.3%	
26				WH				
				WH		Dark brown Silty PEAT, little Clay, occasional woody fibers, very soft, wet, PT	MC = 264.4%	
27				1				
			PROBE	WH				
28								
29								
30								SALTMARSH WETLAND
31								
32								
33								
34								
35								
36								
37								
38					-32+/-			
39								
40								
41								
42								PROBABLE GLACIAL MARINE CLAY
43								
44								

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Bedrock Joints Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees
Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES	SOIL BORING LOG	Boring #:	B-1
	Project: Tidal Crossing Improvement	Project #:	25102
	Location: Spinney Mill Road	Sheet:	3 of 4
	City, State: Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services
Driller:	Shawn Floyd
Summit Staff:	Ellis Dixon, E.I., Georgia Doore
Boring Elevation:	6 feet +/-
Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Date started:	6/3/2025
Date Completed:	6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	3.5 feet	2.5 feet +/-	Observed in sample
6/3/2025	9.3 feet	- 3.3 feet +/-	Measured in 25 ft of Augers

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE	WH				
44								
45								
46								
47								
48								PROBABLE GLACIAL MARINE CLAY
49								
50								
51								
52								
53								
54								
55				3				
56				3	-50+/-			
						Denser stratum		
57				6				
58				6				
59				5				
60				5				PROBABLE MARINE SAND
61				3				
62				7				
63				6				
64				8				
65				7				
				8				

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Bedrock Joints Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES	SOIL BORING LOG		Boring #:	B-1
	Project:	Tidal Crossing Improvement	Project #:	25102
	Location:	Spinney Mill Road	Sheet:	4 of 4
	City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	3.5 feet	2.5 feet +/-	Observed in sample
6/3/2025	9.3 feet	- 3.3 feet +/-	Measured in 25 ft of Augers

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE					
66			↓	12				PROBABLE MARINE SAND
67				11				
					-61.5+/-			
68				50/6"		End of Exploration at 67.5 feet; Refusal on Probable Bedrock		PROBABLE BEDROCK
69								
70								
71								
72								
73								
74								
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								

Granular Soils		Cohesive Soils		% Composition	NOTES:		Soil Moisture Condition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487		PP = Pocket Penetrometer, MC = Moisture Content	
						LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test	Dry: S = 0%
0-4	V. Loose	<2	V. soft		Bedrock Joints	Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength	Humid: S = 1 to 25%
5-10	Loose	2-4	Soft	< 5% Trace	Shallow = 0 to 35 degrees		Damp: S = 26 to 50%
11-30	Compact	5-8	Firm	5-15% Little	Dipping = 35 to 55 degrees		Moist: S = 51 to 75%
31-50	Dense	9-15	Stiff	15-30% Some	Steep = 55 to 90 degrees		Wet: S = 76 to 99%
>50	V. Dense	16-30	V. Stiff	> 30% With			Saturated: S = 100%
		>30	Hard		Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches		
					Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200		

SUMMIT GEOENGINEERING SERVICES	**SOIL BORING LOG**		Boring #:	**B-2**
	Project:	Tidal Crossing Improvement	Project #:	25102
	Location:	Spinney Mill Road	Sheet:	1 of 4
	City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	3" Casing	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	5 feet	1 foot +/-	Observed in sample
6/3/2025	23.9 feet	-17.9 feet +/-	Measured in open hole

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
						5.5" Bituminous Pavement		PAVEMENT
1	S-1	24/16	0.6 - 2.6	19		Dark brown medium SAND, trace Silt, trace-little		FILL
				16		Gravel, dense, humid, SP		
2				11		Brown SAND, trace Silt & Gravel, compact-dense		
				11		humid, SP		
3								
4								
5								
	S-2	24/4	5 - 7	2		Gray Silty SAND, trace-little Gravel, loose, saturated,		
6				3		SM		
				2				
7				1	-1+/-			
						Spoon tip: Gray SILT, trace Sand & Clay, soft,		SALTMARSH WETLAND
8						wet-saturated, ML		
9								
10								
	S-3	24/24	10 - 12	WH		Dark brown Organic SILT, little Sand, trace Clay, frequent	PP = 1.25 tsf	
11				WH		woody fibers, very soft, wet, OL	MC = 77.1%	
				1				
12				2				
						Change to 3" casing		
13								
14								
15								
	UT-1	30/26	15 - 17.5	PUSH		Dark gray-brown Organic SILT, little-some fine Sand,	MC = 37.8%	
16				↓		frequent Organic fibers, occasional shells & seaweed,	γ_{sat} = 112 pcf	
						soft, wet, OL		
17								
18								
	FV-1					S_u > 1500 psf		
19								
20	FV-2					S_u = 1450 psf		
	S-4	24/18	20 - 22	WH*		Dark gray Clayey SILT, little Sand, trace Organics, very	MC = 47.4%	
21				WH*		soft, wet, ML		
				WH				
22				WH				
						* Disturbed by field vanes		

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES	SOIL BORING LOG		Boring #:	B-2
	Project:	Tidal Crossing Improvement	Project #:	25102
	Location:	Spinney Mill Road	Sheet:	2 of 4
	City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	3" Casing	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH			
Date	Depth	Elevation	Reference
6/3/2025	5 feet	1 foot +/-	Observed in sample
6/3/2025	23.9 feet	-17.9 feet +/-	Measured in open hole

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
23	FV-3					S_u = 1350 psf		
24								
25								SALTMARSH WETLAND
26	FV-4					S_u = 1400 psf		
27								
	FV-5					S_u > 1500 psf		
28								
29								
30					-24+/-			
	UT-2	30/26	30 - 32.5	PUSH		Dark gray Organic CLAY, some Silt, occasional Organic fibers, soft, wet, OH	LL = 95	
31							PI = 67	
							MC = 61.6%	
32							γ_{sat} = 93 pcf	
33								
34	FV-6					S_u = 750 psf		
35								
	FV-7					S_u = 550 psf		
36								
37	FV-8					S_u = 500 psf		GLACIAL MARINE
38								
	FV-9					S_u = 450 psf		
39								
			PROBE	WH				
40	FV-10					S_u = 550 psf		
41								
42								
43								
44								

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES

SOIL BORING LOG

Boring #:	B-2	Project #:	25102
Project:	Tidal Crossing Improvement	Sheet:	3 of 4
Location:	Spinney Mill Road	Chkd by:	WMP
City, State:	Arrowsic, ME		

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	3" Casing	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	5 feet	1 foot +/-	Observed in sample
6/3/2025	23.9 feet	-17.9 feet +/-	Measured in open hole

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE	WH				
44								
45								
46								
47								PROBABLE GLACIAL MARINE CLAY
48								
49								
50								
51								
52								
53								
54								
55					-49+/-			
						Denser stratum		
56				5				
57				6				
58				6				
59				5				
60				6				PROBABLE MARINE SAND
61				6				
62				7				
63				7				
64				8				
65				7				
				8				

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES	SOIL BORING LOG		Boring #:	B-2
	Project:	Tidal Crossing Improvement	Project #:	25102
	Location:	Spinney Mill Road	Sheet:	4 of 4
	City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	3" Casing	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	5 feet	1 foot +/-	Observed in sample
6/3/2025	23.9 feet	-17.9 feet +/-	Measured in open hole

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE					
66				8				PROBABLE MARINE SAND
67				9				
68				9				
69				9				
70				10				
71				16	-65+/-			
						Denser Stratum		PROBABLE GLACIAL TILL
72				34				
73				35	-67+/-			
						End of Exploration at 73 feet; Not Refusal		
74								
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES

SOIL BORING LOG

Boring #:	B-3		
Project:	Tidal Crossing Improvement	Project #:	25102
Location:	Spinney Mill Road	Sheet:	1 of 4
City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	4 feet	2 feet +/-	Observed on tooling after augering to 5'

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
						3.5" Bituminous Pavement		PAVEMENT
1	S-1	24/11	0.7 - 2.7	7		Brown SAND, little-some Silt, trace Gravel, 1.5"		
				6		stone at 1.5', compact, damp, SP-SM		
2				10				
				12		Black Silty SAND, trace-little Gravel, compact, damp-		
3						moist, SM		
4								
5								
	S-2	24/17	5 - 7	8		Gray medium-coarse SAND, trace-no Silt, trace		
6				39		Gravel, compact, dense, wet, SP		
				24		White ROCK, crushed in spoon		FILL
7				21		0.5" Bituminous pavement layer at 7'		
						In spoon tip: Olive gray SAND, little Silt, trace		
8						Gravel, dense, wet, SP-SM		
9								
						Encountered Running Sand at 10', pull casing and		
10						resample at 10'		
	S-3	24/3	10 - 12	16		Gray Silty SAND, little Gravel, compact, wet, SM		
11				20				
				10				
12				6				
13								
14								
15					-9+/-			
	S-4	24/24	15 - 17	WH		Dark brown Silty PEAT, little Clay, occasional woody	MC = 274.1%	
16				WH		fibers, very soft, wet, PT		
				WH				
17				WH				
18								
19								SALTMARSH WETLAND
20								
	S-5	24/24	20 - 22	WH		Dark brown Organic SILT, little-some Clay, occasional	MC = 149.2%	
21				2		woody fibers, soft, wet, OH		
				1				
22				1		Wood in spoon tip		

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Bedrock Joints Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SOIL BORING LOG

SUMMIT GEOENGINEERING SERVICES	Project: Tidal Crossing Improvement	Boring #:	B-3
	Location: Spinney Mill Road	Project #:	25102
	City, State: Arrowsic, ME	Sheet:	2 of 4
		Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	4 feet	2 feet +/-	Observed on tooling after augering to 5'

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE					
23				WH				SALTMARSH WETLAND
24				WH	-18+/-			
25				3		Denser Stratum		PROBABLE GLACIAL MARINE CLAY
26				1				
27				4				
28				3				
29				4	-23+/-			
30				6		Denser Stratum		PROBABLE MARINE SAND
31				6				
32				5				
33				5				
34				5				
35				5				
36				7				
37				7				
38				7				
39				6				
40				7				
41				8				
42				8				
43				9				
44				8				
				8				

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Bedrock Joints Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SUMMIT GEOENGINEERING SERVICES	SOIL BORING LOG		Boring #:	B-3
	Project:	Tidal Crossing Improvement	Project #:	25102
	Location:	Spinney Mill Road	Sheet:	3 of 4
	City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started: 6/3/2025	Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	4 feet	2 feet +/-	Observed on tooling after augering to 5'

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE			Probable Marine SAND		
44				8				
45				8				
46				8				
47				10				
48				9				
49				10				
50				10				
51				10				
52				10				
53				11				
54				9				
55				10				
56				11				PROBABLE MARINE SAND
57				11				
58				9				
59				11				
60				12				
61				11				
62				12				
63				11				
64				12				
65				12				
				13				

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

SOIL BORING LOG

SUMMIT GEOENGINEERING SERVICES		Boring #:	B-3
Project:	Tidal Crossing Improvement	Project #:	25102
Location:	Spinney Mill Road	Sheet:	4 of 4
City, State:	Arrowsic, ME	Chkd by:	WMP

Drilling Co:	Summit Geoengineering Services	Boring Elevation:	6 feet +/-
Driller:	Shawn Floyd	Reference:	Estimated from Maine 2ft Contours, Maine Geodatabase
Summit Staff:	Ellis Dixon, E.I., Georgia Doore	Date started:	6/3/2025 Date Completed: 6/3/2025

DRILLING METHOD		SAMPLER	
Vehicle:	Trailer	Length:	24" SS
Model:	9630 Pro	Diameter:	2"OD/1.5"ID
Method:	2-1/4" HSA	Hammer:	140 lb
Hammer Style:	Auto	Method:	ASTM D1586

ESTIMATED GROUND WATER DEPTH

Date	Depth	Elevation	Reference
6/3/2025	4 feet	2 feet +/-	Observed on tooling after augering to 5'

Depth (ft.)	No.	Pen/Rec (in)	Depth (ft)	blows/6"	Elev. (ft.)	SAMPLE DESCRIPTION	Geological/ Test Data	Geological Stratum
			PROBE					
66				13				
67				12				
68				12				
69				13				PROBABLE MARINE SAND
70				12				
71				14				
72				14				
73				13				
					-67.5+/-			
74				4/6"		End of Exploration at 74.5 feet; Not Refusal		
75								
76								
77								
78								
79								
80								
81								
82								
83								
84								
85								
86								
87								

Granular Soils		Cohesive Soils		% Composition
Blows/ft.	Density	Blows/ft.	Consistency	ASTM D2487
0-4	V. Loose	<2	V. soft	
5-10	Loose	2-4	Soft	< 5% Trace
11-30	Compact	5-8	Firm	5-15% Little
31-50	Dense	9-15	Stiff	15-30% Some
>50	V. Dense	16-30	V. Stiff	> 30% With
		>30	Hard	

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index, FV = Field Vane Test
Bedrock Joints Su = Undrained Shear Strength, Su(r) = Remolded Shear Strength
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees
Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

Soil Moisture Condition
Dry: S = 0%
Humid: S = 1 to 25%
Damp: S = 26 to 50%
Moist: S = 51 to 75%
Wet: S = 76 to 99%
Saturated: S = 100%

Appendix C

Laboratory Results

Laboratory Determination of Water (Moisture) Content of Soil ASTM D2216

PROJECT NAME:	Tidal Crossing	PROJECT #:	25102
PROJECT LOCATION:	Spinney Mill Road, Arrowsic, ME	DRYING METHOD:	Oven Dried
CLIENT:	Inter-fluve	DESCRIPTION:	Saltmarsh Wetland
SOURCE:	Borings	TECHNICIAN:	Georgia Doore
COLLECTION DATE:	06/03/25	TESTING DATE:	6/5/25 to 6/23/25

Location	Sample No.	Depth	Moisture Content	Remarks
B-1	S-5	10' - 12'	100.4%	Organic Silt, trace Clay
B-1	S-6	12' - 14'	103.5%	Organic Silt, little Clay
B-1	S-7	15' - 17'	84.9%	Organic Silt, little-some Clay
B-1	S-8	17' - 19'	97.2%	Organic Silt, little-some Clay
B-1	S-9	20' - 22'	58.7%	Clayey Silt, occ. organics
B-1	S-10A	25' - 26.2'	85.3%	Organic Silt, little-some Clay
B-1	S-10B	26.2' - 26.6'	264.4%	Silty Peat, occ. fibers
B-2	S-3	10' - 12'	77.1%	Organic Silt, little Sand
B-2	UT-1	15' - 17.5'	37.8%	(Tube Report)
B-2	S-4	20' - 22'	47.4%	Clayey Silt, little Sand
B-2	UT-2	30' - 32.5'	61.6%	(Atterberg Limit)
B-3	S-4	15' - 17'	274.1%	Silty Peat, little Clay
B-3	S-5	20' - 22'	149.2%	Organic Silt, little-some Clay

REMARKS:

Reviewed By: CRS

Mailing: PO Box 515, Gardiner, ME 04345
Office: 210 Maine Avenue, Farmingdale, ME 04344

THIN WALLED TUBE SAMPLING - ASTM D1587

PROJECT NAME:	Tidal Crossing	PROJECT #:	25102
PROJECT LOCATION:	Spinney Mill Rd., Arrowsic, ME	CLIENT:	Inter-Fluve
COLLECTION DATE:	6/3/2025	SAMPLE #:	UT-1
TEST DATE:	6/23/2025	TECHNICIAN:	Erika Stewart, P.E.

Test Boring Information

Boring Number: B-2
Drilling Method: Direct Push
Drilling Tooling: 3-inch Casing
Sampling Method: Push

Sample Information

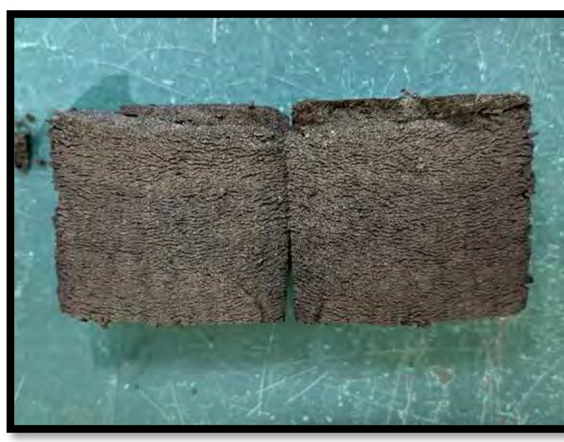
Tube Length: 30"
Recovery: 26"
Tube Diameter: 2.5"
Depth: 15' - 17.5'

Trial / Specimen Number	Moisture Content	Unit Weight	Torvane
1	43.3%	114 pcf	540 psf
2	32.1%	116 pcf	800 psf
3	38.2%	105 pcf	540 psf
Average	37.8%	112 pcf	620 psf

Visual Description (ASTM D2488):

Dark Gray-brown Organic SILT, little-some fine Sand, frequent Organic fibers, occasional shells & seaweed, soft, wet, OL

Photograph of cross sectional sample view.



Photograph of longitudinal sample view.

REMARKS:

Reviewed By: CRS

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Office: 210 Maine Avenue, Farmingdale, ME 04344

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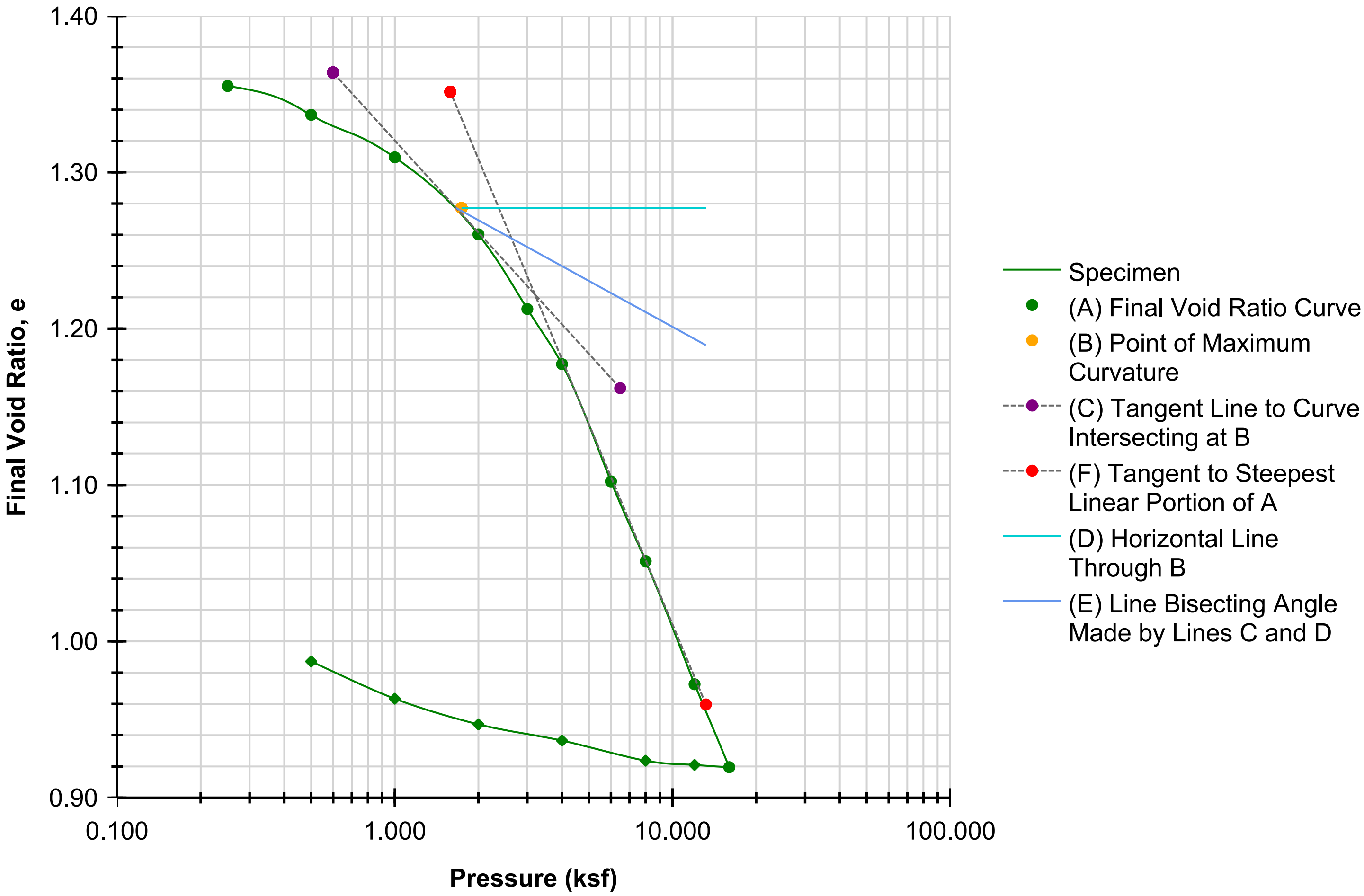
207-446-3360

Final Voids [Log]

ASTM D2435



Preconsolidation Stress (ksf)	2.631	**Cc**	0.436	**Cr**	0.044

	BEFORE	AFTER			
			Liquid Limits	0	**Test Date** 6/23/2025
Moisture (%)	53.8	40.3	**Plastic Limits**	0	
Dry Density (pcf)	67.2	80.8			
Saturation (%)	100.3	106.0			
Void Ratio	1.37	0.97	**Specific Gravity**	2.55	ASSUMED

Sample Description	Dark gray-brown Organic SILT, little-some fine Sand, occ. organic fibers, soft, wet, OL			
Project Number	25102	**Depth (ft)**	15 - 17.5	**Remarks**
Sample Number	UT-1	**Boring Number**	B-2	
Project	Tidal Crossing			
Client	Inter-Fluve			
Location	Spinney Mill Rd., Arrowsic, ME			

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Consolidated Test Results

ASTM D2435

Project:	Tidal Crossing
Project Number:	25102
Job Number:	25102
Test Date:	6/23/2025

Sampling Date:	6/3/2025
Sample Number:	UT-1
Depth (ft)	15 - 17.5
Boring Number:	B-2
Location:	Spinney Mill Rd., Arrowsic, ME
Client Name:	Inter-Fluve
Remarks:	

Specific Gravity:	2.55	Plastic Limit:	0	Liquid Limit:	0
Specific Gravity Method:	ASSUMED			Weight of Ring (g)	59.1
Sampling Method:	Undisturbed	Soil Classification:	OL		
Specimen Description:	Dark gray-brown Organic SILT, little-some fine Sand, occ. organic fibers, soft, wet, OL				

Parameters	Initial	Final
Height (in)	0.7845	0.6597
Height Source	NA	TEST RESULTS
Diameter (in)	2.0000	NA
Area (in²)	3.142	NA
Volume (in³)	2.4646	2.0725
Weight of Container (g)	13.0	12.2
Weight of Wet Soil + Container (g)	52.5	73.9
Weight of Dry Soil + Container (g)	38.7	56.2
Moisture Content (%)	53.8	40.3
Moist Weight + Ring Weight (g)	126.0	120.8
Dry Density (pcf)	67.2	80.8
Wet Density (pcf)	103.4	113.4
Saturation (%)	100.3	106.0
Void Ratio	1.4	1.0

SUMMIT
GEOENGINEERING SERVICES

THIN WALLED TUBE SAMPLING - ASTM D1587

PROJECT NAME: Tidal Crossing
PROJECT LOCATION: Spinney Mill Rd., Arrowsic, ME
COLLECTION DATE: 6/3/2025
TEST DATE: 6/17/2025

PROJECT #: 25102
CLIENT: Inter-Fluve
SAMPLE #: UT-2
TECHNICIAN: Ellis Dixon, E.I.

Test Boring Information

Boring Number: B-2
Drilling Method: Direct Push
Drilling Tooling: 3-inch Casing
Sampling Method: Shelby Tube

Sample Information

Tube Length: 30"
Recovery: 26"
Tube Diameter: 2.5"
Depth: 30' - 32.5'

Trial / Specimen Number	Moisture Content	Unit Weight	Torvane
1 *	59.1%	103 pcf	460 psf
2	98.7%	88 pcf	440 psf
3	97.9%	88 pcf	600 psf
Average	85.2%	93 pcf	500 psf

*Specimen 1 contained less organics than specimens 2 & 3.

Visual Description (ASTM D2488):

Dark gray Organic CLAY, some Silt, occasional Organic fibers, soft, wet, OH

Photograph of cross sectional sample view.

Photograph of longitudinal sample view.

REMARKS:

Reviewed By: CRS

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SUMMIT
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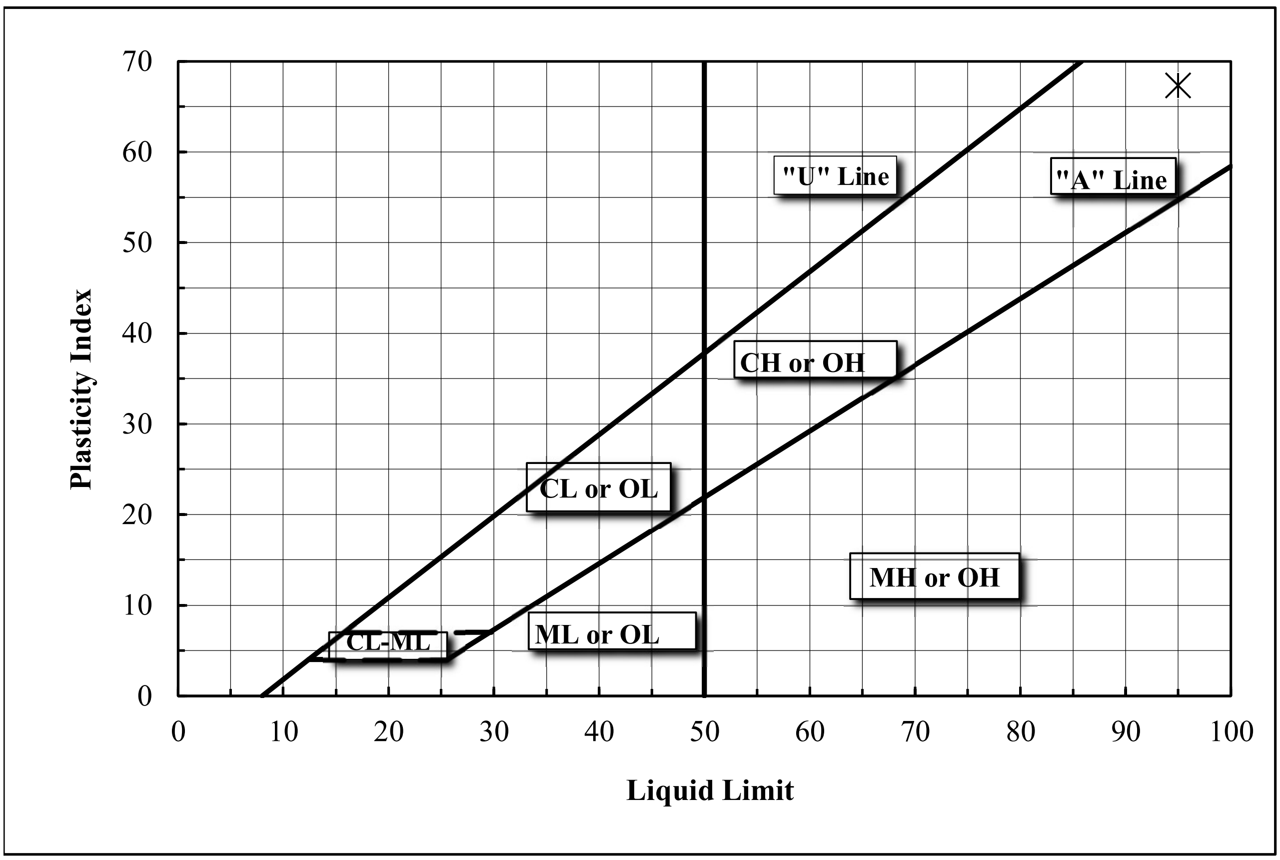
ATTERBERG LIMIT TEST - ASTM D4318

Method "A" (Multi-point)

PROJECT NAME:	Tidal Crossing	PROJECT NUMBER:	25102
LOCATION:	Spinney Mill Rd., Arrowsic, ME	SAMPLE NUMBER:	UT-2
CLIENT:	Inter-Fluve	DEPTH:	30' - 32.5'
TEST DATE:	6/18/2025	TECHNICIAN:	Ellis Dixon, E.I.

DATA

Source	Depth	LL	PL	PI	Classification
B-2	30' - 32.5'	95	28	67	Dark gray Organic CLAY, some Silt, occasional Organic fibers, OH



Notes: Moisture Content = 61.6%

Reviewed By: CRS

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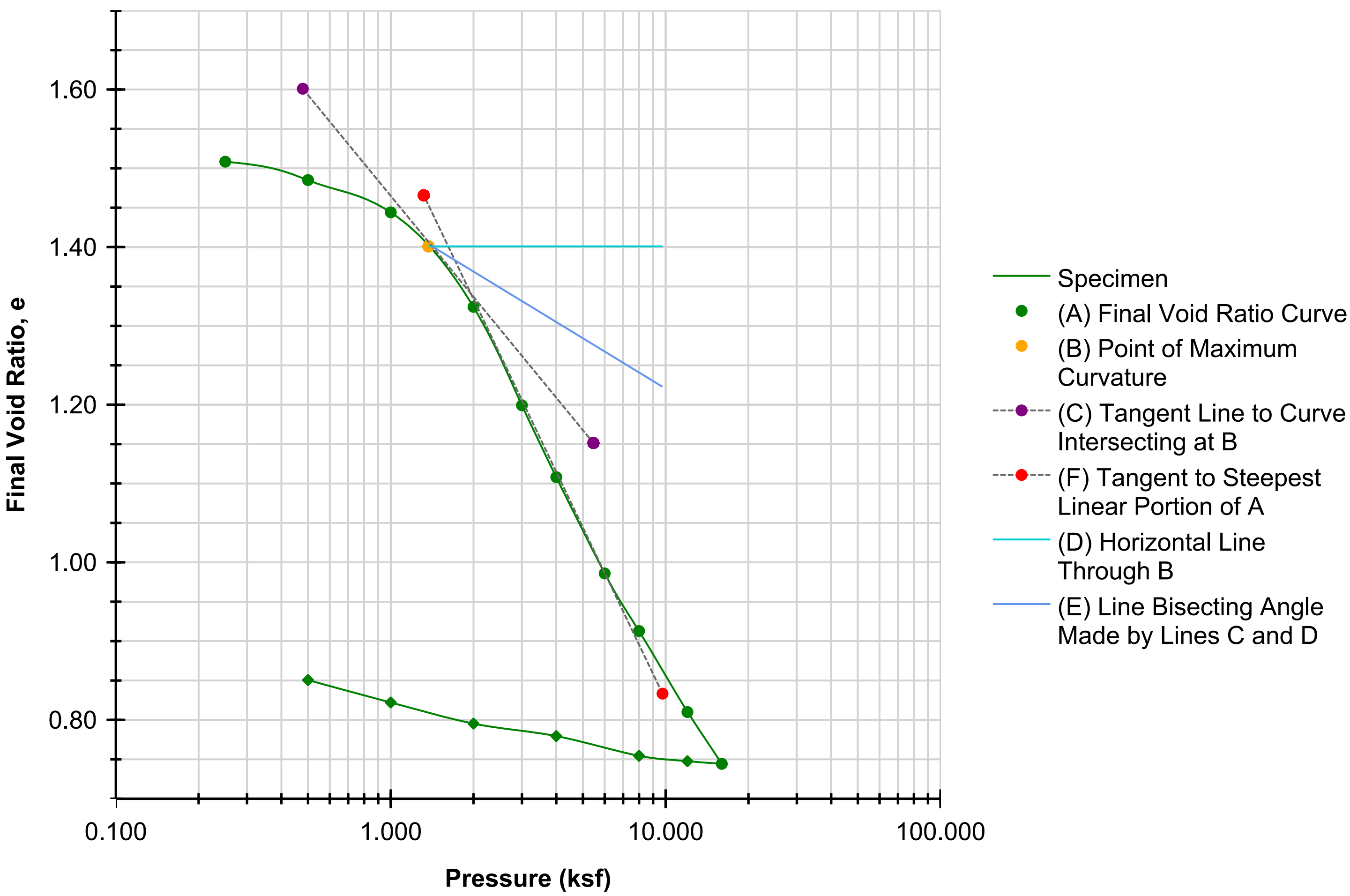
207-446-3360

Final Voids [Log]

ASTM D2435



Preconsolidation Stress (ksf)	1.711	**Cc**	0.753	**Cr**	0.075

	BEFORE	AFTER			
			Liquid Limits	95	**Test Date** 6/17/2025
Moisture (%)	57.2	47.0	**Plastic Limits**	28	
Dry Density (pcf)	61.7	77.2			
Saturation (%)	93.5	115.0			
Void Ratio	1.53	1.02	**Specific Gravity**	2.5	ASSUMED

Sample Description	Dark gray Organic CLAY, some Silt, occ. Organic fibers, soft, wet, OH			
Project Number	25102	**Depth (ft)**	30 - 32.5	**Remarks**
Sample Number	UT-2	**Boring Number**	B-2	
Project	Tidal Crossing			
Client	Inter-Fluve			
Location	Spinney Mill Rd., Arrowsic, ME			

Summit Geoengineering Services
210 Maine Avenue
Farmingdale, Maine 04344
207-446-3360

Consolidated Test Results

ASTM D2435

Project:	Tidal Crossing
Project Number:	25102
Job Number:	25102
Test Date:	6/17/2025

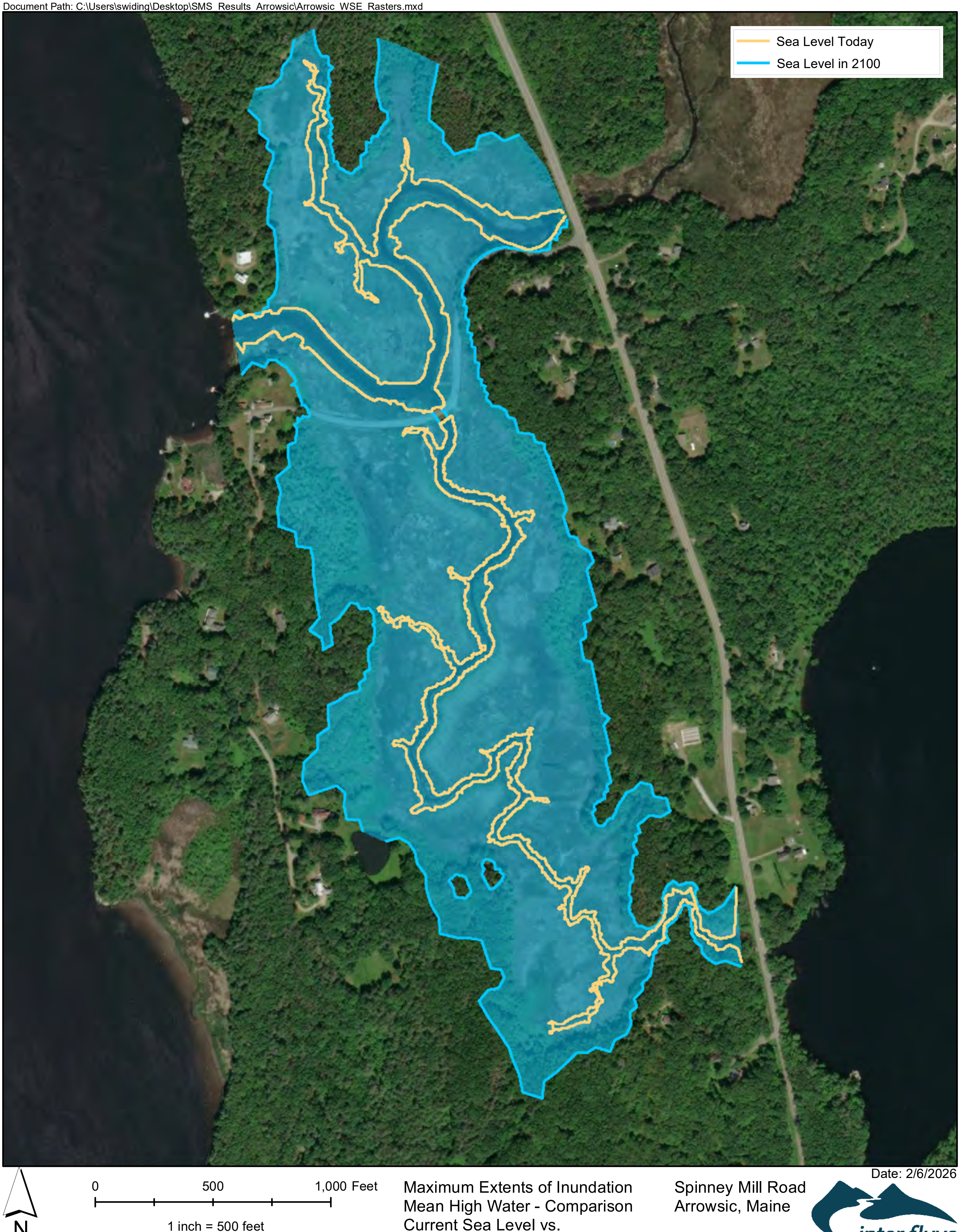
Sampling Date:	6/3/2025
Sample Number:	UT-2
Depth (ft)	30 - 32.5
Boring Number:	B-2
Location:	Spinney Mill Rd., Arrowsic, ME
Client Name:	Inter-Fluve
Remarks:	

Specific Gravity:	2.5	Plastic Limit:	28	Liquid Limit:	95
Specific Gravity Method:	ASSUMED			Weight of Ring (g)	60.0
Sampling Method:	Undisturbed	Soil Classification:	OH		
Specimen Description:	Dark gray Organic CLAY, some Silt, occ. Organic fibers, soft, wet, OH				

Parameters	Initial	Final
Height (in)	0.7758	0.5688
Height Source	NA	TEST RESULTS
Diameter (in)	2.0000	NA
Area (in^2)	3.142	NA
Volume (in^3)	2.4371	1.7870
Weight of Container (g)	13.3	14.5
Weight of Wet Soil + Container (g)	58.8	67.5
Weight of Dry Soil + Container (g)	42.3	50.6
Moisture Content (%)	57.2	47.0
Moist Weight + Ring Weight (g)	122.0	113.2
Dry Density (pcf)	61.7	77.2
Wet Density (pcf)	97.0	113.5
Saturation (%)	93.5	115.0
Void Ratio	1.5	1.0

Appendix B| Inundation Mapping

SRH-2D Model Results

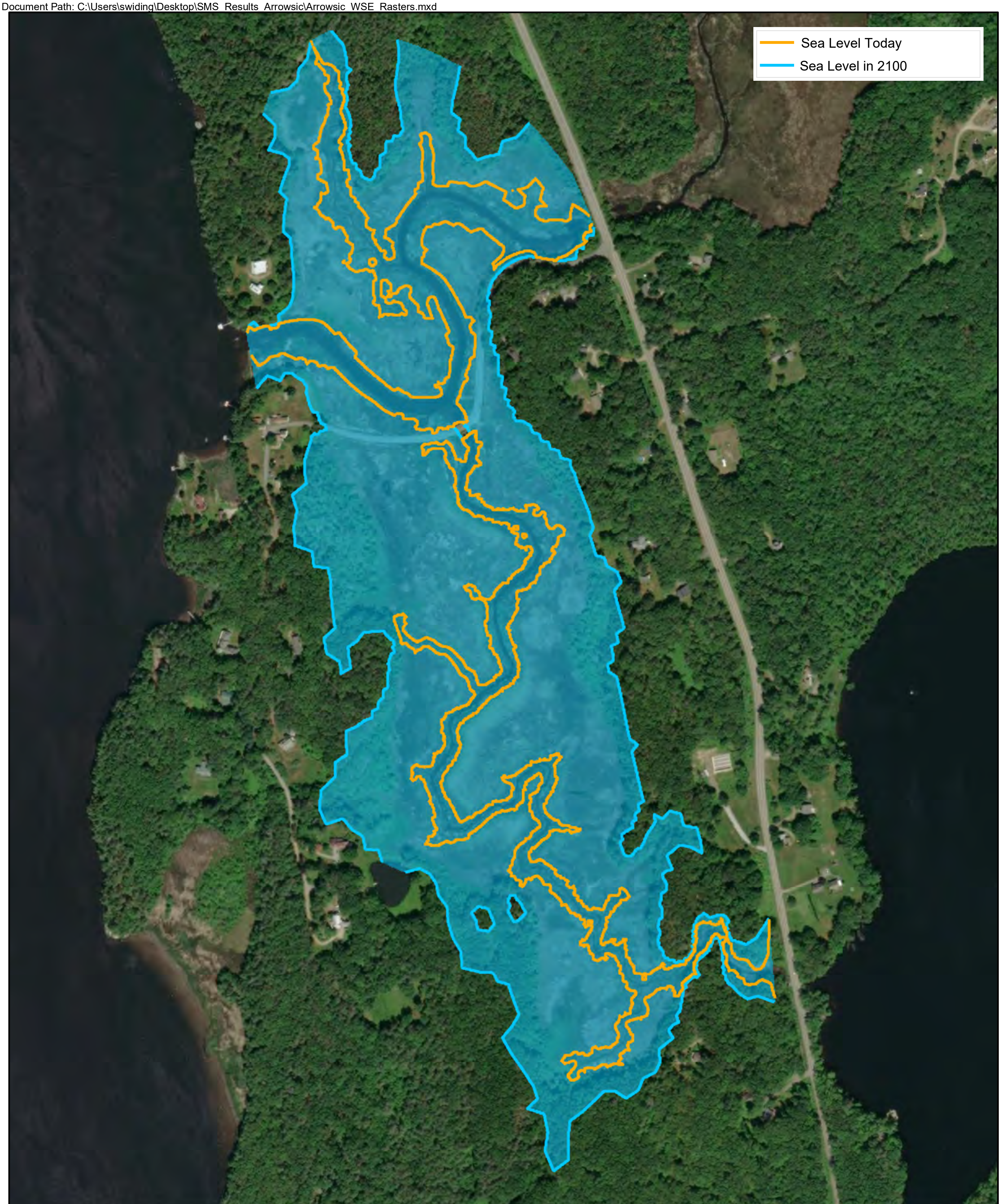


Maximum Extents of Inundation
Mean High Water - Comparison
Current Sea Level vs.
Sea Level in 2100 (+3.9 ft)

Spinney Mill Road
Arrowsic, Maine

Date: 2/6/2026

inter·fluve



N

0 500 1,000 Feet

1 inch = 500 feet

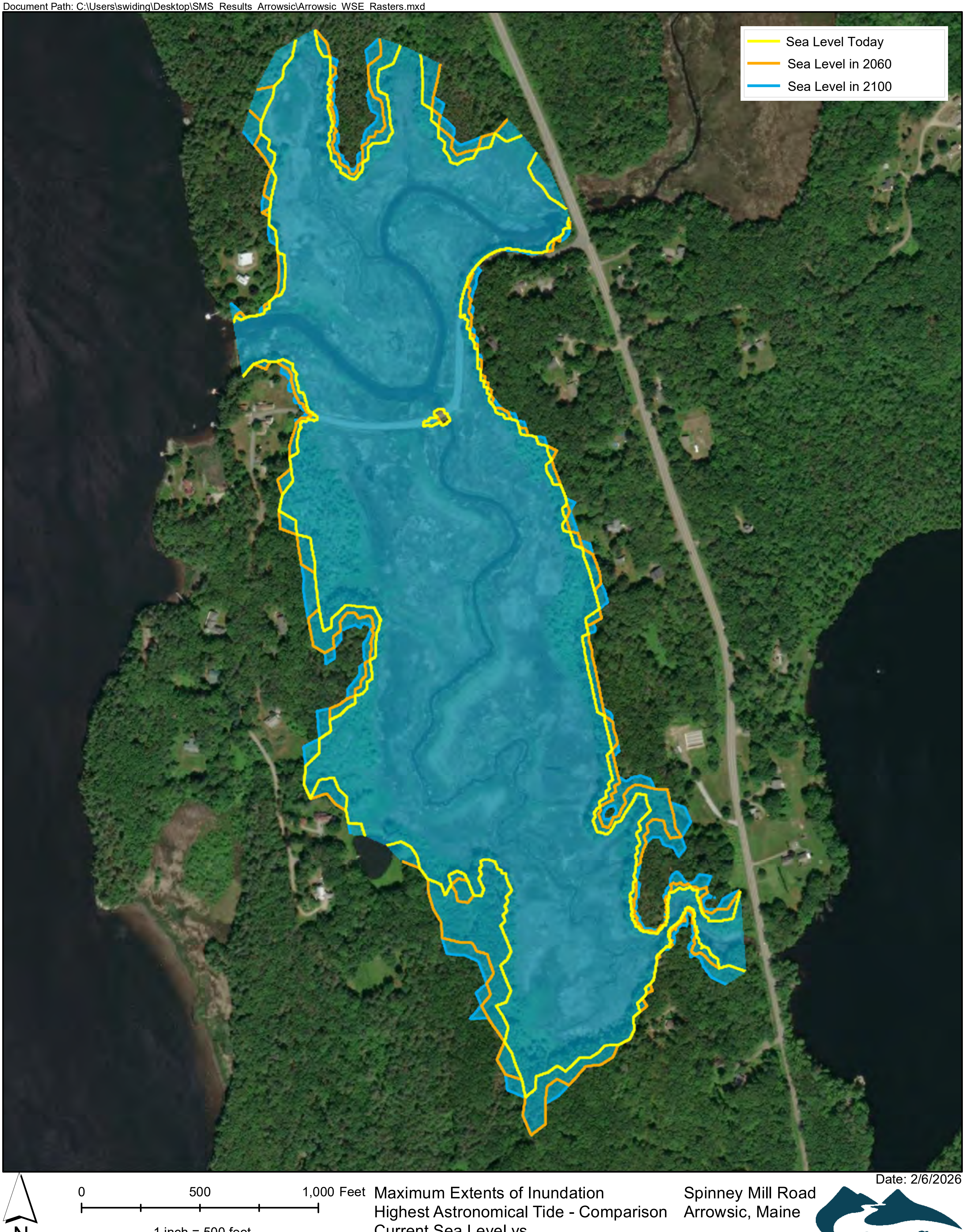
Maximum Extents of Inundation
Mean Higher High Water - Comparison
Sea Level Today vs.
Sea Level in 2100 (+3.9 ft)

Spinney Mill Road
Arrowsic, Maine

Date: 2/6/2026

inter·fluve

Document Path: C:\Users\swiding\Desktop\SMS_Results_Arrowsic\Arrowsic_WSE_Rasters.mxd



Date: 2/6/2026

Maximum Extents of Inundation
Highest Astronomical Tide - Comparison
Current Sea Level vs.
Sea Level in 2060 (+ 2.0 ft)
Sea Level in 2100 (+ 3.9 ft)

Spinney Mill Road
Arrowsic, Maine

inter·fluve

Document Path: C:\Users\swiding\Desktop\SMS_Results_Arrowsic\Arrowsic_WSE_Rasters.mxd

N

0 500 1,000 Feet

1 inch = 500 feet

Maximum Extents of Inundation
10-Year Flood Event - Comparison
Current Sea Level vs.
Sea Level in 2100 (+3.9 ft)

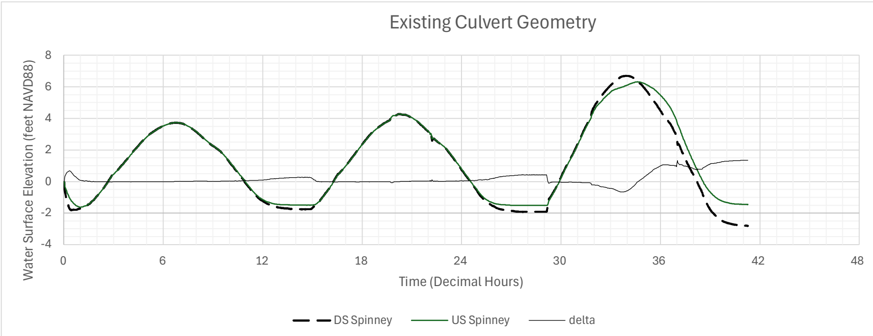
Spinney Mill Road
Arrowsic, Maine

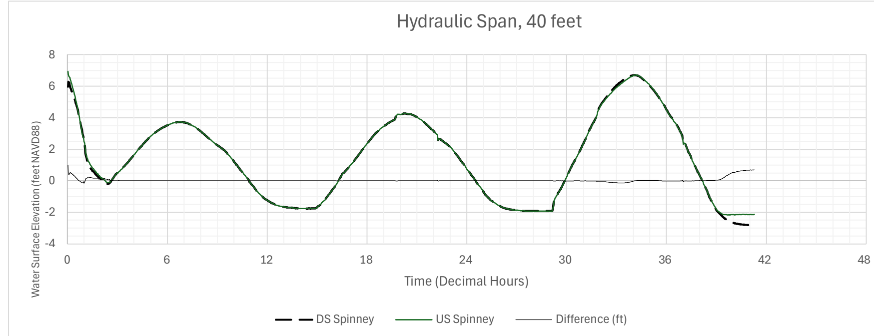
Date: 2/6/2026

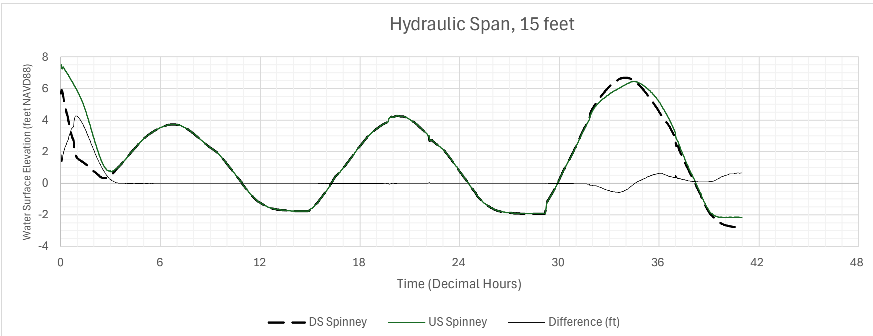
inter·fluve

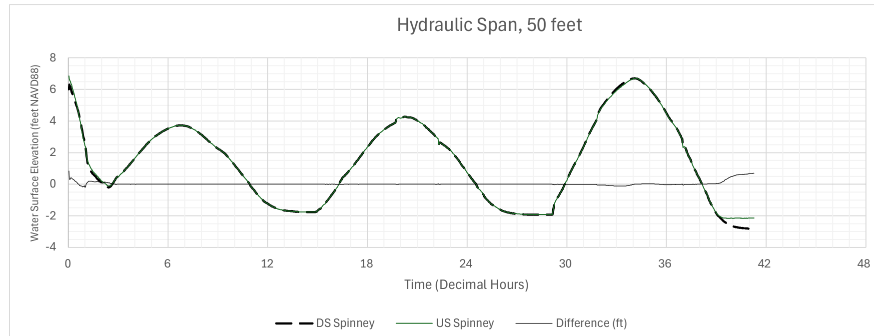
Appendix C| Model Output Hydrographs

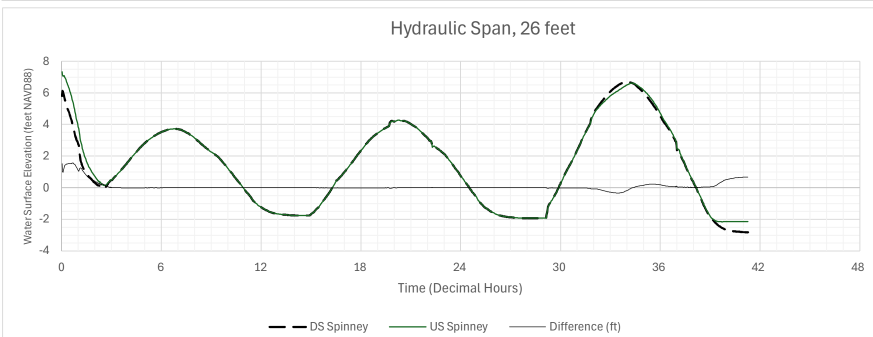
SRH-2D Model Results

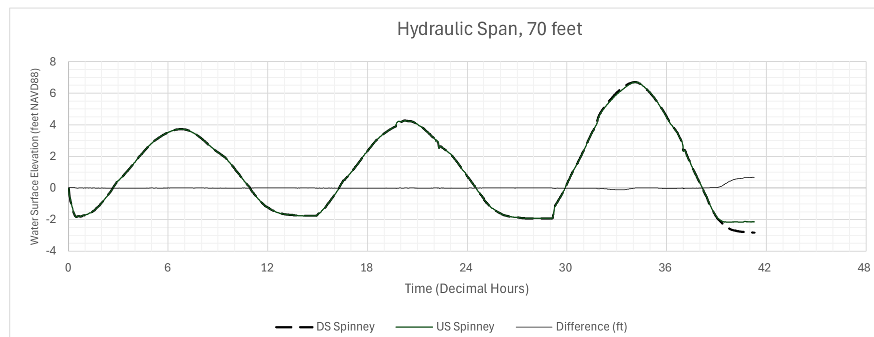




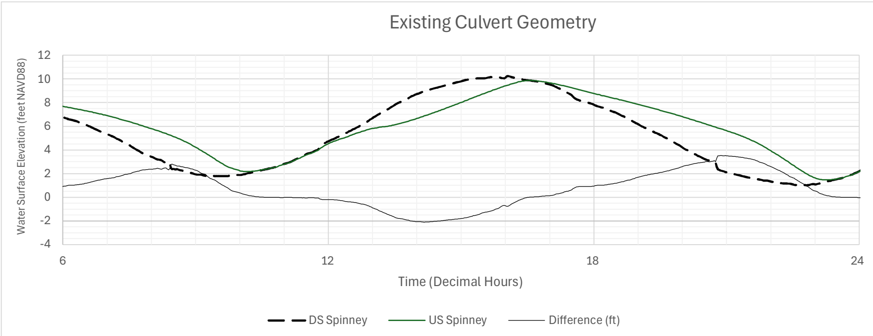


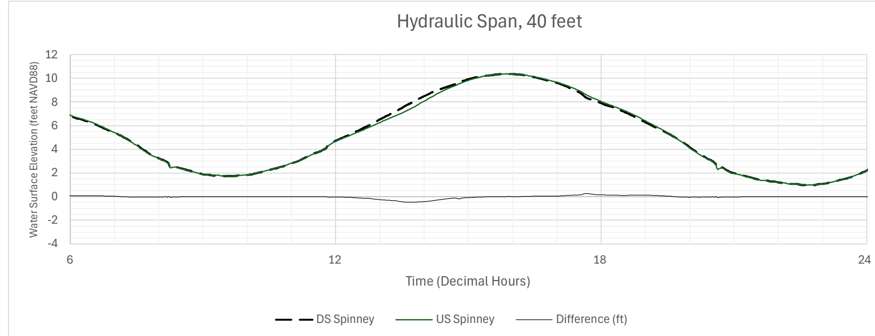


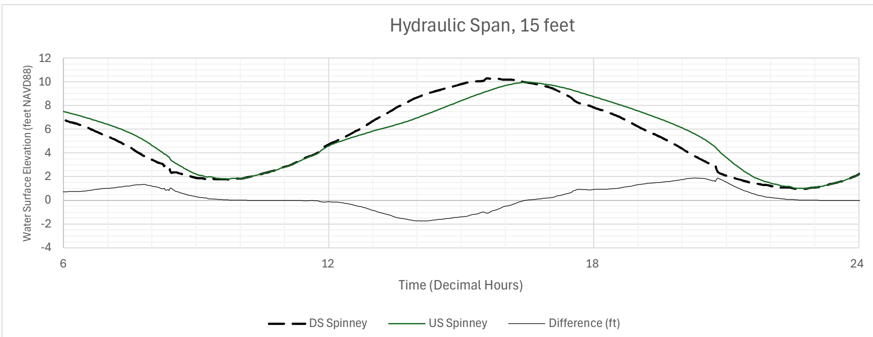


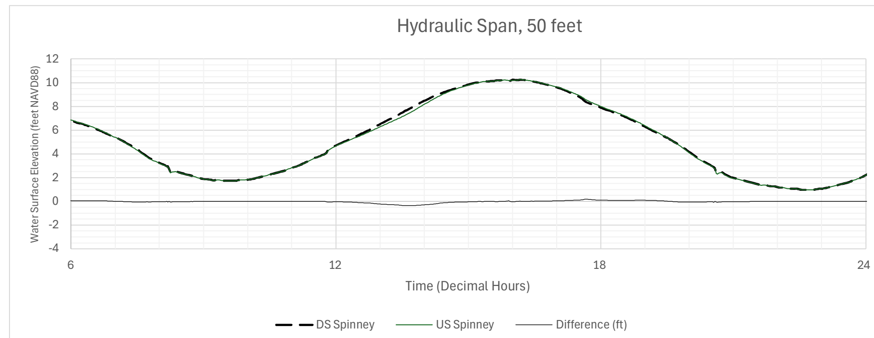


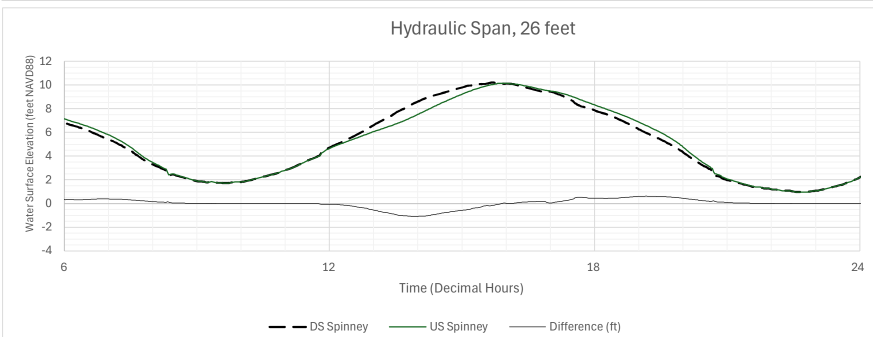
DS Spinney: Simulated Results Downstream of Spinney Mill Road
US Spinney: Simulated Results Upstream of Spinney Mill Road

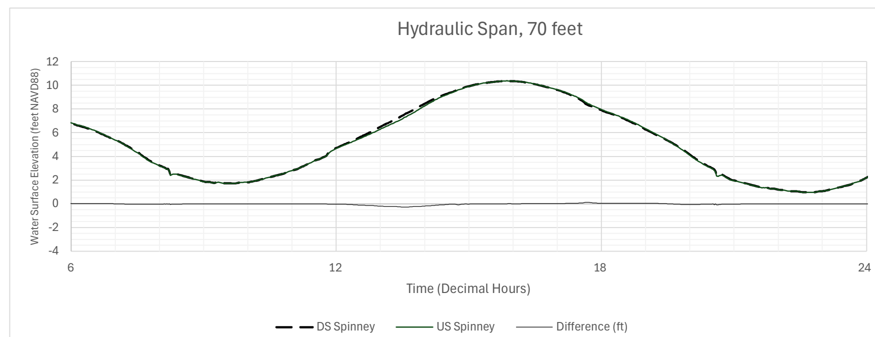










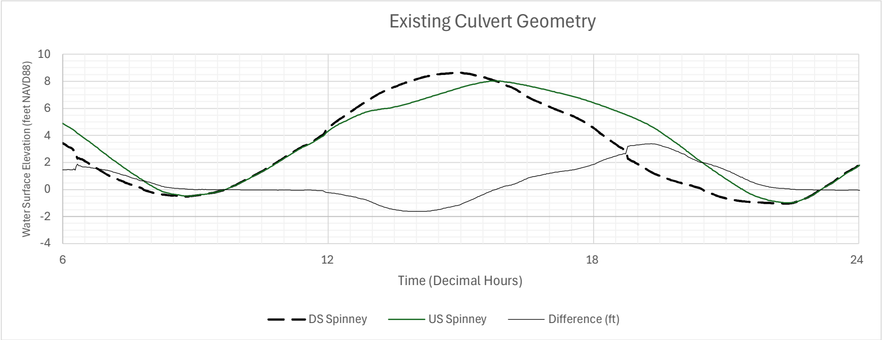


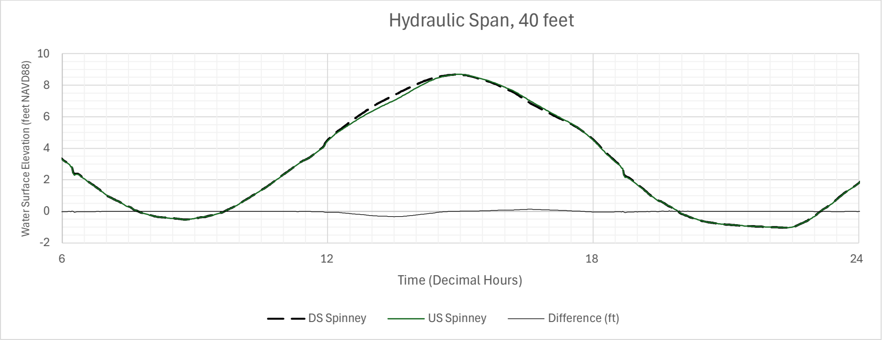
DS Spinney: Simulated Results Downstream of Spinney Mill Road
US Spinney: Simulated Results Upstream of Spinney Mill Road

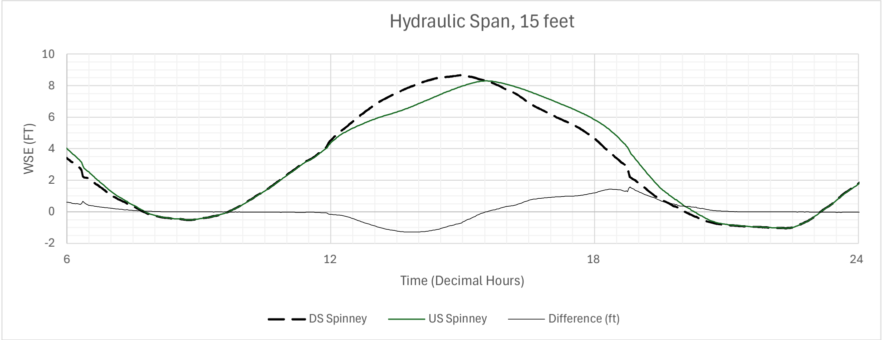
Spinney Mill Road
Hydrodynamic Modeling Results
Sea Level in 2060 (+ 2.0 feet)

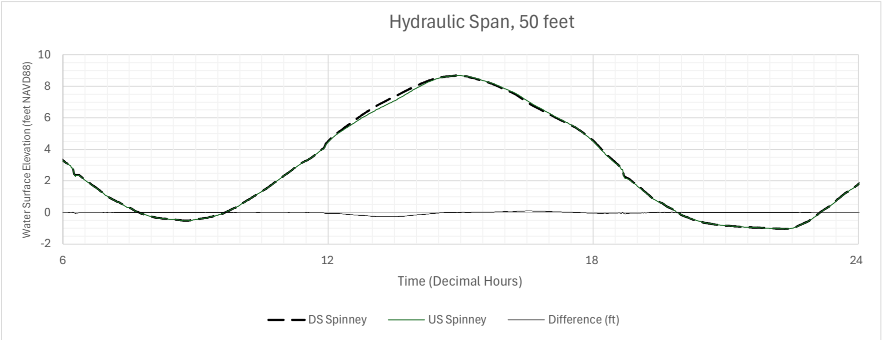
Highest Astronomical Tide
HAsT

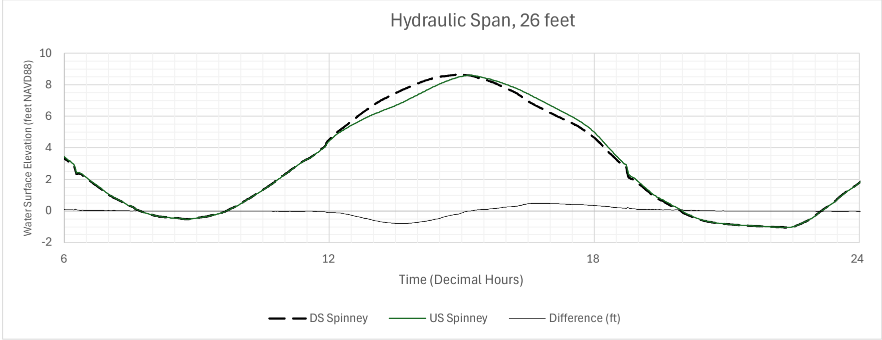
4/6/2026

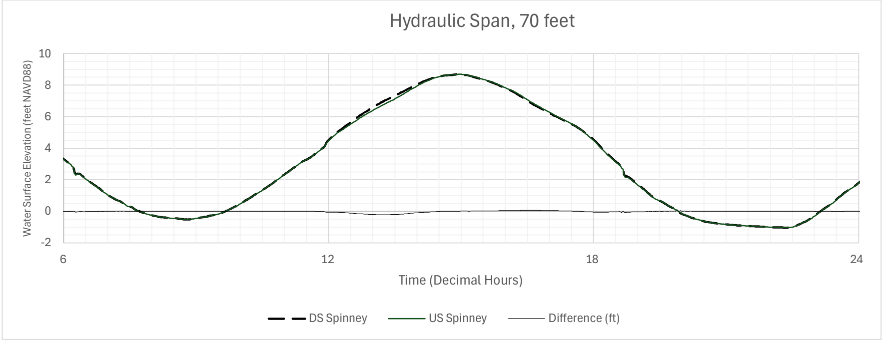












DS Spinney: Simulated Results Downstream of Spinney Mill Road
US Spinney: Simulated Results Upstream of Spinney Mill Road

Appendix D| Concept Designs

Drawings

PLAN VIEW - EXISTING CONDITIONS

NOTES:

1. HORIZONTAL COORDINATES ARE REFERENCED TO NORTH AMERICAN DATUM OF 1983 (NAD83) (2011) MAINE STATE PLANE, WEST ZONE, US FEET. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), US FEET.

2. TOPOBATHY LIDAR DATA OBTAINED FROM NOAA, COLLECTED IN 2022/2023 PROVIDES SUPPLEMENTAL TOPOGRAPHY OUTSIDE THE LIMITS OF THE TOPOGRAPHIC AND BATHYMETRIC SURVEY.

3. SELECT TOPOGRAPHIC AND BATHYMETRIC SURVEY COLLECTED BY USFWS (DATE) AND INTERFLUVE (MAY 2025) PROVIDE LIMITED ELEVATION DATA ACROSS THE PROJECT SITE.

NO.	BY	DATE	REVISION DESCRIPTION

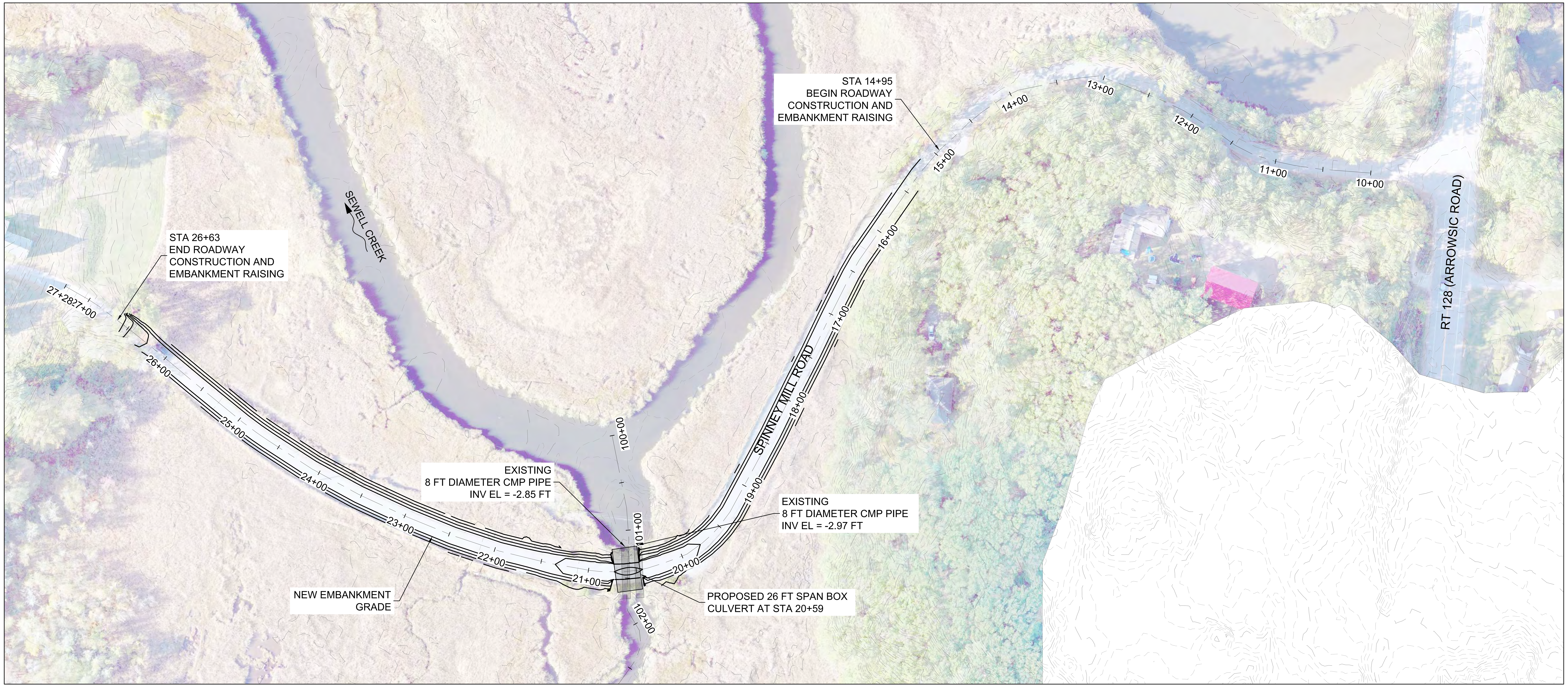
JAT	MYS	MB
DRAWN	DESIGNED	CHECKED
-	04/2026	
APPROVED	DATE	PROJECT

TOWN OF ARROWSIC/KELT
SPINNEY MILL TIDAL ROAD CROSSING
ARROWSIC, ME

inter·fluve

181 Main Street, 2nd Floor
P.O. Box 236
Damariscotta, ME 04543
207.315.7014
www.interfluve.com

EXISTING CONDITIONS



0 60 120

SCALE IN FEET

LEGEND

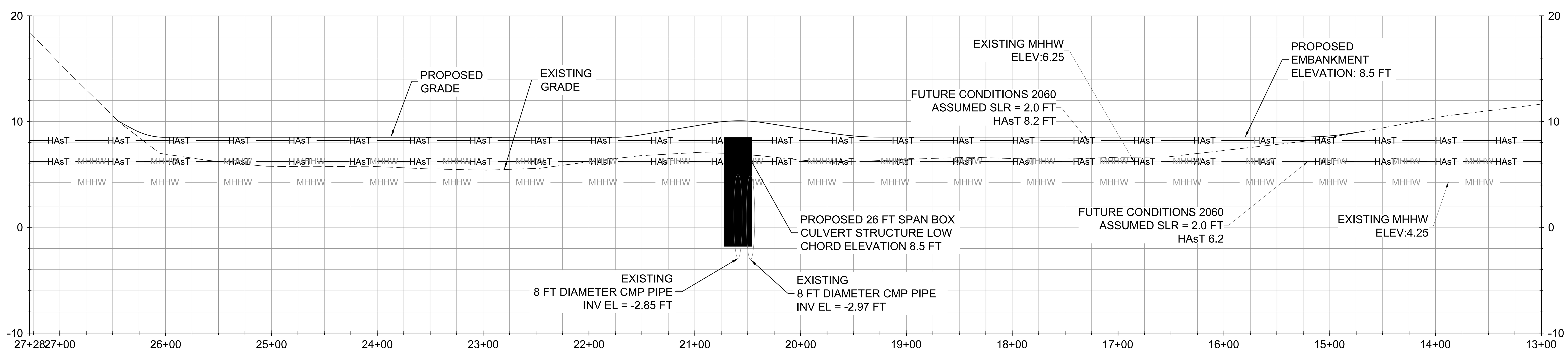
EXISTING 1 FT. CONTOUR

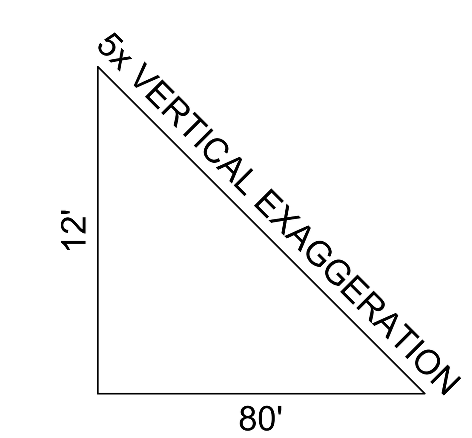
EXISTING 5 FT. CONTOUR

PROPOSED CONTOURS 1 FT

CENTERLINE ALIGNENT

PLAN VIEW - 2060 PLANNING HORIZON





PROFILE VIEW - 2060 PLANNING HORIZON

NO.	BY	DATE	REVISION DESCRIPTION

JAT	MYS	MB
DRAWN	DESIGNED	CHECKED
-	04/2026	
APPROVED	DATE	PROJECT

TOWN OF ARROWSIC/KELT
SPINNEY MILL TIDAL ROAD CROSSING
ARROWSIC, ME

inter-fluve

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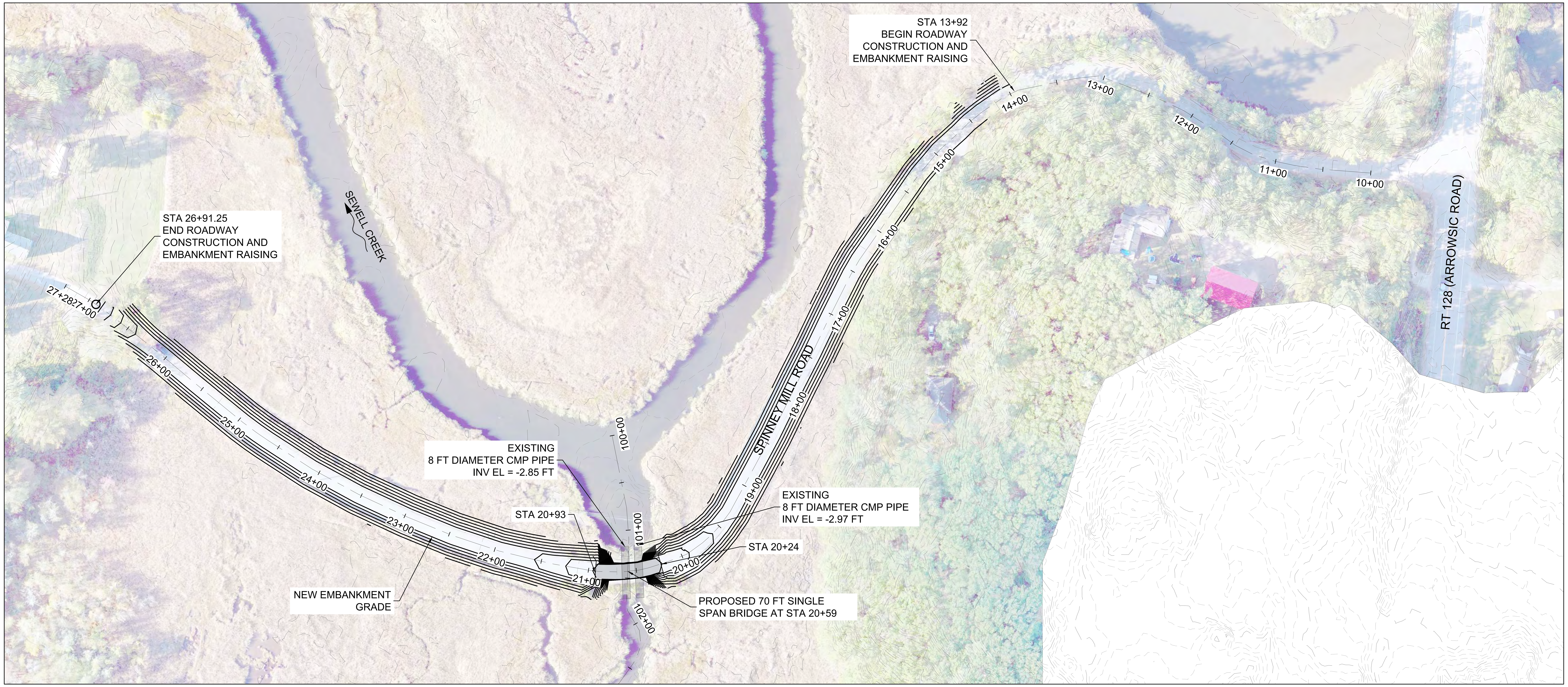
P.O. Box 236
Damariscotta, ME 04543
207.315.7014
www.interfluve.com

PROPOSED PLAN AND PROFILE - 2060 PLANNING HORIZON

SHEET
2 OF 3

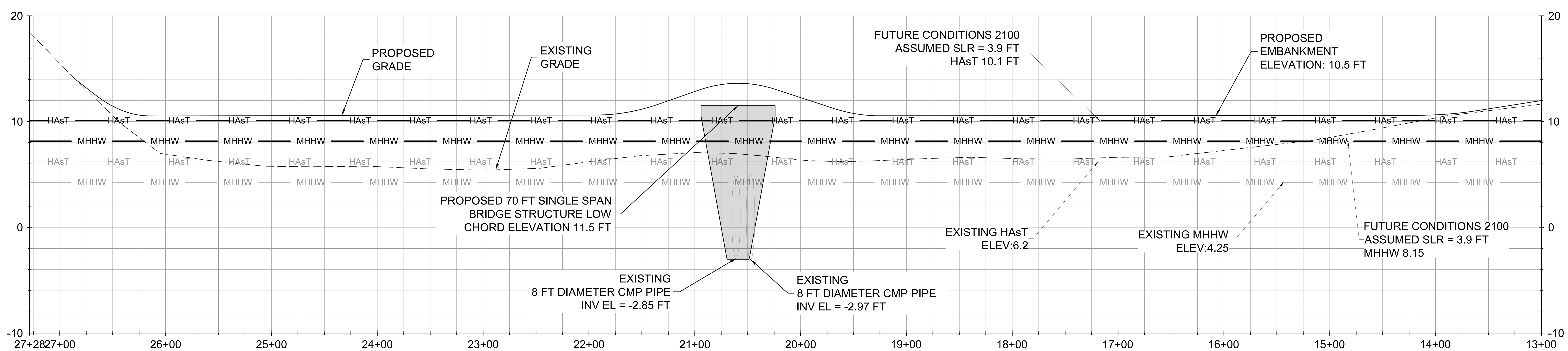


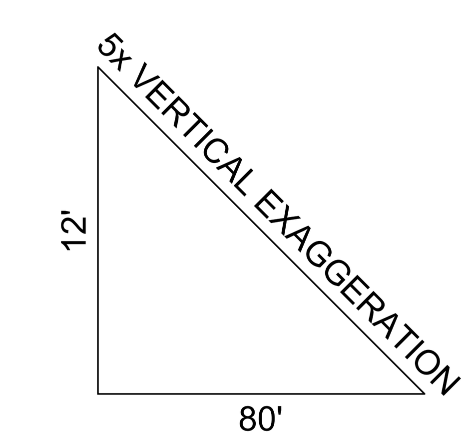
0 60 120
SCALE IN FEET

LEGEND

- EXISTING 1 FT. CONTOUR
- EXISTING 5 FT. CONTOUR
- PROPOSED CONTOURS 1 FT
- CENTERLINE ALIGNENT

PLAN VIEW - 2100 PLANNING HORIZON





PROFILE VIEW - 2100 PLANNING HORIZON

NO.	BY	DATE	REVISION DESCRIPTION

JAT	MYS	MB
DRAWN	DESIGNED	CHECKED
-	04/2026	
APPROVED	DATE	PROJECT

TOWN OF ARROWSIC/KELT
SPINNEY MILL TIDAL ROAD CROSSING
ARROWSIC, ME

inter·fluve

181 Main Street, 2nd Floor
P.O. Box 236
Damariscotta, ME 04543
207.315.7014
www.interfluve.com

PROPOSED PLAN AND PROFILE - 2100 PLANNING HORIZON

Appendix E| Conceptual Design Option Cost Opinion Tables

Opinions of Cost for Conceptual Design Options

Table E1. Conceptual Cost Analysis for Alternative 1: 45' Average Span (69' total span), Raise Road to HAsT 2100 (Low Elevation 12.5 ft-NAVD88)

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Site Management Costs						
1	Mobilization	1	LS	$ 379,000	$ 379,000	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Access & Staging Development	1	LS	$ 60,000	$ 60,000	Estimated
3	Control of Water	1	LS	$ 200,000	$ 200,000	Estimated
4	Erosion, Sediment & Pollution Control	1	LS	$ 100,000	$ 100,000	Misc control activities
Transportation Work						
5	69' Total Span Bridge With Abutments	1400	SF	$ 1,200	$ 1,680,000	Order of Magnitude cost per square-foot, 69-foot total span, 20-foot wide bridge.
6	Road Raising	1,250	LF	$ 1,200	$ 1,500,000	Estimated
7	Paving & Guardrail	1,250	LF	$ 200	$ 250,000	Estimated
			Construction Subtotal		$ 4,169,000	
			Contingency (25%)		$ 1,042,300	
Project Contruction Total (2026 Dollars)					**$ 5,211,300**	

Initial Project Delivery Costs			
Item	**Estimated % of Construction Cost**	**Total Cost**	**Notes**
Project Management	1.0%	$52,100	
Permitting	1.0%	$52,100	
Geotech and Engineering Design	10.0%	$521,100	
Construction Contract Administration	1.0%	$52,100	
Construction Observation	1.0%	$52,100	
Initial Project Delivery Costs Total	**14%**	**$729,500**	
Total Initial Project Costs		**$5,940,800**	

Table E2. Conceptual Cost Analysis for Alternative 2: 26' Concrete Box, Raise Road to HAsT 2060 (Low Elevation 10.5 ft-NAVD88)

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Site Management Costs						
1	Mobilization	1	LS	$ 281,000	$ 281,000	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Access & Staging Development	1	LS	$ 60,000	$ 60,000	Estimated
3	Control of Water	1	LS	$ 200,000	$ 200,000	Estimated
4	Erosion, Sediment & Pollution Control	1	LS	$ 100,000	$ 100,000	Misc control activities
Transportation Work						
5	26' Box Culvert with Support Slab	1	LS	$ 1,200,000	$ 1,200,000	
6	Road Raising	1,250	LF	$ 800	$ 1,000,000	Estimated
7	Paving & Guardrail	1,250	LF	$ 200	$ 250,000	Estimated
			Construction Subtotal		$ 3,091,000	
			Contingency (25%)		$ 772,800	
Project Contruction Total (2026 Dollars)					**$ 3,863,800**	

Initial Project Delivery Costs			
Item	**Estimated % of Construction Cost**	**Total Cost**	**Notes**
Project Management	1.0%	$38,600	
Permitting	1.0%	$38,600	
Geotech and Engineering Design	10.0%	$386,400	
Construction Contract Administration	1.0%	$38,600	
Construction Observation	1.0%	$38,600	
Initial Project Delivery Costs Total	**14%**	**$540,800**	
Total Initial Project Costs		**$4,404,600**	

Table E3. Conceptual Cost Analysis for Alternative 3: 45' Average Span (69' total span), Raise Road to HAsT 2060 (Low Elevation 10.5 ft-NAVD88)

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Site Management Costs						
1	Mobilization	1	LS	$ 329,000	$ 329,000	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Access & Staging Development	1	LS	$ 60,000	$ 60,000	Estimated
3	Control of Water	1	LS	$ 200,000	$ 200,000	Estimated
4	Erosion, Sediment & Pollution Control	1	LS	$ 100,000	$ 100,000	Misc control activities
Transportation Work						
5	69' Total Span Bridge With Abutments	1400	SF	$ 1,200	$ 1,680,000	Order of Magnitude cost per square-foot, 69-foot total span, 20-foot wide bridge.
6	Road Raising	1,250	LF	$ 800	$ 1,000,000	Estimated
7	Paving & Guardrail	1,250	LF	$ 200	$ 250,000	Estimated
				Construction Subtotal	$ 3,619,000	
				Contingency (25%)	$ 904,800	
				Project Contruction Total (2026 Dollars)	**$ 4,523,800**	

Initial Project Delivery Costs			
Item	**Estimated % of Construction Cost**	**Total Cost**	**Notes**
Project Management	1.0%	$45,200	
Permitting	1.0%	$45,200	
Geotech and Engineering Design	10.0%	$452,400	
Construction Contract Administration	1.0%	$45,200	
Construction Observation	1.0%	$45,200	
Initial Project Delivery Costs Total	**14%**	**$633,200**	
Total Initial Project Costs		**$5,157,000**	