SQUANNACOOK RIVER DAM REMOVAL FEASIBILITY STUDY

June 2024

Massachusetts Division of Ecological Restoration
100 Cambridge Street, Floor 6
Boston, MA 02114

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ATTACHMENTS

Preliminary Design Assessment Report

Groton, Massachusetts

1.0 INTRODUCTION

The Horsley Witten Group, Inc. (HW) is pleased to provide this report to the Massachusetts Division of Ecological Restoration (DER) summarizing our initial feasibility study and preliminary design assessment of the dam removal and river restoration opportunities for the Squannacook River Dam in Groton and Shirley, MA (the Site). Other significant Project Partners include the Town of Groton (the Town and Co-Owner) Department of Public Works (DPW) and Conservation Department (CD), and Mr. Helmar Nielsen (the Co-Owner). The Nashua River Watershed Association (NRWA) is also assisting with project outreach and has provided additional background documentation on the dam.

The Squannacook River is a 16.4-mile-long tributary of the Nashua River; itself a tributary to the Merrimack River. The Squannacook River forms the border between the Towns of Groton and Shirley and the subject dam itself is located half in Groton and half in Shirley. The Groton half of the dam is owned by the Town and the Shirley half is privately owned. The dam is situated just downstream from the West Groton Bridge, 2.5 miles upstream of the confluence of the Squannacook and Nashua Rivers. From downstream to upstream, the Squannacook River Dam is the first of five dams located on the Squannacook River, making it a critical barrier for migratory fish passage.

Figure 1 identifies key features discussed in this report, which are discussed at greater length below. In this memo, all left and right directional references are relative to the direction of the river flow looking downstream; river left refers to the river's left (generally approximately east) bank and river right refers to the river's right (generally approximately west) bank. All elevation data given in this memo are relative to the NAVD88 vertical datum in units of feet.

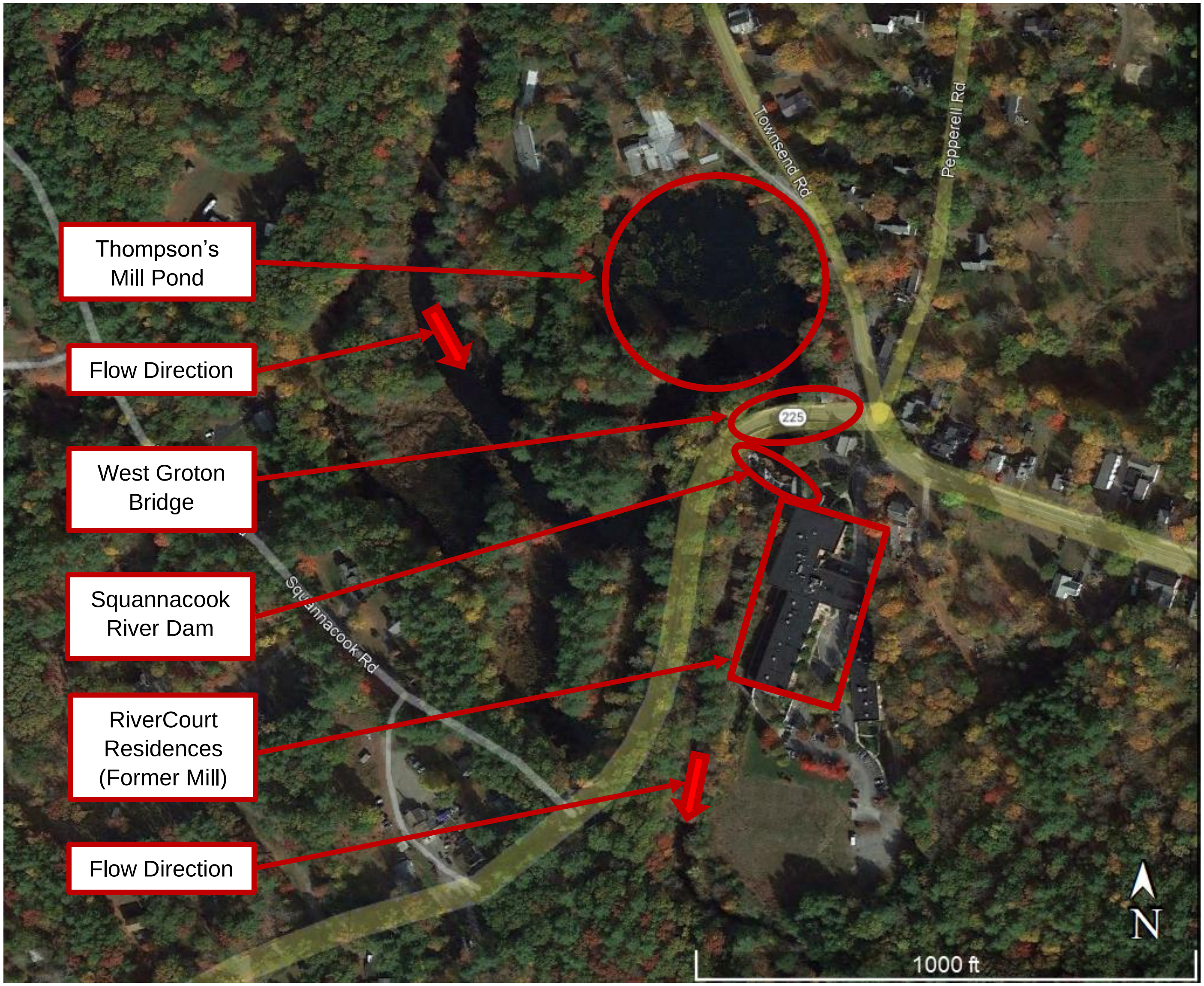

Figure 1. Key Project Area Features

1.1 PROJECT GOALS AND OBJECTIVES

The primary Project goals and objectives include:

1) Restoring connectivity of aquatic habitat along the Squannacook River;
2) Restoring aquatic habitat in the Squannacook River Dam impoundment;
3) Improving public safety; and
4) Elimination of liability and maintenance needs required by the dam.

The Squannacook River Dam currently has no known functional use. While the Groton half of the dam recently received significant repairs in 2013, the Shirley half of the dam has not received significant repairs in recent decades. According to the Squannacook River Dam Phase I Inspection Evaluation prepared by Haley & Aldrich Inc., the portion of the dam located in Shirley is in need of repair, as a large portion of the dam's concrete structure is either loose or deteriorated. Debris has also accumulated along the dam in general. At present, the dam creates an impoundment exacerbating flood risk to surrounding properties and infrastructure along Townsend Road in Groton and Route 225 in Groton and Shirley and creating a risk to downstream infrastructure if the dam were to breach. Due to the deteriorated state of the dam, including structural and functional deficiencies, the dam has been identified by the Town and the Co-Owner as a candidate for removal. This feasibility study assesses the potential impacts of removing the Squannacook River Dam and provides a preliminary design for dam removal.

1.2 Site Visit and Background Information

Information referenced in this report includes observations and data collected during site visits on January 24, 30, and 31, 2024; background information provided by Project Partners, and other readily available information collected by HW. Information on the Squannacook River Dam and the adjacent areas along the Squannacook River that was reviewed in preparation of this report includes:

1) Proposed Bridge Replacement Plans: Route 225 Over Squannacook River, prepared for Mass Highway by Luchs Associates, Inc., dated January 14, 1995;

2) Contour Map of the Land Surface now under W. Groton Pond, prepared by CDM Camp Dresser & McKee, dated March 2000. Provided by Carl Canner.

3) Groton at 350: The History of a Massachusetts Town, 1655-2005, by Barbara Murray, Deborah E. Johnson, and Jaume Kulesz, 2005;

4) Form A – Area: West Groton, prepared for the Massachusetts Historical Commission by Sanford Johnson, 2006;

5) Flood Insurance Study, Middlesex County, Massachusetts. By Federal Emergency Management Agency, dated July 2016;

6) Magnitude of Flood Flows at Selected Annual Exceedance Probabilities for Streams in Massachusetts, U.S. Geological Survey Scientific Investigations Report, dated 2017;

7) Well Drilling, Massachusetts Executive Office of Energy and Environmental Affairs, 2018;

8) Squannacook River Dam Phase I Inspection/Evaluation, prepared for the Town of Groton by Haley & Aldrich, Inc., dated May 5, 2023; and
9) Property Tax Parcels, MassGIS, dated March 2024.

As mentioned above, HW visited the site three times in January 2024, as listed below.

- **January 24:** HW conducted a topographic and bathymetric survey of the Site. Within the river, HW probed the channel bottom in order to measure the depth of soft sediment that has accumulated within the impoundment upstream of the Squannacook River Dam. Survey data was collected using total station and GPS-RTK methods.
- **January 30:** HW conducted a delineation of wetland resource areas in the immediate vicinity of the Squannacook River Dam. Wetland resources identified during the delineation included Bank, Riverfront Area, Land Subject to Flooding, and Land Under Water Bodies and Waterways.
- **January 31:** HW continued the topographic and bathymetric survey. Additionally, HW collected sediment samples from six locations along the Squannacook River. Sediment samples were combined from each of two similarly situated discrete locations to produce two composite samples for laboratory analysis: one upstream sample within the impoundment and one downstream sample.

  HW also met with Project Partners at the site on January 31 to discuss site conditions and project goals. During this initial on-site meeting, Project Partners discussed goals for removal as well as potential items for study, including proximity of the impoundment to wells and abutter concerns. Project Partners also discussed timing and resources for potential public engagement opportunities after the results of this feasibility study are determined. Groton Town representatives shared information on recent dam repairs and logistics related to dam access.

2.0 PROJECT AREA

2.1 Squannacook River Dam

The Squannacook River Dam (National ID: MA 00442), also called the Leatherboard Dam, is located within Middlesex County in Groton and Shirley, Massachusetts at 42.60292° N, 71.6272° W. As stated above, the dam is located along the Squannacook River, approximately 2.5 miles upstream of the confluence with the Nashua River. The Squannacook River Dam is approximately 100 feet downstream of the West Groton Bridge (Route 225). The dam is adjacent to RiverCourt Residences, a senior living facility that occupies the former mill building associated with the dam. The former mill building is listed on the MassHistoric Commission Inventory's National Register of Historic Places, but the dam itself does not have historic listing status.

No construction records are available for the original dam, although the year 1926 is imprinted in concrete on the dam. This date likely represents a major reconstruction rather than the original construction date. The earliest available USGS maps, dated 1893 (**Figure 2**) show a dam impoundment at the site and there is little evident change in the size of the impoundment behind the dam comparing that oldest map to current conditions. In *Groton at 350*, Murray, Kulesz, and Johnson write that a sawmill was established at the site of the dam prior to 1744. According to the Massachusetts Historical Commission (MHC) Form A prepared by Sanford Johnson (Background Document #3), the area around West Groton was sparsely populated until 1847, at which time railroad services expanded into the area. Around this time a grist-and-saw mill was constructed by Thomas Tarbell at the current location of the RiverCourt Residences. By 1875, the Tarbell Mill was replaced by E.H. Sampson's Groton Leatherboard factory, which quickly became the primary industrial center in West Groton. Groton Historical Commission researchers have claimed that the Groton Leatherboard factory was the first leatherboard factory in the nation.

Figure 2. USGS Topographic Maps of Groton (left two, 1893 and 1935) and Shirley (right, 1965)

After a fire in 1914, the leatherboard factory began the process of replacing its wood frame mill building and three wood storehouses with the brick buildings that make up the current RiverCourt Residences. Mill operations resumed in 1916 and were ongoing at the site until 1978. Mr. Helmar Nielsen purchased the mill buildings in 1979 and began production of metal art frames for six to seven years. In 1996, Groton acquired the buildings and the portion of the dam located in Groton. The Shirley portion of the dam is still owned by Mr. Nielsen. The mill site was listed on the National Register of Historic Places in 2002.

Figure 3. Groton Leatherboard Company workers outside of the reconstructed brick mill building, approximately 1916. Photo courtesy of Stanley J. Kopec.

The current dam is a run-of-the-river, stone masonry and concrete structure, approximately 150 feet long with a structural height of 18 feet and crest elevation of 228.15 feet. On the river right side of the dam, a masonry training wall meets the dam at approximately the dam elevation. This training wall provides structural support to Groton Road in Shirley (Route 225).

On the river left side of the dam, a 10-foot-high masonry training wall extends from the dam parallel to the riverbank, forming a penstock. An overflow spillway at elevation 225.85 is located along this penstock, and a low level outlet structure consisting of a square wooded gate about 40 inches wide and tall is located at the bottom of the training wall. According to the DPW, the low level outlet is rarely used except in dry periods (typically in summer) when flow in the Squannacook River is insufficient out of the overflow spillway and the upstream impoundment becomes stagnant. During these times, the low level outlet is opened by one foot.

Figure 4. The Squannacook River Dam looking west, from the penstock (left bank) to Groton Road (Route 225) (right bank)

At the base of the dam, a concrete splashpad dissipates water that flows out of the overflow spillway along the penstock. Bedrock outcrop is located along the base of the main spillway of the dam.

A 6-foot diameter pipe runs from the penstock approximately 100 to 150 feet along the former mill building – previously used to generate power at the mill. The pipe was plugged with concrete at some point between 1999 and 2006. A discharge channel from the former mill building runs between the legacy bank of the Squannacook River and the parking lot of the RiverCourt Residences, forming a peninsula in the river. A wooden pedestrian bridge on steel trusses connects the peninsula to the parking lot (**Figure 5**).

Figure 5. Looking east from the peninsula to the former mill building and parking lot

The Squannacook River Dam is jointly owned by the Town of Groton and by Mr. Helmar Nielsen, with ownership divided on the Groton-Shirley town line. Groton performed dam repairs to its side of the dam as recently as 2013. During the repairs, cracked and spauling concrete on the Groton side of the dam was chipped and repaired with reinforced concrete. The Shirley side (river-right) of the dam is due for repairs, and the overall condition of the dam is rated by the Massachusetts Office of Dam Safety as “Fair” due to the maintenance needs of the Shirley side. The Office of Dam Safety also classified the dam as an Intermediate, High Hazard dam due to its size and the potential risk of loss of life and property damage in the event of failure. Necessary repairs to the dam were estimated by Haley & Aldrich in 2023 to cost $306,000.

2.2 Squannacook River Dam Impoundment

2.2.1 Impoundment Characteristics

According to the Haley & Aldrich 2023 inspection report of the Squannacook River Dam, the impoundment upstream of the dam holds a maximum capacity of 110 acre-feet of water. The surface area of the impoundment was estimated to be 28 acres, which includes the area immediately upstream of the dam up to the base of the next upstream dam, the Hollingsworth & Vose Co. Dam.

HW survey data shows that at its deepest point, the impoundment bottom is 15.5 feet lower than the dam spillway elevation and 9.6 feet lower than the estimated bedrock elevation underlying the dam. The backwater section of the impoundment immediately upstream/directly north of the dam (locally referred to as “Thompson Mill Pond”) was dredged in 2003, during which the impoundment was deepened by as much as 5 feet. The impoundment extents immediately upstream of the dam are shown schematically below in **Figure 6**. The extents shown in **Figure 6** only include the project area, and do not include the full extent of the impoundment extending further upstream, as estimated in the Haley & Aldrich 2023 inspection report. It should also be noted that the impoundment immediately upstream of the dam was frozen at the time of survey, and as a result transect 11 was not fully surveyed.

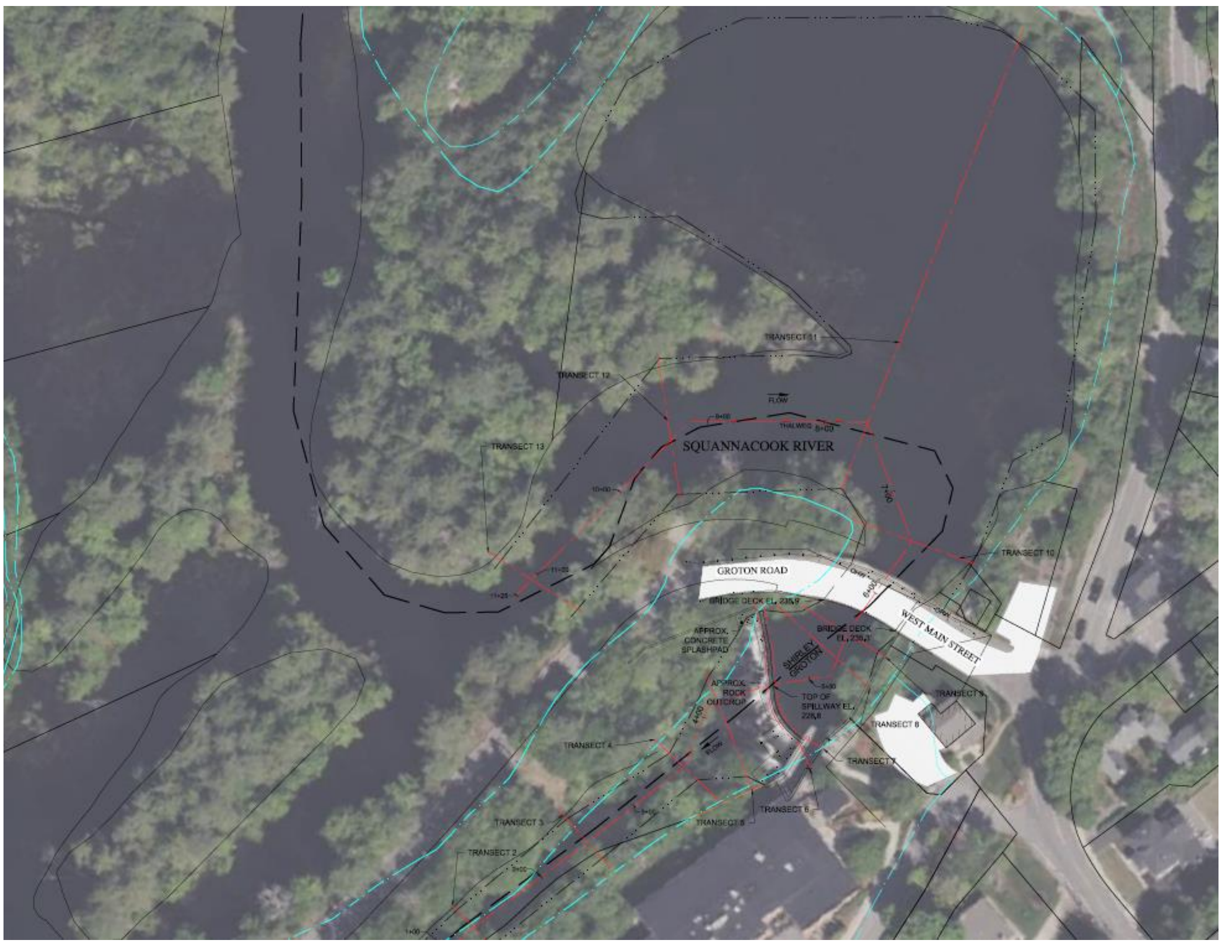

Figure 6. Squannacook River Dam Impoundment Schematic

2.2.2 Longitudinal Profile

Figure 7 is a longitudinal profile developed based on bathymetric and sediment probing data surveyed by HW along the approximate historic channel centerline through the Squannacook River Dam impoundment to approximately 630 feet upstream of the dam. The figure includes the locations of the Squannacook River Dam and the West Groton Bridge.

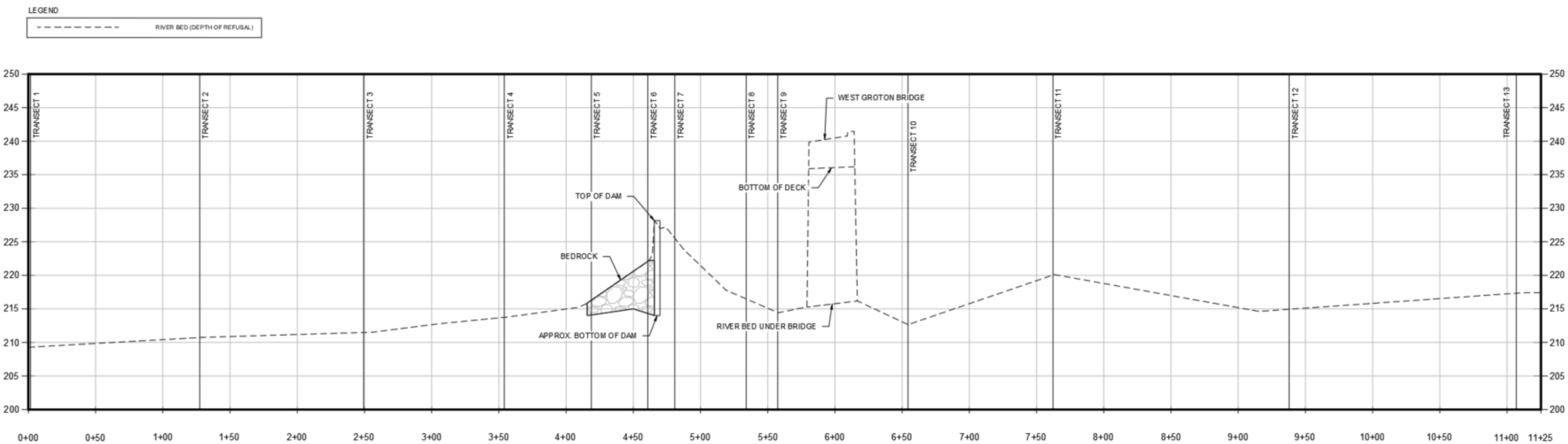

Figure 7. Longitudinal Profile of Squannacook River in Vicinity of Squannacook River Dam

2.2.3 Impoundment Sediment

Sediment Composition

Sediment samples composited from within the impoundment consisted mostly of brown poorly graded sand, and field observations included gravel and cobbles as well. HW field staff probed the channel bottom in order to measure the depth of soft sediment that has accumulated within the impoundment upstream of the Squannacook River Dam. HW found minimal soft sediment had accumulated within the impoundment upstream of the dam, measuring approximately 0.1 feet at its thickest point, located approximately 290 feet upstream from the dam near Transect 11. In future project phases, additional sampling of the Thompson Mill Pond area of the impoundment (which was frozen at the time of field survey) should be conducted.

Sediment Volumes

In addition to soft sediment, impounded sediment extends from the dam to approximately 50 feet upstream of the dam, and the mobile sediment volume is estimated to be approximately 1,360 cubic yards. The greatest thickness of impounded sediment (including soft and hard sediment) is estimated to be 10.5 ft, approximately 4 feet upstream of the dam. This value was obtained through consideration of the channel's elevation at that location (227 feet) and the assumption that pre-impoundment conditions at that location would have been similar to the elevation of the channel immediately downstream of the dam (216.5 feet). Additional probing of the Thompson Mill Pond area of the impoundment is necessary in future phases; as discussed further below, this area is not expected to experience sediment transport, and therefore is not included in the estimate of total mobile sediment volume.

2.3 Project Reach of Squannacook River

2.3.1 Upstream Reach

The upstream reach of the Squannacook River (**Figure 8**) is characterized by a relatively gentle channel slope (0.8%)[1], and an overwidened width measured by HW to be around 95 feet (influenced by dam impoundment effects). A number of side channels and inlets are present along the upstream reach, also possibly influenced by the impoundment tailwater elevation. Vegetation on both sides of the river upstream of the dam consists of an open mix of native tree species as well as both native and invasive shrub and vine species. Evidence of beaver activity was observed on the right bank of the upstream reach.

[1] Classifying Your Stream Slope, *The Watershed Center*, Niwot, CO

Figure 8. Reach of Squannacook River Upstream of West Groton Bridge

2.3.2 Downstream Reach

The downstream reach of the Squannacook River below the dam (**Figure** 9) is a relatively natural segment of river, extending from downstream of the Squannacook River for 2.5 miles to the confluence of the Nashua River. The left bank along the mill building may have been altered for the construction of the mill's discharge channel.

This section of river slopes at a moderate 1.4%[2]. Despite the low gradient, water was observed flowing at a high velocity in this section. The river substrate consists of coarse material including gravel, cobbles, and boulders. The existing high velocity and coarse substrate are very likely a consequence of the high-energy outflow of the dam, which drops over 12 feet from the crest of the dam to the end of the plunge pool (approximately 50 feet downstream of the dam). This downstream reach has an estimated bankfull width of 57 feet, nearly 40 feet narrower than the upstream reach, and is likely a reasonable estimate of the river's natural bankfull width were the dam to be removed. Vegetation observed on the east and west banks downstream of the dam includes various trees and shrubs from the alluvial hardwood community and the white pine-oak forest community, as well as both native and invasive vine species. The downstream reach

[2] Ibid.

appears to be a good candidate to use as a reference reach for the project area of the Squannacook River.

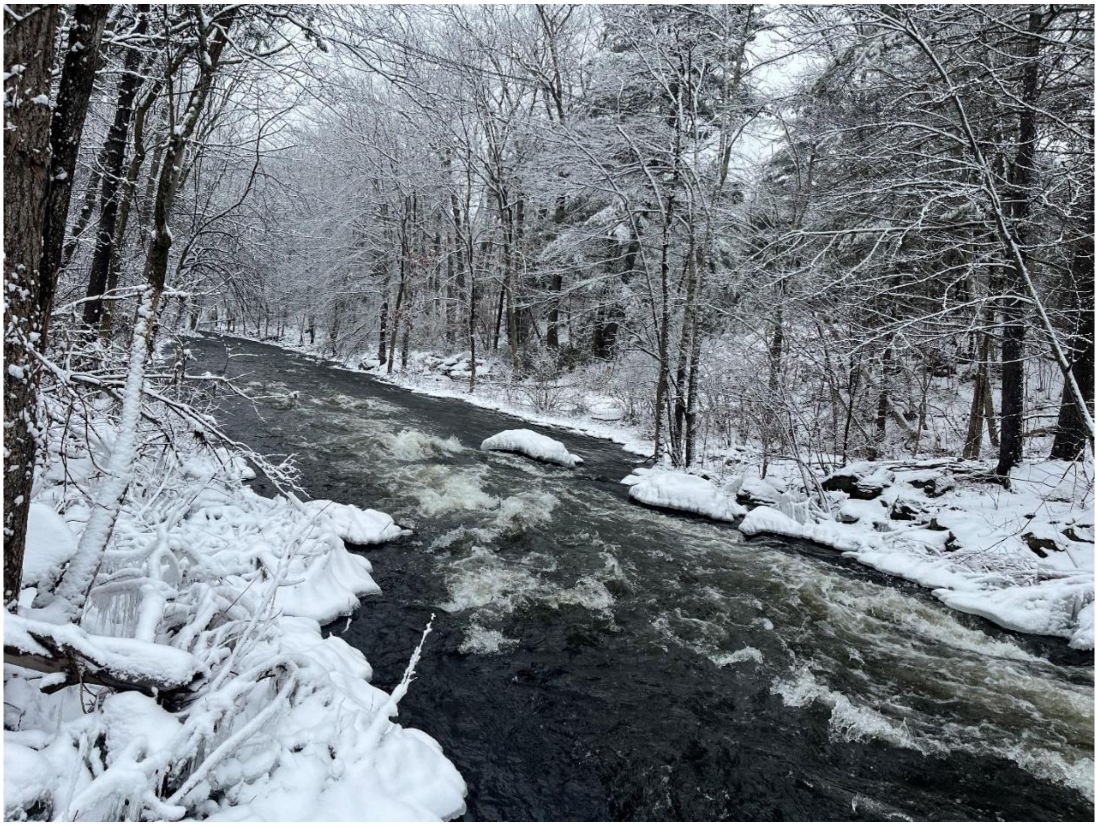

Figure 9. Reach of Squannacook River Downstream of Squannacook River Dam

Relative elevation mapping of the Squannacook River valley provided by NRWA (developed by Shirley resident Sarah Widing) indicates that the downstream reach may have historically meandered river-left in the location of the former mill building and the former Boston and Maine Railroad (**Figure 10**). Meander scars, left by the former path of the river, are visible north of West Groton Street. The current course of the Squannacook River may have been altered for the construction of the mill or the railroad, although insufficient information is available to be certain.

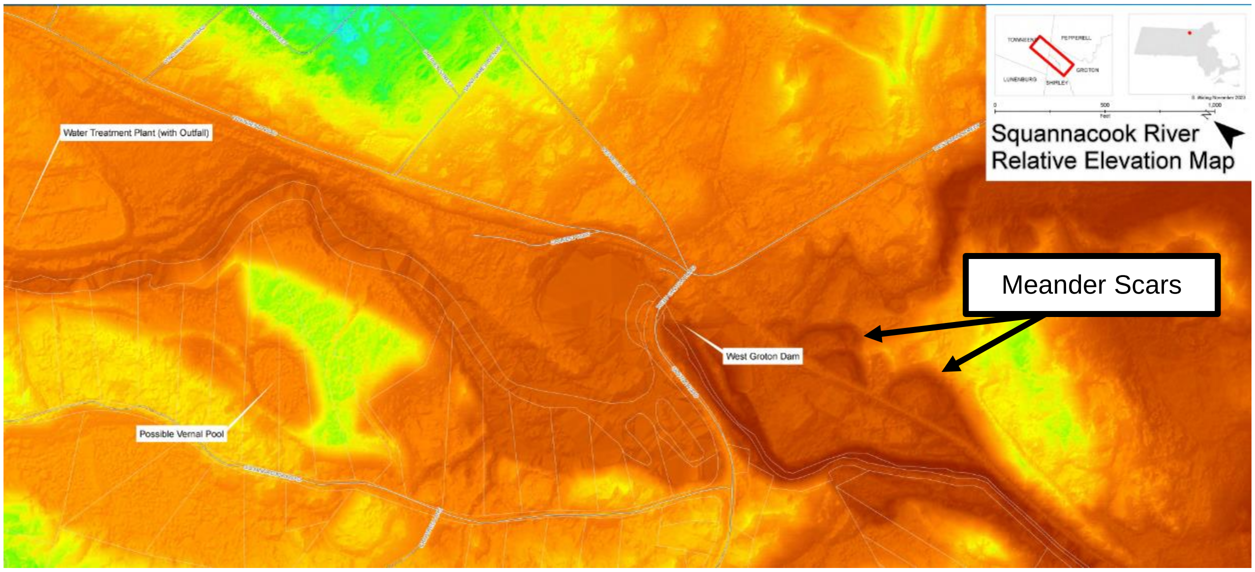

Figure 10. Relative Elevation Map of Squannacook River Valley, Courtesy of Sarah Widing

2.3.3 Natural Resources

The site supports freshwater wetland resource areas, as defined under the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40), the Town of Groton Wetlands Bylaw (Chapter 215), the Town of Shirley Wetlands Bylaw, and their respective regulations and/or policies. An HW wetlands biologist identified and delineated these resource areas during the January 30, 2024 site visit. Jurisdictional areas identified on or adjacent to the site include Bank; Riverfront Area (RA); Land Subject to Flooding (LSF); Land Under Water Bodies and Waterways (LUW), the 50-foot No Disturb Buffer and 100-foot Buffer to Bank within the Town of Groton, and the 25-foot Vegetated Buffer and 100-foot Buffer Zones to Bank within the Town of Shirley.

HW followed wetland resource area identification and on-site delineation procedure guidelines described in the Massachusetts *Wetlands Protection Act* (M.G.L. Ch. 131 § 40), and its implementing Regulations (310 CMR 10.00), including those described in the Massachusetts Department of Environmental Protection (MassDEP) handbook, entitled *Massachusetts Handbook for Delineation of Bordering Vegetated Wetlands* (September, 2022), the Town of Groton Wetlands Bylaw (Chapter 215), the Town of Shirley Wetlands Bylaw, and their respective regulations and/or policies.

Prior to conducting field delineations, HW reviewed existing source data, including USGS Geological Survey 7.5 minute topographic maps, Massachusetts Department of Environmental Protection (MassDEP) wetlands source data available through the Massachusetts Geographic Information System (MassGIS), USDA Natural Resources Conservation Service (NRCS) soils survey, U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps, and other source data to identify the presence of jurisdictional wetlands and waters of the United States within the site. This information was used to compile base mapping to assist in the understanding of the hydrologic variables, soils conditions, and vegetation communities (where applicable).

A brief description of the regulatory definitions and the observed resources areas is provided below.

Bank

Bank is defined at 310 CMR 10.54(2)(a) as "*the portion of land surface which normally abuts and confines a water body. It occurs between a water body and a vegetated bordering wetland and adjacent floodplain, or, in the absence of these, it occurs between a water body and an upland. A Bank may be partially or totally vegetated, or it may be comprised of exposed soil, gravel or stone. The upper boundary of a Bank is the first observable break in the slope or the mean annual flood level, whichever is lower. The lower boundary of a Bank is the mean annual low flow level*" [310 CMR 10.54(2)(c)].

Bank is defined by the Town of Groton Wetlands Bylaw [§215-9(B)] as, *"… the land area which normally abuts and confines a water body: the lower boundary being the mean annual low flow level, and the upper boundary being the first observable break in slope or the mean annual flood level, whichever is greater."*

The Town of Shirley Wetlands Bylaw applies the same Bank definition found in 310 CMR, as stated above.

HW observed Bank on both sides of the Squannacook River, within the vicinity of the Dam site:

Groton Bank

Along the eastern side of the Squannacook River, south of the dam structure, within the jurisdiction of the Town of Groton, the Bank consists primarily of a sparsely vegetated rock revetment, which rises steeply to the east from the edge of the river and then flattens out to a vegetated strip adjacent to the former mill building at the RiverCourt Residences property (**Figure 11**). Vegetation observed on the bank includes slippery elm (*Ulmus rubra*), red maple (*Acer rubrum*), glossy buckthorn (*Frangula alnus*), silky dogwood (*Cornus amomum*), alder (*Alnus sp.*), poison ivy (*Toxicodendron radicans*), and grape (*Vitis sp.*). Additional species observed directly adjacent to the Bank includes red oak (*Quercus rubra*), white pine (*Pinus strobus*), black cherry (*Prunus serotina*), cherry birch (*Betual lenta*), shrub honeysuckle (*Lonicera sp.*), glossy buckthorn, Japanese barberry (*Berberis thunbergia*), staghorn sumac (*Rhus typhina*), steeplebush (*Spiraea tomentosa*), poison ivy, grape, and Asian bittersweet (*Celastrus orbiculatus*). Along this extent of the river, the locally-defined (Town of Groton) upper boundary of Bank is distinct from the upper boundary of Bank as defined by the Massachusetts Wetlands Protection Act at 310 CMR 10.54(2)(a). HW delineated the upper boundary of the locally-defined Bank at the first break in slope with consecutive bright green flagging stations labeled BANK 100 to BANK 102. HW delineated the upper boundary of the state-defined Bank at the mean annual flood level with consecutive pink flagging stations labeled MA BANK 100 to MA BANK 102.

Figure 11. Looking upstream at the Bank south of the dam, on the eastern side of the river.

Along the eastern side of the Squannacook River, between the dam structure and the West Groton Bridge, within the jurisdiction of the Town of Groton, the Bank is primarily defined by a vertical stone wall that confines the river along the west side of the RiverCourt Residences property (**Figure 12**). The adjacent upland area consists of lawn, landscaping, walkway, and parking lot features associated with the RiverCourt Residences. There is a small section of vegetated Bank at the base of the stone wall along this extent, which consists of slippery elm, red maple, common buckthorn (*Rhamnus cathartica*), highbush blueberry (*Vaccinium corymbosum*), Japanese barberry, silky dogwood, poison ivy, and grape. Along this extent of the river, the locally-defined (Town of Groton) upper boundary of Bank coincides with the upper boundary of Bank as defined by the Massachusetts Wetlands Protection Act at 310 CMR 10.54(2)(a), due to the presence of the stone wall. HW delineated the upper boundary of the Bank with consecutive pink flagging stations labeled BANK 103 to BANK 106.

Figure 12. Looking upstream at the Bank along the eastern side of the river, between the dam and bridge.

Shirley Bank

Along the western side of the Squannacook River, south of the dam structure, within the jurisdiction of the Town of Shirley, the Bank is vegetated with a mix of trees and shrubs and represents the edge of an alluvial hardwood flat community present along the low-lying area adjacent to the river (**Figure 13** and **Figure 14**). The slope then rises steeply up to the right of way of West Groton Road and is vegetated with a white pine-oak forest community. From the downstream side of the dam, a stone wall extends to the south, approximately parallel to West Groton Road. The eastern face of this wall is exposed along the northern section and confines the river at the mean annual flood level; therefore, the wall represents the upper boundary of the Bank along this section. Further to the south, the wall becomes embedded into the slope downgradient of West Groton Road, where the mean annual flood level occurs further to the east, downgradient from the wall. Vegetation observed on the bank includes slippery elm, red maple, river birch (*Betula nigra*), gray birch (*Betula populifolia*), and silky dogwood. Commonly observed species directly adjacent to the Bank includes red oak, cherry birch, white pine, ash (*Fraxinus sp.*), slippery elm, and common buckthorn. The extent of the Bank in the section closest to the dam was delineated along the mean annual flood elevation, where there is no distinct break in slope between the river and the mean annual flood elevation. Further to the south, the slope between the river and the mean annual flood elevation rises steeply from the river's edge before breaking sharply and transitioning into the alluvial hardwood flat community; therefore, the upper boundary of the Bank was delineated at the break in slope along this extent. HW delineated the upper boundary of the Bank with consecutive pink flagging stations labeled BANK 202 to BANK 207.

Figure 13. Looking upstream at the Bank along the western side of river, directly south of the dam.

Figure 14. Looking downstream at the Bank along the western side of the river, where the upper boundary occurs at the first break in slope.

Along the western side of the Squannacook River, between the dam structure and the West Groton Bridge, within the jurisdiction of the Town of Shirley, the Bank consists of an open mix of shrub and vine species and is defined by the mean annual flood level. The slope rises steeply between the Bank and the bridge and consists primarily of vines and herbaceous species (**Figure 15**). Commonly observed vegetation along the Bank includes slippery elm, glossy buckthorn, silky dogwood, and Asian bittersweet. Commonly observed species directly upgradient of the Bank include poison ivy, Asian bittersweet, and bush clover (*Lespedeza sp.*). HW delineated the upper boundary of the Bank with consecutive pink flagging stations labeled BANK 200 to BANK 202.

Figure 15. Looking downstream at the Bank between the bridge and dam.

Riverfront Area

Riverfront Area is defined at 310 CMR 10.58(2)(a)3 as *"the area of land between a river's mean annual high-water line measured horizontally outward from the river and a parallel line located 200 feet away (…)"*

2. Mean Annual High-water Line of a river is the line that is apparent from visible markings or changes in the character of soils or vegetation due to the prolonged presence of water and that distinguishes between predominantly aquatic and predominantly terrestrial land. (…).

The Town of Groton Wetland Bylaw and Town of Shirley Wetlands Bylaw both apply the same Riverfront definition found in 310 CMR, as stated above.

Riverfront Area at the Site extends 200 feet landward from the mean high-water line (equivalent to the ordinary high-water line) of the Squannacook River. Riverfront Area overlaps with the

Banks and associated buffer zones. The Riverfront Area begins at the upper boundary of the delineated Bank sections labeled MA BANK 100-102, BANK 103-106, and BANK 200-207 in the Existing Conditions Plan (**Attachment C,** Sheet EX-4).

<u>Regulatory Designations</u>

Wild and Scenic Rivers Designation

The Squannacook River holds a national designation as a Wild and Scenic River for its outstanding natural, recreational, scenic, historic, and cultural resources. Services of the Squannacook River that earned this designation include but are not limited to biological and ecological diversity, scenic vistas, and "some of the best fly-fishing within reach of Boston".[3] (**Figure 16**)

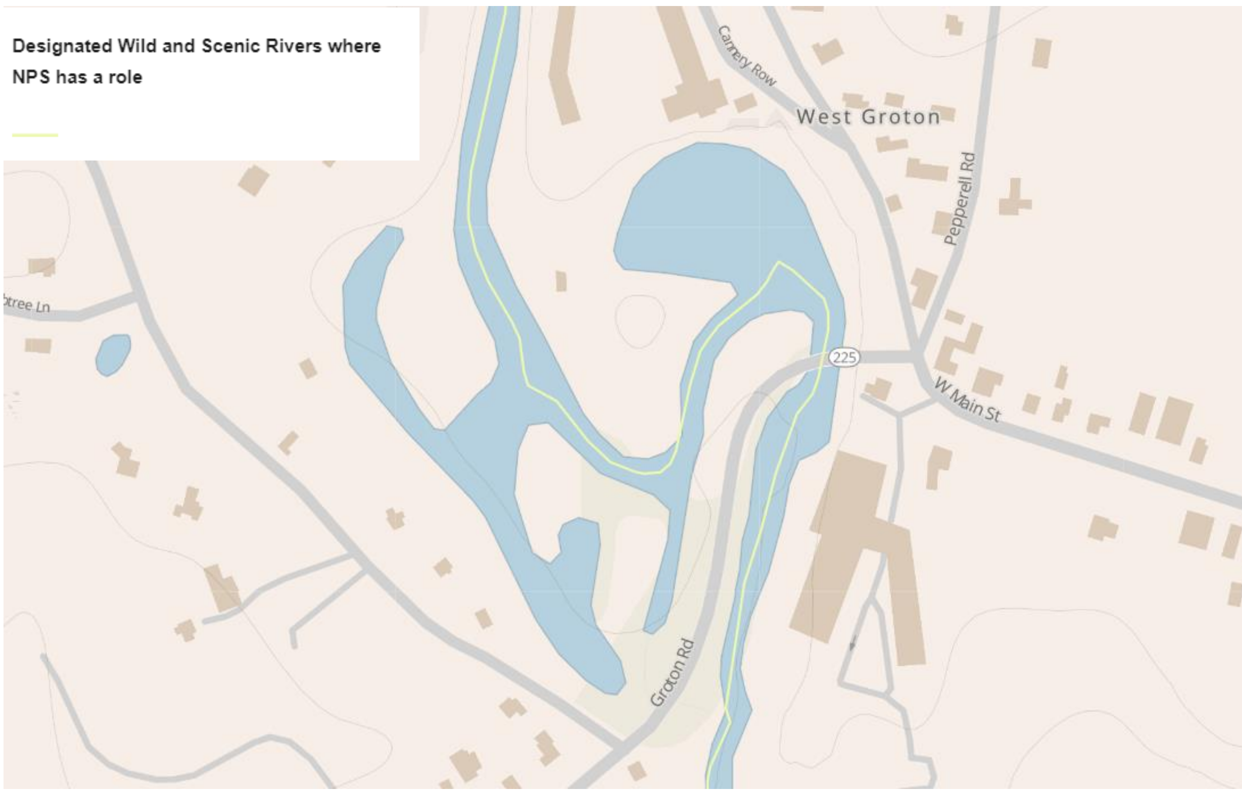

Figure 16: National Wild and Scenic Rivers Map

[3] Nashua Wild and Scenic Rivers, Massachusetts and New Hampshire. P.L. 116-9. 133 Stat. 690. Enacted Mar. 12, 2019. https://www.rivers.gov/river/nashua

Biomap Core Habitat Aquatic Core Designation and DFW Coldwater Fisheries Resources Designation

According to the Massachusetts Bureau of Geographic Information, (MassGIS), the site is designated as a BioMap Core Habitat Core Aquatic area and a DFW Coldwater Fisheries Resource. Rivers within BioMap Core Habitat Core Aquatic areas encompass segments with the native fish diversity, strongest anadromous fish runs, and occurrences of rare species in all of Massachusetts.[4] As a Coldwater Fish Resource (CFR), the Squannacook River has been identified as a critical resource for maintaining the overall health of cold-water fish species, which hold an ecologically significant role to Massachusetts aquatic habitat.[5] (**Figure 17**)

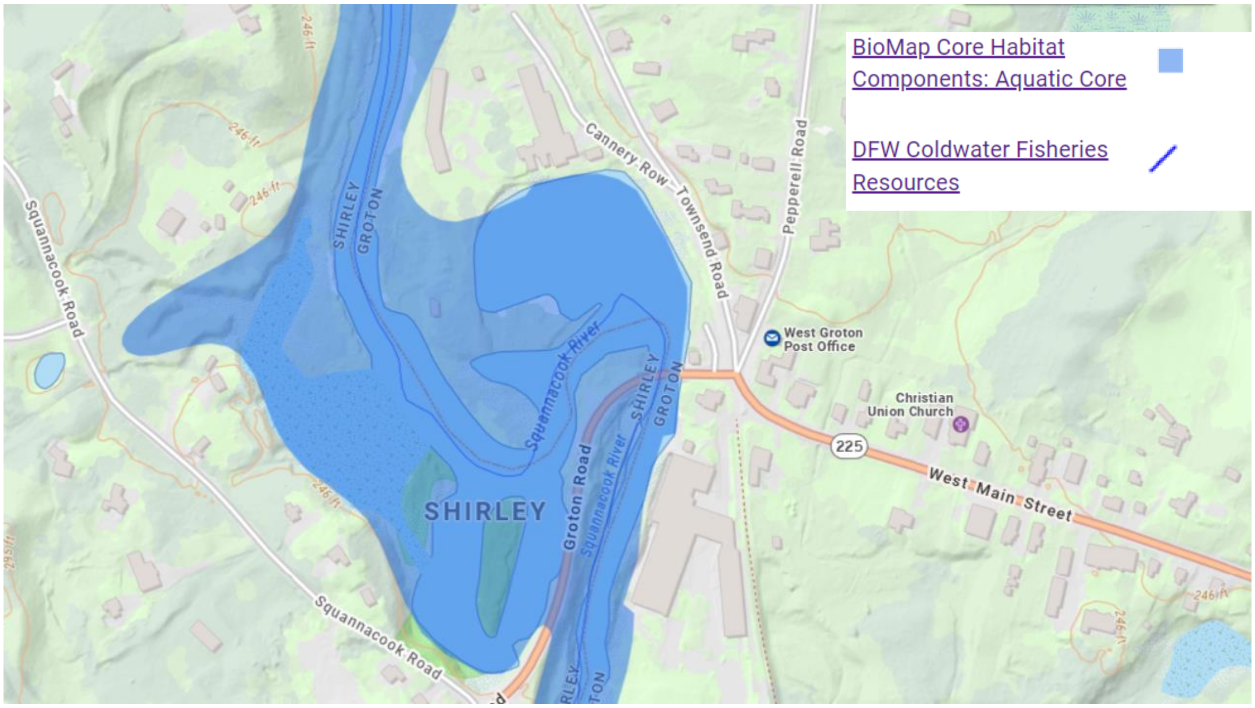

Figure 17: Coldwater Fish Resource and BioMap Core Map

[4]Massachusetts Division of Fisheries and Wildlife, The Nature Conservancy, "What is BioMap?". July 27,2023. https://storymaps.arcgis.com/stories/d8e383e6c651419e88f36f38b4fdc924

[5] The Nashua River Watershed Association & The Massachusetts Watershed Initiative Nashua Team. 2003. "Nashua River Watershed 5 Year Action Plan 2003-2007". https://www.nashuariverwatershed.org/5yr_plan/subbasins/squannacook.htm

FEMA Designation

According to the Federal Emergency Management Agency (FEMA) National Flood Hazard Map (Community Panel No. 25017C0182E, effective June 4, 2010 and No. 25017C0182F, preliminary June 8, 2023), the Site is located within Special Flood Hazard Areas, Regulatory Floodway, and Zone AE (1% annual chance of flooding). Additionally, there are also Other Areas of Flood Hazard at the site, which are categorized as Zone X (0.2% annual chance of flooding, areas of 1% annual chance flood average depth less than one foot or drainage areas of less than one square mile) to the west and northeast of the site (**Figure 18**).

Figure 18. Excerpt from the Federal Emergency Management Agency (FEMA) FIRMette for the site.

State-listed Rare Species Habitat

According to the most recent version of the *Massachusetts Natural Heritage Atlas* (15th Edition, August 1, 2021), the site is located within areas mapped as *Estimated Habitat of Rare Wildlife* (EH 1300) and *Priority Habitat of Rare Species* (PH 2035) as designated by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) (**Figure 19**). There are no *Certified Vernal Pools* or *Potential Vernal Pools* mapped within the vicinity of the project.

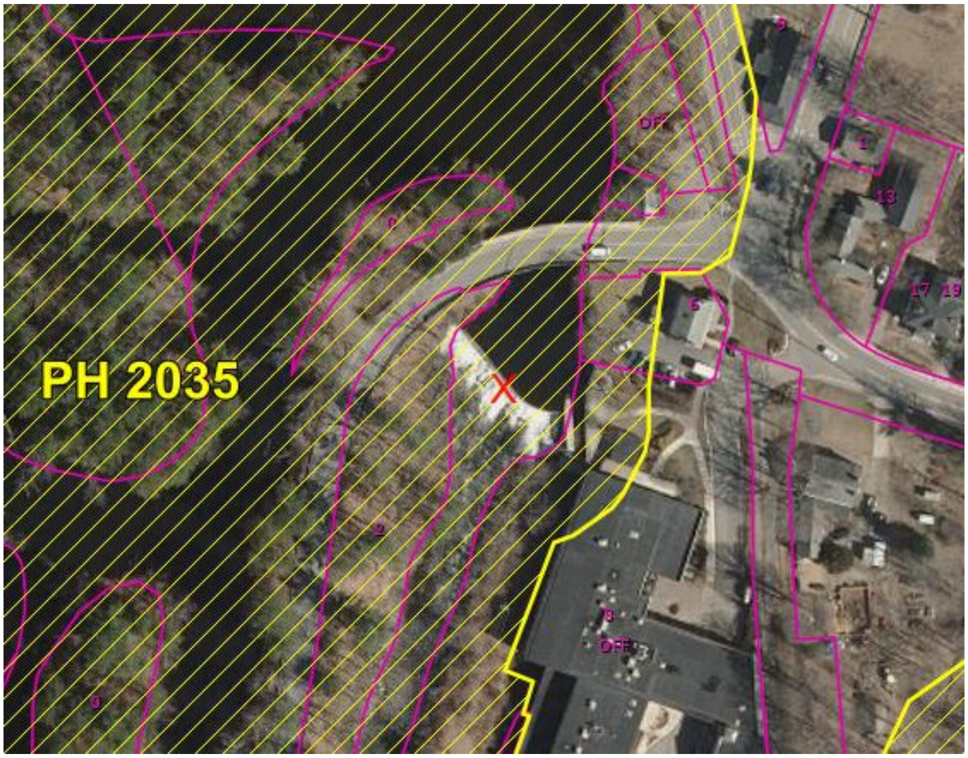

Figure 19. Rare species habitat (Source: MassMapper 2024)

2.3.4 Upstream Infrastructure

Groton Road (Route 225)

Groton Road is a state road that crosses the Squannacook River upstream of the Squannacook River Dam. The east end of Groton Road meets West Groton Center, at which point it transitions into West Main Street. Groton Road crosses the Squannacook River over the West Groton Bridge (see below) and continues along an embankment that separates the downstream and upstream reaches of the Squannacook River. It is unclear whether this embankment is natural or human-made; boring logs in the 1995 reconstruction plans for the West Groton Bridge do not indicate whether soil in the embankment is fill or not. The roadway has a low elevation of 239.6 on its northern side. The only known utilities along this section of Groton Road are overhead wires – no gas, water, sewer, or drainage are understood to run between the Towns.

West Groton Bridge

The West Groton Bridge (**Figure 20**) is a 20-foot-wide bridge that spans 65 feet of the Squannacook River along Groton Road. The bridge is comprised of concrete and stone masonry. The bridge deck is approximately 19 feet higher than the channel bottom of the Squannacook River at the thalweg, 6 feet higher than the ordinary high water elevation, and 8 feet higher than the dam spillway. Proposed Bridge Replacement Plans by Luchs Associates, Inc. (Background Document #1) show that prestressed concrete box beams support the bridge under the deck. During the January 31, 2024 site visit, 6 feet of separation was present between the water level and the bridge deck.

Figure 20. West Groton Bridge (Viewed from Downstream)

Based on the 1995 bridge reconstruction plans, the bridge footings of the West Groton Bridge are at least partially exposed to the flow of the river. No riprap is currently in place to protect the footings against scour.

Hollingsworth & Vose Dam

The Hollingsworth & Vose Dam is the next upstream dam along the Squannacook River, located 1.2 miles upstream of the Squannacook River Dam. The dam is operated by the Hollingsworth and Vose Company, which also operates the Townsend Harbor Dam an additional 4.9 miles upstream. Both dams are managed to control the water level of the Squannacook River Reservoir, the impoundment formed by the Hollingsworth & Vose Dam. In the summer, stop logs are used to raise the dam elevation by up to 12 inches in order to increase the depth of the impoundment. Stop logs are typically removed in the fall. Coordination with dam operators at Hollingsworth & Vose Company would be necessary prior to any potential construction activities at the Squannacook River Dam in order to ensure no unexpected impoundment release occurs.

Private Wells (Shirley)
Groton DPW personnel confirmed that residents of Groton in the vicinity of the Squannacook River Dam impoundment are on Town water, supplied by a well in the Groton Town Forest (downstream of the dam).

In Shirley, mapping from the Executive Office of Energy and Environmental Affairs indicates that properties in the vicinity of the impoundment along Groton Road and Squannacook Road receive water from private wells, which was also expressed by members of the public during a public meeting about this study, held on February 26th, 2024. Recorded well depths generally range from 30 to 85 feet, with a few wells deeper than 400 feet. While impacts from dam removal to wells of these depths are unlikely, and evaluation of such potential impacts is not in the scope of this study, future studies related to potential dam removal should evaluate the potential impacts of dam removal on wells due to lowered groundwater levels.

In general, if impacts to selected wells are identified as a concern during future evaluations, such impacts could be mitigated by drilling deeper replacement wells for those affected properties. If enough wells are identified to have concern associated with them, Groton could consider extending Groton Town water into Shirley for the affected homes.

2.3.5 Abutters and Access Considerations

Review of tax parcels available through MassGIS indicates that there are at least 3 private parcels that directly abut the Squannacook River Dam impoundment in Groton and at least 6 private parcels that abut the impoundment in Shirley. In Groton, DPW personnel have engaged with one abutter, RiverCourt Residences, when performing dam inspections and repairs in the past. Additional public engagement providing initial information about dam removal has been conducted by NRWA in both Groton and Shirley, and by DER and the town of Groton during a public meeting held on February 26th, 2024.

As discussed further below, construction access to the Squannacook River Dam would likely be achieved through the northern driveway on the RiverCourt Residences property. This was the access route used during the 2013 repairs to the Groton side of the dam (**Figure 21**). During the 2013 repairs, cofferdams were used to control water flow and create areas to work in the dry, and ladders were used to enter and exit the work area.

Figure 21. Access to Squannacook River Dam from RiverCourt Residences

3.0 SEDIMENT ASSESSMENT AND MANAGEMENT

3.1 Due Diligence Review

HW completed a limited due diligence review to evaluate potential historical threats to water and sediment quality and to inform sediment sampling to be conducted as part of our preliminary restoration design project for the Squannacook River Dam along the Squannacook River in Groton, MA (the “Subject Property”).

The limited due diligence review consisted of the following:

- An evaluation of online records available from the Massachusetts Department of Environmental Protection (MassDEP) Waste Site and Reportable Releases Database (the “Database”);
- A review of historical topographical maps, Sanborn Fire Insurance maps, and historical aerial photographs available online from the EDR™ Report, published by Environmental Data Resources Inc. (“EDR”);
- A screening of regulatory records for environmental conditions at and abutting the Subject Property from the EDR Radius Map™ Report, published by EDR;
- A visual field assessment of the Subject Properties for evidence of a release of oil and/or hazardous materials (OHM).

HW utilized historical information along with a review of regulatory records for environmental conditions at and abutting the Subject Property from the EDR Radius Map™ Report, published by Environmental Data Resources Inc. (“EDR”) as well as online records available from the Massachusetts Department of Environmental Protection (MassDEP) Waste Site and Reportable Releases Database to determine and research known “Release Sites” at and abutting the Subject Properties. Based on a review of the EDR Report, four release sites were identified within a half-mile of the Subject Properties. Details on the release sites and a map of release sites are provided below.

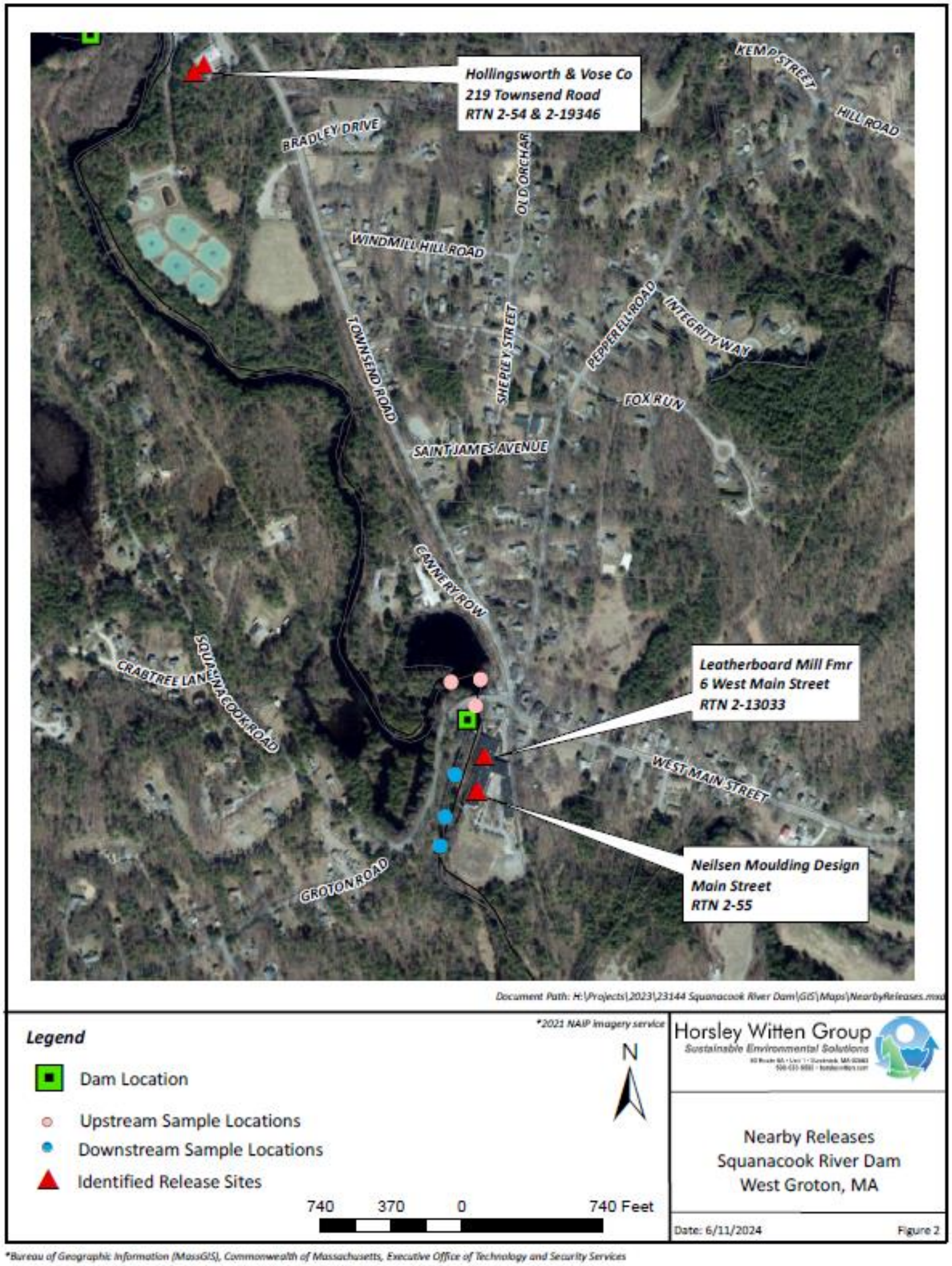

Figure 22: Nearby Release Sites and Sampling Locations

Nielson Moulding | **Release Tracking Number (RTN) 2-55**
8 West Main Street RTE 225 | **Immediately east of Squannacook River Dam**

Leatherboard Mill Former | **Release Tracking Number (RTN) 2-13033**
6 West Main Street | **Immediately east of Squannacook River Dam**

According to the report titled *Class A-2 Response Action Outcome (RAO) Report and Statement* prepared by ENVIRON International Corporation and dated February 2011, two releases have occurred at this property. A release of metals and volatile organic compounds (VOCs) were identified in soil and groundwater, RTN 2-55, during an environmental site assessment. The second release, RTN 2-13033, was identified as a result of observed non-aqueous phase liquid (NAPL) fuel oil in a monitoring well on the property.

Various investigations have occurred at the property including a due diligence assessment wherein concentrations of polycyclic aromatic hydrocarbons (PAHs) and tetrachloroethene (PCE) were detected in groundwater. Response actions included installation of monitoring wells, soil sampling, and surface water sampling of the Squannacook River.

According to the report titled *Immediate Response Action Plan Completion* prepared by Leggette, Brashears & Graham, Inc. (LBG) and dated July 10, 2000, a release of NAPL oil was observed in a monitoring well near a former 25,000-gallon No. 6 fuel oil underground storage tank (UST). The release was identified to have impacted soil and groundwater at the property. Response actions included the excavation and removal of approximately 200 cubic yards of visually impacted soil and 72 gallons of groundwater via a vacuum truck. A 15,000-gallon AST, as well as 4,460 gallons of oil, was removed from the property, and during cleanup, a total of 2,370 pounds of drummed oil, oil solids, paint solids, acid, and caustic solution were removed from the property for off-site disposal. A total of 584.24 tons of impacted soils were disposed of off-site. Soil samples were collected from the tank grave areas, and monitoring wells were installed on property.

Based on a Method 3 Risk Characterization, a condition of No Significant Risk had been achieved on the property in regard to groundwater. Additionally, a Temporary Solution under a Class-C Response Action Outcome (RAO) for natural attenuation as concentrations of contaminants in groundwater (Extractable Petroleum Hydrocarbons, VOCs, and/or PAHs were detected at low levels slightly exceeding GW-1 concentrations. After various additional rounds of groundwater sampling and the installation and/or replacement of monitoring wells as response actions as a result of additional MassDEP audits, a Method 3 Risk Characterization statement was presented, and a condition of No Signfiicant Risk had been achieved for the site. Considering the regulatory status, the releases associated with RTN 2-55 and RTN 2-13033 are unlikely to significantly impact the Subject Property.

Hollingsworth & Vose Co. | **Release Tracking Number (RTN) 2-54**
219 Townsend Road | **Approximately 2,703 feet northwest/upstream**

According to the letter report titled *Final Screening Site Investigation* prepared by NUS Corporation and dated May 29, 1991, a release was observed on the property as an overflow of raw waste directly into the Squannacook River. This property operated as a manufacturer of industrial and technical papers and landfill, and paper sludge and wastewater are disposed of into two sludge beds on the property. The release was attributed to an issue with the facility's wet well pump, and the untreated water consisted of “an acrylic latex mix and paper machine white water containing cellulosic fibers”. Response actions included groundwater and surface water monitoring as well as soil samples on the property.

According to the *LSP Evaluation Opinion* prepared by Goldman Environmental Consultants (GEC), Inc. and dated February 6, 1995, a site investigation including surface water and groundwater monitoring was conducted. As a result of the monitoring, no evidence indicated a significant release of oil or hazardous materials to the sampled media. GEC also sampled the three sludge drying beds on the property, and the results also indicated no evidence of a significant release of oil or hazardous materials. As a result of GEC’s evaluation, the site was not considered a disposal site under the MCP, and therefore, the release associated with RTN 2-54 is unlikely to significantly impact the Subject Property.

Hollingsworth & Vose Co. **Release Tracking Number (RTN) 2-19346**
219 Townsend Road **Approximately 2,703 feet northwest/upstream**

According to the report titled *Immediate Response Action Completion Report and Permanent Solution Statement* prepared by Clean Harbors Environmental Services, Inc. and dated April 21, 2015, a historical release of No. 6 fuel oil was discovered during a subsurface investigation and boring advancement. The location of the release was observed in the vicinity of an existing fuel storage building and two buried concrete 50,000-gallon underground storage tanks (USTs) that were closed in place. Response actions included the advancement of additional soil borings and soil sampling. Groundwater was encountered at approximately nine feet below grade while contaminated soils were identified as deep as 10.5 feet below grade. Groundwater monitoring wells were installed and sampled. According to the report, groundwater was minimally but measurably impacted with detections slightly above the applicable Method 1 GW-1 standard. An Activity and Use Limitation exists at the property regarding the contaminated soil and groundwater on the property. Approximately 20 cubic yards of oily soil exists 7 feet below grade and is isolated beneath pavement or a building. As a result of the AUL, a Permanent Solution with Conditions has been established on site. Considering the regulatory status, the release associated with RTN 2-19346 is unlikely to significantly impact the Subject Property.

3.1.1 Additional Considerations

According to a Groton resident whose property abuts the Thompson Mill Pond area of the impoundment, the Hollingsworth & Vose Co. previously manufactured cigarette filters containing asbestos, as recently as the 1950s. In our due diligence review, HW found no records of a known release associated with asbestos products. The abutter’s statement about potential asbestos concerns was provided to HW after our due diligence review, the sampling plan, the sampling itself, and all laboratory analyses were completed. However, given the abutter expressed concern that asbestos may be present in the impounded sediment upstream of the dam, the potential presence of asbestos should be evaluated during a future project phase.

3.2 Sediment Sampling Plan

The known contaminant sources at the historic mills and industrial land along the Squannacook River Dam and closely surrounding the Subject Properties suggests the potential for polychlorinated biphenyls (PCBs), metals, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs) to impact sediment quality.

Based upon the above-discussed due diligence review, and in consideration of the 401 Water Quality Certification requirements (314 CMR 9.00), a sediment sampling program was completed that included only those compounds originally included in the Project Scope of Work, as follows:

- Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Volatile Organic Compounds (VOCs)*;
- Polychlorinated Biphenyls with congeners;
- Extractable Petroleum Hydrocarbons (EPH);
- Total Organic Carbon;
- Percent water; and
- Grain Size Distribution – wet sieve (ASTM D422).

*Discrete sediment samples were field screened prior to compositing. The sediment was field screened for the presence of Total Organic Volatiles (TOV) using a calibrated Photoionization Detector (PID) in order to select those sample locations that most warrant VOC analysis (unlike other parameters, VOCs are not allowed to be composited for WQC from multiple locations).

Sediment sampling locations included the following:

- One composite sample comprised from three locations within the impoundment.
- One composite sample comprised from three locations below the dam to identify existing background conditions.

Figure 22 above depicts the discrete sampling points and the groupings for each composite sample. All samples were vertically blended from the top several feet of sediment (as could be effectively reached with sampling equipment) likely to be potentially mobilized in a dam removal scenario.

3.3 Sediment Sampling Results

HW conducted sediment sampling on January 31, 2024, as part of the preliminary restoration design project for the Squannacook River Dam. Sediment sampling was completed following the above referenced sediment sampling plan, which was established as a result of the due diligence review of potential contamination sources. The Sediment Sampling Plan defined what chemical parameters to test for, where samples would be collected, sampling procedures, and how individual sediment sample locations would be composited for laboratory analysis.

Sediment sampling locations included the following:

- One composite sample comprised from three locations within the impoundment. Discrete samples were 0-to-1-foot grabs at each location.
- One composite sample comprised from three locations below the dam to identify existing background conditions. Discrete samples were 0-to-1-foot grabs at each location.

As discussed in the Sampling Plan section above, the sediment samples were analyzed for the following parameters:

- Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc)**;

- Polycyclic Aromatic Hydrocarbons (PAHs);
- Volatile Organic Compounds (VOCs)*;
- Polychlorinated Biphenyls with congeners;
- Extractable Petroleum Hydrocarbons (EPH);
- Total Organic Carbon;
- Percent water; and
- Grain Size Distribution – wet sieve (ASTM D422).

*Discrete sediment samples were field screened prior to compositing.
**Note TCLP analyses were not run as those parameters were not detected above the TCLP 20X rule.

All samples were collected in appropriate laboratory delivered containers, stored on ice, and picked up the next day by ESS Laboratories from Cranston, Rhode Island. During field sampling, visual and olfactory observations were made for evidence of release of oil and hazardous materials (OHM), and none were noted. Soil samples were field screened for TOV with a PID using the jar headspace method. TOV PID values ranged from less than the detection limit of the equipment (<0.1 ppmv) to a maximum of 0.4 ppmv.

Laboratory sediment quality results were entered into the standard DER sediment quality spreadsheet for comparison to the Massachusetts Contingency Plan (MCP) S-1/GW-1 standards for human health as well as the key ecological thresholds Threshold Effects Concentrations (TEC) and Probable Effects Concentrations (PEC) for freshwater. The analytical results include a statistical summary of the sediment quality of upstream and downstream sampling locations within the river (denoted by US and DS, respectively). The full laboratory results are included here as **Attachment A**.

Key observations from the sediment sampling are as follows:

- Most results were below laboratory detection limits and are shown in green font on the MADER Sediment Quality Table with values equal to half of the laboratory reporting limit. Black font values are results in excess of reporting limits for MA DEP Soil Standards and Guidance Values, orange highlighted values are results in excess of Sediment Threshold Effects Concentrations, and yellow highlighted values are actual results in excess of Sediment Probable Effects Concentrations.

- Metals were detected above laboratory reporting limits, but most metals were detected below both MCP standards and sediment thresholds. One metal, arsenic, was detected in the downstream sample (Groton DS) at concentrations greater than the sediment threshold TEC values. There were no metals detections above MCP S1 standards.

- Polycyclic aromatic hydrocarbons (PAHs) were detected in both the upstream and downstream samples. Both upstream and downstream, individual concentrations were below TEC values with the exception of Anthracene, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b]fluoranthene, Benzo[g,h,i]perylene, Benzo[k]fluoranthene, Chrysene, Dibenz[a,h]anthracene, Fluoranthene, Fluorene, Indeno[1,2,3-cd]pyrene, Naphthalene, Phenanthrene, and total PAHs, which were detected at a concentration greater than the Sediment Thresholds TEC values but below values listed in MCP S1 standards.

- Volatile Organic Compounds (VOCs) were not detected over reporting limits in either upstream or downstream sample.
- Polychlorinated Biphenyls (PCBs) were detected upstream and downstream in both samples above reporting limits but below sediment threshold TEC standard values and below MCP S1 standards. PCBs were anticipated to be detected due to the historical use in the vicinity of the Subject Property.
- Extractable Petroleum Hydrocarbons (EPH) were not detected above reporting limits at either upstream or downstream samples.
- Sediment for all composite samples consisted of mostly brown poorly graded sand. Upstream samples consisted of 9.9% gravel, 85.5% sand, and 4.6% fines. Downstream samples consisted of 5.5% gravel, 91.7% sand, and 2.8% fines.

Based on these findings, dam removal would not be expected to result in threats to water or sediment quality due to transport of moveable sediments from upstream to downstream. It is likely that few contaminants were retained within the sediment due to its coarse nature and associated interstitial spaces, which are larger and allow more space for water to flush contaminants out of the sediment. The potential presence of asbestos in the impounded sediment (particularly in the Thompson Mill Pond area, as indicated by an abutter) will necessitate additional sediment sampling in future project phases. Consultation with the Massachusetts Department of Environmental Protection (MassDEP) will be needed to determine if further sampling will be needed, and whether dam removal planning may continue as determined through the 401 Water Quality Certification process.

4.0 HYDROLOGIC AND HYDRAULIC ANALYSIS

HW developed a hydrologic and hydraulic (H&H) model of the subject reach of the Squannacook River to provide an understanding of how the Squannacook River Dam affects water levels, flow velocities, and sediment transport within the project area. Specifically, this analysis was used to determine the potential future impacts of removing the Squannacook River Dam.

Hydrology, in this context, refers to the volume of precipitation-derived water from the watershed conveyed to the river under different storm and flow conditions, while hydraulics refers to the flow characteristics of the river resulting from those hydrologic inputs under the same set of flow conditions.

4.1 Model Development

A one-dimensional, subcritical, steady-state flow model was developed using the USACE Hydraulic Engineering Center River Analysis System software (HEC-RAS, v. 6.4.1) to investigate the potential hydraulic implications of dam removal. One dimensional HEC-RAS models are well-suited for situations like the current study where hydraulic changes occur predominantly in one dimension (i.e., from upstream to downstream along the centerline of the channel). Adding vertical variance, two- and three-dimensional models are more complex and require significantly more input data, as well as more advanced modeling software. In HEC-RAS the user defines the channel extents, cross-sectional dimensions, and hydrologic flows. Based on those inputs, HEC-RAS calculates the water surface elevation profile, velocities, and depths. HEC-RAS can also be used to determine the effects of various obstructions such as bridges and culverts in the channel and floodplain. For this project, HEC-RAS was run under steady state conditions, which refers to the condition where the fluid (i.e., water) properties at a single point in the system do not change over time.

4.1.1 Hydrology

In the H&H analysis developed for this project, the hydrologic inputs were determined after evaluating three hydrological estimation methods. Those methods include:

- The Prorated Gage Method uses annual peak flow data from USGS Gage 0109600, which is located on the Squannacook River approximately 3 miles upstream of the Squannacook River Dam. The method prorates gaged flow statistics based on the relative watershed areas of the gauged station and the ungauged location at the dam. Based on 74 years of available data, peak flow statistics for this gaging station were calculated from the annual peak flow values. Statistics were then prorated by the ratio of the contributing drainage area of the Squannacook River at the Squannacook River Dam (69.5 square miles) to the drainage area at the upstream gage (63.7 square miles).
- The FEMA FIS Method uses peak flow statistics provided by the Federal Emergency Management Agency (FEMA) Flood Insurance Study No. 25017CV001C for the Squannacook River. Peak flow statistics were calculated by FEMA at several points along the Squannacook River based on the same gage used in the Prorated Gage Method described above. Values for the 10-, 2-, 1-, and 0.2-percent-annual-chance discharges at the gage were calculated by FEMA using a Log-Pearson Type III analysis of annual peak flow data and were scaled to estimate flows at the Squannacook River's confluence with the Nashua River. The Natural Resources Conservation Service (NRCS)'s standard methodology for the hydrologic routing of flows was applied by FEMA to define discharge-frequency relationships for the Squannacook River at sections upstream and downstream of the gaging station. In a similar fashion as the Prorated Gage Method, the NRCS method uses the ratio of drainage areas at two different points to find their respective discharges in cubic feet per second per square mile.

  Although the Prorated Gage Method and the FEMA FIS Methods follow very similar processes, their results vary due to differences in data. The Prorated Gage Method uses flow statistics from the start of USGS Gage 0109600 in 1949 to 2024 (74 years), while the FEMA FIS Method uses data from 1949 to 2014 (64 years). With a smaller sized data set utilized in the FEMA FIS Method, individual outliers have a greater impact on the calculated hydraulic inputs. Thus, the Prorated Gage Method is predicted to be the more accurate method due to its larger dataset.

- StreamStats is a software program produced by USGS that generates estimates of stream properties such as peak flow rates, low-flow statistics, and bankfull width. To do so, StreamStats uses regression models based on basin characteristics such as drainage area, mean basin slope, basin length and width, and percent of land characterized by water bodies, forest, and sandy/gravelly soils. Different regression models are developed regionally; peak flow rate estimates for the Squannacook River are based on a hydrological model developed by USGS for Massachusetts. The estimates of flow rates during peak flood and more frequent daily recurrence intervals using each of the aforementioned hydrologic methods is shown below in **Table 1**. **Table 1** estimates are based on a location in the river immediately upstream of the West Groton Bridge.

Table 1. Comparison of Peak Flow Estimates (cfs) Upstream of Squannacook River Dam by Different Hydrological Methods

Recurrence Interval	Prorated Gage	FEMA	StreamStats
95% exceedance	12.0	*	*
50% exceedance	78.6	*	*
5% exceedance	400.4	*	*
2 year	1,553	*	1,370
5 year	2,508	*	2,210
10 year	3,246	3,540	2,860
25 year	4,293	*	3,810
50 year	5,155	6,880	4,610
100 year	6,094	8,840	5,430
200 year	7,109	*	6,350
500 year	*	15,160	7,650

*data not available

As illustrated, different peak flow estimates for all events are generated using the three different methods. Because of its reliance on the most extensive dataset of local-scale field data, the Prorated Gage Method-generated flows are considered the most accurate overall and were therefore used for subsequent modeling and analyses discussed herein.

Further, the Prorated Gage Method offers a reasonable middle estimate as compared to the lower estimated flows from StreamStats and the considerably higher estimated flows produced by FEMA. Based on USGS Gage No. 01096000, the historical record of peak flow is estimated to be 4,820 cfs (in April 2007), which falls between the range of the 25-year and 50-year storm flows of the Prorated Gage hydrology. During the April 2007 peak flow, DPW personnel confirmed that water levels were well below the bottom of the West Groton Bridge. By contrast, FEMA's Flood Insurance Rate Maps (FIRM), which are based on the FEMA flow rates described above, predict that Route 225 would become inundated during the 25- and 50-year events. Based on observed peak flooding, it is likely that the FEMA hydrology is an overestimation of on-site flows.

4.1.2 Existing Conditions Model

To develop the existing HEC-RAS model, HW incorporated topographic and bathymetric field data collected from 13 transects along the Squannacook River. The locations and number of cross sections collected by HW were chosen based on where the most detail along the length of the stream was needed for the model to perform an accurate representation of flow dynamics resulting from changes in topography and hydraulics. Cross sections were extended across the floodplain using available light detection and ranging (LiDAR) data. **Figure 23.** Final HW Existing Conditions HEC-RAS Model Schematic - Project Area shows a schematic plan of the existing HEC-RAS model.

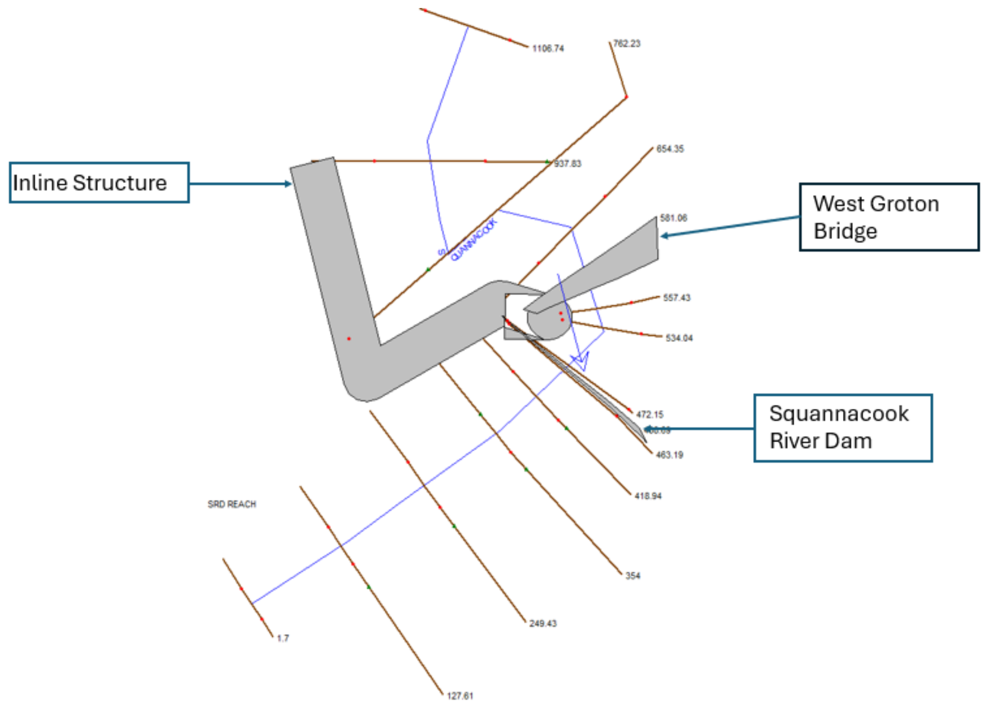

Figure 23. Final HW Existing Conditions HEC-RAS Model Schematic - Project Area

Schematics of the Squannacook River Dam and the West Groton Bridge are shown below as **Figure 24.** Squannacook River Dam HEC-RAS Model Schematic and **Figure 25,** respectively.

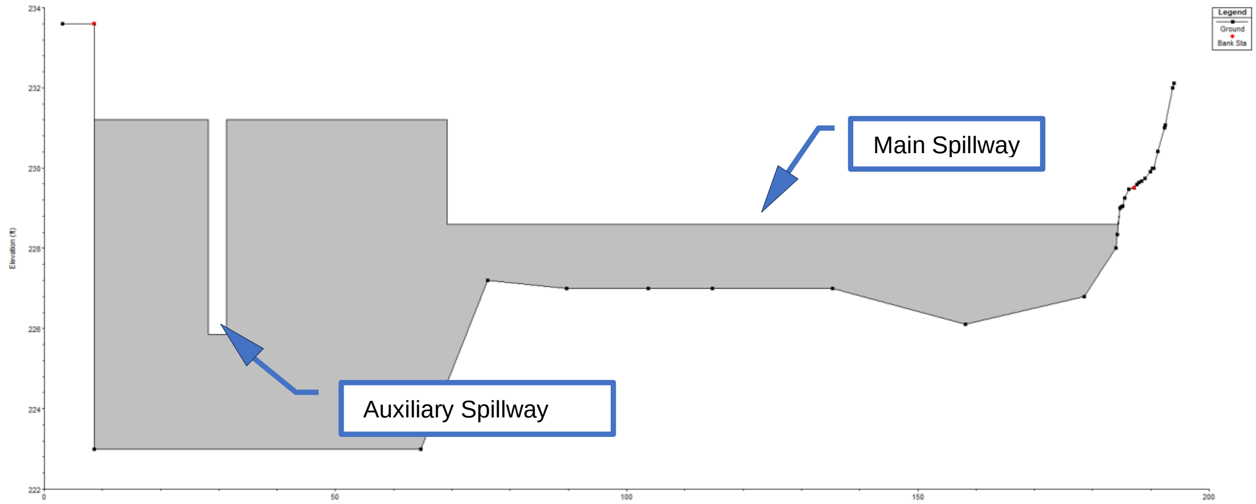

Figure 24. Squannacook River Dam HEC-RAS Model Schematic

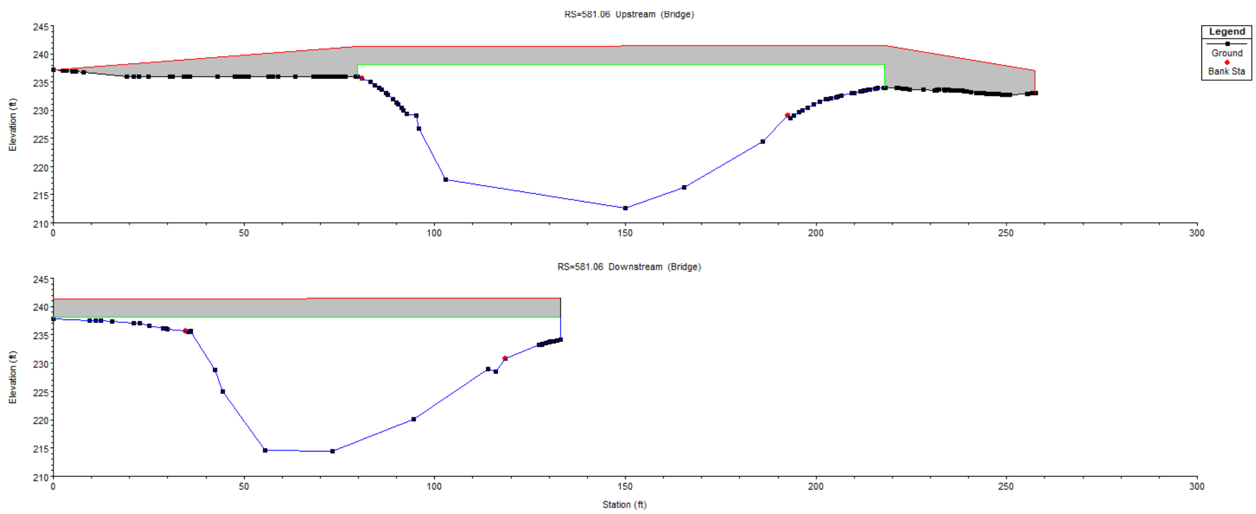

Figure 25. West Groton Bridge HEC-RAS Model Schematic

Flow measurements taken by the USGS West Groton Gage on the days of HW's topographic and bathymetric field data collection were used along with measurements of the WSE along the river to calibrate the model. Based on the observed water surface measurements during the HW survey, variables such as channel roughness and downstream boundary conditions were adjusted to match HEC-RAS predictions of water surface elevations with observed elevation measurements.

4.2 Model Results

The existing conditions model was modified incrementally to create a proposed conditions model. The proposed conditions, dam-out model includes the following:

- Removal of the full vertical and horizontal extent of the Squannacook River Dam; and

- Sediment mobilization and transport, assumed to occur via instream sediment management.

The proposed conditions model was developed with the assumption that bedrock immediately downstream of (and perhaps underneath) the dam would not be removed or mobilized by dam removal. The location and elevation of bedrock at the dam was modeled by referencing the Construction Completion Report of the Squannacook River Dam by Haley & Aldrich, Inc. on January 10th, 2014.

Model results relative to sediment transport and fish passage are discussed in the section below.

4.2.1 Dam Removal and Sediment Transport

Table 2 presents the water surface elevations for the median daily flow, the 2-year flow, and the 100-year flow at two points upstream of the Squannacook River Dam, under existing conditions and proposed conditions.

Table 2. Water Surface Elevations Under Dam Removal Conditions

	Downstream of Squannacook River Dam (Transect 1)	Downstream of Squannacook River Dam (Transect 5)	Upstream of Squannacook River Dam (Transect 7)	Upstream of West Groton Bridge (Transect 10)
50% Flow (78.6 cfs)				
Existing Conditions Elevation (feet)	210.41	215.82	228.85	228.85
Dam Removed Elevation (feet)	210.41	215.82	217.32	219.76
Difference	**0**	**0**	**-11.53**	**-9.09**
2-Year Flow (1,553 cfs)				
Existing Conditions Elevation (feet)	215.01	219.93	231.36	231.40
Dam Removed Elevation (feet)	215.01	219.93	220.13	224.33
Difference	**0**	**0**	**-11.23**	**-7.07**
100-Year Flow (6,094 cfs)				
Existing Conditions Elevation (feet)	220.39	225.41	234.56	234.85
Dam Removed Elevation (feet)	220.39	225.41	225.57	229.64
Difference	**0**	**0**	**-8.99**	**-5.21**

Removal of the Squannacook River Dam is predicted to reduce impoundment water levels by as much as 11.5 feet during median flows. During the 100-year flow, water levels are predicted to be reduced by up to 9.0 feet. **Table 3** shows the friction slope, which represents the energy available to transport sediment along the length of the channel . Under proposed conditions, the friction slope is expected to increase upstream relative to existing conditions. These increases in friction slope values do not exceed existing downstream value at Transect 2; therefore, the existing channel slope at Transect 2 is likely to be the maximum slope of the channel bottom upstream of the dam in post-dam removal conditions.

Table 3. Friction Slope During 100-Year Flow

Position	Transect Number	Friction Slope (ft/ft) under Existing Conditions	Friction Slope (ft/ft) under Proposed Conditions
Upstream of Dam	13	0.000369	0.001553
	12	0.000124	0.000890
	11	0.000133	0.000869
	10	0.000259	0.000827
	9	0.000716	0.006713
	8	0.000638	0.005658
	7	-	0.004242
Downstream of Dam	6	0.005407	0.004371
	5	0.004524	0.004524
	4	0.004554	0.004554
	3	0.004503	0.004503
	2	0.009646	0.009646
	1	-	-

While some sediment immediately upstream of the dam is expected to transport soon after the dam is removed, long-term sediment transport as a result of the proposed dam removal is expected to be negligible. It is likely that much of the soft sediment loading received by the Squannacook River is intercepted by the Hollingsworth and Vose Dam farther upstream, resulting in the small amount of sediment observed within the Squannacook River Dam impoundment. It is also possible that the 2003 dredging of the Thompson Mill Pond area of the impoundment has reduced the total sediment accumulation upstream of the dam, although minimal transport is expected to occur in this relatively static backwater area.

Channel velocities and shear stress values upstream of the dam under the 2-year flow are shown for existing and proposed conditions in **Table 4**. Velocities under proposed conditions are expected to reach a peak of 7.36 feet per second (fps) upstream of the dam, with a corresponding shear stress of 1.81 pounds per square foot (psf). These values exceed the transport thresholds for up to and including 2-inch diameter gravel and cobbles, indicating that particles with diameters equal to or less than 2-inches have the potential to mobilize during or soon after the dam removal process. However, consideration of the energy grade line, which is equivalent to the friction slope or slope at which sediment transport is expected to occur, indicates that there are only two main locations where the river would have the energy required for transport post-removal: immediately upstream of the dam and approximately 200-400 feet upstream of the dam. The position of the stream bed below the presumed energy grade line (**Figure 26**) is used as a reference for the maximum slope at which sediment transport would be expected to occur.

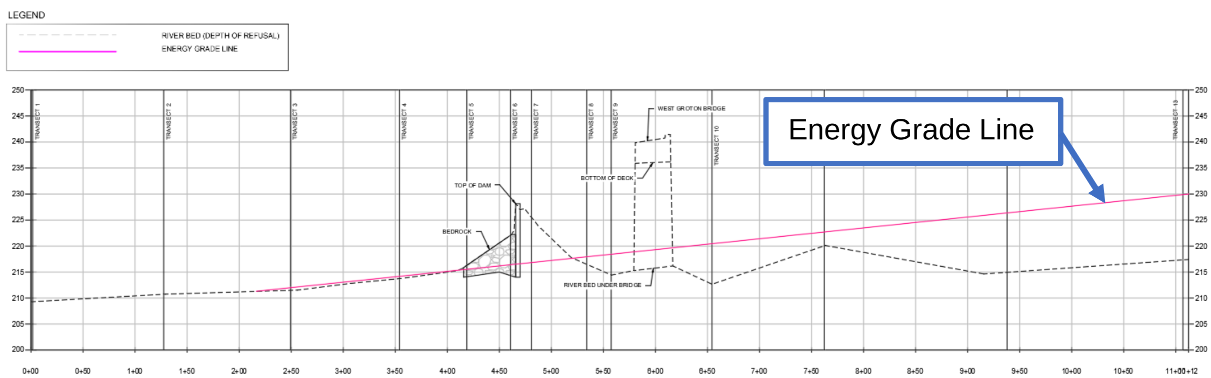

Figure 26. Profile of Energy Grade Line in the vicinity of the Squannacook River Dam

Table 4. Velocity and Shear Immediately Upstream of Squannacook River Dam Under the 2-Year Flow

Condition	Main Channel Velocity (feet/sec)	Main Channel Shear Stress (lb/sq ft)
Existing	1.50	0.06
Proposed	7.36	1.81

Instream sediment management is estimated to result in a total sediment transport volume of ~1,940 cubic yards. The expected depth and lateral extents of sediment transport are shown in **Figure 27** and **Figure 28.** Due to the high velocity required to prevent coarse grained material from settling, coarse-grained sediment is not predicted remain suspended for as long as for fine-grained sediment and thus will not be carried as far downstream. Still, it is likely that the initial release of impounded sediment will result in the transport of larger sediment sizes downstream of the former dam. This transport is likely to be beneficial for river health, as the area downstream of the dam is probably sediment starved due to the presence of the dam. The deposition of sediment downstream could replenish these areas and help to prevent erosion in the future.

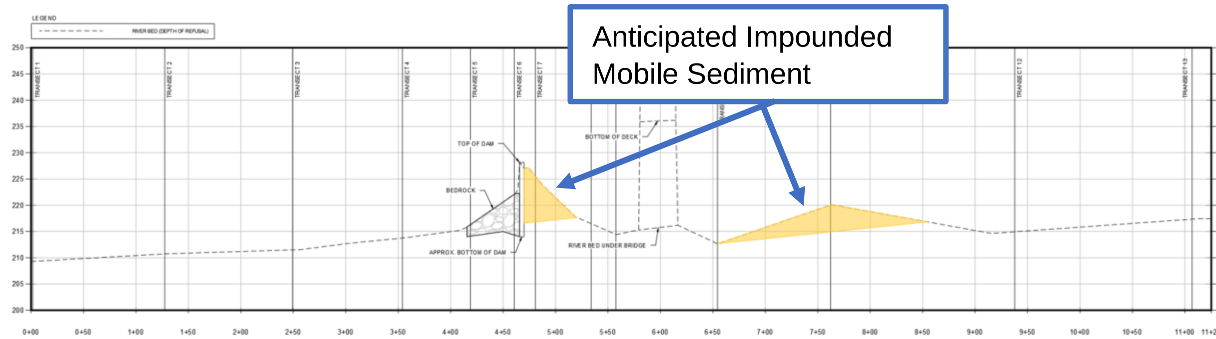

Figure 27. Profile of Anticipated Sediment Mobilization in the Vicinity of the Squannacook River Dam

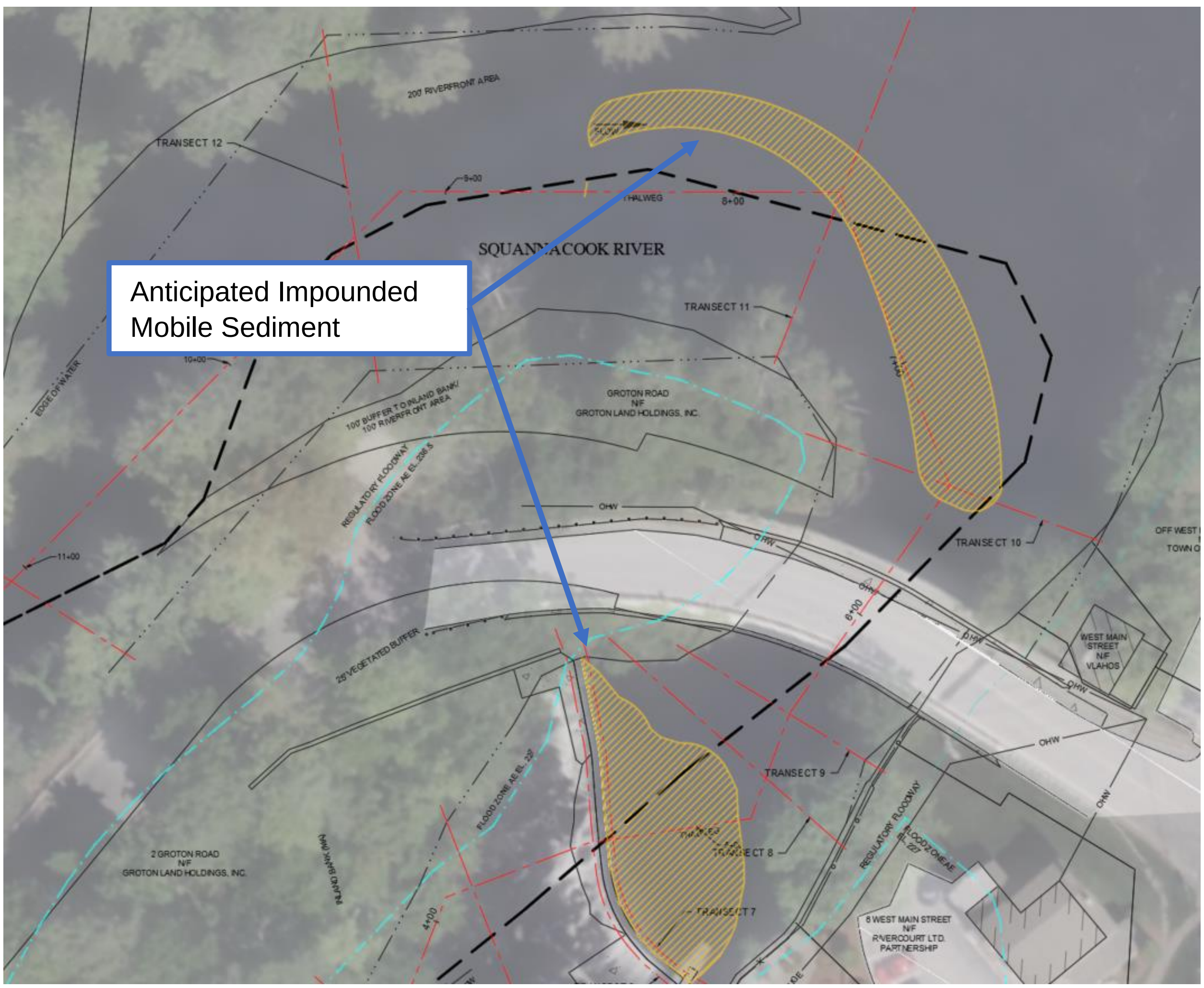

Figure 28. Approximate Extents of Anticipated Mobilized Sediment

Table 5 shows the comparison of potentially mobile impounded sediment to watershed-wide sediment loads. The potential sediment load induced by dam removal is predicted to be a moderate increase of 21% of the total annual sediment load estimated to occur in the Squannacook River. Despite this moderate increase, transport of impounded sediment would most likely occur over the course of a year or more, meaning that the increase to annual sediment loading in the river will be gradually redistributed at a smaller proportion of the annual load than 21%.

Table 5. Comparison of Potentially Mobile Impounded Sediment vs. Watershed Sediment Loads

Parameter	Volume (cy)	Avg. Dry Unit Weight (kg/cy)[6]	Sediment Load (kg, dry)
Estimated Potentially Mobile Sediment Impounded by Squannacook River Dam	1938.98[7]	600	1,163,388
Mean Annual Modeled Sediment Loads for Squannacook River Watershed Upstream of the Dam[8]			5,351,914
Percent of annual mean sediment load that may mobilize due to dam removal[9]			**21%**

4.2.2 Post-Removal Impoundment

As discussed above, water levels in the impoundment are predicted to decrease by over 9 feet during typical, median flow conditions post-dam removal. Transect 11, which bisects the Thompson's Mill Pond area of the impoundment, is used herein as a reference for assessing conditions in the impoundment post-dam removal. **Table 6** shows the predicted water surface elevations in the impoundment during the 95% (low), 50% (median), and 5% (high) flows. **Figure 29** depicts these elevations from an aerial view.

Table 6. Water Surface Elevations at Transect 11

Flow	Existing Conditions	Proposed Conditions	Proposed Depth (ft)
95% (low)	227.14	220.74	.7
50% (medium)	228.85	221.46	1.4
5% (high)	229.69	222.69	2.7

[6] Calculated based on standard average soil bulk density, HEC-RAS 2D Sediment Technical Reference Manual. https://www.hec.usace.army.mil/confluence/rasdocs/d2sd/ras2dsedtr/latest/model-description/water-and-sediment-properties/sediment-properties
[7] Calculated from sediment probing data collected in January 2024 within the main flow path
[8] Simulated by the EPA Model My Watershed – Watershed Multi-Year Model (simulates 30-years of daily data by the GWLF-E (MapShed) model).
[9] Total of likely + potentially mobile sediment divided by the modeled mean annual sediment load for the watershed.

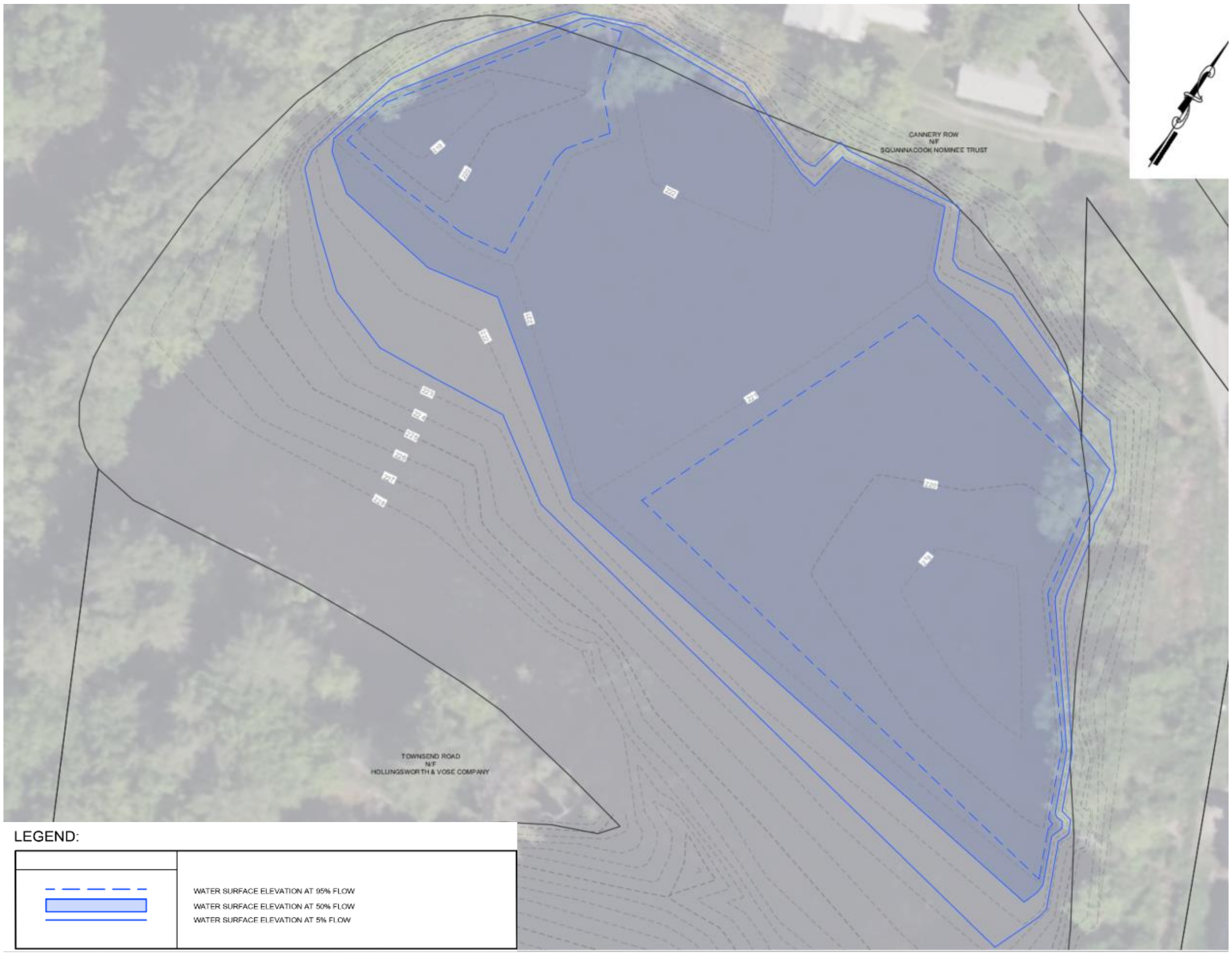

Figure 29. Predicted Water Surface Elevations under Dam Removal Conditions
Extents of Low Flow (Dashed Line, Inner), Median Flow (Blue, Middle) and High Flow (Solid Line, Outer)

4.3 Fish Passage

The existing Squannacook River Dam represents a significant barrier to the passage of aquatic organisms. The proposed condition eliminates this obstacle, increasing stream connectivity and flow velocities at the former dam site. The impacts of dam removal and sediment transport on water depths and velocities are displayed in **Table 7**.

The Squannacook River subbasin includes multiple priority habitat areas which were designated for their role in supporting native brook trout populations.[10] Due to its presence in the Squannacook river and its ecological role as an indicator species of relatively healthy riverine environments[11], the Eastern Brook Trout was selected as a target species used to evaluate the impacts of proposed dam removal activities. Fish passage is assessed in terms of brook trout navigability during low (95% exceedance) and high (5% exceedance) flow events. Brook trout

[10] Nashua River Watershed Association, *Nashua River Watershed 5 Year Action Plan 2003-2007,* 2003.
[11] Massachusetts Division of Fisheries and Wildlife, *Brook Trout Fact Sheet,* 2015

have a maximum burst speed of approximately 3.0 fps[12] and require a minimum water depth of 0.3 feet[13] for successful passage.

Table 7. Main Channel Water Depth and Velocity

	5% Exceedance Flow (400.4 cfs)		95% Exceedance Flow (12.0 cfs)	
	Minimum Thalweg Depth (feet)	**Main Channel Velocity (fps)**	**Minimum Thalweg Depth (feet)**	**Main Channel Velocity (fps)**
Existing Conditions				
Downstream of Dam (Transect 4)	2.08	**7.23****	0.34	2.56
Downstream of Dam (Transect 5)	2.51	2.79	0.55	0.97
Downstream of Dam (Transect 6)	1.01	**5.46****	**0.10***	1.80
Upstream of Dam (Transect 7)	6.67	0.55	4.14	0.04
Upstream of Dam (Transect 8)	11.89	0.52	9.35	0.02
Dam Removed				
Downstream of Dam (Transect 4)	2.08	**7.23****	0.34	2.56
Downstream of Dam (Transect 5)	2.51	2.79	0.55	0.97
Downstream of Dam (Transect 6)	1.27	**6.13****	**0.13***	1.75
Upstream of Dam (Transect 7)	1.21	**6.01****	**0.13***	1.75
Upstream of Dam (Transect 8)	2.83	**6.84****	0.77	2.75

*** bold asterisk** indicates depth below criteria for brook trout passage.
****bold double asterisk** indicates velocity exceeds criteria for brook trout passage.

Although modeling results indicate that dam removal would cause velocities during high flow conditions to exceed the brook trout maximum burst speed, main channel velocities reach a peak of 7.23 fps downstream of the dam in both the existing and proposed conditions. Thus, velocities upstream of the dam are not expected to exceed those that currently occur in the reach downstream of the dam. Assuming that brook trout are currently able to migrate up to the base of the dam, the proposed dam removal would not represent an additional barrier to the passage of brook trout.

On the other hand, modeling also indicates that main channel depths may develop that are too shallow for brook trout navigation during low flows, with a low minimum thalweg water depth of 0.13 feet under proposed conditions. Under existing conditions, the existing main channel depth at Transect 6 is already lower than the proposed low value (0.10 feet under existing conditions). Since the predicted main channel depths do not fall below the existing minimum depth, the change in channel depths because of the proposed dam removal is not expected to have a detrimental impact on the passage of brook trout The conservative nature of this model should also be noted when considering fish passage. Depth and velocity were considered at the thalweg and the main channel, representing the greatest respective depths and flows at each cross section. Within those cross sections, however, exist areas of lower flow and shallower depth that could potentially provide conditions suitable for brook trout passage. Additional in-

[12] Kondratieff, M.C. and Myrick, C.A. 2006. Brook Trout Jumping Performance. American Fisheries Society.
[13] Ibid.

stream modifications during potential future dam removal, such as creation of a low flow channel or placement of boulders, could also increase the likelihood of successful upstream passage under the full range of flow conditions.

4.4 Scour Assessment

The risk of increased scour along existing riverbanks, retaining walls, and bridge abutments was assessed with respect to the 100-year flow event (**Table 8**). Immediately downstream of the dam, velocities in the Squannacook River are expected to decrease post-dam removal relative to existing conditions, indicating that the risk of increased downstream scour due to dam removal is minimal. Upstream of the dam, velocities in the Squannacook River are predicted to increase throughout the project reach upstream of the dam, indicating heightened risk of scour. 100-year flow velocities are modeled to increase by the largest amount immediately downstream of the West Groton Bridge.

Table 8. 100-Year Channel Velocity

Position	Transect	100-Year Velocity (fps) Existing	Proposed
Downstream of Dam	5	6.40	6.40
	6	7.45	6.51
Upstream of Dam	7	3.78	6.66
	8	4.95	13.04
	9	5.38	9.48
	10	3.51	5.17
	11	1.48	3.12
	12	3.10	4.91
	13	5.07	8.75

Armoring banks and structures with riprap or vegetation is recommended to mitigate the risk of scour upstream of the dam post-removal. Scour protection included in the proposed removal design are described further below. A more detailed scour assessment is not covered in the scope of this project phase, but should be addressed in future phases.

4.5 RMAT Tool

In order to assess the potential changes in site hydrology under future climate conditions, HW utilized the ResilientMass Action Team's (RMAT's) Climate Resilience Design Standards Tool to generate design flows appropriate for the project setting. The RMAT Tool uses climate change projections to assess potential flooding impacts and inform design standards. The RMAT Project Report (**Attachment B)** recommends that a 25-year storm with a projected 24-hr total precipitation depth of 6.6 inches is used as the design storm for assessing the impacts of climate change at the Project Site. The report also recommends that the extreme precipitation output values are compared to the NOAA+ methodology to calculate total precipitation depth for a 24-hr design storm. Because the 25-year storm is less conservative than the 100-year flow used in the previously discussed H&H Model, the NOAA+ methodology was used to account for the impacts of climate change at the Project Site.

HW scaled the Prorated Gage Method hydrology by the ratio of the NOAA+ rainfall estimates to the standard NOAA Atlas 14 rainfall estimates in Groton to produce a hydrology that accounts for higher rainfall depths as a result of climate change, per the RMAT recommendations (**Table 9**). The updated hydrology was then input into HEC-RAS to estimate the impacts of higher flow rates on the post-dam removal river.

Table 9. Comparison of Peak Flow Estimates (cfs) Upstream of Squannacook River Dam with and without Adjusting for Climate Change

Recurrence Interval	Prorated Gage	NOAA+ Adjustment
95% exceedance	12.0	13.09
50% exceedance	78.6	85.69
5% exceedance	400.4	436.81
2 year	1,553	1,689
5 year	2,508	2,749
10 year	3,246	3,557
25 year	4,293	4,913
50 year	5,155	6,020
100 year	6,094	7,391
200 year	7,109	8,642

As shown below in **Table 10**, climate change impacts on sediment transport upstream of the Squannacook River Dam are minimal. The main channel velocity is expected to increase by 0.02 fps, while the main channel sheer stress is expected to decrease by 0.02 psf respectively.

Table 10. Velocity and Shear Upstream of Squannacook River Dam Under the 2-Year Flow

Condition	Main Channel Velocity (fps)	Main Channel Shear Stress (psf)
Existing	1.50	0.06
Proposed	7.36	1.81
Proposed with Climate Change	7.38	1.79

Under climate change, water surface elevations are expected to increase slightly, although the river is not predicted to overtop the West Groton Bridge (elevation 241.53) (**Table 11**). Water elevations upstream of the Squannacook River Dam are predicted to decrease relative to existing conditions, even when accounting for climate change.

Table 11. Water Surface Elevations Under Dam Removal Conditions

	Upstream of Squannacook River Dam (Transect 7)	**Upstream of West Groton Bridge (Transect 10)**
25-Year Flow		
Existing Conditions Elevation (feet) ***4,293 cfs***	233.48	233.67
Proposed Conditions Elevation (feet) ***4,293 cfs***	223.66	227.93
Proposed Conditions Elevation with Climate Change (feet) ***4,912 cfs***	224.44	228.55
100-Year Flow		
Existing Conditions Elevation (feet) ***5,585 cfs***	234.56	234.85
Proposed Conditions Elevation (feet) ***5,585 cfs***	225.57	229.64
Proposed Elevation with Climate Change (feet) ***7,391 cfs***	226.83	230.74

Climate change is expected to have minimal impact on fish passage. Main channel velocities may increase by up to 0.16 fps and minimum thalweg depths are predicted to increase by as much as 0.03 feet (**Table 12**). Though velocities during high flow conditions are expected to exceed pre-climate change maximum velocities at Transect 4, no transect directly downstream or anywhere upstream of the former dam is predicted to exceed the velocities of Transect 4. It is likely that, regardless of dam removal, velocity at this location would increase due to higher flows induced by climate change.

Table 12. Main Channel Water Depth and Velocity

	5% Exceedance Flow Minimum Thalweg Depth (feet)	5% Exceedance Flow Channel Velocity (fps)	95% Exceedance Flow Minimum Thalweg Depth (feet)	95% Exceedance Flow Channel Velocity (fps)
Existing Conditions ***(5% Flow = 400.4 cfs; 95% Flow = 12.0 cfs)***				
Downstream of Dam (Transect 4)	2.08	**7.23****	0.34	2.56
Downstream of Dam (Transect 5)	2.51	2.79	0.55	0.97
Downstream of Dam (Transect 6)	1.01	**5.46****	**0.10***	1.80
Upstream of Dam (Transect 7)	6.67	0.55	4.14	0.04
Upstream of Dam (Transect 8)	11.89	0.52	9.35	0.02
Proposed Conditions ***(5% Flow = 400.4 cfs; 95% Flow = 12.0 cfs)***				
Downstream of Dam (Transect 4)	2.08	**7.23****	0.34	2.56
Downstream of Dam (Transect 5)	2.51	2.79	0.55	0.97
Downstream of Dam (Transect 6)	1.27	**6.13****	**0.13***	1.75
Upstream of Dam (Transect 7)	1.21	**6.01****	**0.13***	1.75
Upstream of Dam (Transect 8)	2.83	**6.84****	0.77	2.75
Proposed Conditions with Climate Change ***(5% Flow = 436.8 cfs; 95% Flow = 13.1 cfs)***				
Downstream of Dam (Transect 4)	2.19	**7.37****	0.35	2.71
Downstream of Dam (Transect 5)	2.64	2.87	0.57	0.98
Downstream of Dam (Transect 6)	1.34	**6.29****	**0.13***	2.07
Upstream of Dam (Transect 7)	1.28	**6.17****	**0.14***	1.84
Upstream of Dam (Transect 8)	2.94	**6.94****	0.80	2.80

*** bold asterisk** indicates depth below criteria for brook trout passage.

****bold double asterisk** indicates velocity exceeds criteria for brook trout passage.

5.0 PRELIMINARY DAM REMOVAL DESIGN

Preliminary (approximately 30%) design plans and cost estimate are included herein as **Attachments C and D.** The preliminary design is presented as a 10-sheet plan that includes existing conditions, construction access, site preparation, demolition plan, site layout, restoration and stabilization plan, and typical details.

The preliminary design was based on information acquired during the initial site visits and conversations with project partners. This coordination informed the conditions that the design would need to accommodate. The following are key components of the preliminary design:

- Construction access would be through the RiverCourt Residences parking lot. A stabilized construction entrance will be required to minimize sediment tracking out of the construction zone and erosion of the existing areas. Parking lot features will be protected in place during construction, or removed and reset as necessary.
- Construction equipment and materials staging will occur adjacent to the site entrance within the RiverCourt Residences parking lot as well as the lot at the corner of Route 225 and Townsend Road (Carol G. Wheeler Park).
- Dam removal is recommended to occur during the driest season of the year (August-October). The dam’s low level outlet will be used to lower the impoundment and enable

work to occur "in the dry." Additional dewatering activities may be approved as appropriate. The dam will be demolished incrementally, such that impoundment water levels are able to lower gradually and outflow velocities from the impoundment are minimized.

- Dam operators at the Hollingsworth & Vose Company will be coordinated with to ensure that maximum water is retained upstream during the dam removal and that no upstream dam releases occur throughout the duration of construction.
- The potential elevation of the upstream stream channel hard bottom post-dam removal is uncertain. To the extent practicable, the dam should be demolished until the entire concrete structure and any footing materials have been removed from the stream channel. Consideration should also be given to creating a low-flow channel or channels where deeper water can concentrate during low flow conditions to facilitate fish passage.
- Once the dam is fully demolished, the banks in the vicinity of the dam will be stabilized using constructed banks made from stone redistributed from the dam demolition. Impounded coarse material will be reused as possible, and otherwise will be allowed to passively transport.
- Provided that MassDEP concurs during the permitting process, most sediment will be managed through instream management techniques, thereby allowing accumulated materials to naturally transport and redistribute in sediment-starved areas downstream of the dam. Note that some sediment will be manually redistributed to constructed banks.

Though not covered in the scope of this project phase, future phases should address the following:

- Evaluation of the well drawdown potential at Shirley wells in the vicinity of the dam impoundment.
- Evaluation of scour potential along the West Groton Bridge footings and elsewhere upstream of the dam.
- More detailed sediment sampling and analyses, including evaluating the potential for presence of asbestos in sediments upstream of the dam as suggested as a possibility by an abutting property owner. Sampling for asbestos may not necessarily be necessary pending more detailed research into the potential for its presence based on the manufacturing history at the Hollingsworth & Vose Company.

6.0 DISCUSSION

6.1 Potential Ecological Impacts and Benefits

An immediate impact of removing the Squannacook River Dam would be the release of mobile sediment that has accumulated behind the structure. Downstream sediment transport is a natural riverine process, which has been altered by the presence of the Squannacook River Dam. Long-term sediment transport is expected to be negligible, and it is expected that a new equilibrium will be reached within one to two years, pending the types of storms and flow events experienced post dam removal.

The impact on aquatic species depends on the concentration, exposure time, and time of year. Sessile communities are more susceptible to sediment impacts than fish (which can move upstream or downstream of the impact zone and thus avoid many of the negative impacts). Coordination with the Massachusetts Division of Fisheries and Wildlife (Mass Wildlife) Natural Heritage Endangered Species Program (NHESP) will need to occur prior to dam removal to avoid impacting any state listed sessile species, such as mussels. This may require a sediment monitoring and rare species relocation plan, if applicable. Timing the dam removal so that sediment is released well ahead of fish migration periods (likely October-November) will help to minimize the impacts to migratory fish. Final determination of fish migration periods will need to be verified with Mass Wildlife during the project permitting phase. It is recommended that potential impacts associated with deposition downstream of the dam are monitored following dam removal. As discussed above, the amount of sediment that is expected to be mobilized relative to the size of the river will not be significant.

The above mentioned potential minimal and temporary impacts can be easily mitigated and are largely outweighed by the significant and long-term ecological benefits resulting from dam removal. For most small dams, removal results in the restoration of a river's natural water temperature regime along the former impoundment area and downstream of the dam.[14] Removal of a dam will encourage active flow, help reduce water temperatures, and support higher dissolved oxygen concentrations, making the part of the river currently upstream of the dam more hospitable to cold water species. Removal of the dam will also allow free movement of motile aquatic and terrestrial organisms upstream and downstream.

In general, following dam removal, overall lotic macroinvertebrate abundance and diversity tends to increase relative to that of impoundment communities as a new channel is formed and more heterogenous in-channel habitat becomes available for both invertebrates and fish.[15,16,17] Such a change is anticipated following removal of the dam. Restoration of sediment continuity through this reach would be beneficial over the long term, not only for restoring habitat locally, but also for replenishment of sediment to downstream habitats and floodplains.

Model results indicate that predicted water surface profiles and flow velocities through the former dam location may sometimes be unfavorable to fish passage, although predicted velocities post-removal are not expected to exceed those that currently occur in the reach

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[14] Pawloski, J.T. and Cook, L.A., 1993, Sallings Dam drawdown and removal. In *Unpublished manuscript presented at The Midwest Region Technical Seminar on Removal of Dams, Association of State Dam Safety Officials* (Vol. 30), September 1993.
[15] Bushaw-Newton, K.L., Hart, D.D., Pizzuto, J.E., Thomson, J.R., Egan, J, Ashley, J.T., Johnson, T.E., Horwitz, R.J., Keeley, M, Lawrence, J., Charles, D., Gatenby, C., Kreeger, D.A., Nightengale, T., Thomas, R.L. and D.J. Velinsky. 2002. An integrative approach towards understanding ecological responses to dam removal: The Manatawny Creek Study. *J. Am. Wat. Res. Assoc.* 38(6) 1581-1599.
[16] Calaman, H. and C.P. Ferreri. 2002. *Effects of dam removal on benthic macroinvertebrate diversity*. Pennsylvania State University School of Forest Resources.
[17] Pollard, A.I. and Reed-Anderson, T. 2001. Benthic invertebrate community change following dam removal in a small Wisconsin stream. *Bulletin of the North American Benthological Society* 18: 173.

downstream of the dam. Additionally, some modeled lower flow events resulted in water column depths that may become too shallow for brook trout passage. HW recommends that during construction, care be given to create a suitable low-flow channel in the vicinity of the former concrete splashpads where flow can concentrate to accommodate fish passage.

6.2 Potential Impacts and Benefits for Flooding, Infrastructure, and Recreation

Potential flooding impacts were not specifically evaluated during this project, but the Inspection Report completed by Haley & Aldrich, Inc. in 2023 states that failure of the dam "may cause loss of life and temporary flooding to the lowest level of the mill building." H&H modeling and examination of aerial photography and available topographic data indicates that structures surrounding the Squannacook River Dam impoundment are generally outside of the current flood plain extents. Infrastructure adjacent to the floodplain is limited to the West Groton Bridge, RiverCourt Residences, an abandoned structure on the North side of Route 225, and the Carver's Guild Mirror Shop building. Hydrologic and hydraulic analysis under existing conditions indicates that none of these structures are currently at risk of inundation during flood flows with return intervals of 100 years or less. Still, removal of the Squannacook River Dam is expected to reduce impoundment water levels, further reducing the minimal risk of flooding to these structures. As a run-of-the-river structure, removal of the Squannacook River Dam would not be anticipated to significantly affect the downstream flood conditions. However, removing the dam does eliminate the risk of dam failure, which would likely result in flooding downstream.

Existing infrastructure along the river channel including the West Groton Bridge and the retaining walls adjacent to the river may be impacted by the higher flow velocities that are predicted to occur upstream of the current location of the dam subsequent to removal. Risk of scour can be mitigated with additional scour protection in the form of riprap armoring and bank construction. Velocities are not predicted to increase downstream of the dam, and therefore scour risk is not predicted to increase along the retaining wall adjacent to the former mill building. The former mill building and current structure of RiverCourt Residences is not anticipated to be impacted by dam removal.

Recreation along the Squannacook River currently includes paddling (generally downstream of the Squannacook River Dam[18]) and fly fishing (generally for brook trout, upstream of the Hollingsworth and Vose Dam[19]). Paddling downstream of the dam is not expected to be significantly affected by dam removal, since velocities and water depths are not modeled to change post-removal. Removal of the dam would restore continuity of paddling along a portion of the Squannacook River, although conditions may only be suitable for advanced paddlers. Restoration of river continuity and potentially aquatic passage would be beneficial to brook trout populations and range, potentially improving fly fishing opportunities.

[18] Brettal, Squannacook River in Massachusetts, https://paddling.com/paddle/trips/squannacook-river-in-massachusetts
[19] Tango, J., (2016). Overview: the Squannacook River, https://blogflyfish.com/2016/03/overview-squannacook-river.html

6.3 Environmental Permitting

A detailed permitting evaluation was not conducted as part of this project. However, based on experience, **Table 13** below lists the environmental permits that are anticipated to be required for this project. Actual permitting may vary depending on funding sources and other factors to be determined in subsequent project phases. It should also be noted that this project is likely to qualify as an ecological restoration project and therefore may be exempt from MEPA review.

Table 13. Potential Permitting Requirements

Permits, Reviews, or Authorizations Required
Local
Groton Conservation Commission Restoration Order of Conditions
Shirley Conservation Commission Restoration Order of Conditions
State
Massachusetts Environmental Policy Act (MEPA) Review / Secretary's Certificate
Massachusetts Dept. of Environmental Protection (DEP) 401 Water Quality Certification
Massachusetts Dept. of Environmental Protection (DEP) Chapter 91 Permit
Massachusetts Historical Commission (MHC) Comment
Natural Heritage and Endangered Species Program Comment
Massachusetts Division of Fish and Wildlife Coordination Regarding a Potential Time of Year Restriction
Federal
United States Army Corps of Engineers (USACE) Section 404 / Section 10 Permit

7.0 ESTIMATED PROJECT COSTS AND FUTURE PHASING

Permit level design is the recommended next step to advance dam removal, and it is recommended that this step includes further scour analysis of the upstream bridge and drawdown analysis of nearby wells. The overall timeline for permit level design is typically 1-2 years, and construction may occur in the following 1-2 years after receiving permitting approval.

Approximate concept-level project costs are provided in **Table 14** below. A detailed concept-level opinion of probable construction cost is included as **Attachment D**. As is typical, construction costs are estimated to be the largest overall portion of future project phases. Primary contributors to the estimated construction cost include dewatering and access costs and (most substantially) excavation of the reinforced concrete structures of the dam, sluice wall, and concrete splashpads. Estimated costs utilize the most recently available median unit bid prices provided by the Massachusetts Department of Transportation (MA DOT).

Removal and disposal of the large volume of reinforced concrete associated with this project is the largest cost element for multiple reasons. First, reinforced concrete is significantly more difficult to break apart than would be unreinforced stone, masonry, or non-reinforced concrete construction materials. In particular, the reinforcing steel bars may need to be cut in the field many times to break the structures into movable pieces. Second, unlike a dam of natural stone block construction where the dam materials can be utilized as scour protection or other project in-river elements, the reinforced concrete needs to be removed from the river, trucked away, and disposed of properly. The concrete and rebar debris would not be considered hazardous waste, but would be construction debris requiring disposal or recycling at an appropriate facility.

Table 14. Concept-Level Project Costs and Future Phases

Project Phase	**Approximate Cost Estimate**
Permit Level Design	$80 – 120K
Additional Field Work and Analysis	
50-60% Design	
Permitting	
Final Design	$30– 50K
Additional Field Work and Analysis	
100% Design	
Specifications	
Construction Administration	$30 – 50K
Bid Documents	
Bidding Assistance	
Construction Inspections & Submittal Reviews	
As-built Survey and Plans	
Construction (**Attachment D**)	$1.9 – 2.7M
Post-Construction Monitoring	$25 – 50K
Water Levels	
Habitat/Ecology	
Total	**$2.2 – 2.9M**

ATTACHMENT A

Sediment Quality Laboratory Results

Standard Analyses for Dam Removal Projects
(adjust if due dilligence suggests additional pollutant risks)

Parameters	Units	"Natural Soil" Background	"Urban Soil" Background	Ecological Thresholds (aquatic) Freshwater TEC/TEL	PEC/PEL	Human Exposure Thresholds (upland/floodplain) *(for comparison)* Method 1 Soil Standards S-1/GW-1	TCLP	Max Concentrations for Toxicity	Downstream Samples Results Groton DS 1/31/2024	Upstream Samples Groton US 1/31/2024
Metals (mg/kg)							mg/kg	mg/L		
Arsenic	mg/kg (ppm)	20	20	9.79	33.0	20	100.0	5.0	13.5	6.17
Cadmium	mg/kg (ppm)	2	3	0.99	4.98	80	20.0	1.0	0.44	0.17
Chromium (TOTAL)	mg/kg (ppm)	30	40	43.4	111	100	100.0	5.0	6.24	5.7
Copper	mg/kg (ppm)	40	200	31.6	149				6	6.46
Lead	mg/kg (ppm)	100	600	35.8	128	200	100.0	5.0	13.5	31.5
Mercury	mg/kg (ppm)	0	1	0.18	1.06	20	4.0	0.2	0.029	0.024
Nickel	mg/kg (ppm)	20	30	22.7	48.6	700			5.87	7.01
Zinc	mg/kg (ppm)	100	300	121	459	1,000			35.8	22.9
PAHs (ug/kg)										
Acenaphthene	ug/kg (ppb)	500	2,000	6.71	88.9	4,000			5.5	44
Acenaphthylene	ug/kg (ppb)	500	1,000	5.87	128	2,000			5.5	5
Anthracene	ug/kg (ppb)	1,000	4,000	57.2	845	1,000,000			5.5	179
Benzo(a)anthracene	ug/kg (ppb)	2,000	9,000	108	1,050	20,000			14	361
Benzo(a)pyrene	ug/kg (ppb)	2,000	7,000	150	1,450	2,000			15	419
Benzo(b)fluoranthene	ug/kg (ppb)	2,000	8,000			20,000			16	340
Benzo(g,h,i)perylene	ug/kg (ppb)	1,000	3,000			1,000,000			12	291
Benzo(k)fluoranthene	ug/kg (ppb)	1,000	4,000			200,000			13	290
Chrysene	ug/kg (ppb)	2,000	7,000	166	1,290	200,000			17	360
Dibenzo(a,h)anthracene	ug/kg (ppb)	500	1,000	33.0	135	2,000			5.5	118
Fluoranthene	ug/kg (ppb)	4,000	10,000	423	2,230	1,000,000			31	1010
Fluorene	ug/kg (ppb)	1,000	2,000	77.4	536	1,000,000			5.5	62
Indeno(1,2,3-cd)pyrene	ug/kg (ppb)	1,000	3,000			20,000			5.5	233
2-Methylnaphthalene	ug/kg (ppb)	500	1,000			700			5.5	11
Naphthalene	ug/kg (ppb)	500	1,000	176	561	4,000			5.5	16
Phenanthrene	ug/kg (ppb)	3,000	20,000	204	1,170	10,000			20	677
Pyrene	ug/kg (ppb)	4,000	20,000	195	1,520	1,000,000			28	813
Total PAHs	ug/kg (ppb)	26,500	103,000	1,610	22,800	5,183,400			210	5229
PCBs (mg/kg or ppm)										
Total PCBs (mg/kg)	mg/kg (ppm)			0.0598	0.676	1.00			0.00061	0.00499
PCB-8									0.000185	0.000175
PCB-18									0.000185	0.000175

PCB-28					0.000185	0.000175
PCB-44					0.000185	0.000175
PCB-52					0.000185	0.000175
PCB-66					0.000185	0.000175
PCB-77					0.000185	0.000175
PCB-101					0.000185	0.00061
PCB-105					0.000185	0.000175
PCB-118					0.000185	0.000175
PCB-128					0.000185	0.000175
PCB-138					0.00061	0.00111
PCB-153					0.000185	0.00085
PCB-170					0.000185	0.0007
PCB-180					0.000185	0.00117
PCB-187					0.000185	0.00055
PCB-195					0.000185	0.000175
PCB-206					0.000185	0.000175
TPH and EPH (mg/kg or ppm)						
C9-C18 Aliphatic Hydrocarbons	mg/kg (ppm)			1,000	10.4	9.75
C19-C36 Aliphatic Hydrocarbons	mg/kg (ppm)			3,000	10.4	9.75
C11-C22 Aromatic Hydrocarbons	mg/kg (ppm)			1,000	10.5	9.45
Physical Characteristics						
Total Organic Carbon (%)	%				2.87	1.24
Percent Water (%)	%				27	23
Sieve No. 4 (% passing)	% passing				90.1	94.5
Sieve No. 10 (% passing)	% passing				85.5	92.1
Sieve No. 40 (% passing)	% passing				52.7	39.2
Sieve No. 60 (% passing)	% passing				30.8	15.9
Sieve No. 200 (% passing)	% passing				4.6	2.8
Volatile Organic Compounds (VOCs)						
Acetone	mg/kg (ppm)			6.00	0.01385	0.0128
Benzene	mg/kg (ppm)			2.00	0.0014	0.0013
Bromobenzene					0.0014	0.0013
Bromochloromethane					0.0014	0.0013
Bromodichloromethane	mg/kg (ppm)			0.10	0.0014	0.0013
Bromoform	mg/kg (ppm)			0.10	0.0014	0.0013
Bromomethane	mg/kg (ppm)			0.50	0.00275	0.00255
sec-Butylbenzene					0.0014	0.0013
n-Butylbenzene					0.0014	0.0013
tert-Butylbenzene					0.0014	0.0013
Carbon Disulfide					0.0014	0.0013

Carbon Tetrachloride	mg/kg (ppm)			10.00		0.0014	0.0013
Chlorobenzene	mg/kg (ppm)			1.00		0.0014	0.0013
Chlorodibromomethane						0.0014	0.0013
Chloroethane						0.00275	0.00255
Chloroform	mg/kg (ppm)			0.40		0.0014	0.0013
Chloromethane						0.00275	0.00255
Chlorotoluene, 2-						0.0014	0.0013
Chlorotoluene, 4-						0.0014	0.0013
1,2-Dibromo-3-chloropropane PP						0.0014	0.0013
Dibromoethane, 1,2- (EDB)						0.0014	0.0013
Dibromomethane						0.0014	0.0013
Dichlorobenzene, 1,3- (m-DCB)	mg/kg (ppm)			3.00		0.0014	0.0013
Dichlorobenzene, 1,2- (o-DCB)	mg/kg (ppm)			9.00		0.0014	0.0013
Dichlorobenzene, 1,4- (p-DCB)	mg/kg (ppm)			0.70		0.0014	0.0013
Dichlorodifluoromethane (Freon 12)						0.00275	0.00255
Dichloroethane, 1,1-	mg/kg (ppm)			0.40		0.0014	0.0013
Dichloroethane, 1,2-	mg/kg (ppm)			0.10		0.0014	0.0013
Dichloroethylene, 1,1-	mg/kg (ppm)			3.00		0.0014	0.0013
Dichloroethylene, cis-1,2	mg/kg (ppm)			0.30		0.0014	0.0013
Dichloroethylene, trans-1,2	mg/kg (ppm)			1.00		0.0014	0.0013
Dichloropropane, 1,2-	mg/kg (ppm)			0.10		0.0014	0.0013
Dichloropropane, 1,3-	mg/kg (ppm)					0.0014	0.0013
Dichloropropane, 2,2-						0.0014	0.0013
Dichloropropene, 1,1-						0.0014	0.0013
Dichloropropene, cis-1,3-3						0.0014	0.0013
Dichloropropene, trans-1,3- 3						0.0014	0.0013
Diethyl Ether OXY						0.0014	0.0013
Diisopropyl Ether (DIPE) OXY						0.0014	0.0013
Dioxane, 1,4- PP, 1	mg/kg (ppm)			0.20		0.0277	0.02565
Ethylbenzene	mg/kg (ppm)			40.00		0.0014	0.0013
Hexachlorobutadiene	mg/kg (ppm)			30.00		0.0014	0.0013
Hexanone (MNBK), 2- PP						0.01385	0.0128
Isopropylbenzene (Cumene)2						0.0014	0.0013
Isopropyltoluene, p-2						0.0014	0.0013
m+p Xylene						0.00275	0.00255
Methyl Acetate						0.0014	0.0013
Methyl Cyclohezane						0.0014	0.0013
Methyl Isobutyl Ketone (MIBK) PP	mg/kg (ppm)			4.00		0.01385	0.0128
Methyl Tertiary Butyl Ether (MTBE) OXY	mg/kg (ppm)			0.40		0.0014	0.0013
Methylene Chloride						0.0069	0.0064

Naphthalene	mg/kg (ppm)	500	1,000	176.00	561.00	4,000.00	0.0014	0.0013
2-Nitampme (MEK)							0.01385	0.0128
o-Xylene							0.0014	0.0013
Propylbenzene, n-2							0.0014	0.0013
Styrene	mg/kg (ppm)					3.00	0.0014	0.0013
tert-Butyl Alcohol (TBA)							0.0014	0.0013
tert-Butyl Ethyl Ether (TBEE)							0.0014	0.0013
Tetrachloroethane, 1,1,1,2-	mg/kg (ppm)					0.10	0.0014	0.0013
Tetrachloroethane, 1,1,2,2-	mg/kg (ppm)					0.01	0.0014	0.0013
Tetrachloroethylene	mg/kg (ppm)					1.00	0.0014	0.0013
Tetrahydrofuran (THF)							0.00555	0.00515
Toluene	mg/kg (ppm)					30.00	0.0014	0.0013
trans-1,4 Dichloro-2-butene							0.0014	0.0013
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)							0.0014	0.0013
Trichlorobenzene, 1,2,4-	mg/kg (ppm)					2.00	0.0014	0.0013
Trichlorobenzene, 1,2,3-							0.0014	0.0013
1,3,5-Trichlorobenzene							0.0014	0.0013
Trichloroethane, 1,1,1-	mg/kg (ppm)					30.00	0.0014	0.0013
Trichloroethane, 1,1,2-	mg/kg (ppm)					0.10	0.0014	0.0013
Trichloroethylene (TCE)	mg/kg (ppm)					0.30	0.0014	0.0013
Trichlorofluoromethane (Freon 11)							0.0014	0.0013
Trichloropropane, 1,2,3-							0.0014	0.0013
1,2,4-Trimethylbenzene							0.0014	0.0013
1,3,5-Trimethylbenzene							0.0014	0.0013
Vinyl Chloride	mg/kg (ppm)					0.30	0.00275	0.00255
Xylenes	mg/kg (ppm)					400	0.00275	0.00255

ESS Laboratory
DIVISION OF THE RISE GROUP
BAL Laboratory Analytical Balance

CERTIFICATE OF ANALYSIS

Jonas Procton
Horsley & Witten
90 Route 6A
Sandwich, MA 02563

RE: Squannacook River Dam (231214)
ESS Laboratory Work Order Number: 24B0025

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

REVIEWED
By ESS Laboratory at 8:03 pm, Feb 09, 2024

Laurel Stoddard
Laboratory Director

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

Subcontracted Analvses

CTS - Cranston, RI	Grain Size Analysis

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam ESS Laboratory Work Order: 24B0025

SAMPLE RECEIPT

The following samples were received on February 01, 2024 for the analyses specified on the enclosed Chain of Custody Record.

Low Level VOA vials were frozen by ESS Laboratory on Febuary 1, 2024 at 17:10.

Sample ID 24B0025-01 and 24B0025-02 for Metals were oven dried at 60 degrees Celsius prior to digestion and relogged in as Sample ID 24B0025-03 and 24B0025-04. This was done to increase the dry weight of the sample digested which decreases variability of results and lowers the detection limits for samples with high water content.

Lab Number	Sample Name	Matrix	Analysis
24B0025-01	Groton DS	Sediment	2540G, 8082A Cong, 8260D Low, EPH8270, EPH8270SIM, LK, MADEP-EPH, SUB
24B0025-02	Groton US	Sediment	2540G, 8082A Cong, 8260D Low, EPH8270, EPH8270SIM, LK, MADEP-EPH, SUB
24B0025-03	Groton DS Oven Dried	Sediment	6010C, 7471B
24B0025-04	Groton US Oven Dried	Sediment	6010C, 7471B

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam   ESS Laboratory Work Order: 24B0025

PROJECT NARRATIVE

8082 Polychlorinated Biphenyls (PCB) / Congeners

24B0025-02	**Lower value is used due to matrix interferences (LC).**	
	BZ#138 , BZ#153 [2C]	
24B0025-02	**Percent difference between primary and confirmation results exceeds 40% (P).**	
	BZ#138 , BZ#153 [2C]	

Volatile Organics Low Level

D4B0041-CCV1	**Continuing Calibration %Diff/Drift is above control limit (CD+).**
	1,2-Dibromo-3-Chloropropane (33% @ 20%), 1,4-Dioxane (31% @ 20%), Tetrahydrofuran (41% @ 20%)
DB40219-BS1	**Blank Spike recovery is above upper control limit (B+).**
	Tetrahydrofuran (138% @ 70-130%)
DB40219-BSD1	**Relative percent difference for duplicate is outside of criteria (D+).**
	Acetone (36% @ 20%)

No other observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05
Percent Solids: 73
Initial Volume: 12.4g
Final Volume: 10ml
Extraction Method: 5035

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: MEK
Prepared: 2/2/24 9:00

Volatile Organics Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
1,1,1,2-Tetrachloroethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,1,1-Trichloroethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,1,2,2-Tetrachloroethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,1,2-Trichloroethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,1-Dichloroethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,1-Dichloroethene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,1-Dichloropropene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2,3-Trichlorobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2,3-Trichloropropane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2,4-Trichlorobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2,4-Trimethylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2-Dibromo-3-Chloropropane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2-Dibromoethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2-Dichlorobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2-Dichloroethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,2-Dichloropropane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,3,5-Trimethylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,3-Dichlorobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,3-Dichloropropane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,4-Dichlorobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
1,4-Dioxane	ND (0.0554)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
2,2-Dichloropropane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
2-Butanone	ND (0.0277)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
2-Chlorotoluene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
2-Hexanone	ND (0.0277)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
4-Chlorotoluene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
4-Isopropyltoluene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
4-Methyl-2-Pentanone	ND (0.0277)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Acetone	ND (0.0277)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Benzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Bromobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05
Percent Solids: 73
Initial Volume: 12.4g
Final Volume: 10ml
Extraction Method: 5035

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: MEK
Prepared: 2/2/24 9:00

Volatile Organics Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Bromochloromethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Bromodichloromethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Bromoform	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Bromomethane	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Carbon Disulfide	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Carbon Tetrachloride	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Chlorobenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Chloroethane	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Chloroform	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Chloromethane	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
cis-1,2-Dichloroethene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
cis-1,3-Dichloropropene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Dibromochloromethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Dibromomethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Dichlorodifluoromethane	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Diethyl Ether	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Di-isopropyl ether	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Ethyl tertiary-butyl ether	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Ethylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Hexachlorobutadiene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Isopropylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Methyl tert-Butyl Ether	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Methylene Chloride	ND (0.0138)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Naphthalene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
n-Butylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
n-Propylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
sec-Butylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Styrene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
tert-Butylbenzene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Tertiary-amyl methyl ether	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Tetrachloroethene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05
Percent Solids: 73
Initial Volume: 12.4g
Final Volume: 10ml
Extraction Method: 5035

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: MEK
Prepared: 2/2/24 9:00

Volatile Organics Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Tetrahydrofuran	ND (0.0111)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Toluene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
trans-1,2-Dichloroethene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
trans-1,3-Dichloropropene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Trichloroethene	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Trichlorofluoromethane	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Vinyl Chloride	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Xylene O	ND (0.0028)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Xylene P,M	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219
Xylenes (Total)	ND (0.0055)		8260D Low		1	MEK	02/02/24 14:37	D4B0041	DB40219

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichloroethane-d4	*118 %*		*70-130*
Surrogate: 4-Bromofluorobenzene	*94 %*		*70-130*
Surrogate: Dibromofluoromethane	*110 %*		*70-130*
Surrogate: Toluene-d8	*102 %*		*70-130*

ESS Laboratory
DIVISION OF THE RISE GROUP
BAL Laboratory   Analytical Balance

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05
Percent Solids: 73
Initial Volume: 24.8g
Final Volume: 1ml
Extraction Method: 3546

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment
Units: mg/kg dry

Prepared: 2/2/24 15:16

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	ND (20.8)		MADEP-EPH		1	NXL	02/05/24 18:06	D4B0093	DB40221
C19-C36 Aliphatics1	ND (20.8)		MADEP-EPH		1	NXL	02/05/24 18:06	D4B0093	DB40221
C11-C22 Unadjusted Aromatics1	ND (20.8)		EPH8270		1	MJV	02/07/24 19:28	D4B0154	DB40221
C11-C22 Aromatics1,2	ND (21.0)		EPH8270			TJ	02/07/24 19:28		[CALC]
2-Methylnaphthalene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Acenaphthene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Naphthalene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Phenanthrene	**0.020** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Acenaphthylene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Anthracene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Benzo(a)anthracene	**0.014** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Benzo(a)pyrene	**0.015** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Benzo(b)fluoranthene	**0.016** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Benzo(g,h,i)perylene	**0.012** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Benzo(k)fluoranthene	**0.013** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Chrysene	**0.017** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Dibenzo(a,h)Anthracene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Fluoranthene	**0.031** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Fluorene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Indeno(1,2,3-cd)Pyrene	ND (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221
Pyrene	**0.028** (0.011)		EPH8270SIM		1	TJ	02/06/24 21:48	D4B0131	DB40221

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*50 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*88 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*84 %*		*40-140*
Surrogate: O-Terphenyl	*56 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05
Percent Solids: 73

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Percent Moisture	**27** (1)		2540G		1	EAM	02/01/24 19:41	%	DB40110
Total Organic Carbon (Average)	**28700** (477)		LK		1	CCP	02/06/24 11:55	mg/kg	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment

Subcontracted Analysis

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Grain Size	**See Attached** (N/A)								

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS
Date Sampled: 01/31/24 11:05
Percent Solids: 73
Initial Volume: 30.3g
Final Volume: 2ml
Extraction Method: 3540C

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-01
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: DMC
Prepared: 2/5/24 12:30

8082 Polychlorinated Biphenyls (PCB) / Congeners

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
BZ#8	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#18	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#28	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#44	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#52	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#66	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#101	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#105	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#118 [2C]	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#128	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#138 [2C]	**0.00061** (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#153 [2C]	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#170	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#180	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#187	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#195	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#206	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505
BZ#209	ND (0.00037)		8082A Cong		1	02/06/24 13:42	D4B0101	DB40505

	%Recovery	Qualifier	Limits
Surrogate: Tetrachloro-m-xylene [2C]	*66 %*		*30-150*

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00
Percent Solids: 77
Initial Volume: 12.6g
Final Volume: 10ml
Extraction Method: 5035

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: MEK
Prepared: 2/2/24 9:00

Volatile Organics Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
1,1,1,2-Tetrachloroethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,1,1-Trichloroethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,1,2,2-Tetrachloroethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,1,2-Trichloroethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,1-Dichloroethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,1-Dichloroethene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,1-Dichloropropene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2,3-Trichlorobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2,3-Trichloropropane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2,4-Trichlorobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2,4-Trimethylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2-Dibromo-3-Chloropropane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2-Dibromoethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2-Dichlorobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2-Dichloroethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,2-Dichloropropane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,3,5-Trimethylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,3-Dichlorobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,3-Dichloropropane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,4-Dichlorobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
1,4-Dioxane	ND (0.0513)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
2,2-Dichloropropane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
2-Butanone	ND (0.0256)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
2-Chlorotoluene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
2-Hexanone	ND (0.0256)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
4-Chlorotoluene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
4-Isopropyltoluene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
4-Methyl-2-Pentanone	ND (0.0256)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Acetone	ND (0.0256)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Benzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Bromobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219

ESS Laboratory

DIVISION OF THE RISE GROUP

BAL Laboratory   Analytical Balance

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00
Percent Solids: 77
Initial Volume: 12.6g
Final Volume: 10ml
Extraction Method: 5035

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: MEK
Prepared: 2/2/24 9:00

Volatile Organics Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Bromochloromethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Bromodichloromethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Bromoform	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Bromomethane	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Carbon Disulfide	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Carbon Tetrachloride	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Chlorobenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Chloroethane	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Chloroform	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Chloromethane	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
cis-1,2-Dichloroethene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
cis-1,3-Dichloropropene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Dibromochloromethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Dibromomethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Dichlorodifluoromethane	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Diethyl Ether	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Di-isopropyl ether	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Ethyl tertiary-butyl ether	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Ethylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Hexachlorobutadiene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Isopropylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Methyl tert-Butyl Ether	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Methylene Chloride	ND (0.0128)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Naphthalene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
n-Butylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
n-Propylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
sec-Butylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Styrene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
tert-Butylbenzene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Tertiary-amyl methyl ether	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Tetrachloroethene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219

ESS Laboratory
DIVISION OF THE RISE GROUP

BAL Laboratory   Analytical Balance

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00
Percent Solids: 77
Initial Volume: 12.6g
Final Volume: 10ml
Extraction Method: 5035

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: MEK
Prepared: 2/2/24 9:00

Volatile Organics Low Level

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Tetrahydrofuran	ND (0.0103)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Toluene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
trans-1,2-Dichloroethene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
trans-1,3-Dichloropropene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Trichloroethene	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Trichlorofluoromethane	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Vinyl Chloride	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Xylene O	ND (0.0026)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Xylene P,M	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219
Xylenes (Total)	ND (0.0051)		8260D Low		1	MEK	02/02/24 14:11	D4B0041	DB40219

	%Recovery	Qualifier	Limits
Surrogate: 1,2-Dichloroethane-d4	*113 %*		*70-130*
Surrogate: 4-Bromofluorobenzene	*99 %*		*70-130*
Surrogate: Dibromofluoromethane	*107 %*		*70-130*
Surrogate: Toluene-d8	*101 %*		*70-130*

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00
Percent Solids: 77
Initial Volume: 24.8g
Final Volume: 1ml
Extraction Method: 3546

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment
Units: mg/kg dry

Prepared: 2/2/24 15:16

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	ND (19.5)		MADEP-EPH		1	NXL	02/05/24 18:41	D4B0093	DB40221
C19-C36 Aliphatics1	ND (19.5)		MADEP-EPH		1	NXL	02/05/24 18:41	D4B0093	DB40221
C11-C22 Unadjusted Aromatics1	ND (19.5)		EPH8270		1	MJV	02/07/24 20:07	D4B0154	DB40221
C11-C22 Aromatics1,2	ND (19.7)		EPH8270			TJ	02/07/24 20:07		[CALC]
2-Methylnaphthalene	**0.011** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Acenaphthene	**0.044** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Naphthalene	**0.016** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Phenanthrene	**0.677** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Acenaphthylene	ND (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Anthracene	**0.179** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Benzo(a)anthracene	**0.361** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Benzo(a)pyrene	**0.419** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Benzo(b)fluoranthene	**0.340** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Benzo(g,h,i)perylene	**0.291** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Benzo(k)fluoranthene	**0.290** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Chrysene	**0.360** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Dibenzo(a,h)Anthracene	**0.118** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Fluoranthene	**1.01** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Fluorene	**0.062** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Indeno(1,2,3-cd)Pyrene	**0.233** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221
Pyrene	**0.813** (0.010)		EPH8270SIM		1	TJ	02/06/24 22:09	D4B0131	DB40221

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*55 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*92 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*87 %*		*40-140*
Surrogate: O-Terphenyl	*71 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00
Percent Solids: 77

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Percent Moisture	**23** (1)		2540G		1	EAM	02/01/24 19:41	%	DB40110
Total Organic Carbon (Average)	**12400** (483)		LK		1	CCP	02/06/24 13:01	mg/kg	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment

Subcontracted Analysis

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Grain Size	**See Attached** (N/A)								

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US
Date Sampled: 01/31/24 15:00
Percent Solids: 77
Initial Volume: 30.1g
Final Volume: 2ml
Extraction Method: 3540C

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-02
Sample Matrix: Sediment
Units: mg/kg dry
Analyst: DMC
Prepared: 2/5/24 12:30

8082 Polychlorinated Biphenyls (PCB) / Congeners

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyzed	Sequence	Batch
BZ#8	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#18	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#28	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#44	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#52	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#66	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#101 [2C]	**0.00061** (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#105	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#118 [2C]	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#128	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#138	**P, LC 0.00111** (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#153 [2C]	**P, LC 0.00085** (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#170 [2C]	**0.00070** (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#180	**0.00117** (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#187	**0.00055** (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#195 [2C]	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#206 [2C]	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505
BZ#209 [2C]	ND (0.00035)		8082A Cong		1	02/06/24 14:13	D4B0101	DB40505

	%Recovery	Qualifier	Limits
Surrogate: Tetrachloro-m-xylene	*70 %*		*30-150*

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton DS Oven Dried
Date Sampled: 01/31/24 11:05
Percent Solids: 100

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-03
Sample Matrix: Sediment
Units: mg/kg dry

Extraction Method: 3050B

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Arsenic	**13.5** (0.98)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521
Cadmium	**0.44** (0.10)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521
Chromium	**6.24** (0.39)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521
Copper	**6.00** (0.98)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521
Lead	**13.5** (1.95)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521
Mercury	**0.029** (0.009)		7471B		1	AFV	02/05/24 17:13	2.09	40	DB40504
Nickel	**5.87** (0.98)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521
Zinc	**35.8** (0.98)		6010C		1	KJB	02/07/24 19:58	5.12	100	DB40521

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
Client Sample ID: Groton US Oven Dried
Date Sampled: 01/31/24 15:00
Percent Solids: 100

ESS Laboratory Work Order: 24B0025
ESS Laboratory Sample ID: 24B0025-04
Sample Matrix: Sediment
Units: mg/kg dry

Extraction Method: 3050B

Total Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Arsenic	**6.17** (0.98)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521
Cadmium	**0.17** (0.10)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521
Chromium	**5.70** (0.39)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521
Copper	**6.46** (0.98)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521
Lead	**31.5** (1.96)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521
Mercury	**0.024** (0.009)		7471B		1	AFV	02/05/24 17:15	2.12	40	DB40504
Nickel	**7.01** (0.98)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521
Zinc	**22.9** (0.98)		6010C		1	KJB	02/07/24 20:00	5.11	100	DB40521

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Total Metals										
Batch DB40504 - 7471B										
Blank										
Mercury	ND	0.031	mg/kg wet							
LCS										
Mercury	19.1	3.00	mg/kg wet	21.60		88	80-120			
LCS Dup										
Mercury	19.0	2.87	mg/kg wet	21.60		88	80-120	0.4	30	
Batch DB40521 - 3050B										
Blank										
Arsenic	ND	2.50	mg/kg wet							
Cadmium	ND	0.25	mg/kg wet							
Chromium	ND	1.00	mg/kg wet							
Copper	ND	2.50	mg/kg wet							
Lead	ND	5.00	mg/kg wet							
Nickel	ND	2.50	mg/kg wet							
Zinc	ND	2.50	mg/kg wet							
LCS										
Arsenic	180	8.33	mg/kg wet	223.0		81	70-102			
Cadmium	180	0.83	mg/kg wet	226.0		79	74-105			
Chromium	204	3.33	mg/kg wet	230.0		88	80-120			
Copper	216	8.33	mg/kg wet	239.0		90	80-120			
Lead	243	16.7	mg/kg wet	275.0		88	80-120			
Nickel	103	8.33	mg/kg wet	118.0		87	80-120			
Zinc	242	8.33	mg/kg wet	286.0		85	80-120			
LCS Dup										
Arsenic	178	7.46	mg/kg wet	223.0		80	70-102	2	20	
Cadmium	178	0.75	mg/kg wet	226.0		79	74-105	1	20	
Chromium	200	2.99	mg/kg wet	230.0		87	80-120	2	20	
Copper	213	7.46	mg/kg wet	239.0		89	80-120	1	20	
Lead	241	14.9	mg/kg wet	275.0		88	80-120	1	20	
Nickel	101	7.46	mg/kg wet	118.0		86	80-120	2	30	
Zinc	241	7.46	mg/kg wet	286.0		84	80-120	0.5	20	
Volatile Organics Low Level										
Batch DB40219 - 5035										
Blank										
1,1,1,2-Tetrachloroethane	ND	0.0050	mg/kg wet							
1,1,1-Trichloroethane	ND	0.0050	mg/kg wet							
1,1,2,2-Tetrachloroethane	ND	0.0050	mg/kg wet							
1,1,2-Trichloroethane	ND	0.0050	mg/kg wet							
1,1-Dichloroethane	ND	0.0050	mg/kg wet							
1,1-Dichloroethene	ND	0.0050	mg/kg wet							
1,1-Dichloropropene	ND	0.0050	mg/kg wet							

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier

Volatile Organics Low Level

Batch DB40219 - 5035

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
1,2,3-Trichlorobenzene	ND	0.0050	mg/kg wet							
1,2,3-Trichloropropane	ND	0.0050	mg/kg wet							
1,2,4-Trichlorobenzene	ND	0.0050	mg/kg wet							
1,2,4-Trimethylbenzene	ND	0.0050	mg/kg wet							
1,2-Dibromo-3-Chloropropane	ND	0.0050	mg/kg wet							
1,2-Dibromoethane	ND	0.0050	mg/kg wet							
1,2-Dichlorobenzene	ND	0.0050	mg/kg wet							
1,2-Dichloroethane	ND	0.0050	mg/kg wet							
1,2-Dichloropropane	ND	0.0050	mg/kg wet							
1,3,5-Trimethylbenzene	ND	0.0050	mg/kg wet							
1,3-Dichlorobenzene	ND	0.0050	mg/kg wet							
1,3-Dichloropropane	ND	0.0050	mg/kg wet							
1,4-Dichlorobenzene	ND	0.0050	mg/kg wet							
1,4-Dioxane	ND	0.100	mg/kg wet							
2,2-Dichloropropane	ND	0.0050	mg/kg wet							
2-Butanone	ND	0.0500	mg/kg wet							
2-Chlorotoluene	ND	0.0050	mg/kg wet							
2-Hexanone	ND	0.0500	mg/kg wet							
4-Chlorotoluene	ND	0.0050	mg/kg wet							
4-Isopropyltoluene	ND	0.0050	mg/kg wet							
4-Methyl-2-Pentanone	ND	0.0500	mg/kg wet							
Acetone	ND	0.0500	mg/kg wet							
Benzene	ND	0.0050	mg/kg wet							
Bromobenzene	ND	0.0050	mg/kg wet							
Bromochloromethane	ND	0.0050	mg/kg wet							
Bromodichloromethane	ND	0.0050	mg/kg wet							
Bromoform	ND	0.0050	mg/kg wet							
Bromomethane	ND	0.0100	mg/kg wet							
Carbon Disulfide	ND	0.0050	mg/kg wet							
Carbon Tetrachloride	ND	0.0050	mg/kg wet							
Chlorobenzene	ND	0.0050	mg/kg wet							
Chloroethane	ND	0.0100	mg/kg wet							
Chloroform	ND	0.0050	mg/kg wet							
Chloromethane	ND	0.0100	mg/kg wet							
cis-1,2-Dichloroethene	ND	0.0050	mg/kg wet							
cis-1,3-Dichloropropene	ND	0.0050	mg/kg wet							
Dibromochloromethane	ND	0.0050	mg/kg wet							
Dibromomethane	ND	0.0050	mg/kg wet							
Dichlorodifluoromethane	ND	0.0100	mg/kg wet							
Diethyl Ether	ND	0.0050	mg/kg wet							
Di-isopropyl ether	ND	0.0050	mg/kg wet							
Ethyl tertiary-butyl ether	ND	0.0050	mg/kg wet							
Ethylbenzene	ND	0.0050	mg/kg wet							
Hexachlorobutadiene	ND	0.0050	mg/kg wet							

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier

Volatile Organics Low Level

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch DB40219 - 5035										
Isopropylbenzene	ND	0.0050	mg/kg wet							
Methyl tert-Butyl Ether	ND	0.0050	mg/kg wet							
Methylene Chloride	ND	0.0250	mg/kg wet							
Naphthalene	ND	0.0050	mg/kg wet							
n-Butylbenzene	ND	0.0050	mg/kg wet							
n-Propylbenzene	ND	0.0050	mg/kg wet							
sec-Butylbenzene	ND	0.0050	mg/kg wet							
Styrene	ND	0.0050	mg/kg wet							
tert-Butylbenzene	ND	0.0050	mg/kg wet							
Tertiary-amyl methyl ether	ND	0.0050	mg/kg wet							
Tetrachloroethene	ND	0.0050	mg/kg wet							
Tetrahydrofuran	ND	0.0200	mg/kg wet							
Toluene	ND	0.0050	mg/kg wet							
trans-1,2-Dichloroethene	ND	0.0050	mg/kg wet							
trans-1,3-Dichloropropene	ND	0.0050	mg/kg wet							
Trichloroethene	ND	0.0050	mg/kg wet							
Trichlorofluoromethane	ND	0.0050	mg/kg wet							
Vinyl Chloride	ND	0.0100	mg/kg wet							
Xylene O	ND	0.0050	mg/kg wet							
Xylene P,M	ND	0.0100	mg/kg wet							
LCS										
1,1,1,2-Tetrachloroethane	0.0551	0.0050	mg/kg wet	0.05000		110	70-130			
1,1,1-Trichloroethane	0.0603	0.0050	mg/kg wet	0.05000		121	70-130			
1,1,2,2-Tetrachloroethane	0.0583	0.0050	mg/kg wet	0.05000		117	40-160			
1,1,2-Trichloroethane	0.0565	0.0050	mg/kg wet	0.05000		113	70-130			
1,1-Dichloroethane	0.0597	0.0050	mg/kg wet	0.05000		119	70-130			
1,1-Dichloroethene	0.0649	0.0050	mg/kg wet	0.05000		130	70-130			
1,1-Dichloropropene	0.0594	0.0050	mg/kg wet	0.05000		119	70-130			
1,2,3-Trichlorobenzene	0.0566	0.0050	mg/kg wet	0.05000		113	70-130			
1,2,3-Trichloropropane	0.0574	0.0050	mg/kg wet	0.05000		115	70-130			
1,2,4-Trichlorobenzene	0.0561	0.0050	mg/kg wet	0.05000		112	70-130			
1,2,4-Trimethylbenzene	0.0590	0.0050	mg/kg wet	0.05000		118	70-130			
1,2-Dibromo-3-Chloropropane	0.0640	0.0050	mg/kg wet	0.05000		128	70-130			
1,2-Dibromoethane	0.0559	0.0050	mg/kg wet	0.05000		112	70-130			
1,2-Dichlorobenzene	0.0538	0.0050	mg/kg wet	0.05000		108	70-130			
1,2-Dichloroethane	0.0576	0.0050	mg/kg wet	0.05000		115	70-130			
1,2-Dichloropropane	0.0575	0.0050	mg/kg wet	0.05000		115	70-130			
1,3,5-Trimethylbenzene	0.0588	0.0050	mg/kg wet	0.05000		118	70-130			
1,3-Dichlorobenzene	0.0537	0.0050	mg/kg wet	0.05000		107	70-130			
1,3-Dichloropropane	0.0574	0.0050	mg/kg wet	0.05000		115	70-130			
1,4-Dichlorobenzene	0.0540	0.0050	mg/kg wet	0.05000		108	70-130			
1,4-Dioxane	1.29	0.100	mg/kg wet	1.000		129	70-130			
2,2-Dichloropropane	0.0623	0.0050	mg/kg wet	0.05000		125	70-130			
2-Butanone	0.328	0.0500	mg/kg wet	0.2500		131	40-160			

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Volatile Organics Low Level

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch DB40219 - 5035										
2-Chlorotoluene	0.0570	0.0050	mg/kg wet	0.05000		114	70-130			
2-Hexanone	0.295	0.0500	mg/kg wet	0.2500		118	40-160			
4-Chlorotoluene	0.0573	0.0050	mg/kg wet	0.05000		115	70-130			
4-Isopropyltoluene	0.0556	0.0050	mg/kg wet	0.05000		111	70-130			
4-Methyl-2-Pentanone	0.281	0.0500	mg/kg wet	0.2500		112	40-160			
Acetone	0.372	0.0500	mg/kg wet	0.2500		149	40-160			
Benzene	0.0588	0.0050	mg/kg wet	0.05000		118	70-130			
Bromobenzene	0.0539	0.0050	mg/kg wet	0.05000		108	70-130			
Bromochloromethane	0.0574	0.0050	mg/kg wet	0.05000		115	70-130			
Bromodichloromethane	0.0635	0.0050	mg/kg wet	0.05000		127	70-130			
Bromoform	0.0493	0.0050	mg/kg wet	0.05000		99	40-160			
Bromomethane	0.0503	0.0100	mg/kg wet	0.05000		101	40-160			
Carbon Disulfide	0.0632	0.0050	mg/kg wet	0.05000		126	70-130			
Carbon Tetrachloride	0.0618	0.0050	mg/kg wet	0.05000		124	70-130			
Chlorobenzene	0.0543	0.0050	mg/kg wet	0.05000		109	70-130			
Chloroethane	0.0514	0.0100	mg/kg wet	0.05000		103	40-160			
Chloroform	0.0581	0.0050	mg/kg wet	0.05000		116	70-130			
Chloromethane	0.0505	0.0100	mg/kg wet	0.05000		101	40-160			
cis-1,2-Dichloroethene	0.0590	0.0050	mg/kg wet	0.05000		118	70-130			
cis-1,3-Dichloropropene	0.0614	0.0050	mg/kg wet	0.05000		123	40-160			
Dibromochloromethane	0.0540	0.0050	mg/kg wet	0.05000		108	40-160			
Dibromomethane	0.0569	0.0050	mg/kg wet	0.05000		114	70-130			
Dichlorodifluoromethane	0.0378	0.0100	mg/kg wet	0.05000		76	40-160			
Diethyl Ether	0.0617	0.0050	mg/kg wet	0.05000		123	70-130			
Di-isopropyl ether	0.0605	0.0050	mg/kg wet	0.05000		121	70-130			
Ethyl tertiary-butyl ether	0.0591	0.0050	mg/kg wet	0.05000		118	70-130			
Ethylbenzene	0.0568	0.0050	mg/kg wet	0.05000		114	70-130			
Hexachlorobutadiene	0.0569	0.0050	mg/kg wet	0.05000		114	40-160			
Isopropylbenzene	0.0605	0.0050	mg/kg wet	0.05000		121	70-130			
Methyl tert-Butyl Ether	0.0578	0.0050	mg/kg wet	0.05000		116	70-130			
Methylene Chloride	0.0582	0.0250	mg/kg wet	0.05000		116	70-130			
Naphthalene	0.0573	0.0050	mg/kg wet	0.05000		115	40-160			
n-Butylbenzene	0.0599	0.0050	mg/kg wet	0.05000		120	70-130			
n-Propylbenzene	0.0580	0.0050	mg/kg wet	0.05000		116	70-130			
sec-Butylbenzene	0.0547	0.0050	mg/kg wet	0.05000		109	70-130			
Styrene	0.0565	0.0050	mg/kg wet	0.05000		113	40-160			
tert-Butylbenzene	0.0567	0.0050	mg/kg wet	0.05000		113	70-130			
Tertiary-amyl methyl ether	0.0575	0.0050	mg/kg wet	0.05000		115	70-130			
Tetrachloroethene	0.0448	0.0050	mg/kg wet	0.05000		90	70-130			
Tetrahydrofuran	0.0690	0.0200	mg/kg wet	0.05000		138	70-130			B+
Toluene	0.0573	0.0050	mg/kg wet	0.05000		115	70-130			
trans-1,2-Dichloroethene	0.0620	0.0050	mg/kg wet	0.05000		124	70-130			
trans-1,3-Dichloropropene	0.0580	0.0050	mg/kg wet	0.05000		116	70-130			
Trichloroethene	0.0564	0.0050	mg/kg wet	0.05000		113	70-130			

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Volatile Organics Low Level

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch DB40219 - 5035										
Trichlorofluoromethane	0.0575	0.0050	mg/kg wet	0.05000		115	40-160			
Vinyl Chloride	0.0572	0.0100	mg/kg wet	0.05000		114	70-130			
Xylene O	0.0564	0.0050	mg/kg wet	0.05000		113	70-130			
Xylene P,M	0.117	0.0100	mg/kg wet	0.1000		117	70-130			
LCS Dup										
1,1,1,2-Tetrachloroethane	0.0540	0.0050	mg/kg wet	0.05000		108	70-130	2	20	
1,1,1-Trichloroethane	0.0585	0.0050	mg/kg wet	0.05000		117	70-130	3	20	
1,1,2,2-Tetrachloroethane	0.0562	0.0050	mg/kg wet	0.05000		112	40-160	4	20	
1,1,2-Trichloroethane	0.0556	0.0050	mg/kg wet	0.05000		111	70-130	2	20	
1,1-Dichloroethane	0.0590	0.0050	mg/kg wet	0.05000		118	70-130	1	20	
1,1-Dichloroethene	0.0631	0.0050	mg/kg wet	0.05000		126	70-130	3	20	
1,1-Dichloropropene	0.0577	0.0050	mg/kg wet	0.05000		115	70-130	3	20	
1,2,3-Trichlorobenzene	0.0579	0.0050	mg/kg wet	0.05000		116	70-130	2	20	
1,2,3-Trichloropropane	0.0541	0.0050	mg/kg wet	0.05000		108	70-130	6	20	
1,2,4-Trichlorobenzene	0.0579	0.0050	mg/kg wet	0.05000		116	70-130	3	20	
1,2,4-Trimethylbenzene	0.0587	0.0050	mg/kg wet	0.05000		117	70-130	0.4	20	
1,2-Dibromo-3-Chloropropane	0.0598	0.0050	mg/kg wet	0.05000		120	70-130	7	20	
1,2-Dibromoethane	0.0533	0.0050	mg/kg wet	0.05000		107	70-130	5	20	
1,2-Dichlorobenzene	0.0544	0.0050	mg/kg wet	0.05000		109	70-130	1	20	
1,2-Dichloroethane	0.0567	0.0050	mg/kg wet	0.05000		113	70-130	2	20	
1,2-Dichloropropane	0.0572	0.0050	mg/kg wet	0.05000		114	70-130	0.7	20	
1,3,5-Trimethylbenzene	0.0579	0.0050	mg/kg wet	0.05000		116	70-130	2	20	
1,3-Dichlorobenzene	0.0542	0.0050	mg/kg wet	0.05000		108	70-130	0.9	20	
1,3-Dichloropropane	0.0558	0.0050	mg/kg wet	0.05000		112	70-130	3	20	
1,4-Dichlorobenzene	0.0539	0.0050	mg/kg wet	0.05000		108	70-130	0.1	20	
1,4-Dioxane	1.19	0.100	mg/kg wet	1.000		119	70-130	8	20	
2,2-Dichloropropane	0.0605	0.0050	mg/kg wet	0.05000		121	70-130	3	20	
2-Butanone	0.288	0.0500	mg/kg wet	0.2500		115	40-160	13	20	
2-Chlorotoluene	0.0567	0.0050	mg/kg wet	0.05000		113	70-130	0.4	20	
2-Hexanone	0.252	0.0500	mg/kg wet	0.2500		101	40-160	16	20	
4-Chlorotoluene	0.0571	0.0050	mg/kg wet	0.05000		114	70-130	0.3	20	
4-Isopropyltoluene	0.0547	0.0050	mg/kg wet	0.05000		109	70-130	2	20	
4-Methyl-2-Pentanone	0.260	0.0500	mg/kg wet	0.2500		104	40-160	8	20	
Acetone	0.257	0.0500	mg/kg wet	0.2500		103	40-160	36	20	D+
Benzene	0.0579	0.0050	mg/kg wet	0.05000		116	70-130	1	20	
Bromobenzene	0.0533	0.0050	mg/kg wet	0.05000		107	70-130	1	20	
Bromochloromethane	0.0567	0.0050	mg/kg wet	0.05000		113	70-130	1	20	
Bromodichloromethane	0.0637	0.0050	mg/kg wet	0.05000		127	70-130	0.3	20	
Bromoform	0.0473	0.0050	mg/kg wet	0.05000		95	40-160	4	20	
Bromomethane	0.0496	0.0100	mg/kg wet	0.05000		99	40-160	1	20	
Carbon Disulfide	0.0612	0.0050	mg/kg wet	0.05000		122	70-130	3	20	
Carbon Tetrachloride	0.0595	0.0050	mg/kg wet	0.05000		119	70-130	4	20	
Chlorobenzene	0.0530	0.0050	mg/kg wet	0.05000		106	70-130	2	20	
Chloroethane	0.0492	0.0100	mg/kg wet	0.05000		98	40-160	4	20	

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Volatile Organics Low Level										
Batch DB40219 - 5035										
Chloroform	0.0578	0.0050	mg/kg wet	0.05000		116	70-130	0.4	20	
Chloromethane	0.0488	0.0100	mg/kg wet	0.05000		98	40-160	3	20	
cis-1,2-Dichloroethene	0.0585	0.0050	mg/kg wet	0.05000		117	70-130	0.8	20	
cis-1,3-Dichloropropene	0.0611	0.0050	mg/kg wet	0.05000		122	40-160	0.5	20	
Dibromochloromethane	0.0534	0.0050	mg/kg wet	0.05000		107	40-160	1	20	
Dibromomethane	0.0554	0.0050	mg/kg wet	0.05000		111	70-130	3	20	
Dichlorodifluoromethane	0.0353	0.0100	mg/kg wet	0.05000		71	40-160	7	20	
Diethyl Ether	0.0620	0.0050	mg/kg wet	0.05000		124	70-130	0.5	20	
Di-isopropyl ether	0.0606	0.0050	mg/kg wet	0.05000		121	70-130	0.2	20	
Ethyl tertiary-butyl ether	0.0597	0.0050	mg/kg wet	0.05000		119	70-130	0.9	20	
Ethylbenzene	0.0547	0.0050	mg/kg wet	0.05000		109	70-130	4	20	
Hexachlorobutadiene	0.0565	0.0050	mg/kg wet	0.05000		113	40-160	0.7	20	
Isopropylbenzene	0.0590	0.0050	mg/kg wet	0.05000		118	70-130	3	20	
Methyl tert-Butyl Ether	0.0573	0.0050	mg/kg wet	0.05000		115	70-130	0.8	20	
Methylene Chloride	0.0591	0.0250	mg/kg wet	0.05000		118	70-130	2	20	
Naphthalene	0.0565	0.0050	mg/kg wet	0.05000		113	40-160	1	20	
n-Butylbenzene	0.0588	0.0050	mg/kg wet	0.05000		118	70-130	2	20	
n-Propylbenzene	0.0567	0.0050	mg/kg wet	0.05000		113	70-130	2	20	
sec-Butylbenzene	0.0533	0.0050	mg/kg wet	0.05000		107	70-130	3	20	
Styrene	0.0556	0.0050	mg/kg wet	0.05000		111	40-160	1	20	
tert-Butylbenzene	0.0556	0.0050	mg/kg wet	0.05000		111	70-130	2	20	
Tertiary-amyl methyl ether	0.0579	0.0050	mg/kg wet	0.05000		116	70-130	0.6	20	
Tetrachloroethene	0.0412	0.0050	mg/kg wet	0.05000		82	70-130	8	20	
Tetrahydrofuran	0.0617	0.0200	mg/kg wet	0.05000		123	70-130	11	20	
Toluene	0.0557	0.0050	mg/kg wet	0.05000		111	70-130	3	20	
trans-1,2-Dichloroethene	0.0607	0.0050	mg/kg wet	0.05000		121	70-130	2	20	
trans-1,3-Dichloropropene	0.0575	0.0050	mg/kg wet	0.05000		115	70-130	1	20	
Trichloroethene	0.0553	0.0050	mg/kg wet	0.05000		111	70-130	2	20	
Trichlorofluoromethane	0.0550	0.0050	mg/kg wet	0.05000		110	40-160	4	20	
Vinyl Chloride	0.0544	0.0100	mg/kg wet	0.05000		109	70-130	5	20	
Xylene O	0.0550	0.0050	mg/kg wet	0.05000		110	70-130	2	20	
Xylene P,M	0.113	0.0100	mg/kg wet	0.1000		113	70-130	4	20	
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch DB40221 - 3546										
Blank										
C19-C36 Aliphatics1	ND	15.0	mg/kg wet							
C9-C18 Aliphatics1	ND	15.0	mg/kg wet							
Blank										
C11-C22 Unadjusted Aromatics1	ND	15.0	mg/kg wet							
Blank										
2-Methylnaphthalene	ND	0.008	mg/kg wet							
Acenaphthene	ND	0.008	mg/kg wet							

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch DB40221 - 3546										
Acenaphthylene	ND	0.008	mg/kg wet							
Anthracene	ND	0.008	mg/kg wet							
Benzo(a)anthracene	ND	0.008	mg/kg wet							
Benzo(a)pyrene	ND	0.008	mg/kg wet							
Benzo(b)fluoranthene	ND	0.008	mg/kg wet							
Benzo(g,h,i)perylene	ND	0.008	mg/kg wet							
Benzo(k)fluoranthene	ND	0.008	mg/kg wet							
Chrysene	ND	0.008	mg/kg wet							
Dibenzo(a,h)Anthracene	ND	0.008	mg/kg wet							
Fluoranthene	ND	0.008	mg/kg wet							
Fluorene	ND	0.008	mg/kg wet							
Indeno(1,2,3-cd)Pyrene	ND	0.008	mg/kg wet							
Naphthalene	ND	0.008	mg/kg wet							
Phenanthrene	ND	0.008	mg/kg wet							
Pyrene	ND	0.008	mg/kg wet							
LCS										
C19-C36 Aliphatics1	13.7	15.0	mg/kg wet	16.00		85	40-140			
C9-C18 Aliphatics1	7.8	15.0	mg/kg wet	12.00		65	40-140			
LCS										
C11-C22 Unadjusted Aromatics1	30.0	15.0	mg/kg wet	34.00		88	40-140			
LCS										
2-Methylnaphthalene Breakthrough	0.0		%				0-5			
Naphthalene Breakthrough	0.0		%				0-5			
LCS										
2-Methylnaphthalene	1.20	0.040	mg/kg wet	2.000		60	40-140			
Acenaphthene	1.26	0.040	mg/kg wet	2.000		63	40-140			
Acenaphthylene	1.34	0.040	mg/kg wet	2.000		67	40-140			
Anthracene	1.48	0.040	mg/kg wet	2.000		74	40-140			
Benzo(a)anthracene	1.38	0.040	mg/kg wet	2.000		69	40-140			
Benzo(a)pyrene	1.59	0.040	mg/kg wet	2.000		79	40-140			
Benzo(b)fluoranthene	1.53	0.040	mg/kg wet	2.000		77	40-140			
Benzo(g,h,i)perylene	1.56	0.040	mg/kg wet	2.000		78	40-140			
Benzo(k)fluoranthene	1.46	0.040	mg/kg wet	2.000		73	40-140			
Chrysene	1.43	0.040	mg/kg wet	2.000		71	40-140			
Dibenzo(a,h)Anthracene	1.61	0.040	mg/kg wet	2.000		81	40-140			
Fluoranthene	1.45	0.040	mg/kg wet	2.000		72	40-140			
Fluorene	1.32	0.040	mg/kg wet	2.000		66	40-140			
Indeno(1,2,3-cd)Pyrene	1.55	0.040	mg/kg wet	2.000		78	40-140			
Naphthalene	1.16	0.040	mg/kg wet	2.000		58	40-140			
Phenanthrene	1.33	0.040	mg/kg wet	2.000		66	40-140			
Pyrene	1.52	0.040	mg/kg wet	2.000		76	40-140			
LCS Dup										
C19-C36 Aliphatics1	11.6	15.0	mg/kg wet	16.00		72	40-140	16	25	

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
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ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch DB40221 - 3546										
C9-C18 Aliphatics1	6.8	15.0	mg/kg wet	12.00		57	40-140	14	25	
LCS Dup										
C11-C22 Unadjusted Aromatics1	29.7	15.0	mg/kg wet	34.00		87	40-140	0.9	25	
LCS Dup										
2-Methylnaphthalene Breakthrough	0.0		%				0-5		200	
Naphthalene Breakthrough	0.0		%				0-5		200	
LCS Dup										
2-Methylnaphthalene	1.30	0.040	mg/kg wet	2.000		65	40-140	8	30	
Acenaphthene	1.32	0.040	mg/kg wet	2.000		66	40-140	5	30	
Acenaphthylene	1.41	0.040	mg/kg wet	2.000		71	40-140	5	30	
Anthracene	1.53	0.040	mg/kg wet	2.000		77	40-140	3	30	
Benzo(a)anthracene	1.14	0.040	mg/kg wet	2.000		57	40-140	19	30	
Benzo(a)pyrene	1.34	0.040	mg/kg wet	2.000		67	40-140	17	30	
Benzo(b)fluoranthene	1.34	0.040	mg/kg wet	2.000		67	40-140	13	30	
Benzo(g,h,i)perylene	1.33	0.040	mg/kg wet	2.000		67	40-140	16	30	
Benzo(k)fluoranthene	1.22	0.040	mg/kg wet	2.000		61	40-140	18	30	
Chrysene	1.17	0.040	mg/kg wet	2.000		58	40-140	20	30	
Dibenzo(a,h)Anthracene	1.37	0.040	mg/kg wet	2.000		68	40-140	16	30	
Fluoranthene	1.48	0.040	mg/kg wet	2.000		74	40-140	2	30	
Fluorene	1.39	0.040	mg/kg wet	2.000		69	40-140	5	30	
Indeno(1,2,3-cd)Pyrene	1.32	0.040	mg/kg wet	2.000		66	40-140	17	30	
Naphthalene	1.23	0.040	mg/kg wet	2.000		61	40-140	5	30	
Phenanthrene	1.38	0.040	mg/kg wet	2.000		69	40-140	4	30	
Pyrene	1.23	0.040	mg/kg wet	2.000		62	40-140	21	30	
Classical Chemistry										
Batch DB40239 - General Preparation										
Blank										
Total Organic Carbon (1)	ND	500	mg/kg							
Total Organic Carbon (2)	ND	500	mg/kg							
LCS										
Total Organic Carbon (1)	8730	500	mg/kg	10010		87	80-120			
Total Organic Carbon (2)	8820	500	mg/kg	10010		88	80-120			
LCS Dup										
Total Organic Carbon (1)	8880	500	mg/kg	10010		89	80-120	2	25	
Total Organic Carbon (2)	8260	500	mg/kg	10010		83	80-120	7	25	
8082 Polychlorinated Biphenyls (PCB) / Congeners										
Batch DB40505 - 3540C										
Blank										
BZ#101	ND	0.00027	mg/kg wet							
BZ#101 [2C]	ND	0.00027	mg/kg wet							

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
					8082 Polychlorinated Biphenyls (PCB) / Congeners					
Batch DB40505 - 3540C										
BZ#105	ND	0.00027	mg/kg wet							
BZ#105 [2C]	ND	0.00027	mg/kg wet							
BZ#118	ND	0.00027	mg/kg wet							
BZ#118 [2C]	ND	0.00027	mg/kg wet							
BZ#128	ND	0.00027	mg/kg wet							
BZ#128 [2C]	ND	0.00027	mg/kg wet							
BZ#138	ND	0.00027	mg/kg wet							
BZ#138 [2C]	ND	0.00027	mg/kg wet							
BZ#153	ND	0.00027	mg/kg wet							
BZ#153 [2C]	ND	0.00027	mg/kg wet							
BZ#170	ND	0.00027	mg/kg wet							
BZ#170 [2C]	ND	0.00027	mg/kg wet							
BZ#18	ND	0.00027	mg/kg wet							
BZ#18 [2C]	ND	0.00027	mg/kg wet							
BZ#180	ND	0.00027	mg/kg wet							
BZ#180 [2C]	ND	0.00027	mg/kg wet							
BZ#187	ND	0.00027	mg/kg wet							
BZ#187 [2C]	ND	0.00027	mg/kg wet							
BZ#195	ND	0.00027	mg/kg wet							
BZ#195 [2C]	ND	0.00027	mg/kg wet							
BZ#206	ND	0.00027	mg/kg wet							
BZ#206 [2C]	ND	0.00027	mg/kg wet							
BZ#209	ND	0.00027	mg/kg wet							
BZ#209 [2C]	ND	0.00027	mg/kg wet							
BZ#28	ND	0.00027	mg/kg wet							
BZ#28 [2C]	ND	0.00027	mg/kg wet							
BZ#44	ND	0.00027	mg/kg wet							
BZ#44 [2C]	ND	0.00027	mg/kg wet							
BZ#52	ND	0.00027	mg/kg wet							
BZ#52 [2C]	ND	0.00027	mg/kg wet							
BZ#66	ND	0.00027	mg/kg wet							
BZ#66 [2C]	ND	0.00027	mg/kg wet							
BZ#8	ND	0.00027	mg/kg wet							
BZ#8 [2C]	ND	0.00027	mg/kg wet							
LCS										
BZ#101	0.00223	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#101 [2C]	0.00219	0.00027	mg/kg wet	0.003333		66	40-140			
BZ#105	0.00238	0.00027	mg/kg wet	0.003333		71	40-140			
BZ#105 [2C]	0.00236	0.00027	mg/kg wet	0.003333		71	40-140			
BZ#118	0.00222	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#118 [2C]	0.00224	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#128	0.00227	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#128 [2C]	0.00231	0.00027	mg/kg wet	0.003333		69	40-140			
BZ#138	0.00223	0.00027	mg/kg wet	0.003333		67	40-140			

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

8082 Polychlorinated Biphenyls (PCB) / Congeners

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Batch DB40505 - 3540C										
BZ#138 [2C]	0.00227	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#153	0.00222	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#153 [2C]	0.00221	0.00027	mg/kg wet	0.003333		66	40-140			
BZ#170	0.00226	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#170 [2C]	0.00228	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#18	0.00223	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#18 [2C]	0.00225	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#180	0.00228	0.00027	mg/kg wet	0.003333		69	40-140			
BZ#180 [2C]	0.00232	0.00027	mg/kg wet	0.003333		69	40-140			
BZ#187	0.00268	0.00027	mg/kg wet	0.003333		80	40-140			
BZ#187 [2C]	0.00228	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#195	0.00222	0.00027	mg/kg wet	0.003333		66	40-140			
BZ#195 [2C]	0.00229	0.00027	mg/kg wet	0.003333		69	40-140			
BZ#206	0.00216	0.00027	mg/kg wet	0.003333		65	40-140			
BZ#206 [2C]	0.00222	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#209	0.00210	0.00027	mg/kg wet	0.003333		63	40-140			
BZ#209 [2C]	0.00217	0.00027	mg/kg wet	0.003333		65	40-140			
BZ#28	0.00238	0.00027	mg/kg wet	0.003333		71	40-140			
BZ#28 [2C]	0.00229	0.00027	mg/kg wet	0.003333		69	40-140			
BZ#44	0.00228	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#44 [2C]	0.00227	0.00027	mg/kg wet	0.003333		68	40-140			
BZ#52	0.00269	0.00027	mg/kg wet	0.003333		81	40-140			
BZ#52 [2C]	0.00219	0.00027	mg/kg wet	0.003333		66	40-140			
BZ#66	0.00213	0.00027	mg/kg wet	0.003333		64	40-140			
BZ#66 [2C]	0.00224	0.00027	mg/kg wet	0.003333		67	40-140			
BZ#8	0.00235	0.00027	mg/kg wet	0.003333		71	40-140			
BZ#8 [2C]	0.00215	0.00027	mg/kg wet	0.003333		64	40-140			
LCS Dup										
BZ#101	0.00211	0.00027	mg/kg wet	0.003333		63	40-140	6	30	
BZ#101 [2C]	0.00214	0.00027	mg/kg wet	0.003333		64	40-140	2	30	
BZ#105	0.00234	0.00027	mg/kg wet	0.003333		70	40-140	2	30	
BZ#105 [2C]	0.00227	0.00027	mg/kg wet	0.003333		68	40-140	4	30	
BZ#118	0.00213	0.00027	mg/kg wet	0.003333		64	40-140	4	30	
BZ#118 [2C]	0.00218	0.00027	mg/kg wet	0.003333		65	40-140	3	30	
BZ#128	0.00237	0.00027	mg/kg wet	0.003333		71	40-140	4	30	
BZ#128 [2C]	0.00223	0.00027	mg/kg wet	0.003333		67	40-140	4	30	
BZ#138	0.00219	0.00027	mg/kg wet	0.003333		66	40-140	2	30	
BZ#138 [2C]	0.00219	0.00027	mg/kg wet	0.003333		66	40-140	4	30	
BZ#153	0.00215	0.00027	mg/kg wet	0.003333		64	40-140	3	30	
BZ#153 [2C]	0.00213	0.00027	mg/kg wet	0.003333		64	40-140	4	30	
BZ#170	0.00219	0.00027	mg/kg wet	0.003333		66	40-140	3	30	
BZ#170 [2C]	0.00221	0.00027	mg/kg wet	0.003333		66	40-140	3	30	
BZ#18	0.00198	0.00027	mg/kg wet	0.003333		59	40-140	12	30	
BZ#18 [2C]	0.00218	0.00027	mg/kg wet	0.003333		65	40-140	3	30	

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam
ESS Laboratory Work Order: 24B0025

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier

8082 Polychlorinated Biphenyls (PCB) / Congeners

Batch DB40505 - 3540C

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
BZ#180	0.00220	0.00027	mg/kg wet	0.003333		66	40-140	4	30	
BZ#180 [2C]	0.00224	0.00027	mg/kg wet	0.003333		67	40-140	3	30	
BZ#187	0.00262	0.00027	mg/kg wet	0.003333		79	40-140	2	30	
BZ#187 [2C]	0.00220	0.00027	mg/kg wet	0.003333		66	40-140	4	30	
BZ#195	0.00216	0.00027	mg/kg wet	0.003333		65	40-140	2	30	
BZ#195 [2C]	0.00223	0.00027	mg/kg wet	0.003333		67	40-140	3	30	
BZ#206	0.00210	0.00027	mg/kg wet	0.003333		63	40-140	3	30	
BZ#206 [2C]	0.00217	0.00027	mg/kg wet	0.003333		65	40-140	2	30	
BZ#209	0.00204	0.00027	mg/kg wet	0.003333		61	40-140	3	30	
BZ#209 [2C]	0.00212	0.00027	mg/kg wet	0.003333		64	40-140	2	30	
BZ#28	0.00239	0.00027	mg/kg wet	0.003333		72	40-140	0.5	30	
BZ#28 [2C]	0.00231	0.00027	mg/kg wet	0.003333		69	40-140	1	30	
BZ#44	0.00217	0.00027	mg/kg wet	0.003333		65	40-140	5	30	
BZ#44 [2C]	0.00222	0.00027	mg/kg wet	0.003333		67	40-140	2	30	
BZ#52	0.00262	0.00027	mg/kg wet	0.003333		78	40-140	3	30	
BZ#52 [2C]	0.00214	0.00027	mg/kg wet	0.003333		64	40-140	2	30	
BZ#66	0.00221	0.00027	mg/kg wet	0.003333		66	40-140	4	30	
BZ#66 [2C]	0.00220	0.00027	mg/kg wet	0.003333		66	40-140	2	30	
BZ#8	0.00232	0.00027	mg/kg wet	0.003333		70	40-140	1	30	
BZ#8 [2C]	0.00226	0.00027	mg/kg wet	0.003333		68	40-140	5	30	

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam ESS Laboratory Work Order: 24B0025

Notes and Definitions

Z-08	See Attached
U	Analyte included in the analysis, but not detected
P	Percent difference between primary and confirmation results exceeds 40% (P).
LC	Lower value is used due to matrix interferences (LC).
D+	Relative percent difference for duplicate is outside of criteria (D+).
D	Diluted.
CD+	Continuing Calibration %Diff/Drift is above control limit (CD+).
B+	Blank Spike recovery is above upper control limit (B+).
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: Horsley & Witten
Client Project ID: Squannacook River Dam   ESS Laboratory Work Order: 24B0025

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

Thielsch DIVISION OF THE RISE GROUP	195 Frances Avenue Cranston RI, 02910 Phone: (401)-467-6454 Fax: (401)-467-2398 cts.thielsch.com *Let's Build a Solid Foundation*	Client Information: Horsley Witten Group Boston, MA 02109 Project Manager: Jonas Procton Assigned By: ESS Laboratory Collected By: HW	Project Information: **Saquanacook River Dam Removal** **Groton, MA** Project Number: 24B0025 Summary Page: 1 of 1 Report Date: 2.5.24

LABORATORY TESTING DATA SHEET, Report No.: 7424-B-108

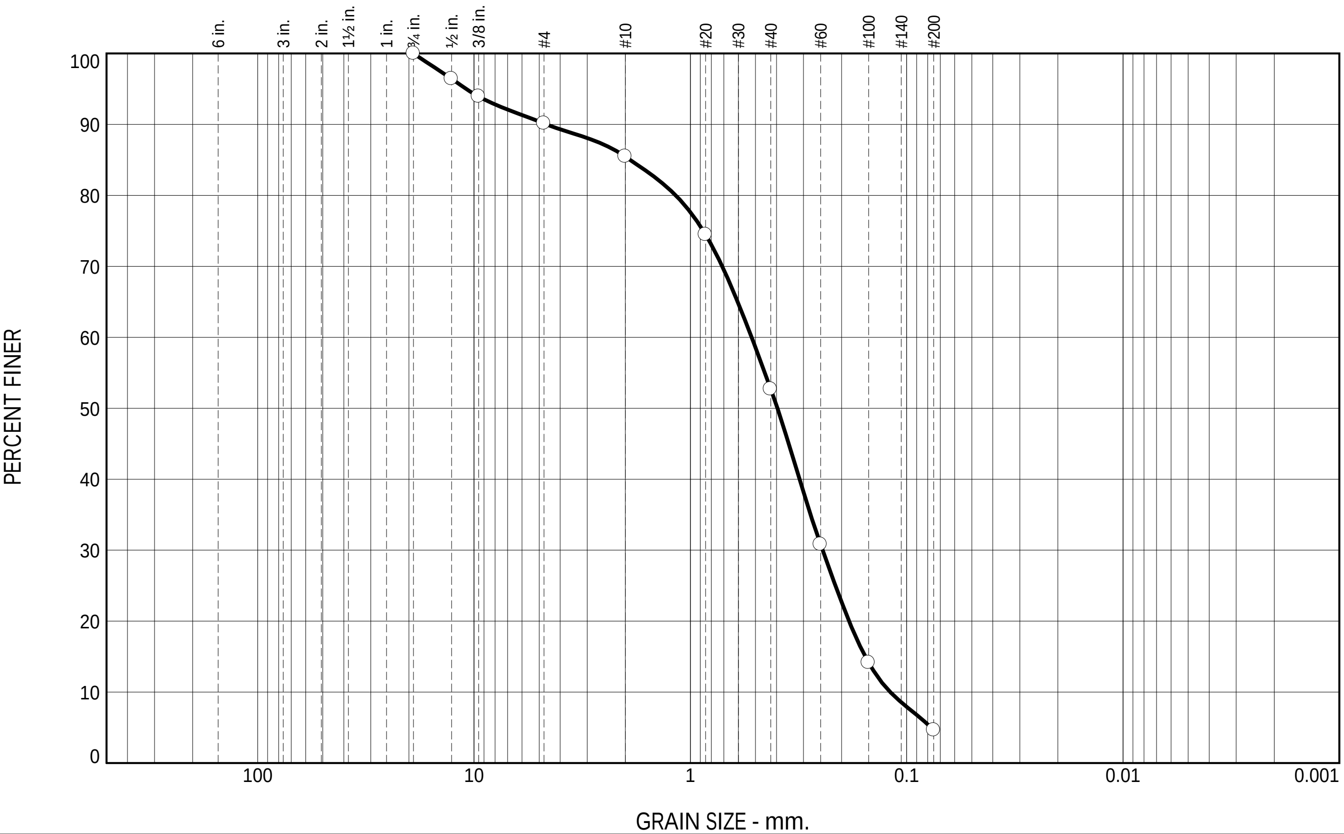
Material Source	Sample ID	Depth (ft)	Laboratory No.	Identification Tests									Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Rcvd Moisture Content %	LL %	PL %	OD LL	Gravel %	Sand %	Fines %	Org. %	pH	g_d MAX (pcf) W_{opt} (%)	g_d MAX (pcf) W_{opt} (%) (Corr.)	Dry unit wt. (pcf)	Test Moisture Content %	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318			D6913			D2974	D4792	D1557								
Composite	Groton DS	-	24B0025-01					9.9	85.5	4.6											Brown poorly graded sand
Composite	Groton US	-	24B0025-02					5.5	91.7	2.8											Brown poorly graded sand

Date Received: 2.2.24 Reviewed By: [signature] Date Reviewed: 2.7.24

This report only relates to items inspect and/or tested. No warranty, expressed or implied, is made.
This report shall not be reproduced, except in full, without prior written approval from the Agency, as defined in ASTM E329.

These results are for the exclusive use of the client for whom they were obtained. This report only relates to items inspect and/or tested. No warranty, expressed or implied, is made.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.9	4.6	32.8	48.1	4.6	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	96.4		
3/8"	93.9		
#4	90.1		
#10	85.5		
#20	74.5		
#40	52.7		
#60	30.8		
#100	14.1		
#200	4.6		

* (no specification provided)

Soil Description

Brown poorly graded sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 4.6202 D_{85}= 1.8990 D_{60}= 0.5213
D_{50}= 0.3960 D_{30}= 0.2447 D_{15}= 0.1555
D_{10}= 0.1191 C_u= 4.38 C_c= 0.96

Classification

USCS= SP AASHTO= A-3

Remarks

Source of Sample: Composite Depth: -
Sample Number: Groton DS

Date: 2.6.24

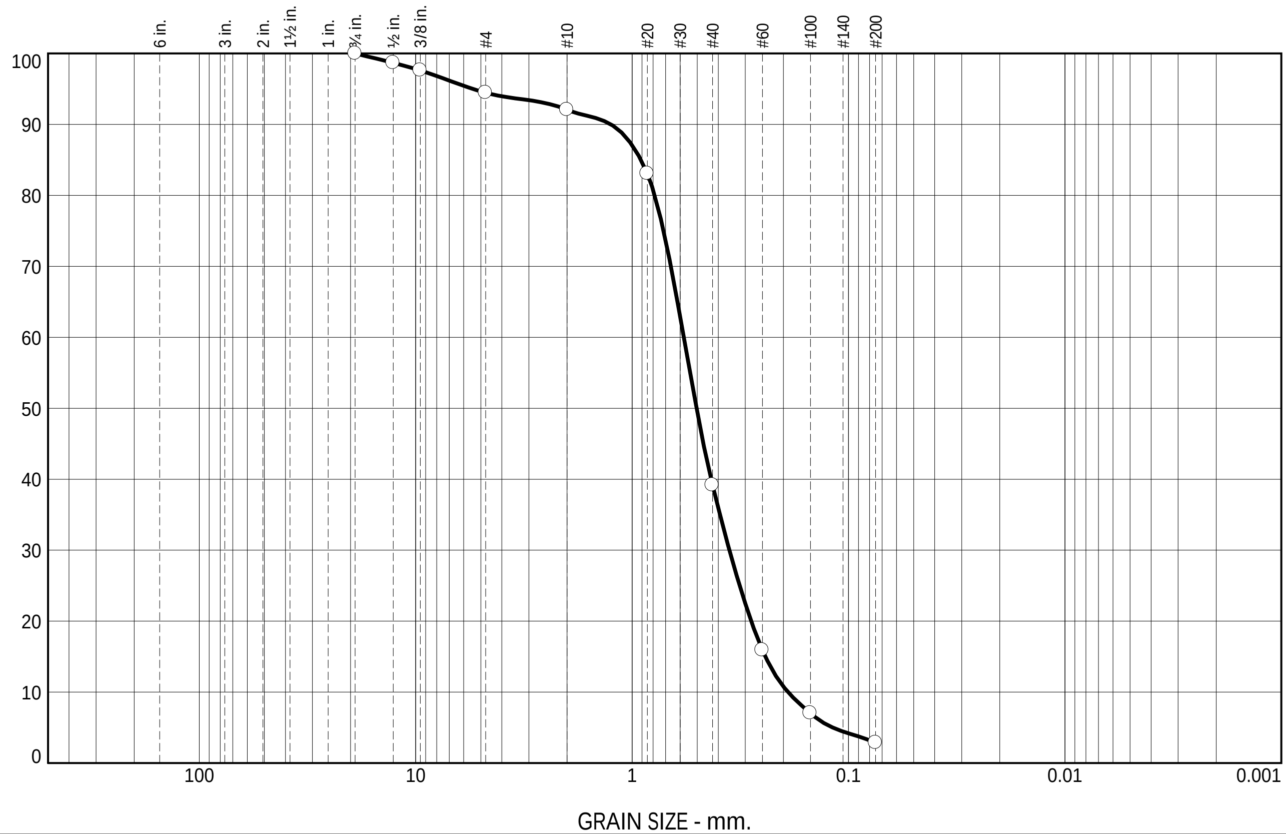
Thielsch Engineering Inc.

Cranston, RI

Client: ESS Laboratory
Project: Saquanacook River Dam Removal
Groton, MA
Project No: 24B0025 Fig. 24B0025-01

Tested By: SP Checked By: Kris Roland

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.5	2.4	52.9	36.4	2.8	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	98.7		
3/8"	97.6		
#4	94.5		
#10	92.1		
#20	83.1		
#40	39.2		
#60	15.9		
#100	7.0		
#200	2.8		

* (no specification provided)

Soil Description

Brown poorly graded sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 1.2525 D_{85}= 0.9102 D_{60}= 0.5768
D_{50}= 0.5037 D_{30}= 0.3552 D_{15}= 0.2424
D_{10}= 0.1904 C_u= 3.03 C_c= 1.15

Classification

USCS= SP AASHTO= A-1-b

Remarks

Source of Sample: Composite Depth: -
Sample Number: Groton US

Date: 2.6.24

Thielsch Engineering Inc.

Cranston, RI

Client: ESS Laboratory
Project: Saquanacook River Dam Removal
Groton, MA
Project No: 24B0025 Fig. 24B0025-02

Tested By: SP Checked By: Kris Roland

ESS Laboratory Sample and Cooler Receipt Checklist

Client: Horsley Witten Group - TJM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 24B0025
Date Received: 2/1/2024
Project Due Date: 2/8/2024
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 0.5 Iced with: Ice
5. Was COC signed and dated by client? Yes

6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA (NA circled)
10. Were any analyses received outside of hold time? Yes / No (No circled)

11. Any Subcontracting needed? Yes / No (Yes circled)
    ESS Sample IDs: **1--2**
    Analysis: **Grain size**
    TAT: **5 day**

12. Were VOAs received? Yes / No (Yes circled)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA (Yes circled)

13. Are the samples properly preserved? Yes / No (Yes circled)
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: 2/1/24 Time: 1710 By: TD

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No (No circled)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	516557	Yes	N/A	Yes	VOA Vial	MeOH	
1	516559	Yes	N/A	Yes	VOA Vial	DI Water	
1	516560	Yes	N/A	Yes	VOA Vial	DI Water	
1	516563	Yes	N/A	Yes	Driller Jar	NP	
1	516565	Yes	N/A	Yes	8 oz jar	NP	
1	516566	Yes	N/A	Yes	8 oz jar	NP	
1	516569	Yes	N/A	Yes	4 oz. Jar	NP	
2	516558	Yes	N/A	Yes	VOA Vial	MeOH	
2	516561	Yes	N/A	Yes	VOA Vial	DI Water	
2	516562	Yes	N/A	Yes	VOA Vial	DI Water	
2	516564	Yes	N/A	Yes	Driller Jar	NP	
2	516567	Yes	N/A	Yes	8 oz jar	NP	
2	516568	Yes	N/A	Yes	8 oz jar	NP	
2	516570	Yes	N/A	Yes	4 oz. Jar	NP	

2nd Review
Were all containers scanned into storage/lab? Initials RL

ESS Laboratory Sample and Cooler Receipt Checklist

Client: Horsley Witten Group - TJM

ESS Project ID: 24B0025
Date Received: 2/1/2024

Are barcode labels on correct containers?	(Yes) / No
Are all Flashpoint stickers attached/container ID # circled?	Yes / No / (NA)
Are all Hex Chrome stickers attached?	Yes / No / (NA)
Are all QC stickers attached?	(Yes) / No / NA
Are VOA stickers attached if bubbles noted?	Yes / No / (NA)

Completed By: [signature] Date & Time: 2/1/24 1640

Reviewed By: [signature] Date & Time: 2/1/24 1711

ESS LABORATORY
185 Frances Avenue
Cranston, RI 02910
Phone: 401-461-7181
Fax: 401-461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 24B0025 | Page 1 of 1

Turn Time (Days) ☑ > 5 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Same Day

Regulatory State: Criteria:

Is this project for any of the following?: ☐ CT RCP ☐ MA MCP ☐ RGP ☐ Permit ☑ 401 WQ

ELECTRONIC DELIVERABLES (Final Reports are PDF)
☐ Limit Checker ☐ State Forms ☐ EQuIS
☑ Excel ☐ Hard Copy ☐ Enviro Data
☐ CLP-Like Package ☐ Other (Specify) →

CLIENT INFORMATION

Client: Horsley Witten Group
Address: 112 Water St, 6th floor, Boston MA 02109
Phone: 857-263-8193
Email Distribution List: nprice@horsleywitten.com, jprocton@horsleywitten.com, carmstrong@horsleywitten.com, aschully@horsleywitten.com

PROJECT INFORMATION

Project Name: Saquanacook River Dam Removal
Project Location: Groton MA
Project Number: 23124
Project Manager: Jonas Procton / HW
Bill to: torciuch@horsleywitten.com
PO#:
Quote#:

Client acknowledges that sampling is compliant with all EPA / State regulatory programs

REQUESTED ANALYSES

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix (Sediment)	Sample ID	Metals	PCBs	EPH	TOC	% Water	Grain Size
1	1/31/24	11:05	Composite	J 1	Groton DS	✓	✓	✓	✓	✓	✓
1	↓	11:05	↓	AG 1	↓	✓	✓	✓	✓	✓	✓
1	↓	11:05	↓	AG 1	↓	✓	✓	✓	✓	✓	✓
1	↓	11:05	↓	AG 1	↓	✓	✓	✓	✓	✓	✓
2	↓	2:10	↓	J 1	Groton US	✓	✓	✓	✓	✓	✓
2	↓	2:15	↓	AG 1	↓	✓	✓	✓	✓	✓	✓
2	↓	2:30	↓	AG 1	↓	✓	✓	✓	✓	✓	✓
2	↓	3:00	↓	AG 1	↓	✓	✓	✓	✓	✓	✓

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz (11-Other*)

Preservation Code: (1-Non Preserved) 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*

Sampled by: HW

Chain needs to be filled out neatly and completely for on time delivery.

Laboratory Use Only
Cooler Temperature (°C): -0.5
On ice

Comments: * Please specify "Other" preservative and containers types in this space
8 oz Amber Jar 2 oz Driller Jar
2oz Amber Jar

All samples submitted are subject to ESS Laboratory's payment terms and conditions.

Dissolved Filtration ☐ Lab Filter

Relinquished by (Signature)	Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)
[signature]	2/1/24	1:52	[signature] 2/1/24 1:52	[signature]	2.1.24	1623	[signature]

ESS LABORATORY
185 Frances Avenue
Cranston, RI 02910
Phone: 401-461-7181
Fax: 401-461-4486
www.esslaboratory.com

CHAIN OF COUNTODY

ESS Lab # 24B0025 | Page 1 of 1

Turn Time (Days) ☑ > 5 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Same Day

Regulatory State: Criteria:

Is this project for any of the following?: ☐ CT RCP ☐ MA MCP ☐ RGP ☐ Permit ☑ 401 WQ

ELECTRONIC DELIVERABLES (Final Reports are PDF)
☐ Limit Checker ☐ State Forms ☐ EQuIS
☑ Excel ☐ Hard Copy ☐ Enviro Data
☐ CLP-Like Package ☐ Other (Specify) →

CLIENT INFORMATION

Client: Horsley Witten Group
Address: 112 Water St, 6th floor
Boston, MA, 02109
Phone: 857-263-8193
Email Distribution List: nprice@horsleywitten.com, jprocton@horsleywitten.com, carmstrong@horsleywitten.com, aschully@horsleywitten.com

PROJECT INFORMATION

Project Name: Sogvanacook River Dam Removal
Project Location: Groton, MA
Project Number: 23144
Project Manager: Jonas Procton / HW
Bill to: torcivcn@horsleywitten.com
PO#:
Quote#:
Sediment

Client acknowledges that sampling is compliant with all EPA / State regulatory programs

REQUESTED ANALYSES

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	VOCs High	VOCs Low	Total Number of Bottles
1	1/31/24	11:05	Grab	V 11 10	Groton DS VOC	✓ (struck)	✓	1
1	↓	11:05	↓	V 11 10	↓	✓ (struck)	✓	1
1	↓	11:05	↓	V 11 6	↓	✓		1
2	↓	2:15	↓	V 11 10	Groton US VOC	✓ (struck)	✓	1
2	↓	2:15	↓	V 11 10	↓	✓ (struck)	✓	1
2	↓	2:15	↓	V 11 6	↓	✓		1

Total: 6

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile (V-Vial)

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz (11-Other*)

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH (6-Methanol) 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl (10-DI H2O) 11-Other*

Sampled by :

Chain needs to be filled out neatly and completely for on time delivery.

Laboratory Use Only
Cooler Temperature (°C): -0.5
On Ice

Comments: * Please specify "Other" preservative and containers types in this space
11: Other: 35 mL Vial

All samples submitted are subject to ESS Laboratory's payment terms and conditions.

Dissolved Filtration
☐ Lab Filter

Relinquished by (Signature)	Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)
[signature]	2/1/24	1:52	[signature] 2/1/24 1:52	[signature]	2.1.24	1622	[signature]
Relinquished by (Signature)	Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)

ATTACHMENT B

ResilientMass Action Team (RMAT) Report

Climate Resilience Design Standards Tool Project Report

Squannacook River
Date Created: 2/16/2024 2:14:54 PM
Created By: aschully
Date Report Generated: 2/16/2024 3:18:55 PM
Tool Version: Version 1.2
Project Contact Information: Ava Schully (aschully@horsleywitten.com)

Project Summary

Link to Project

Estimated Capital Cost: $500000.00
End of Useful Life Year: 2026
Project within mapped Environmental Justice neighborhood: No

Ecosystem Service Benefits	Scores
Project Score	High

Exposure	Scores
Sea Level Rise/Storm Surge	Not Exposed
Extreme Precipitation - Urban Flooding	High Exposure
Extreme Precipitation - Riverine Flooding	High Exposure
Extreme Heat	Moderate Exposure

Asset Preliminary Climate Risk Rating Summary

Number of Assets: 1

Asset Risk	Sea Level Rise/Storm Surge	Extreme Precipitation - Urban Flooding	Extreme Precipitation - Riverine Flooding	Extreme Heat
river	—— Natural Resource project assets do not receive a preliminary climate risk rating. ——			

Climate Resilience Design Standards Summary

	Target Planning Horizon	Intermediate Planning Horizon	Percentile	Return Period	Tier
Sea Level Rise/Storm Surge					
river					
Extreme Precipitation					
river	2030				Tier 1
Extreme Heat					
river	2030		th		Tier 1

Scoring Rationale - Project Exposure Score

The purpose of the Exposure Score output is to provide a preliminary assessment of whether the overall project site and subsequent assets are exposed to impacts of natural hazard events and/or future impacts of climate change. For each climate parameter, the Tool will calculate one of the following exposure ratings: Not Exposed, Low Exposure, Moderate Exposure, or High Exposure. The rationale behind the exposure rating is provided below.

Sea Level Rise/Storm Surge

This project received a "Not Exposed" because of the following:

- Not located within the predicted mean high water shoreline by 2030
- No historic coastal flooding at project site
- Not located within the Massachusetts Coast Flood Risk Model (MC-FRM)

Extreme Precipitation - Urban Flooding

This project received a "High Exposure" because of the following:

- Historic flooding at the project site
- No increase to impervious area
- Maximum annual daily rainfall is within 6 to 10 inches within the overall project's useful life
- Existing impervious area of the project site is between 10% and 50%

Extreme Precipitation - Riverine Flooding

This project received a "High Exposure" because of the following:

- Project site has a history of riverine flooding
- Part of the project is within a mapped FEMA floodplain, outside of the Massachusetts Coast Flood Risk Model (MC-FRM)
- Part of the project is within 100ft of a waterbody
- Project is potentially susceptible to riverine erosion

Extreme Heat

This project received a "Moderate Exposure" because of the following:

- Existing impervious area of the project site is between 10% and 50%
- 10 to 30 day increase in days over 90 deg. F within project's useful life
- Located within 100 ft of existing water body
- No increase to the impervious area of the project site
- No tree removal

Scoring Rationale - Asset Preliminary Climate Risk Rating

A Preliminary Climate Risk Rating is determined for each infrastructure and building asset by considering the overall project Exposure Score and responses to Step 4 questions provided by the user in the Tool. Natural Resource assets do not receive a risk rating. The following factors are what influenced the risk ratings for each asset.

Asset - river
Primary asset criticality factors influencing risk ratings for this asset:

No score available

Project Climate Resilience Design Standards Output

Climate Resilience Design Standards and Guidance are recommended for each asset and climate parameter. The Design Standards for each climate parameter include the following: recommended planning horizon (target and/or intermediate), recommended return period (Sea Level Rise/Storm Surge and Precipitation) or percentile (Heat), and a list of applicable design criteria that are likely to be affected by climate change. Some design criteria have numerical values associated with the recommended return period and planning horizon, while others have tiered methodologies with step-by-step instructions on how to estimate design values given the other recommended design standards.

Asset: river — Natural Resources

Sea Level Rise/Storm Surge

Applicable Design Criteria

Projected Tidal Datums: NOT APPLICABLE

Projected Water Surface Elevation: NOT APPLICABLE

Projected Wave Action Water Elevation: NOT APPLICABLE

Projected Wave Heights: NOT APPLICABLE

Return Period Recommendations for natural resource assets and subsequent projected values are provided as a consideration for users, not a formal standard. Users should follow industry best practices for designing natural resource assets in coordination with the appropriate regulatory agencies.

Projected Duration of Flooding: NOT APPLICABLE

Projected Design Flood Velocity: NOT APPLICABLE

Projected Scour & Erosion: NOT APPLICABLE

Extreme Precipitation

Target Planning Horizon: 2030

LIMITATIONS: The recommended Standards for Total Precipitation Depth & Peak Intensity are determined by the user drawn polygon and relationships as defined in the Supporting Documents. The projected Total Precipitation Depth values provided through the Tool are based on the climate projections developed by Cornell University as part of EEA's Massachusetts Climate and Hydrologic Risk Project, GIS-based data as of 10/15/21. For additional information on the methodology of these precipitation outputs, see Supporting Documents.

While Total Precipitation Depth & Peak Intensity for 24-hour Design Storms are useful to inform planning and design, it is recommended to also consider additional longer- and shorter-duration precipitation events and intensities in accordance with best practices. Longer-duration, lower-intensity storms allow time for infiltration and reduce the load on infrastructure over the duration of the storm. Shorter-duration, higher-intensity storms often have higher runoff volumes because the water does not have enough time to infiltrate infrastructure systems (e.g., catch basins) and may overflow or back up during such storms, resulting in flooding. In the Northeast, short-duration high intensity rain events are becoming more frequent, and there is often little early warning for these events, making it difficult to plan operationally. While the Tool does not provide recommended design standards for these scenarios, users should still consider both short- and long-duration precipitation events and how they may impact the asset.

The projected values, standards, and guidance provided within this Tool may be used to inform plans and designs, but they do not provide guarantees for future conditions or resilience. The projected values are not to be considered final or appropriate for construction documents without supporting engineering analyses. The guidance provided within this Tool is intended to be general and users are encouraged to do their own due diligence

Applicable Design Criteria

Tiered Methodology: Tier 1

Projected Total Precipitation Depth & Peak Intensity for 24-hr Design Storms: APPLICABLE

Asset Name	Recommended Planning Horizon	Recommended Return Period (Design Storm)	Projected 24-hr Total Precipitation Depth (inches)	Step-by-Step Methodology for Peak Intensity
river	2030	25-Year (4%)	6.6	Downloadable Methodology PDF

Return Period Recommendations for natural resource assets and subsequent projected values are provided as a consideration for users, not a formal standard. Users should follow industry best practices for designing natural resource assets in coordination with the appropriate regulatory agencies.

ATTENTION: This is a Tier 1 project. It is advised to compare the extreme precipitation output values to the NOAA+ methodology to calculate total precipitation depth for 24-hr design storms.

This methodology can be found in the following PDF. (Link).

Projected Riverine Peak Discharge & Peak Flood Elevation: APPLICABLE
Methodology to Estimate Projected Values : Tier 1

Extreme Heat

Target Planning Horizon: 2030
Percentile: Does not apply

Applicable Design Criteria

Tiered Methodology: Tier 1

Projected Annual/Summer/Winter Average Temperatures: APPLICABLE
Methodology to Estimate Projected Values : Tier 1

Projected Heat Index: NOT APPLICABLE

Projected Growing Degree Days: NOT APPLICABLE

Projected Days Per Year With Max Temp > 95°F, >90°F, <32°F: NOT APPLICABLE

Projected Number of Heat Waves Per Year & Average Heat Wave Duration: NOT APPLICABLE

Projected Cooling Degree Days & Heating Degree Days (base = 65°F): NOT APPLICABLE

Project Inputs

Core Project Information

Name:	Squannacook River
Given the expected useful life of the project, through what year do you estimate the project to last (i.e. before a major reconstruction/renovation)?	2026
Location of Project:	Groton
Estimated Capital Cost:	$500,000
Who is the Submitting Entity?	Private Other Horsley Witten Group Ava Schully (aschully@horsleywitten.com)
Is this project being submitted as part of a state grant application?	No
Which grant program?	
What stage are you in your project lifecycle?	No physical assets planned for this project
Is climate resiliency a core objective of this project?	Yes
Is this project being submitted as part of the state capital planning process?	No
Is this project being submitted as part of a regulatory review process or permitting?	No
Brief Project Description:	Through this project, HW will develop feasibility assessments and preliminary designs for the potential removal of the Squanacook River Dam in North Andover, MA. The primary goals of this initial feasibility project are: 1.) Identify the anticipated benefits and challenges to each specific dam removal in order to assess its overall feasibility and then rank it among other potential dam removal projects for further project advancement; and 2.) Create preliminary project designs that can then be further advanced during later project phases, assuming that the overall project feasibility and ranking proves suitable for further advancement.
Project Submission Comments:	

Project Ecosystem Service Benefits

Factors Influencing Output

✓ This is an ecological restoration project
✓ Project provides flood protection through nature-based solutions
✓ Project reduces storm damage
✓ Project improves water quality
✓ Project protects fisheries, wildlife, and plant habitat
✓ Project protects land containing shellfish
✓ Project provides recreation
✓ Project provides cultural resources/education

Factors to Improve Output

✓ Protect public water supply by reducing the risk of contamination, pollution, and/or runoff of surface and groundwater sources used for human consumption
✓ Increase plants, trees, and/or other vegetation to provide oxygen production

Is the primary purpose of this project ecological restoration?

Yes

Project Benefits

Provides flood protection through nature-based solutions	Yes
Reduces storm damage	Yes
Recharges groundwater	No
Protects public water supply	Maybe
Filters stormwater using green infrastructure	No
Improves water quality	Yes
Promotes decarbonization	No
Enables carbon sequestration	No
Provides oxygen production	Maybe
Improves air quality	No
Prevents pollution	No
Remediates existing sources of pollution	No
Protects fisheries, wildlife, and plant habitat	Yes
Protects land containing shellfish	Yes
Provides pollinator habitat	No
Provides recreation	Yes
Provides cultural resources/education	Yes

Project Climate Exposure

Is the primary purpose of this project ecological restoration?	Yes
Does the project site have a history of coastal flooding?	No
Does the project site have a history of flooding during extreme precipitation events (unrelated to water/sewer damages)?	Yes
Does the project site have a history of riverine flooding?	Yes
Does the project result in a net increase in impervious area of the site?	No
Are existing trees being removed as part of the proposed project?	No

Project Assets

Asset: river
Asset Type: Aquatic Ecosystems
Asset Sub-Type: Large- and mid-size rivers
Construction Type: Dam Removal
Construction Year: 2025
Monitoring Frequency: 1

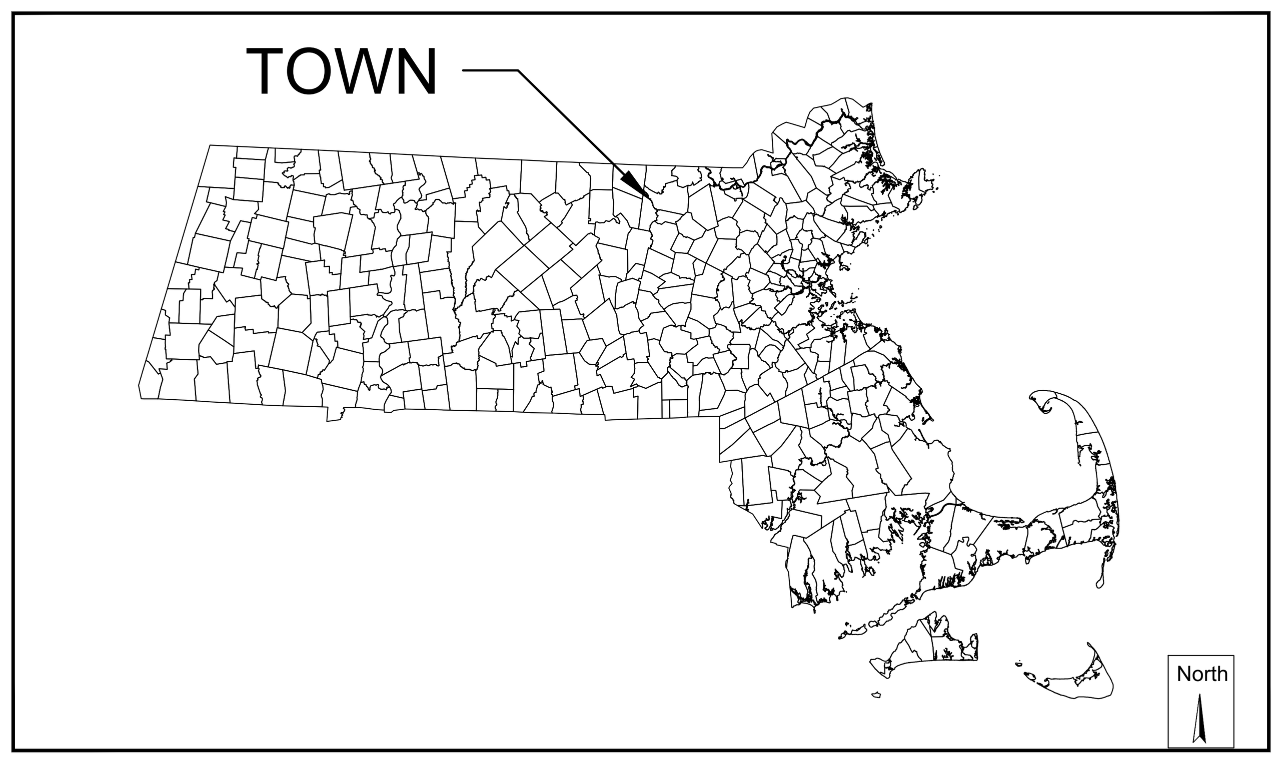
Report Comments

N/A

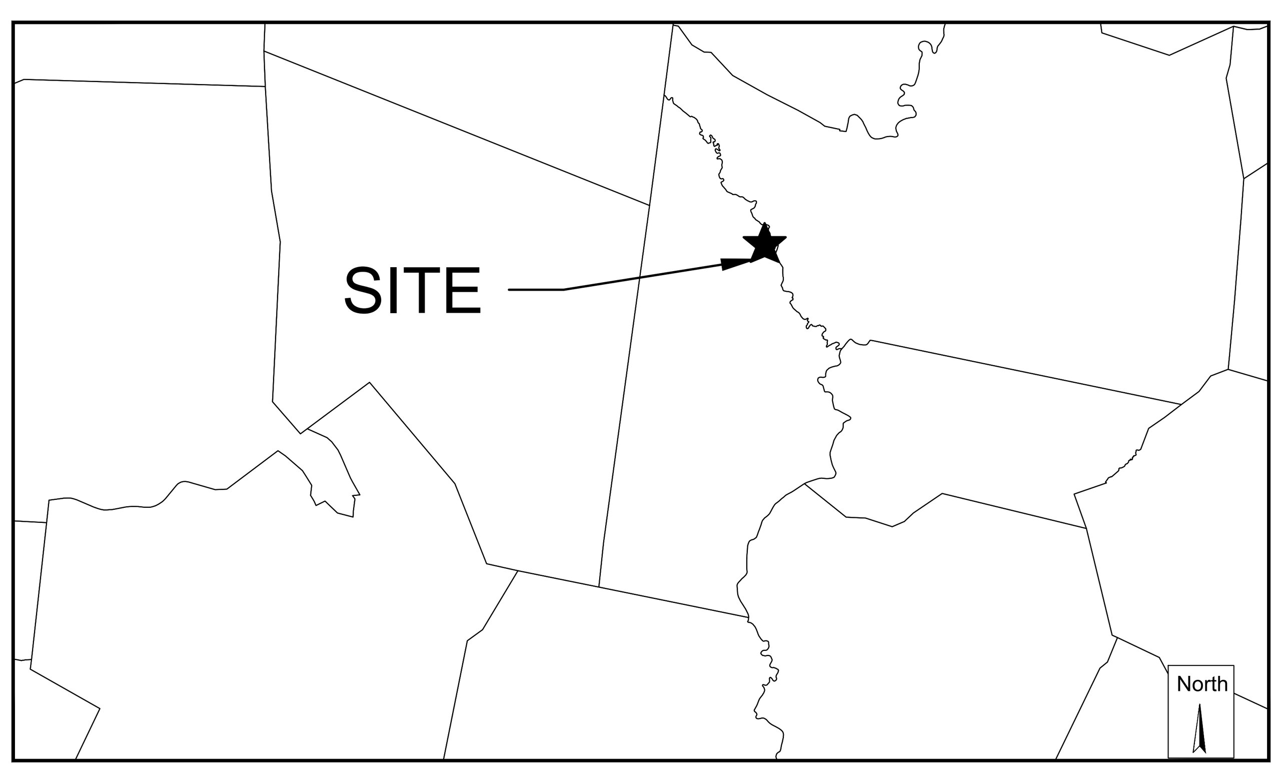
ATTACHMENT C

Preliminary Design Plans

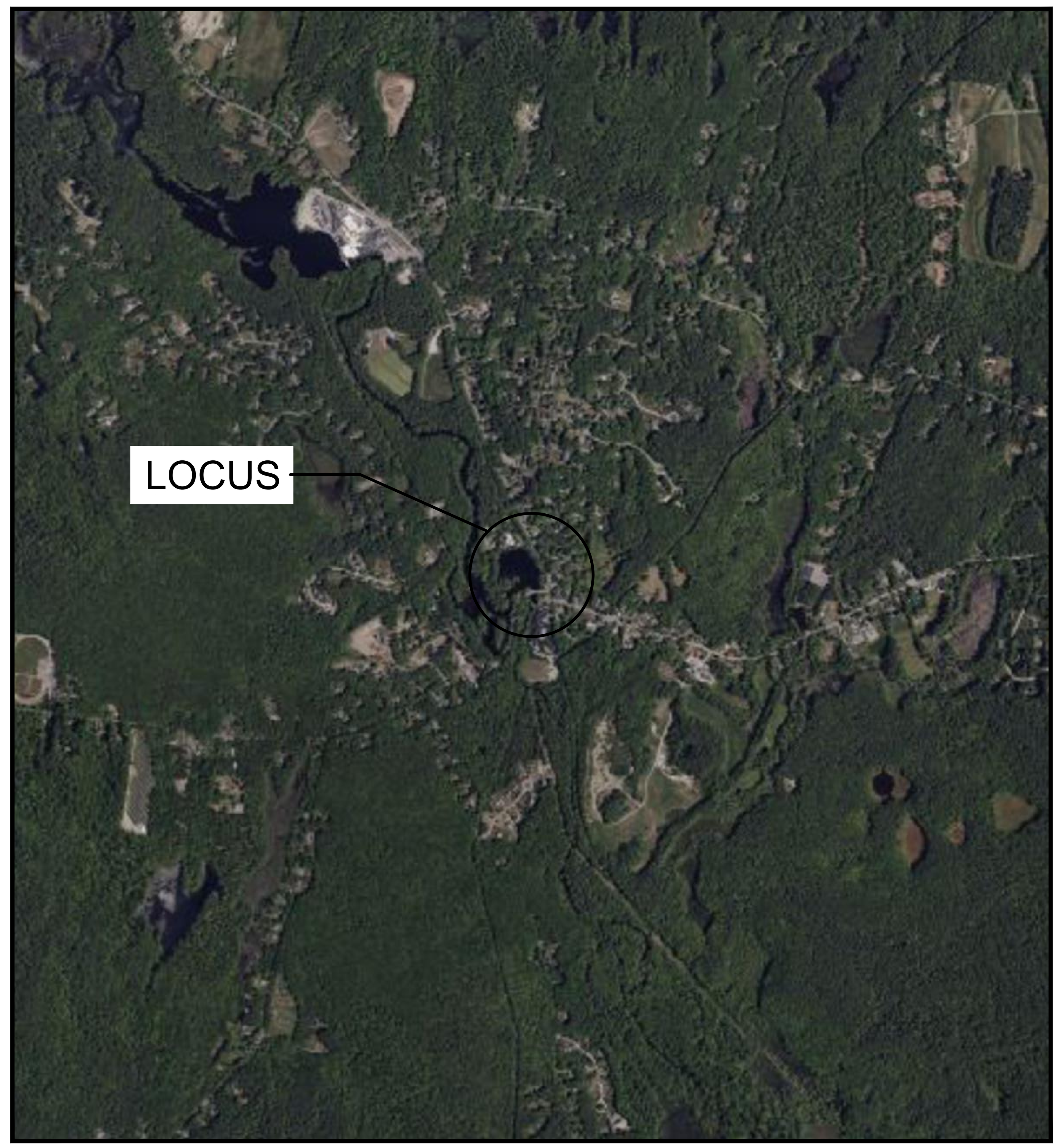
DAM REMOVAL - PRELIMINARY DESIGN
SQUANNACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS
JUNE 2024



MASSACHUSETTS
Graphic Scale
0 150000
SCALE IN FEET
1:150000



TOWN
Graphic Scale
0 12000
SCALE IN FEET
1:12000



VICINITY MAP
Graphic Scale
1-inch = 1000-feet

Sheet List Table	
Sheet Number	Sheet Title
1	COVER
2	CONSTRUCTION NOTES
3	OVERALL EXISTING CONDITIONS
4	EXISTING CONDITIONS
5	CROSS SECTIONS (1)
6	CROSS SECTIONS (2)
7	LONGITUDINAL PROFILE
8	SITE PREPARATION AND DEMOLITION PLAN
9	SITE LAYOUT PLAN
10	RESTORATION AND STABILIZATION PLAN

GENERAL NOTES:

1. THIS PLAN SET IS CONCEPTUAL ONLY AND NOT FOR CONSTRUCTION.
2. ABUTTER INFORMATION FROM ASSESSOR'S MAP.
3. SITE INFORMATION:
   - PLAT 101
   - LOT: 10
   - ADDRESS: 6 WEST MAIN STREET, GROTON, MA
   - ZONING DISTRICT: BUSINESS 1

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANNACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
(617) 626-1540

Prepared By:
Horsley Witten Group, Inc.
Sustainable Environmental Solutions
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Headquarters
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Sandwich, MA 02563
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112 Water Street, 6th Floor
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Phone: (857) 263-8193

1 Turks Head Place, Suite 300
Providence, RI 02903
Phone: (401) 272-1717
Fax: (401) 437-8368

113 R2 Water Street
Exeter, NH 03833
Phone: (603) 658-1660

Date Issued: JUNE 2024
Designed By: AS/JMP
Drawn By: AS
Checked By: NP

Registration:
DRAFT
NOT FOR CONSTRUCTION

Revisions

Rev.	Date	By	Appr.	Description
1				
2				
3				
4				
5				
6				
7				

Project Number: 23144
Sheet Number: 1 of 10
Drawing Number: C-1

last modified: 06/18/24 printed: 06/20/24 by as H:\Projects\2023\23144 Squanacook River Dam\Drawings\23144 SQUANACOOK CV.dwg

GENERAL CONSTRUCTION NOTES:

1. ALL SITE WORK TO COMPLETE THIS PROJECT AS INDICATED ON THE DRAWINGS AND IN THE SPECIFICATIONS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.
2. IMMEDIATELY CONTACT AND COORDINATE WITH THE ENGINEER AND OWNER IF ANY DEVIATION OR ALTERATION OF THE WORK PROPOSED ON THESE DRAWINGS IS REQUIRED.
3. UTILIZE ALL PRECAUTIONS AND MEASURES TO ENSURE THE SAFETY OF THE PUBLIC, ALL PERSONNEL AND PROPERTY DURING CONSTRUCTION IN ACCORDANCE WITH OSHA STANDARDS, INCLUDING THE INSTALLATION OF TEMPORARY FENCING BARRICADES, SAFETY LIGHTING, CONES, POLICE DETAIL AND/OR FLAGMEN AS DETERMINED NECESSARY BY THE TOWN. THE CONTRACTOR IS RESPONSIBLE FOR THE COST OF POLICE DETAIL AND FOR COORDINATING WITH THE LOCAL OR STATE POLICE DEPARTMENT FOR ALL REQUIRED POLICE DETAIL.
4. MAKE ALL NECESSARY CONSTRUCTION NOTIFICATIONS AND APPLY FOR AND OBTAIN ALL NECESSARY CONSTRUCTION PERMITS, PAY ALL FEES INCLUDING POLICE DETAILS AND POST ALL BONDS, IF NECESSARY, ASSOCIATED WITH THE SAME, AND COORDINATE WITH ASHLAND CONSERVATION COMMISSION, THE DEPARTMENT OF PUBLIC WORKS, AND THE ENGINEER.
5. ALL EXISTING CONDITIONS SHOWN ARE APPROXIMATE AND ARE BASED ON THE BEST INFORMATION AVAILABLE. PRIOR TO THE START OF CONSTRUCTION, VERIFY THAT THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS DO NOT CONFLICT WITH ANY KNOWN EXISTING OR OTHER PROPOSED IMPROVEMENTS. IF ANY CONFLICTS ARE DISCOVERED, NOTIFY THE OWNER AND THE ENGINEER PRIOR TO INSTALLING ANY PORTION OF THE SITE WORK WHICH WOULD BE AFFECTED.
6. IMPORT ONLY CLEAN MATERIAL. MATERIAL FROM AN EXISTING OR FORMER 21E SITE AS DEFINED BY THE MASSACHUSETTS CONTINGENCY PLAN 310 CMR 40.0000 WILL NOT BE ACCEPTED .
7. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO ESTABLISH AND MAINTAIN ALL CONTROL POINTS AND BENCHMARKS DURING CONSTRUCTION INCLUDING BENCHMARK LOCATIONS AND ELEVATIONS AT CRITICAL AREAS. COORDINATE WITH THE ENGINEER THE LOCATION OF ALL CONTROL POINTS AND BENCHMARKS.
8. SITE LAYOUT SURVEY REQUIRED FOR CONSTRUCTION MUST BE PROVIDED BY THE CONTRACTOR AND PERFORMED BY A MASSACHUSETTS' REGISTERED PROFESSIONAL LAND SURVEYOR. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING WITH THE SURVEYOR FOR ALL SITE SURVEY WORK.
9. MAINTAIN ALL GRADE STAKES SET BY THE SURVEYOR. GRADE STAKES ARE TO REMAIN UNTIL A FINAL INSPECTION OF THE ITEM HAS BEEN COMPLETED BY THE ENGINEER. RE-STAKING OF PREVIOUSLY SURVEYED SITE FEATURES IS THE RESPONSIBILITY (INCLUDING COST) OF THE CONTRACTOR.
10. UNLESS OTHERWISE INDICATED ON THE DRAWINGS AND/OR IN THE SPECIFICATIONS, ALL SITE CONSTRUCTION MATERIALS AND METHODOLOGIES ARE TO CONFORM TO THE MOST RECENT VERSION OF THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS
11. PROVIDE ALL CONSTRUCTION SERVICE IN ACCORDANCE WITH APPLICABLE LAWS AND REGULATIONS REGARDING NOISE, VIBRATION, DUST, SEDIMENTATION CONTAINMENT, AND TRENCH WORK.
12. COLLECT SOLID WASTES AND STORE IN A SECURED DUMPSTER. THE DUMPSTER MUST MEET ALL LOCAL AND STATE SOLID WASTE MANAGEMENT REGULATIONS.
13. RESTORE ALL SURFACES EQUAL TO THEIR ORIGINAL CONDITION AFTER CONSTRUCTION IS COMPLETE PER SPECIFICATIONS. LEAVE ALL AREAS NOT DISTURBED BY CONSTRUCTION IN THEIR NATURAL STATE. TAKE CARE TO PREVENT DAMAGE TO SHRUBS, TREES, OTHER LANDSCAPING AND/OR NATURAL FEATURES. WHEREAS THE PLANS DO NOT SHOW ALL LANDSCAPE FEATURES, EXISTING CONDITIONS MUST BE VERIFIED BY THE CONTRACTOR IN ADVANCE OF THE WORK.
14. REGULARLY INSPECT THE PERIMETER OF THE PROPERTY TO CLEAN UP AND REMOVE LOOSE CONSTRUCTION DEBRIS BEFORE IT LEAVES THE SITE. PROMPTLY REMOVE ALL DEMOLITION DEBRIS FROM THE SITE TO AN APPROVED DUMP SITE.
15. ALL TRUCKS LEAVING THE SITE MUST BE COVERED.
16. AT THE END OF CONSTRUCTION, REMOVE ALL CONSTRUCTION DEBRIS AND SURPLUS MATERIALS FROM THE SITE AS INDICATED IN THE SPECIFICATIONS. PERFORM A THOROUGH INSPECTION OF THE WORK PERIMETER. COLLECT AND REMOVE ALL MATERIALS AND BLOWN OR WATER CARRIED DEBRIS FROM THE SITE.

GENERAL DEMOLITION NOTES:

THIS PLAN SET DOES NOT INCLUDE DETAILS & SPECIFICATIONS FOR ALL DEMOLITION WORK REQUIRED WITHIN THE PROPOSED CONSTRUCTION LIMITS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO COORDINATE WITH THE OWNER AND OTHER PROJECT ENGINEERS INVOLVED WITH THE PROPOSED NEW CONSTRUCTION TO DEVELOP A SUITABLE DEMOLITION PLAN, WHICH WILL ALLOW THE FACILITIES TO REMAIN IN OPERATION DURING THE ENTIRETY OF CONSTRUCTION.

1. UNLESS OTHERWISE NOTED, THE CONTRACTOR IS RESPONSIBLE FOR THE RELOCATION, DEMOLITION, REMOVAL AND DISPOSAL, IN A LOCATION APPROVED BY ALL GOVERNING AUTHORITIES, OF ALL EXISTING SITE ELEMENTS AND STRUCTURES INCLUDING, BUT NOT LIMITED TO, CEMENT CONCRETE, GRAVEL, CURBS, WALKWAYS, SIDEWALKS, FENCES, BOLLARDS, POSTS, PLANTING BEDS, TREES, SHRUBS, AND ALL OTHER STRUCTURES SHOWN AND NOT SHOWN WITHIN CONSTRUCTION LIMITS, AND WHERE NEEDED, TO ALLOW FOR CONSTRUCTION.
2. REMOVE ALL DEBRIS FROM THE SITE AND DISPOSE OF THE DEBRIS IN A PROPER AND LEGAL MANNER.
3. OBTAIN ALL PERMITS REQUIRED FOR DEMOLITION AND DISPOSAL.
4. PRIOR TO DEMOLITION OCCURRING, ALL EROSION AND WATER CONTROL DEVICES ARE TO BE INSTALLED.
5. 401 WATER QUALITY CERTIFICATION MUST BE RECEIVED PRIOR TO PASSIVE RELEASE OF SEDIMENT.

DEWATERING NOTES:

1. IF DEWATERING IS REQUIRED DURING EXCAVATION, TEMPORARILY LOWER THE WATER TABLE PER SPECIFICATIONS, INSTALL A DEWATERING BASIN AS INDICATED IN THE DEWATERING BASIN DETAIL, AND PROVIDE A DEWATERING PLAN DEPICTING PROPOSED DEWATERING LOCATION FOR REVIEW AND APPROVAL. DIRECT THE PUMP DISCHARGE TO BASIN TO PREVENT SEDIMENTS FROM LEAVING THE CONSTRUCTION AREA. INSTALL ADDITIONAL BASINS IF REQUIRED. INSTALL THE BASIN AS INDICATED ON DRAWINGS IF SO NOTED, OTHERWISE INSTALL THE BASIN(S) WITHIN THE LIMIT OF DISTURBANCE INDICATED BY THE SILT FENCE OR STRAWBALES.
2. PRIOR TO ANY DEWATERING, THE DEWATERING PLAN MUST BE APPROVED BY THE ENGINEER.
3. IF DEWATERING IS NECESSARY DURING CONSTRUCTION, IMPLEMENT THE PROPER ESC MEASURES ON SITE TO PREVENT EROSION OR SEDIMENT RUNOFF. THESE MEASURES CAN INCLUDE DEWATERING BAGS, TEMPORARY STRAWBALES, SILT FENCES, SILT SOCKS AND/OR OTHER APPROVED DEVICES AS INDICATED IN THE DETAILS.

BASIC CONSTRUCTION SEQUENCE:

THE FOLLOWING CONSTRUCTION SEQUENCE IS TO BE USED AS A GENERAL GUIDELINE. COORDINATE WITH THE OWNER, ENGINEERS, AND LANDSCAPE ARCHITECT AND SUBMIT A PROPOSED CONSTRUCTION SEQUENCE FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION.

1. SURVEY AND STAKE THE PROPOSED LIMIT OF DISTURBANCE AND LIMIT OF SEDIMENTATION BARRIERS.
2. PLACE SEDIMENTATION BARRIERS AS INDICATED ON DRAWINGS AND STAKED OUT IN THE FIELD. UNDER NO CIRCUMSTANCES IS THE LIMIT OF WORK TO EXTEND BEYOND THE SEDIMENTATION BARRIERS/LIMIT OF DISTURBANCE AS INDICATED ON DRAWINGS AS APPROVED BY THE GROTON AND SHIRLEY CONSERVATION COMMISSIONS AND DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP).
3. INSTALL TEMPORARY CONSTRUCTION ENTRANCES IN LOCATIONS INDICATED ON DRAWINGS. NO OTHER ENTRANCES ARE TO BE USED TO GAIN ACCESS TO THE SITE BY ANY CONSTRUCTION OR DELIVERY VEHICLES.
4. BEGIN CLEARING THE SITE AS REQUIRED IN ORDER TO ACCESS THE DAM.
5. EXAMINE THE INTEGRITY OF THE EXISTING DAM AND DETERMINE MEANS OF REMOVAL. DEMOLITION METHODOLOGY TO BE APPROVED BY THE ENGINEER AND THE GROTON AND SHIRLEY CONSERVATION COMMISSIONS.
6. LOWER IMPOUNDMENT WATER LEVEL USING LOW LEVEL OUTLET LOCATED BELOW AUXILIARY SPILLWAY.
7. IF ANY DEWATERING IS REQUIRED, CONTRACTOR TO PROVIDE DEWATERING PLAN FOR APPROVAL BY ENGINEER. DEWATER AS NECESSARY.
8. DEMOLISH EXPOSED PORTION OF THE DAM, WORKING INCREMENTALLY, AS NEEDED. FLOW AND SEDIMENT TRANSPORT SHALL BE OBSERVED THROUGHOUT REMOVAL PROCESS FOR POTENTIAL NEGATIVE DOWNSTREAM IMPACTS BEFORE PROCEEDING.
9. IDENTIFY VERTICAL LOCATION OF BEDROCK OR COMPETENT BOTTOM BELOW DAM AND EVALUATE CHANNEL RECONSTRUCTION BASED ON OBSERVED BEDROCK PRESENCE. ENSURE THAT AN ADEQUATE LOW-FLOW CHANNEL IS PRESENT FOR FISH PASSAGE, AS DIRECTED BY THE ENGINEER. DEWATER AS NECESSARY, ACCORDING TO APPROVED DEWATERING PLAN.
10. ONCE DAM IS ENTIRELY REMOVED, INSTALL BANK STABILIZATION MEASURES. DO NOT DESTABILIZE SURROUNDING AREAS DURING THIS PROCESS.
11. PERMANENTLY PLANT AND SEED ALL DISTURBED AREAS.
12. SWEEP THE ROADWAY TO REMOVE ALL SEDIMENTS.
13. ENGINEER TO APPROVE THE REMOVAL OF ALL TEMPORARY SOIL EROSION AND SEDIMENTATION CONTROL MEASURES FOLLOWING VEGETATIVE ESTABLISHMENT OF ALL DISTURBED AREAS AND DETERMINE WHEN THE CONTRIBUTING AREA HAS REACHED A MINIMUM OF 80% STABILIZATION.
14. MONITOR DISTURBED AREA AND EVALUATE WHETHER OR NOT ADDITIONAL EROSION CONTROL SEED MIX APPLICATIONS OR OTHER MEASURES ARE WARRANTED FOR IMPROVED STABILIZATION.

GENERAL GRADING AND DRAINAGE NOTES:

1. ALL CUT AND FILL SLOPES SHALL BE 3:1 OR FLATTER UNLESS OTHERWISE NOTED.
2. EXISTING GRADE CONTOUR INTERVALS SHOWN AT 1 FOOT.
3. PROPOSED GRADE CONTOUR INTERVALS SHOWN AT 1 FOOT.
4. PROPOSED ELEVATIONS ARE SHOWN TO FINISH GRADE UNLESS NOTED OTHERWISE.
5. ALL EARTHWORK AND SITE PREPARATION MUST BE DONE IN STRICT ACCORDANCE WITH THE RECOMMENDATIONS OF ANY SUBSURFACE INVESTIGATION OR GEOTECHNICAL REPORTS PREPARED FOR THIS SITE.
6. GENERAL AREA UPSTREAM OF DAM SHALL RECEIVE MINIMAL EARTHWORK. ALL EARTH MOVING ACTIVITIES SUBSEQUENT TO DAM REMOVAL MUST BE APPROVED BY THE CONSERVATION AGENT AND BY THE ENGINEER. IN GENERAL, EARTHWORK SHALL BE CONFINED TO BANK STABILIZATION ACTIVITIES AND CONSTRUCTION OF A LOW FLOW CHANNEL, AS REQUIRED.

EROSION & SEDIMENT CONTROL NOTES:

1. DESIGNATE THE SITE CONSTRUCTION FOREMAN AS THE ON-SITE PERSONNEL RESPONSIBLE FOR THE DAILY INSPECTION AND MAINTENANCE OF ALL SEDIMENT AND EROSION CONTROLS AND IMPLEMENTATION OF ALL NECESSARY MEASURES TO CONTROL EROSION AND PREVENT SEDIMENT FROM LEAVING THE SITE.
2. INSTALL ALL EROSION AND SEDIMENT CONTROL (ESC) MEASURES AS INDICATED ON DRAWINGS IN CONSULTATION WITH THE CONSERVATION AGENT, AND ENGINEER BEFORE ANY CONSTRUCTION ACTIVITIES BEGIN. INSPECT, MAINTAIN REPAIR AND REPLACE EROSION CONTROL MEASURES, AS NECESSARY, DURING THE ENTIRE CONSTRUCTION PERIOD OF THE PROJECT. THE SITE PERIMETER EROSION CONTROLS ARE THE DESIGNATED LIMIT OF WORK. INFORM ALL PERSONNEL WORKING ON THE PROJECT SITE THAT NO CONSTRUCTION ACTIVITY IS TO OCCUR BEYOND THE LIMIT OF WORK AT ANY TIME THROUGHOUT THE CONSTRUCTION PERIOD.
3. MAINTAIN A MINIMUM SURPLUS OF 100 FEET OF EROSION CONTROL BARRIER (SILT FENCE AND/OR SILT SOCK) ONSITE AT ALL TIMES. IF DEWATERING IS REQUIRED, PROVIDE EXTRA DEWATERING BAG.
4. PROTECT THE ADJACENT RESOURCE AREA FROM SEDIMENTATION DURING PROJECT CONSTRUCTION UNTIL ACCEPTANCE BY THE OWNER & IN CONFORMANCE WITH THE ORDER OF CONDITIONS.
5. PROVIDE CONSTRUCTION EXITS AS INDICATED ON DRAWINGS TO SHED DIRT FROM CONSTRUCTION VEHICLE TIRES. CLEAN AND/OR REPLACE THE CRUSHED STONE PAD, AS NECESSARY, TO MAINTAIN ITS EFFECTIVENESS.
6. KEEP THE LIMIT OF CLEARING, GRADING AND DISTURBANCES TO A MINIMUM WITHIN THE PROPOSED AREA OF CONSTRUCTION. PHASE THE SITE WORK IN A MANNER TO MINIMIZE AREAS OF EXPOSED SOIL. IF TREES ARE TO BE CUT ON THE ENTIRE SITE, CLEAR AND GRUB ONLY THOSE AREAS WHICH ARE ACTIVELY UNDER CONSTRUCTION. PROPERLY INSTALL THE SEDIMENTATION CONTROLS PRIOR TO BEGINNING ANY LAND CLEARING ACTIVITY AND/OR OTHER CONSTRUCTION RELATED WORK.
7. MONITOR LOCAL WEATHER REPORTS DURING CONSTRUCTION AND PRIOR TO SCHEDULING EARTHMOVING OR OTHER CONSTRUCTION ACTIVITIES WHICH LEAVE LARGE DISTURBED AREAS UNSTABILIZED. IF INCLEMENT WEATHER IS PREDICTED, USE BEST PROFESSIONAL JUDGEMENT AND GOOD CONSTRUCTION PRACTICES WHEN SCHEDULING CONSTRUCTION ACTIVITIES AND ENSURE THE NECESSARY EROSION CONTROL DEVICES ARE INSTALLED AND FUNCTIONING PROPERLY TO MINIMIZE EROSION FROM ANY IMPENDING WEATHER EVENTS.
8. INSPECT EROSION AND SEDIMENT CONTROL DEVICES AND STABILIZED SLOPES ON A WEEKLY BASIS AND AFTER EACH RAINFALL EVENT OF 025 INCH OR GREATER. REPAIR IDENTIFIED PROBLEMS WITHIN 24 HOURS TO ENSURE EROSION AND SEDIMENT CONTROLS ARE IN GOOD WORKING ORDER. RESET OR REPLACE MATERIALS AS REQUIRED.
9. SURROUND THE PERIMETER OF SOIL STOCKPILES WITH SILT SOCK OR SILT FENCE.
10. DISTURBED AREAS AND SLOPES MUST NOT BE LEFT UNATTENDED OR EXPOSED FOR EXCESSIVE PERIODS OF TIME SUCH AS THE INACTIVE WINTER SEASON. PROVIDE APPROPRIATE STABILIZATION PRACTICES ON ALL DISTURBED AREAS AS SOON AS POSSIBLE BUT NOT MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT AREA HAS TEMPORARILY OR PERMANENTLY CEASED, REINFORCE TEMPORARY AREAS HAVING A SLOPE GREATER THAN 4:1 WITH EROSION BLANKETS OR APPROVED EQUAL UNTIL THE SITE IS PROPERLY STABILIZED. TEMPORARY SWALES MAY ALSO BE REQUIRED IF DETERMINED NECESSARY IN THE FIELD BY THE ENGINEER.
11. INSTALL A SILT SACK OR APPROVED EQUIVALENT IN EACH EXISTING CATCHBASIN RECEIVING RUNOFF FROM THE SITE. UPON THE INSTALLATION OF EACH CATCH BASIN, INSTALL A SILT SACK OR APPROVED EQUIVALENT. INSPECT SILT SACKS, AFTER EACH SIGNIFICANT STORM EVENT AND REMOVE AND EMPTY AS NEEDED FOR THE DURATION OF THE CONSTRUCTION PERIOD.
12. CONTAIN ALL SEDIMENT ONSITE. SWEEP ALL EXITS FROM THE SITE AS NECESSARY INCLUDING ANY SEDIMENT TRACKING. SWEEP PAVED AREAS AS NEEDED TO REMOVE SEDIMENT AND POTENTIAL POLLUTANTS ACCUMULATED DURING SITE CONSTRUCTION.
13. REMOVE ACCUMULATED SEDIMENT FROM ALL TEMPORARY PRACTICES AND DISPOSE OF IN A PRE-APPROVED LOCATION.
14. PROVIDE ON SITE OR MAKE READILY AVAILABLE THE NECESSARY EQUIPMENT AND SITE PERSONNEL DURING CONSTRUCTION HOURS FOR THE DURATION OF THE PROJECT TO ENSURE ALL EROSION AND SEDIMENTATION CONTROL DEVICES ARE PROPERLY MAINTAINED AND REPAIRED IN A TIMELY AND RESPONSIBLE MANNER. IF SITE WORK IS SUSPENDED DURING THE WINTER MONTHS THE CONTRACTOR MUST CONTINUE TO PROVIDE PERSONNEL AND EQUIPMENT EITHER ON SITE OR READILY AVAILABLE TO PROPERLY MAINTAIN AND REPAIR ALL EROSION AND SEDIMENTATION CONTROL DEVICES IN A TIMELY AND RESPONSIBLE MANNER.
15. CONTROL DUST BY WATERING OR OTHER APPROVED METHODS AS NECESSARY, OR AS DIRECTED BY THE ENGINEER.
16. SEDIMENT MANAGEMENT TO BE DETERMINED IN CONSULTATION WITH MASSDEP DURING PERMITTING PROCESS.

Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com
90 Route 6A, Unit 1
Sandwich, MA 02563
Phone: (508) 833-6600
Fax: (508) 833-3150

Date:	Designed By:	Drawn By:	Checked By:
JUNE 2024	AS/JMP	AS	NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
CONSTRUCTION NOTES

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540
Fax: - -

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
Fax: 508-833-3150
Dated: January 31, 2024

Registration:
DRAFT
NOT FOR CONSTRUCTION

Project Number: 23144
Sheet : 2 of 10
Sheet Number: C-2

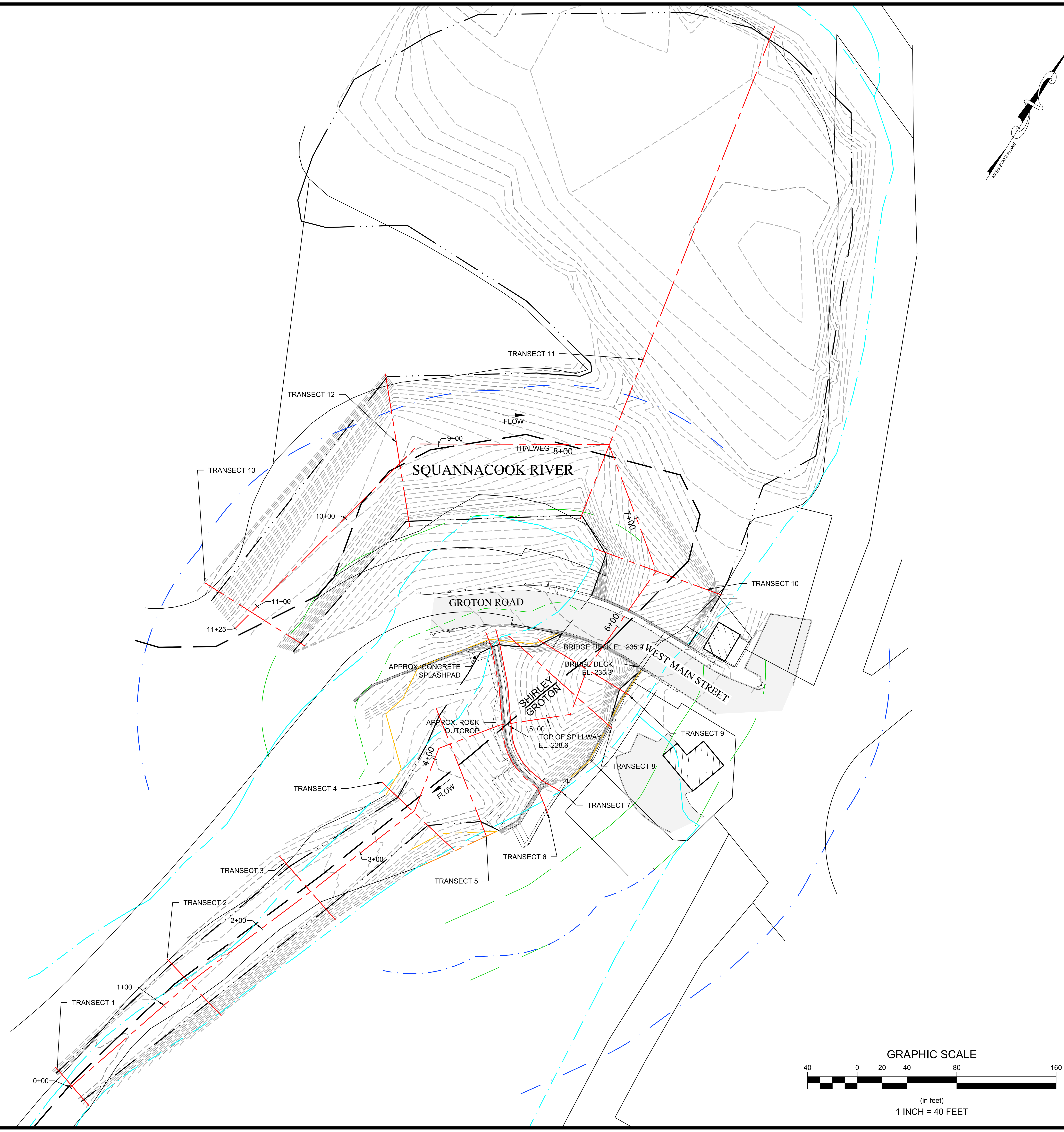
last modified: 06/20/24 printed: 06/20/24 by as H:\Projects\2023\23144 Squanacook River Dam\Drawings\23144 SQUANACOOK CN.dwg

SURVEY NOTES

1. THE TOPOGRAPHY AND EXISTING SITE CONDITIONS DEPICTED HEREON ARE THE RESULT OF AN ON THE GROUND FIELD SURVEY CONDUCTED BY THE HORSLEY WITTEN GROUP, INC. JANUARY 24 AND JANUARY 31, 2024.
2. HORIZONTAL DATUM IS MASS STATE PLANE COORDINATE SYSTEM. DATUM ESTABLISHED BY RTK GPS.
3. THE ELEVATIONS DEPICTED HEREON WERE BASED ON THE NORTH AMERICAN VERTICAL DATUM (NAVD) OF 1988 IN UNITS OF FEET.
4. THE PROPERTY LINES AND RIGHTS OF WAYS DEPICTED ARE APPROXIMATE ONLY.
5. THIS PLAN DOES SHOW EXISTING EASEMENTS. HOWEVER, THIS DOES NOT CONSTITUTE A GUARANTEE THAT THIS PLAN IS A FULL LIST OF EASEMENTS EITHER RECORD OR UNWRITTEN.
6. THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AND STRUCTURES AS SHOWN ON THESE PLANS ARE BASED ON RECORDS OF VARIOUS UTILITY COMPANIES, AND WHEREVER POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THIS INFORMATION IS NOT TO BE RELIED UPON AS BEING EXACT OR COMPLETE. THE LOCATION OF ALL UNDERGROUND UTILITIES AND STRUCTURES SHALL BE VERIFIED IN THE FIELD PRIOR TO THE START OF ANY CONSTRUCTION. THE CONTRACTOR MUST CONTACT THE APPROPRIATE UTILITY COMPANY, ANY GOVERNING PERMITTING AUTHORITY IN THE TOWNS OF SHIRLEY AND GROTON, AND "DIGSAFE" (1-888-344-7233) AT LEAST 72 HOURS PRIOR TO ANY EXCAVATION WORK IN PREVIOUSLY UNALTERED AREAS TO REQUEST EXACT FIELD LOCATION OF UTILITIES.
7. UTILITY PROVIDERS: ELECTRIC - MUNICIPAL TELEPHONE - VERIZON CABLE - COMCAST WATER - MUNICIPAL GAS - NATIONAL GRID
8. THE PROPERTY IS LOCATED WITHIN FEMA FLOOD ZONE AE EL. 226.9-236.5 AS SHOWN ON PRELIMINARY PANEL NO. 25017C0182F DATED JUNE 8, 2023.
9. THE WETLAND DELINEATION SHOWN HEREON WAS CONDUCTED BY THE HORSLEY WITTEN GROUP, INC. ON JANUARY 30, 2024.
10. REFERENCE PLANS:
    PLAN TITLED "PROPOSED BRIDGE REPLACEMENT" BY LUCHS ASSOCIATES INC. DATED NOVEMBER 14, 1995.
    PLAN TITLED "EXISTING CONDITIONS PLAN" BY HALEY & ALDRICH DATED FEBRUARY 1, 2013.

LEGEND:

GENERAL		SYMBOLS
	BERM	BENCHMARK
	BUILDING	BOLLARD
44	CONTOUR - MINOR	EM ELECTRIC METER
45	CONTOUR - MAJOR	CATCHBASIN
	CONCRETE	EXISTING TREE
	EDGE OF PAVEMENT	UP1 UTILITY POLE
	FENCE - CHAIN LINK	GUY
X	FENCE - METAL	WF WETLAND FLAG
	GUARD RAIL	SIGN
	STONE	98.45 EXISTING SPOT GRADE
	WALL - RETAINING	
OHW	OVERHEAD WIRE	
PROPERTY INFORMATION		
	PROPERTY LINE (APPROXIMATE)	
	TOWN BOUNDARY	
ENVIRONMENTAL		
	INLAND BANK - GROTON	
	INLAND BANK - MASSACHUSETTS (EQUIVALENT TO ORDINARY HIGH WATER LINE)	
	25' VEGETATED BUFFER	
	50' NO DISTURB BUFFER ZONE	
	100' BUFFER TO INLAND BANK	
	100' RIVERFRONT AREA	
	200' RIVERFRONT AREA	
	FEMA PRELIMINARY FLOOD ZONE	
	EDGE OF WATER	
	CROSS SECTION/LONGITUDINAL PROFILE LINE	



Revisions

Rev.	Date	By	Appr.	Description
1	---	---	---	---
2	---	---	---	---
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5	---	---	---	---
6	---	---	---	---
7	---	---	---	---

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
www.horsleywitten.com
508-833-6600

Date: JUNE 2024 | Designed By: AS/JMP | Drawn By: AS | Checked By: NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANNACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
OVERALL EXISTING CONDITIONS

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600

Dated: January 31, 2024

Registration:
DRAFT NOT FOR CONSTRUCTION

Project Number: 23144 | Sheet: 3 of 10

Sheet Number: EX - 3

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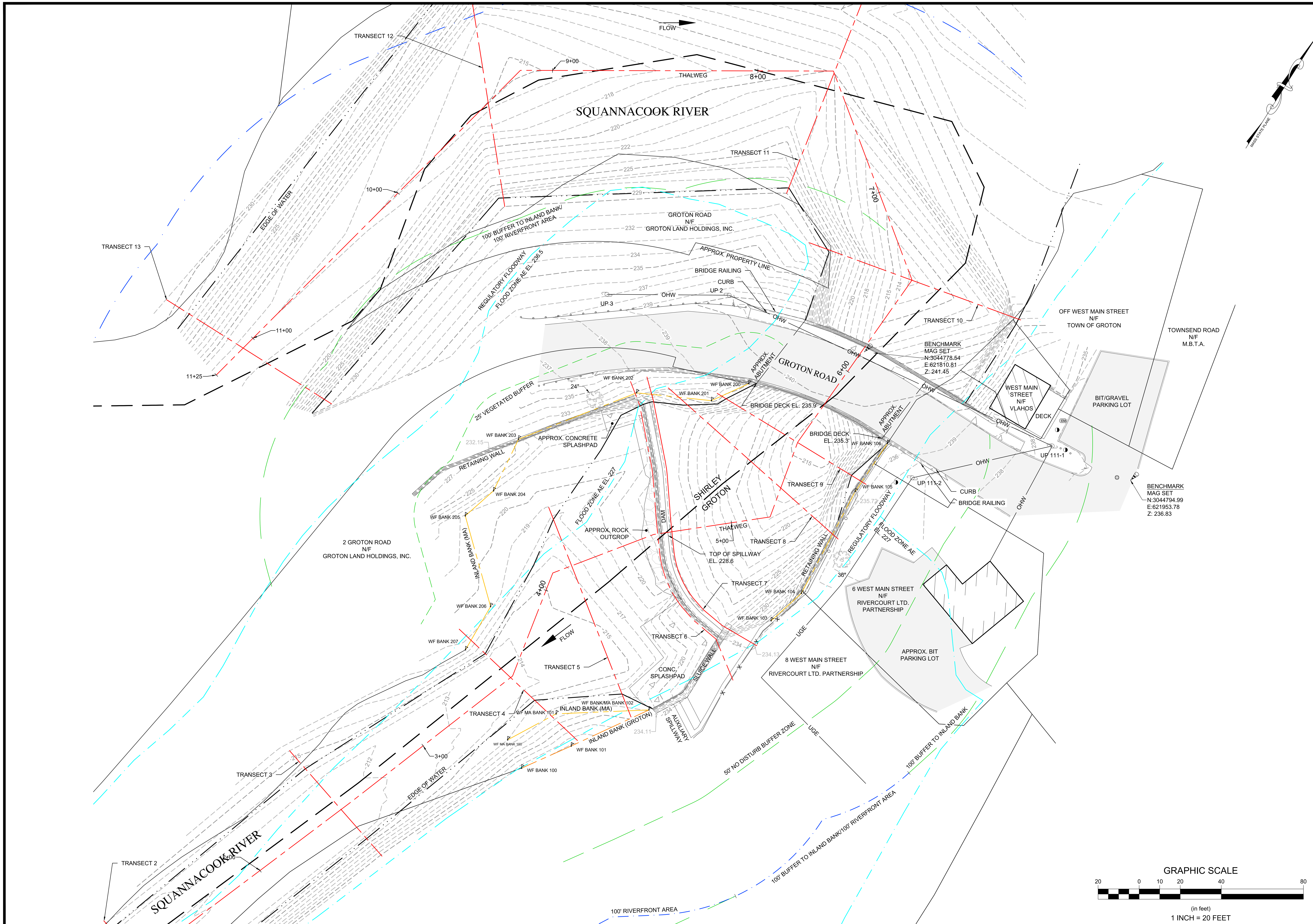
last modified: 06/19/24 printed: 06/20/24 by as



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Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
www.horsleywitten.com
508-833-6600

Date: JUNE 2024
Designed By: AS/JMP
Drawn By: AS
Checked By: NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN SQUANNACOOK RIVER DAM GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
EXISTING CONDITIONS

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540

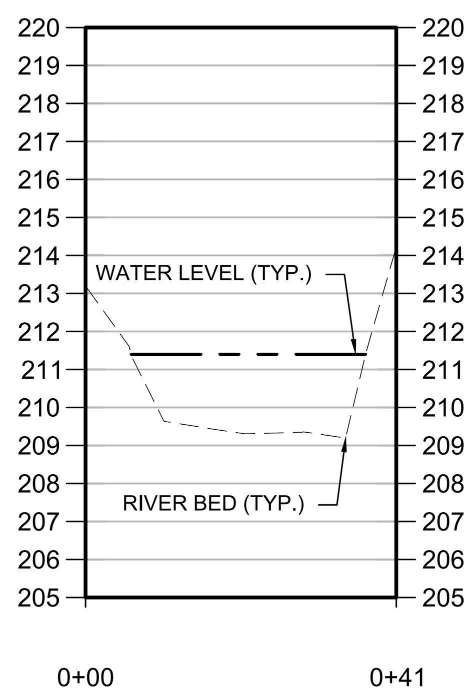
Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
Dated: January 31, 2024

Registration:
DRAFT
NOT FOR CONSTRUCTION

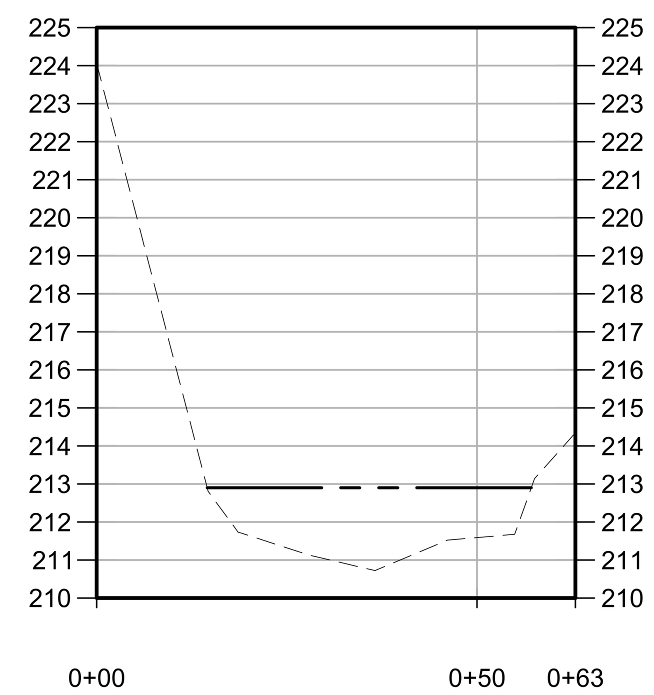
Project Number: 23144
Sheet: 4 of 10
Sheet Number: EX - 4

LEGEND

(dashed line)	RIVER BED
(dashed line)	WATER LEVEL (JANUARY 30, 2024)
(dashed line)	DEPTH TO REFUSAL



TRANSECT 1 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'



TRANSECT 2 PROFILE
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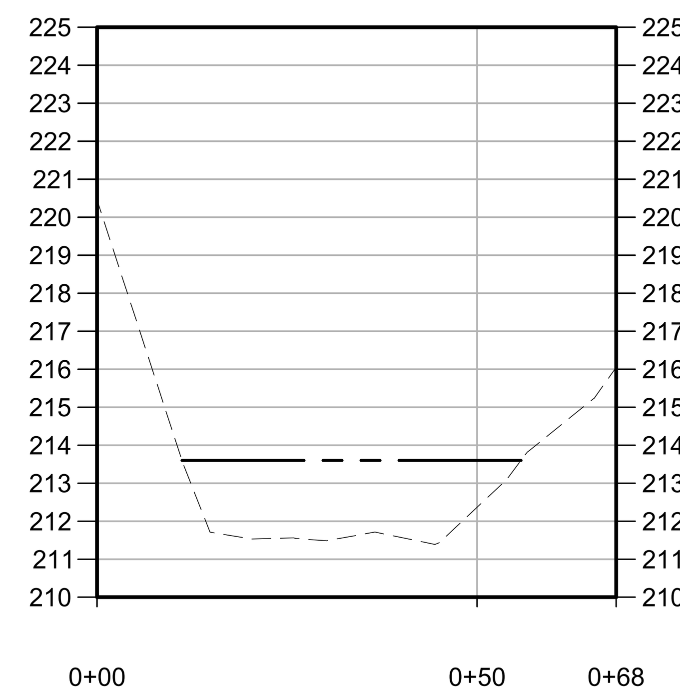
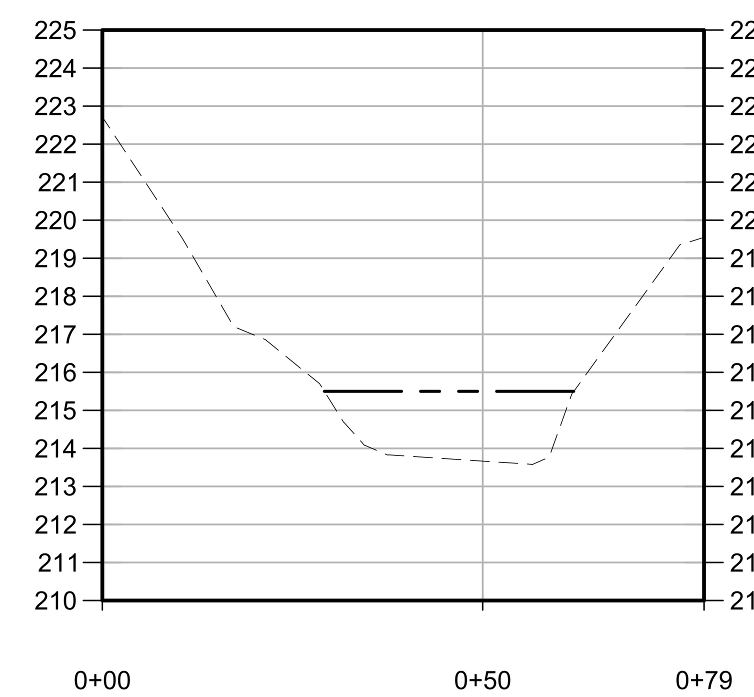
VERTICAL SCALE: 1" = 8'



TRANSECT 3 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'



TRANSECT 4 PROFILE
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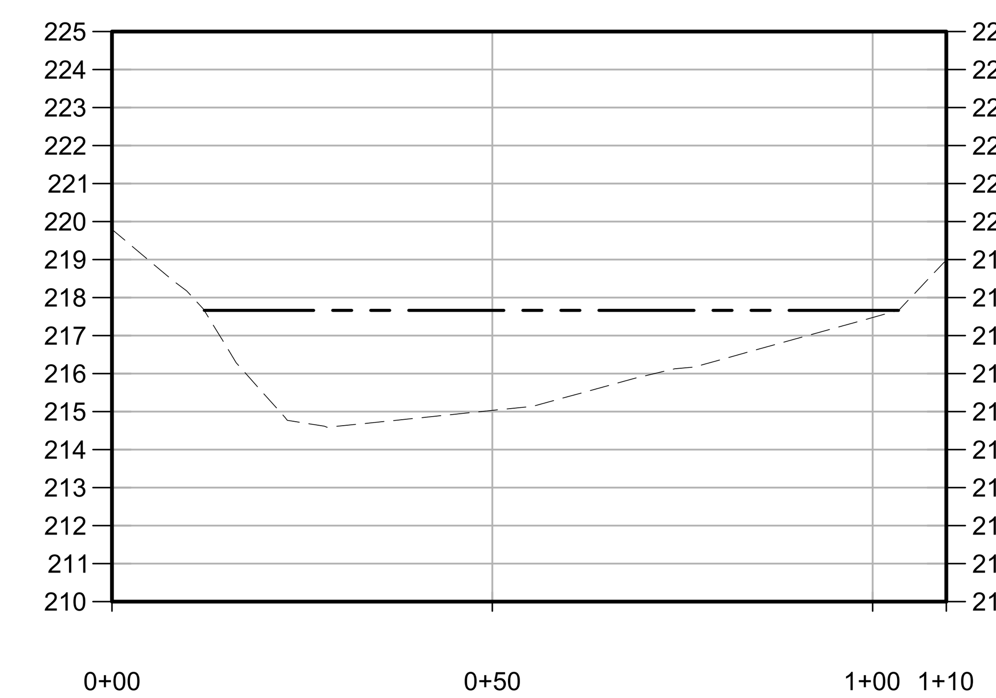
VERTICAL SCALE: 1" = 8'



TRANSECT 5 PROFILE
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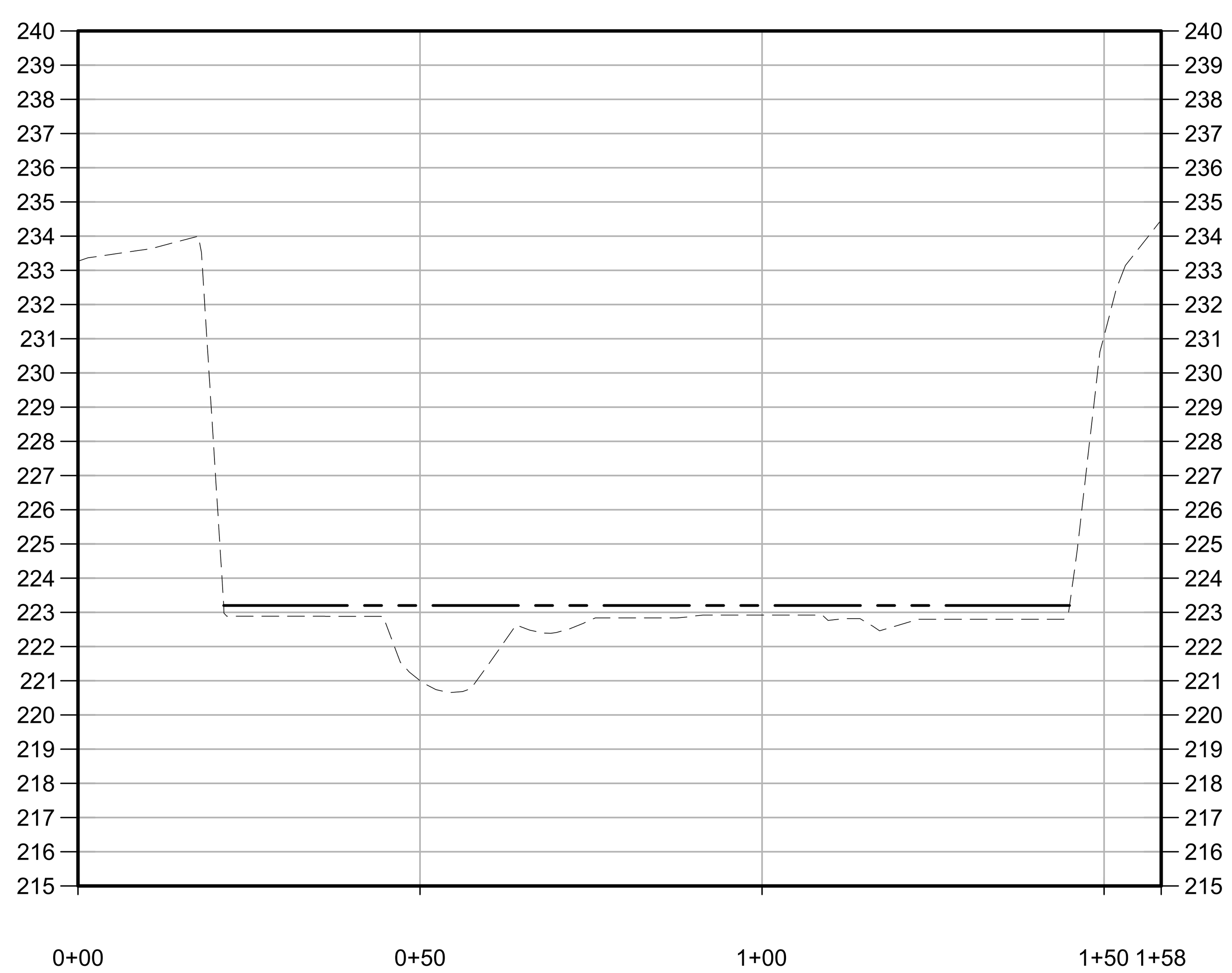
VERTICAL SCALE: 1" = 8'



TRANSECT 6 PROFILE
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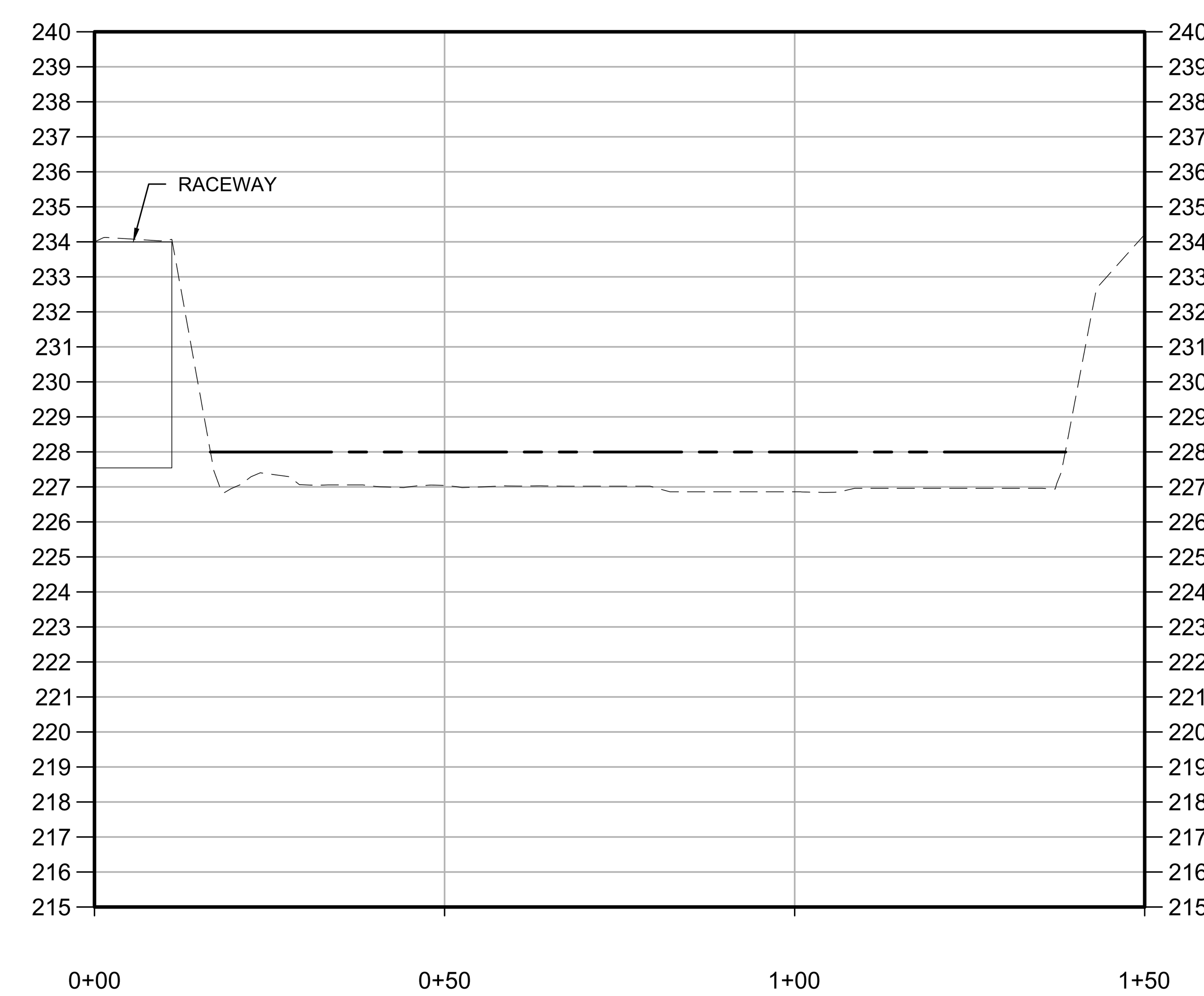
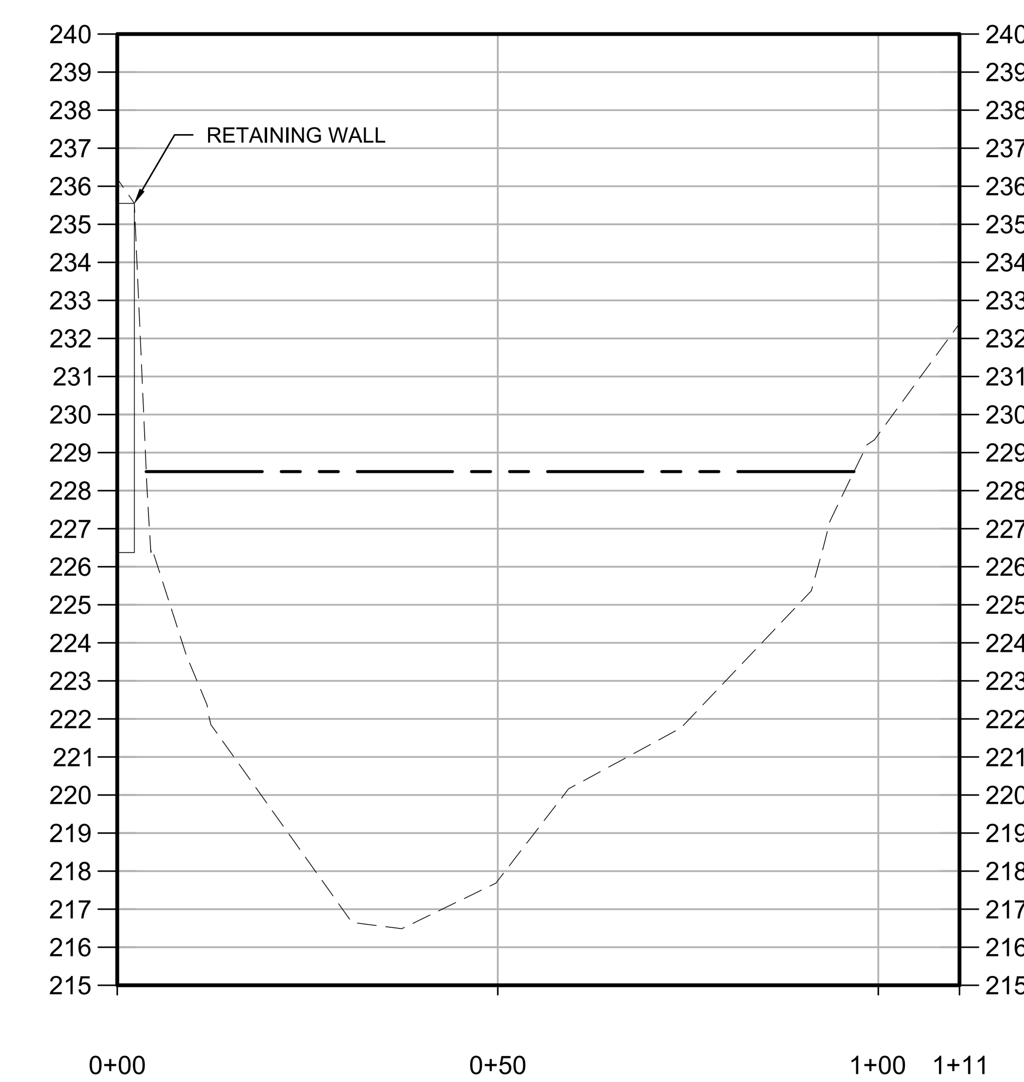
VERTICAL SCALE: 1" = 8'



TRANSECT 7 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'



TRANSECT 8 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'

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last modified: 06/19/24 printed: 06/20/24 by as

Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
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508-833-6600

Date: JUNE 2024
Designed By: AS/JMP
Drawn By: AS
Checked By: NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
CROSS SECTIONS (1)

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540

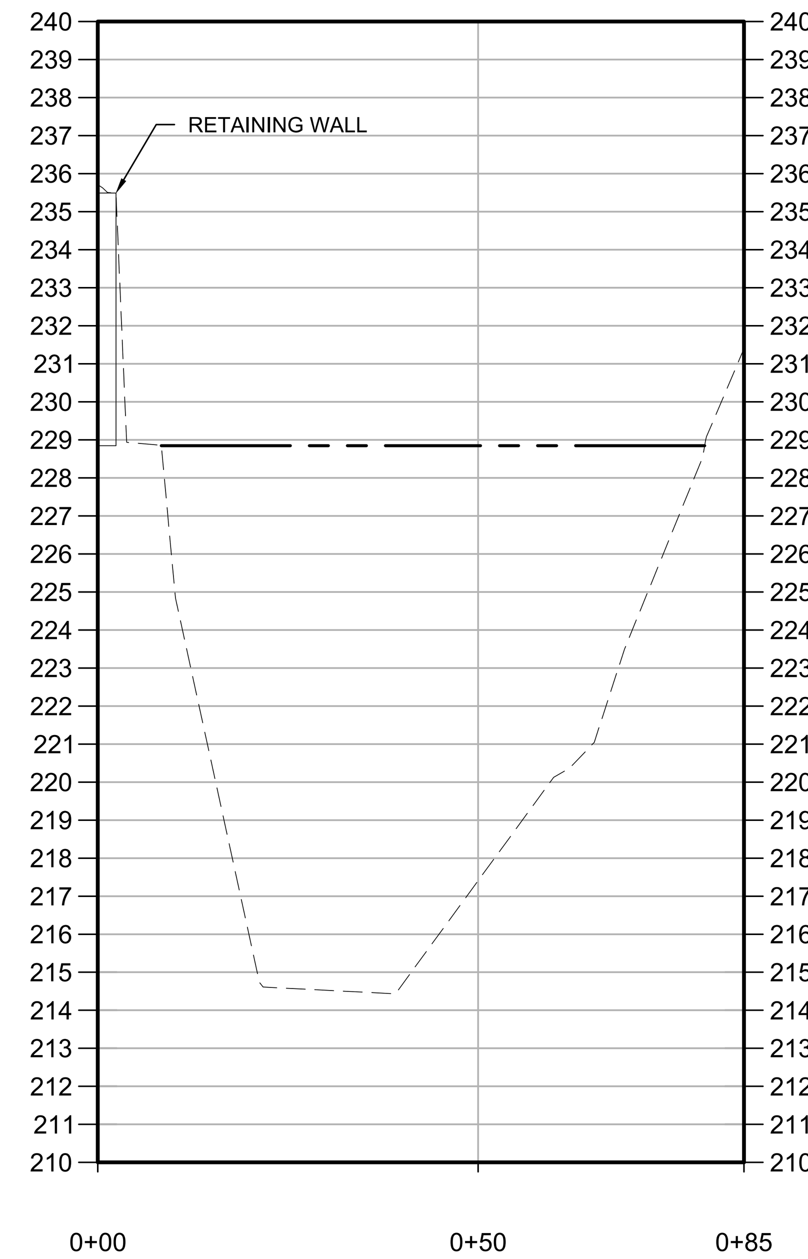
Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
Dated: January 31, 2024

Registration:
DRAFT
NOT FOR CONSTRUCTION

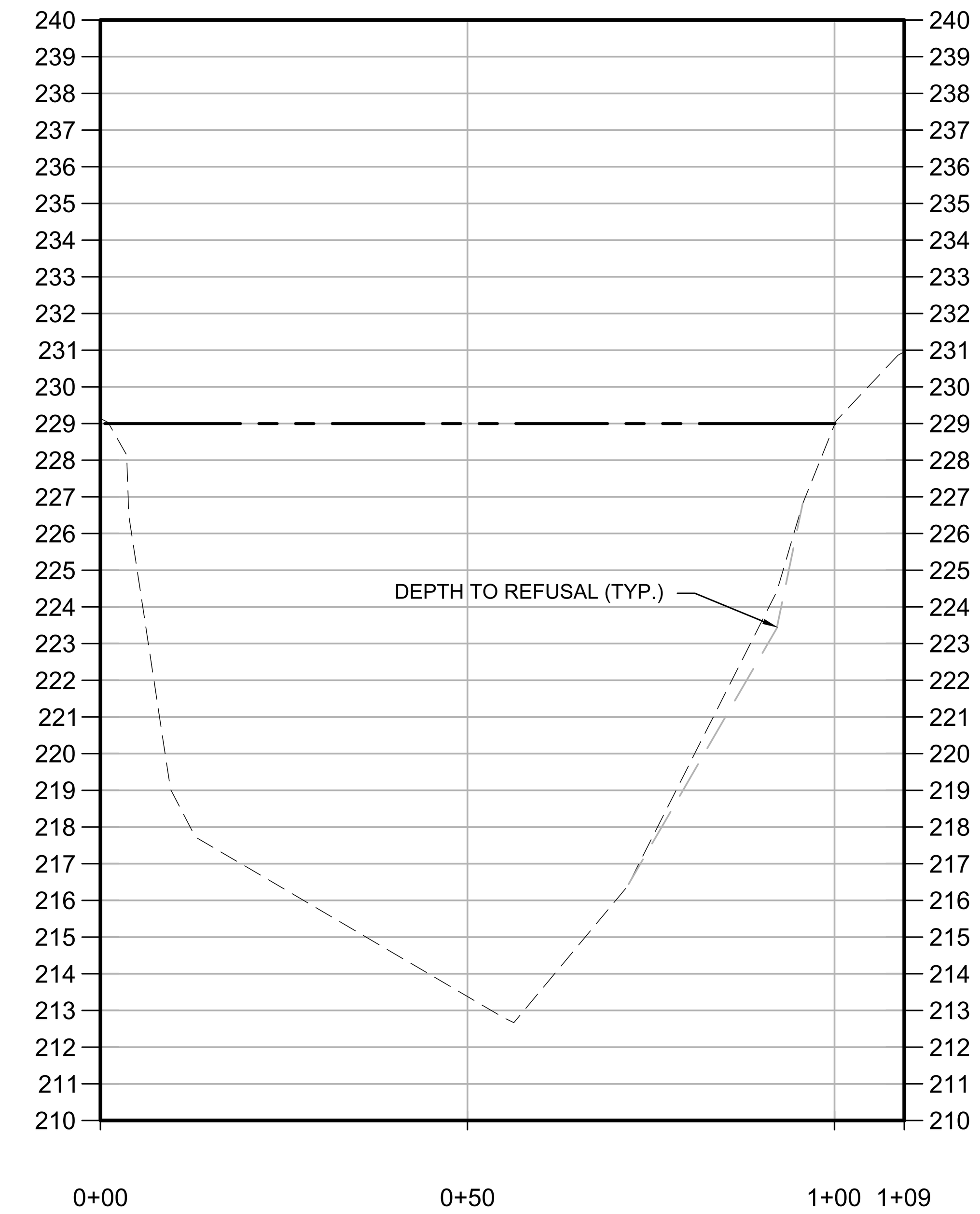
Project Number: 23144
Sheet: 5 of 10
Sheet Number: EX - 5

LEGEND

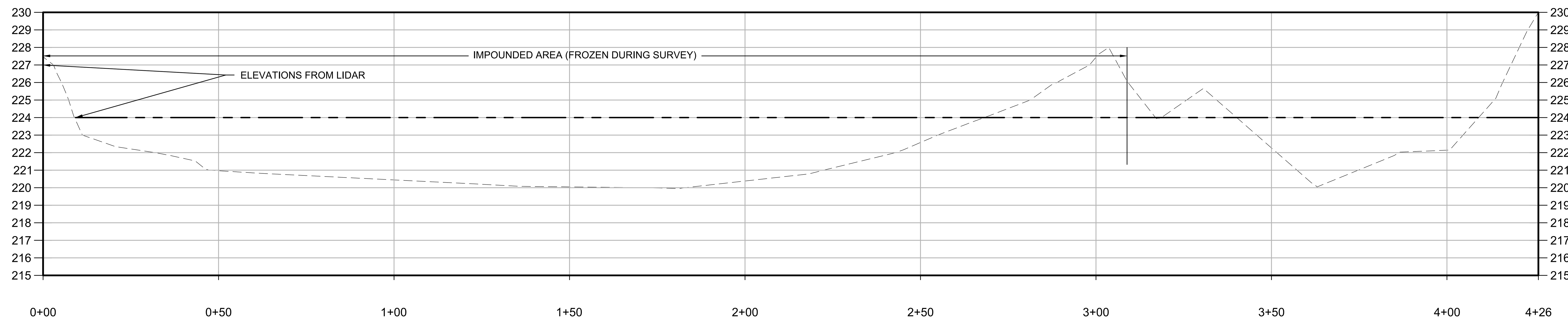
(dashed line)	RIVER BED
(dash-dot line)	WATER LEVEL (JANUARY 30, 2024)
(long dashed line)	DEPTH TO REFUSAL



TRANSECT 9 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'



TRANSECT 10 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'



TRANSECT 11 PROFILE
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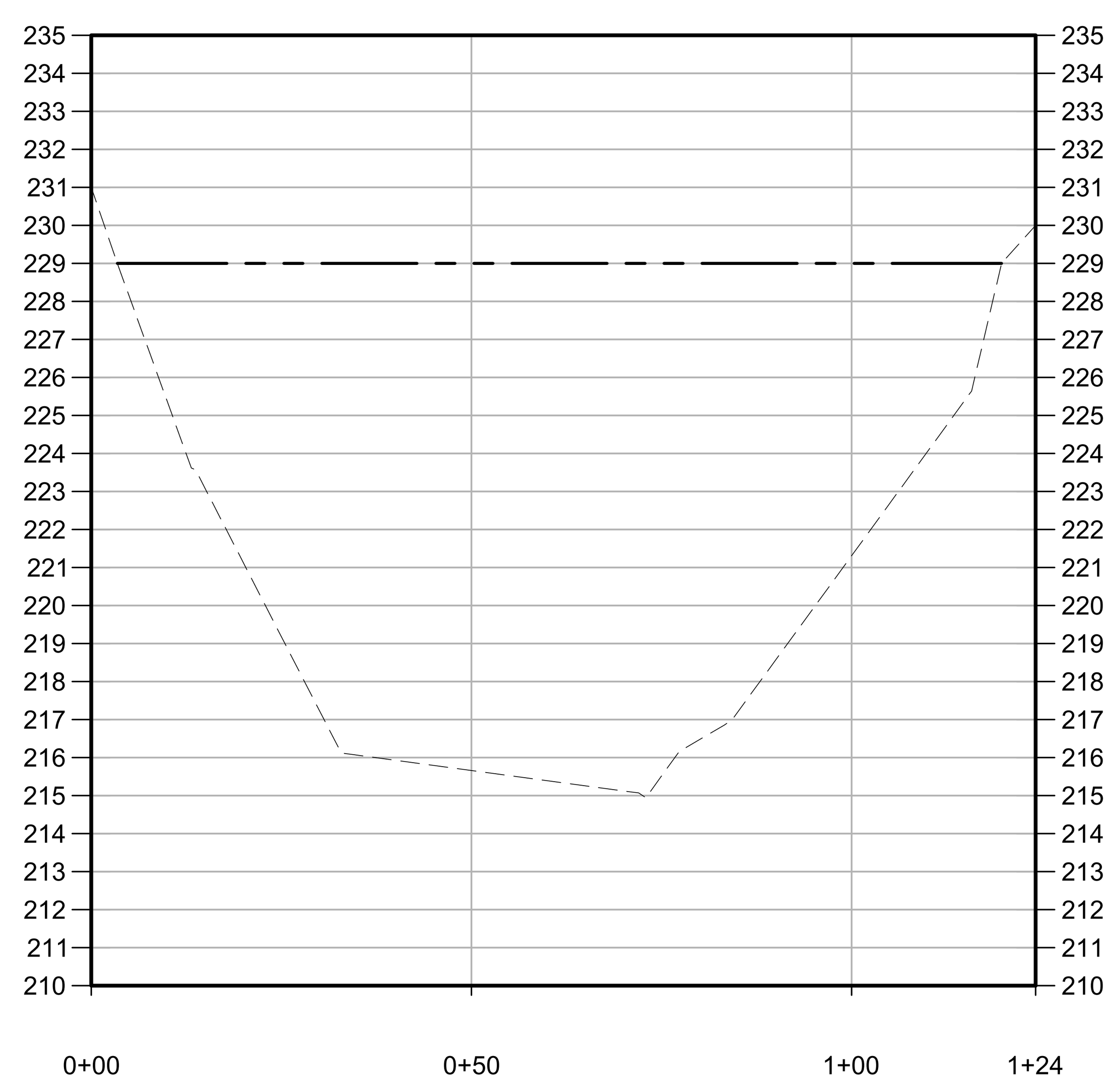
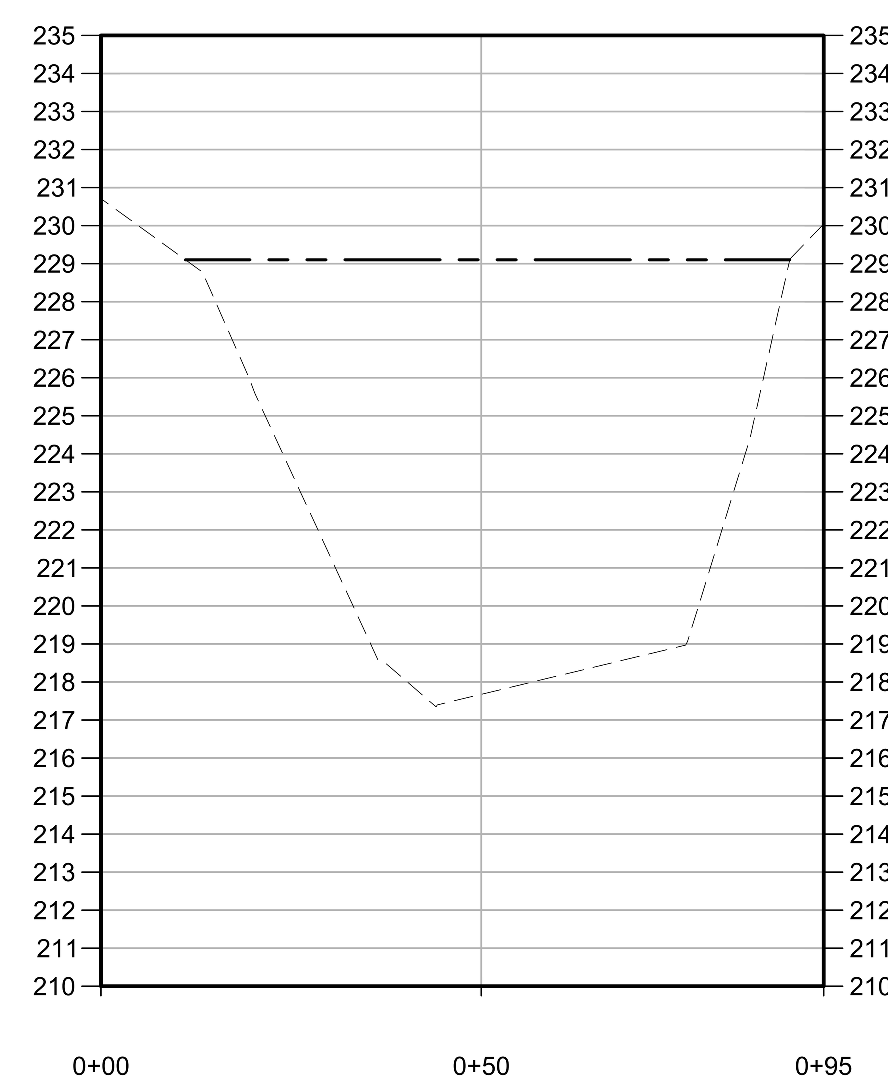
VERTICAL SCALE: 1" = 8'



TRANSECT 12 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'



TRANSECT 13 PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'

Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
90 Route 6A Sandwich, MA 02563
www.horsleywitten.com
508-833-6600

Date: JUNE 2024
Designed By: AS/JMP
Drawn By: AS
Checked By: NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
CROSS SECTIONS (2)

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
Dated: January 31, 2024

Registration:
DRAFT
NOT FOR CONSTRUCTION

Project Number: 23144
Sheet: 6 of 10
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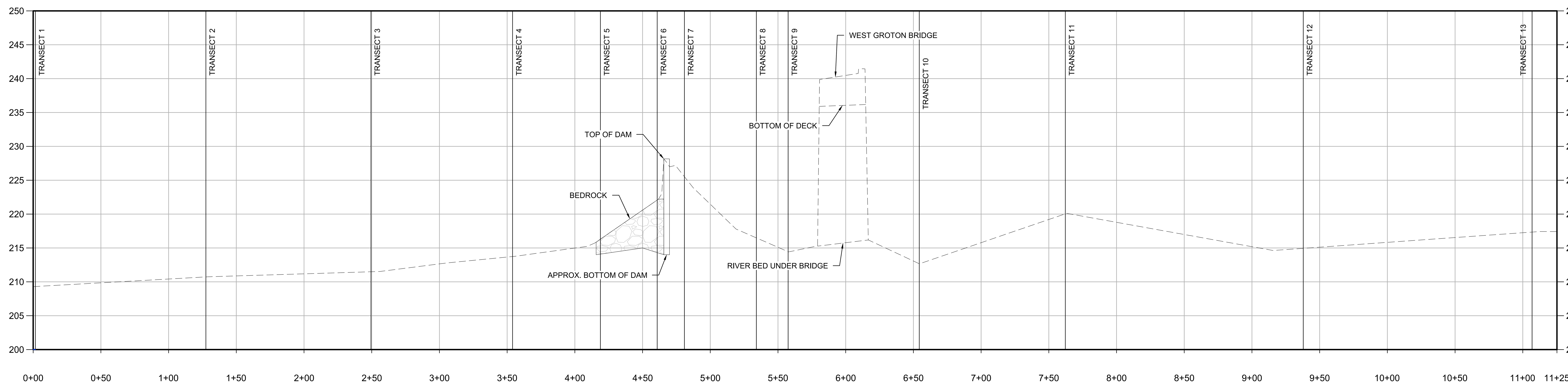
LEGEND

RIVER BED (DEPTH OF REFUSAL)



LONGITUDINAL PPROFILE PROFILE
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 8'

last modified: 06/19/24 printed: 06/20/24 by as H:\Projects\2023\23144 Squanacook River Dam\Drawings\23144 SQUANACOOK EX.dwg

Revisions

Rev.	Date	By	Appr.	Description
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Horsley Witten Group, Inc.
Sustainable Environmental Solutions
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Date: JUNE 2024
Designed By: AS/JMP
Drawn By: AS
Checked By: NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
LONGITUDINAL PROFILE

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
Dated: January 31, 2024

Registration:

DRAFT
NOT FOR CONSTRUCTION

Project Number: 23144
Sheet: 7 of 10
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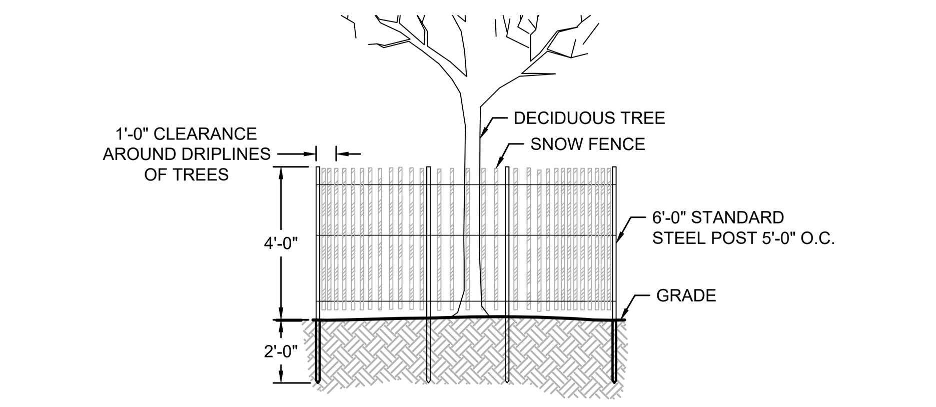
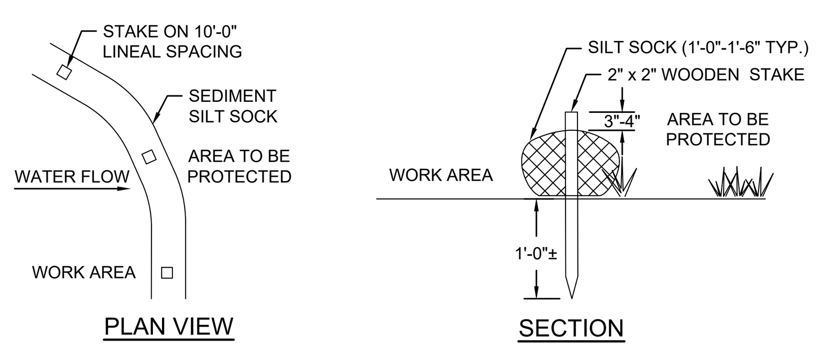


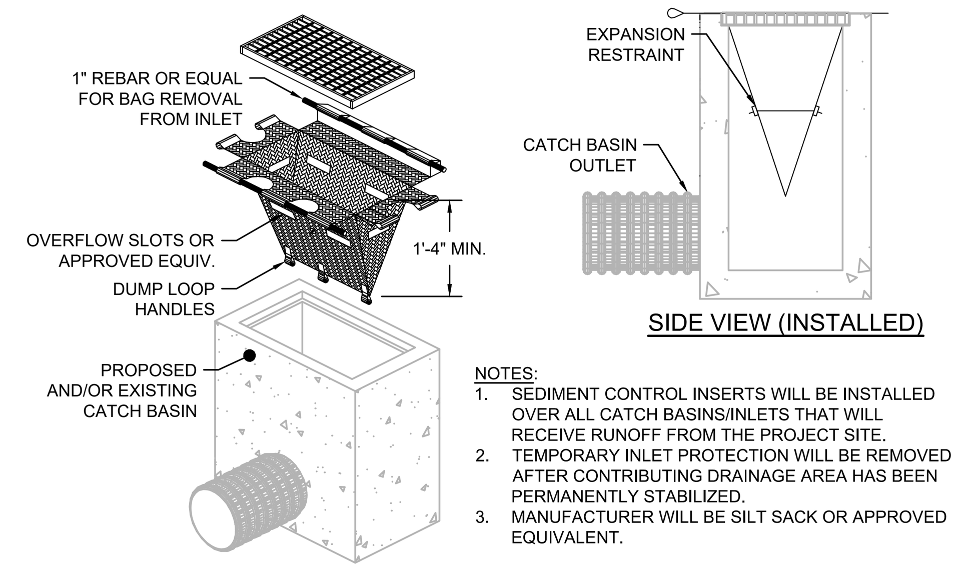
NOTES:
1. FENCING WILL BE ORANGE RESINET SM60 BARRIER FENCE "SNOW FENCE" OR APPROVED EQUIVALENT.
2. POST WILL BE HOT ROLLED RAIL STEEL & FORMED INTO A "T". DIMENSIONS OF "T" POST SECTION WILL BE APPROXIMATELY 1 7/16" X 1 5/16" X 1/8" X 6' (SIX FEET) LONG. THE POST WILL BE PAINTED GREEN OR GALVANIZED.
3. THE FENCING WILL REMAIN IN PLACE UNTIL ALL EXCAVATION HAS BEEN COMPLETED & THE SURFACE HAS BEEN RE-ESTABLISHED

TREE PROTECTION
NOT TO SCALE



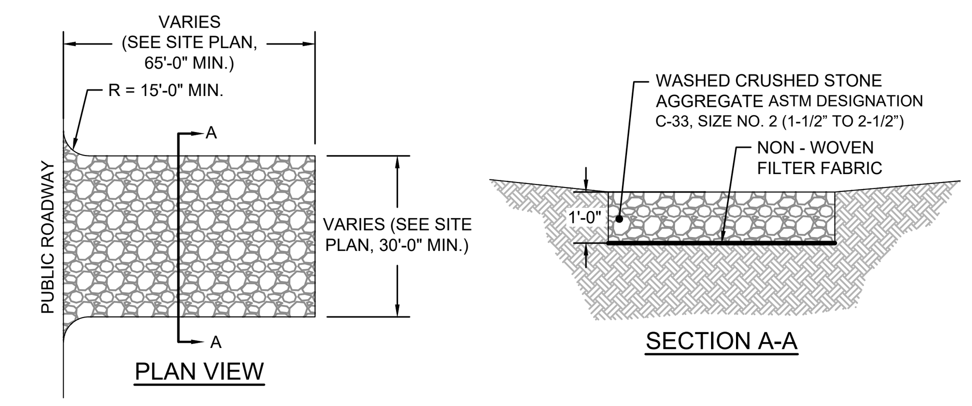
NOTES:
1. SILT SOCK MANUFACTURER WILL BE SILT SOXX OR ENGINEER APPROVED EQUAL.
2. ALL MATERIAL WILL MEET MANUFACTURER'S SPECIFICATIONS.
3. SEDIMENT SILT SOCK WILL BE FILLED WITH LEAF COMPOST AND/OR WOODY MULCH PER MANUFACTURER'S REQUIREMENTS.
4. FOLLOWING CONSTRUCTION & SITE STABILIZATION, COMPOST MATERIAL WILL BE REMOVED OR DISPERSED ON SITE, AS APPROVED BY THE ENGINEER.

SILT SOCK
NOT TO SCALE



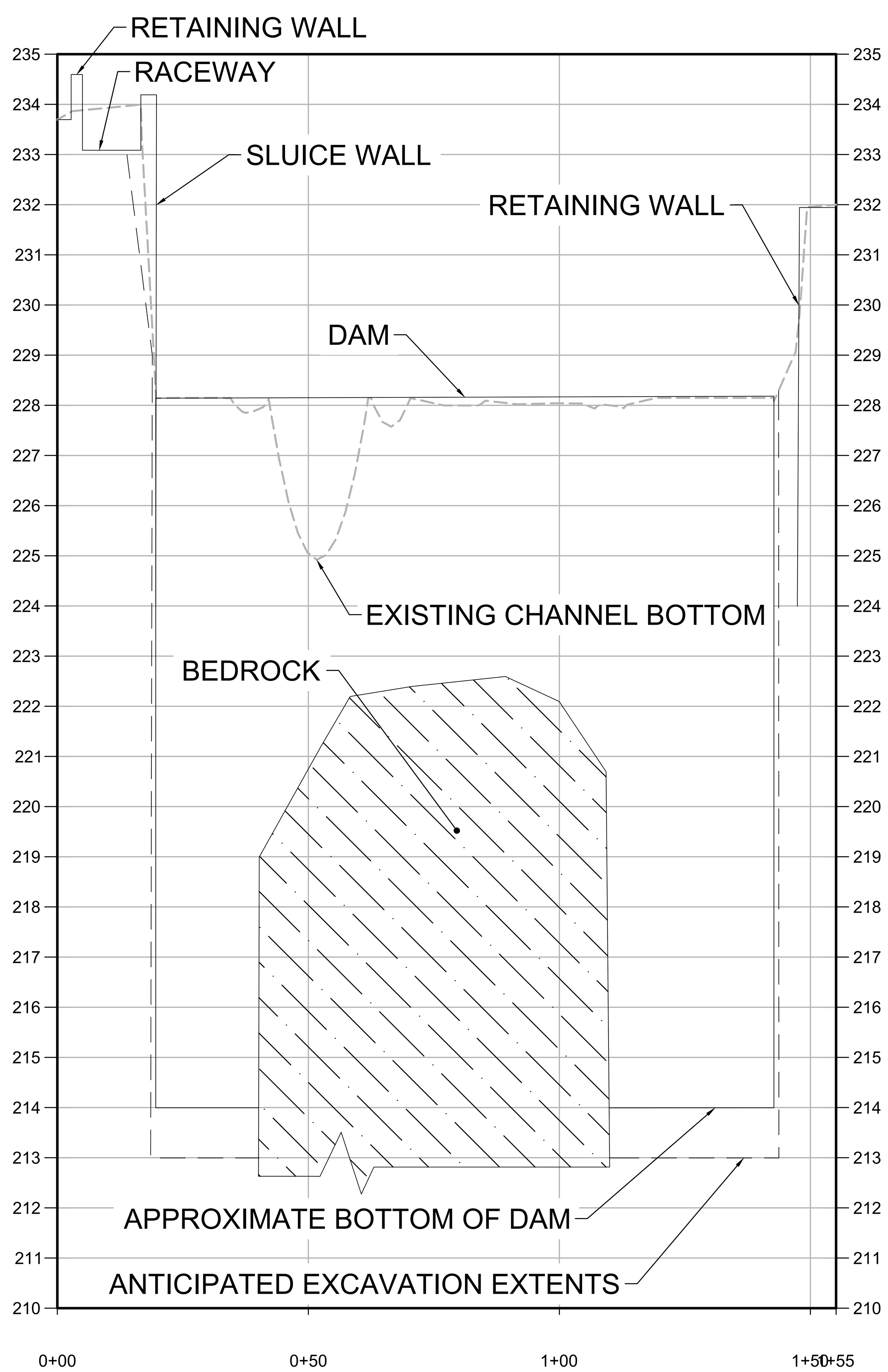
NOTES:
1. SEDIMENT CONTROL INSERTS WILL BE INSTALLED OVER ALL CATCH BASINS/INLETS THAT WILL RECEIVE RUNOFF FROM THE PROJECT SITE.
2. TEMPORARY INLET PROTECTION WILL BE REMOVED AFTER CONTRIBUTING DRAINAGE AREA HAS BEEN PERMANENTLY STABILIZED.
3. MANUFACTURER WILL BE SILT SACK OR APPROVED EQUIVALENT.

INLET PROTECTION
NOT TO SCALE

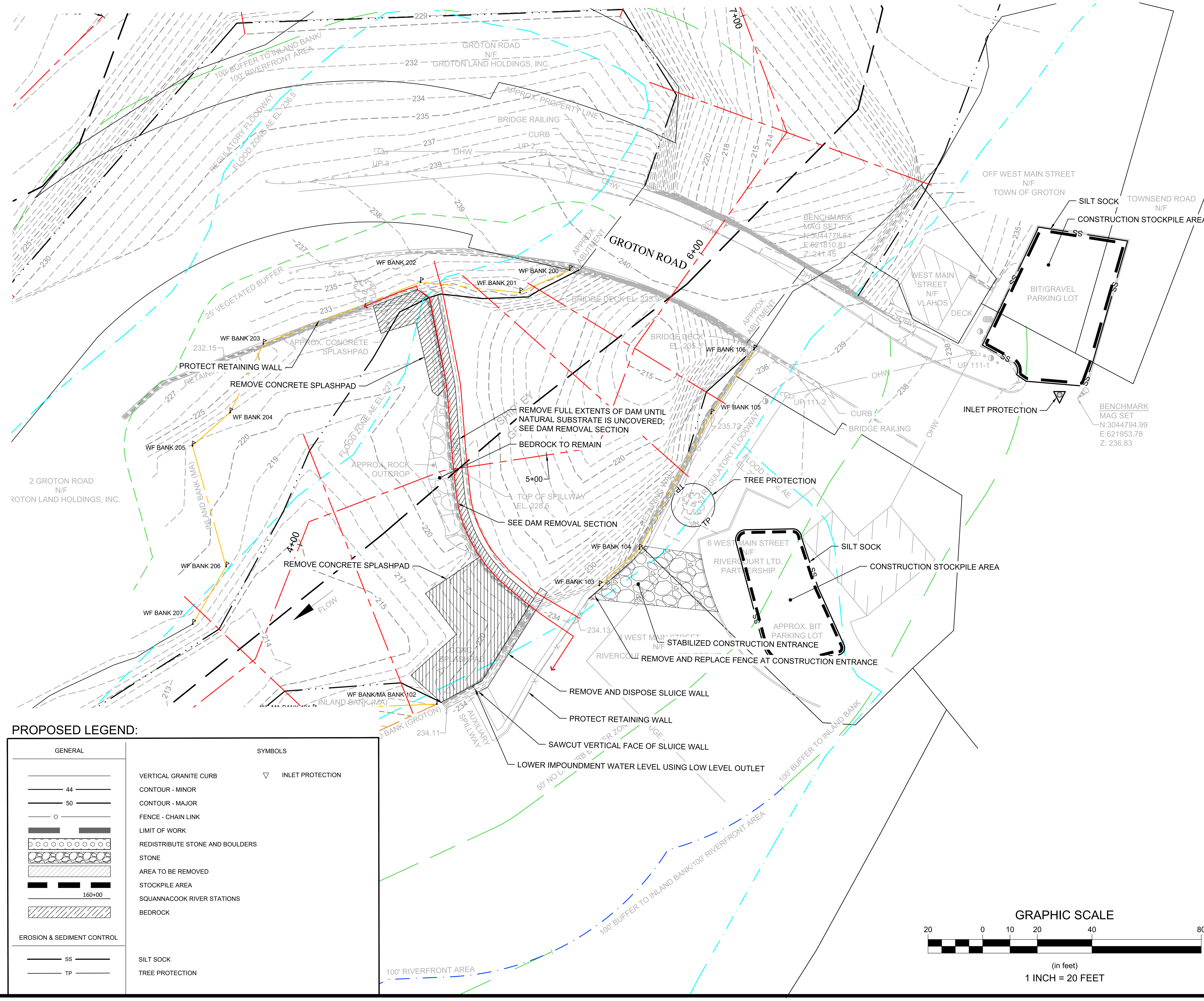


NOTES:
1. STONE CONSTRUCTION ENTRANCE(S) WILL REMAIN UNTIL INSTALLATION OF PAVEMENT SUB-BASE IS SET TO BEGIN.
2. SEE SITE PLAN FOR LOCATION & ACTUAL DIMENSIONS

STABILIZED STONE CONSTRUCTION ENTRANCE
NOT TO SCALE



DAM REMOVAL SECTION
HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'



PROPOSED LEGEND:

GENERAL	SYMBOLS
VERTICAL GRANITE CURB	INLET PROTECTION
CONTOUR - MINOR	
CONTOUR - MAJOR	
FENCE - CHAIN LINK	
LIMIT OF WORK	
REDISTRIBUTE STONE AND BOULDERS	
STONE	
AREA TO BE REMOVED	
STOCKPILE AREA	
SQUANNACOOK RIVER STATIONS	
BEDROCK	
EROSION & SEDIMENT CONTROL	
SILT SOCK	
TREE PROTECTION	

Revisions

Rev.	Date	By	Appr.	Description
1				
2				
3				
4				
5				
6				
7				

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com
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Sandwich, MA 02563
Phone: (508) 833-6600
Fax: (508) 833-3150

Date: JUNE 2024 | Designed By: AS/JMP | Drawn By: AS | Checked By: NP

Plan Set: DAM REMOVAL - PRELIMINARY DESIGN
SQUANNACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title: SITE PREPARATION AND DEMOLITION PLAN

Prepared For: Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540
Fax: - -

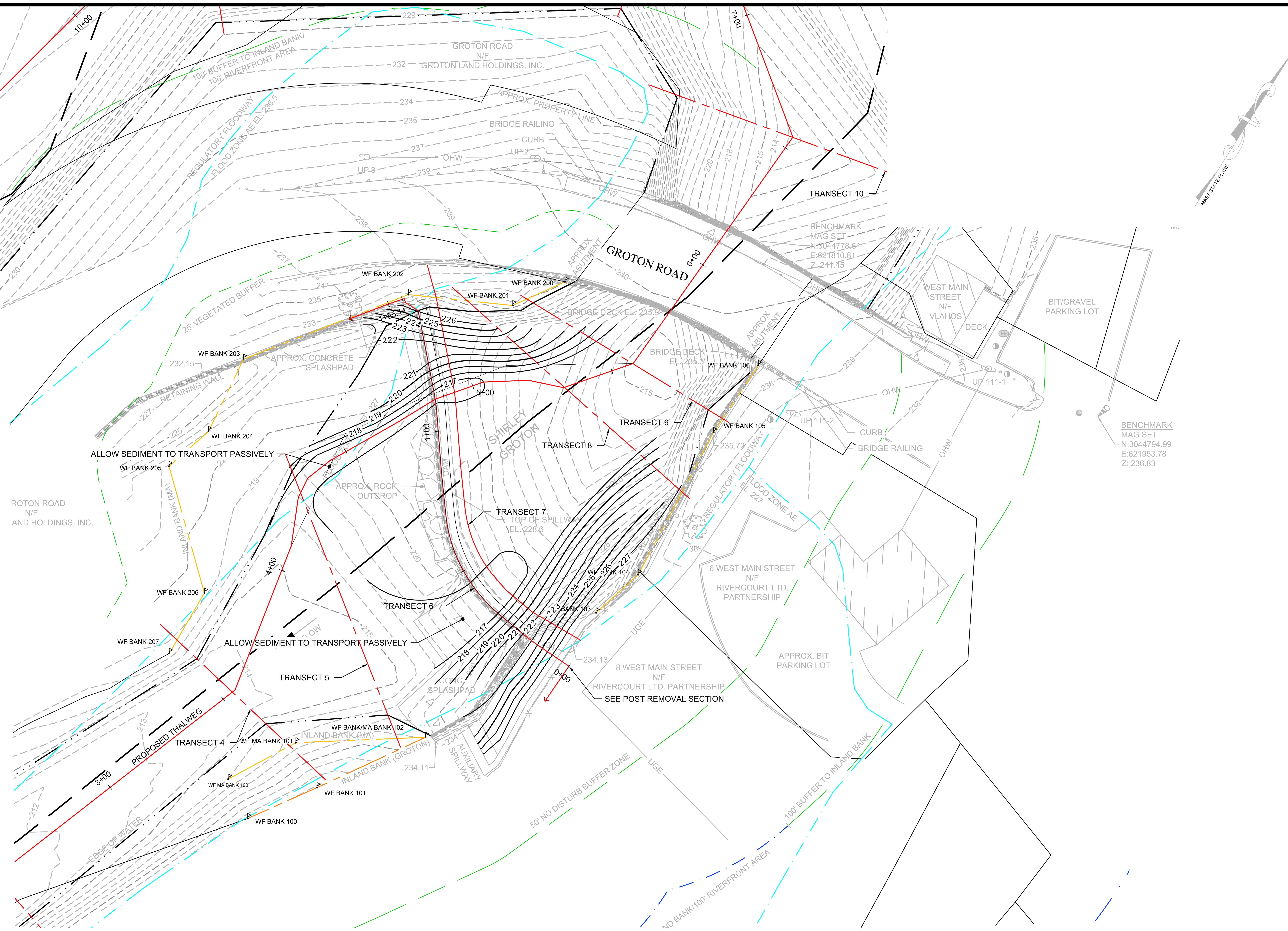
Survey Provided By: Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
Fax: 508-833-3150
Dated: January 31, 2024

Registration:
DRAFT NOT FOR CONSTRUCTION

Project Number: 23144
Sheet: 8 of 10
Sheet Number: C-8

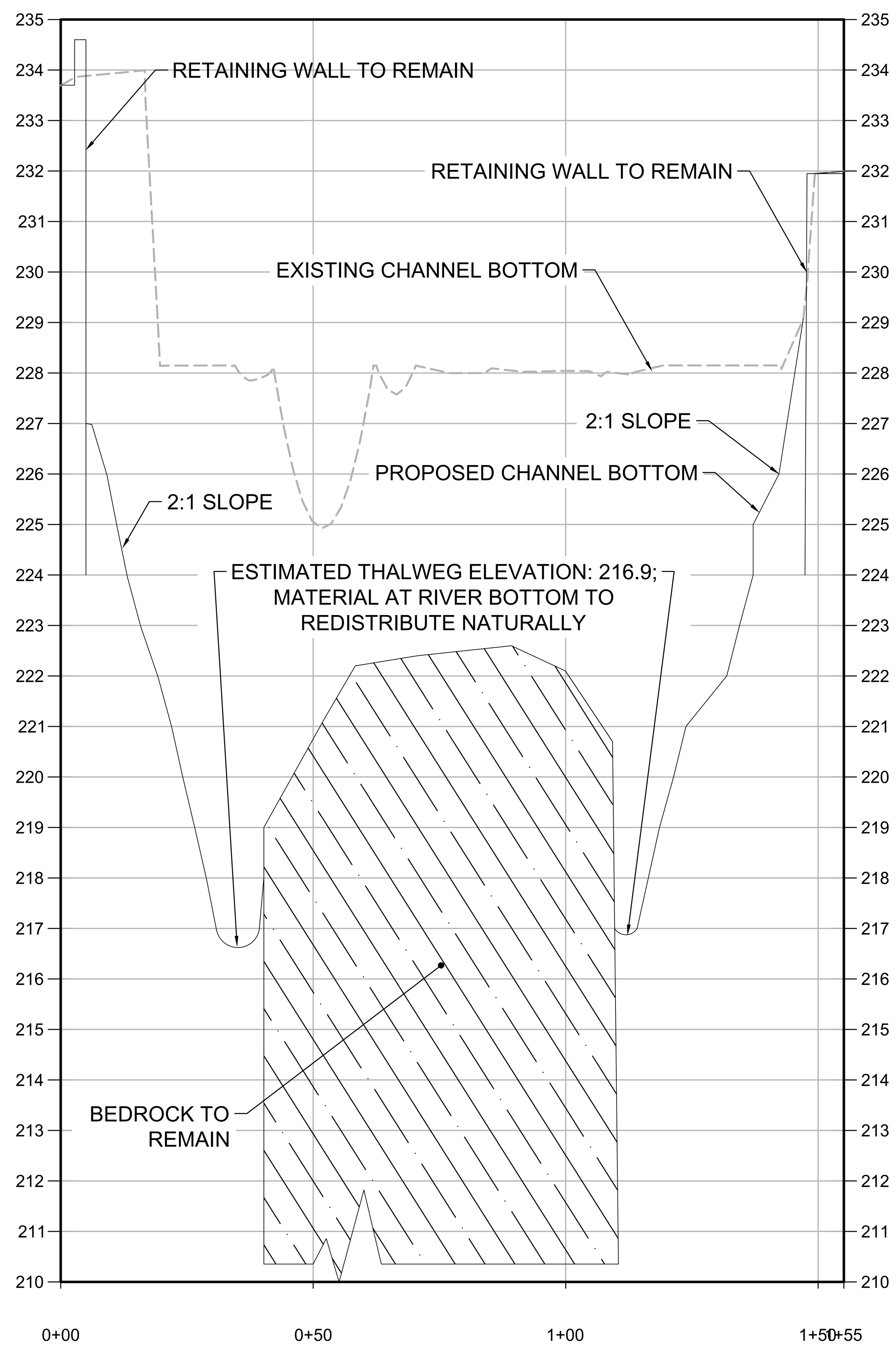
last modified: 06/19/24 printed: 06/20/24 by as H:\Projects\2023\23144 Squanacook River Dam\Drawings\23144 SQUANACOOK ESC.dwg

NOTES:
1. GRADING SHOWN BELOW INDICATES HYPOTHETICAL RIVER CHANNEL BATHYMETRY POST-DAM REMOVAL. GRADES DO NOT INDICATE WORK TO BE DONE IN CHANNEL.

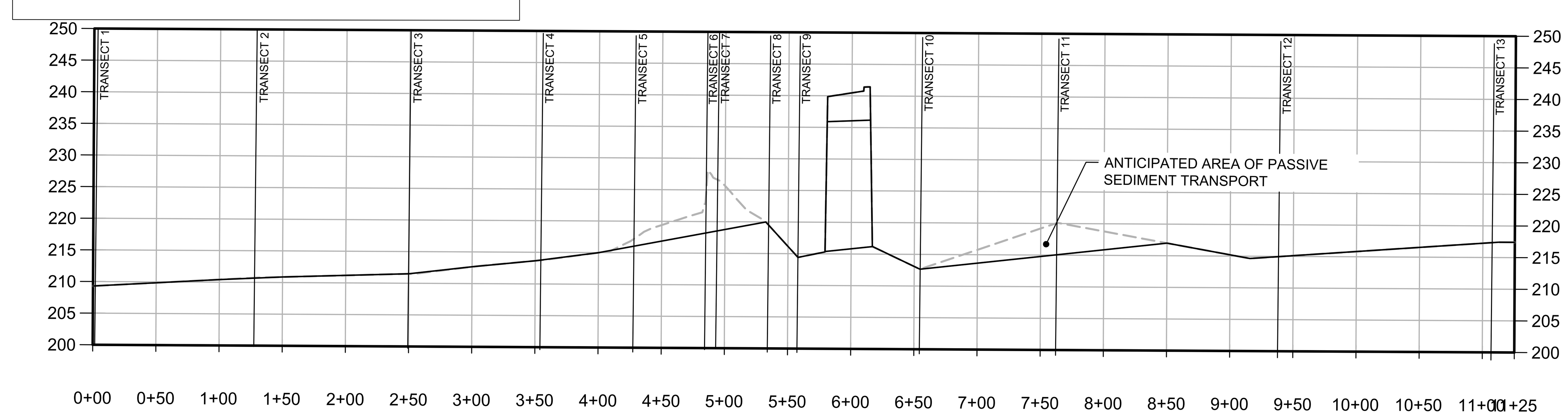


LEGEND

- - - -	EXISTING RIVER BED (DEPTH OF REFUSAL)
———	PROPOSED RIVER BED

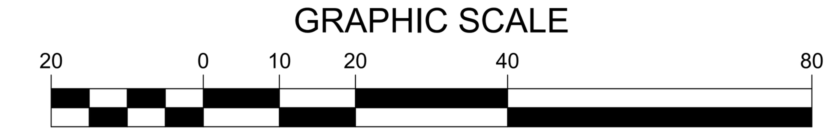


POST-REMOVAL SECTION
HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'



PROPOSED LONGITUDINAL PROFILE
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 16'

GRAPHIC SCALE



(in feet)
1 INCH = 20 FEET

Revisions

Rev.	Date	By	Appr.	Description

Horsley Witten Group, Inc.
Sustainable Environmental Solutions
www.horsleywitten.com
90 Route 6A, Unit 1
Sandwich, MA 02563
Phone: (508) 833-6600
Fax: (508) 833-3150

Checked By: NP
Drawn By: AS
Designed By: AS/JMP
Date: JUNE 2024

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
SITE LAYOUT PLAN

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540
Fax: -

Survey Provided By:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02536
Phone: 508-833-6600
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Dated: January 31, 2024

Registration:

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Project Number: 23144
Sheet: 9 of 10
Sheet Number: C-9

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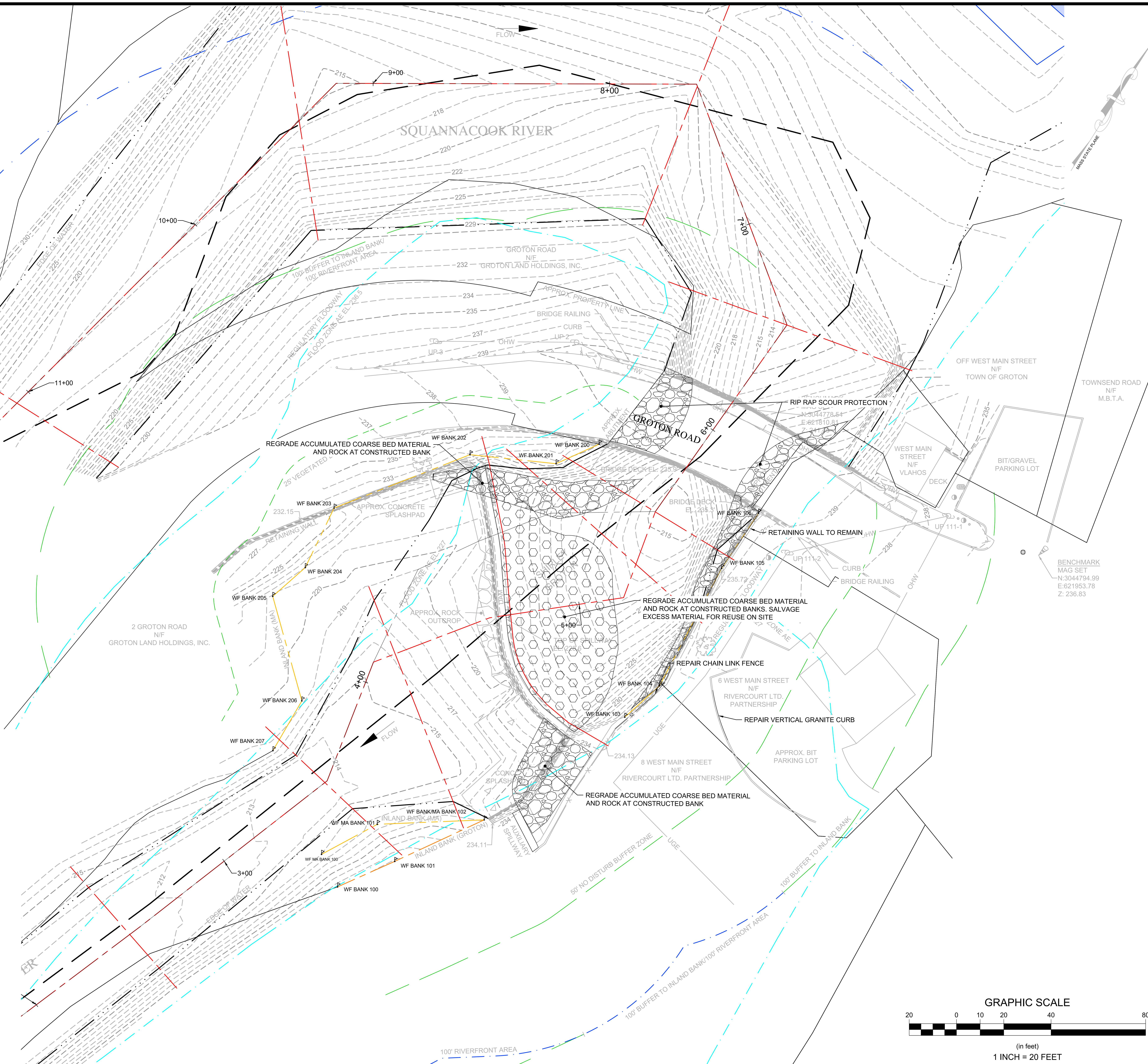

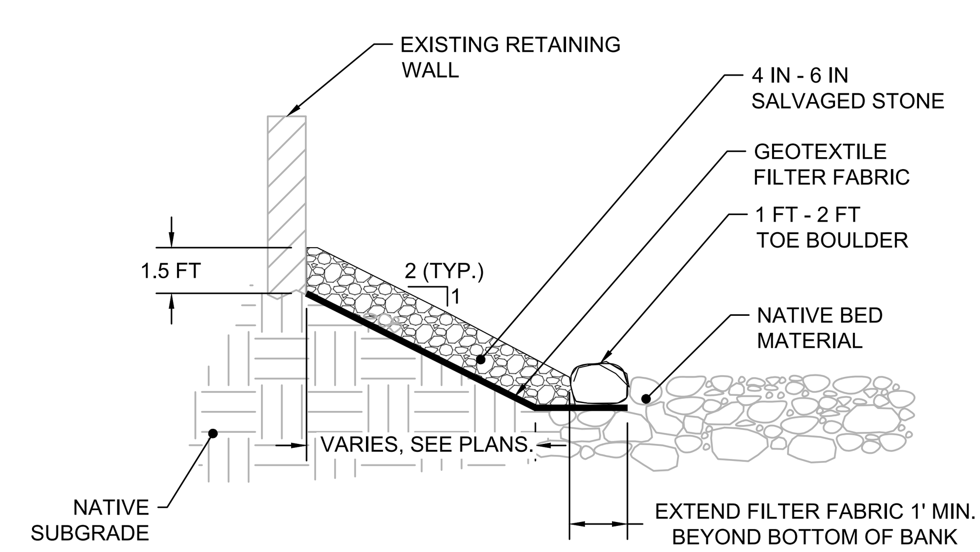

SECTION VIEW

NOTES:
1. CONSTRUCT ROCK TOE WITH SALVAGED ROCK ACCEPTED FOR RE-USE ONLY BY THE ENGINEER OR WITH ROUNDED TO SUBANGULAR STONE.
2. D50 OF ALL SALVAGED ROCK TO BE 4" OR LARGER.

CONSTRUCTED BANK
NOT TO SCALE

GRAPHIC SCALE
20 0 10 20 40 80
(in feet)
1 INCH = 20 FEET

Revisions

Rev.	Date	By	Appr.	Description
1				
2				
3				
4				
5				
6				
7				

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Date: JUNE 2024
Designed By: AS/JMP
Drawn By: AS
Checked By: NP

Plan Set:
DAM REMOVAL - PRELIMINARY DESIGN
SQUANNACOOK RIVER DAM
GROTON & SHIRLEY, MASSACHUSETTS

Plan Title:
RESTORATION AND STABILIZATION PLAN

Prepared For:
Massachusetts Division of Ecological Restoration
100 Cambridge Street, 6th Floor
Boston, MA
Phone: (617) 626-1540
Fax: - -

Survey Provided By:
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Sheet : 10 of 10
Sheet Number: C-10

ATTACHMENT D

Preliminary Opinion of Probable Cost

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

Project: Squannacook River Dam Removal
Location: Groton & Shirley, MA

Submission: Feasibility Study
Date: 5/9/2024

Estimator: JMP **Checked By:** NP

GENERAL SITEWORK	**Unit**	**Quantity**	**Unit Cost**	**Total Cost**
SITE PREPARATION & DEMOLITION				
Site Mobilization / Demobilization	LS	1	$ 50,000.00	**$ 50,000.00**
Temp. Entrance Mat For Truck Traffic & Sediment Control	TON	44	$ 60.00	**$ 2,640.00**
Silt Sock Erosion Control	LF	330	$ 7.00	**$ 2,310.00**
Catch Basin Inserts (silt sack)	EA	1	$ 210.00	**$ 210.00**
Flow Management	LS	1	$ 20,000.00	**$ 20,000.00**
Remove and Replace Fence	LF	30	$ 70.00	**$ 2,100.00**
Remove and Stockpile Vertical Granite Curb	LF	30	$ 45.00	**$ 1,350.00**
Sawcut Vertical Concrete Faces - Sluice Wall	LF	30	$ 7.00	**$ 210.00**
Concrete Excavation - Sluice Wall	CY	70	$ 3,000.00	**$ 210,000.00**
Concrete Excavation - Concrete Splashpad	CY	170	$ 3,000.00	**$ 510,000.00**
Concrete Excavation - Dam	CY	210	$ 3,000.00	**$ 630,000.00**
Subtotal Site Preparation & Demolition			**$ 1,428,820.00**	
SITE LAYOUT				
Excavate and Relocate Material	CY	530	$ 100.00	**$ 53,000.00**
Subtotal Earthworks			**$ 53,000.00**	
RESTORATION AND STABILIZATION				
Filter Fabric for Constructed Banks	SY	210	$ 10.00	**$ 2,100.00**
Subtotal Buffer Restoration/Streambank Stabilzation			**$ 2,100.00**	
TOTAL GENERAL SITEWORK			**$ 1,484,000.00**	

TOTAL ESTIMATED CONSTRUCTION COST		**$ 1,484,000.00**
General Conditions	10%	$ 148,400.00
ESTIMATED CONSTRUCTION COSTS (Including General Conditions)		**$ 1,632,400.00**
Construction Overhead and Profit	15%	$ 244,900.00
Contingency	25%	$ 326,500.00
TOTAL ESTIMATED CONSTRUCTION COSTS		**$ 2,203,800.00**
ALLOWANCES		
Additional Dewatering and Access		$ 75,000.00
TOTAL ESTIMATED CONSTRUCTION COSTS INCLUDING ALLOWANCES		**$ 2,278,800.00**
RANGE (-15% TO +20%)		
Low	**-15%**	**$ 1,937,000.00**
High	**20%**	**$ 2,734,600.00**

Qualifications:
The following items are not included in the scope of work:

Police /Traffic details
Sheeting / Earth Support

Quantities provided are based on conceptual plans "Dam Removal - Preliminary Design, Squannacook River Dam, Groton & Shirley, MA" May 2024, prepared by Horsley Witten Group.

Unit prices provided are based upon typical 2024 construction costs and data. Unit prices are subject to change due to adjustments to material and labor costs, site conditions and inflation.