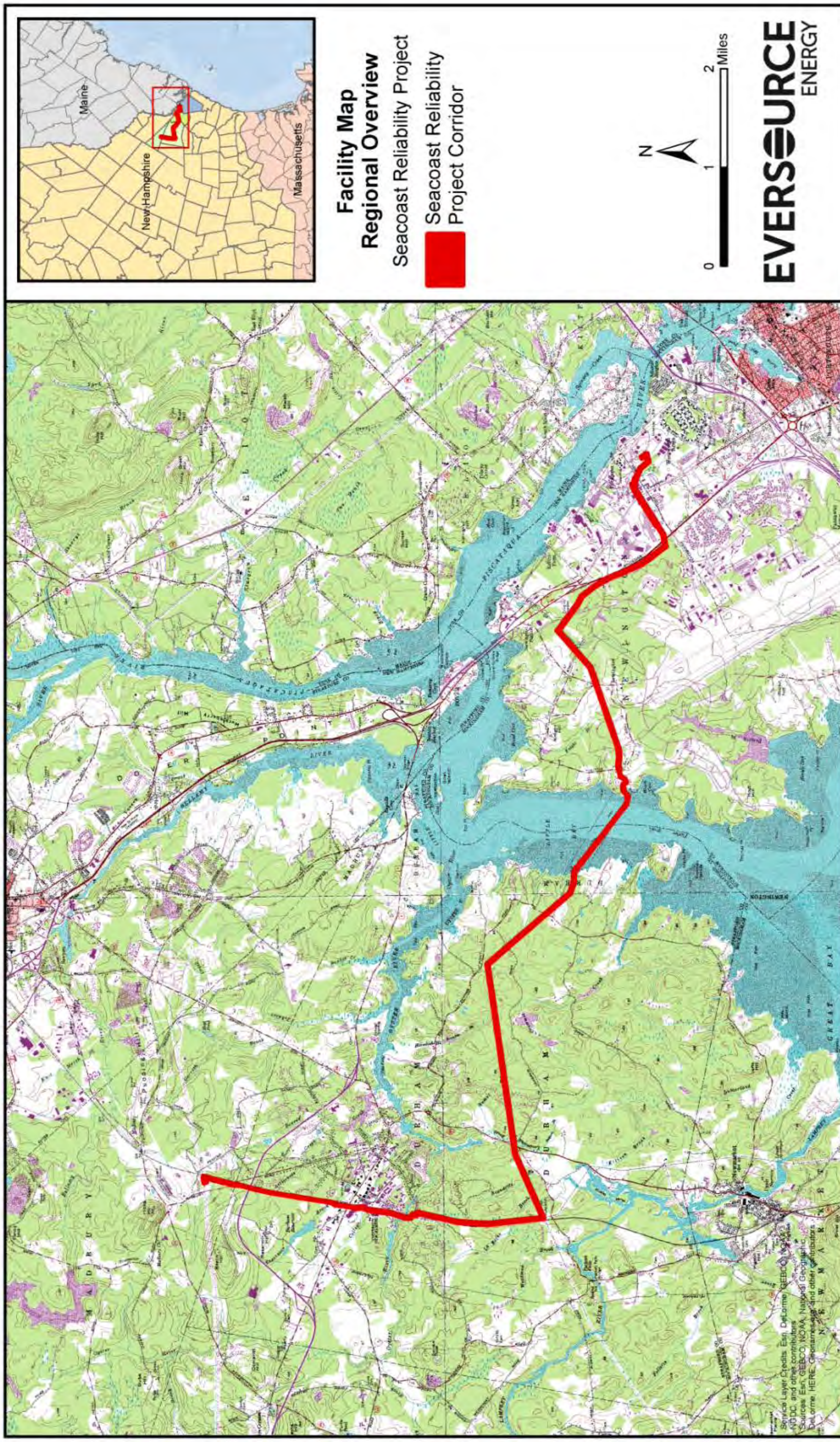

Figure 1-1. Regional Overview of the Seacoast Realiability Project

(1) consultation with the New Hampshire NHNHB, New Hampshire Fish and Game Department ("NHFG"), USFWS and NMFS to obtain a list of RTE species and exemplary communities occurring or potentially occurring in the vicinity of the site,

(2) review of Geographic Information Systems ("GIS") data (such as aerial photographs, topographic maps, soils data, field delineated wetlands/streams, etc.) to assess potential habitats within the Project Area, and

(3) field surveys for RTE species, communities or potential habitat, as applicable.

In 2013, NHNHB provided Normandeau with a list of RTE species and exemplary natural communities documented in the vicinity of the Project Area (NHNHB 2013; Appendix A). This list included seven plant species, four natural communities, seven vertebrate species, and one invertebrate. Normandeau biologists evaluated these species and communities during 2013 and early 2014, through field and/or desktop studies. In September 2014, Normandeau requested updated NHNHB data for the site. The updated list, which includes an addendum (NHNHB 2014a, b; Appendix A) contained an additional two plant species, two natural communities, and eight vertebrate species. Normandeau evaluated the potential of these species to occur within the Project Area using available data and ground surveys in 2015. Normandeau subsequently requested an updated list in October 2015, also provided in Appendix A. The update confirmed the previous lists, although several species were dropped because they were on the edge of the project review area. Since Normandeau had already completed the assessments, the information for all species is included.

Table 1-1 lists the RTE species and exemplary natural community element occurrences mapped in the vicinity of the site for state and federal agencies. For each of the listed occurrences, Table 1-1 summarizes its listing status, known location, preferred habitat, date of last observation, the approximate distance of the mapped occurrence from the Project Area, and the date and results of Normandeau's survey for the species or community.

The following sections describe the evaluations conducted for the plant, natural community, wildlife, fish and invertebrate species mapped in the vicinity of the Project Area.

Table 1-1. Rare, threatened and endangered species and plant communities mapped within 0.5 miles of the SRP Project Area.

Species or Community	Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
Plants					
Black Maple (*Acer nigrum*)	T	floodplain forests, rich mesic forests, often in moist high pH soils (FACU)	1996	within ~ 500 ft of corridor	Searched 9/24/13. Not observed within SRP Project Area.
Bulbous Bitter-cress (*Cardamine bulbosa*)	E	swamps, stream shores, ditches (OBL) (permanently wet, seepy, or submerged soil)	1996	mapped immediately south of corridor, partially in corridor	Searched 5/20/14. Not observed within SRP Project Area.
Crested Sedge (*Carex cristatella*)	E	mesic to hydric soils of meadows, marshes, open swamps, stream banks (FACW). (Univ. of New Hampshire)	1946/ historical; current condition unknown	along E edge of corridor; partially inside corridor	Searched 9/25/13 and 7/22/15. Not observed within SRP corridor. Area is currently developed, UNH campus area.
Crested Sedge (*Carex cristatella*)	E	(Mill Road South)	1943/ historical; current condition unknown	along E edge of corridor; partially inside corridor	Searched 9/25/13, 10/30/13, 7/22/15, and 7/24/15. Observed within SRP corridor in four locations in Durham.
Engelmann's Quillwort (*Isoetes engelmannii*)	E	Shallow waters of lakes and rivers; sometimes emergent (muddy bottom of old reservoir; in 1 ft of water)	1947/ historical; current condition unknown	approx. 500 ft west of corridor (lots of development here now)	Searched 9/25/13. Not observed in SRP corridor and no suitable habitat observed.
Great Bur-reed (*Sparganium eurycarpum*)	T	Shorelines and shallow circumneutral to basic still or slow moving water	2007	Immed. N of corridor	Searched 9/24/13. Not observed within SRP corridor.
Greater Fringed-gentian (*Gentianopsis crinita*)	T	Wet meadows, woods, stream borders (OBL)	1978/ historical; current condition unknown	mapped in corridor	Searched 9/25/13 and 10/30/13. Not observed within SRP corridor. Area is currently developed, UNH campus area.

(continued)

Table 1-1. (Continued)

Species or Community	State Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
Rigid Sedge (*Carex tetanica*)	Tracked but not listed	Calcareous/ circumneutral fens, wet meadows, graminoid marshes, moist to wet woods (FACW)	1942/ historical; current condition unknown	within ~ 2000 ft of corridor (now highly developed)	Searched 9/25/13 and 6/30/15. Not observed within SRP corridor. Area is currently developed, UNH campus area.
Marsh Elder (*Iva frutescens*)	T	Salt marshes, at the limit of normal high tide	2004	approx. 3,000 feet north of corridor	Searched on 9/10/14. Not observed within SRP corridor.
Small whorled pogonia (*Isotria medeoloides*)	T, T*	Deciduous or mixed forest, with appropriate soils and slopes	Not provided by NHNHB	approx. 0.5 mile northwest of corridor	Searched on 6/30/15. Two areas of marginally suitable habitat within the corridor were surveyed based on habitat guidance from USFWS, but species was not found.
Communities					
Hemlock - beech - oak- pine forest	Tracked but not listed	N/A	2006	along western edge of corridor	Searched 9/25/13. Not observed within SRP corridor. Area is currently developed, UNH campus area.
Red maple - sensitive fern swamp	Tracked but not listed	N/A	2006	mapped immed south of corridor; may extend into corridor	Searched 5/20/14. Not observed within SRP corridor.
Red maple - sensitive fern swamp	Tracked but not listed	N/A	1990/ historical; current condition unknown	within few thousand feet south of corridor	Searched 5/20/14. Not observed within SRP corridor.
Salt marsh system	Tracked but not listed	N/A	2010	occurs intermittently along the margins and shores of Great Bay.	9/10/14 and 4/22/15. Field delineated boundaries of fringing marsh on eastern and western shores of Little Bay

(continued)

Table 1-1. (Continued)

Species or Community	State Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
High salt marsh	Tracked but not listed	N/A	2008	within approx. 1500 feet of corridor	9/10/14. Field delineated small high marsh on western shore of Little Bay.
Sparsely vegetated intertidal system	Tracked but not listed	N/A	2010	crosses Project Area	Delineated boundaries using aerial photography and bathymetry.
Subtidal system	Tracked but not listed	N/A	2010	crosses Project Area	Delineated boundaries using aerial photography and bathymetry.
Invertebrates					
Ringed Boghaunter (*Williamsonia lintneri*)	E	Sphagnum peatlands and surrounding upland or mesic forests. Breeding and larvae in dwarf shrub fens, graminoid fens, sphagnum filled pools or basins	2008	immed. N of Project Area	Searched for appropriate habitat on 5/20/14. Wetland DW40 identified as marginal habitat. No adults or exuvia observed.
Fish					
Short-nosed Sturgeon (*Acipenser brevirostrum)*	Ext, E*	Freshwater, estuarine, marine (Little Bay)	1971	Within Great Bay Estuary	No survey conducted; presence is assumed and impacts will be avoided with BMPs
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus)*	T*	Marine, estuarine (Little Bay)	Andecdotal	Within Great Bay Estuary	No survey conducted; presence is assumed and impacts will be avoided with BMPs
American Eel (*Anguilla rostrata*)	SC	Marine, estuarine, freshwater (Oyster River)	1998	within 0.5 miles east of corridor	No survey conducted; presence is assumed and impacts will be avoided with BMPs

(continued)

Table 1-1. (Continued)

Species or Community	State Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
American Eel (*Anguilla rostrata*)	SC	Described above (Lamprey River)	2003	within 0.5 miles southwest of corridor	No surveys conducted. presence is assumed. Lamprey River is outside of project Project Area, but species may use LaRoche Brook. No direct impacts and indirects will be avoided using BMPs.
Banded Sunfish (*Enneacanthus obesus*)	SC	Vegetated areas of lakes, ponds and backwaters of lowland streams; tolerate acid water (Oyster River)	2007	Approx 300' south of SRP corridor	No survey conducted; presence is assumed. No direct impacts, habitat impacts will be avoided with BMPs
Swamp Darter (Etheostoma fusiforme)	SC	Weedy, freshwater swamps, ponds, and slow-moving streams. Usually muddy bottoms with a layer of detritus, and plenty of aquatic vegetation. Occasionally open sandy bottoms. Tolerates low oxygen levels and acidic conditions. (Oyster River)	2005	approx. 1 mile downstream, and within ~500 ft upstream of corridor	No surveys conducted; presence is assumed. No direct impacts, habitat impacts will be avoided with BMPs
Reptiles					
Eastern Hognose Snake (*Heterodon platirhinos*)	E	Sandy soils, open woodlands	1960s/ historical; current condition unknown	Approximately 4000' south of corridor	Not observed during routine surveys; no known locations of this species in seacoast region
Northern Black Racer (*Coluber constrictor constrictor*)	T	Variety of habitats including dry brushy pastures, powerline corridors, rocky ledges, and woodlands (grassy roadside) (Beards Creek)	2011	mapped in corridor	Surveys conducted 10-31-13 and 4-2215 . Not observed but habitat is suitable, presence is assumed and impacts will be avoided with BMPs
Northern Black Racer (*Coluber constrictor constrictor*)	T	(Packers Falls/Bennet Rd)	2013	approx. 0.5 mile southwest of corridor	Not observed during routine surveys, presence is assumed and impacts will be avoided with BMPs

(continued)

Table 1-1. (Continued)

Species or Community	State Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
Blanding's Turtle (*Emydoidea blandingii*)	E	Wetlands with permanent shallow water and emergent vegetation, vernal pools, may use slow rivers and streams for travel between wetlands; terrestrial habitats for nesting and travel among wetlands (Crommet Creek)	1997	Approximately 1000′ south of corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs
Blanding's Turtle (*Emydoidea blandingii*)	E	Described above	2006	Approximately 1000′ south of corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs
Spotted Turtle (*Clemmys guttata*)	T	marshes, vernal pools, wet meadows, swamps, ponds, and slow-moving streams and rivers, terrestrial habitat (small wetland near Langmaid Rd)	1993-1998/ historical; current condition unknown	Approximately 500′ south of corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs
Spotted Turtle (*Clemmys guttata*)	T	Described above (S. of Crommet Creek, Dame Rd)	2012	long linear polygon crosses corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs
Spotted Turtle (*Clemmys guttata*)	T	Described above (La Roche Brook/UNH Foss Farm West)	2002	Approximately 1000′ west of corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs
Spotted Turtle (*Clemmys guttata*)	T	Described above (Hicks Hill)	2006	approx. 0.5 mile northwest of corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs
Birds					
Bald Eagle (*Haliaeetus leucocephalus*)	T	Large bodies of water containing abundant fish, large trees for nesting, perching and roosting (Wilcox Point)	2011	within 1 mile south of corridor	Not observed during routine surveys; presence is assumed and impacts will be avoided with BMPs

(continued)

Table 1-1. (Continued)

Species or Community	State Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
Bald Eagle (*Haliaeetus leucocephalus*)	T	(Great Bay Megasite, Cedar Point, Woodman Point)	1993	Presumed north of corridor (not shown on map)	Adult observed over Great Bay; impacts will be avoided with BMPs
Osprey (*Pandion haliaetus*)	SC	Elevated nest sites near water with abundant fish	2010	within 0.5 mile south of corridor	No nests on existing structures. Nest survey prior to construction season to confirm presence/absence
Golden-winged Warbler (Vermivora chrysoptera)	SC	Brushy open areas, especially clearings in deciduous woodlands with saplings, forbs, grasses	1984/ historical; current condition unknown	within 0.5 mile south of corridor	Not observed during routine surveys; NHNHB records are historic,
Least Bittern (*Ixobrychus exilis*)	SC	Freshwater wetlands with tall, dense vegetation	1995	approx. 0.5 mile north of corridor	No survey conducted; records are not current, not within SRP corridor and habitat within corridor is marginal.
Roseate Tern	E, E*	Nests in small numbers on offshore islands, is observed feeding off NH seacoast	No records in Great Bay	East to open ocean	No survey conducted; may occasionally feed in Great Bay, though no observations of such
Sedge Wren (*Cistothorus platensis*)	E	wetlands dominated by sedges and grasses with shrub cover (wet hayfields, spagnum moss bogs, pond margins); Don't use wetlands with sparse cover or ones dominated by cattails (wet meadow/field)	2001	Approximately 1000' west of corridor	No survey conducted; records are not current, not within corridor and habitat within corridor is marginal.
Upland Sandpiper (*Bartramia longicauda*)	E	Open habitats with low vegetation/ large grassy areas	2002	approx. 0.5 mile south of corridor	No survey conducted; the SRP corridor does not provide suitable habitat for this species

(continued)

Table 1-1. (Continued)

Species or Community	State Status[1]	Preferred Habitat[2]	Last Observed	Proximity of Record to SRP Project Area	Survey Results
Mammals					
Northern Long-eared Bat (*Myotis septrionalis)*	T, T*	Various forest types that include trees and snags with suitable roosting structures (crevices, hollows, loose bark)	n/a - no NHB record	n/a - no NHB record	No survey conducted; suitable summer habitat is present throughout the corridor
New England Cottontail (*Sylvilagus transitionalis)*	E	Dense shrubs and regenerating clear cuts	n/a - no NHB record	n/a - no NHB record	No survey conducted; 2014-2015 NHFG survey did not find this species. Parcels directly adjacent to the corridor are actively managed to benefit this species.

Notes:

1. E-State Endangered
   T- State Threatened
   SC-State Special Concern
   Ext - Extirpated
   *-Federal status
2. N/A – Not applicable
   FACU –facultative upland species
   OBL – obligate wetland species
   FACW- facultative wetland species

2.0 Results

2.1 Plants and Natural Communities

According to data Normandeau received from NHNHB in 2013 and 2014 (NHNHB 2014a,b; Appendix A), nine RTE plant species and six exemplary natural communities are on record as occurring in the vicinity of the Project Area (Table 1).

During 2013 through 2015, Normandeau botanists searched for all RTE plant species and exemplary communities listed in Table 1 in targeted areas of the SRP Project Area. Areas of the Project with appropriate habitat and located within approximately half mile, or in some cases up to one mile of NHNHB records for state-listed species or communities were surveyed. Locations proximal to mapped natural communities were visited to determine whether the communities extend into the Project Area.

Only one state-listed plant species, crested sedge, *Carex cristatella*, was found within the SRP Project Area. In addition, four exemplary natural communities or natural community systems were identified within the Project Area: *High salt marsh (shallow peat variant)*, *Salt marsh system*, *Sparsely vegetated intertidal system* and *Subtidal system.*

The RTE plant species and natural communities that were surveyed for are described below.

Black Maple

A population of the state-threatened black maple (*Acer nigrum*) is mapped south of, and within approximately 500 feet of the the Project Area in Durham (NHNHB 2014b; Appendix A; Table 1). This species is typically found in rich mesic forests and riparian forests, often in locations with high-pH bedrock (Haines 2011). The plants mapped near the Project Area, which were last observed in 1996, typically occur in semi-rich mesic forest, circumneutral talus forest, semi-rich dry-mesic Appalachian oak-hickory forest, hardwood forested seep, semi-rich oak-hickory-sugar maple forest, and streamside swamp (NHNHB 2014b). On September 24, 2013 a Normandeau botanist searched for this species within half a mile of the mapped population. No plants of black maple or its close congener, sugar maple (*Acer saccharum*), were observed.

Bulbous Bitter-cress

The state endangered bulbous bitter-cress (*Cardamine bulbosa*) is a spring-flowering species that typically occurs in wet woods (Magee and Ahles 2007). This species is mapped immediately south and west of the Project Area and partly within the Project Area in Newington (NHNHB 2014a; Appendix A; Table 1). The population in this area was last observed in 1996 (NHNHB 2014a). A Normandeau botanist searched the Project Area within half a mile of this population on May 20, 2014 (excluding developed areas); however, this species was not found.

Crested Sedge

Two historic records exist for the state endangered crested sedge (*Carex cristatella*) in the vicinity of the Project Area in Durham (NHNHB 2014a; Appendix A; Table 1). Both populations are mapped immediately east of, and partly within, the Project Area. One population, last observed in 1946, is mapped on the University of New Hampshire ("UNH") campus, in an area that is currently developed. The second population, last observed in 1943, is mapped further south, in a less developed area. Crested sedge occurs in mesic to hydric soils of meadows, marshes, open swamps and stream banks (Haines 2011). The best time to identify this species is during summer (July 4 – August 4 [Seymour 1969]).

A Normandeau botanist conducted initial surveys for this species on September 25 and October 30, 2013 in Project Areas within approximately half mile of the mapped populations. Additional surveys were conducted on July 22 and 24, 2015 within approximately 1 mile of the historic populations. During the July surveys, Normandeau personnel observed and delineated four patches of this plant species in the Project Area south of the historic populations (Confidential Figure 2-1). The patches are located within an approximately 0.6 mile stretch of corridor in the Town of Durham; they occur within the cleared portions of the corridor under the existing distribution line. A voucher specimen was collected on August 21, 2015 and submitted to NHNHB on October 1, 2015. In addition, a Rare Species Occurrence Record field form (Special Plant form) was completed and submitted to NHNHB.

Engelmann's Quillwort

According to NHNHB, an historic (1947) record for the state endangered Engelmann's quillwort (*Isoetes engelmannii*) is located approximately 500 feet west of the Project Area in Durham (NHNHB 2014b; Appendix A; Table 1). Engelmann's quillwort was observed on the muddy bottom of an old reservoir, in 1 foot of water. Much development has occurred in the general vicinity and the current condition of the population is unknown. This species is usually found submerged in shallow water of lakes and rivers; it is sometimes emergent (Haines 2011). On September 25, 2013 a Normandeau botanist searched the Project Area within half a mile of the historic record. Engelmann's quillwort was not observed and no appropriate habitat was found.

Great Bur-reed

A population of the state threatened great bur-reed (*Sparganium eurycarpum*), last observed in 2007, is mapped immediately north of the Project Area in Durham (2014a; Appendix A; Table 1). Great bur-reed is known to occur along shorelines and in shallow, circumneutral to basic, still or slow-moving water (Haines 2011). On September 24, 2013, a Normandeau botanist searched the Project Area within half mile of the mapped population; however, this species was not observed and little or no appropriate habitat was found.

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Figure 2-1. Locations of crested sedge observed within the SRP corridor.

Greater Fringed-gentian

Greater fringed-gentian (*Gentianopsis crinita*) is a state threatened species found in fields, meadows, roadsides, and clearings (Haines 2011). Its flowering period is generally from mid to late August through October (Seymour 1969). According to NHNHB, an historic population of greater fringed gentian is mapped in the vicinity of the Project Area in Durham (NHNHB 2014a; Appendix A; Table 1). The population was last observed in 1978. On September 25 and October 30, 2013, a Normandeau botanist conducted surveys for this species in the Project Area within half a mile of the historic population, but this species was not found.

Rigid Sedge

An historic (1942) population of rigid sedge (*Carex tetanica*) is mapped approximately 2,000 feet east of the Project Area in Durham, in an area that is currently developed (UNH campus) (NHNHB 2014a; Appendix A; Table 1). Rigid sedge is believed to be extirpated in the state. This species occurs in meadows, moist to wet woods and bogs (usually calcareous) and is most easily identified from May to July (Magee and Ahles 2007). On September 25, 2013 and June 30, 2015, a Normandeau botanist searched for rigid sedge within a half mile of the mapped population; however this species was not found.

Marsh Elder

The state threatened marsh elder (*Iva frutescens*) occurs in salt marshes, usually near the limit of high tide (Haines 2011). According to NHNHB, a population of marsh elder is located in Durham, approximately 3,000 feet north of the project ROW (NHNHB 2014a; Appendix A; Table 1). On September 10, 2014, a Normandeau botanist searched appropriate habitat for this species within the Project Area, but this species was not found.

Small Whorled Pogonia

Small whorled pogonia (*Isotria meleloides*) is a state and federally threatened species mapped within one-half mile of the Project Area in Madbury (NHNHB 2014a; Appendix A; Table 1). USFWS was consulted and two sites with potentially appropriate habitat for the sensitive plant species were identified within the Project Area based on soils data and aerial photography. A Normandeau botanist searched these sites on June 30, 2015, but this species was not found.

Hemlock – Beech – Oak – Pine Forest

According to data from NHNHB, an exemplary *Hemlock – beech – oak – pine forest* is mapped immediately west of the Project Area in Durham (NHNHB 2014a; Appendix A; Table 1). This community type has a state ranking of S5 (demonstrably widespread and secure) and is one of the most common upland forest communities in southern and central parts of the state (NHNHB 2015). The community mapped in the vicinity of the Project Area is considered to be of good quality ('B' on a scale of A-D) and was last observed in 2006 (NHNHB 2014a; Appendix A). On September 25, 2013, a Normandeau botanist surveyed the Project Area in the vicinity of this mapped natural community. The community occurs within College Woods, a recreational hiking area and is located west of Colovos Road. The SRP corridor, which extends east from Colovos Road in this area, does not overlap with the natural community.

Red Maple – Sensitive Fern Swamp

Two exemplary *Red maple – sensitive fern swamps* are mapped in the vicinity of the Project Area in Newington (NHNHB 2014a; Appendix A; Table 1). This community type has a state ranking of S3S4 (a range rank indicating a range of uncertainty from S3 [very rare and local, local in a restricted range, or vulnerable due to other factors] to S4 [widespread and apparently secure]). It is considered to be a common type of (weakly) minerotrophic red maple swamp in central and southern New Hampshire (NHNHB 2015). The portions of the ProjectArea located near these mapped communities were surveyed by a Normandeau botanist on May 20, 2014, but these communities were not found to extend into the Project Area.

Estuarine Natural Communities and Systems

Four exemplary estuarine natural communities/systems are mapped in the Project Area where it crosses Little Bay: *High salt marsh*, *Salt marsh system*, *Sparsely vegetated intertidal system*, and *Subtidal system* (NHNHB 2014a; Appendix A; Table 1). The *High salt marsh* natural community has a state ranking of S3 (very rare and local or vulnerable). Natural community systems are not generally ranked.

The *High salt marsh* occurs within a narrow fringing *Salt marsh system*, so these two community types occupy the same area within the Project. The limits of *High salt marsh* and the complete *Salt marsh system* were field located b on the west shore on September 10, 2014, and on the east shore on April 22, 2015. The boundaries of the *Sparsely vegetated intertidal system* and *Subtidal system* were delineated from aerial photography and site-specific bathymetry based on the approximate elevation of Mean Lower Low Water.

2.2 Invertebrates

Ringed Boghaunter

According to NHNHB (2014b; Appendix A), the state endangered ringed boghaunter dragonfly (*Williamsonia lintneri*) is mapped just north of the Project Area in Durham (Table 1). The ringed boghaunter lays its eggs and develops as larvae in sphagnum pools, acidic sedge fens and dwarf shrub fens, which are surrounded by upland forest (NHFG 2005a, MA NHESP 2012). All breeding habitats used by this species contain at least some sphagnum moss and typically hold 6 to 12 inches of water (or otherwise hold water long enough for larvae to complete development) (NHFG 2005a, MA NHESP 2012). The preferred breeding areas contain open water with some emergent vegetation; permanent standing water is not required. The adults use upland forests surrounding the breeding areas (NHFG 2005a).

On May 20, 2014 Normandeau biologists surveyed for potential ringed boghaunter habitat within a segment of the Project Area located within the mapped occurrence of this species (i.e, between Long Marsh Road and Sandy Brook Drive). One wetland was identified that appeared to contain marginally suitable habitat for ringed boghaunter. This wetland was located adjacent to upland forest. It contained open water at least six inches deep, some emergent graminoids, and many shrubs along the edges where emerging larvae could attach. The ringed boghaunter is typically described as occurring in *Sphagnum* pools or troughs, whereas this wetland had a mineral substrate, and *Sphagnum* was observed only along the edges of the wetland. Also, unlike typical peatlands, the shrub species in this wetland did not include heath species. Given these characteristics, this wetland appeared to be less acidic and more nutrient-enriched than usual ringed boghaunter habitat. The edges of the wetland were inspected but no dragonfly exuviae were observed. No adult ringed boghaunters were observed within the SRP woodlands. The flight period for ringed boghaunters occurs between mid-April and mid-June (Nikula et al., 2003).

2.3 Fish

The proposed Project, which includes the terrestrial Project Area and the Little Bay cable crossing, potentially contains habitat for multiple fish Species of Special Concern (SC) as identified by the NHFG and NMFS (Appendix A). Atlantic sturgeon and short-nosed sturgeon are federally listed species. American Eel and the freshwater species Banded Sunfish and Swamp Darter state-listed Species of Special Concern are classified as Category A or B. Species with Category A designation are considered 'Near-threatened' presently, but may become 'Threatened' in the near future if conservation actions are not taken. Sub-category A1 describes species susceptible to further decline. Sub-category A2 identifies species that are considered recovered and were recently down-listed from the state Endangered and Threatened list. Category B Species of Special Concern are described as 'Responsibility Species', with a major portion of the total global population existing with New Hampshire.

Shortnose Sturgeon

Shortnose sturgeon (*Acipenser brevirostrum*) is a designated federally endangered species in the Gulf of Maine that may occur in the Project Area (Pers. Comm., Edith Carson NOAA 12/2/2014). Shortnose sturgeon range from Saint John River, New Brunswick, to the Saint Johns River, Florida, and are smaller than their congener, Atlantic sturgeon, with a maximum length of around 1 meter (3 feet) (Musick 2002). Shortnose sturgeon are about as long-lived as Atlantic sturgeon with a maximum age of around 60 years, and they reach maturity in about 10-13 years in the northern part of their range. Threats to Shortnose sturgeon include construction of dams which limit access to spawning grounds, water pollution, habitat alteration, dredging and disposal activities, and development in estuaries, mudflats and marshes, and commercial exploitation (NOAA 2014).

Shortnose sturgeon are amphidromous fish meaning they spend most of their lives in freshwater but will periodically visit estuarine or salt water. They spawn in freshwater on hard substrates where they deposit demersal adhesive eggs. The larvae remain in freshwater as they mature into the juvenile stage. Keiffer and Kynard (1993) tracked the movements of shortnose sturgeon in the Merrimack River and found that they were typically found in the freshwater portion of the river at salinities less than 1.0 ppt. Post-spawning males were captured 32-31 km upstream of the mouth of the Merrimack River in Haverhill, Massachusetts, in April and larvae were captured in the same area in May indicating that this is a spawning area. Shortnose sturgeon are opportunistic benthic foragers (Musick 2002) and primary food items in estuaries include mollusks, shrimp, and polychaete worms (Dadswell 1979).

Shortnose sturgeon have not been observed in New Hampshire since 1971 (NHFG 2005b). Populations of shortnose sturgeon exist in the Kennebec River system to the north of the Project Area and the Merrimack River to the south so it is possible that they could transit the Project Area, although they do not wander as far from their natal rivers as Atlantic sturgeon. There is no spawning, egg, or larval habitat for shortnose sturgeon in the Project Area, although it is possible that wandering shortnose sturgeon could use the area as feeding habitat. They are considered to be extirpated in New Hampshire (NHFG 2005b).

Atlantic Sturgeon

The Atlantic sturgeon is designated a federally listed threatened species in the Gulf of Maine and it is possible that members of the endangered Distinct Population Segment from New York Bight could occur in the Project Area (Pers. Comm. Edith Carson, NOAA, 12/15/2014). Atlantic sturgeon are large (up to 5.5 meters), long-lived (up 60 years) anadromous fish that range from Labrador to northern Florida (Musick 2002). Maturity occurs at 22-24 years for males and 27-28 years for females in the northern part of their range. Threats to Atlantic sturgeon include loss of spawning habitat in freshwater, bycatch mortality, loss of habitat due to locks and dams, mortality due to dredging activities, and possible ship strikes. Perhaps the greatest threat is commercial overfishing prior to a moratorium introduced in 1997 and 1998 (NOAA 2010). Because this fish matures at such a late age the beneficial results of the fishing moratorium may not be detected for more than 20 years after the cessation of fishing.

Atlantic sturgeon spawn in the tidal freshwater or slightly brackish portions of estuaries (Musick 2002). The eggs are demersal and adhesive and are attached to hard substrate. As the larvae mature, they start to disperse downstream but juveniles may remain in the natal river for several years. Keiffer and Kynard (1993) tracked the movements of juvenile Atlantic sturgeon in the Merrimack River and found that they were typically found in the estuarine portion of the river at salinities greater than 10 ppt. No Atlantic sturgeon of adult size were captured in that study.

There are anecdotal reports of Atlantic sturgeon occurring in the Great Bay complex (B. Smith NHFG Pers. Comm.12/15/2014; NHFG 2005b) and they may transit the Project Area. The Project Area is not spawning, egg or larval habitat, although juvenile and adult Atlantic sturgeon may use the area for feeding. Atlantic sturgeon are opportunistic benthic feeders (Musick 2002) and will feed on polychaetes, isopods, decapod crustaceans, and amphipods, with bivalves and small fish making small contributions to the diet (Johnson et al. 1997).

American Eel

American eel (*Anguilla rostrata*) is currently designated as a Species of Special Concern Category A1 (SC-A1) due to declines in most populations relative to historic levels, and limited access to historic spawning grounds (NHFG 2009).

The American Eel is a catadromous species found from Greenland to South America (Collette and Klein-MacPhee 2002). Spawning occurs in the winter and spring in the ocean, as does larval development. In the spring, juveniles ("elvers") migrate into estuaries as transparent "glass eels", where they develop into pigmented juveniles ("browns"). Elvers then continue upstream migration into freshwater to develop into adults and remain for up to 25 years as "yellow" eels before migrating back to sea to spawn as "silvers".

Ongoing surveys in the Oyster River (yellow eels) and Lamprey River (glass eels/elvers) indicate that the Great Bay Estuary and its tributaries should be considered currently viable American eel habitat (NHFG 2013b, Enterline *et al*. 2013). From late-April through late-September 2012, a total of 4,092 glass eels and 121 browns were collected during a NHFG survey of the Lamprey River in Newmarket, New Hampshire (NHFG 2013b). Therefore, the proposed Project Area may contain both freshwater and marine habitat for American eels. The SRP crosses the Oyster River (freshwater) in Durham, New Hampshire where American eels were reported in 1985 and 1998 (NHNHB 2014). Additionally, American eels were reported in 2003 in the Lamprey River (freshwater) in Durham, N ew Hampshire (NHNHB 2014). The Project Area crosses LaRoche Brook, a tributary of the Lamprey River, in Durham, New Hampshire . There are no barriers that would prevent American eels access from the Lamprey River to the LaRoche Brook segment within the Project Area. The La Roche Brook segment within the Project Area can be considered to provide habitat for juvenile and adult American eels.

Although the SRP does not cross the Lamprey River, access to the Lamprey River and its tributaries from the Atlantic Ocean requires passage through the Little Bay cable corridor. The reported occurrence of American eel in the Lamprey River indicates that Little Bay had provided temporary habitat for migrating glass eels and elvers during their transition into freshwater. Assuming survival to reproductive age within the Lamprey River, Little Bay would also provide temporary habitat for adults migrating back to the ocean for spawning.

In New England, juvenile American eel migration into freshwater may occur from March through June (Greene *et al*. 2009). Glass eels progress into estuaries by drifting on flood tides and holding position near the bottom during ebb tides (McCleave and Wippelhauser 1987). Migrating elvers are mainly active at night, and may burrow into soft undisturbed bottom sediments or remain in deep waters during the day (Facey and Van den Avyle 1987). Spawning in the ocean occurs during the winter and the spring (McCleave and Kleckner. 1985), indicating that Little Bay has the potential be used by out-migrating adults in the fall and winter. Based on this, the habitat at Little Bay Project location may be considered American eel habitat during the spring for juveniles and during fall and winter for adults. The portion of the Oyster River within the Corridor may be considered year-round habitat for adult (yellow) American eels. Adult eels present in the Oyster River would have the ability to avoid the SRP crossing of the river during any temporary disturbance caused by construction activities.

The Little Bay Cable Area may also provide staging habitat for juvenile American eels (glass eels and brown elvers) as they migrate upstream (Table 2-1).

Table 2-1. Potential seasonal occurrence of American eels within the proposed SRP Project Area.

Species	Designation*	Life Stage	Spring	Summer	Fall	Winter
American Eel	SC-A1	Juveniles (Elvers)	X			
		Adults (Yellow)	X	X	X	X
		Adults (Silver)	X			X

* New Hampshire Fish and Game Department - Nongame and Endangered Species Program (NHFG 2009).

Banded Sunfish

The banded sunfish (*Enneacanthus obesus*) is currently designated as SC-A1B and described as a species of Northeast Regional Conservation Concern due to increasing habitat threats in southern NH. These threats include shoreline development in rapidly expanding areas that may impact the intact, vegetated shoreline habitat of which the banded sunfish is highly dependent (NHFG 2009).

The preferred habitat of the banded sunfish is weedy areas of lakes and lowland stream backwaters (Sarcola 1987). This species has been found in the Upper Oyster River (2007), Oyster River (1985, 2005), and Longmarsh Brook (2005; NHNHB 2014). In the Upper Oyster River, the habitat was vegetated margins of small streams flowing through abandoned beaver ponds. The SRP crosses Longmarsh Brook approximately 300 feet downstream of the sampling location where banded sunfish were found in 2005. Aerial imagery from 2013 indicates a vegetated shoreline habitat in the portion of Longmarsh Brook within the Project Area (ESRI 2014). The likely presence of optimal habitat combined with occurrence of the species documented nearby in the same stream indicates that banded sunfish has a high probability of occurrence within the Project Area in Longmarsh Brook. The documented species occurrence in the Upper Oyster River and Oyster River upstream and downstream of the Project Area suggests that banded sunfish has the potential to occupy the Oyster River within the Project Area if habitat conditions are adequate.

Swamp Darter

Swamp darter (*Etheostoma fusiforme*) is currently designated as SC-A1 due to increasing habitat threats, especially fragmentation, in developing areas of southern New Hampshire (NHFG 2009). Swamp darter habitat includes soft substrates in shallow vegetated areas of lakes and ponds (NHFG 2005b). Although more abundant in ponds, the species can also be found in swift or slow streams that contain patches of dense vegetation. Stream populations are typically associated with a nearby pond population, and spawning has not been observed in streams (Schmidt and Whitworth 1979, NHFG 2005b). Swamp darters were observed in the Oyster River in 1985 and 2005 (NHNHB 2014). In 1985, three swamp darters were observed below the Oyster River Reservoir Dam, approximately 0.2 miles upstream from the Project Area. In 2005, one individual was observed approximately 1 river-mile downstream from the Project Area. Aerial imagery from 2013 indicates the Oyster River habitat within the Project Area is similar to the habitats in other portions of the Oyster River where swamp darters have been observed (ESRI et al. 2014).

2.4 Reptiles

Eastern Hog-nosed Snake

Records from NHNHB indicate that the eastern hognose snake (*Heterodon platirhinos*; State Endangered) was historically (prior to 1993) recorded in the Town of Durham. This species requires sandy, gravely soils and usually occurs in open fields, river valleys, pine forests, and upland hillsides where these types of soils are present. Toads are their preferred prey, although frogs, salamanders, small mammals, birds and invertebrates are also taken. Because toads are favored, good habitat for hog-nosed snakes also includes good breeding habitat for amphibians (wetlands, vernal pools). Hog-nosed snakes hibernate in mammal burrows, under woody debris, or under trash piles. Mating generally occurs in spring, and eggs that are deposited in June and July hatch in August and September. Females typically deposit 15-25 eggs in a depression under rocks or logs, in sandy soil, or in mulch piles. Power line corridors are known to provide suitable habitat for this species.

The nearest known, current occurrence of eastern hog-nosed snake to the Project Area is in a power line corridor in the Concord/Pembroke area. This is the eastern-most known occurrence of the species in New Hampshire. During project construction, BMPs should be implemented to prevent impacts to all special status reptiles potentially present in the Project Area, and construction of this Project may improve habitat for eastern hog-nosed snake by reducing canopy cover which will improve basking and nesting opportunities in the Project Area.

Northern Black Racer

Records from NHNHB indicate that an adult northern black racer (*Coluber constrictor constrictor;* State Threatened) was recently observed within the project Area in Madbury, as well as in the Project vicinity in Durham. The black racer in Madbury was observed on the grassy roadside area of the Madbury Road overpass of Boston-Maine RR at the Madbury/Durham town line. The NHNHB data indicates that a black racer was first reported at this location in 2004, and last reported in 2011. It is unclear if there were additional reports in the intervening years. The Durham specimen was observed in 2013 about 0.5 miles from the Project corridor south of the Packers Falls substation.

Northern black racers are habitat generalists, but are usually terrestrial, and may use relatively sparsely vegetated areas. They use a variety of habitats including dry brushy pastures, power line corridors, rocky ledges, and woodlands. They are often found in edge habitats, such as forest edges, old fields, and wetland edges. They have large home ranges (10-20 hectares) and therefore require a relatively large patch of suitable habitat. Black racers are only active during the daytime and are most active in warm weather. At night and during cool weather they take refuge in underground burrows, rock crevices, or under cover such as boards or tin. Black racers hibernate in rock crevices or mammal burrows, and they often den communally with other black racers or with other snake species. They may use the same den for years.

Because the specimen reported from Madbury occurred within the Project corridor, a survey of this location was conducted two occasions. A Certified Wildlife Biologist® visited the Madbury Road overpass of Boston-Maine RR at the Madbury/Durham town line on October 31, 2013, and on April 22, 2015. The October visit was primarily to assess the habitat suitability of the area for northern black racers. Although it is possible that black racers would still be basking outside their hibernacula in late October, the weather on the day of the site visit was cold (40°F) and overcast, negating the likelihood of observing snakes directly. Conversely, April 22 was a sunny day with temperatures ranging from about 58°F to 68°F degrees during the visit, which was conducted from 10:30 to 12:30. No racers were observed on either visit.

During the October visit, the biologist examined the vegetation and substrate around the overpass, and then observed the area northward along the corridor by walking to the substation along the railroad tracks. During the April visit, the biologist examined the same area, but spent the majority of the time observing the rocky embankment (described below) where snakes would be likely to bask.

The SRP abuts a railroad corridor which contains a single track laid on supporting cobble, and an adjacent access road for wheeled vehicles, consisting of hard-packed dirt, sand, and gravel. The Project Area spans wetlands and uplands, and supports dense shrub vegetation and /or regenerating hardwood forest species in both the wetland and upland areas. The embankments of the overpass area are mowed periodically, and were densely vegetated with grassy species growing about 10 inches high. At the base of the embankment, exposed large rocks placed as part of the embankment construction were partly to mostly overgrown by forbs and shrubby vegetation. Loose piles of discarded railroad ties were present at the interface of the power line and railroad corridors, about 600 feet north of the overpass.

The survey indicated that the area provides useful resources to northern black racers and any individual with a home range that includes this area would likely use this portion of the Project Area. Within the survey area relatively dense vegetation abuts the unvegetated railroad corridor creating a distinct edge. Because northern black racers are habitat generalists with an affinity for edges, the Project Area potentially offers suitable habitat for this species. The diverse mix of uplands and wetland cover types provides high quality foraging opportunities for this generalist predator. Additionally, the open, packed dirt and stones of the railroad corridor offers high quality basking opportunities for snakes while the overgrown power line corridor offers escape cover. The large rocks at the base of the overpass embankment also offer plenty of nooks and crannies for snakes to spend the night in, or to escape hot temperatures on summer days. There is also some possibility that these rocks could provide overwintering habitat. The discarded railroad ties also potentially offer suitable summer thermoregulatory or escape cover for snakes. Similar conditions occur in a number of places where the Project Area abuts the railroad Project corridor. Given that the two NHNHB records of this species bookend the section of the SRP that coincides with the rail line, it is possible that black racers may use this entire area.

Blanding's and Spotted Turtles

Records from NHNHB indicate both that Blanding's turtle (*Emydoidea blandingii*; State Endangered) and spotted turtle (*Clemmys guttata*; State Threatened) were historically present in various locations in Durham near the Project, and that spotted turtles have recently been recorded within the Project Area. All New Hampshire turtles overwinter in permanent water bodies (i.e., ponds, streams, wetlands) with preference for a certain type of water body varying by species and to some degree by availability. During their active season, Blanding's and spotted turtles are semi-aquatic, using a mix of wetland, open water and upland habitats. Both species also use upland habitats to varying degrees to forage, and to travel between wetland habitats. Additionally, they lay their eggs in upland areas in late spring and early summer, digging shallow nests where they leave their eggs unattended to develop and hatch in two to three months.

Based on their known distribution, both Blanding's and spotted turtles are likely to be present within the Project Area at some time during the year. In particular, power line corridors have the potential to provided suitable nesting habitat. Habitat quality for turtle nesting depends on vegetation density and soil type. Loose, sandy soils with sparse vegetation have the highest habitat quality for nesting turtles, allowing them to dig nests easily and minimize the shading of nests. Any area, with an open canopy and loose, relatively dry soils located within 1,000 meters of a suitable water body has the potential to be used by turtles for nesting.

Species-specific surveys were not conducted for these two species, and none were encountered during other project work. However, based on their known distribution, it should be assumed that both turtles use portions of the Project Area in Durham during portions of their life cycle. During project construction, BMPs should be implemented to prevent impacts to all special status reptiles potentially present in the Project Area. In the long term, construction of this project may enhance habitat for turtles by reducing canopy cover which may improve nesting conditions in the Project Area.

2.5 Birds

Bald Eagle

Records from NHNHB indicate that bald eagles (*Haliaeetus leucocephalus*; State Threatened) are currently present near the Project Area, but have not been recorded within it. This species is present in New Hampshire year-round, and uses a wide variety of habitats that combine large bodies of water containing abundant fish, and large trees for nesting, perching and roosting. There may be marked shifts in the locations of habitats used between summer and winter. High quality habitats may be used repeatedly from year to year, but this species continues to expand its range in New Hampshire and continues to adopt new nesting and winter roosting locations. Bald eagles are reported to e-bird in and around the Great Bay area on a consistent basis, and are potentially present anywhere within the Project Area. Based on this species' known distribution, surveys were not conducted although bald eagles were incidentally observed flying over Great Bay. However, in the season prior to construction, potential nesting or roosting areas should be surveyed to determine if they are currently being used. If eagle nests are within 0.25 miles of the Project Area, timing restrictions on construction activity within the 0.25-mile radius should be implemented to prevent disturbance. The transmission lines have been designed to Avian Power Line Interaction Committee's ("APLIC") bird-safe standards to minimize the possibility of electrocuting all types of raptors including eagles, and other large birds (APLIC 2006).

Osprey

Records from NHNHB indicate that ospreys (*Pandion haliaetus*; Species of Special Concern) was recently recorded nesting in the vicinity of the Project. This species breeds in New Hampshire during the spring and summer, then migrates south during the colder months of the year. Ospreys use habitats that combine large bodies of water containing abundant fish, and suitable structures for nesting and perching. This species is known to be present in and around the Great Bay area, and has nested on other features in the vicinity of the Project (NHNHB 2014). Based on the small size of the existing poles, species-specific surveys were not conducted along the SRP corridor. PSNH staff and Normandeau biologists surveying the Project Area for other purposes did not report existing osprey nests. However, in the season prior to construction, the Project Area should be reviewed to determine if it is currently being used. If ospreys are present, construction activities should be modified to prevent disturbance. The transmission lines have been designed to APLIC's bird-safe standards to minimize the possibility of electrocuting all types of raptors including eagles, and other large birds (APLIC 2006).

Golden-winged Warbler

Records from NHNHB indicate that the golden-winged warbler (*Vermivora chrysoptera*; Species of Special Concern) was historically recorded adjacent to the Project Area in Durham. This species uses semi-open park-like habitats and shrublands. Power line corridors potentially provide good quality habitat for this species (Confer et al. 2011), and expanding the SRP clearing could improve habitat conditions for this species. NHNHB does not require surveys for historic species. Because the most recent record for this species in the Project Area is from 1984, and there no current records in the vicinity of the Project, no survey was conducted for this species.

Grasshopper Sparrow

Records from NHNHB indicate that grasshopper sparrow (*Ammodramus savannarum*; State Threatened) was recently present near the Project in Newington, but has not been recorded within it. This species requires breeding sites of at least 30 acres and prefer sites greater than 99 acres. These areas are primarily dry upland sites, composed of short native bunch grasses, minimal litter cover, patches of bare ground, scattered forbs, and short shrubs. Fence posts and shrubs are used as song perches. Bare ground is important for allowing adult birds and young to run and escape predators and to search for insects. Hayfields and other agricultural uses do not generally provide suitable vegetative structure for this species. (Vickery 1996, Mass Audubon 2013). There are no suitable habitat areas for this species within the Project Area.

Henslow's Sparrow

Records from NHNHB indicate that Henslow's sparrow (*Ammodramus savannarum*) was historically present near the Project in Newington, but has not been recorded within it. This species is tracked by NHNHB but is not listed by State of New Hampshire. Preferred breeding habitats in the Northeast are wet meadows with tall, dense vegetation and thick litter. Hayfields and other agricultural uses do not generally provide suitable vegetative structure for Henslow's sparrow (Herkert 2003). No survey for this species was conducted as the NHNHB records are historic and not within the Project Area.

Least Bittern

Records from NHNHB indicate that least bittern (*Ixobrychus exilis*; Species of Special Concern) was historically present near the Project in Durham, but has not been recorded within it. This species is associated with various types of shallow and deep marsh dominated by grass-like species, including cattails, bulrushes, and sedges. Some woody or shrubby vegetation is usually also present. This species is most likely to be present in wetlands at least 12 acres in size, but will use wetlands as small as one acre (Poole et al. 2009). Ideal habitat consists of an equitable mix of open water and dense vegetation patches. No survey for this species was conducted as the NHNHB records are historic and not within the Project Area, and habitat within the Project Area is marginal.

Roseate Tern

The northeast population of the roseate tern (*Sterna dougallii*) is listed as endangered under both federal and New Hampshire State Endangered Species Acts. Records from NHNHB indicate that this species has not been observed in the vicinity of the Project Area. This species breeds in small numbers (<100 pairs) on New Hampshire's coastal islands during the spring and summer, then migrates south during the colder months of the year. Roseate terns feed on a variety of fish and smaller invertebrates, generally hunting over open ocean, but sometimes hunting or loafing in coastal locations, including shorelines and estuaries. The Great Bay could potentially offer some foraging resources to this species. Based on e-bird reports form the last 10 years, this species is seen regularly in coastal locations in Rye and New Castle. There are no inland reports of this species, including no reports from Great Bay.

Sedge Wren

Records from NHNHB indicate that the Sedge wren (*Cistothorus platensis*; State Endangered) was historically present near the Project in Durham, but has not been recorded within it. This species nests among dense, tall growths of sedges and grasses in wet meadows, hayfields, retired croplands, upland margins of ponds and marshes, coastal marshes, and sphagnum bogs. Sedge wrens usually avoid short, sparse, or open vegetative cover, flooded areas, and wetlands dominated by cattails (Herkert et al. 2011). This species reaches its greatest densities in the grassland regions of the upper midwest and adjacent Canada, in the early part of the breeding season. Later in the breeding season it appears in lower densities in other regions, including New England, but it is notorious for its erratic and inconsistent distribution outside its core upper midwest range (Herkert et al. 2011).

Based on its erratic and inconsistent distribution in New England, the historic nature of the records for it, and the small amount of suitable habitat, this species is unlikely to be present in the Project Area. No survey was conducted.

Upland Sandpiper

Records from NHNHB indicate that upland sandpiper (*Bartramia longicauda*; State Endangered) was historically present near the Project in Newington, but has not been recorded within it. This species requires extensive grassland (>30 hectares) breeding sites. Habitat requirements consist of dry grasslands with low to moderate forb cover, low woody cover, moderate grass cover, moderate to high litter cover, and little bare ground (Dechant et al. 2003). Fence posts may be used song perches, but even sparse shrub cover is avoided. Regularly mowed fields (hay) do not generally provide suitable vegetative structure for this species. There is no suitable habitat for this species within the Project Area, and no surveys were conducted for it.

2.6 Mammals

Northern Long-eared Bat

The northern long-eared bat (NLEB; *Myotis septrionalis*) is state and federally threatened. Therefore, a formal consultation with the USFWS is required as part of the permitting process (See NLEB Biological Assessment, in appendices). The USFWS rules and guidance on this species is still evolving. The interim 4(d) rule published as part of the NLEB's April 2, 2015 listing allows tree clearing for expansions of transmission corridors up to 100 feet from the edge of an existing cleared Project Area, but the final rule may contain different or additional requirements. PSNH is committed to meeting the USFWS rules when finalized.

Existing information about NLEB summarized in the NHWAP indicates that this species has been recorded in Carroll, Coos, Cheshire, Grafton, Hillsborough and Rockingham counties (Preston 2015). Unpublished data also indicates that this species was detected at Great Bay NWR in 2014. Additionally, the known range of the NLEB encompasses the entire Northeast, making it almost certainly a resident throughout New Hampshire. The USFWS considers all coastal towns in New Hampshire to be known NLEB habitat.

NLEB summer roosts have been documented in forested habitats, primarily in deciduous trees under loose bark, tree hollows, and crevices, and sometimes in wooden structures such as barns (Preston 2015). In New Hampshire, data from the White Mountain National Forest (WMNF) indicated that the majority of NLEB summer roosts were in large snags, but live trees were also used. Large, tall trees/snags with intact bark and moderate levels of decay were commonly used, especially if they had hollows. Maternity roosts were almost always in hardwood trees and generally in trees that were taller than the stand average, with a preponderance of 'recently dead' trees being used (Sasse 1995). Summer habitat is considered widespread and abundant for this species across its range.

Female NLEBs form maternity colonies ranging from a few to more than 100 individuals roosting in cavities within snags or under exfoliating bark of live or dead trees. Although these colonies are generally located in closed forest locations, exposure to sunlight and consequently warmer temperatures are preferred, as warmer temperatures promote more rapid development of young. Throughout much of their range, female NLEBs typically switch roost trees every few days and may travel up to two kilometers between successive roost trees, but roosts are commonly clustered in small (less than 20 hectares) areas (Johnson et al. 2009).

These bats are non-migratory and hibernate locally in caves, rock overhangs, and mines. In summer they use forested habitats and are adapted for flight in more cluttered environments than other bat species. This allows NLEB to forage more extensively under the forest canopy then other bat species, as well as in forest openings, and only uncommonly over open water.

New England Cottontail

Records from NHNHB indicate that New England Cottontail (*Sylvilagus transitionalis*; State Endangered) has not been recorded within the vicinity of Project. However, there are parcels being actively managed to create suitable habitat for New England cottontail (described below) in the Towns of Lee, Durham, and Dover. Two of the parcels being managed in Durham abut the Project Area, UNH's Foss Farm and NHFG's LaRoche Brook parcels.

The New England cottontail requires early successional habitats, and depends more upon vegetation structure (form, height, and density) rather than specific species (Litvaitis and Jakubas 2004). Preferred habitats include shrubby old fields and regenerating clear cuts. Regenerating clear cuts used by New England cottontail usually include hardwoods such as birch, aspen, and red maple; conifer regeneration does not seem to attract New England cottontail (newenglandcottontail.org 2012). Studies indicate that New England cottontails are reluctant to venture more than 5 meters (16 feet) from cover within their habitat patches (Barbour and Litvaitis 1993). Adult rabbits stay within their home range and make few long distance movements. However, sub-adult males normally make long one-way movements outside of their natal patch. Long-range movements for sub-adult females are less common. In summer, diets of the New England cottontail consist of a wide variety of herbaceous plant. During winter months, New England cottontail feeds mainly on woody browse from small trees, shrubs, and vines (Litvaitis and Jakubas 2004). New England cottontail are preyed upon by a wide variety of predators and individuals have a life expectancy of less than 2 years (newenglandcottontail.org 2012)

The SRP currently contains an existing narrow cleared corridor, abutted by a railroad corridor along the western side. Power line corridors in New England are one of the best sources of shrubby habitats in a landscape which is largely forested. Regular vegetation maintenance in these corridors creates shrubby conditions that New England cottontails require, and the extensive, linear nature of a corridor can provide connections to other patches of shrubland. The proposed SRP will widen the existing power line corridor, creating incrementally more shrub habitat. The current habitat quality offered by the existing power line corridor is likely to be improved by the additional width. PSNH currently collaborates with NHFG during maintenance on transmission corridors to improve habitat for this species, and will do so on this project.

3.0 Discussion

The results of field surveys and desktop analyses indicate that the Project Area currently provides habitat for several state and federally protected species, including: 1 plant, 4 natural communities, 1 invertebrate, 5 fish, 3 reptiles, 2 birds and 2 mammals (Table 3-1). Permanent impacts of the Project include placement of new transmission structures, removal of existing wooden poles, and vegetation clearing to remove trees to clear a maximum corridor width of 100 feet. Temporary impacts include mowing the work area, timber mats placed in work areas in wetlands and other sensitive resources to provide access for construction equipment, trenching (cut and cover) in the sections proposed for underground cable on land, and use of a jetplow to bury three cables under Little Bay.

In general, impacts to protected species will be managed through Best Management Practices during construction. Examples include pre-construction surveys to ensure the absence of nesting bald eagles and osprey (if either species is breeding within or near the Project Area, time-of-year restrictions may apply); repeated searches during construction to clear the active work area of turtles and snakes; hand cutting in the vicinity of the ringed boghaunter habitat in the unlikely case that larvae use the marginal habitat in the Project Area; and minimization of clearing preferred shrubby areas in New England cottontail habitat.

Approximately 0.02 acres of unavoidable temporary impacts to the fringing salt marsh will be restored following burial of the cable. Restoration techniques will include salvaging the intact peat prior to trenching for replacement after the cables are buried. Temporary impacts to rocky shore may also occur. The extent of impacts will depend on the most suitable approach to traversing the rocky shore, and will in turn depend on the type of ledge and the installer. Possibilities include cut and cover, and surface burial in a protective cover. The resulting impacted area will be restored to its original configuration to the extent possible. Recolonization by macroalgae on rocky substrates is expected to occur naturally.

The intertidal flats and subtidal bottom will be allowed to restore and recolonize naturally after completion of the cable installation. The jetplow process will disturb sediments while laying the cable, but the water pressure of the jets and the speed of the plow will be controlled to minimize sediments going into suspension in the water column. The currents within the channel and wave and ice action on the tidal flats are expected to restore existing bottom contours in the vicinity of the trenches, followed by recolonization of benthic infauna and ultimately shellfish after completion of construction.

Monitoring of all impacted tidal and freshwater resources will occur both during and after construction to assess the success of the habitat restoration.

Table 3-1. Protected species and Exemplary Vegetation Communities known to, or likely to occur, in the SRP corridor.

Species	Status[1]	Species Management
Crested Sedge (*Carex cristatella*)	E	Possible impacts during tree clearing, minimize by clearing in dormant season.
Salt marsh system	Tracked but not listed	Temporary impacts, restore habitat
High salt marsh	Tracked but not listed	Temporary impacts, restore habitat
Sparsely vegetated intertidal system	Tracked but not listed	Temporary impacts, restore habitat
Subtidal system	Tracked but not listed	Temporary impacts, restore habitat
Ringed Boghaunter (*Williamsonia lintneri*)	E	Marginal habitat; hand cut along stream to avoid impacts to larvae
Short-nosed Sturgeon (*Acipenser brevirostrum)*	Ext, E*	Not likely to be adversely affected – will avoid jetplow and can tolerate high TSS
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus)*	T*	Not likely to be adversely affected – will avoid jetplow and can tolerate high TSS
American Eel (*Anguilla rostrata*)	SC	No impacts anticipated – all streams avoided or bridged. Fall construction period will avoid silver migrants.
Banded Sunfish (*Enneacanthus obesus*)	SC	No impacts anticipated – construction and clearing in all known habitat avoided
Swamp Darter (*Etheostoma fusiforme*)	SC	No impacts anticipated – no construction or clearing in Oyster River
Northern Black Racer (*Coluber constrictor constrictor*)	T	Survey to remove individuals from construction area; wider maintained corridor may benefit species
Blanding's Turtle (*Emydoidea blandingii*)	E	Survey to remove individuals from construction areas
Spotted Turtle (*Clemmys guttata*)	T	Survey to remove individuals from construction areas
Bald Eagle (*Haliaeetus leucocephalus*)	T	Nest survey before construction
Osprey (*Pandion haliaetus*)	SC	Nest survey before construction

(continued)

Table 3-1. (Continued)

Species	Status[1]	Species Management
Northern Long-eared Bat (*Myotis septrionalis)*	T, T*	The current 4(d) rule issued as part of the federal listing of this species allows expansion of existing transmission corridors of 100 feet or less if there are no impacts to known maternity roosts; there are no known roosts in the Project Area.
New England Cottontail (*Sylvilagus transitionalis)*	E	No known occurrence. Use BMPs to minimize adverse habitat impacts; work with NHFG to enhance habitat during corridors maintenance.

1. E-State Endangered
   T- State Threatened
   SC-State Special Concern
   Ext - Extirpated
   *-Federal status

4.0 References

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Appendix A (separate doc in Draft due to file size)

Protected Species Records from NH Natural Heritage Bureau, US Fish and Wildlife Service and National Marine Fisheries Service

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 COMMERCIAL STREET, SUITE 300
CONCORD, NH 3301
PHONE: (603)223-2541 FAX: (603)223-0104
URL: www.fws.gov/newengland

Consultation Tracking Number: 05E1NE00-2015-SLI-0118 November 20, 2014
Project Name: PSNH Seacoast Reliability Project

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project.

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment

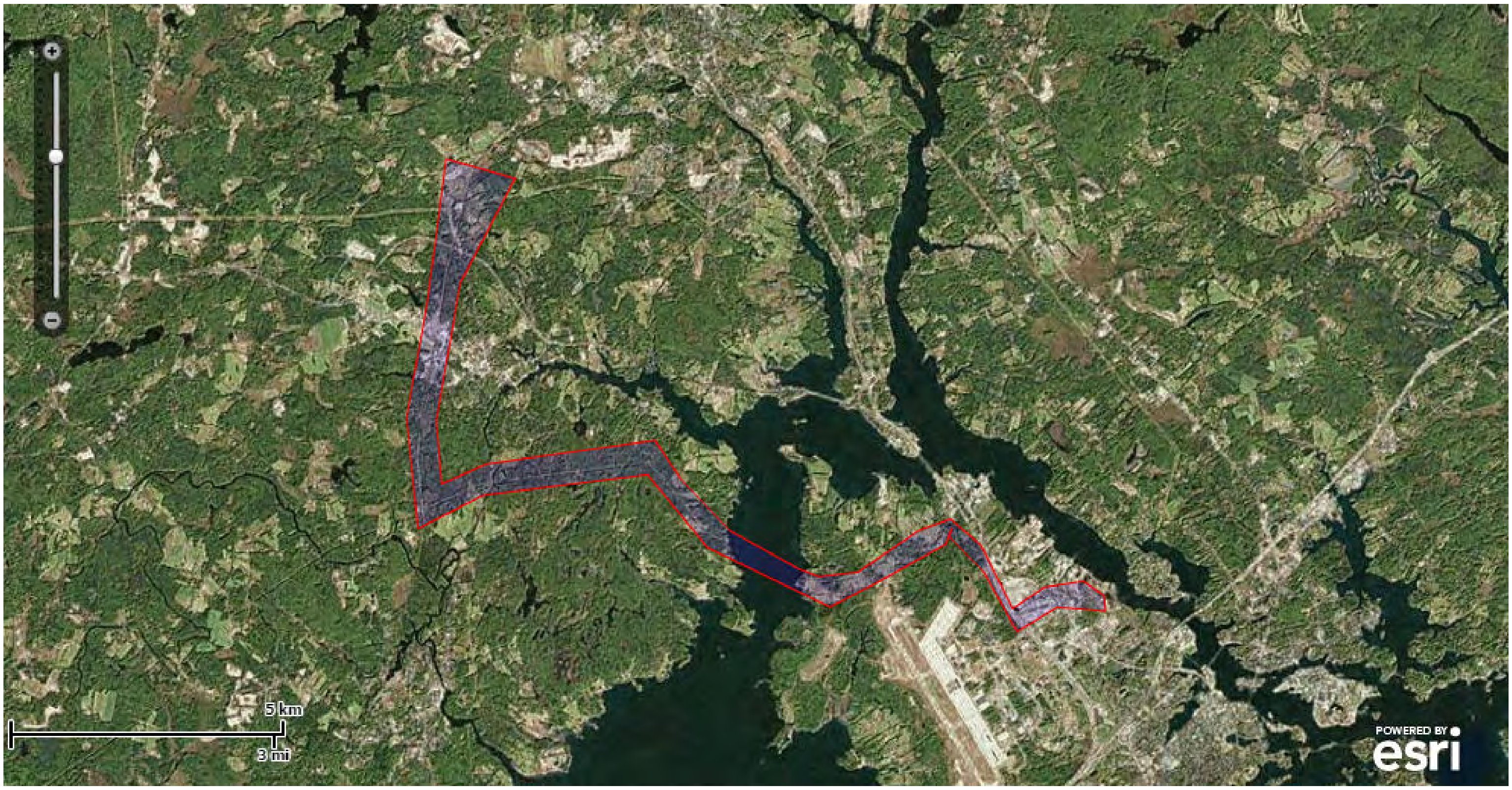
Official Species List

Provided by:

New England Ecological Services Field Office
70 COMMERCIAL STREET, SUITE 300
CONCORD, NH 3301
(603) 223-2541
http://www fws.gov/newengland

Consultation Tracking Number: 05E1NE00-2015-SLI-0118
Project Type: Transmission Line
Project Description: PSNH is proposing to construct a new 13-mile 115kV transmission line between their Madbury and Portsmouth substations. It will
predominantly follow existing ROW. It will cross the Great Bay National Wildlife Refuge and have a submarine segment under
Little Bay

Project Location Map:



Project Coordinates: MULTIPOLYGON (((-70.9179682 43.1648082, -70.9182446 43.164808, -70.9306041 43.1475873, -70.9360124 43.1249784, -70.9348108 43.1145158, -70.9246825 43.1178352, -70.8865746 43.1217195, -70.8809107 43.1154562, -70.8697527 43.1068719, -70.8541315 43.1005426, -70.8495825 43.0992892, -70.8407419 43.1000413, -70.8269223 43.1069346, -70.8198842 43.1087518, -70.8131036 43.1045534, -70.8058938 43.0940246, -70.798684 43.0975344, -70.7898435 43.0985372, -70.7852944 43.0961556, -70.7851228 43.0956542, -70.7848825 43.0935828, -70.7904442 43.093962, -70.7957657 43.0942754, -70.8048637 43.0902013, -70.812434 43.1001008, -70.8202265 43.1058694, -70.8196256 43.1071853, -70.8196256 43.107248, -70.8208273 43.1046787, -70.8369634 43.0980985, -70.8470915 43.0942722, -70.8747353 43.1040522, -70.8882965 43.1160829, -70.9253754 43.1126995, -70.9401382 43.1071854, -70.9427046 43.1254802, -70.9378809 43.1450221, -70.933761 43.1680635, -70.9179682 43.1648082)))

Project Counties: Rockingham, NH | Strafford, NH

Endangered Species Act Species List

There are a total of 2 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

Birds	**Status**	**Has Critical Habitat**	**Condition(s)**
Roseate tern *(Sterna dougallii dougallii)* Population: northeast U.S. nesting pop.	Endangered		
Flowering Plants			
Small Whorled pogonia *(Isotria medeoloides)*	Threatened		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

DEC - 2 2014

Ann E. Pembroke
Vice President
Normandeau Associates, Inc.
25 Nashua Rd.
Bedford, NH 03110

Re: Public Service of New Hampshire Seacoast Reliability Project

Dear Ms. Pembroke:

This is in response to your letter received November 24, 2014 requesting information on the presence of species listed under the Endangered Species Act by NOAA's National Marine Fisheries Service (NMFS) in the proposed project area. The proposed project involves constructing a new 115 kilovolt (kV) transmission line between the existing Madbury and Portsmouth substations. The 12.9 mile long project begins at the existing Public Service of New Hampshire (PSNH) Madbury Substation in Madbury, traverses Durham, crosses Little Bay via an underwater cable into Newington, and then continues east before ending in Portsmouth. The method of installing the underwater cable has not been decided.

The following endangered species may occur in Little Bay and Oyster River: Shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (Distinct Population Segments [DPS]: New York Bight, Chesapeake Bay, Carolina, South Atlantic).

The following threatened species may occur in Little Bay and Oyster River: Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (Distinct Population Segments [DPS]: Gulf of Maine).

Conclusion

As listed species of sturgeon may occur in Little Bay and Oyster River, and thus, within the vicinity of your proposed project, any proposed in-water work has the potential to impact these species. If your project involves dredging or sediment disturbance, we would recommend placing a turbidity curtain around the project area. This will not only contain suspended sediment within the affected area, but will also prevent sturgeon from coming in contact with any increased turbidity or mechanical activity associated with the project. We would also recommend using the Horizontal Directional Drilling (HDD) method in installing the underwater cable as it would also prevent sturgeon from coming into contact with any mechanical activity.

As project details become finalized, a consultation, pursuant to section 7 of the Endangered Species Act (ESA) of 1973, as amended, may be necessary as any discretionary federal action, such as the approval or funding of a project by a federal agency, that may affect a listed species must undergo consultation pursuant to section 7 of the ESA of 1973, as amended. If the proposed project has the potential to affect listed species, and it is being approved, permitted or funded by a Federal agency, the lead Federal agency, or their designated non-Federal representative, is responsible for determining whether the proposed action is likely to affect the listed species. The Federal agency would submit their determination along with justification for their determination and a request for concurrence, to the attention of the ESA Section 7 Coordinator, NMFS Greater Atlantic Fisheries Regional Office, Protected Resources Division, 55 Great Republic Drive, Gloucester, MA 01930. After reviewing this information, NMFS would then be able to conduct a consultation under section 7 of the ESA. Should you have any questions about these comments or about the section 7 consultation process in general, please contact Edith Carson at 978-282-8490 or by email Edith.Carson@noaa.gov.

Essential Fish Habitat (EFH)
NMFS Habitat Conservation Division (HCD) is responsible for conducting consultations with State and Federal agencies for proposed actions that may adversely affect EFH and other NOAA trust resources. HCD's Mike Johnson sent you an email on November 24, 2014 regarding EFH in your proposed project area. If you have any further questions regarding EFH, please contact Mike Johnson at 978-281-9130 or by email at Mike.R.Johnson@noaa.gov.

Sincerely,

for

Kimberly Damon-Randall
Assistant Regional Administrator
for Protected Resources

EC: Carson, NMFS/PRD
File Code: Section 7/Nonfisheries/Private Firms/Technical Assistance/2014/ Normandeau Public Service of NH Seacoast Reliability Project

Memo

NH NATURAL HERITAGE BUREAU
NHB DATACHECK RESULTS LETTER

To: Susan Hegarty, Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110

From: Amy Lamb, NH Natural Heritage Bureau
Date: 11/9/2015 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB15-3561   Town: Madbury, Durham, Newington, Portsmouth   Location:

Description: Eversource is proposing to construct a new 13-mile 115kV transmission line between their Madbury and Portsmouth substations. It will predominantly follow existing ROW. It will consist primarily of overhead structures, but will have an underground section at UNH in Durham and will have a submarine segment under Little Bay. This is an update request. Our previously requested data expired on 10/2/2015. NHB file ID: NHB14-3618.

cc: Kim Tuttle

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments: This review is a follow-up to NHB14-3618 (9/24/2014) and the NHB14-3618 Addendum (10/2/2014). Continued coordination with NHB and NH Fish & Game is needed as this project progresses through permitting.

Invertebrate Species	**State[1]**	**Federal**	**Notes**
Ringed Boghaunter (*Williamsonia lintneri*)	E	--	Contact the NH Fish & Game Dept (see below).

Natural Community	**State[1]**	**Federal**	**Notes**
Hemlock - beech - oak - pine forest	--	--	Threats include logging, introduction of invasive species, and direct destruction due to development.
High salt marsh	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
Red maple - sensitive fern swamp	--	--	These swamps are influenced by groundwater seepage and springs which moderate water fluctuations and maintain conditions favorable for the accumulation of organic matter. The primary threats are changes to the hydrology of the wetland complex, particularly raising or lowering the water levels, and increased nutrient and pollutant input carried in by stormwater runoff.

Salt marsh system	--	--	Threats are primarily changes to the hydrology of the system, introduction of invasive species, and increased input of nutrients and pollutants.
Sparsely vegetated intertidal system	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as alterations that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
Subtidal system	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as alterations that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.

Plant species	**State[1]**	**Federal**	**Notes**
Black Maple (*Acer nigrum*)	T	--	Threats are primarily damage to its floodplain or riverbank habitat, including changes to local hydrology, land conversion and fragmentation, introduction of invasive species, and increased input of nutrients and pollutants.
bulbous bitter-cress (*Cardamine bulbosa*)	E	--	This species occurs in forested swamps, low floodplain forest, and moist thickets.. Threats to the plants include canopy removal and destruction (draining) of its habitat.
crested sedge (*Carex cristatella*)*	E	--	This wetland species, which occurs in bogs, fens, seeps, and wet meadows, would be threatened by changes to local hydrology, including increased nutrient input from stormwater runoff, and sedimentation from nearby disturbance.
Engelmann's Quillwort (*Isoetes engelmannii*)*	E	--	Primarily vulnerable to changes to the hydrology of its wetland habitat, especially alterations that change water levels. It may also be susceptible to increased pollutants and nutrients carried in stormwater runoff.
great bur-reed (*Sparganium eurycarpum*)	T	--	Threats to aquatic species include changes in water quality, e.g., due to pollution and stormwater runoff, and significant changes in water level.
greater fringed-gentian (*Gentianopsis crinita*)*	T	--	Vulnerable to shading by invading trees and to disturbances that destroy plants or impede their ability to reproduce (such as mowing in the mid-summer while the plants are in bloom).
Marsh Elder (*Iva frutescens*)	T	--	Threats are primarily alterations to the hydrology of the wetland, such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat, activities that eliminate plants, and increased input of nutrients and pollutants in storm runoff.
Rigid Sedge (*Carex tetanica*)*	--	--	This plant relies on open habitat, and maintenance of the hydrology of any wetland where it occurs.
Sensitive species	T	T	Please contact NH Natural Heritage (271-2215 x 323) if project impacts could occur

in the area shown on the map.

Vertebrate species	State[1]	Federal	Notes
American Eel (*Anguilla rostrata*)	SC	--	Contact the NH Fish & Game Dept (see below).
Bald Eagle (*Haliaeetus leucocephalus*)	T	--	Contact the NH Fish & Game Dept (see below).
Banded Sunfish (*Enneacanthus obesus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Blanding's Turtle (*Emydoidea blandingii*)	E	--	Contact the NH Fish & Game Dept (see below).
Eastern Hognose Snake (*Heterodon platirhinos*)*	E	--	Contact the NH Fish & Game Dept (see below).
Grasshopper Sparrow (*Ammodramus savannarum*)	T	--	Contact the NH Fish & Game Dept (see below).
Least Bittern (*Ixobrychus exilis*)	SC	--	Contact the NH Fish & Game Dept (see below).
Northern Black Racer (*Coluber constrictor constrictor*)	T	--	Contact the NH Fish & Game Dept (see below).
Osprey (*Pandion haliaetus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Sea Lamprey (*Petromyzon marinus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Sedge Wren (*Cistothorus platensis*)	E	--	Contact the NH Fish & Game Dept (see below).
Spotted Turtle (*Clemmys guttata*)	T	--	Contact the NH Fish & Game Dept (see below).
Swamp Darter (*Etheostoma fusiforme*)	SC	--	Contact the NH Fish & Game Dept (see below).
Upland Sandpiper (*Bartramia longicauda*)	E	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "SC" = Special Concern, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544.

A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

Memo

NH Natural Heritage Bureau
NHB Datacheck Results Letter

To: Susan Hegarty, Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110

From: Melissa Coppola, NH Natural Heritage Bureau
Date: 9/24/2014 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB14-3618 Town: Madbury, Durham, Newington, Portsmouth Location: new 13-mile 115kv transmission line

Description: PSNH is proposing to construct a new 13 mile 115kV transmission line between their Madbury and Portsmouth substations. It will predominantly follow existing right-of-way. It will cross Great Bay National Wildlife Refuge and have a submarine segment under Little Bay.

cc: Kim Tuttle, Maria Tur

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments: NHB recommends a pre-application meeting to discuss the details of the project and to address NHB and Fish and Game concerns and survey needs.

Natural Community	State[1]	Federal	Notes
Hemlock - beech - oak - pine forest	--	--	Threats include logging, introduction of invasive species, and direct destruction due to development.
High salt marsh	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
Red maple - sensitive fern swamp	--	--	These swamps are influenced by groundwater seepage and springs which moderate water fluctuations and maintain conditions favorable for the accumulation of organic matter. The primary threats are changes to the hydrology of the wetland complex, particularly raising or lowering the water levels, and increased nutrient and pollutant input carried in by stormwater runoff.
Salt marsh system	--	--	Threats are primarily changes to the hydrology of the system, introduction of invasive species, and increased input of nutrients and pollutants.
Sparsely vegetated intertidal system	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as alterations that might affect the sheet flow of tidal waters across the intertidal

			flat) and increased input of nutrients and pollutants in storm runoff.
Subtidal system	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as alterations that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.

Plant species	**State[1]**	**Federal**	**Notes**
bulbous bitter-cress (*Cardamine bulbosa*)	E	--	This species occurs in forested swamps, low floodplain forest, and moist thickets.. Threats to the plants include canopy removal and destruction (draining) of its habitat.
crested sedge (*Carex cristatella*)*	E	--	This wetland species, which occurs in bogs, fens, seeps, and wet meadows, would be threatened by changes to local hydrology, including increased nutrient input from stormwater runoff, and sedimentation from nearby disturbance.
great bur-reed (*Sparganium eurycarpum*)	T	--	Threats to aquatic species include changes in water quality, e.g., due to pollution and stormwater runoff, and significant changes in water level.
greater fringed-gentian (*Gentianopsis crinita*)*	T	--	Vulnerable to shading by invading trees and to disturbances that destroy plants or impede their ability to reproduce (such as mowing in the mid-summer while the plants are in bloom).
Marsh Elder (*Iva frutescens*)	T	--	Threats are primarily alterations to the hydrology of the wetland, such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat, activities that eliminate plants, and increased input of nutrients and pollutants in storm runoff.
Rigid Sedge (*Carex tetanica*)*	--	--	This plant relies on open habitat, and maintenance of the hydrology of any wetland where it occurs.
Sensitive species	T	T	Please contact NH Natural Heritage (271-2215 x 323) if project impacts could occur in the area shown on the map.

Vertebrate species	**State[1]**	**Federal**	**Notes**
American Eel (*Anguilla rostrata*)	SC	--	Contact the NH Fish & Game Dept (see below).
Bald Eagle (*Haliaeetus leucocephalus*)	T	--	Contact the NH Fish & Game Dept (see below).
Blanding's Turtle (*Emydoidea blandingii*)	E	--	Contact the NH Fish & Game Dept (see below).
Eastern Hognose Snake (*Heterodon platirhinos*)*	E	--	Contact the NH Fish & Game Dept (see below).
Golden-winged Warbler (*Vermivora chrysoptera*)*	SC	--	Contact the NH Fish & Game Dept (see below).
Grasshopper Sparrow (*Ammodramus savannarum*)	T	--	Contact the NH Fish & Game Dept (see below).

Henslow's Sparrow (*Ammodramus henslowii*)*	--	--	Contact the NH Fish & Game Dept (see below).
Least Bittern (*Ixobrychus exilis*)	SC	--	Contact the NH Fish & Game Dept (see below).
Northern Black Racer (*Coluber constrictor constrictor*)	T	--	Contact the NH Fish & Game Dept (see below).
Osprey (*Pandion haliaetus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Sedge Wren (*Cistothorus platensis*)	E	--	Contact the NH Fish & Game Dept (see below).
Spotted Turtle (*Clemmys guttata*)	T	--	Contact the NH Fish & Game Dept (see below).
Swamp Darter (*Etheostoma fusiforme*)	SC	--	Contact the NH Fish & Game Dept (see below).
Upland Sandpiper (*Bartramia longicauda*)	E	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "SC" = Special Concern, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544. Contact for federally-listed animals: Anthony Tur, US FWS, at (603) 223-2541. Contact for federally-listed species: Maria Tur, US FWS, at (603) 223-2541.

A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

Department of Resources and Economic Development
Division of Forests and Lands
(603) 271-2214 fax: 271-6488

DRED/NHB
PO Box 1856
Concord NH 03302-1856

Memo

To: Susan Hegarty, Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110

ADDENDUM TO NHB14-3618

From: Melissa Coppola, NH Natural Heritage Bureau
Date: 10/2/2014 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB14-3618 Addendum   Town: Madbury, Durham, Newington, Portsmouth   Location: new 13-mile 115kv transmission line
Description: PSNH is proposing to construct a new 13 mile 115kV transmission line between their Madbury and Portsmouth substations. It will predominantly follow existing right-of-way. It will cross Great Bay National Wildlife Refuge and have a submarine segment under Little Bay.
cc: Kim Tuttle

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments: NHB recommends a pre-application meeting to discuss the details of the project and to address NHB and Fish and Game concerns and survey needs.

Invertebrate Species	State[1]	Federal	Notes
Ringed Boghaunter (*Williamsonia lintneri*)	E	--	Contact the NH Fish & Game Dept (see below).

Plant species	State[1]	Federal	Notes
Black Maple (*Acer nigrum*)	T	--	Threats are primarily damage to its floodplain or riverbank habitat, including changes to local hydrology, land conversion and fragmentation, introduction of invasive species, and increased input of nutrients and pollutants.
Engelmann's Quillwort (*Isoetes engelmannii*)*	E	--	Primarily vulnerable to changes to the hydrology of its wetland habitat, especially alterations that change water levels. It may also be susceptible to increased pollutants and nutrients carried in stormwater runoff.

Vertebrate species	State[1]	Federal	Notes
Banded Sunfish (*Enneacanthus obesus*)	SC	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "SC" = Special Concern, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

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(603) 271-2214 fax: 271-6488

DRED/NHB
PO Box 1856
Concord NH 03302-1856

Memo

NH Natural Heritage Bureau
NHB Datacheck Results Letter

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544.

A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. An on-site survey would provide better information on what species and communities are indeed present.

Memo

NH NATURAL HERITAGE BUREAU
NHB DATACHECK RESULTS LETTER

To: Sarah Allen, Normandeau Associates
25 Nashua Rd
Bedford, NH 03110

From: Melissa Coppola, NH Natural Heritage Bureau
Date: 8/13/2013 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB13-2434 Town: Madbury, Durham, Newington, Portsmouth Location: Tax Maps: multiple

Description: PSNH is proposing to construct a new 13-mile 115kV transmission line between their Madbury and Portsmouth substations. It will predominantly follow existing ROW. It will cross the Great Bay National Wildlife Refuge and have a submarine segment under Little Bay.

cc: Kim Tuttle

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments: NHB recommends a pre-application meeting to discuss the details of the project and to address NHB and NH Fish and Game concerns.

Invertebrate Species	State[1]	Federal	Notes
Ringed Boghaunter (*Williamsonia lintneri*)	E	--	Contact the NH Fish & Game Dept (see below).

Natural Community	State[1]	Federal	Notes
Hemlock - beech - oak - pine forest	--	--	Threats include logging, introduction of invasive species, and direct destruction due to development.
Red maple - sensitive fern swamp	--	--	These swamps are influenced by groundwater seepage and springs which moderate water fluctuations and maintain conditions favorable for the accumulation of organic matter. The primary threats are changes to the hydrology of the wetland complex, particularly raising or lowering the water levels, and increased nutrient and pollutant input carried in by stormwater runoff.
Sparsely vegetated intertidal system	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as alterations that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
Subtidal system	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as alterations that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.

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DRED/NHB
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Memo

Plant species	State[1]	Federal	Notes
Black Maple (*Acer nigrum*)	T	--	Threats are primarily damage to its floodplain or riverbank habitat, including changes to local hydrology, land conversion and fragmentation, introduction of invasive species, and increased input of nutrients and pollutants.
bulbous bitter-cress (*Cardamine bulbosa*)	E	--	This species occurs in forested swamps, low floodplain forest, and moist thickets.. Threats to the plants include canopy removal and destruction (draining) of its habitat.
crested sedge (*Carex cristatella*)*	E	--	This wetland species, which occurs in bogs, fens, seeps, and wet meadows, would be threatened by changes to local hydrology, including increased nutrient input from stormwater runoff, and sedimentation from nearby disturbance.
Engelmann's Quillwort (*Isoetes engelmannii*)*	E	--	Primarily vulnerable to changes to the hydrology of its wetland habitat, especially alterations that change water levels. It may also be susceptible to increased pollutants and nutrients carried in stormwater runoff.
great bur-reed (*Sparganium eurycarpum*)	T	--	Threats to aquatic species include changes in water quality, e.g., due to pollution and stormwater runoff, and significant changes in water level.
greater fringed-gentian (*Gentianopsis crinita*)*	T	--	Vulnerable to shading by invading trees and to disturbances that destroy plants or impede their ability to reproduce (such as mowing in the mid-summer while the plants are in bloom).
Rigid Sedge (*Carex tetanica*)*	--	--	This plant relies on open habitat, and maintenance of the hydrology of any wetland where it occurs.

Vertebrate species	State[1]	Federal	Notes
American Eel (*Anguilla rostrata*)*	SC	--	Contact the NH Fish & Game Dept (see below).
Banded Sunfish (*Enneacanthus obesus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Blanding's Turtle (*Emydoidea blandingii*)	E	--	Contact the NH Fish & Game Dept (see below).
Northern Black Racer (*Coluber constrictor constrictor*)	T	--	Contact the NH Fish & Game Dept (see below).
Sedge Wren (*Cistothorus platensis*)	E	--	Contact the NH Fish & Game Dept (see below).
Spotted Turtle (*Clemmys guttata*)	T	--	Contact the NH Fish & Game Dept (see below).
Swamp Darter (*Etheostoma fusiforme*)	SC	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "SC" = Special Concern, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

Memo

NH Natural Heritage Bureau
NHB Datacheck Results Letter

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544.

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Appendix D: Biological Assessment for the Northern Long-eared Bat for the Seacoast Reliability Project

NORMANDEAU ASSOCIATES
Environmental Consultants

Public Service of New Hampshire
Seacoast Reliability Project

Strafford and Rockingham Counties, NH

Biological Assessment for the Northern Long-eared Bat

Prepared For:
Public Service Company of New Hampshire
d/b/a Eversource Energy
780 North Commercial Street
Manchester, NH 03101

Submitted:
February 2016

Prepared By:
Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110

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1.0 Introduction

This Biological Assessment ("BA") documents potential effects of the Seacoast Reliability Project ("Proposed Action") on the Northern Long-eared bat ("NLEB", *Myotis septrionalis*). The Seacoast Reliability Project ("SRP") is a new 115 kilovolt ("kV") transmission line proposed to be located in the Towns of Madbury, Durham and Newington as well as the City of Portsmouth, in Strafford and Rockingham Counties, New Hampshire. The SRP will be built within an existing power line corridor, but will require some additional tree clearing within the corridor limits to accommodate the new line.

The federal nexus for this BA is the 404 permit required under the Clean Water Act for the Proposed Action. The applicant is Public Service of New Hampshire d/b/a Eversource Energy ("PSNH"), which engages in electric delivery to businesses and residences throughout New Hampshire. PSNH has extensive experience constructing and operating transmission lines and operates New England's largest utility system, which serves more than 3.6 million electric and natural gas customers in Connecticut, Massachusetts, and New Hampshire.

2.0 Project Description

2.1 Construction

The SRP will be approximately 12.9 miles long and include a combination of overhead, underground, and underwater components. It will travel through existing electric utility corridors,[1] including a submarine cable crossing from Durham to Newington under Little Bay (Figure 1). The Project will not change existing land uses within or along the corridor. Most of the project's route is within or along the edge of forested areas. The entire line will be constructed within existing electric corridors, with minor adjustments to the corridor widths in several locations. The corridor ranges from 50-300 feet wide, but is predominantly 100 feet wide. For most of the length of the corridor, a cleared area approximately 60 feet in width is currently maintained by PSNH by periodic mowing in support of the existing electric distribution line. Construction will require expanding this cleared area by up to 40 feet, to a maximum width of 100 feet in some locations. This expansion will result in the removal of approximately 31 acres of forest cover.

The majority of the SRP will be constructed aboveground on overhead structures between 85 and 120 feet in height. It will cross under Little Bay by being buried 3.5-8 feet in the substrate using a combination of jetplow and hand-jet technology. In most locations, the existing distribution line will be co-located on the new structures and the existing distribution structures will be removed. In several locations, the existing distribution line

[1] The Project corridor is defined as the combination of the existing PSNH owned utility easements, PSNH fee owned property, and any and all other easements, licenses or the PanAm railway right-of-way, in which the Project facilities will be located.

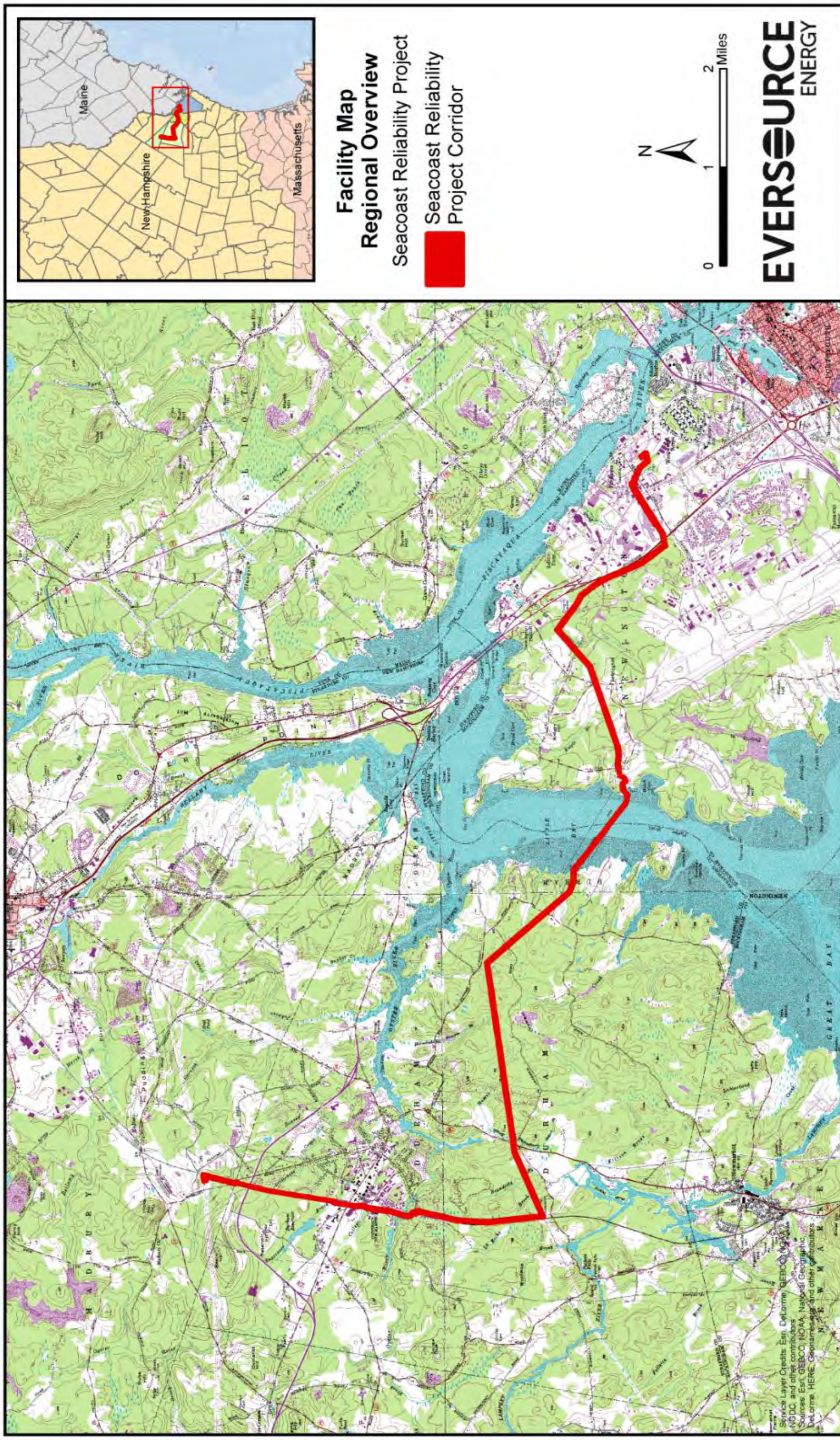

Figure 1. Seacoast Reliability Project Location Map.

will be relocated to the side of the project corridor and the new structures will carry the new transmission cables only. A short portion of an existing transmission line will need to be relocated to accommodate the new SRP alignment at The Crossings at Fox Run Mall in Newington. Substation improvements in Madbury and Portsmouth will be confined to the existing substation footprints. No other substation modifications are proposed.

The SRP is a reliability project, providing a parallel path to enhance the existing 115 kV loop between the Deerfield and Scobie Pond Substations. It is designed to address reliability concerns in the New Hampshire Seacoast Region, which have previously been identified by the Independent System Operator – New England ("ISO-NE"). PSNH, working with ISO-NE, conducted a needs assessment study which concluded that the New Hampshire Seacoast Region requires additional transmission capacity to support the reliable delivery of electric power to meet the Region's current demand and future increased demand.

2.2 Operations

After construction of the Project is complete, periodic mowing of the cleared right-of-way ("ROW") will be required to maintain grassy and/or shrubby vegetation conditions. Tree trimming and removal of hazard trees may also be required to protect the transmission line from encroaching branches and tree fall. Repairs to the structures/line will be performed as needed.

2.3 Conservation Measures

PSNH has designed the SRP to avoid environmental impacts where possible. Extensive environmental surveys were conducted by an experienced team of consultants and in consultation with the regulatory agencies. The results of these studies were incorporated into the siting, design and construction aspects of the Project, resulting in a final design that avoids and minimizes environmental impacts to the greatest extent possible, while still achieving the goals of the Project. Specific to avoiding impacts to NLEBs, the tree clearing standards put forth in the final 4(d)rule pertaining to this species, which are in effect as of February 16, 2016 will be followed (81 FR 1900, 2016). Based on this directive, no trees will be cleared within ¼ mile of known, occupied hibernacula at any time of the year, or within 150 feet of a known, occupied maternity roost during the June 1 – July 31 pup season. Note that there are no known, occupied hibernacula or maternity roost trees within the applicable radii of the Project.

3.0 Action Area

3.1 Location and Extent of the Action Area

The Action Area is the footprint of the Project where construction will occur, as well as a buffer of the footprint which encompasses an area equal to the known summer range of an NLEB at any point on the ROW centerline. The U.S. Fish and Wildlife Service ("USFWS" 2014) indicated that a three mile buffer drawn around any point will encompass the expected home range of an NLEB. The Action Area encompasses approximately 62,323 acres, and is the area where cumulative impacts may occur. As described above, the SRP transmission line will be approximately 12.9 miles long, including a 1 mile crossing under Little Bay (Figure 1). The entire line will be constructed within existing electric corridors, with minor adjustments to the corridor widths in several locations. This Project area encompasses 149.7 acres, which is less than 0.01 percent of the Action Area. The Action area consists of a wide variety of developed and undeveloped lands, including forested and unforested natural habitats, the town centers of Durham, Newington, and Portsmouth, suburban development, the University of New Hampshire, and the Pease Tradeport.

3.2 Existing Conditions within the Action Area

The Project corridor is located within the Coastal Plain ecological region of New Hampshire. The highest elevation along the project corridor is approximately 130 feet above sea level near the Madbury Substation. The corridor ranges from 40-130 feet wide, but is predominantly 100 feet wide. For most of the length of the corridor, a cleared area approximately 60 feet in width is currently maintained by PSNH by periodic mowing in support of the existing electric distribution line. The vegetation in the maintained area consists of grasses, herbaceous plants and shrubs (described in detail below). The edges of the corridor are unmaintained and frequently support forest, and it is these trees which will need to be cleared for the SRP. The lands surrounding the SRP corridor have a low to moderate amount of development, including some protected conservation lands, substantial areas of low density residential development, and some areas of higher intensity development associated with Durham and Newington/Portsmouth. The undeveloped areas and low density residential areas are primarily forested while the vegetation maintenance practices conducted in the existing cleared corridor create grass and/or shrubby habitat types.

Based on the New Hampshire Fish and Game Department ("NHFG") 2015 Wildlife Action Plan ("WAP") cover type map and field observations, habitat cover types which the Project passes through consist mostly of Appalachian oak-pine forest, with smaller areas of marshes, floodplain forest and grasslands. The Appalachian oak-pine forests are found across the subtle ridges and rises within the landscape, with the depressions and low areas consisting mostly of larger wetland complexes. These forests have a mix of canopy species including white, black, scarlet and red oaks (*Quercus* spp.), shagbark hickory (*Carya ovata*), white ash (*Fraxinus americana*), white pine (*Pinus strobus*), and other species common in more northern portions of New Hampshire such as birches (*Betula* spp.), maples (*Acer* spp.) and beech (*Fagus grandifola*) (Sperduto and Kimball, 2011). The Project also passes through residential and open areas (generally hayfields) are also present within the Action Area. The residential areas are planted with common landscaping species and lawn grasses and escaped ornamental species are common in close proximity to residential areas.

Under the existing electric lines, the vegetation is shrub and grasses as a result of periodic mowing in contrast with the adjacent forested communities. Common upland forest species found along the edge of the corridor include white pine, red and white oak (*Q. rubra* and *Q. alba*), quaking aspen (*Populus tremuloides*) and gray birch (*B. populifolia*). The sizes of trees vary from mature to early successional depending on the adjacent land use. Common shrub species within upland areas include glossy and common buckthorn (*Rhamnus frangula* and *R. cathartica*), multi-flora rose (*Rosa multiflora*), sumacs (*Rhus* spp.), barberries (*Berberis* spp.), honeysuckles (*Lonicera* spp.) and dogwoods (*Cornus* spp.). Many of these species are non-native invasives in New Hampshire. Clovers (*Trifolium* sp.), hayscented fern (*Dennstaedtia punctilobula*), sweet fern (*Comptonia peregrina*), goldenrods (*Solidago* spp.), common juniper (*Juniperus communis*), raspberries and blackberries (*Rubus* spp.), little bluestem (*Schizachyrium scoparium*), and plantain species (*Plantago* sp.) were frequently noted upland herbaceous plants in the maintained portion of the corridor.

Wetlands identified within the project corridor were generally dominated by both scrub-shrub and emergent (herbaceous) plant species. Common woody species include red maple, glossy buckthorn, silky dogwood (*Cornus amomum*), speckled alder (*Alnus incana*) and several meadowsweet (*Spiraea* sp.) species. Herbaceous species include sedges (*Carex* sp.), cattails (*Typha* sp.), several hydrophytic fern species including sensitive (*Onoclea sensibilis*), cinnamon and interrupted varieties (*Osmunda cinnamomea* and *O. claytoniana*), rushes (*Scirpus* sp.), and other species such as tearthumb (*Polygonum* sp.), asters (*Symphyotrichum* sp.), and purple loosestrife (*Lythrum salicaria*), which is an invasive species. Trees were observed within the wetland along the edges of the corridor, including red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), and cedar (*Thuja* sp.).

The SRP corridor crosses though some areas designated as Highest Priority Habitat by the 2015 WAP (Map 5). The remainder of the corridor passes primarily though areas that are designated as Supporting Landscapes or that have no designation at all. The relative proportion of these habitat types in the corridor reflects their wider distribution in the surrounding landscape.

4.0 Northern Long-eared Bat

This section summarizes existing information about the NLEB. In Section 5.0, this information is applied to information about known existing and proposed conditions in the Project Area to determine the potential impact of the Project.

4.1 Species Biology

Range: The known range of the NLEB includes the entire Northeastern United States and extends northward into central Quebec Province, making this species almost certainly resident throughout New Hampshire. Additionally, recent survey data indicates that NLEBs may be more abundant/prevalent in coastal New England, including all towns on the coast of New Hampshire (USFWS 2015a), including the four municipalities crossed by the SRP.

Life History: NLEBs are a non-migratory forest bat, adapted to flying in cluttered environments. As described by the USFWS (USFWS 2014, 2015c), NLEBs emerge at dusk to forage in upland and lowland woodlots and tree-lined corridors, feeding on insects, which they catch while in flight using echolocation. This species also feeds by gleaning insects from vegetation and water surfaces. NLEBs overwinter in caves or mines and spend the summer in local forests. A single pup is born in June or July in the Northeast, and volant (capable of flying) young have been observed as early as three weeks following birth. During the maternity period, the sexes separate, with females roosting in small (commonly 30-60 individuals) maternity colonies and males roosting singly. Lactating females switch roost trees every two to five days. In New Hampshire, volant sub-adults were captured as early as July (Sasse and Pekins 1996).

Winter Habitat: As described in the USFWS (USFWS 2014, 2015c), suitable winter habitat (hibernacula) for the NLEB includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). These hibernacula typically have large passages with significant cracks and crevices for roosting; relatively constant, cool temperatures (32-48°F) and with high humidity and minimal air currents. Bats in New Hampshire use mines or talus caves to hibernate, but there are few places humid enough for them and most New Hampshire cave bats fly to Vermont, Massachusetts or New York to hibernate (NHFG 2015).

Spring Staging and Fall Swarming Habitat: As described by the USFWS (USFWS 2014, 2015c), spring staging and fall swarming habitat consist of forested habitats within five miles of a hibernaculum entrance. Forested areas with suitable roost trees would likely provide the best habitat.

Summer Habitat: As described by the (USFWS 2014, 2015c), suitable summer habitat for NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (described below), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit characteristics of suitable roost trees and are within 1,000 feet of other forested/wooded habitat. NLEB has also been observed roosting in human-made structures, such as buildings, barns, bridges, and bat houses.

Roost Trees: As described in the (USFWS 2014, 2015c), suitable NLEB roosts are trees (live, dying, dead, or snag) with a diameter at breast height ("dbh") of 3 inches or greater that exhibits any of the following characteristics: exfoliating bark, crevices, cavity, or cracks. Isolated trees are considered suitable habitat when they exhibit the characteristics of a suitable roost tree and are less than 1,000 feet from the next nearest suitable roost tree within a woodlot, or wooded fencerow. NLEBs do not appear to prefer a certain species of tree, instead choosing trees based on structural suitability for roosting.

4.2 White-nose Syndrome

As described in in the USFWS's July 2015 Fact Sheet (USFWS 2015b), white-nose syndrome ("WNS") is a disease affecting hibernating bats, including NLEBs. Named for a white fungus that appears on the muzzle and other parts of bats, WNS is associated with extensive mortality of these animals in eastern and mid-western North America. First documented in New York in the winter of 2006-2007, WNS has spread rapidly across the eastern and Midwestern United States and eastern Canada. Evidence of WNS has been documented in most New Hampshire hibernacula (NHFG 2015).

WNS is deadly to bats for a variety of reasons. In winter, bats with WNS may fly outside their hibernacula during the day and/or cluster near the entrances of caves and other hibernation areas. These behaviors lead to starvation and death due to exposure. Additionally, WNS is documented to create an immune response in bats that can be lethal, and damage to wing membranes due to WNS can make bats unable to fly, precluding them from foraging. Bats have been found sick and dying in unprecedented numbers in and around caves and mines. WNS is estimated to have killed more than 5.5 million bats in the Northeast and Canada. In some areas, 90 to 100 percent of cave hibernating bats have died. WNS is the number one threat to NLEBs (USFWS 2015a, 2015c) and if this disease had not emerged, it is unlikely that this species would be experiencing such dramatic declines. Since symptoms were first observed in New York in 2006, white-nose syndrome has spread rapidly across the core of the NLEB's range. Based on hibernacula counts, NLEBs have declined by up to 99 percent in the Northeast (USFWS 2015c).

4.3 Status within the Action Area

The forested habitats within the Action Area almost certainly provide suitable habitat for NLEBs. No assessment of the level of suitability or the distribution of most suitable habitat has been conducted, and there are no known roost trees within the Action Area. However, given the relatively general habitat requirements of this species (describe in Section 4.1), and the extensive amount of forested habitat available within the Action Area, areas of suitable habitat are almost certainly present to varying degrees throughout the Action Area. There are no known hibernacula in the Action Area.

A comprehensive assessment of the NLEB population within the Action Area has also not been conducted. However, given the known distribution of this species discussed in Section 4.1, it is assumed to be present, and limited acoustic survey conducted at the Great Bay National Wildlife refuge in 2014 did document the presence of NLEBs (Svedlow 2015). Given the known status and spread of WNS throughout the Northeast, numbers of NLEBs within the Project area are expected to be low.

5.0 Effects Analysis

Based on the known range, habitat preference and life history of the NLEB, as described in Section 4.0, and the existing conditions within the Action Area, described in Section 3.0, NLEBs are potentially present within the Action Area and have the potential to be affected by the Proposed Action. The primary effect of the Proposed Action is the removal of trees to widen the existing, cleared corridor during construction.

5.1 Impacts Due to Construction

The primary effect of the Proposed Action on NLEBs is the removal of trees to widen the existing cleared corridor during construction, as described in Section 2.1. Approximately 31 acres of forest will be removed along the length of the SRP corridor, clearing an average of 20 feet on either side of the existing 60-foot wide (average) corridor. Tree clearing that occurs when NLEBs are present and using affected trees for roosting has the potential to impact NLEBs directly via disturbance of roosting adults and mortality of any young non-flying bats present, although no maternity roosts are known to occur in the Action Area. Indirect impacts are also possible due to tree clearing. Indirect effects consist of the loss of summer habitat, including foraging habitat and roost trees, due to the removal of trees. Due to the narrow corridor clearing, both direct and indirect impacts are anticipated to be minor. Tree removal will therefore not affect swarming habitat, and project construction does not have the potential to affect wintering habitat.

Direct permanent terrestrial wetland impacts are limited to the footprints of 27 structures totaling 792 square feet that were unavoidably located in wetlands. Approximately 317,800 square feet of indirect impacts will result from wetland conversion due to tree removal in forested wetlands and an additional 87,225 square feet of tree removal within upland stream buffers. Temporary wetland impacts will occur due to construction and have some small potential to impact NLEBs during their active season. Wetlands pools may provide water for drinking and may be a source of insects that NLEBs forage upon. However, the Project was designed to minimize temporary wetland impacts to the extent practicable, and best management practices, such as timber mats for access roads and work pads will be used where impacts are unavoidable. PSNH has developed a compensatory mitigation plan through participation in the Aquatic Resource Mitigation Fund (i.e. in-lieu fee) to compensate for permanent and indirect wetland impacts.

5.2 Impacts Due to Operations

Impacts due operations are secondary impacts. During operations maintenance of vegetation in the corridor and repair of the Project infrastructure, if needed, have some potential to affect NLEBs. Vegetation maintenance consists of periodically mowing the corridor to maintain it in a shrubby state, removal of tree limbs that protrude into the clear zone that must be maintained for the safe operation of power lines, and removal of hazard trees at the edge of the cleared corridor that have the potential to strike the lines if they fall due to natural causes. Mowing will have no effect on NLEBs as it removes woody vegetation that is too small in height and diameter to provide foraging or roosting habitat for NLEBs. Tree trimming and hazard tree removal would have little to no impact on the amount of foraging habitat, but does have the potential to remove suitable roosting habitat. No new tree clearing will be required for any needed Project infrastructure repairs, and all repair activities will be conducted in a manner that minimizes environmental impacts, similar to initial construction of the Project.

5.3 Cumulative Impacts

Cumulative impacts within the Action Area will occur due to removal of forest cover for a variety of types of development, including home building, commercial development, and other infrastructure projects (e.g., roadways, power lines, pipelines). The removal of approximately 31 acres of forest cover due to Project construction will contribute to these cumulative impacts, but is unlikely to be a major contributor to forest removal in the Action Area, given the current density of development in it, and the high likelihood that development in the region will continue to expand. Additionally, the narrow, linear, incremental nature of the clearing for the Project minimizes the impact of this clearing at any given location.

6.0 Conclusion

The conclusion of the BA is that the effect of construction and operation of the SRP on this species is so small as to be inconsequential to the population that may be present in the Action Area based on PSNH's commitment to meet the USFWS final guidance and the limited tree removal proposed. This conclusion is based on the following rationale:

1. The tree clearing required for construction of the Proposed Action will be conducted in compliance with the final 4(d) rule which goes into effect on February 16, 2016.
2. Direct impacts associated with the felling of trees will be relatively minor due to the narrow corridor to be cleared (20 feet on either side of an existing 60-foot wide (average) corridor) and the reduction of forest cover in the Action Area will be negligible. In total, just less than 31 acres of forest cover will be removed. This is an insignificant amount of potentially suitable forest habitat, compared to the total amount of potentially suitable forest habitat for NLEBs available in the Action Area.
3. Secondary impacts will include maintenance removal of limbs and hazard trees during operations. The Interim 4(d) Rule published in conjunction with the formal listing of the NLEB categorizes the removal of hazard trees as an exempt activity that is not considered to impact this species.
4. The Project will contribute to the cumulative removal of forest within the Action Area, but this contribution is likely to be minimal, as compared to the existing and future development likely to occur in the Region.

7.0 References

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Appendix E: Modeling Sediment Dispersion from Cable Burial for Seacoast Reliability Project, Little Bay, New Hampshire

Modeling Sediment Dispersion from Cable Burial for Seacoast Reliability Project, Little Bay, New Hampshire

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Executive Summary

Public Service of New Hampshire d/b/a Eversource Energy (PSNH) has proposed the construction of an electrical cable system to increase the reliability of the electrical transmission grid in southern New Hampshire. This cable, known as the Seacoast Reliability Project, would cross the Little Bay portion of the Great Bay Estuarine System. The crossing would entail burial of three separate but parallel cable bundles by jet plowing, which is a technique that liquefies the sediment with high pressure water jets and simultaneously allows the cable to be buried at a predetermined depth. The cable sections in the shallow areas near the western and eastern landfalls will be buried by diver. The environmental consultant for the Project, Normandeau Associates, Inc., contracted with RPS ASA to supply its modeling capabilities to simulate the jet plowing and diver burial processes along the cable route to determine both the likely suspended sediment concentrations generated in the water column above the cable route and the resulting re-deposition of the sediments in and along the route.

Two computer models were used in the analysis: BELLAMY, a hydrodynamic model used for predicting the currents in Little Bay, and SSFATE, a sediment dispersion model used for predicting the fate and transport of sediment resuspended by the jet plowing operation. BELLAMY, a finite element, two-dimensional, vertically averaged, time stepping circulation model developed at Dartmouth College and previously applied to the Great Bay Estuarine System (GBES) (McLaughlin et al. 2003; Swanson et al. 2014) was used in this analysis. The model can calculate the time varying surface elevation and currents under the influence of tides, winds and river flow on a model domain discretized by a large number of finite element triangles. Due to the fact that Great Bay is tidally dominated (currents up to 2 m/s [6.6 ft/s] and much of it consists of narrow channels in which the tidal currents mostly flow in flood and ebb directions, the effect of wind is expected to show only in areas with relatively larger surface areas such as Great Bay proper and not Little Bay where the cable burial will occur. The model includes simulation of wetting and drying of tidal flats. All simulation parameters were set to be consistent with previously published work. The reader is referred to Swanson et al., (2014), Bilgili et al. (2005) and McLaughlin et al. (2003) for more detailed information.

The SSFATE (Suspended Sediment FATE) model was utilized to predict the excess suspended sediment concentration and the dispersion of suspended sediment resulting from jetting and diver activities. Since ambient suspended sediment concentrations are variable and generally unpredictable, the model predicts excess concentration, which is defined as the concentration above ambient suspended sediment concentration generated by the jetting activities. In addition SSFATE calculates the resulting deposition thickness of resuspended sediments that have resettled back on the bottom. The sediment grain size information necessary to characterize the sediment was extracted from vibracore data logs taken in April 2014. Some of the cores exhibited high (70 to 90%) fractions of fines (clays and silts) while others exhibited equally high (70 to 90%) of sands. A single representative cable route among the three cable bundles crossing Little Bay was chosen for modeling since the cables will be installed in sequence and are proposed to be separated by only about 9.4 m (30 ft) and all were parallel except when they approached the landfalls.

The cables in the offshore areas are to be buried by jet plowing to minimum depths of 1.07 m (42 in) deep in the shallows on the western but offshore section of Little Bay and 2.7 m (8 ft) in the center and east sections. For ease of discussion, this report refers to the jet plow disturbance as a trench although while the jet plow will be occupying a three-dimensional space, the "trench" is very temporary as it will

fill in immediately behind the jet plow. The total depth of the trench was 1.42 m (96 in) for the western section and 2.79 m (110 in) for the central and eastern sections. Based on Caldwell's specification the trench width was defined as 0.32 m (12.75 in) resulting in a vertical-walled trench cross sectional area of 0.46 m^2 (4.96 ft^2) in the shallow western portion and an area of 0.90 m^2 (9.69 ft^2) in the deeper central and eastern portions. The lengths of the trenches were defined by Caldwell to be 559 m (1,835 ft) for the shallow burial and 741 m (2,431 ft) for the deeper burial. The jet plow rate of advance was provided by the cable installer, Caldwell Marine International, LLC to be 100 m/hr (330 ft/hr). The model run was started on the west side of Little Bay at slack high water which is the beginning of the ebb tide. It was also conservatively assumed, based on past experience, that 25% of the material in the trench would be resuspended into the water column by the jetting activity.

The cables in the nearshore areas are to be buried by divers in trenches with a minimum depth of 1.07 m (42 in) deep in the shallows on both the western and eastern portions of Little Bay with lengths of 90 m (296 ft) in the western portion and 178 m (584 ft) in the eastern portion. The total depth of the trench was 1.22 m (48 in). Based on Caldwell's specification the trench width was defined as 1.22 m (48 in) resulting in a trench cross sectional area of 1.49 m^2 (16 ft^2). The diver rate of advance was much slower than the jet plowing at 2.3 m/hr (7.5 ft/hr) with an operational time restriction of 4 hr/dy. It was also conservatively assumed, based on past experience, that 50% of the material in the trench would be resuspended into the water column by the diver activity. The model run was started around two hours before high slack water and continued for four hours due to diver requirements of lower currents and deeper water. An option to use silt curtains for the diver burial operations in the western and eastern portions was also examined.

Jet Plowing

The size of the resulting excess suspended sediment (SS) concentration plume in the lower water column is defined as a series of areas enclosed by different concentration levels. The water column concentration contours shown, which are defined by a single concentration level, totally surround an enclosed area where concentrations are at or above the specified concentration, i.e., the area is cumulative. The entire area encompassed by the plume (as defined by the 10 mg/L excess SS concentration contour) averaged over time was 14.8 ha (36.58 ac) ranging from a low of 5.91 ha (14.61 ac) at 1 hr to a high of 22.36 ha (55.25 ac) at 10 hrs. These total enclosed areas dropped dramatically for the higher concentrations, averaging 1.94 ha (4.79 ac) at 100 mg/L, 0.28 ha (0.68 ac) at 1,000 mg/L and 0.02 ha (0.05 ac) at 5,000 mg/L. indicating that the extent of the plume is limited for higher concentrations. In the shallows, suspended sediments from the jet plow activity are likely to reach nearly to the water surface. In the channel, excess suspended sediments will be restricted to the lower half of the water column.

An important metric defining the plume is its duration for different concentrations, which could have biological significance if exposure (duration multiplied by concentration) is sufficiently elevated. The maximum plume size and duration at 10 mg/L excess SS concentration in the area that is totally enclosed by the contour is 90.20 ha (222.89 ac) but lasts for only 1 hr. This short duration continues for all the concentration contour thresholds through 1,000 mg/L. The enclosed areas quickly drop in time for a given concentrations so by 2 hrs the 10 mg/L area has dropped to 32.20 ha (79.57 ac) and the plume has completely dissipated within 6 hrs. The area coverages drop dramatically for the higher concentrations near the jet plow indicating that the duration and extent of the plume is relatively limited. Once the jet plow reaches the eastern terminus and shuts down no additional sediment will be suspended and the residual plume will quickly dissipate.

The bottom deposition was calculated based on all three cable routes being jet plowed and assuming that any sediment deposited on the bottom remained in place. The bottom deposition thickness is defined for the area exclusively between the range of thicknesses described, i.e., the area is not cumulative. As with the water column concentrations of suspended sediment the sizes of the deposition thickness patterns generally drop in size, but not always. At the range of 0.1 to 0.5 mm (0.004 to 0.02 in) thickness the area is 35.6 ha (87.9 ac) due to jet plowing the three cable routes. These areas drop overall for the high deposition thicknesses (e.g., 2.4 ha [5.9 ac] for the 5 to 10 mm (0.2 to 0.4 in) thickness range) near the jet plow indicating that the extent of the plume is relatively limited.

Diver Burial Assuming No Use of Silt Curtains

The size of the excess SS concentration plumes for the west and east diver burial sections were also examined. It was assumed that no silt curtains were used during this activity (if they had been modeled the amount of excess SS and would be reduced 10-fold outside the silt curtained area). Typically, at 10 mg/L excess SS concentration, the instantaneous total area enclosed by the contour is 8.4 ha (20.7 ac) for the west section and 1.9 ha (4.7 ac) for the east section. However, these total enclosed areas drop dramatically for the higher concentrations near the diver burial activities, i.e., the area at 1,000 mg/L is only about 0.2 ha (0.6 ac) for the west section and 0.0 ha (0.1 ac) for the east section, indicating that the extent of the plume is again relatively limited.

Assuming no silt curtains were used, the total area in the west section that is enclosed by the 10 mg/L excess SS concentration contour is 14.6 ha (36.1 ac) but lasts for only 1 hr. This short duration continues through all the concentration contour thresholds through 5,000 mg/L. The enclosed areas decrease in time for a given concentrations so by 6 hrs the 10 mg/L area has dropped to 8.6 ha (21.2 ac). The 10 mg/L area persists for two days because the initial buildup occurs near slack water with grain size distribution indicating mostly fines (silts and clays). The area coverages decrease for higher concentrations near the diver burial activities. At the east section the 10 mg/L excess SS concentration total area that is enclosed by the contour is 8.2 ha (20.2 ac) but lasts for only 1 hr. This short duration continues through all the concentration contour thresholds through 500 mg/L. The enclosed areas decrease in time for a given concentration so by 6 hrs the 10 mg/L area has dropped to 4.1 ha (10.2 ac). The 10 mg/L area persists for two days because the initial buildup occurs near slack water with grain size distribution indicating mostly fines (silts and clays). The area coverages decrease for higher concentrations near the diver burial activities.

The sizes of the deposition thickness patterns also dropped as the deposition increased. At the 0.1 to 0.5 mm (0.004 to 0.02 in) thickness range the area is 3.4 ha (8.5 ac) for the west and 4.4 ha (10.8 ac) for the east, both including the three cable routes combined. These areas drop dramatically for the higher deposition thicknesses (e.g., 0.5 ha [1.2 ac] for the 10 to 50 mm (0.4 to 2 in) thickness on the west section and 1.2 ha (2.9 ac) for the east section indicating that the extent of the plume is limited.

Diver Burial Assuming Use of Silt Curtains

The effects of using silt curtains were estimated by assuming that 90% of the suspended sediment resuspended from diver burial operations would be trapped by the curtains. That being the case, the results based on no silt curtain use can be reduced by a factor of 10 to estimate the concentrations outside the silt curtain. At 10 mg/L excess SS concentration the area enclosed by the contour was 1.2 ha (3.0 ac) for the west section and 0.4 ha (0.9 ac) for the east section.

In terms of exposure, for the west section at 10 mg/L excess SS concentration the area that is enclosed by the contour is 5.9 ha (14.7 ac) but lasts for only 1 hr. The areas decrease in time for a given concentrations so by 6 hrs the 10 mg/L area has dropped to 2.3 ha (5.7 ac). For the east section at 10 mg/L excess SS concentration the area that is enclosed by the contour is 2.1 ha (5.1 ac) but lasts for only 1 hr. The areas decrease in time for a given concentration so by 6 hrs the 10 mg/L area has dropped to 1.4 ha (3.6 ac). The area within the silt curtain area would, of course, see a significant increase in concentration until the material has settled out.

With the use of silt curtains the bottom deposition thickness outside the silt curtains can also be reduced by a factor of 10. At the 0.1 -> 0.5 mm (0.004 -> 0.02 in) thickness the area enclosed by the contour is 1.9 ha (4.6 ac) for the west and 1.1 ha (2.6 ac) for the east. Based on the trench geometry for diver burial 90% of the entire west resuspension volume or 181.0 m^3 (6,394 ft^3) spread over the area enclosed by the silt curtain results in an average deposition thickness of 94 mm (3.71 in) while 90% of the entire partial east resuspension volume or 224.5 m^3 (7,927 ft^3) spread over the enclosed area results in an average deposition thickness of 110 mm (4.32 in). Larger thicknesses would be found closest to the burial routes (including in the trenches) and smaller thicknesses found closer to the silt curtains distant from the routes.

Stability of Deposited Sediments

A measure of the stability of deposited sediments to the seabed is a function of the erosion velocity for each grain size in the sediment. Since the freshly deposited sediment is unconsolidated, the fine grains (clay and silt) and sand are eroded at a velocity of about 20 cm/s (0.4 kt). Maximum tidal currents exceed this minimum speed across most of Little Bay except in the shallows very near the shore. Thus sediment particles deposited along much of the route will likely be resuspended on subsequent tides and dispersed from the areas initially affected by deposition.

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1 Introduction

Public Service of New Hampshire d/b/a Eversource Energy (PSNH) has proposed the construction of an electrical cable system to increase the reliability of the electrical transmission grid in southern New Hampshire. This cable, known as the Seacoast Reliability Project, would cross the Little Bay portion of the Great Bay Estuarine System as shown in Figure 1-1. The crossing would entail burial of three separate but parallel cable bundles by jet plowing, which is a technique that liquefies the sediment with high pressure water jets and simultaneously allows the cable to be buried at a predetermined depth. The cable sections in the shallow areas near the western and eastern landfalls will be buried by diver. The environmental consultant for the Project, Normandeau Associates, Inc. (Normandeau), contracted with RPS ASA to supply its modeling capabilities to simulate the jet plowing process along the cable route to determine both the likely suspended sediment concentrations generated in the water column above the cable route and the resulting re-deposition of the sediments in and along the route.

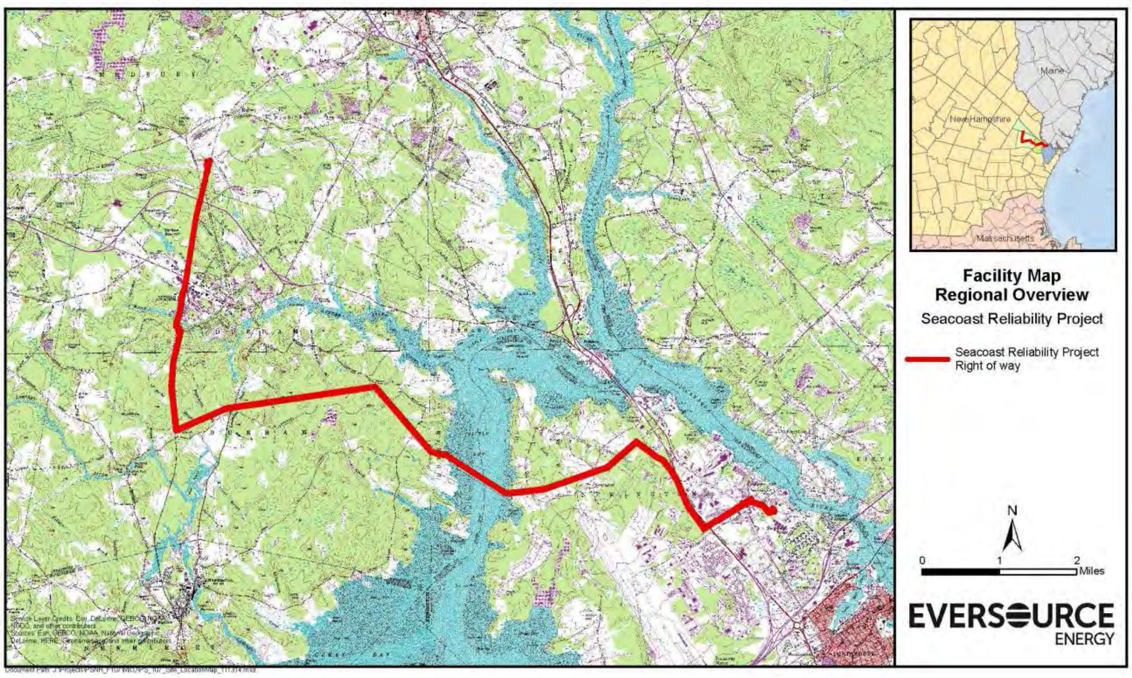

Figure 1-1. Location of the proposed cable route across Little Bay in the Great Bay Estuarine System (image from Normandeau Associates).

This report documents the hydrodynamic and sediment dispersion modeling activities performed to assess the effects from installation of the electrical cable using jet plowing and diver burial. Specifically, Section 1 provides an introduction to the effort by RPS ASA documented in the report, Section 2 presents the hydrodynamic modeling performed, and Section 3 presents the sediment dispersion modeling performed. Section 4 consists of conclusions drawn from the study and references are listed in Section 5.

2 BELLAMY Hydrodynamic Model

2.1 Model Description

A computer model system developed at Dartmouth College and previously applied by RPS ASA to the Great Bay Estuarine System (GBES) (McLaughlin et al. 2003) was used in this analysis and was based on the recent work of Swanson et al. (2014). The model system includes a finite element, two-dimensional, vertically averaged, time stepping circulation model. The circulation model, known as BELLAMY, can calculate the time varying surface elevation and currents under the influence of tides, winds and river flow on a model domain discretized by a large number of finite element triangles. Due to the fact that Great Bay is tidally dominated (currents up to 2 m/sec) and much of it consists of narrow channels in which the tidal currents mostly flow in flood and ebb directions, the effect of wind is expected to show only in areas with relatively larger wet surface areas such as Great Bay proper and not Little Bay where the cable burial will occur. The model includes simulation of wetting and drying of tidal flats.

All simulation parameters were set to be consistent with previously published work. The reader is referred to Swanson et al. (2014), Bilgili et al. (2005) and McLaughlin et al. (2003) for more detailed information. Sensitivity analyses previously reported are the basis for some of the values chosen. Some key assumptions and resulting parameter values are summarized as follows:

- The model domain consists of the entire GBES plus a stretch of the coastal Atlantic Ocean extending from Portland, ME, in the north to the tip of Cape Ann, MA, in the south to incorporate the effect of the Gulf of Maine coastal current. The Little Bay region is shown in Figure 2-1 between the Lower Piscataqua River-North to the east and Great Bay to the south.
- Tidal forcing used the constituent set of M2, N2, S2, O1, K1 and Z0 as described in previously published work (Bilgili et al. 2005).
- No wind forcing was applied to be consistent with previous studies, which showed the wind effect is short term and minimal, particularly since the modeling focused on steady state conditions.
- The model includes annually averaged freshwater discharges from the major rivers as constant values (Bilgili et al. 2005). The effect of time varying discharges is not investigated due to the fact that the total freshwater volume entering the estuary is less than 2% of the tidal prism (Reichard and Celikkol, 1978). The yearly averaged discharges from the WWTF outfalls are also incorporated as constants since these are considered as additional fresh water sources (Trowbridge, 2009).
- The internal hydrodynamic model time step was 99.36 seconds with model predicted velocities output on a 30 min interval. The model was run to capture the 15-day spring-neap cycle.

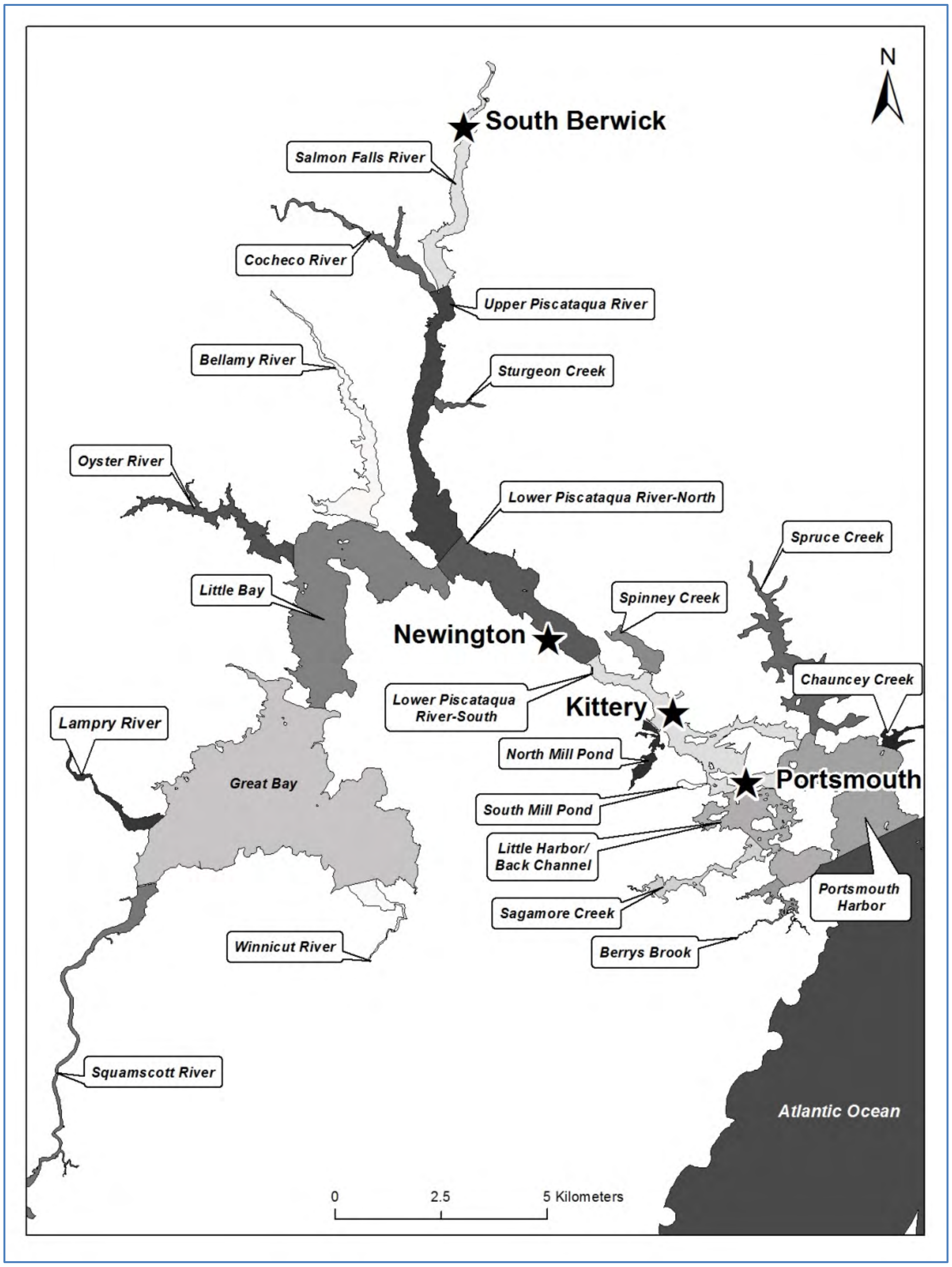

Figure 2-1. Great Bay Estuarine System regions used for previous modeling (Swanson et al., 2014). Little Bay is located in the central portion of the System.

BELLAMY has been tested and calibrated extensively in the Great Bay estuary over the past two decades (Ip et al. 1998; Erturk et al. 2002; McLaughlin et al. 2003; Bilgili et al. 2005). One quantitative statistical measure indicating how well the model reproduces observed currents is “skill”, with 0 indicating no match to data and 1 indicating perfect match with data. McLaughlin et al. (2003) report a mean skill of 0.918 while the Bilgili et al. (2005) work improves this to 0.942 for cross-section averaged current velocity comparisons. Point velocity comparisons also show good fit (McLaughlin et al. 2003; Bilgili et al. 2005), especially considering the inherent variability in this type of measurements.

2.2 Model Results

As noted above the current velocities to be used to disperse the excess suspended sediment were based on previous hydrodynamic modeling of the Great Bay System. Example current vectors for flood and ebb tides in lower Little Bay are shown in Figures 2-2 and 2-3. The vectors are scaled as displayed in the window in the upper left portion of the figures. The line shown across the Bay is a representative approximation of the route of the cables. The strength of the currents is similar in both flood and ebb directions at about 50 cm/s (1 kt) except at the shallow areas located on both sides of the Bay where the currents are reduced.

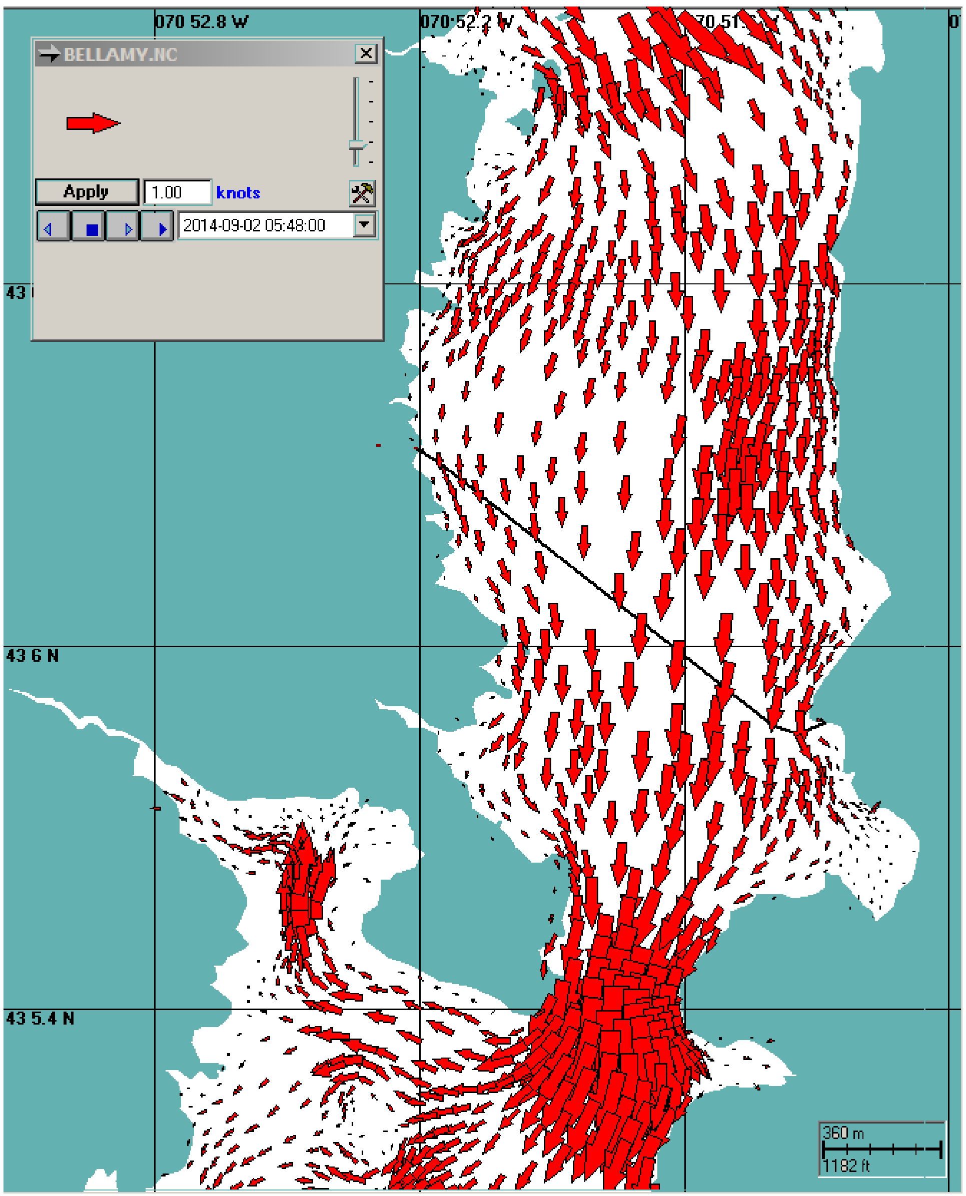

Figure 2-2. Example flood tide currents for lower Little Bay with the solid black line indicating the approximate cable route.

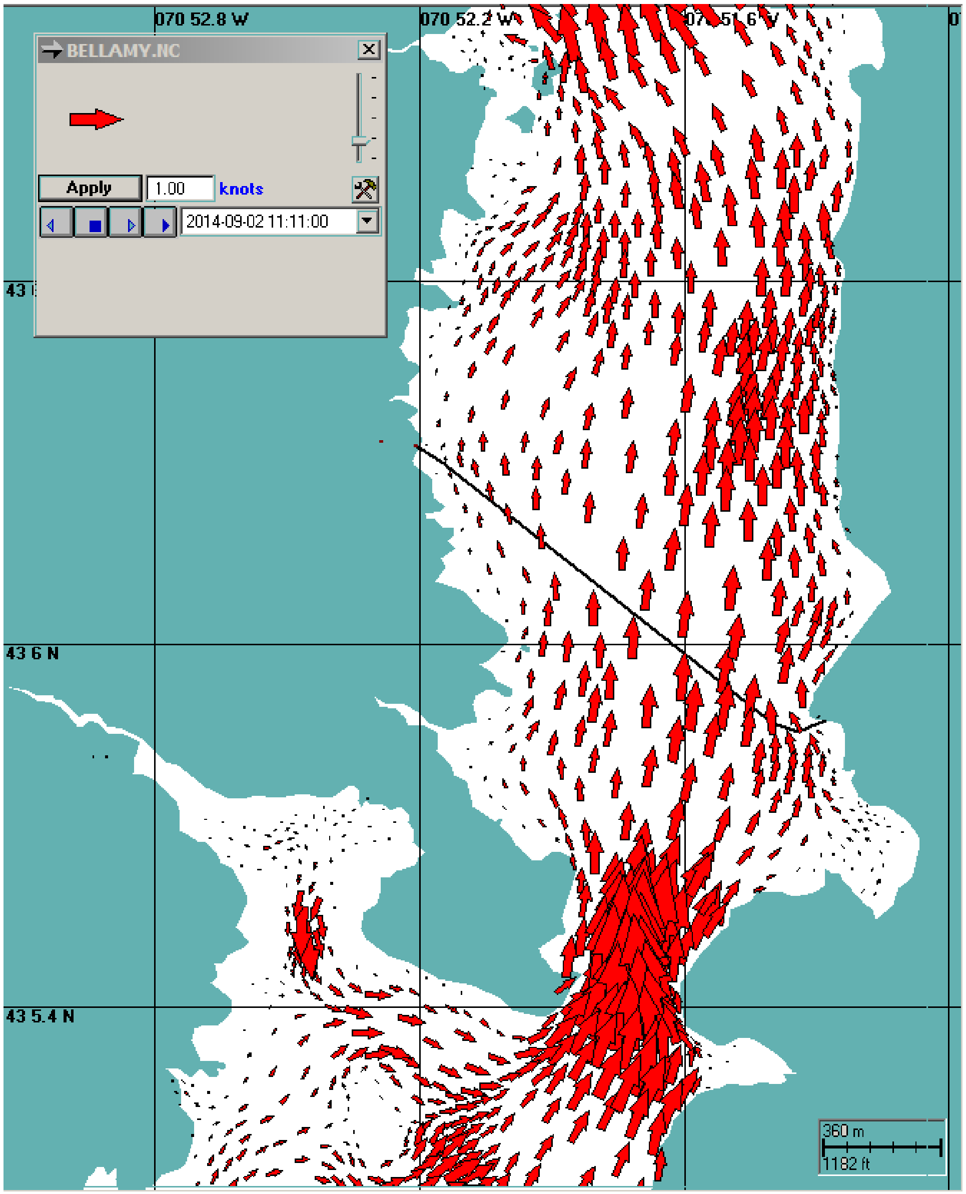

Figure 2-3. Example ebb tide currents for lower Little Bay with the solid black line indicating the approximate cable route.

3 SSFATE Sediment Dispersion Model

3.1 Model Description

The SSFATE (Suspended Sediment FATE) model was utilized to predict the excess suspended sediment concentration and the dispersion of suspended sediment resulting from jetting and diver activities. SSFATE addresses the short term movement of sediments where sediment is introduced into the water column and predicts the path and fate of the sediment particles using the local currents. Excess concentration is defined as the concentration generated by the jetting or diver activities above ambient suspended sediment concentration. In addition SSFATE calculates the resulting deposition thickness of resuspended sediments that have resettled back on the bottom.

SSFATE was jointly developed by ASA and the U.S. Army Corps of Engineers (USACE) Environmental Research and Development Center (ERDC) to simulate the sediment suspension and deposition from jetting operations. It has been documented in a series of USACE Dredging Operations and Environmental Research (DOER) Program technical notes (Johnson et al. 2000 and Swanson et al. 2000); at a previous World Dredging Conference (Anderson et al. 2001) and a series of Western Dredging Association Conferences (Swanson et al., 2004; Swanson and Isaji, 2006). A number of ASA technical reports have been prepared that demonstrate successful application to dredging. In addition SSFATE has been extended to include the simulation of dredged material disposal as well as cable and pipeline burial operations using water jet plows (Swanson et al., 2006; Mendelsohn et al., 2012), diver activities and mechanical plows.

The SSFATE modeling system computes suspended sediment distributions and deposition patterns resulting from various seabed activities. The suspended sediment concentrations are computed in three dimensions while the depositional patterns are computed in two dimensions. The model contains the following features:

- Ambient currents can be imported from a variety of numerical hydrodynamic models;
- The procedure which is a standard numerical approach that mimics the mixing of sediment within the water column due to turbulence;
- SSFATE simulates suspended sediment source strength and vertical distribution from mechanical (e.g., clamshell, long arm excavator) or hydraulic (e.g., cutterhead, hopper) dredges; and water jet plows, divers and mechanical plows;
- SSFATE assumes a continuous release of sediments over time, and calculates average excess sediment concentrations within each grid cell (minimum cell dimension of 10 to 25 m) at each time step;
- Multiple sediment types (different grain sizes) or fractions can be simulated simultaneously;
- SSFATE output consists of excess suspended sediment concentration contours in both horizontal and vertical planes, time series plots of concentrations, and the spatial distribution of sediment deposited on the sea floor.

In far field calculations the mean transport and turbulence associated with ambient currents dominate the distribution of the sediment particles. SSFATE, a particle-based model, predicts the transport and dispersion of the suspended material generated by seabed activities. Particle advection (i.e., transport) is based on the simple relationship that a particle moves linearly with a local velocity, obtained from the hydrodynamic model, for a specified model time step. Particle diffusion (i.e., dispersion) is assumed to follow a simple random walk process frequently used in simulating the dispersion of particles.

The particle model allows the user to predict the transport and dispersion of the different size classes of particles e.g., sands, silts, and clays. The particle-based approach is extremely robust and independent of the grid spacing. Thus, the method is not subject to artificial diffusion near sharp concentration gradients and is easily interfaced with all types of sediment sources including dredging, jet plowing, and backfilling operations.

In addition to transport and dispersion, sediment particles also settle at some rate through the water column to the bottom. Settling of mixtures of particles, some of which may be cohesive in nature, is a complex but predictable process with the different size classes interacting, i.e., the settling of one particle size is not independent of the other sizes. In addition, the clay-sized particles, typically cohesive, undergo enhanced settling due to flocculation. These processes have been implemented in SSFATE using empirically based formulations based on previous USACE studies (Teeter, 1998).

At the end of each time step, the concentration of each sediment class, as well as the total concentration, is computed on a concentration numerical grid. The size of all grid cells is the same, with the total number of cells increasing as the excess suspended sediment moves away from the source. The settling velocity of each particle size class is computed along with a deposition probability based on shear stress. Finally, the deposition of sediment from each size class from each bottom cell during the current time step is computed and the calculation cycle begins anew. Deposition is calculated as the mass of sediment particles that accumulate over a unit area.

Outputs from the model are sediment concentrations for each grid cell and deposition thickness for each grid cell that shares a boundary with the bottom of the river or bay. Concentrations and thicknesses are available for every time step during the period that the model is run.

3.2 Seabed Sediment Characterization

The sediment grain size information was extracted from vibracore data logs taken during a survey for the project in April 2014 by Normandeau (personal communication). The survey consisted of 12 sampling stations shown in Figure 3-1. The qualitative descriptions of each vibracore sediment sample were converted into fractions of sand, silt and clay based on a classification scheme presented by Flemming (2000). The classification scheme uses a ternary diagram where text descriptions of sediment texture (for example, “silty sand”), as summarized in Table 3-1, are mapped onto the diagram and assigned a sand-silt-clay ratio. If a vibracore contained only one sediment sample, the ratio obtained from the diagram defined the size fractions used in the SSFATE model simulations (Table 3-2). If more than one sediment sample was taken from a vibracore, a composite of the size fractions was calculated based on the relative quantities each sample contributed to the whole. Since the SSAFTE classification scheme divides silt into medium-fine and fine silt, the silt fraction obtained from the ternary diagram was equally divided.

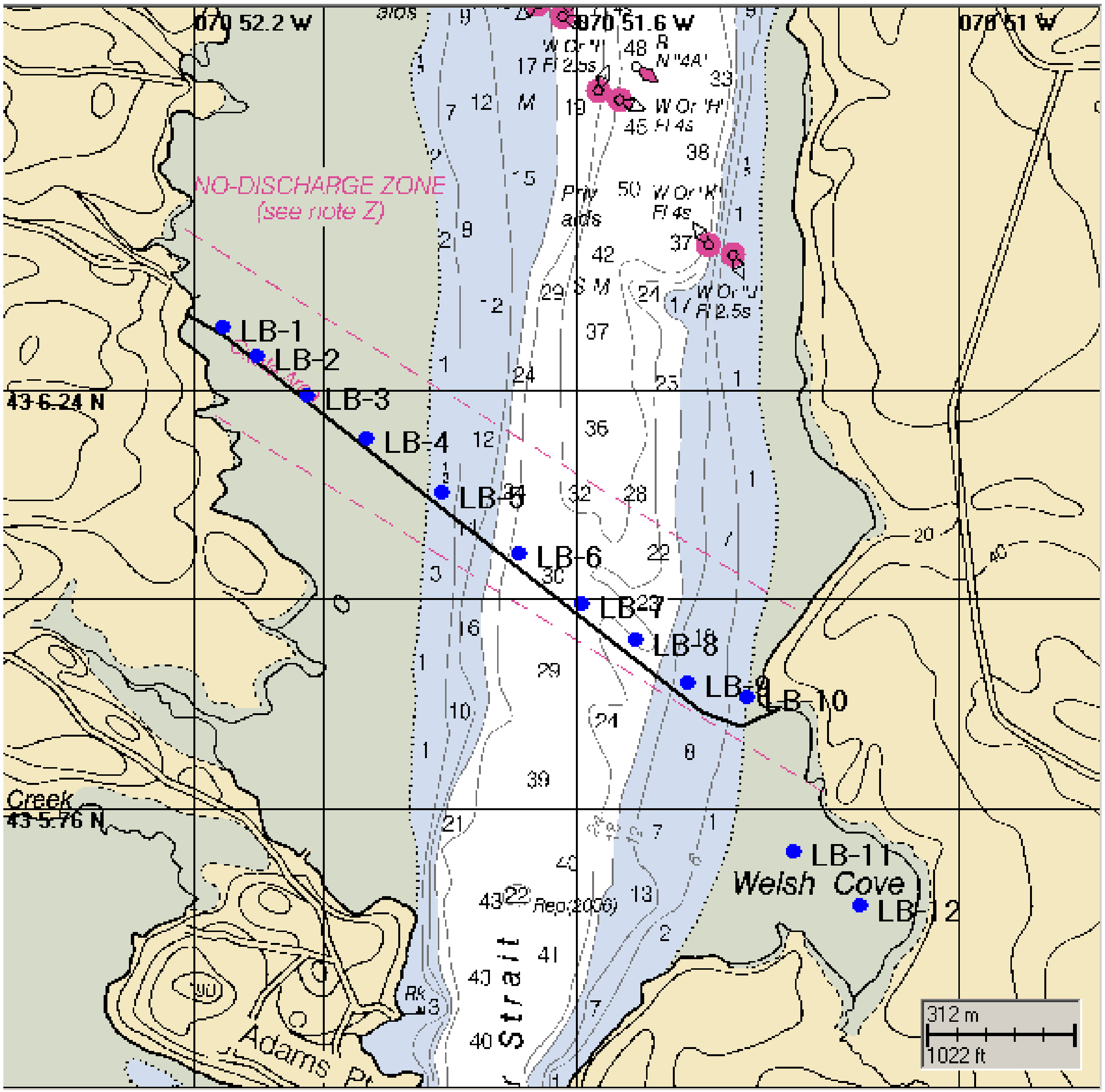

Figure 3-1. Location of vibracore borings across Little Bay along route of cable crossing (indicated by solid line).

Table 3-1 summarizes the vibracore data logs by location across the Bay from tidal flats at the western shore to Welsh Cove at the eastern shore, the Station number, penetration depth and sediment description. Table 3-2 and Figure 3-2 show the resulting sediment grain size distributions for each boring.

Table 3-1. Qualitative description of sediments along cable route from vibracore data logs from survey conducted in April 2014.

Zone	Station	Penetration Depth	Sediment Description
Tidal Flat (west)	LB-1-A	94”	Cohesive Clay with silt
	LB-2-B	104”	
	LB-3-B	104”	
	LB-4-A	120”	Cohesive Clay with silt and trace of fine sands
	LB-5-B	86”	
Channel	LB-6-A	44”	Cohesive Fine to medium sand with small amount of clay and silt
	LB-7-B	63”	0-19”: Cohesive Fine to medium sand with small amount of clay and silt
			19-63”: cohesive Clay with silt
	LB-8-B	29”	0-15”: cohesive Fine to medium sand with small amount of clay and silt
			15-22”: cohesive Fine sand and clay, shell fragments present
			22-29”: cohesive Clay
Slope	LB-9-A	97”	0-22”: cohesive Fine to medium sand with small amount of clay and silt
			22-97”: cohesive Clay with silt, minor shell fragments throughout
Tidal Flat (east)	LB-10-D	44”	Cohesive Fine to medium sand with small amounts of clay

Zone	Station	Penetration Depth	Sediment Description
Welsh Cove	LB-11-B	103”	Cohesive Clay and fine sand with silt
	LB-12-B	46”	0-18”: cohesive Clay and fine sand with silt
			Cohesive Fine to medium sand with little clay and silt; minor amount of wood debris and shell fragments

Table 3-2. Grain size distributions (in percent) for vibracore stations (composited over vertical).

CORE	Coarse Sand	Fine Sand	Med Fine Silt	Fine Silt	Clay
LB-1-A	0.00	0.00	10.00	10.00	80.00
LB-2-B	0.00	0.00	10.00	10.00	80.00
LB-3-B	0.00	0.00	10.00	10.00	80.00
LB-4-A	0.00	5.00	7.50	7.50	80.00
LB-5-B	0.00	5.00	7.50	7.50	80.00
LB-6-A	9.00	81.00	2.50	2.50	5.00
LB-7-B	1.78	16.03	10.52	10.52	61.15
LB-8-B	1.41	17.03	2.32	2.32	76.93
LB-9-A	2.06	18.56	10.21	10.21	58.96
LB-10-D	9.00	81.00	2.50	2.50	5.00
LB-11-B	0.00	20.00	2.50	2.50	75.00
LB-12-B	7.31	69.56	2.50	2.50	18.13

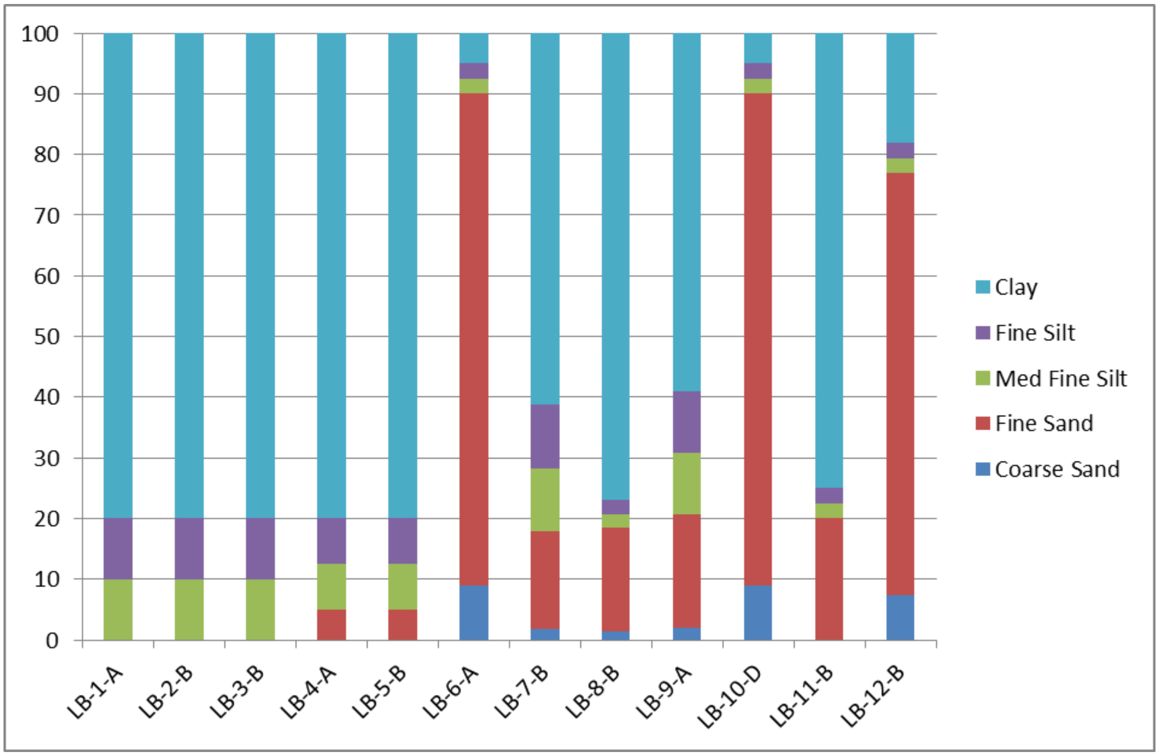

Figure 3-2. Histogram of grain size distributions (in percent) for vibracore stations in Little Bay.

The first five cores exhibit a large fraction (80%) of clay with smaller fractions of fine silt, medium fine silt and fine sand. In contrast cores LB-6-A and LB-10-D show 81% fine sand followed by LB-12-B with 70% fine sand, all within a range of 7 to 9% coarse sand. Cores LB-7-B, LB-8_B, LB-9-A and LB-11-B show clay fractions between 59 and 77% clay and between 16 and 20% fine sand. In general the cores with higher fines fractions will tend to generate larger suspended sediment plumes while those with higher sand fractions smaller plumes.

3.3 Model Input Parameters

The details of the planned route across Little Bay are shown in Figure 3-3 with the upper panel showing the western half of the route and the lower panel showing the eastern half. The three angled parallel lines represent the jet plow portion of the crossing for the three bundled cables with a separation of 9.4 m (30 ft). The western and eastern ends connecting the jet plowing portions to the land are represented by non-parallel routes ending at the shore which use diver burial.

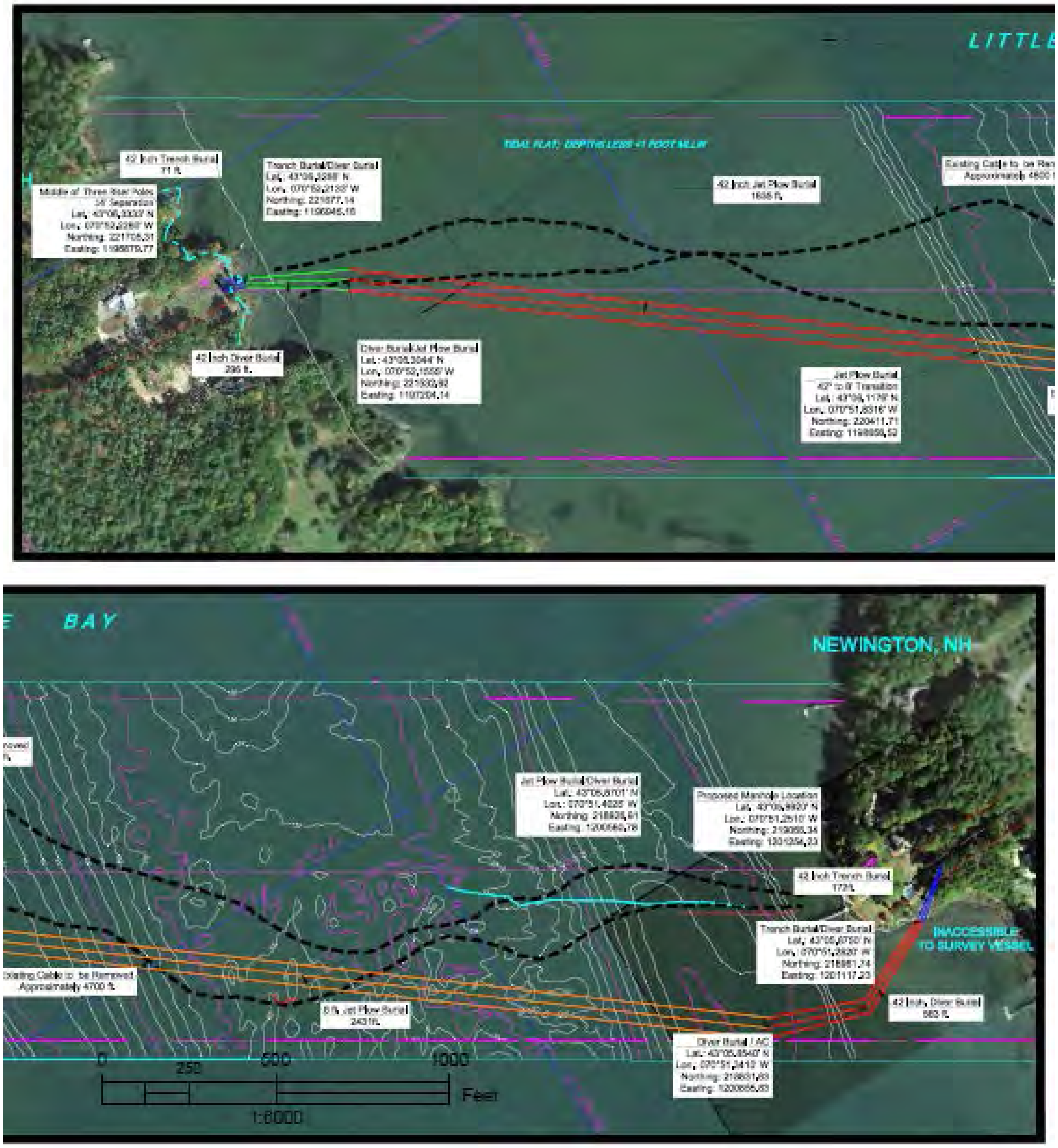

Figure 3-3. Details of proposed cable routes across Little Bay developed by Caldwell (Rev 6 Issue 01 – 20150424). Upper panel shows western half and lower panel shows eastern half.

3.3.1 Jet Plow Burial

The jet plow rate of advance was provided by the cable installer, Caldwell Marine International, LLC to be 100 m/hr (328 ft/hr). The central cable route among the three cable bundles crossing Little Bay was chosen for modeling since the cables are to be separated by only 9.4 m (30 ft).

The cables are to be buried by jet plowing to minimum depths of 1.07 m (42 in) deep in the shallows on the western but offshore section of Little Bay and 2.44 m (8 ft) in the center and east sections. For ease of discussion, this report refers to the jet plow disturbance as a trench although while the jet plow will be occupying a three-dimensional space, the “trench” is very temporary as it will fill in immediately behind the jet plow. The total depth of the trench included the minimum burial depth plus the cable diameter of 0.15 m (6 in) and an overage of 0.20 m (8 in) totaling 1.42 m (96 in) for the western section and 2.79 m (110 in) for the central and eastern sections. Based on Caldwell’s specification the vertical-walled trench width was defined as 0.32 m (12.75 in) resulting in a trench cross sectional area of 0.46 m^2 (5.0 ft^2) in the shallow western portion and an area of 0.90 m^2 (9.7 ft^2) in the deeper central and eastern portions. The length of the each trench was defined by Caldwell to be 559 m (1,835 ft) for the shallow burial and 741 m (2,431 ft) for the deeper burial. The model run was started on the west side of Little Bay at slack high water which is the beginning of the ebb tide.

It was assumed that 25% of the material in the trench would be resuspended into the water column by the jetting activity. This is a conservative estimate consistent with previous studies that found a range of 10 to 35% (Foreman, 2002). Caldwell indicated that the jet plow technology they will be using generates significantly lower resuspension rates, closer to about 10%.

Table 3-3 summarizes the trench dimensions and SSFATE input parameters used in the jet plow simulation.

Table 3-3. Summary of trench dimensions and SSFATE input parameters for the jet plow portion of the cable burial simulation.

Parameter	Shallow Jet Plow Burial	Deep Jet Plow Burial
Cable burial depth	1.07 m 3.50 ft	2.44 m 8.00 ft
Cable diameter	0.15 m 0.5 ft	0.15 m 0.5 ft
Overage amount	0.2 m 0.67 ft	0.2 m 0.67 ft
Total trench depth	1.42 m 4.67 ft	2.79 m 9.17 ft
Trench width	0.32 m 12.75 in	0.32 m 12.75 in
Trench cross sectional area	0.46 m^2 4.96 ft^2	0.90 m^2 9.7 ft^2
Route distance	559 m 1835 ft	741 m 2431 ft
Advance Rate	100 m/hr 328 ft/hr	100 m/hr 328 ft/hr
Duration	5.6 hr	7.4 hr
Timing	Start at high slack	Continue after shallow portion
Resuspension Fraction	25% of trench volume	25% of trench volume

3.3.2 Diver Burial

The diver rate of advance was much slower than the jet plow at 2.3 m/hr (7.5 ft/hr). Again the central cable route among the three cable bundles crossing Little Bay was chosen for modeling since the cables are to be separated by a maximum of 9.4 m (30 ft) and decreased as they approached the landfalls.

The cables are to be buried by divers in trenches with a minimum depth of 1.07 m (42 in) deep in the shallows on both the western and eastern portions of Little Bay with lengths of 90 m (296 ft) in the western portion and 178 m (584 ft) in the eastern portion. The total depth of the trench included the minimum burial depth plus the cable diameter of 0.15 m (6 in) which equals 1.22 m (48 in). Based on Caldwell's specification the trench width was defined as 1.22 m (48 in) resulting in a trench cross sectional area of 1.49 m^2 (16.0 ft^2). The model run was started two hours before high slack water and continued for four hours due to diver requirements of working in lower currents and deeper water. It was also assumed, based on past experience, that 50% of the material in the trench would be resuspended into the water column by the diver activity. This rate is twice the rate for jet plowing because the technology used, high pressure water hoses, is expected to cause a higher resuspension rate. Modeling was done assuming that silt curtains would not be employed during the diver installation.

Table 3-4 summarizes the trench dimensions and SSFATE input parameters used in the diver portion of the simulation.

Table 3-4. Summary of trench dimensions and SSFATE input parameters for the diver portion of the single cable burial simulation.

Parameter	West Diver Burial	East Diver Burial
Cable burial depth	1.07 m 3.50 ft	1.07 m 3.50 ft
Cable diameter	0.15 m 0.5 ft	0.15 m 0.5 ft
Total trench depth	1.22 m 4.00 ft	1.22 m 4.00 ft
Trench width	1.22 m 4.00 ft	1.22 m 4.00 ft
Trench cross sectional area	1.49 m^2 16.0 ft^2	1.49 m^2 16.0 ft^2
Route distance	90 m 296 ft	178 m 583 ft
Advance Rate	2.29 m/hr 7.5 ft/hr	2.29 m/hr 7.5 ft/hr
Duration	4 hr/day for 9.9 days	4 hr/day for 19.4 days
Timing	Start at 2 hrs before high slack	Start at 2 hrs before high slack
Resuspension Fraction	50% of trench volume (no silt curtains used)	50% of trench volume (no silt curtains used)

3.4 Model Results

3.4.1 Jet Plow Results

3.4.1.1 Water Column Concentrations

The total duration of the cable burial by jet plowing is 13 hours based on an average advance rate of 100 m/hr (328 ft/hr) and a route distance of 1,300 m (4,266 ft) (see Table 3-3). To best display the resulting water column concentration a series of figures were generated for each hour of the crossing resulting in 13 "snapshots" of the submerged plume at that time. Figures 3-4 through 3-7 shows the plan view of the predicted instantaneous excess SS concentration in 1-hr increments after the start of jet plowing at high slack tide with four panels shown per page. The submerged SS concentration plume extends north of the cable route for hours 1 through 7 indicating an ebb condition and south of the route for hours 8 through 13 indicating a flood condition. The water column concentration contours shown, which are defined by a single concentration level, totally surround an enclosed area where concentrations are at or above the specified concentration, i.e., the area is cumulative. Thus the areas with higher concentrations must be smaller than areas with lower concentrations since those areas are enclosed within the lower concentration contour.

The contours show a decreasing concentration away from the immediate location of the jet plow on the cable route as material dilutes and settles out. The colored contours can be identified from the legend in the upper left corner of each panel showing concentrations from 10 mg/L and higher. A larger SS concentration legend is shown in the upper left panel of Figure 3-4.

A vertical section view defined along the cable route looking north is inserted at the bottom left of each hourly panel. The insert shows that the highest concentrations occur just above the jet plow near the bottom with reduced concentrations extending up into the water column above the plow. In the shallows, suspended sediments from the jet plow activity are likely to reach nearly to the water surface. In the channel, excess suspended sediments will be restricted to the lower half of the water column.

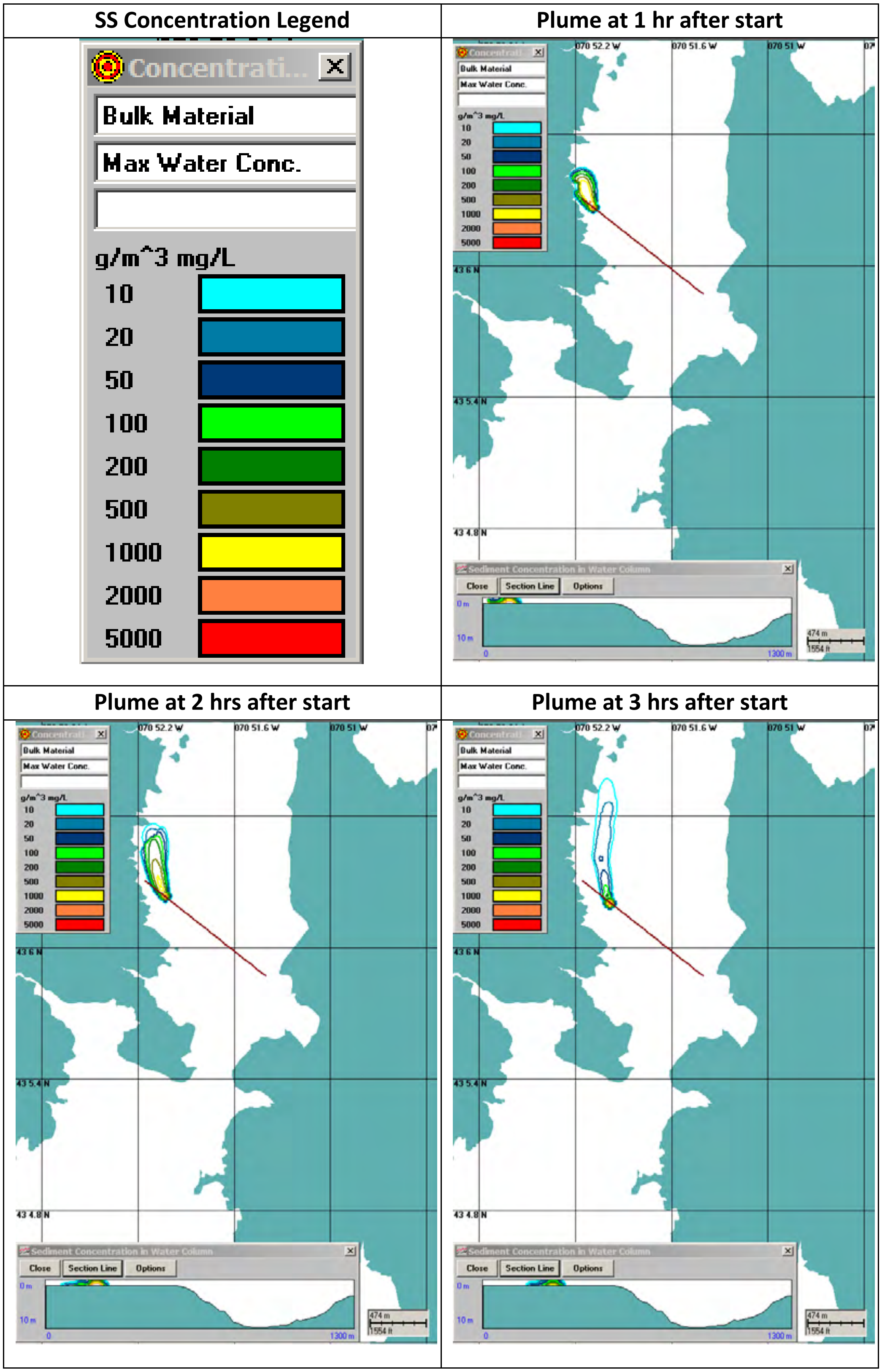

Figure 3-4. Plan view of instantaneous excess SS concentrations at 1 through 3 hrs after start of jet plowing. Vertical section view at lower left of each panel.

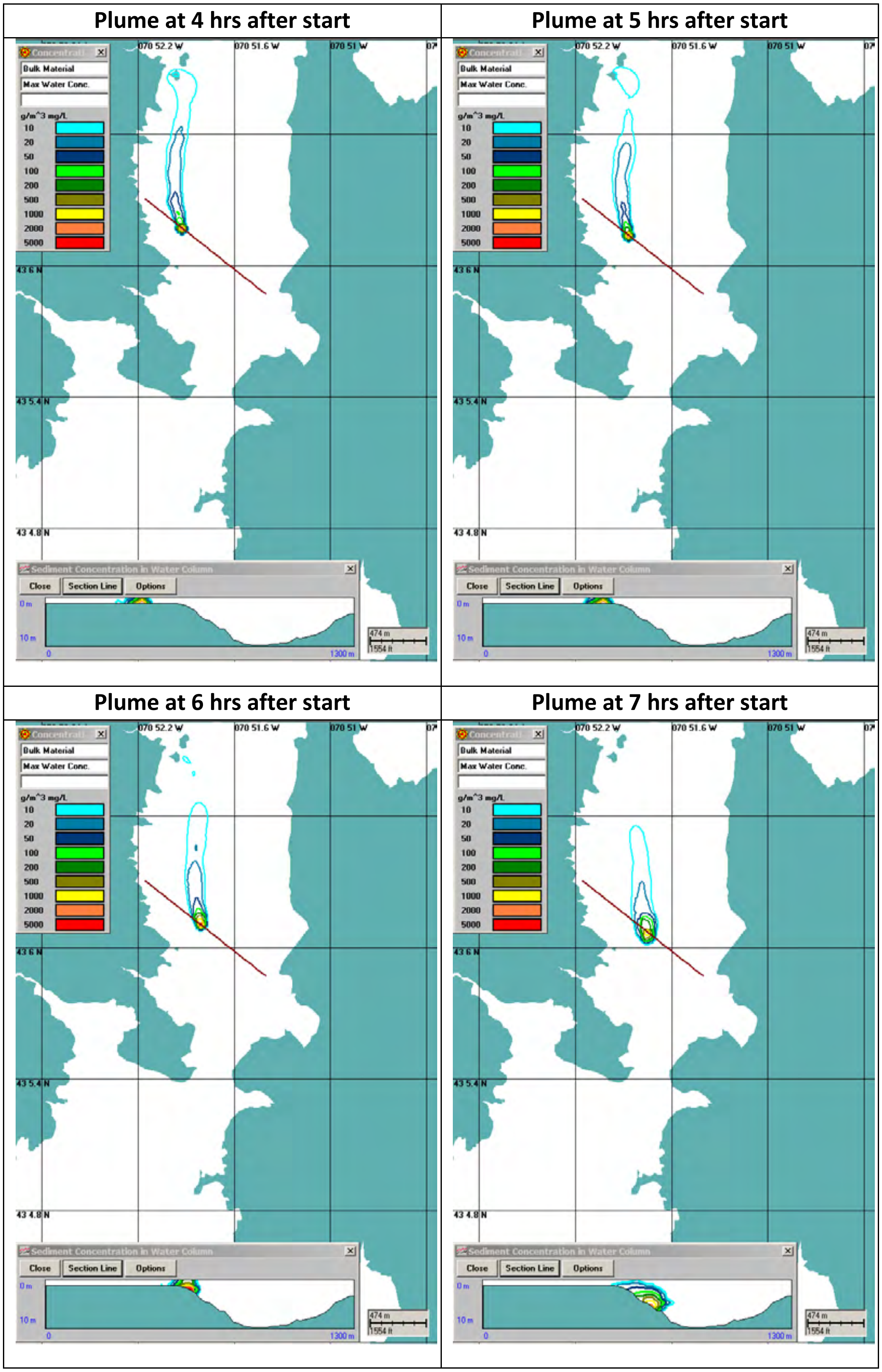

Figure 3-5. Plan view of instantaneous excess SS concentrations at 4 through 7 hrs after start of jet plowing. Vertical section view at lower left of each panel.

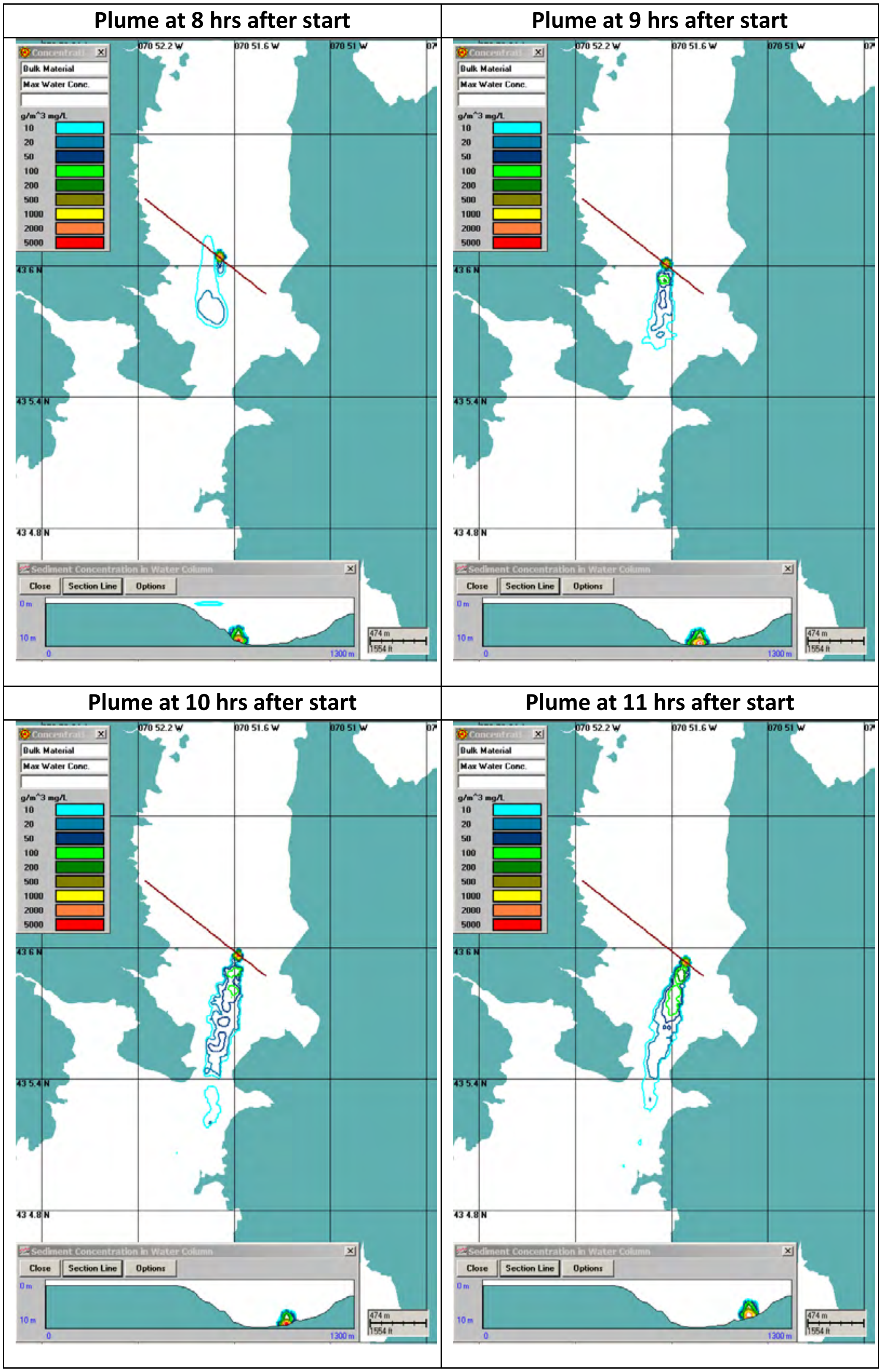

Figure 3-6. Plan view of instantaneous excess SS concentrations at 8 through 11 hrs after start of jet plowing. Vertical section view at lower left of each panel.

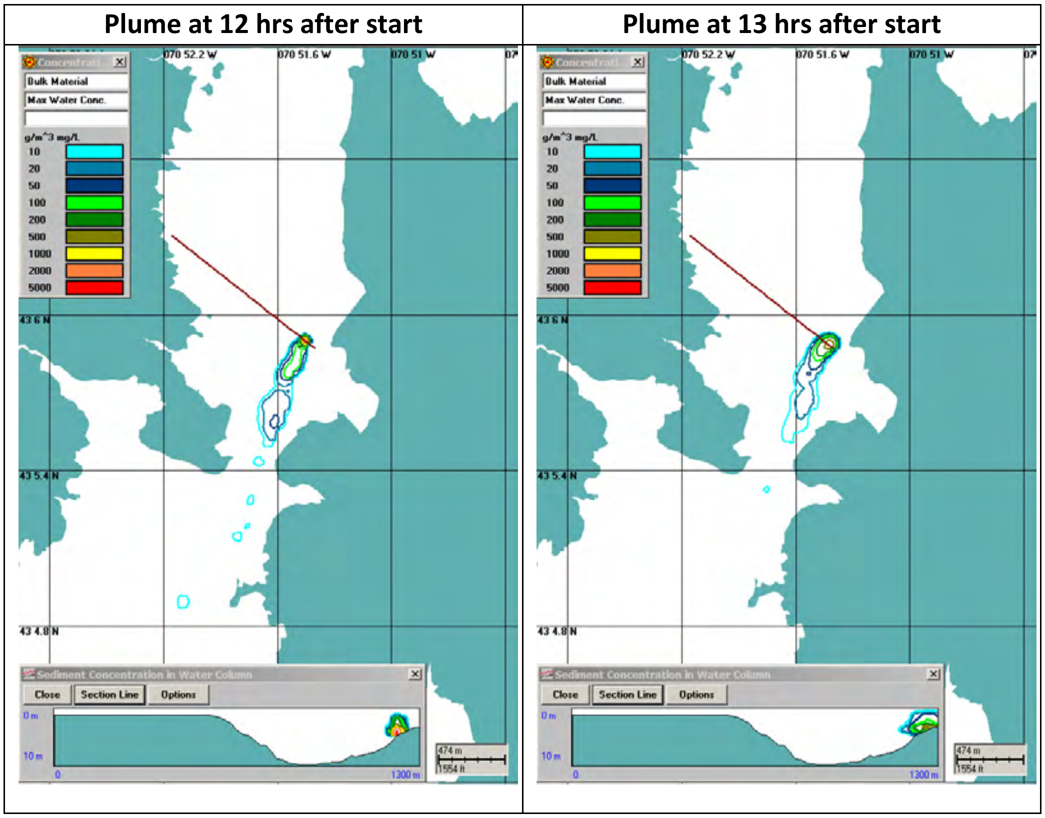

Figure 3-7. Plan view of instantaneous excess SS concentrations at 12 through 13 hrs after start of jet plowing. Vertical section view at lower left of each panel.

Since the currents are smaller right after slack water, the extent of the plume is smaller for hrs 1 and 2. The plume is at its greatest northern extent for hrs 4, 5, and 6. By hr 8 the tide has turned and the plume reaches its maximum southern extent by hrs 10, 11, and 12.

The instantaneous total enclosed area of the excess SS concentration plumes seen in Figures 3-4 through 3-7 is quantitatively summarized in Tables 3-5 (in area units of hectares) and 3-6 (in units of acres) for each 1-hr increment identified at the top of each figure panel. On average the entire area encompassed by the plume (as defined by the 10 mg/L excess SS concentration contour) was 14.8 ha (36.58 ac), ranging from a low of 5.91 ha (14.61 ac) at 1 hr to a high of 22.36 ha (55.25 ac) at 10 hrs. These total enclosed areas dropped dramatically for the higher concentrations, averaging 1.94 ha (4.79 ac) at 100 mg/L, 0.28 ha (0.68 ac) at 1,000 mg/L and 0.02 ha (0.05 ac) at 5,000 mg/L. indicating that the extent of the plume is limited for higher concentrations.

Table 3-5. Summary of the total area (hectares) enclosed by the excess SS threshold concentration contours shown in Figures 3-4 through 3-7 due to jet plowing. Hours start at high slack tide.

TSS (mg/L)	Area (ha) 1 hr Ebb	Area (ha) 2 hr Ebb	Area (ha) 3 hr Ebb	Area (ha) 4 hr Ebb	Area (ha) 5 hr Ebb	Area (ha) 6 hr Ebb	Area (ha) 7 hr Ebb
10	5.91	11.66	14.42	18.73	16.77	15.38	15.14
20	5.47	9.55	8.43	7.59	7.23	5.91	5.99
50	4.55	7.59	2.24	2.08	1.68	1.96	2.64
100	3.87	6.43	0.88	0.64	0.72	1.24	1.84
200	3.16	4.59	0.28	0.28	0.44	0.72	1.24
500	2.32	1.92	0.20	0.20	0.20	0.48	0.32
1000	1.44	0.44	0.20	0.20	0.20	0.28	0.08
2000	0.08	0.04	0.04	0.04	0.04	0.08	0.04
5000	0.00	0.00	0.04	0.00	0.00	0.04	0.00

TSS (mg/L)	Area (ha) 8 hr Flood	Area (ha) 9 hr Flood	Area (ha) 10 hr Flood	Area (ha) 11 hr Flood	Area (ha) 12 hr Flood	Area (ha) 13 hr Flood	Area (ha) Average
10	13.62	11.30	22.36	20.13	13.74	13.26	14.80
20	4.95	5.99	15.14	14.22	9.07	7.71	8.25
50	0.52	2.24	5.63	5.75	3.44	3.24	3.35
100	0.32	0.80	1.36	3.36	1.84	1.92	1.94
200	0.16	0.28	0.20	0.72	0.28	1.28	1.05
500	0.16	0.20	0.16	0.20	0.20	0.32	0.53
1000	0.16	0.16	0.16	0.08	0.20	0.00	0.28
2000	0.04	0.04	0.04	0.04	0.04	0.00	0.04
5000	0.04	0.04	0.04	0.00	0.04	0.00	0.02

Table 3-6. Summary of the total area (acres) enclosed by the excess SS threshold concentration contours shown in Figures 3-4 through 3-7 due to jet plowing.

TSS (mg/L)	Area (ac) 1 hr Ebb	Area (ac) 2 hr Ebb	Area (ac) 3 hr Ebb	Area (ac) 4 hr Ebb	Area (ac) 5 hr Ebb	Area (ac) 6 hr Ebb	Area (ac) 7 hr Ebb
10	14.61	28.81	35.63	46.28	41.44	38.00	37.41
20	13.52	23.59	20.82	18.75	17.86	14.61	14.80
50	11.25	18.75	5.53	5.13	4.14	4.84	6.51
100	9.57	15.89	2.17	1.58	1.78	3.06	4.54
200	7.80	11.35	0.69	0.69	1.09	1.78	3.06

TSS (mg/L)	Area (ac) 1 hr Ebb	Area (ac) 2 hr Ebb	Area (ac) 3 hr Ebb	Area (ac) 4 hr Ebb	Area (ac) 5 hr Ebb	Area (ac) 6 hr Ebb	Area (ac) 7 hr Ebb
500	5.72	4.74	0.49	0.49	0.49	1.18	0.79
1000	3.55	1.09	0.49	0.49	0.49	0.69	0.20
2000	0.20	0.10	0.10	0.10	0.10	0.20	0.10
5000	0.00	0.00	0.10	0.00	0.00	0.10	0.00

TSS (mg/L)	Area (ac) 8 hr Flood	Area (ac) 9 hr Flood	Area (ac) 10 hr Flood	Area (ac) 11 hr Flood	Area (ac) 12 hr Flood	Area (ac) 13 hr Flood	Area (ac) Average
10	33.66	27.92	55.25	49.74	33.95	32.77	36.58
20	12.24	14.80	37.41	35.14	22.40	19.05	20.38
50	1.28	5.53	13.91	14.21	8.49	7.99	8.27
100	0.79	1.97	3.36	8.29	4.54	4.74	4.79
200	0.39	0.69	0.49	1.78	0.69	3.16	2.59
500	0.39	0.49	0.39	0.49	0.49	0.79	1.31
1000	0.39	0.39	0.39	0.20	0.49	0.00	0.68
2000	0.10	0.10	0.10	0.10	0.10	0.00	0.11
5000	0.10	0.10	0.10	0.00	0.10	0.00	0.05

The simulation was continued for an additional six hours after jet plowing was completed (hour 13 after the start of installation) to ensure that all residual concentrations had dissipated. Figure 3-8 showing the plan view of the maximum time-integrated excess SS concentration contours includes that additional post operational period. The time-integrated maximum concentration is generated from the model results by determining the highest concentration in each SSFATE grid cell which overlays Little Bay during the entire simulation. This plot shows only the maximum excess SS concentration integrated over time and would not be actually seen in the Bay (the results shown in Figures 3-4 through 3-7 are representative of what would be seen instantaneously). The advance rate is sufficiently slow that one sees the ebb-directed plume heading north on the west side of the Bay at the beginning of the simulation, then the flood-directed plume heading south in the center of the Bay and finally another ebb-directed plume heading north on the east side of the Bay (after the jetting operation has ceased and the plume is dissipating). The contours again show decreasing concentration from either side of the cable route with higher concentrations adjacent to the jet plow route.

A vertical section view defined by the jet plow route is shown at the bottom left of the figure. The highest concentrations, between 2,000 and 5,000 mg/L occur just above the bottom at the jet plow with reduced concentrations extending up into the water column along the route.

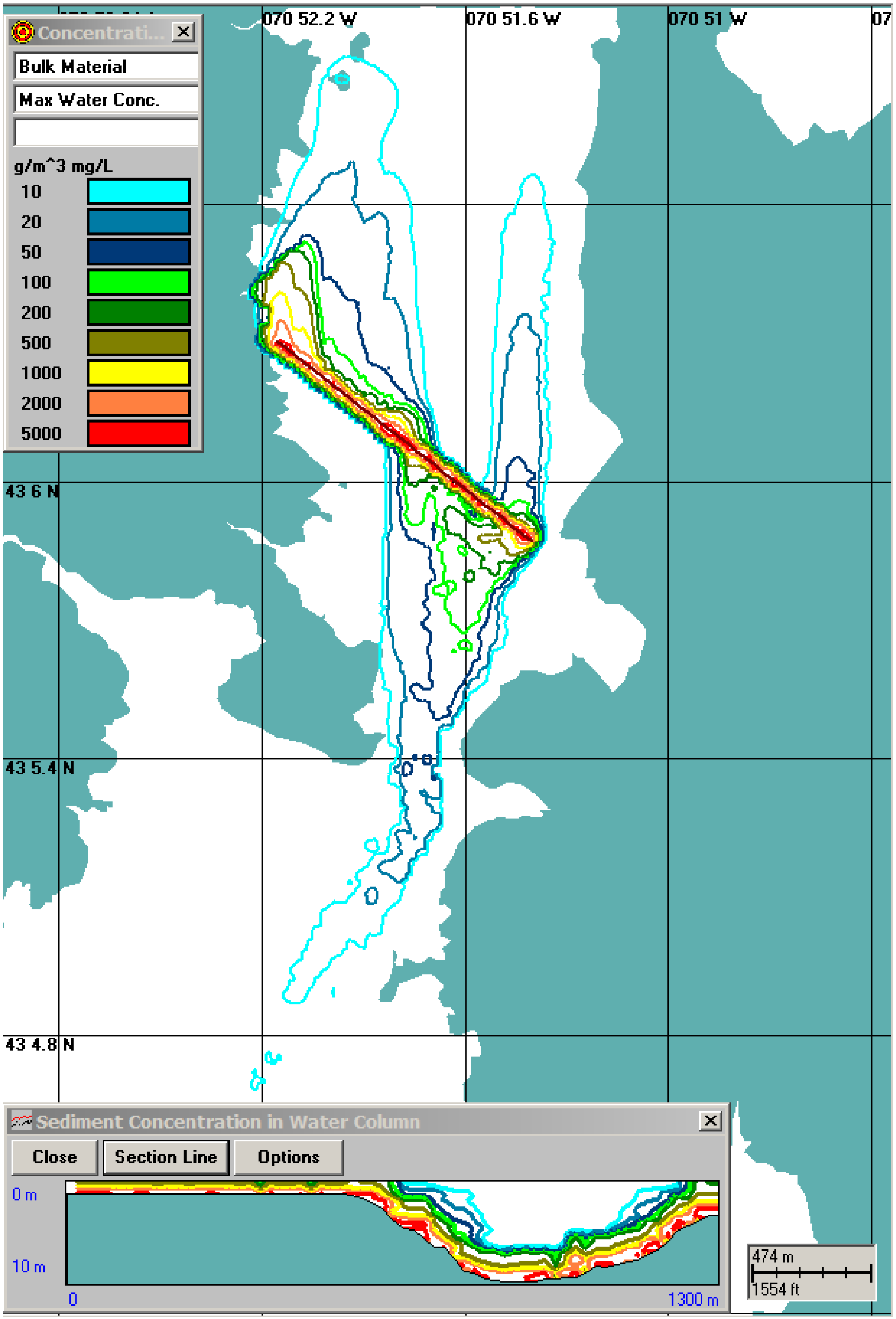

Figure 3-8. Plan view of maximum time integrated excess SS concentration contours over the entire jet plowing operation and the post operational period (while concentrations dissipate). Vertical section view at lower left.

Table 3-7 summarizes the total area enclosed by the maximum time-integrated excess SS concentration contours over the entire jet plowing operation and the post operational period (while concentrations dissipate) shown in Figure 3-8. This table shows that during the operation and post operational period an area of 165.1 ha (408.0 ac) sees a 10 mg/L concentration for a minimum of 5 minutes (the SSFATE model output timestep) but at different times during the simulation. The 5,000 mg/L time integrated enclosed area is 1.9 ha (4.6 ac) and is restricted to the area averaging about 14 m (46 ft) wide straddling the cable route and lasting only a short time.

Table 3-7. Summary of the total area (hectares and acres) enclosed by the maximum time-integrated excess SS concentration contours over the entire jet plowing operation and the post operational period (while concentrations dissipate) in Figure 3-8.

TSS	Area	Area
(mg/L)	(ha)	(ac)
10	165.1	408.0
20	107.4	265.4
50	56.2	138.9
100	35.9	88.7
200	22.0	54.3
500	14.2	35.1
1000	9.3	23.1
2000	4.2	10.3
5000	1.9	4.6
10000	0.0	0.0

An important metric defining the plume is its duration for different concentrations, which could have biological significance if exposure (duration multiplied by concentration) is sufficiently elevated. Figure 3-9 and Table 3-8 summarize the area that experiences a specific exposure (duration at or above concentration) due to jet plow operations. Areas totaling 90.20 ha (222.89 ac), 32.2 ha (79.57 ac), 3.57 ha (8.82 ac) are exposed to a concentration of 10 mg/L or greater for 1 hr, 2 hrs and 4 hrs respectively while no areas are exposed to such a concentration for a duration of six hours; note that these areas are summations and not necessarily contiguous. The area coverages drop dramatically for the exposures of higher concentrations near the jet plow indicating that the duration and extent of the plume is relatively limited. Furthermore, once the jet plow stops operating, no additional sediments will be dispersed into the water column and concentrations above 10 mg/L dissipate within approximately 2 hrs (Figure 3-10).

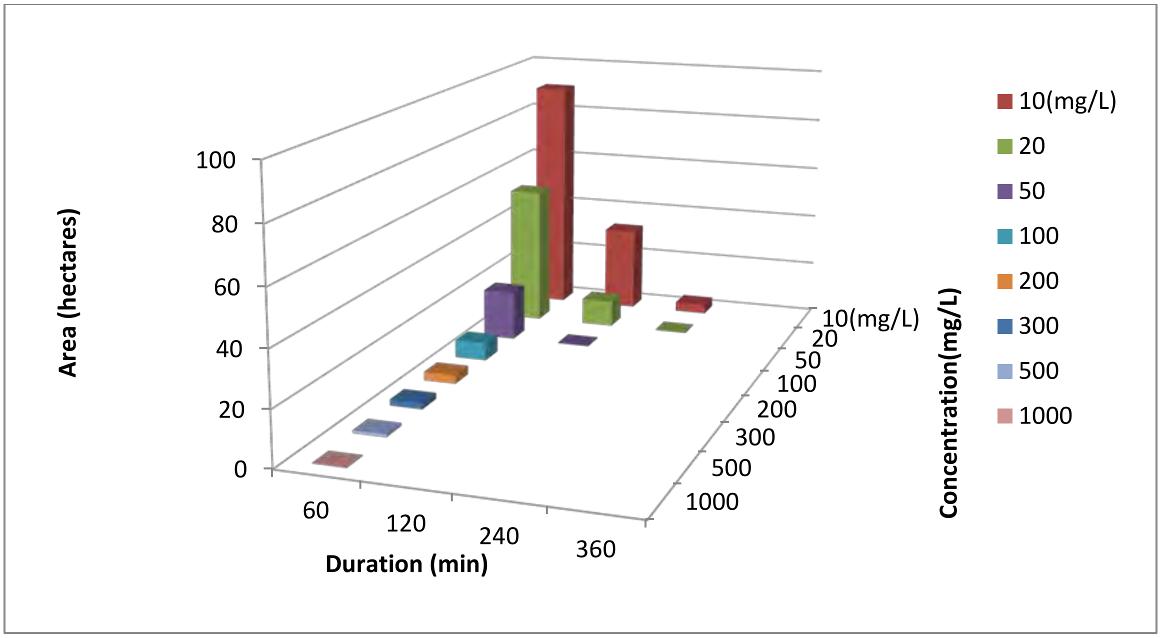

Figure 3-9. Duration (minutes) and total enclosed area (hectares) of maximum time integrated excess SS concentration contours over the entire jet plowing operation and the post operational period (while concentrations dissipate).

Table 3-8. Duration (minutes) and total enclosed area (hectares and acres) of maximum time integrated excess SS concentration contours over the entire jet plowing operation and the post operational period (while concentrations dissipate).

SS Concentration	Hectares				Acres			
	60	120	240	360	60	120	240	360
(mg/L)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)
10	90.20	32.20	3.57		222.89	79.57	8.82	
20	52.60	10.00	0.12		129.98	24.71	0.30	
50	18.70	0.16			46.21	0.40		
100	6.72				16.61			
200	3.20				7.91			
300	2.24				5.54			
500	1.04				2.57			
1000	0.08				0.20			

Plume ½ hr after Jet Plow Stops	Plume 1 hr after Jet Plow Stops

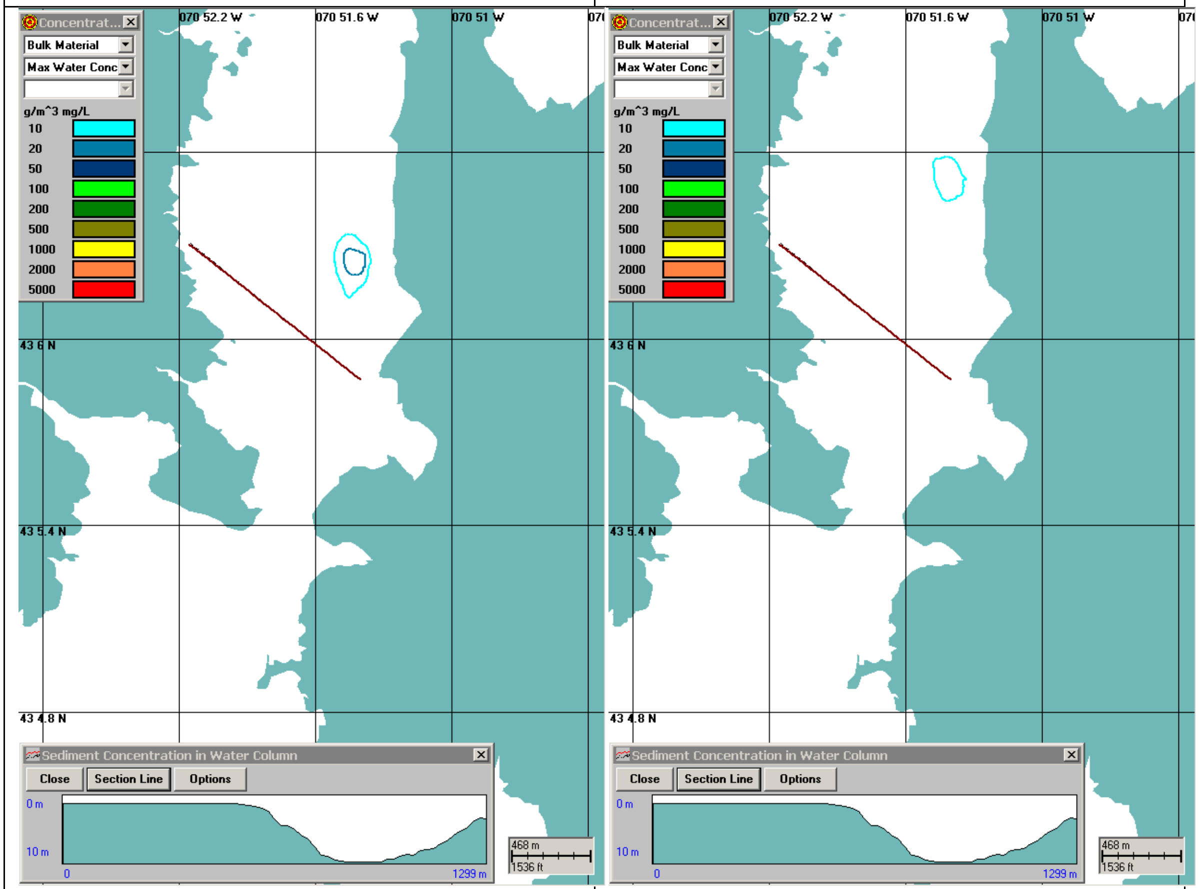

Figure 3-10. Plan view of instantaneous excess SS concentrations at 0.5 and 1 hour after cessation of jet plowing (13.5 and 14 hrs after start of jet plowing). Vertical section view at lower left of each panel.

3.4.1.2 Bottom Deposition

Figure 3-11 shows the plan view of the bottom deposition thickness distribution from 0.1 to 10 mm (0.004 to 0.4 in) due to jet plowing all three cable routes combined and assuming that any sediment deposited on the bottom remains in place. The color filled areas are defined by the legend for different deposition thickness ranges, e.g., 1 mm to 5 mm (0.04 to 0.2 in) denoted by yellow. In contrast to the water column concentration contours, which are defined by a single concentration value totally surrounding an enclosed area where concentrations are at or above the specified concentration (i.e., the area is cumulative), the bottom deposition thickness is defined for the area exclusively between the range of thicknesses described (i.e., the area is not cumulative). Thus the areas with larger thicknesses are not necessarily smaller than areas with smaller thicknesses. The shape of the distribution pattern is generally similar to the water column plume (ebb-then-flood) but reduced in extent. The higher deposition areas are at and adjacent to the cable route and occur when the sediment distribution is weighted toward the sand fractions. There are a few non-contiguous areas of 0.1 to 0.5 mm (0.004 to 0.02 in) deposition further south of the cable route that are due to the slight changes in current direction transporting water column plumes from slightly different locations on the route so that they happen to form a thin deposit at the same place.

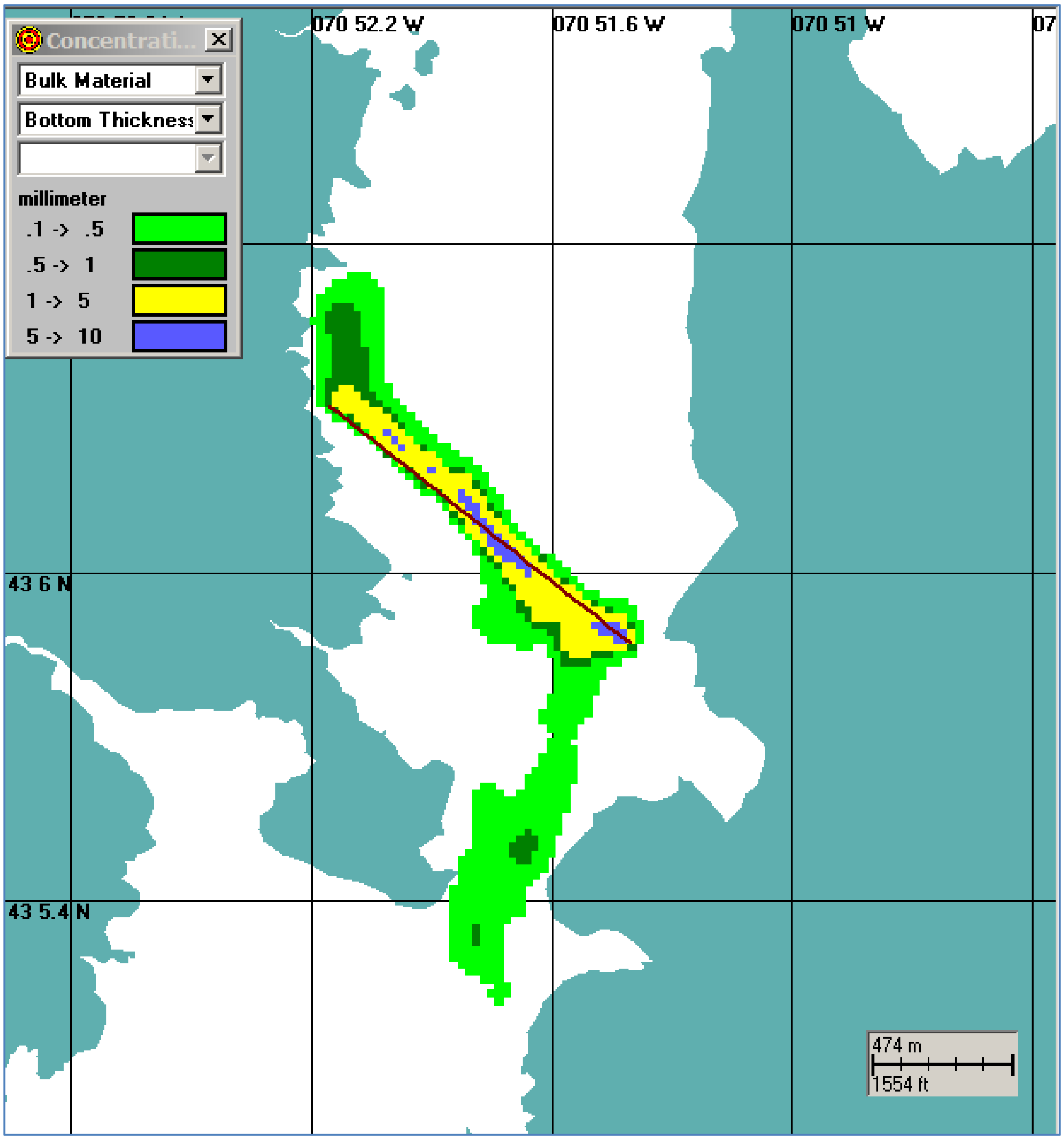

Figure 3-11. Plan view of integrated bottom thickness (mm) distribution due to jet plowing for the three cable trenches combined.

The areal sizes of the deposition thickness patterns seen in Figure 3-11 are summarized in Table 3-9 for each thickness increment range. At the range of 0.1 to 0.5 mm (0.004 to 0.02 in) thickness range the area is 35.6 ha (87.9 ac) due to jet plowing the three cable routes. These areas generally drop in size, but not always, for the higher deposition thicknesses. For example, the area of 12.4 ha [30.7 ac] for the 1 to 5 mm [0.04 to 0.2 in) thickness range is larger than the 0.5 to 1 mm (0.02 to 0.04 in) area of 8.1 ha (20.0 ac).

Table 3-9. Bottom thickness (millimeter and inch) areal distribution (hectare and acre) due to jet plowing for the three cable routes combined.

Thickness (mm)	Area (ha)	Thickness (in)	Area (ac)
0.1 to 0.5	35.6	0.004 to 0.02	87.9
0.5 to 1	8.1	0.020 to 0.04	20.0
1 to 5	12.4	0.04 to 0.2	30.7
5 to 10	2.4	0.2 to 0.4	5.9
Totals 0.1 to 10	58.5	0.004 to 0.4	144.5

3.4.2 Diver Burial Results

3.4.2.1 Water Column Concentrations

The total duration of the cable burial by divers is 4 hr/day for 9.9 days for the west area and 4 hr/day for 19.4 days for the east area for each of the three cable bundles to be buried. This is based on an estimated advance rate of 2.29 m/hr (7.5 ft/hr) for the 4 hrs around high slack water for a 90 m (296 ft) route distance for the west area and 178 m (583 ft) for the east area (see Table 3-4). To best display the resulting water column concentration a figure was generated for each area for 1 day at a representative location in the area. Figure 3-12 shows the plan view of the predicted instantaneous excess SS concentration contours for both the west and east area. The submerged SS concentration plumes extend both north and south of the cable route due to the timing of operations before and after slack water. Again, the water column concentration contours shown, which are defined by a single concentration level, totally surround an enclosed area where concentrations are at or above the specified concentration, i.e., the area is cumulative. Thus the areas with higher concentrations must be smaller than areas with lower concentrations since those areas are enclosed within the lower concentration contour.

The contours in Figure 3-12 show a decreasing concentration away from the location of the diver activities on the cable route as material dilutes and settles out. The colored contours can be identified from the legend in the upper right corner of the figure showing concentrations from 10 mg/L and higher. Modeling was done assuming that silt curtains would not be employed during the diver installation.

A vertical section view defined along the cable route looking north is inserted at the bottom left of the figure. The insert shows that the highest concentrations occur near the bottom with reduced concentrations extending up into the water column. In the western shallows, suspended sediments from the diver burial activity are likely to reach nearly to the water surface. In the somewhat deeper eastern area, excess suspended sediments will be restricted to the lower half of the water column.

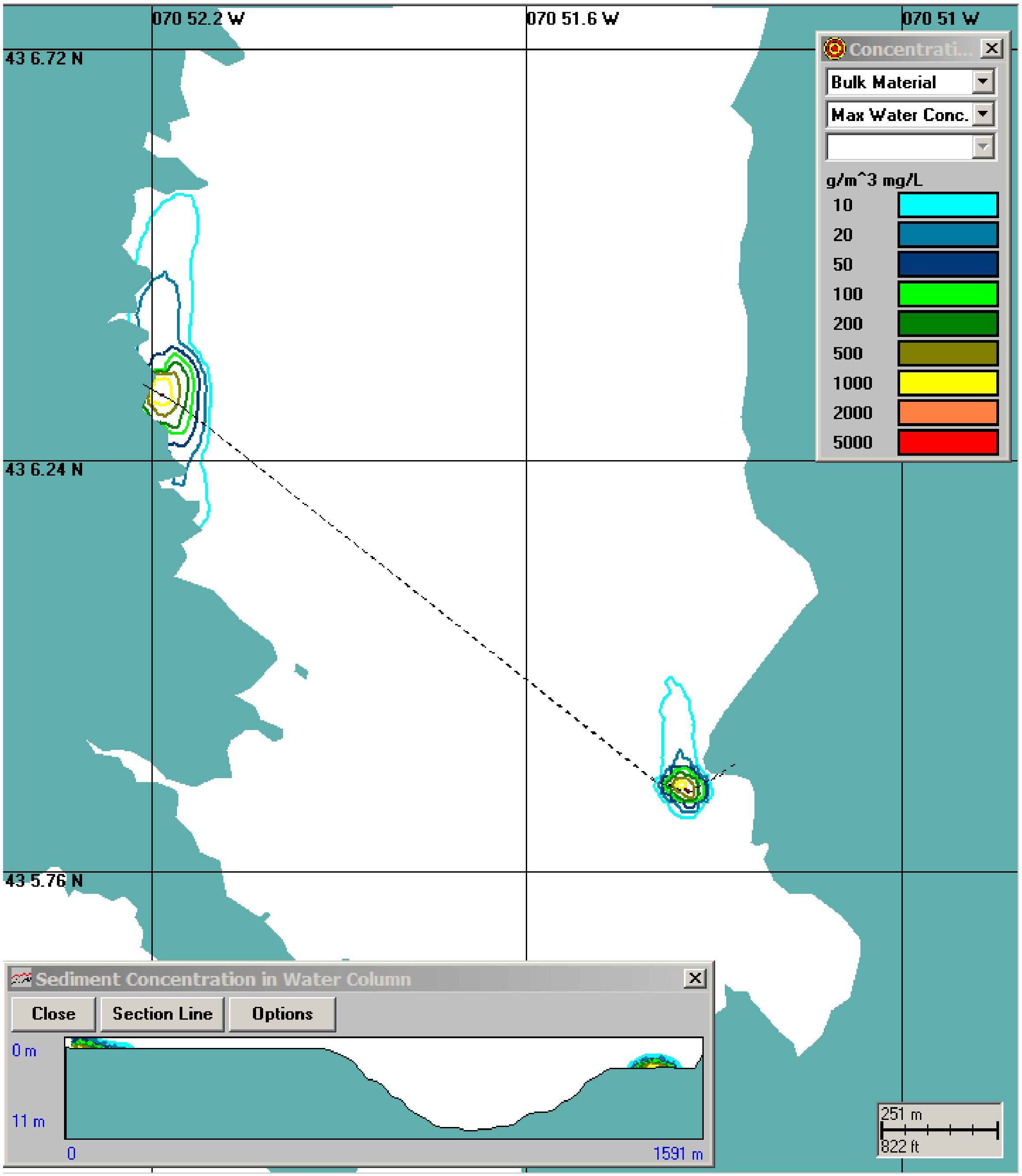

Figure 3-12. Plan view of instantaneous maximum excess SS concentration contours for 1 day approximately midway across the west and east diver burial sections. Vertical section view at lower left. Assumes silt curtains were not used.

The instantaneous total enclosed area of the excess SS concentration plumes for the west and east diver burial sections seen in Figure 3-12 is summarized in Table 3-10 for each increment identified in the color legend. At 10 mg/L excess SS concentration the total area enclosed by the contour is 8.4 ha (20.7 ac) for the west section and 1.9 ha (4.7 ac) for the east section. However, these total enclosed areas drop dramatically for the higher concentrations near the diver burial activities, i.e., the area at 1,000 mg/L is only about 0.2 ha (0.6 ac) for the west section and 0.0 ha

(0.1 ac) for the east section, indicating that the extent of the plume is again relatively limited for higher concentrations.

Table 3-10. Summary of the total area (hectares and acres) enclosed by the excess SS threshold concentration contours shown in Figure 3-11 due to diver burial. Assumes silt curtains were not used.

TSS (mg/L)	West Section Area (ha)	West Section Area (ac)	East Section Area (ha)	East Section Area (ac)
10	8.4	20.7	1.9	4.7
20	4.5	11.0	0.8	2.0
50	2.0	4.9	0.5	1.2
100	1.2	3.0	0.4	0.9
200	1.0	2.5	0.3	0.7
500	0.5	1.2	0.1	0.3
1000	0.2	0.6	0.0	0.1

Figure 3-13 shows the plan view of the maximum time-integrated excess SS concentration contours for both diver burial sections. As before, these concentrations are generated from the model results by determining the highest concentration in each SSFATE grid cell during the entire simulation, approximately 10 and 20 days for the west and east sections, respectively. This plot shows only the maximum excess SS concentration integrated over time and would not be actually seen in the Bay. The contours again show decreasing concentration from either side of the cable route with higher concentrations adjacent to the jet plow route. This model run assumed silt curtains were not used.

A vertical section view defined by the jet plow route is shown at the bottom left of the figure. The highest concentrations, above 5,000 mg/L on the west side, occur just above the bottom with dramatically reduced concentrations extending up into the water column along the route. The same is true for the east section but the highest concentrations there are between 500 and 1,000 mg/L.

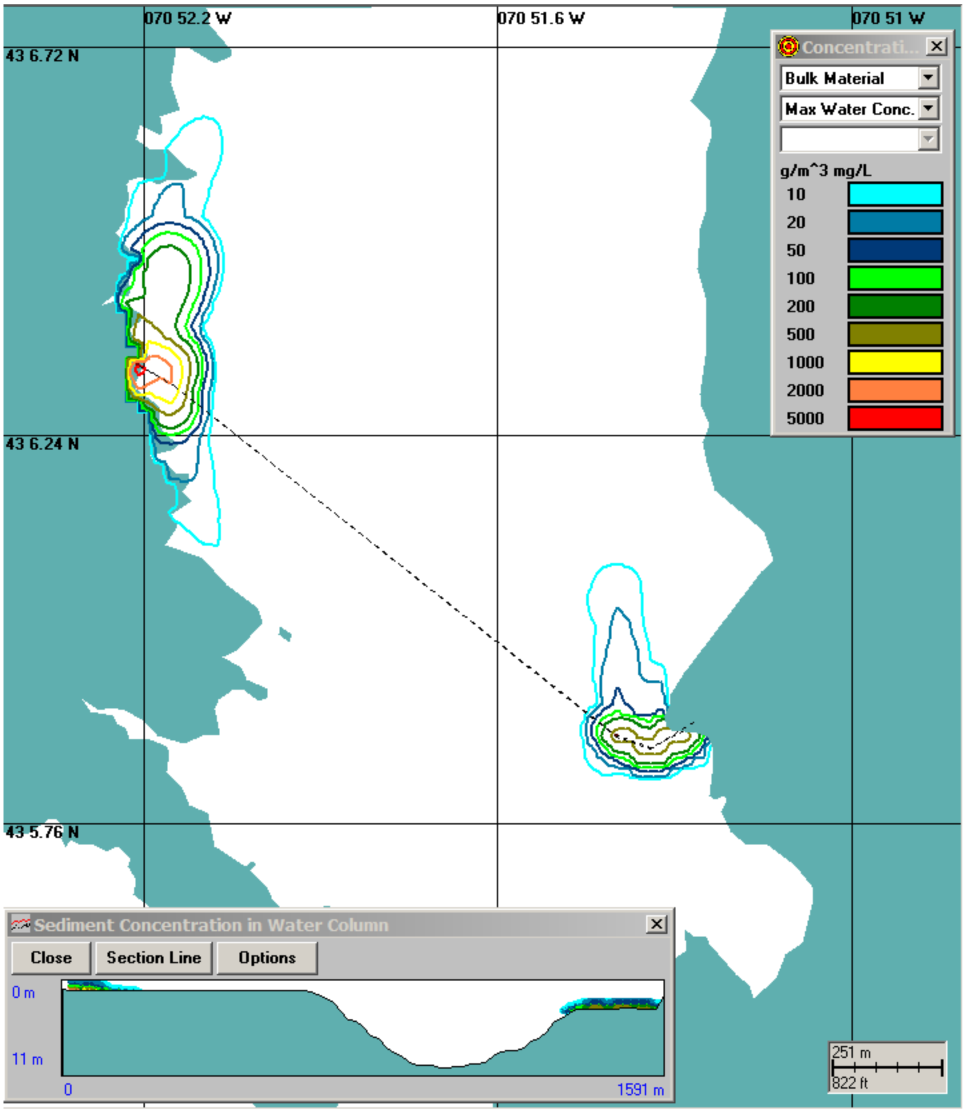

Figure 3-13. Plan view of maximum time integrated excess SS concentration contours over both diver burial operations. Vertical section view at lower left. Assumes silt curtains were not used.

Table 3-11 summarizes the total western and eastern areas enclosed by the maximum time-integrated excess SS concentrations over the diver burial operations shown in Figure 3-13. This table shows that during the diver burial activities on the west side, a total enclosed area of 14.5 ha (35.9 ac) sees a minimum 10 mg/L concentration for a minimum of 5 minutes (the SSFATE model output timestep) but at different times during the simulation. For the east side the 10 mg/L concentration contour encloses a total area of 8.2 ha (20.2) ac.

Table 3-11. Summary of the total area (hectares and acres) enclosed by the maximum time-integrated excess SS threshold concentration contours shown in Figure 3-13 due to diver burial for the west and east sections. Assumes silt curtains were not used.

TSS (mg/L)	West Area (ha)	West Area (ac)	East Area (ha)	East Area (ac)
10	14.5	35.9	8.2	20.2
20	9.7	24.0	5.1	12.5
50	7.2	17.7	2.9	7.1
100	5.9	14.6	2.1	5.1
200	4.5	11.1	1.6	3.9
500	2.0	4.9	0.5	1.2
1000	1.2	3.1		
2000	0.6	1.4		
5000	0.1	0.2		
10000				

An important metric defining the plume is its duration for different concentrations, which could have biological significance if exposure (duration multiplied by concentration) is sufficiently elevated. The total enclosed area and duration of the time-integrated maximum west section plume seen in Figure 3-13 is summarized in Figure 3-14 and Table 3-12 for each contour identified in the color legend. At 10 mg/L excess SS concentration the total area that is enclosed by the contour is 14.6 ha (36.1 ac) but lasts for only 1 hr. This short duration continues through all the concentration contour thresholds through 5,000 mg/L. The enclosed areas decrease in time for a given concentrations so by 6 hrs the 10 mg/L area has dropped to 8.6 ha (21.2 ac). The 10 mg/L area persists for two days because the initial buildup occurs near slack water with grain size distribution indicating mostly fines (silts and clays). The area coverages decrease for higher concentrations near the diver burial activities.

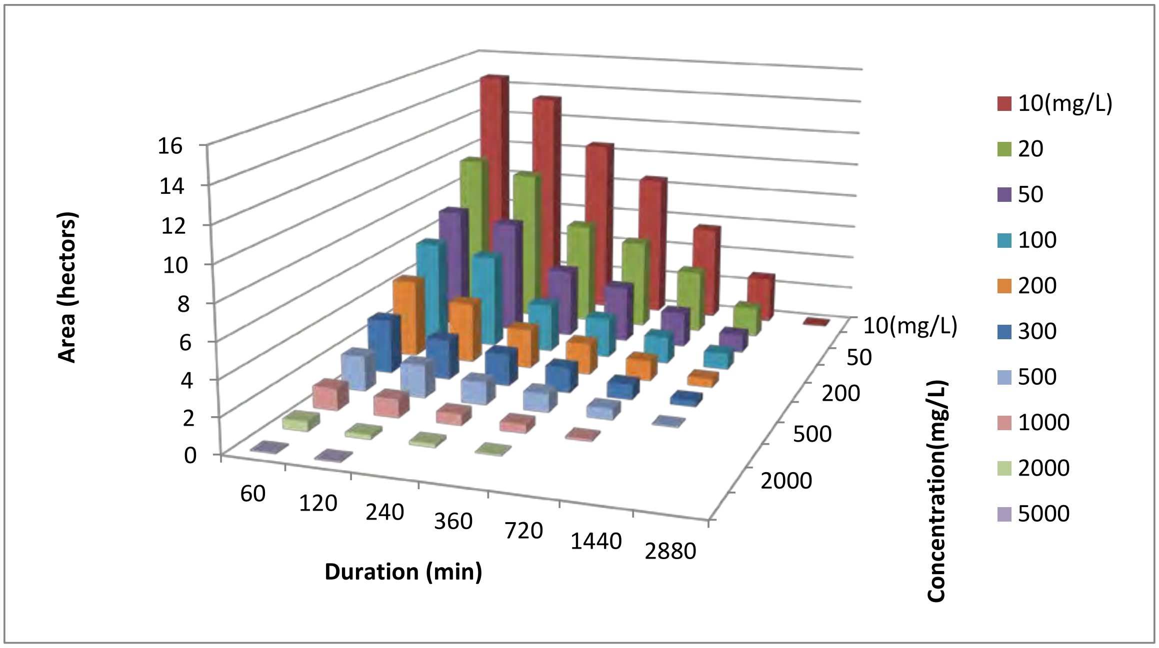

Figure 3-14. **Duration (minutes) and total enclosed area (hectares) of maximum time integrated excess SS concentration due to diver burial for west section with total duration of 9.9 4-hour days (2,368 min). Assumes silt curtains were not used.**

Table 3-12. Duration (minutes) and total enclosed area (hectares and acres) of maximum time integrated excess SS concentration due to diver burial for west section with total duration of 9.9 4-hour days (2,368 min). Assumes silt curtains were not used.

West	Area (ha)						
Max SS (mg/L)	Minutes						
	60	120	240	360	720	1440	2880
10	14.6	13.4	10.5	8.6	5.6	2.8	0.1
20	9.8	9.1	6.0	5.3	3.7	1.8	
50	7.2	6.7	4.0	3.3	2.1	1.1	
100	5.9	5.4	2.8	2.3	1.6	0.9	
200	4.5	3.5	2.3	1.8	1.2	0.5	
300	3.1	2.3	1.9	1.4	0.9	0.4	
500	2.0	1.9	1.3	1.1	0.6	0.1	
1000	1.3	1.1	0.6	0.5	0.1		
2000	0.6	0.3	0.2	0.1			
5000	0.1	0.1					

West	Area (ac)						
Max SS (mg/L)	Minutes						
	60	120	240	360	720	1440	2880
10	36.1	33.1	26.0	21.2	13.9	6.8	0.2
20	24.1	22.4	14.9	13.0	9.1	4.3	

West	Area (ac)						
Max SS	Minutes						
(mg/L)	60	120	240	360	720	1440	2880
50	17.8	16.5	9.9	8.2	5.1	2.6	
100	14.7	13.4	7.0	5.7	3.9	2.3	
200	11.1	8.6	5.6	4.5	2.9	1.2	
300	7.7	5.7	4.6	3.6	2.2	0.9	
500	4.9	4.6	3.2	2.6	1.5	0.2	
1000	3.1	2.6	1.6	1.2	0.3		
2000	1.4	0.6	0.5	0.2			
5000	0.2	0.2					

The total enclosed area and duration of the time-integrated maximum east section plume seen in Figure 3-13 is summarized in Figure 3-15 and Table 3-13 for each contour identified in the color legend. At 10 mg/L excess SS concentration the total area that is enclosed by the contour is 8.2 ha (20.2 ac) but lasts for only 1 hr. This short duration continues through all the concentration contour thresholds through 500 mg/L. The enclosed areas decrease in time for a given concentration so by 6 hrs the 10 mg/L area has dropped to 4.1 ha (10.2 ac). The 10 mg/L area persists for two days because the initial buildup occurs near slack water with grain size distribution indicating mostly fines (silts and clays). The area coverages decrease for higher concentrations near the diver burial activities. These results assumed silt curtains were not used.

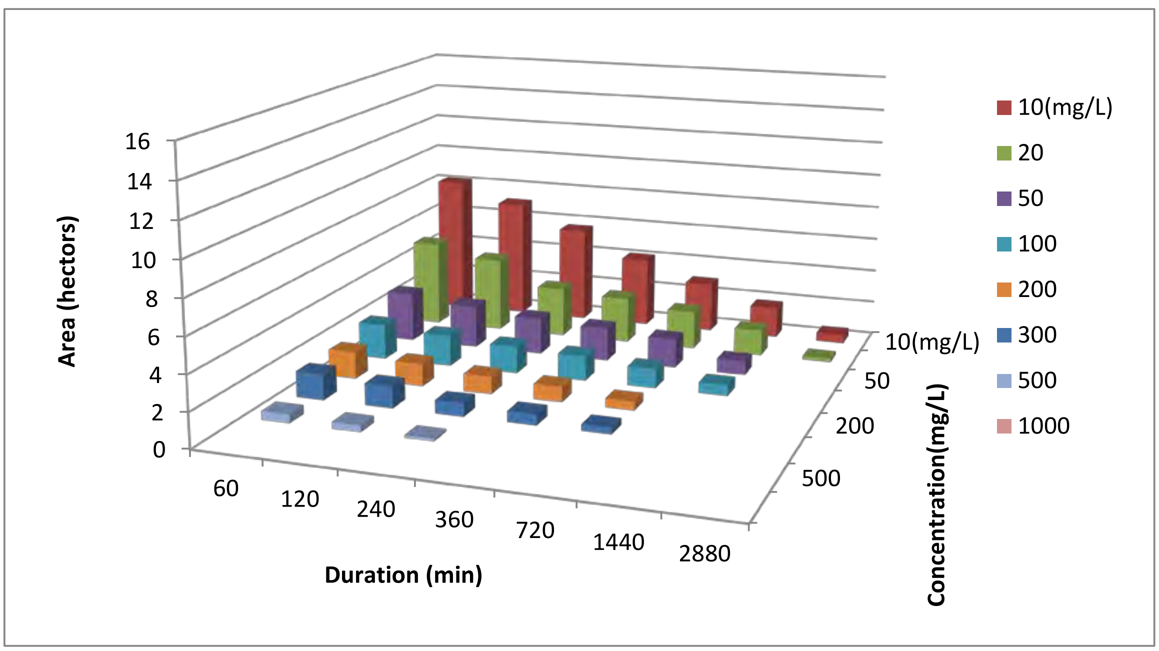

Figure 3-15. Duration (minutes) and total enclosed area (hectares) of maximum time integrated excess SS concentration due to diver burial for east section with total duration of 19.4 4-hour days (4,664 min). Assumes silt curtains were not used.

Table 3-13. Duration (minutes) and total enclosed area (hectares and acres) of maximum time integrated excess SS concentration due to diver burial for east section with total duration of 19.4 4-hour days (4,664 min). Assumes silt curtains were not used.

East	Area (ha)						
Max SS	Minutes						
(mg/L)	60	120	240	360	720	1440	2880
10	8.2	7.1	5.7	4.1	2.9	1.8	0.5
20	5.1	4.4	2.9	2.7	2.3	1.5	0.2
50	2.9	2.5	2.1	1.9	1.7	0.8	
100	2.1	1.8	1.6	1.4	1.1	0.6	
200	1.6	1.3	1.0	0.9	0.5		
300	1.5	1.3	0.8	0.6	0.4		
500	0.5	0.4	0.1				
1000							

East	Area (ac)						
Max SS	Minutes						
(mg/L)	60	120	240	360	720	1440	2880
10	20.2	17.4	14.0	10.2	7.3	4.5	1.2
20	12.5	10.8	7.2	6.6	5.6	3.7	0.5
50	7.1	6.2	5.3	4.8	4.2	2.0	
100	5.1	4.5	3.9	3.6	2.8	1.5	
200	3.9	3.2	2.5	2.2	1.2		
300	3.7	3.1	1.9	1.5	0.9		
500	1.2	0.9	0.3				
1000							

Use of Silt Curtains

The effects of using silt curtains can greatly reduce the size of the water column areas affected which has been described above. The US Army Corps of Engineers refers to reductions in loss rates up to 80 to 90% when silt curtains are correctly employed (Francingues and Palermo, 2005). A recent model application by the USACE (Lackey, et. al., 2012) assumed reductions of 90 to 100% in loss rates due to the use of silt curtains to be protective of coral reefs in Guam.

If a 90% reduction is assumed with the use of silt curtains then the excess suspended sediment concentration results presented above can be reduced by a factor of 10 for areas outside the silt curtains. This means that the legend appearing in Figures 3-12 through 3-15 showing concentration levels ranging from 10 to 5000 mg/L can be reduced to 1 to 500 mg/L to be representative of the results from using silt curtains. In addition, Tables 3-10 through 3-13 can also be reinterpreted for the use of silt curtains by reducing the listed concentrations by a factor of 10. The area inside the silt curtains adjacent to the cable routes will, of course, see a local increase in concentrations.

3.4.2.2 Bottom Deposition

Figure 3-16 shows the plan view of the bottom deposition thickness distribution from 0.1 mm to 50 mm (0.004 to 2 in) due to diver activity for both the west and eastern sections of all three cable routes combined and assumed that any sediment deposited on the bottom remained in place. The color filled areas are defined by the legend for different deposition thickness ranges, e.g., 1 mm to 5 mm (0.04 to 0.2 in) denoted by yellow. The bottom deposition thickness is defined for the area exclusively between the range of thicknesses described, i.e., the area is not cumulative. Thus the areas with larger thicknesses are not necessarily smaller than areas with smaller thicknesses. The distribution pattern is generally similar to the water column plume (ebb) but much reduced in extent. The higher deposition areas are adjacent to the cable route.

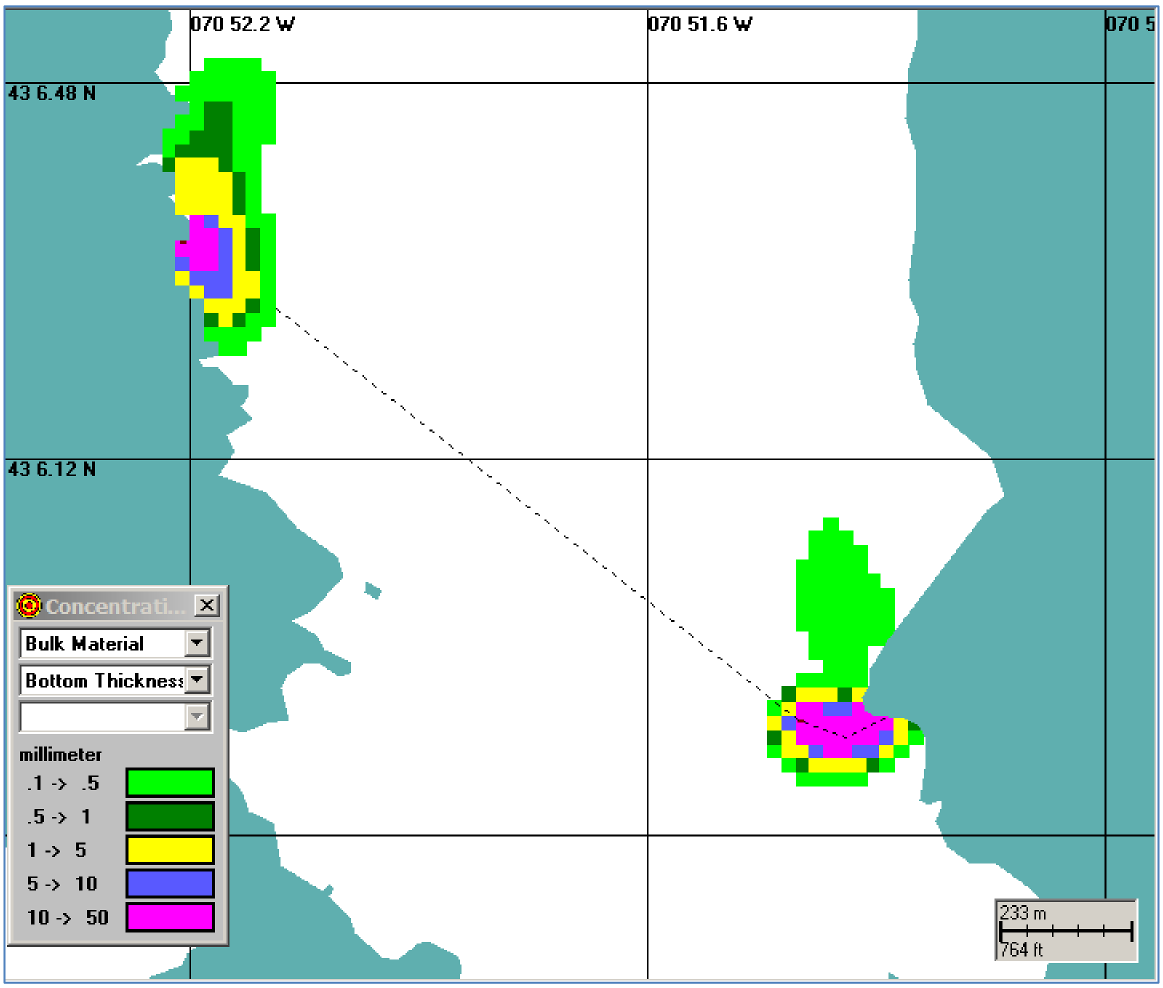

Figure 3-16. Plan view of time integrated bottom thickness (mm) distribution due to diver burial for west and east sections for three cable routes combined. Assumes that silt curtains were not used.

The areal sizes of the deposition thickness patterns seen in Figure 3-16 for both the west and east sections are summarized in Table 3-14 for each thickness increment range. At the 0.1 to 0.5 mm (0.004 to 0.02 in) thickness range the area is 3.4 ha (8.5 ac) for the west and 4.4 ha (10.8 ac) for the east, both including the three cable routes combined. These areas generally drop in size, for example, the west area of 1.9 ha [4.6 ac] and the east area of 1.1 ha [2.6 ac] for the 1 to 5 mm [0.04 to 0.2 in) thickness range is larger than the 0.5 to 1 mm (0.02 to 0.04 in) areas but not always, for the higher deposition thicknesses.

Table 3-14. Bottom thickness (millimeter and inch) areal distribution (hectare and acre) due to diver burial for west and east sections for the three cable routes combined. Assumes silt curtains were not used.

Thickness (mm)	West Area (ha)	East Area (ha)	Thickness (in)	West Area (ac)	East Area (ac)
0.1 to 0.5	3.4	4.4	0.004 to 0.02	8.5	10.8
0.5 to 1	1.4	0.4	0.02 to 0.04	3.4	0.9
1 to 5	1.9	1.1	0.04 to 0.2	4.6	2.6
5 to 10	0.6	0.5	0.2 to 0.4	1.5	1.2
10 to 50	0.5	1.2	0.4 to 2	1.2	2.9
Totals 0.1 to 50	7.8	7.6	0.004 to 2	19.2	18.4

Use of Silt Curtains

As with the 10-fold reduction in suspended sediment concentrations with the use of silt curtains, the results shown for bottom deposition can also be reduced by a factor of 10. This means that the legend appearing in Figure 3-16 showing bottom thickness levels ranging from 0.1 to 50 mm (0.004 to 2 in) can be reduced to 0.01 to 5 mm (0.0004 to 0.2 in) to be representative of the results from using silt curtains. In addition, Table 3-14 can also be reinterpreted for the use of silt curtains by reducing the listed thickness ranges by a factor of 10.

The area inside the silt curtains adjacent to the cable routes will, of course, see a significant local increase in bottom deposition thickness. Current velocities in the area where diver burial will be required on the western tidal flat and in the intertidal portion of the diver burial area on the eastern side are in the range for which silt curtains can be used effectively. In the more exposed portion of the diver burial area on the eastern end of the route, currents are likely to exceed those for which silt curtains can be used. The project proposes that silt curtains will be used to enclose the entire three western diver burial routes 90 m (296 ft) long with an area of 1,923 m^2 (20,695 ft^2) and also used along a portion (112 m [367 ft]) of the three eastern diver burial routes enclosing an area of 2,046 m^2 (22,021 ft^2). Approximately 66 m (216 ft) of each of the three cables on the eastern end of the route will not be enclosed during diver burial. Based on the trench geometry for diver burial summarized in Table 3-4 90% of the entire west resuspension volume or 181.0 m^3 (6,394 ft^3) spread over the enclosed area results in an average deposition thickness of 94 mm (3.71 in) while 90% of the entire partial east resuspension volume or 224.5 m^3 (7,927 ft^3) spread over the enclosed area results in an average deposition thickness of 110 mm (4.32 in). Larger thicknesses would be found closest to the burial routes (including the trenches) and smaller thicknesses found closer to the silt curtains distant from the routes.

3.5 Effects of Multiple Cable Laying Operations

Since there are three cable bundles to be laid in individual trenches the question arises as to what happens to the water column concentration and bottom deposition created by a single pass and whether it might affect the subsequent pass. The schedule to embed each cable by jet plowing is planned to occur on a 5 to 7 day interval. The water column concentration duration analysis shows that the excess concentration will drop to zero within approximately 6 hours. Thus there will be no cumulative increases in suspended sediment concentrations as a result of these installations.

A measure of the stability of deposited sediments to the seabed is a function of the erosion velocity for each grain size in the sediment. This relationship is shown via a Hjulstrom diagram as shown in Figure 3-17. Here the y-axis is the current velocity in Little Bay and the x-axis is sediment grain size. Since the freshly deposited sediment is unconsolidated, the fine grains (clay and silt) and sand would be eroded at a velocity of about 20 cm/s (0.4 kt). Examining the example figures of flood and ebb tide velocities in Figures 2-2 and 2-3, respectively, this minimum speed is exceeded across most of Little Bay except in the shallow tidal flat very near the shore where there could be some accumulation. Thus most of the fine sediment is likely to be resuspended on subsequent tides and dispersed from the areas initially affected by deposition unless flocculation of the clay particles occurs and they remain in place. The larger grain sizes will quickly drop back into the channel when first resuspended by the jetting process.

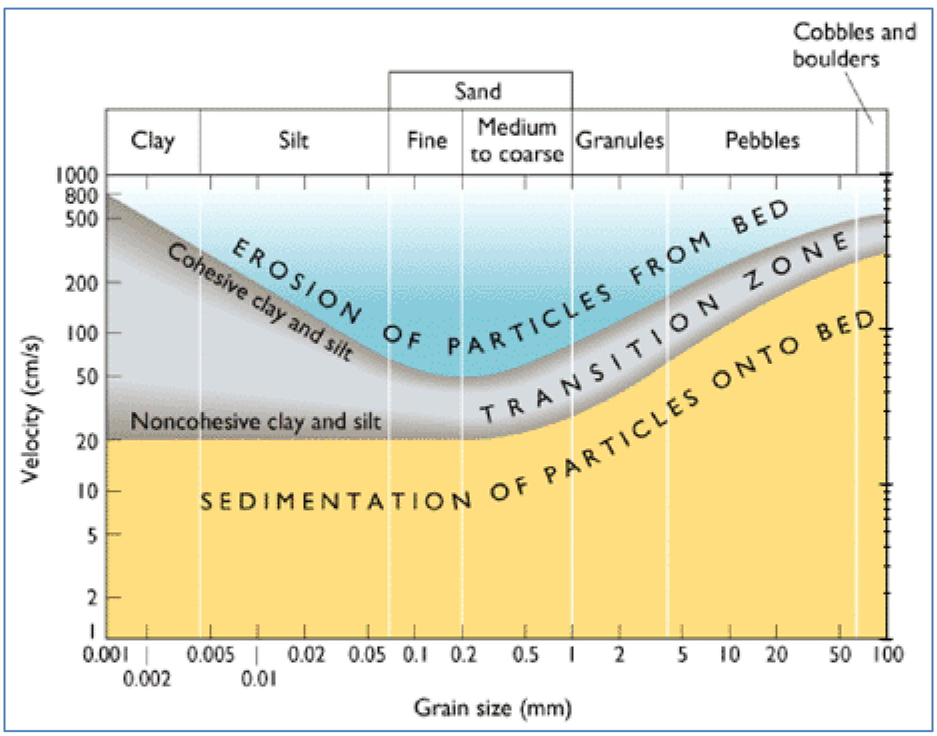

Figure 3-17. Hjulstrom diagram showing relationship between velocity and gran size (from http://eesc.columbia.edu/courses/ees/lithosphere/homework/hmwk1_s08.html).

4 Conclusions

Two computer models were used in the analysis: BELLAMY, a hydrodynamic model used for predicting the currents in Little Bay, and SSFATE, a sediment dispersion model used for predicting the fate and transport of sediment resuspended by the jet plowing and diver burial operations. BELLAMY is a finite element, two-dimensional, vertically averaged, time stepping circulation model developed at Dartmouth College and previously applied to the Great Bay Estuarine System. The SSFATE (Suspended Sediment FATE) model was utilized to predict the excess suspended sediment concentration and the dispersion of suspended sediment resulting from jetting activities. The model predicts excess concentration, which is defined as the concentration above ambient suspended sediment concentration generated by the seabed activities. The SSFATE model results are summarized below for the jetting and diver burial activities.

Jet Plowing

The size of the resulting excess suspended sediment (SS) concentration plume in the lower water column is defined as a series of areas enclosed by different concentration levels. The water column concentration contours shown, which are defined by a single concentration level, totally surround an enclosed area where concentrations are at or above the specified concentration, i.e., the area is cumulative. The entire area encompassed by the plume (as defined by the 10 mg/L excess SS concentration contour averaged over time was 14.8 ha (36.58 ac) ranging from a low of 5.91 ha (14.61 ac) at 1 hr to a high of 22.36 ha (55.25 ac) at 10 hrs. These total enclosed areas dropped dramatically for the higher concentrations, averaging 1.94 ha (4.79 ac) at 100 mg/L, 0.28 ha (0.68 ac) at 1,000 mg/L and 0.02 ha (0.05 ac) at 5,000 mg/L. indicating that the extent of the plume is limited for higher concentrations. In the shallows, suspended sediments from the jet plow activity are likely to reach nearly to the water surface. In the channel, excess suspended sediments will be restricted to the lower half of the water column.

An important metric defining the plume is its duration for different concentrations, which could have biological significance if exposure (duration multiplied by concentration) is sufficiently elevated. The maximum plume size and duration at 10 mg/L excess SS concentration in the area that is totally enclosed by the contour is 90.20 ha (222.89 ac) but lasts for only 1 hr. This short duration continues for all the concentration contour thresholds through 1,000 mg/L. The enclosed areas quickly drop in time for a given concentrations so by 2 hrs the 10 mg/L area has dropped to 32.20 ha (79.57 ac) and by 6 hrs the plume is completely gone. The area coverages drop dramatically for the higher concentrations near the jet plow indicating that the duration and extent of the plume is relatively limited.

The areal sizes of the deposition thickness patterns also generally drop in size, but not always. At the range of 0.1 to 0.5 mm (0.004 to 0.02 in) thickness the area is 35.6 ha (87.9 ac) due to jet plowing the three cable routes. These areas drop overall for the higher deposition thicknesses (e.g., 2.4 ha [5.9 ac] for the 5 to 10 mm (0.2 to 0.4 in) thickness range) near the jet plow indicating that the extent of the plume is relatively limited.

Diver Burial Assuming No Use of Silt Curtains

The total enclosed area of the excess SS concentration plumes for the west and east diver burial sections were also examined, specifically assuming that silt curtains were not used. Typically, at

10 mg/L excess SS concentration the instantaneous total area enclosed by the contour is 8.4 ha (20.7 ac) for the west section and 1.9 ha (4.7 ac) for the east section. However, these total enclosed areas drop dramatically for the higher concentrations near the diver burial activities, i.e., the area at 1,000 mg/L is only about 0.2 ha (0.6 ac) for the west section and 0.0 ha (0.1 ac) for the east section, indicating that the extent of the plume is again relatively limited.

Assuming no silt curtains were used, the total area in the west section that is enclosed by the 10 mg/L excess SS concentration contour is 14.6 ha (36.1 ac) but lasts for only 1 hr. This short duration continues through all the concentration contour thresholds through 5,000 mg/L. The enclosed areas decrease in time for a given concentrations so by 6 hrs the 10 mg/L area has dropped to 8.6 ha (21.2 ac). The 10 mg/L area persists for two days because the initial buildup occurs near slack water with grain size distribution indicating mostly fines (silts and clays). The area coverages decrease for higher concentrations near the diver burial activities. At the east section the 10 mg/L excess SS concentration total area that is enclosed by the contour is 8.2 ha (20.2 ac) but lasts for only 1 hr. This short duration continues through all the concentration contour thresholds through 500 mg/L. The enclosed areas decrease in time for a given concentration so by 6 hrs the 10 mg/L area has dropped to 4.1 ha (10.2 ac). The 10 mg/L area persists for two days because the initial buildup occurs near slack water with grain size distribution indicating mostly fines (silts and clays). The area coverages decrease for higher concentrations near the diver burial activities.

The sizes of the deposition thickness patterns also dropped as the deposition increased. At the 0.1 to 0.5 mm (0.004 to 0.02 in) thickness range the area is 3.4 ha (8.5 ac) for the west and 4.4 ha (10.8 ac) for the east, both including the three cable routes combined. These areas drop dramatically for the higher deposition thicknesses (e.g., 0.5 ha [1.2 ac] for the 10 to 50 mm (0.4 to 2 in) thickness on the west section and 1.2 ha (2.9 ac) for the east section indicating that the extent of the plume is limited.

Diver Burial Assuming Use of Silt Curtains

The effects of using of silt curtains were estimated by assuming that 90% of the suspended sediment resuspended from diver burial operations would be trapped by the curtains. That being the case, the results based on no silt curtain use can be reduced by a factor of 10 to estimate the concentrations outside the silt curtain. At 10 mg/L excess SS concentration the area enclosed by the contour was 1.2 ha (3.0 ac) for the west section and 0.4 ha (0.9 ac) for the east section.

In terms of exposure, for the west section at 10 mg/L excess SS concentration the area that is enclosed by the contour is 5.9 ha (14.7 ac) but lasts for only 1 hr. The areas decrease in time for a given concentrations so by 6 hrs the 10 mg/L area has dropped to 2.3 ha (5.7 ac). For the east section at 10 mg/L excess SS concentration the area that is enclosed by the contour is 2.1 ha (5.1 ac) but lasts for only 1 hr. The areas decrease in time for a given concentration so by 6 hrs the 10 mg/L area has dropped to 1.4 ha (3.6 ac). The area within the silt curtain area would, of course, see a significant increase in concentration until the material has settled out.

With the use of silt curtains the bottom deposition thickness outside the silt curtains can also be reduced by a factor of 10. At the 0.1 -> 0.5 mm (0.004 -> 0.02 in) thickness the area enclosed by the contour is 1.9 ha (4.6 ac) for the west and 1.1 ha (2.6 ac) for the east. Based on the trench geometry for diver burial 90% of the entire west resuspension volume or 181.0 m^3 (6,394 ft^3)

spread over the area enclosed by the silt curtain results in an average deposition thickness of 94 mm (3.71 in) while 90% of the entire partial east resuspension volume or 224.5 m^3 (7,927 ft^3) spread over the enclosed area results in an average deposition thickness of 110 mm (4.32 in). Larger thicknesses would be found closest to the burial routes (including in the trenches) and smaller thicknesses found closer to the silt curtains distant from the routes.

Stability of Deposited Sediments

A measure of the stability of deposited sediments to the seabed is a function of the erosion velocity for each grain size in the sediment. Since the freshly deposited sediment is unconsolidated, the fine grains (clay and silt) and sand are eroded at a velocity of about 20 cm/s (0.4 kt). This minimum speed is exceeded across most of Little Bay except in the shallow very near the shore. Thus sediment particles deposited along much of the route will likely be resuspended on subsequent tides and dispersed from the areas initially affected by deposition.

5 References

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Appendix F: Memorandum: Environmental Mitigation Project along the Wagon Hill Farm Shoreline, Town of Durham Department of Public Works

Department of Public Works
Town of Durham
100 Stone Quarry Drive
Durham, N.H. 03824
603-868-5578
Fax 603-868-8063

MEMORANDUM

TO: Sarah Allen, Normandeau Associates Inc.

FROM: Michael Lynch, Public Works Director

DATE: September 3, 2015

RE: Environmental Mitigation Project along the Wagon Hill Farm Shoreline

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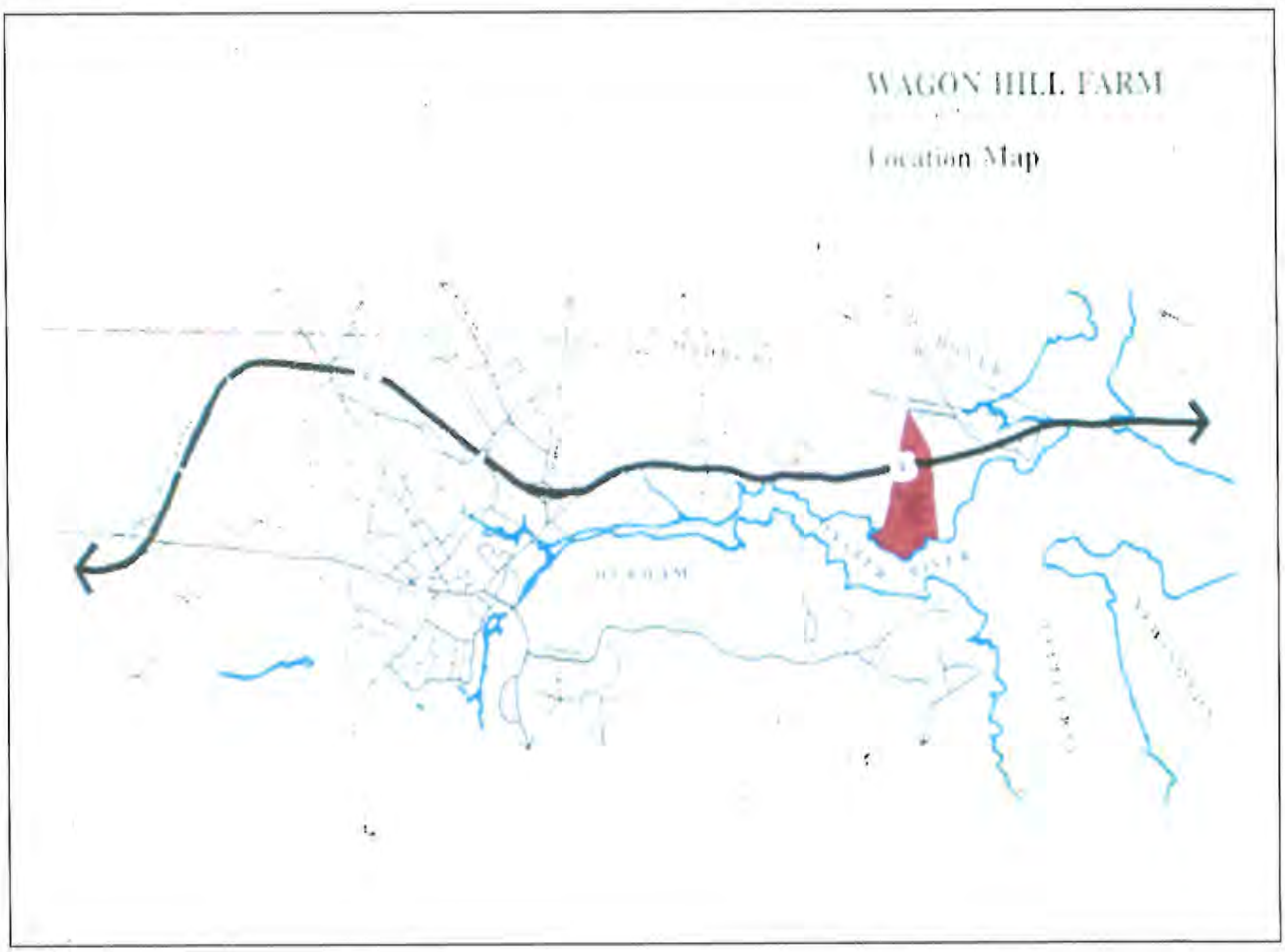
The Town of Durham in cooperation with Eversource (previously Public Service of New Hampshire) is partnering to propose an Environmental Mitigation Project which will eliminate a significant amount of erosion from the Wagon Hill Farm shoreline along the Great Bay Estuary and the Oyster River.

BACKGROUND

The Wagon Hill Farm consists of 139 acres. It consists of a 99 acre parcel on the south side of Route 4 and a 40 acre parcel on the north side of Route 4. It has approximately 1100 feet of frontage on Little Bay.

The farm was purchase by the Town of Durham in 1989. The land was purchased by the Town ***"to preserve its scenic vistas, provide for future municipal purposes, preserve open space, provide a healthful and attractive outdoor environment for work and recreation, and to conserve land, water, forest and wildlife resources."***

In 1995 the Strafford Regional Planning Commission and the Town of Durham received a grant from the New Hampshire Office of State Planning, New Hampshire Coastal Program to hire a consultant to prepare a master and a management plan for the process. The Strafford Regional Planning Commission issued a Request for Proposals for the work. It received four proposals from consulting firms. After reviewing three of the firms who submitted proposals it selected one of the firms, The Cavendish Partnership Inc., to perform the work. The following documents, the planning process and planning and management recommendations for the Wagon Hill Farm.



Existing Site Conditions

The 139 acre site is located three miles from downtown Durham on Route 4. The site is bisected east to west by Route 4 with 99 acres to the south and 40 acres to the north. The farm has not been used agriculturally for several years and indigenous plants have begun to reclaim the pastures north of Route 4 to some degree around the perimeter of the southern parcel. Gently rolling fields are the dominant feature of the parcel south of Route 4. (See location map)

The openness of the meadows affords distant views to Little Bay to the south and Oyster River to the southwest. The high knolls create an opportunity for significant views across the 99 acre parcel. The views from the shores of the Oyster River are exceptionally good. The views of Route 4 may be considered undesirable due to the heavy volume of automobile and truck traffic. The "wagon" is the focal point on the property for motorists traveling on Route 4.

There are a number of important historic sites and structures on the property. The most prominent historic feature of this site is the Bickford-Chesley farmhouse and its surrounding foundations. The Davis graveyard and the area where the garrison house once stood are also important features. On the northern parcel are the remains of a school house close to Route 4. The history of the site could be interpreted to provide a strong focus for future improvements.

The existing trails system traverses the southern portion of the site with trails in both meadows and wooded areas. Overall the trails are in excellent condition however, some degradation has occurred due to excessive use in sensitive areas by pedestrians and equestrians. Improved surfaces and the introduction of some structures in sensitive areas could prevent future degradation in wet and shoreline areas. If the number of visitors continues to increase, the trails will have to be surfaced with a material that will help define and maintain the walking surfaces while at the same time providing a surface suitable for physically and visually impaired visitors.

Elevation and Surface Hydrology

The site has two distinct high points. The northern high point is at the most northerly portion of the 40 acre parcel along Watson Road. Water drains from this area and collects in the wetland adjacent to Route 4. The other high point is on the 99 acre parcel and is where the wagon is located. Water drains from this ridge north to the wetlands along Route 4 and south to Davis Creek. Water that collects in the wetland along Route 4 eventually exits under the Wagon Hill driveway westerly to Smith Creek and into the Oyster River.

Slope Analysis

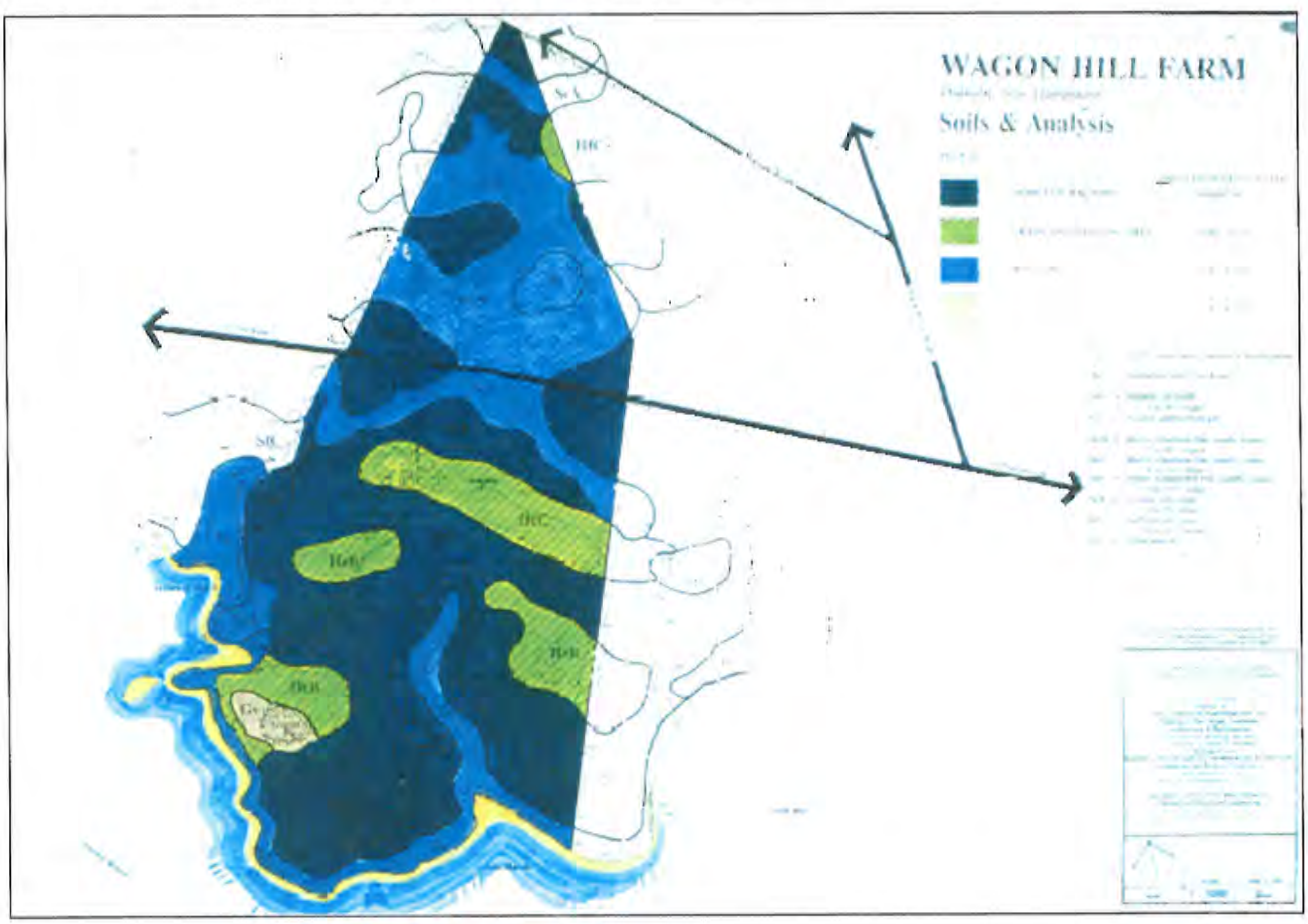
The slope analysis data was derived from United States Geological Survey mapping and site observations. The slopes are generally gradual to moderate on the 40 acre parcel with no areas above 10% gradient. The steepest slopes, in excess of 10% are on the 99 acre parcel around the farmhouse; along the southerly and westerly shorelines; in the gravel pit; adjacent to the knoll with the wagon; and along Davis Creek. The remainder of the 99 acre parcel has gradients within the 2 to 10% range. (See Slope Analysis Map)

Soils Analysis

Soil information was derived from the Soil Survey of Strafford County, New Hampshire prepared by the United States Department of Agriculture- Soil Conservation Service and the Soils Potential Report, prepared by the Strafford County Conservation District. The following soil types have been identified on the Wagon Hill Farm site. (See Soils Analysis Map)

Be	Biddeford Silty Clay on a small portion of the 40 acre parcel
BzB	Buxton Silt Loam- 3 to 8% gradients on the 99 and 40 acre parcels
GV	Gravel Pit located on in the southwest portion of the 99 acre parcel
HcB	Hollis-Charlton- fine sandy loams on top of the knoll on the 99 acre parcel
HcH	Hollis-Charlton- on 8 to 15% gradients on the 99 acre parcel
HfC	Hollis-Gloucester- fine sandy loams, on 8 to 15% gradients on the northeast portion of the 40 acre parcel
ScA	Scantic silt loams on 0 to 3% slopes on the majority of the 40 acre parcel and in the low lands adjacent to Route 4 on the 99 acre parcel
Ta	Tidal Marsh- along the shores of the Oyster River

The Soils Potential Report identified 48 acres on the 99 acre parcel (BzB and SfC) as having medium potential for recreational development. The remaining 92 acres were poorly drained with low to no potential for recreational development.



Vegetation

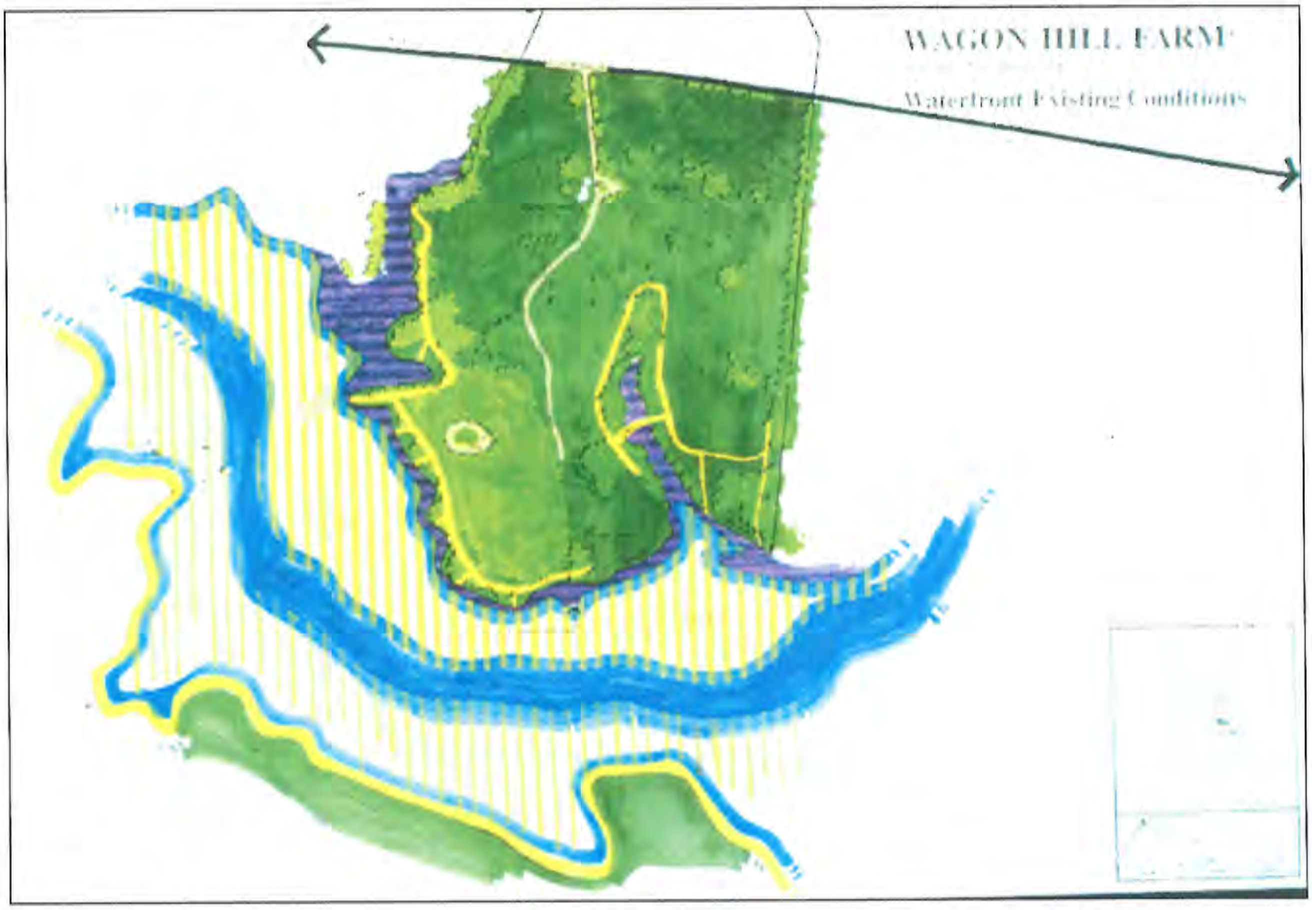
This information was derived from a report entitled, Summary of Existing Potential Bio-diversity of Wagon Hill Farm, Durham, New Hampshire, by Auchly, Jones, Kimmel, Midura, 1990. The report identified forty four different plants. The types of vegetation are indicative of the micro climatic and soil conditions of the site. The white pine stand is significant in that historically the British Navy harvested white pines for ships masts from this region. The diverse plant material also provides food for a variety of wildlife that lives on or in close proximity to the site. The site may be suitable for an arboretum or coastal botanical garden.

Wildlife and Domesticated Animals

This information was also derived from the Summary of Existing and Potential Bio-diversity of Wagon Hill Farm, Durham, New Hampshire report that identified birds, mammals, and coastal flora and fauna. There were fourteen bird species identified on the site and in addition another 28 species were identified as having the potential to utilize the site. Eleven mammals and two sea creatures were also identified. The site is used extensively by visitors walking and running dogs. Dogs (domesticated or otherwise) are natural predators for a variety of animal species and they are naturally perceived as a threat by mammals and birds, even if they don't physically harm them. Dogs may threaten other species by leaving a scent, making noise or by disturbing habitat areas. Dogs running loose can trample plants and unattended leave scat throughout the site. It is recommended that the management plan should provide an opportunity for dog owners to continue to bring their dogs to the farm if specific areas are designated for walking dogs with leashes and for allowing dogs to run free. In addition, existing leash laws should be strictly enforced and owners should be responsible for removing scat from the farm. Preservation and enhancement of the wildlife should be encouraged to create a balance in natural, economic and social use of the site.

Shoreline Conditions

The existing shoreline conditions are a result of soil and ice and tidal forces and human intervention. Segments of the shoreline indicate over use by visitors which has created erosion. These unnatural conditions (pathways) are exacerbated by natural conditions including wind, tidal and ice forces. This erosion, unchecked, has and will continue to result in degradation of the shoreline and salt marshes, negative impacts on wildlife, shell fish and fish habitats. It is recommended that a shoreline stabilization program be implemented as soon as possible. The measures taken should as minimally as possible, emulating the natural conditions of the shoreline. Rip-rapping should only be used where absolutely necessary and whenever possible plant materials or erosion control fabrics should be used. The farm site is susceptible to flooding during the 100-year flood stage and flooding should not impact most recreational uses. (See Waterfront Existing Conditions Map)



Water-based Recreation

The farm is primarily used for land-based recreation. The potential for boating is limited due to tidal conditions, water depths and shoreline that are naturally limited for launching boats. The installation of piers and boar landings may be difficult to permit and implement due to the currents, ice and tidal conditions. Swimming is now taking place on the 99 acre parcel on a limited basis. The site is not ideal for swimming due to tidal conditions and the water currents and it is not recommended that this activity be encouraged to expand for both safety and environmental reasons. Environmentally the salt marshes are particularly sensitive to pedestrian activity which may result from the unplanned expansion of existing swimming areas. Limited access from the water by canoes and kayaks is now taking place and has minimal impact on the farm as long as the access points are defined and controlled. (See Waterfront Existing Conditions Map)

SHORELINE RESTORATION RECOMMENDATIONS

1. The shoreline is in a state of deterioration and it is not anticipated that it will stabilize itself naturally. Shoreline stabilization along the water's edge should take two forms: a hardened edge installation of a rip rap slope. This would be appropriate in limited areas above the salt marsh fringe to prevent continued erosion. Rip rap would include filter

fabric insulation- $410 per linear foot, $451,000. (This project recommends rip rap in limited areas.)

A softer form of shoreline stabilization would require the installation of vegetated fiber roll along the toe of the slope backfilled with soil suitable for the salt marsh plantings. The system would include palette mats that are pre-vegetated to begin the initial re-vegetation of shoreline areas. This method is most desirable where the salt marsh has eroded and replacement is required to prevent further degradation of the salt marsh. Vegetated shoreline stabilization- $205 per linear foot= $225,500. (This project recommends substantial salt marsh plantings.)

2. Protecting the pristine marsh system involves two steps:
First areas of limited degradation should be re-vegetated using a pre-seeded mesh to reestablish plants quickly. The area around the point needs to be rip rapped to protect the area from further erosion.

Secondly, the area known as "The Point" where Davis Creek meets the Oyster River will require some type of structure and/or protection to prevent any further erosion. The area is a part of the pristine marsh system identified by the Durham Coastal Method Inventory & Evaluation Project (DCMT & EP). The structure will be a valuable spot to observe wildlife in the river and marsh. Some of the shoreline degradation is caused by ice and tides, however, most of the impact in this area is from human intervention. Estimate is $20,000

3. There is a desire to short cut the present trail system at Davis Creek bringing people through sensitive wetland habitats. Building a bridge structure will help prevent erosion from occurring at the crossing and will create a wildlife and habitat observation point along the trail. The construction of the bridge should begin by flagging the wetlands in the area and then creating a structure that effectively keeps people above the grasses.

A footbridge at Davis Creek would help protect the wetlands that are now being jeopardized by people crossing the creek. The cost could be minimized by donations- $50 per square foot or approximately $10,000.

4. Trail system improvements include the spreading mulch to help keep people on the trail and to prevent root compaction through wooded areas. The new surface will help prevent people from tripping over tree roots or into holes as well. Areas such as the steep bank down to the beach in the southeast shoreline should either be closed off to prevent further erosion or re-vegetated with plant mats to help protect the bank from further degradation. Simplifying the trails through the area south of the orchard will help keep environmental impact to a minimum. If a phasing program is needed to defer the costs, the areas closet to the river and through any wet areas should be the first to receive the bark mulch. No cost- in house project.

Project Details

Location: Route 4
Tax Map: Map 12, Lot 8-2
Acreage: Entire Property 139 acres
Road Frontage: 1,341' +/- of frontage on Piscataqua Road (US Route 4)
River Frontage: 1,100' +/- of tidal frontage on the Oyster River and Smith Creek
Zoning: Residence Coastal, with a minimum lot size of 150,000 square feet and road frontage requirement of 300 feet.

Wagon Hill Farm consists of high quality working farmland, healthy forest, and significant coastal and estuarine resources along the Oyster River in Durham, NH. The tract has important ecological resources including significant undeveloped coastal shoreline, tidal and estuarine riparian conservation values, and water quality protection attributes.

With 1100 feet of tidal frontage on Little Bay, Oyster River and Smith Creek, and 8.5 acres of tidal and freshwater wetlands, this project will permanently protect important on and off-site aquatic resources. The project will help protect the water quality and aquatic habitats of the Great Bay estuary including the adjacent NHB-documented "sparsely vegetated intertidal system", an exemplary natural community. Wagon Hill Farm has critical pollutant (e.g. nitrogen) attenuation characteristics (NH DES). Historically abundant oyster populations occurred in the Oyster River and Great Bay which The Nature Conservancy and others are working to restore to mitigate water quality impairments of Great Bay. This project will remove the threat of sediment loading from incompatible uses on the property that could smother oyster reefs. The Oyster River and Smith Creek are part of the Piscataqua River Network, classified as having "high relative resilience" according to a recent scientific analysis of predicted resilience to the impacts of climate change (TNC 2013). This project will incorporate significant riparian buffers to protect the estuarine and coastal resources of Smith Creek and the Oyster River.

Maintain Prominent Scenic Vista:

This project provides a very prominent viewshed for commuters along the heavily traveled corridor of Route 4 and boat traffic along the Oyster River. In fact, this parcel is the most visible and recognized parcel due to the prominent fields and the wagon on the hill.

The Durham Master Plan (2000) identifies this viewshed as one part of "the entrance to Durham as you pass Wagon Hill Farm, Emery Farm, Johnson Creek, Old Piscataqua River, and Bunker Creek" . . . protection of these viewsheds should be and will continue to be a high priority for Durham.

Draft Project Budget

Expenses

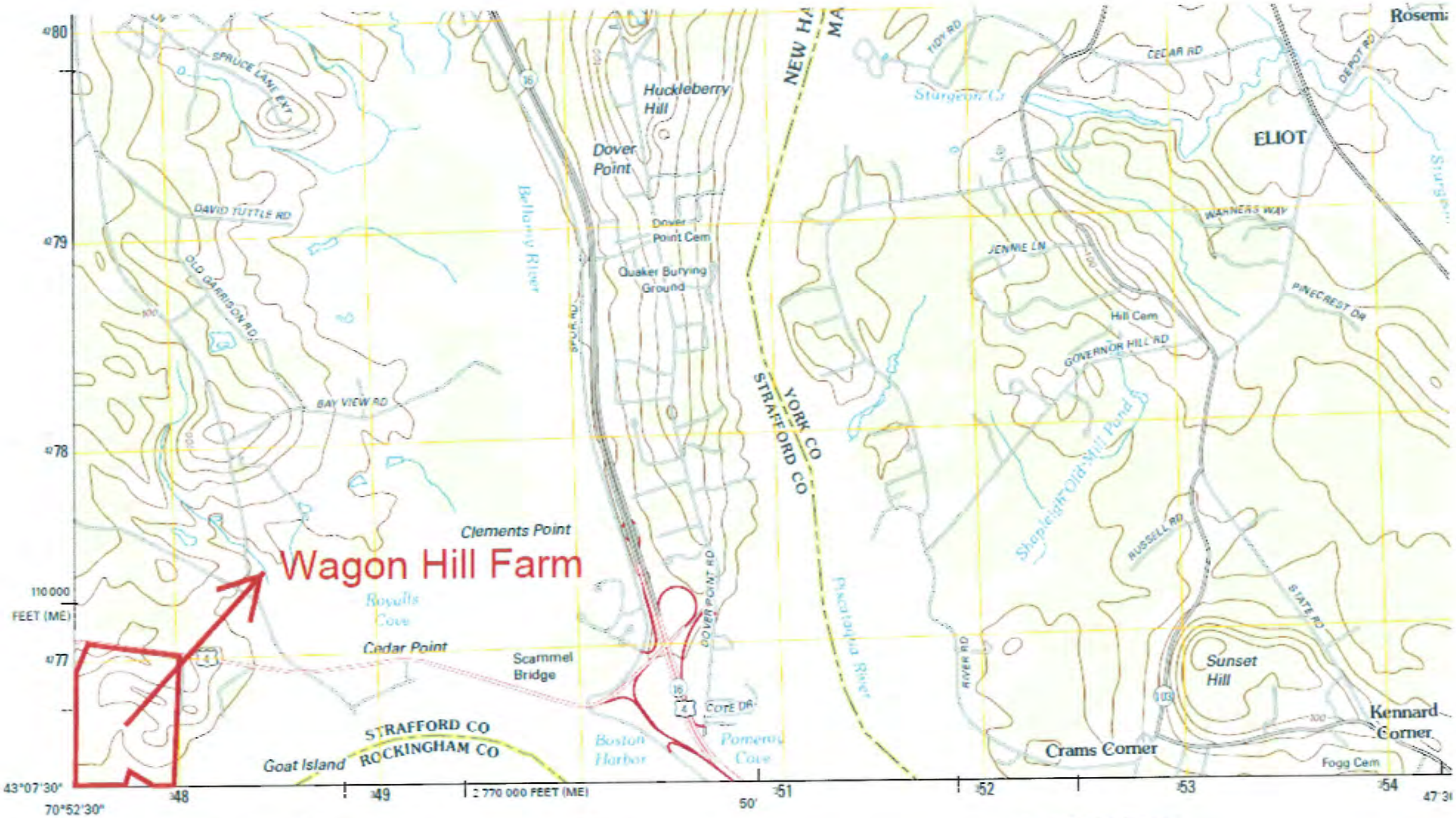
Shoreline Restoration	$338,250	(mix of hardened edge and soft re-vegetated stabilization.)
Bridge (Davis Creek)	$10,000	
Davis Creek Point	$20,000	
TOTAL EXPENSES	**$368,250**	

Revenues

Eversource Mitigation Project	$170,000
Lois Brown Trust	$115,000
Town of Durham	$83,250
TOTAL INCOME	**$368,250**

Attachments:

USGS Map
Current Erosion Photos (9/3/15)



Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and 1 000-meter grid: Universal Transverse Mercator, Zone 19T
10 000-foot ticks: Maine Coordinate System of 1983 (west zone), New Hampshire Coordinate System of 1983

Imagery..........NAIP, July 2009 - July 2011
Roads..........©2006-2011 TomTom
Names..........GNIS, 2011
Hydrography..........National Hydrography Dataset, 2009
Contours..........National Elevation Dataset, 2005
Boundaries..........Census, IBWC, IBC, USGS, 1972 - 2010

15° 24' 274 MILS
1° 14' 22 MILS
MN
GN

UTM GRID AND 2012 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
CH
Grid Zone Designation
19T

SCALE 1:24 000

KILOMETERS 1 0.5 0 1 2
METERS 1000 500 0 1000 2000
MILES 1 0.5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.2

EROSION PHOTOS 9/3/15