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U.S. NAVY ENGINEERING FIELD ACTIVITY NORTHEAST
REMEDIAL ACTION CONTRACT (RAC)
CONTRACT NO. N62472-99-D-0032
CONTRACT TASK ORDER NO. 0063

FINAL
LONG TERM WETLAND MONITORING PLAN
AREA A DOWNSTREAM/OBDA
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONNECTICUT

September 2001

Prepared by

Foster Wheeler Environmental Corporation
133 Federal Street
Boston, Massachusetts 02110

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1.0 INTRODUCTION

Between July 1999 and August 2000, contaminated soils and sediments were remediated at the Area A Downstream Watercourses and Over Bank Disposal Area (Area A Downstream/OBDA) at Naval Submarine Base - New London in Groton, Connecticut. Remedial activities involved removal, treatment, and discharge of surface waters; excavation of contaminated soil and sediment; onsite dewatering of excavated soil and sediment to remove free water; treatment and discharge of removed water; and offsite disposal of dewatered media at approved landfills. As a result of soil and sediment excavation and removal, 2.90 acres of palustrine emergent, scrub-shrub and forested wetlands and open water were disturbed. Pursuant to the wetland restoration plan, as outlined in the 100% Design (FWENC, 2000a), compensatory mitigation for this impact required the restoration of 2.43 acres of palustrine emergent, scrub-shrub and forested wetlands and 0.47 acres of open water.

Planned restoration of impacted wetlands was completed in two stages:

- Stage 1 – Grading and Herbaceous Cover Establishment; and
- Stage 2 – Woody Cover Establishment.

The wetland restoration was planned in two stages to allow for groundwater monitoring prior to the planting of woody material since pre-remediation water table data were not available. Stage 1 seeding of disturbed areas was planned to provide soil erosion/sediment control, establish desirable wetland or upland species and prevent establishment of weedy invasive species.

Stage 1 Restoration was completed on August 24, 2000 (FWENC, 2000b). All disturbed areas were restored to final grade with a topsoil mix supplemented with organic material upon completion of excavation, backfilling and rough grading. Final grading was completed sequentially between April 13, 2000 and July 24, 2000. Final grades are presented in Figure 1, Appendix A. Once final grading was complete, areas were re-seeded with native wetland and upland herbaceous species. Seed mixes used for restored areas are provided in Appendix B, Tables B-1 through B-5.

All reseeded areas were allowed to equilibrate or “settle” through the first winter and early spring post-remediation. Reseeded areas were monitored during this period for the following parameters: germination and aerial coverage of seeded material, encroachment of invasive species, and ground water levels. Monitoring results were evaluated and hydrological zones were established (FWENC, 2001). Figure 1 (Appendix A) shows hydrology zones where soils were saturated or ponded for 10 consecutive days during the growing season (emergent zone), or within 10 inches of the surface (scrub/shrub–forested zone).

Stage 2 involves establishment of woody cover. This Stage of the restoration was completed on April 26, 2001. Species and general locations are provided in Appendix C, Tables C-1, and C-2. Placement of woody plants was based on hydrological requirements and tolerance of each species. Appropriate species were planted in established hydrological zones as indicated on Figure 1, Appendix A. Restored wetlands will be monitored after completion of planting and their successful establishment will be determined by meeting performance standards presented in this plan.

The long-term goal of the Wetlands Restoration Plan is re-establishment of wetlands disturbed during site remediation. The specific objectives of the Wetland Restoration Plan are fourfold:

1. Restore 2.90 acres of palustrine wetlands and open water (1.26 acres emergent, 1.17 acres scrub-shrub/forested, and 0.47 acres open water) disturbed during removal of contaminated soils and sediments;
2. Establish a self sustaining, functional palustrine wetland system composed of emergent, scrub-shrub, forested and open water cover classes;
3. Establish a plant community that has a competitive advantage over invasive species; and
4. Restore and enhance pre-remediation wetland functions.

2.0 PRE-REMEDIAL CONDITIONS

A general description of the Area A Downstream/OBDA is included in the Preliminary Design Report. Pre-remedial conditions for the Area A Downstream/OBDA wetlands, including detailed descriptions of fauna, flora, soils, and hydrology, are included in two previous reports; a wetlands delineation report (Atlantic 1995); and the functions and values assessment (Niering and Brawley 1997). The existing wetland conditions have also been previously summarized in the ROD (Brown and Root, 1997). A summary of the existing conditions of each wetland area affected by the selected remedial action is presented below. Table D-1, Appendix D provides a summary of the functions and values performed by each of these wetlands.

One wetland previously identified within Area A Downstream/OBDA was not directly affected by soil and sediment removal. A small (0.027 acre) isolated palustrine scrub/shrub and forested wetland just north of the Lower Pond Wetland was not identified as having contaminated soil or sediment, and was not excavated. Additionally, wetland areas immediately northeast and south of the OBDA Pond also did not exhibit contamination and were partitioned and protected from any removal activities. These wetlands are not discussed further in this Wetland Restoration Plan.

2.1 Upper Pond Wetland

The Upper Pond Wetland is located approximately 300 feet downstream from the Area A wetland. Prior to remedial activities Upper Pond Wetland was a palustrine, shallow, open-water wetland surrounded by palustrine emergent, non-persistent, narrow-leaved wetlands with an artificial water regime (Atlantic 1995). Water depth had been reported to range from approximately 1.5 to 4 feet. The Upper Pond has historically dried out seasonally. Soils in Upper Pond Wetland included poorly to very poorly drained fine-textured marine sediments that were naturally transported into the pond from the upgradient Area A wetland. The sediments were very fine and were generally unconsolidated. The dominant plant species within this wetland was common reed (*Phragmites australis*). Red maple (*Acer rubrum*) was the dominant tree species along the perimeter of the pond, while gray birch (*Betula populifolia*), black birch (*Betula lenta*), sassafras (*Sassafras albidum*), and flowering dogwood (*Cornus florida*) were also present in the canopy. Sweetpepper bush (*Clethra alnifolia*) and winged sumac (*Rhus copallina*) were present within the sparse shrub layer. A layer of decomposing leaves and two aquatic plants, duckweed (*Lemna minor*) and water starwort (*Callitriche heterophylla*), covered most of the pond's sediment. Frogs and turtles had occasionally been observed in Upper Pond Wetland, but it did not contain fish. No threatened or endangered species had been observed in the wetland.

After remediation, the open water portion Upper Pond encompasses an area of 0.24 acres. Water depth ranges from 3 to 8 feet. The shallower periphery of Upper Pond remains a palustrine wetland dominated by emergent, non-persistent, narrow-leaved vegetation. The lower banks were seeded with Northeast Wetland Grass/Forb Mix (Appendix B, Table B-3) and the upper banks with Northeast Upland Wildlife Mix (Appendix B, Table B-5). Woody material planted within the vicinity of Upper Pond includes red maple (*Acer rubrum*), gray birch (*Betula populifolia*), black birch (*Betula lenta*), sweet pepperbush (*Clethra alnifolia*), highbush blueberry (*Vaccinium corymbosum*) and maple-leaved viburnum (*Viburnum acerifolium*).

2.2 Lower Pond Wetland

The 0.48-acre Lower Pond Wetland is located approximately 50 feet downgradient from Upper Pond Wetland, but is not hydrologically connected to Upper Pond by any surface flow. Lower Pond Wetland is classified as a palustrine, shallow, open-water wetland, and prior to remedial activities was surrounded by palustrine scrub/shrub and forested broad-leaved deciduous wetlands (Atlantic 1995). Lower Pond Wetland had a seasonal water regime, with standing water generally present only during the winter and spring. The tree layer was dominated by red maple (*Acer rubrum*) and also contained black gum (*Nyssa sylvatica*). The shrub layer was dominated by sweet pepperbush (*Clethra alnifolia*), and also contained highbush blueberry (*Vaccinium corymbosum*), winterberry (*Ilex verticillata*), and black chokeberry (*Aronia melanocarpa*). The herbaceous layer of this wetland formerly contained cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), marsh fern (*Thelypteris palustris*), loose-flowered sedge (*Carex laxiflora*), and barnyard grass (*Echinochloa crusgalli*). Following remedial activities, woody planted material surrounding Upper Pond includes red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), sweetpepper bush (*Clethra alnifolia*), highbush blueberry (*Vaccinium corymbosum*) and maple-leaved viburnum (*Viburnum acerifolium*). Disturbed wetland areas within and surrounding Lower Pond were seeded with the Northeast Wetland Grass/Forb mix (Appendix B, Table B-3).

Mapped soils in the vicinity of the Lower Pond Wetland were classified as native Ridgebury fine sandy loam which are poorly drained, moderately course textured, glacial till developed over compact till. A thick layer of decomposing and partially decomposed leaves covered the sediments in the open water portion. Neither fish nor amphibians were previously observed in Lower Pond Wetland. The Lower Pond Wetland was considered to be the least disturbed wetland within Area A Downstream/OBDA, and provided the greatest number of positive wetland functions and values (Niering and Brawley 1997). No threatened or endangered species had been previously observed in the wetland.

2.3 OBDA Wetland

The 0.74-acre OBDA Wetland is located immediately below the northwest slope of the dike that forms the Area A wetland. This wetland prior to remedial activities formed a complex of a palustrine emergent, non-persistent, narrow-leaved wetlands (OBDA Pond) surrounded by scrub/shrub and forested broad-leaved deciduous wetlands (OBDA Ponds Wetland) with a non-tidal seasonal water regime (Atlantic 1995). The emergent vegetation was dominated by a monotypic stand of common reed (*Phragmites australis*), with small clumps of soft rush (*Juncus effusus*). Tulip tree (*Liriodendron tulipifera*) and gray birch (*Betula populifolia*) dominated the forest canopy along the perimeter of the pond. Witch hazel (*Hamamelis virginiana*) was formerly abundant in the shrub stratum, with mountain laurel (*Kalmia latifolia*) and sweet pepperbush (*Clethra alnifolia*) also common. Mapped soils in the vicinity of the OBDA Wetland are classified as native Ridgebury fine sandy loam, which is poorly drained, moderately coarse textured, glacial till developed over compact till. Past Navy activities may have resulted in the placement of fill in this area. The pond's primary source of water was and still is a seep that flows year round and enters the pond from the base of the dike. Groundwater also likely

contributes to the pond during high water table conditions. Prior water depth was 1 to 1.5 feet. Frogs had occasionally been observed within the wetland, but the wetland did not contain fish. No threatened or endangered species had been previously observed in the wetland.

After remediation, the regraded OBDA pond was seeded with the Northeast Wetland Diversity Mix (Appendix B, Table B-2). Red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), sweet pepperbush (*Clethra alnifolia*), spicebush (*Lindera benzoin*), and highbush blueberry (*Vaccinium corymbosum*) were planted along the OBDA pond. Tuliptree (*Liriodendron tulipifera)* was planted in the transition area between the OBDA Pond and surrounding uplands.

2.4 Stream 1 Wetland

The Stream 1 Wetland is approximately 380 feet long and runs between the outlet of OBDA Pond Wetland and Stream 6, a culverted stream that exits Area A Downstream/OBDA and runs along the south side of North Lake. Approximately 0.55-acre of palustrine scrub/shrub and forested broad-leaved deciduous wetland was associated with Stream 1 prior to remedial activities. This wetland was dominated by red maple (*Acer rubrum*), mixed with tuliptree (*Liriodendron tulipifera*), red oak (*Quercus rubra*), and white oak (*Q. alba*). The shrub layer in this wetland previously consisted of witch hazel (*Hamamelis virginiana*) and sweet pepperbush (*Clethra alnifolia*), with a herbaceous layer of a variety of species including cinnamon fern (*Osmunda cinnamomea*), Virginia water horehound (*Lycopus virginicus*), cardinal flower (*Lobelia cardinalis*), false nettle (*Boehmeria cylindrica*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea sensibilis*), soft rush (*Juncus effusus*), wool grass (*Scirpus cyperinus*), and bur-reed (*Sparganium americanum*). Following remediation the wetland was planted with red maple (*Acer rubrum*), tuliptree (*Liriodendron tulipifera)* black gum (*Nyssa sylvatica*), buttonbush (*Cephalanthus occidentalis*), sweet pepperbush (Clethra alnifolia), witch hazel (*Hamamelis virginia*), spicebush (*Lindera benzoin*), maple-leaved viburnum (*Viburnum acerifolium*), and seeded with the Northeast Wetland Grass Seed Mix (Appendix B, Table B-4). Stream 1 was a low energy, first order stream prior to remediation and remains as such following remedial activities. During the spring of 1995, the stream ranged from 1.5 to approximately 3 feet wide and 4 to 8 inches deep. A thick mat of decomposing leaf litter and detritus formerly covered the stream's bottom. The western portion of the streambed was a mix of gravel, cobble, and sediments in a ripple and pool complex. No threatened or endangered species had previously been observed in the wetland.

2.5 Stream 2 Wetland

The Stream 2 Wetland is approximately 170 feet long and runs between the outlet of Lower Pond and a storm drain. Prior to remediation it included approximately 0.11 acres of palustrine scrub/shrub and forested broad-leaved deciduous wetland. A hardwood forest of red maple (*Acer rubrum*), white ash (*Fraxinus americana*), and black gum (*Nyssa sylvatica*) previously surrounded this stream. The shrub layer within this drainage way was dominated by sweet pepperbush (*Clethra alnifolia*) and highbush blueberry (*Vaccinium corymbosum*). The herbaceous layer contained sensitive fern (*Onoclea sensibilis*) and loose-flowered sedge (*Carex laxiflora)*. After remediation the wetland was planted with red maple (*Acer rubrum*), white ash (*Fraxinus americana*) black gum (*Nyssa sylvatica*), sweet pepperbush (*Clethra alnifolia*), spicebush (*Lindera benzoin*), highbush blueberry (*Vaccinium corymbosum*), and seeded with the Northeast Wetland Grass Seed Mix (Appendix B, Table B-4). Stream 2 was previously and remains a small, low energy first order stream. The substrates were highly organic and composed of partially decomposed leaves and detritus. No gravel or cobble was formerly observed in the streambed. Prior to remediation Stream 2 was approximately 2 feet wide and 4 to 8 inches deep. Post remediation dimensions approximate pre-remediation dimensions. The Stream 2 Wetland, along with the Lower

Pond Wetland, is the least disturbed wetland on site. No threatened or endangered species have been observed in the wetland.

2.6 Stream 3 Wetland

The Stream 3 Wetland is approximately 400 feet long and runs between Upper Pond and a culvert under Triton Avenue. The Stream 3 Wetland formerly was a narrow, palustrine emergent wetland approximately 0.13 acre in size. Oaks (*Quercus sp.*), black birch (*Betula lenta*), red maple (*Acer rubrum*), and flowering dogwood (*Cornus florida*) dominated uplands surrounding this stream. The wetland vegetation found along this streambank previously included northern willow herb (*Epilobium glandulosum*), water purslane (*Ludwigia palustris*), Virginia water horehound (*Lycopus virginicus*), sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinnamomea*), soft rush (*Juncus effusus*), and rice cutgrass (*Leersia oryzoides*). Post remediation the wetland was planted with red maple (*Acer rubrum*), black birch (*Betula lenta*), black gum (*Nyssa sylvatica*), sweet pepperbush (*Clethra alnifolia*), spicebush (*Lindera benzoin*), highbush blueberry (*Vaccinium corymbosum*), and seeded with the Northeast Wetland Grass Seed Mix (Appendix B, Table B-4).

Prior to remedial activities Stream 3 had a straight (man-made channel) with relatively hard-packed substrates and relatively deep, steep-sided banks that cut through marine sediments apparently washed downgradient from the Area A Wetland. It was reconstructed with a more sinuous channel. The stream bottom formerly consisted of a combination of fine clay and sand. Stream 3 is approximately 3 feet wide an 8 to 12 inches deep. Post remediation dimensions approximate prior dimensions. Parts of the stream bank were previously dominated by common reed (*Phragmites australis*), particularly those portions adjacent to the Upper Pond. No threatened or endangered species have been observed in the wetland.

2.7 Stream 4 Wetland

The Stream 4 Wetland is approximately 300 feet long, and runs from just downslope of the outlet from Area A Wetland to Upper Pond. The Stream 4 Wetland formerly was a narrow, palustrine emergent and forested wetland approximately 0.07 acre in size. Red maple (*Acer rubrum*) and black birch (*Betula lenta*) dominated the canopy of this wetland. The shrub layer contained mountain laurel (*Kalmia latifolia*) and highbush blueberry (*Vaccinium corymbosum*). Herbaceous vegetation included white wood aster (*Aster divaricatus*), striped wintergreen (*Chimaphila maculata*), blue stemmed goldenrod (*Solidago caesia*), rough stemmed goldenrod (*S. rugosa*), cinnamon fern (*Osmunda cinnamomea*), royal fern (*Osmunda regalis*), low sedge (*Carex lurida*), and upland bentgrass (*Agrostis perennans*). Post remediation the wetland was planted with red maple (*Acer rubrum*), black birch (*Betula lenta*), mountain laurel (*Kalmia latifolia*), highbush blueberry (*Vaccinium corymbosum*), and seeded with the Northeast Wetland Grass Seed Mix (Appendix B, Table B-4). Stream 4 drains into Upper Pond, and was a man made channel with relatively hard-packed substrates. Stream 4 is approximately 3 to 4 feet wide and 6 to 8 inches deep. Post remediation conditions approximate pre-remedial conditions. No threatened or endangered species had been previously observed in the wetland.

2.8 Stream 5

Stream 5 is approximately 560 feet long. It receives water through an underground culvert from Stream 3 and eventually discharges to the Thames River. Stream 5 was a man made channel with primarily sand and gravel substrates in the streambed and higher organic content in the adjacent floodplain. Stream 5 is approximately 3 to 4 feet wide and 4 to 6 inches deep during low flow periods and 20 to 30 feet wide and 12 to 18 inches deep during flood stages. Based on a delineation conducted prior to commencement of remedial activities at Stream 5 (FWENC, 2000c), it was determined that wetlands were not associated

with Stream 5. There was evidence of accumulated sandy sediments indicating that active deposition occurs within the floodplain. The lack of hydrophytic vegetation and hydrology led to the conclusion that the floodplain associated with Stream 5 is not wetlands. Following remediation the streambank was planted with the Northeast Upland Wildlife Seed Mix (Appendix B, Table B-5). No threatened or endangered species had been previously observed in the stream.

3.0 PERFORMANCE STANDARDS

The following standards will be used to determine the successful reestablishment of all restored wetlands at the Area A Downstream/OBDA site at the end of the monitoring:

Vegetation

1. A minimum of 80% areal cover, excluding planned open water areas, by noninvasive hydrophytic species for all seeded areas;
2. Greater than 50% of dominant plant species that have a wetland indicator status of facultative (FAC), facultative wetland (FACW), or obligate wetland (OBL) with no more than 50% of FAC species;
3. For planted woody species, a minimum of 80% survival based on stem count; and
4. A 20% increase in tree height and diameter at breast height.

Soils

1. Trend towards hydric condition within upper 18 inches of soil profile.

Hydrology

1. Emergent zone hydrology that consists of soil saturated to the surface, water on the surface or a combination of surface water and saturated soils for at least 10 consecutive days during the growing season; and
2. Scrub/shrub and forested zone hydrology that consists of soil that is saturated to the surface, or the groundwater table that is within 10 inches of the surface, for at least 10 consecutive days of the growing season.

Functions and Values

1. All streams and ponds show a trend toward greater biological diversity in the benthic invertebrate community;
2. Post-remedial functions and values equal to or greater than pre-remedial functions and values;
3. Predicted potential habitat for 27% (16) of all wetland-dependent amphibians, reptiles, and mammals evaluated by the WEThings Method; and
4. Restoration of 1.26 acres of emergent wetland, 1.17 acres of scrub/shrub/forested wetland and 0.47 acres open water.

For the purpose of the vegetation performance standard No. 1, invasive species will be defined as one of the following:

- Cattails (*Typha latifolia, T. angustifolia, T. glauca*);
- Common Reed (*Phragmites australis*);
- Purple Loosestrife (*Lythrum salicaria*); and
- Reed Canary Grass (*Phalaris arundinacea*).

4.0 MONITORING COMPONENTS

Long-term monitoring will consist of four components: vegetation, soils, hydrology, and functions and values. Long-term monitoring will commence upon the completion of the Stage 2 plantings. Monitoring will be initially conducted for three years based on the contingency that all the performance standards are met and successful restoration of disturbed wetlands is clearly demonstrated. If at the end of the third year of monitoring, the above performance standards are not achieved, two additional years of monitoring will be conducted and appropriate adjustments recommended (*i.e.*, additional plantings). In addition, the information and review of annual monitoring reports will initiate technical meetings between concerned parties to discuss the status of the long-term monitoring and to determine whether mid-course corrections are necessary. This plan will not address control of common reed (*Phragmites austalis*), as the Navy has included its potential control as part of their base-wide maintenance program. A general overview of the long-term monitoring program is presented in Appendix E, Table E-1.

4.1 Vegetation

Vegetation will be monitored biannually, once in the spring and once in the fall of each monitoring year. Planted woody material and seeded herbaceous material will be monitored separately. The survival and vigor of planted trees and shrubs will be assessed directly for each plant. For survival status, the number of live or dead trees and shrubs will be recorded by species. To determine vigor of planted trees, the height and diameter at breast height of all trees will be recorded. For shrub species, the height of ten randomly selected shrubs per species will be recorded per monitoring event. Each planted woody plant will be tagged with an identification number. An as-built drawing will be prepared indicating the location of each planted tree and shrub. Data will be entered into a GIS database allowing assessment of survival and growth by species, hydrological zone, and location.

Seeded herbaceous material will be assessed by sampling plants either along 200-foot transects or within one meter square plots. A total of three 200-foot transects will be located throughout Lower Pond, OBDA Pond and Stream 1, one at each location. Twelve one-meter square plots will be located throughout the wetlands associated with Upper Pond, and Streams 2, 3 and 4, three within each wetland. Locations of the sample transects and plots are indicated on the Figure 1, Appendix A. Data recorded at each sample transect and plot will include plant count by species, indicator status, total percent cover, and percent species cover. For linear transects, intercept length of the ground surface condition (bare ground, open water, species coverage) will be recorded by linear distance. For plant species the perpendicular projection of foliage to the line will be measured to estimate coverage. For one-meter plots, number of individual plants within the plot will be enumerated by species. Cover estimates will be based on visual assessment of areal cover for the total plot and for each species encountered.

As part of the herbaceous sampling effort, special attention will be paid to the occurrence of invasive species. For this purpose invasive species will be defined as cattails (*Typha latifolia, T. angustifolia,*

T. glauca), common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and reed canary grass (*Phalaris arundinacea*). The location and extent of invasive species occurrence will be mapped. This map will be updated annually to indicate new invasions or areas of successful removal. Additionally, photographs will be taken at standardized locations for each wetland or water body (Upper Pond, Lower Pond, OBDA Pond, OBDA Pond Wetland, and Streams 1 through 4) concurrent with vegetation monitoring during each monitoring event. Photo locations will also be indicated on the site map.

Preliminary assessments of the woody plantings at the Area A Downstream site indicate steadily progressing extensive, severe deer browse damage, especially to certain woody sapling species. The first biannual vegetation monitoring, scheduled for the fall of 2001, will include a thorough assessment of deer browse damage to all woody plantings at the site. The subsequent monitoring report will quantify deer browse damage on a species specific level and make recommendations for deer browse damage control and replanting in the spring of 2002. Based on the amount and severity of the browse damage, recommendations may be made to either replant heavily damaged species and protect those plantings with deer repellants, caging or site perimeter fencing, replant heavily damaged species with larger specimens to discourage deer browse, or shift the species composition mix from heavily damaged species to lightly damaged species through the replanting of those species observed to have incurred little or no deer damage.

4.2 Soils

Soils will be examined for the development of hydric soil characteristics during the fall of each monitoring year. Soil borings will be extracted from restored wetlands at Upper Pond, Lower Pond, ODBA Pond, OBDA Pond Wetland, and Streams 1, 2, 3, and 4 Wetlands. Soils profiles will be examined in the fall of each year to determine development of hydric characteristics. Profiles will be recorded in standard log format by horizon. Information to be recorded will include color, structure, texture and hydric soil indicators, e.g., oxidized root channels, mottling, present of sulfuric odors, iron and manganese concretions. In addition, pH and redox potential field measurements will be recorded with an Orion oxidation-reduction potential meter, model SA250A, at each soil boring location.

4.3 Hydrology

Hydrology will be monitored every two weeks during the growing season. The growing season will be defined as that portion of the year when soil temperatures are higher than biological zero and is approximated by the number of frost-free days. Estimated start and stop dates for the growing season will be based on the 28°F air temperature thresholds at a frequency of five years in ten. According to the Soil Survey of New London County, Connecticut, this represents a 199 day period (Crouch, 1983). Depth to ground water will be measured at 24 piezometers located throughout the restored wetland areas. Piezometer locations are shown on Figure 1, Appendix A. Depth of ponding will be measured at three staff gauges located at Upper Pond, Lower Pond and OBDA Pond.

Additionally, flow rates (channel center and sides) and water depths (channel center and sides) will be recorded at Streams 1, 2, 3, and 4 during the spring and fall of each monitoring year. Flow rates will be estimated using channel morphology and a timed float trial. A minimum of three trials will be run per event and a daily average calculated. Rainfall data generated from the National Weather Service certified Meteorological Station located at Groton / New London Airport (KGON 41-19-39N 072-02-58W) will be accessed and used to evaluate seasonal patterns. This weather station is located approximately 4 miles from the site and represents site conditions. Rainfall data from each growing

season will be compared to the 10-year average to evaluate the seasonal trends affecting the wetland system.

4.4 Functions and Values Assessment

Wetland functions and values will be assessed using two methods: 1) the U.S. Army Corps of Engineers New England District Highway Methodology (1995) and the Wetland Habitat Indicators for Nongame Species (WEThings) (Whitlock, et. al. 1994a,b). Each of the seven restored wetlands will be evaluated individually. These assessments will be conducted at the end of the third year after wetlands have been delineated as described below.

The Highway Methodology involves a descriptive approach to evaluate the aspect and importance of 13 wetland functions and values (groundwater recharge/discharge, fish and shellfish habitat, floodflow alteration, sediment retention, nutrient removal, production export, shoreline stabilization, wildlife habitat, recreation, education/scientific value, uniqueness, aesthetics, and endangered species habitat). Data will be recorded on a standard wetland function and evaluation form (Appendix F). In addition, all observations of fish and wildlife will be recorded and photographs will be taken at each site. Post remedial functions and values will be compared to those determined by Niering and Brawley (1997) for pre-remedial conditions.

The Wetland Habitat Indicators for Nongame Species (WEThings) rapid assessment method will be used to further evaluate wildlife functions in the restored wetlands. WEThings provides a standardized, fully documented method of determining habitats of amphibians, reptiles, and nongame mammals endemic to New England. This method evaluates wetland systems, as defined by the U.S. Fish and Wildlife Service Classification System (Cowardin et. al., 1979) and assumes that an approved state or federal method has been used to delineate wetland boundaries.

The WEThings assessment involves four steps. Step 1 employs a matrix evaluation to generate a list of species that potentially use wetlands in the site's specific geographic location. A list of species that would potentially use restored wetlands is presented in Appendix G, Table G-1. Step 2 involves refining the species list through a field evaluation of specific wetland components: vegetation, substrate, hydrology, and specific upland features. Discrete assessment areas are identified for this evaluation. In this case the assessment areas will be equal to each of the seven restored wetlands. Data will be entered on a standardized data form (Appendix H). Step 3 entails analysis of the field data using the WEThings computer program to generate a potential species list. Step 4 requires review and interpretation of the generated lists. This step involves reviewing the individuals species models and modifying the generated lists, if required, using best professional judgement.

4.5 Benthic Community Analysis

The objective of the benthic survey is to monitor the recolonization of the benthic community in restored waterbodies. In October 2000 a benthic macroinvertebrate survey was conducted as part of the short term monitoring effort. This survey represents the post-remedial baseline for comparison of subsequent monitoring results. The benthic community will be sampled in the fall of each monitoring year. Seven locations will be monitored: Streams 1 through 4, Upper Pond, Lower Pond, and OBDA Pond.

During each sample event, three replicate samples will be collected from each of the water bodies, Streams 1 through 4, Upper Pond, Lower pond, and the OBDA Pond. A total of 21 samples will be collected. Each year, the samples will be collected at a new location within the water body, to avoid depletion of the substrate at a single point, and to avoid monitoring the post-sampling recovery of a

location as opposed to monitoring the post-restoration recovery of each water body. However, each of the samples collected from within each water body will be located in areas within the water body with similar flow regimes (pools, riffles) and substrates. Water quality data and a description of the benthic substrate will be recorded at each sample station. Sampling will be conducted in accordance with Hicks (1997) and Barbour et al. (1999).

The benthic macroinvertebrate community at Upper Pond will be sampled using a petite ponar ($0.023m^2$). Streams 1, 2, 3, and 4, Lower Pond, and OBDA Pond will be sampled using a kick net. Kick net sampling will be conducted using a 30" x 30" kick net with 500 µm mesh. A 1 foot by 3 feet area (3 square feet) will be sampled. The kick net will be held vertical, perpendicular to the flow in the water column. Disturbance/washing of the substrates will be held constant to a period of five minutes for each of the replicates collected. Following sample collection, the collected sediment and detritus collected in the net will be examined for invertebrates.

Replicates will be collected moving in an upstream direction at each station so as to minimize disturbance to the unsampled upstream replicates during sampling. Coarse material (i.e., woody debris, stones, whole leaves) will be examined before being removed from the sample and the leavings washed into a No. 35 (500 µm mesh) standard testing sieve from which the remaining sample will be condensed. Each replicate collected will be preserved in a separate 500 milliliter (ml) polyethylene sample container, with the sample identified by an internal and external label. Samples will be preserved in 70% ethanol or an equivalent preservative and shipped to a subcontractor laboratory for formal identification to lowest practical taxon and enumeration.

The identification and enumeration data provided by the laboratory will be presented in tabular format for each sample location. In addition, the data will be summarized in tabular format for the entire site. The data will be used to derive metrics which describe community composition, as presented in the New England Freshwater Wetlands Invertebrate Biomonitoring Protocol (Hicks, 1997). In addition, the Shannon-Wiener Diversity Measure (Wilson & Bossert, 1971) will be calculated. The metrics to be calculated are as follows:

- Total organisms – Total number of organisms collected at each location.
- Percent Composition of Dominant Family/Group – Describes relative representation of dominant taxa at a particular location.
- Taxa Richness – Total number of identified taxa (families or genera) present at each site.
- EOT Richness – Total of the Ephemeroptera (Mayflies), Odonata (Dragonflies and Damselflies), and Trichoptera (Caddisflies) families present at each site.
- EOT/Chironomidae Ratio – Total Avg. density (individuals) EOT /Total Avg. density (individuals) Chironomidae.
- Shannon-Wiener Diversity Measure – $H' = - \quad (p_i)(\ln p_i)$,
  where:
  H' = the Shannon-Wiener diversity value (unitless)
  p_i = proportion of individuals in taxa i to the total number of individuals sampled
  $\ln p_i$ = the natural logarithm of p_i

The calculated metrics for each sample event will then be compared to calculated metrics for the baseline benthic survey event, conducted in October 2000. The comparison will be used to monitor the recolonization of the water bodies by benthic macroinvertebrates. Improvement will be considered as the following:

- An increase in total organisms, taxa richness, EOT richness, EOT/Chronomidae ratio, and the Shannon-Wiener diversity measure.
- A decrease in percent composition of dominant family group.
- Stabilization of metrics over time.

Variation in metrics will be considered relative to physical and hydrological variations among sampling events.

4.6 Post-restoration Wetland Delineation

A post-restoration wetlands delineation will be conducted near the end of the third growing season and the wetlands boundary compared to the boundary proposed in the final wetlands restoration design. The status of this comparison will be included in the three-year monitoring report. Site wetlands will be field delineated using the routine on-site determination method identified in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987). In addition, the delineation will follow guidance provided by the U.S. Army Corps of Engineers, New England District in *New England District Performance Standards and Supplemental Definitions for Use with the 1987 Corps Manual* (2000).

The 1987 Federal Manual incorporates a three-parameter approach using vegetation, soils, and hydrology to identify the presence of freshwater wetlands. Wetland boundaries are initially identified through visual assessment of vegetation and hydrology. After the initial assessment, paired sample stations are located along the identified wetland boundary. Generally only two stations, a wetland and an upland station, are sampled for each wetland. These sample stations typically confirm the initial wetland boundary. The wetland boundary line will be marked with flagging at 50 to 75 foot intervals (depending on line of sight) and numbered sequentially. Soil logs, indicating the center of each sample station, will be flagged and numbered. Photographs will be taken at selected locations, which will be indicated on the site drawing showing wetland boundaries. The direction in which each photograph is taken will also be noted.

Vegetation, soil, and hydrology indicators will be examined at each station where dominant plant species and estimated cover were recorded by stratum. Data will be recorded for tree, vine, sapling (0.4 to 5 inches diameter at breast height 20 feet tall or greater), shrubs (at least 3 feet tall but less than 20 feet tall), and seedling/herb strata according to guidance provided in the *New England District Performance Standards and Supplemental Definitions for Use with the 1987 Corps Manual* (U.S. Army Corps of Engineers, 2000). The data sheet to be used for the Wetland Delineation is provided in Appendix I. Visual estimates of areal cover will be made separately for all strata. Soil pits generally will be dug to a depth of 18 to 20 inches or greater and observations will be recorded in standard soil log format. Hydrological indicators, consisting of obvious signs of flooding and saturation will be noted at each sample station.

5.0 REPORT

An annual report will be prepared and submitted to the US EPA and Connecticut DEP following the completion of each monitoring season. The annual report will discuss the status of restoration, including monitoring results, progress toward achieving performance standards, corrective actions taken, and any recommendations for future corrective actions, if required. The annual report will include the

photographs taken during spring and fall monitoring events. All reports will be provided to the agencies by the first of December of each year.

Following completion of three years of monitoring, a three-year monitoring report will be submitted documenting the status of revegetation success. The report will include a recommendation of whether or not additional monitoring, and/or supplemental planting and seeding is required based on the success of revegetation. The results of the comparison of the post-restoration wetland delineation and the wetland boundary proposed in the final wetland restoration design will be included in the three-year monitoring report.

A wetland delineation report will be prepared documenting the results of the on-site wetland delineation effort conducted at the end of the third growing season. The report will characterize the wetlands identified, on-site methodologies employed in delineating wetlands, provide a description of the site, and a description of vegetation, soils and hydrology. The report will also include a summary, list of references, and resumes of personnel involved in the completion of the project. A compilation of species recorded and their indicator status, photographs with captions, soil logs, and data forms will be included as appendices. The wetland delineation report will be included as an appendix to the three-year monitoring report.

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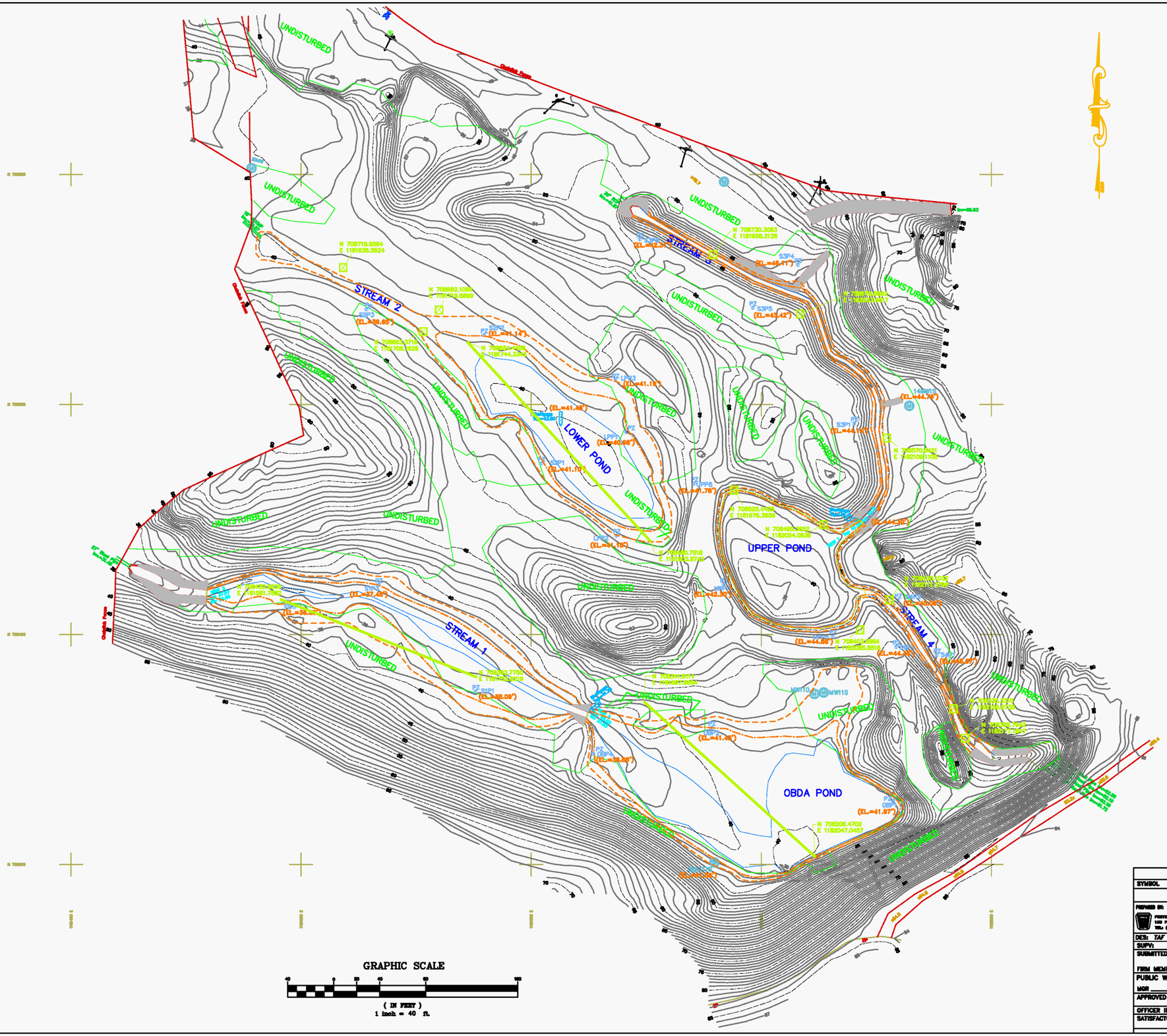
APPENDIX A

AS BUILT 1-FOOT CONTOUR DRAWING



PIEZOMETERS				
Point No.	Northing	Easting	Elevation	Piezometer
3173	708531.1464	1181941.7406	47.28	UPP8
3289	708429.6626	1182118.6550	48.97	S4P2
3291	708362.0619	1182152.6069	50.44	S4P1
3357	708398.2576	1182062.0213	49.96	UPP6
3358	708389.1958	1182117.2359	52.36	S4P3
3432	708443.3326	1181967.1327	50.59	UPP7
3560	708318.7139	1181956.7900	44.09	OBP2
3627	708255.4109	1182114.7147	42.99	OBP1
3802	708296.1982	1181854.0752	42.31	OBP4
3822	708350.2903	1181751.6141	39.46	S1P1
3871	708443.1012	1181667.3380	39.27	S1P3
3924	708424.6797	1181586.6556	38.69	S1P4
4073	708721.3558	1182031.7257	50.36	S3P4
4284	708583.3413	1182080.6235	52.58	S3P1
4347	708684.0805	1181992.5081	51.36	S3P5
4363	708743.5020	1181894.4073	50.96	S3P6
4418	708621.0616	1181872.9847	44.30	LPP3
4422	708576.0196	1181882.4478	44.13	LPP1
4444	708548.7275	1181808.7616	44.35	S2P1
4466	708485.9125	1181874.0544	44.89	LPP2
4509	708660.3148	1181758.9748	43.85	S2P2
4531	708682.7014	1181656.6690	45.47	S2P3

LEGEND

- 80 — Contour Index
- 82 — Contour Intermedit
- Water Course
- Rip Rap
- ACCMP — Asphalt Coated Corrugated Pipe
- EP — Edge of Pavement
- Flag Pole
- Guy
- INV — Invert
- Manhole Unknown
- Monitoring Well
- Piezometer
- RCP — Reinforced Concrete Pipe
- SNET — Southern New England Telephone
- x53.8 — Spot Elevation
- Traffic Light
- Utility Pole
- Water Valve

NOTES:

1. Survey base plan has been prepared in accordance with the regulation of Connecticut State Agencies, Section 20–300b–1 thru 20–300b–20, the "Standards For Surveys and Maps in The State Of Connecticut". Adopted by the Connecticut Association of Land Surveyors, Inc. on September 26, 1996. The type of survey is a "Topographic Survey", and the horizontal control accuracy conforms to Class A–2. The topographic survey accuracy conforms to T–2.
2. Field survey was performed August 28, 2000 through September 5, 2000.
3. Horizontal Datum is NAD '83 based on control points #211, #212, #215 and #913.
4. Vertical Datum is NAVD '88 based on control points #212 and #913.
5. Contours are one interval.
6. Underground utility, structure and facility locations depicted and noted hereon have been compiled, in part, from record mapping supplied by the respective utility companies or governmental agencies from parol testimony and from other sources. These locations must be considered as approximate in nature, additionally, other features may exist on the site, the existence of which are unknown to Compass Engineering Group, L.L.C. The size, location and existence of all such features must be field determined and verified by the appropriate authorities prior to construction. Call Before You Dig 1–800–922–4455.

KEY:

- INTERSECTION OF WATER TABLE W/GROUND SURFACE i.e. DTW = 0"
- AREA WHERE WATER TABLE IS WITHIN 10"
- (EL.=41.43") GROUNDWATER ELEVATION AS MEASURED 9/20/00
- PROPOSED VEGETATION MONITORING PLOT
- PROPOSED VEGETATION MONITORING TRANSECT

SYMBOL	DESCRIPTION	DATE	APPR.

REVISIONS

PREPARED BY: FOSTER WHEELER ENVIRONMENTAL CORPORATION 120 FEDERAL STREET, BOSTON, MA 02110 TEL: (617) 457-2500 FAX: (617) 457-2400

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
NAVAL SUBMARINE BASE NEW LONDON
GROTON, CONN.

DES: TAF DR: FGM CHK: LEK
SUPV: CH ENGR:
SUBMITTED BY DATE APRIL 2001
FIRM MEMBER (TITLE)
PUBLIC WORKS RVD
MGR DIR
APPROVED DATE
OFFICER IN CHARGE
SATISFACTORY TO DATE

AREA A DOWNSTREAM/OBDA REMEDIATION
POST–CONSTRUCTION
WETLAND RESTORATION SITE PLAN
LONG TERM MONITORING

SIZE D | CODE IDENT. NO. 80091 | NAVFAC DRAWING NO. | CONSTR. CONTR. NO. N62472–94–D–0398

FIGURE 1

SCALE: AS SHOWN SPEC. SHEET 1 OF 1

CADD FILE: D024–A004.DWG

APPENDIX B

SEED MIXES

Table B-1
Seeding Mixes

Seed Mix	Upper Pond	Lower Pond	OBDA Wetland	OBDA Pond	Stream 1 Wetland	Stream 2 Wetland	Stream 3 Wetland	Stream 4 Wetland	Stream 5	Uplands
Northeast Wetland Grass					X	X	X	X		
Northeast Wetland Diversity				X						
Northeast Wetland Grass/Forb	X	X	X							
Northeast Upland Wildlife Seed									X	X

Table B-2
Northeast Wetland Diversity Seed Mix

Scientific Name	Common Name	Percent By Number of Seeds[1] (not by weight)
Scirpus atrovirens	Green Bulrush	28.82%
Juncus effusus	Soft Rush	13.05%
Mimulus ringens	Monkey Flower	12.01%
Carex vulpinoidea	Fox Sedge	8.35%
Penthorum sedoides	Ditch Stone Crop	7.83%
Glyceria grandis	Reed Meadowgrass	6.68%
Scirpus cyperinus	Wool Grass	5.22%
Verbena hastata	Blue Vervain	4.18%
Eupatorium perfoliatum	Boneset	2.09%
Leersia oryzoides	Rice Cut Grass	1.57%
Helenium autumnale	Common Sneezeweed	1.48%
Glyceria canadensis	Canada Mannagrass	1.36%
Eupatorium maculatum	Joe Pye Weed	0.89%
Aster Novae-angliae	New England Aster	0.73%
Alisma plantago-aquatica	Water Plantain	0.52%
Euthamia graminifolia	Grassleaf Goldenrod	0.47%
Solidago rugosa	Wrinkled Goldenrod	0.47%
Cyperus strigosus	Straw Colored Flatsedge	0.47%
Aster puniceus	Purple Stemmed Aster	0.42%
Cephalanthus occidentalis	Buttonbush	0.38%
Scirpus tabernaemontanii	Soft Stem Bulrush	0.36%
Aster umbellatus	Flat-Top White Aster	0.35%
Carex comosa	Bearded Sedge	0.31%
Carex crinita	Fringed Sedge	0.26%
Solidago gigantea	Giant Goldenrod	0.24%
Panicum clandestinum	Deertongue	0.24%
Bidens cernua	Nodding Beggar-Ticks	0.22%
Sium suave	Water Parsnip	0.21%
Scirpus microcarpus	Small Fruited Bulrush	0.18%
Cicuta maculata	Water Hemlock	0.16%
Elymus canadensis	Wild Rye	0.10%
Bidens frondosa	Devil's Beggar-Ticks	0.08%
Angelica atropurpurea	Purple-Stem Angelica	0.06%
Rumex verticillatus	Water Dock	0.05%
Carex lurida	Shallow Sedge	0.05%
Polygonum pensylvanicum	Pennsylvania Smartweed	0.04%
Asclepias incarnata	Swamp Milkweed	0.04%
Elymus riparius	Riverbank Wild Rye	0.03%
Carex lupulina	Hop Sedge	0.02%
Iris versicolor	Blue Flag	0.01%

[1] The percentages shown are approximate and may vary slightly based on seed harvest of prior season.

Table B-3
Northeast Wetland Grass/Forb Mix

Scientific Name	Common Name	Percent By Number of Seeds[1] (not by weight)
Glyceria canadensis	Canada Mannagrass	37.3%
Glyceria grandis	Reed Meadowgrass	29.3%
Calamagrostis canadensis	Blue Joint	7.5%
Panicum dichotomiflorum	Smooth Panic-Grass	7.3%
Leersia oryzoides	Rice Cut Grass	4.9%
Echinochloa crusgalli	Japanese Millet	3.9%
Verbena hastata	Blue Vervain	3.0%
Elymus canadensis	Canada Wild Rye	1.7%
Alisma plantago-aquatica	Water Plantain	1.5%
Polygonum pensylvanicum	Pennsylvania Smartweed	0.9%
Bidens cernua	Nodding Bur-Marigold	0.8%
Cicuta maculata	Spotted Water Hemlock	0.7%
Cinna arundinacea	Stout Wood-Reedgrass	0.7%
Bidens frondosa	Beggar-Ticks	0.3%
Rumex verticillatus	Swamp Dock	0.2%

Table B-4
Northeast Wetland Grass Mix

Scientific Name	Common Name	Percent By Number of Seeds[1] (Not by weight)
Agrostis stolonifera	Creeping Bentgrass	63.0%
Poa trivialis	Rough Bluegrass	17.0%
Alopecurus arundinaceus	Meadow Toxtail	11.0%
Panicum clandestinum	Deertongue	4.5%
Lolium multiflorum	Annual Ryegrass	4.5%

Table B-5
Northeast Upland Wildlife Seed Mix

Scientific Name	Common Name	Percent By Number of Seeds[1] (not by weight)
Perennials		
Phleum pratense	Timothy	42.5%
Trifolium hybridum	Alsike Clover	24.9%
Dactylis glomerata	Orchard Grass	15.6%
Lespedeza bicolor	Bicolor Lespedeza	3.9%
Panicum virgatum	Switchgrass	3.5%
Andropogon virginicus	Broom-Sedge	0.9%
Annuals		
Setaria italica	Fox-Tail Bristle Grass	5.3%
Helianthus annuus	Common Sunflower	1.9%
Polygonum pensylvanicum	Pennsylvania Smartweed	0.8%
Avena sativa	Oats	0.7%

[1] The percentages shown are approximate and may vary slightly based on seed harvest of prior season.

APPENDIX C

WOODY PLANTING MATERIAL

Table C-1
Plantings by Location

Species	Common Name	Indicator Status	Upper Pond	Lower Pond	OBDA Wetland	OBDA Pond	Stream 1 Wetland	Stream 2 Wetland	Stream 3 Wetland	Stream 4 Wetland	Stream 5	Uplands
Trees												
Acer rubrum	Red Maple	FAC	X	X	X		X	X	X	X		
Betula lenta	Black Birch	FACU	X[2]						X[2]	X[2]		X
Betula populifolia	Gray Birch	FAC	X									
Fraxinus ***americana***	White Ash	FACU						X[2]				
Liriodendron tulipifera	Tuliptree	FACU			X[2]		X[2]					X
Nyssa sylvatica	Black Gum	FAC		X	X		X	X	X			
Quercus rubra	Northern Red Oak	FACU-										X
Quercus alba	White Oak	FACU-										X
Shrubs												
Cephalanthus occidentalis	Buttonbush	OBL					X					
Clethra alnifolia	Sweet Pepperbush	FAC+	X	X	X		X	X	X			X
Hamamelis virginia[1]	Witch Hazel	FAC-			X		X					X
Kalmia latifolia	Mountain Laurel	FACU								X		
Lindera benzoin	Spicebush	FACW-			X		X	X	X			
Myrica pennsylvanica	Northern Bayberry	FAC										X
Vaccinium corymbosum	Highbush Blueberry	FACW-	X	X	X			X	X	X		X
Viburnum acerifolium[1]	Maple-leaved Viburnum	UPL			X		X					X

1 One of these three plants will be planted at the discretion of the Wetlands Biologist.
2 Trees will be randomly placed in transition area/uplands within 15 feet of delineated wetland boundary.

Table C-2
Wetland Plant Material Specifications

Species	Common Name	Type	Height	Caliper	Total Number
Acer rubrum	Red Maple	tree	6-8 feet	¾ inch	45
Acer rubrum	Red Maple	tree	5-6 feet	½ inch	8
Acer rubrum	Red Maple	tree	10-12 feet	1½ inch	5
Betula lenta	Black Birch	tree	6-7 feet	¾ inch	74
Betula populifolia	Gray Birch	tree	6-8 feet	¾ inch	10
Fraxinus americana	White Ash	tree	6-8 feet	¾ inch	10
Liriodendron tulipifera	Tuliptree	tree	6-8 feet	¾ inch	14
Nyssa sylvatica	Blackgum	tree	6-8 feet	¾ inch	21
Quercus rubra	Northern Red Oak	tree	6-8 feet	¾ inch	22
Quercus rubra	Northern Red Oak	tree	10-12 feet	1½ inch	5
Quercus alba	White Oak	tree	6-8 feet	¾ inch	19
Cephalanthus occidentalis	Buttonbush	shrub	3-4 feet	3-4 canes	27
Clethra alnifolia	Sweet Pepperbush	shrub	2-3 feet	3-4 canes	191
Hamamelis virginiana[2]	Witch Hazel	shrub	2-3 feet	3-4 canes	52
Kalmia latifolia	Mountain Laurel	shrub	2-3 feet	3-4 canes	3
Lindera benzoin	Spicebush	shrub	3-4 feet	3-4 canes	15
Myrica pennsylvanica	Bayberry	shrub	2-3 feet	3-4 canes	39
Vaccinium corymbosum	Highbush blueberry	shrub	2-3 feet	3-4 canes	55
Viburnum acerifolium	Maple-leaf viburnum	shrub	15-18 inches	1-2 canes	39
				Total	654

APPENDIX D

WETLAND FUNCTIONS AND VALUES

Table D-1
Summary of Existing and Proposed
Wetlands Functions and Values[1]

	Upper Pond Wetland		Lower Pond Wetland		OBDA Wetland		Stream 1 Wetland[2]		Stream 2 Wetland[3]		Stream 3 Wetland[3]		Stream 4 Wetland[5]	
	Exist.[6]	**Prop.**	**Exist.**	**Prop.**	**Exist.**	**Prop.**	**Exist.**	**Prop.**	**Exist.**	**Prop.**	**Exist.**	**Prop.**	**Exist.**	**Prop.**
Groundwater Recharge/Discharge	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Floodflow Alteration	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fish and Shellfish Habitat	N	P	P	PN	N	N	N	N	P	N	N	N	N	N
Sediment/Toxicant Retention	Y*	Y	Y*	Y	Y*	Y	Y	Y	Y*	Y	Y*	Y	Y*	Y
Nutrient Removal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Production Export	P	P	Y	Y	P	P	P	P	Y	Y	P	P	P	P
Sediment/Shoreline Stabilization	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Wildlife Habitat	P	P	Y*	Y	P	P	P	P	Y*	Y	P	P	P	P
Recreation	N	P	N	P	N	P	N	P	N	P	N	P	N	P
Educational Scientific Value	N	P	P	P	N	P	N	P	P	P	N	P	N	P
Uniqueness/Heritage	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Visual Quality/Aesthetics	N	N	Y*	P	N	Y	N	N	Y*	Y	N	N	N	N
Endangered Species Habitat	N	N	N	N	N	N	N	N	N	N	N	N	N	N

1 Existing Functions and Values from Niering and Brawley, (1997) .
2 Stream 1 Wetland included with OBDA Pond Wetland in Niering and Brawley (1997).
3 Stream 2 Wetland included with Lower Pond Wetland in Niering and Brawley (1997).
4 Assessment of existing functions and values of Stream 3 Wetland not included in Niering and Brawley (1997).
5 Stream 4 Wetland included with Upper Pond Wetland in Niering and Brawley (1997).
6 N = No, Y = Yes, P = Potential, *indicates principal function/value.

APPENDIX E

OVERVIEW OF MONITORING PROGRAM

Table E-1
Overview of Monitoring Program

Component	Frequency	Sample Method	Sample Location
Vegetation	Biannual, Spring and Fall	Herbaceous Layer – total percent cover, species composition (200 foot transects, one per location).	Lower Pond, OBDA Pond, Stream 1 Wetland
		Herbaceous Layer – total percent cover, species composition (square meter plots, 3 per location).	Upper Pond, Streams 2, 3, and 4 Wetlands
		Trees and shrubs – enumeration of live/dead trees/shrubs by species, height and diameter breast height of all trees, height of ten shrubs per species.	Upper Pond, Lower Pond, OBDA Pond, OBDA Pond Wetlands, Stream 1, 2, 3, and 4 Wetlands
		Aquatic bed – total percent cover, species composition.	Upper Pond, Lower Pond, OBDA Pond, Streams 1, 2, 3, and 4
Soils	Biannual, Spring and Fall	Soil profile of upper 18 inches at one designated location along each restored wetland. pH and redox potential field measurements for each sample location.	Upper Pond, Lower Pond, OBDA Pond, OBDA Pond Wetlands, Streams 1, 2, 3, and 4 Wetlands
Hydrology	Biweekly, during the growing season	Piezometer field measurements	Upper Pond (3), Lower Pond (3), OBDA Pond (4), Stream 1 Wetland (3), Stream 2 Wetland (3), Stream 3 Wetland (5), and Stream 4 Wetland (3)
		Staff gauge field measurements	Upper Pond, Lower Pond, and OBDA Pond
		Flow rates - (channel center and sides) Water depths -	Streams 1, 2, 3, and 4
Functions and Values – Benthic Communities	Annual, Fall	Petite ponar (0.023m^2) grab sample from 0-10 cm depth interval.	Upper Pond (3), OBDA Pond (3) and Stream 2 (3)
		Kick Net Samples	Lower Pond (3), Stream 1 (3), Stream 3 (3), and Stream 4 (3)
Functions and Values – Assessment	End of Third Growing Season	U.S. Army Corps of Engineers Highway Methodology Assessment (1995).	Upper Pond, Lower Pond, OBDA Pond Wetlands, Streams 1, 2, 3, and 4 Wetlands
Functions and Values – Assessment	End of Third Growing Season	Wetland Habitat Indicators for Nongame Species (WEThings) (Whitlock, et. al. 1994a,b).	Upper Pond, Lower Pond, OBDA Pond Wetlands, Streams 1, 2, 3, and 4 Wetlands
Functions and Values – Wetland Delineation	End of Third Growing Season	*Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987), and the New England District in *New England District Performance Standards and Supplemental Definitions for Use with the 1987 Corps Manual* (1995).	Upper Pond, Lower Pond, OBDA Pond Wetlands, Streams 1, 2, 3, and 4 Wetlands

APPENDIX F

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT HIGHWAY METHODOLOGY
STANDARD WETLAND FUNCTION AND EVALUATION FORM

Wetland evaluation supporting documentation; Reproducible forms.

Below is an example list of considerations that was used for a New Hampshire highway project. Considerations are flexible, based on best professional judgment and interdisciplinary team consensus. This example provides a comprehensive base, however, and may only need slight modifications for use in other projects.

GROUNDWATER RECHARGE/DISCHARGE— This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. It refers to the fundamental interaction between wetlands and aquifers, regardless of the size or importance of either.

CONSIDERATIONS/QUALIFIERS

1. Public or private wells occur downstream of the wetland.
2. Potential exists for public or private wells downstream of the wetland.
3. Wetland is underlain by stratified drift.
4. Gravel or sandy soils present in or adjacent to the wetland.
5. Fragipan does not occur in the wetland.
6. Fragipan, impervious soils, or bedrock does occur in the wetland.
7. Wetland is associated with a perennial or intermittent watercourse.
8. Signs of groundwater recharge are present or piezometer data demonstrates recharge.
9. Wetland is associated with a watercourse but lacks a defined outlet or contains a constricted outlet.
10. Wetland contains only an outlet, no inlet.
11. Groundwater quality of stratified drift aquifer within or downstream of wetland meets drinking water standards.
12. Quality of water associated with the wetland is high.
13. Signs of groundwater discharge are present (e.g., springs).
14. Water temperature suggests it is a discharge site.
15. Wetland shows signs of variable water levels.
16. Piezometer data demonstrates discharge.
17. Other

FLOODFLOW ALTERATION (Storage & Desynchronization) — This function considers the effectiveness of the wetland in reducing flood damage by water retention for prolonged periods following precipitation events and the gradual release of floodwaters. It adds to the stability of the wetland ecological system or its buffering characteristics and provides social or economic value relative to erosion and/or flood prone areas.

CONSIDERATIONS/QUALIFIERS

1. Area of this wetland is large relative to its watershed.
2. Wetland occurs in the upper portions of its watershed.
3. Effective flood storage is small or non-existent upslope of or above the wetland.
4. Wetland watershed contains a high percent of impervious surfaces.
5. Wetland contains hydric soils which are able to absorb and detain water.
6. Wetland exists in a relatively flat area that has flood storage potential.
7. Wetland has an intermittent outlet, ponded water, or signs are present of variable water level.
8. During flood events, this wetland can retain higher volumes of water than under normal or average rainfall conditions.
9. Wetland receives and retains overland or sheet flow runoff from surrounding uplands.
10. In the event of a large storm, this wetland may receive and detain excessive flood water from a nearby watercourse.
11. Valuable properties, structures, or resources are located in or near the floodplain downstream from the wetland.
12. The watershed has a history of economic loss due to flooding.
13. This wetland is associated with one or more watercourses.
14. This wetland watercourse is sinuous or diffuse.
15. This wetland outlet is constricted.
16. Channel flow velocity is affected by this wetland.
17. Land uses downstream are protected by this wetland.
18. This wetland contains a high density of vegetation.
19. Other

FISH AND SHELLFISH HABITAT (FRESHWATER) — This function considers the effectiveness of seasonal or permanent watercourses associated with the wetland in question for fish and shellfish habitat.

CONSIDERATIONS/QUALIFIERS

1. Forest land dominant in the watershed above this wetland.
2. Abundance of cover objects present.

STOP HERE IF THIS WETLAND IS NOT ASSOCIATED WITH A WATERCOURSE

3. Size of this wetland is able to support large fish/shellfish populations.
4. Wetland is part of a larger, contiguous watercourse.
5. Wetland has sufficient size and depth in open water areas so as not to freeze solid and retain some open water during winter.
6. Stream width (bank to bank) is more than 50 feet.
7. Quality of the watercourse associated with this wetland is able to support healthy fish/shellfish populations.
8. Streamside vegetation provides shade for the watercourse.
9. Spawning areas are present (submerged vegetation or gravel beds).
10. Food is available to fish/shellfish populations within this wetland.
11. Barrier(s) to anadromous fish (such as dams, including beaver dams, waterfalls, road crossing) are absent from the stream reach associated with this wetland.
12. Evidence of fish is present.
13. Wetland is stocked with fish.
14. The watercourse is persistent.
15. Man-made streams are absent.
16. Water velocities are not too excessive for fish usage.
17. Defined stream channel is present.
18. Other

Although the above example refers to freshwater wetlands, it can also be adapted for marine ecosystems. The following is an example provided by the National Marine Fisheries Service (NMFS) of an adaptation for the fish and shellfish function.

FISH AND SHELLFISH HABITAT (MARINE) — This function considers the effectiveness of wetlands, embayments, tidal flats, vegetated shallows, and other environments in supporting marine resources such as fish, shellfish, marine mammals, and sea turtles.

CONSIDERATIONS/QUALIFIERS

1. Special aquatic sites (tidal marsh, mud flats, eelgrass beds) are present.
2. Suitable spawning habitat is present at the site or in the area.
3. Commercially or recreationally important species are present or suitable habitat exists.
4. The wetland/waterway supports prey for higher trophic level marine organisms.
5. The waterway provides migratory habitat for anadromous fish.
6. Essential fish habitat, as defined by the 1996 amendments to the Magnuson-Stevens Fishery & Conservation Act, is present (consultation with NMFS may be necessary).
7. Other

SEDIMENT/TOXICANT/PATHOGEN RETENTION — This function reduces or prevents degradation of water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants, or pathogens in runoff water from surrounding uplands or upstream eroding wetland areas.

CONSIDERATIONS/QUALIFIERS

1. Potential sources of excess sediment are in the watershed above the wetland.
2. Potential or known sources of toxicants are in the watershed above the wetland.
3. Opportunity for sediment trapping by slow moving water or deepwater habitat are present in this wetland.
4. Fine grained mineral or organic soils are present.
5. Long duration water retention time is present in this wetland.
6. Public or private water sources occur downstream.
7. The wetland edge is broad and intermittently aerobic.
8. The wetland is known to have existed for more than 50 years.
9. Drainage ditches have not been constructed in the wetland.

STOP HERE IF WETLAND IS NOT ASSOCIATED WITH A WATERCOURSE.

10. Wetland is associated with an intermittent or perennial stream or a lake.
11. Channelized flows have visible velocity decreases in the wetland.
12. Effective floodwater storage in wetland is occurring. Areas of impounded open water are present.
13. No indicators of erosive forces are present. No high water velocities are present.
14. Diffuse water flows are present in the wetland.
15. Wetland has a high degree of water and vegetation interspersion.
16. Dense vegetation provides opportunity for sediment trapping and/or signs of sediment accumulation by dense vegetation is present.
17. Other

NUTRIENT REMOVAL/RETENTION/TRANSFORMATION — This function considers the effectiveness of the wetland as a trap for nutrients in runoff water from surrounding uplands or contiguous wetlands and the ability of the wetland to process these nutrients into other forms or trophic levels. One aspect of this function is to prevent ill effects of nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

CONSIDERATIONS/QUALIFIERS

1. Wetland is large relative to the size of its watershed.
2. Deep water or open water habitat exists.
3. Overall potential for sediment trapping exists in the wetland.

4. Potential sources of excess nutrients are present in the watershed above the wetland.
5. Wetland saturated for most of the season. Ponded water is present in the wetland.
6. Deep organic/sediment deposits are present.
7. Slowly drained fine grained mineral or organic soils are present.
8. Dense vegetation is present.
9. Emergent vegetation and/or dense woody stems are dominant.
10. Opportunity for nutrient attenuation exists.
11. Vegetation diversity/abundance sufficient to utilize nutrients.

STOP HERE IF WETLAND IS NOT ASSOCIATED WITH A WATERCOURSE.

12. Waterflow through this wetland is diffuse.
13. Water retention/detention time in this wetland is increased by constricted outlet or thick vegetation.
14. Water moves slowly through this wetland.
15. Other

PRODUCTION EXPORT (Nutrient) — This function evaluates the effectiveness of the wetland to produce food or usable products for humans or other living organisms.

CONSIDERATIONS/QUALIFIERS

1. Wildlife food sources grow within this wetland.
2. Detritus development is present within this wetland
3. Economically or commercially used products found in this wetland.
4. Evidence of wildlife use found within this wetland.
5. Higher trophic level consumers are utilizing this wetland.
6. Fish or shellfish develop or occur in this wetland.
7. High vegetation density is present.
8. Wetland exhibits high degree of plant community structure/species diversity.
9. High aquatic vegetative diversity/abundance is present.
10. Nutrients exported in wetland watercourses (permanent outlet present).
11. "Flushing" of relatively large amounts of organic plant material occurs from this wetland.
12. Wetland contains flowering plants that are used by nectar-gathering insects.
13. Indications of export are present.
14. High production levels occurring, however, no visible signs of export (assumes export is attenuated).
15. Other

SEDIMENT/SHORELINE STABILIZATION — This function considers the effectiveness of a wetland to stabilize streambanks and shorelines against erosion.

CONSIDERATIONS/QUALIFIERS

1. Indications of erosion or siltation are present.
2. Topographical gradient is present in wetland.
3. Potential sediment sources are present up-slope.
4. Potential sediment sources are present upstream.
5. No distinct shoreline or bank is evident between the waterbody and the wetland or upland.
6. A distinct step between the open waterbody or stream and the adjacent land exists (i.e., sharp bank) with dense roots throughout.
7. Wide wetland (>10') borders watercourse, lake, or pond.
8. High flow velocities in the wetland.
9. The watershed is of sufficient size to produce channelized flow.
10. Open water fetch is present.
11. Boating activity is present.
12. Dense vegetation is bordering watercourse, lake, or pond.
13. High percentage of energy-absorbing emergents and/or shrubs border a watercourse, lake, or pond.
14. Vegetation is comprised of large trees and shrubs that withstand major flood events or erosive incidents and stabilize the shoreline on a large scale (feet).
15. Vegetation is comprised of a dense resilient herbaceous layer that stabilizes sediments and the shoreline on a small scale (inches) during minor flood events or potentially erosive events.
16. Other

WILDLIFE HABITAT — This function considers the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered. Species lists of observed and potential animals should be included in the wetland assessment report.[1]

CONSIDERATIONS/QUALIFIERS

1. Wetland is not degraded by human activity.
2. Water quality of the watercourse, pond, or lake associated with this wetland meets or exceeds Class A or B standards.
3. Wetland is not fragmented by development.
4. Upland surrounding this wetland is undeveloped.
5. More than 40% of this wetland edge is bordered by upland wildlife habitat (e.g., brushland, woodland, active farmland, or idle land) at least 500 feet in width.
6. Wetland is contiguous with other wetland systems connected by a watercourse or lake.
7. Wildlife overland access to other wetlands is present.
8. Wildlife food sources are within this wetland or are nearby.
9. Wetland exhibits a high degree of interspersion of vegetation classes and/or open water.
10. Two or more islands or inclusions of upland within the wetland are present.
11. Dominant wetland class includes deep or shallow marsh or wooded swamp.
12. More than three acres of shallow permanent open water (less than 6.6 feet deep), including streams in or adjacent to wetland, are present.
13. Density of the wetland vegetation is high.
14. Wetland exhibits a high degree of plant species diversity.
15. Wetland exhibits a high degree of diversity in plant community structure (e.g., tree/shrub/vine/grasses/mosses)
16. Plant/animal indicator species are present. (List species for project)
17. Animal signs observed (tracks, scats, nesting areas, etc.)
18. Seasonal uses vary for wildlife and wetland appears to support varied population diversity/abundance during different seasons.
19. Wetland contains or has potential to contain a high population of insects.
20. Wetland contains or has potential to contain large amphibian populations.
21. Wetland has a high avian utilization or its potential.
22. Indications of less disturbance-tolerant species are present.
23. Signs of wildlife habitat enhancement are present (birdhouses, nesting boxes, food sources, etc.).
24. Other

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[1]In March 1995, a rapid wildlife habitat assessment method was completed by a University of Massachusetts research team with funding and oversight provided by the New England Transportation Consortium. The method is called WEThings (wetland habitat indicators for non-game species). It produces a list of potential wetland-dependent mammal, reptile, and amphibian species that may be present in the wetland. The output is based on observable habitat characteristics documented on the field data form. This method may be used to generate the wildlife species list recommended as backup information to the wetland evaluation form and to augment the considerations. Use of this method should first be coordinated with the Corps project manager. A computer program is also available to expedite this process.

RECREATION (Consumptive and Non-Consumptive) — This value considers the suitability of the wetland and associated watercourses to provide recreational opportunities such as hiking, canoeing, boating, fishing, hunting, and other active or passive recreational activities. Consumptive opportunities consume or diminish the plants, animals, or other resources that are intrinsic to the wetland. Non-consumptive opportunities do not consume or diminish these resources of the wetland.

CONSIDERATIONS/QUALIFIERS

1. Wetland is part of a recreation area, park, forest, or refuge.
2. Fishing is available within or from the wetland.
3. Hunting is permitted in the wetland.
4. Hiking occurs or has potential to occur within the wetland.
5. Wetland is a valuable wildlife habitat.
6. The watercourse, pond, or lake associated with the wetland is unpolluted.
7. High visual/aesthetic quality of this potential recreation site.
8. Access to water is available at this potential recreation site for boating, canoeing, or fishing.
9. The watercourse associated with this wetland is wide and deep enough to accommodate canoeing and/or non-powered boating.
10. Off-road public parking available at the potential recreation site.
11. Accessibility and travel ease is present at this site.
12. The wetland is within a short drive or safe walk from highly populated public and private areas.
13. Other

EDUCATIONAL/SCIENTIFIC VALUE — This value considers the suitability of the wetland as a site for an "outdoor classroom" or as a location for scientific study or research.

CONSIDERATIONS/QUALIFIERS

1. Wetland contains or is known to contain threatened, rare, or endangered species.
2. Little or no disturbance is occurring in this wetland.
3. Potential educational site contains a diversity of wetland classes which are accessible or potentially accessible.
4. Potential educational site is undisturbed and natural.
5. Wetland is considered to be a valuable wildlife habitat.
6. Wetland is located within a nature preserve or wildlife management area.
7. Signs of wildlife habitat enhancement present (bird houses, nesting boxes, food sources, etc.).
8. Off-road parking at potential educational site suitable for school bus access in or near wetland.
9. Potential educational site is within safe walking distance or a short drive to schools.
10. Potential educational site is within safe walking distance to other plant communities.
11. Direct access to perennial stream at potential educational site is available.
12. Direct access to pond or lake at potential educational site is available.
13. No known safety hazards exist within the potential educational site.
14. Public access to the potential educational site is controlled.
15. Handicap accessibility is available.
16. Site is currently used for educational or scientific purposes.
17. Other

UNIQUENESS/HERITAGE — This value considers the effectiveness of the wetland or its associated waterbodies to provide certain special values. These may include archaeological sites, critical habitat for endangered species, its overall health and appearance, its role in the ecological system of the area, its relative importance as a typical wetland class for this geographic location. These functions are clearly valuable wetland attributes relative to aspects of public health, recreation, and habitat diversity.

CONSIDERATIONS/QUALIFIERS

1. Upland surrounding wetland is primarily urban.
2. Upland surrounding wetland is developing rapidly.
3. More than 3 acres of shallow permanent open water (less than 6.6 feet deep), including streams, occur in wetlands.
4. Three or more wetland classes are present.
5. Deep and/or shallow marsh or wooded swamp dominate.
6. High degree of interspersion of vegetation and/or open water occur in this wetland.
7. Well-vegetated stream corridor (15 feet on each side of the stream) occurs in this wetland.
8. Potential educational site is within a short drive or a safe walk from schools.
9. Off-road parking at potential educational site is suitable for school buses.
10. No known safety hazards exist within this potential educational site.
11. Direct access to perennial stream or lake exists at potential educational site.
12. Two or more wetland classes are visible from primary viewing locations.
13. Low-growing wetlands (marshes, scrub-shrub, bogs, open water) are visible from primary viewing locations.
14. Half an acre of open water or 200 feet of stream is visible from the primary viewing locations.
15. Large area of wetland is dominated by flowering plants or plants that turn vibrant colors in different seasons.
16. General appearance of the wetland visible from primary viewing locations is unpolluted and/or undisturbed.
17. Overall view of the wetland is available from the surrounding upland.
18. Quality of the water associated with the wetland is high.
19. Opportunities for wildlife observations are available.
20. Historical buildings are found within the wetland.
21. Presence of pond or pond site and remains of a dam occur within the wetland.
22. Wetland is within 50 yards of the nearest perennial watercourse.
23. Visible stone or earthen foundations, berms, dams, standing structures, or associated features occur within the wetland.
24. Wetland contains critical habitat for a state- or federally-listed threatened or endangered species.
25. Wetland is known to be a study site for scientific research.
26. Wetland is a natural landmark or recognized by the state natural heritage inventory authority as an exemplary natural community.
27. Wetland has local significance because it serves several functional values.
28. Wetland has local significance because it has biological, geological, or other features that are locally rare or unique.
29. Wetland is known to contain an important archaeological site.
30. Wetland is hydrologically connected to a state or federally designated scenic river.
31. Wetland is located in an area experiencing a high wetland loss rate.
32. Other

VISUAL QUALITY/AESTHETICS — This value considers the visual and aesthetic quality or usefulness of the wetland.

CONSIDERATIONS/QUALIFIERS

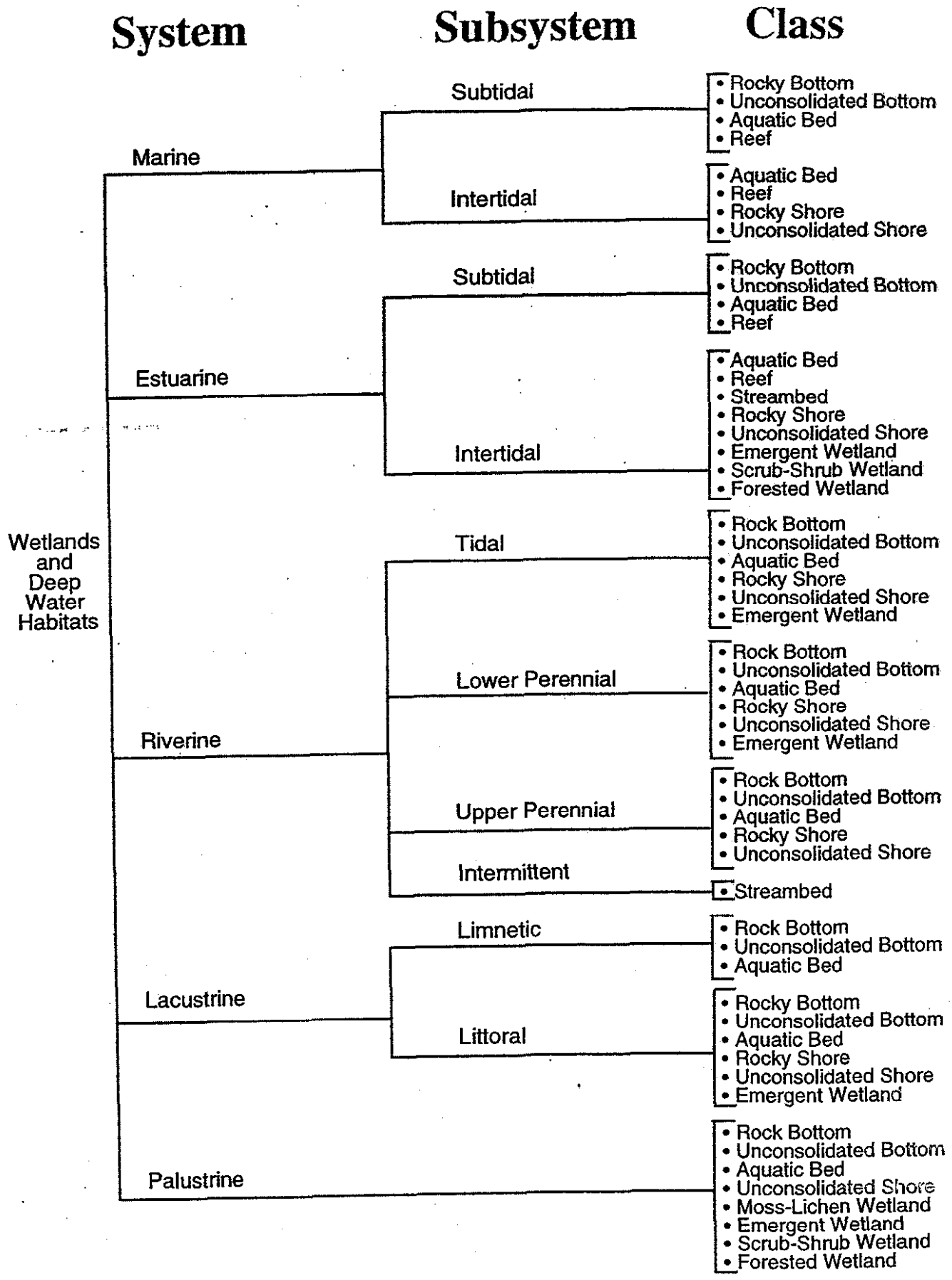
1. Multiple wetland classes are visible from primary viewing locations.
2. Emergent marsh and/or open water are visible from primary viewing locations.
3. A diversity of vegetative species is visible from primary viewing locations.
4. Wetland is dominated by flowering plants or plants that turn vibrant colors in different seasons.
5. Land use surrounding the wetland is undeveloped as seen from primary viewing locations.
6. Visible surrounding land use form contrasts with wetland.
7. Wetland views absent of trash, debris, and signs of disturbance.
8. Wetland is considered to be a valuable wildlife habitat.
9. Wetland is easily accessed.
10. Low noise level at primary viewing locations.
11. Unpleasant odors absent at primary viewing locations.
12. Relatively unobstructed sight line exists through wetland.
13. Other

ENDANGERED SPECIES HABITAT — This value considers the suitability of the wetland to support threatened or endangered species.

ES

CONSIDERATIONS/QUALIFIERS

1. Wetland contains or is known to contain threatened or endangered species.
2. Wetland contains critical habitat for a state or federally listed threatened or endangered species.


System
Subsystem
Class
Wetlands and Deep Water Habitats
Marine
Subtidal
• Rocky Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Reef
Intertidal
• Aquatic Bed
• Reef
• Rocky Shore
• Unconsolidated Shore
Estuarine
Subtidal
• Rocky Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Reef
Intertidal
• Aquatic Bed
• Reef
• Streambed
• Rocky Shore
• Unconsolidated Shore
• Emergent Wetland
• Scrub-Shrub Wetland
• Forested Wetland
Riverine
Tidal
• Rock Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Rocky Shore
• Unconsolidated Shore
• Emergent Wetland
Lower Perennial
• Rock Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Rocky Shore
• Unconsolidated Shore
• Emergent Wetland
Upper Perennial
• Rock Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Rocky Shore
• Unconsolidated Shore
Intermittent
• Streambed
Lacustrine
Limnetic
• Rock Bottom
• Unconsolidated Bottom
• Aquatic Bed
Littoral
• Rocky Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Rocky Shore
• Unconsolidated Shore
• Emergent Wetland
Palustrine
• Rock Bottom
• Unconsolidated Bottom
• Aquatic Bed
• Unconsolidated Shore
• Moss-Lichen Wetland
• Emergent Wetland
• Scrub-Shrub Wetland
• Forested Wetland

Wetland Function-Value Evaluation Form

Total area of wetland_____ Human made?_____ Is wetland part of a wildlife corridor?_____ or a "habitat island"?_____

Adjacent land use_____ Distance to nearest roadway or other development_____

Dominant wetland systems present_____ Contiguous undeveloped buffer zone present_____

Is the wetland a separate hydraulic system?_____ If not, where does the wetland lie in the drainage basin?_____

How many tributaries contribute to the wetland?_____Wildlife & vegetation diversity/abundance (see attached list)

Wetland I.D._____

Latitude_____ Longitude_____

Prepared by:_____ Date_____

Wetland Impact:
Type_____Area_____

Evaluation based on:
Office_____ Field_____

Corps manual wetland delineation completed? Y_____ N_____

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)*	Principal Function(s)/Value(s)	Comments
Groundwater Recharge/Discharge					
Floodflow Alteration					
Fish and Shellfish Habitat					
Sediment/Toxicant Retention					
Nutrient Removal					
Production Export					
Sediment/Shoreline Stabilization					
Wildlife Habitat					
Recreation					
Educational/Scientific Value					
Uniqueness/Heritage					
Visual Quality/Aesthetics					
ES Endangered Species Habitat					
Other					

Notes:

*Refer to backup list of numbered considerations.

Wetland I.D.	Total Acres	Impacted Acres

Symbols Key

- Groundwater Recharge/ Discharge
- Floodflow Alteration (Storage & Desynchronization)
- Fish and Shellfish Habitat
- Sediment/Toxicant Retention
- Nutrient Removal/ Retention/Transformation
- Production Export (Nutrient)
- Sediment/Shoreline Stabilization
- Wildlife Habitat
- Recreation(Consumptive & Non-Consumptive)
- Educational/Scientific Value
- Uniqueness/Heritage
- Visual Quality/Aesthetics
- ES Endangered Species

APPENDIX G

WETHINGS
POTENTIAL INDICATOR SPECIES

TABLE G-1

WETHINGS
POTENTIAL INDICATOR SPECIES

Common Name	Species
Amphibians	
Northern Spring Peeper	*Hyla crucifer*
Bullfrog	*Rana catesbeiana*
Pickerel Frog	*Rana palustris*
Green Frog	*Rana clamitans*
Birds	
Mallard	*Anas platyrhynchos*
Yellow Warbler	*Dendroica petechia*
Gray Catbird	*Dumetella carlinensis*
Common Yellowthroat	*Geothlypis trichas*
Song Sparrow	*Melospiza melodia*
Red-winged Blackbird	*Agelaius phoeniceus*
American Goldfinch	*Carduelis tristis*

APPENDIX H

WETHINGS
STANDARDIZED DATA FORM

FIELD DATA FORM FOR THE WEThings METHOD
SECTION A
CHARACTERIZATION OF WETLAND SYSTEM

Site _____ Technician _____ Date _____

A1. Where is the wetland located? Town _____ County _____ State _____

Geographic area:

- ☐ Northern Vermont
- ☐ Northern New Hampshire
- ☐ Inland Maine
- ☐ Central Vermont
- ☐ Central New Hampshire
- ☐ Transitional Maine
- ☐ Southern Vermont
- ☐ Southern New Hampshire
- ☐ Coastal Maine
- ☐ Massachusetts (except southeast, Cape Cod and islands)
- ☐ Southeastern Massachusetts, Cape Cod and islands
- ☐ Connecticut
- ☐ Rhode Island

A2. In which of the following landforms is the wetland located?

- ☐ Calcareous valley
- ☐ Major river valley
- ☐ Atlantic Coastal Plain
- ☐ Major forested wetland system
- ☐ Glacial sand deposit
- ☐ Other (please describe) _____

A3. How many wetland cover types are present? _____

A4. How many upland cover types are present? _____

A5. Cowardin classification of all wetland cover types present:

Cover type #	System	Subsystem	Class	Subclass	Descriptors

A6. List all upland cover types present:

Cover type #	Description

FIELD DATA FORM FOR THE WEThings METHOD
SECTION A
CHARACTERIZATION OF WETLAND SYSTEM

Site Technician Date

A7. Draw a diagram showing the relationship between wetland and upland cover types and areas of open water. Number each cover type to correspond with data sheets. Include some measure of scale. Label the diagram as fully as possible.

FIELD DATA FORM FOR THE WEThings METHOD
SECTION A
CHARACTERIZATION OF WETLAND SYSTEM

Site Technician Date

Answer questions A8 and A9 for forested and scrub-shrub cover types only.

A8. List the cover type number(s) from A7 that are at least 100 m in width: _____

A9. List the cover type number(s) from A7 that border a river or stream channel for at least 15 m in length: _____

A10. Landscape features with approximate distances from the wetland:

	100 m	200 m	300 m	400 m	500 m	1 km
Upland forest(s)	☐	☐	☐			
Deciduous or mixed upland forest(s)	☐	☐	☐	☐	☐	☐
Open canopy, upland sandy soil	☐	☐	☐			
Permanently flooded wetland(s)	☐	☐	☐	☐	☐	
Non-permanently flooded wetland(s)	☐	☐	☐	☐	☐	☐
Palustrine forested wetland(s)	☐	☐	☐			
Lacustrine wetland(s)	☐	☐	☐	☐		
Permanently/seasonally flooded wetland(s)	☐	☐	☐			

FIELD DATA FORM FOR THE WEThings METHOD
SECTION B
CHARACTERIZATION OF INDIVIDUAL WETLAND COVER TYPES

Site _____ Wetland cover type # _____ Technician _____ Date _____

B1. Cowardin classification of wetland cover type: _____

VEGETATION

B2. Wetland vegetation:

Type	Present	% cover	Dominant species
Submergents	☐	_____	_____
Surface plants	☐	_____	_____
Persistent emergents	☐	_____	_____
Non-persistent emergents	☐	_____	_____
Ground cover (moss lichen)	☐	_____	_____
Shrubs	☐	_____	_____
Trees	☐	_____	_____
No vegetation	☐	_____	_____

B3. Maximum depth of mosses: _____ cm

B4. Tree canopy closure over cover type: ☐ Open ☐ Partial ☐ Closed

HYDROLOGY

B5. Hydrologic classification of cover type (check one):

☐ Permanently flooded ☐ Saturated
☐ Intermittently exposed ☐ Temorarily flooded
☐ Semi-permanently flooded ☐ Intermittently flooded
☐ Seasonally flooded ☐ Artificially flooded

B6. Water depth:

Palustrine or Lacustrine System	Riverine System
Average _____ m	Runs _____ m
Maximum _____ m	Riffles _____ m
Max. at low water _____ m	Pools _____ m
	Max. at low water _____ m

B7. If surface waters are not present, what is the depth to groundwater? _____ cm

B8. Is the cover type adjacent to or hydrologically connected with deep water systems? ☐ Yes ☐ No

FIELD DATA FORM FOR THE WEThings METHOD
SECTION B
CHARACTERIZATION OF INDIVIDUAL WETLAND COVER TYPES

Site _____ Wetland cover type # _____ Technician _____ Date _____

B9. Characterization of water flow (check one):

☐ All fast water ☐ Laminar flow ☐ Intermittent flow
☐ Complex of rapids and pools ☐ Trickle of seeps or springs ☐ No flow

B10. In Riverine system, what is the discharge rate?

☐ Less than 0.1 cm ☐ Between 0.1 and 30 cm ☐ More than 30 cm

B11. Are there areas of quiet shallow water present in the cover type? ☐ Yes ☐ No

B12. If the wetland cover type is not permanently flooded, at what time of year does it flood?

☐ Spring ☐ Summer ☐ Fall ☐ Winter ☐ Not seasonal ☐ Do not know

B13. Are there areas that do not freeze to the bottom in winter? ☐ Yes ☐ No ☐ Do not know

B14. In Palustrine system, are vernal ponds present? ☐ Yes ☐ No

SUBSTRATE AND STRUCTURAL COMPONENTS

B15. Substrate in wetland cover type (check all that apply):

☐ Peat ☐ Silt ☐ Gravel ☐ Bedrock
☐ Muck/mud ☐ Sand ☐ Cobbles/rocks
☐ Clay ☐ Loam ☐ Boulders

B16. Is moist mull humus present at the water's edge? ☐ Yes ☐ No

B17. Structural components are located (check all that apply):

☐ Under water's surface ☐ Within 2 m of water's edge
☐ At the water's surface ☐ More than 2 m from water
☐ Above water's surface ☐ No structural components present

Answer questions B18-22 according to boxes checked in question B17.

B18. Structural components present under water's surface:

☐ Organic debris ☐ Crevices ☐ Sloping sand
☐ Rocks ☐ Overhanging dirt banks ☐ Mud banks
☐ Flat rocks

FIELD DATA FORM FOR THE WEThings METHOD
SECTION B
CHARACTERIZATION OF INDIVIDUAL WETLAND COVER TYPES

Site	Wetland cover type #	Technician	Date

B19. Structural components present at water's surface:

- ☐ Organic debris
- ☐ Rocks
- ☐ Flat rocks
- ☐ Crevices
- ☐ Overhanging dirt banks
- ☐ Sloping sand
- ☐ Mud banks
- ☐ Tussocks
- ☐ Sphagnum hummocks
- ☐ Shrubs
- ☐ Beaver lodges/dams

B20. Structural components present above water's surface:

- ☐ Organic debris
- ☐ Rocks
- ☐ Flat rocks
- ☐ Crevices
- ☐ Overhanging dirt banks
- ☐ Tussocks
- ☐ Sphagnum hummocks
- ☐ Shrubs

B21. Structural components present within 2 m of water's edge:

- ☐ Organic debris
- ☐ Rocks
- ☐ Flat rocks
- ☐ Crevices
- ☐ Tussocks
- ☐ Sphagnum hummocks
- ☐ Shrubs
- ☐ Beaver lodges/dams

B22. Structural components present more than 2 m from water's edge:

- ☐ Organic debris
- ☐ Rocks
- ☐ Flat rocks
- ☐ Crevices
- ☐ Tussocks
- ☐ Sphagnum hummocks
- ☐ Low dense vegetation
- ☐ Shrubs

Answer questions B23-B27 if "organic debris" was checked in any of the corresponding questions, B18-B22, above.

B23. Type(s) of organic debris under water's surface:

- ☐ Leaf litter
- ☐ Logs
- ☐ Boards
- ☐ Stumps
- ☐ Branches
- ☐ Overhanging branches

B24. Type(s) of organic debris at the water's surface:

- ☐ Leaf litter
- ☐ Logs
- ☐ Water soaked/ rotten logs
- ☐ Boards
- ☐ Stumps
- ☐ Branches
- ☐ Overhanging branches

FIELD DATA FORM FOR THE WEThings METHOD
SECTION B
CHARACTERIZATION OF INDIVIDUAL WETLAND COVER TYPES

Site	Wetland cover type #	Technician	Date

B25. Type(s) of organic debris above water's surface:

- ☐ Leaf litter
- ☐ Boards
- ☐ Branches
- ☐ Logs
- ☐ Stumps
- ☐ Overhanging branches
- ☐ Water-soaked/ rotten logs
- ☐ Water soaked/ rotten stumps

B26. Type(s) of organic debris within 2 m of water's edge:

- ☐ Leaf litter
- ☐ Overhanging branches
- ☐ Logs
- ☐ Mats of algae or other vegetation (may condense to Algae mats)
- ☐ Stumps

B27. Type(s) of organic debris more than 2 m from water's edge:

- ☐ Leaf litter
- ☐ Water soaked/ rotten stumps
- ☐ Logs
- ☐ Branches
- ☐ Stumps

B28. Sloping sand is: ☐ Absent ☐ Limited ☐ Abundant

B29. What is the degree of interspersion of structural features and standing water?

☐ Low ☐ Moderate ☐ High

WATER QUALITY

B30. Water salinity: ☐ Freshwater ☐ Brackish with freshwater influx ☐ Predominantly saline

B31. What is the water pH? ☐ Less than 6 ☐ Between 6–7.4 ☐ Greater than 7.4

B32. Is the water oligotrophic? ☐ Yes ☐ No

B33. Water color: ☐ Clear ☐ Tea-colored ☐ Murky ☐ Muddy

B34. Are any of the following types of disturbances present? (check all that apply)

- ☐ Algal blooms
- ☐ Urbanization
- ☐ Chemical pollutants
- ☐ None of the above
- ☐ High level of recreational activity
- ☐ Other (please describe) _____

FIELD DATA FORM FOR THE WEThings METHOD
SECTION B
CHARACTERIZATION OF INDIVIDUAL WETLAND COVER TYPES

Site	Wetland cover type #	Technician	Date

WETLAND SIZE / PHYSICAL CHARACTERIZATION

Answer questions B35–B37 for Lacustrine systems only

B35. Are wave-formed shorelines present? ☐ Yes ☐ No

B36. What is the wetland size? ☐ Less than 8 ha ☐ Greater than 8 ha

B37. For wetland greater than 8 ha, are irregular shorelines present? ☐ Yes ☐ No

Answer questions B38–B42 for Riverine systems only.

B38. Is there more than 0.8 km of stream reach present? ☐ Yes ☐ No

B39. What is the stream gradient? ☐ Less than 5% ☐ 5–14 % ☐ At least 15%

B40. What is the bank height? ☐ Less than 0.2 m ☐ At least 0.2 m

B41. What is the width of the stream/river? ☐ Less than 1 m ☐ At least 1 m

B42. What is the bank slope? ☐ Less than 10 degrees ☐ At least 10 degrees

WILDLIFE OBSERVATIONS

B43. Are fish present? ☐ Yes ☐ No

B44. List wildlife species or their sign observed in this cover type. If invertebrate indicators were used to determine wetland hydrology, list those also.

B45. Additional notes and comments:

FIELD DATA FORM FOR THE WEThings METHOD
SECTION C
CHARACTERIZATION OF INDIVIDUAL UPLAND COVER TYPES

Site | Upland cover type # | Technician | Date

C1. Upland cover type: ☐ Forest ☐ Scrub-shrub ☐ Fields/meadow ☐ Other

Answer questions C2 and C3 for forested upland cover types only.

C2. Which term best describes the forest type?
☐ Deciduous ☐ Mixed deciduous ☐ Evergreen

C3. Forest understory: ☐ Open ☐ Not open

Answer the remaining questions for all upland cover types:

C4. Tree canopy closure over upland cover type: ☐ Open ☐ Partial ☐ Closed

C5. Upland substrate (check all that apply):
☐ Silt ☐ Gravel ☐ Bedrock
☐ Sand ☐ Cobbles/rocks
☐ Loam ☐ Boulders

C6. Are the soils in this cover type well drained? ☐ Yes ☐ No

C7. Structural components present in upland cover type (check all that apply):
☐ Organic debris ☐ Sand piles/banks/dunes ☐ Low dense vegetation
☐ Rocks ☐ Tunnels ☐ Man-made structures

☐ Other (please describe): _____

C8. Type(s) of organic debris present in upland cover type (check all that apply):
☐ Leaf litter ☐ Hollow logs ☐ Boards
☐ Logs ☐ Stumps ☐ Branches

C9. Are large crevices present in rocks or log piles? ☐ Yes ☐ No

C10. Additional notes or comments:

APPENDIX I

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
PERFORMANCE STANDARDS AND SUPPLEMENTAL DEFINITIONS
FOR USE WITH THE 1987 CORPS MANUAL

PROJECT TITLE: TRANSECT: PLOT:

DELINEATOR(S): DATE

VEGETATION

Stratum and Species	Dominance Ratio	Percent Dominance	DOM	NWI Status

OBL	FACW	FAC	Other Hydrophytes	FAC-	FACU	UPL
____	____	____	____	____	____	____

Hydrophyte Subtotal (A): _____ Non-hydrophyte Subtotal (B): _____

PERCENT HYDROPHYTES (100A/A+B): _____

HYDROLOGY

☐ RECORDED DATA:

Stream, lake or tidal gage Identification: _____

Aerial Photograph Identification: _____

Other Identification: _____

☐ NO RECORDED DATA

☒ OBSERVATIONS:

Depth to free water: _____

Depth to saturation (including capillary fringe): _____

Describe altered hydrology: _____

☐ Inundated ☐ Saturated In upper 12 inches ☐ Water Marks ☐ Drift Lines ☐ Sediment Deposits ☐ Drainage Patterns within Wetlands

☐ Other (explain) : Irregularly inundated by stream drainage.

SOIL

Depth	Horizon	Matrix Color	Redoximorphic Features (color, abundance, size & contrast)	USDA Texture: and nodules, concretions, masses, pore linings, restrictive layers, root distribution, soil water, etc.

Hydric Soil indicator(s):

References:

Optional Soil Data:

References:

Taxonomic Subgroup:

Map Unit Name:

Soil Drainage Class:

Depth to Active Water Table:

NTCHs Hydric Soil Criterion:

CONCLUSIONS

	Yes	no		yes	no
Greater than 50% Hydrophytes?	☐	☐	Is This Datapoint Within A Wetland?	☐	☐
Hydric Soils Criterion Met?	☐	☐	Remarks:		
Wetland Hydrology Met?	☐	☐			

PROJECT TITLE: TRANSECT: PLOT: