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OXBOW AREA
WETLAND DELINEATION REPORT AND FUNCTIONS AND VALUES ASSESSMENT

CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE NORTH PROVIDENCE, RHODE ISLAND

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Acronyms and Abbreviations

ACOE	Army Corps of Engineers
CMRPSS	Centredale Manor Restoration Project Superfund Site
DBH	Diameter at breast height
Ft	Foot or feet
GPS	Geographic Positioning System
GIS	Geographic Information System
m	Meter
NRCS	Natural Resources Conservation Service
RIDEM	Rhode Island Department of Environmental Management
RI	Rhode Island
RIGIS	Rhode Island Geographic Information System
USGS	United States Geological Survey

1.0 INTRODUCTION

This report describes wetlands resources at the "Oxbow Area" at the Centredale Manor Restoration Project Superfund Site (CMRPSS) in North Providence, Rhode Island (RI) [see Location Map, Figure 1]. It includes a map of the wetland plant communities, a description of the wetland communities, and a wetland functions and values assessment.

The Oxbow Area, as defined in this report, is a ca. 40 acre area located at the northern end of Lyman Mill Pond and south of Allendale Dam (Figure 2). It is complex of riverine, emergent, scrub-shrub, and forested wetland, and adjacent uplands. Most of the wetlands are within the 100-year floodplain of the Woonassquatucket River.

Available data indicate that flooding of the Woonasquatucket River may have deposited CMRPSS related contamination in and on the surficial soils and sediment in the Oxbow Area. A baseline ecological risk assessment indicates that verminivorous mammal and bird populations occurring within the Oxbow Area appear to be at a substantial risk of harm due to direct exposure to site related contaminants in floodplain soil and prey items (Battelle, 2006a). 2,3,7,8-TCDD is the most substantial contributor to the estimated risks to vermivorous receptors. A baseline human health risk assessment completed for the area indicates that there is a significant cancer risk associated with floodplain soil exposure in the Oxbow Area for passive recreation visitors. Dioxin is the largest single contributor to the incremental cancer risk.

1.1 Environmental Setting

The Woonasquatucket River flows 18 miles from the town of North Smithfield, RI to downtown Providence, RI where it joins the Moshassuck River to form the Providence River, which in turn flows into Narragansett Bay. The river has a drainage area of approximately 51.9 square miles. Together with the Blackstone River to the north, the Woonasquatucket was designated an American Heritage River in 1998.

The Woonasquatucket River is classified as "B1" by the Rhode Island Department of Environmental Management. The reach between the Smithfield waste water treatment facility discharge point in Smithfield to Glenbridge Avenue in Providence is impaired. The river is listed as "not supporting" for fish and wildlife habitat, fish consumption, and primary and secondary recreation. Causes of impairment listed in the draft 2008 Section 303(d) evaluation include metals (mercury, zinc), dioxin, PCBs, low dissolved oxygen, and fecal coliforms (RIDEM, 2008).

Lyman Mill Pond is a shallow ca. 30 acre impoundment on the Woonasquatucket formed by the Lyman Mill Pond dam (or Lymanville Dam). Most of the pond is classified as littoral habitat (i.e. less than 3 meters deep). Much of the bottom is vegetated with beds of water milfoil and pond weeds (Battelle, 2004) and the pond is considered eutrophic. In addition to the Woonasquatucket from the north, the pond receives drainage from Assapumset Brook from the west and an unnamed stream from the east. The pond supports a warmwater fishery.

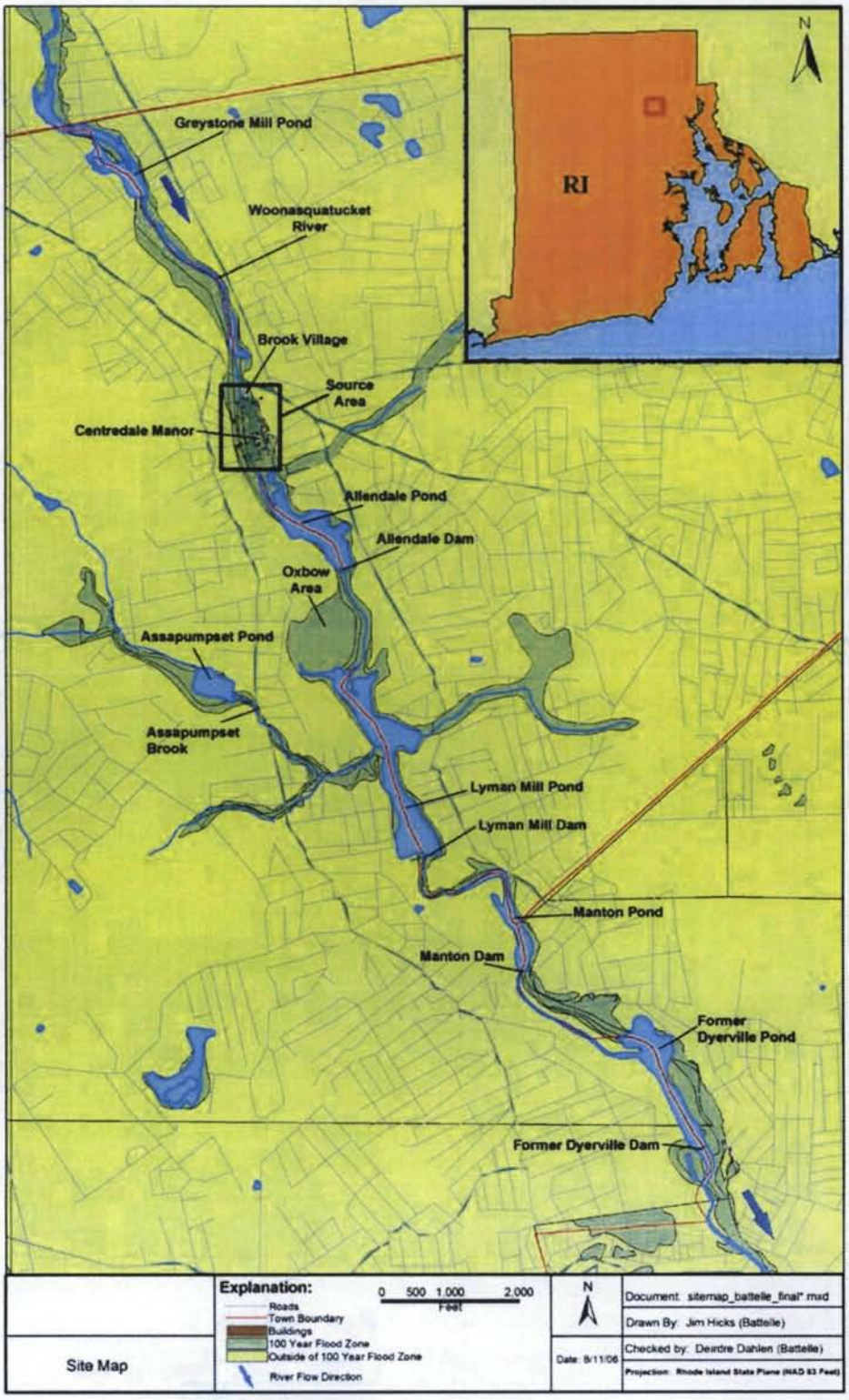

Figure 1: Site Location Map

The Oxbow Area and Lyman Mill Pond are shown in Figure 2. The area surrounding the Lyman Mill Pond and the Oxbow Area is very highly developed, and includes residential, commercial, and industrial properties. The Oxbow Area, however, is among the largest areas of forested riparian habitat remaining along the Woonasquatucket River downstream of the Smithfield town line.

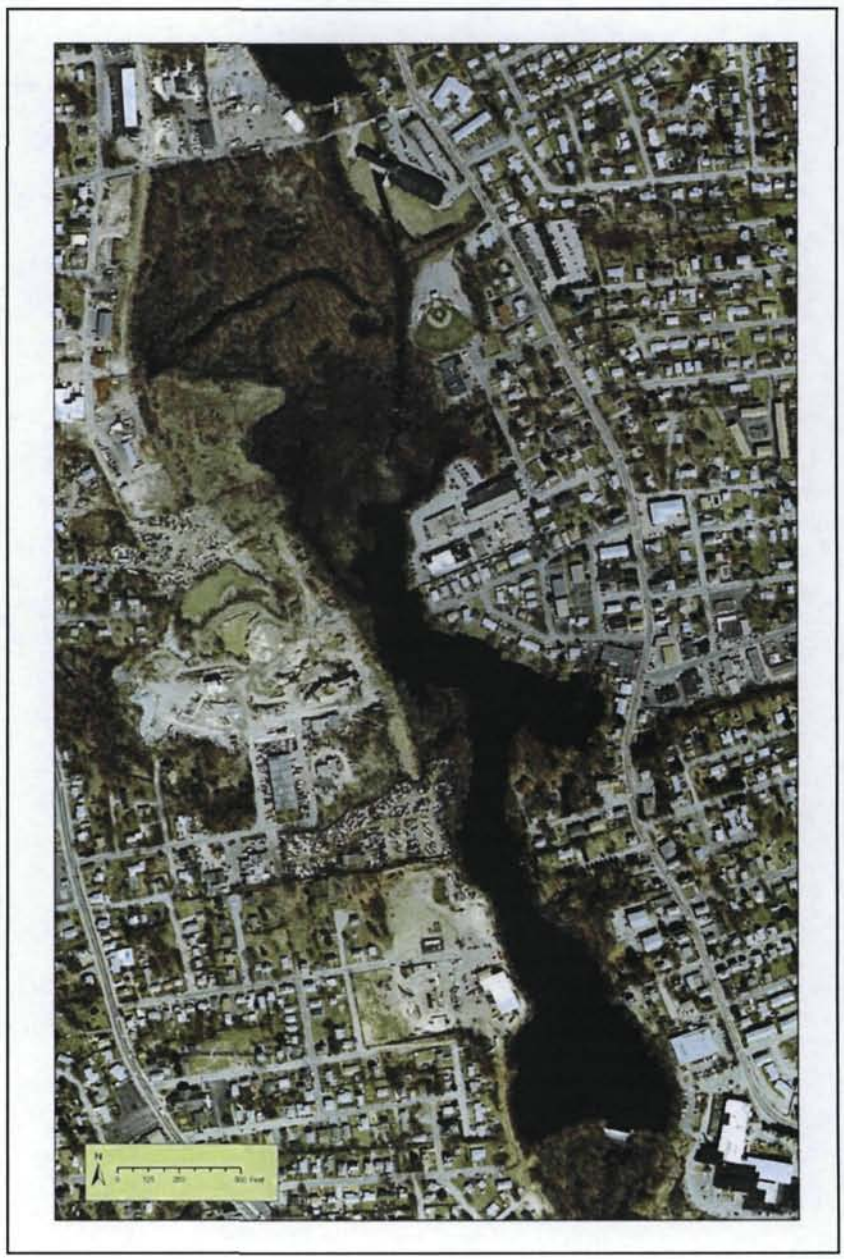

Figure 2. 2003 Aerial Photograph of the Lyman Mill Pond and the Oxbow Area.

1.2 Site History

A review of historic United States Geological Survey (USGS) topographic maps and aerial photographs indicate that the Oxbow Area has been altered significantly since the 1890's. The 1894 USGS 15 minute Providence, RI quadrangle shows the Woonasquatucket River flowing southwest from Allendale Dam and then south/southeast to Lyman Mill Pond (Figure 3). The 1939 USGS 15 minute Providence, RI quadrangle shows an altered configuration of the river channel between Allendale Pond and Lyman Mill Pond (Figure 4). A portion of the original channel was filled and a new channel created which flows south from Allendale to Lyman Mill Pond. The configuration of the main Woonasquatucket channel as shown in the 1939 map is very similar to the current configuration (Figure 2). The northern end of Lyman Mill Pond is shown as open water in the 1894 map. The 1939 map indicates development of some fringing wetland along the old Woonasquatucket channel.

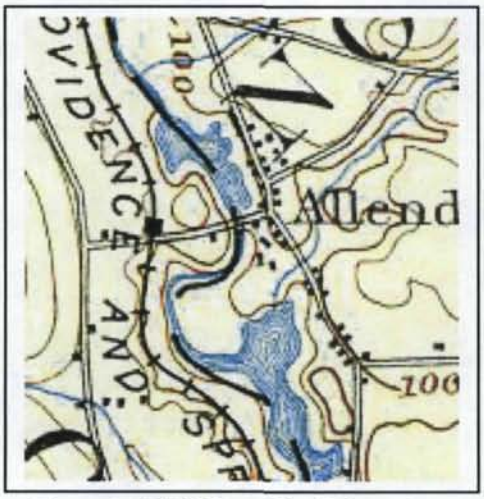

Figure 3: 1894 Map of the Oxbow Area.

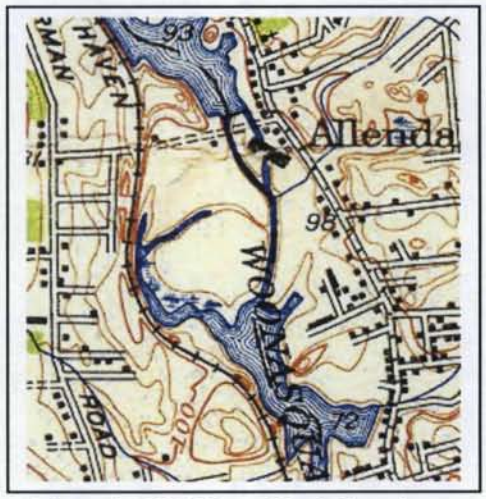

Figure 4: 1939 Map of the Oxbow Area

A 1939 aerial photograph shows the northern portion of the Oxbow Area to be highly disturbed (Figure 5). Other areas appear to be vegetated, perhaps with shrubs or small trees. The photo clearly shows the relocated river channel, remnants of the original channel (the "Oxbow Remnant"), the apparent excavation of an east west channel which nearly connects the old river channel with the new channel, and the excavation of a ponded area near the Woonasquatucket. The next major alternation occurred sometime after 1976 when approximately 3.5 acres of the northwest corner of Lyman Mill Pond were filled (Figure 6). Aerial photos available from the State of Rhode Island Geographic Information System Database (RIGIS) indicate that much of this area was filled between 1976 and 1981, but that the filling did not end until sometime between 1997 and 2002. Aerial photographs indicate two other areas near the Oxbow Area were filled between 1962 and 1975. These include an area along the eastern shoreline of Lyman Mill Pond and a forested area located east of the Woonasquatucket and just south of a present day athletic field. From the available imagery it is uncertain whether the area filled area south of the field was forested wetland or upland habitat.

Figure 5: 1939 Aerial Photograph of the Oxbow Area.

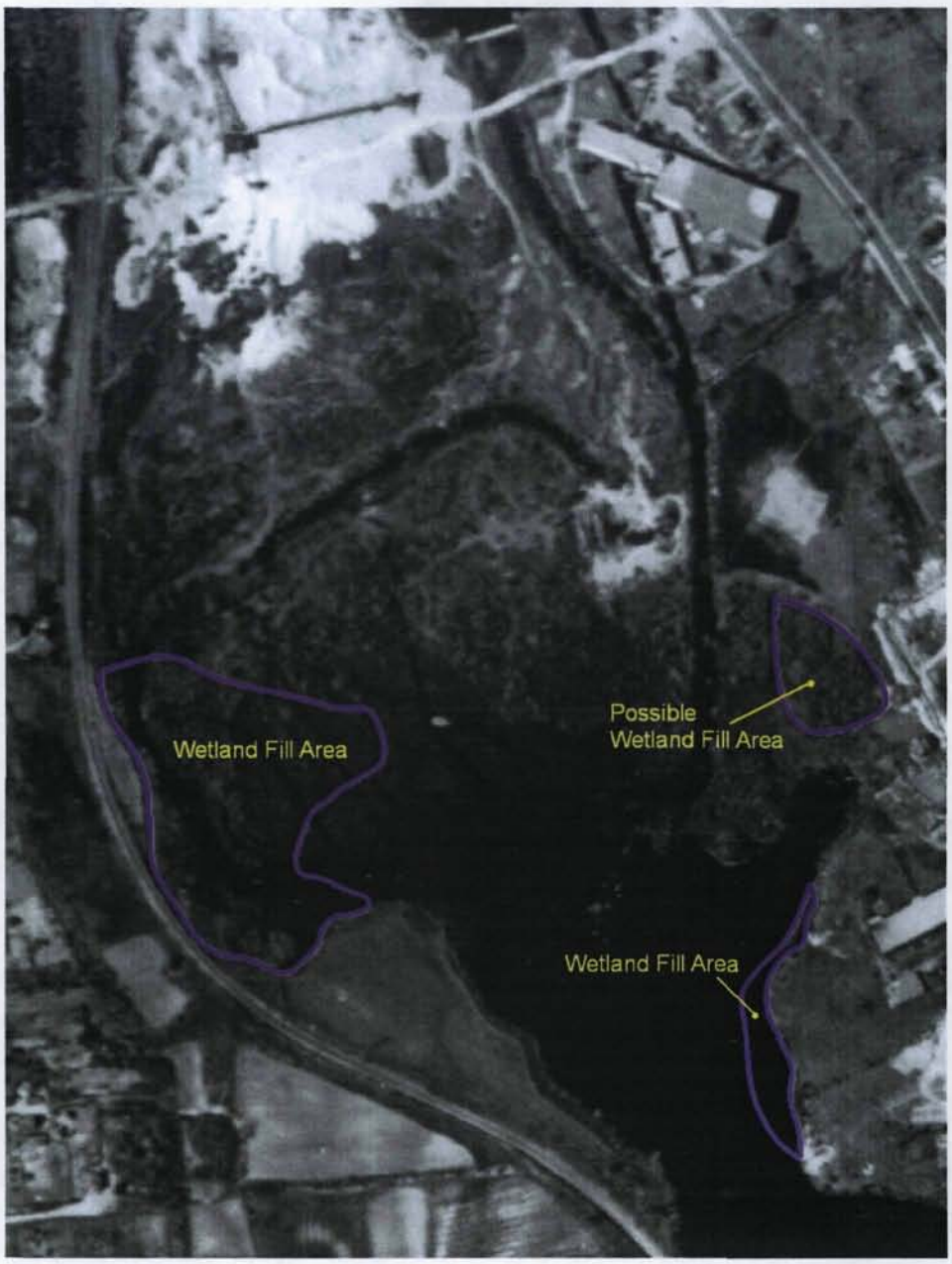

Figure 6: Location of Filled Areas Identified by Inspection of Aerial Photographs dating from 1951 to 2003, Superimposed over the 1939 Aerial Photograph.

1.3 Sources of Existing Soil, Wetland and Floodplain Information

Information on soils and wetland mapping is available from RIGIS and the Rhode Island Office of the Natural Resources Conservation Service (NRCS). The Rhode Island wetland map is not spatially corrected and could not be directly overlain on aerial imagery. Topographical information (2 ft. contours, interpreted from aerial imagery) and one-hundred year flood elevation was available from GIS maps prepared by Battelle.

The NRCS soil map of the study area is provided in Figure 7. The map was published in 1981 and does not reflect some of the filling of wetland which has occurred since that time. Descriptions of soil map unit are available on-line (USDA SCS, 1981). Map unit Aa (Adrian Muck) is a hydric soil.

2.0 METHODS

2.1 Wetlands Delineation

The wetland determination for the Oxbow Area was conducted through interpretation of existing information, including stereo-paired aerial imagery, soil survey information, and field work to delineate wetland boundaries. The wetland boundary was identified with numbered flags. Flag location was determined by GPS using a Trimble XT unit. Reception was improved by using a Trimble Hurricane antennae with a 15 ft. tall telescoping pole. The delineation was conducted primarily in the late summer and fall of 2006.

2.2 Plant Community Mapping and Community Analysis

Wetlands plant communities were classified according to the Cowardin et al. (1979) system (see Table 1). The study area includes the main portion of the Oxbow Area at the northern end of Lyman Mill Pond, the filled area on the western side of the pond (see Figure 6), and the confluence of Assapumpset Brook with Lyman Mill Pond. Mapping was based primarily on interpretation of stereo-paired black and white aerial photographic 9 inch x 9 inch contact prints (flown in 2003) using a stereoscope and field studies. Wetland and deepwater habitats were located based on identifying observable, characteristic photographic signatures evidenced by color (gray-scale), texture, landscape position, vegetation and relative depth of field. Wetlands and waterways were identified by superimposing copies of acetate overlays onto an individual contact print, and lining up the corresponding stereo-pair under the stereoscope to obtain the proper stereo (3-dimensional) image and reflectance. This information was transferred to GIS maps using ArcGis 9.2 software

Groundtruthing was conducted to confirm plant community classification and to gather information for plant community descriptions. Because of difficult site conditions only limited access to scrub-shrub/emergent and emergent communities at the north end of Lyman Mill Pond was possible. Emergent communities at the north end of Lyman Mill

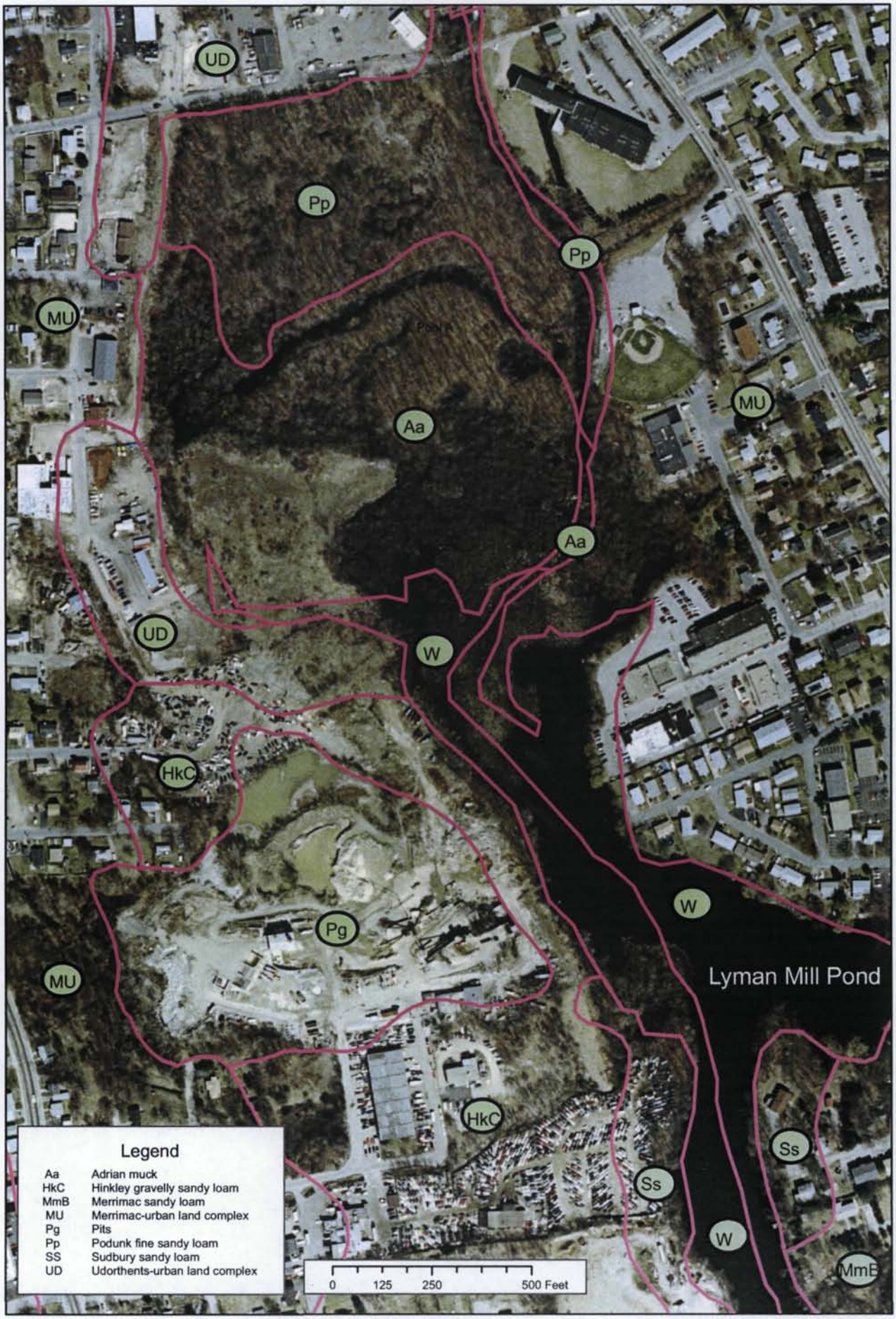

Figure 7: Soil Map of the Oxbow Area

Pond were inspected primarily from a kayak. Meander surveys were augmented by plot data collected along two transects in the northern portion of Oxbow Area. Data was collected from 8 locations using a using a nested plot design with concentric 1 m, 5 m, and 10 m diameter plots for, respectively, herbaceous, shrub and tree strata. Because most of the field work was conducted in late summer or early fall, herbaceous species which flower in the spring and early summer are under represented. The botanical survey was augmented by observations in the spring of 2007. An increment borer was used to determine tree age. Plant species identification was according to Magee and Ahles (1999).

Table 1: Vegetation Classification System for Lyman Mill Pond and the Oxbow Area

LACUSTRINE	
LOW	Open Water. Body of water greater than 20 acres in area, 6.6 ft in depth
LAB1	Aquatic bed vegetation, rooted vascular
LAB2	Aquatic bed vegetation, floating vascular
LEM2	Emergent vegetation, nonpersistent
PALUSTRINE	
POW	Open water, less than 20 acres
PAB1	Aquatic bed vegetation, rooted vascular
PAB2	Aquatic bed vegetation, floating vascular
PEM1	Emergent vegetation, persistent
PEM2	Emergent vegetation, non-persistent
PSS1	Scrub-shrub, broad-leaved deciduous
PF01	Forested, broad-leaved deciduous
POW/PEM1	Mixed open water, persistent emergent
PEM1/PSS1	Mixed persistent emergent, scrub-shrub
PSS1/PF01	Mixed scrub-shrub, forested
RIVERINE	
ROW	Open water contained within a channel
IS	Intermittent Stream
NON-WETLAND	
U-FO	Upland forest
U-S	Upland shrub land
U-G	Upland grassland (old field)
VERNAL POOL	
VP	Vernal Pool or Potential Vernal Pool

2.3 Functions and Values Assessment

The functions and values assessment was based on the Army Corps of Engineers (ACOE) New England Division "Highway Methodology" (ACOE, 1995).

3.0 RESULTS

3.1 Wetland Delineation

The results of the wetland delineation and plant community mapping are provided in Figure 8. The delineation is straightforward in locations where the wetland-upland boundary is associated with an abrupt change in elevation, soil, and vegetation type.

In some locations, however, the wetland delineation was problematic. These include the northern boundary between forested upland and forested wetland, boundaries between forested wetland and upland "islands", and recently filled areas dominated by herbaceous vegetation.

In the northern forested areas and upland islands the transition from upland to wetland was often not associated with a sharp change in topography. In problem areas the vegetation was predominantly hydrophytic, but the soils were atypical and not clearly hydric. A site visit to the Oxbow Area with the ACOE New England District Regulatory Branch and the Rhode Island Office of the NRCS confirmed that the site contained "problem soils". Soils in forested areas were difficult to interpret because of past history of disturbance, shallow topsoil underlain by coarse sand, gravel and stone, staining by seepage of iron rich water from adjacent hillsides, alluvial deposits from the Woonasquatucket River and a storm drain system which discharges into the northwest corner of site. Furthermore, soils in the northern portion of the site classified as "Podunk fine sandy loam" differed from the published description of this soil type.

ACOE New England District regulatory staff recommended using the evidence of vegetation and hydrology to make the wetland determination, and when information about hydrology during the growing season was unavailable, making a conservative determination based on vegetation alone. The wetland determination along the northern portion of study area and the upland islands was conducted in the fall of 2006 and is based primarily on vegetation. The Corps regulatory office recommended collecting hydrological information during the spring of 2007, indicating that "evidence of groundwater close to the surface that is, or could be reasonably extrapolated as during the early growing season being, within 12" of the surface" would be indicative of wetland hydrology (Minkin, 2006). Observations made from mid March through early May of 2007 indicate soils in problem areas classified by vegetation as wetland were saturated within 12" of the soil surface. Therefore the delineation based on vegetation conducted in the fall of 2006 appears accurate. Precipitation during the early spring of 2007 was above normal and whether soil moisture observations are typical of spring site conditions is uncertain.

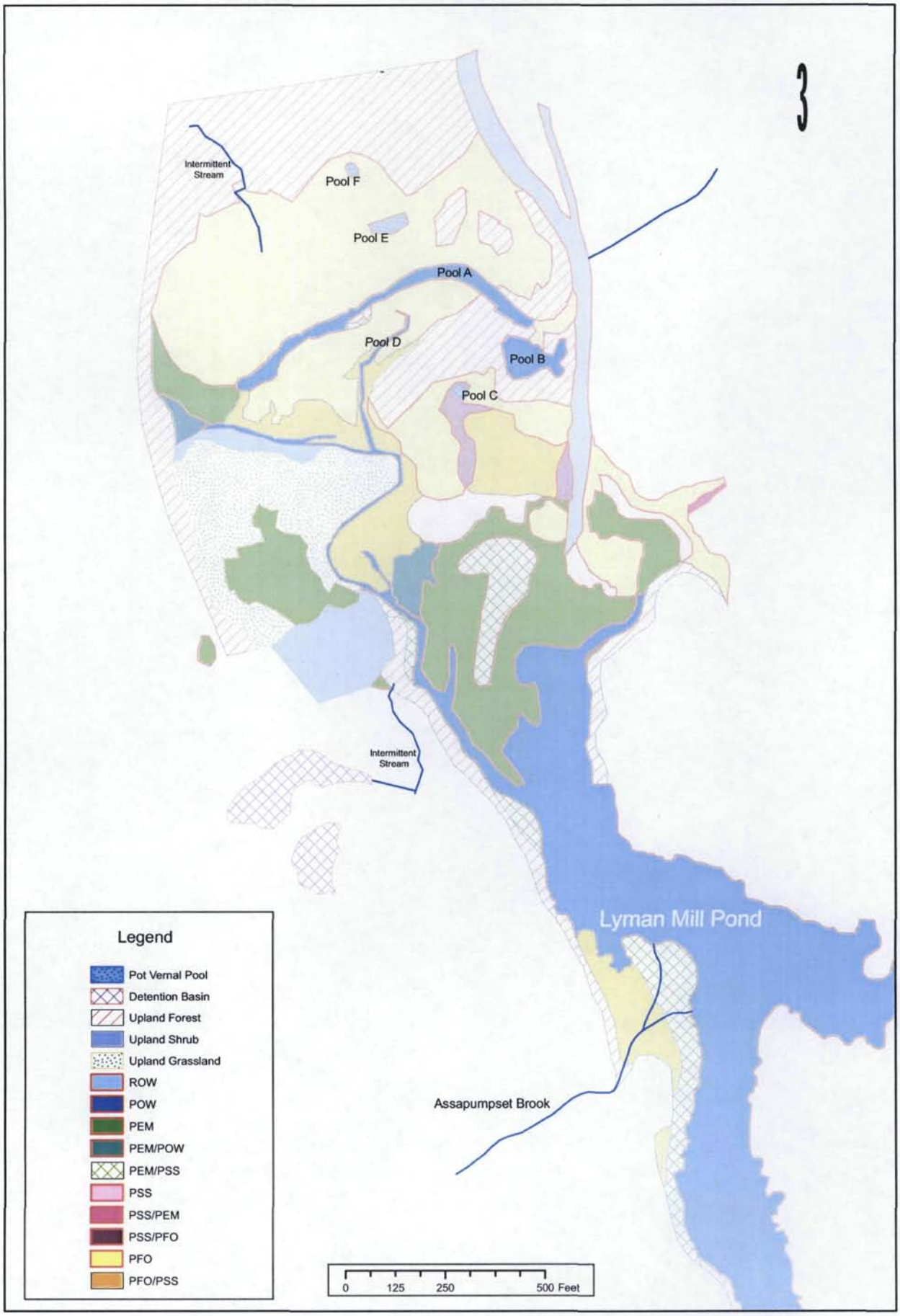

Figure 8: Oxbow Area Plant Community Map

Filled areas at the southwest portion of the site also did not exhibit typical hydric soils. The wetland boundary in these areas was based on vegetation, evidence of hydrology, and presence or absence of redoximorphic features within 12" of the soil surface.

3.2 Plant Community Descriptions

This section provides a brief description of plant communities encountered on the site. The description is based primarily on meander surveys and, for forested and forested/scrub-shrub communities, plot data provided in Appendix A. Plant communities are shown in Figure 8. Appendix B provides a list of plants noted during the study with common and scientific names. Table 3 gives the area (acres) for each community type in the Oxbow Area (exclusive of the Assapumpset Brook confluence).

Table 2: Communities at Lyman Mill Pond and the Oxbow Area

Community Type	Area (acres)
LACUSTRINE	
Open Water	20.9
PALUSTRINE	
Open Water	0.9
Emergent vegetation, persistent	5.4
Scrub-shrub, broad-leaved deciduous	0.9
Forested, broad-leaved deciduous	11.1
Mixed open water, persistent emergent	0.5
Mixed persistent emergent, scrub-shrub	2.2
Mixed scrub-shrub, forested	3.8
RIVERINE	
Open Water	1.5
Intermittent Stream	<0.1
UPLAND	
Forest	10.6
Shrub	1.5
Grassland	3.0
OTHER	
Vernal Pool or Potential Vernal Pool	0.1
Sediment Retention Basin	1.0
TOTAL	63.4

Notes:
Wetland classification system modified from Cowardin et al. (1978)
Potential vernal pools which appear to be permanent pools are classified as Palustrine Open Water

3.2.1 Oxbow Area

Emergent (persistent emergent)

The emergent community at the northern end of Lyman Mill Pond is dominated by swamp loosestrife and purple loosestrife (Photograph 1). Associated species include swamp rose, sweet fern, tall meadow rue, cattail, climbing hempweed, and common morning glory. Red maple saplings, red osier dogwood, and other shrubs are also present.

Scrub-shrub

Species encountered in Oxbow scrub-shrub communities include northern arrow-wood, red osier dogwood, highbush blueberry, glossy buckthorn, speckled alder winterberry, poison ivy, Virginia creeper, honeysuckle, and red maple. Herbaceous species present include skunk cabbage, royal fern, cinnamon fern, sensitive fern, and jack in the pulpit.

Forested Wetland

The tree strata in forested wetlands was dominated by red maple. Maple ranged in diameter up to about 16", with a maximum age of about 60 years. Multiple stemmed trees were common. Northern red oak was common at higher elevations (wetland upland transition zone and isolated hummocks) and occurred occasionally at lower elevations. Other tree species present include swamp white oak, black oak, black gum, aspen, black willow, and cottonwood. The shrub stratum was dominated by bush honeysuckle, glossy buckthorn, and northern arrowwood. Other shrubs present include high bush blueberry, winterberry, speckled alder, witch hazel, and Japanese barberry. Skunk cabbage was common in the understory, and formed dense colonies in some areas (Photograph 2). Other herbaceous species present include cinnamon fern, royal fern, sensitive fern, jack in the pulpit, jewelweed, Canada mayflower, wood anemone, wood aster, and Japanese knotweed. Vines present include green briar, poison ivy, wild grape, Virginia creeper, multiflora rose, and Oriental bittersweet. Trees in the forested wetland had shallow roots systems, indicative of high ground water and/or shallow soils (Photograph 3).

Forested Upland Islands

Several upland islands occurring within forested wetlands were delineated. The largest island (1.6 acres) is located south of the Oxbow Remnant (Photograph 4). Northern red oak was the dominant canopy species with red maple of secondary importance. Other trees noted include white oak, black oak, black cherry, American hornbeam, and American beech. A core taken from one of the larger oaks (18" DBH) showed the tree was 72 years old. There was no evidence of recent logging activity (cut stumps). Fallen dead limbs and snags were common. The understory was largely open with only scattered shrubs and saplings. Canada mayflower was the most common herbaceous species. There was also a large colony of lily of the valley, a naturalized herbaceous

species. Dry land access to the upland island is provided solely by a narrow berm between the Oxbow Remnant and a permanently ponded area (Pool B, see below).

Three other small (0.14 – 0.45 acre) upland islands were delineated north of the oxbow. Common trees species on these islands were northern red oak, aspen, red maple, American hornbeam, and black cherry. Other small (most much less than 0.1 acre) upland islands occur in forested wetland but were not delineated.

Forested Upland (North of the Oxbow Forested Wetland)

Forested upland north of the oxbow wetlands supports a diverse plant community. The eastern third of the area consists of early successional forest vegetated with aspen, sumac, tree of heaven, white ash, Japanese knotweed, and Asiatic bittersweet. The remainder is vegetated with more mature forest, with red maple the most common species in sample plots. Other tree species present include white oak, white ash, cottonwood, common catalpa, black cherry, red oak, black oak, hackberry, tree of heaven, Norway maple, and apple. The largest trees noted in sample plots were a cottonwood and a catalpa, which both had a DBH of about 30 inches. Red maple with dbh ranging from 10 – 16" were common and a large (16" dbh) hackberry was noted. Species noted in the shrub/sampling layer include red maple, glossy buckthorn, bush honeysuckle, oriental barberry, black cherry, cottonwood, and Norway maple. Canada mayflower and wild lily of the valley, dewberry, poison ivy, jewelweed, and yucca occur in the herbaceous layer. In areas with a more open canopy caused by tree falls or some other disturbance, Virginia creeper, oriental knotweed, green briar, bramble, oriental bittersweet, jewelweed, and grasses are common. Oriental knotweed and Asiatic bittersweet are abundant along the forest edge. Snags and fallen dead wood are common. There was no indication or recent logging activity (i.e. no cut stumps).

3.2.2 Filled Area

Communities delineated in or near the filled area along the northeastern shoreline of Lyman Mill Pond are described below.

Emergent Wetland

About 1 acre of the area is emergent wetland (Photograph 5). The community is dominated by herbaceous species. Shrubs are present but cover is less than 10 percent. The site has shallow soils, and generally could not be augured below 8 – 12". Small pools of standing water were present in the fall of 2006. The plant community is quite diverse. Herbaceous species present include soft rush, Joe pye weed, purple loosestrife, woolgrass, sedges, trefoil, little blue stem, lance leaved goldenrod, deer tongue grass, water-dock, other grasses, daisy fleabane, mugwort, bonset, Queen Anne's lace, and Phragmites. Tree and shrub species present include pussy willow, gray birch, meadowsweet, hardtack, alder, cottonwood seedlings, glossy buckthorn, autumn olive and high bush blueberry. Poison ivy is also present.

Upland Grassland (old field)

About 3 acres of the area is grassland (old-field) vegetated with a mix of grasses, herbaceous vegetation, and early successional trees and shrubs. Tree and shrub cover is about 30 percent. Common species present include mugwort, cottonwood, bedstraw, autumn olive, and pussy willow. Other species present include oriental knotweed, daisy fleabane, goldenrod, tansy, sunflowers, vetch, deer tongue grass, tree of heaven, high bush blueberry, bramble, grey birch, and common catalpa.

Shrub land (early successional forest)

About 1.5 acres of the filled area is wooded with aspen, grey birch, autumn olive, and willow. Tree and shrub cover in this area is about 75 percent. Associated species include goldenrods, grasses (including little blue stem), orietnal knotweed, Asiatic bittersweet, Russian olive, speckled alder, red oak, and white oak seedlings.

3.2.3 Lyman Mill Pond

Lacustrine Open Water

Lyman Mill Pond supports a productive submerged aquatic plant community but no attempt was made to map distribution of aquatic vegetation within the pond and the entire pond was simply classified as LOW/LAB.

Riparian Vegetation along Lyman Mill Pond

Except for wetland complex at the north end of the pond the shoreline along most of Lyman Mill Pond quickly transitions to upland habitat. In many areas only a narrow fringe of trees and shrubs buffers the pond from development. Along the western shoreline north of the Assapumpset Brook confluence, the narrow riparian zone is well vegetated with mature trees and shrubs (Photograph 6). Common species present include northern red oak, red maple, alder, sweet pepperbush, and northern arrowwood. Other species noted include highbush blueberry, red osier dogwood, winterberry, staghorn sumac, Asiatic bittersweet, multiflora rose, black willow, American beech, indigobush, witch hazel, grey birch, white oak, Japanese knotweed, and wild grape.

3.2.4 Assapumpset Brook Confluence

About two acres of vegetated riparian habitat is present the confluence of Assapumpset Brook with Lyman Mill Pond. Most of this area is forested/scrub-shrub wetland with a small amount of emergent wetland along the shoreline Red maple, speckled alder, and red osier dogwood are the dominant species. Other species noted include black willow, common catalpa, wild grape, green briar, sensitive fern, and skunk cabbage. The emergent vegetation is dominated by swamp loosestrife, purple loosestrife, and cattail.

3.2.5 Sediment Retention Ponds

Two sediment retention ponds are present east of Lyman Mill Pond. The ponds have a combined area of 1 acre. Both ponds are used by a material processing company. The shoreline of the larger pond is vegetated with a narrow band of trees, shrubs, and *Phragmites*. This pond was frequently observed discharging turbid water through a channel which flows into Lyman Mill Pond (Photograph 7).

3.3 Rare Plant Species

No native plants listed as rare or protected in Rhode Island (Enser, 2002) were noted. The most unusual plant found on site was sweet bay (*Magnolia virginiana*). A single 10 ft. tall specimen was noted growing in scrub-shrub wetland near the upland island located south of the oxbow. Sweet bay is a southern species at the northern limit of its range in Rhode Island.

3.4 Invasive Plant Species

As is the case for most urbanized areas in southern New England the Oxbow Area supports populations of numerous invasive species. Invasive species encountered on site include Oriental knotweed, *Phragmites*, purple loosestrife, glossy buckthorn, bush honeysuckle, Asiatic bittersweet, multiflora rose, green briar, tree of heaven, and common catalpa. Bush honeysuckle and glossy buckthorn are common in the understory in forested wetland and upland north of the Oxbow. Knotweed is common in edge habitat north the west of the Oxbow. It also occurs within forested areas (both wetland and upland) but is not abundant because shade limits its growth. Knotweed also occurs in the filled area and elsewhere along Lyman Mill Pond. Purple loosestrife is abundant in emergent wetland located at the north end of the Lyman Mill Pond. It also occurs in the filled area emergent wetland. Several small patches of *Phragmites* occur in forest wetlands north of the Oxbow, mostly within 100 feet of an intermittent stream. Most shoots are less than 6 ft tall and their growth appears shade limited. The filled area emergent wetland includes a small patch (ca. 1000 sf) of Phragmites which is expanding and poses a long term threat to the wetland. No *Phragmites* was noted in emergent or scrub-shrub wetland at the north end of Lyman Mill Pond but the area appears vulnerable to *Phragmites* colonization. *Phragmites* also occurs in the sediment retention ponds east of Lyman Mill Pond. Oriental bittersweet is common in edge habitat and disturbed areas with abundant sunlight. Green briar is found in both wooded upland and wetland areas.

3.5 Vernal Pools

The Oxbow Area contains depressions that hold water for varying lengths of time. Some of these areas are isolated or semi-isolated from the Woonasquatucket River and Lyman Mill Pond and could provide fishless habitat for invertebrates and amphibians. These areas can be classified according to hydrological classes described by Colburn (2004):

Hydrological Class	Duration of Flooding
Ephemeral or Rainwater Pools	A few weeks
Short-cycle, spring-filling pools	3-4 Months
Long-cycle, spring-filling pools	5-8 Months
Short-cycle, fall-filling pools	7-9 Months
Long-cycle, fall-filling pools	9-11 Months
Partially Drying Pools	Draw down consistently but a relatively small area of standing water or saturated substrate usually remains
Semi-permanent pools	36-120 months; occasionally may dry out completely as rarely as every 5 to 10 years; may temporarily sustain fish
Permanent Fishless Ponds	Do not dry or drawdown substantially except during droughts; fish eliminated by freezing or seasonal anoxic conditions

Classic vernal pools would generally be described as short or long cycle pools. These pools may remain wet long enough to support breeding activity by wood frog and mole salamanders but do not support fish. Semi-permanent and permanent fishless ponds typically do not support wood frogs or mole salamanders but may support frogs which require more than one year to complete their life cycle such as bullfrog and green frog. All these habitats, including ephemeral pools, support invertebrates such as protists, rotifers, crustaceans, and insects, and thus enhance local biodiversity.

Figure 8 shows the location of Oxbow Area pools.

Pool A (the "Oxbow Remnant"): This 0.6 acre channel nearly divides the Oxbow Area from east to west. This area includes the former river channel and an area. excavated many decades ago (Photographs 8 and 9). The Oxbow Remnant is not normally connected to the Woonasquatucket River, but receives overland flow during high flow events. During an April 16, 2007 flood, overland flow crossed the Oxbow at several locations and there was a direct connection to the Woonasquatucket River. Under normal flow conditions the Oxbow Remnant is connected through emergent marsh and a narrow channel to Lyman Mill Pond. Pool A probably supports fish, at least seasonally, and therefore is unlikely to provide breeding habitat for mole salamanders, frogs or invertebrates associated with classic vernal pools. It may provide valuable nursery habitat for fish.

Pool B: This pool is man made and was apparently constructed in the 1930's. It is ringed by a steep sided earthen berm (Photograph 10). This pool was constantly flooded from the summer of 2006 to May of 2007 present and is likely either semi-permanent pool or permanent fishless pool. It was frozen to the bottom (or nearly so) in February of 2007. The pool is rarely flooded by the Woonasquatucket River. Based on observations of high water mark (leaf staining and wrack line) it was not flooded during an April 16, 2007 event when other areas of the Oxbow were inundated by overland flow. The pool

was searched for amphibian egg masses on May 8, 2007. Water depth ranged to about 4 ft. and averaged about 2 feet. The substrate was hard bottomed, overlain with about 6-12" of soft surficial sediment and leaves. No wood frog or mole salamander egg masses wee found. Year old bullfrog pollywogs were present. Invertebrates noted include midge larvae, mosquito larvae, and isopods. The Oxbow Area was visited on the evening of May 12 to listen for frog calls. Only an occasional bullfrog call was heard at this location.

Pool C: This small (ca. 30 ft diameter) pool is located within forested wetland south of the large upland island (Photograph 11). This pool was observed from September of 2006 to May 2007. It was dry in early fall but inundated by February and is best classified as a short-cycle fall-filling pool. The pool was searched for amphibian egg masses on May 8, 2007. At this time water depth water depth ranged to about 12 – 18". The substrate was hard bottomed, with about 6 – 12' of soft surficial sediment and leaves. No wood frog or mole salamander eggs masses were found. An unidentified frog, likely a green frog or bullfrog, was seen. Invertebrates noted included midge larvae, isopods, amphipods, springtails, dytiscid larvae, and mosquito larvae. The pool was visited on the evening of May 12 to listen for frog calls. Only an occasional bullfrog call was heard at this location.

Pool D: This pool is a long linear, shallow pool located south of the Oxbow Remnant (Pool A) and adjacent to the large upland island. This area was inundated during the early fall of 2006 through May of 2007. The pool is normally about 10 – 15 feet wide and has a water depth less than 18". It is normally connected to other surface waters at its southern end. During high flow events it functions as a stream channel, but is more typically ponded and supports an aquatic invertebrate community more characteristic of vernal pools than intermittent streams. A spring peeper was heard calling near the pool on May 12.

Pool E: This shallow pool was observed full in the winter of 2007 and may be a short cycle fall-filing pool (Photograph 12). It was inundated by the April 16, 2007 flood event. A few weeks later (May 8) the pool was 75 percent dry and had a maximum water depth of about 12 inches and had a thick, iron rich surface film. No frog or mole salamander egg masses were observed in the pool. Water boatmen and mosquito larvae were noted. No frog calls were heard near the pool on May 12.

Pool F: This shallow pool was observed in the winter of 2007 and appears to be a short cycle fall-filing pool. It was not inundated by the April 16 flood event and was nearly dry on May 8 (Photograph 13). No frog calls were heard near the pool on May 12.

Other Oxbow Area Pools: A small pool is present at the base of the steep embankment near the north western end of the site. A few spring peepers were heard calling in this vicinity on May 12. Several other small depressions observed within forested wetlands north of the Oxbow may function as short – cycle or ephemeral pools.

The USFWS conducted an anuran call survey at Lyman Mill Pond and other areas along the Woonasquatucket in 2000 and 2001 (Eaton-Poole, 2002). One of the stations was

located on Lyman Mill Pond, south of the Oxbow Area emergent wetland. Calls of spring peeper, pickerel frog, American toad, Fowler's toad, green frog, bullfrog, and gray tree frog were heard at this location. The site had the highest diversity and abundance of frogs of all the Woonasquatucket monitoring stations. The results of the USFWS call study are not comparable to those of this study, which was narrowly focused on individual vernal pools.

3.6 Streams and Rivers

3.6.1 Woonasquatucket River

The 1200 ft. long reach of the Woonasquatucket River between Allendale Dam and Lyman Mill Pond is mostly run and pool habitat, with short sections of riffle located near Allendale Dam and a few hundred feet downstream of the dam. The width of the river averages about 50 feet. The substrate is mostly sand and cobble, with few large boulders. The banks are generally well vegetated (Photographs 14 and 15).

3.6.2 Assaspumpset Brook

Assapumpset Brook originates in wetlands in Johnston near the Smithfield town line and flows 2.8 miles to Lyman Mill Pond. Water quality of the stream is classified as "B" by the Rhode Island DEM. Two sections of the brook, totaling about 750 ft, are culverted downstream of Waterman Road. The brook daylights into a confined channel about 800 feet upstream of Lyman Mill Pond (Photograph 16) and flows through an industrial area (automobile junk yard). The final 100 feet of the brook flows freely through a wooded area to Lyman Mill Pond (Photograph 17).

3.6.3 Intermittent Streams

The Oxbow Area receives drainage from one large storm drain. The 24 inch drain enters from the northwest and cuts a 4 – 6 ft. wide, 400 ft. long channel through forested upland and wetland (Photograph 18). The drainage channel ends in a braided, sandy outwash plain.

3.7 Wildlife Observations

Table 3 lists wildlife noted in the study area. The list includes incidental observations and is not a comprehensive inventory of wildlife inhabiting the area. Reports by local residents added red fox and opossum to the list. Animal burrows, probably those of wood chuck or fox, were common in forested upland.

Table 3: Wildlife Observed at the Oxbow Study Area.

Class	Common Name	Scientific Name
Mammals	red fox	*Vulpes vulpes*
	white-tailed deer	*Odocoileus virginianus*
	Virginia opossum	*Didelphis virginiana*
	Eastern cottontail	*Sylvilagus floridanus*
	Eastern chipmunk	*Tamias striatus*
	gray squirrel	*Sciurus caroliensis*
	raccoon	*Procyon lotor*
Birds	Canada goose	*Branta canadensis*
	mallard duck	*Anas platyrhynchos*
	song sparrow	*Melospiza melodia*
	blue jay	*Cyanocitta cristata*
	Northern cardinal	*Cardinalis cardinalis*
	common yellowthroat	*Geothlypis trichas*
	black-capped chickadee	*Parus atricapillus*
	grackle	*Quiscalus quiscula*
	tufted titmouse	*Parus bicolor*
	golden crowned kinglet	*Regulus satrapa*
	Brown-headed cowbird	*Molothrus ater*
	sharp shinned hawk	*Accipter striatus*
	red-tailed hawk	*Buteo jamaicensis*
	killdeer	*Charadrius vociferus*
	American crow	*Corvus brachyrhynchos*
	great blue heron	*Ardea herodias*
	American goldfinch	*Carduelis tristis*
	redwing blackbird	*Agelaius phoeniceus*
	kingfisher	*Ceryle alcyon*
	downy woodpecker	*Picoides pubescens*
	white-breasted nuthatch	*Sita carolinensis*
	vireo	*Virea sp.*
	mourning dove	*Zenaida macroura*
Reptiles	painted turtle	*Chysemys picta*
Amphibians	bull frog	*Rana catesbeiana*
	wood frog	*Rana sylvatica*
	spring peeper	*Hyla crucifer*

4.0 Functions and Values Assessment

4.1 General

The Corps Highway Methodology lists eight wetland functions and five wetland values (See Box 1). This list of wetlands functions and values is fairly comprehensive and can be used as framework for assessment wetland functions and values. For this assessment one function has been added to the list – Carbon Sequestration. For each function or value the Highway Methodology included a series of descriptors to help with the evaluation. The list of descriptors is again, not exhaustive, but can be used as basis for the assessment. The descriptors listed for each function and value are provided in Appendix C.

4.2 Oxbow Area Assessment

The Highway Method includes an evaluation form. A modified version of this form was used to rate the 6 major wetland communities found at the Oxbow. These are:

- Forested (PFO)
- Forested/scrub-shrub (PFO/PSS)
- Emergent/scrub-shrub (PEM/PSS)
- Emergent (PEM) – Lyman Mill Pond
- Emergent (PEM) – "filled" area
- Open water (POW) - "Oxbow Remnant"

The completed evaluation forms are provided in Appendix D. A general discussion of each function/value is provided below.

4.2.1 Groundwater Recharge/Discharge

Groundwater recharge is the movement of surface water through the subsurface to groundwater. This function is often difficult to accurately assess without detailed hydrogeologic studies. Assessing recharge involves determining if the rate of recharge exceeds the rate of groundwater discharge. Indicators of the potential for groundwater recharge opportunity are subsurface geology, soils, topography, and available water table information. Although the process is the same, infiltration of surface water that replenishes soil moisture but does not reach an underlying aquifer is technically not groundwater recharge.

The study area is not mapped as a critical groundwater recharge area or a groundwater reservoir by RIGIS (2007). Groundwater in the area is classified as "GA" by the RIDEM. Lyman Mill Pond and the Oxbow Area are located in a glacial valley and are underlain by sand and gravel deposits (Corcoran, n.d). This suggests some recharge could occur from the reservoir and adjacent wetlands.

Box 1: Wetland Functions and Values

1) GROUNDWATER RECHARGE/DISCHARGE — This function considers the Potential for a wetland to serve as a groundwater recharge and/or discharge area. Recharge should relate to the potential for the wetland to contribute water to an aquifer. Discharge should relate to the potential for the wetland to serve as an area where groundwater can be discharged to the surface.

2) FLOODFLOW ALTERATION (Storage & Desynchronization) — This function considers the effectiveness of the wetland in reducing flood damage by Attenuation of floodwaters following precipitation or runoff events.

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

4) 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.

5) NUTRIENT REMOVAL/RETENTION/TRANSFORMATION — This function relates to the effectiveness of the wetland to prevent adverse effects of excess nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers, or estuaries.

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

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

8) 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.

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

Box 1: Wetland Functions and Values (continued)

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

11) UNIQUENESS/HERITAGE — This value relates to the effectiveness of the Wetland or its associated waterbodies to produce certain special values. Special values may include such things as archaeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geologic Features.

12) VISUAL QUALITY/AESTHETICS — This value relates to the visual and aesthetic qualities of the wetland.

13) THREATENED or ENDANGERED SPECIES HABITAT — This value relates to the effectiveness of the wetland or associated waterbodies to support threatened or endangered species.

14) CARBON SEQUESTRATION — This function relates to the ability of the wetland to sequester carbon from the atmosphere through retention in biomass in vegetation (living or dead) and the soil.

Groundwater discharge is the movement of subsurface water to the ground surface, Sometimes through seeps and springs. The patterns of discharge may vary spatially and temporally and can be difficult to assess in the field. A good indicator of potential groundwater discharge is a permanent saturated or flooded condition in an area where an inlet is absent. Another good indicator is the presence of seeps and springs.

Groundwater seeps were noted discharging iron rich groundwater at the base of steep slopes along the northern edge of the forested wetland (Photograph 19). The volume of these seeps is very low relative to flow of the Woonasquatucket River. They do however; add to habitat diversity at the site.

4.2.2 Floodflow Alteration

Flood flow alteration is the ability of a wetland to reduce the extent and duration of flooding by reducing or desynchronizing peak flows. Flows may be reduced by either surface or subsurface storage of floodwaters. Indicators of potential for flood flow alteration include surface waters that temporarily increase in size, rough surfaces or dense vegetation (which slow flows) constricted outlets, and permeable soils that allow subsurface storage.

Almost all delineated Oxbow Area wetlands are within the 100 year floodplain. Direct and indirect observations indicate that floodwaters fan across the forested wetland north of the Oxbow Remnant during flood events (Photographs 20, 21). These waters either return to the Woonasquatucket River or flow into the Oxbow Remnant. Water reaching the remnant is gradually discharged into Lyman Mill Pond.

Scrub-shrub and emergent wetlands at the head of Lyman Mill Pond restrict flow of the Woonasquatucket into open water areas of the pond. The Oxbow wetlands are relatively flat and provide temporary storage for floodwaters. This storage function may be primary supported by forested, scrub-shrub, and scrub-shrub-emergent wetlands because some of the emergent wetland adjacent to the pond may be semi-floating and not always inundated by flood waters. As flood flows recede some water is retained in temporary pools within the wetlands.

The magnitude of flood flow alteration provided by the Oxbow wetlands is unknown. A hydrologic evaluation would be needed to quantify the impacts of wetlands on downstream water surface elevations during flood events. Areas downstream of Lyman Mill Pond are heavily developed so the wetlands may provide some flood damage reduction benefits.

4.2.3 Fish Habitat

Wetlands can provide important breeding, feeding, and resting habitat for fish. Indicators associated with effective aquatic habitat include the presence of perennial open water or open water/emergent habitat, good water quality (well oxygenated), lack of barriers to fish movement, and lack of extreme water level fluctuations. Wetlands without perennial open water may provide fisheries habitat if they are flooded seasonally and contiguous with a riverine or perennial open water habitat.

The Oxbow Remnant and associated emergent wetland are permanently flooded and connected to Lyman Mill Pond. These areas likely provide at least seasonal habitat for adult or juvenile warm water fish species which occur in Lyman Mill Pond. The Oxbow Remnant freezes and it is unknown if fish can overwinter in the area. Other permanent or temporary pools within vegetated wetlands dry up seasonally or freeze to the bottom and do not provide fish habitat.

The Woonasquatucket River once supported populations of anadromous fish including, Atlantic salmon, shad, and alewife. There is currently interest in restoring shad and alewife through provision of fish passage facilities or removal of dams downstream of Lyman Mill Pond. There are currently no plans to provide fish passage at the Lyman Mill Pond dam.

4.2.4 Sediment/Toxicant/Pathogen Reduction

This function relates to the ability of the wetland to trap sediment and contaminants contained in runoff from surrounding uplands or surface waters which inundate wetland areas. Indicators associated with this function include a source of sediment or contaminants, periodic or permanent inundation of the wetlands with surface waters, and evidence of sediment or contaminant accumulation. Retention of sediment is enhanced by diffuse surface flow, slow water velocity, and thick surface vegetation or leaf litter.

Documented accumulation of contaminants from the upstream Centredale Superfund source area is indicative of this function occurring in site wetlands. The highest concentrations of site contaminants in the Oxbow have been found in the Oxbow Remnant. This area receives flow from the Woonasquatucket River via overland flow through forested wetland and, during very high flow events, via a direct connection with the Woonasquatucket River. Accumulation of fine grained sediment and Centredale derived contaminants in the Oxbow Remnant confirms that it functions to retain sediment and sediment bound contaminants. Deposits of fine sediment on leaf liter indicate that retention of sediment and possibly contaminants also occurs within vegetated forested and scrub-shrub wetland areas that are submerged during flood events.

The forested wetland retains sediment deposited by an intermittent stream that originates with a storm drain at northwest corner of the Oxbow. Fairly thick (<0.6") deposits of sediment can be found near the end of the 400 ft long channel. The sediment deposited in the wetland is likely both material eroded by high flows through the channel and sediment (road runoff) discharged from the storm drain.

4.2.5 Nutrient Removal/Retention/Transformation

This function relates to the ability of the wetland to retain nutrients contained in runoff from surrounding uplands or surface waters which inundate wetland areas. Indicators associated with this function include a source of nutrients, periodic or permanent inundation of the wetlands with surface waters, and evidence of sediment accumulation. Retention of sediment bound nutrients is enhanced by diffuse surface flow, slow water velocity, and thick surface vegetation or leaf litter. Transformation of nitrogen (nitrate) to nitrogen gas (N^2) is enhanced by anaerobic condition occurring within wetland soils or aquatic sediment.

Documented upstream sources of nutrients along with evidence of sediment retention are indicative of this function occurring in site wetlands. Sediment accumulation occurs in the Oxbow Remnant and within vegetated wetland areas that are submerged during flood events. The retained sediment likely contains both phosphorus and nitrogen. The phosphorus will remain bound to soil under aerobic conditions. Under anaerobic conditions, phosphorus is released into wetland soils and may be transported by surface waters or groundwater. Ammonia may be taken up by wetland vegetation or transformed (under aerobic conditions) in wetlands soils to nitrate. Transformation of nitrate nitrogen to nitrogen gas likely occurs in sediment within the Oxbow Remnant and anaerobic soils

or subsoil within vegetated wetlands. Studies elsewhere indicate that forested wetland can significantly reduce nitrogen and phosphorus levels in soil water as it passes through the wetland. Emergent wetlands associated with Lyman Mill Pond probably function poorly for nutrient retention since they are rarely flooded during the growing season. Also, phosphorus retention in herbaceous vegetation is time-limited since most of the phosphorus in leaves is released quickly as the leaves senesce in the fall.

4.2.6. Production Export

Production export is the production of organic material that supports the food chain. Production export includes leaf litter and dead wood, fruit, seeds, nectar, insects, and harvestable wildlife. Wetland production can support food chains within the wetland and, through export, other communities. An example of export is leaf litter from a forested wetland supporting aquatic food chains in an adjacent riverine system. Indicators that a wetland may be effective at food chain export include proximity to riverine habitat, overhanging vegetation, existence of an outlet which allow for flushing of production from a wetland, plants which produce abundant fruits and seeds, and productive vegetation.

All wetlands in the Oxbow Area produce organic mater that supports food chains within the wetland. Potential for production export is greatest for forested wetland along the Woonasquatucket River where exported leaf litter and snags help support the riverine invertebrate and fish communities. In emergent wetland, nectar produced by purple loosestrife supports local pollinator populations. Vernal pools and temporary pools produce flying insects (e.g. midges, mosquitoes) which support wide ranging insectivorous species (swallows and bats). Seed from wetland trees (oak and maple) may support small mammals which inhabit adjacent uplands. Although wildlife such as deer and squirrel occur in the Oxbow wetlands, hunting is not permitted in Johnston, RI, so there is no legal production "export" for human use.

4.2.7 Sediment/Shoreline Stabilization

Shoreline stabilization occurs along rivers and lakes where wetland vegetation increases resistance to erosion caused by wave action and currents. This function is usually absent in wetlands not associated with an open water body or flowing water. The potential for strong waves or currents and the presence of strong root masses are indicators of this function.

In the Oxbow Area, forested and scrub shrub wetland growing along the Woonasquatucket River provide this function. Although there are localized areas of minor erosion, the river bank appears stable (Photograph 14).

4.2.8 Wildlife Habitat

Wetlands provide food, shelter, and nesting areas for many types of wildlife, including game and non-game species. General indicators that characterize wildlife diversity and

abundance include: habitat size and complexity, connectivity to other habitat areas, wildlife food sources, availability of nesting habitat, and evidence that animal use the area.

Wildlife habitat is a principle function of the Oxbow wetlands. Key indictors of habitat function are discussed below.

Habitat Size: The Oxbow wetlands and adjacent upland habitat provide a ca. 40 acre habitat "island" in an otherwise heavily developed urban landscape. The area is the largest block of vegetated wetland habitat along the lower Woonasquatucket River and the largest remnant of riparian forest habitat. While the 20 acres of forested habitat is significant in a local landscape context, the area is too small to provide habitat for wildlife species that require large blocks of unfragmented forest. The area of forest is smaller than the minimum size needed to support interior orientated nesting birds such as scarlet tanager. The area however, is large enough to support edge tolerant breeding birds which nest in wooded areas, such as downy woodpecker, black-capped chickadee, and blue jay. It is also large enough to provide habitat for small mammals such as moles, chipmunk, squirrels, and white tailed deer.

Emergent and scrub-shrub habitat at the northern end of Lyman Mill Pond totals about 8 acres, a large enough area to support breeding birds such as red winged blackbird, swamp sparrow, and yellow warbler.

The emergent wetland and old field habitat in the filled area is large enough to support breeding activity by some early succession bird species like song sparrow, gold finch, and catbird. It is too small however, to provide nesting habitat for grassland specialists such as meadowlark, bobolink, and grasshopper sparrow.

Habitat Diversity: The Oxbow wetlands contain a variety of habitat types, ranging from mature red maple forested wetland to emergent wetland. The presence of different habitat types is typically associated with greater species diversity (species richness).

Wildlife Food Plants: Forested wetland and adjacent uplands support a diverse plant community (Appendix B). Many of the dominant plant species are considered good or excellent wildlife food plants because of the seeds or fruits they produce (Martin et al, 1951; Reddington, 1994). Forested wetlands and adjacent uplands are dominated by red maple and oaks, both of which produce seeds that are heavily used by birds and mammals. Other tree species found in the Oxbow Area, including white ash, cottonwood, aspen, and hackberry, also have moderate to high wildlife food value. Northern arrowwood, high bush blueberry, red osier dogwood, and other native shrubs occurring in the forest understory and scrub–shrub wetlands are excellent wildlife food plants. Invasive shrubs prevalent in the understory, bush honeysuckle and glossy buckthorn, are considered poor quality food sources but may provide an important source of winter food for birds after the fruits of native species are depleted. Small mammals such as deer mice also consume bush honeysuckle fruits. Asiatic bittersweet, the

prevalent vine in forested areas and edge habitat, is a poor wildlife food plant. Oriental knotweed is a good source of nectar for many insects.

Forested wetlands and uplands contain a moderate amount of downed woody material (mostly limb wood) and standing dead (snags) (Photographs 22 and 23). This material supports a complex detrivore food chain, ranging from microorganisms and fungi to insects and songbirds. Snags can be important feeding winter feeding habitat for year-round residents such as northern black capped chickadees and nuthatches.

The two prevalent species in emergent wetland, purple loosestrife and swamp loosestrife, are good sources of nectar and pollen to bees and other pollinators. Swamp loosestrife is a food plant for two species of Sphinx moth and its seeds are consumed by many species of waterfowl.

Nest Sites: Shrubs and trees in Oxbow wetlands provide nest sites for songbirds, owls, and hawks. Nests were most commonly noticed in scrub-shrub wetland or forested scrub/shrub areas. Gray squirrel nests were noted in trees within forested wetland. Animal burrows (likely woodchuck) were common in upland forest and occasionally found in small upland islands within forested wetlands (Photograph 24). Forested wetland and adjacent upland contained a moderate density of snags and downed woody debris (mostly fallen limb wood, with an occasional large tree fall). Snags and tree cavities provide nest sites for birds and small mammals. The species which may use a snag depends on snag diameter and height off the ground. Most of the snags and cavity trees at the oxbow area were small (less than 10" in diameter). Species which may use snags found in the Oxbow Area and their snag size (diameter) preferences include black capped chickadee (4-7"), brown creeper (6-16"), and downy woodpecker (6-10") (Tubbs, et. al, 1987). No snags observed in the Oxbow Area are suitable for species which require large snags such as red headed or pileated woodpecker (16-24") or wood duck (> 18''). No wood duck nest boxes were noted. Some snags in the area are large enough to provide habitat for small mammals such as chipmunk and northern flying squirrel.

4.2.9 Recreation

The ability of wetlands to provide recreational opportunities is recognized as wetland function. Recreational activities provided by wetlands include fishing, boating, hunting, hiking, and nature observation.

Opportunities for recreational activity in the Oxbow Area are limited because of poor public access and lack of established hiking trails. Public access is also discouraged because of chemical contamination in the soil and sediment. There is one well worn trail that parallels the Johnson side of the river from the bridge downstream of the Allendale Pond to the Oxbow Remnant (Photograph 25). The trail provides access to the river for hikers and fisherman, and access to a "tree house" apparently constructed by teenagers (Photograph 26). The trail is also used by off-road vehicles. There is no legal hunting in the town of Johnston and no evidence of hunting activity (e.g. spent shells) was observed. During the study only one person was encountered in the Oxbow Area. This person said

he frequently walked thought the area and enjoyed nature observation. Lyman Mill Pond is navigable and it is possible to canoe or kayak for a short distances into emergent wetland via a narrow, shallow channel. Thick vegetation and a braided channel prevents navigation between the north end of the Lyman Mill Pond and the Woonasquatucket River.

4.2.10 Education/Scientific Value

The area is not used for environmental education or any scientific studies other than those associated with remediation of Centredale Manor Superfund Site. Poor public access would limit potential of the site for environmental education even if soil and sediment contamination were not a concern.

4.2.11 Uniqueness/Heritage

This value relates to the ability of wetland to produce certain special values. These may include such things as archaeological sites, unusual aesthetic quality, historical events, or unique plants, animals, or geologic features.

The Woonasquatucket River was designated an American Heritage River in 1998. The river played an active role in the American industrial revolution and the history of Rhode Island (WRWC, 2008). Lyman Mill Pond is one of several mill ponds remaining on the river which illustrate its long industrial history. The Oxbow Remnant, an engineered abandoned river channel, is a unique feature with possible historic significance.

The Oxbow Area wetlands and adjacent upland habitat encompass about 40 acres, including 20 acres which are forested. This is the largest patch of habitat remaining along the lower Woonasquatucket River. Although the riparian forest is relatively young (most trees are les than 70 years old) it provides an example of what was very likely the dominant pre-colonial habitat type along the Woonasquatucket River.

4.2.12 Visual Qualities/Aesthetics

The Oxbow wetlands do not have any outstanding visual or aesthetic qualities. There is no vantage point from where the wetlands can be observed or appreciated. Perhaps the most notable view is the view the Woonasquatucket River looking downstream from the bridge located about 100 feet downstream of Allendale Dam. This bridge is closed to traffic but passable by pedestrians.

4.2.13 Rare Species Habitat

No currently listed state or federal rare species are known to occur in the Oxbow Area. American eel, a catandromous species, occurs in the river, including the Lyman Mill Pond area. Although North Atlantic populations of American eel are apparently suffering a widespread decline (Friedland et al., 2007), there is no current plan to designate eel as a federally threatened or endangered species.

4.2.14 Carbon Sequestration

Carbon sequestration refers to the long-term storage of carbon in wetland vegetation, soils, and sediment. Photosynthesis by wetland plants converts atmospheric carbon dioxide into biomass which may be stored in living or dead vegetation, soils, or sediment. Wetlands may also sequester carbon by acting as sediment traps for carbon-rich sediments originating from outside the wetland. Decomposition processes may release carbon as carbon dioxide, dissolved carbon, and methane. Wetlands are net carbon sinks if the rate of carbon accumulation exceeds the net export. Release of carbon may occur as vegetation decomposes, as wetland soils or sediment dry out and are oxidized, and as methane is generated under anaerobic condition. The net carbon sequestering versus carbon release roles of wetlands are complex, change over time, and are not easy to quantify.

Review of old maps and aerial photographs show that considerable accumulation of sediment has occurred within northern end of Lyman Mill Pond over the last century. This sediment likely contains considerable carbon sequestered as recalcitrant organic compounds that decompose very slowly. The sediment bound carbon likely originated both from decomposition of wetland vegetation and upstream watershed sources.

Forested and scrub-shrub wetlands contain considerable carbon in living biomass, dead wood and litter, and organic rich soils. While it is very likely the Oxbow wetlands are accumulating carbon, the magnitude of carbon sequestration is unknown and impossible to easily quantify. One study in Rhode Island estimated biomass accumulation in a mature (55 year old) red maple forest to be 2870 lbs/acre (Braiewa et al.,1985). This does not include biomass accumulated in roots or retained in the soil.

5. Restoration Opportunities

During the study two potential habitat restoration sites were identified. These are: the Lyman Mill Pond filled area (and adjacent underused industrial land) and riparian habitat along the Assapumsett Brook near its confluence with Lyman Mill Pond.

The Lyman Mill Pond filled area offers an excellent opportunity to restore several acres of aquatic habitat. The area was filled between the 1960's and 1990's and is currently old field and emergent wetland. The emergent wetland is perched and has no connection with the Lyman Mill Pond, limiting its functional value. Restoration options range from removal of the fill material to restore aquatic habitat to preserving the area as open space and allowing wooded riparian habitat to develop. The depth of fill material is not known but is probably at least 4-8 feet. Restoration of the filled area could be combined with restoration of riparian habitat on other adjacent underutilized industrial land. In lieu of fill removal, eradication of *Phragmites* from the emergent wetland in the filled area offers another restoration opportunity. Without a control effort, *Phragmites* will eventually

colonize the entire wetland and greatly reduce plant community richness. Eradication of *Phragmites* from the wetland using the herbicide ROUNUP is feasible.

Assapumpset Brook offers an opportunity for both riparian habitat restoration and stream restoration. Two sections the brook near Lyman Mill Pond are culverted and could be daylighted to restore stream habitat. Another 800 feet of the brook is channelized where it passes through an automobile junkyard. A natural stream channel and about 4 acres of riparian habitat could also be restored by removing the junk yard (Photograph 27).

6. Summary and Conclusions

Approximately 27 acres of vegetated wetland was delineated in the Oxbow Area. Additional resources identified in the area include 10.6 acres of forested upland and 4.5 acres of old field and shrub habitat. The wetland is vegetated with plant species typical of southern New England forested, scrub-shrub, and emergent wetland. Forested wetland is dominated by red maple. Dominant species in the understory and herbaceous layers include northern arrowwood, bush honeysuckle, glossy buckthorn, and skunk cabbage. The largest red maple growing in the wetlands are about 60 years old. Common species in scrub-shrub wetland include northern arowwood, high bush blueberry, and red maple. Emergent wetland is dominated by swamp loosestrife and purple loosestrife. No state or federally listed rare plants were noted.

The site contains several shallow water bodies which may function as vernal pools. The largest pool is permanently inundated. It does not appear to support fish but does support bullfrog, and therefore is unlikely to support obligate vernal pool species such as wood frog and mole salamander. The other pools are seasonal and may support amphibians in additional to invertebrate species. No wood frog or mole salamander breeding activity was noted in these pools during the spring of 2007.

Functions and values of Oxbow Area wetlands were assessed using the Corps of Engineers "Highway Methodology". This method evaluates 13 wetlands functions or values. An additional function, carbon sequestration, was added to the analysis. The vegetated wetlands exhibit functions that are typical of freshwater palustrine systems. The most important function provided by the Oxbow wetlands is wildlife habitat. Other wetland functions and values provided by the wetlands to a notable degree include flood flow alteration, fish habitat, sediment/toxicant reduction, nutrient removal/transformation, production export, uniqueness/heritage value, and carbon sequestration.

Review of historic USGS maps show that a section of the Woonasquatucket River in the study area was altered sometime between the 1890's and 1938. A portion of the river was cut off from the existing river channel and a new channel created. The cut-off channel, the "Oxbow Remnant", still receives flow from the Woonasquatucket during flood events.

Review of aerial photographs taken between 1938 and present reveals that several acres of Lyman Mill Pond have been filled. The filled area is currently low quality emergent

wetland and upland (old field). This area and nearby underutilized industrial land are a promising restoration site. There is also a good opportunity to restore stream and riparian habitat along the lower reaches of Assapumpset Brook.

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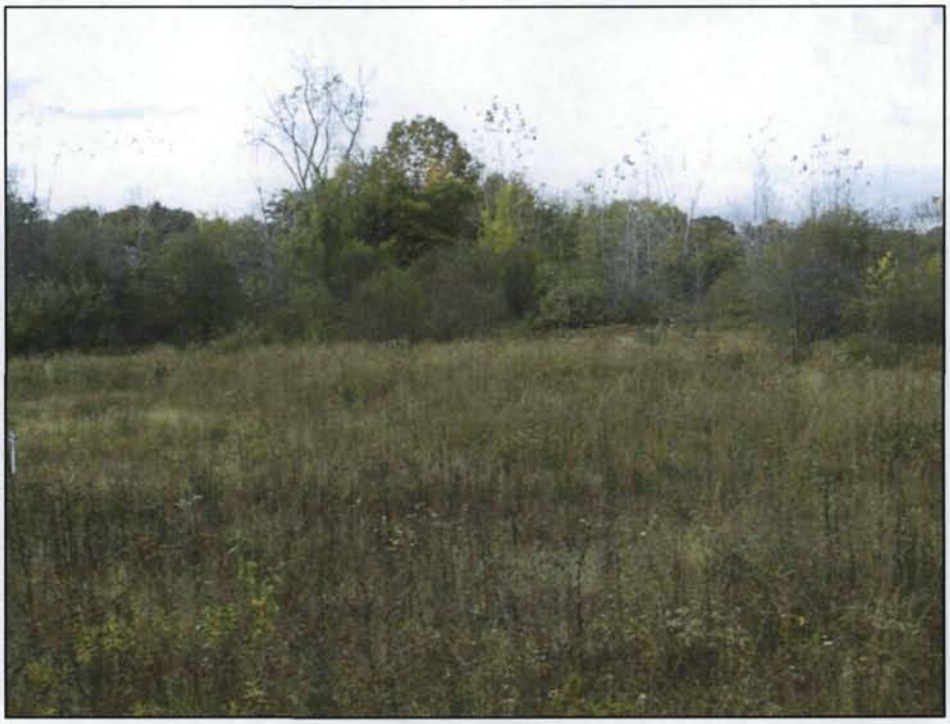
PHOTOGRAPHS

Photograph 1: Emergent wetland at the north end of Lyman Mill Pond.

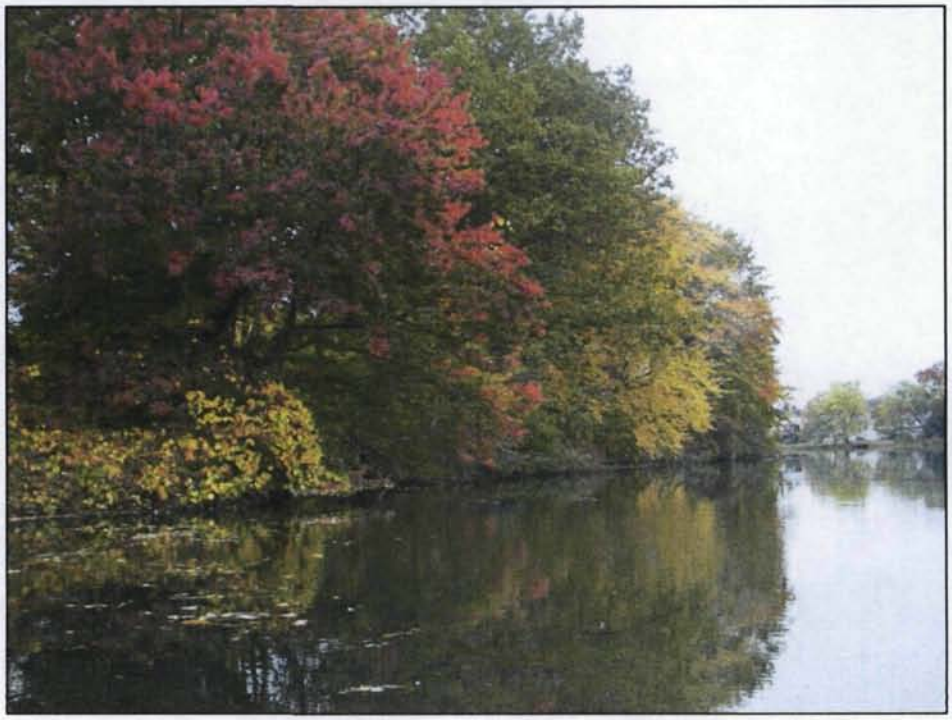
Photograph 2: Skunk cabbage in forested wetland.

Photograph 3: Shallow root system of red maple in Oxbow Area wetland.

Photograph 4: The large upland island south of Oxbow Remnant.



Photograph 5: Emergent wetland in the filled area west of Lyman Mill Pond.



Photograph 6: Riparian vegetation along Lyman Mill Pond.

Photograph 7: Discharge from retention pond to Lyman Mill Pond.

Photograph 8: The Oxbow Remnant.

Photograph 9: Oxbow Remnant (eastern end).

Photograph 10: Pool "B" .

Photograph 11: Pool "C".

Photograph 12: Pool "E".

Photograph 13: Pool F.

Photograph 14: Woonasquatucket River downstream of Allendale Road bridge.

Photograph 15: Wonnasquatucket River between Allendale Dam and Lyman Mill Pond.

Photograph 16: Assapumpset Brook (looking upstream towards culvert outlet).

Photograph 17: Assapumpset Brook at junkyard.

Photograph 18: Storm drain channel (intermittent stream) in Oxbow Area.

Photograph 19: Iron rich seepage water in Oxbow Area wetland.

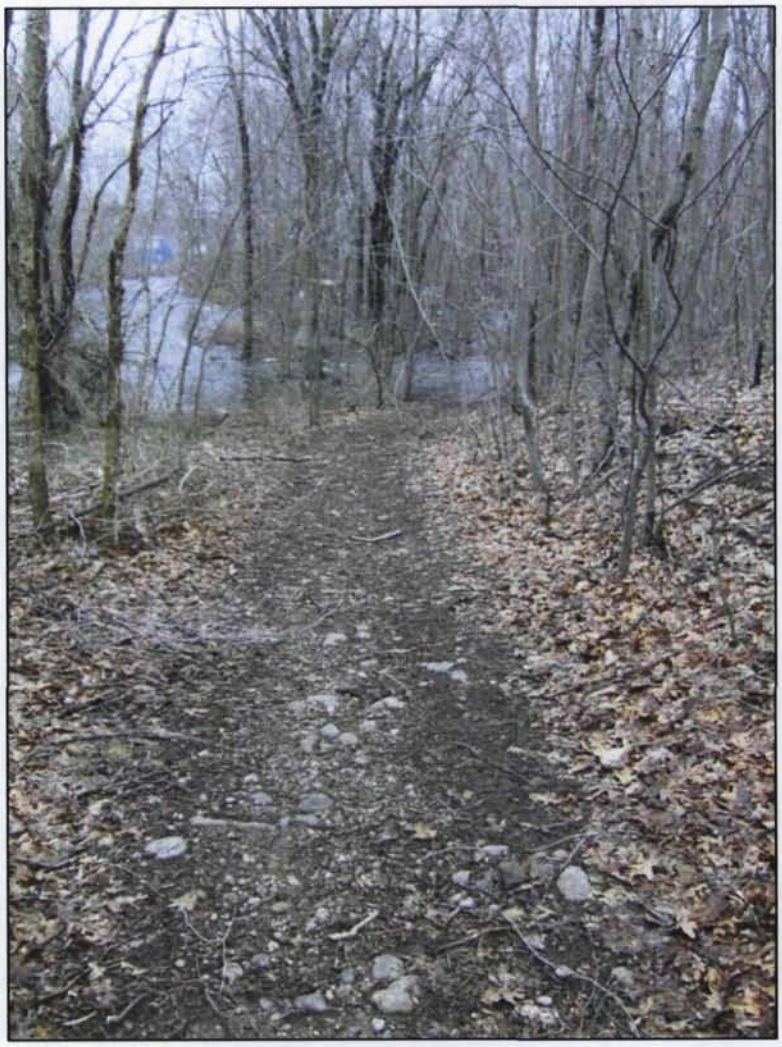
Photograph 20: Oxbow Area during April 16, 2007 flood event.

Photograph 21: Oxbow Area during April 16, 2007 flood event.

Photograph 22: Typical density of downed trees and limb wood.

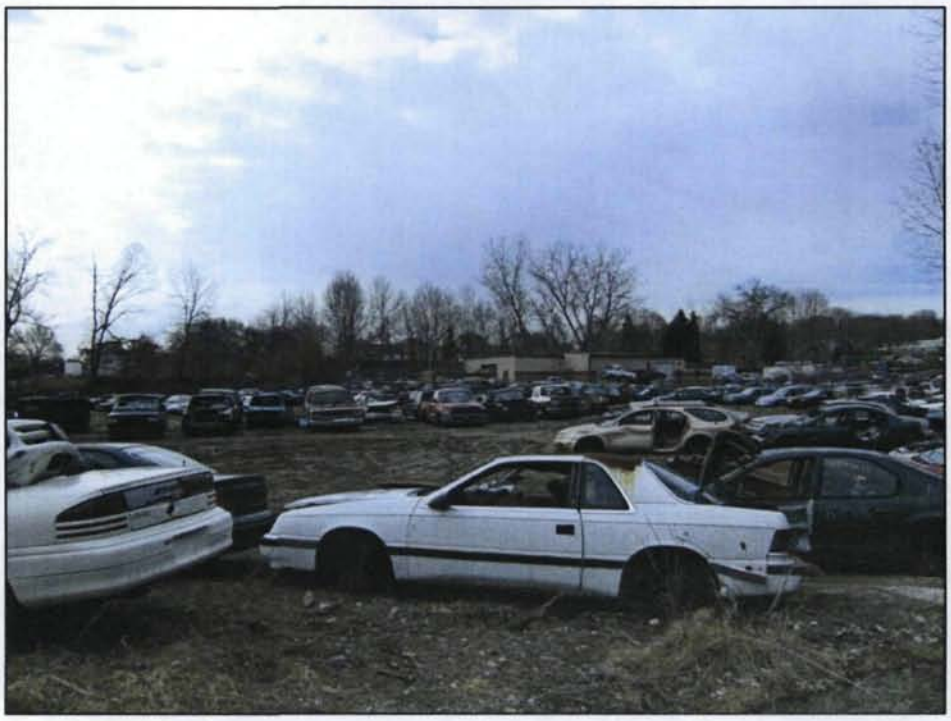
Photograph 23: Woody debris and leaf litter on forest floor.

Photograph 24: Animal burrow in Oxbow wetlands.



Photograph 25: Trail leading to the Oxbow Area from Allendale Avenue.

Photograph 26: Tree house in the Oxbow Area near the banks of the Woonasquatucket River.



Photograph 27: Junkyard along Assapumpset Brook.

APPENDIX A

PLANT COMMUNITY QUANTITATIVE PLOT DATA AND WETLAND DELINEATION DATA FORMS

PROJECT/SITE:	Centerdale	Flag 333 Upland Plot (large upland island south of Oxbow Remnant)
DELINEATOR(S):	M. Penko, J. Johnson	DATE: 10/24/2006

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*white oak*	8.2	0.03		8.8	FACU-
	red oak	13.2	0.09		61.2	FACU
	red oak	14.3	0.10			
	red oak	5.7	0.02			
	red maple	12.6	0.08		26.5	FAC
	red maple	3.8	0.01			
	musclewood	3.2	0.01		2.9	FAC
	Total		**0.34**			
Sapling	*red maple*			3		FAC
Shrub	*northern arrowood*			1		FACW-
Shrub	*unknown*			2		
Herbaceous	*winterberry*			1		FACW+

Remarks: Soils: O: trace; A1: 1-5 cm 7.5yr 2.5/1 medium sand; A2: 5 - 10 cm 10yr/3/2; B 10-45 cm, 10yr4/6 medium sand, dry with stones. Hydrology: no indicators

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**Flag 333 Wetland Plot (large upland island south of Oxbow Remnant)**	
DELINEATOR(S):	M. Penko, J. Johnson	**DATE:** 10/24/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*white oak*	8.4	0.04		12.1	FACU-
	red oak	12.7	0.08		48.5	FACU
	red oak	12.8	0.08			
	red maple	5.7	0.02		42.4	FAC
	red maple	5.7	0.02			
	red maple	5.7	0.02			
	red maple	6.2	0.02			
	red maple	11.0	0.06			
	Total		**0.33**			
Sapling	*glossy buckthorn*			3		NI
Shrub	*sweet pepperbush*			4		FAC+
	glossy buckthorn			2		NI
Vine	*grape sp.*			1		
	greenbriar			3		FAC
Herbaceous	*sweet pepperbush*			2		FAC+

Remarks: Soils: A1: 1-9 cm organic mineral soil 10yr 2/2; A2: 9-15 cm, organic mineral soil 10yr 2/1; A3: 15-19 cm, sand 5 yr/2.5/2; B: gray sand with yellowish redoximporphic features (50%) 2.5y 5/4; Hydrology: water in soil pit at 8 cm

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	TRANSECT: T1	PLOT: 1
DELINEATOR(S):	M. Penko, R. Loyd	DATE: 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Quercus rubra/velutina*	14.2	0.10		52	NI
		12.7	0.08			
		10.5	0.06			
		13.7	0.10			
		12.3	0.08			
	Acer rubrum	5.4	0.01		20	FAC
		5.6	0.02			
		8.3	0.03			
		13.7	0.10			
	Betula alleghaniensis	9.2	0.04		6	FAC
	Fraxinus americana	4.8	0.01		1	FACU
	Populus deltoides	9.1	0.04		11	FAC
		7.5	0.03			
		6.2	0.02			
	Prunus serotina	6.4	0.02		3	FACU
	Quercus alba	9.7	0.05		6	FACU-
Sapling	*Acer rubrum*			2		FAC
	Betula alleghaniensis			2		FAC
	Fraxinus americana			1		FACU
	Juniperus virginiana			1		FACU
	Quercus alba			3		FACU-
	Rhamnus cathartica			2		UPL
Herbaceous	*Convolvulus arvensis*			1		NI
	Grass			1		
	Prunus serotina			1		FACU
	Viburnum dentatum			1		FACW-
	Rhamnus cathartica			2		UPL
	Rubus sp. (dewberry)			1		UPL

Remarks: Half of the plot is on a hummock (upland island). There is no standing dead vegetation or snags larger than 5" in diameter. There are 4 snags >3" in diameter and a lot of woody debris. There is some trash on the ground. There is evidence of flooding (leaf dams, etc.). There is animal burrow in the plot approximately 6" in diameter.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T1	**PLOT:** 2
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	8.9	0.04		5	FAC
	Quercus rubra/velutina	5.1	0.01		95	FACU-
		9.6	0.05			
		6.4	0.02			
		8.3	0.03			
		12.1	0.07			
		9.7	0.05			NI
		8.0	0.03			
		10.4	0.05			
		11.5	0.07			
		10.8	0.06			
		4.3	0.01			
		12.4	0.08			
		9.2	0.04			
		11.9	0.07			
		11.6	0.07			
		11.5	0.07			
Sapling	*Castanea dentata*			1		NI
Herbaceous	*Vaccinium angustifolium*			3		FACU-

Remarks: Plot is an upland "island" area. There is one large standing snag. There are several 3" -6" diameter limbs on ground. There are no burrows. The soil is upland soil.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T1	**PLOT:** 3
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	7.3	0.03		22.5	FAC
		8.4	0.04			
		10.4	0.05			
		5.6	0.02			
		4.6	0.01			
	Pinus resinosa	7.5	0.03		4.4	FACU
	Quercus alba	6.7	0.02		3.5	FACU-
	Quercus rubra/velutina	13.7	0.10		69.5	FACU-
		12.6	0.08			
		13.4	0.09			
		8.9	0.04			
		12.9	0.08			
		10.4	0.05			NI
Sapling	*Carpinus caroliniana*			1		FAC
	Prunus serotina			1		FACU
	Viburnum dentatum			1		FACW-
Herbaceous	*Carpinus caroliniana*			1		FAC
	Prunus serotina			1		FACU
	Gaultheria procumbens			1		U
	Unknown			1		
	Viburnum dentatum			1		FACW-

Remarks: Plot is immediately adjacent to pool. There is a standing dead tree7" in diameter, and 2 smaller snags. There are 3 fallen dead trees in the 4-6" diameter range.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T1	**PLOT:** 4
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	5.4	0.01		58.9	FAC
		9.1	0.04			
		4.9	0.01			
		10.0	0.05			
		8.4	0.04			
	Quercus rubra/velutina	14.6	0.11		41.1	NI
Sapling	*Clethra alnifolia*			5		FAC+
	Sassafras albidum			2		FACU
	Smilax spp.			2		FACU
Herbaceous	*Clethra alnifolia*			4		FAC+
	Sassafras albidum			1		FACU
	Maianthemum canadense			1		FAC-
	Unknown			1		
	Viburnum dentatum			1		FACW-

Remarks: This is a half-plot because of proximity to water. There is a standing dead snag 6" in diameter, three fallen snags that are 6" in diameter and several smalelr ones. There is a 6" animal burrow in the bank.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	TRANSECT: T2	PLOT: 1
DELINEATOR(S):	M. Penko, R. Loyd	DATE: 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (Inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	7.8	0.03		31.4	FAC
		4.0	0.01			
		14.6	0.11			
		11.1	0.06			
		15.4	0.12			
		9.4	0.04			
		9.9	0.05			
		4.3	0.01			
		0.5	0.00			
	Celtis occidentalis	16.4	0.14		9.8	FACU
	Populus deltoides	8.8	0.04		54.6	FAC
		23.4	0.28			
		29.5	0.44			
	Prunus serotina	8.0	0.03		2.3	FACU
	Fraxinus americana	5.7	0.02		1.2	FACU
	Quercus alba	4.3	0.01		0.7	FACU-
Sapling	*Acer rubrum*			3		FAC
	Lonicera morrowi			3		NI
	Populus deltoides			3		FAC
Herbaceous	*Celastrus orbiculatus*			4		
	Rubus sp. (dewberry)			1		
	Unknown Seedling			1		

Remarks: This is an upland plot with 4 6-10" diameter down snags and a tree with a cavity. There is a large depression that could hold water. There are MANY earthworms present.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T2	**PLOT:** 2
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	16.4	0.14		88.8	FAC
		11.3	0.06			
		8.4	0.04			
		9.4	0.04			
		9.2	0.04			
		10.7	0.06			
		5.6	0.02			
		10.0	0.05			
		4.9	0.01			
		21.5	0.23			
		13.2	0.09			
		11.1	0.06			
		13.2	0.09			
		11.9	0.07			
	Celtis occidentalis	4.8	0.01		1.0	
	Fraxinus americana	15.1	0.12		10.2	FACU
Sapling	*Berberis vulgaris*			1		FACU
	Lonicera morrowi			3		NI
	Prunus serotina			2		FACU
	Unknown sp			3		
	Unknown sp			1		
Herbaceous	*Lonicera morrowi*			4		NI
	Rubus sp. (dewberry)			1		
	Toxicodendron radicans			1		FAC

Remarks: The base of this plot is wetland and the center is an artificial upland mound approximately 5 meters in diameter. There is a standing dead snag 12" in diameter, about 8 6-10" diameter fallen dead snags, and a cavity tree. There is a lot of poison ivy growing up into the canopy. There are several animals burrows in the mound.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T2	**PLOT:** 3
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	14.8	0.11		21.9	FAC
		8.1	0.03			
		7.5	0.03			
	Ailanthus altissima	4.8	0.01		1.5	NI
	Catalpa speciosa	29.0	0.43		53.8	FAC
	Malus pumila	11.5	0.07		17.0	
		10.0	0.05			
		5.7	0.02			
	Fraxinus americana	9.6	0.05		5.9	FACU
Sapling	*Celastrus scandens*			2		FACU-
	Rhamnus cathartica			5		UPL
	Unknown sp			2		
Herbaceous	*Impatiens capensis*					FACW
	Toxicodendron radicans					FAC

Remarks: This plot is within the braided outflow channel from the nearby culvert. There is a standing dead tree 8" in diameter. There are several 6"+ snags on the ground. There are scattered sandy deposits from the culvert.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T2	**PLOT:** 4
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Acer rubrum*	8.3	0.03		44.9	FAC
		8.6	0.04			
		9.4	0.04			
		10.7	0.06			
	Fraxinus americana	3.8	0.01		7.2	FACU
		6.4	0.02			
	Quercus rubra/velutina	4.1	0.01		48.0	FACU-
		3.2	0.01			
		18.5	0.17			FACU-
Sapling	*Cornus amomum*			1		FACW
	Fraxinus americana			1		FACU
	Hamamelis virginiana			3		FAC-
	Rhamnus cathartica			2		UPL
	Quercus velutina			1		NI
	Viburnum dentatum			4		FACW-
Herbaceous	*Impatiens capensis*			2		FACW
	Osmunda cinnamomea			2		FACW
	Rhamnus cathartica			1		UPL
	Viburnum dentatum			3		

Remarks: *There are standing dead snags 6" and 4" in diameter. There are several fallen dead snags <3" in diameter. There is a cavity tree present.* In the nearby understory there is royal fern, sensitive fern, and winterberry. There are numerous acorns on the ground.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

PROJECT/SITE:	Centerdale	**TRANSECT:** T2	**PLOT:** 5
DELINEATOR(S):	M. Penko, R. Loyd	**DATE:** 10/12/2006	

VEGETATION

Stratum	Plant Species	DBH (inches)	Basal Area (m^2)	% Cover*	% Dominance	NWI Status
Trees	*Populus tremuloides*	7.0	0.02		100.0	FACU
		2.2	0.00			
		3.0	0.00			
		3.7	0.01			
		3.3	0.01			
Sapling	*Clethra alnifolia*			4		FAC+
	Ilex verticillata			1		FACW+
	Rhamnus cathartica			3		UPL
	Smilax			1		FAC
	Vaccinium angustifolium			2		FACU-
	Viburnum dentatum			2		FACW-
Herbaceous	*Clethra alnifolia*			2		FAC+
	Osmunda cinnamomea			2		FACW
	Osmunda regalis			1		OBL

Remarks: This plot is adjacent to an oxbow and is very wet. The mineral soil is dark with a high organic content. The are several about 10 4-6" snags on the ground, including a log covered with sphagnum moss. There are several nearby pools with skunk cabbage. The aspen trees are growing on a slight hummock.

* For % Cover:	1 = <1%	2 = 1-5%	3 = 5-25%	4 = 25-50%	5 = 50-75%	6 = 75-100%

APPENDIX B

PLANT SPECIES LIST

Scientific Name	Common Name	Location								
		Oxbow Area				Lyman Mill Pond	Filled Area			Assapumpset
		Forested Upland	Forested Wetland	FO/SS	Emergent Wetland	Riparian	Main Emergent Wetland	Upland	Small Emergent Wetland	
Grasses and Herbs										
Aralia nudicaulis	Wild sarsaparilla	x								
Arisaema triphyllum	Jack in the pulpit		x							
Artemesia compestris	Wormwood							x		
Artemesia vulgaris	Mugwort							x		
Aster sp.	Aster sp.	x	x					x		
Bidens sp.	Bidens sp.	x	x					x		
Boehmeria cylindrica	False nettle		x							
Carex lurida	Lurid sedge		x							
Carex sp	Sedge	x	x					x		
Carex stricta	Tussock sedge								x	
Chelone glabra			x							
Convallaria majalis	Lily of the valley	x								
Conyza candensis	Horseweed							x		
Cyperus sp.	Flatsedge								x	
Daucus carota	Wild carrot							x		x
Dennstaedtia punctilobula	Hay-scented fern	x								
Dichanthelium clandestinum	Deer tongue grass							x		x
Eleocharis sp.	Spike rush								x	
Equisetum sp.	Horsetail							x		
Erigeron annuus	Daisy fleabane								x	x
Eupatorium maculatum	Joe-pye weed									x
Eupatorium perfoliatum	Bonset		x					x	x	
Eupatorium purpureum	Joe-pye weed							x		
Euthamia graminifolia	Lance-leaved goldenrod						x		x	
Galium sp.	Bedstraw							x		
Goodyera sp.	Ratlesnake plantain	x								
Graminae	Unidentifeid grasses	x					x	x	x	
Impatiens capensis	Jewelweed	x	x							
Ipomoea	Morning glory				x					
Juncus effusus	Soft rush		x						x	x
Lycopodium obscurum	Tree club moss	x								

Scientific Name	Common Name	Location								
		Oxbow Area				Lyman Mill Pond	Filled Area			Assapumpset
		Forested Upland	Forested Wetland	FO/SS	Emergent Wetland	Riparian	Main Emergent Wetland	Upland	Small Emergent Wetland	
Grasses and Herbs										
Lythrum salicaria	Purple loosestrife								x	x
Maianthemum canadense	Canada mayflower	x			x					
Mikania scandens	Climbing hempweed				x	x				
Onoclea sensibilis	Sensitve fern	x	x		x					x
Osmunda cinnamomea	Cinnamon fern	x	x							
Osmunda regalis	Royal fern		x							
Oxalis montana	Common wood-sorrel		x							
Oxalis sp.	Yellow wood sorrel	x								
Panicum sp.	Panic grass						x			
Phragmites australis	Common reed		x							x
Phytolacca americana	Pokeweed		x							
Polygonum cuspidatum	Oriental knotweed	x						x		
Polygonum sp.	Smartweed	x	x						x	
Potemageton	Pondweed				x					
Rumex crispus	Dock							x	x	
Sagittaria latifolia	Broadleaf arrowhead				x					
Schizachyrium scoparium	Little bluestem							x		
Scirpus cyperinus	Woolgrass							x		
Solidago sp.	Goldenrod sp.							x	x	x
Solidago tennuifolia	Slender fragrant goldenrod								x	x
Symplocarpus foetidus	Skunk cabbage	x	x	x						
Tanacetum vulgare	Common tansy							x	x	
Thalictrum pubescens	Tall meadow-rue		x							
Thelypteris palustris	Marsh fern			x					x	
Trillium sp.	Trillium	x								
Typha sp.	Cattail sp.							x	x	x
Urtica dioica	Stinging nettle		x							
Verbena hastata	Blue vervain								x	
Vicia cracca	Vetch							x		
Yucca	Yucca	x								

Scientific Name	Common Name	Location								
		Oxbow Area				Lyman Mill Pond	Filled Area			Assapumpset
		Forested Upland	Forested Wetland	FO/SS	Emergent Wetland	Riparian	Main Emergent Wetland	Upland	Small Emergent Wetland	
Tree, Shrubs, and Vines										
Acer negundo	Box elder									x
Acer platanoides	Norway maple	x								
Acer rubrum	Red maple	x	x		x	x				x
Acer saccharum	Sugar maple	x								
Ailanthus altissima	Tree of heavan	x						x		
Alnus incana rugosa	Speckled alder					x		x	x	x
Alnus serrulata	Smooth alder				x					
Amorpha fruticosa	False indigobush					x				
Berberis thunbergii	Japanese barberry	x	x			x				
Betula alleghaniensis	Yellow birch	x	x							
Betula lenta	Black birch	x								
Betula populifolia	Gray birch	x				x		x		
Carpinus caroliniana	Ironwood	x	x							
Catalpa bignoniodes	Common catalpa	x	x					x		x
Celastrus orbiculata	Asiatic bittersweet	x				x		x		
Celtis occidentalis	Common hackberry	x								
Clethera alnifolia	Sweet pepperbush	x	x			x				
Cornus ammonum	Silky dogwood									x
Cornus sericea	Red-osier dogwood				x	x				x
Decadon verticillatus	Water willow				x					x
Elaeagnus angustifolia	Russian olive							x		
Elaeagnus umbellata	Autumn Olive							x		x
Fagus grandifolia	American beech	x				x				
Fraxinus americana	White ash	x								
Fraxinus nigra	Black ash		x							
Fraxinus pennsylvanica	Green Ash		x							
Hamamelis virginiana	Witch-hazel	x	x			x				
Illex verticillata	Winterberry		x			x				
Juniperus virginiana	Red cedar	x						x		
Lonicera sp.	Honeysuckle	x	x	x	x					
Magnolia virginiana	Sweet bay		x							

Scientific Name	Common Name	Location								
		Oxbow Area				Lyman Mill Pond	Filled Area			Assapumpset
		Forested Upland	Forested Wetland	FO/SS	Emergent Wetland	Riparian	Main Emergent Wetland	Upland	Small Emergent Wetland	
Tree, Shrubs, and Vines										
Parthenocissus quinquefolia	Virginia creeper	x				x				
Pinus rigida	Pitch pine	x								
Populus deltoides	Cottonwood	x	x					x		x
Populus tremuloides	Aspen	x	x					x		
Prunus serotina	Black cherry	x								
Pyrus malus	Apple	x	x							
Quercus alba	White oak	x				x		x		
Quercus bicolor	Swamp white oak	x	x					x		
Quercus rubra	Northern red oak	x	x			x		x		
Quercus velutina	Black oak	x	x							
Rhamnus cathartica	Common buckthorn	x								
Rhamnus frangula	Glossy buckthorn	x	x					x	x	
Rhus radicans	Poison ivy	x	x					x		
Rhus typhina	Staghorn sumac					x		x		
Rosa multiflora	Multiflora rose	x				x		x		
Rosa palustris	Swamp Rose				x					
Rubus sp.	Dewberry	x						x		
Salix discolor	Pussy willow								x	x
Salix nigra	Black willow		x		x	x	x	x		x
Salix sp.	Willow sp.					x				
Smilax rotundifolia	Common greenbriar	x	x							x
Solanum dulcamara	Bittersweet nightshade	x								
Spiraea tomentosa	Steeplebush							x		
Spirea latiolia	Meadowsweet							x		
Toxicodendron radicans	Poison ivy									x
Ulmus americana	American elm	x								
Vaccinium angustifolium	Low bush blueberry	x								
Vaccinium corymbosum	Highbush blueberry		x			x		x		
Viburnum acerifolium	Maple-leaved viburnum		x							
Virburnum recognetum	Northern arrowwood	x	x			x				x
Vitis sp.	Wild grape	x				x				x

APPENDIX C

INDICATORS OF WETLAND FUNCTIONS AND VALUES FROM ACOE HIGHWAY METHODOLOGY

Indicators of Wetland Functions and Values (from the Highway Methodology Handbook)

1 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

2. 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

3. 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.
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) Absence of invasive aquatic plants or animals
19) Other

4. 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.
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

5. 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.
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

6. PRODUCTION EXPORT

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) Potential for production of forest resources.
16) Other

7. 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
16) shoreline on a small scale (inches) during minor flood events or potentially erosive events.
17) Other

8. 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.

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 openwater.
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) Absence of invasive plants.
25) Other.

9. 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 toaccommodate 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

10. 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

11. 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

12. 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

13. RARE, THREATENED, AND ENDANGERED SPECIES HABITAT

This value considers the suitability of the wetland to support threatened or endangered species.

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.

14. CARBON SEQUESTRATION

This function considers the suitability of the wetland to sequester carbon.

CONSIDERATIONS/QUALIFIERS

1) Wetland is forested and contains a large amount of biomass in living trees and shrubs.
2) Wetland contains large amount of snags or downed woody debris.
3) Wetland has organic soil or an organic rich mineral soil.
4) Wetland soil normally saturated.
5) Wetland contains floating mat of organic material.
6) Wetland is underlain by deep peat deposits.
7) Wetland is nutrient poor (ombrotrophic) with low decomposition rate.

APPENDIX D

FUNCTIONS AND VALUES ASSESSMENT DATA FORMS

Oxbow Area Wetland Function-Value Evaluation Form

Wetland Community Type or Area: Forested **Area: 11.1 acres**

Function/Value	Suitability Y	Suitability N	Rationale (reference number)	Principal F/V	Comments
Groundwater Recharge/Discharge	X		2,3,4,7,13,15		Receives ground water discharge from adjacent uplands.
Floodflow Alteration	X		4,5,6,7,8,10,11,12,13,14	X	Receives surface flow from Woonasquatucket.
Fish and Shellfish Habitat		X	4,6,8,12,14,16,17		
Sediment/Toxicant Retention	X		2,3,7,10,11,12,14,16	X	Intermittently flooded.
Nutrient Removal	X		3,4,10,11,12		Intermittently flooded.
Production Export	X		1,2,4,5,7,8,12,13,15		Potential to produce forest resources.
Sediment/Shoreline Stabilization	X		1,2,4,7,8,9,14		
Wildlife Habitat	X		3,6,8,10,11,12,13,14,15,16,17,18,19,21,22	X	Along with other Oxbow Area wetlands and forested upland is a significant habitat island.
Recreation		X	4,5,8,11,12		Accessible but public use discouraged because of contamination. No hunting.
Educational/Scientific Value		X	5, 16		USEPA superfund site.
Uniqueness/Heritage	X		1,3,4,5,15,22,23,25,27,28,32	X	WR is designated an American Heritage River.
Visual Quality/Aesthetics		X	4		Noise and odor from adjacent industrial facilities.
Rare/Endangered Species Habitat		X			
Carbon Sequestration	X		1,2	X	An apparently productive red maple forest.

Notes:

Oxbow Area Wetland Function-Value Evaluation Form

Wetland Community Type or Area: Forested/scrub-shrub **Area:** 3.8 acres

Function/Value	Suitability Y	Suitability N	Rationale (reference number)	Principal F/V	Comments
Groundwater Recharge/Discharge	X		2,3,7,15		
Floodflow Alteration	X		4,5,6,7,8,10,11,12,13,14,18	X	Receives surface flow from Woonasquatucket.
Fish and Shellfish Habitat		X	4,8,12,14,16		Braided channel flows through the wetland.
Sediment/Toxicant Retention	X		2,3,7,10,11,12,14,16	X	Intermittently flooded.
Nutrient Removal	X		3,4,10,11,12		Intermittently flooded.
Production Export	X		1,2,4,5,7,8,12,13,14		
Sediment/Shoreline Stabilization	X		4,7,12,13		
Wildlife Habitat	X		3,5,6,8,10,11,12,13,14,15,16,17,18,19,21, 22	X	Along with other Oxbow Area wetlands and forested upland is a significant habitat island.
Recreation		X	5		Inaccessible and public use discouraged because of contamination. No hunting.
Educational/Scientific Value		X	5, 16		USEPA superfund site.
Uniqueness/Heritage	X		1,3,4,5,15,22,23,25,27,28,32	X	WR is designated an American Heritage River.
Visual Quality/Aesthetics		X	4		Noise from adjacent industrial facilities.
Rare/Endangered Species Habitat		X			
Carbon Sequestration	X		1,3,4	X	Organic rich mineral soil.

Notes:

Oxbow Area Wetland Function-Value Evaluation Form

Wetland Community Type or Area: Emergent/scrub-shrub **Area:** 2.2 acres

Function/Value	Suitability Y	Suitability N	Rationale (reference number)	Principal F/V	Comments
Groundwater Recharge/Discharge		X	2,3,7		
Floodflow Alteration	X		4,5,6,10,11,12,13,14,18	X	Receives surface flow from Woonasquatucket.
Fish and Shellfish Habitat		X	4,12,14,16		Braided channel flows through the wetland.
Sediment/Toxicant Retention	X		2,3,8,10,11,12,14,15,16	X	Intermittently flooded.
Nutrient Removal	X		3,4,5,6,7,8,9,10,11,12,13,14		Intermittently flooded.
Production Export	X		1,2,4,5,7,8,12,14		
Sediment/Shoreline Stabilization	X		4,7,12,13		
Wildlife Habitat	X		3,5,6,8,11,13,14,15,16,17,18,19,21,22	X	Along with other Oxbow Area wetlands and forested upland is a significant habitat island.
Recreation		X	5		Inaccessible and public use discouraged because of contamination. No hunting.
Educational/Scientific Value		X	5, 16		USEPA superfund site.
Uniqueness/Heritage	X		1,3,4,5,15,22,25,27,28,32	X	WR is designated an American Heritage River.
Visual Quality/Aesthetics		X	4		Noise from adjacent industrial facilities.
Rare/Endangered Species Habitat		X			
Carbon Sequestration	X		3,4	X	Organic rich mineral soil.

Notes:

Oxbow Area Wetland Function-Value Evaluation Form

Wetland Community Type or Area: Emergent (Lyman Mill Pond) **Area:** 5.4 acres

Function/Value	Suitability Y	Suitability N	Rationale (reference number)	Principal F/V	Comments
Groundwater Recharge/Discharge		X	2,3,7		
Floodflow Alteration	X		4,6,10,11,12,13,14,18	X	Receives surface flow from Woonasquatucket.
Fish and Shellfish Habitat		X	4,9,12,14,16		Braided channel flows through the wetland.
Sediment/Toxicant Retention	X		2,3,5,8,10,11,12,14,15,16		Limited surface water contact with vegetation.
Nutrient Removal	X		3,4,5,6,7,8,9,10,11,12,13,14		Limited surface water contact with vegetation.
Production Export	X		1,2,4,5,7,12,14		Abundant purple loosestrife (for pollinators).
Sediment/Shoreline Stabilization	X		4,7,12,13,15		
Wildlife Habitat	X		3,5,6,8,11,13,16,17,18,19,21,22	X	Along with other Oxbow Area wetlands and forested upland is a significant habitat island.
Recreation		X	5		Inaccessible and public use discouraged because of contamination. No hunting.
Educational/Scientific Value		X	5, 16		USEPA superfund site.
Uniqueness/Heritage	X		1,3,4,5,15,22,25,27,28,32	X	WR is designated an American Heritage River.
Visual Quality/Aesthetics		X	4		Noise from adjacent industrial facilities.
Rare/Endangered Species Habitat		X			
Carbon Sequestration	X		3,4	X	Possible floating or semi-floating mat. Organic soil.

Notes:

Oxbow Area Wetland Function-Value Evaluation Form

Wetland Community Type or Area: Emergent (Filled Area) **Area:** 1 acre

Function/Value	Suitability Y	Suitability N	Rationale (reference number)	Principal F/V	Comments
Groundwater Recharge/Discharge		X	7,9,15		Underlain by fill.
Floodflow Alteration		X	4,6,10,11,12,13,18		Flooded only perhaps by extreme events.
Fish and Shellfish Habitat		X	4		Isolated from Lyman Mill Pond.
Sediment/Toxicant Retention		X	2,4,5,7,13,16		Limited surface water contact with wetland.
Nutrient Removal		X	3,4,5,7,8,9,11,13,14		Limited surface water contact with wetland.
Production Export		X	1,2,5,7,12		
Sediment/Shoreline Stabilization		X	15		
Wildlife Habitat	X		3,5,6,8,11,13,16,17,18,19,21,22	X	Along with other Oxbow Area wetlands and uplands is a significant habitat island.
Recreation		X	5		Inaccessible (industrial area, fencing).
Educational/Scientific Value		X	16		
Uniqueness/Heritage		X	1,3,7,,22,25,27,28,32		WR is designated an American Heritage River.
Visual Quality/Aesthetics		X	4		Noise from adjacent industrial facilities.
Rare/Endangered Species Habitat		X			
Carbon Sequestration		X			Low organic mineral soil.

Notes:

Oxbow Area Wetland Function-Value Evaluation Form

Wetland Community Type or Area: Oxbow Remnant **Area:** 0.6 acre

Function/Value	Suitability Y	Suitability N	Rationale (reference number)	Principal F/V	Comments
Groundwater Recharge/Discharge		X			
Floodflow Alteration		X	4,6,10,11,12,13,18		The area has is a channel with little storage capacity.
Fish and Shellfish Habitat	X		2,3,4,5(?),7,8,1014,16,16,17	X	Connected to Lyman Mill Pond
Sediment/Toxicant Retention	X		2,4,5,7,13,161,2,3,4,5,8,10	X	High concentrations of contaminant in sediment.
Nutrient Removal	X		2,3,4,5,6,10,13,14	X	
Production Export		X			
Sediment/Shoreline Stabilization		X	4,6		
Wildlife Habitat		X	3,5,6,8,12,17,19	X	Kingfisher observed in area.
Recreation		X	5		Inaccessible.
Educational/Scientific Value		X	16		USEPA Superfund site.
Uniqueness/Heritage	X		1,7,23,25,28		
Visual Quality/Aesthetics		X	4		Noise from adjacent industrial facilities.
Rare/Endangered Species Habitat		X			Likely habitat for American eel.
Carbon Sequestration		X	3,4		Organic rich sediments.

Notes: