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APPENDIX A

Preliminary Habitat and Biota Impact Assessment of Sediment Remediation Technologies GE Housatonic River Study Area

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I. INTRODUCTION

A key component in the overall evaluation of the feasibility and utility of remedial actions in ecologically sensitive areas, such as wetlands, is the potential for adverse effects to the environment as a result of those remedial actions. As part of the Preliminary Investigation of Corrective Measures (PICM) for the General Electric (GE) Housatonic River Site, ENVIRON has undertaken an assessment, termed the Preliminary Habitat and Biota Impact Assessment, of the potential ecological impacts from certain remedial actions for sediments in the Housatonic River between the GE facility and Woods Pond, in Woods Pond itself, and in the bordering vegetated wetlands adjacent to, and in the floodplain of, the Housatonic River and Woods Pond. Potential intrusive sediment remediation technologies, summarized and screened in the March 1995 PICM Proposal (Canonie Environmental 1995a), include removing the contaminated sediments (dredging or excavation) or capping them (armoring). The potential for impacts resulting from such remedial actions on sensitive habitats and wildlife include: (1) direct physical disturbance of habitats from actual remedial actions; (2) direct physical disturbance of habitats as a result of infrastructure establishment (e.g., access roads, staging areas) and remedial operations; (3) indirect impacts to adjacent and downstream areas from disruption of wetland hydrology and other physical processes; (4) disturbance, displacement, and mortality of biota present in directly disturbed and adjacent areas; and (5) the release and transport of PCBs to less contaminated downstream environments. To evaluate these potential impacts, ENVIRON has undertaken the following tasks:

- First, ENVIRON preliminarily evaluated the potential impacts to habitats and biota, both direct and indirect, resulting from the implementation of applicable sediment remediation technologies, as well as the potential for restoring the remediated areas to pre-remediation conditions; and

- Second, to determine the significance of such impacts within the Housatonic River system, ENVIRON compiled available information describing the existing habitats, biota, and other biological characteristics associated with the Housatonic River, Woods Pond, and the bordering vegetated wetlands, focusing on those attributes that are most important ecologically or are particularly sensitive to disturbance from intrusive remedial actions.

This appendix presents the results of these tasks. It should be emphasized that the discussions contained in this appendix are necessarily preliminary and general because the environmental impacts associated with sediment remedial actions, as well as the potential for restoring disturbed habitats, are highly site-specific, and at this stage of the remedial process for the Housatonic River Site, the need for and specific areas warranting sediment remediation have not been determined and specific remedial alternatives have not been developed.

A. Delineation of the Study Area

Based on the results of the site investigations (BBL 1991, 1992, 1996), the highest PCB concentrations in sediments occur within the Housatonic River between the GE facility and the Woods Pond dam and in Woods Pond itself. PCB concentrations are also elevated in soils present within the floodplain of the river in this stretch, although soil concentrations greater than 1 ppm are generally limited to well within the 10-year floodplain (BBL 1996). Thus, the study area for this preliminary assessment of sediment remedial technologies encompasses the following areas:

- The Housatonic River between the GE facility and Woods Pond dam;
- Woods Pond; and
- Bordering vegetated wetlands and other habitats adjacent to, and within the 10-year floodplain of, the Housatonic River and Woods Pond.

This study area is shown in Figure 1. The study area does not include Silver Lake.

B. Study Description and Information Sources

Based on the above discussion, this study focuses on qualitatively evaluating the potential impacts from intrusive sediment remedial actions (notably removal and armoring) on biota and habitats as well as describing the habitats and biota present within the study area.

1. Potential Impacts of Remedial Actions

The evaluation of potential direct and indirect impacts of sediment remediation on the habitats and biota of the wetlands, Housatonic River channel, and Woods Pond contained within the study area was conducted using available literature on environmental impacts (and restoration potential) to riverine/wetland habitats from anthropogenic disturbances.

2. Description of Habitats and Biota

To compile a description of the habitats and biota present within the study area that could be impacted by remedial actions, a field reconnaissance survey was conducted, the literature was searched for relevant material, and natural resource agencies were consulted. The habitat and biota descriptions focus on:

- Describing the type and areal extent of existing habitats within the Housatonic River, Woods Pond, and bordering wetlands;
- Identifying the potential wetland functions and values for major wetland types in the study area;
- Identifying the terrestrial, wetland, and aquatic plant and animal species and communities associated with these habitat types; and
- Identifying the known or potential occurrences of federal and state threatened, endangered, or special concern plant and animal species or communities in the study area.

A two-day field reconnaissance survey of the major wetland/aquatic habitats present within the study area was conducted by two ENVIRON biologists on 5 and 6 October 1995. During this survey, the general habitat types delineated on available mapping were assessed against actual conditions, a qualitative appraisal of habitat quality was made for each habitat type/location within the study area, and incidental observations of fauna and flora were noted.

Specific information sources used for this evaluation include: (1) site-specific consultant reports prepared for GE (e.g., ChemRisk 1994; Chadwick & Associates 1994; BBL 1991, 1992, 1996); (2) the Massachusetts Natural Heritage Atlas (MADFW 1995c); (3) National Wetland Inventory (NWI) and U.S. Geological Survey (USGS) topographical maps for the Pittsfield East, Pittsfield West, Stockbridge, and East Lee 7.5-minute quadrangles; (4) soil survey of Berkshire County (USDA 1988); (5) Housatonic River Protected Open Space & NHESP Habitat Areas mapping from the Massachusetts Geographical Information System (MADFW 1994); (6) Christmas Bird Count data compiled by the National Audubon Society; and (7) Breeding Bird Atlas Project data (compiled in Veit and Peterson 1993). In addition, the open literature was searched for reports containing relevant data pertaining to the study area and for general references on the habitats and geographical ranges of wildlife species.

The following state and federal natural resource agencies were contacted for information concerning fish and wildlife resources (including rare and endangered species): (1) U.S. Fish and Wildlife Service (USFWS) New England Field Office; (2) Massachusetts Department of Fisheries and Wildlife (MADFW) Western Wildlife District office in Pittsfield; (3) MADFW Field Office in Westborough; and (4) MADFW Natural Heritage Program.

II. PHYSIOGRAPHIC FEATURES OF THE STUDY AREA

The study area is located within Berkshire County, Massachusetts, which is notably hilly and rugged. The county, located within the New England Physiographic Province, is contained within three major physiographic sections: the Berkshire Hills, the Taconic Range, and the Berkshire Valley (NERBC 1980; Veit and Peterson 1993). The Berkshire Hills, a southern extension of Vermont's Green Mountains, form a ridge that extends down the eastern half of Berkshire County. The Taconic Range, which extends from west-central Vermont to southeastern New York, forms the western boundary of Berkshire County. The Berkshire Valley, which contains the study area, lies between the Taconic Range and the Berkshire Hills. The valley, which is characterized by many cultivated pastures and rocky (limestone) outcrops, contains the headwaters of the Housatonic River (Veit and Peterson 1993).

Housatonic River elevations range from 1,500 feet above mean sea level (msl) near the origin of the East Branch to sea level where the river enters Long Island Sound in Connecticut (Lawler, Matusky, and Skelly Engineers 1975). The study area encompasses a relatively low-gradient portion of the river, with elevations ranging from about 972 feet msl at the GE facility to approximately 958 feet msl at Woods Pond dam. Since the study area encompasses about 12 river miles, the elevational gradient is about 1.2 feet per mile of river. Most of this elevational change occurs within the upstream half of the study area; the downstream half of the study area is relatively flat.

Soils in the Housatonic River Basin may be divided into six major associations based on the nature of the parent material (NERBC 1980). Three of these are upland soils (Paxton-Woodbridge, Charlton-Hollis, and Lyman-Peru-Marlow-Berkshire) derived from glacial till and schist and are characterized by shallow depth to bedrock, hardpan, stoniness, or steep slope. Soils derived from limestones and schists in the valleys (Copake-Groton) and western highlands (Stockbridge-Farmington-Amenia-Pittsfield) are deep and well drained. Finally, Hinckley-Merrimac soils are found along the valley edges on terraces of glacial outwash.

They are sandy and well drained, deep, acidic, and are underlain by thick beds of sand and gravel.

The study area generally falls within the Copake-Hero-Hoosic soil complex (comparable to the Copake-Groton association discussed above). These soils are very deep, well drained, nearly level to moderately steep, loamy soils formed in glacial outwash (USDA 1988). On a finer scale, at least 17 soil series are represented within the study area; the majority are sandy loams or silt loams although other types, such as mucks, are also represented. Limerick silt loam, Winooski silt loam, Saco silt loam, and Palms and Carlisle mucks are the most common soil types present in the study area in terms of areal extent (USDA 1988).

Average annual precipitation in the study area region is 46 to 48 inches and annual snowfall averages 60 to 70 inches. Monthly average temperatures range from 28°F in January to 68°F in July, with an average annual temperature of 45°F. The average length of the growing season ranges from 115 to 125 days (NERBC 1980).

III. POTENTIAL REMEDIAL IMPACTS TO HABITATS AND BIOTA

In this section, the potential impacts, both direct and indirect, of intrusive sediment remediation technologies on the habitats and biota present within the study area are assessed in a preliminary manner. The assessment focuses on potential sediment remediation technologies that would significantly disturb the sediments, specifically removal (dredging or excavation) technologies and armoring (capping).

Contaminated sediments can be removed through either dredging or excavation. Dredging is normally defined as the removal of sediment using equipment specifically designed to remove material from below the water. Hydraulic, mechanical, and pneumatic dredging technologies were selected for evaluation in the PICM (Canonie Environmental 1995a). Excavation is defined as the removal of sediments using conventional land-based excavation and earth-moving equipment. The technique of river isolation and wet excavation using conventional earthmoving equipment was also selected for evaluation in the PICM. Once sediments are removed, they must be dewatered and transported to a treatment or disposal facility. These steps are also evaluated in the PICM report.

Armoring, also known as capping, involves placing layers of clean material over the contaminated sediment to reduce the potential for direct contact of human or ecological receptors to the contaminated sediments and to prevent contaminated sediments from being washed downstream or becoming resuspended in the water column. The thickness of, and materials used to construct, the cap are designed to prevent burrowing organisms from contacting the underlying sediments and to provide a clean substrate for bottom feeding species. The armoring materials can consist of granular soils or rock, geosynthetic materials, or a combination of both (Canonie Environmental 1995a).

The present evaluation of the environmental impacts of these remedial technologies is necessarily preliminary and general. The impact of using these technologies to remediate aquatic, wetland, and/or terrestrial ecosystems is highly dependent on the characteristics of the specific area that is to be dredged, excavated, or capped, as is the potential for restoration to pre-remediation conditions. At this stage of the remedial process, the need for and areal extent of sediment remediation have not been determined, the particular areas for which these remedial technologies will be considered have not been identified, and specific remedial alternatives have not been developed. Accordingly, this evaluation will be general, and it will assume a fairly extensive application of the remedial technologies, since the specific locations for more limited application cannot be determined at this time. Once the need for and specific areas to be subject to sediment remediation have been determined and remedial alternatives developed, a more detailed and specific evaluation of the environmental impacts of sediment removal and/or armoring in those areas, as well as potential mitigation measures and an evaluation of restoration potential, can be made.

A. Agency Guidance on Remedial Impacts to Ecological Receptors

Draft Massachusetts Department of Environmental Protection (MADEP) guidance on ecological risk assessment briefly addresses feasibility study considerations. Although not yet official MADEP policy, it states that risks from contaminants in the environment must be balanced with potential harm resulting from habitat destruction during remediation. This is particularly applicable to wetland habitats protected under the Massachusetts Wetland Protection Act and to habitats occupied by rare species.

USEPA Remedial Investigation/Feasibility Study guidance (USEPA 1988) recommends that potential adverse environmental impacts that may result from the construction and implementation of a remedial alternative be evaluated. USEPA ecological risk assessment guidance, developed primarily for the Superfund program, also acknowledges that remedial actions can have environmental impacts (USEPA 1989a, 1989b). The most recent draft ecological risk assessment guidance (USEPA 1994a) states that risk reductions associated with the cleanup of contaminants must be balanced with potential impacts of the remedial actions themselves. As such, consideration of the environmental effects of the remedy itself may result in a decision to allow higher contaminant levels to remain on-site than would otherwise be allowable based on the results of the risk assessment. This balance may also require tradeoffs between long-term risk and short-term impacts.

USEPA has developed a contaminated sediment management strategy (USEPA 1994b) which states that "USEPA will not proceed with an active clean-up when implementation of the remedial alternative would cause more environmental harm than leaving the contaminants in place". USEPA guidance on selecting remediation techniques for contaminated sediments (USEPA 1993) also states that the no-action alternative (natural recovery) is appropriate when the environmental effects of clean-up are more damaging than allowing the contaminants to remain in place. Thus, in appropriate circumstances, the best strategy or preferred remediation technique for a contaminated sediment site may be implementation of source controls allowing natural recovery to occur (USEPA 1994b).

B. Potential Ecological Impacts of Intrusive Remedial Actions

Potential impacts to habitats and biota from the implementation of intrusive remedial actions (removal and armoring) can be divided into direct impacts and indirect impacts. Each of these types of impacts can have relatively long-term or relatively short-term impacts to ecological receptors. These potential impacts are discussed below separately for removal and armoring technologies. Where available, specific examples from the literature are provided.

1. Dredging/Excavation

The direct and indirect effects of dredging on biota and their habitats have been fairly well documented, primarily from environmental impact assessments of navigational dredging projects in rivers, harbors, and estuaries (e.g., USACOE 1992, 1976a, 1976b). These impacts are summarized below as they could potentially pertain to the Housatonic River study area and are based on the three cited U.S. Army Corps of Engineers (USACOE) studies, which occurred in riverine environments, as well as on the general summaries of dredging impacts provided in Ludwig et al. (1995) and Wallace (1992). No studies were located which discussed the environmental impacts of wet excavation techniques in riverine settings. However, the impacts of wet excavation on ecological receptors and habitats are expected to be generally similar to those discussed for dredging.

a. Direct Impacts

Potential direct impacts of dredging/excavation include:

Physical disturbance and alteration of habitats. The greatest potential direct impact of dredging/excavation is the removal, physical disturbance, and/or alteration of wetland and aquatic habitats. The removal of sediments during dredging results in relatively long-term changes to the substrate characteristics and thus the habitat value of the site. The removal or disturbance of emergent or submerged aquatic vegetation during dredging also alters habitat values. These impacts generally have long-term consequences. For example, major dredging in Lilly Lake, a small, shallow lake in Wisconsin, completely disrupted the macrophytic plant community. Plant species diversity and biomass had not recovered to pre-dredging levels after three years and shifts in plant species dominance occurred due to changes in the bottom substrate from muck to sand (Dunst et al. 1984).

Long-term alteration of vegetated habitats may decrease the value of a particular area by reducing wetland functions such as production export. Such changes may also alter the ability of the area to serve as a habitat, nursery, or spawning area for aquatic and terrestrial species.

Dredging may change the availability or accessibility of protective space. Removal of coarse substrates (rock, rubble), snags, and emergent or submerged aquatic vegetation decreases the quality and quantity of cover available for aquatic organisms to seek protection from predation. For example, the standing crop of fish was 83% less in a channelized section of the Chariton River (Missouri) where snags were removed relative to an adjacent unmodified river section with snags 30 years after the channel was modified (Sedell et al. 1990). Snag removal also contributed to a large decline in catfish populations in the Missouri River (Sedell et al. 1990). Snag habitats supported an estimated 78% of the drifting invertebrates in the Satilla River (Georgia) and provided the principal source of food for several fish species (Sedell et al. 1990). Thus, removal of snags and other cover would be expected to significantly reduce invertebrate populations as well as fish populations.

Direct physical habitat disturbance may also occur through the establishment of infrastructure to support the remedial actions. This could include staging areas, access roads, material storage areas, and treatment/dewatering facilities in addition to the confined disposal facilities potentially used to dispose of excavated/dredged materials. Depending upon the areal extent and locations of impacted areas, direct physical disturbance could also result in habitat fragmentation and the interruption of wildlife travel corridors. Rare, threatened, and endangered species are particularly vulnerable to habitat disturbance and alteration.

Disturbance in wetland habitats may also allow invasive plant species with relatively low wildlife value, such as common reed and purple loosestrife, to colonize affected wetlands and establish monocultures, thereby reducing plant species diversity and eliminating plant species with higher wildlife value (Fredrickson and Reid 1988). These invasive species can be very difficult and expensive to control once established (Thompson 1989; Cross and Fleming 1989).

Direct mortality. Plants and other relatively immobile organisms, such as benthic invertebrates, may be killed or injured during dredging operations. Dredging operations result in the destruction of bottom habitat and the loss of the existing sessile benthic community. For example, it is estimated that dredging removes between 75 and 100 percent of the benthic organisms from the dredge cut (Allen and Hardy 1980). More mobile organisms can escape the path of the dredge provided that dredging occurs during the active portion of their year or life cycle. Sessile organisms, such as worms and molluscs, would not be able to leave the dredging area. These organisms would be removed with the sediments and would not be expected to survive. Less motile life stages of mobile organisms, such as fish eggs, larvae, and young juveniles, would also not be able to escape the path of the dredge and would not be expected to survive.

Displacement of organisms. Physical disturbance of habitats will also displace resident plant, aquatic, and wildlife communities occupying the areas undergoing remediation. The degree of this displacement would depend on the habitats impacted, the duration and extent of the impacts (including the time needed for restoration or recovery), and the timing of the impacts. Potential impacts would be most severe for relatively immobile organisms and organisms for which suitable habitats outside of the impacted areas are limited or unavailable within the range they can easily travel. The extent and duration of direct impacts depends in large part on the species pool available for immigration back into the remediated area when/if suitable habitat conditions are re-established. This is discussed in Section III.D.

Mobile species, such as birds, mammals, and fish, occupying habitats in or adjacent to remediated areas may be displaced or disturbed by noise and other human-related activities associated with dredging. This potential impact would be most prevalent during the breeding season and could reduce reproductive output.

b. Indirect Impacts

Potential indirect impacts of dredging/excavation include:

Resuspension of sediments in the water column. Dredging inherently involves disturbance of the sediments, which usually results in the relatively short-term resuspension of a portion of the sediments into the water column. The degree of sediment resuspension varies with the dredging equipment used, the operational handling of the equipment, the physical nature of the sediments, the characteristics of the river system (such as flow), and the sediment control measures employed. Studies of turbidity impacts in the Yazoo (Mississippi) and Yalobusha Rivers during dredging indicated that turbidity plumes extended up to one-half mile downstream of the dredge zone, even when containment areas were utilized (Wallace 1992).

The suspension of bottom sediments in the water column leads to increased water turbidity. Increased turbidity restricts the light penetration that is necessary for phytoplankton and other aquatic flora, reducing their growth. Increased levels of turbidity may affect finfish in several ways. Reduced visibility may impact the feeding success of sight-dependent species. Elevated levels of suspended sediments may interfere with respiration through clogging of gill filaments. These impacts would be most severe on early life stages of fish (larvae/ichthyoplankton) as they tend to be most sensitive and are less able to leave the area of the dredge plume due to low motility (USACOE 1992).

Contaminant release. Dredging results in the release and downstream dispersal of chemical contaminants from the sediments to the water column and biota. These effects can persist for relatively long periods of time. For example, the effects of dredging to remove PCB-contaminated sediments from the Shiawassee River (Michigan) were studied by Rice and White (1987) using caged clams and fish to monitor bioavailability of PCBs before, during, and after dredging. Monitoring of water, clams, and fish confirmed that significant amounts of PCBs were released from the sediments. During dredging, PCB concentrations in clams increased from 13.82 μg/g to 59.08 μg/g at the site of dredging. In a comparison of pre-dredging conditions to conditions one year following dredging, clams showed elevated PCB tissue concentrations at the site of dredging (13.82 μg/g pre-dredging versus 18.30 μg/g one year post-dredging) and at locations up to 11 km downstream, the farthest station sampled (13.21 μg/g pre-dredging versus 15.26 μg/g one year post-dredging). For fish, PCB tissue concentrations one year following dredging (61.14 μg/g) were nearly twice as high as pre-dredging PCB tissue concentrations (32.09 μg/g) 11 km downstream of the site of dredging.

Large increases in PCB bioavailability to fish during dredging activities have also been documented in the Grasse River in upstate New York. Pre-dredging PCB concentrations averaged 2.7 μg/g in near-shore downgradient caged fish, while PCB concentrations in caged fish placed at the same location during dredging averaged 54 μg/g (Sturtzer 1996).

Changes in the physical parameters of the water column. Dredging resuspends sediments in the water column and degrades water quality. The persistence of the degradation is related to sediment sizes, volume, type of equipment involved, and operational window. The increased turbidity, vertical mixing, and potential translocation can have a localized effect on water temperature. The water depth created by dredging may raise or lower water temperature in the immediate locality for some unspecified period of time.

For sediments with relatively high levels of organic matter, resuspension within the water column will induce an increase in the biological and chemical oxygen demand, resulting in reduced levels of dissolved oxygen by 16 to 83 percent (USACOE 1976b; Wallace 1992). Decreased light penetration caused by the increased turbidity (see above) can impair the ability of phytoplankton to photosynthesize and produce oxygen. A reduction in dissolved oxygen concentrations, resulting from the combination of a lower photosynthetic rate and increased oxygen consumption due to resuspension of sediments, can adversely impact all aquatic organisms requiring oxygen. The magnitude of this impact would depend on the extent of the dissolved oxygen reduction and the time period over which it was sustained.

Disruption of the aquatic food chain. Phytoplankton are considered to be the base of the aquatic food chain in deeper rivers and in large standing water bodies such as ponds and lakes. They are consumed by zooplankton and planktonic macroinvertebrates, which in turn are consumed by larger aquatic organisms. Impacts to phytoplankton, as discussed above, could result in disruption of food chains. Dredging can also destroy benthic invertebrate communities, causing a decline in the food source for higher trophic levels such as dabbling ducks and fish, as well as for wildlife species which consume fish.

Alteration of channel configuration. Long-term impacts in rivers, adjacent wetlands, backwaters, and entire floodplains can result from changes in hydrology and stream gradient following dredging (Allen and Hardy 1980). Removal of sediment can alter water velocities by increasing the cross-sectional area of flow and reducing frictional impacts, or channelizing flows and increasing water velocities along the surface or along the bottom. Dredging alters water depth, which can affect water temperature and sunlight penetration.

2. Armoring

The potential direct and indirect effects of armoring on biota and their habitats have been examined and documented, primarily for dredged material disposal sites in estuarine and marine systems. No studies evaluating the environmental impacts of armoring were located for freshwater, riverine systems. The potential impacts of armoring are summarized below as they could potentially pertain to the Housatonic River study area. This discussion is primarily based on the general summary provided in Ludwig et al. (1995) for capping and filling activities. Specific studies located in the literature (e.g., Brannon et al. 1986; USACOE 1994) focused largely on the effectiveness of caps in isolating PCBs and other contaminants from biota and evaluating effective cap thicknesses in estuarine and marine systems, not on impacts to biota from cap placement.

a. Direct Impacts

Potential direct impacts of armoring include:

Physical disturbance and alteration of habitats. Placement of cap materials can result in long-term alteration of the bottom substrate and the habitat value of an area. For example, placing gravel cap material on a mud bottom will alter the habitat and thus benthic community structure. In Long Island Sound, caps composed of silt were recolonized with benthic fauna similar to those found in surrounding areas (also composed of silt) but sand caps were recolonized by completely different species (USEPA 1993). The impacts to biota and habitats would be generally similar to those discussed for dredging.

Direct mortality. Placement of cap material smothers immobile organisms such as rooted plants and benthic invertebrates. These impacts would be generally similar to those discussed for dredging.

Displacement of organisms. Physical disturbance of habitats will also displace resident plant, aquatic, and wildlife communities occupying the areas undergoing remediation. These impacts would be generally similar to those discussed for dredging.

b. Indirect Impacts

Potential indirect impacts of armoring include:

Changes in the physical parameters of the water column. Capping may increase water temperatures if an area's depth is significantly reduced. This could result in long-term impacts to biota intolerant of higher temperatures. Depending upon the type of capping material used, a short-term increase in oxygen demand, resulting in decreased dissolved oxygen levels, may occur.

Disruption of the aquatic food chain. Capping smothers benthic invertebrate communities and plants, causing direct mortality and indirect effects to higher trophic levels via reduction in available food supply.

Alteration of channel configuration. Long-term impacts in rivers, adjacent wetlands, backwaters, and entire floodplains can result from changes in hydrology and stream gradient following capping (Allen and Hardy 1980). Capping can alter the flow patterns of a river system resulting in changes in water velocity and the creation of areas of altered circulation. These may impact benthic habitat and plant/animal communities through scouring effects or flushing organisms from habitats. Changes in water depth could alter the plant and benthic communities that recolonize the area following completion of capping.

3. Comparison of the Impacts from Removal and Armoring

The greatest potential direct impact of intrusive remedial actions is direct physical disturbance of habitats. These impacts are most likely highest for remedial technologies involving dredging or excavation, but would also occur for armoring which would disturb the river bottom or floodplain through the placement of capping materials. Direct physical disturbance may also occur through the establishment of infrastructure to support the remedial actions. This could include staging areas, access roads, material storage areas, and treatment/dewatering facilities in addition to the confined disposal facilities potentially used to dispose of excavated/dredged materials. Since fewer support facilities would be required for armoring, these impacts would be less than for dredging.

Physical disturbance of habitats will also displace resident plant, aquatic, and wildlife communities occupying the areas undergoing remediation. The degree of this displacement would depend on the habitats impacted, the duration and extent of the impacts (including the time needed for restoration or recovery), and the timing of the impacts. Potential impacts would be most severe for relatively immobile organisms and organisms for which suitable habitats outside of the impacted areas are limited or unavailable within the range they can easily travel. These impacts would be similar for armoring and dredging.

Plants and other relatively immobile organisms, such as benthic invertebrates, reptiles, and amphibians, may be killed or injured during remedial actions. This would apply relatively equally to removal and capping technologies. Other more mobile species, such as birds, mammals, and fish, occupying habitats in or adjacent to remediated areas may be displaced by noise and other human-related activities associated with remedial actions. This potential impact would be lower for armoring relative to dredging due to the shorter duration of remedial activities and the reduced infrastructure needed to support armoring.

In addition to potential direct impacts to biota and their habitats from remedial actions, other wetland functions and values, such as sediment stabilization, nutrient removal, and production export, may also be directly impacted, at least in the short term. These impacts would likely be similar in overall magnitude for removal and armoring technologies.

The principal potential indirect impacts associated with intrusive remedial actions involve sediment/contaminant resuspension and transport, and alterations in the hydrology of the river/wetland system. Potential impacts from sediment/contaminant resuspension and transport would be highest for remedial alternatives involving dredging, especially mechanical dredging. Since wet excavation technologies would isolate the portion of the river being remediated, resuspension and transport of sediments and PCBs would be reduced. Armoring, with proper controls, would not be expected to result in much resuspension of sediments due to the types of materials typically used for the construction of the cap. Thus, impacts due to turbidity and contaminant mobilization would be significantly less for armoring relative to dredging or excavation.

Intrusive remedial actions also have the potential to alter the channel geometry and depth profile of the river and thus to alter the hydrology of the river channel and adjacent wetlands. Dredging and excavation, depending on the amount of material removed, would deepen the river channel while armoring would reduce water depth by the thickness of the cap. Both could alter the hydrology of the river system and changes in the depth profile could also result in changes in water temperature and other parameters important to aquatic organisms. Wet excavation, since it would isolate portions of the river during remediation, would likely result in the greatest short-terms impacts to hydrology of the technologies considered.

4. Other Considerations

Other considerations of remedial impacts include the distinction between long-term and short-term impacts, the timing of remediation (seasonally) and the overall duration of the impacts (length of remediation). Impacts associated with direct physical disturbance of habitats could be either short or long-term, depending upon the degree of disturbance, the habitat type involved, and the type of mitigation and restoration measures implemented. In general, forested upland and wetland types, especially mature areas, would be more sensitive to disturbance since the removal of the live and dead (snags) trees within these areas would have long-term impacts as the regeneration time for a mature tree would be measured in decades. In emergent wetland and open water areas, the regeneration time for many emergent and aquatic bed plant species (including invasive species and species currently present) would be relatively shorter (generally two to five years depending on the restoration methods used and weather conditions), although it could take considerably longer until diverse and fully functioning plant communities are reestablished (see Section III.D).

The timing of remediation activities is also important since many species are more susceptible to disturbance during the breeding season. The overall duration (number of months or years) of remediation is also important since the longer the remediation period, the longer potential impacts associated with those activities will occur.

C. Potential Remedial Impacts Within the Study Area

Based on the foregoing discussion, it is clear that intrusive sediment remediation technologies, notably dredging, excavation, and armoring, could have significant short- and long-term adverse impacts on the habitats and biota in the areas disturbed by such activities. To assess the significance of such impacts within the Housatonic River system, ENVIRON has compiled available information on the existing habitats and biota in the study area. The findings of that task are presented in detail in Section IV (habitats) and Section V (biota) of this appendix. This subsection (III.C) summarizes the potential impacts of the intrusive sediment remediation technologies within the study area. For a more detailed understanding of the significance of such impacts, Sections IV and V should be consulted.

As will be discussed in Section IV, the quality of the habitats present within the study area varies by location. Thus, the severity of potential impacts of remedial actions on the habitats and biota within the study area would also vary by location.

On a relative basis, the habitats between the GE facility and the confluence of the East and West Branches of the Housatonic River (the upstream reach) are of lower overall quality due to the surrounding land uses (largely developed areas), the channelized nature of the river (resulting in a narrow floodplain), and the lack of bordering vegetated wetlands. Within the river itself, habitat quality in this reach is relatively low due to the limited cover present for biota such as fish. Thus, intrusive remedial actions within this area would have less of an impact to habitats and biota than would such remedial actions further downstream with one exception. Since this area is upstream of higher quality habitats, sediment/ contaminant resuspension and downstream transport would be of concern for remedial actions involving dredging undertaken within this portion of the river.

Downstream of the confluence of the East and West Branches of the Housatonic River, habitats become more diverse and of higher overall quality, and more diverse biotic assemblages are associated with these habitats. Of particular concern are rare species, and their habitats, present within this portion of the study area (see Figure 1).

Intrusive remedial actions within downstream portions of the study area would result in potentially significant impacts to habitats and biota; many of these impacts could be long-term. Of particular concern would be physical disturbance of forested habitats within the floodplain of the river as these habitats, once disturbed, would require long periods of time (decades) before they could be restored. The various vegetated wetland habitat types within this area are also well interspersed with each other and with open water areas, resulting in high quality habitat for many wildlife species. Intrusive remedial actions would disrupt this excellent interspersion of habitat types and reduce habitat quality over the long-term for many species. For example, Voigts (1976) found that maximum invertebrate abundance occurred where different wetland vegetative types (e.g., emergent and submerged plant species) were well interspersed. Maximum invertebrate populations, in turn, attracted high densities of nesting marsh bird species. Direct mortality of relatively sessile organisms, including the high diversity of plant, invertebrate, amphibian, and reptile species documented as occurring in these reaches, could be substantial for widespread intrusive remedial actions. This direct mortality would also have indirect adverse effects to food chains which would affect higher trophic level organisms such as birds and mammals.

Also of concern would be changes in the depth profile of the river or wetlands, resulting in changes to the hydrology and water chemistry of these habitats. Armoring within these areas would replace the existing sediments with granular and/or artificial materials that would be less suitable for some benthic organisms, and for the reestablishment of plant communities, for long periods of time, until natural sediment transport covered them with more suitable sediments (fines) and organic matter. Changes to the depth profile, hydrology, and/or substrate could also adversely impact other wetland functions and values. These potential impacts include reduced flood storage, sediment stabilization, nutrient removal, and production export.

As will be discussed in Section IV, nearly the entire stretch between the confluence of the East and West Branches of the Housatonic River and Woods Pond dam is classified as an "estimated habitat of rare wetlands wildlife", as a "high priority site for rare species", or as an "exemplary natural community" (Figure 1). As such, any intrusive remedial actions undertaken within these areas could have significant direct impacts (e.g., mortality) to rare species, especially immobile species such as plants, and/or to the wetland habitats they depend on (habitat destruction and/or alteration). The extent of these impacts would depend on the species present within the potentially impacted area, its status/rarity, its mobility, its seasonal occurrence, and the presence of other suitable habitats within its travel range, as well as the extent, duration, and nature of the disturbance. Impacts to immobile species such as plants classified as endangered due to low numbers within its range (not just within its range in Massachusetts) would potentially be more severe than for a more mobile species, such as a bird, listed as special concern and that is abundant in other portions of its range outside of Massachusetts.

Until specific remedial alternatives are developed, the potential impacts at specific locations within the study area are difficult to evaluate. Once these remedial alternatives are developed, a more location-specific evaluation of potential environmental impacts would be conducted.

D. Restoration Potential of Impacted Habitats and Biotic Communities

The restoration of wetland vegetation (habitat), and the recolonization of some faunal groups (especially benthic invertebrates and fish), in lotic (river and stream) environments following disturbance have been fairly well studied. This section provides a general summary of what is known concerning the restoration potential for wetland and lotic ecosystems. Where available, specific examples from the literature are provided.

1. Rivers and Streams (Lotic Communities)

Yount and Niemi (1990) define a disturbance in a lotic system as "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment". Disturbances can be divided into two types. A pulse disturbance causes a relatively short-term alteration in the densities of certain species after which the system recovers to its previous state (Yount and Niemi 1990). Spills of nonpersistent chemical stressors are examples of pulse disturbances (Niemi et al. 1990). Press disturbances are relatively long-term and often involve physical changes in the watershed or stream channel (Niemi et al. 1990). While a biological community will ultimately reestablish itself following press disturbances, it may be considerably different than the pre-disturbance community due to the alteration of habitat conditions. River channelization and extensive dredging are examples of press disturbances.

Yount and Niemi (1990) reviewed available case studies for disturbed lotic communities. Few thorough studies have been conducted on recovery of large river systems after anthropogenic pulse or press disturbances. Much of the available data relates to smaller streams and comes from relatively short-term studies of natural disturbances (such as floods), and much is anecdotal. In general, longer recovery times for fish and macroinvertebrate communities in lotic habitats have been observed for press disturbances, such as channelization and dredging, that resulted in alterations to physical conditions and habitats. Yount and Niemi (1990) give the following examples:

- Total numbers and biomass of macrobenthos in a channelized segment of the Little Auglaize River in Ohio had not recovered after four years in comparison to an upstream control segment.
- Recovery of fish and macroinvertebrate density and biomass had not occurred five years after channelization in Rush Creek, California.
- Based on surveys of 46 channelized streams in North Carolina, an average recovery time of 15 years was estimated for fish diversity.
- Aquatic community attributes in channelized portions of the Luxapalila River, Mississippi had not fully recovered 52 years after the disturbance.

- In a study of dredging in the River Hull, England, benthic invertebrate abundance and community composition had not returned to pre-disturbance conditions after one year.

In contrast, lotic systems recovered relatively rapidly (generally less than three years and frequently less than one year) from most pulse disturbances, which characterized the majority of studies examined. The most commonly cited reasons for relatively short recovery times for these types of disturbances were: (1) life history characteristics that allowed rapid recolonization and repopulation of the affected areas; (2) the availability and accessibility of unaffected upstream and downstream areas and internal refugia to serve as sources of organisms for repopulation; (3) the high flushing rates of lotic systems that allowed them to quickly dilute or replace polluted waters; (4) the fact that lotic systems are naturally subjected to a variety of disturbances and the biota have evolved life history characteristics that favor flexibility or adaptability.

Niemi et al. (1990) conducted an extensive review of the published literature on the natural recovery of aquatic systems from disturbance. They identified more than 150 case studies in freshwater systems, 79% of which were for lotic (rivers and streams) systems. Only three of these case studies involved dredging and all were in lentic (lake) systems. Eleven studies addressed channelization of lotic systems but only a few addressed larger lotic systems such as rivers. Given this, they concluded that when the disturbance resulted in physical alteration of the existing habitat and/or when the system was isolated and recolonization was suppressed, recovery times were substantial, in the range of 10 to 50 years. In contrast, these systems are relatively resilient to most pulse disturbances with recovery times being generally less than three years.

Only a few restoration projects for major river systems (on the scale of the Housatonic River) are currently underway; these include the Des Plaines River in Illinois and the Kissimmee River in Florida (Jordan et al. 1988). Long-term data on the success of restoration are not yet available.

2. Vegetated Wetlands

The single most important factor in freshwater wetland restoration is restoring the hydrology, including appropriate seasonal fluctuations in water levels. Changes in water depth from original conditions will shift the wetland plant community from submergent species to emergent and woody species if water depths decrease and vice versa if they increase (Adamus and Brandt 1990). When hydrological restoration is done properly, considerable development of wetland plant communities typically occurs even in the absence of further active restoration efforts (Jordan et al. 1988). This depends, however, on retaining sufficient quantities of the original wetland soil to provide a seed bank for subsequent plant growth. Where the original wetland soil structure is significantly altered over large areas through dredging or capping, the restoration of a suitable soil substrate may be necessary. Introduction of plant propagules may be then be critical to the restoration of the native vegetation (Jordan et al. 1988), since the new soil is unlikely to contain a suitable seed bank of desirable wetland plant species and colonization from surrounding areas may be impeded by the areal extent of the disturbance. Restoration of the vegetation is normally done by planting a few key species and relying on natural colonization to increase plant species diversity over time (Jordan et al. 1988), with the time period varying on a site-by-site basis depending upon site conditions and the presence of, and distance to, undisturbed wetland areas. However, preventing the establishment of exotic invasive species, such as common reed and purple loosestrife, during this recovery process can be difficult in some cases (Jordan et al 1988). Total removal or destruction of a wetland, particularly an isolated wetland, would lessen the likelihood of full recovery relative to a smaller-scale disturbance which would leave in place soil and biota for direct recolonization.

While it is recognized that it is possible to restore or create individual wetland functions or to approximate some simple natural wetland systems, the current wetland mitigation literature includes concerns that an artificial wetland restoration or creation project cannot fully duplicate all of the functions and values of a naturally occurring wetland (Normandeau Associates 1992). Evaluation of wetland creation or restoration efforts in terms of functional replacement would likely conclude that many such efforts deemed "successful" based on the evaluation of limited attributes, generally revegetation, failed either wholly or partially in replacing all functions and values of a naturally functioning wetland.

Little information is available regarding success of riparian ecosystem creation and restoration projects. Data on survival and growth of planted vegetation have been the most commonly used parameters to support the success of these projects. Typically, these variables have been measured for only the first few growing seasons. However, it may take several years beyond that time for the revegetated sites to achieve the desired plant species diversity. This is particularly true for the relatively slower growth of riparian hardwoods. A reestablished bottomland forest can take 40-60 years to become self-generating and to produce full value to many wildlife species (Manci 1989). Evaluation of the reestablishment of wetland functions and values other than revegetation/wildlife habitat in restored riparian habitats is generally lacking. This is also generally true for non-riparian wetland habitats (Lowry 1989; D'Avanzo 1989).

Only a few restoration projects for major riverine wetland systems are currently underway; these include the Des Plaines River in Illinois and the Kissimmee River in Florida (Jordan et al. 1988). Long-term data on the success of restoration are not yet available. Well over 200 wetlands, many associated with riverine systems, have been created in Massachusetts during 1983-1988. However, all of these wetlands were less than 2 acres in extent and most were less than 0.5 acres (Lowry 1989). No studies could be found addressing wetland creation/restoration at the extent and scale that would be applicable to extensive intrusive remedial actions in the Housatonic River study area.

More data are available which address non-riparian wetland restoration, especially for emergent wetland types. For example, Confer and Niering (1992) compared five three- to four-year-old created palustrine emergent wetlands with five nearby natural wetlands of comparable size and type. Created sites exhibited more open water, greater water depth, and greater fluctuation in water depth than natural wetlands. Typical wetland soils, characterized by mottling and organic accumulation, were not well developed in created wetlands relative to the natural wetlands. Cattail was the characteristic emergent vegetation at created sites, often existing in monocultures, while a more diverse mosaic of emergent wetland species was often associated with cattail at the natural sites. Invasive species, purple loosestrife and common reed, may pose a threat to future species richness at the created sites.

The Confer and Niering (1992) study and other literature suggests that it is possible to create small emergent wetlands having certain functions associated with natural wetlands, such as flood storage, sediment stabilization, and wildlife habitat. Whether these wetlands will replicate all of the functions of similar natural wetlands would require a decade or more of study, which generally has not been done. Some important wetland attributes, such as the development of hydric soils and the accumulation of organic matter in the soils, may take a decade or more to occur (D'Avanzo 1989). Reestablishment of some wetland vegetation types, such as forested areas, may take a half-century or more. The ability to recreate or restore a wetland to a fully functioning natural state is thus very uncertain given the current state-of-the-art.

3. Macroinvertebrate Communities

The restoration of stable and viable benthic macroinvertebrate communities is an integral component of the effective restoration of a stream or river ecosystem. It is a particularly critical component if the benthos are known to supply a major portion of the food base for fish populations of the system (Gore 1985).

Several mechanisms of recolonization are available to stream benthos: (1) migration from deeper sediment zones to surface substrates; (2) upstream movements; (3) downstream drift from upstream or tributary areas; and (4) aerial recolonization (Wallace 1990). Only a small fraction of macroinvertebrates has been shown to exhibit significant upstream movements. Drift, the passive transport of aquatic invertebrates in the water column, represents an important mechanism for invertebrate colonization and redistribution of stream benthos. Drift is, by far, the most frequently cited mechanism of recolonization following disturbance (Wallace 1990). An experiment in a Canadian stream showed drift to be the most important source of recolonizing animals, contributing 41.4% to the total number of colonists. This compared to 28.2% from aerial sources, 18.2% from upstream migration, and 19.1 from movement up from within the substrate (Williams and Hynes 1976).

The ability of animals to recolonize by drifting also may be influenced by stream size and the presence of upstream and tributary sources of colonists. The amount of drift passing over a given area of bottom appears to be higher in larger, deeper rivers than in small streams, and drift distances appear to be greater in large streams than in small streams (Wallace 1990). With the exception of many insect species, aerial recolonization by terrestrial adult stages is not possible for most lotic macroinvertebrates. Several studies have shown that molluscs are among the last taxa to recover following disturbances that eliminate species from a given length of stream, taking as long as several years (Wallace 1990). Ephemeroptera (mayflies) and Diptera (true flies), which have the highest recovery rates, also have the highest drift rates relative to benthic standing crop (Niemi et al. 1990).

Studies examining the resilience of impacted macroinvertebrate populations have identified a number of factors that contribute to the rate of recovery following termination of a disturbance. These include: (1) persistence of the impact, including changes in system productivity, habitat integrity, and persistence of the stressor; (2) duration, areal extent, and frequency of the disturbance; (3) condition of the habitat following disturbance; (4) life history of the organism, including generation time, emergence time, and propensity to disperse; (5) time of year in which disturbance occurs; (6) the presence of nearby epicenters (refugia) as a source of organisms for recolonization, including upstream and downstream sections of the river and its tributaries; (7) vagility or mobility of populations; and (8) distance to source for recolonization and upstream or downstream direction (Niemi et al. 1990; Wallace 1990; Gore 1979).

The resulting physical state of the habitat following disturbance or following restoration/mitigation efforts is critical in determining the resulting benthic macroinvertebrate community that will be present since specific benthic invertebrate taxa are associated with particular habitats. These habitats range from rooted vegetation and periphyton (many gastropods, amphipods, isopods, coleoptera, and odonates) to sand and silt (many burrowing Ephemeroptera and most chironomids) to gravel and cobble substrates (most free-roaming Plecoptera, Ephemeroptera, Trichoptera, and most filter feeders of large particulates) (Gore 1985).

It is generally acknowledged that the physical habitat characters which most directly control macroinvertebrate distributions in unstressed streams are velocity, depth, and substrate and water quality (Gore 1985). Reduction in macroinvertebrate abundances is associated with some habitat conditions such as: (1) the accumulation of sediments in depositional areas; (2) the loss of large woody debris which provides habitat for both invertebrates and fish and whose presence alters channel morphology, sediment movements, and organic matter storage; (3) low amounts of detritus, since, as this material accumulates, the habitat complexity increases which, in turn, increases the production ability of the habitat for macroinvertebrates; and (4) the lack of submerged aquatic plants since macroinvertebrates are many times more abundant in vegetated areas than in non-vegetated areas (Wallace 1990; Gore 1979; Krull 1970). Habitat restoration and mitigation efforts would need to consider these potential limiting factors.

As noted above, downstream drift is the primary recolonization mechanism in lotic environments. If the disturbed area is far from refugia, reproductive capacity characteristics assume more importance in dictating recovery rate. In general, population recovery is rapid, usually less than two years, if the physical diversity of the habitat is unchanged, that is, the response of the biota is rapid relative to the recovery of the physical habitat (Niemi et al. 1990). Disturbances which produce long-term changes in habitats will delay recovery until the natural habitat is restored. When habitat variables are severely altered, changes in community structure may persist for decades (Wallace 1990).

The single most important factor affecting the recovery rate of lotic macroinvertebrate communities is the nature of the disturbance. The longest recovery times (5 to 25 years) are associated with press disturbances, such as channelization, leading to long-term alterations of habitat (Wallace 1990). In such situations, the post-recovery benthic community will likely differ in structure and composition relative to the pre-disturbance community. In contrast, most macroinvertebrate communities studied (85%) recovered within 18 months following pulse disturbances (Niemi et al. 1990). In these situations, the post-recovery benthic community is more likely to closely resemble the original community.

Tilton and Denison (1992) concluded that invertebrate populations generally began colonizing restored vegetated wetlands within several months after the completion of restoration activities regardless of hydrologic connection or planting method. Similarly, benthic organisms from adjacent areas typically begin to recolonize disturbed areas soon after the completion of dredging operations in river channels. Recolonization may take two or more growing seasons and the resulting benthic community will most likely be different from the original (Allen and Hardy 1980). Transitional fauna usually consist of opportunistic species and species diversity is usually limited (Allen and Hardy 1980). The extent of recolonization subsequent to dredging depends on a number of factors including the resulting substrate type, the amount of light penetration due to depth and/or turbidity, distance from similar habitat for recolonization, and long-term changes in water quality.

When colonization was examined using denuded or previously stressed stream ecosystems, maximum densities of benthic invertebrates were reported between 70 and 150 days following reclamation of the habitat. Attainment of maximum densities, however, does not necessarily imply reclamation success. The establishment of stable benthic communities takes longer periods of time, typically 300 to 500 days in a habitat-enhanced stream. Stable benthic communities are typically established in 600 to 800 days from initiation of colonization without significant habitat enhancements (Gore 1979, 1985; Gore and Johnson 1979, 1980). Again, depending upon the extent and nature of the habitat alteration and the habitat enhancement measures implemented, the post-recovery benthic community, while stable, may not resemble the pre-impacted community.

4. Fish Communities

The single most important factor affecting the recovery rate of lotic fish communities is the nature of the disturbance. The longest recovery times are associated with disturbances/stressors leading to long-term alterations of habitat (press disturbances). In contrast, recovery times with single or multiple natural stressors, or pulse anthropogenic stressors, were all less than five years (Niemi et al. 1990). Detenbeck et al. (1992) reached similar conclusions in their summary of the available literature on the recovery of lotic fish communities from disturbance. They found that fish population recovery times following pulse disturbances varied between one month and six years, while recovery times following press disturbances (such as river channelization and extensive dredging) varied between five and more than 52 years. Press disturbances typically cause large-scale modification or alteration of instream and riparian habitats, which prolongs the recovery process. Mitigation measures can sometimes be successful in reducing recovery times. In several cases, effective habitat mitigation measures reduced recovery times to about five years (Detenbeck et al. 1992). However, recovery times were typically longer, even with mitigation, and the implementation of mitigation measures did not guarantee full recovery of resident fish populations.

In general, recovery of all individual species population densities is much slower than recovery of community parameters such as species richness or total density (Detenbeck et al. 1992). Centrarchids (bass/sunfish) and minnows are typically most resilient to disturbance. Species within rock-substrate/nest-spawning guilds required significantly longer time periods to either recolonize or reestablish pre-disturbance population densities than did species within other reproductive guilds. Size of fish at reproduction also was related to species-specific population recovery rates. Smaller fish, such as minnows, have shorter generation times than larger fish species so that both immigration and population growth rates would contribute to recovery (Detenbeck et al. 1992).

Timing of disturbance events relative to spawning season were unrelated with time to first appearance of fish species but were related to time to recovery of fish densities. Recovery rates within specific case studies were significantly affected by the location of disturbances relative to barriers to migration (such as dams) and by the presence of refugia upstream or downstream of the disturbance event. Recovery was enhanced by the presence of refugia but was delayed by barriers to migration, especially when source populations for recolonization were relatively distant. The presence of barriers to migration prolonged, but did not necessarily prevent, recovery. The spatial extent of pulse disturbances affected recovery times by increasing the distance source populations must migrate to recolonize disturbed areas (Detenbeck et al. 1992; Niemi et al. 1990). For pulse disturbances, migration and recolonization rather than increase of the resident population was the main mechanism for recovery. Thus, the presence and distance of refugia or unperturbed stretches relative to a stressed site and the timing of a stressor relative to spawning season influenced recovery times. Generation time and species of year-class-specific migratory tendencies affected recovery rate only in sites isolated by large disturbances or barriers (Niemi et al. 1990).

Tilton and Denison (1992) concluded that fish populations develop rapidly in restored wetlands that have good vegetation development and are connected to an existing wetland or water course. Fish populations may develop slowly and with less diversity when a wetland lacks a connection to another water body.

5. Amphibians and Reptiles

Limited data on the reestablishment of amphibians and reptiles are available following disturbance. Tilton and Denison (1992) concluded that amphibians colonized restored wetland areas in a pattern similar to that observed for fish (see the previous subsection). However, reptiles, in particular turtles, are slow to colonize restored wetlands even when suitable habitats, including basking logs and nest sites, are provided. Canonie Environmental (1995b) reports that three years following excavation of sediments in the North Ditch of the Waukegan Harbor site (Illinois), snapping turtles had not recolonized the area, likely due to minimal vegetative (habitat) reestablishment.

6. Summary and Evaluation of Restoration Potential

Based on the above discussion, the potential to restore wetland habitats and biotic communities, such as those found in the Housatonic River study area, following widespread intrusive remedial actions depends upon a number of key factors. The most critical is the nature and areal extent of the disturbance. If remedial actions result in large-scale alteration of habitats (press disturbances), restoration potential is reduced and/or recovery time is significantly lengthened relative to a more small-scale (pulse) disturbance. While the implementation of mitigation measures can increase the probability of recovery for some ecological components, there is no guarantee that even comprehensive mitigation measures can fully restore all ecological components and wetland functions to their pre-disturbance condition.

Of importance would be the amount of time it could take to restore all of the impacted habitats and biotic communities following widespread intrusive remedial actions. While some biotic groups, such as benthic invertebrates, typically begin to recolonize disturbed areas relatively quickly even in the absence of habitat enhancement measures, initial colonists generally consist of only a few opportunistic species which are adapted to disturbed conditions. Much longer time periods are typically required for the reestablishment of stable, diverse communities and fully functioning habitats. For example, reestablishment of a mature, diverse woody plant community can take up to 60 years in forested wetland habitats.

The ecological components most frequently restored using active mitigation methods are wetland structural features (such as topographic contours) and wetland vegetation. Active mitigation for faunal groups, such as introductions, is relatively rare, with natural colonization normally relied upon to reestablish these populations. Since post-disturbance habitat conditions will likely differ from pre-disturbance conditions following large-scale disturbance, even if mitigation measures are employed, the restored ecological communities will likely differ in species composition, structure, and other parameters from pre-disturbance conditions. Thus, some species or functional values present in pre-disturbance habitats may never be fully restored.

IV. DESCRIPTION OF EXISTING HABITATS

A. Overview

Berkshire County lies within the transitional zone of the eastern continental forest. Its forested hills contain mostly second-growth hardwoods. The dominant tree species are beech, hemlock, sugar maple, and yellow birch (Veit and Peterson 1993). Southern Berkshire County is characterized by oaks, hickories, ash, and red maple. White pine is the dominant conifer of the southern part of the county but is gradually replaced by spruce in more northern areas (Veit and Peterson 1993). There are numerous marshes, swamps, and bogs in Berkshire County, and dense growths of alder and willow are common in the poorly drained wetland areas of the Berkshire Hills (Veit and Peterson 1993). The Hoosic and Housatonic Rivers are the principal flowing water bodies present in Berkshire County.

Figure 2 illustrates the general habitat types present in the study area. As shown in that figure, alteration of natural habitats along the Housatonic River has occurred to a large extent within the city of Pittsfield from the GE facility downstream to just above the confluence of the East and West Branches of the Housatonic River (the upstream reach). Within this area, large-scale urban development has occurred, the river channel has been straightened by filling wetlands and oxbows for flood control purposes, and native vegetation has been replaced with ornamental species or eliminated entirely (ChemRisk 1994). In many areas upstream of this confluence, these activities have resulted in the elimination, fragmentation, or reduced suitability of habitats for many wildlife species.

Between the confluence of the East and West Branches of the Housatonic River and the New Lenox Road bridge (the middle reach), habitats have received fewer and less severe physical stresses associated with human development than upstream areas. However, some residential and industrial development (wastewater treatment plant, electrical substation, mining) encroaches on the river within this stretch (Figure 2). The stretch between the New Lenox Road bridge and the headwaters of Woods Pond (the downstream reach) is largely undeveloped. Portions of this area, such as the Housatonic Valley Wildlife Management Area and Woods Pond, are used for recreational activities such as hunting, fishing, and trapping.

Within the study area, a railroad right-of-way generally parallels the west side of the river in the middle and downstream reaches (Figure 1). In several locations, this right-of-way bisects wetland areas adjacent to the river. A power line corridor also crosses through the study area, generally in a north-south direction (Figure 1). This corridor crosses over Woods Pond and re-crosses the river at about the mid-point of the study area. Both the railroad and power line corridors are maintained through physical (mowing) or chemical means.

B. Aquatic Habitats

The Housatonic River and its major tributaries (Sackett Brook, Sykes Brook, Mill/Roaring Brook, Yokun Brook, and Willow Creek) and impoundments (Woods Pond) are the principal aquatic habitats present in the study area. The Housatonic River (both branches and the main stem) is classified on National Wetland Inventory (NWI) maps as a riverine, lower perennial, open water wetland (Figure 1). Parts of Sackett Brook are classified as riverine, upper perennial, open water; palustrine forested (broad-leaved deciduous); and palustrine emergent wetland. Parts of Mill and Roaring Brooks are classified as palustrine forested (broad-leaved deciduous) and palustrine open water wetland. Yokun Brook is classified as riverine, intermittent, streambed. Sykes and Willow Brooks are not classified on the NWI maps. Woods Pond is classified as a lacustrine, limnetic, open water wetland (Figure 1).

The East and West Branches of the Housatonic River converge just downstream of downtown Pittsfield to form the main stem of the Housatonic River. From there, the river flows generally southward for 132 miles to Long Island Sound, with a total fall of 959 feet (NERBC 1980). About 70 miles of the river are contained in Massachusetts, with the rest in Connecticut. The watershed of the Massachusetts portion of the Housatonic River Basin encompasses 545 square miles, representing 28% of the total watershed of the Housatonic River Basin (Lawler, Matusky, and Skelly Engineers 1975).

The Housatonic River in Massachusetts is relatively narrow, varying in width from 40 to 140 feet (Lawler, Matusky, and Skelly Engineers 1975). Mean river width generally increases from upstream to downstream locations, not exceeding 40 feet at the most upstream location evaluated during on-site aquatic studies (near the headwaters of the East Branch) and approaching 120 feet at the most downstream location evaluated (near the Massachusetts-Connecticut border) (Chadwick & Associates 1994). Between Pittsfield and the upstream end of Woods Pond, the maximum water depth (under normal flow) in the Housatonic River is 9 feet, with a typical range of 1 to 3 feet. At the upstream end of Woods Pond, the channel widens and the river attains a maximum depth of 13 feet, averaging 5 to 10 feet. The remainder of Woods Pond, covering approximately 60 acres, is generally shallow, averaging 1 to 3 feet, although maximum depths of 16 feet are attained in several channels within this pond (BBL 1991). Measured mean water depth (September) was 0.7 to 2.6 feet at shallow locations and 3.6 to 6.6 feet at deep sampling locations within the Housatonic River (Chadwick & Associates 1994).

Within the Housatonic River, the nearest gauging stations to the study area are in Coltsville (1.5 miles upstream of the GE facility along the East Branch) and near Great Barrington (about 18.3 miles downstream of Woods Pond). At Coltsville, the average streamflow, based on 41 years of data, is 114 cubic feet per second (cfs). The maximum measured streamflow at this station is 6,400 cfs and the minimum (daily) measured streamflow is 4.4 cfs. Monthly average flows range from 44.1 cfs (August) to 276 cfs (April). At Great Barrington, the average streamflow, based on 64 years of data, is 525 cfs. The maximum measured streamflow is 12,200 cfs and the minimum (daily) measured streamflow is 1.0 cfs. Monthly average flows range from 229 cfs (August) to 1,294 cfs (April) (NERBC 1980; Lawler, Matusky, and Skelly Engineers 1975).

Based on data collected from late May to late September 1993, water temperature in the portion of the Housatonic River within the study area ranged from 11°C to 32°C, dissolved oxygen ranged from 6.2 to 9.4 mg/L, and pH was 7.9 to 8.3; these ranges were similar to data from upstream and downstream locations except that maximum dissolved oxygen concentrations tended to be higher at downstream locations. For Woods Pond, temperature ranged from 12 to 33°C and dissolved oxygen ranged from 3.2 to 11.2 mg/L; pH was not measured (Chadwick & Associates 1994).

A number of dams are present along the river, although no dams are present between the GE facility and Woods Pond. The southern extent of the study area is defined by the Woods Pond dam, the first dam downstream of the GE facility. Over 20 major tributaries enter the Massachusetts portion of the river, with five of these tributaries (Sackett Brook, Sykes Brook, Mill/Roaring Brook, Yokun Brook, and Willow Creek) contained within the study area.

The Pittsfield wastewater treatment plant is present along the Housatonic River at about the mid-point of the study area (Figure 1). During 1995, this treatment plant discharged an average of 11.6 million gallons per day (mgd) (range of 8 to 27 mgd) of treated effluent (tertiary treatment) to the Housatonic River (T. Landry, superintendent, personal communication). This equals an average flow into the Housatonic River of 17.9 cfs (range of 12.4 to 41.8 cfs).

In the Housatonic River, cover generally accounted for less than 10% of the surface area at the locations sampled by Chadwick & Associates (1994). Cover was generally provided by bank structure (e.g., tree roots, overhanging bank vegetation) and snags (in-stream logs, stumps, and branches). Shallow river sites tended to have a higher percentage of cover than deeper water sites (Chadwick & Associates 1994). Plant communities present in the river channel are addressed in the section on wetland habitats.

C. Wetland Habitats

In general, the floodplain along the Housatonic River tends to be very narrow near the location of the GE facility. The floodplain begins to widen in the southern portions of Pittsfield near Pomeroy Avenue (Figure 1). Between Pomeroy Avenue and New Lenox Road, the floodplain widens significantly to follow the local topography. South of New Lenox Road to the Woods Pond dam, the floodplain widens slightly again. Approximately 0.5 miles south of New Lenox Road, the floodplain along the east bank of the river is confined by October Mountain, while the west bank has a relatively flat topography resulting in an extended floodplain (BBL 1996). Within the reach adjacent to October Mountain, the Housatonic River is slow flowing, meandering, and associated with substantial wetland and backwater areas.

This report section (IV.C) describes open water, emergent, and aquatic bed wetland types present within the study area. Forested and shrub wetland types are briefly addressed in this section and are discussed more completely in the section on terrestrial habitats (IV.D). The discussion on wetland functions and values (Section IV.F) encompasses all wetland types within the Housatonic River floodplain.

1. General Wetland Description

Based on National Wetland Inventory mapping, a number of wetland types occur within the study area (Figure 1). The type and extent of wetland habitats varies throughout the study area. Within the upstream reach, no bordering vegetated wetlands are present (Figure 1). Within this stretch of the river, the floodplain is very narrow due to steep banks and a well defined river channel, and only a very narrow wooded fringe separates the river from the surrounding land uses, which consist mostly of developed areas (Figure 2).

Within the middle reach, bordering vegetated wetlands are common but are not continuous along the entire stretch of river. Based on the October 1995 field visit, the wetland areas shown on NWI maps (Figure 1) appear to be generally accurate. Palustrine forested and scrub-shrub wetland types are most prevalent within this stretch. Typical canopy heights in forested areas are 40 to 60 feet and the dominant tree species is typically sugar maple (*Acer saccharum*), with elm and ash also fairly common. Ground cover is dominated by ferns, particularly sensitive fern (*Onoclea sensibilis*), and other herbaceous growth. Emergent areas are uncommon and submerged aquatic plant species are uncommon within the river channel.

Within the downstream reach, bordering vegetated wetlands are continuous along the river channel and within the relatively wide floodplain. Wetland types are more diverse within this stretch and include open water areas, palustrine forested, palustrine scrub-shrub, and palustrine emergent wetlands, along with various combinations of these wetland types (Figure 1). In general, forested and scrub-shrub wetland types dominate the floodplain areas although there is a good mixture of these and the other wetland types nearer to the river channel. Based on the October 1995 field visit, open water and emergent wetland types appear to be more common than shown on NWI maps and Figure 1. In addition, areas delineated as palustrine forested wetlands on NWI maps appear to actually include a significant shrub component. Areas classified on NWI maps as open water areas in this stretch often contained significant quantities of aquatic bed plant species, so much so that some of these areas should probably be classified as aquatic bed wetland types.

2. Open Water and Aquatic Bed Wetlands

Aquatic bed wetlands are dominated by plants that grow principally on or below the surface of the water for most of the growing season (Cowardin et al. 1979). This wetland type is frequently interspersed with open water areas lacking such vegetation. Many of the palustrine open water (POW) wetland areas shown on Figure 1 between New Lenox Road and Woods Pond, especially in backwater areas of the river outside of the main channel, contain a variety of submerged and floating (aquatic bed) plant species. Typical species include lesser duckweed (*Lemna minor*), yellow water lily (*Nuphar variegatum*), arrowhead (*Sagittaria latifolia*), pondweed (*Potamogeton spp.*), hornwort (*Ceratophyllum demersum*), and water milfoil (*Myriophyllum humile*). These species would be typical of Woods Pond as well.

3. Emergent Wetlands

Palustrine emergent wetlands are characterized by erect, rooted, herbaceous hydrophytic plant species which are present for most of the growing season. Most wetlands of this type are dominated by perennial plant species and thus maintain a similar appearance between years (Cowardin et al. 1979). Major palustrine emergent wetland areas present in the study area are shown on Figure 1. These areas are dominated by cattail (*Typha latifolia*) in several areas north of Woods Pond. Other emergent species which are prevalent include pickerelweed (*Pontederia cordata*), arrow arum (*Peltandra virginica*), rushes (*Juncus spp.*), and bur-reed (*Sparganium spp.*). Smartweed (*Polygonum spp.*) is present in scattered locations, especially in more upstream areas. Reed canary grass (*Phalaris arundinacea*) is also common along the river banks in some areas adjacent to open fields.

D. Terrestrial Habitats

The type and extent of upland and wooded wetland habitats varies throughout the study area. Within the upstream reach, the floodplain is very narrow due to steep banks and a well defined river channel. Only a very narrow wooded fringe separates the river from the surrounding land uses, which consist of residential, commercial, and industrial development (Figure 2).

Within the middle reach, there is less residential and commercial development; commercial development includes a wastewater treatment plant, an electrical substation, and one area with active mining (Figure 2). Undeveloped habitat types are about equally split between pasture/cropland and forested areas. Typical canopy heights in forested areas are 40 to 60 feet and the dominant tree species is sugar maple (*Acer saccharum*), with elm and ash also fairly common. Ground cover is dominated by ferns, particularly sensitive fern (*Onoclea sensibilis*), and other herbaceous growth.

Within the downstream reach, forested habitats predominate within and outside of the floodplain. Pasture and shrub meadows (open land) are also present. There is little residential development within this area and commercial land uses are generally restricted to a small area near Woods Pond (Figure 2).

Data from quantitative analyses of vegetation are available for forested and shrub meadow habitats within the downstream reach (ChemRisk 1994). One sample plot was established in forested habitat within the 10-year floodplain on the west side of the river about 0.75 miles south of New Lenox Road. Two sample plots were established in shrub meadow habitat types, one adjacent to the floodplain forest plot and a second (reference) plot established outside of the 10-year floodplain about 0.4 miles south of New Lenox Road.

1. Forested Upland and Wetland Habitats

Table 1 lists the woody plant species identified in the floodplain forest sample plot. As shown in that table, 13 species or genera of trees (defined as woody plants with stems greater than 4 cm DBH) were identified in the floodplain forest sample plot. Sugar maple was numerically dominant, accounting for 63% of the total stems. White pine was the only coniferous species observed. Canopy cover was estimated at 67 percent and canopy height was approximately 65 feet. The number of standing dead trees (snags), which provide nesting substrate for cavity-nesting wildlife, averaged 461 stems/ha, with the number of cavities present in these snags estimated at 33 per ha (ChemRisk 1994).

Sixteen species or genera of shrubs were identified within the floodplain forest study plot (Table 1). Arrowwood and sugar maple were the most common species present. The majority (58%) of the ground stratum in the sample plot was covered by plants; ferns accounted for approximately half of this cover. Fallen logs, which provide cover for numerous species of wildlife, were estimated at 439 per hectare (ChemRisk 1994).

Based on the reconnaissance-level field survey conducted in October 1995, the forested habitat throughout the study area is generally similar to that contained in the floodplain forest plot sampled by ChemRisk (1994) except that some areas, especially north of Woods Pond, are less mature (canopy heights of 30 to 40 feet), more open (canopy cover less than 50 percent), and have a higher density of snags. Additional tree species observed outside of this sample plot include quaking aspen (*Populus tremuloides*), red oak (*Quercus rubra*), white oak (*Quercus alba*), red maple (*Acer rubrum*), and eastern hemlock (*Tsuga canadensis*).

In addition, forested/shrub wetland habitats immediately adjacent to the river channel south of New Lenox Road are dominated by silver maple (*Acer saccharinum*), not sugar maple, and the dominant shrub species is red-osier dogwood (*Cornus stolonifera*) in many of these areas. Other woody species present in these areas include willow (*Salix spp.*), speckled alder (*Alnus rugosa*), and silky dogwood (*Cornus amomum*).

2. Shrub Meadow Habitats

Shrub meadows along the Housatonic River are early successional ecosystems dominated by grass, forb, and shrub communities. Portions of many of these areas within the study area are mowed periodically (ChemRisk 1994).

A list of plant genera or species observed in the two (reference and study area) shrub meadow sample plots is presented in Table 2. Sixteen plant genera/species were observed in the reference plot and 18 were observed in the study plot; 10 species were common to both plots. Bentgrass, sensitive fern, and goldenrod were the dominant species within each plot, accounting for 70 and 63 percent of the plant community in the reference and study plots, respectively (Table 3).

Relative dominance of each major vegetation category in mowed and unmowed portions of the reference and study shrub meadow plots is presented in Table 4. Forbs were the dominant vegetation type within both mowed and unmowed portions of both plots.

E. Significant Habitats

Based on Massachusetts Natural Heritage database records (MADFW 1995a, 1995c), a number of state-designated "significant" habitats are known to occur within the study area. These include "estimated habitats of rare wetlands wildlife", "high priority sites of rare species", and "exemplary natural communities", as shown in Figure 1. None of these designated habitats has any connection with the habitat protection provisions (designation of "critical" habitat) of the Massachusetts Endangered Species Act. Rather, the significance of these designations is described below.

Maps of "estimated habitats of rare wetlands wildlife", developed by MADFW, are intended to be used as a "trigger" to provide for review of projects potentially impacting wetland-dependent wildlife species listed as rare or endangered and are used in conjunction with the Massachusetts Wetland Protection Act regulations for the filing of a Notice of Intent (MADFW 1995c). They are used in this preliminary assessment to identify specific wetland areas present within the study area where rare wetland-dependent wildlife may occur. As shown in Figure 1, five such areas have been delineated within the project area. One is along the Housatonic River just upstream of the study area, the second occurs within the study area south of the confluence of the East and West Branches of the Housatonic River where Sackett Brook enters the river, the third occurs along the Housatonic River and straddles New Lenox Road, the fourth is along Roaring Brook within the October Mountain State Forest (east of the study area), and the fifth encompasses the northern portion of Woods Pond. All told, the three estimated habitats within the study area account for approximately 40% of the study area within the middle and downstream reaches.

Maps of "high priority sites of rare species", also developed by MADFW, indicate the approximate extent of the most important sites for rare species in Massachusetts (MADFW 1995c). Unlike the "estimated habitat" maps discussed above, "high priority site" maps include upland as well as wetland habitats and include plant as well as wildlife species. "Exemplary natural communities" are MADFW-designated habitat types that are considered rare within the state; these designated habitats usually contain known locations of rare plant or wildlife species. Figure 1 shows the combined locations of "high priority sites/exemplary natural communities" present within the study area. Three distinct sites have been delineated, all of which are within the middle and downstream reaches. In general, these sites overlap portions of the Housatonic Valley Wildlife Management Area.

The Housatonic Valley Wildlife Management Area, established in 1968, encompasses approximately 750 acres in the municipalities of Pittsfield, Lenox, and Lee and is wholly contained within the study area (Figure 1). In addition, October Mountain State Forest borders the southeastern portion of the study area (Figure 1).

F. Wetland Functions and Values

Wetlands within the study area provide a variety of functions and values of importance ecologically and to society in general. Based on the available information on the wetland habitats present in the study area, a qualitative evaluation of individual wetland functions and values is presented in this subsection. The individual functions and values evaluated are those addressed by the Wetland Evaluation Technique (WET) methodology (Adamus et al. 1987). While general in nature, this discussion can be used to determine the need for, and type of, additional evaluations which may be required to more fully characterize wetland functions and values within the study area.

Groundwater recharge is defined as the flow of water from a wetland to the groundwater table, evaluated on a net annual basis. **Groundwater discharge** is defined as the flow of water from the groundwater table to a wetland on a net annual basis (Adamus et al. 1987). Most of the wetlands in the Housatonic River Basin overlie stratified drift deposits and therefore have important hydrologic functions such as groundwater aquifer discharge and recharge (NERBC 1980). Insufficient information is available to evaluate the degree to which study area wetlands contribute to groundwater recharge or discharge.

Floodflow alteration is defined as the storage of surface water flow or the attenuation of the velocity of surface water flow (Adamus et al. 1987). The relatively broad floodplain present along the Housatonic River in the southern half of the study area, combined with the prevalence of bordering vegetated wetlands and the relatively low elevational gradient of this stretch of river, provide significant floodflow alteration functions. This is supported by NERBC (1980), which states that the major wetland systems along the Housatonic River, such as those associated with the Housatonic Valley Wildlife Management Area, are particularly valuable for flood water storage and wildlife habitat.

Sediment stabilization is defined as the binding of soil/sediment resulting in the dissipation of erosive forces while **sediment/toxicant retention** is defined as the physical or chemical trapping and retention, on a net annual basis, of inorganic sediments and/or chemical substances generally toxic to aquatic life (Adamus et al. 1987). The wetland areas within the downstream reach provide both of these functions. The extensive vegetated wetland areas present, their interspersion with the open water areas of the river channel, and the relatively slow water flow in this area (due to low elevational gradient and the extensive meandering of the river channel) allow for the trapping, deposition, and binding of sediments as well as any chemical contaminants that may be adhered to these sediments. Wetland areas in the upstream and middle reaches are likely to provide these functions only to a limited degree since wetland areas are less common and they are less interspersed with the open water areas constituting the river channel.

Nutrient removal/transformation involves the retention or transformation of inorganic phosphorus and/or nitrogen into their organic forms on either a net annual basis or during the growing season while **production export** is defined as the flushing of relatively large amounts of organic plant material (specifically, net annual primary production) from wetlands to downgradient areas. The wetland areas in the downstream reach provide both of these functions. The extensive vegetated wetland areas present, their interspersion with the open water areas of the river channel, and the relatively slow water flow in this area (due to low elevational gradient and the extensive meandering of the river channel) allow for the trapping, retention, and transformation of nutrients. Due to wastewater treatment plant discharges upstream of these wetlands, there is a significant opportunity for these wetlands to perform an important nutrient removal function. These nutrients, in turn, stimulate primary productivity which appears relatively high in these wetlands, based on the amount of aquatic vegetation observed. However, due to the presence of the Woods Pond dam, it is uncertain how much of this productivity is retained in Woods Pond and how much is transported downstream of the study area. Wetland areas in the upstream and middle reaches are likely to provide these functions only to a limited degree since wetland areas are less common and they are less interspersed with the open water areas constituting the river channel.

Wildlife diversity/abundance is defined as the support of a diversity and/or abundance of wetland-dependent wildlife species during the breeding, wintering, and/or migratory periods. **Aquatic diversity/abundance** is defined as the support of a diversity and/or abundance of fish and invertebrate species (Adamus et al. 1987). These functions and values are described and discussed in Section V. In general, the middle and downstream reaches provide relatively high quality aquatic and wildlife habitat that supports a relatively large diversity and abundance of wildlife and aquatic species.

The **uniqueness/heritage** function is defined as the possession of unique traits or socioeconomically or culturally valuable attributes. The wetlands present in the study area do not possess any known unique cultural or socioeconomic traits, although, as noted above, large portions of the lower sections of the study area are classified as "estimated habitats of rare wetlands wildlife", "high priority sites for rare species", or "exemplary natural communities". To this degree, they are somewhat unique relative to wetland habitats present in Massachusetts as a whole. The **recreation** function is defined as providing recreational opportunities to the surrounding community. In this regard, the study area wetlands provide ample recreational opportunities, particularly for hunting, fishing, and canoeing. The portions of the study area within the Housatonic Valley Wildlife Management Area are actively hunted for waterfowl, as evidenced by numerous duck blinds. These areas are also likely trapped for furbearing mammals. Fishing occurs within Woods Pond and along portions of the river. A canoe launch is present at about the midpoint of the study area and several canoes were observed in the water during the October 1995 field visit.

In summary, the study area wetlands provide numerous wetland functions and values. These functions and values are mostly provided by wetlands areas in the middle and downstream reaches; vegetated wetlands in the upstream reach are rare and the river channel itself (an open water wetland type) provides very limited functions and values.

G. Qualitative Evaluation of Habitat Quality

Alteration of natural habitats along the Housatonic River has occurred to a large extent within the upstream reach (Figure 2). Within this reach, large-scale urban development has occurred, the river channel has been straightened by filling wetlands and oxbows for flood control purposes, and native vegetation has been replaced with ornamental species or eliminated entirely (ChemRisk 1994). In many areas of the upstream reach, these activities have resulted in the elimination, fragmentation, or reduced suitability of habitats for many wildlife species. In addition, the river channel itself contains little cover valuable to fish and other aquatic species, reducing its value as habitat.

Within the middle reach, habitats have received fewer and less severe physical stresses associated with human development relative to upstream areas. However, some residential and industrial development (wastewater treatment plant, electrical substation, and mining) encroaches on the floodplain of the river within this stretch (Figure 2). The aquatic, wetland, and upland habitats present within this reach are, however, relatively undisturbed and do provide relatively good quality habitats for many aquatic and wildlife species. This is reflected by the fact that most of this stretch is designated as either an "estimated habitat of rare wetlands wildlife", a "high priority site of rare species habitat, and/or an "exemplary natural community" (Figure 1). Invasive wetland species indicative of disturbance, such as common reed (*Phagmites communis*), are absent from these wetlands; this is another indicator of their general quality.

The downstream reach is almost entirely undeveloped and provides the highest quality aquatic and wildlife habitats within the study area. Again, invasive wetland species indicative of disturbance, such as common reed (*Phagmites communis*), are absent from these wetlands, thus indicating the general quality of these wetlands. This reach contains an excellent interspersion of open water, emergent, forested, and shrub wetland types as well as an excellent diversity of upland, wetland, and aquatic plant communities which provide abundant food and cover for wildlife. Nest boxes (primarily designed for wood ducks) are prevalent in these wetland areas as are naturally occurring snags; many of the natural snags, however, are of relatively small diameter and would not be suitable substrates for the larger cavity-nesting birds. The high quality of these wetland habitats is reflected by the fact that this entire reach, except for the southern half of Woods Pond, is designated as either an "estimated habitat of rare wetlands wildlife" or as a "high priority site of rare species habitat/exemplary natural community" (Figure 1).

In summary, a number of significant habitat types occur within the study area and they are considerable in extent within the middle and downstream reaches. The quality of the aquatic (the Housatonic River channel and Woods Pond), vegetated wetland, and adjacent upland habitats within the study area varies from poor to excellent. In general, the quality of all three of these general habitat types increases along an upstream to downstream gradient, with overall habitat quality lowest in the upstream reach and highest in the downstream reach.

V. FISH AND WILDLIFE RESOURCES

Fish and wildlife species which may occur within the study area were determined through literature review, agency consultation, and field survey data. These are discussed by major taxonomic group, below. For each taxonomic group evaluated, species lists include those species which are known to occur within the study area, based on actual sightings during site-specific studies, as well as species which are likely to occur within the study area, based on documented occurrence (from literature sources) within an area that includes, but is not necessarily limited to, the study area. Following this taxa-specific discussion, the fish and wildlife species known or likely to occur in the study area are related to the specific habitat types present within the study area.

A. Birds

Avian species are important components of all major ecosystems, occupying the full range of available ecological niches and trophic levels. Birds are often the most conspicuous animals present within ecosystems, allowing avian community structure to be used in assessing habitat quality as well as serving as a barometer of environmental changes (both naturally occurring and anthropogenically induced) (Morrison 1986).

Through 1991, 460 species of birds have been definitely recorded in Massachusetts, of which 196 are regular breeders (Veit and Peterson 1993). Of these 460 species, 259 are known, or are likely, to occur within the study area and immediate vicinity of which 84 species are present only as migrants or as occasional transient species (Table 5[1]). Thus, approximately

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[1] Table 5 provides a complete listing of all bird species known or likely to be present within the study area. Bird species listed in Tables 6 through 8 represent subsets of this total species list for breeding and wintering birds.

175 species of birds are likely to occur with some regularity within the study area during the breeding and/or winter periods. Of these, 105 species have actually been observed within the study area during site-specific studies (Table 5) although it should be noted that species which occur only during the winter period (e.g., snow bunting) would be missed since none of these site-specific studies occurred during the winter period.

The Housatonic Valley Wildlife Management Area, established in 1968, encompasses approximately 750 acres in the municipalities of Pittsfield, Lenox, and Lee. Since 1970, 176 species of birds have been recorded in this area (MADFW 1986) as follows:

- Abundant (a very common species) - 15 species
- Common (likely to be seen in suitable habitat) - 86 species
- Uncommon (present but not likely to be seen) - 28 species
- Occasional (seen only a few times a season) - 16 species
- Rare (not expected to be seen every year) - 23 species
- Accidental (recorded only once or twice) - 8 species

1. Breeding Season

The Massachusetts Breeding Bird Atlas project was a six-year effort (1974-1979) to map the distribution of all bird species nesting in the state. These unpublished data have been compiled and evaluated by Veit and Peterson (1993). Since these data are somewhat dated, Veit and Peterson (1993) have included only those data that still accurately reflect each species' current pattern of distribution and breeding status as determined through comparisons with other data sources. Based on these "validated" breeding bird atlas data, Veit and Peterson (1993) list 119 bird species known or suspected of breeding in the six survey blocks encompassing the study area and immediate vicinity, including 90 species listed as confirmed breeders, 25 species listed as probable breeders, and 4 species listed as possible breeders (Table 6). Of these 119 species, 91 are known to breed within the Housatonic Valley Wildlife Management Area (MADFW 1986; Table 5).

Site-specific data on the density of breeding birds is also available from ChemRisk (1994) for forested habitats within the 10-year floodplain of the Housatonic River.

These data were collected within a 5.85-ha census plot located 0.75 miles south of New Lenox Road using a modified version of the territory mapping method. Four sets of censuses were conducted on 25 to 28 May 1993 during the early morning hours (ChemRisk 1994). The results of these censuses are summarized in Table 7 and are typical for this type of habitat in this area of the Northeastern United States (ChemRisk 1994). Of the 23 avian species for which densities could be calculated, the five most abundant species observed were American redstart, veery, red-eyed vireo, wood thrush, and ovenbird.

2. Winter Period

To characterize winter bird usage of the study area and immediate vicinity, Christmas Bird Count data from 1990 to 1995 were used (Neumuth 1991, 1992, 1993, 1994, 1995). Christmas Bird Counts are one day counts conducted annually during the months of December or January within a circle with a diameter of 15 miles. Birds seen or heard are enumerated during these counts.

The nearest Christmas Bird Count plot is centered within the study area at the junction of Holmes and Chapman Roads, Pittsfield. Thus, the entire study area is within the diameter of the census plot. Table 8 lists the number of birds, by species, observed during the past five surveys; a total of 75 species were observed during this period. Based upon five-year mean values, the ten most commonly observed bird species during the winter period are: (1) European starling; (2) Canada goose; (3) American crow; (4) black-capped chickadee; (5) house finch; (6) ring-billed gull; (7) rock dove; (8) mourning dove; (9) blue jay; and (10) house sparrow. Since the census plot encompasses a larger area and more diverse habitats (several large lakes are included) than are present within the study area, all of the species listed in Table 8 may not regularly occur within the study area during the winter period.

3. Migration

Aside from the protracted summer and fall migration of shorebirds, most of the major migratory activity through Massachusetts occurs between mid-March and early June and late August through mid-November (Veit and Peterson 1993). The geographical location and topographical features of Massachusetts have an effect on the behavior and distribution of migrants. Although large numbers of birds, especially waterfowl, shorebirds, and other waterbirds, are known to migrate through coastal and near-coastal areas of Massachusetts (Myers et al. 1987; Veit and Peterson 1993), considerable migration also takes place in inland areas.

Passerines generally migrate on a broad front through Massachusetts, although grounded migrants in interior locations frequently concentrate in river valleys, such as the Housatonic and Connecticut river valleys, during migratory stop-overs or when forced down by unfavorable weather conditions (Veit and Peterson 1993). Hawks also generally migrate along a broad front but may also follow topographical features, such as ridgelines and river valleys.

There is much evidence to indicate that many waterfowl, shorebirds, and several other waterbird groups make inland passages over New England in great numbers. For example, up to 225,000 ducks, composed of a number of dabbling and diving duck species, may pass through western Massachusetts annually (Bellrose 1980). During migration, the central Berkshire Valley contains the best habitat in Berkshire County for herons, waterfowl, and shorebirds. Large lakes within this area, principally Lake Onota (two miles northwest of the study area), Richmond Pond (3.5 miles west of the study area), Pontoosuc Lake (two miles north of the study area), Stockbridge Bowl (three miles west of Woods Pond), and Laurel Lake (two miles southwest of Woods Pond) are especially attractive to these birds; Lake Onota has historically been best (Veit and Peterson 1993).

B. Mammals

Mammals are also important components of ecosystems. Many species of small mammals, such as mice and voles, serve as important food sources for upper trophic level predators. In addition, many of the top predators within ecosystems are mammalian species.

A total of 53 species of mammals are known to occur, or are likely to occur, within the study area. These species are listed in Table 9. Of these, 24 species have actually been observed within the study area during site-specific studies, as noted in Table 9. Site-specific data on densities are available only for small mammals.

A pilot small mammal trapping study was conducted in on-site forested and shrub meadow habitats in 1993 by ChemRisk (1994). Based on this pilot study, the white-footed mouse and southern red-backed vole were the predominant small mammals present in the floodplain forest and meadow voles, short-tailed shrews, and masked shrews were the dominant small mammal species present in shrub meadow habitats (ChemRisk 1994).

Following the pilot study, mark-recapture studies were conducted to gather site-specific data on the density of the dominant small mammal species present in these two habitat types. For the forested floodplain habitat, on-site density estimates for the white-footed mouse and southern red-backed vole were 16 and 8.7 individuals/ha, respectively (ChemRisk 1994). These densities compared favorably to density estimates reported in the literature. For shrub meadow habitats, insufficient numbers of shrews were captured to estimate population densities. During 300 trap-nights, one short-tailed shrew and four masked shrews were caught in the plot located within the floodplain (target plot), and three short-tailed shrews and six masked shrews were caught in the plot located outside of the floodplain (reference plot) (ChemRisk 1994).

C. Amphibians and Reptiles

Amphibians and reptiles generally function as low to mid trophic level components of ecosystems, particularly in wetland and aquatic habitats. Many species of amphibians and reptiles are sensitive to habitat and water quality changes and thus serve as good indicators of habitat quality, especially in wetland and aquatic systems.

A total of 35 species of reptiles and amphibians are known to occur, or are likely to occur, within the study area. These species are listed in Table 10 and include 9 species of salamanders, 9 species of frogs and toads, 6 species of turtles, and 11 species of snakes. Of these 35 species, 13 species have actually been observed within the study area during site-specific studies, as noted in Table 10, including 3 species of salamanders, 6 species of frogs and toads, 2 species of turtles, and 2 species of snakes. Twenty-six of these 35 species are known to occur within the Housatonic Valley Wildlife Management Area (MADFW 1995b), including 5 species of salamanders, 8 species of frogs and toads, 5 species of turtles, and 8 species of snakes (Table 10).

D. Aquatic Communities

Data on aquatic communities present within the study area are available for fish, benthic invertebrates, and phytoplankton. These are discussed separately in the following subsections.

1. Fish

Within aquatic communities, predatory fish species generally occupy the top of the food chain, while other (forage) fish species serve as important food items for larger fish, as well as for birds and mammals which utilize aquatic and wetland habitats.

A total of 39 species of fish in 10 families have been collected from the Massachusetts sections of the Housatonic River in the five studies conducted since 1943 (Chadwick & Associates 1994). These species are listed in Table 11. Of these 39 species, 18 have been collected within the study area portion of the Housatonic River, 16 have been collected from Woods Pond, and 20 have been collected from both the river and pond areas during site-specific studies (Table 11). Seventeen of these 39 species are also known to occur within the Housatonic Valley Wildlife Management Area (Table 11; MADFW 1995b).

Within the Housatonic River, Cyprinidae (minnows) was the most numerous of the six fish families observed, representing 67% of the total fish collected in 1992 and 1993. Bluntnose minnow, white sucker, yellow perch, common shiner, and spottail shiner were the five most numerous species collected from the river (Table 12). Within Woods Pond, Centrarchidae (sunfish/bass) was the most numerous family (40%), followed by Percidae (perch; 19%), Cyprinidae (18%), and Catostomidae (suckers; 16%). Yellow perch, bluegill, white sucker, pumpkinseed, and largemouth bass were the five most numerous species collected from Woods Pond (Table 12).

Extensive stocking of trout species, particularly brown trout, has occurred in the East Branch of the Housatonic River above Pittsfield and in several cold water tributaries (NERBC 1980; Lawler, Matusky, and Skelly Engineers 1975). However, MADFW no longer stocks fish in the Housatonic River.

2. Benthic Invertebrates

Benthic invertebrates are important components of aquatic and wetland systems since they serve as the primary food source for many species of fish and amphibians, as well as for certain bird species (such as waterfowl) during the breeding season. They are also important in the processing of organic debris and the cycling of nutrients.

A total of 149 taxa of benthic invertebrates in 73 families have been collected from the Massachusetts sections of the Housatonic River during 1993 studies (Chadwick & Associates 1994). These taxa are listed in Table 13. Of these, 91 taxa in 51 families have been collected within the study area portion of the Housatonic River and 34 taxa in 22 families have been collected from Woods Pond (Table 13).

Within the Housatonic River, chironomids dominated the benthic invertebrate community, accounting for 72% of the total observed density. The chironomids *Tanytarsus spp.* (34.8%), *Cricotopus trifasciata* (13.4%), and *Bruninella spp.* (7.3%), along with the caddisfly *Cheumatopsyche spp.* (7.3%), were the most numerous taxa collected from the river (Table 14). Chadwick & Associates (1994) attributed the relatively high insect abundances (especially of caddisflies) observed during their studies to nutrient enrichment from wastewater treatment plants discharging to the Housatonic River. Within Woods Pond, chironomids also dominated the benthic invertebrate community, accounting for 63% of the total observed density. *Cladopelma spp.* (a chironomid; 35.8%), *Procladius spp.* (a chironomid; 22.2%), oligochaetes (12.4%), and *Chaoborus spp.* (a dipteran; 8.6%) were the most numerous taxa collected from Woods Pond (Table 14).

Table 15 presents a breakdown of the number of invertebrate families observed in the Housatonic River and Woods Pond by major taxonomic group. Within the study area portion of the Housatonic River, insect families were most numerous; the insect order Diptera was represented by the most families (8). Insect orders Ephemeroptera, Plecoptera, and Trichoptera, considered pollution sensitive, were well represented, accounting for 14 (27%) of the total observed families (Table 15). Insect families were also most numerous in Woods Pond. The insect order Diptera and molluscs were represented by the most families (5 each; Table 15).

Total densities of benthic invertebrates ranged from 2,653 to 8,003 organisms/m^2 for the three sampling stations located within the study area portion of the Housatonic River (Table 16). Diversity indices ranged from 2.96 to 3.94, indicating a relatively diverse benthic invertebrate community within this portion of the river. In Woods Pond, the total density of benthic invertebrates was 1,161 organisms/m^2, with a diversity index of 2.82 (Table 16).

3. Phytoplankton

Phytoplankton form the base of the food web in relatively shallow and slow flowing aquatic and wetland systems. Lawler, Matusky, and Skelly Engineers (1975) summarize available data from summer surveys conducted in 1963 and 1964 on the phytoplankton species and faunal groups present in the Massachusetts portion of the Housatonic River. The numerically dominant organisms were the green algae *Scenedesmus* and *Spirogyra* and the blue-green algae *Oscillatoria*; the dominant faunal group was rotifers. At the three sampling stations within the study area, between 2 and 7 genera of plankton were collected during these surveys.

E. Threatened and Endangered Species Occurrences

Based on a search of the Massachusetts Natural Heritage database, consultations with the USFWS New England Field Office (USFWS 1995), and a comparison of the wildlife species lists (Tables 5, 9, 10, and 11) with the list of endangered, threatened, and special concern species in the Commonwealth of Massachusetts, a total of 120 species of flora and fauna known or likely to occur in the "vicinity" of the study area are listed as federal or state threatened, endangered, or special concern, or are on the state watch list. These species are listed in Table 17 and include 77 plants, four mammals, 24 birds, five amphibians, four reptiles, one fish, and five invertebrates. Due to the sensitive nature of the information, specific locations of sightings are not provided by the Natural Heritage Program for listed species. Also, due to the size of the study area, the Natural Heritage Program would not plot the locations of specific sightings to provide a study area-specific list of species. The best resolution they would provide was on a USGS quadrangle scale. Since the study area encompasses portions of four USGS quadrangles, many of the 120 species listed in Table 17 may not occur in the study area.

In order to narrow the species listed in Table 17 to provide a more study area-specific list, the 120 species were categorized using data from field observations, species reported from the Housatonic Valley Wildlife Management Area, the list of endangered, threatened, and special concern species broken down by township in BBL (1991) (the study area is in the townships of Pittsfield, Lenox, and Lee), and habitat requirements relative to the habitats present in the study area. Historical species (defined for this assessment as species not observed or reported within the last 25 years) were also screened out. Based on this procedure, a list of species known (observed during site-specific studies) or likely (reported from the Housatonic Valley Wildlife Management Area or other literature sources) to occur in the study area was generated (Table 18) and includes 58 species. Table 19 breaks down these 58 species by major taxonomic group and listing status. Of the 58 species, three are federally listed (one endangered bird, one threatened bird, and one candidate plant species). All 58 species are state listed, including 12 listed as endangered, 10 listed as threatened, 26 listed as special concern, and 10 species which are on the watch list. Plants (33 species) and birds (16 species) were the most frequently listed taxa (Table 19). Many of these listed species utilize wetland and aquatic habitats.

One state threatened amphibian (marbled salamander [*Ambystoma opacum*]) is reported to occur within the study area. Three additional amphibians are listed as special concern and a fifth is on the state watch list (Table 18). Two species of reptiles, both turtles, listed as special concern are known or are likely to occur in the study area within the past 25 years (Table 18). One state special concern fish species, the longnose sucker (*Catostomus catostomus*), is known to occur within the study area (Table 18). This species was observed in the Housatonic River during 1992/1993 fish studies.

One federally listed endangered bird species, the peregrine falcon (*Falco peregrinus*), and one federally listed threatened bird species, the bald eagle (*Haliaeetus leucocephalus*), may occur within the study area but are considered to be occasional, transient species in this area (USFWS 1995). The federal listing status of the bald eagle was recently changed from endangered to threatened in the lower 48 states (Federal Register 36000, 12 July 1995) although this species is still listed as state endangered in Massachusetts. Bald eagles were sighted within the study area during 1993 wildlife studies. In addition to the bald eagle and peregrine falcon, five other bird species are listed as state endangered, four bird species are listed as state threatened, four bird species are listed as state special concern, and one bird species is on the state watch list (Tables 18 and 19).

No listed mammalian species are thought to occur within the study area. One aquatic invertebrate species, the tule bluet (*Enallagma carunculatum*), is listed as state special concern. Five state endangered, five state threatened, 15 state special concern, and eight watch list plant species are known or likely to occur within the study area (Tables 18 and 19).

F. Summary of Existing Wildlife Communities

Table 20 summarizes the number of taxa, by major taxonomic group, which are likely to occur within the study area, which have been reported in the Housatonic Valley Wildlife

Management Area, and which have been observed within the study area during site-specific studies. As this table shows, the study area supports a large and diverse aquatic and wildlife community, some species of which are listed as rare or endangered. Table 21 provides a matrix of preferred and utilized habitats for each of the wildlife species likely to occur within the study area. With the exception of upland coniferous forest, all of the habitat types listed in Table 21 occur within the study area. Table 21 thus provides a summary of the potential wildlife community associated with each habitat type present within the study area. Aquatic communities (fish, benthic invertebrates, and phytoplankton) were discussed in Section V.D. The wildlife and aquatic communities associated with each on-site habitat, as well as the habitats (plant communities) themselves, served as the ecological receptors in the assessment of the potential direct and indirect impacts from specific remedial actions in specific areas of the study area (see Section III.C).

VI. CONCLUSIONS

In conclusion, large portions of the Housatonic River study area provide high quality habitats for large numbers of species, some of them rare or endangered. Intrusive remedial actions, either removal or capping, within these areas would have significant short- and long-term impacts to these species and the habitats on which they depend. Relative to extensive dredging or excavation, capping would have fewer adverse impacts due primarily to much lower rates of sediment resuspension (turbidity), greatly reduced mobilization of contaminants, and less infrastructure-related disturbances.

Based on the results of this assessment, several additional studies would be useful to better quantify potential impacts to biota and habitats from remedial actions. These additional studies include a more quantitative analysis of wetland functions and values, particularly for functions and values other than those directly related to biotic communities. Rare and endangered species surveys, particularly for plants, would also help define the portions of the study area potentially most susceptible to disturbance by better documenting the presence and areal extent of these species within the study area.

Once areas (if any) that warrant remediation are identified and detailed remedial alternatives (including specific technologies and methodologies) are developed, this preliminary impact assessment would be refined to focus on specific habitats and biota within the remediation zone. This refined evaluation, in conjunction with the additional studies outlined above, would allow a more site-specific and quantitative analysis of potential remedial impacts to be conducted, as well as allowing for a site-specific assessment of potential mitigation measures and recovery potential for impacted habitats.

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TABLES

TABLE 1
Woody Plant Species Identified in Floodplain Forest Sample Plots

Common Name	Scientific Name	Density (stems/ha)	Relative Density (percent)
Trees (>4 cm DBH)			
Sugar maple	*Acer saccharum*	1,117	62.9
Balsam poplar	*Populus balsamifera*	339	19.0
Gray birch	*Betula populifolia*	72	4.0
Black cherry	*Prunus serotina*	67	3.8
White pine	*Pinus strobus*	61	3.4
Alder	*Alnus spp.*	39	2.2
Paper birch	*Betula papyrifera*	28	1.6
Slippery elm	*Ulmus rubra*	17	1.0
Ironwood	*Carpinus caroliniana*	11	0.6
Yellow birch	*Betula alleghaniensis*	11	0.6
Domestic apple	*Pyrus malus*	6	0.3
Black oak	*Quercus velutina*	6	0.3
Ash	*Fraxinus spp.*	6	0.3
Shrubs			
Arrowwood	*Viburnum recognitum*	300	20.5
Sugar maple	*Acer saccharum*	233	15.9
Honeysuckle	*Lonicera spp.*	183	12.6
Black cherry	*Prunus serotina*	167	11.5
Blueberry	*Vaccinium spp.*	117	8.0
Ash	*Fraxinus spp.*	117	8.0
Holly	*Ilex spp.*	117	8.0
Dogwood	*Cornus spp,*	83	5.6
White pine	*Pinus strobus*	33	2.2
Silver maple	*Acer saccharinum*	17	1.1
Unidentified viburnum	*Viburnum spp.*	17	1.1
Sweetbay magnolia	*Magnolia virginiana*	17	1.1
American basswood	*Tilia americana*	17	1.1

TABLE 1
Woody Plant Species Identified in Floodplain Forest Sample Plots

Common Name	Scientific Name	Density (stems/ha)	Relative Density (percent)
Alder	*Alnus spp.*	17	1.1
Cherry	*Prunus spp.*	17	1.1
Boxelder	*Acer negundo*	17	1.1

Source: ChemRisk (1994).

TABLE 2
Plant Species Observed in Shrub Meadow Sample Plots

Common Name	Scientific Name
Grasses	
Bentgrass	*Agrostis spp.*
Muhly	*Muhlenbergia spp.*
Rush	*Juncus spp.*
Sedge	*Carex spp.*
Forbs	
Aster	*Aster spp.*
Beardtongue	*Penstemon spp.*
Bedstraw	*Galium spp.*
Black-eyed susan	*Rudbeckia hirta*
Clover	*Trifolium spp.*
Clubmoss	*Lycopodium spp.*
Common thoroughwort	*Eupatorium perfoliatum*
Daisy fleabane	*Erigeron spp.*
Goldenrod	*Solidago spp.*
Horsetail	*Equisetum spp.*
Jewelweed	*Impatiens capensis*
Lettuce	*Lactuca spp.*
Mint	*Mentha spp.*
Sensitive fern	*Onoclea sensibilis*
Shield fern	*Dryopteris spp.*
St. Johnswort	*Hypericum spp.*
Sweet joe-pye weed	*Eupatorium purpureum*
Vetch	*Vicia spp.*
Virgin's-bower	*Clematis virginiana*
Wild cucumber	*Echinocystis lobata*
Wood sorrel	*Oxalis spp.*

TABLE 2 Plant Species Observed in Shrub Meadow Sample Plots	
Common Name	**Scientific Name**
Trees/Shrubs	
Alder	*Alnus spp.*
American meadow-sweet	*Spirea latifolia*
Ash	*Fraxinus spp.*
Birch	*Betula spp.*
Cinquefoil	*Potentilla spp.*
Holly	*Ilex spp.*
Plum	*Prunus spp.*
Raspberry	*Rubus spp.*
Red maple	*Acer rubrum*
Red-osier dogwood	*Cornus stolonifera*
Snowberry	*Symphoricarpos spp.*
Willow	*Salix spp.*
Source: ChemRisk (1994).	

TABLE 3
Relative Dominance of the Ten Most Common Plant Species Observed in Shrub Meadow Sample Plots

Common Name	Scientific Name	Relative Dominance (percent)
Reference Area		
Bentgrass	*Agrostis spp.*	30
Sensitive fern	*Onoclea sensibilis*	21
Goldenrod	*Solidago spp.*	19
Bedstraw	*Galium spp.*	9.3
Red-osier dogwood	*Cornus stolonifera*	5.8
Cinquefoil	*Potentilla spp.*	2.2
Muhly	*Muhlenbergia spp.*	2.2
Sedge	*Carex spp.*	2.2
Vetch	*Vicia spp.*	2.0
Birch	*Betula spp.*	1.6
Study Area		
Sensitive fern	*Onoclea sensibilis*	25
Goldenrod	*Solidago spp.*	23
Bentgrass	*Agrostis spp.*	15
American meadow-sweet	*Spirea latifolia*	10
Bedstraw	*Galium spp.*	8.1
Raspberry	*Rubus spp.*	5.8
Snowberry	*Symphoricarpos spp.*	2.5
Red-osier dogwood	*Cornus stolonifera*	2.0
Clubmoss	*Lycopodium spp.*	1.9
Shield fern	*Dryopteris spp.*	1.9

Source: ChemRisk (1994).

TABLE 4 Relative Dominance of Vegetation Types Observed in Shrub Meadow Sample Plots		
	Relative Dominance (percent)	
Vegetation Type	Unmowed Areas	Mowed Areas
Reference Area		
Forbs	48	52
Grasses	36	33
Shrubs	13	13
Trees	3	0
Bare ground/rock	0	2
Study Area		
Forbs	53	65
Grasses	32	17
Shrubs	14	13
Trees	1	1
Bare ground/rock	0	4
Source: ChemRisk (1994).		

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Acadian flycatcher	*Empidonax virescens*	4*
✓ Alder flycatcher	*Empidonax alnorum*	2,4,5,6,7C@
✓ American bittern (E)[b]	*Botaurus lentiginosus*	2,4,5,6,7U@,9
✓ American black duck	*Anas rubripes*	1,2,3,4,5,6,7C@
American coot	*Fulica americana*	1,4*
✓ American crow	*Corvus brachyrhynchos*	1,2,3,4,5,6,7A@
✓ American goldfinch	*Carduelis tristis*	1,2,3,4,5,6,7C@
✓ American kestrel	*Falco sparverius*	1,2,4,5,6,7C@
American pipit	*Anthus rubescens*	4*
✓ American redstart	*Setophaga ruticilla*	2,4,5,6,7C@
✓ American robin	*Turdus migratorius*	1,2,3,4,5,6,7A@
American tree sparrow	*Spizella arborea*	1,4,5,7C
American wigeon	*Anas americana*	4*
✓ American woodcock	*Scolopax minor*	1,2,4,5,6,7C@
✓ Bald eagle (E/FT)	*Haliaeetus leucocephalus*	1,4*,6,7X,8*
✓ Bank swallow	*Riparia riparia*	2,4,5,6,7C@
✓ Barn swallow	*Hirundo rustica*	2,4,5,6,7C@
✓ Barred owl	*Strix varia*	1,2,4,5,6,7U@
✓ Bay-breasted warbler	*Dendroica castanea*	4*,6,7U
✓ Belted kingfisher	*Ceryle alcyon*	1,2,3,4,5,6,7C@
Black scoter	*Melanitta nigra*	4*
✓ Black-and-white warbler	*Mniotilta varia*	2,4,5,6,7C@
Black-bellied plover	*Pluvialis squatarola*	4*
Black-billed cuckoo	*Coccyzus erythropthalmus*	2,4,5,7O
✓ Black-capped chickadee	*Parus atricapillus*	1,2,3,4,5,6,7A@
Black-crowned night heron	*Nycticorax nycticorax*	4*,5,7R
Black-throated blue warbler	*Dendroica caerulescens*	2,4,5,7C
✓ Black-throated green warbler	*Dendroica virens*	2,4,5,6,7C
✓ Blackburnian warbler	*Dendroica fusca*	2,4,5,6,7C

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Blackpoll warbler (SC)	*Dendroica striata*	4*,7U
✓ Blue jay	*Cyanocitta cristata*	1,2,3,4,5,6,7A@
✓ Blue-gray gnatcatcher	*Polioptila caerulea*	2,4,5,6,7U@
✓ Blue-winged teal	*Anas discors*	2,4,6,7U@
✓ Blue-winged warbler	*Vermivora pinus*	2,4,5,6,7O@
✓ Bobolink	*Dolichonyx oryzivorus*	2,4,5,6,7C@
Bohemian waxwing	*Bombycilla garrulus*	4*
Bonaparte's gull	*Larus philadelphia*	4*,7R
Brant	*Branta bernicla*	4*
Broad-winged hawk	*Buteo platypterus*	2,4,5,7C@
✓ Brown creeper	*Certhia americana*	1,2,4,5,6,7C@
✓ Brown thrasher	*Toxostoma rufum*	2,4,5,6,7C@
✓ Brown-headed cowbird	*Molothrus ater*	1,2,4,5,6,7C@
Bufflehead	*Bucephala albeola*	1,4*,7U
✓ Canada goose	*Branta canadensis*	1,2,3,4,6,7A@
✓ Canada warbler	*Wilsonia canadensis*	2,4,5,6,7U
Canvasback	*Aythya valisineria*	4*
Cape May warbler	*Dendroica tigrina*	4*,7U
Carolina wren	*Thryothorus ludovicianus*	1,4*
Cattle egret	*Bubulcus ibis*	4*,7X
✓ Cedar waxwing	*Bombycilla cedrorum*	1,2,3,4,5,6,7A@
✓ Chestnut-sided warbler	*Dendroica pensylvanica*	2,4,5,6,7C@
✓ Chimney swift	*Chaetura pelagica*	2,4,5,6,7C
✓ Chipping sparrow	*Spizella passerina*	2,4,5,6,7C@
✓ Cliff swallow	*Hirundo pyrrhonota*	2,4,5,6,7C@
Common barn-owl (SC)	*Tyto alba*	4*,5
Common goldeneye	*Bucephala clangula*	1,4*,7C
✓ Common grackle	*Quiscalus quiscula*	2,4,5,6,7A@
Common loon (SC)	*Gavia immer*	1,4*,7R

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Common merganser	*Mergus merganser*	1,4,5,7C
✓ Common moorhen (SC)	*Gallinula chloropus*	2,4,5,6,7C@,9
✓ Common nighthawk	*Chordeiles minor*	2,4,5,6,7C
✓ Common raven	*Corvus corax*	1,4,5,6
Common redpoll	*Carduelis flammea*	1,4,5,7R
Common snipe	*Gallinago gallinago*	1,2,4,7C@
✓ Common yellowthroat	*Geothlypis trichas*	2,4,5,6,7C@
Connecticut warbler	*Oporornis agilis*	4*,7R
Cooper's hawk (SC)	*Accipiter cooperii*	1,4,5,7O
✓ Dark-eyed junco	*Junco hyemalis*	1,2,3,4,5,6,7C
Double-crested cormorant	*Phalacrocorax auritus*	4*,7R
✓ Downy woodpecker	*Picoides pubescens*	1,2,3,4,5,6,7C@
Dunlin	*Calidris alpina*	4*
Eastern bluebird	*Sialia sialis*	1,2,4,5,7R
✓ Eastern kingbird	*Tyrannus tyrannus*	2,4,5,6,7C@
Eastern meadowlark	*Sturnella magna*	2,4,5,7C@
✓ Eastern phoebe	*Sayornis phoebe*	2,3,4,5,6,7C@
Eastern screech-owl	*Otus asio*	2,4,5
✓ Eastern wood-pewee	*Contopus virens*	2,4,5,6,7C@
✓ European starling	*Sturnus vulgaris*	1,2,3,4,5,6,7A@
Evening grosbeak	*Coccothraustes vespertina*	1,2,4,5,7A
Field sparrow	*Spizella pusilla*	2,4,5,7C@
Fish crow	*Corvus ossifragus*	1*
Fox sparrow	*Passerella iliaca*	1,4*,7O
Gadwall	*Anas strepera*	4*
Glossy ibis	*Plegadis falcinellus*	4*,7X
Golden eagle	*Aquila chrysaetos*	4*
Golden-crowned kinglet	*Regulus satrapa*	1,2,4,5,7C
✓ Golden-winged warbler (E)	*Vermivora chrysoptera*	2,4,5,6,7R

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Grasshopper sparrow (T)	*Ammodramus savannarum*	2,4,5,9
✓ Gray catbird	*Dumetella carolinensis*	2,3,4,5,6,7C@
Gray-cheeked thrush	*Catharus minimus*	4*,5,7R
Great black-backed gull	*Larus marinus*	1,4*
✓ Great blue heron (WL)	*Ardea herodias*	1,3,4,5,6,7C,9
✓ Great crested flycatcher	*Myiarchus crinitus*	2,4,5,6,7U@
Great egret	*Casmerodius albus*	4*,7R
Great horned owl	*Bubo virginianus*	1,2,4,5,7U@
Greater scaup	*Aythya marila*	4*,7R
✓ Greater yellowlegs	*Tringa melanoleuca*	4*,6,7C
Green heron	*Butorides virescens*	2,4,5,7C@
Green-winged teal	*Anas crecca*	2,4,7O
✓ Hairy woodpecker	*Picoides villosus*	1,2,4,5,6,7C@
Hermit thrush	*Catharus guttatus*	2,4,5,7U
✓ Herring gull	*Larus argentatus*	1,3,4,7C
Hoary redpoll	*Carduelis hornemanni*	4*,5
Hooded merganser	*Lophodytes cucullatus*	1,4,5,7C
Horned grebe	*Podiceps auritus*	4*
Horned lark	*Eremophila alpestris*	1,4,5
✓ House finch	*Carpodacus mexicanus*	1,2,4,5,6,7A@
✓ House sparrow	*Passer domesticus*	1,2,4,5,6,7A@
✓ House wren	*Troglodytes aedon*	2,4,5,6,7C@
Indigo bunting	*Passerina cyanea*	2,4,5,7C@
✓ Killdeer	*Charadrius vociferus*	2,4,5,6,7C@
✓ King rail (T)	*Rallus elegans*	4*,5,6,9
Lapland longspur	*Calcarius lapponicus*	4*,5
Least bittern (E)	*Ixobrychus exilis*	2,4,5,9
✓ Least flycatcher	*Empidonax minimus*	2,4,5,6,7C@
✓ Least sandpiper	*Calidris minutilla*	4*,6,7U

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Lesser scaup	*Aythya affinis*	4*,7R
Lesser yellowlegs	*Tringa flavipes*	4*,7O
Lincoln's sparrow	*Melospiza lincolnii*	4*
Loggerhead shrike (E)	*Lanius ludovicianus*	4*
Long-eared owl (SC)	*Asio otus*	4*,5
Louisiana waterthrush	*Seiurus motacilla*	2,4,5,7U
Magnolia warbler	*Dendroica magnolia*	2;4,5,7U
✓ Mallard	*Anas platyrhynchos*	1,2,3,4,5,6,7C@
Marsh wren	*Cistothorus palustris*	4*,5
Merlin	*Falco columbarius*	4*
✓ Mourning dove	*Zenaida macroura*	1,2,3,4,5,6,7A@
Mourning warbler (SC)	*Oporornis philadelphia*	4*,5
Mute swan	*Cygnus olor*	4*
Nashville warbler	*Vermivora ruficapilla*	2,4,5,7C
Northern bobwhite	*Colinus virginianus*	4,5
✓ Northern cardinal	*Cardinalis cardinalis*	1,2,4,5,6,7C@
✓ Northern flicker	*Colaptes auratus*	1,2,3,4,5,6,7C@
✓ Northern goshawk	*Accipiter gentilis*	1,2,4,5,6,7O
Northern harrier (T)	*Circus cyaneus*	4*,5,7O
✓ Northern mockingbird	*Mimus polyglottos*	1,2,4,5,6,7C@
✓ Northern oriole	*Icterus galbula*	2,4,5,6,7C@
Northern parula (T)	*Parula americana*	4*,7O
Northern pintail	*Anas acuta*	4*,7R
✓ Northern rough-winged swallow	*Stelgidopteryx serripennis*	4,5,6
Northern saw-whet owl	*Aegolius acadicus*	1,2,5,7R@
Northern shoveler	*Anas clypeata*	4*
Northern shrike	*Lanius excubitor*	4*,5,7O
✓ Northern waterthrush	*Seiurus noveboracensis*	2,4,5,6,7U@
Oldsquaw	*Clangula hyemalis*	4*,7X

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Olive-sided flycatcher	*Contopus borealis*	4,5
Orchard oriole	*Icterus spurius*	4,5
✓ Osprey	*Pandion haliaetus*	4*,6,7C
✓ Ovenbird	*Seiurus aurocapillus*	2,4,5,6,7C@
Palm warbler	*Dendroica palmarum*	4*,7U
Pectoral sandpiper	*Calidris melanotos*	4*,7U
Peregrine falcon (E/FE)	*Falco peregrinus*	7R,8*,9
Pied-billed grebe (E)	*Podilymbus podiceps*	5,7O,9
✓ Pileated woodpecker	*Dryocopus pileatus*	1,2,3,4,5,6,7U@
Pine grosbeak	*Pinicola enucleator*	1,4,5,7R
Pine siskin	*Carduelis pinus*	1,2,4,5,7O
Pine warbler	*Dendroica pinus*	4,5
Prairie warbler	*Dendroica discolor*	4,5,7R
✓ Purple finch	*Carpodacus purpureus*	1,2,4,5,6,7C@
Red crossbill	*Loxia curvirostra*	1,4*
Red-breasted merganser	*Mergus serrator*	1,4*,7X
✓ Red-breasted nuthatch	*Sitta canadensis*	1,2,3,4,5,6,7U
✓ Red-eyed vireo	*Vireo olivaceus*	2,4,5,6,7C@
Red-headed woodpecker	*Melanerpes erythrocephalus*	4,5
Red-necked grebe	*Podiceps grisegena*	4*
Red-shouldered hawk	*Buteo lineatus*	2,4,5,7U@
✓ Red-tailed hawk	*Buteo jamaicensis*	1,2,4,5,6,7C@
✓ Red-winged blackbird	*Agelaius phoeniceus*	1,2,4,5,6,7A@
Redhead	*Aythya americana*	4*
Ring-billed gull	*Larus delawarensis*	1,4,7C
Ring-necked duck	*Aythya collaris*	1,4*,7R
✓ Ring-necked pheasant	*Phasianus colchicus*	1,2,4,5,6,7A@
✓ Rock dove	*Columba livia*	1,2,3,4,5,6,7A@
✓ Rose-breasted grosbeak	*Pheucticus ludovicianus*	2,4,5,6,7C@

TABLE 5 Bird Species Known or Likely to be Present Within the Study Area		
Common Name	**Scientific Name**	**Source[a]**
Rough-legged hawk	*Buteo lagopus*	4*,5,7O
Ruby-crowned kinglet	*Regulus calendula*	4*,7C
✓ Ruby-throated hummingbird	*Archilochus colubris*	2,4,5,6,7C@
Ruddy duck	*Oxyura jamaicensis*	4*
✓ Ruffed grouse	*Bonasa umbellus*	1,2,4,5,6,7U@
✓ Rufous-sided towhee	*Pipilo erythrophthalmus*	2,4,5,6,7C@
Rusty blackbird	*Euphagus carolinus*	1,4,7C
Savannah sparrow	*Passerculus sandwichensis*	2,4,5,7C@
✓ Scarlet tanager	*Piranga olivacea*	2,4,5,6,7C@
Sedge wren (E)	*Cistothorus platensis*	4,5,9
Semipalmated plover	*Charadrius semipalmatus*	4*
Semipalmated sandpiper	*Calidris pusilla*	4*,7U
Sharp-shinned hawk (SC)	*Accipiter striatus*	1,4,5,7C
Short-billed dowitcher	*Limnodromus griseus*	4*
Short-eared owl (E)	*Asio flammeus*	4*,5
Snow bunting	*Plectrophenax nivalis*	1,4,5
Snow goose	*Chen caerulescens*	1,4*,7R
Snowy egret	*Egretta thula*	7X*
Snowy owl	*Nyctea scandiaca*	4*
✓ Solitary sandpiper	*Tringa solitaria*	4*,6,7C
✓ Solitary vireo	*Vireo solitarius*	2,4,5,6,7C
✓ Song sparrow	*Melospiza melodia*	1,2,3,4,5,6,7C@
Sora	*Porzana carolina*	2,4,5,7R@
✓ Spotted sandpiper	*Actitis macularia*	2,4,5,6,7C
Swainson's thrush	*Catharus ustulatus*	4,5,7O
✓ Swamp sparrow	*Melospiza georgiana*	2,4,5,6,7C@
Tennessee warbler	*Vermivora peregrina*	4*,7U
✓ Tree swallow	*Tachycineta bicolor*	2,4,5,6,7C@
✓ Tufted titmouse	*Parus bicolor*	1,2,4,5,6,7C@

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Tundra swan	*Cygnus columbianus*	1,4*
✓ Turkey vulture	*Cathartes aura*	4*,5,6,7C
Upland sandpiper (E)	*Bartramia longicauda*	7X*
✓ Veery	*Catharus fuscescens*	2,4,5,6,7C@
Vesper sparrow (T)	*Pooecetes gramineus*	4,5,7R
✓ Virginia rail	*Rallus limicola*	2,4,5,6,7U@
✓ Warbling vireo	*Vireo gilvus*	2,4,5,6,7C@
Western sandpiper	*Calidris mauri*	4*
Whip-poor-will	*Caprimulgus vociferus*	2,4,5,7U@
✓ White-breasted nuthatch	*Sitta carolinensis*	1,2,3,4,5,6,7C@
White-crowned sparrow	*Zonotrichia leucophrys*	4*,7O
✓ White-throated sparrow	*Zonotrichia albicollis*	1,2,3,4,5,6,7C
White-winged crossbill	*Loxia leucoptera*	4*
✓ Wild turkey	*Meleagris gallopavo*	1,2,3,4,5,6,7U@
✓ Willow flycatcher	*Empidonax traillii*	2,4,5,6,7C@
Wilson's phalarope	*Phalaropus tricolor*	4*
Wilson's warbler	*Wilsonia pusilla*	4*,7O
Winter wren	*Troglodytes troglodytes*	2,4,5,7R
✓ Wood duck	*Aix sponsa*	1,2,3,4,5,6,7C@
✓ Wood thrush	*Hylocichla mustelina*	2,4,5,6,7C@
✓ Worm-eating warbler	*Helmitheros vermivorus*	4*,6
✓ Yellow warbler	*Dendroica petechia*	2,4,5,6,7C@
✓ Yellow-bellied sapsucker	*Sphyrapicus varius*	2,4,5,6,7C@
Yellow-billed cuckoo	*Coccyzus americanus*	4,5,7R
Yellow-breasted chat	*Icteria virens*	4,5,7X
✓ Yellow-rumped warbler	*Dendroica coronata*	2,3,4,5,6,7C
✓ Yellow-throated vireo	*Vireo flavifrons*	2,4,5,6,7U@

TABLE 5
Bird Species Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]

[a] 1 - Christmas Bird Count data (see Table 8); 2 - Breeding Bird Atlas data (see Table 6); 3 - Field visit (October 1995); 4 - Veit and Petersen (1993); 5 - DeGraaf and Rudis (1987); 6 - ChemRisk (1994); 7 - MADFW (1986): A = Abundant (a very common species), C = Common (likely to be seen in suitable habitat), U = Uncommon (present but not likely to be seen), O = Occasional (seen only a few times a season), R = Rare (not expected to be seen every year), X = Accidental (recorded only once or twice); 8 - USFWS (1995); 9 - MADFW (1995a).

Modifiers: * - the species is present in the area as a migrant or occasional transient only
@ - nesting species (Housatonic Valley Wildlife Management Area)

✓ Species observed during site-specific studies (ChemRisk 1994; October 1995 ENVIRON field visit).

[b] E - State Endangered; T - State Threatened; SC - State Special Concern; WL - State Watch List (not a legal designation); FE - Federally Endangered; FT - Federally Threatened.

TABLE 6
Breeding Bird Atlas Data for the Study Area

Common Name	Scientific Name	Breeding Status[a]
American bittern	*Botaurus lentiginosus*	Pr
Least bittern	*Ixobrychus exilis*	Po
Green heron	*Butorides virescens*	C
Canada goose	*Branta canadensis*	C
Wood duck	*Aix sponsa*	C
American black duck	*Anas rubripes*	C
Mallard	*Anas platyrhynchos*	C
Green-winged teal	*Anas crecca*	C
Blue-winged teal	*Anas discors*	C
Northern goshawk	*Accipiter gentilis*	C
Red-shouldered hawk	*Buteo lineatus*	C
Broad-winged hawk	*Buteo platypterus*	C
Red-tailed hawk	*Buteo jamaicensis*	Pr
American kestrel	*Falco sparverius*	C
Ring-necked pheasant	*Phasianus colchicus*	Pr
Ruffed grouse	*Bonasa umbellus*	C
Wild turkey	*Meleagris gallopavo*	Pr
Virginia rail	*Rallus limicola*	C
Sora	*Porzana carolina*	Pr
Common moorhen	*Gallinula chloropus*	C
Killdeer	*Charadrius vociferus*	C
Spotted sandpiper	*Actitis macularia*	Pr
Common snipe	*Gallinago gallinago*	C
American woodcock	*Scolopax minor*	C
Rock dove	*Columba livia*	C
Mourning dove	*Zenaida macroura*	C
Black-billed cuckoo	*Coccyzus erythropthalmus*	Pr
Eastern screech-owl	*Otus asio*	C
Great horned owl	*Bubo virginianus*	C

TABLE 6
Breeding Bird Atlas Data for the Study Area

Common Name	Scientific Name	Breeding Status[a]
Barred owl	*Strix varia*	Pr
Northern saw-whet owl	*Aegolius acadicus*	C
Common nighthawk	*Chordeiles minor*	C
Whip-poor-will	*Caprimulgus vociferus*	Po
Chimney swift	*Chaetura pelagica*	C
Ruby-throated hummingbird	*Archilochus colubris*	Pr
Belted kingfisher	*Ceryle alcyon*	C
Yellow-bellied sapsucker	*Sphyrapicus varius*	C
Downy woodpecker	*Picoides pubescens*	C
Hairy woodpecker	*Picoides villosus*	C
Northern flicker	*Colaptes auratus*	C
Pileated woodpecker	*Dryocopus pileatus*	C
Eastern wood-pewee	*Contopus virens*	C
Alder flycatcher	*Empidonax alnorum*	Pr
Willow flycatcher	*Empidonax trailli*	C
Least flycatcher	*Empidonax minimus*	Pr
Eastern phoebe	*Sayornis phoebe*	C
Great crested flycatcher	*Myiarchus crinitus*	Pr
Eastern kingbird	*Tyrannus tyrannus*	C
Tree swallow	*Tachycineta bicolor*	C
Bank swallow	*Riparia riparia*	Pr
Cliff swallow	*Hirundo pyrrhonota*	C
Barn swallow	*Hirundo rustica*	C
Blue jay	*Cyanocitta cristata*	C
American crow	*Corvus brachyrhynchos*	C
Black-capped chickadee	*Parus atricapillus*	C
Tufted titmouse	*Parus bicolor*	Pr
Red-breasted nuthatch	*Sitta canadensis*	C
White-breasted nuthatch	*Sitta carolinensis*	C

TABLE 6
Breeding Bird Atlas Data for the Study Area

Common Name	Scientific Name	Breeding Status[a]
Brown creeper	*Certhia americana*	C
House wren	*Troglodytes aedon*	C
Winter wren	*Troglodytes troglodytes*	Pr
Golden-crowned kinglet	*Regulus satrapa*	Pr
Blue-gray gnatcatcher	*Polioptila caerulea*	C
Eastern bluebird	*Sialia sialis*	C
Veery	*Catharus fuscescens*	C
Hermit thrush	*Catharus guttatus*	Pr
Wood thrush	*Hylocichla mustelina*	C
American robin	*Turdus migratorius*	C
Gray catbird	*Dumetella carolinensis*	C
Northern mockingbird	*Mimus polyglottos*	C
Brown thrasher	*Toxostoma rufum*	C
Cedar waxwing	*Bombycilla cedrorum*	C
European starling	*Sturnus vulgaris*	C
Solitary vireo	*Vireo solitaria*	Pr
Yellow-throated vireo	*Vireo flavifrons*	C
Warbling vireo	*Vireo gilvus*	C
Red-eyed vireo	*Vireo olivaceus*	C
Blue-winged warbler	*Vermivora pinus*	Pr
Golden-winged warbler	*Vermivora chrysoptera*	Pr
Nashville warbler	*Vermivora ruficapilla*	Po
Yellow warbler	*Dendroica petechia*	C
Chestnut-sided warbler	*Dendroica pensylvanica*	C
Magnolia warbler	*Dendroica magnolia*	Pr
Black-throated blue warbler	*Dendroica caerulescens*	C
Yellow-rumped warbler	*Dendroica coronata*	C
Black-throated green warbler	*Dendroica virens*	Pr
Blackburnian warbler	*Dendroica fusca*	Pr

TABLE 6
Breeding Bird Atlas Data for the Study Area

Common Name	Scientific Name	Breeding Status[a]
Black-and-white warbler	*Mniotilta varia*	C
American redstart	*Setophaga ruticilla*	C
Ovenbird	*Seiurus aurocapillus*	C
Northern waterthrush	*Seiurus noveboracensis*	Pr
Louisiana waterthrush	*Seiurus motacilla*	C
Common yellowthroat	*Geothlypis trichas*	C
Canada warbler	*Wilsonia canadensis*	C
Scarlet tanager	*Piranga olivacea*	C
Northern cardinal	*Cardinalis cardinalis*	C
Rose-breasted grosbeak	*Pheucticus ludovicianus*	C
Indigo bunting	*Passerina cyanea*	C
Rufous-sided towhee	*Pipilo erythrophthalmus*	C
Chipping sparrow	*Spizella passerina*	C
Field sparrow	*Spizella pusilla*	C
Savannah sparrow	*Passerculus sandwichensis*	C
Grasshopper sparrow	*Ammodramus savannarum*	Pr
Song sparrow	*Melospiza melodia*	C
Swamp sparrow	*Melospiza georgiana*	C
White-throated sparrow	*Zonotrichia albicollis*	C
Dark-eyed junco	*Junco hyemalis*	C
Bobolink	*Dolichonyx oryzivorus*	C
Red-winged blackbird	*Agelaius phoeniceus*	C
Eastern meadowlark	*Sturnella magna*	C
Common grackle	*Quiscalus quiscula*	C
Brown-headed cowbird	*Molothrus ater*	C
Northern oriole	*Icterus galbula*	C
Purple finch	*Carpodacus purpureus*	C
House finch	*Carpodacus mexicanus*	C
Pine siskin	*Carduelis pinus*	C

TABLE 6
Breeding Bird Atlas Data for the Study Area

Common Name	Scientific Name	Breeding Status[a]
American goldfinch	*Carduelis tristis*	C
Evening grosbeak	*Coccothraustes vespertina*	Po
House sparrow	*Passer domesticus*	C

[a] C - Confirmed breeding; Pr - Probable breeding; Po - Possible breeding.

Source: Veit and Peterson (1993); MADFW (1986).

TABLE 7
Summary of Site-Specific 1993 Avian Breeding Bird Censuses

Common Name	Scientific Name	Density (Territories/40 ha)
American redstart	*Setophaga ruticilla*	88
Veery	*Catharus fuscescens*	60
Red-eyed vireo	*Vireo olivaceus*	50
Wood thrush	*Hylocichla mustelina*	42
Ovenbird	*Seiurus aurocapillus*	28
Black-capped chickadee	*Parus atricapillus*	25
Eastern wood-pewee	*Contopus virens*	25
American robin	*Turdus migratorius*	21
Blue jay	*Cyanocitta cristata*	14
Gray catbird	*Dumetella carolinensis*	11
Northern oriole	*Icterus galbula*	11
Downy woodpecker	*Picoides pubescens*	7
Common yellowthroat	*Geothlypis trichas*	7
Northern waterthrush	*Seiurus noveboracensis*	7
American woodcock	*Scolopax minor*	7
Brown-headed cowbird	*Molothrus ater*	7
Hairy woodpecker	*Picoides villosus*	4
Red-winged blackbird	*Agelaius phoeniceus*	4
Great crested flycatcher	*Myiarchus crinitus*	4
Ruffed grouse	*Bonasa umbellus*	4
Willow flycatcher	*Empidonax traillii*	4
Rose-breasted grosbeak	*Pheucticus ludovicianus*	4
Pileated woodpecker	*Dryocopus pileatus*	4
Blue-gray gnatcatcher	*Polioptila caerulea*	Present
Eastern kingbird	*Tyrannus tyrannus*	Present

Source: ChemRisk (1994).

TABLE 8
Summary of Avian Abundance During the Winter Period
Christmas Bird Count Data - Central Berkshire, MA Census Plot

Species	1994-1995	1993-1994	1992-1993	1991-1992	1990-1991	Average
European starling	2353	2141	2273	1486	1338	1918.20
Canada goose	1984	636	5	101	812	707.60
American crow	544	808	421	623	377	554.60
Black-capped chickadee	550	582	466	435	495	505.60
House finch	364	594	713	283	248	440.40
Ring-billed gull	898	118	79	2	178	255.00
Rock dove	182	207	194	380	170	226.60
Mourning dove	119	210	291	225	247	218.40
Blue jay	189	164	323	224	182	216.40
House sparrow	246	183	132	147	245	190.60
Evening grosbeak	1	249	0	115	491	171.20
Mallard	231	227	76	70	151	151.00
American tree sparrow	135	114	70	74	114	101.40
Cedar waxwing	52	62	120	182	80	99.20
Dark-eyed junco	225	49	52	67	65	91.60
American goldfinch	138	42	44	173	60	91.40
American black duck	39	131	30	41	87	65.60
Herring gull	174	16	75	0	15	56.00
American robin	5	0	2	266	1	54.80

TABLE 8 Summary of Avian Abundance During the Winter Period Christmas Bird Count Data - Central Berkshire, MA Census Plot						
Species	1994-1995	1993-1994	1992-1993	1991-1992	1990-1991	Average
Northern cardinal	47	57	43	45	44	47.20
White-breasted nuthatch	47	39	39	35	49	41.80
Downy woodpecker	37	44	22	31	36	34.00
Red-breasted nuthatch	48	24	15	26	26	27.80
Pine grosbeak	0	95	0	0	0	19.00
Golden-crowned kinglet	34	3	4	36	10	17.40
Tufted titmouse	18	14	24	18	7	16.20
Great black-backed gull	40	9	29	0	0	15.60
Horned lark	0	10	0	28	34	14.40
Wild turkey	9	3	37	0	20	13.80
Common goldeneye	0	0	0	0	67	13.40
Red-tailed hawk	12	14	8	11	11	11.20
Common redpoll	0	52	0	3	0	11.00
Hairy woodpecker	3	14	4	11	13	9.00
White-throated sparrow	11	1	11	15	5	8.60
Red-winged blackbird	4	7	0	0	30	8.20
Song sparrow	5	1	13	12	3	6.80
Northern mockingbird	8	4	6	8	3	5.80
Pine siskin	0	0	3	21	4	5.60

TABLE 8
Summary of Avian Abundance During the Winter Period
Christmas Bird Count Data - Central Berkshire, MA Census Plot

Species	1994-1995	1993-1994	1992-1993	1991-1992	1990-1991	Average
Red crossbill	28	0	0	0	0	5.60
American coot	27	0	0	0	0	5.40
Brown creeper	2	6	2	6	8	4.80
Eastern bluebird	0	15	0	5	0	4.00
Rusty blackbird	0	0	0	0	20	4.00
Common merganser	0	1	0	0	18	3.80
Pileated woodpecker	5	4	1	4	5	3.80
Common raven	2	4	5	3	2	3.20
Belted kingfisher	1	4	3	3	2	2.60
Ring-necked pheasant	1	0	4	0	5	2.00
Sharp-shinned hawk	2	3	2	1	1	1.80
Ruffed grouse	3	0	2	0	2	1.40
Great blue heron	1	1	0	3	0	1.00
Purple finch	0	0	1	4	0	1.00
American kestrel	0	0	2	3	0	1.00
Great horned owl	2	0	0	2	1	1.00
Cooper's hawk	2	0	1	1	0	0.80
Wood duck	2	0	2	0	0	0.80
Ring-necked duck	0	4	0	0	0	0.80

TABLE 8
Summary of Avian Abundance During the Winter Period
Christmas Bird Count Data - Central Berkshire, MA Census Plot

Species	1994-1995	1993-1994	1992-1993	1991-1992	1990-1991	Average
Brown-headed cowbird	0	2	0	0	1	0.60
Snow goose	3	0	0	0	0	0.60
Scaup spp.	2	0	0	0	0	0.40
Red-breasted merganser	2	0	0	0	0	0.40
Hooded merganser	2	0	0	0	0	0.40
Northern flicker	0	1	0	1	0	0.40
Snow bunting	0	0	0	2	0	0.40
Fish crow	0	0	2	0	0	0.40
Carolina wren	0	0	1	0	0	0.20
Common loon	1	0	0	0	0	0.20
Northern goshawk	0	1	0	0	0	0.20
Common snipe	0	0	0	0	1	0.20
Northern saw-whet owl	0	0	0	1	0	0.20
Barred owl	0	0	0	0	1	0.20
Bald eagle	0	0	0	0	1	0.20
American woodcock	0	0	0	1	0	0.20
Tundra swan	1	0	0	0	0	0.20
Fox sparrow	0	1	0	0	0	0.20
Bufflehead	0	1	0	0	0	0.20

TABLE 8 Summary of Avian Abundance During the Winter Period Christmas Bird Count Data - Central Berkshire, MA Census Plot						
Species	1994-1995	1993-1994	1992-1993	1991-1992	1990-1991	Average
Total Individuals	8841	6972	5652	5234	5786	6497.00
Total Species	52	49	45	47	49	48.40

TABLE 9 Mammals Known or Likely to be Present Within the Study Area		
Common Name	Scientific Name	Source[a]
✓ Beaver	*Castor canadensis*	1,2,3
Big brown bat	*Eptesicus fuscus*	2
✓ Black bear	*Ursus americanus*	2,3
✓ Bobcat	*Lynx rufus*	2,3
✓ Coyote	*Canis latrans*	2,3
✓ Deer mouse	*Peromyscus maniculatus*	2,3
✓ Domestic cat	*Felis domesticus*	1
✓ Eastern chipmunk	*Tamias striatus*	2,3
✓ Eastern cottontail	*Sylvilagus floridanus*	2,3
Eastern mole	*Scalopus aquaticus*	2
Eastern pipistrelle	*Pipistellus subflavus*	2
Ermine	*Mustela erminea*	2
Fisher	*Martes pennanti*	2
Gray fox	*Urocyon cinereoargenteus*	2
✓ Gray squirrel	*Sciurus carolinensis*	1,2,3
Hairy-tailed mole	*Parascalops breweri*	2
Hoary bat	*Lasiurus cinereus*	2
House mouse	*Mus musculus*	2
Keen's myotis (bat)	*Myotis keenii*	2
✓ Little brown bat	*Myotis lucifugus*	2,3
Long-tailed (rock) shrew (SC)[b]	*Sorex dispar*	2
Long-tailed weasel	*Mustela frenata*	2
✓ Masked shrew	*Sorex cinereus*	2,3
✓ Meadow jumping mouse	*Zapus hudsonius*	2,3
✓ Meadow vole	*Microtus pennsylvanicus*	2,3
Mink	*Mustela vison*	2
✓ Muskrat	*Ondatra zibethicus*	2,3
New England cottontail	*Sylvilagus transitionalis*	2
✓ Northern flying squirrel	*Glaucomys sabrinus*	2,3

TABLE 9
Mammals Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
✓ Northern short-tailed shrew	*Blarina brevicauda*	2,3
Norway rat	*Rattus norvegicus*	2
Pine (woodland) vole	*Microtus pinetorum*	2
Porcupine	*Erethizon dorsatum*	2
✓ Raccoon	*Procyon lotor*	2,3
Red bat	*Lasiurus borealis*	2
Red fox	*Vulpes vulpes*	2
✓ Red squirrel	*Tamiasciurus hudsonicus*	2,3
River otter	*Lutra canadensis*	2
Silver-haired bat	*Lasionycteris noctivagans*	2
Small-footed myotis (SC)	*Myotis leibii*	2
Smoky shrew	*Sorex fumeus*	2
Snowshoe hare	*Lepus americanus*	2
Southern bog lemming (SC)	*Synaptomys cooperi*	2
Southern flying squirrel	*Glaucomys volans*	2
✓ Southern red-backed vole	*Clethrionomys gapperi*	2,3
Star-nosed mole	*Condylura cristata*	2
✓ Striped skunk	*Mephitis mephitis*	2,3
Virginia opossum	*Didelphis virginiana*	2
Water shrew (SC)	*Sorex palustris*	2
✓ White-footed mouse	*Peromyscus leucopus*	2,3
✓ White-tailed deer	*Odocoileus virginianus*	1,2,3
✓ Woodchuck	*Marmota monax*	2,3
✓ Woodland jumping mouse	*Napaeozapus insignis*	2,3

[a] 1 - Field visit (October 1995); 2 - DeGraaf and Rudis (1987); 3 - ChemRisk (1994).
[b] E - State Endangered; T - State Threatened; SC - State Special Concern; WL - State Watch List (not a legal designation); FE - Federally Endangered; FT - Federally Threatened.

✓ Species observed during site-specific studies (ChemRisk 1994; October 1995 ENVIRON field visit).

TABLE 10
Amphibians and Reptiles Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Salamanders		
Four-toed salamander (SC)[b]	*Hemidactylium scutatum*	2,4
Jefferson salamander (SC)	*Ambystoma jeffersonianum*	2,4,5
Marbled salamander (T)	*Ambystoma opacum*	2,4
Northern dusky salamander	*Desmognathus f. fuscus*	2,5
Northern spring salamander (SC)	*Gyrinophilus p. porphyriticus*	2,4,5
Northern two-lined salamander	*Eurycea bislineata*	2
✓ Red-spotted newt	*Notophthalmus v. viridescens*	1,2,3
✓ Redback salamander	*Plethodon cinereus*	2,3,5
✓ Spotted salamander (WL)	*Ambystoma maculatum*	2,3,4,5
Frogs and Toads		
✓ Bullfrog	*Rana catesbeiana*	2,3,5
✓ Eastern American toad	*Bufo a. americanus*	2,3,5
Fowler's toad	*Bufo woodhousei fowleri*	2
Gray treefrog	*Hyla versicolor*	2,5
✓ Green frog	*Rana clamitans melanota*	1,2,3,5
✓ Northern leopard frog	*Rana pipiens*	1,2,3,5
✓ Northern spring peeper	*Pseudacris c. crucifer*	2,3,5
Pickerel frog	*Rana palustris*	2,5
✓ Wood frog	*Rana sylvatica*	2,3,5
Turtles		
Bog turtle (E)	*Clemmys muhlenbergii*	6,7
Common musk turtle	*Sternotherus odoratus*	2,5
Common snapping turtle	*Chelydra s. serpentina*	2,5
✓ Painted turtle	*Chrysemys picta*	2,3,5
Spotted turtle (SC)	*Clemmys guttata*	2,5
✓ Wood turtle (SC)	*Clemmys insculpta*	2,3,4,5

TABLE 10
Amphibians and Reptiles Known or Likely to be Present Within the Study Area

Common Name	Scientific Name	Source[a]
Snakes		
✓ Eastern garter snake	*Thamnophis s. sirtalis*	2,3,5
Eastern hognose snake	*Heterodon platirhinos*	2
Eastern milk snake	*Lampropeltis t. triangulum*	2,5
Eastern ribbon snake	*Thamnophis s. sauritus*	2,5
Eastern smooth green snake	*Opheodrys v. vernalis*	2,5
Northern black racer	*Coluber c. constrictor*	2
Northern brown snake	*Storeria d. dekayi*	2,5
Northern redbelly snake	*Storeria o. occipitomaculata*	2,5
✓ Northern ringneck snake	*Diadophis punctatus edwardsii*	2,3,5
Northern water snake	*Nerodia s. sipedon*	2,5
Timber rattlesnake (E)	*Crotalus horridus*	2

[a] 1 - Field visit (October 1995); 2 - DeGraaf and Rudis (1987); 3 - ChemRisk (1994); 4 - MADFW (1995a); 5 - MADFW (1995b) for the Housatonic Valley Wildlife Management Area; 6 - USFWS (1995); 7 - BBL (1991).

[b] E - State Endangered; T - State Threatened; SC - State Special Concern; WL - State Watch List (not a legal designation); FE - Federally Endangered; FT - Federally Threatened.

✓ Species observed during site-specific studies (ChemRisk 1994; October 1995 ENVIRON field visit).

TABLE 11
Fish Species Collected From the Housatonic River and Woods Pond

Common Name	Scientific Name	Source[a]
Banded killifish[c]	*Fundulus diaphanus*	1
Black crappie[c,d,e]	*Pomoxis nigromaculatus*	1,3
Blacknose dace[c,d]	*Rhinichthys atratulus*	1,3
Bluegill[c,d,e]	*Lepomis macrochirus*	1,3
Bluntnose minnow[c,d,e]	*Pimephales notatus*	1
Brindle shiner	*Notropis bifrenatus*	1
Brook trout[c]	*Salvelinus fontinalis*	1,3
Brown bullhead[c,d,e]	*Ameiurus nebulosus*	1,3
Brown trout	*Salmo trutta*	1,3
Chain pickerel[c,d,e]	*Esox niger*	1,3
Common carp[c,d,e]	*Cyprinus carpio*	1
Common shiner[c,d,e]	*Luxilus cornutus*	1,3
Creek chub[c,d]	*Semotilus atromaculatus*	1
Creek chubsucker	*Erimyzon oblongus*	1
Fallfish[c,d]	*Semotilus corporalis*	1
Fathead minnow[c]	*Pimephales promelas*	1
Golden shiner[c,e]	*Notemigonus crysoleucas*	1,3
Goldfish[c,d,e]	*Carassius auratus*	1,3
Grass pickerel	*Esox americanus*	1
Green sunfish	*Lepomis cyanellus*	1
Largemouth bass[c,d,e]	*Micropterus salmoides*	1,3
Longnose dace[c,d]	*Rhinichthys cataractae*	1
Longnose sucker (SC)[b,c]	*Catostomus catostomus*	1,2,3
(Tiger?) Muskellunge	*Esox masquinongy*	1
Northern pike[e]	*Esox lucius*	1
Pumpkinseed[c,d,e]	*Lepomis gibbosus*	1,3
Rainbow trout	*Oncorhynchus mykiss*	1,3
Redbreasted sunfish	*Lepomis auritus*	1
Redear sunfish	*Lepomis microlophus*	1

TABLE 11
Fish Species Collected From the Housatonic River and Woods Pond

Common Name	Scientific Name	Source[a]
Rock bass[c,d,e]	*Ambloplites rupestris*	1,3
Slimy sculpin	*Cottus cognatus*	1
Smallmouth bass[c]	*Micropterus dolomieu*	1
Spottail shiner[c,d,e]	*Notropis hudsonius*	1
Tessellated darter[c]	*Etheostoma olmstedi*	1
Trout-perch	*Percopsis omiscomaycus*	1
White crappie[c]	*Pomoxis annularis*	1
White sucker[c,d,e]	*Catostomus commersoni*	1,3
Yellow bullhead[c]	*Ameiurus natalis*	1
Yellow perch[c,d,e]	*Perca flavescens*	1,3

[a] 1 - As summarized in Chadwick & Associates (1994); 2 - MADFW (1995a); 3 - MADFW (1995b) for the Housatonic Valley Wildlife Management Area portion of the Housatonic River.

[b] E - State Endangered; T - State Threatened; SC - State Special Concern; WL - State Watch List (not a legal designation); FE - Federally Endangered; FT - Federally Threatened.

[c] Observed during 1992 and/or 1993 site-specific studies of the Massachusetts portion of the Housatonic River (Chadwick & Associates 1994).

[d] Observed during 1992 and/or 1993 site-specific studies of the portion of the Housatonic River within the study area (Chadwick & Associates 1994).

[e] Observed in Woods Pond during 1992 and/or 1993 site-specific studies (Chadwick & Associates 1994).

TABLE 12
Relative Abundance of Fish Species Collected From the Housatonic River and Woods Pond in 1992 and 1993

Common Name	Housatonic River[a]		Woods Pond[b]	
	1992	1993	1992	1993
Centrarchidae				
Black crappie	3	1	11	10
Bluegill	7	5	48	75
Largemouth bass	30	23	34	26
Rock bass	38	60	1	3
Pumpkinseed	30	7	37	31
Esocidae				
Chain pickerel	2	0	3	0
Northern pike	0	0	1	1
Percidae				
Yellow perch	97	116	82	50
Ictaluridae				
Brown bullhead	2	1	4	32
Catostomidae				
White sucker	155	276	36	75
Cyprinidae				
Blacknose dace	11	75	0	0
Bluntnose minnow	242	925	12	1
Common carp	2	2	1	1
Common shiner	0	153	15	0
Creek chub	1	17	0	0
Fallfish	13	72	0	0
Golden shiner	0	0	24	11
Goldfish	4	0	30	21
Longnose dace	14	48	0	0
Spottail shiner	0	119	0	7

TABLE 12
Relative Abundance of Fish Species Collected From the Housatonic River and Woods Pond in 1992 and 1993

Common Name	Housatonic River[a]		Woods Pond[b]	
	1992	1993	1992	1993
Total Number Collected	651	1,900	339	344
Species Richness	16	16	15	14

[a] For the three Housatonic River sampling locations (EB2, HR1, and HR2) within the study area (from Chadwick & Associates [1994]).

[b] For the one Woods Pond sampling location (WP1) (from Chadwick & Associates [1994]).

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
PLATYHELMINTHES				
TURBELLARIA				
Planariidae				
Dugesia tigrina		x	X	
NEMATODA (Unidentified)	x	X		
MOLLUSCA				
GASTROPODA				
Ancylidae				
Ferrissia fragalis			X	
Ferrissia spp.	x	X		
Hydrobiidae				
Amnicola limosa			X	X
Marstonia decepta			X	
Physidae				
Physella spp.	x	X	X	X
Planorbidae				
Gyraulus spp.			x	
Gyraulus parvus				X
Planorbella campanulata		x		
Valvatidae				
Valvata tricarinata				X
PELECYPODA (BIVALVIA)				
Sphaeriidae				
Musculium spp.		x	x	
Pisidium spp.			x	
Sphaerium spp.		X	X	X
ANNELIDA				

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
OLIGOCHAETA (Unidentified)	x	X	X	X
Tubificidae			X	
Ilyodrilus mastix	x	x		
Monopylephorus helobius	x		x	
Lumbricidae				
Eiseniella tetraedra		x		
HIRUDINEA				
Erpobdellidae				
Erpobdella punctata		x		
Mooreobdella fervida		x		
Glossiphoniidae				
Helobdella stagnalis			X	
ARTHROPODA				
ARACHNIDA				
Hydracarina				
Hygrobatidae				
Hygrobates spp.	x	X	x	
Lebertiidae				
Lebertia spp.	x	X		
Sperchonidae				
Sperchon/Sperchonopsis	x	X		
Torrenticolidae				
Torrenticola spp.	x	X		
INSECTA				
Ephemeroptera				
Baetidae				
Baetis amplus		X		

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Baetis flavistrion		x		
Baetis flavistriga	x	X	x	
Baetis insignificans		x	x	
Baetis intercalaris		x	x	
Callibaetis spp.		X	X	X
Caenidae				
Caenis anceps	x	X	X	X
Ephemerellidae				
Ephemerella spp.	x	x	x	
Ephemeridae				
Ephemera spp.		X		
Heptageniidae				
Leucrocuta spp.			x	
Stenacron spp.	x	X	x	
Stenonema mediopunctatum		x		
Stenonema modestum	x	X		
Stenonema terminatum	x	X	x	
Stenonema vicarium	x	X	x	
Leptophlebiidae		x		
Paraleptophlebia spp.		X		
Oligoneuriidae				
Isonychia spp.	x	x	x	
Tricorythidae				
Tricorythodes spp.		X	x	
Odonata				
Aeshnidae				
Boyeria spp.	x	X		

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

	Upstream	Downstream[a]		
Taxa	**Shallow**	**Shallow**	**Deep**	**Woods Pond**
Calopterygidae				
Calopteryx spp.		X		
Coenagrionidae		x		X
Anomalagrion/Ischnura		X	X	X
Argia spp.		X		
Coenagrion spp.				X
Enallagma spp.			X	
Gomphidae	x	X	x	
Ophiogomphus spp.		X		
Libellulidae				
Libellula spp.				X
Plecoptera				
Perlidae				
Acroneuria spp.		x		
Paragnetina spp.		X	x	
Trichoptera				
Brachycentridae				
Micrasema spp.			x	
Hydropsychidae (pupae)		x		
Cheumatopsyche spp.	x	X	X	
Hydropsyche spp.	x	X	x	
Macrostemum spp.			x	
Hydroptilidae (pupae)	x		x	
Hydroptila spp.	x	X		
Leucotrichia pictipes	x	x	x	
Neotrichia spp.			x	X
Oxyethira spp.			x	X

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Leptoceridae				
Mystacides spp.		X	x	
Nectopsyche spp.		X	x	X
Oecetis spp.	x	X	X	
Limnephilidae				
Nemotaulius hostilis		x	X	
Polycentropodidae				
Neureclipsis spp.	x			
Polycentropus spp.		x	X	
Psychomyiidae				
Psychomyia flavida	x	X		
Philopotamidae				
Chimarra spp.	x	x	x	
Phryganeidae				
Phryganea spp.			X	
Rhyacophilidae				
Rhyacophila spp.	x			
Megaloptera				
Corydalidae				
Corydalus spp.		x	x	
Nigronia spp.	x	x		
Sialidae				
Sialis spp.		x		
Hemiptera				
Corixidae		X		
Sigara spp.			x	
Trichocorixa spp.				X

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Gerridae				
Gerris spp.			x	
Trepobates spp.		X		
Hebridae				
Merragata spp.		X		
Mesoveliidae				
Mesovelia spp.			X	
Notonectidae				
Notonecta spp.			x	
Pleidae				
Neoplea spp.			X	
Veliidae				
Microvelia spp.		X	X	X
Paravelia spp.			x	
Rhagovelia spp.	x	x		
Lepidoptera				
Pyralidae				
Acentria spp.		X	X	X
Coleoptera				
Dytiscidae				
Laccophilus spp.			x	
Elmidae				
Ancyronyx variegata		x		
Dubiraphia spp.		X	X	
Macronychus glabratus		X	x	
Optioservus ampliatus	x	x		
Optioservus trivittatus	x	X	x	

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Promoresia elegans	x	X	X	
Stenelmis spp.	x	X	x	
Stenus spp.		X		
Gyrinidae				
Dineutus spp.			x	
Haliplidae				
Haliplus spp.			x	X
Peltodytes spp.			X	
Hydrophilidae				
Laccobius spp.		X		
Psephenidae				
Ectopria nervosa		x		
Psephenus spp.	x	x	x	
Diptera				
Athericidae				
Atherix lantha	x	X		
Ceratopogonidae				
Bezzia/Palpomyia			X	
Ceratopogon spp.		x	x	X
Mallochohelea spp.	x	X	x	
Sphaeromias spp.			X	X
Chaoboridae				
Chaoborus spp.			x	X
Chironomidae (pupae)	x	X	X	X
Ablabesmyia spp.	x	X	X	
Brundiniella spp.	x	X	x	
Cladopelma spp.				X

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Cricotopus tremulus		x	X	
Cricotopus trifasciata	x	X	X	
Cryptochironomus spp.		X	X	
Dicrotendipes spp.		X	X	X
Einfeldia spp.			x	
Glyptotendipes spp.	x	x	x	X
Guttipelopia spp.			x	
Heleniella spp.		X		
Microchironomus spp.			x	
Microtendipes spp.	x	X	x	
Nanocladius spp.			X	
Natarsia spp.			X	X
Orthocladius spp.			X	
Paratanytarsus spp.				X
Paratrissocladius spp.				X
Parorthocladius spp.		x		
Pentaneura spp.			X	
Polypedilum spp.	x	X	X	X
Procladius spp.		X	X	X
Sublettea spp.	x			
Tanytarsus spp.	x	X	X	X
Thienemanniella spp.		x	X	
Tvetenia spp.	x	X	X	
Culicidae				
Anopheles spp.			x	
Culicoides spp.				X
Dolichopodidae		X		

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Empididae				
Hemerodromia spp.	x	X	X	
Psychodidae				
Pericoma spp.		x		
Simuliidae				
Simulium spp.		X	x	
Stratiomyidae				
Hedriodiscus/Odontomyia				X
Tabanidae				
Atylotus/Tabanus		X	X	
Tipulidae				
Antocha spp.	x	X	X	
Helius spp.			X	
Limonia spp.	x	X		
Tipula spp.	x	X		
ENTOGNATHA				
Collembola				
Isotomidae				
Agrenia bidenticulata	x			
Isotomurus spp.			X	
Sminthuridae				
Bourletiella spp.			X	
CRUSTACEA				
Amphipoda				
Gammaridae				
Gammarus lacustris		x		
Talitridae				

TABLE 13
Benthic Invertebrate Taxa Collected From the Massachusetts Portion of the Housatonic River and Woods Pond Relative to the Location of the GE Facility

Taxa	Upstream	Downstream[a]		
	Shallow	Shallow	Deep	Woods Pond
Hyalella azteca	x	X	X	X
Isopoda				
Asellidae				
Acecidotea spp.	x			
Caecidotea spp.			x	
Decapoda				
Cambaridae				
Orconectes spp.	x	X		

[a] X = observed at a location within the study area.
x = observed at a location outside of the study area.

Source: Chadwick & Associates (1994).

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m^2)			
	Housatonic River[a]			
	Average	Minimum	Maximum	Woods Pond
PLATYHELMINTHES				
TURBELLARIA				
Planariidae				
Dugesia tigrina	9.7	0	29	
NEMATODA (Unidentified)	10	0	30	
MOLLUSCA				
GASTROPODA				
Ancylidae				
Ferrissia fragalis	4.7	0	14	
Ferrissia spp.	K[b]	--	--	
Hydrobiidae				
Amnicola limosa	67	0	201	14
Marstonia decepta	K	--	--	
Physidae				
Physella spp.	2.3	0	7	K
Planorbidae				
Gyraulus parvus				K
Valvatidae				
Valvata tricarinata				K
PELECYPODA (BIVALVIA)				
Sphaeriidae				
Sphaerium spp.	15	0	43	K
ANNELIDA				
OLIGOCHAETA (Unidentified)	146	7	373	144
Tubificidae	9.7	0	29	
HIRUDINEA				

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m²)			
	Housatonic River[a]			Woods Pond
	Average	Minimum	Maximum	
Glossiphoniidae				
Helobdella stagnalis	14	0	43	
ARTHROPODA				
ARACHNIDA				
Hydracarina				
Hygrobatidae				
Hygrobates spp.	40	0	117	
Lebertiidae				
Lebertia spp.	33	0	73	
Sperchonidae				
Sperchon/Sperchonopsis	21	0	63	
Torrenticolidae				
Torrenticola spp.	2.3	0	7	
INSECTA				
Ephemeroptera				
Baetidae				
Baetis amplus	78	0	200	
Baetis flavistriga	19	0	50	
Callibaetis spp.	1	0	3	K
Caenidae				
Caenis anceps	11	0	29	K
Ephemeridae				
Ephemera spp.	1	0	3	
Heptageniidae				
Stenacron spp.	9	0	27	
Stenonema modestum	50	0	93	

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m²)			
	Housatonic River[a]			Woods Pond
	Average	Minimum	Maximum	
Stenonema terminatum	29	0	67	
Stenonema vicarium	4.3	0	13	
Leptophlebiidae				
Paraleptophlebia spp.	5.7	0	17	
Tricorythidae				
Tricorythodes spp.	2.3	0	7	
Odonata				
Aeshnidae				
Boyeria spp.	K	--	--	
Calopterygidae				
Calopteryx spp.	K	--	--	
Coenagrionidae				29
Anomalagrion/Ischnura	19	0	57	K
Argia spp.	K	--	--	
Coenagrion spp.				K
Enallagma spp.	24	0	72	
Gomphidae	1	0	3	
Ophiogomphus spp.	K	--	--	
Libellulidae				
Libellula spp.				K
Plecoptera				
Perlidae				
Paragnetina spp.	K	--	--	
Trichoptera				
Hydropsychidae				
Cheumatopsyche spp.	369	0	900	

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m²)			
	Housatonic River[a]			Woods Pond
	Average	Minimum	Maximum	
Hydropsyche spp.	39	0	63	
Hydroptilidae				
Hydroptila spp.	5.7	0	17	
Neotrichia spp.				K
Oxyethira spp.				K
Leptoceridae				
Mystacides spp.	K	--	--	
Nectopsyche spp.	K	--	--	K
Oecetis spp.	18	0	40	
Limnephilidae				
Nemotaulius hostilis	K	--	--	
Polycentropodidae				
Polycentropus spp.	9.7	0	29	
Psychomyiidae				
Psychomyia flavida	K	--	--	
Phryganeidae				
Phryganea spp.	4.7	0	14	
Hemiptera				
Corixidae	K	--	--	
Trichocorixa spp.				K
Gerridae				
Trepobates spp.	K	--	--	
Hebridae				
Merragata spp.	K	--	--	
Mesoveliidae				
Mesovelia spp.	K	--	--	

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m^2)			
	Housatonic River[a]			
	Average	Minimum	Maximum	Woods Pond
Pleidae				
Neoplea spp.	4.6	0	14	
Veliidae				
Microvelia spp.	K	--	--	K
Lepidoptera				
Pyralidae				
Acentria spp.	1	0	3	K
Coleoptera				
Elmidae				
Dubiraphia spp.	36.3	0	23	
Macronychus glabratus	K	--	--	
Optioservus trivittatus	21	0	53	
Promoresia elegans	K	--	--	
Stenelmis spp.	9	7	20	
Stenus spp.	K	--	--	
Haliplidae				
Haliplus spp.				14
Peltodytes spp.	K	--	--	
Hydrophilidae				
Laccobius spp.	K	--	--	
Diptera				
Athericidae				
Atherix lantha	1	0	3	
Ceratopogonidae				
Bezzia/Palpomyia	9.7	0	29	
Ceratopogon spp.				29

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m²)			
	Housatonic River[a]			Woods Pond
	Average	Minimum	Maximum	
Mallochohelea spp.	2.3	0	7	
Sphaeromias spp.	4.7	0	14	57
Chaoboridae				
Chaoborus spp.				100
Chironomidae (pupae)	153	57	260	29
Ablabesmyia spp.	24	0	72	
Brundiniella spp.	369	0	900	
Cladopelma spp.				416
Cricotopus tremulus	K	--	--	
Cricotopus trifasciata	678	0	1200	
Cryptochironomus spp.	65	43	100	
Dicrotendipes spp.	264	33	660	14
Glyptotendipes spp.				K
Heleniella spp.	K	--	--	
Microtendipes spp.	22	0	67	
Nanocladius spp.	38.3	0	115	
Natarsia spp.	9.7	0	29	K
Orthocladius spp.	4.7	0	14	
Paratanytarsus spp.				K
Paratrissocladius spp.				K
Pentaneura spp.	K	--	--	
Polypedilum spp.	136	43	233	K
Procladius spp.	87	0	229	258
Tanytarsus spp.	1754	129	3500	14
Thienemanniella spp.	K	--	--	
Tvetenia spp.	27	0	67	

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m²)			
	Housatonic River[a]			Woods Pond
	Average	Minimum	Maximum	
Culicidae				
Culicoides spp.				29
Dolichopodidae	K	–	–	
Empididae				
Hemerodromia spp.	140	0	347	
Simuliidae				
Simulium spp.	K	–	–	
Stratiomyidae				
Hedriodiscus/Odontomyia				K
Tabanidae				
Atylotus/Tabanus	8	0	14	
Tipulidae				
Antocha spp.	41	0	63	
Helius spp.	K	–	–	
Limonia spp.	K	–	–	
Tipula spp.	1	0	3	
ENTOGNATHA				
Collembola				
Isotomidae				
Isotomurus spp.	K	–	–	
Sminthuridae				
Bourletiella spp.	K	–	–	
CRUSTACEA				
Amphipoda				
Talitridae				
Hyalella azteca	55	0	144	14

TABLE 14
Density of Benthic Invertebrate Taxa Collected From the Housatonic River and Woods Pond For Locations Within the Study Area

Taxa	Density (number/m²)			
	Housatonic River[a]			Woods Pond
	Average	Minimum	Maximum	
Decapoda				
Cambaridae				
Orconectes spp.	1	0	3	

[a] For locations EB2, HR1, and HR2; Chadwick & Associates (1994).
[b] No densities are available - observed in kick net samples only.

TABLE 15
Summary of Benthic Invertebrate Data for the Study Area

Taxonomic Group	Number of Families Present		
	Total - All Data[a]	Housatonic River Within Study Area	Woods Pond
Molluscs	6	4	5
Oligochaetes	2	1	1
Insect orders:			
- Ephemeroptera	8	6	2
- Odonata	5	4	2
- Plectoptera	1	1	0
- Trichoptera	10	7	2
- Hemiptera	7	6	2
- Coleoptera	6	3	1
- Diptera	12	8	5
Crustaceans	4	2	1
Other taxa	12	9	1
TOTAL	73	51	22

[a] *Includes areas sampled within the Housatonic River upstream and downstream of the study area,* as well as data from the study area for the Housatonic River and Woods Pond.

TABLE 16 Benthic Invertebrate Metrics From the Housatonic River/Woods Pond				
Sampling Location	**Type[a]**	**Density (number/m²)**	**Number of Taxa**	**Diversity (H')**
Upstream of the GE Facility				
EB-1	S	10,429	42	3.56
WB-1	S	9,040	35	2.34
Within Study Area				
EB-2	S	8,003	50	3.06
HR-1	S	4,474	43	2.96
HR-2	D	2,653	47	3.94
WP-1	P	1,161	34	2.82
Downstream of Study Area				
HR-3	S	54,429	50	3.15
HR-4	S	31,415	63	4.35
HR-5	D	1,362	56	3.29
HR-6	D	5,378	38	3.36

[a] S - Shallow; D - Deep; P - Pond.

Source: Chadwick & Associates (1994).

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]
Amphibians							
Jefferson salamander	*Ambystoma jeffersonianum*	SC	--	--	1,3,4	1990	Rep: 1,2[f]
Spotted salamander	*Ambystoma maculatum*	(WL)	--	--	1,3,4	1993	Obs
Marbled salamander	*Ambystoma opacum*	T	--	--	1,4	1976	Rep: 2[f]
Spring salamander	*Gyrinophilus porphyriticus*	SC	--	--	1,3,4	1990	Rep: 1,2[f]
Four-toed salamander	*Hemidactylium scutatum*	SC	--	--	1,4	1988	Rep: 2[f]
Reptiles							
Spotted turtle	*Clemmys guttata*	SC	--	--	3	??	Rep: 1[f]
Wood turtle	*Clemmys insculpta*	SC	--	--	1,3,4	1994	Obs
Bog turtle	*Clemmys muhlenbergii*	E	--	--	2,4	1966	Rep: 2[f]
Timber rattlesnake	*Crotalus horridus*	E	--	--	4	1969	Rep: 2[f]
Fish							
Longnose sucker	*Catostomus catostomus*	SC	--	--	1,3,4	1993	Obs
Birds							
Cooper's hawk	*Accipiter cooperii*	SC	--	--	Table 5	??	Rep: 1
Sharp-shinned hawk	*Accipiter striatus*	SC	--	--	Table 5	??	Rep: 1[f]
Grasshopper sparrow	*Ammodramus savannarum*	T	--	--	1,4	1981	Rep: 2[f]
Great blue heron	*Ardea herodias*	(WL)	--	--	1	1995	Obs
Short-eared owl	*Asio flammeus*	E	--	--	Table 5	??	-

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]
Long-eared owl	*Asio otus*	SC	--	--	Table 5	??	-
Upland sandpiper	*Bartramia longicauda*	E	--	--	Table 5	??	Rep: 1
American bittern	*Botaurus lentiginosus*	E	--	--	1,3,4	1993	Obs
Northern harrier	*Circus cyaneus*	T	--	--	Table 5	??	Rep: 1
Sedge wren	*Cistothorus platensis*	E	--	--	1	??	+[f]
Blackpoll warbler	*Dendroica striata*	SC	--	--	Table 5	??	Rep: 1
Peregrine falcon	*Falco peregrinus*	E	FE	--	1,2	??	Rep: 1
Common morehen	*Gallinula chloropus*	SC	--	--	1,3,4	1993	Obs
Common loon	*Gavia immer*	SC	--	--	Table 5	??	Rep: 1
Bald eagle	*Haliaeetus leucocephalus*	E	FT	--	2	1993	Obs
Least bittern	*Ixobrychus exilis*	E	--	--	1,3	1972	Rep: 1[f]
Loggerhead shrike	*Lanius ludovicianus*	E	--	--	Table 5	??	-
Mourning warbler	*Oporornis philadelphia*	SC	--	--	Table 5	??	-
Northern parula	*Parula americana*	T	--	--	Table 5	??	Rep: 1
Pied-billed grebe	*Podilymbus podiceps*	E	--	--	1	??	Rep: 1[f]
Vesper sparrow	*Pooecetes gramineus*	T	--	--	Table 5	??	Rep: 1
King rail	*Rallus elegans*	T	--	--	1,4	1993	Obs
Common barn-owl	*Tyto alba*	SC	--	--	Table 5	??	-
Golden-winged warbler	*Vermivora chrysoptera*	E	--	--	Table 5	1993	Obs

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]
Mammals							
Long-tailed (rock) shrew	*Sorex dispar*	SC	--	--	Table 9	??	0[f]
Small-footed myotis	*Myotis leibii*	SC	--	--	Table 9	??	-
Water shrew	*Sorex palustris*	SC	--	--	Table 9	??	+
Southern bog lemming	*Synaptomys cooperi*	SC	--	--	Table 9	??	+
Invertebrates							
Tule bluet (damselfly)	*Enallagma carunculatum*	SC	--	--	1,4	1976[e]	Rep: 2[f]
Early hairstreak (butterfly)	*Erora laeta*	T	--	--	1	??	-[f]
Mustard white (butterfly)	*Pieris napi oleracea*	SC	--	--	1	??	0[f]
Pilsbry's spire snail	*Pyrgulopsis lustrica*	E	--	--	1	??	+[f]
Boreal turret snail	*Valvata sincera*	E	--	--	1,4	1961	Rep: 2[f]
Plants							
Black maple	*Acer nigrum*	SC	--	FACU-	1	??	-[f]
Climbing fumitory	*Adlumia fungosa*	T	--	UPL	1	??	-[f]
Hairy agrimony	*Agrimonia pubescens*	T	--	UPL	1,4	1925	Rep: 2[f]
Bartram's shadbush	*Amelanchier bartramiana*	T	--	FAC	1	??	0[f]
Roundleaf shadbush	*Amelanchier sanguinea*	SC	--	UPL	1	??	-[f]
Smooth rock-cress	*Arabis laevigata*	T	--	UPL	1,4	1865	Rep: 2[f]
Lyre-leaved rock-cress	*Arabis lyrata*	T	--	FACU	1	??	-[f]

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]
Dwarf mistletoe	*Arceuthobium pusillum*	SC	--	UPL	1	??	-[f]
Crooked-stem aster	*Aster prenanthoides*	SC	--	FAC	1,4	1988	Rep: 2[f]
Swamp birch	*Betula pumila*	T	--	OBL	1	??	+[f]
Fen cuckoo flower	*Cardamine pratensis var palustris*	T	--	OBL	1	??	+[f]
Foxtail sedge	*Carex alopecoidea*	T	--	FACW	1,3,4	1993	Rep: 1,2[f]
Bush's sedge	*Carex bushii*	E	--	FACW	1	??	+[f]
Chestnut-colored sedge	*Carex castanea*	E	--	OBL	1,4	1987	Rep: 2[f]
Creeping sedge	*Carex chordorrhiza*	E	--	OBL	1	??	+[f]
Handsome sedge	*Carex formosa*	T	C2	FAC	1	??	0[f]
Gray's sedge	*Carex grayi*	T	--	FACW+	1,4	1920	Rep: 1,2[f]
Hitchcock's sedge	*Carex hitchcockiana*	SC	--	UPL	1,4	1989	Rep: 2[f]
Schweinitz's sedge	*Carex schweinitzii*	E	C2	OBL	1	??	+[f]
Fen sedge	*Carex tetanica*	SC	--	FACW	1,4	1984	Rep: 2[f]
Tuckerman's sedge	*Carex tuckermanii*	E	--	OBL	1	??	+[f]
Devil's-bit	*Chamaelirium luteum*	E	--	FAC	1	??	0[f]
Purple clematis	*Clematis occidentalis*	SC	--	UPL	1	??	-[f]
Hemlock parsley	*Conioselinum chinense*	SC	--	FACW	1,4	1982	Rep: 2[f]
Fragile rock-brake	*Cryptogramma stelleri*	T	--	FACU-	1	??	-[f]
Small yellow lady's-slipper	*Cypripedium calceolus var parviflorum*	E	--	FAC+	1	??	+[f]

TABLE 17 Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity							
Common Name	**Scientific Name**	**State Status[a]**	**Federal Status[a]**	**Wetland Status[b]**	**Source[c]**	**Last Observed**	**On-Site Status[d]**
Showy lady's-slipper	*Cypripedium reginae*	SC	--	FACW	1,4	1988	Rep: 2[f]
Glade fern	*Diplazium pycnocarpon*	(WL)	--	UPL	1,4	1983	Rep: 2[f]
Goldie's fern	*Dryopteris goldiana*	(WL)	--	FAC+	1,4	1983	Rep: 2[f]
Redfoot spike-rush	*Eleocharis erythropoda*	(WL)	--	OBL	1	??	+[f]
Intermediate spike-sedge	*Eleocharis intermedia*	T	--	FACW+	1,4	1989	Rep: 2[f]
Few-flowered spike-rush	*Eleocharis pauciflora*	E	--	OBL	1	??	+[f]
Dwarf scouring-rush	*Equisetum scirpoides*	SC	--	FAC	1,4	1983	Rep: 2[f]
Variegated horsetail	*Equisetum variegatum*	(WL)	--	FACW	1,4	1983	Rep: 2[f]
Frank's lovegrass	*Eragrostis frankii*	SC	--	FACW	1,4	1989	Rep: 2[f]
Slender cottongrass	*Eriophorum gracile*	T	--	OBL	1	??	+[f]
Northern bedstraw	*Galium boreale*	E	--	FACU	1	??	-[f]
Labrador bedstraw	*Galium labradoricum*	SC	--	OBL	1,4	1982	Rep: 2[f]
Fringed gentian	*Gentiana crinita*	(WL)	--	OBL	1,4	1977	Rep: 2[f]
Long-leaved bluet	*Houstonia longifolia var longifolia*	T	--	UPL	1	??	-[f]
Large whorled pogonia	*Isotria verticillata*	(WL)	--	FACU	1	??	-[f]
Great blue lobelia	*Lobelia siphilitica*	T	--	FACW+	1	??	+[f]
Hairy honeysuckle	*Lonicera hirsuta*	E	--	FAC	1,4	1984	Rep: 2[f]
White adder's-mouth	*Malaxis brachypoda*	T	C2	FACW	1,4	1983	Rep: 2[f]
Whorled water-milfoil	*Myriophyllum verticillatum*	T	--	OBL	1	??	+[f]

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]
Adder's-tongue fern	*Ophioglossum pusillum*	T	--	FACW	1	??	+[f]
Ginseng	*Panax quinquefolius*	SC	--	UPL	4	1983	Rep: 2[f]
Gattinger's panic-grass	*Panicum gattingeri*	SC	--	FAC	1	??	0[f]
Sweet coltsfoot	*Petasites frigidus var palmatus*	T	--	FACW	1,4	1967	Rep: 2[f]
Pale green orchis	*Platanthera flava var herbiola*	T	--	FACW	1	??	+[f]
Braun's holly-fern	*Polystichum braunii*	E	--	UPL	1,4	1920	-
Fries's pondweed	*Potamogeton friesii*	T	--	OBL	1	??	+[f]
Hill's pondweed	*Potamogeton hillii*	SC	C3	OBL	1,4	1980	Rep: 2[f]
Pink pyrola	*Pyrola asarifolia var purpurea*	E	--	FACW	1,4	1983	Rep: 2[f]
Mossy-cup oak	*Quercus macrocarpa*	SC	--	FAC-	1,3,4	1984	Rep: 1,2[f]
Long-beaked water-crowfoot	*Ranunculus longirostris*	(WL)	--	OBL	1,4	1973	Rep: 2[f]
Bristly buttercup	*Ranunculus pensylvanicus*	T	--	OBL	1,3	1992	Rep: 1[f]
Great laurel	*Rhododendron maximum*	T	--	FAC	1,4	1983	Rep: 2[f]
Capillary beak-sedge	*Rhynchospora capillacea*	E	--	OBL	1,4	1983	Rep: 2[f]
Swamp red currant	*Ribes triste*	SC	--	OBL	1,4	1988	Rep: 2[f]
Wapato	*Sagittaria cuneata*	E	--	OBL	1,3,4	1994	Rep: 1,2[f]
Hoary willow	*Salix candida*	(WL)	-	OBL	1,4	1983	Rep: 1,2[f]
Autumn willow	*Salix serissima*	(WL)	--	OBL	1,4	1988	Rep: 2[f]
Long-styled sanicle	*Sanicula odorata*	T	--	UPL	1	??	-[f]

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]
Pendulous bulrush	*Scirpus pendulus*	SC	--	OBL	1,4	1987	Rep: 2[f]
Rock spikemoss	*Selaginella rupestris*	(WL)	--	UPL	1	??	-[f]
Slender blue-eyed grass	*Sisyrinchium mucronatum*	T	--	UPL	1,4	1912	Rep: 2[f]
Small bur-reed	*Sparganium natans*	E	--	OBL	1	??	+[f]
Shining wedgegrass	*Sphenopholis nitida*	T	--	UPL	1	??	-[f]
Hooded ladies'-tresses	*Spiranthes romanzoffiana*	E	--	OBL	4	1911	Rep: 2[f]
Small dropseed	*Sporobolus neglectus*	E	--	FACU-	1,4	1899	Rep: 2[f]
Arborvitae	*Thuja occidentalis*	E	--	FACW	1	??	+[f]
Large-flowered bellwort	*Uvularia grandiflora*	(WL)	--	UPL	1,4	1983	Rep: 2[f]
Sessile water-speedwell	*Veronica catenata*	E	--	OBL	1	??	+[f]
Culver's root	*Veronicastrum virginicum*	SC	--	FACU	1,3,4	1992	Rep: 1,2[f]
Downy arrowwood	*Viburnum rafinesquianum*	T	--	UPL	1	??	-[f]
Barren strawberry	*Waldsteinia fragariodes*	SC	--	UPL	1,4	1989	Rep: 2[f]

[a] E - State Endangered; T - State Threatened; SC - State Special Concern; WL - State Watch List (not a legal designation); FE - Federally Endangered; FT - Federally Threatened; C2 - Federal Candidate (Category 2); C3 - Previously considered for Federal listing but no longer a candidate species.

[b] OBL = Obligate wetland species; FAC = Faculative Wetland Species (U = Upland; W = Wetland); UPL = Upland Species (Reed 1988).

[c] 1 - MADFW (1995a) for the Pittsfield East, Pittsfield West, East Lee, and Stockbridge 7.5 minute quadrangles; 2 - USFWS (1995); 3 - MADFW (1995b); 4 - BBL (1991).

[d] Obs = Observed within the study area; Rep = Reported in: 1 - the Housatonic Valley Wildlife Management Area, 2 - the towns of Pittsfield, Lenox, and/or Lee; + = reported in 4-quadrangle area that includes the study area and likely to occur in the study area based on habitat requirements; 0 = reported in 4-quadrangle area that includes the study area and may occur in the study area based on habitat requirements; - = reported in 4-quadrangle area that includes the study area and not likely to occur in the study area based on habitat requirements.

TABLE 17
Rare, Threatened, and Endangered Species Potentially Present Within the Study Area and Vicinity

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Wetland Status[b]	Source[c]	Last Observed	On-Site Status[d]

[e] Specimens in genus *Enallagma* (not identified to species) were observed in the river during 1993 studies (Chadwick & Associates 1994).
[f] Also reported within the Massachusetts portion of the Housatonic River watershed from 1970 to present.

TABLE 18 Rare, Threatened, and Endangered Species Known or Likely to be Present Within the Study Area - 1970 to Present					
Common Name	**Scientific Name**	**State Status[a]**	**Federal Status[a]**	**Last Observed or Reported**	**On-Site Status**
Amphibians					
Jefferson salamander	*Ambystoma jeffersonianum*	SC	--	1990	Reported
Spotted salamander	*Ambystoma maculatum*	(WL)	--	1993	Observed
Marbled salamander	*Ambystoma opacum*	T	--	1976	Reported
Spring salamander	*Gyrinophilus porphyriticus*	SC	--	1990	Reported
Four-toed salamander	*Hemidactylium scutatum*	SC	--	1988	Reported
Reptiles					
Spotted turtle	*Clemmys guttata*	SC	--	Unknown	Reported
Wood turtle	*Clemmys insculpta*	SC	--	1994	Observed
Fish					
Longnose sucker	*Catostomus catostomus*	SC	--	1993	Observed
Birds					
Cooper's hawk	*Accipiter cooperii*	SC	--	Unknown	Reported
Sharp-shinned hawk	*Accipiter striatus*	SC	--	Unknown	Reported
Grasshopper sparrow	*Ammodramus savannarum*	T	--	1981	Reported
Great blue heron	*Ardea herodias*	(WL)	--	1995	Observed
American bittern	*Botaurus lentiginosus*	E	--	1993	Observed
Northern harrier	*Circus cyaneus*	T	--	Unknown	Reported
Sedge wren	*Cistothorus platensis*	E	--	Unknown	Likely

TABLE 18 Rare, Threatened, and Endangered Species Known or Likely to be Present Within the Study Area - 1970 to Present					
Common Name	**Scientific Name**	**State Status**[a]	**Federal Status**[a]	**Last Observed or Reported**	**On-Site Status**
Blackpoll warbler	*Dendroica striata*	SC	--	Unknown	Reported
Peregrine falcon	*Falco peregrinus*	E	FE	Unknown	Reported
Common morehen	*Gallinula chloropus*	SC	--	1993	Observed
Bald eagle	*Haliaeetus leucocephalus*	E	FT	1993	Observed
Least bittern	*Ixobrychus exilis*	E	--	1972	Reported
Northern parula	*Parula americana*	T	--	Unknown	Reported
Pied-billed grebe	*Podilymbus podiceps*	E	--	Unknown	Reported
King rail	*Rallus elegans*	T	--	1993	Observed
Golden-winged warbler	*Vermivora chrysoptera*	E	--	1993	Observed
Invertebrates					
Tule bluet (damselfly)	*Enallagma carunculatum*	SC	--	1976[b]	Reported
Plants					
Crooked-stem aster	*Aster prenanthoides*	SC	--	1988	Reported
Foxtail sedge	*Carex alopecoidea*	T	--	1993	Reported
Chestnut-colored sedge	*Carex castanea*	E	--	1987	Reported
Hitchcock's sedge	*Carex hitchcockiana*	SC	--	1989	Reported
Fen sedge	*Carex tetanica*	SC	--	1984	Reported
Hemlock parsley	*Conioselinum chinense*	SC	--	1982	Reported
Showy lady's-slipper	*Cypripedium reginae*	SC	--	1988	Reported

TABLE 18
Rare, Threatened, and Endangered Species Known or Likely to be Present Within the Study Area - 1970 to Present

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Last Observed or Reported	On-Site Status
Glade fern	*Diplazium pycnocarpon*	(WL)	--	1983	Reported
Goldie's fern	*Dryopteris goldiana*	(WL)	--	1983	Reported
Intermediate spike-sedge	*Eleocharis intermedia*	T	--	1989	Reported
Dwarf scouring-rush	*Equisetum scirpoides*	SC	--	1983	Reported
Variegated horsetail	*Equisetum variegatum*	(WL)	--	1983	Reported
Frank's lovegrass	*Eragrostis frankii*	SC	--	1989	Reported
Labrador bedstraw	*Galium labradoricum*	SC	--	1982	Reported
Fringed gentian	*Gentiana crinita*	(WL)	--	1977	Reported
Hairy honeysuckle	*Lonicera hirsuta*	E	--	1984	Reported
White adder's-mouth	*Malaxis brachypoda*	T	C2	1983	Reported
Ginseng	*Panax quinquefolius*	SC	--	1983	Reported
Hill's pondweed	*Potamogeton hillii*	SC	C3	1980	Reported
Pink pyrola	*Pyrola asarifolia var purpurea*	E	--	1983	Reported
Mossy-cup oak	*Quercus macrocarpa*	SC	--	1984	Reported
Long-beaked water-crowfoot	*Ranunculus longirostris*	(WL)	--	1973	Reported
Bristly buttercup	*Ranunculus pensylvanicus*	T	--	1992	Reported
Great laurel	*Rhododendron maximum*	T	--	1983	Reported
Capillary beak-sedge	*Rhynchospora capillacea*	E	--	1983	Reported
Swamp red currant	*Ribes triste*	SC	--	1988	Reported

TABLE 18
Rare, Threatened, and Endangered Species Known or Likely to be Present Within the Study Area - 1970 to Present

Common Name	Scientific Name	State Status[a]	Federal Status[a]	Last Observed or Reported	On-Site Status
Wapato	*Sagittaria cuneata*	E	--	1994	Reported
Hoary willow	*Salix candida*	(WL)	-	1983	Reported
Autumn willow	*Salix serissima*	(WL)	--	1988	Reported
Pendulous bulrush	*Scirpus pendulus*	SC	--	1987	Reported
Large-flowered bellwort	*Uvularia grandiflora*	(WL)	--	1983	Reported
Culver's root	*Veronicastrum virginicum*	SC	--	1992	Reported
Barren strawberry	*Waldsteinia fragariodes*	SC	--	1989	Reported

[a] E - State Endangered; T - State Threatened; SC - State Special Concern; WL - State Watch List (not a legal designation); FE - Federally Endangered; FT - Federally Threatened; C2 - Federal Candidate (Category 2); C3 - Previously considered for Federal listing but no longer a candidate species.

[b] Specimens in genus *Enallagma* (not identified to species) were observed in the river during 1993 studies (Chadwick & Associates 1994).

TABLE 19
Summary (Number of Species) of Rare, Threatened, and Endangered Species Known or Likely to be Present Within the Study Area - 1970 to Present

Taxonomic Group	Federal			State				Total Species
	Endangered	Threatened	Candidate	Endangered	Threatened	Special Concern	Watch List	
Amphibians	0	0	0	0	1	3	1	5
Reptiles	0	0	0	0	0	2	0	2
Fish	0	0	0	0	0	1	0	1
Birds	1	1	0	7	4	4	1	16
Mammals	0	0	0	0	0	0	0	0
Aquatic Invertebrates	0	0	0	0	0	1	0	1
Plants	0	0	1	5	5	15	8	33
TOTAL	1	1	1	12	10	26	10	58

TABLE 20
Summary of Taxa Known or Likely to be Present Within the Study Area

Taxonomic Group	Number of Species[a]		
	Total[b]	Reported in Housatonic WMA[c]	Observed On-site
Birds	259	176	105
Mammals	53	No data	24
Amphibians	18	13	9
- salamanders	9	5	3
- frogs/toads	9	8	6
Reptiles	17	13	4
- turtles	6	5	2
- snakes	11	8	2
Fish	39	17	20
Aquatic Invertebrates	73	No data	57

[a] Number of families for aquatic invertebrates.
[b] Includes reported, as well as observed, species within the study area and immediate vicinity.
[c] MADFW (1986, 1995b).

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Amphibians												
Spotted salamander				w	w	w	Bw	bw	B	b	b	
Red-spotted newt				w	w	w	bw	bw	Bw	w	bw	Bw
Northern dusky salamander				w	w	w	w		bw	bw	Bw	
Redback salamander	bw			bw	bw	bw	bw					
Four-toed salamander				bw	bw	bw	Bw		b	bw	b	
Northern spring salamander				bw	bw		Bw			bw	B	
Northern two-lined salamander				bw	bw	bw	bw			BW	Bw	
Jefferson salamander				bw			Bw	bw	Bw	bW		
Marbled salamander						bw	Bw	bw	bw			
Eastern American toad		bw	bw	w	w	w	bw	bw	b	w	b	b
Fowler's toad		w	w		w	w	w		Bw	w		B
Northern spring peeper				w	w	w	bw	bw	Bw	w	b	b
Bullfrog				w		w	w		Bw		bw	Bw
Green frog							bw	bw	bw	Bw	bw	bw
Wood frog				w	w	w	bw	bw	bw	bw	b	
Northern leopard frog			b				bw		BW		bw	bw
Pickerel frog				b	b	b	bw		Bw		w	Bw

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Gray treefrog				w		w	w	bw	b	bw		b
Reptiles												
Common snapping turtle		b	b		b	b	w		bW	bw	w	W
Bog turtle		bw	bw	w			w		Bw	w		
Wood turtle		bw	bw	bw	bw	bw	bw	w	w	bw	bW	w
Midland painted turtle		b					b	w	W	Bw		w
Spotted turtle		B	Bw				b	b	BW	bw	w	
Common musk turtle		b	b						W	b	w	W
Northern water snake							bw	b	bw	bw	b	b
Northern brown snake	BW	bw	bw	bw	bw	bw	bw	w	w			
Northern redbelly snake	bw	bw		Bw	Bw	Bw	bw	bw	b			
Eastern garter snake	bw	bw	bw	bw	bw	bw	bw	w	w	w	w	
Eastern ribbon snake				bw	bw		Bw	bw	Bw	Bw	B	b
Eastern hognose snake	bw	BW	bw	bw	bw	Bw			Bw	bw		
Eastern smooth green snake		Bw	bw	bw			bw	b	bw	b		
Northern ringneck snake	bw	bw		bw	bw		Bw					
Northern black racer	bw	Bw	bw	bw	Bw	Bw	bw	bw	b	bw		
Eastern milk snake	BW	bw	bw	bw	bw	bw	bw				b	

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Timber rattlesnake				bw		bw	bw					
Birds												
Common loon									m		m	m
Pied-billed grebe									Bw	w	w	
Horned grebe									m	m	m	m
Red-necked grebe									m	m	m	m
Double-crested cormorant										m	m	m
American bittern							w	w	Bw	w		
Least bittern		w					w	w	Bw	w	w	w
Great blue heron							B	w	Bw	w	w	w
Great egret									m	m	m	
Snowy egret									m	m	m	
Cattle egret									m	m		
Green heron							B		Bw	w	bw	w
Black-crowned night heron								Bw	w	w	w	
Glossy ibis									m		m	m
Tundra swan		w							w	w	w	w
Mute swan		w	w						w	w	w	w

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Snow goose		m							m	m	m	m
Brant										m	m	m
Canada goose		bw							Bw	b	B	
Wood duck							B	b	bw	B	b	b
Green-winged teal									Bw			
American black duck		w					b	b	BW	bw	b	bw
Mallard		bw	b				b	b	Bw	bw	bw	bw
Northern pintail		m							m	m	m	m
Blue-winged teal									B			
Northern shoveler									m			
Gadwall												m
American wigeon		m							m			m
Canvasback									m			m
Redhead									m			m
Ring-necked duck									w		w	w
Greater scaup									m		m	m
Lesser scaup									m		m	m
Oldsquaw												m

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Black scoter												m
Common goldeneye									w		w	W
Bufflehead											w	w
Hooded merganser				B	B	b	B		w		b	BW
Common merganser											w	w
Red-breasted merganser											w	w
Ruddy duck									m		m	m
Turkey vulture		Bw	b	bw	bw	Bw	w					
Osprey											b	b
Bald eagle		w		b	b	b			w		bw	Bw
Northern harrier		bw	bw				b	b	Bw			
Sharp-shinned hawk		bw	bw	BW	BW	BW	bw					
Cooper's hawk		bw	bw	BW	bw	BW	bw					
Northern goshawk		b	b	Bw	bw	bw	bw					
Red-shouldered hawk				Bw	bw	bw	Bw	Bw		BW		
Broad-winged hawk		B		B	b	B	B					
Red-tailed hawk		Bw	bw	bw	bw	Bw	BW					
Rough-legged hawk		W	w				w		w			

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Golden eagle			m	m	m	m			m			
American kestrel		BW	bw	bw	bw	bw	bw		bw			
Merlin		m	m		m							
Peregrine falcon		m	m					m	m			
Ring-necked pheasant		BW	bW									
Ruffed grouse			b	BW	bw	bw	b					
Wild turkey		bw	bw	bW	w	BW	w					
Northern bobwhite		BW	bw			BW						
King rail									Bw			
Virginia rail									BW			
Sora							b	b	B			
Common moorhen									B			b
American coot									w		w	w
Black-bellied plover									m	m		
Semipalmated plover									m	m		
Killdeer		Bw	bw						bw	b		
Greater yellowlegs									m	m	m	m
Lesser yellowlegs									m	m	m	m

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Solitary sandpiper								m	m	m	m	m
Spotted sandpiper		b							b	b	B	b
Upland sandpiper		m	m									
Semipalmated sandpiper									m	m	m	m
Western sandpiper									m	m	m	m
Least sandpiper									m	m	m	m
Pectoral sandpiper									m	m	m	m
Dunlin									m	m	m	m
Short-billed dowitcher									m	m	m	m
Common snipe							BW	BW	bw	bw		
American woodcock		B	b	B	b		B	b	b			
Wilson's phalarope									m	m	m	m
Bonaparte's gull											m	m
Ring-billed gull											w	w
Herring gull											w	w
Great black-backed gull											w	w
Rock dove	BW	BW										
Mourning dove		BW	bw	bw	bw	Bw	w					

TABLE 21
***Habitat Utilization of Wildlife Species Possibly Present in the Study Area*[a]**

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Black-billed cuckoo			b	B	b	B	b	b				
Yellow-billed cuckoo			b	b		B	b					
Common barn-owl	BW	BW	bw									
Eastern screech-owl		bw	bw	bw	bw	bw	BW		W	BW		
Great horned owl		bw	bw	bw	Bw	bw	Bw					
Snowy owl		W							W			
Barred owl		bw	bw	BW	bw	BW	BW			BW	w	
Long-eared owl		bw	b	bw	BW	bw	bw					
Short-eared owl		w							w			
Northern saw-whet owl		bw		BW	BW	bW	BW					
Common nighthawk	b	b	b	b	b	b	b		b	b		
Whip-poor-will		b	b	B	B	B	b					
Chimney swift	B	b	b						b			
Ruby-throated hummingbird		b	b	B	B	b	B					
Belted kingfisher									bw	BW	bw	bw
Red-headed woodpecker			b	bw		BW	BW			bw		
Yellow-bellied sapsucker				Bw	b	bw	bw			bw		
Downy woodpecker				BW	bw	BW	BW					

TABLE 21
Habitat Utilization of Wildlife Species Possibly Present in the Study Area[a]

Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Hairy woodpecker				BW	bw	bw	BW			bw		
Northern flicker	b	BW	bw	B	BW	BW	b					
Pileated woodpecker				BW	BW	BW	BW			bw		
Olive-sided flycatcher				b	B		b		b			
Eastern wood-pewee				b	b	b	b			B		
Acadian flycatcher						b	b			b		
Alder flycatcher			b	b	b	b	B	B		B		
Willow flycatcher			B	B		b	b					
Least flycatcher				B	b	B	B			b		
Eastern phoebe	B			b	b	b	b					
Great crested flycatcher				b	b	b	b					
Eastern kingbird		b	b	b		b	b					
Horned lark		BW	bw									
Tree swallow		b	b				B	b	B	b	b	b
Northern rough-winged swallow		B	b						b	B	b	
Bank swallow		B	b						b	b	b	
Cliff swallow	B	B	b						b			
Barn swallow	B	B	b						b	b	b	

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		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Blue jay				Bw	Bw	BW	Bw			bw		
American crow		BW	bw	bw	Bw	Bw	bw		bw			
Fish crow										w	w	
Common raven			w	bw	bw	bw			w			W
Black-capped chickadee				BW	bw	bw	BW			bw		
Tufted titmouse				bw	bw	BW	bw			BW		
Red-breasted nuthatch				bw	BW	bw						
White-breasted nuthatch				BW	bw	BW	bw			bw		
Brown creeper				bw	bw	bw	bw			bw		
Carolina wren			b	bw		bw	BW			b		
House wren	B		b	b		b	b			b		
Winter wren				bw	b	w	Bw	bw		w		
Sedge wren									B			
Marsh wren									b			
Golden-crowned kinglet				w	Bw	w	w					
Ruby-crowned kinglet					m	m						
Blue-gray gnatcatcher			b	b		B	B	b				
Eastern bluebird		bw	bw	B	bw	B	b					

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Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Veery			b	B	b	b	B			B		
Gray-cheeked thrush					B							
Swainson's thrush				B	B							
Hermit thrush			b	B	Bw	bW	bw	w				
Wood thrush				B	b	B	b			b		
American robin	b	B		b	bw	bw	bw	bw		bw		
Gray catbird			B	b	b	B	B	b		B		
Northern mockingbird		bw	Bw				B					
Brown thrasher		Bw	Bw	b		BW	b			b		
American pipit		m								m		
Bohemian waxwing		w	w							w		
Cedar waxwing		bw	bw	Bw	bw	bw	BW	bw		bw		
Northern shrike		W	W	w	w	w	w		w			
Loggerhead shrike		w	w									
European starling	BW	bW	w	bw		bw	bw			bw		
Solitary vireo				b	B	b	b					
Yellow-throated vireo				b		B	B					
Warbling vireo				b		b	B		b	b	b	

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Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Red-eyed vireo				B	b	b	b			b		
Blue-winged warbler		b	B	B		B	b	b				
Golden-winged warbler			B	b		b	b					
Tennessee warbler			m	m	m	m	m	m				
Nashville warbler		b		B	B	b	b	b				
Northern parula				m	m		m	m				
Yellow warbler		b	b	b	B	b	B	b		B		
Chestnut-sided warbler			b	B			B	b				
Magnolia warbler					B							
Cape May warbler					m							
Black-throated blue warbler				B	b	b	b					
Yellow-rumped warbler			w	b	B	b	Bw	w				
Black-throated green warbler				B	B	b	b					
Blackburnian warbler				B	B							
Pine warbler					B	b						
Prairie warbler		b	b	B	b	B						
Palm warbler					m	m		m		m		
Bay-breasted warbler			m		m					m		

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		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Blackpoll warbler				m	m							
Black-and-white warbler		b		B	b	B	b			b		
American redstart		b		B	b	b	b			b		
Worm-eating warbler				b		B						
Ovenbird				B	b	B	b					
Northern waterthrush				b	b		B	b		B	b	
Louisiana waterthrush							B	b		B	b	
Connecticut warbler			m	m		m	m	m		m		
Mourning warbler			m	m	m		m	m				
Common yellowthroat		B	B	B	b	B	B	B	b	B		
Wilson's warbler				m	m			m		m		
Canada warbler				b	B	b	b	b		b		
Yellow-breasted chat		B	B	b	b	b	b			B		
Scarlet tanager				B	b	B	b					
Northern cardinal		w	bw	bw	bw	bw	BW	b		bw		
Rose-breasted grosbeak			b	B	b	B	b			b		
Indigo bunting		B	B	b	b	b	b			b		
Rufous-sided towhee			b	B	B	B	b					

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Species	Buildings/ Structures	Upland Field		Upland Forest			Palustrine Wetland			Riparian	Open Water	
		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
American tree sparrow		w	w	w	w	w	w	w	w	w		
Chipping sparrow		b		b	B	B	b					
Field sparrow		BW	bW									
Vesper sparrow		B	b									
Savannah sparrow		BW	bw						bw			
Grasshopper sparrow		B	b									
Fox sparrow			W			W						
Song sparrow		bw	BW	bw	bw	bw	BW	Bw	w	Bw		
Lincoln's sparrow			m					m				
Swamp sparrow		bw						Bw	bw	bw		
White-throated sparrow		bw	bW	bw	bw	bw	bw			w		
White-crowned sparrow			m	m		m	m	m		m		
Dark-eyed junco		w	bw	bw	Bw	bw	bw					
Lapland longspur		W										
Snow bunting		W							w			
Bobolink		B	b						b			
Red-winged blackbird		bW	b					bw	Bw	bw		
Eastern meadowlark		BW	bw									

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		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Rusty blackbird					B		bw	bw		bw	w	
Common grackle		BW	bw		b		Bw	Bw	bw	bw		b
Brown-headed cowbird		BW	bw	b	b	b	bw		w	bw		
Orchard oriole						b	b			b		
Northern oriole				b		b	b			b		
Pine grosbeak		w		w	w	w						
Purple finch				w	BW	bw	w					
House finch						bw						
Red crossbill				w	W							
White-winged crossbill				w	W							
Common redpoll		W	W	W	w							
Hoary redpoll		W	W	W	w							
Pine siskin		W	W	w	Bw	w	w			b		
American goldfinch		Bw	Bw	bw	bw	bw	BW	Bw	Bw	bW		
Evening grosbeak			w	w	Bw	w	w					
House sparrow	BW	BW	bw									
Mammals												
Virginia opossum	bw	w	w	bw		bW	BW	Bw	B	Bw		

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		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Masked shrew		bw	bw	bw	bw	bw	bw	bw	bw	bw		
Northern short-tailed shrew	bw	bw	bw	bw	bw	bw	bw	bw	BW	BW		
Long-tailed shrew				bw	bw	bw						
Smoky shrew				BW	bw		bw			bw		
Water shrew				bw	bw		bw	BW	BW	bw	BW	BW
Hairy-tailed mole		bw	bw	bw	bw	bw	bw					
Star-nosed mole					bw		bw	bw	BW	bw	bw	bw
Eastern mole		BW	bw	bw		bw	bw					
Little brown bat	B	b	b	bw	bw	bw	bw	B	B	B	B	B
Keen's myotis	B	b	b	bw	bw	bw	bw	B	B	B	B	B
Small-footed myotis	B	b	b	bw	bw			b	b	b	b	
Big brown bat	B	b	b	bw	bw	bw	bw	B	B	B	B	B
Silver-haired bat	B	b	b	b	b	b	b	B	B	B	B	B
Red bat		b	b	b	b	b	b	b	b	b	b	b
Hoary bat		b	b	b	b	b		b	b	b	b	b
Eastern pipistrelle	B	b	b	bw	bw	bw	bw	B	B	B	B	B
Eastern cottontail	bw	B	BW	bW	bw	bw	bw	Bw	B	b		
New England cottontail		b	Bw	bw	bw	bw	bW	BW	b	bw		
Snowshoe hare		w	Bw	b	bw	bw	b	Bw		bw		

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		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Eastern chipmunk		bw	bw	bw	bw	bw	bw					
Woodchuck	BW	BW	BW	bw	bw	bw	bw					
Gray squirrel	bw			BW		BW	bw			bw		
Red squirrel	bw			bw	BW	bw	bw					
Southern flying squirrel	bw			BW		BW	bw					
Northern flying squirrel	bw			BW	BW	BW						
Beaver				BW			BW	bw	BW	BW	BW	BW
Deer mouse	BW		bw	bw	BW	bw	bw					
White-footed mouse	BW	bw	BW	BW	bw	BW	bw	bw	bw	bw		
Southern bog lemming		bw	bw	bw	bw	bw	bw		BW	bw		
Meadow vole		BW	BW					bw	bw	bw		
Southern red-backed vole		bw	bw	BW	BW	BW	bw	bw		bw		
Woodland vole		BW	bw	bw		bw	bw					
Muskrat								bw	BW	bw	bw	bw
House mouse	BW	bw	bw									
Norway rat	BW	bw	bw									
Meadow jumping mouse		BW	bw					bw	B	bw		
Woodland jumping mouse			BW	BW	bw	bw	BW	bw		bw		

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		Mowed/ Cropland	Old Field/ Shrub	Deciduous	Coniferous	Mixed	Forested	Shrub	Emergent/ Aquatic Bed		Riverine/ Stream	Lacustrine
Porcupine		b	bw	BW	BW	bw	bw	w				
Red fox		BW	bw	BW	BW	BW	BW	bw	bw	bw		
Gray fox		bw	bw	BW	bw	BW	BW	bw	bw	bw		
Coyote		bw	bw	bw	bw	bw	bw	bw	bw	bw		
Black bear		b	b	Bw	bw	Bw	Bw	b	b	b	b	b
Raccoon	bw	B	b	bw	bw	bw	BW	Bw	B	Bw		
Long-tailed weasel		bw	bw	bw	bw	bw	bw	bw	bw	BW		
Ermine		bw	BW	bw	bw	bw	bw	bw		bw		
Mink				bw	bw	bw	BW	bw	BW	BW	BW	BW
River otter				bw	bw	bw	bw	bw	bw	BW	BW	BW
Fisher				BW	bw		bw	bw		bw		
Striped skunk		BW	bW	bw	bw	bw	bw	b	b	b		
Bobcat		bw	bw	bw	bw	bw	bw	bw				
White-tailed deer		bw	bw	bw	bW	b	b	bw	b	b		

[a] lower case - Occurrence; upper case - Preferred Habitat
B - Breeding season; W - Winter (non-breeding) season; M - Migration only

Sources: DeGraaf and Richard (1986); DeGraaf and Rudis (1987); DeGraaf et al. (1992).

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FIGURES

Key to Wetland Codes on Figure 1

Wetland Classification (Cowardin et al. 1979):

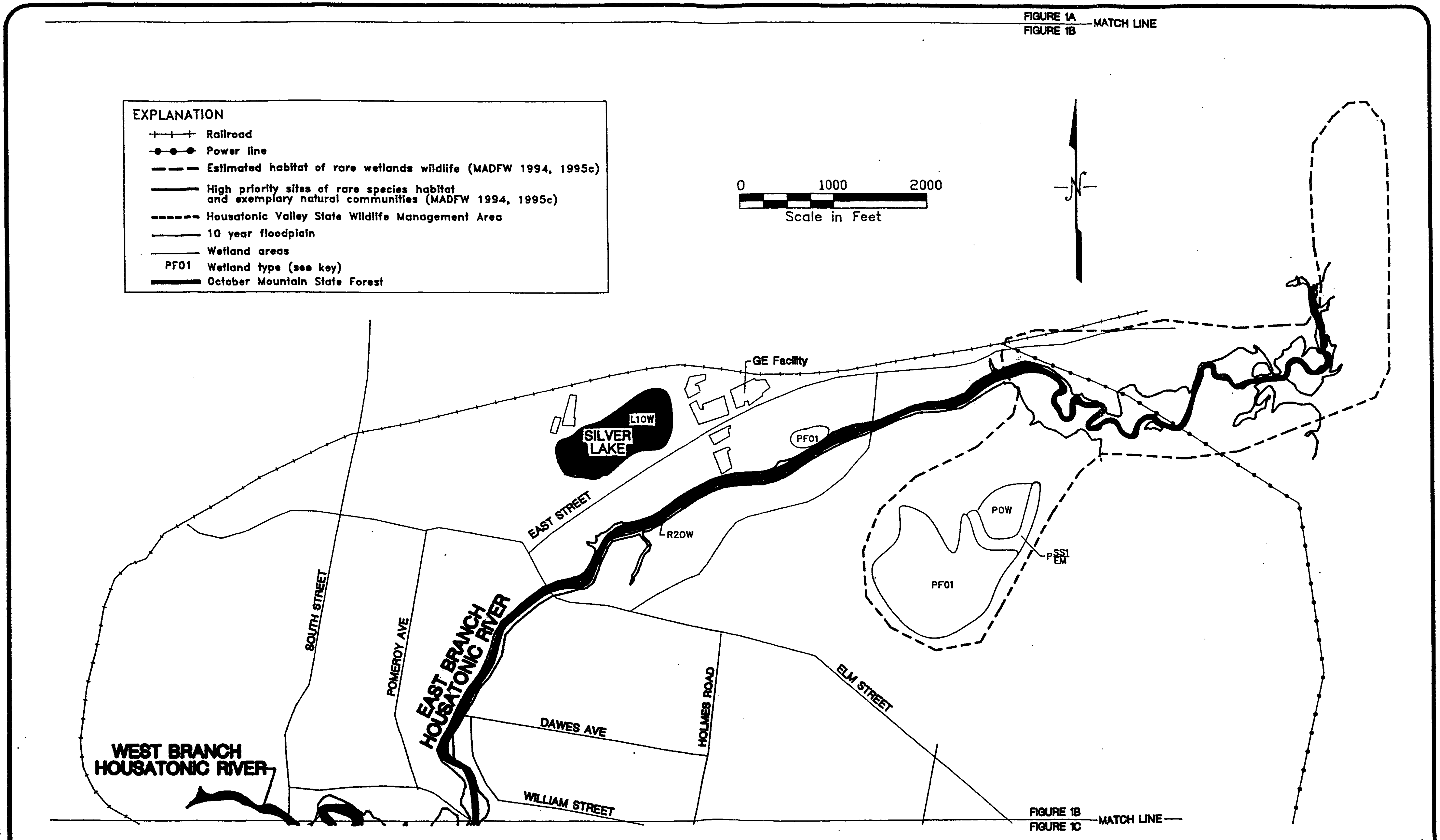
- R - Riverine
  - 2 - Lower Perennial
    - OW - Open Water (unknown bottom)
  - 3 - Upper Perennial
    - OW - Open Water (unknown bottom)
  - 4 - Intermittent
    - SB - Streambed

- L - Lacustrine
  - 1 - Limnetic
    - OW - Open Water (unknown bottom)

- P - Palustrine
  - EM - Emergent
  - SS - Scrub-Shrub
    - 1 - Broad-Leaved Deciduous
    - 3 - Broad-Leaved Evergreen
  - FO - Forested
    - 1 - Broad-Leaved Deciduous
    - 2 - Needle-Leaved Deciduous
    - 4 - Needle-Leaved Evergreen
  - OW - Open Water (unknown bottom)

Modifiers:

- Water Regime
  - E - Seasonally Saturated



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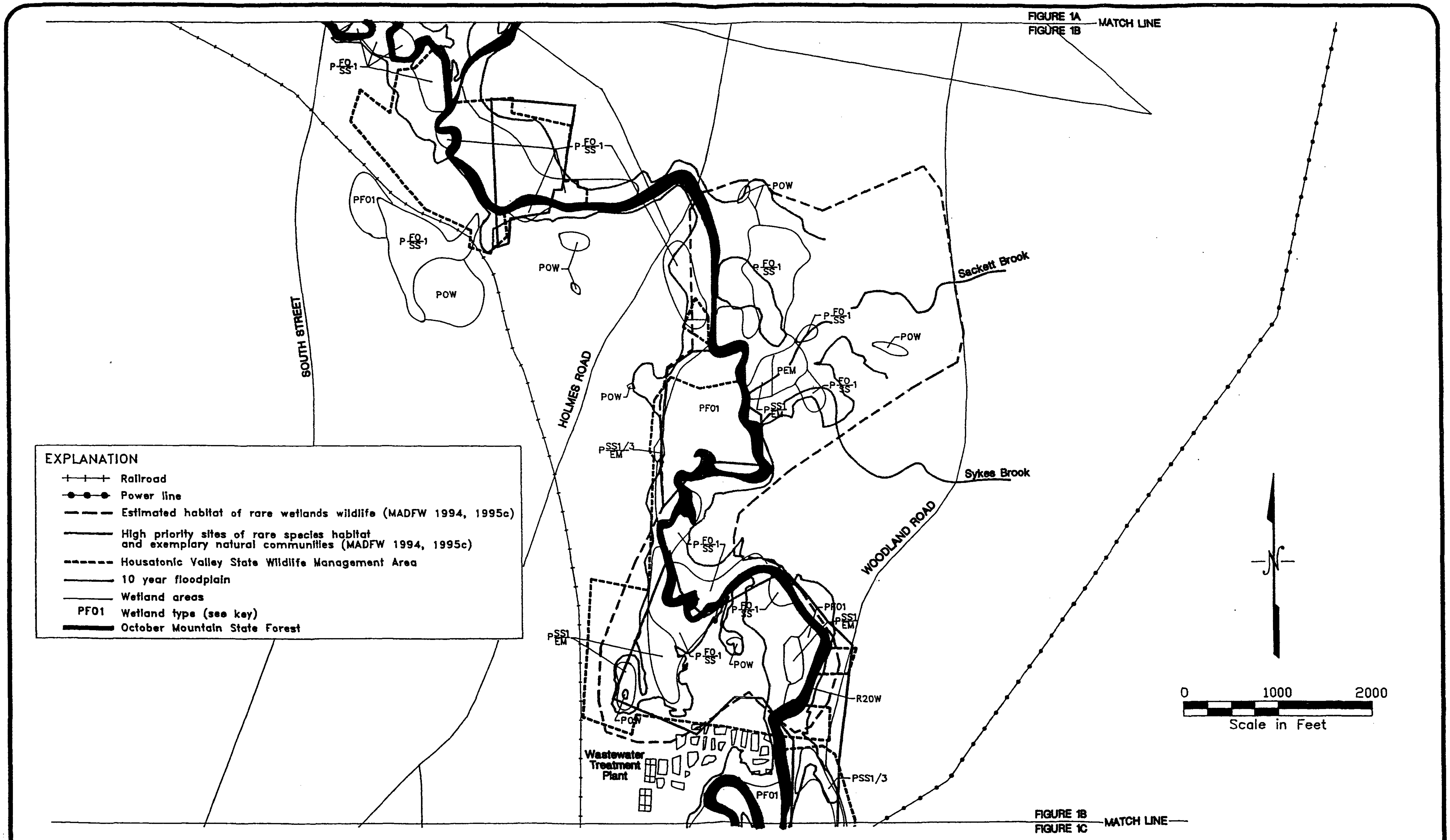
WETLAND AND SPECIAL HABITAT AREAS WITHIN THE STUDY AREA

Figure 1A



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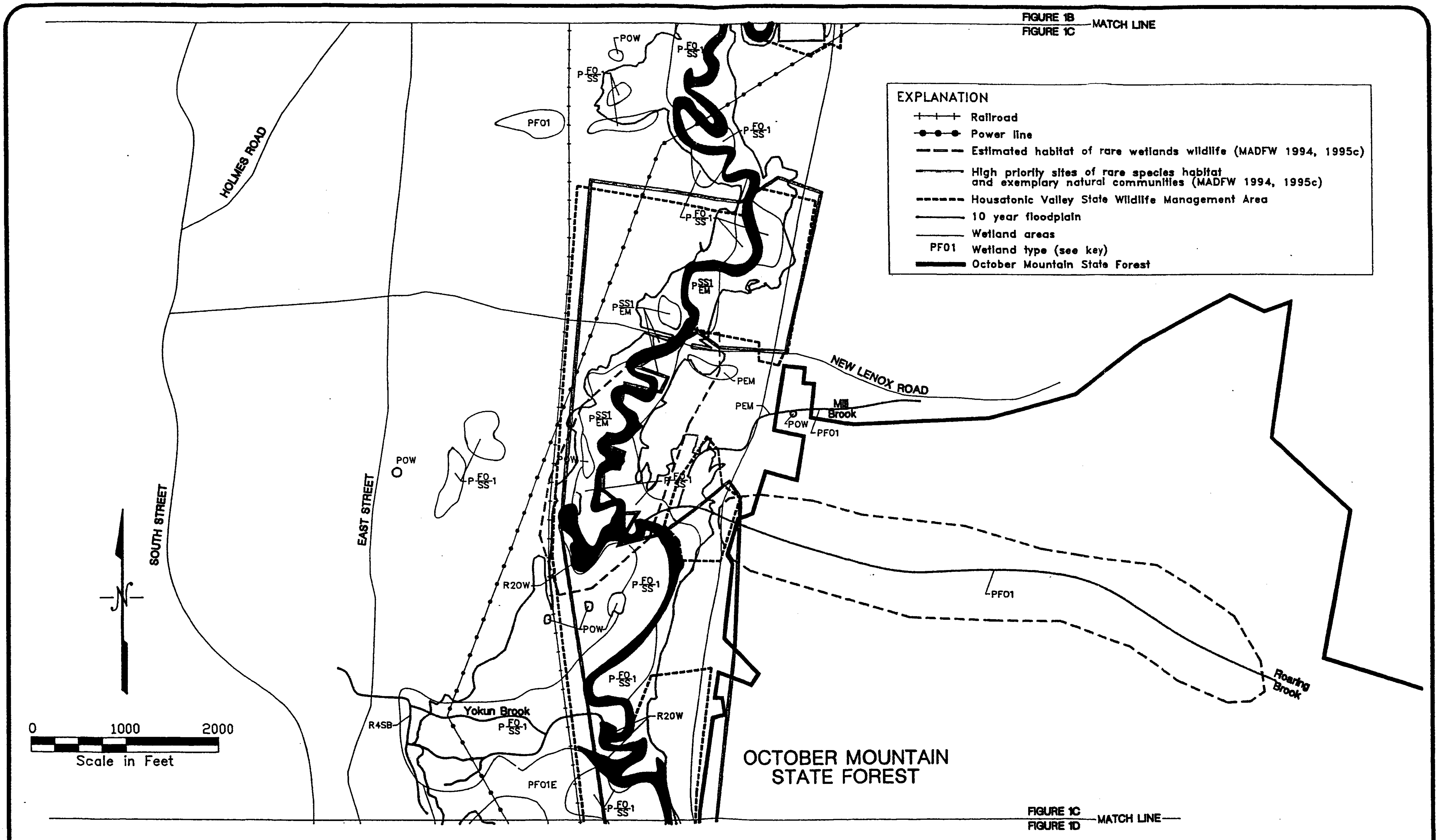
WETLAND AND SPECIAL HABITAT AREAS WITHIN THE STUDY AREA

Figure 1B

7 of 6



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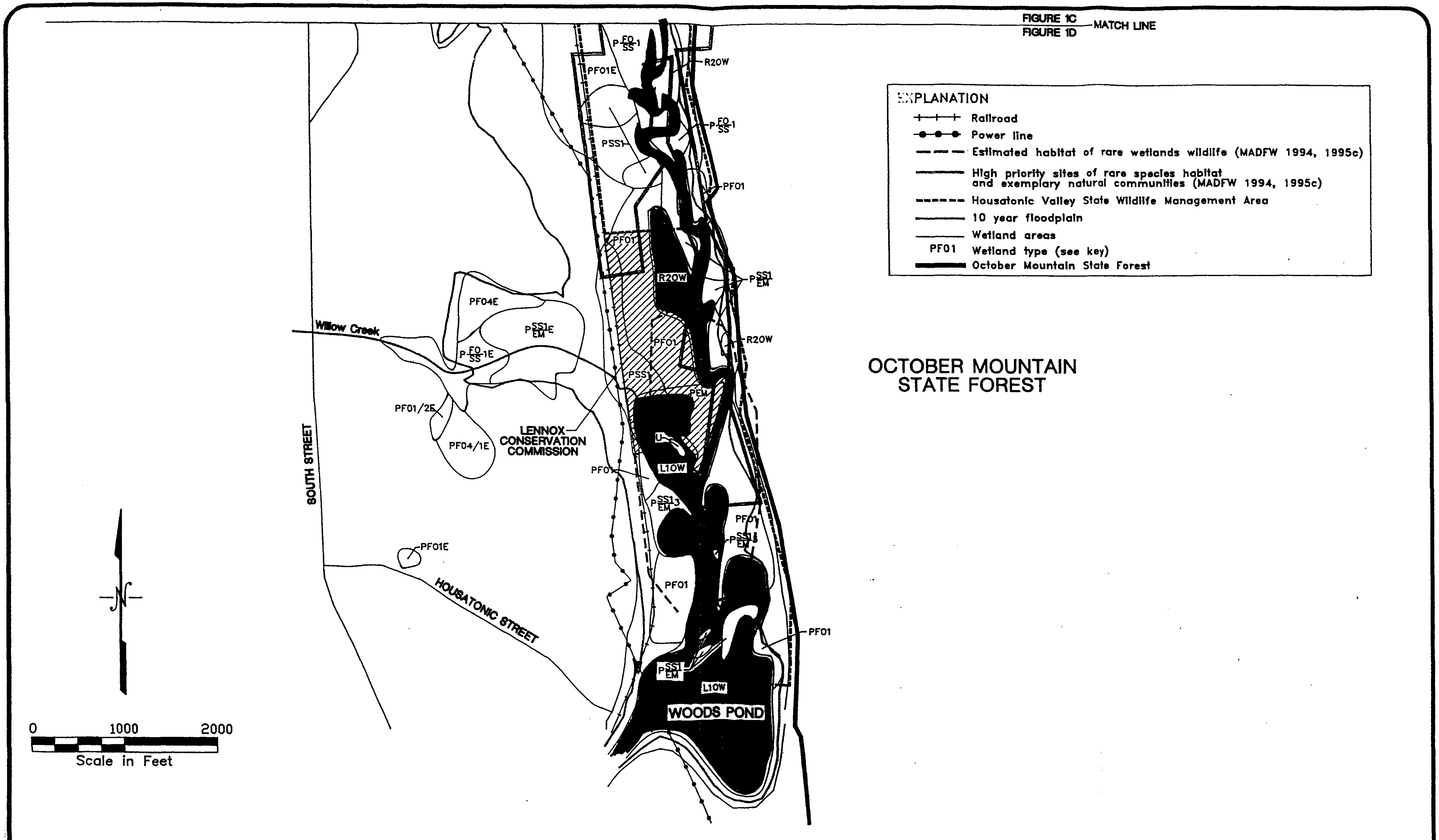
WETLAND AND SPECIAL HABITAT AREAS WITHIN THE STUDY AREA

Figure 1C



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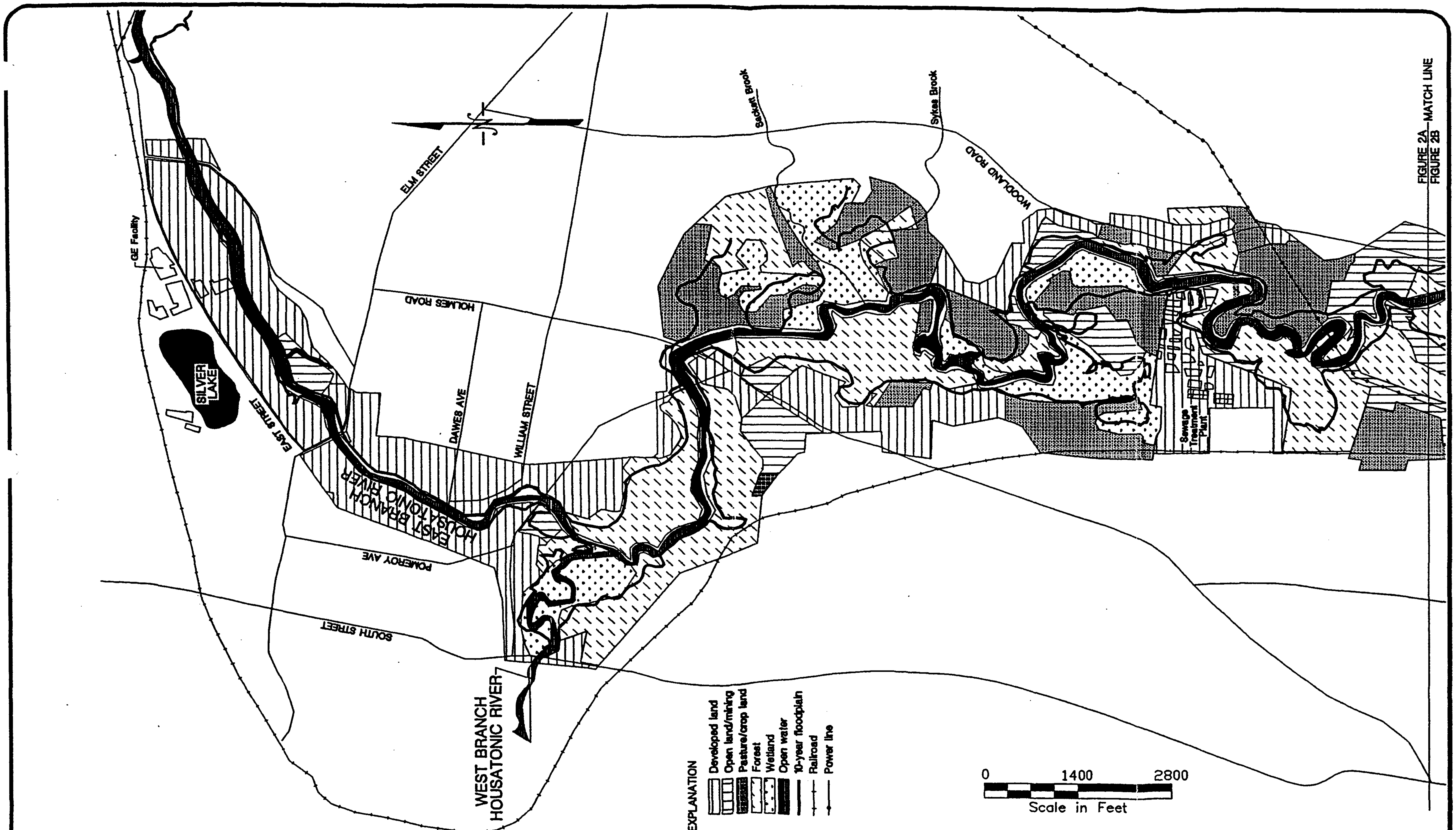
WETLAND AND SPECIAL HABITAT AREAS WITHIN THE STUDY AREA

Figure
1D



SOURCE: BBL (1992)

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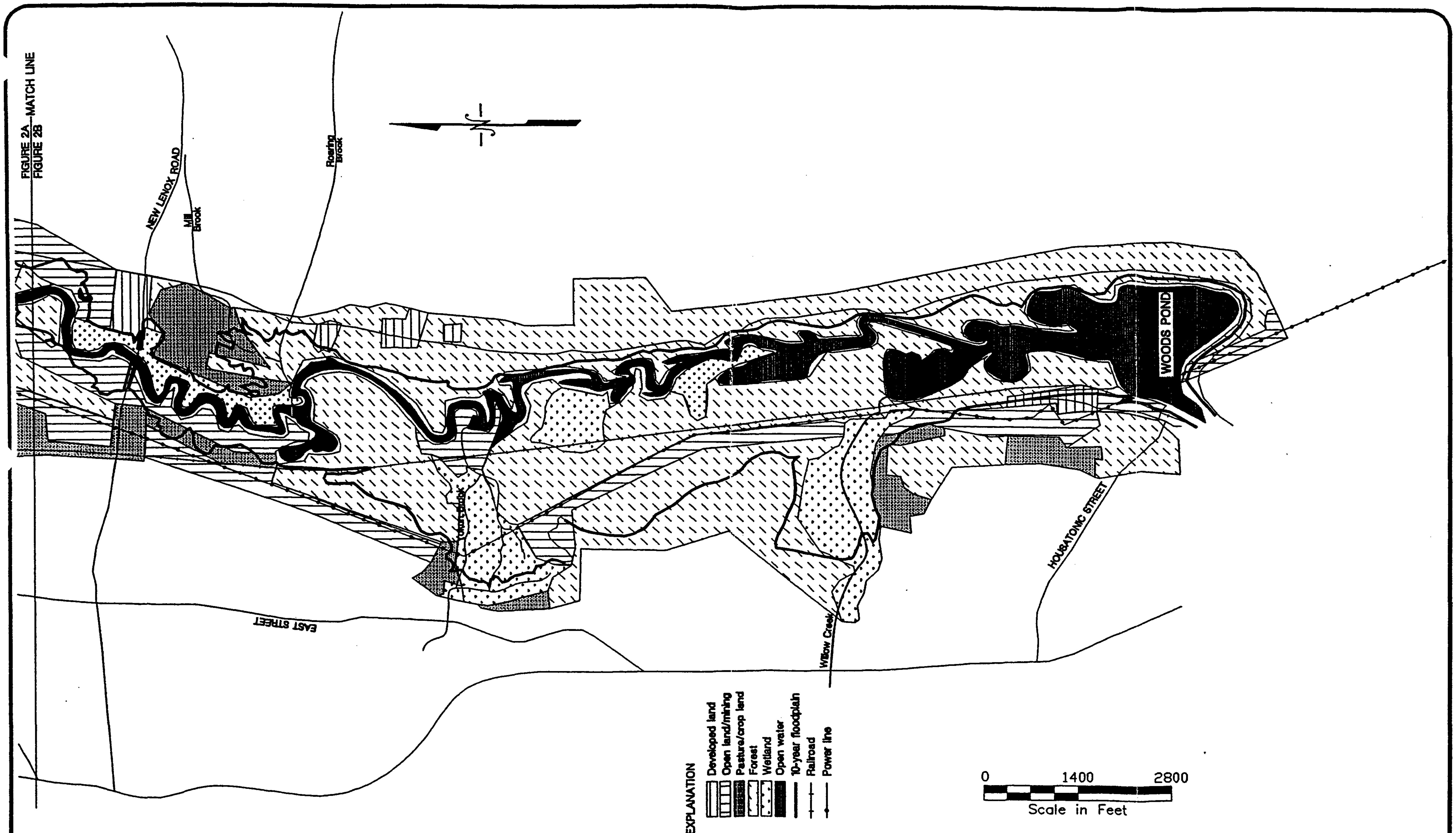
GENERAL HABITAT TYPES PRESENT IN THE STUDY AREA

Figure 2A



SOURCE: BBL (1992)

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GENERAL HABITAT TYPES PRESENT IN THE STUDY AREA

Figure 2B