# Wetland Inventory and Assessment in Thetford, Vermont

**January 20, 2011**

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## 1.0 Introduction

In 2010, the Thetford Conservation Commission retained Arrowwood Environmental to conduct a wetlands inventory, mapping and assessment project for the town of Thetford, Vermont. The project consisted of four phases: Phase I Remote Identification of Wetlands; Phase II Field Inventory; Phase III Remote Functions and Values Assessment; and Phase IV Final Map and Report Production. This report, attached map and digital data represent Phase IV, the final map and report.

According to the National Wetlands Inventory maps, there are 269 wetlands in the town of Thetford. The remote inventory (Phase I) for this project resulted in the identification of 489 wetlands and potential wetlands in the town of the Thetford. The "potential" category is used to denote sites where the remote data is unclear and field work is needed to confirm the presence of a wetland. In addition to the creation of the map of the 489 wetlands, data was collected on each wetland during the remote inventory phase. This data included natural community name, ecological notes, hydric soil type (when appropriate), presence of vernal pool habitat, acreage, and confidence of the mapping.

Before any field work (Phase II) was conducted, landowner permission to access particular sites was obtained by the Thetford Conservation Commission. Permission was obtained for 27 parcels. Trained town volunteers visited many of the vernal pool wetlands in the town in the early spring of 2010. Approximately 130 of the remotely identified wetlands were visited during the public access survey (viewed from public roads and trails). In addition, approximately 30 wetlands received a more intensive field visit. Data on the type, boundaries, functions and values of each wetland was obtained during these field visits. For wetlands that did not receive a field visit, a remote functional assessment (Phase III) was performed.

The Final Map (Phase IV) includes all of the wetlands from the remote inventory, data obtained from the field work as well as data obtained from previous inventories (see Methodology Section 5.0). This final map includes 562 wetlands and potential wetlands in the town. Information on natural communities of these wetlands, functions and values assessments and significant wetlands are presented below.

## 2.0 Natural Communities

Essential to understanding wetlands in Thetford is a working knowledge of the natural community concept. A "natural community" is defined as an "interacting assemblage of organisms, their physical environment and the natural processes that affect them." (Thompson and Sorenson, 2000). This means that certain combinations of the physical environment (geology, soils, and climate) gives rise to certain assemblages of organisms. These assemblages or patterns of vegetation occur repeatedly across the landscape and are summarized as natural community types. These different natural community types in Vermont are described and classified based on their vegetation composition and structure. These types are described in detail in the book Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont.

(Thompson and Sorenson, 2000). Work on the natural community classification is an ongoing process, so there are some recent changes to this classification that are not present in the book. Those relevant to wetland communities in Thetford are mentioned in the text below.

In addition to the formal community classification, there are certain colloquial terms related to wetlands that are helpful to understand. The terms marsh, bog, and swamp for example are often used interchangeably when in fact they refer to specific types of wetlands. A marsh refers to a wetland that is dominated by herbaceous vegetation. A swamp refers to a wetland that is dominated by woody vegetation (either shrubs or trees). Dense shrub swamps are also sometimes referred to as shrub thickets. A bog refers to a wetland characterized by the build-up of peat (un-decomposed organic matter) and very acidic, nutrient poor conditions. A fen is also a wetland where peat accumulates but under more nutrient rich and less acidic conditions than bogs. Both of these "peatland" types are uncommon or rare. A wet meadow generally refers to a sedge-dominated wetland (as in a Sedge Meadow).

**Table 1: Wetland Natural Community Summary Table**

| Natural Community | # of Occurrences | Average Acreage | Total Acreage |
|---|---|---|---|
| Agricultural Field | 39 | 0.8 | 29.9 |
| Alder Swamp | 76 | 2.1 | 158.1 |
| Alluvial Shrub Swamp | 10 | 5.2 | 52.2 |
| Beaver Wetland | 10 | 7.3 | 73.2 |
| Black Spruce Woodland Bog | 1 | 1.8 | 1.8 |
| Cattail Marsh | 2 | 4.2 | 8.5 |
| Clayplain Forest | 1 | 26.8 | 26.8 |
| Deep Broadleaf Marsh | 2 | 4.5 | 9.0 |
| Dwarf Shrub Bog | 1 | 3.1 | 3.1 |
| Floodplain Forest | 8 | 3.5 | 28.3 |
| Hemlock-Balsam Fir-Black Ash Seepage Swamp | 16 | 3.2 | 51.5 |
| Intermediate Fen | 2 | 7.0 | 13.9 |
| Old Field | 39 | 1.9 | 75.2 |
| Pond | 121 | 1.1 | 135.1 |
| Red Maple-Black Ash Swamp | 30 | 5.8 | 175.1 |
| Red Spruce-Cinnamon Fern Swamp | 4 | 1.2 | 5.0 |
| Sedge Meadow | 1 | 5.4 | 5.4 |
| Seep | 51 | 0.3 | 13.0 |
| Seepage Forest | 26 | 1.1 | 28.9 |
| Shallow Emergent Marsh | 60 | 2.4 | 144.6 |
| Spruce-Fir-Tamarack Swamp | 33 | 4.6 | 153.1 |
| Sugar Maple-Ostrich Fern Floodplain Forest | 5 | 4.5 | 22.4 |
| Sweetgale Shoreline Shrub Swamp | 1 | 4.0 | 4.0 |
| Vernal Pool | 23 | 0.1 | 1.3 |
| **TOTAL** | **557** | | **1219** |

The Thetford Wetlands Inventory documented a total of 21 different wetland natural community types in Thetford. This does not include agricultural fields, old fields, or ponds since these are not "natural" communities (though these were also mapped).

Most of these wetland types are described in detail in the book Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont (Thompson and Sorenson, 2000). A very brief description of each community along with some notes on its distribution and typical functions and values is present below.

## 2.1 Agricultural Fields and Old Fields

Though not actually natural communities, there are many places in Thetford that are open fields that may also be jurisdictional wetlands. When it appeared that a field was no longer used for agricultural purposes and was being colonized by shrubs or trees, the site was classified as Old field. Many of the wetlands that were mapped in agricultural fields were low confidence wetlands (those that have a lower probability of actually containing a wetland). This is due to the fact that the native vegetation is gone and cannot be used as a remote indicator of the wetness present on the site. This disturbed vegetation in combination with the land use history (including, in some cases, drainage) make remote determination of wetlands in agricultural fields difficult. According to the remote assessment, most of these sites lack functions and values. This is due to the fact that the natural processes of these systems were interrupted or drastically altered when the field was put into agriculture.

## 2.2 Alder Swamps and Alluvial Shrub Swamps

These are the two most common shrub-dominated communities in Vermont and are both characterized by dense growth of speckled alder (*Alnus incana*). Depending on the site, willow species (*Salix spp*.) may also be dominant. The Alluvial Shrub Swamp occurs exclusively along rivers and streams. The ecology of these communities is driven by the flooding of the site by the associated surface water. The soils tend to be mineral soils and the vegetation has much in common with riverine floodplain areas. The Alder Swamp community can occur along streams but is also common in more isolated basins and as part of larger wetland complexes. The soils of the Alder Swamp tend to be organic because of the lack of flooding that would wash away fine organic sediments. The majority of the shrub swamps in Thetford are the non-alluvial Alder Swamp. This is a common community type in the state whereas the Alluvial Shrub Swamps are uncommon communities. Alluvial Shrub Swamps are often significant for many functions related to surface waters such as erosion control, surface water protection and floodwater control. The functions and values present in Alder Swamps vary with the nature and landscape position of the swamp.

## 2.3 Beaver Wetland

Though not an official natural community, this is a mapping unit used to describe wetlands influenced by beavers. Beaver wetlands are dynamic systems that are continually changing based on the degree of flooding that is present. This means that the natural communities at the site are also constantly in flux. For these reasons,

it is useful to use the Beaver Wetland mapping unit. The most common natural communities present in this unit are Shallow Emergent Marsh and Alder Swamp. In some cases Sedge Meadows, Cattail Marshes or Deep Broadleaf Marshes may also be present.

Beaver Influenced wetlands are typically significant for numerous functions and values including water quality protection and flood water retention. They perform these functions, however, only when the hydrological systems are relatively stable. Catastrophic dam failures do occur, and these can negatively (sometimes drastically) impact downstream resources. The function of wildlife habitat, on the other hand, is typically high for these wetlands and much more stable.

### 2.4 Black Spruce Woodland Bog and Dwarf Shrub Bog

These peatland communities are characterized by the accumulation of Sphagnum peat and very nutrient poor and acidic conditions. Dwarf shrubs such as leatherleaf (*Chamaedaphne calyculata*) are common and, in the case of the woodland type, scattered stunted black spruce (*Picea mariana*) or tamarack (*Larix laricina*) trees. Only one potential occurrence of each of these peatland communities was mapped in Thetford, and neither could be field verified due to lack of landowner permission. Both are rare natural community types and should be investigated if the opportunity arises. It is unlikely that others exist.

### 2.5 Cattail Marsh

Cattail Marshes are similar to Shallow Emergent Marsh but are dominated (sometimes overwhelmingly) by broad-leaved cattail (*Typha latifolia*) or narrow-leaved cattail (*Typha angustifolia*). While only two Cattail Marshes were mapped in the town, other likely exist as part of Beaver Wetlands or Shallow Emergent Marshes. Statewide, they are more commonly associated with large wetland complexes and large bodies of water.

### 2.6 Valley Clayplain Forest

This uncommon community type is found almost exclusively in the clay soils of the Champlain lowlands. It is a forested type characterized by more southern tree species such as oaks (*Quercus spp*.) and, in the drier sites hickories (*Carya spp*.). Only one occurrence is known from the Connecticut River watershed and that is the one around Conant Swamp. This community was much more abundant before European settlement and conversion to agriculture. Because of the rarity of this community, these sites are significant for the Exemplary Natural Community Function.

### 2.7 Deep Broadleaf Marsh

This community is one of deep waters and mixed emergent and floating aquatic vegetation. It is most commonly associated with slow moving rivers, bays in lakes and ponds and beaver influenced wetlands. Only two occurrences have been mapped during the current inventory, but it is likely that other, smaller sites exist. The occurrences associated with Beaver Wetlands are likely ephemeral whereas those associated with rivers and lakes are more stable. All provide valuable wildlife habitat, among other functions.

## 2.8 Hemlock-Balsam Fir-Black Ash Seepage Swamp

This forested swamp community is the new name for some of the Hemlock Swamps as described in the Wetland, Woodland, Wildland book (Thompson and Sorenson, 2000). It is used here because it more accurately describes the mixed conifer-hardwood swamp found in Thetford. These are typically headwater swamps dominated by a mixture of conifers such as hemlock (*Tsuga canadensis*) and balsam fir (*Abies balsamea*), and hardwoods such as black ash (*Fraxinus nigra*) and red maple (*Acer rubrum*). Functions and values of these wetlands vary depending on the ecological condition and landscape position of the particular swamp.

## 2.9 Floodplain Forest and Sugar Maple-Ostrich Fern Floodplain Forest

As the name implies, these are both Floodplain forests found along the banks of larger rivers. In the case of Thetford, all of these sites occur along the banks of the Ompompanoosuc River (Main or West Branch). In addition to the Sugar Maple-Ostrich Fern Riverine Floodplain Forest previously mapped, there are three other types of floodplain forest in Vermont, two of which are likely found in Thetford: the Silver Maple-Ostrich Fern Riverine Floodplain Forest and the Silver Maple-Sensitive Fern Riverine Floodplain Forest. With European settlement, the majority of these sites across the state were plowed under and put into agriculture or development. What largely remains of this community occur in smaller fragments, often in an early successional state and somewhat disturbed. Being located along the banks of major rivers, these sites often rank moderate to high for many functions such as flood water control, surface water protection, fisheries habitat, and erosion control.

A final note should be made regarding the soils of these communities. Given their landscape position and association with the river, the soils at these sites are usually sands or sandy loams. The sandy soils at some of these sites may not be wetland (hydric) soils which means that some floodplain forests are not considered jurisdictional wetlands. Only a site visit and a detailed soil description can determine if a specific site is a wetland. For the purpose of this inventory, any floodplain forest type was mapped as a wetland or a potential wetland.

## 2.10 Intermediate Fen

Only two examples of this rare community were mapped in Thetford, though a few smaller sites may exist that could not be detected by remote sources. The typical example of this community is dominated by tall stems of wire sedge (*Carex lasiocarpa*). These sites are most commonly associated with the peaty shores of lakes or ponds or the margins of larger peatlands. These communities are typically significant as Exemplary Natural Communities and, in some cases, as habitat for rare species.

## 2.11 Red Spruce-Cinnamon Fern Swamp

Formally considered a variant of the Spruce-Fir-Tamarack Swamp, the Red Spruce-Cinnamon Fern Swamp is a swamp characterized by a mixture of conifer and hardwoods. As the name implies, red spruce (*Picea rubens*) is common, along with red maple (*Acer rubrum*), yellow birch (*Betula*

*alleghaniensis*) or black ash (*Fraxinus nigra*). The understory is dominated by cinnamon fern (*Osmunda cinnamomea*) and herbaceous diversity is relatively low. Only four occurrences of this community were documented in Thetford, but other sites remotely mapped as Red Maple-Black Ash Swamps may best belong with this community. Most occurrences of these swamps are small, headwater swamps within a forested matrix. They typically rank significant for wildlife habitat and water quality. Like Seeps, some of them may be "presumed significant" because of their headwater status.

### 2.12 Pond

Though not a natural community and, in some cases, not considered a wetland, ponds were mapped as part of this wetland inventory. This is because many ponds appear on the Vermont Significant Wetlands Inventory (VSWI) map and are therefore regulated Class II wetlands. In the spirit of thoroughness, all ponds in Thetford were therefore mapped. During the remote mapping process it is sometimes difficult to determine if a particular site is natural or manmade. If it was obvious, notes were made in the comments section. The functions and values that ponds provide vary widely based on their landscape position, relation to surface waters, surrounding land use and the nature of the pond itself.

### 2.13 Red Maple-Black Ash Swamp

Red Maple-Black Ash Swamps are hardwood-dominated forested swamps that occur in a wide variety of landscape positions. They occur in low flat basins (like Conant Swamp) as well as small headwater swamps in a forested matrix (like Twayblade Swamp). They are dominated by red maple (*Acer rubrum*), black ash (*Fraxinus nigra*) and sometimes yellow birch (*Betula alleghaniensis*). Most of the hardwood swamps assessed during this inventory were the Red Maple-Black Ash Seepage Swamp. Based on recent analysis, this is the proper name for swamps that show some nutrient enrichment characteristic of groundwater seepage. These wetlands are generally significant for wildlife habitat and, in some cases, erosion control

### 2.15 Sedge Meadow

Sedge Meadows are herbaceous dominated wetlands typically found associated with surface water (ponds or streams) or as part of larger wetland complexes like Beaver Wetlands. They are dominated by sedges including common tussock sedge (*Carex stricta*), lakeshore sedge (*Carex lacustris*) or bladder sedge (*Carex vesicaria*) but can include other marsh vegetation as well. While only one occurrence was mapped during this inventory, others are likely present but can only be discovered during field work.

The remote inventory cannot distinguish between these communities and the Shallow Emergent Marsh sites.

### 2.16 Seeps

The Seep natural community is a fairly widespread community both in Thetford and throughout Vermont. It consists of small wetland areas where groundwater "seeps" to the surface. These are typically found as small openings within upland forests and can form the headwaters of mountain streams. There were 51 examples of this type found during the wetland inventory, but since most of these wetlands are small and difficult to identify from remote sources, it

is likely that only a fraction of the total number of Seeps were discovered during the present inventory. Seeps appear to have low to moderate functionality for many of the functions assessed. This is in part related to this community's wide ranging topographic positions and community characteristics. Based on the fact that Seeps are often headwater wetlands, however, many of them may be presumed significant under the new Vermont Wetland Rules (discussed below).

### 2.17 Seepage Forests

Seepage Forests are similar to Seeps in that they are also dominated by groundwater discharge. Seepage forests, however, occur intermixed with trees and generally occur in a more diffuse situation where openings are mixed with areas of closed canopy. Because they occur in a more diffuse pattern, these sites are generally much larger than the well-defined Seeps. This is a newer natural community type and not included in the Wetland, Woodland, Wildland book (Thompson and Sorenson, 2000). Similar to Seeps, Seepage Forests generally rank low for water quality functions, but may be "presumed" significant because most are headwaters wetlands.

### 2.18 Shallow Emergent Marsh

The Shallow Emergent Marsh community is one of the most common and widespread wetland communities in the state. It is also one of the most variable. It can be dominated by a diverse mixture of herbaceous vegetation including bulrushes (*Scirpus spp.*), sedges (*Carex spp.*), grasses such as common bluejoint grass (*Calamagrostis canadensis*), and herbs such as common joe-pye weed (*Eupatorium maculatum*). It can occur in a wide variety of landscape positions including the edges of ponds, lakes and streams, associated with beaver wetlands, in isolated basins, as oxbows and as part of larger wetland complexes. During the remote mapping process, most herbaceous wetlands are placed into this category until field work can confirm a different type is present. The functions and values that these wetlands perform vary widely with the nature and position of the particular wetland.

### 2.19 Spruce-Fir-Tamarack Swamp

The Spruce-Fir-Tamarack Swamp community is a conifer-dominated swamp that can occupy a wide variety of landscape positions. These wetlands are characterized by a canopy of red spruce (*Picea rubens*) and tamarack (*Larix laricina*) with an occasional hardwood such as red maple (*Acer rubrum*). When remote mapping wetlands, most conifer dominated swamps are placed into this type, though field work may reveal that they are Red Spruce-Cinnamon Fern Swamps or Hemlock-Balsam Fir-Black Ash Seepage Swamps. Functions and values of these sites can vary widely depending on the landscape position and nature of the swamp.

### 2.20 Sweet Gale Shoreline Swamp

The Sweet Gale Shoreline Swamp is an uncommon, shrub-dominated community that is typically associated with large peatlands or the margins of peaty lakes and ponds. As the name implies, it is dominated by the shrub sweet gale (*Myrica gale*), though leatherleaf (*Chamaedaphne calyculata*) can also be present. There is only one occurrence of this community mapped in Thetford (Gillette Swamp). Since these are

uncommon wetlands in the state, they are often significant for the Exemplary Natural Community function.

### 2.21 Vernal Pool

Vernal Pools occur in seasonally flooded depressions that hold water during the spring and early summer and then dry up during the late summer months. They differ from all other natural communities in Thetford in that they are largely defined by the obligate wildlife assemblages that use them rather than a plant assemblage. This wildlife includes the Jefferson salamander (*Ambystoma jeffersoniana*), blue spotted salamander (*Ambystoma laterale*), spotted salamander (*Ambystoma maculatum*), wood frog (*Rana sylvatica*), fairy shrimp (*Eubranchipus spp*.) and fingernail clams (family *Sphaeriidae*). Since vernal pools are defined by their hydroperiod and the obligate wildlife that use them, they occur in a wide variety of landscape positions. The most common is small depressions and benches within upland forests.

The locations of potential vernal pools are being mapped as part of the Vermont Vernal Pool Mapping Project. Only vernal pools that were confirmed with a field visit were included in the final report and map of this inventory. These sites typically rank high for the wildlife habitat function.

## 3.0 Locally and State Significant Wetlands in Thetford

In order to more fully understand the wetland resources in Thetford, a wetland functional assessment was conducted on each wetland as outlined in Methodology section 5.0. In addition, each wetland natural community that was visited was ranked according to the NNHP guidelines for determining state significance (Vermont Agency of Natural Resources, 2004). These two separate ranking procedures give an overall picture of the most significant wetlands in the town. However, wetlands that were not visited in this (or previously documented inventories) often could not be assessed and therefore could not be ranked. Of the wetlands which have been visited, 34 are ranked as either state significant natural communities or locally significant for functions and values (see Table 2)

As can be seen in Table 2, there are both single wetlands and groups of wetlands that are considered significant. Because these wetland groups are hydrologically and ecologically interconnected, it is useful to think of them as a unit, or a "wetland complex". Each significant wetland and wetland complex is named and listed below. Following the table is a brief description of the wetland, the justification of significance and, for wetlands visited during this inventory, management recommendations.

**Table 2. Locally and State Significant Wetlands in Thetford**

| Site Name | Unique ID | Natural Communities | Significance |
|---|---|---|---|
| Balsam Swamp | 381 | Hemlock-Balsam Fir-Black Ash Seepage Swamp | State Significant Natural Community |
| Town Forest Swamp | 382 | Red Maple-Black Ash Swamp | State Significant Natural Community |
| Connant Swamp | 320 | Red Maple-Black Ash Swamp | State Significant Natural Community |
| | 318 | Clayplain Forest | State Significant Natural Community |
| Gillette Swamp | 159 | Intermediate Fen | State Significant Natural Community |
| | 160 | Alder Swamp | State Significant Natural Community |
| | 162 | Hemlock-Balsam Fir-Black Ash Seepage Swamp | State Significant Natural Community |
| | 479 | Sweetgale Shoreline Shrub Swamp | State Significant Natural Community |
| | 480 | Alder Swamp | Locally Significant for Functions and Values |
| | 481 | Shallow Emergent Marsh | State Significant Natural Community |
| Godfrey Road Marsh | 270 | Alder Swamp | Locally Significant for Functions and Values |
| | 487 | Shallow Emergent Marsh | Locally Significant for Functions and Values |
| Gove Hill Seep | 484 | Seep | State Significant Natural Community |
| Norwich-Thetford Swamp | 227 | Red Maple-Black Ash Swamp | State Significant Natural Community |
| Post Mills Alluvial Wetlands | 123,125-6,140,554 | Sugar Maple-Ostrich Fern Floodplain Forest | Locally Significant for Functions and Values |
| | 130 | Spruce-Fir-Tamarack Swamp | Locally Significant for Functions and Values |
| | 122,124,127-8,134,556-7 | Floodplain Forest | Locally Significant for Functions and Values |
| | 141-2 | Alluvial Shrub Swamp | Locally Significant for Functions and Values |
| Thetford Hill Marsh | 354 | Cattail Marsh | Locally Significant for Functions and Values |
| | 488 | Deep Broadleaf Marsh | Locally Significant for Functions and Values |
| | 489 | Red Maple-Black Ash Swamp | Locally Significant for Functions and Values |
| Thetford Swamp | 163 | Hemlock-Balsam Fir-Black Ash Seepage Swamp | State Significant Natural Community |
| | 164 | Beaver Wetland | Locally Significant for Functions and Values |
| | 165 | Shallow Emergent Marsh | Locally Significant for Functions and Values |
| | 169 | Spruce-Fir-Tamarack Swamp | Locally Significant for Functions and Values |

| Site Name | Unique ID | Natural Communities | Significance |
|---|---|---|---|
| | 485 | Alder Swamp | Locally Significant for Functions and Values |
| Twayblade Swamp | 355 | Red Maple-Black Ash Swamp | State Significant Natural Community |
| Union Village Beaver Wetland | 197 | Alder Swamp | Locally Significant for Functions and Values |
| | 198 | Beaver Wetland | Locally Significant for Functions and Values |
| Zebedee Brook Marsh | 213 | Shallow Emergent Marsh | Locally Significant for Functions and Values |
| | 232 | Alder Swamp | Locally Significant for Functions and Values |
| | 233 | Deep Broadleaf Marsh | Locally Significant for Functions and Values |
| | 234 | Shallow Emergent Marsh | Locally Significant for Functions and Values |
| Unnamed Vernal Pools | 120-121 | Vernal Pools | State Significant Natural Community |

## 3.1 Balsam Swamp and Town Forest Swamp

### *3.1.1 Natural Communities*

Balsam Swamp sits in a forested matrix and forms the headwater of a stream which drains into the Ompompanoosuc River. Though officially typed as a Hemlock-Balsam Fir-Black Ash Seepage Swamp, this is most closely related to the Hemlock Swamp as described in the Wetland, Woodland, Wildland book (Thompson and Sorenson, 2000). This swamp is named for one of the canopy dominants, balsam fir (*Abies balsamea*). Also in the canopy are species such as black ash (*Fraxinus nigra*), yellow birch (*Betula alleghaniensis*) and red maple (*Acer rubrum*). There is a tall shrub layer comprised of speckled alder (*Alnus incana*) and balsam fir (*Abies balsamea*). The herbaceous layer is dominated by two related ferns, cinnamon fern (*Osmunda cinnamomea*) and royal fern (*Osmunda regalis*). Other species such as dwarf blackberry (*Rubus pubescens*), naked miterwort (*Mitella nuda*) and golden saxifrage (*Chrysosplenium americanum*) are also present. The non-vascular layer consists of *Mnium sp.*, *Sphagnum squarrosum*, *Calliergon stramineum*, and *Thudium sp*. Hummocks and hollows are well developed and standing water is common in the hollows.

This is a beautiful swamp which appears to be free of any recent human disturbance. The combination of size, community condition and landscape make this a B-ranked swamp and therefore considered state significant.

**Figure 1. Cinnamon fern dominates the understory of Town Forest Swamp.**

Town Forest Swamp is an example of a Red Maple-Black Ash Seepage Swamp which is similar to the Red Maple-Black Ash Swamp described in Wetland, Woodland, Wildland (Thompson and Sorenson, 2000). This is a beautiful swamp that feeds a small brook which drains into the Ompompanoosuc River. It appears to be in excellent condition and free from any recent human disturbance. The canopy is composed of a mixture of black ash (*Fraxinus nigra*) and yellow birch (*Betula alleghaniensis*) with smaller amounts of hemlock (*Tsuga canadensis*) and balsam fir (*Abies balsamea*). There is a shrub layer composed of canopy species. The herbaceous layer is dominated by cinnamon fern (*Osmunda cinnamomea*). Other species such as brome-like sedge (*Carex bromoides*), sensitive fern (*Onoclea sensibilis*), dwarf blackberry (*Rubus pubescens*) and royal fern (*Osmunda regalis*) are also present. There is a moderate non-vascular layer composed of a mix of *Sphagnum squarrosum*, *Thuidium sp*., *Calliergon stramineum* and *Rhytidiadelphus triquetrus*. The combination of size, community condition and landscape make this a B-ranked swamp and therefore considered state significant.

### *3.1.2 Functions and Values*

The most significant function and value associated with these swamps are the high ranking they receive as Exemplary Natural Communities, as described above. They also have a low ranking for wildlife and water quality.

### *3.1.3 Management Recommendations*

In order to protect the fragile soils in these swamps, logging activity should be excluded. Improper logging can create ruts which can disrupt the local hydrology. It can also create areas of exposed soil which can lead to invasion by non-native invasive species. Either of these disturbances would lead to a degradation of the condition of these swamps.

## 3.2 Conant Swamp

### *3.2.1 Natural Communities*

Conant Swamp is the largest forested swamp in Thetford and the only one in the lowlands along the Connecticut River. Though not visited during the present inventory, this site has been assessed by NNHP. Conant Swamp actually consists of two different natural communities, a Red Maple-Black Ash Swamp and a Valley Clayplain Forest. This example of the Clayplain forest is the only site currently known in the Connecticut River valley (all others are found in the Champlain Valley). Both of these sites are considered state-significant natural communities.

### *3.2.2 Functions and Values*

Though not visited during this inventory, a functional analysis was conducted on this

wetland based on remote and previously existing data. The most significant function for this site is the high ranking it received for Exemplary Natural Community. This wetlands was also considered to be moderately significant for floodwater retention and water quality protection. Low significance was attributed to this wetland for wildlife habitat and erosion control.

### *3.2.3 Management Recommendations*

Since this site was not visited during the present inventory, no recommendations are presented here. The source of the original data may contain management recommendations.

## 3.3 Gillette Swamp

### *3.3.1 Natural Communities*

Gillette Swamp is a large wetland complex which includes 6 different natural communities and comprises a total of 52.5 acres. It is fed by two streams which flow through the Swamp and drain into the Ompompanoosuc River 1 mile to the south. As with many larger wetlands in this region, the presence of flowing water often leads to the establishment of beaver. The activity of beaver populations through the years tends to be a driving ecological force in these communities, creating times when the site is flooded alternating with times when the site is drained. At the time of the current inventory, the water level was fairly low, creating areas of "mud flat". Numerous braided channels, however, flow through most of the open and shrubby parts of the wetland complex.

The most typical wetland natural communities found occupying beaver influenced wetlands are Shallow Emergent Marshes and Alder Swamps. Both of these community types are present in Gillette Swamp, occupying most of the eastern and northern sides of the wetland complex. Sitting in the southwest corner of the wetland complex, is a Red Spruce-Cinnamon Fern Swamp. Once considered a variant of the Spruce-Fir-Tamarack Swamp, this community is characterized by a mixture of hemlock (*Tsuga canadensis*), black ash (*Fraxinus nigra*) and red spruce (*Picea rubens*) in the canopy. There is a sub-canopy and tall shrub layer composed of canopy species and a very diverse herbaceous layer. The most dominant herbaceous species are three-seeded sedge (*Carex trisperma*), cinnamon fern (*Osmunda cinnamomea*), but other species such as small enchanter's nightshade (*Circaea alpina*), goldthread (*Coptis trifolia*), dwarf blackberry (*Rubus pubescens*), and orange jewelweed (*Impatiens capensis*) are also present. There is a well developed hummock and hollow complex colonized by many species of moss and liverworts. These include *Thuidium spp*., *Mnium spp*., *Sphagnum squarrosum*, *Sphagnum centrale* and *Bazzania trilobata*.

The Intermediate Fen at this site occupies most of the western side of this wetland complex. This community is most commonly found on the shores of undisturbed ponds or other open water wetlands and is only infrequently associated with beaver wetlands. It is characterized by the accumulation of peat, in this case sedge peat, and the dominance of wire sedge (*Carex lasiocarpa*). Other species present in this occurrence include common bluejoint grass (*Calamagrostis canadensis*), bladder sedge (Carex vesicaria), and blue flag (*Iris versicolor*).

**Figure 2. The Intermediate Fen at Gillette Swamp is dominated by wire sedge.**

Scattered throughout the Intermediate Fen are a few shrubs of sweet gale (*Myrica gale*). These shrubs become more abundant further north in the wetland until the site grades into a Sweet Gale Shoreline Swamp community. As with the Intermediate Fen, the example of this community in Gillette Swamp shows sign of beaver influence. In addition to the typical dominance of sweet gale (*Myrica gale*), this site also has broad-leaved cattail (*Typha latifolia*), bladder sedge (*Carex vesicaria*), lakeshore sedge (*Carex lacustris*), steeplebush (*Spiraea tomentosa*), and scattered speckled alder (*Alnus incana*). In the north and east of this community, speckled alder becomes more dominant until the site grades into an Alder Swamp community.

The Intermediate Fen, the Sweet Gale Shoreline Swamp and the Hemlock-Balsam Fir-Black Ash Seepage Swamp are uncommon community types in the state. Using the NNHP ranking specifications, each of these communities at Gillette Swamp is considered a state significant natural community.

### *3.3.2 Functions and Values*

Taken as a whole, the Gillette Swamp wetland complex is significant for many functions and values. Being positioned along two streams that feed the Ompompanoosuc River, these wetlands are moderately significant for erosion control. These wetlands are also moderately significant for water quality protection. Both of these functions and the flood water retention function, however, are somewhat lessened due to the fact that it is a beaver influenced wetland. The hydrologic changes associated with these wetlands can positively impact their use by wildlife. Like other beaver wetlands, this complex is significant because it provides habitat to a wide variety of wildlife species. Finally, as described above, parts of this wetland are significant as Exemplary Wetland Natural Communities.

### *3.3.3 Management Recommendations*

The most pressing concern relating to the integrity of this wetland complex is the establishment of a small colony of phragmites (*Phragmites australis*) in the Intermediate Fen. Phragmites is a non-native, invasive species that can quickly become established in wetlands and choke out native vegetation. A large colony of this species would degrade the Intermediate Fen community and likely decrease its significance. Some effort should be made to control or eradicate this species. In addition, any development within 100' of these wetlands should be avoided. This buffer zone will help to ensure that the natural communities present maintain their integrity and that the functions and values that these wetlands perform are maintained. In the case of Hemlock-Balsam Fir-Black Ash Seepage Swamp, logging should not occur due to the presence of fragile soils.

Disturbing the soils in these sites can disrupt local hydrology of the wetland and open the site up to invasion by non-native plant species.

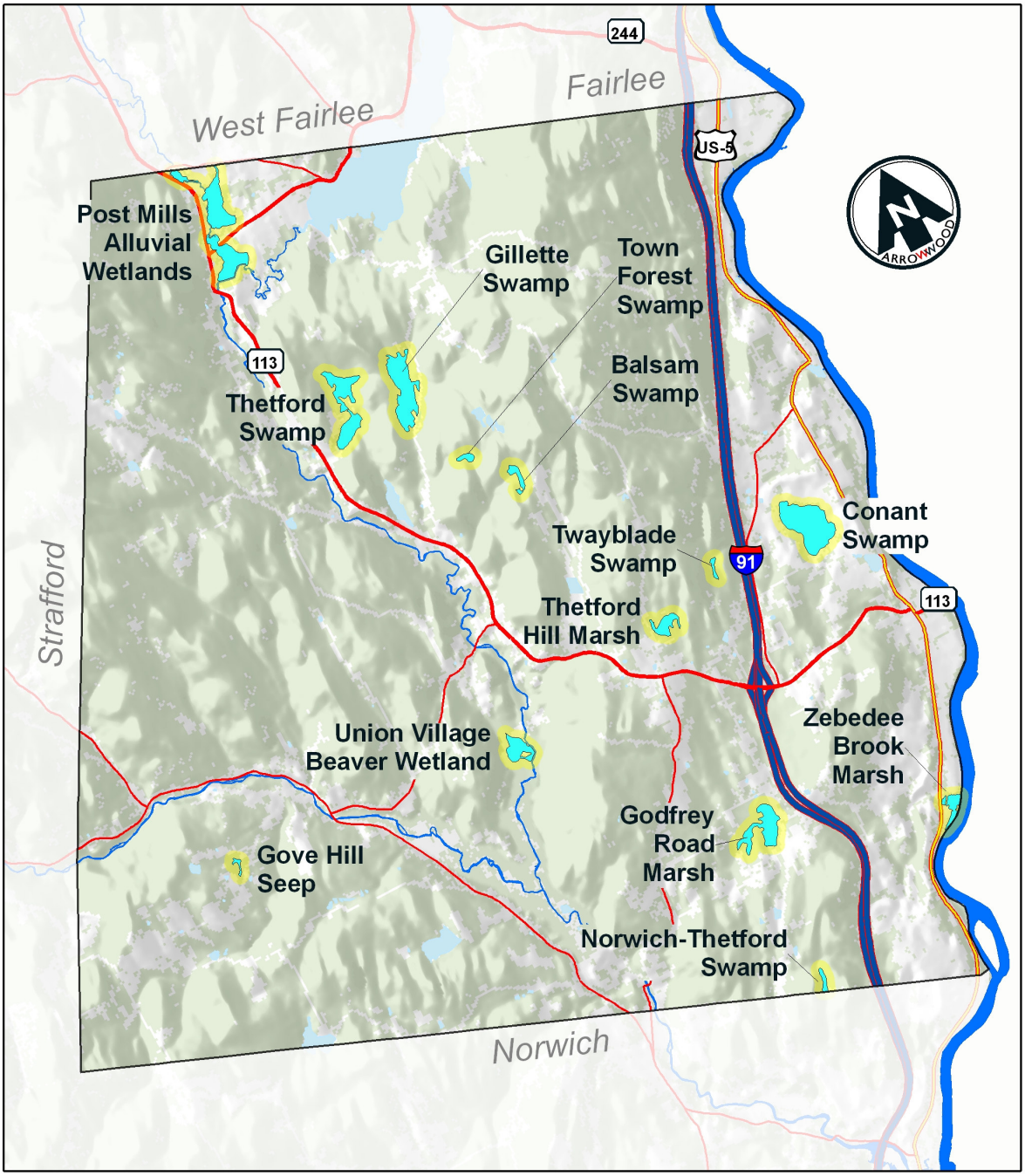


**Figure 3. Significant Wetlands in Thetford**

## 3.4 Godfrey Road Marsh

### *3.4.1 Natural Communities*

Godfrey Road Marsh consists of two different natural communities: an 11 acre Shallow Emergent Marsh and a large 22 acre Alder Swamp. Only a portion of this

large wetland was visited during the present inventory due to landowner permission constraints. The entire wetland is influenced by beaver activity which recently impacted Godfrey Road. The Shallow Emergent Marsh consists of a mixture of open water and herbaceous vegetation. Broad-leaved cattail (*Typha latifolia*), common tussock sedge (*Carex stricta*), and marsh fern (*Thelypteris palustris*) are all common. The open water areas are colonized by pondweeds (*Potamogeton spp.*) and bladderworts (*Utricularia spp.*) including uncommon species of both. The Alder Swamp is a diverse mixture of dense alder shrubs, areas of herbaceous vegetation, open water and braided channels. Some invasive species such as reed canary grass (*Phalaris arundinacea*) and Tartarian honeysuckle (*Lonicera tatarica*) are present on the edge of this shrub swamp. While these are good examples of beaver influenced wetlands, these community types are common in the state and neither are considered state significant natural communities.

**Figure 4. The Godfrey Road Shallow Emergent Marsh consists of a mixture of open water and herbaceous vegetation.**

### *3.4.2 Functions and Values*

Like many beaver influenced wetlands, the Godfrey Road Marsh displays a wide variety of wildlife habitat, from dense shrub thickets, to herbaceous marsh to open water. This diversity yields a site that is rich in wildlife and also can perform many functions and values including nutrient and sediment retention, floodwater control, and erosion control. As mentioned in the Gillette Swamp section, however, the presence of beaver dams can have a detrimental affect on downstream resources. This wetland is also significant as open space because of its visibility in town.

### *3.4.3 Management Recommendations*

The biggest management concern associated with the Godfrey Road Marsh is the recent problem with the flooding of Godfrey Road. Ultimately, a long term solution should be employed for managing beaver populations. Many techniques for managing beavers are presented in the document "Best Management Practice for Resolving Human-Beaver Conflicts in Vermont" (VT Fish and Wildlife, 2004).

## 3.5 Gove Hill Seep

### *3.5.1 Natural Community*

The Gove Hill Seep is a large Seep community situated along a small brook just east of Gove Hill. It is characterized by groundwater upwelling and a dense, fairly diverse herbaceous layer. The dominant species include rice cutgrass (*Leersia oryzoides*), rough-stemmed sedge (*Carex scabrata*), orange jewelweed (*Impatiens capensis*), sensitive fern (*Onoclea sensibilis*), great mannagrass (*Glyceria grandis*), and gynandrous sedge (*Carex gynandra*). There is also an occasional white pine (*Pinus strobus*) and

red maple (*Acer rubrum*) tree. The Seep appears to be in fairly good condition, though there are a few invasive Tartarian honeysuckle (*Lonicera tatarica*) around the edges of the community. Primarily because of its size, this seep is considered a state significant natural community.

**Figure 5. The Gove Hill Seep is dominated by rough-stemmed sedge and sensitive fern.**

### *3.5.2 Functions and Values*

This seep is considered significant for water quality, wildlife and erosion control.

### *3.5.3 Management Recommendations*

Because the soils in this community often remain wet throughout the year, they are very susceptible to disturbance from heavy equipment. Logging operations involving heavy equipment should maintain a 50 foot natural buffer around this (and other seeps) to prevent disruption of the soils. Disrupting the soils can change the local hydrology resulting in sedimentation of the water systems downstream. This has the potential of decreasing the wildlife habitat not only of the seep community but of the stream that is associated with the seep.

## 3.6 Norwich-Thetford Swamp

### *3.6.1 Natural Community*

The Norwich-Thetford Swamp straddles the Norwich-Thetford town line in southeastern Thetford. This is an example of a Red Maple-Black Ash Seepage Swamp which is similar to the Red Maple-Black Ash Swamp described in Wetland, Woodland, Wildland (Thompson and Sorenson, 2000). This swamp was not visited during the present inventory but was assessed in 2000 and determined to be a state significant natural community.

### *3.6.2 Functions and Values*

Though not visited during this inventory, a functional analysis was conducted on this wetland based on remote and previously existing data. The most significant function for this swamp is the high ranking it received for Exemplary Natural Community. This swamp also received a low ranking for wildlife habitat.

### *3.6.3 Management Recommendations*

Since this site was not visited during the present inventory, no recommendations are presented here. The source of the original data may contain management recommendations.

## 3.7 Post Mills Alluvial Wetlands

### *3.7.1 Natural Communities*

The Post Mills Alluvial Wetlands complex consists of 18 different wetlands made up

of 4 different wetland community types. These types include: Sugar Maple-Ostrich Fern Floodplain Forest, Spruce-Fir-Tamarack Swamp, Alluvial Shrub Swamp and Floodplain Forests. The one thing that all of the wetlands share is that they are associated with the Ompompanoosuc River. Because these sites were assessed previously, they did not obtain a field visit in the present inventory. These previous inventories (conducted by B. Engstrom) indicate that most of these floodplain communities are early successional and somewhat disturbed sites. None at this time are, therefore, considered significant natural communities.

**Figure 6. The Post Mills Alluvial Wetlands contain examples of Sugar Maple-Ostrich Fern Floodplain Forests.**

### *3.7.2 Functions and Values*

The real value in these wetlands, however lie in the functions that they perform on the landscape. All of these wetlands sit along the banks of the Ompompanoosuc River. The dense, persistent vegetation stabilizes the banks and prevents erosion. Being in this floodplain position, they also have the potential to attenuate floodwaters by providing an expandable basin. These wetlands also have the potential to filter out nutrients making them important for surface water protection (water quality). The association with the river along with the diverse wetland communities present makes this complex significant for wildlife and fisheries habitat.

### *3.7.3 Management Recommendations*

Since this site was not visited during the present inventory, no recommendations are presented here. The source of the original data may contain management recommendations.

## 3.8 Thetford Hill Marsh

### *3.8.1 Natural Communities*

Thetford Hill Marsh consists of a Cattail Marsh, a Deep Broadleaf Marsh and a small Red Maple-Black Ash Seepage Swamp. The two marshes present are part of a beaver-influenced wetland that forms the headwaters of Zebedee Brook. They are both very wet sites, with standing water common throughout the Cattail Marsh and the Deep Marsh, living up to it's name. The cattail marsh is a dense colony of broad-leaved cattail (*Typha latifolia*) and narrow-leaved cattail (*Typha angustifolia*) along with other mixed herbaceous species such as wool-grass (*Scirpus cyperinus*), common bluejoint grass (*Calamagrostis canadensis*), common tussock sedge (*Carex stricta*), and great mannagrass (*Glyceria grandis*). There is also a small population of an uncommon grass species, northern mannagrass (*Glyceria borealis*). The Deep Broadleaf Marsh is colonized by emergent vegetation such as broad-leaved arrowhead (*Sagittaria latifolia*) as well as floating aquatic vegetation such as white waterlily (*Nymphaea odorata*). Both of these community types are fairly common in the state. None of the sites here are

considered state significant natural communities.

**Figure 7. The Thetford Hill Marsh consists of a Deep Broadleaf Marsh and a Shallow Emergent Marsh.**

### *3.8.2 Functions and Values*

The combination of open water and dense wetland vegetation make these ideal wetlands for a wide variety of wildlife. By retaining waters from the stream that flows through these wetlands, they are able to protect surface waters from excessive nutrients and sediment, providing important water quality functions. Being associated with this stream, they also have functionality for erosion control and floodwater attenuation. Finally, because they are located on conserved land and surrounded by recreational trails, they are highly significant for recreation, open space and potentially significant for education.

### *3.8.3 Management Recommendations*

Sitting on conserved land, development of the nearby uplands does not appear to be a threat to these wetlands. The only management concern is the presence of a small population of purple loosestrife (*Lythrum salicaria*) in the Cattail Marsh. In addition, in the northern spur of this wetland (not accessed due to lack of landowner permission) it looks like there is a small colony of phragmites (*Phragmites australis*). Both of these species should be controlled at this site while the populations are still small and relatively manageable.

## 3.9 Thetford Swamp

### *3.9.1 Natural Community*

The Thetford Swamp wetlands consist of 5 different natural communities: Alluvial Shrub Swamp, Spruce-Fir-Tamarack Swamp, Shallow Emergent Marsh, Red Maple-Black Ash Seepage Swamp, and a Beaver Wetland. In terms of natural communities, the "Thetford Swamp" names refers only to the Red Maple-Black Ash Seepage Swamp, which is the only site in this complex that is considered a state significant natural community. This swamp has been assessed in the past by Brett Engstrom and ranked by NNHP (1999). Since that time, it appears that the size of the forested swamp has decreased while the size of the adjacent Beaver Wetland has increased. What remains of this forested swamp, however, is in fairly good condition. It is dominated by black ash (*Fraxinus nigra*) and red maple (*Acer rubrum*) with lesser amounts of hemlock (*Tsuga canadensis*) in the canopy. Young balsam fir (*Abies balsamea*) regeneration is common. There is a diverse herbaceous layer consisting of cinnamon fern (*Osmunda cinnamomea*), dwarf blackberry (*Rubus pubescens*), bladder sedge (*Carex intumescens*), and wood horsetail (*Equisetum sylvaticum*), among others. The combination of size, community condition and landscape make this a B-ranked swamp and therefore a state significant natural community.

**Figure 8. Thetford Swamp is dominated by black ash and cinnamon fern.**

### *3.9.2 Functions and Values*

While the hardwood swamp community of this wetland complex (described above) is most significant as an Exemplary Natural Community, the rest of the wetlands in this complex are significant for many other functions. In particular, the combination of open water beaver wetlands with herbaceous and shrubby vegetation (in the Shallow Emergent Marsh and Alluvial Shrub Swamps) make this complex highly significant as wildlife habitat. It is also low-moderately significant for water quality, floodwater storage and erosion control. As mentioned in the Section 2.3, since this is a beaver influenced wetland, these later functions are somewhat lessened.

### *3.9.3 Management Recommendations*

Most of the wetlands in the Thetford Swamp complex are, or have been in the past, influenced by beaver activity. These are dynamic wetland systems which constantly change through the years from open water to marsh to swamp and back to open water. This cycle is valuable to a wide variety of wildlife, which is the most significant function for these wetlands other than the Red Maple-Black Ash Seepage Swamp. Any activity that would disrupt this cycle, disrupt the hydrology of the wetland system or negatively affect its functions should be avoided. For the Red Maple-Black Ash Seepage Swamp, this includes any activity that would degrade the condition of the natural community. Logging within this swamp can be done in a relatively non-intrusive manner. Given the difficultly of doing this and the decreasing size of this swamp, however, it is recommended that logging be excluded from the borders of this wetland.

## 3.10 Twayblade Swamp

### *3.10.1 Natural Communities*

Twayblade swamp is a relatively small, 3 acre swamp that sits at the headwaters of a small stream. Surrounded by a forested matrix, this swamp appears to be undisturbed and in excellent condition. This is a Red Maple-Black Ash Seepage Swamp which is considered a type of Red Maple-Black Ash swamp as described in Wetland, Woodland and Wildland (Thompson and Sorenson, 2000). It is dominated by black ash (*Fraxinus nigra*) with lesser amounts of hemlock (*Tsuga canadensis*) and red maple (*Acer rubrum*). The understory is mostly a sea of cinnamon fern (*Osmunda cinnamomea*). Smaller amounts of other herbs are also present, including the beautiful orchid Loesel's twayblade (*Liparis loeselii*), for which this swamp is named. Hummocks and hollows are well developed in this swamp, with standing water common in the hollows and in the lag around the margins of the swamp.

A diverse moss layer consisting of *Thuidium spp.*, *Bazzania trilobata*,

*Rhytidiadelphus triquetrus*, *Mnium spp*., and *Calliergon sp.* is also present. The condition of the natural community, its landscape setting and its size combine to make this a B-ranked example of this community. This swamp is therefore considered to be a state significant natural community.

### *3.10.2 Functions and Values*

Because of its state significance status, Twayblade swamp is highly significant for the Exemplary Wetland Natural Community function. In addition, Twayblade Swamp also has a low-ranking significance for wildlife habitat, erosion control and water quality.

### *3.10.3 Management Recommendations*

In order to protect the fragile soils in this swamp, logging activity should be excluded. Improper logging can create ruts which can disrupt the local hydrology. It can also create areas of exposed soil which can lead to invasion by non-native invasive species. Either of these disturbances would lead to a degradation of the condition of the swamp.

## 3.11 Union Village Beaver Wetland

### *3.11.1 Natural Communities*

This wetland was not visited during the present inventory but was assessed in 2000 as part of an inventory on Army Corps of Engineers land. At that time, this site contained a Sedge Meadow, Shallow Emergent Marsh, Alder Swamp, Cattail Marsh, and a floating leaved aquatic wetland. Though none of these communities was considered state significant, they were considered locally significant for their functions and values.

### *3.11.2 Functions and Values*

Those functions and values include excellent wildlife habitat in the wide diversity of wetland types present. The Beaver Wetland is also ranked high for rare species function because of a population of a threatened plant found there. These wetlands also have moderate function for erosion control, open space, floodwater storage, and water quality.

### *3.11.3 Management Recommendations*

Since this site was not visited during the present inventory, no recommendations are presented here. The source of the original data may contain management recommendations.

## 3.12 Zebedee Brook Wetlands

### *3.12.1 Natural Community*

The Zebedee Brook Wetlands sit at the confluence of Zebedee Brook and the Connecticut River. The Zebedee Brook watershed is fairly large, and includes drainage from the Godfrey Road Marsh and the Thetford Hill Marsh. In comparison, the Zebedee Brook wetlands are rather small, totaling only 10 acres. But their position on the shores of the Connecticut River makes them important for many functions and values. There are three different natural community types that comprise the Zebedee Brook Wetlands: Shallow Emergent Marsh, Deep Broadleaf Marsh and Alder Swamp. Being surrounded by roads, agricultural fields and railroad tracks, these wetlands are not in a pristine, undisturbed state.

They have been fragmented, hydrologically altered and likely differ dramatically from their original state. Invasive species are present in each of these wetlands-most notably phragmites (*Phragmites australis*) colonies in the Deep Broadleaf Marsh. These wetlands are therefore not considered significant for the quality of the natural communities present.

**Figure 9. The Zebedee Brook Shallow Emergent Marsh gets flooded by the Connecticut River during high water events.**

### *3.12.2 Functions and Values*

Despite the disturbances described above, these wetlands still perform a wide variety of functions and values. They are one of the few wetland complexes remaining in Thetford that sits on the banks of the Connecticut River. This factor combined with the physical and biological characteristics make them significant for surface water protection, flood water storage, wildlife habitat, rare species habitat, fisheries, recreation and erosion control. The combination of open water and emergent vegetation make many parts of this wetland complex ideal for a wide variety of fish and wildlife and for filtering out sediments and nutrients from surface waters before they reach the Connecticut River. The dense, persistent vegetation along Zebedee Brook and the Connecticut River helps to prevent erosion along those banks. Finally, a species of rare plant was discovered in these wetlands which was not previously known on the Connecticut River in Vermont, making this wetland significant as rare species habitat.

### *3.12.3 Management Recommendations*

The most significant threat to these wetlands now is the existence of the invasive species. As mentioned above phragmites (*Phragmites australis*) has colonized a large part of the Deep Broadleaf Marsh. It has become fairly well established and may be very difficult to eradicate, especially since new propagules can become introduced from the Connecticut River or Zebedee Brook. In addition to the phragmites, other species such as purple loosestrife (*Lythrum salicaria*), European buckthorn (*Rhamnus frangula*), multiflora rose (*Rosa multiflora*) and reed canary grass (*Phalaris arundinacea*) are established in the other wetlands in this complex. The purple loosestrife, rose and buckthorn all appear to be in relatively low abundance. If there are resources to apply to the eradication of invasive species at this site, they may be best spent on these species. Finally, as mentioned above, these wetlands have seen a fair bit of disturbance in the past. Further disturbance may affect their ability to perform the above mentioned functions and should be avoided. This should include a 50' protected buffer from the wetland boundary.

## 3.13 Vernal Pools

### *3.13.1 Natural Communities*

As mentioned above, Vernal Pools are the only natural community in Vermont that is classified by the wildlife that use them. Using the NNHP ranking guidelines, two Vernal Pools that were assessed in Thetford were determined to be state significant pools. Both of these sites were used extensively by spotted salamanders (*Ambystoma maculata*) and wood frogs (*Rana sylvatica*). They also appeared to be undisturbed and were located in a natural forest matrix. Other vernal pools that are included on the attached inventory map may also warrant the state significance designation, however a lack of adequate data may have prevented such a ranking.

### *3.13.2 Functions and Values*

Both of these sites rank high for the wildlife habitat that they provide.

### *3.13.3 Management Recommendations*

The goal of vernal pool management is to maintain the ecological integrity of the pool. Since the ranking of the pool is, in a large part, based on the wildlife that use the pool, the management of vernal pool ecosystems consists of protecting the actual pool and properly managing the surrounding forested landscape. For this reason, the management recommendations presented for Vernal Pools are more detailed than those presented for other wetland types.

Similar to other wetlands, the actual boundary of the vernal pool should be excluded from any disturbance or development. Unlike other wetlands, however, vernal pools essentially "disappear" during the dry summer months and can be inadvertently impacted. In addition to avoiding disturbance to the actual pool, certain management protocols should be considered for the buffer zones of vernal pools. These recommendations take into account that most of the life cycle of the amphibians that reproduce in the vernal pools actually takes place in the surrounding upland landscape.

As can be seen on the Figure (10) below, there are two buffer areas around each vernal pool. These buffer distances are based on the work of Semlitsch (1998), Calhoun and Klemens (2002), Calhoun and deMayandier (2004). The first buffer distance is 100' in diameter and is important because the density of amphibians within this area is very high both during the spring breeding period and the fall juvenile dispersal period. The nature of the forest immediately around the vernal pool has a tangible affect on the nature of the pool itself. Shading from surrounding trees can drastically prolong the hydroperiod of a pool. In addition, leaf litter that enters the pool from the surrounding trees forms the basis for the food chain in the vernal pool ecosystem.

The condition of the forest in this 100' buffer zone is therefore strongly linked to the condition of the vernal pool itself. For this reason, it is recommended that the vernal pool envelope be managed in a way that will not interfere with the functioning of the vernal pool. This includes maintaining a complete forested cover within this envelope. Light thinning of forest trees is, in most cases, acceptable but should come no closer than 25' to the pool's edge. Since many amphibians require a dense leaf litter on the forest

floor with un-compacted soils, logging should occur when the soils are frozen and there is adequate snow cover. The creation of ruts in this area can often disrupt the hydrology of the nearby vernal pool. Development and other barriers to amphibian movement should be avoided within this buffer zone.

The next buffer shown in the Figure is calculated at 750' from the vernal pool

habitat. This is termed the "amphibian life zone" or the "critical terrestrial habitat". As mentioned above, amphibians that breed in vernal pools spend most of their adult lives in the forests surrounding their natal pools. These amphibians require a forest with dense leaf litter, decomposing woody
debris, un-compacted soils, and adequate canopy cover. Calhoun and Klemens (2002) recommend maintaining 75% forested cover within this life zone to retain adequate habitat for forest dwelling amphibians. If logging is to occur in this area, it should occur in the winter when the ground in frozen and there is adequate snow cover. Ruts that occur in the life zone can fill with water and create population sinks as amphibians lay eggs in the ruts and never reach the more reliable vernal pool. Compaction of the soil can also result in direct loss of habitat for mole salamanders.

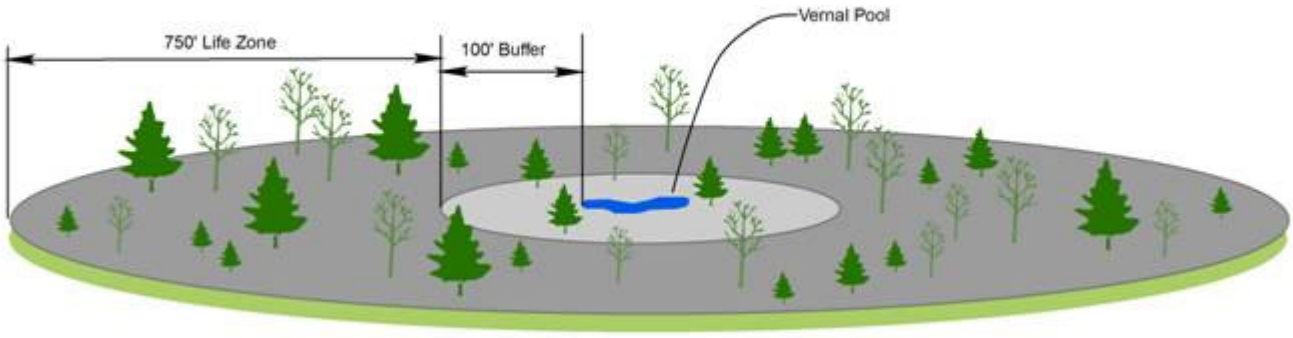


**Figure 10. Vernal Pool Buffer Zones**

## 4.0 The Vermont Wetland Rules

In 2010, the Vermont State Legislature adopted new Wetland Rules to replace the rules originally adopted in 1990. According to the old rules, a wetland was under the purview of the Vermont Wetlands Office if it was a Class II wetland or contiguous to a Class II wetland. A Class II wetland was defined as something that appeared on the Vermont Significant Wetlands Inventory (VSWI) maps. Under this system, changing the "Class" of a wetland (from Class III to Class II for example) was a complicated process involving a determination by the Water Resources Board. Under the new rules, however, "the secretary determines [the wetland] to merit protection…based upon an evaluation of the extent to which it serves

the functions and values…". This means that changing the Class of a wetland can be done within the Agency of Natural Resources. Furthermore, the justification for the change can be based on the wetland performing certain functions or values. The new rules also include a list of wetlands that are "presumed significant". These include: that any wetland that is contiguous to a Class II wetland, any wetland that is the same type and threshold size as those mapped on VSWI maps, any wetland with persistent vegetation along a stream or river, vernal pools with amphibian breeding habitat, headwater wetlands, and wetlands adjacent to impaired surface waters. For a complete list and actual wording, refer to the VT Wetland Rules adopted July 16, 2010.

Because a determination of jurisdiction (and therefore protection by the State) will, in many cases, be based on the presence of functions and values, the functional analysis associated with this inventory may be useful for those wetlands that are not already on the VSWI map. It must be noted, however, that only a representative from the Vermont Wetlands Office can make an official determination about the Class of a wetland. The functional analysis, therefore, is to be used as a guide or a starting point from which further field-based information must be obtained, especially in the case of proposed develop in the wetland or buffer zone. For a more detailed discussion of the functions and values assessment presented as part of this inventory, please refer to Section 5.0 in the Methodology.

# 5.0 Methodology

The Wetland Inventory and Assessment in Thetford project includes the identification, inventory and assessment of wetlands in the town of Thetford, Vermont. The inventory was conducted from February 2010 to January 2011. The methodology used in mapping and assessing wetlands is outlined below. This methodology section is organized into two sections. The first section details the methods used in remotely mapping and assessing wetlands as well as a brief explanation of the techniques used to collect data for field-visited wetlands. The second section gives an overview of the ranking procedures used in assessing wetland significance.

## 5.1 Wetland Mapping and Assessment

For the purposes of this inventory, a wetland is defined as an area that is inundated by surface or ground water with a frequency sufficient to support organisms that depend on saturated or seasonally saturated soil conditions for growth and reproduction. For any particular site to be considered a jurisdictional wetland, there needs to be the following three criteria present: 1) hydrophytic (wetland) vegetation, 2) hydric soils, and 3) wetland hydrology. The boundaries of wetlands cannot be determined and/or delineated remotely. The boundaries present on the attached inventory map are for planning purposes only; detailed fieldwork is required to determine the actual presence and extent of wetlands. The field work conducted during this study did not attempt to formally delineate the boundaries of any wetlands.

### *5.1.1 Remote Wetlands Mapping*

The landscape analysis represents the first step in conducting an inventory of a Town's wetlands. As part of this Phase, Arrowwood Environmental (AE) identified and mapped the wetlands in Thetford through a comprehensive review and interpretation of available paper and digital resource inventories, maps and photographs.

Information sources that were reviewed during the landscape analysis process include: 1:40,000 Color Infra-Red aerial photographs, Natural Resources Conservation Service soil survey maps, 2000s Orthophotography (black and white), 2009 National Aerial Imaging Program (NAIP) Color ortho photos, Vermont Significant Wetlands Inventory maps and U.S. Geological Survey (USGS) topographic maps.

In general, the process for identifying and mapping wetlands starts with the Color Infra-Red aerial photographs (CIR photos). Wetlands identified from the CIR photos were transferred directly to a digital wetlands database created in an ArcGIS platform using the digital Orthophotographs as a base map. Polygon lines (approximate wetland boundaries) were drawn in this digital wetlands map using common landscape features present in both the CIR photos and the digital Orthophotographs. The digital Natural Resource Conservation Service (NRCS) soils maps, Vermont Significant Wetlands Inventory (VSWI) maps, and U.S. Geological Survey (USGS) topographic maps were also consulted during this inventory. As each wetland was mapped, it was given a preliminary natural community name based on Wetland, Woodland, Wildland. A Guide to the Natural Communities of Vermont (Thompson and Sorenson 2000). Each of the data sources that were used during this inventory is described in detail below.

**1:40,000 NAPP Color Infra-Red Aerial Photographs (CIR)**

The CIR photos were the main data source used to identify wetlands for this inventory. The data sources described below were used to verify or confirm wetlands discovered using the CIR photos. This set of aerial photographs was flown in the spring (April-May) of 1992-1993 at a scale of 1:40,000. These are "false color" photos which combine infrared reflectance with the green and red visible bands. These photos were examined at 3X magnification under a stereoscope. The use of the stereoscope allows the photos to be viewed in three dimensions, thus enabling the interpreter to see elevation. These photos have proven to be the most useful tool for remotely identifying wetlands in Vermont. When evaluating aerial photographs, the most important characteristic is the "photosignature". The photosignature is the way that a feature, in this case a wetland, presents itself on the photograph. Water on the CIR photos presents a very clear, dark photo signature that is distinct from most other features in the photos.

Many wetlands, however, do not have standing water and the wetland photo signature may be unclear. In some cases, it was possible to confirm the presence of a wetland at these sites by using one of the other wetland data sources. At other sites, it was not possible to confirm or deny the presence of a wetland. In these cases, the site was included in the wetlands map but with a lower confidence level. Because there is some uncertainty associated with remotely mapping wetlands (particularly

small wetlands), the "Confidence" rank is meant to track that potential error.

**Vermont Significant Wetlands Inventory Map (VSWI)**

The VSWI map is based on the National Wetlands Inventory Map (NWI) and is used as the standard regulatory wetlands map for Vermont by the State Wetlands Office. In many cases, the location of the wetland from the VSWI map is inaccurate and does not reflect the actual location of the wetland. Using the CIR photos and other map sources, these locations were corrected on the town Wetlands Inventory Map. In most instances, the wetlands on the VSWI map are indeed wetlands. There are a few instances where information from other map sources suggests that the site is not actually a wetland. If a particular site did not appear to be wetland based on other sources, it was not included on the final wetlands map.

All wetlands that appear on the VSWI are considered Class II wetlands, as defined in the State of Vermont Wetland Rules. These wetlands are offered a certain amount of regulatory protection. Because remote sources cannot determine if one wetland is hydrologically connected to another wetland, the classification of the wetlands identified was not included in this inventory. However, all wetlands that are indicated to be VSWI wetlands in the wetland map can be considered Class II wetlands.

**USGS Topographic Maps**

The USGS topographic maps were used as a secondary map source to better understand a wetlands position on the landscape. The topographic position can give insight to the nature of a wetland and the potential for wetlands to occupy certain areas.

**1:5,000 Digital Orthophotographs**

Orthophotographs are 1:5000 aerial photographs that are geo-rectified and, in the case of this inventory, used in a digital format. Unlike the CIR photos, the photo signature of wetlands in orthophotographs is often unclear. Orthophotographs are important, however, because they are digitized and geo-rectified. This allows the photo interpreter to accurately (and digitally) map a wetland that was identified from the CIR aerial photos. These orthophotographs were therefore used as a base map and all mapping of wetlands was done based on common landscape features present in these photographs and the CIR photos.

**Natural Resource Conservation Service (NRCS) Soil Survey**

A digital copy of the Orange County Soil Survey was used during this inventory. A map of all hydric soils in the town was used to identify areas that may contain wetlands. The hydric soils in the town consisted of the following soil types: Cabot, Limerick, Peachum, Raynham, Muck (unclassified) Saco and Walpole soils. Each soil type forms under different environmental conditions and can give clues to the nature of the wetland or potential wetland site.

As mentioned above, the presence of a wetland is dependent on hydric soils, wetland hydrology and wetland vegetation. Some areas of hydric soil, therefore, are not wetlands. Wherever hydric soils were present, other remote data sources were used to determine if the

site likely contained a wetland. In many circumstances, other data sources led to the conclusion that wetlands occurred only in part of the hydric soil area. In these cases, polygon lines were redrawn to reflect probable wetland boundaries. The NRCS hydric soils boundary and the approximate wetland boundary are therefore not identical. In most cases, the wetland areas are smaller than the hydric soil areas.

### *5.1.2 Remote Wetland Functions and Values Assessments*

Wetlands were assessed remotely utilizing information available from existing digital and paper databases. Eight functional criteria were used in remotely assessing the wetland resources in the study area. Each of the identified wetland areas was evaluated for the presence of factors that would indicate that the wetland was serving a significant function as a productive ecosystem and/or a public resource. The wetland assessment methodology integrates information about a wetland's soils, vegetation, shape and size, habitat diversity and position in the landscape to produce a composite picture about a wetland's role in the larger ecosystem. The functional criteria assessed are described in detail in Section 5.2.2.

## 5.2 Field Assessments

Field assessments of selected wetlands were conducted during the 2010 field season. The purpose of the field inventory was to assess the accuracy of the remote wetlands identification procedure and to obtain more in depth data about a wetland's natural community type and functions and values. Wetlands selected for a site visit were chosen with the intent of visiting a cross-section of wetlands in terms of natural communities, functions and values, and remote mapping confidence. Landowner permission for conducting field visits was obtained by the town of Thetford. Letters describing the project and requesting permission were sent to every landowner in the town.

### *5.2.1. Natural Community Assessments*

Each wetland that was visited received a natural community assessment. This assessment involves collecting data on wetland soils, vegetation structure and composition, topographic position and other relevant ecological information. Special attention was paid to noting factors that may degrade the quality of the wetland community such as invasion of exotic plants, disruption of local hydrology, surrounding land-use or direct development in the wetland. Together, this information was used to assign each community visited a final natural community name and to give information about the current condition of the community.

### *5.2.2. Field-Based Functions and Values Assessment*

Each wetland that obtained a field visit also received an in depth functions and values assessment. The assessment involves evaluating a wetland based on its vegetation, hydrology, habitat diversity, topographic position, shape, size and position in the watershed for select functions and values. The Vermont Wetland Evaluation Form, US Army Corps of Engineers Highway Methodology Handbook and Golet Model Wetland Evaluation Form were used as

guides for establishing the functions and values criteria. As a result of the assessment, each wetland is given a functional score based on a scale of low/medium/high. Each visited wetland was assessed for the following functions and values:

1. Storage for Flood Water &/or Storm Runoff (Flood Control)
2. Surface and Ground Water Protection (Water Quality)
3. Wildlife Habitat
4. Fisheries Habitat
5. Erosion Control through Binding and Stabilizing Soil
6. Exemplary Wetland Natural Community
7. Rare, Threatened or Endangered Species Habitat
8. Open Space & Aesthetics
9. Recreation Value and Economic Benefits
10. Education & Research in Natural Sciences

The following is a description of how wetlands perform the specified function and/or value listed above. The functional assessment is based upon whether the wetland has the capacity for the function or value and whether there is an opportunity for the wetland to perform the specific function or value

**Storage for Flood Water &/or Storm Runoff**

Wetlands that retain and slowly release floodwaters are usually associated with streams or rivers. In order for a wetland to perform this function, there must be an expandable basin present in the wetland that allows room for the floodwater to disperse. This expandable basin and the presence of persistent vegetation have the effect of slowing the water down and diffusing the energy of the floodwater.

The most significant wetlands for this function are located upstream of significant natural resources or human resources such as developed areas, culverts, and roads. In these circumstances, the upstream wetlands may be protecting these resources from floodwaters, such that any activity that impairs the wetland's ability to perform this function will often have serious impacts to downstream resources.

**Surface and Ground Water Protection (Water Quality)**

Many wetlands filter sediments and nutrients, such as phosphorus and nitrogen, from surface waters resulting in improved water quality. Wetlands that retain nutrients generally have diffuse or sinuous drainage pathways which slow down the flow of water. Slower water velocity provides more opportunity for sediments and nutrients to settle out and to be absorbed by vegetation. The velocity of the water moving through a wetland is determined by slope, landscape position and the outlet conditions in the wetland. Wetlands with constricted outlets generally have much slower water velocities and greater potential for sediment and nutrient removal. The presence of persistent vegetation is also important for slowing down water velocities.

The water quality function takes on particular importance in impaired watersheds where surface water and its uses are diminished. The opportunity for a particular wetland to perform this function is determined by the presence of agricultural lands, urban impervious

surfaces, steep slopes, and areas of impaired water quality. Wetlands that recharge a wellhead protection area or contribute to the flows of Class A surface water may also be of particular importance.

**Wildlife Habitat**

Wildlife use of wetlands is widely variable and dependent upon the size, diversity and structure of the wetland. In general, the wetlands that are the most valuable for wildlife are those that have multiple community types, greater vegetative diversity, some open water and multiple layers of vegetation. The interspersion of the open water and different vegetation cover can also be important for determining wildlife use. In general, a greater diversity of wildlife is often found in wetlands that have open water that is extensively interspersed with vegetation. The interspersion of different vegetation or cover types is also important.

Large wetlands, with ample space and a variety of food and cover resources often harbor a greater diversity of wildlife. Smaller wetlands are also important for wildlife when viewed not as individual wetlands but as groups or clusters of wetlands on the landscape. These smaller wetlands often work in concert to provide habitat for species that utilize several different wetlands throughout their weekly or yearly movements on the landscape.

**Fisheries Habitat**

The fisheries function is determined primarily upon a wetland's connection to a permanent surface water that could provide fish habitat. Wetlands that are associated with these permanent surface waters can increase the fisheries habitat by: 1) providing pools and refugia during periods of low water; 2) providing shade to the surface waters thereby lowering the temperature of the water (which is crucial to some species of fish); 3) providing stream bank stability thereby decreasing the amount of river clogging sediments in the water system; 4) providing undercut banks which offer spawning, nursery, feeding and cover habitat for fish and; 5) providing an input of cool, clean spring water into the surface water system.

**Exemplary Wetland Natural Community**

The exemplary wetland natural community function is meant to evaluate whether or not wetlands may harbor significant natural communities or vegetation. In general, wetlands of rare or unusual types, such as bogs, fens, alpine peatlands or black gum swamps are considered significant for this function. Also, any wetland which contains the best example of a particular natural community in the county or region is considered significant for this function. For the purposes of this study, any site that was considered locally or state significant was also considered significant for this function.

In addition to natural communities, the Exemplary Wetland Natural Community function is meant to assess if the wetland contains rare or uncommon plants. Any wetland that harbors a rare plant or a plant at its range limit may be considered significant for this function.

**Rare, Threatened and Endangered (RTE) Species Habitat**

The presence of the RTE function is determined based upon the presence of a

Federal or State listed Threatened and Endangered species of plant or animal. This includes the historic (within the last 10 years) presence of a rare element in the wetland. The opportunity for this function is based on the presence of appropriate habitat for RTE species. Wetlands were scored high for this function if a rare species is known to occur there. In some cases, wetlands in this study were given a low score for this function if the habitat was appropriate for RTE species.

**Erosion Control through Binding and Stabilizing Soil**

Many wetlands located in areas where erosive forces are present are important for this function. This includes wetlands along rivers and streams and wetlands along lakes and ponds where there is enough fetch to produce erosion along the shore. In Thetford, wetlands found along streams with at least seasonally heavy, erosive flow are most important for this function. This tends to occur at low to middle watershed positions. The most important element in a wetland significant for this function is the presence of persistent vegetation, especially woody vegetation such as trees and shrubs. The roots of this vegetation act to bind the soil and prevent it from eroding. Wetlands that perform this function upstream of biologically significant areas such as spawning habitat, significant natural communities, or RTE element sites are very valuable.

**Open Space & Aesthetics**

The Open Space function is determined primarily by a wetland's position in the landscape in relation to ease of public viewing. Wetlands that can be readily viewed by the public such as those on public lands or along the road network are often significant for this function. These wetlands are important because they enhance the likelihood of observing wildlife and colorful wildflowers. Open space becomes a particularly important function in more developed areas.

**Recreation Value and Economic Benefits**

The recreation function is determined based on the presence or likelihood of recreational activities occurring within the wetland or wetlands that provide economic benefits. This includes wetlands that provide habitat for species that can be fished, hunted or trapped and/or the presence of wild foods that are harvested.

**Education & Research in Natural Sciences**

Wetlands that are significant for Education and Research are generally those that have a history of use for these purposes or have the real potential to be used for these purposes. Publicly owned wetlands, wetlands with unique features and wetlands with RTE species are characteristics that may make a wetland significant for this function.

### 5.3.3 Public Access Assessments

As part of the inventory process, information on wetland boundaries and natural community types was gathered from points of public access such as public roads. Observations from this survey were used to help refine the wetland inventory map. Data on the wetland natural communities, functional assessment information and wetland boundary information were collected. This assessment is an abbreviated version of the

natural community and functions and values evaluations described above.

### 5.3 Wetlands Map Creation

Once fieldwork was concluded, field data was compiled and integrated into the Wetlands Inventory Map. This involved adding wetlands that were discovered during the field inventory, changing wetland boundaries on the map and removing sites that were determined not to be wetlands. Data from the field visits were also incorporated into the digital attribute table which is linked to the map. The final map also includes data from previous wetland and natural community inventories conducted in the town. The information included in the attribute table is provided in an Excel spreadsheet format on the project CD.

## 6.0 Ranking for Biodiversity Conservation

Determining the local or state significance of natural features occurs after all of the field work is completed and the final maps are compiled. The local or state significance methodology is based on the system used by the Vermont NonGame and Natural Heritage Program. For natural communities this methodology takes into account the rarity, size and condition of the community as well as the quality of the landscape that the community exists in.

The state has a system of rarity rankings that are based on a numeric system of 1-5 (from rarest to most common). This rank is usually preceded by an "S" to indicate that the rank is on the state-wide scale. This ranking is assigned to each community type as a whole and does not refer to specific examples of the community. This rarity ranking is included in the database in the "State_Rank" field and is based on the following system:

S1 Very Rare (1-5 occurrences)
S2 Rare (6-20 occurrences)
S3 Uncommon (> 20 occurrences)
S4 Apparently Secure
S5 Demonstrably Secure

Particular occurrences of communities are ranked based on the conditions present on the site. As mentioned above, the factors that determine the rank of a particular community include its condition, size and condition of the landscape. This alphabetic ranking (A-D) is included in the database in the "EO_Rank" (Element Occurrence) field. In most cases, sites that did not receive a field visit were not ranked. In some cases, assumptions were made about particular communities based on field work in nearby sites and remote sources.

For many natural communities, the ranking methodology allows for multiple communities to be grouped together and ranked as a single unit. Multiple communities of the same type which are separated by short distances on the landscape may be considered as one "element" when ranking. The grouping of some of these communities is shown in the "SiteName" field.

Once particular communities are ranked, the Element Occurrence ("EO_Rank" field) is compared to the State rarity rank ("State_Rank" field). A community would be considered state significant if the following criteria are met: S1 or S2 communities with an EO rank of A, B or C; S3 or S4 communities with an EO rank

of A or B; S5 communities with an EO rank of A. These guidelines are considered in conjunction with professional judgment and knowledge about the site.

Local significance is determined in two different ways. The first method follows the methodology of determining state significance but puts the community in a local perspective. Local geology, biophysical region, size and condition of the community all play a role in determining local significance. All communities that were considered to be state significant, are also considered locally significant. In addition, any community that does not meet the criteria for state significance but is considered to be significant on the town scale, is labeled as locally significant.

The second method for determining local significance is assessed in terms of functions and values. Wetlands that are performing a wide variety of functions or values on the landscape are also considered to be significant. During the functions and values analysis, these sites must rate high for multiple criteria to be considered locally significant. The reason for assigning local significance (because of natural community or functions and values) is listed in the "Justification" field of the attribute table.

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