

INVENTORY AND ANALYSIS OF WATERSHED RESOURCES

Inventory and Analysis of Watershed Resources

Watershed Description

Berry's Brook Watershed comprises an area of 3,802 acres in four (4) seacoast communities -- Greenland, North Hampton, Portsmouth and Rye. The brook is 6.2 miles long beginning at its headwaters in the Breakfast Hill area of Greenland and flowing northeasterly along the Portsmouth - Rye border becoming Seavey Creek as the waters begin to mix with saline waters before discharging into Little Harbor near the bridge on Pioneer Road.

The Berry's Brook system is a relatively small but important estuary; one of many that border the Gulf of Maine. As an estuary it is a significant functional ecosystem because of the generic characteristics shared by all water bodies that join land and fresh water with the marine environment; they contribute basic nutrients to the marine environment, aid in dispersion of terrestrial derived wastes, provide habitat for uniquely adapted plants and animals, and act as a breeding and nursery area for many marine species.

Estuaries are also a valuable transitional area that contain species that are in evolutionary flux from the saline coastal waters to brackish waters. Important fisheries exist in many estuaries and, beyond the estuary itself, there are both nutritional and life stage links with coastal marine fisheries. All these recognized estuarine ecosystem values are found in Berry's Brook. In addition to these actual values, although slight in a global sense, estuaries have benefit as an instructional tool for the educational objectives that are part of this plan. While it is difficult to measure quantitatively the positive contributions of Berry's Brook to the Gulf of Maine and to the terrestrial watershed area it drains, it should be recognized for its long term value to the marine environment.

The Watershed is an area of great natural beauty and is a valuable ecosystem that contains an extensive wetland system that includes upland drainage, feeder tributaries, Bellyhack Bog, nine (9) potential Prime Wetland areas, an estuary and tidal marsh. At present, it is the most pristine watershed/wetland complex in the four-town area. It has a diversity and abundance of plant and animal species, including a number that are rare, endangered or threatened, such as the Atlantic white cedar. The Watershed offers great recreational opportunities from hunting and fishing to cross-country skiing, bird-watching and ice skating. There are also two (2) historic mill sites -- Seavey Mills 1 and 2 just below Sagamore Road.

The New Hampshire Coastal Resources Management Program (1979) and the Rye Master Plan (1985) have identified the watershed and its wetland system as an unusual coastal resource, because of the rare plant species found along the banks of the brook, such as spice bush and Atlantic White Cedar and the brook's sea run brown trout. The Portsmouth Open Space Plan (1972) has identified this area as one of several in Portsmouth "accorded high ecological values because they contain unique or significant ecological communities." The Conservation Master Plan for the Town of Rye (1978) declares that "the Berry's Brook - Bellyhack Bog ecosystem is the largest wilderness watershed in the Town of Rye".

Thus, by all accounts the Berry's Brook Watershed is a unique natural system. In spite of the recognition of this resource as a high quality ecosystem, there have been and continue to be, impacts from real estate development and inappropriate land use activities. These threats to the natural integrity appear to be associated with developments such as those along Lafayette Road, Lang Road and Liberty Common off Wallis Road, where watershed resources such as wetlands have been directly impacted.

For purposes of this study only Greenland, Portsmouth, and Rye were included in the inventory, analysis and action plan, since North Hampton has only a small amount of acreage in the southernmost portion of the Watershed.

Natural Resources

The following discussion is an inventory and analysis of the Watershed's natural resources, including: topography and slope; geology and soils; water resources (including wetlands); vegetation; and fish and wildlife. In 1991, IEP, Inc. conducted a natural resources map inventory of the watershed using the ARC/INFO geographic information system. Copies of these maps are located with community officials in Portsmouth and Rye. A description of these maps is found in **Appendix A** of this report. These maps are referred to in the Watershed description.

Topography and Slope

The Berry's Brook Watershed tends to be gently sloping with elevations that range from sea level to 151 feet at Breakfast Hill near the headwaters in Greenland. More significant topography is located in Rye and Greenland between the Portsmouth boundary and Breakfast Hill Road and Washington Road where the range is from 40 feet to 140 feet. Further down the Watershed are several areas of higher topography that also coincide with the roadway crossings. The first is at Lang Road where the elevations are between approximately 40 and 60 feet. The second is at Sagamore Road where the elevation is approximately 16 feet and the third is at Brackett Road where the elevation is between 10 and 12 feet. See **Map 7, Topography**, from the Berry's Brook Watershed Map Inventory.

- o *Very poorly drained* - These soils include freshwater muck and peat (524 acres) and tidal marsh (70 acres). Poorly and very poorly drained soils generally constitute what the Soil Conservation Service considers hydric soils. These soils are often used as the basis for wetlands regulations in many New Hampshire communities, including Rye. Poorly and very poorly drained soils constitute almost one half (46%) of the watershed's soils. By including open water, 46.87% of the watershed may be considered "wetland".
- o *Excessively drained* - These gravelly loam soils associated with stratified glacial drift are found along the ridgeline that constitutes the boundary of the watershed in Rye. These soils have exceedingly high permeability and tend to be the most suitable for development. However, problems should be anticipated from residential developments where the lots along the watershed boundary may be on well drained soils while back lots closer to the Berry's Brook or its associated wetlands may encounter seasonal high water table or poorly and very poorly drained soils. In addition, the rapid infiltration rates associated with these soils make groundwater susceptible to contamination from septic systems or roadway runoff.

The remainder of the Watershed -- 498 acres or approximately 13% -- is composed of either open water, urban land (particularly adjacent to Lafayette Road) and the Coakley gravel pit/landfill in Greenland.

Water Resources

The water resource or hydrologic system in the watershed is complex and due to the lack of specific, comprehensive data, only a qualitative analysis follows, based in large part upon the *Water Quality Management Plan for the Town of Rye* (Wright - Pierce Engineers, 1982).

Berry's Brook is a sluggish brook flowing through freshwater and tidal marshes for much of its 6.2 mile length. Its average fall is only 13 feet per mile as compared to the other streams in the area that fall at least 26 feet per mile. Its mean flow is estimated to be 1.8 cubic feet/second (cfs). This flow does not include the influence of the twice daily tidal flush that results in a significant flow of oceanwater into the lower reaches of the brook. Wright-Pierce estimated the fill volume (based upon water depth at high tide) to be 5.1 million cubic feet compared to Bailey Brook which has a fill volume of only 1.2 million cubic feet. Berry's Brook also has an estimated tidal flow of 470 cfs compared to Rye Harbor which has a tidal flow 111 cfs. The tidal flow in Berry's Brook is quite significant relative to other tidal streams in Rye and is far in excess of freshwater flows, thus providing significant dilution of pollutant loads. (Wright-Pierce, 1982).

Groundwater

Groundwater levels within the Watershed tend to approximate tide levels in the lower reaches of the watershed and streamwater levels in the lowland inland areas. In the upland areas it is believed that groundwater is bedrock controlled, although elevations are generally unknown except where there are larger sand and gravel deposits (stratified drift) along the ridge lines along Washington and Wallis Roads in Rye and along Lafayette Road in Portsmouth and Rye. In these areas, subsurface contours indicate depths of 40 to 80 feet to groundwater significance. See **Map 8, Aquifers** from the Watershed Map Inventory.

Although these areas are not used for municipal supplies and many of the Watershed's residents and businesses are on municipal water, the existing groundwater in the Watershed may be susceptible to impacts from leaking septic systems, or urban runoff that infiltrates into the soil. Sands and gravels tend to be more permeable than other soils and are particularly susceptible to contamination.

Floodplains

Floodplains are valuable because they have the ability to store flood waters during storm events. They are generally best left undeveloped, providing habitat for flora and fauna and potential passive recreation. Due to the relatively small size of the drainage area of the watershed, floodplains are confined to the tidal marsh areas at the lower reaches of the watershed and to the wetland and ravine areas adjacent to the brook itself in the inland areas.

Portsmouth, Rye and Greenland participate in National Flood Insurance Programs and have regulations that manage development in Zone A -- 100 Year Special Flood Hazard Area. Berry's Brook in Portsmouth and Rye is within Zone A. At present, however, the segment of Berry's Brook in Greenland is not in the 100-year floodplain.

In Rye, the undeveloped land in the 100 - year floodplain is also generally classified as wetlands and thus is strictly regulated by ordinance to ensure that only appropriate activities are allowed. Portsmouth, on the other hand, does regulate activities in the floodplain through a floodplain ordinance, but without a wetlands regulation it does not have the same degree of control over its floodplain areas.

THREATS TO WATERSHED RESOURCES

Surface Water Quality

Berry's Brook is legally classified as a Class B water under RSA 485A:8, meaning that it is suitable for fishing and swimming. The water quality standards for Class B waters are found in **Appendix B**. Two critical parameters for Berry's Brook that determine water quality are: (1) dissolved oxygen (DO) which must be maintained at not less than 75% of saturation, and (2) *Escherichia coli* that must not exceed greater than 153 per 100 milliliters in any one sample. In tidal waters where the growing and harvesting of shellfish occurs the number of enterococci can not exceed 104 per 100 milliliters in any one sample.

The State of New Hampshire through the Water Supply and Pollution Control Division of the Department of Environmental Services conducts a statewide water quality sampling and analysis program. The closest stations to Berry's Brook are located in Little Harbor with two (2) on Frost Point (Odiorne State Park) and one (1) in mid-channel of the harbor near the breakwater. The water quality at these stations in 1977, based on total coliform, was of good quality -- consistently at or below 15 total coliforms/100 ml (at that time the standard was 70 total coliforms/100 ml). Subsequent monitoring has not been conducted.

In 1979, as part of the Water Quality Management Plan for Rye, a water quality sampling and analysis program was undertaken. The purpose of the program was, in part, to assess Rye's general surface water quality and to determine the impact of known potential point and nonpoint sources of contamination on surface water quality. Four (4) sampling stations were located in the Berry's Brook Watershed:

- o Station 21 - in the estuary at Brackett Road.
- o Station 22 - at Sagamore Road near Bellyhack Bog.
- o Station 23 - off the main channel on a small tributary at the Liberty Common Subdivision.
- o Station 24 - near Breakfast Hill Road in Greenland.

A summary of the results follows in **Table 2**. According to the Wright-Pierce report, total coliform concentrations generally exceed the standard for both fresh and marine waters in Berry's Brook, although the tidal water sampling station (#21) further down the brook indicates lower coliform counts than the other three fresh water stations. The report concludes that high total coliform counts are generally soil-based or naturally occurring rather than contamination from human sources.

Table 2 Summary of Water Quality Data, 1979

Logarithmic Average (H/100 ml, Membrane Filter)							Arithmetic Average	
Station	No. Samples	Total Coliform	Fecal Coliform	Fecal Strep.	FC/FS	DO Sat. (%)	Nitrate (mg/l)	Total Non-Filterable Residue (mg/l)
21*	4	280	28	52	0.5	85	0.05	45
22	3	1,615	43	83	0.5	62	0.05	39
23	2	2,088	20	85	0.2	39	0.32	39
24	4	698	29	161	0.2	20	0.11	46
Totals	13	757	30	88	0.3			

For Comparison: (logarithmic averages)	Total Coliform	Fecal Coliform	Fecal Strep.	FC/FS
1976 Merrimack R. at Nashua	30,500	1,770	180	9.0
1976 Saco R. at Bartlett	50	10	18	0.6
1978 Androscoggin R. at Gorham	88,600	13,700	---	

* Indicates tidal water.

Source: Water Quality Management Plan, Town of Rye, 1982.

The brook also exhibits a dissolved oxygen (DO) deficiency from its source in Greenland to the tidal portion of the stream. At the time of the sampling in 1979, this condition was attributed in part to upstream beaver impoundments, that created a marsh environment, resulting in a DO deficiency. This condition was unable to be mitigated until the tidal estuary was reached, because of the slow moving, marshy environment in the freshwater portions of Berry's Brook.

The nitrate levels were relatively low and it was concluded that there appeared to be no significant contributions of effluent to the brook from human sources, such as septic tanks or failed septic systems. In addition, even at saturation build out, it was predicted that nitrogen loading to the brook would not be significant (Wright-Pierce, 1979). Wright Pierce concluded that the low dissolved oxygen levels, high suspended solids, moderately high and erratic total coliform densities, low fecal coliform densities and low FC/FS ratios are typical of small, sluggish streams with a preponderance of marshes such as Berry's Brook.

Since 1984, there has been a state interagency group (including the Department of Public Health, the Fish and Game Department and Water Supply, and Pollution Control Division) that has been monitoring the estuarine waters of the state to determine coliform and contaminant levels in sediment, water and shellfish. Several documents summarizing the results of bacterial contamination in shellfish waters have been published since 1987. Little Harbor is one of the designated areas that has been sampled and analyzed. There are four (4) stations in the Berry's Brook area: one at the Brackett Road crossing, one at the Pioneer Road crossing, one at Sheafes Point and a final one at the Little Harbor breakwater. See Figure 1. Results of this sampling and findings can be found in:

- o Interagency Report on the Shellfish Waters of New Hampshire, 1989,
- o Coastal Shellfish and Water Quality, August 1991,
- o Draft Report, Findings and Recommendations, Legislative Shellfish Committee, November 1992, and
- o Annual Sampling Summaries, Department of Public Health Services.

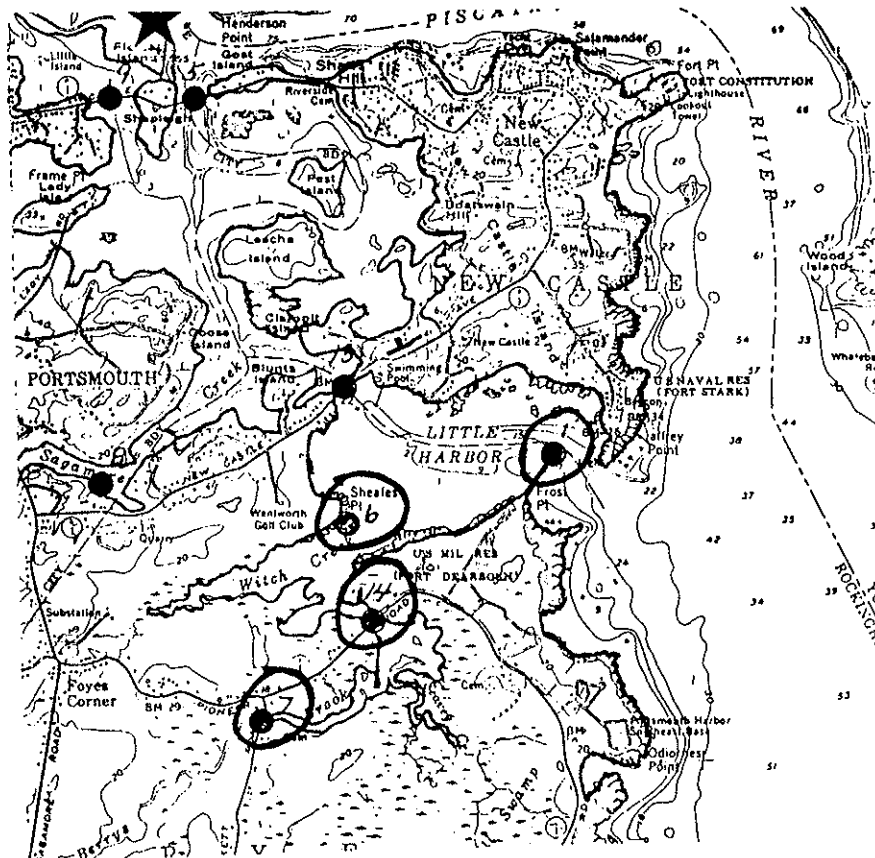


Figure 2 - Water Sampling Stations in Little Harbor Area
Source: Coastal Shellfish and Water Quality - Progress Report, 1992

In the original 1984 sampling, high coliform counts were discovered at the sampling stations in Berry's Brook. Given the available funding and the decision to concentrate on areas where there was expected to be more improvement in the water quality, the interagency shellfish group decided to eliminate the sampling stations in Berry's Brook.

These reports attributed much of the past water quality problems in the Little Harbor/Berry's Brook area to the Portsmouth Sewage Treatment Facility. In 1992, Portsmouth activated an advanced primary system that is expected to settle heavy metals and organic pollutants, thereby improving the water quality in the Lower Piscataqua and Little Harbor area. Other potential sources of coliform bacteria include marinas on a seasonal basis and unsewered locations in Sagamore Creek (Fish and Game, 1991).

The 1989 Interagency Report made several recommendations to improve water quality in shellfish waters that might lead to re-opening the shellfish beds: 1) initiate a sanitary survey and take appropriate actions to eliminate any failed septic systems, and 2) identify causes and sources of coliform problems due to nonpoint-source pollution. The Legislative Committee report recommends an expansion of the basic monitoring program, both in terms of the number of stations sampled, and also in terms of more frequent sampling.

A program that has been sponsored by the UNH Sea Grant Extension Program, called the Great Bay Watch, has been monitoring the water quality of the Great Bay Estuary and the Coastal Marine Laboratory in New Castle. Unfortunately, at this time, there are no stations in the area of Berry's Brook.

The quality of the surface water in Berry's Brook needs to be maintained at a Class B standard. Although the brook has been given this standard, past water quality monitoring has been inconsistent and needs to be conducted on a routine basis to provide a more accurate assessment of the key water quality parameters. In addition, testing for such parameters as heavy metals and organic compounds can provide a more accurate measure of the pollutants reaching the brook from urban runoff -- ie. streets, parking lots, commercial land uses, etc.

Wetlands

Berry's Brook watershed contains over 1,340 acres of wetlands or approximately 35% of the watershed based upon the wetlands map from the watershed map inventory conducted in 1991¹.

Using data from the Portsmouth and Rye wetlands maps, the wetlands in the watershed, were grouped on the basis of the predominance of certain plant communities and then aggregated onto a single map for the Watershed inventory. The wetland types were classified into seven general categories based upon the major characteristics and vegetative species likely to be encountered. These include: open water, scrub/shrub, forested wetlands, fresh marsh, tidal marsh, and mud flats. The emergent marsh and forested wetlands are further divided as seen in **Table 3**, and further described in **Appendix A, Map Inventory - Summary Report**.

The most predominant wetlands type is forested wetland comprising over 75% of the wetland community. The most abundant species in the forested wetland is red maple. Understory species include such tall, bushy shrubs as blueberry, northern arrowwood, and winterberry. Ground level species include skunk cabbage, cinnamon and sensitive fern. Typical coniferous species include: hemlock, white pine and Atlantic white cedar. These have been classified as a subset of the forested wetlands in **Table 3** and **Map 3, Wetlands**, from the Watershed Map Inventory.

The second most abundant type of wetland is the emergent marsh that comprises only 10% of the wetlands. The emergent marsh, usually characterized by very poorly drained soils, includes such species as: cattail, rushes, water lilies and a variety of sedges.

¹ These figures vary with the previous calculation for wetlands in the Geology and Soils Section of this report, in part, because different definitions for wetlands have been employed depending upon which method for wetland delineation has been used. For purposes of this wetlands discussion, the definition is based upon a modified version of the US Fish and Wildlife Service Wetland Classification System. Using the Soil Conservation Service definition of hydric soils, almost half of the watershed (46%) can be considered wetland (see previous discussion on soils). The wetlands of both Rye and Portsmouth have been mapped individually using the modified US Fish and Wildlife Service method -- Rye's through the Coastal Wetlands Mapping project sponsored by the New Hampshire Office of State Planning in 1986 and Portsmouth through its Wetland Delineation and Mapping Project in 1985.

United States Soil Conservation Service/Wetland Definition

Wetland Soils - Poorly and very poorly drained mineral and organic soils with the water table at or near the ground surface for seven or more months of the year.

United States Fish and Wildlife Service/Wetland Definition

Wetlands - are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface of the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Table 3 Acreages of the various wetland cover types identified within the Berry's Brook watershed.

<u>Wetland Type</u>	<u>Acres</u>	<u>Percent of Total</u>
Forested Wetlands		
Deciduous	935	69.7%
Coniferous	59.6	4.4%
Atlantic White Cedar	8.3	0.6%
Dead	5.8	<u>1.4%</u>
		76.1%
Scrub/Shrub	118	8.8%
Emergent Marsh		
Wet Meadow	22	1.6%
Shallow	86	6.4%
Deep	13	<u>1.0%</u>
		9.0%
Open Water	23	1.7%
High Salt Marsh	59	4.4%
Panne	7.3	0.5%
Mud Flats	<u>4.7</u>	<u>0.3%</u>
Total	1,341.7 acres	100%

Sources: Coastal Wetlands Mapping Program, Normandeau Associates, Inc., NHOSP, 1986
 Portsmouth Wetland Delineation and Mapping Project, IEP, Inc., 1985.

The Portsmouth Wetland Mapping Project identified 14 individual wetlands within the Portsmouth portion of the watershed. Of these 14 wetlands, it was determined that two - BB-3 and BB-7 -- were suitable candidates to be designated as Prime Wetlands under NH RSA 482-A:15. BB-3 is a large system south of Lang Road and BB-7 is a large system north of Lang Road and east of Lafayette Road. The mapping project also identified these two (2) wetlands and a third -- BB-1 -- as three of the five most threatened in the City, because of nearby development or inappropriate land-use practices, such as inadequate treatment of runoff and erosion. The Berry's Brook Watershed Map Inventory identified another prime wetland candidate that was originally classified as a Packers Bog wetland -- PB-3. This wetland is actually within the Berry's Brook watershed and appears to be hydrologically connected with BB-1 and BB-2. Consequently, it would appear that this total system -- located to the west of Lafayette Road in the Coach Road area -- is not only valuable because of its prime wetland qualities, but also because it is one of the most threatened.

The Rye Coastal Wetlands Mapping Program, identified eleven (11) individual wetlands within the watershed. Of these, six (6) fulfill the definition of Prime Wetlands under New Hampshire law -- BE012 and BE014 through BE018.

The Watershed's wetlands (in Rye) are "in good condition and represent natural resources whose integrity should be preserved and protected." (Wright-Pierce, 1982). The Wright-Pierce report did not consider the wetlands in the Portsmouth and Greenland portion of the Watershed. While it appears that the wetland resources in much of the Watershed are in "good condition", there have been some significant direct impacts to wetland resources since 1982, eg. the Woodlands in Portsmouth. The major impacts have been associated with developments along Lafayette Road and subdivision developments along Washington and Wallis Roads. This type of development has degraded the quality of some of the Watershed's wetlands and needs to be more rigorously regulated in the future in order to better protect these resources.

Vegetation

The Watershed's natural forest vegetation consists of a variety of deciduous and coniferous species. The majority of these are associated with the wetland environment that constitutes a significant portion of the Watershed. Much of the Watershed is comprised of stands of deciduous forest consisting of primarily red maple (*Acer rubrum*). There are also scattered stands of white birch. Significant forest stands are located in: (1) the headwaters area, and (2) a large area that straddles the east-west border between Rye and Portsmouth, including an area referred to as the Parsonage Woods. These woods also contain other species, including white pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), spruce (*Picea rubens*), and beech (*Fagus grandifolia*). (Reynolds, 1978).

Another large forested area adjacent to the brook begins at Lang Road and runs to Bellyhack Bog. Interconnected with this forest area is a stand that runs easterly across a Rye conservation commission parcel and town-owned parcel adjacent to the Rye Elementary School and then south through the Liberty Commons area across the Rand Lumber property to an area called Tahltan Woods. These tracts include lowland forests consisting of such species as red maple, red elm (*Ulmus serotina*) and some black birch (*Betula lenta*) and upland woodlands characterized by white pine, red spruce (*Picea rubens*), hemlock, beech, sugar maple (*Acer saccharum*), and yellow birch (*Betula lutea*). (Reynolds, 1978). These tracts are all second growth forests.

The Bellyhack Bog area is an extensively vegetated marsh that has a variety of plant species from emergent marsh to deciduous and coniferous forest species to a significant scrub/shrub wetland that includes tall and compact shrubs and tree saplings, such as speckled alder (*Alnus rugosa*), pepper bush (*Clethra alnifolia*) and red-osier dogwood (*Cornus stolonifera*).

The final segment of the Watershed is the area between Sagamore Road and the bridge at Pioneer Road. In addition to a complete array of saltwater marsh plants, the estuary area contains various forest species between Brackett and Sagamore Roads. After crossing Sagamore Road, Berry's Brook flows through an extensive hemlock (Tsuga canadensis) ravine forest before entering the marsh to the west of Brackett Road. This hemlock forest contains many mature old trees, and is very dense and shaded in character. Mixed in with the hemlocks are numerous white pine (Pinus strobus) trees. At the point where the stream leaves the hemlock forest and begins to enter the marsh estuary, numerous transitional species grow. Some of these include Atlantic white cedar (Chamaecyparis thyoides), white oak (Quercus bicolor), tupelo (Nyssa sylvatica), red cedar (Juniperus virginiana) and bayberry (Myrica pennsylvatica). (Reynolds, 1978).

The salt marsh area begins approximately half way between Sagamore and Brackett Roads and continues to the Pioneer Road bridge. It is dominated by salt tolerant species such as low cord grass (Spartina alterniflora) in the intertidal zone, salt hay grass (Spartina patens), and high marsh species including spike grass (Distichlis spicata) and blackgrass (Juncus gerardii).

As part of the vegetative cover mapping (see **Map 3, Wetlands**) for the original Watershed mapping project, Atlantic white cedar stands were specifically identified because of their inherent value and scarcity. These locations were taken from maps that were based upon field work conducted by Clotilde Straus between 1972 and 1975. Four (4) individual stands are located near Lafayette Road where Berry's Brook crosses at the Rye - Portsmouth boundary. Another stand has been identified off Lafayette Road in Portsmouth near one of the tributaries of Berry's Brook. Through easements, acquisition and regulation several stands in the Portsmouth area have been protected.

The New Hampshire Natural Heritage Inventory has listed the following rare plants known to be found within the boundaries of Portsmouth, Rye and Greenland and which are likely to occur in Berry's Brook watershed. Future field reconnaissance and studies should confirm the presence or absence of these species, since some may no longer exist (Straus, 1992).

- o Chamaecyparis thyoides (Atlantic White Cedar)
- o Salicornia begelowi (Dwarf Glasswort)
- o Iris Prismatica (Slender Blue Flag)
- o Agalinis maritima (Salt-marsh Gerardia)
- o Melampyrum lineare var. latifolium (Cow-wheat)
- o Malaxis unifolia (Green Adder's-mouth)
- o Campanula uliginosa (Greater Marsh-bellflower)
- o Equisetum variegatum (Variegated Horsetail)

The Watershed is rich in its diversity of natural vegetation, much of which is an integral part of the Watershed's wetland ecosystem. Many of these species are "threatened or rare" and have been subject to impacts from previous developments, such as those cited in the preceding wetlands section. These resources need to be protected in order to sustain the integrity of the vegetative and wetland environment of the Watershed.

Fish and Wildlife

The mix of fresh and salt water environments in Berry's Brook provide a rich habitat for a variety of fish and wildlife. Sea run brown trout are found in the brook from the estuary up to Bellyhack Bog. The New Hampshire Fish and Game Department annually stocks this stream with up to 7,000 anadromous fish. Other trout are also found in the brook, including rainbow and brook trout. These species are not stocked.

The Fish and Game Department has initiated an angler survey program to obtain better data on the amount and size of brown trout caught or taken from the brook to monitor the success of the stocking program. Survey cards are placed in a box on Brackett Road where the brook crosses. In addition, there are oyster beds from the estuary up to the area near Brackett Road, although all beds have been closed for the past five years.

The Fish and Game Department also keeps trapping records by town and city throughout the state. Based on an analysis of these records, there appears to be a diversity of wildlife in the watershed area. However, this conclusion is based upon interpretation of the data by municipality, not for the Watershed. Based upon these records, populations of beaver, otter, mink, muskrat, racoon, fisher, weasel, gray fox and red fox are likely to be found in the watershed. Furthermore, the towns of Rye, Greenland and North Hampton have the highest density of deer of any communities in the state. This density is due in part to the milder climates of the Seacoast area and relatively light hunting pressure as well as the diversity of habitat, such as is found in the watershed. Because the deer habitat is so extensive on a year round basis, the State Fish and Game Department has not identified specific deer wintering yards. However, it is common for deer to winter during periods of deep snow in coniferous -- especially hemlock -- stands. There are several of these in the Watershed. See the Watershed Map Inventory Map 3, **Wetlands and Vegetative Cover**.

There is also a variety of song, shore and migratory birds, waterfowl and ground nesting birds in the Watershed. The migratory birds and the combination of wetlands and upland habitats provide food and cover. The variety of birds is also the result of the large undisturbed acreage available in the watershed. Critical habitat size for the species typically found in the Watershed is between 500 - 1,000 acres.

The Audubon Society of New Hampshire has identified a number of threatened and endangered wildlife species of known or potential occurrence in the Watershed.

Endangered species include: banded bog skimmer, shortnose sturgeon, common tern, upland sandpiper, bald eagle, peregrine falcon, sedge wren and Henslow's sparrow.

Threatened species include: least tern, arctic tern, roseate tern, Cooper's hawk, northern harrier, osprey, common night hawk and purple martin. Species of special concern include: American brook lamprey, Jefferson salamander, Blandings turtle, least bittern, red-shouldered hawk, eastern screech owl, vesper sparrow and New England cottontail.

The New Hampshire Natural Heritage Inventory has listed the Orchard Oriole (Icterus spurius) as a rare animal species known to be found within the boundaries of Portsmouth, Rye and Greenland and which is likely to occur in Berry's Brook watershed. The complete list of species and explanations are found in **Appendix C, Rare, Threatened and Endangered Species.**

Dr. Clotilde Straus, Portsmouth City Arborist, has also conducted field studies in the Watershed for rare and valuable plant species. The results of this work are included in **Appendix D.**

Analysis of Land Use Regulations

Rye

The land that is still vacant or open in the Watershed in Rye is generally zoned either as Single Residence or General Residence. Both districts require at least 44,000 square foot lots with a coverage of no more than 30%. The Single Residence District is somewhat more restrictive requiring a deeper front yard (40 feet compared to General Residence of 30 feet). The General Residence allows 2 - family dwellings as long as the frontage and depth are at least 200 feet and the lot area is 88,000 sf.

Along Washington and Wallis Roads there are several small Business and Commercial zones. These districts require 44,000 square foot lots. In the Business District lot coverage cannot be more than 40%. In the Commercial District lot coverage can be no more than 75%. There is also a Historic District along Wallis Road in the Rye Center area. There is a significant Commercial District along both sides of Lafayette Road which encompasses property that could be developed for commercial use.

Regulations directly concerned with natural resource management and protection include the Wetlands and Flood Hazard Overlay Districts. The Wetlands District, based upon Soil Conservation Service poorly and very poorly drained soil categories, encourages conservation and protection of the town's wetland resources allowing only such uses as forestry, agriculture and passive recreation. Permanent structures are generally not permitted. In addition, there is a 100-foot buffer from tidal marshes, perennial streams and freshwater marshes that prohibits dredging and filling, septic systems and permanent structures. The ordinance also is very restrictive in terms of forest management and tree cutting.

The Town has also implemented a Flood Hazard District that corresponds with the FIRM 100-year flood plain. These regulations in effect allow development in flood plains as long as certain building standards are met.

The Town's Land Development (subdivision) Regulations, adopted in 1988, contain "Standards of the Preservation of Natural Features and the Environment" that encourage protection of wetlands, woodlands, historic resources, open areas for recreation, and groundwater protection. In addition, the regulations require adherence to the design practices for erosion and sediment control as outlined in the Soil Conservation Service's *Erosion and Sediment Control Design Handbook for Developing Areas of New Hampshire* (1981). Furthermore, the Planning Board may request "minimum lot size by soil classification", a provision that requires High Intensity Soils Mapping for a proposed subdivision. Minimum lot size based on this mapping is intended to ensure no degradation to water quality from septic systems. The Planning Board recently adopted the updated model soil-based lot size regulations published by NH DES (1991). In some instances, poorly drained (wetland) soils may be used as part of the lot size calculation.

This provision is a change from former regulations that did not allow any wetland soils to be used in a minimum lot size calculations.

In short, it would appear that Rye's Zoning Ordinance and Land Development Regulations are generally adequate to protect the Watershed from inappropriate development. Some updating of standards to minimize environmental impact from development should be considered; otherwise, the challenge for the town is to ensure that the regulations are properly enforced.

Portsmouth

Land within the City of Portsmouth portion of the Watershed that is still available for development includes land zoned for residential, commercial and industrial land use (see Watershed Map Inventory, **Map 2, Municipal Zoning**). In the northwestern portion of the watershed (generally in the area of the Woodlands development), there is available land in the SR I and II Districts. Along the eastern border with Rye, in addition to the SR I district there is also land available in the Rural Residential District. In addition, there is land available in the Commercial and Mobile Home District east of Lafayette Road and south of Hillcrest Estates to the Rye border. There is also vacant land west of Lafayette Road in the Coach Road area that is within the Industrial and Rural Districts.

The Single Residence (SR) I and II Districts and rural districts generally permit single family homes and accessory uses. The following table presents lot size and cover requirements for each of these districts:

<u>District</u>	<u>Minimum Lot Lot Size</u>	<u>Maximum Building Coverage (%)</u>	<u>Minimum Open Space (%)</u>
SR I	1 Acre	10	50
SR II	20,000 sf	20	40
Rural	5 Acres	5	75

The Industrial District permits a variety of business and institutional uses. It requires a 2-acre minimum lot size with a maximum building coverage of 50% and a minimum open space of 20%.

Two city-owned lots comprising 54 acres between the Beechstone and Springbrook developments constitute a Conservation District. The Conservation District permits only tree farms and forestry; wildlife refuges; parks and play grounds; and nature trails and horse riding areas.

The City has adopted a Floodplain Development Ordinance as part of the Zoning Ordinance that applies to all lands within the special flood hazard area as indicated on the FIRM maps -- 100-year flood plain. These ordinances regulate development in floodplain areas to ensure that additional flooding does not result and that the structure is properly sited and constructed to be flood proof.

Portsmouth does not have a natural resources overlay district, such as a wetland ordinance, although a draft ordinance is currently being developed.

Portsmouth's subdivision regulations for residential development may require natural feature protection; buffer strips of at least 50 feet around surface waters, wetlands or other natural features; and park dedication. The regulations provide for a plan for "minimizing soil erosion and sedimentation during construction and operation of the proposed development". These regulations provide general guidelines for the plan, but do not, at present, reference any design handbooks or manuals as a guide to developers for generally accepted practices to minimize impacts from storm runoff, erosion and sedimentation.

Portsmouth has also developed a rigorous set of Site Review Regulations for all developments except small commercial, industrial or residential activities, i.e., less than five (5) dwelling units. These regulations are set up as a community impact analysis for traffic, utilities, schools, fire, site drainage, noise, flood hazards, and natural features. There are also standards for pedestrian circulation and screening and landscaping. This approach to regulating development is generally commendable, although it appears as though the standards for protection of natural features are rather weak since impacts are to be avoided "whenever possible". There are no specific standards to be met.

These standards and regulations are administered, in the first instance, at a minimum, by the Site Review Technical Advisory Committee, comprised of representatives of all City Departments concerned with development. The Chairman of the Conservation Commission sits as a voting member of the Committee. The TAC makes recommendations as to conditions contingent on approval to the Planning Board which, as a rule, follows them.

Portsmouth's land development regulations need to be significantly improved in the area of natural resource protection, especially standards for stormwater management, erosion and sediment control, and wetland protection. It should be noted that, at the time this Management Plan is being written, the Zoning Ordinances and Site Review Regulations are in the process of revision and it can be expected that many matters now unwritten will be addressed and codified.

Greenland

Within the Berry's Brook Watershed land is only zoned Residential. In this district the minimum lot size is 60,000 square feet of which at least 45,000 square feet must be contiguous non-wetland soil. Wetland soils are defined as poorly and very poorly drained soils, as determined by using high intensity soils mapping. There must also be a minimum lot frontage of 200 feet and minimum setback of 30 feet.

The subdivision regulations contain a provision to minimize soil erosion and to require developers to provide an erosion and/or sedimentation control plan. Any erosion control plan required by the state shall be made available to the Planning Board. The town also has stringent standards for septic systems. In addition to meeting state standards, the town requires vertical distances from the bottom of each leach field to be:

Vertical Distance

Seasonal High Water Table	4 feet
Hard Pan Layer	4 feet
Bedrock	8 feet
(6 feet with community or municipal water supply)	

In addition, the town requires 18 inches of natural permeable soil above seasonal high water table for leachfields and four feet of natural soil above bedrock.

Greenland's Site Plan Review Regulations are rather perfunctory and provide little or no standards for development.

Because of its large lot zoning that requires large areas of non-wetland soil and stringent septic system regulations, Greenland's land use regulations are generally protective of water quality in the watershed. However, the large lots may have significant negative impact on other watershed resources, such as wildlife habitat. The town has no natural resource protection overlay districts, such as for wetlands, that might provide greater overall watershed resource protection.

Existing and Potential Threats to Watershed Resources

There are a number of existing and potential threats to the quality of surface waters, wetlands and wildlife habitat within the Berry's Brook Watershed. In general, these pollution sources are considered to be nonpoint-source pollutants. Examples of sources that may affect the Watershed include:

- o Runoff from streets and parking lots, that may contain bacteria, heavy metals, hydrocarbons, sediments and suspended solids;
- o Stormwater runoff that may contain pesticides, herbicides and fertilizers;
- o Inappropriate road salting and storage practices, such as spreading large quantities of salt unnecessarily or not covering salt storage piles;
- o Soil erosion and sedimentation from improperly controlled construction practices;
- o Leaking underground storage tanks;
- o Failing septic systems;
- o Direct application of mosquito - control chemicals, and
- o Impacts from marine-related activities.

Some of these threats have been documented for the Watershed while others are suspected and may need further investigation.

In 1991, the Rockingham Regional Planning Commission conducted a pollution source mapping project that included Portsmouth, Rye and Greenland. The report was limited to the following types of threats: mining, storm drains, combined sewer overflow, sludge/seepage disposal, salt storage piles, snow dumps and pesticide application sites. Therefore the listing below should not be considered a complete list. In the Berry's Brook watershed only storm drains were identified as threats. The potential threats identified in this report are as follows:

<u>Location</u>	<u>Type of Threat</u>
Rye Junior High School	Storm Drains, Drain into Wetlands
Washington Road	
Breakfast Hill Common	Storm Drain
Washington Road/Route 1	
Beechstone Apartments	Storm Drain, Drains into Wetlands
Lang Road/Lafayette Road	

<u>Location</u>	<u>Type of Threat</u>
White Birch Plaza Lafayette Road/Heritage Avenue	Storm Drain
Southgate Plaza Lafayette Road	Storm Drain, drains into wetland area across Lafayette Road

Source: Pollution Source Identification, RPC Region, Phase I, 1992.

The junior high school and Breakfast Hill Common are considered to be minor or insignificant threats to the water quality of the Watershed. They are relatively small in area and are not adjacent to a permanent surface water tributary to Berry's Brook.

Other threats to the Watershed's resources were identified by Council members. These include some of the above in addition to:

- o Ralph's Truck Sales at the intersection of Lafayette Road and Lang Road for storage of potentially hazardous materials.
- o Hillcrest Estates Mobile Home Park on Lafayette Road. This park is adjacent to a wetland area which is a candidate for Prime Wetlands (BB-3) designation as identified in the Portsmouth Wetland Mapping project. There has been incremental encroachment into wetland areas as the park has expanded.
- o Beechstone Apartments, Spring Brook Condominiums and the Woodlands. The Beechstone Apartments are prevented by agreement with the City to expand towards Berry's Brook. However, the Springbrook Condominiums have available land for expansion. These developments have encroached upon a Prime Wetland candidate (BB-7). The Beechstone Apartments and the Cedars Condominiums were among several sites that were field investigated in the spring of 1993. At the Beechstone, it was observed that at least one parking lot stormwater drain discharges directly into a wetland area. This type of situation could be mitigated through a minimal change to the stormwater runoff design that provides for a small detention area to trap sediments. Similarly at the Cedars, there is at least one area where stormwater from a parking area discharges directly into one of the large detention ponds without being filtered through a vegetative buffer. As a result, sediment has collected in the near shore waters of the pond. Current practices, such as those observed at the Beechstone and Cedars can pose a cumulative threat to the Watershed's resources. Further observation and analysis of existing stormwater management and erosion and sediment control practices should be considered.

- o The Coach Road area west of Lafayette Road near the Rye boundary is a potentially serious threat to the Watershed's resources because the area is zoned for industrial uses. As noted in the wetlands section, this area has a rich diversity of wetland wildlife and forest resources, such as upland hemlocks and Atlantic white cedars. The wetland area is a Prime Wetland candidate BB-1 that is associated with both BB-2 and the wetland that has been identified in the Packers Bog Watershed as PB-3 -- also a potential Prime Wetland.
- o Habitat fragmentation - the rapid and dense development within certain portions of the Watershed, especially along the Lafayette Road corridor has resulted in loss of valuable wildlife habitat. This development has had an impact on the Watershed's resources by reducing the land area that provides food, nesting and breeding habitat and travel corridors for wildlife.
- o The Coakley Landfill Superfund Site in North Hampton is just outside the topographic boundary of the Watershed. It is currently under investigation as a Superfund Site. In 1988, a remedial investigation and feasibility study was conducted that identified contamination at the landfill and the fact that contaminants including volatile organic compounds (VOC's), heavy metals and nitrates were migrating to the northwest of the site. This area includes wetlands at the headwaters of Berry's Brook in the Breakfast Hill area in Greenland. At present there are monitoring wells at the northwest, southwest and Route 1 portions of the site that have been sampled on a periodic basis. In 1989, representatives from NOAA investigated the Breakfast Hill wetland areas and were not concerned about the potential impact. The EPA has recommended that the landfill be capped and that a program to pump and treat the groundwater for up to 10 years be implemented. At present, consultants for the PRP's (Potentially Responsible Parties) are conducting investigations of the site. The consultants will document results of the studies and provide recommendations for remediation in a report to be completed in the fall of 1993.

To date there appears to be no definable impact to the water quality of Berry's Brook. The existing release of contaminated waste is being addressed through the Superfund remediation process. However, the Council should continue to monitor the progress of the remediation program. A final "feasibility study and proposed plan for remediation" is due to be made public by late fall of 1993. The Council should be prepared to respond to this report.

- o The former Rye Landfill - is located within the Watershed near the headwaters just west of Lafayette Road and south of Breakfast Hill Road. It is an approximately 6-acre site that was closed in 1986 and capped in 1987 with six inches of loam and a clay cap. There are eight (8) monitoring wells of which three are wet. The wells have been monitored regularly, since the facility was closed.

All water quality parameters are below EPA guidelines for contamination. This site does not appear to pose a threat to the water quality of Berry's Brook nor the sensitive natural resources of the Watershed.

In addition, there are several areas within the Watershed that are subject to development that pose potentially serious impacts to the Watershed because of large size and/or nearness to Berry's Brook or its contiguous wetlands. These include:

1. The headwaters area west of Lafayette Road, that includes both residential and commercial zones; in Greenland (where much of the land is owned by Seawall and Ciborowski) and in Portsmouth (where much of the land is owned by Ciborowski).
2. Two areas in the southern portion of the Watershed east of Lafayette Road, including one in Rye (owned by Ciborowski) and one in Portsmouth between the town boundary and the Hillcrest Mobile Home Park.
3. A residential area in the southeast portion of the watershed in Rye adjacent to Washington Road near the Webster Nursing Home.
4. Several residentially-zoned areas off Lang Road in both Rye and Portsmouth, also including a portion of the Rand property.
5. A residentially zoned area in Portsmouth that includes the Cavaretta property.
6. Two large residentially-zoned parcels on either side of Brackett Road in the lower portion of the Watershed.

These areas are categorized as Developable Lands on the **Watershed Management Plan Map** that is part of this report.