CHAPTER 7 – NATURAL RESOURCES

7.1 INTRODUCTION

Land and water resources are prevalent in Rye, creating a complex fabric of land uses, natural resources and conserved lands. A multi-disciplinary approach to managing and protecting resources which are both natural, cultural and historic highlights the important connections between our green landscapes, built infrastructure, and community and social capital.

Figure 7-1 summarizes land use and natural resources changes from 1962 to 2015.
(The Land Use/Land Cover maps are in Appendix A)

Figure 7-1

RYE HISTORICAL AND CURRENT RESOURCES AND LAND USE (acres)							
Land Use Type	**1962**	**1974**	**1998**	**2005**	**2010**	**2015**	% change 2010-2015
Active Agricultural	679	345	249	220	220	217	-1.0
Auxiliary Transportation+	--	--	--	10	10	12	26.5
Farmsteads	2	--	--	73	73	72	-1.5
Industrial/Commercial	88	104	150	132	132	121	-8.4
Mixed Urban+	4	120	185	22	22	21	0.0
Open Wetlands & Forest**	5,473	5,357	5,184	4,998	4,998	4,958	-0.8
Other/Idle	525	608	326	339	318	304	-4.2
Playing Fields/Recreation	--	--	--	218	231	232	0.1
Railroad	--	--	--	2	2	2	0.0
Residential	1,135	1,357	1,776	1,763	1,771	1,832	3.5
Transportation	133	143	158	179	179	182	1.8
Utilities	--	--	--	11.2	11.2	11	0.0
Water	366	372	377	441	441	441	0.0
Totals	**8,405**	**8,406**	**8,405**	**8,408.2**	**8,408.2**	**8,406**	**-0.2**

** Note: Years 1962,1974 and 1998 were compiled with a slightly different methodology than 2005, 2010 and 2015. Auxiliary Transportation, Playing Fields and Utilities are categories only broken out in 2005, 2010 and 2015. Classification of wetlands was improved between 1998 and 2005. Due to poor-quality aerial photography, many wetlands were classified as 'Forested' before 2005.
+ Auxiliary Transportation includes cloverleafs, medians, roundabouts and traffic circles. Mixed Urban includes vacant municipal properties, graveyards and other non-specified uses.

Development can affect the health and productivity of land and water-based ecosystems, the quantity and quality of drinking water and the volume of stormwater runoff and flooding. The balance between preserving natural resources and developing land is delicate and a vital function of municipal long-range planning. The consideration of development and natural resources and the associated social and economic implications give rise to the following challenging questions:

- What are the economic, environmental and social costs and benefits of our long-term planning for growth?
- How will the town preserve its working landscape of farms, equestrian facilities, open areas, saltwater marshes and forests in the face of population growth and development pressures?
- How can our natural resources be utilized for recreational and educational opportunities without degrading the very resources we seek to protect?
- How does the day-to-day work of town elected officials, staff, Boards and Commissions affect the longer-term management of our natural resources?

To address these questions, there is a need to identify the significant threats to natural resources, evaluate available data on the status and condition of natural resources and utilize the planning and legal tools available for management of natural resources.

The Master Plan must also consider the views of the community, as expressed through the public Visioning Process, town surveys and voter opinions on proposed warrant articles to formulate goals and strategies to sustain our natural resources. This chapter will begin with a discussion of the views expressed by members of the community during the Master Plan Visioning Process, followed by a brief inventory of existing natural resources and identification of current and future threats to natural resources. The chapter concludes with recommended goals and strategies for natural resource management and protection.

7.2 Master Plan Visioning Process

The opinions expressed in the 2002 Master Plan visioning sessions demonstrate that the many residents of Rye recognize the challenges they face in addressing natural resource concerns and offer solutions to address them. Progress has been made in keeping our beaches clean, maintaining our scenic views, improving our marshes and wetlands, preserving more open space, increasing our bike paths, providing senior housing and repairing the sidewalks on Cable Road. Figure 7-2 summarizes the issues raised and includes representative comments from participants.

Figure 7-2

MAIN ISSUE SUMMARY	
Issue	**Comments from Individuals Who Attended 2002 Visioning Session**
Beaches/ waterfront	• Keep beaches clean • Control dogs on the beach, ban dogs from the beach • Reclaim harbor, Jenness Beach, Wallis Sands for Rye • Encourage non-motorized craft on designated waterways and roadways, ban jet skis
Wastewater disposal issues	• Concern about discharge into the ocean, silt, sewer system and fresh water management • Question capacity of existing resources to support increased population

Air/Noise pollution	• Concern about locally, regionally, and nationally generated pollution
Scenic views/ Quality of life	• Maintain and enhance scenic views • Natural resources enhance quality of life • Open space creates atmosphere of small town • Cell tower effects on natural resources/aesthetics

MAIN ISSUE SUMMARY	
Issue	**Comments from Individuals Who Attended 2002 Visioning Session**
Wooded lots	• Purposes are viewing, noise mitigation, issue of burning wooded lots/forest management
Wetlands	• Need for stricter enforcement of wetlands regulations • Let Rye be more strict than the NHDES requirements
Marsh lands	• Enhance the flushing of marshlands/ roads issue
Open space	• Open space should be visible/frontage • Consider incentives for private owners • Allow for creativity in site design/subdivision for open space • Investigate real estate transfer tax to "Rye land bank" for purchase and maintenance of open space • Consider seniors leaving their homes and selling land for development; need empty nest housing • Continue funding for open space • Restrict back lot development
Wildlife corridors/greenbelts	• Maintain wildlife corridors to provide habitat, visual & sound barrier and wind protection • Monitor development until wildlife corridors are clearly established and protected • Control mosquitoes • Improve pest control issues such as ticks/deer
Paths and sidewalks	• Consider need for bikeways, bike paths • Need walkways to school, library • Prefer permeable surface paths for bikes, runners, cross-country skiing, walking. • Link the two schools with paths

MAIN ISSUE SUMMARY	
Issue	**Comments from Individuals Who Attended Climate Sessions**
Climate Change*	• Loss of salt marsh from sea-level rise and damage from storm events • Salt water intrusion impacts to drinking water supplies/wells • Impacts to fisheries and wildlife habitat from sea-level rise • Impacts to beaches from sea-level rise and erosion • Flooding from sea-level rise and increased precipitation • Need for infrastructure improvements to address local flooding and increased precipitation • Water quality, water supply, local aquifer • Changes to freshwater wetlands, changes to location and extent of buffer areas • Changes to shoreline habitat, shifting of sand bars and dunes

* Public comment from Preparing for Climate Change project (2014) and Tides to Storms 2 Coastal Hazards and Climate Adaptation Chapter (draft 2016).

7.3 COASTAL RESOURCES

The term "coastal resources" refers to those natural resources and features located along the Atlantic coast, tidal tributaries and salt marshes in Rye. Rye's beaches are one of its most valuable and visible natural resources. Rye is fortunate to have an abundance of shoreline and tidal waterways which adds to its attractiveness as a place to live or just spend the day.

A. Description of Beaches and Beach Access

Rye has six beaches and sand dune areas totaling 87 acres starting at the town line of North Hampton. Sand dunes and waterfront areas have been developed since the early 1900's and, in recent decades, seasonal cottages have been redeveloped into permanent residences.

Access to the beaches has been an issue of concern for many years and some of the access points have been lost to the Town and public due to court battles, encroachments and lack of maintenance. In 2011, a study was conducted of beach access points with presentations to the Selectmen. Learn more about the presentation on the Town's website at http://www.town.rye.nh.us/pages/RyeNH_SelectMin/2011/BOS_Minutes_9-26-11.pdf.

With approval from the Selectmen, signs were installed marking beach access points for public use at the following locations:

- **Bass Beach** – Access onto Bass Beach on the town line of Rye and North Hampton and there are two signs, one to name the beach, the other for "Beach Access".
- **Philbrick's Beach** – Access onto Philbrick's Beach south of the Beach Club and there are two signs, one to name the beach and the other for "Beach Access".

- **Sawyer's Beach** – Two (2) signs are located at both ends of this town owned beach; each location has two signs, one to name the beach and the other for "Beach Access". Parking is limited to residential beach permits only.
- **Jenness State Beach -** The beach is partly owned by the state and by the Town. The state owned portion has a parking lot and signs posted by the state.
- **Jenness Beach (town owned portion)** – This beach has multiple access points as listed below:

  E Street – Foot path across from Rye General Store with two signs, one for the access name and the other "Beach Access".

  F Street – Access to the beach is at the end via pedestrian foot traffic only.

  G Street – Originally designated as a Beach Access but later discovered it is a private right-of-way and the signs were removed.

  Cable Road (public road) –Access to the beach at the end with beach permit only parking along the roadside. There are two signs at this location, one to name the street and the other for "Beach Access".

  Sunrise Path (public road) – A gravel path with access to the beach and parking on one side. There are two signs at this location, one to name the street and the other for "Beach Access".

  Old Beach Way (public right-of-way)– A gravel path with access to the beach and with beach permit parking on one side. There are two signs at this location, one to name the street and the other for "Beach Access".

  Old Town Way – This is a driveway for the residents and a footpath only for the area as per Superior Court order, September Term, 1986, No. E-275-91. There is no signage at this access.

- **Foss Beach** – The beach is a long stretch that runs from Rye Harbor State Park, along Ocean Boulevard just past Washington Road. Wooden ramps provide access to the beach. There are two signs along the beach, one to name the beach and the other for "Beach Access".
- **Concord Point** – Just north of Concord Point Road is a gravel road for beach parking. There are two signs at this location, one to name the location, the other for "Beach Access".
- **Wallis Sands Beach –** The beach is partly owned by the state and the Town. The state-owned portion has a parking lot and has signage posted by the State.
- **Wallis Sands Beach (the Town owned portion)** – The beach is accessed from Wallis Road. There are two signs at this location, one to name the street and there is parking by beach permit only and the other sign for "Beach Access".
- **Saunders Point** – Saunders Point is located at the northeast most corner of the Wentworth by the Sea Country Club property adjacent to Route 1B. There is parking for four vehicles and a short trail that leads to the beach. The property is privately owned, but the public is allowed to park and access the beach because of a public easement.

There are many other small access points to the Atlantic Ocean along Ocean Boulevard, which is a state highway, maintained by the state. These access points are mostly paved turn off areas and some have either one or two-hour parking limits.

During the past 10 to 15 years, there has been a growing concern over the ownership and increased use of the town owned beaches that are developed with both seasonal and year-round residences. Eventually, this situation ended in a court case brought before Superior Court in 1999. The outcome of case #95-E-0455, G. William Purdy and others, versus the Attorney General of New Hampshire was that under the Public Trust Doctrine the limit of the public's right to beach access and use is mean high tide (or the wet portion of the beach up to the observable high tide line).

It is important that all parties, the Town of Rye, beachfront property owners and the public acknowledge their legal rights so that all may enjoy continued use of the beaches without infringing on the rights of other parties.

B. Rye Harbor

In addition to town and state-owned beaches, another important natural resource and tourist attraction is Rye Harbor. The harbor is an inlet from the ocean that has been improved by the addition in 1939 of jetties consisting of large granite blocks the Harbor and provides to commercial fishing and recreational boats protected docking, mooring and water access. Rye Harbor also has a long tradition of providing employment opportunities such as lobstering, fishing, whale watching, boat maintenance and other jobs typical of a small seaport.

As reported in 2017 by the NH Division of Ports and Harbors, Rye Harbor has 167 moorings, 119 in the harbor and 49 near-shore. Commercial moorings can only be transferred to other commercial fishermen. As of 2017, there is a wait list of approximately 160 individuals requesting available moorings. The management of Rye Harbor is provided by the New Hampshire Port Authority for the State of New Hampshire.

C. Tidal Wetlands and Salt Marsh Restoration Projects

Refer to the Freshwater and Tidal Wetlands map in Appendix A.

New Hampshire has about 6,200 acres of salt marsh. Due to its coastal location, Rye's 1,100 acres of salt marshes are an important and prominent ecosystem in the Town of Rye. Tidal systems and salt marshes are highly productive ecosystems that rely on a delicate balance between marine and terrestrial environments. Marshes provide scenic views, open space and habitats for many types of wildlife including fish and birds such as snowy egrets and great blue herons. Tidal systems and salt marshes also provide water filtration and areas for flood retention and flood control (NRCS, 2005). Historically, salt marshes were harvested for salt marsh hay.

Salt marshes are the transition zone between ocean and land and the interface between fresh water and salt water. Salt marshes are highly productive ecosystems due to wide fluctuations in salinity, water flow, temperature and oxygen levels. Salt marshes consist of microhabitats containing species adapted to particular physical and chemical conditions in different areas of the marsh. Four distinct areas of plant growth can be observed when looking out across a salt marsh from open water to the upland border: the low marsh grass (*Spartina alterniflora)*, the high marsh grass (*Spartina patens*, *Distichlis spicata and Juncus gerardii)*, mud flats and open water pools.

Tidal wetlands comprise 16 percent of the total land and water area of Rye.

Figure 7-3

TIDAL WETLAND TYPES AND ACREAGE	
Wetland Type	**Acres**
Estuarine and Marine Deepwater	102.05
Estuarine and Marine Wetland	1,015.8
Total	***1,117.9***
Tidal Open Water	210.5

Threats to tidal wetlands and salt marshes include changes to natural hydrology, erosion, pollution, coastal development, filling and invasive plant species. During the early 1900s, roads and railroads were constructed severing connections between salt marshes and the ocean This division reduced or eliminated tidal flooding, which disrupted the natural hydrology and altered soil and water chemistry, resulting in changes to natural plant and animal communities, including the introduction of invasive species such as Phragmites and purple loosestrife (DES, 2004). These invasive species are extremely hardy and aggressively colonize natural systems and disturbed areas. Without proper management controls, these invasive species outcompete native plants, transforming diverse ecosystems into monocultures. In some locations in Rye, saltmarsh grasses have been replaced with a sea of Phragmites.

Other threats to salt marshes include failed attempts to maintain flow, for example when culverts are replaced or new culverts are installed, which in many cases are undersized (NRCS, 2005). Mosquito control efforts have also sometimes resulted in negative impacts to salt marshes through poorly designed drainage ditches or other attempts to drain marshes (NRCS, 2005).

State and local regulations now recognize these negative effects and programs are in place to actively restore salt marshes. Restoration efforts are discussed at length with the Conservation Commission.

Mosquito control is very important in any town on the New Hampshire seacoast. Salt marshes are of prime importance as a place for natural predation of mosquito larvae.

Saltmarsh Restoration

The influence of tides is crucial to the productivity of salt marshes, carrying in nutrients for plant growth and carrying away pollutants and excess sediments and organic material. Sediments deposited on the marsh surface and decomposing plant material accumulate and, over long periods, form a dense layer called peat (NES, 2004). Assurance of uninhibited salt marsh tidal flow is critical to protecting these ecosystems. Every reasonable effort should be made to sustain tidal flow, and where tidal flow has been restricted remedial actions should be implemented to reclaim the restricted areas to their original state.

Salt marsh restoration is being pursued in Rye based on a 1994 study prepared by the USDA Soil Conservation Service. Through a combination of culvert replacements and fill removal tidal flow has been restored to over 275 acres of salt marsh in Rye. The Rockingham County Conservation District (RCCD) has implemented a *Phragmites* control program in the Seacoast region for many years. Rye's Conservation Commission will continue to compete for grants from federal and state environmental agencies to fund restoration projects. These funds will complement funds raised from individual contributions and private environmental foundations.

The following is a partial list of completed salt marsh and other restoration projects by RCCD and the NH Coastal Program. This information was provided by the NH Coastal Program which keeps an inventory of saltmarsh restoration projects.~~:~~

- Parson's Creek Marsh: off Wallis Road - 53 acres restored from 1998-1999
- Fairhill Marsh: west of Wallis Sands State Beach - Phase I 1997, Phase II 2004
- Awcomin Salt Marsh: 40 acres restored from 1992-2008
- Massacre Marsh: off Brackett Road – 2003
- Rye Harbor – 56 acres in 1998 and 2001
- Harbor Road – 4.6 acres from 1997-1999
- Locke Road – 24 acres from 1995-1997
- Odiorne Point – 0.5 acres in 2005
- Parsons Creek watershed and water quality restoration project - ongoing

D. Shellfish

The New Hampshire Department of Environmental Services (DES) Watershed Management Bureau is responsible for monitoring coastal shellfish growing waters. The shellfish program evaluates the sanitary quality of all coastal shellfish growing waters in the state and ensures that these evaluations are kept current through periodic re-evaluations. The program identifies pollution sources and other factors that may render shellfish resources unfit for human consumption. Agents in the program work with local officials, state agencies, environmental organizations, and members of the public to eliminate pollution sources and inform and educate the public about the quality of the state's shellfish resources and potential health risks associated with shellfish.

Three state agencies are responsible for the overall management of shellfish sanitation, harvesting, and resource health: DES is responsible for monitoring; Fish and Game is responsible for issuing harvesting licenses, managing resources, and enforcing the decisions of the DES to open or close a shellfish harvesting area; and the Department of Health and Human Services regulates aspects of the commercial shellfish industry.

Rye Harbor is one of the locations where DES collects water quality samples for analysis. This information is used to make decisions concerning open/closed areas and to track changes in water quality over time.

7.4 Preservation of Open Space and Areas of Scenic Importance

(Conservation Lands map and Town Owned Property map in Appendix A)

Both the natural and cultural history of these unique areas of Rye have been well documented and can serve as useful resources for the citizens of Rye in formulating strategies to restore habitat, protect natural areas and respond to impacts to natural resources resulting from residential and commercial development. Select parcels of land will continue to be acquired for conservation and public use through voluntary easements and land purchases. The objective is to provide additional protection for Rye's marshes, streams, ponds and selected forested areas and to expand contiguous wildlife habitats and preserve agricultural lands. Examples of conservation include the Philbrick easement and Goss Farm.

Rye is known for its rural town character and abundance of open space, and its citizens have supported investments to preserve open space. This support was evident when in 2000 Rye voters enthusiastically supported the purchase of Parson's Park and Parson's Woods. In 1996, Varrell Woods was acquired, a significant parcel adjoining Awcomin Marsh and the Town Forest. Again in 2003, a $5 million bond issue was approved, and the Open Space Fund was established. By the close of 2012, the town had completed the purchase of fourteen (14) easements, thereby protecting an additional 238 plus acres for $4,414,000. The town also purchased more than 200 acres for $4,684,900 in 2014. This was accomplished by leveraging other town lands and grants from NOAA, federal wetlands programs and farm and ranch land grants. The town has permanently conserved over 1,030 acres. The town has received more than $4,100,000 in gifts of lands, donations and grant assistance. There are additional Rye land owners who wish to grant conservation easements on their farmland and open space. With the increase in large developments and the importance of water quality, the Commission is strong in its intent to continue its history of preserving open space, wildlife corridors and water quality. An annotated map of trails in the Rye Town Forest is provided in Appendix A.

The New Hampshire Coastal Program has also identified eight areas of coastal scenic importance in Rye that have uniqueness or character which set them apart from other categories of coastal resources. Scenic areas include the Isles of Shoals, Rye Harbor, and all scenic sections of Ocean Boulevard as listed below:

1. Little Harbor
2. Berry's Brook Estuary (i.e. the Berry's Brook-Bellyhack ecosystem)
3. Fairhill-White Cedar Swamp
4. Odiorne State Park
5. Eel Pond/Cedar Swamp Run
6. Burkes Pond (and Browns Mill pond)
7. Rye Ledge
8. Isles of Shoals

A. Agricultural Resources

Prime farmland and farmland of local and statewide importance comprise 37 percent of Rye's 8,406 acres of land and water area. Of this percentage, only 9 percent or 289 acres are in active agriculture or part of a farmstead. Refer to the Land Use Map in the Map Appendix.

Figure 7-4

FARMLAND TYPE AND ACREAGE	
Farmland Type	**Acres**
Prime Farmland	289.9
Farmland of Local Importance	1,167.5
Farmland of Statewide Importance	1,620.9
Total	***3,078.3***

The Goss Farm

The Goss Farm, (corner of Harbor Road and Ocean Boulevard), was owned and farmed by the same family since the 1700's. The property was purchased in 2010 for the Town of Rye with funds from the Town and assistance from the USDA National Resources Conservation Service and through a farm and ranch land program award. Our Conservation Commission manages the nine (9) plus acre property, and a conservation easement is held by the Rockingham County Conservation District. There is one structure on the property, the historic Goss Barn, that is listed in the New Hampshire State Register of Historic Places.

The main use of the Goss Farm property is to promote local agriculture. The Goss Farm provides an opportunity to connect with and preserve farming traditions of the past and provides Rye schools an opportunity to educate children about agricultural practices. Since the property is adjacent to wetland meadows and salt marshes, buffer areas have been established to protect runoff from the proposed farming areas.

B. Forest Resources

Rye has roughly 2,308 acres of forest on both private and public lands. Forests comprise 27 percent of Rye's 8,406 acres of land and water.

Three large publicly accessible areas are the Town Forest known as Parson's Woods (accessible from Washington Road), Marden Woods (accessible from Washington Road) and Varrell Woods (accessible from Parson's and Recreation Road). All areas contain trails that are well used by residents for exercise, dog walking, skiing and snowshoeing. All areas are protected by a conservation easement, managed by the Rye Conservation Commission and supervised by the Rockingham County Conservation District. The Town Forest is used frequently by guests, residents, tourists and the Rye schools as part of their natural study program.

Other unique forest areas include public walking trails and beach access at Odiorne State Park.

Securing wildlife corridors in the Town Forest is an important goal of the Rye Conservation Commission. The Rye Conservation Commission has a forest management plan for the Town Forest. In 2017, Rye voters authorized the Conservation Commission to establish a Trail Access Feasibility Committee to explore the feasibility and funding requirements of expanding one of the existing trails through the Rye Town Forest (behind Parson's Field) to increase access to the Rye Recreational Area from the town center and for the students at Rye Junior High School.

Larger forest blocks are more likely to support viable populations of species and therefore act as a source of individuals that can interact with populations in other blocks. Small block fragments may be unable to support breeding populations. Persistent and widespread fragmentation may lead to genetic changes and a loss of genetic diversity, as populations are subdivided into small locally breeding populations.

~~Two large publicly accessible areas are the Town Forest known as Parson's Woods (accessible from Washington Road), and the Varrell Woods (accessible from Parson's and Recreation Road). Both areas contain trails that are well used by residents. for exercise, dog walking, and skiing and snowshoeing. Both areas are protected by a conservation easement, managed by the Rye Conservation Commission and supervised by the Rockingham County Conservation District. The Town forest is used frequently by guests, residents, tourists and the Rye schools as part of their natural study program.~~

~~Other unique forest areas include public walking trails and beach access at Odiorne State Park, and the Atlantic White Cedar Preserve on Cedar Swamp Run. The Town forest is used frequently by guests, residents, tourists and the Rye schools as part of their natural study program.~~

C. Odiorne Point State Park and Islands

Rye is fortunate to be home to Odiorne Point State Park, a state property that preserves vast open space including 330 acres of coastal land and water along Route 1-A. The park includes walking trails, picnic areas and the Seacoast Science Center. Wildlife habitat at the park includes salt marshes, rocky shores, upland shrub forest, meadows, salt and fresh water ponds, sand beach and dunes. In addition to its natural amenities, the park also contains historical and cultural resources such as the remnants of World War II military structures, cellar holes and stone walls. The Park is operated by the Division of Parks and Recreation, with the exception of the Seacoast Science Center which is a public/private partnership managed by the Audubon Society under contract with DPR in affiliation with the Friends of Odiorne Point State Park, the Seacoast Science Center, Inc. and the University of New Hampshire Sea Grant Program. These groups are each represented on the Seacoast Science Center Advisory Committee, which is responsible for overseeing the management and activities of the Center. The Science Center hosts visitors, school groups and day campers and implements educational programs and field and interpretive programs.

Several documented habitat inventories and related studies have been conducted in Odiorne Point State Park by university graduate students, professional consultants, and volunteer naturalists. More information on the wildlife habitat, natural history, and cultural history of the Park can be obtained from the Seacoast Science Center and in The Odiorne Point State Park and White Island Master Plan (1999) and the Management Plan for the Cultural Landscape Features of Odiorne State Park (2002).

In addition to its ownership and management of the coastal areas of Odiorne Point State Park, the Division of Parks and Recreation also owns and manages White Island and Seavey Island, two islands off the Isles of Shoals. Habitat restoration projects have been sponsored on these islands by the NH Audubon and the NH Fish and Game Department. The New Hampshire Islands of the Isles of Shoals are part of the Rye Historic District. The Rye Historic Commission is tasked with preserving the cultural, economic, social, political and architectural history of the Rye Historic District.

D. Berry's Brook – Bellyhack Ecosystem

In 1990, the Rye Planning Board and the Portsmouth Planning Board began an inter-municipal effort of watershed protection planning for the Berry's Brook watershed. The Berry's Brook Watershed Protection Council was organized and grant assistance from the State coastal program was used for the preparation of eight planning base maps of the watershed. The base maps portray, respectively, the study area, zoning, wetland soils, parcel ownership, slopes, aquifers and utilities within the watershed.

Berry's Brook has a total stream length of 6.2 miles, of which the easternmost 1.0 miles is tidal. The Berry's Brook drainage basin is 5.9 square miles in area. Approximately 55 percent of the drainage basin is in the Town of Rye; 40 percent in the City of Portsmouth; and 5 percent, at the headwaters at Breakfast Hill, in the Town of Greenland. In late 1992, further coastal program grant assistance was received for the preparation of a Watershed Management Plan for Berry's Brook. The Berry's Brook Watershed

Management Plan was completed in June 1993. The plan report contains a detailed inventory and analysis of the watershed, a build-out analysis and an action plan for watershed management.

The following is excerpted from the Berry's Brook Water Quality Management Plan (WQMP. P 28-29) which is available on the town's website at http://www.town.rye.nh.us/pages/RyeNH_Planning/berry%27sbrookfolder.pdf/plan.pdf.

The Berry's Brook-Bellyhack Bog ecosystem is an area of great natural beauty and has prime importance as a healthy and functional wetlands system comprising upland drainage, feeder streams, an estuary and a tidal marsh. Its biological productivity is exceptionally high in abundance and diversity of plant and animal species. A study of this ecosystem offers one an education in the dynamics of the energy-food web upon which we are all dependent in the broad sense as well as in a strict sense. The latter refers to the fish and shellfish that can be caught or gathered in modest but adequate amounts for many families to enjoy. For example, seasonal smelt and flounder fishing is often excellent in the tidal area.

Berry's Brook has the only sea run brown trout population in New Hampshire. The marsh area is a haven for shore birds and waterfowl. Kingfishers, Great Blue Herons and Snowy Egrets can be frequently observed from the Brackett Road Bridge. The waters of Berry's Brook contain an abundance of aquatic vegetation that provides food and shelter to many other species and contributes to the estuarine detrital reservoir. This is the first step in the food chain, which ultimately provides for the fish, shellfish, birds, and mammals indigenous to this estuary, many of which are transient or seasonal (e.g. the sea run brown trout). Due to its sensitivity to pollutants there are potential health risks to the species and humans. If the primary producers in the food chain, the green photosynthetic plants of the wetlands, are destroyed or rendered unhealthy, eventually the whole system will breakdown and become more limited in productivity. One of the most tangible results of the degradation of ecosystems such as this to the ultimate consumer—humans—is that most of the shellfish and fin fish which depend wholly or in part on the estuarine-marsh system for their life cycles become increasingly scarce and costly.

~~In 1990, the Rye Planning Board and the Portsmouth Planning Board began an inter-municipal effort of watershed protection planning for the Berry's Brook watershed. The Berry's Brook Watershed Protection Council was organized, and grant assistance from the State coastal program was used for the preparation of eight planning base maps of the watershed. The base maps portray, respectively, the study area, zoning, wetland soils, parcel ownership, slopes, aquifers and utilities within the watershed.~~

E. Wildlife Corridors, Biodiversity and Habitat

1. Wildlife Corridors

Rye has several notable wildlife corridors used by animals as routes to food, water and habitat areas. Some of these corridors are protected by conservation easements established by the Conservation Commission. The primary corridors that should be

protected include the following: from Breakfast Hill along Berry's Brook to Sagamore Creek and Odiorne State Park, from the Junior High School to the Massacre Marsh, from Parsons Field to Awcomin Marsh, from West Road through Brown's Pond to Eel Pond and the freshwater and tidal portions of the Parson's Creek watershed. It is the goal of the Conservation Commission to keep these corridors protected to enhance wildlife protection.

2. Species Abundance and Biodiversity

Wildlife losses can be measured not only in terms of individual species but also in terms of an overall loss in species abundance and diversity, also referred to as biodiversity. Biodiversity is critical to ecosystem function due to the interdependent relationships between animal and plant species. Biodiversity is important to sustaining the built and social infrastructures, due to the importance of ecosystem function to recreation, cultural heritage, economics and public health.

With increased development pressures, the environmental, economic and social benefits provided by New Hampshire's water resources, wetlands, forests, fields and wildlife are severely compromised. Ecosystems are made up of dynamic, adaptive processes that can respond to many stressors, called ecosystem resilience. The recent impacts of growth and the loss of important resources has resulted in the loss of species and the degradation and loss of water resources, forests, wetlands, salt marsh and wildlife habitat.

3. Invasive Species

Invasive species disrupt the natural balance of plant and animal species and entire ecosystems. An action plan should be developed and funding made available to monitor and manage invasive species. The plan should include services at the Rye Transfer Station, such as providing adequate disposal facilities for certain types of invasive species. Although the NH Department of Environmental Services Coastal program conducts invasive species surveys in saltmarshes, the town should consider a comprehensive effort to map invasive species throughout the town, including salt marches, wetlands, side roads, public spaces and the town forest. Information about invasive species and how to control them should be provided to the public, land use boards, elected officials and municipal staff.

4. Land Conservation Plan for NH's Coastal Watersheds

The Land Conservation Plan for NH's Coastal Watersheds (2006) documents those lands and waters that are most important for conserving living resources – native plants, animals, and natural communities – and water quality in the greater coastal watershed. The Plan identifies Core Focus Areas of exceptional significance containing multiple high value resources including plants of conservation concern. These Core Focus Areas are priority lands for conservation efforts, comprising 43 percent of Rye's 8,406 acres of land and water. *Refer to the Core Focus Areas Map in Appendix A.*

Figure 7-5
CORE FOCUS AREAS AND ACREAGE

Core Focus Areas	Description	Acres
Cedar Swamp Run (Bailey Brook)	0.9 miles of 1st order streams; 2.0 miles of 2nd order streams; >500 acre forested block; 37.4 acres of farmland of statewide importance; grassland, marsh and peatland habitats; exemplary seasonally flooded Atlantic White Cedar swamp; wellhead protection areas for Rye Water District and Aquarion Water Company	564.2
Seavey Creek / Fairhill Swamp	3,900 feet of estuarine shoreline along Little Harbor; 1.9 miles of costal shoreline; 136 acres of undeveloped shoreland; 192.3 acres of saltmarsh; exemplary Bayberry/beach plum shrubland and beach grassland	633.4
Lower Berry's Brook	1.4 miles of 1st order streams; 1.1 miles of 2nd order streams; 18.7 acres of saltmarsh; marsh and peatland habitats; exemplary high-brackish and low-brackish tidal riverbank marsh	270.2
Upper Berry's Brook	3.8 miles of 1st order streams; 2.8 miles of 2nd order streams; 2 contiguous blocks >500 acres; grassland, marsh and peatland habitats; 35.5 acres of prime farmland, 35.4 acres of farmland of statewide importance; wellhead protection areas for Rye Water District and Adams Mobile Home Park	786.0
Packer Bog	3.3 miles of 1st order streams; contained within a 5,000 acres forested block; marsh and peatland habitats; exemplary Red maple-sensitive fern swamp and Atlantic White Cedar-yellow birch-pepperbush swamp; wellhead protection areas for Portsmouth Water Works and Adams Mobile Home Park	174.8
Wallis Marsh	2.1 miles of 1st order streams; 2.3 miles of 2nd order streams; 73 acres of undeveloped shoreland; 128 acres of saltmarsh; 13.2 acres of prime farmland and 8.5 acres of farmland of statewide importance	310.9
Awcomin Marsh	3.4 miles of 1st order streams; 1.4 miles of 2nd order streams; 1.5 miles of 3rd order streams; 650 feet and 145 acres of undeveloped shoreland; >500 acre forested block; grassland, marsh and peatland habitats; exemplary low and high saltmarsh, intertidal flat, and subtidal/tidal creek bottom; 62.7 acres of prime farmland and 95.1 acres of farmland of statewide importance; wellhead protection areas for Rye Water District and Aquarion Water Company	884.9
Total Acreage		***3,624.4***

5. NH Wildlife Action Plan

The Fish and Game Department's NH Wildlife Action Plan (2015) contains information about high value wildlife habitat as well as mapping of wildlife habitat areas across the state. The Plan identifies three habitat tiers:

Tier 1: highest quality wildlife habitat in New Hampshire, representing the top 10-15% of wildlife habitats in the state, the ones most likely to maintain biological integrity over time

Tier 2: highest quality habitat within an ecoregion

Tier 3: locally high quality habitat

The Wildlife Habitat Map of Rye shows the occurrence of the 10 different habitat types occurring in Rye. These habitat types and acreage are reported in Figure 7-6, and a list of species for each habitat type is included in the appendix with this map. The Plan was updated in 2015 to include information about how climate change may impact and alter critical coastal habitats.

Tier 1, 2 and 3 habitats comprise 50 percent of Rye's 8,406 acres of land and water.
Refer to the Wildlife Action Plan map in Appendix A.

Figure 7-6

Habitat Types and acreage from the NH Wildlife Action Plan

Wildlife Action Plan Habitat Types	Appalachian Oak-Pine	Coastal Island	Dune	Grassland	Hemlock Hardwood Pine	Peatland	Salt Marsh	Temperate Swamp	Wet Meadow, Shrub Wetland	NLCD Developed Lands
Tier 1 = 1,715 acres	0.0	35.0	157.1	39.8	0.0	9.1	832.1	439.9	202.2	0.0
Tier 2 = 660.9 acres	120.8	0.0	0.0	13.8	14.9	100.1	0.0	372.2	38.0	1.1
Tier 3 = 1,856.6 acres	588.5	0.0	0.0	59.0	8.0	183.9	0.0	596.1	407.0	14.0
Total = 4,232.7 acres	***709.3***	***35.0***	***157.1***	***112.6***	***22.9***	***293.1***	***832.1***	***1408.3***	***647.3***	***15.1***

NLCD - National Land Cover Database

The Town could use the Wildlife Action Plan and maps to develop plans for management of town owned lands and to identify areas worthy of protection.

7.5 WATER RESOURCES AND SUPPLY

Since Rye is located in Rockingham County, one of the fastest growing population areas in New Hampshire, our water supply is a highly valuable important natural resource in the community. Approximately 75 percent of the town's drinking water is supplied by the Rye Water District from a system of bedrock wells. A portion of Rye is served by Aquarion Water Company and Portsmouth Water Division.

A. Ground Water Resources, Aquifers and Wellhead Protection Areas

Groundwater is present in both bedrock and in unconsolidated materials deposited by glaciers (sand, gravel, and till) that overlie bedrock (overburden). Rye is fortunate to have valuable groundwater deposits in both glacially derived deposits and bedrock.

1. Bedrock Aquifer

The Rye Complex which underlies much of Rye is a geologic formation containing zones of fractured bedrock filled with groundwater which provide sufficient yield to be a valuable drinking water supply source. The Rye Water District has sited drinking water wells on Garland Road in the stratified drift aquifer and the Rye Complex. Maps of Geologic Formations and Surficial Geology are in Appendix A.

2. Stratified Drift Aquifer

The glacially derived stratified drift aquifers, primarily composed of sand and gravel, are valuable drinking water sources. The Stratified Drift Aquifers Map in Appendix A shows the extent of these aquifers. The dark blue indicates areas where saturated sand and gravel have the highest yield or the greatest ability to transmit groundwater to wells. Stratified drift aquifers comprise 20 percent of Rye's 8,406 acres of land and water.

Figure 7-7

ACREAGE AND TRANSMISSIVITY OF STRATIFIED DRIFT AQUIFERS

Transmissivity	Acres
Less than 1,000 ft^2 per day	1,497.9
1,000-2,000 ft^2 per day	127.9
2,000-4,000 ft^2 per day	54.6
Greater than 4,000 ft^2 per day	16.0
Total	1,696.3

Transmissivity of Stratified Drift Aquifers quantifies the ability of an aquifer to transmit water.

Designated wellhead protection areas secure Rye's municipal drinking water wells and their contributing aquifer area. The town's Aquifer and Wellhead Protection District ordinance (Zoning Ordinance Article II, Section 306, adopted 2008, revised 2015) requires developers to protect the quality and quantity of groundwater resources in the district. Wellhead Protection Area and Stratified Drift Aquifer maps are in Appendix A.

3. Aquifer Protection

In 2008, Rye adopted an Aquifer Protection Overlay District within the boundaries of the Stratified Drift Aquifer. This limits land uses and prevents development and land use practices that would contaminate or reduce the recharge to the identified aquifers, and requires a hydrologic study for developments meeting certain size criteria. The Aquifer Protection Overlay District ordinance should be periodically reviewed and updated to assure that it is current with respect to town needs and hydrologic understanding.

4. Drinking Water Supply and Sources

Rye Water District

Rye Water District has two main sources of water, Rye production wells and water purchased from Portsmouth for customers on Wentworth Road, a section of Frontier Street, and Elizabeth Lane (off Pioneer Road). The District's primary source is the Garland well, a gravel-pack well, developed in the mid-seventies, which yields 400-470 gallons per minute (GPM). The District's secondary sources are two deep-driven high-yielding bedrock wells. First is the Bailey Brook well developed in the early eighties, which yields 300-325 GPM. Second is the Cedar Run well, our most recent source, developed and brought online in the mid-nineties. Cedar Run well yields 325-340 GPM. Combined, these three wells supplied over 133.5 millions gallons in 2016. The drinking water provided within the District's service area is a blend of all three wells.[1]

Aquarion Water Company

Aquarion Water Company services a small area of Rye located along the southeast coastal areas which include Jenness Beach and the Rye Beach Village District serviced primarily by Well 5A on Central Road. A map of this well is in Appendix A. For more information visit their website: http://www.aquarion.com/.

Portsmouth Water Division

The Portsmouth Water Division services portions of Rye from Wentworth Road along Sagamore Road to Foyes's Corner. For more information visit their website: http://www.cityofportsmouth.com/publicworks/water.

[1] Rye Water District 2016 annual report

In addition to the Aquifer Protection Overlay District ordinance, the town should

- Promote low impact development to protect all water resources in the town.
- Continue to promote best management practices for municipal, commercial and residential land use.
- Provide outreach and education to residents and business owners about threats to surface water and groundwater quality and water conservation practices.
- Continue to work closely with the Rye Water District on their drinking water and groundwater management activities.
- Seek to permanently protect land through land purchase or conservation easement to protect the water resource especially adjacent to water supply wells and wellhead protection areas.

Groundwater and Surface Water – a Single Resource

Although often thought of as distinct systems, groundwater and surface water, especially in coastal New Hampshire, are closely linked. A recent US Geological Society report states "As the Nation's concerns over water resources and the environment increase, the importance of considering ground water and surface water as a single resource has become increasingly evident". (Winter, et al., 1998). Groundwater will discharge to surface streams, wetlands and ponds, and surface water often provides recharge to underlying groundwater. Therefore, human activity can directly affect both the quality and the quantity of both

B. Surface Waters

Surface water resources are plentiful and diverse in Rye, but are nevertheless prone to threats from a variety of sources. Water quality is threatened by pollution from point sources (pollution from an identifiable point of discharge) such as septic systems, or run-off from parking lots and from non-point sources (pollution from an unidentifiable point of discharge) such as atmospheric deposition of acid rain and mercury. Waters are classified as "impaired" if they are of unsuitable quality for drinking, swimming, maintaining healthy aquatic biota and contact recreation (Flanagan et al., 1998).

Surface waters comprise 5 percent of Rye's 8,406 acres of land and water.

Figure 7-8

SURFACE WATER AND ACREAGE	
Surface Water Type	**Acres**
River/Stream	73.9
Lake/Pond	115.8
Other	49.8
Tidal Water	210.5
Total	***400.2***

Threats to surface water quality include a number of contaminants, such as metals (including mercury), PCBs, dioxin, nutrients (phosphorous and nitrogen) from agriculture and septic systems, commercial and residential use of fertilizers and pesticides, and industrial waste. Other pollution from physical and biological processes, including

siltation, erosion and accumulation of organic matter can cause low dissolved oxygen levels, drainage barriers, and habitat alterations. According to the Department of Environmental Services (DES), metals, PCBs (polychlorinated biphenyls), and bacteria are the leading threats to water quality in freshwater rivers and streams. Most recently, emerging contaminants such as PFCs have been detected in drinking water and groundwater in New Hampshire which poses a human health risk.

C. Freshwater Wetlands

Refer to the Freshwater and Tidal Wetlands map in Appendix A.

Rye has approximately 7 miles of coastline with tidal and fresh water wetlands comprising approximately 38 percent of Rye's total land area. Today, the coastline, estuaries, fresh water wetlands and salt marshes are protected by federal, state, and local regulations. Protection is given to Rye's wetlands by state regulations administered by the New Hampshire Department of Environmental Services (RSA 482-A), which requires that anyone planning to excavate, remove, fill, dredge or construct within a wetland obtain a state permit. The Rye Conservation Commission reviews all applications for state wetlands permits. Environmental impacts are assessed for each requested permit affecting these protected areas and their associated buffer zones.

Significant wetland acreage in Rye is located on town-owned land - Town Forest, Varrell Woods, Seavey Acres - and is preserved and made available for limited public use. Scenic hiking and walking trails are maintained through good forest management practices that promote healthy forest growth and wildlife habitat.

There are 5 major freshwater wetland systems in Rye, and two major tidal systems at Rye Harbor Marsh and Awcomin Marsh:

1. Berry's Brook – Bellyhack Bog
2. Witch Creek
3. Fairhill Swamp
4. Concord Point Drainage Basin
5. Cedar Swamp Run (sometimes known as Bailey's Brook)

Studies have found the Berry's Brook – Bellyhack Bog system to be the most pristine and the Concord Point Drainage Basin to be the most threatened. In 1993, the Berry's Brook Watershed Protection Council developed the Watershed Management Plan for Berry's Brook, prepared by Appledore Engineering, Inc. The Berry's Brook Plan includes an extensive inventory and analysis of watershed resources, a discussion of threats to watershed resources, a build-out analysis, an action plan of regulatory and non-regulatory strategies. The Plan recommends seven key policies to protect the watershed and its natural resources through an inter-municipal management framework.

The Conservation District, as adopted in the Rye Zoning Ordinance in 1989, also protects wetlands. The Conservation District is a resource based district, which includes most of Rye's salt marshes within its boundaries. The uses permitted in the Conservation District

include forestry, conservation, aquaculture, trail, nature centers and wildlife viewing blinds. Commercial, business, industrial and residential uses are prohibited.

The Town may wish to utilize the information in Figure 7-8 from the *Freshwater Wetland Mitigation Inventory for Nineteen Coastal Communities* (by West Environmental and Carex Ecosystem Services, in cooperation with Doucet Survey, Inc. 2003) to inform its current and future actions to protect Rye's wetlands.

D. Water Quality

1. Hydrology

Rye is part of two major drainage watersheds, the Piscataqua River Watershed and the Coastal Watershed, and six smaller subwatersheds. The ridge which traverses Rye diagonally from Little Harbor to Breakfast Hill forms the divide between the two watersheds. Water from the land surface flows towards the streams, wetlands and rivers located in the lowest points in each watershed area.

There is a large area of stratified drift aquifer in Rye, which contains several smaller areas of high transmission, as shown on the Stratified Drift Aquifers Map (in Appendix A). Transmission is a measure that quantifies the ability of water to flow through an aquifer, measured in feet squared per day. The aquifer's highest transmission rates are found in two areas, generally along Washington Road to the intersection of West Road, and near the intersection of Washington Road and Grove Road.

The information about the groundwater resources in Rye has been enhanced by the Fracture Trace Analysis done by the Rye Water District. Groundwater within the two major watersheds is interconnected by bedrock fractures so that water is exchanged between the two areas. Groundwater from municipal wells located in west Rye off Garland Road in the stratified drift aquifer and fractured bedrock provides much of the town's drinking water supply.

The primary relationships between hydrology and development concerns water quantity and water quality. Recent water quality evaluations have revealed bacterial contamination in the Parson's Creek watershed. Restoration of water quality in this area is under investigation and should be continued to identify and clean up these bacteria source areas. A septic system pump out ordinance for the Parson's Creek Watershed went into effect in 2016. Its impact on water quality improvements and the long-term viability of single home septic systems in this low--lying area are still not known as septic systems continue to be pumped for the first time under the program, inspected and potentially replaced.

2. Impervious Surfaces

Impervious or impermeable surfaces are hardened surfaces or structures in developed landscapes. Rainwater and snow melt flow across these impervious surfaces rapidly, picking up pollutants such as sediment, nutrients and petroleum-based compounds. Examples of impervious or impermeable surfaces include roads, parking lots, buildings,

roofs, concrete, pavement, compacted soils and crushed stone/gravel driveways. An zoning ordinance amendment in 2015 better defined impervious surfaces to include compacted gravel type driveways and parking.

Of the 8,107 acres of land in Rye, impervious surfaces have increased from 7.2 percent (576 acres) to 15.5 percent (1,350 acres) from 1990 to 2010.[2]

As shown in Figure 7-9, the amount of precipitation associated with the 50-year and greater storms events has increased in the last 40 years. This increase in precipitation when combined with the increased impervious surface has resulted in more frequent flooding and failure of older infrastructure not designed to manage increased runoff volume.

Figure7-9. Data for a range of 24-hour rainfall events. (TP40, 1961; NRCC, 2014)

24-hour Rainfall Events						
Source	**1 year**	**2 year**	**10 year**	**25 year**	**50 year**	**100 year**
TP40	2.6	3.1	4.4	5.2	5.8	6.5
NRCC	2.6	3.2	4.8	6.1	7.3	8.8

TP40 Technical Paper 40 was the previous standard used by the NH Department of Environmental Services, Alteration of Terrain Bureau. NRCC – Northeast Region Climate Center at http://precip.eas.cornell.edu/.

The increase of impervious surfaces through development affects water resources in several ways. Impervious surfaces impede the infiltration of water into the soil, reducing recharge of groundwater. Impervious surfaces combined with urban drainage systems such as curbs, gutters and storm drain pipes can alter the natural hydrology in a watershed by increasing the volume of stormwater runoff and altering drainage to wetlands and surface waters. Impervious surfaces can also result in loss of aquatic habitat, loss of biological diversity, and an overall decrease in water quality due to the accelerated delivery of pollutants into rivers, lakes, and estuaries (NHEP, 2004).

Studies report that levels of impervious surface in excess of 10% in a watershed can negatively affect water quality. When the percentage of impermeable surfaces in a watershed is 10% or less, streams typically retain good water quality and stable channels. More than twenty-five percent impervious surface can lead to severe physical and ecological damage to streams in a watershed.[3]

Increases in impervious surface may result in less infiltration of rainwater into the soil, conveying pollutants to water bodies, increasing flooding, streambed erosion, and sedimentation. Runoff may also change the temperature of bodies of water as it may be

[2] 2013 State of Our Estuaries Report, Piscataqua Region Estuaries Partnership

[3] Deacon, J.R., Soule, S.A., and Smith, T.E., 2005, Effects of urbanization on stream quality at selected sites in the Seacoast region in New Hampshire, 2001-03: U.S. Geological Survey Scientific Investigations Report 2005-5103, 18 p.

warmer. Loss of vegetated buffers adjacent to wetlands and surface waters due to development or erosion can also alter water temperature to a level at which species cannot persist.

Impervious surfaces represent a threat not only to natural landscapes, surface water and groundwater but also to the social and built infrastructure components of municipal services. In other words, reducing impervious surface not only helps to improve water quality, it may also result in lower municipal costs for road maintenance, snow clearing and lower development costs. A 100-foot reduction in road length will result in a savings of about $15,000. This figure includes savings from reduced pavement, curb and gutter and stormwater management structures (Center for Watershed Protection, 1998). Well-planned street layouts will reduce impervious surface and increase roadway connectivity. The goal is to protect sensitive resources and habitats, and create a street system that optimizes the ability of town fire and rescue officials to respond to emergencies in a timely and efficient fashion.

3. Pollution Sources

Contaminants introduced to groundwater pose a number of human health concerns. Pollutants in stormwater and snow melt runoff that can enter groundwater include pesticides, nitrates, phosphates, salt for de-icing roads (Perkins, 2004), household chemicals, metals, fertilizers, pesticides, oil, grease and pathogens. Other pollutants often found in runoff include pollutants derived from petroleum products which can leach from asphalt and coal tar-based sealants. Toxic substances in groundwater can affect humans through impaired drinking water supplies, water contact recreation and consumption of fish and shellfish. Contaminated groundwater and surface water affect wildlife species by degrading the overall water quality required for ecosystem function. Increased turbidity in freshwater streams for example results from erosion and has a negative impact on aquatic life. Fish and shellfish contamination not only affects human health but also has an economic impact on the fisheries economy and travel/tourism industry.

4. Impact of Septic System Expansion on Drainage and Water Quality

The negative environmental impact on water quality caused by septic system expansion and/or replacement in areas shallow to bedrock soil is an increasing problem. The mounding of the soil to properly elevate septic designs above the seasonal high water table causes excessive runoff to the adjacent roads, wetlands, and adjacent properties. Often, these septic systems are surrounded by lawn irrigation systems adding chemical and other pollutants to runoff which pose a threat to natural habitats and wildlife. There are several examples of this problem in the Fairhill Estate section of Rye. In fact, this has caused drainage problems adjacent to these “mounded” septic systems during particularly wet periods.

A better approach might be to include site-specific natural drainage planning when septic approvals are considered. This proactive approach could consider landscaping requirements using swales, rocks, shrubs, to allow lot specific drainage and, therefore,

avoid interrupting natural drainage patterns. This approach would proactively prevent standing water on the roads, which leads to pavement deterioration.

Septic systems that have failed or are not working properly can introduce excess nitrogen and bacteria into groundwater. Other components of septic effluent are not treated by infiltration and soil biological activity in the subsurface. New threats to groundwater and surface water include pharmaceuticals and personal care products that pass to groundwater from human waste through septic systems and from wastewater discharge. Household and landscape chemicals if not properly used or applied can also become incorporated into runoff and leach into surface water and groundwater.

Figure 7-10 summarizes water quality threats and describes strategies to address them.

Figure 7-10

WATER QUALITY THREATS AND STRATEGIES	
Threats to Water Resources	**Proposed Strategies for Rye**
Point Source Pollution	
Petroleum related contaminants, PFC's. snow removal chemicals such as road salt, accidental spills of chemicals related to commercial and industrial uses.	An Aquifer Protection Ordinance was adopted by the Planning Board which limits land use and requires protective measures and design review. Regular updates to the Ordinance should be incorporated to keep it current with new understanding of potential contamination sources_ –and other impacts to groundwater quality such as the emerging PFC contamination detected in monitoring wells at the old Coakley Landfill, Rye Breakfast Hill and Grove Road Landfills in the Rye Water District and Aquarion water supplies as well as Berry Brook watershed, ~~y~~. Require appropriate practices for handling and storing waste and snow removal chemicals.
Non-Point Source Pollution	
Atmospheric mercury contamination may have human health impacts, negative impacts to wildlife. Lead contamination from fishing equipment and hunting ammunitions.	Educate residents about fish consumption advisories and impacts of acid rain deposition, support recycling of mercury wastes, follow state plan for mercury reduction. Educate anglers about New Hampshire's prohibition lead sinkers and jigs, and safely dispose of certain lead sinkers and jigs at NH Fish and Game offices. Reference the Berry's Brook Watershed Management Plan.
Pharmaceuticals and personal care products; nitrogen introduced through landscaping chemicals, fertilizer, and septic systems; and hazardous household chemicals.	Promote landscape and field management practices that optimize and reduce landscaping chemicals. Promote on-site management of stormwater. Promote the use of slow release nitrogen fertilizer. Promote these changes through outreach to landscape professionals. Residents and commercial property owners and ordinances if necessary. Additional promotion for the annual Hazard Waste Collection Drive.

Lawn irrigation and landscape water use places demands on water resources during the time of year when water levels are typically lowest.	Provide outreach and education to landscape professionals, residents and commercial property owners on optimizing water use, using low impact irrigation techniques and using water based on soil moisture and plant needs. Consider restrictions on pesticide/fertilizer use in new subdivisions that abut wetlands
Stormwater runoff can introduce pollutant and excess nutrients to surface water and ground water impacting water quality.	General land use and natural resource protection measures incorporated into plans, policies and practices. Follow recommendations of Berry's Brook Watershed Management Plan and other watershed plans developed for Rye watersheds. Review and update these plans as needed. Consider adoption of buffers to surface waters, wetlands and salt marsh.

7.6 Fragmentation and Land Development

Refer to the Developed Parcels map, Zoning District map and Impervious Surface map in Appendix A.

A. Fragmented Landscapes

Everyday human activities and land conversion associated with development can have negative effects on natural resources, ecosystems and wildlife. Loss of habitat and wildlife corridors can impact species abundance and diversity. Direct and secondary impacts from development may include pollution, degraded water quality and changes in hydrology and landscape functions. Lighting can affect the behavior and biological rhythms of species that are guided by cycles of light and dark. Landscape fragmentation takes places when large, contiguous tracts of undeveloped land are broken up into smaller or non-contiguous tracts of land for residential or commercial development. Much of the seacoast region is zoned exclusively for residential development which has created a dispersed land development pattern of low-density subdivisions known as sprawl.

Sprawl interrupts natural landscape functions such as hydrology, ecosystem function, and landscape succession (such as maturation of forests and riparian corridors). Fragmentation and sprawl can lead to negative direct and secondary impacts on natural resources, the economy, and society. Fragmentation impacts flood retention as more impervious surfaces such as pavement and structures disrupt natural drainage patterns.

Forest and Open Space Preservation

Preserving large areas of forests and open space is a tool to prevent fragmentation and is critical for sustaining wildlife and their habitat. Development of the natural landscape results in the loss of habitat and habitat fragmentation. Large blocks of forest, wetlands and farmland that are unfragmented by development or public roads are valuable for many reasons. Having unfragmented blocks have many benefits:

- *Providing essential forest interior habitat for species such as some songbirds that need to be distanced from human activity, pets, and the forest edge to thrive.*
- *Providing habitat for mammals that have large home ranges and prefer to avoid human contact.*
- *Minimizing conflicts that can arise when managed forests and farms are surrounded and interspersed with development.*
- *Offering opportunities for remote recreation, including hunting, hiking and snowmobiling, where landowners allow.*

Impervious surface cannot absorb water allowing runoff to flow more quickly to streams, rivers, and lakes than it would over forested, wetland or grassed landscapes which slow down water flows, act as filters and serve as water recharge areas for groundwater (Forest Service, 2005; CEP, 2003; Biodiversity Project, 2005).

Fragmentation disrupts wildlife corridors used by animals as routes to food and water and connections to habitat areas (Forest Service, 2005). The Society for the Protection of New Hampshire Forests observes that the state's predicted growth over the next twenty years will fragment the large blocks of forests and wetlands that are crucial for providing wildlife habitat and sustaining critical ecological processes (SPNHF, 1999).

7.7 Coastal Hazards and Climate Change

Our ocean frontage may be our most important natural resource, but it also presents a great risk to both municipal assets and private property. Over the years, Rye has experienced damage to seawalls and shale piles, state and local coastal roads and private properties. With concerns about global warming and increased coastal storms, the community should expect conditions that we faced during the storms of 1978 and 2018 to occur again and be prepared to adapt to changing conditions.

Incorporating the latest future projections of sea-level rise and storm related flooding into municipal planning and projects will minimize vulnerability and prove beneficial even if future hazards turn out to be less extreme than anticipated.

Adapting to changing conditions means designing buildings and facilities that account for flooding or modifying uses of land that are compatible under a wide range of conditions. The process of adapting creates buildings and systems that are more ***resilient*** and better able to perform with fewer impacts.

Adaptation – adjustments in ecological, social, or economic systems in response to actual or expected climatic change and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. [http://unfccc.int/focus/adaptation/items/6999.php]

Resilience - a capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment. [EPA http://epa.gov/climatechange/glossary.html]

Climate Change impacts could affect quality of life in New Hampshire. Alterations to our climate will result in adaptive changes or decline in certain sectors of the regional economy, including winter tourism, agriculture, maple syrup production, coastal real estate values due to sea level rise and increase in storm intensity and health costs associated with respiratory health and heat related illnesses. With respect to local hazard mitigation planning, it is important to consider the potential future impacts of climate change including sea level rise, flooding, coastal erosion, increased intensity and frequency of storms and the effects of changes in temperature and precipitation.

Our state's economy is linked to both summer and winter recreational activities based on its natural resources. If these suffer, the economy will also suffer. Increased frequency and severity of damaging storm events and droughts could cause financial and personal hardships. Decreased quality and production of forestry and agriculture products could also have a significant impact on the economy and quality of life.

NH Coastal Risks and Hazards Commission Report (2016)

Rye was represented on the NH Coastal Risks and Hazards Commission (CRHC), whose charge was to investigate future impacts of climate change and coastal hazards including flooding from increased precipitation, coastal storms and sea-level rise. With respect to community planning, infrastructure management, land development and environmental planning, the Commission's report offers the following guidance as well as 35 recommendations relating to the built landscape, natural resources, heritage and economy. The CRHC's report is available at http://www.nhcrhc.org/.

Tides to Storms Vulnerability Assessment (2015)

The Tides to Storms Vulnerability Assessment report (2015, Rockingham Planning Commission) details impacts from sea-level rise and storm surge flooding to Rye's land based and natural resources, transportation infrastructure, and critical facilities. By far salt marshes may be the most heavily impacted by future sea-level rise. Depending upon the ability of salt marshes to adjust to rising seas by increasing in height and the absence of inland barriers, salt marshes may be able to migrate inland over time or, if not, will convert to open water. The report is available at http://www.rpc-nh.org/regional-community-planning/climate-change/resources.

Recommendations for Climate Adaptation Actions
(from the 2015 Master Plan Public Input Session, NH Coastal Risks and Hazards Commission Report (2016) and Tides to Storms Vulnerability Assessment (2015))

NR1. Assess vulnerability of natural features and engineered structures that protect people, structures and facilities under current and future conditions.

- 1a. Identify and map natural resources vulnerable to current and future coastal risks and hazards.
- 1b. Identify potential sites for natural approaches to shoreline stabilization (e.g. saltmarsh, vegetated buffers).
- 1c. Prioritize areas for beach nourishment and other shoreline stabilization techniques.

NR2. Develop natural resource restoration plans that explicitly consider future coastal risk and hazards and the ecological services that they provide.

- 2a. Utilize marsh migration modeling to identify and prioritize marsh migration areas for conservation and restoration.
- 2b. Develop a wetland restoration inventory that identifies opportunities to restore buffers, protect land and restore wetland functions.
- 2c. Provide recommendations and incentives for removal of structures and facilities that create barriers to tidal flow and habitat migration. Prioritize barriers that will be impaired or severely impacted by sea-level rise, storm surge or extreme precipitation.
- 2d. Engage in best practices for invasive species planning and removal and incorporate climate considerations in invasive species removal plans.
- 2e. Manage wildlife that interfere with the function of drainage infrastructure.

NR3. Protect land that allows coastal habitats and populations to adapt to changing conditions.

3a. Continue to support land preservation, acquisition of easements and development rights to transfer property vulnerable to future sea-level rise and coastal flooding to conservation lands.

3b. Establish buffer requirements for waterways, shorelines and wetlands that include consideration of climate change and create a dedicated fund to support local enforcement.

3c. Encourage landowners to preserve the beneficial functions of natural features like wetlands and sand dunes and to restore and protect coastal habitats.

NR4. Consider ecosystem services provided by natural resources in land use planning and development.

4a. Implement strategies and tools (such as land regulations, incentives, building regulations) designed to maintain or restore pervious surfaces, reduce pollution, protect vegetated buffers and maintain wildlife passage.

4b. Encourage best management practices for shoreline buffers, including information on appropriate use of shoreline hardening, bank stabilization, vegetation restoration and agricultural practices.

4c. Explore options to minimize shoreline hardening and promote natural or combination of natural and constructed shoreline protection strategies.

NR5. Develop plans and implement strategies to prepare and adapt recreational resources based on best available climate science.

5a. Assess existing and future recreational areas for their potential to provide storage for flood waters and stormwater runoff.

5b. Integrate protection of recreational resources into land use and management, engineering, regulations and plans.

5c. Utilize research documenting the effects of freshwater flooding and rising temperatures on natural resources and ecosystems.

7.8 Next Steps

Based on information in this chapter and input from the 2002 Master Plan Visioning Session, the following matrix of goals, strategies and actions was developed. Town boards and citizens can use this action plan as a guide to develop action plans to address specific natural resource needs.

Resources are available to assist the Town in developing strategies and specific actions to achieve their chosen goals, including the Rockingham Planning Commission, UNH Cooperative Extension and the Handbook for New Hampshire's Municipal Conservation Commissions (Swope, 2004).

NR6 Convene periodic Community Vision sessions to identify problems and opportunities to improve resource protection and management.

NR7 Continue to acquire and manage lands for conservation, and to protect and restore wildlife corridors. Maintain a current inventory of conservation lands.

NR8 Encourage Conservation Commission to implement public outreach activities and engage the public in natural resource conservation initiatives.

NR9 Ensure the Conservation Commission and local land trust continue outreach to property owners about land stewardship. Increase public awareness of open space and conserved land resources.

NR10 Continue to manage forests for conservation, recreation and commercial uses.

NR11 Protect forests and green corridors through land purchases and the development approval process.

NR12 Periodically update the town's forest management plan.

NR13 Continue protecting wetlands and their buffers from point and non-point source pollution, and strengthen protection through zoning ordinance standards such as a mandatory conservation-open space subdivision ordinance.

NR14 Seek transportation enhancement projects that connect areas of town to improve access to recreation and travel.

NR15 Continue protections for water quality and water quantity and plan for future land use. Educate landowners about proper chemical disposal and use of fertilizers and pesticides.

NR16 Develop an action plan and make funding available to monitor invasive species, which would include activities at the Rye Transfer Station, such as providing adequate disposal facilities for certain types of invasive species.

NR17 Consider preparation of a comprehensive effort to map invasive species throughout the town, including salt marches, wetlands, side roads, public spaces and the town forest.

NR18 Provide information about invasive species and how to control them to the public, land use boards, elected officials and municipal staff.

APPENDIX A: MAPS

Land Use/Land Cover: 1962, 1974, 1998, 2005, 2010, 2015

Freshwater and Tidal Wetlands

Conservation Lands

Core Focus Areas – Land Conservation Plan for New Hampshire's Coastal Watersheds (2006) https://forestsociety.org/resource/land-conservation-plan-nhs-coastal-watersheds

NH Wildlife Action Plan maps at http://www.wildlife.state.nh.us/wildlife/wap.html

Aquifers

Surface Waters

Developed Parcels

Impervious Surfaces