

LANDSCAPING at the Water's Edge

AN ECOLOGICAL APPROACH



A MANUAL FOR NEW HAMPSHIRE LANDOWNERS AND LANDSCAPERS

ACKNOWLEDGEMENTS

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If you were to walk along the shoreline of a lake or river, what would you find? The complexity of this question is better answered through another question: what do you want to see? Well, for most of us, we want to set our eyes upon clear, clean water that invites us to relax and enjoy the beauty before us. The water's edge is the protective barrier that ensures a nice afternoon for boating, swimming, catching that elusive fish, or simply enjoying the beautiful view and watching for wildlife. It also ensures a healthy natural environment for wildlife. Without it, most of the good things about our lakes and rivers would diminish entirely.

Most shorelines include trees, small shrubs and groundcover all designed by nature to protect our water bodies. The more natural barriers we remove, the more likely the lake or river will be negatively impacted by erosion and runoff. Eroded shorelines invite runoff carrying pesticides, chemicals, and nutrients into the water that kill fish and promote the growth of aquatic weeds. Find a waterbody with no vegetation along the shore and you will see a murky mud puddle that no longer is the ideal spot to spend your Saturday afternoon in July.

Once a lake or river has been degraded, it is very difficult to restore its quality. In fact, there is a clear link between property value and water quality. When water quality is high, property values continue to increase. However, if water quality is negatively impacted, property values often go down. Therefore, your home along the lake will decrease in value once there is a decline in water quality.

With a better understanding of landscaping along our water's edge, we can protect our resources and guarantee our investments. After reading through this document, you will understand that you can have your grass and cut it too with a wonderful view, as long as you understand the need to include trees and shrubs along the shoreline as well. Deep roots along the shore make for clear, clean lakes.

Remember, maintaining a healthy waterfront is critical to the ecological, economical and aesthetic investments in your property and New Hampshire's waterbodies.

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INTRODUCTION



An ecological approach to your shoreland landscape will enhance the beauty and functionality of your surroundings. Whether you are a property owner or a landscape professional, the decisions you make affect water quality and the health of the entire ecosystem.

This book will help you understand the basics of how watersheds and shoreland ecosystems function so you can use the strategies and techniques presented to help prevent soil erosion, nutrient and pesticide runoff, exotic plant invasions, and other detrimental processes associated with developed landscapes. Applying the principles of ecological landscaping will support wildlife and plant diversity and maintain or even improve water quality in our lakes, streams, rivers, bays and estuaries.

Besides “doing the right thing,” your actions have a huge impact on human, environmental and economic health. Public health demands abundant supplies of clean drinking water and clean air to breathe, benefits that good landscaping practices help provide. The economic value of waterfront property and a significant share of the state’s tourism revenues derive from the recreational opportunities and attractive views afforded by sparkling water, and healthy, diverse communities of plants and animals.

In 2002 the New Hampshire Lakes Association estimated the economic impact associated with our lakes, rivers, bays and other water bodies at \$1.8 billion annually. The study considered just five major uses of surface water in New Hampshire: swimming, boating, fishing, drinking water, and waterfront property taxes.

Developing waterfront property is no longer simple and easy. State, federal and local agencies have enacted many restrictions, rules, laws, and permit requirements pertaining to construction and landscaping near the water. Although we have referred to some of the key state regulations throughout the book, always make sure to check with local and state authorities before beginning any construction or making major landscape changes near the water. The objective of all these regulations is to protect the land and water from degradation so our surroundings remain clean and safe for recreation and public water supply.

While most of the regulations address construction or major changes to the shoreland or adjacent property, every citizen who lives in the watershed should be concerned with the impact of his or her actions on the environment. The balance of nature is easily disrupted by humans, with far-reaching impacts on water quality, soil health and stability, animal and human health, and the living ecosystems around us.

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Landscaping on the Edge: Soil and Water

Well-landscaped yards add value and character to our homes and properties. Our yards don't have to be professionally designed or elaborate for us to take pride in them. Every tree, shrub, and plant has a special meaning to us and we get great joy from tending to it and watching it bloom and grow.

But a well-landscaped yard offers benefits beyond personal enjoyment. Carefully designed and well-maintained, a home landscape also benefits the environment by creating wildlife habitats, reducing erosion and runoff, and filtering water. Conversely, a poor landscape design and poor maintenance practices can degrade our environment, leading to water pollution, soil erosion, and habitat destruction.

We produced this book to help landscapers and property owners living along New Hampshire's lakes, ponds, rivers, and streams make decisions about landscape design and maintenance that will reduce pollution and environmental degradation. Each chapter addresses a different aspect of environmentally friendly landscaping.

If read from start to finish, this book will guide you through all the steps of creating and maintaining an environmentally-friendly landscape. But each chapter is designed to stand alone, so those with established landscapes can refer to the appropriate section when considering renovations or new maintenance plans.

It all starts with the soil

Healthy soil is the foundation of any productive landscape planting. Good-quality soil holds water but drains well, is well-aerated, and is fertile enough to support plant growth. Soil serves many functions in a landscape. Most importantly, it provides a medium for the exchange of water, nutrients and air among plants, the earth, and the atmosphere. Soil anchors plants to the ground and filters out many pollutants before they reach ground or surface water.

Soil formation

Soil is formed by the weathering of parent rock material over millions of years plus the decomposition of organic material. Five main factors influence soil formation: climate, living organisms, topography, parent material and time.

Climate plays a primary role in soil formation. Soils in warmer regions form more quickly than those in cooler places, because high temperature accelerates chemical reactions that break down rocks. Rainfall also weathers rocks, so soils form faster in regions with substantial rainfall.

Living organisms also play an important role in soil formation. Microorganisms such as fungi and bacteria decompose organic matter and recycle nutrients. Earthworms and burrowing animals aerate the soil by tunneling and break down organic matter as it passes through their digestive systems.

Topography of land also affects soil formation. A soil's composition is influenced by its location relative to the shape and slope of land around it. Soil located at the bottom of a slope tends to accumulate in deeper layers and to be more nutrient-rich than at the top of a slope, where soil is more prone to erosion.

Parent material is weathered bedrock in soil. Residual parent material is formed from rock native to the site, which may be buried under layers of soil or exposed as ledge. Transported parent material is weathered bedrock that has been carried by wind, water, gravity or ice to a different location where soil was being formed. Granite is a common type of bedrock found in the Northeast.

The time it takes for a soil to form depends on the four previous factors and their interactions with one another. Soil forms more quickly in tropical regions, where temperatures are warmer and rainfall is more plentiful than in colder northern regions.

Soil composition

Soil is composed of four types of matter. The solid components are minerals and organic matter. Spaces filled with water and air make up the rest (Figure 1-1).

Minerals derived from weathering rocks make up the greatest percentage of any soil, 45 to 50 percent by volume. Sand (the largest particles), silt (medium-sized particles) and clay (the smallest particles) are called soil separates and are formed from minerals in weathered rock. As noted above, the mix of these soil separates determines the texture of a soil. Sand, silt and clay consist primarily of the elements silicon, oxygen, aluminum, and can contain

PHYSICAL CHARACTERISTICS OF SOIL

Soil texture refers to the proportion of sand (the largest soil particles), silt (particles of intermediate size) and clay (the smallest particles) in a soil. Coarse-textured soil is gravelly or sandy, soil with an intermediate texture is called "loamy," and fine-textured soil is "clayey." Sandy loam, a texture desirable for horticulture, is made of about equal parts of sand, silt and clay. Our Northeastern soils can vary a great deal from one location to the next. This is due to glacial movement of parent material. Since sandy loam is made up of a mixture of particle sizes, it holds enough water for plants but still drains well.

Soil tilth is a term used to describe the porosity and aeration of soil. A soil with good tilth allows water to enter easily, stores water, and drains well. It has plenty of air space for exchange of gases among plant roots, microorganisms and the atmosphere, and it provides space for plant roots to grow. A soil with excellent tilth is very permeable, so it won't contribute much to runoff.

Soil aggregates are clumps of minerals and organic matter bound together by humus, fully-decomposed organic matter that stores nutrients for slow release to plants. Soil with good aggregation has small and large pore spaces between the clumps for air and water to move through. To preserve aggregates in soil, landscapers should cover the soil surface with plants or mulch and avoid practices that compact soil. Soil compaction occurs when soil aggregates are squeezed together by heavy equipment use (such as tractors, mower, and vehicles) and/or repeated foot traffic. When soils become compacted they are not permeable and drainage is impeded. Compacted soils can be as impermeable as cement and can contribute greatly to runoff volume.

Soil structure refers to the way soil particles are held together. Structure is important because it affects infiltration of water and root penetration. Structure depends on the soil-forming factors discussed earlier. Classes of soil structure include granular, blocky and platy.

substantial amounts of potassium, iron, calcium or magnesium, plus very small portions of other elements. Sandy soils don't retain much water because the large spaces between the particles allow for water to move through easily. The smaller particle sizes of clay and silt fit together so tightly water cannot easily flow through the fine spaces between them. Clayey and silty soils retain ample amounts of water, or in some instances such as in heavily compacted soils, are nearly impervious to water infiltration.

Organic matter makes up a small proportion of any soil, typically between one and five percent, but it contributes some of the most important qualities to a healthy soil and plant system. Organic matter is dead and decaying plant and animal matter. Animal manures and compost are good sources of organic matter used in gardens and on crop land. Cover crops such as rye and clover will increase organic matter when incorporated into the soil. Gradually decomposing organic mulches such as straw, leaves, or shredded bark add organic matter to soil, while shading and protecting the soil surface from erosion. Adding organic matter to soil improves its water-holding capacity, promotes a diverse population of beneficial soil organisms and provides a source of plant nutrients. Soils rich in organic matter can absorb and hold more water, reducing the amount of runoff and leaching.

Soil water, about 25 percent of an average soil's volume, is a solution of water, microorganisms, and dissolved nutrients from minerals and decayed organic matter. Plant roots absorb water and nutrients from the soil solution.

Soil air, which ideally occupies another 25 percent of a soil's volume, provides a place for gas exchange for the organisms that live in the soil. Plant roots, microbes and other soil organisms all use oxygen and release carbon dioxide during the essential process of respiration. When soils are saturated, the air spaces are filled with water instead, so respiration rates are reduced.

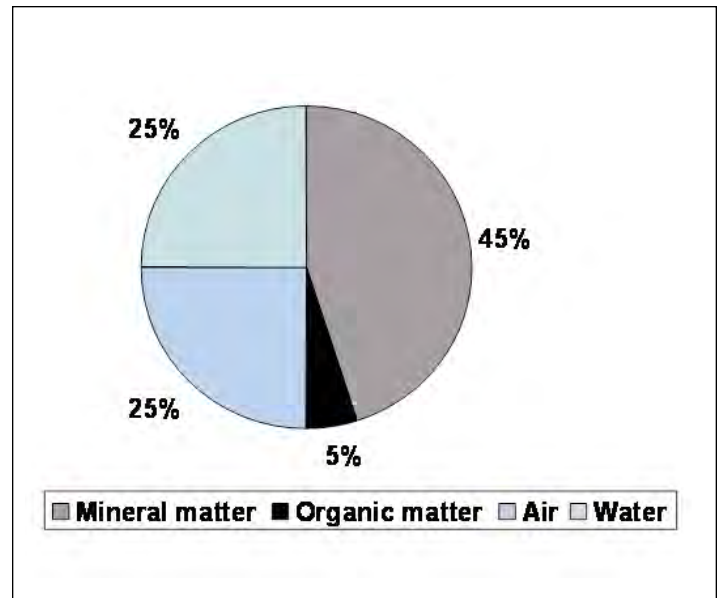


Figure 1-1. About one-half the volume of a good soil is solid particles (mineral and organic matter) and the other half equal portions of water and air space.

Soil pH, fertility and testing

Soil pH is a measure of soil acidity or alkalinity, measured on a scale from 0 to 14, with 7 being neutral. Acidic soil has pH less than 7 and alkaline soil has pH above 7. Soil pH is influenced by parent material, crop management practices, organic matter and water source, including acid rain.

Many of our Northeastern soils are acidic and require limestone or small amounts of wood ash to raise pH to a level where nutrients become available to plants. Most landscape plants grow best in a slightly acidic range of 6.2 to 6.8. Some common exceptions include rhododendron, azalea, holly and blueberry, all of which need a more acidic soil. You can use

elemental sulfur or iron sulfate to lower pH. The most important things to remember about pH management are:

- Test your pH once every 2-3 years.
- Apply limestone or sulfur only when soil test results indicate a need for it.
- Apply limestone, wood ash, or sulfur at the recommended rate based on a soil analysis.

Soil contributes plant nutrients. A plant requires 18 nutrients to grow normally and complete its life cycle. Plants need large amounts of carbon, oxygen and hydrogen. They get carbon and oxygen from air and hydrogen from water. The nutrients you hear most about, because they are commonly applied as fertilizers, are the macronutrients: nitrogen, phosphorus and potassium. You will see them listed as “N-P-K” or simply as a ratio such as 10-5-10, 5-3-4, etc. on bags of commercial fertilizer.

Calcium and magnesium are usually adequately supplied by the soil or by additions of liming materials if needed. Sulfur, iron, manganese, copper, zinc, boron, molybdenum, chlorine, cobalt and nickel are also usually present in adequate amounts in the soil if the pH is adjusted to the proper range. Excess amounts of these micronutrients can be toxic to plants. Building organic matter in soil is the best way to supply and retain many of the nutrients essential to plants.

Managing soil fertility and pH begins with soil testing. Healthy landscape plantings depend on high-quality soil. Home landscapers and professional landscape managers can measure soil fertility by testing for plant nutrients, soil pH and organic matter. University and commercial soil testing laboratories produce more accurate results and provide localized recommendations, so are generally more useful than do-it-yourself kits purchased in retail stores. More information on UNH testing services can be found through the UNH Cooperative Extension website, where fact sheets are also available to help you understand your soil test results (Appendix B).

Soil testing is important because over-application of fertilizer, manure and compost may contaminate surface water and groundwater as excess nutrients run off or leach. Conversely, nutrient-deficient soils may produce weak, unattractive plants susceptible to damage from disease and environmental stress.

A soil test may save a landscaper or homeowner a great deal of money either by avoiding the cost of fertilizer when enough nutrients are already present, or by investing in the long-term health of plants by fertilizing appropriately when soil nutrients are lacking. You may find your soil already has adequate levels of nutrients from organic matter and minerals. As long as the pH is adjusted for optimal growth of the plants you want to grow, you may not need fertilizers. Unless your soil is high in organic matter, however, nitrogen is likely to be recommended for quick growth or green grass.

Everyone lives in a watershed

Even the largest landscaped area seems small in comparison to the whole environment, so it may seem absurd that one tiny yard could have any impact on the environment at large. But it does. You don't have to have a three-acre garden or a scenic view of a lake to have a big impact on water quality. Each one of us affects the quality of water in the lakes, rivers, streams and coastal

drainages in New Hampshire and even New England. That's because each of us lives in a watershed.

A watershed is an area of land that drains into a common body of water. Watersheds can be very small, for example, a neighborhood that drains into a local stream. Or they can be very large, stretching across miles of land, encompassing many smaller watersheds and many small or large tributaries. The Gulf of Maine watershed, for example, includes large areas of Massachusetts, New Hampshire, Maine, New Brunswick and Nova Scotia, encompassing more than 69,000 square miles of land through a network of streams, lakes, rivers, wetlands and other channels.

With our steep terrain and rocky soils, most New Hampshire watersheds are very small and encompass less than three square miles. But these smaller watersheds come together to form nine major river watersheds (Figure 1-2). So, decisions about how we manage the landscapes around our homes can end up having a huge impact, not only on the quality of water in our local streams and ponds, but even in more-distant rivers, lakes and estuaries.

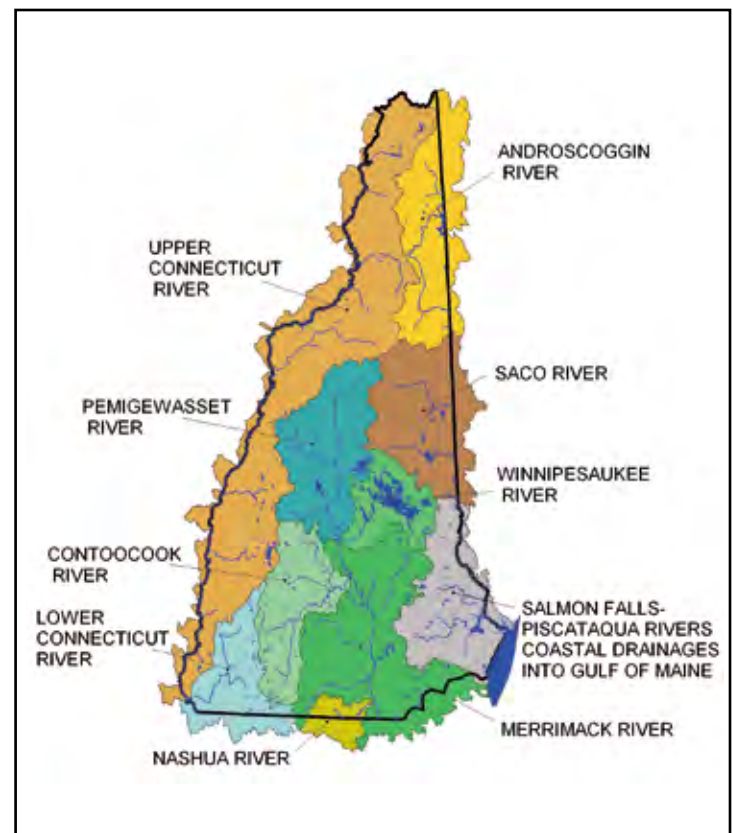


Figure 1-2. New Hampshire's nine major watersheds.

Water on the move

Water travels through a watershed in two ways, across the surface and down through the ground. As water traveling on the surface moves along, following the path of least resistance, it passes across various types of land. In a state as geographically diverse as New Hampshire, a drop of water might travel across your driveway and neighborhood roads, through a wooded area and into an open field. Unless it infiltrates down into the ground, gets intercepted by a plant or evaporates into the atmosphere, the drop will end up in a lake, pond, stream, wetland or estuary.

As water travels downhill, it picks up small particles and soluble materials and carries them along to the water body at the end of its journey. It might pick up pesticides or fertilizers from a backyard garden, and salts and oils from a driveway or patio area. In times of heavy rain, fast-moving water picks up soil and deposits it directly into the water body. Soils and sediments carry nutrients, pesticides and other chemicals, and naturally occurring minerals into surface waters.

The flow of water and materials from a given location across the soil surface and into surface water is called runoff (Figure 1-3). The potential for runoff increases as the slope of the land increases. Runoff also increases as the permeability of the land decreases. Permeability is a measure of the ease with which water or air penetrates and moves through the soil. For example, a paved, impermeable driveway has a greater potential for runoff than a gravel, permeable, driveway. The permeability of a soil greatly depends on the physical characteristics of the

soil, namely soil texture, soil tilth, soil aggregation and soil structure.

Water not carried on the surface by runoff infiltrates and drains downward through the ground. Once below the surface, water not taken up by plant roots drains down beyond the plant root zone where it eventually collects within the semi-permeable layers of rock. The amount of water that travels downward and the speed at which it travels greatly depend on the texture and structure of the soil layers the water travels through.

The process by which water carries soluble fertilizers, pesticides, detergents, and other household materials downward below the root zone of plants is called leaching. Materials that leach through the soil profile may reach groundwater. However, the soil acts as a tremendous filter and many potential contaminants will be adsorbed to soil particles or broken down by soil microbes along the way, preventing them from reaching groundwater. When groundwater feeds into lakes and streams, any remaining contaminants may affect the surface waters.

If you dig down into native soil you'll notice it is composed of different layers that vary in their color, texture, tilth, aggregation, and structure. These different layers (horizons) make up the soil profile. The top layer of the soil is usually very permeable, allowing easy infiltration of water. Construction of houses, roads, parking lots and other buildings usually disturbs the natural soil profile, as topsoil is often removed and/or fill soils brought in from other locations. Soils are often compacted by vehicles and machinery. All these factors can significantly alter the original soil characteristics.

The uppermost layer of soil is called the unsaturated zone because water rarely collects there, instead, either flowing downward or getting absorbed by plant roots (Figure 1-4). Deeper into the soil profile you'll find layers of sand, gravel, and fractured bedrock. These materials aren't as permeable as the soil layers above them, and water has a harder time moving through and around them. These deeper layers are known collectively as the saturated zone, because water collects in cracks and large spaces between the rock materials.

Water held in these semi-permeable layers is called groundwater.

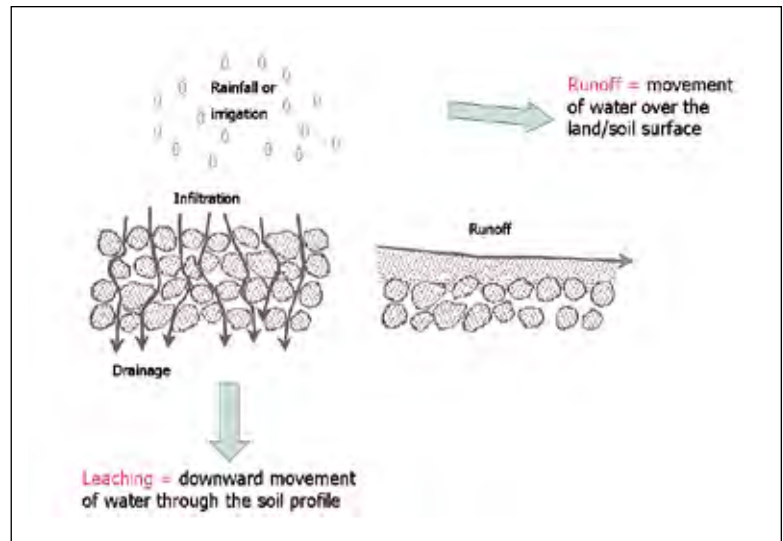
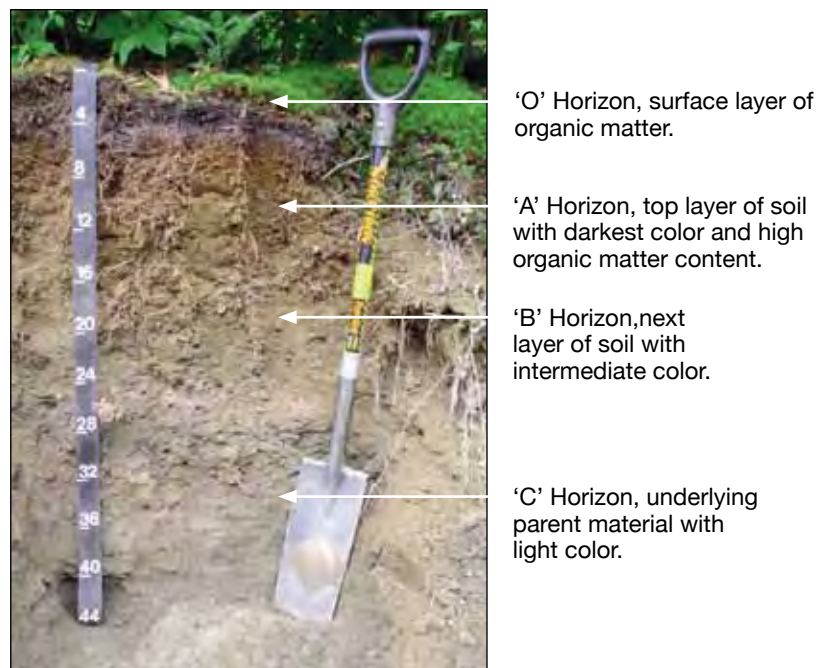


Figure 1-3. Pathways by which water moves from the soil surface.



A soil profile shows differences in color due to organic matter content and mineral make-up. Most root growth is in the top foot of soil.

Note: subsurface drawing not to scale

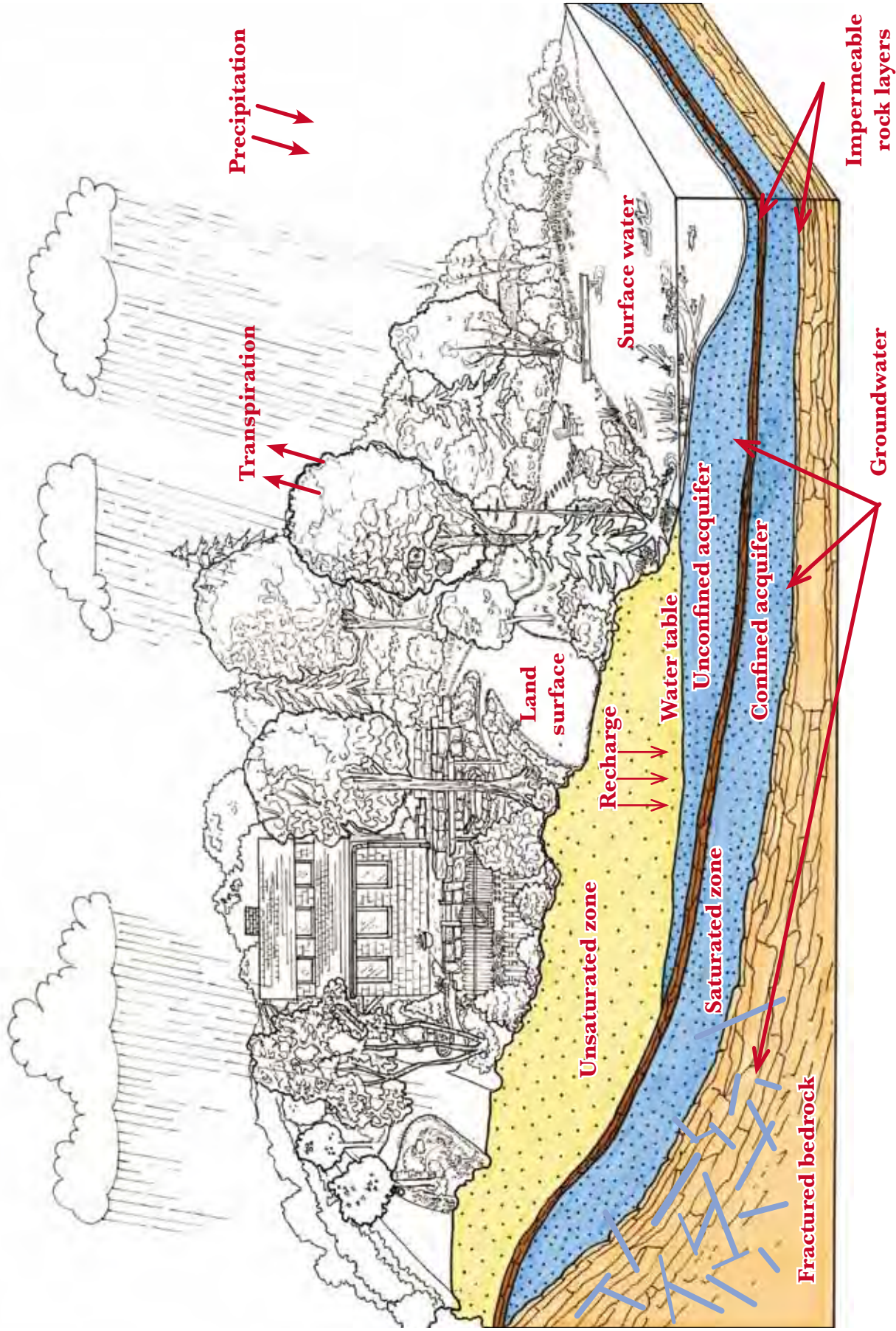


Figure 1-4. Groundwater is recharged by precipitation that infiltrates through the layers of soil in the unsaturated zone and into the underlying aquifer. Wetlands and well-drained soils are particularly important for recharge to occur.

Groundwater is water that fell as precipitation, infiltrated into the soil and was not taken up by plants. It may take rain water decades or centuries to reach and recharge the deep groundwater accumulations we call aquifers.

The line where the unsaturated zone meets the saturated zone is known as the water table. In times of high precipitation or snowmelt, the water table may rise close to the surface of the land. In times of drought, when there is not much groundwater present, the water table can lie deep below the surface.

Where the water table is naturally high, or after a time of heavy precipitation, the groundwater level rises closer to the surface of the land and feeds into a lake, pond or stream. If the groundwater level breaks the surface it is called a “spring” or a “seep.” Surface waters are termed “spring fed” when groundwater is the sole source of water. Some lakes and ponds, called seepage lakes, are fed solely by groundwater. However, most lakes and ponds in New Hampshire also receive surface runoff from tributary streams and surrounding lands.

The main factors that determine the amount of surface water runoff that reaches our lakes and streams are the soil composition, topography, the extent of impervious surfaces, and the amount and type of vegetation that the runoff water encounters along the way. The next chapter offers detailed information to help you inventory and manage water flows on your property.

Plant cover

Plants intercept and slow the speed of water as it travels across the soil surface, allowing more of it to infiltrate into the soil. Plant roots absorb water but use only a little of it for their own

needs, releasing the rest through their leaves as water vapor, a process called transpiration. The more plants growing in an area, the greater the volume of water that is slowed down and captured, reducing the amount that drains all the way through the soil or continues on as surface runoff. We’ll talk more about the importance of plant cover in the following chapters.



The right side of this pond has become enriched by nutrients in runoff from nearby farm fields, causing algae to proliferate and turn the water green. The left section of the pond is isolated from the runoff by a small dam.

CONTRIBUTING SOURCES OF NITROGEN AND PHOSPHORUS IN SURFACE WATER

- Agricultural fertilizers and livestock manure
- Municipal sewage treatment plants
- Individual septic treatment systems
- Decaying plant material including yard waste
- Runoff from urban areas and construction sites
- Stream-bank erosion
- Wildlife and domestic pets

Nonpoint-source pollution

Nonpoint-source pollution occurs when water running over land or through the ground picks up pollutants and deposits them in surface water or groundwater. Nutrients, petroleum products, industrial chemicals, pesticides, sediments, salts and animal waste are all examples of materials that can potentially degrade ground- and surface-water quality through runoff, leaching and soil erosion.

Nutrients

Nutrients serve the same purpose in a lake or a pond as they do in our landscapes: they help plants grow. The two main nutrients of concern to landscape managers are nitrogen and phosphorus. New Hampshire's Comprehensive Shoreland Protection Act prohibits the use of fertilizers within 25 feet of a shoreline's reference line (high water mark) and restricts the type of fertilizer that can be applied beyond this zone. Only low-phosphate, slow-release nitrogen fertilizers may be used beyond 25 feet within the waterfront buffer (Appendix A).

Nitrogen (N) is an element essential for plant growth that landscapers must manage carefully. A few plants can convert nitrogen from the air into a form plants can use. For most plants, however, the relatively small amount of available N in the soil limits growth and applying nitrogen results in increased growth and greener leaves. It is the nutrient we apply in greatest amounts to our lawns, landscapes and gardens. Excess N can present problems for nearby water bodies.

Plants primarily take up nitrogen in the form of nitrate and, to a lesser extent, ammonium. In a warm, healthy soil microbes quickly convert ammonium N to nitrate N. Nitrate is highly water soluble and what plants or microbes don't capture can leach into groundwater following heavy rain or irrigation.

We apply nitrogen to our landscapes in many different forms, including synthetic fertilizers, compost, animal manures, and other organic amendments. Fertilizer bags are labeled with the form of nitrogen the product contains. Some forms of fertilizer, such as organic fertilizers and slow-release synthetic fertilizers, are less water soluble and therefore less likely to leach. However, all types of nitrogen fertilizer have the potential to leach into groundwater and/or run off into surface waters.

Organic materials such as pet and livestock wastes, and septic system drainages and overflows, contribute nitrogen to the soil and water as well. Nitrogen that reaches drinking water sources poses a threat to drinking water quality and human health. EPA regulations deem water unsafe to drink when nitrates exceed 10 parts per million (ppm).

The greatest concern for nitrogen pollution in New Hampshire surface waters is in estuaries and salt marshes. There plants thrive on nitrogen fertilization, which promotes excessive growth. Excess nutrients in these aquatic systems allow plants that typically wouldn't survive in the environment to grow and flourish, creating a habitat that disrupts the natural ecosystem and creates a less advantageous environment for native plant and animal species.

Phosphorus is the main nutrient of concern in freshwater bodies. Many soils are naturally high in phosphorus and human activities can overload soils with more of this nutrient than plants can use. Septic flows, runoff from stored animal manure, use of high-phosphorus commercial fertilizer, and repeated compost applications all contribute to excess high phosphorus levels. Although phosphorus doesn't readily leach through the soil profile as nitrogen does, nonpoint source phosphorus pollution may occur in surface waters as the mineral attaches to soil particles and is delivered into surface waters via runoff and erosion.

Too much phosphorus can cause excessive growth of algae and may stimulate growth of unwanted aquatic weeds. When weeds and algae die, their decomposition depletes oxygen, killing fish and other aquatic organisms.

Lakes and ponds naturally, but very slowly, fill in with vegetation until they become bogs and marshes. A lake that continues to grow vegetation past this point may eventually disappear and become land. This slowly occurring natural process is called eutrophication.

Increasing the nutrient levels of a lake or other body of water by human activities may greatly accelerate this process, resulting in what is termed “cultural eutrophication.” You can see evidence of cultural eutrophication in many small ponds and sections of lakes around New Hampshire. Water bodies going through the late stages of eutrophication may be green with algae or choked with aquatic weeds.

Pesticides: a special concern on waterfront properties

Pesticides are chemical or biological agents, substances, or mixtures of substances intended for preventing, controlling, destroying or repelling insects, rodents, fungi, weeds, mollusks, algae and other organisms considered to be pests. Plant regulators, defoliant and desiccants are also regulated under federal and state pesticide laws.

Most insecticides, herbicides, and fungicides not absorbed by plants will break down into harmless compounds and elements through the action of sunlight, microbial activity, and other forms of natural degradation. However, some pesticides break down faster and more easily than others, and some pesticides can leach into the soil or be carried away by runoff before they can break down, especially if heavy rainfall occurs shortly after application. Pesticides can also end up in surface water because of misapplication, drift, and spills. Leaves from plants or grass sprayed with pesticides may blow into surface water before the pesticides have degraded. Pesticides that persist in the soil can make their way into water by runoff and erosion.

Very small amounts of some pesticides can have significant impacts on water quality, as many microscopic animals important to the aquatic food chain, such as insect larvae, are highly susceptible to even very low concentrations. Loss of these organisms can affect the efficient cycling of nutrients throughout the system and threaten the health of fish and other organisms.

The New Hampshire Division of Pesticide Control prohibits applying pesticides within 25 feet of the shoreland reference line, as well as storing, mixing or loading pesticides within 75 feet of the reference line. In the watershed of a public water supply, you cannot apply pesticides within 250 feet of the reference line on land within five miles of the water supply intake. You may request an exception to these distances from the Division of Pesticide Control through a Special Permit application. More information on setback distances from surface waters and other pesticide rules can be found in Appendix A, along with contact information for the Division.

When applying fertilizers or pesticides on your property, always consider the environment around you and think about where your products may end up. Landscapers or pest control companies must be licensed with the New Hampshire Division of Pesticide Control to apply any pesticide on your property, including organic or nontoxic pest-control products.



Go with the Flow: Understanding How Water Moves Onto, Through and Away from Your Site

Controlling water runoff should be a major objective of any shoreland landscape design. As water collects and flows through channels, it gathers energy for its erosive force. The faster water flows, the greater the particle size and quantity of pollutants it can carry along to the receiving water body (pond, lake, stream, river, wetland or coastal water).

As noted earlier, modifying the landscape with any type of development has the potential to degrade soil and water, resulting in changes in water flow, nutrient- and pollutant-loading, and groundwater recharge. However, if you start with a plan that takes into consideration the specific water runoff situation on your site, your new landscape could even improve the quality of the water coming off it.

COMMON RUNOFF CONTROL STRATEGIES

- **Detention** - holding back or “ponding” a volume of water to slow the speed of its outflow. In some cases water detention may also allow for infiltration and/or evaporation to reduce the final outflow volume.
- **Diversion** - preventing water from traveling over the area of concern, thereby reducing surface runoff and minimizing the potential for erosion and the transport of nonpoint source pollutants.
- **Flow spreading** - allowing a concentrated flow to spread out over a wide, gently sloped area to reduce the water velocity and encourage infiltration.
- **Infiltration** - allowing water to percolate into the ground rather than running across the surface.
- **Plant absorption and transpiration** – the movement of water from the soil into plant roots, up through the stems and leaves and the release of water vapor through the stomates to the atmosphere (Figure 2-1).

This chapter will guide you through the process of assessing your current runoff situation and offer various strategies you can use to minimize the runoff from your site. Combining these approaches with appropriate choices of plants and horticultural products are the keys to ensuring a healthy shoreland environment.

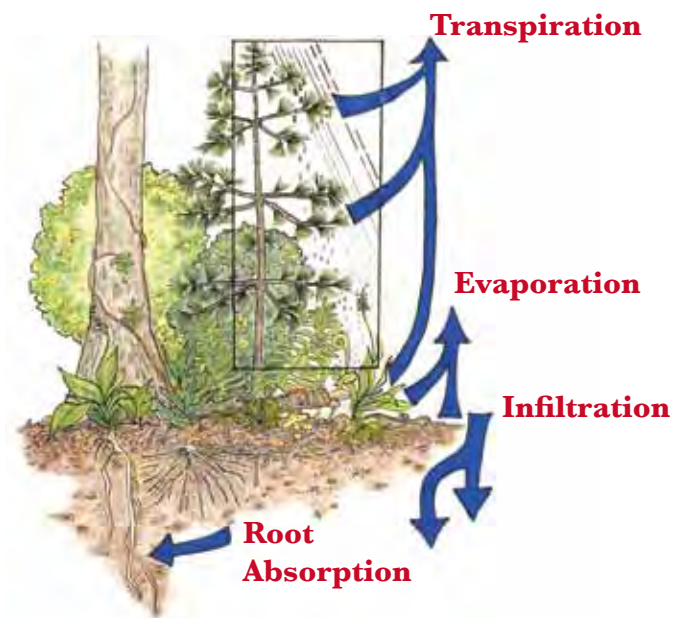


Figure 2-1. Plants are an integral part of the water cycle. Water that infiltrates into the soil can be absorbed by roots and released through the leaves as water vapor, a process called transpiration. Some water also evaporates from the soil and leaf surfaces.

Techniques used to control runoff

Berm - A stabilized mound of dirt or stone to create a diversion and/or redirect water flow.

Check dam - A small mound of stabilized dirt or stone that breaks up the flow of water in a drainage ditch or trench to slow down velocity and allow for the settling of heavier materials.

Cut-in (or Cut-out) - A small trench that diverts water out of an existing channel, to be treated/infiltrated to prevent a significant volume of water from accumulating as it runs down a driveway, walkway or path. Multiple cut-ins may be required for long distances or high slopes.

Infiltration trench - A dug-in trench commonly used for roof runoff that allows for storage of runoff and encourages infiltration into the ground.

Plunge pool - A dug-in hole stabilized by stone, typically placed in a drainage ditch or trench. This allows water to fall below the level of the surface to slow the runoff velocity and capture heavy particles. These are often constructed in a series along a sloped route.

Rain garden - A shallow infiltration basin planted with water tolerant plant species, designed to capture concentrated runoff. Rain gardens are designed to pond water for just few hours at a time, allowing it to be taken up and transpired by plants or infiltrate into the ground.

Swale - A stabilized trench that can act to store water (detention), sometimes also engineered to enhance infiltration.

Vegetative buffer - A relatively flat area stabilized with vegetation that allows water flow to spread out, slow down, infiltrate and be filtered by the soil, and/or be intercepted and transpired by plants.

Waterbar - A diversion device that diagonally crosses a sloped trail, path or road to capture and divert runoff to the side. Commonly made of a log, a stone, a small, reinforced drainage channel, or a partially buried flexible material, a waterbar is most useful for small contributing areas (watersheds less than one acre) that receive foot and vehicle traffic. Waterbars are spaced according to the slope of the land.



A swale constructed along this roadway captures road runoff and prevents it from entering the lake, which is to the left.



A plunge pool is an area where water is collected and allowed to infiltrate.



Waterbars along the path slow flow and divert runoff into the vegetated area.



An infiltration trench was constructed to catch roof runoff at this lakeside home.

Following the flow

Paying attention to how water flows (or will flow) into, over and through your site before, during and after development or landscaping, is critical in determining current and potential negative impacts. Some questions you'll want to answer before proceeding:

- What is the extent of lands and roads above the site that contribute runoff water, and where does the runoff enter your property?
- Where are the impervious areas (paved driveways and walkways, roofs, patios, compacted soils, etc.) and piped source (sump, gutters, etc.) from which you generate runoff?
- Where does that water, along with any additional runoff generated in your new design, run over your site? Is it treated by vegetation, infiltrated or does it accumulate?
- Where will that water then flow off your site? Does it enter the water body directly?
- Most importantly, how might you modify your design to take advantage of these factors in creating diversions, detention and infiltration areas?

Investigate the drainageways

Since water moves downhill, you need to walk your property boundary and note where the major water flows occur after a heavy rainstorm. Does the runoff from abutting roads or a neighbor's driveway flow onto your property? Are there any adjacent steeply sloped lands that rise above the level of your property? Are they extensive enough to contribute water flows during rains and snow melts? Make note of all of these off-site contributors to flow. Also note any occasional or perennial wet areas or streams at your property boundary that encroach on your site.

Investigate onsite runoff generation

Note any wet areas or seeps on your property. Now consider how your house and current landscaping features generate runoff. It is always easy to point uphill and blame runoff on other properties, but most people are surprised at how much runoff their own site creates, even in low-density development. Be aware whether you have areas that divert runoff onto neighboring properties as well.

Take inventory of all paved and compacted areas, such as driveways, patios and walkways. Can you find evidence of water flow moving off these areas and heading downhill? You may see just a small area of sheet erosion, indicated by the appearance of worn-down gravelly areas with small stones and roots showing because finer soil particles have been washed away. Or you may see rills, visible channels where water has eroded away materials a fraction of an inch to a few inches deep. In the worst cases, you'll find gullies where water flows through channels deep enough for you to step into them.

The potential for erosion and runoff increases with site steepness, area of impervious surfaces, and size of contributing watershed area (land above your site).

Investigate the point sources of flows on your property from culverts, drain pipes, and hoses, as well as rain gutters, sump pumps, and tile drainage outlets. These concentrate diffuse flows that need treatment and diversion to ensure they don't contribute to runoff. If

the house doesn't have gutters, look for areas where the roof design intercepts and dumps rainwater onto the property. As you develop your landscape plan (see Chapter 4), consider ways you might reduce the impacts of those flows.

Account for any paths, trails and cleared areas that lead to the water. Shoreland properties almost always have pathways and cleared areas that allow runoff to flow directly into the water body. In the worst cases, a driveway at the top of the property allows water from the road above and the gutter runoff to collect and concentrate, flowing down a pathway directly into a cleared beach area and into the water, often taking a lot of sand with it.

Note how the paths follow the slope of the land. Meandering paths may function to break up runoff before it concentrates, but straight downhill paths encourage flow directly to the water. Also, note the flow-contributing areas that lie above the access area or beach. Do swaths of vegetation above help break up the flow, or does the water pretty much flow straight down and onto the area below?

Finally, look for areas where water tends to pond after it rains. Even flat areas may pond water if the soils don't drain well or if there is a lot of shallow ledge or hardpan present. Be sure to keep track of these areas and prevent additional water from reaching these locations.



Evidence of sheet erosion in a lawn.



Shallow rills forming from the concrete sidewalk runoff.

Minimize and divert runoff

Significant flows coming onto your site may create runoff and erosion problems. Your design should take into account all flows that will come in contact with your newly landscaped area, as well as those flows that may cause runoff concerns in other areas on your property (or your neighbor's).

Of all the methods that can help deal with these situations, diversion and flow-spreading are the most reliable. If you can treat all of the incoming runoff by diverting it and spreading it out over a stable vegetated area before it leaves the property, then by all means do so. However, in situations of high runoff flow coming from off-property sites such as roads, diverting some of the flow may be warranted to keep it from entering your property. The sources of offsite runoff can be diverse and you may not be able to take action without involving neighbors, road associations, and municipalities, since road-drainage diversions and treatment systems require professional design and installation.



Deep rill formed after sediments and sand are washed into the lake leaving heavier stones behind.

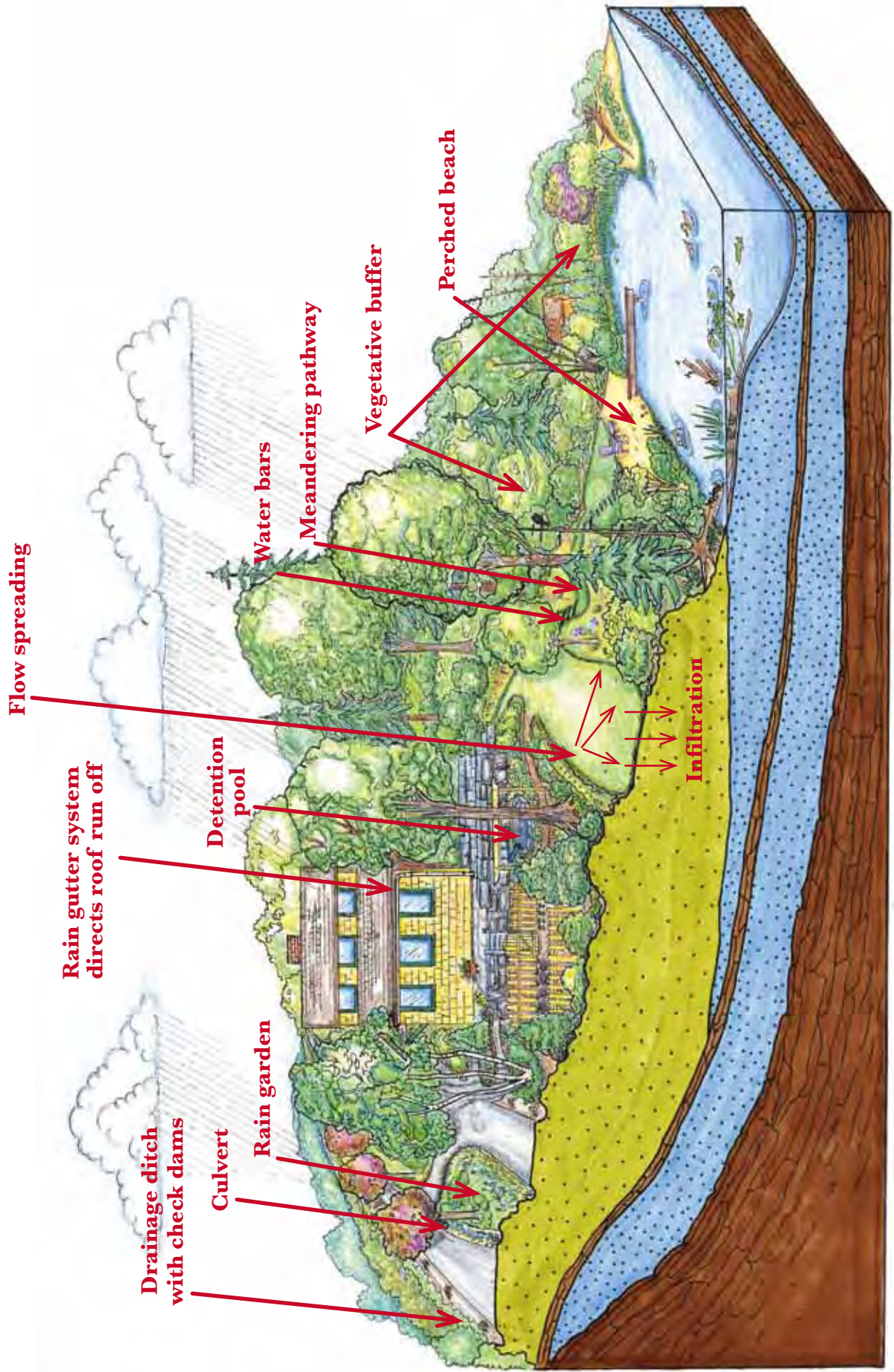


Figure 2-2. This landscape applies many of the recommended strategies and techniques to reduce erosion and prevent runoff water from reaching the lake.

Use what you have (or can design) to break up, slow down and spread out the flow over or into a vegetated area. The goal is to prevent offsite and onsite flows from accumulating and divert them from impervious areas. You may be able to break up the flow by using shallow channels, stone check dams, small vegetated berms, or alternating areas of low and high vegetation.

Simple drainage cut-ins can break the flow and move the water from long driveways and pathways. In more challenging situations—for example, when sites are very steep or narrow—you may need to hire a professional to install a waterbar or similar diversion.

If you can't divert the flows coming onto your site and can't find ways to prevent the flow from concentrating to a significant volume, then consider diverting the water into your existing vegetated areas, or create additional vegetated areas, to allow the water to slow down, spread out and infiltrate the ground, thus losing most of its destructive force and most of its pollutant load. For this to work, you need an adequately sized vegetated area with minimal slope.

The denser the root systems of the plants in vegetated areas, the greater the volume of water the area can process. Mixed types of vegetation with different root depths will have the greatest impact, as contrasted with monocultures, which grow a single type of plant. However, any type of vegetation is better than a bare, cleared, compacted, or impervious area.

The same holds true for dealing with runoff from pavement, roofs, tile drainage, sump flows, and existing drainageways: capture the water and/or divert it by any means possible (plunge pools, waterbars, berms, swales and drainage trenches) to prevent it from running directly down to the shore. Conditions such as lack of space, steep slopes, and/or proximity to the shore create special challenges to diverting the water from a rain gutter or other concentrated flow. In these situations, consider alternative controls such as rain barrels, storage cisterns and infiltration trenches.

You may be able to cut down runoff generation at the source by replacing impervious areas with porous alternatives. For problematic and excessive stormwater volumes you may need to have something engineered to capture water and pump it into other areas for treatment.

If you have enough space, consider installing a rain garden, a shallow, dug-in area planted with water-tolerant plant species. Rain gardens can collect a significant volume of water during a storm, allowing the water that doesn't get used by plants to infiltrate the ground quickly and prevent it from becoming runoff. When designed and constructed correctly the surface of a well-designed rain garden will not flood, eliminating concerns about standing water. Appendix B includes resources for more information on rain garden design and appropriate plants.

Properly designed pathways and trails should meander across the slope and allow each segment to throw water off the trail, rather than letting it flow in a straight path, accumulating as it moves downhill. The best trails are those that follow the ridges and contours of the property. Some low



Demonstration rain garden being installed in Kingston, Rhode Island. At right, puddles remain in the road after a heavy rain but the runoff from the landscape has already infiltrated the soil in the rain garden.



vegetation planted at the corners of the meanders or staggered alternately on the sides of steeper pathways will help break up, capture, and slow down the flow of water as it moves downhill.

To maximize water quality protection as you consider the ways you want to use and enjoy your waterfront property, the key is to remove as little vegetation as possible. For all lake shores and large rivers, the state's Comprehensive Shoreland Protection Act requires that in the "waterfront buffer" (0-50 feet from shore) natural ground cover and duff, shall remain intact. No cutting or removal of vegetation below 3 feet in height (excluding lawns) except for a footpath (6 foot maximum width) is allowed. Stumps, roots, and rocks must remain intact in and on the ground. In addition, within the waterfront buffer, tree coverage is managed with a 50-foot x 50-foot grid and point system that ensures adequate forest cover and prevents new clear cutting. Within the "natural woodland buffer" (50-150 feet from shore) there are additional protections where 25 to 50 percent of that buffer must remain undisturbed dependent on lot size (See Appendix A for more details).

Plan to stabilize a major portion of the shoreline area with a good mix of plants. The more protective vegetation you remove from near the shore, the more you increase the area's potential for transporting pollutants to the lake or stream. Removing taller plants also opens the shore area to receive more sunlight. Exposure to more sun heats up the water, making it less desirable for aquatic organisms and more conducive to submerged and emergent weed growth, including exotic invasive species.

Where you locate the water access area also is important. Areas that don't receive significant runoff from the land above make the best locations for minimizing potential impacts. Water access areas that lie directly below a runoff flow may allow the runoff to reach the water without any reduction in impact. If you have no choice of access location, try to create a diversion of the flow away from the shoreline opening and into a more vegetated area using one or more of the approaches discussed above.

Note: State wetland laws forbid dumping sand or other materials on the shoreline to make a beach. Wetland permits are required for any beach construction. Sand beaches not naturally present are discouraged as they tend to get washed away. In locations where a small opening, with stable groundcover and perhaps a few flat stones or steps will not do, you can apply for a permit for a small perched beach



By choosing ferns and other low-growing understory plants mixed with trees, a shoreland buffer does not need to block the view or make water access difficult.



Pathways made of pavers are semi-pervious to water. The path is not straight, so runoff is distributed into vegetated gardens where it infiltrates the ground before reaching the shore.

located just above the shoreline. Contact the Department of Environmental Services, Wetlands Bureau, for more information (Appendix A).

Structural approaches

Most structural modifications for dealing with flow and runoff require professional design and installation. However, nonprofessionals might try one or more of these simpler approaches before calling in the pros:

- Clear existing drainageways of accumulated materials, including loose sediments and litter, before the snow melts and the spring rains arrive. Encourage vegetative growth in these drainageways however, as the vegetation removes sediments and pollutants from the water as it passes through.
- If possible, divert other flows into your existing drainageways (as long as they themselves don't directly flow into the water body) by some shallow channeling, the use of check dams of stone or gravel, or using small berms.
- Break up the water flow by alternating small berms down a sloped area, diverting water off into vegetated areas before it can accumulate in significant volume.

In general, anything you can do by hand or using hand tools doesn't require any permitting, as long as you stay at least 25 feet away from the shoreline. Any time you have to use a power tool or power equipment, or your project requires significant earth-moving within the 250 foot Shoreland Protection Zone, you probably will need a state permit, and possibly one or more local permits as well.

Making a difference

With the knowledge of how water flows over and currently runs off your site, you now may want to consider adding water diversions, as well as vegetative buffers and infiltration areas into your landscape designs (Chapter 4) to take advantage of the water-treatment properties of vegetation. A typical small shorefront lot on a moderate slope with conventional development (house, forest cut for lawn, paved driveway) can increase water runoff, phosphorus pollution and sediment erosion about 5 times, 7 times and 18 times respectively compared to an undisturbed, forested lot.

By growing out the shoreland buffer (50 feet) and infiltrating the roof runoff using trenching or a rain garden, the impacts can be reduced down to 1.5 times the runoff, 2 times the phosphorus and less than 3 times the sediment over the undisturbed lot. This is a significant reduction by using only two of the practices discussed above. Adding practices could result in even more pollution reductions, not to mention the benefits to wildlife and shoreline integrity.

The next sections discuss how to maintain and establish shoreline buffers, choosing the appropriate plant systems for low impact and low maintenance, and how to plant and maintain lawn areas in an environmentally-friendly way.



Vegetative Buffers

More and more of us are choosing to live near lakes, streams and rivers, with the expectation that our shoreline property will provide lovely views, wildlife habitat, and clean water for fishing, swimming, boating, and other recreational activities. But as development increases it can seriously affect the water quality of our lakes, rivers and streams. Visual signs of declining water quality include increased weed growth and erosion along shorelines, reduced water clarity, algal blooms, sediment deposits and altered wildlife habitat and diversity.

Vegetative buffers are areas of vegetation located between the water and additions to the original property, such as buildings, driveways, patios, and lawns. Plant buffers are an important tool to help lessen the adverse affects of human activity on water quality.

Composed of trees, shrubs, groundcovers and aquatic plants, buffers slow runoff and help catch nutrients, sediments and other pollutants before they can reach the water. The deep roots of trees and shrubs and the layer of leaf litter they provide act like a sponge to temporarily hold water and remove many of the contaminants.

Shoreline buffers perform a number of functions that have significant economic, ecological and social value, as illustrated in Figure 3-1, including:

- They provide a link between the water and the land and serve as transition zones between water and upland areas.
- Dense plantings of trees and shrubs can dampen the noise from boat engines, traffic and adjacent properties. In addition, they provide privacy.
- Vegetative buffers intercept raindrops and meltwater, reducing their impact on the soil. They also help slow the velocity of water running off the land, giving sediments, pollutants, and nutrients time to settle out on land before reaching the water. Suspended sediments in the water reduce the amount of sunlight that reaches submerged plants. This reduces the rate of photosynthesis and upsets the established ecology. Excessive sediments can smother life on the bottom, such as fish eggs and insects that are crucial parts of the food web. An overabundance of sediments can make the bottom mucky and the rocks slippery. Heavy deposits of sediment can create a growing area for unwanted species of rooted plants that change the composition of existing plant communities.
- Vegetative buffers stabilize slopes and help protect banks from erosion. Roots hold the bank soils together and increase water infiltration. Roots and stems together protect the shore by deflecting the cutting action of currents, waves, boat wakes, wind and stormwater.

- In addition to holding soil in place, root systems absorb water and nutrients. Plant roots within vegetative buffers take up dissolved nutrients from fertilizers, animal waste, sewage, wastewater, and erosion and store them in their leaves, stems and roots, preventing those nutrients from reaching the water.
- Vegetative buffers help manage stormwater and reduce flooding. If intercepted by a vegetative buffer, pollutants such as petroleum products, road salt, heavy metals, fertilizers and pesticides carried in stormwater may never reach open water.
- Buffers slow runoff flows, allowing water to infiltrate the soil and recharge the groundwater. Water slowed by a buffer enters the stream, river, pond or lake gradually and over a longer period of time than water running off an impervious or poorly vegetated surface.
- Vegetative buffer areas provide essential habitat for many species of wildlife. Nearly one-third of New Hampshire's native wildlife depends on aquatic and wetland habitats. Birds, mammals, fish, frogs, and turtles spend some or all of their life cycle in or around the water. Fallen tree branches and logs provide habitat for fish, turtles and other aquatic wildlife. Aquatic plants and fallen debris also provide a refuge and a food source for insects, snails and other small creatures critical in the aquatic food chain. Plants along the water's edge help moderate water temperatures by shading shallow water. This provides relief for aquatic organisms during the hot summer months.

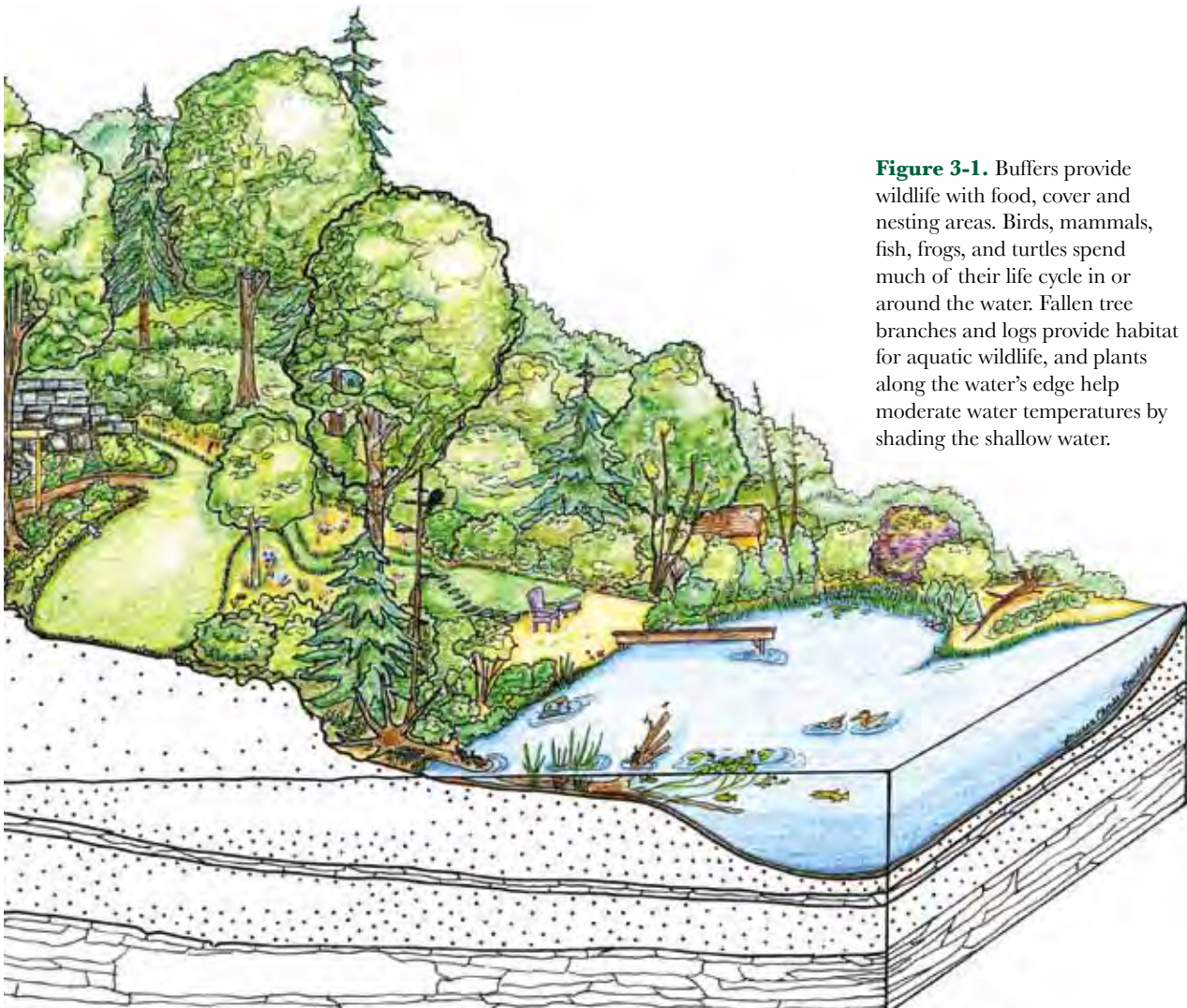


Figure 3-1. Buffers provide wildlife with food, cover and nesting areas. Birds, mammals, fish, frogs, and turtles spend much of their life cycle in or around the water. Fallen tree branches and logs provide habitat for aquatic wildlife, and plants along the water's edge help moderate water temperatures by shading the shallow water.

- Buffer areas along the shoreline contain important nesting, hunting, feeding and perching areas for songbirds. Standing dead trees (or snags) provide nesting cavities for woodpeckers, black-capped chickadees, nuthatches, ducks and other wildlife. Trees, shrubs, vines, and other plants produce a variety of nuts, berries and seed buds for squirrels, deer, grouse, turkey, wood ducks and bears. Plants along the shoreline attract insects that serve as food for many other species.
- Buffers can serve as links between shoreline properties, providing a migration corridor for a wide variety of animals. On the other hand, one benefit of vegetative buffers is that Canada geese don't like to move through brushy areas where they feel more vulnerable to predators. They will rarely cross a buffer to reach your lawn, where their droppings are unsanitary and objectionable.
- Vegetative buffers add aesthetic value. Branches of trees and shrubs can be used to frame a view. Selective removal of a few low branches can provide openings for views from your house to the water without significantly decreasing privacy.

Vegetative buffers can help protect water quality, protect and provide habitat for wildlife, reduce noise, help stabilize the shoreline, reduce flood waters, moderate water temperatures and filter pollutants, nutrients and sediment. Buffers can do some or all of these things while maintaining aesthetic and recreational values.

Table 3-1 suggests minimum buffer widths for water quality protection. Buffers intended for wildlife habitat should be as wide as possible.



This 12-foot wide buffer is not adequate for the steeply-sloped property above it. The paved pathways provide a direct route for runoff water to enter the river.

**TABLE 3-1:
SUGGESTED BUFFER WIDTH RELATIVE
TO SLOPE OF LAND**

Percent Slope	Width of Vegetated Area (feet)
0 – 1 %	25
>1 – 5 %	35
>5 – 9 %	50
>9 – 12%	65
>12 – 15%	75

Note: Assumes vegetated area is not in hydric soils or ledge and that the area doesn't receive channelized flow from drainage outlets, tile drainage or gutters. For any areas bordering a shoreline, a minimum of 75 feet is recommended.

Modified by the University of New Hampshire from USDA Natural Resources Conservation Service.

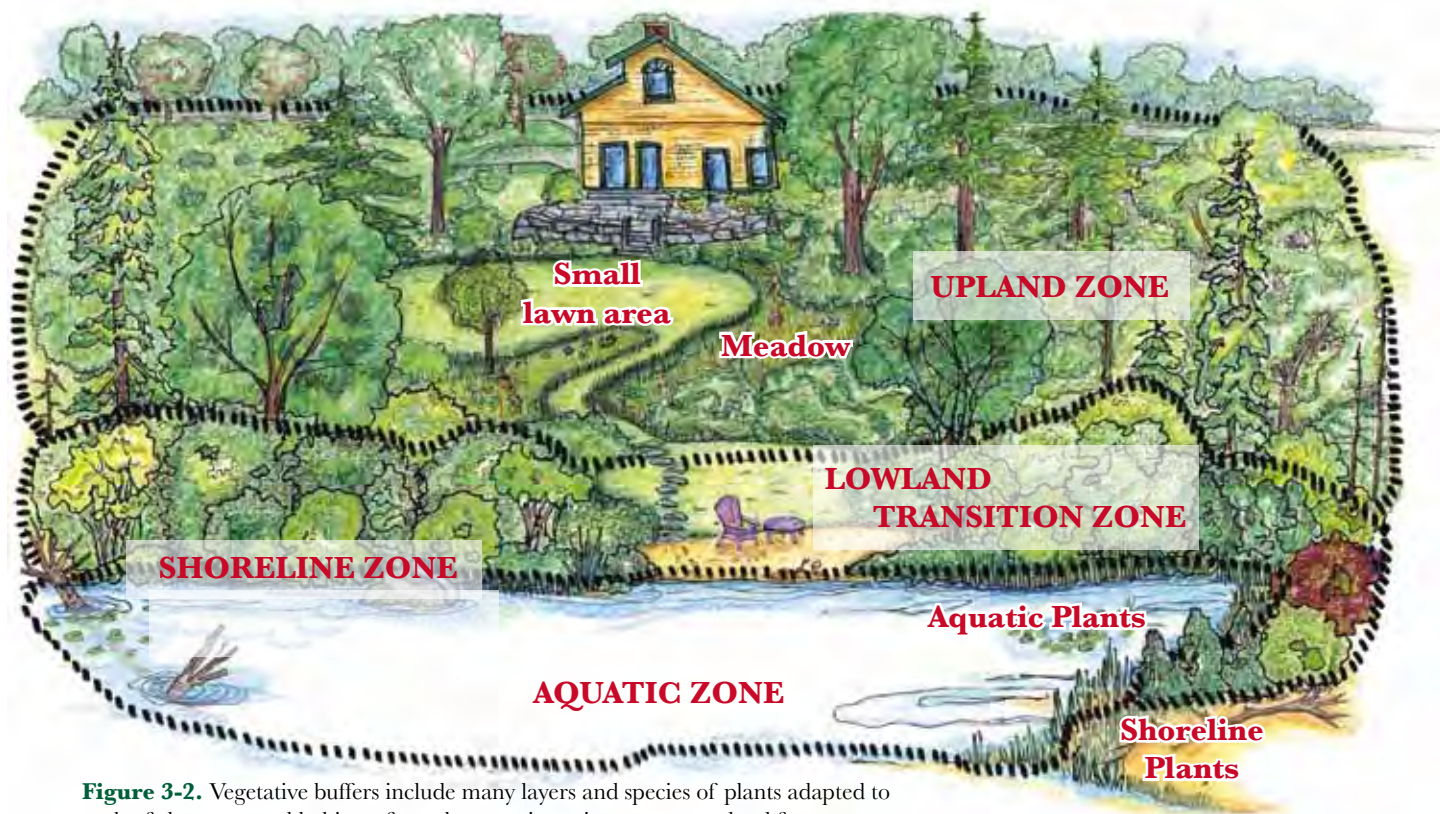


Figure 3-2. Vegetative buffers include many layers and species of plants adapted to each of the zones and habitats, from the aquatic environment to upland forests.

What kinds of plants grow in buffer zones?

Naturally occurring vegetation adjacent to water bodies includes aquatic plants, shoreline plants, plants in the lowland transition zone, and plants in the upland or woodland area.

Aquatic plants can float, grow partially within the water or along the water's edge. They include rooted pondweeds, white water lilies, water milfoils, bladderworts, duckweed, broad and narrow-leaved cattails, bulrushes, rushes, sedges, pickerelweed, arum, spatterdock and water plantain.

The shoreline zone, bordering the water, often includes willows, elderberry, viburnums, dogwoods, winterberry, buttonbush, summersweet, grasses, ferns, leatherleaf, sedges, blue flag iris and marsh marigolds. These plants are adapted to consistently wet soil.

The lowland transition zone begins 10 feet or more from the water. Shrubs, small trees and groundcovers that commonly grow in this area include alders, high-bush blueberry, cranberrybush viburnum, serviceberry, swamp azalea, ferns, asters, jewelweed, turtlehead and Joe-pye weed. These are plants that can tolerate occasional flooding or very wet soils.

The upland zone is rarely subject to flooding. The upland zone may include lawns, meadows, gardens and landscaped areas. In the upland forested area you will find maple, birch, beech, oak, pine, hemlock, fir and/or spruce tree species. Shrubs and groundcovers will include many of those found in lowland areas and many more.

The above lists include those plants commonly found around lakes and other fresh water. If your property borders an estuary or is on the coast, you will find salt-tolerant species in the aquatic, shoreline and transition zones. Woody plants in these habitats include red cedar, pitch pine, several species of oaks, Juneberry, heather, hazelnut, huckleberry, inkberry, bayberry, elderberry, grape, bearberry and various rose species. Herbaceous perennial plants, many of them non-

natives, that survive well in estuarine and coastal landscapes include false blue indigo, wormwood or artemisia, daylily, many grasses, sea lavender, sea oats, ornamental catmint, salvia or sage, lamb's ears, obedient plant and Montauk daisy.

Waterfront environments usually support an impressive abundance of plants, including many more native plants than we've listed here. Unfortunately, undesirable plants easily invade areas with disturbed shoreline.

Exactly what is an invasive? It's an opportunist, a non-native species that moves into an area and monopolizes light, moisture, nutrients, water and space to the detriment of other species. Many of these plants are exotics, introduced either intentionally or accidentally from another region or country. Exotic invasive species are able to grow rapidly, multiply and spread to unmanageable levels within a short period of time. In short, they out-compete native plants.

Most invasive plants:

- Lack natural predators and diseases that keep populations in check in their native habitat
- Affect threatened or endangered species
- Grow very rapidly
- Produce copious amounts of seed with high levels of viability
- Disperse seeds efficiently over long distances
- Tolerate a wide range of environmental conditions
- Thrive in disturbed areas
- Leaf out early and keep their leaves late, shading out the native species beneath them
- Decrease the diversity and populations of native plant species

Some invasives reproduce both by seed and vegetatively (by roots, runners or rhizomes).

When invasive plants become established in an area, they may:

- Negatively impact water quality (many are aquatic weeds)
- Diminish aesthetic and recreational quality of waterfront property
- Require substantial effort and funds for management
- Reduce animal habitat by eliminating native foods, altering cover and destroying nesting sites
- Displace native plants and arrest natural succession

In New Hampshire, the Department of Agriculture, Markets and Food has listed 38 invasive plants (including 14 aquatic species) and 16 insect species “deemed to present an immediate danger to the health of native species, to the environment, to commercial agricultural or forest crop production, or to human health” (RSA 430:51-57). The collection, importation, sale, propagation, transplantation or cultivation of these species is prohibited. The New Hampshire Prohibited Invasive Species plant list included here is current at the time of publication and you can check for updates with the Division of Plant Industry (Appendix A).

Because areas around shorelines are heavily used and frequently degraded, they are especially vulnerable to invasion by invasive plant species. Controlling an established population of

invasives can be difficult and require a persistent effort. Many people want to resort to herbicides to help, but there are restrictions on their use in wetlands or near water (see Chapter 1 and Appendix A). Even where herbicides may be used, control of invasives is difficult to achieve.

What can you do? The Guide to Invasive Upland Plant Species in New Hampshire (Appendix B) contains a wealth of valuable information. Learn to recognize invasive plants on your property, especially those most commonly found near water. Some of these include Oriental bittersweet, Japanese knotweed, yellow flag iris, garlic mustard, variable milfoil, fanwort, purple loosestrife and common reed.

Replace invasive plants in your landscape with non-invasive alternatives. Verify that the plants you are buying for your garden aren't invasive. Inspect newly acquired plants for undesirable insect and weed hitchhikers. After boating, clean your boat thoroughly before transporting it to a different body of water. Last and perhaps most important, protect healthy plant communities by minimizing soil disturbance. Invasives thrive in bare or tilled soils where native plants have been displaced.

NEW HAMPSHIRE PROHIBITED INSECT SPECIES

Acarapis woodi.....Honeybee Tracheal Mite
Adelges tsugae.....Hemlock Woolly Adelgid
Aeolesthes sarta.....City Longhorned Beetle
Anoplophora glabripennis.....Asian Longhorned Beetle
Callidellum rufipenne.....Cedar Longhorned Beetle
Dendrolimus sibiricus.....Siberian Silk Moth
Fiorinia externa.....Elongated Hemlock Scale
Hylurgus lingniperda.....Redhaired Bark Beetle
Ips typographus.....European Spruce Bark Beetle
Lymantria dispar.....Asian Gypsy Moth
Popillia japonica.....Japanese Beetle
Pyrrhalta viburni.....Viburnum Leaf Beetle
Rhizotrogus majalis.....European Chafer
Symantria monacha.....Nun Moth
Tetropium fuscum.....Brown Spruce Longhorn Beetle
Varroa destructor.....Varroa Mite

NEW HAMPSHIRE PROHIBITED PLANT SPECIES

Ailanthus altissima.....Tree of heaven
Alliaria petiolata.....Garlic mustard
Acer platanoides.....Norway maple
Berberis thunbergii.....Japanese barberry
Berberis vulgaris.....European barberry
Butomous umbellata.....Flowering rush
Cabomba caroliniana.....Fanwort
Celastrus orbiculatus.....Oriental bittersweet
Cynanchum nigrum.....Black swallow-wort
Cynanchum rossicum.....Pale swallow-wort
Egeria densa.....Brazilian elodea
Elaeagnus umbellata.....Autumn olive
Euonymus alatus.....Burning bush
Heracleum mantegazzianum.....Giant hogweed
Hydrilla verticillata.....Hydrilla
Hydrocharis morsus-ranae.....European frogbit
Iris pseudoacorus.....Water-flag iris
Ligustrum obtusifolium.....Blunt-leaved privet
Lonicera bella.....Showy bush honeysuckle
Lonicera japonica.....Japanese honeysuckle
Lonicera morrowii.....Morrow's honeysuckle
Lonicera tatarica.....Tatarian honeysuckle
Lythrum salicaria.....Purple loosestrife
Myriophyllum aquaticum.....Parrot feather
Myriophyllum heterophyllum.....Variable milfoil
Myriophyllum spicatum.....European water-milfoil
Najas minor.....European naiad
Nymphoides peltata.....Yellow floating heart
Phragmites australis.....Common reed
Polygonum cuspidatum.....Japanese knotweed
Potamogeton crispus.....Curly-leaf pondweed
Rhamnus cathartica.....Common buckthorn
Rhamnus frangula.....Glossy buckthorn
Rosa multiflora.....Multiflora rose
Trapa natans.....Water chestnut



The Landscape Design Process

Living along a shoreline provides wonderful opportunities to explore nature, recreate and let go of day-to-day stress, but with it comes a responsibility to protect the soil, water and wildlife that makes living there so special. Your property is part of the larger watershed. Before making any landscape changes make sure you read and understand your town or city regulations regarding shoreland protection, in addition to those within New Hampshire's Comprehensive Shoreland Protection Act (Appendix A).

To some degree, your property may already contain areas of aquatic, shoreline, lowland transition and upland buffers, each with its own characteristic plant communities. All these areas work together to filter and slow water movement from spring and fall rains, summer irrigation and winter snowmelt, helping to protect the quality of the water body.

The first thing to consider in designing a landscape is how to protect the valuable features you already have, then move on to making improvements. For example, you may have a significant cluster of alders and winterberry shrubs along the bank of a pond and a large lawn that extends from the shoreline to your backdoor. You could shrink the size of your lawn by increasing the size of an existing shrub border, which in turn would increase filtration and absorption through the additional woody plants, while decreasing the labor and cost of maintaining a large lawn.

Before you put pencil to paper, consider the following shoreland design principles. These principles not only will help protect the water body and other natural resources, they will also help you create a beautiful, low-maintenance landscape that complements the natural world around you.

STEPS IN THE DESIGN PROCESS

1. Review the 10 design principles.
2. Take inventory: explore, get familiar with your site, have fun!
3. Create a base plan (first layer) on paper or vellum.
4. Analyze your site (second layer - Overlay #1) on trace paper.
5. Develop a list of needs and desires (add to Overlay #1).
6. Create a functional bubble diagram (third layer - Overlay #2) on trace paper.
7. Develop a conceptual plan (fourth layer) on paper or vellum.
8. Organize plant systems and itemize plant selections (add to Conceptual Plan).

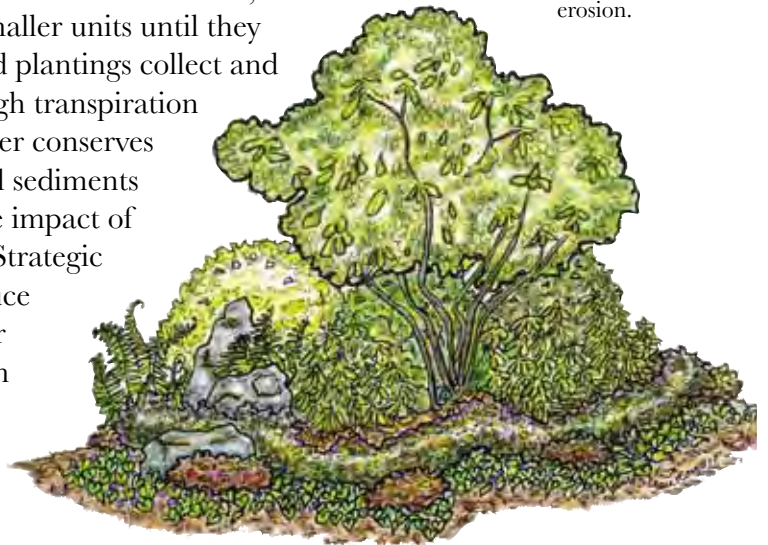


Ten design principles to help protect and improve your shoreland property

1. Protect and improve soil quality. Healthy soil serves as the foundation of a healthy landscape. Amend degraded soil with organic matter, and keep soil covered at all times with vegetation or mulches to reduce compaction and erosion.
2. Include as many vegetative layers as possible throughout your property: overstory and understory trees, understory shrubs and vines, herbaceous (non-woody) plants including perennials, grasses, and both woody and herbaceous groundcovers, and a diverse soil layer, that includes leaf litter, germinating seedlings and soil organic material.
3. When choosing plants, select the right plant for the right place for the right function. Pick plants hardy in your climatic zone and suited to the soils and light available at the planting site. Generous use of native plants in the landscape provides wildlife habitat and may offer your landscape better resistance to plant pests and diseases. When using non-native plants, choose disease- and insect-resistant varieties. By knowing a plant's mature size before putting it into the landscape, you can keep your views open without the need for pruning or frame a desired view. Well-chosen, well-placed plant material can help reduce the severity of winds.
4. Use plants to reduce the force and slow the flow of water. During the growing season, layers of leaves slow the force of rainfall, breaking droplets into smaller and smaller units until they soak into the ground. Densely layered plantings collect and retain water, releasing it slowly through transpiration and evaporation. The slowing of water conserves soil by reducing the movement of soil sediments into the water body and softening the impact of water drops striking the soil surface. Strategic placement of plantings will help reduce the amount and speed at which water runs down steep inclines and off from impervious surfaces such as rooftops, asphalt driveways, walks, and patios.



Figure 4-1. The natural landscape (above) includes diverse layers of vegetation and soil litter. Landscaped areas (below) also benefit from planting in layers and keeping soil covered with vegetation, leaf litter and mulch to reduce soil compaction and erosion.



5. Maximize the amount of vegetative buffer along shorelines. A diverse, dense, layered planting holds, protects and stabilizes the soils with thick mats of roots that penetrate the soil at different depths. One way to maximize the amount of shoreline buffer is to combine and connect your buffer with a neighbor's buffer whenever possible.
6. Minimize areas of impermeable surface. Replacing existing asphalt or cement driveways and walkways with water-penetrating materials such as stone dust, brick, or semi-permeable pavers helps increase water infiltration and can enhance the beauty of your landscape.
7. Rethink the size of your lawn. Instead of grass, consider encouraging plant and wildlife diversity by using ground covers and vertical layers of vegetation. These rougher surfaces also slow runoff and help filter water before it reaches the water body. Keep lawn areas nearly flat to help retain water and reduce the need for irrigation.
8. Design for low inputs. Use cultural practices in place of chemical products whenever possible. For example, pruning and disposing of infected plant parts off-site to prevent the spread of disease and improve air circulation around the plants will reduce or eliminate the need for pesticides.
9. Design a low-maintenance landscape. All landscapes need some maintenance, but your design choices can help reduce the time you'll have to spend maintaining your property (or paying someone else to do it) and provide you more time to enjoy it. Low-maintenance landscapes also limit the need for chemicals thus preventing contamination in the case of any runoff.
10. Remember, your actions on land directly affect the water body. Substances that go onto your land, no matter how far away from the shoreline, may end up in the water body. This includes detergents used in car washing, chemicals used in lawn treatments, exhaust residues or gas and oil leaks from mowers and weed-whackers and seasonal products such as winter deicers and rock salt. Reducing the use of potentially harmful inputs through practices such as using sand as a deicer, limiting use of fertilizers and pesticides, calibrating irrigation systems and installing rain shut-off devices will reduce the potential for negative impacts on the water body.

Shoreland properties benefit from stabilizing and retaining soil and reducing the volume and velocity of water runoff. Minimizing soil disturbance and using vegetation as a filter are key components of waterfront landscaping. The design should consider reducing the steepness of slopes and directing drainage to flow to areas where infiltration can take place. Intermittent boulders and ornamental rocks or granite can structurally stabilize slopes, divert water flows, and look natural. If grading is necessary, you can alter subsurface drainage to improve water infiltration, but remember that graders and other heavy equipment can compact soil, reducing its absorption ability.

When designing your landscape, take clues and cues from the surrounding plant communities and other natural features. Create a design that reflects the natural world around your property to ensure a strong sense of place. Avoid homogenous landscapes that have little wildlife value and could be found anywhere in the country.

The inventory process

Whether creating a brand-new landscape or making a few changes to an existing landscape, begin by taking an inventory of what is already there. The inventory process involves making detailed observations of the site and beyond (as far as the eye can see), the natural world around you and the human uses of the property.

Spend time looking closely at the land features, existing vegetation and wildlife habitat elements. Take a look at the bigger picture, the surrounding community, and think about how your yard fits in. What plant communities lived there before the land was developed?

Whenever possible, inventory your site through a full year of seasons. The effort spent on this part of the design process will help you better understand the land, plants and wildlife and their relationship to the water body. A careful seasonal inventory will help you make the best decisions for a healthy, enduring landscape. Photos showing seasonal conditions are good records, useful during the design process and for permit applications.

The inventory questions that follow are based on the preceding design principles. By answering all the questions, you will have considered each of the principles. Try not to get discouraged by the number of questions. Instead, work through them one at a time. Make a list of the ones you can't answer yourself and set them aside for now. You may decide you need to consult a professional or a resource specialist later on.

Protect soil quality

- Are there areas of exposed soil or soil erosion on your property? Where are they and how do they relate to runoff?
- Are there areas where soil has remained undisturbed for many years? These soils are likely to be in excellent physical condition and support a diverse population of organisms. Try to leave them intact and protect them during construction.
- Does your soil contain enough organic matter (3 percent - 5 percent) to stay moist, cool and alive?
- What do the results of your soil tests suggest about the physical, chemical and biological conditions of your soils?
- Are there areas where soil has been compacted or where heavy machinery was used? Areas that should be fenced off from future automotive traffic and/or heavy equipment use?
- Are there areas to store topsoil during construction projects? Can the soil be placed on a level surface and covered with a tarp to prevent runoff?
- Do sources of runoff originate on or off your property? Where? When? Are there times of excess flow (heavy rainstorm) or seasonal impacts (snow melt)?
- Follow the evidence of a flow after a heavy rainstorm. Consider ways to break up, slow down, and spread out the flow? Chapter 2 provides information on these techniques, which include shallow vegetated channels, stone check dams, vegetated berms or swales, drainage cuts and waterbars.

Include as many vegetative layers as possible throughout your property

- What vegetative layers currently exist?
 - canopy (overstory) trees
 - understory trees
 - shrubs
 - herbaceous plants
 - ground covers
 - decomposing litter layer
- What layers are missing?
- Record the existing vegetation on the site, to the best of your ability. Include:
 - woody plants: trees, shrubs and vines
 - herbaceous (non woody) plants: wildflowers, perennials, annuals and grasses
 - other ground coverings such as mosses, ferns and lichens
- Estimate the percentage of native plants on site.
- Are there any invasive plants of any type? To what extent?
- Note components that provide food, water or habitat for wildlife, such as:
 - water sources
 - bird baths
 - flowers, nectar
 - fruits, seeds
 - feeders
 - worms
 - insects
 - evergreen trees or shrubs
 - travel corridors and flyways
 - burrows, cavities
 - dead or partially dead trees (snags) and downed woody debris
 - houses/boxes
 - rock walls, rock piles
 - brush piles
 - tall grass meadow

Identify and list wildlife, including mammals, birds, reptiles, amphibians, fish, spiders, insects and mollusks that use the site throughout the day and into the evening. Include evidence of food eaten, tracks, nests, scat, and actual sightings. Note the locations of this evidence on your property and estimate populations if possible. Also look for rare or endangered plants or animals onsite or nearby. Appendix B lists some web resources to help you with this step.

Maximize the vegetative buffer along shorelines

- Can you see evidence of shoreline erosion? Follow it backwards to its origin.
- How deep or wide is the vegetative buffer behind the shoreline?
- Estimate the percentage of your total shoreline covered by vegetation.
- Which vegetative layers are present in the buffer? Which are missing?
- Can you increase the depth or length of the buffer?
- Can you increase the density of plants to help compensate for beach or bare shoreline?
- Is part of the shoreline shaded, which is beneficial to many aquatic organisms and reduces submerged and emergent weed growth?
- If you must have sand in the beach area, how will you design and construct a perched beach?

Consider the size and location of your lawn

- What is your idea of an ideal lawn, a single species of very green grass or a mix of species, e.g., fescues, bluegrass, rye, that includes clover or other desirable broadleaf plants?
- How will you use lawn areas?
- How much lawn space do you need for those activities?
- Are there areas of existing lawn you can replace with layered vegetation?
- Do you apply fertilizers, insecticides, herbicides or other products to the lawn? If so, list them all, along with the frequency and rates of application.
- How close is the lawn to the water body?
- Are there buffer areas between the lawn and the water body?

Choose the right plant for the right place for the right function

- Can you find site conditions (e.g., low, wet areas or excessively sandy soils) that will require plants tolerant of those specific conditions?
- Can you identify plants or animals on the site that indicate wet or dry soil conditions?

- Are existing plants appropriately located? Do they frame desirable views? Consider plants for fall and winter interest as well as those that look good during the summer.
- Are the plants in good health, structurally sound and aesthetically pleasing? Do any need to be thinned, moved or removed? You may want to seek the advice of an arborist or other landscape professional.
- Which existing vegetation should be retained in your new plan?
- Are there areas you'd like to have screened? Screens can block undesirable views, reduce noise and/or serve as windbreaks.
- What areas of the site receive full sun, partial sun and little-to-no sun during the growing season?
- What is the plant-hardiness zone (or zones) for the site? Can you locate microclimates that may deserve special consideration, e.g., areas protected from extreme temperatures or exposed to cold winter winds?
- Where can you use plants strategically to intercept and slow water flow?

Design a lower-maintenance landscape

- What practices are currently used to maintain the landscape?
- How often do you mow the lawn? How high do you set the mower?
- Do existing plants need frequent pruning to contain their size? If so, can you move these plants to a location where they can grow to their natural size and shape?
- Have you considered the mature size (height and width) of plants when choosing new plant material?
- Can you leave herbaceous plants, such as ornamental grasses and perennials, standing during the winter months to provide winter interest and wildlife habitat?
- Can you leave plant residue on the site during spring and fall clean-ups to help build soil organic matter, recycle nutrients and reduce waste?

Reduce the area of impermeable surfaces

- What type of materials are your driveways and walks made of?
- Estimate the percentage of area covered with impervious surfaces, e.g., rooftops, asphalt, concrete, flagstone.
- Do you see evidence of water flowing off these surfaces and moving downhill, such as sheet erosion, exposed roots, gullies and rills?
- Can you think of ways to divert the water and slow down runoff from impervious surfaces, such as increasing vegetation, planting rain gardens, constructing swales or setting up rain barrels?
- Are there places where the steepness of your site and the size of impervious areas may allow erosion and runoff?

- Could you replace some impervious surfaces to allow water to infiltrate the soil, while simultaneously improving the area's aesthetic appeal?

Develop awareness of how lifestyle choices influence the water body

- Make a list of indoor and outdoor chemicals you currently use on site, including household, automotive and horticultural products. Consider which products you could eliminate in favor of environmentally-friendly substitutes.
- Check for signs of fluid leakage from motorized vehicles or machines, such as cars, recreational vehicles, mowers, rototillers and weed-whackers.
- When choosing plants, look for those varieties that are insect- and disease-resistant to reduce the need for pesticides.
- Consider replacing lawn areas with groundcovers or grass mixtures that need no chemical inputs and require no or little maintenance.
- Educate yourself in integrated pest management practices to manage problem insects and plant diseases.
- Plan to allow leaves and grass clippings to decompose in place and recycle the nutrients where they can be used by plants, or compost them for later use as mulch. Never dump leaves or clippings in the water, where their decomposition will release nutrients to the water body.
- Understand the importance of cleaning up and disposing of pet waste away from the waterfront.
- Make plans to prevent and clean up any spills of gas, oil, pesticides, fertilizers, salt or other materials to keep them out of the water or the recharge area of shallow drinking-water wells. Store these materials safely, far away from the water.

Use good design to stabilize both water flow and soil retention

- Investigate point sources of flow such as gutters, sump pump outlets and tile drainage. Think of ways to divert these flows to filtration areas.
- Identify areas with steep slopes. Are these sparsely or heavily vegetated? What types of plants can you add to help stabilize the soil?
- Identify relatively flat areas. If a patio or small lawn is needed could these areas be used? Otherwise, can you create a vegetated area designed to slow water and allow infiltration, perhaps a rain garden?
- Do pathways and trails meander across the slopes (following contours and ridges) versus going straight down hill? Are steep pathways terraced to reduce the slope?
- Consider which practices you could use to slow down runoff on your site:
 - rain gardens/catch-basins

- strategically placed boulders or curbing to help channel runoff to vegetated areas
- berming, terracing (but beware of soil compaction caused by the heavy equipment used to construct them)
- mulching, leaving a thick layer of natural litter or adding a layer of organic mulch (straw, chopped leaves, shredded bark, etc.)
- How large is the area cleared for water access? Can it be made smaller in favor of more vegetation? Can plants be chosen to enhance and frame views versus blocking views over time? Do any pockets of vegetation break up the flow of water heading toward the shore?

When designing your landscape, take cues and clues from the surrounding plant communities and natural features

- What native vegetation currently exists?
- If the site's vegetation is dominated by invasive species or cleared of vegetation, what plants may have been present in the early history of the site? Look to undisturbed pockets or undeveloped neighboring areas for evidence of native plant communities.
- What plants native to New Hampshire could you plant on the site? Think about groundcovers, flowers, vines, shrubs, and trees.
- How are plants arranged on your site? Do they grow in groups or clusters? (Nature doesn't plant in rows.)
- What wildlife would you like to attract to your landscape?
- Are there naturally wet areas that could be preserved as bogs, vernal pools and/or rain gardens?

THE EVOLUTION OF AN ECOLOGICAL LANDSCAPE DESIGN



Figure 4-2 a.

This steeply sloped lot was originally cleared for a panoramic view of the water, but now lacks privacy. The sloped turf areas are dangerous and time-consuming to mow and have limited recreational use. Without a plant canopy, seasonal interest is diminished and lacks connections for wildlife movement. The direct pathway to the shoreline involves many stairs to climb, and channels runoff water directly to the shore, carrying with it soil, nutrients, pesticides, petroleum products and other household substances. Portions of the exposed shoreline are lost to erosion each year.



Figure 4-2 b.

Landscape improvement begins by planting a vegetative buffer area to protect the shoreline and by allowing much of the lawn to revert to a meadow-like condition. Reducing the expanse of lawn means less maintenance and more time to enjoy the property. Native plantings restore wildlife habitat, color and seasonal interest. The terraced, stone patio replaces a deck, eliminating one long stairway. Impervious surface is reduced by shrinking the asphalt driveway. Eliminating some of the docks reduces maintenance while still allowing a very usable lakeshore.

Creating your base plan: putting it on paper

With the ten design principles in mind and your inventory complete, it's time to begin the design process. You'll need the following:

- tax map
- topographic map
- soil survey for your area
- building plans (if possible)
- state-approved septic plan



Figure 4-2 c.

As aquatic and shoreline plants become established, the shore is protected against erosion. The larger lawn area is maintained for recreation, and the smaller one for relaxation. Meadows keep the view open while building diversity of habitat for wildlife. Native plantings connect the small fragmented woodlands, and pathways have been defined to create interesting strolls and maximize enjoyment of the property. The slopes are densely planted in layers to increase infiltration and protect soil from erosion. A meandering pathway follows the contour lines for a gentle approach to the water.



Figure 4-2 d.

The addition of more plants maximizes the protection of slopes from erosion, the amount of water that is intercepted and infiltrates into the soil, and the diversity and interest of the landscape. Cover, food and nesting sites are restored for wildlife, and a framed view of the lake creates privacy and easy access to the waterfront.

- directional compass
- 2-ft.by 3-ft. piece of paper or vellum (if purchasing, get two as you'll need a second piece later on in the process)
- drawing pencil and colored pencils or fine markers
- ruler or engineer scale
- trace paper
- your inventory

You don't have to be a professional mapmaker or an artist to create your own plan. We will walk you through the process step by step.

Use the scale one inch equals ten feet. Begin with a large sheet of paper and your tax map or building plans. The first steps to creating your base plan are to draw:

- property lines
- roads and driveways
- compass points (transfer from your building plans or topographic map)
- easements or setbacks

Building footprints and utilities

The next component of the base plan will include measuring and placing buildings, continuing to use the scale one inch equals ten feet. For this, you can use building plans or take your own measurements. Include the following additions to the base plan:

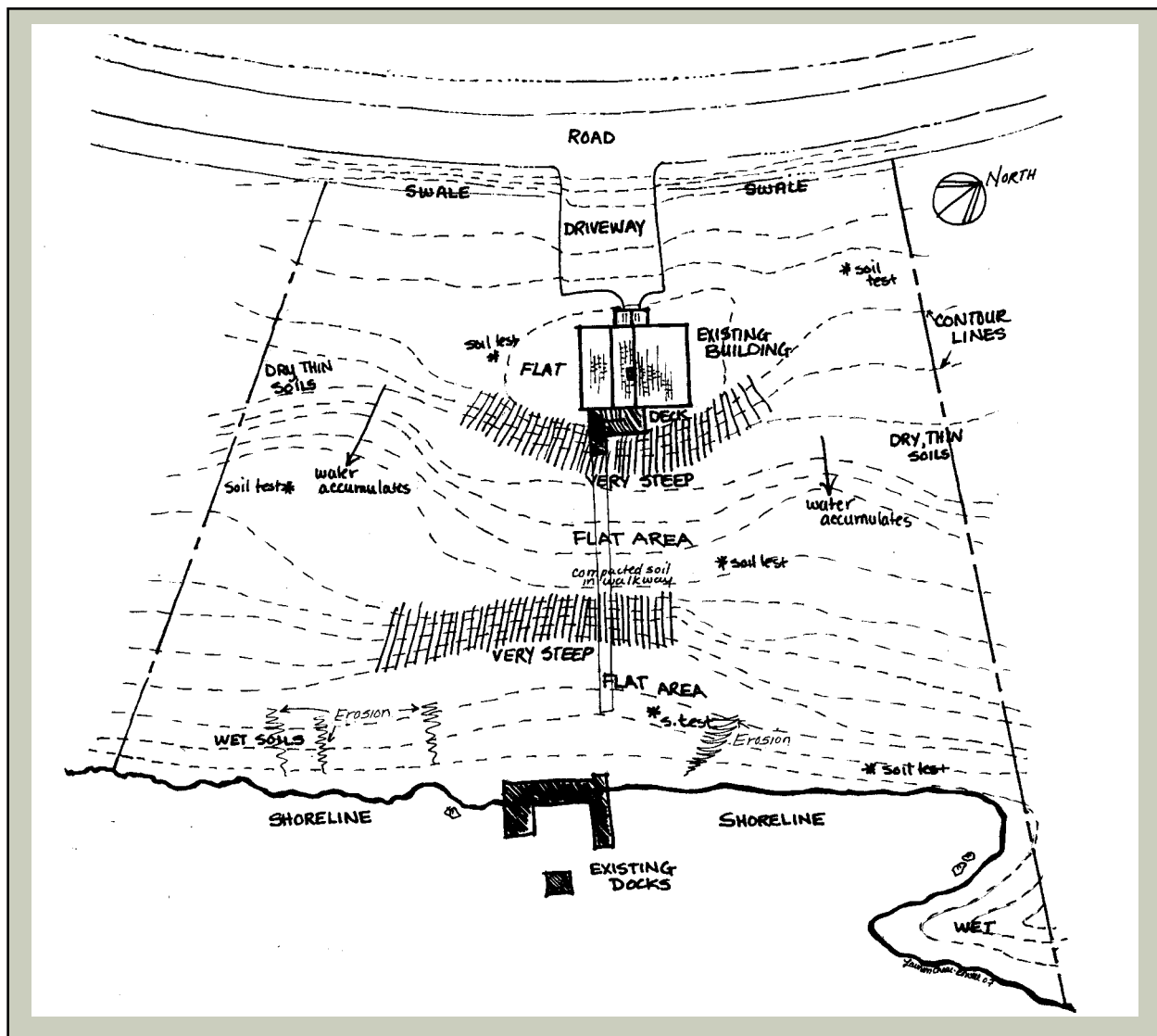


Figure 4-3a. Base plan showing property lines, road and driveways, directional orientation, building footprint, other structures, physical features and soil information.

- the footprint (dimensions) of your building
- size and placement of doors and windows, including heights of windows off the ground
- floor plan of interior layout
- locations of utilities, including electrical, water, gas, oil and septic. (Your septic plan, available from the state, will give you its exact location, depth and typical components, including septic tank, distribution box, leach field and location of your well.)
- outbuildings and permanent structures (Once you've drawn the footprint of your home you may locate the outbuildings accurately by taking measurements from the corners of your home.)

Physical features

A topographic map can help you locate physical features, including:

- Landforms such as sloped areas, ridges, flat areas, wetlands, vernal pools, shoreline and drainage swales. These features will help you begin to see how water moves across your property. In almost all cases you will see that water travels downhill toward the body of water. Also add any observations from Chapter 2's "Following the flow."
- Water Bodies: seasonal streams, rivers, ponds, lakes, saltwater bodies
- Soil Information (from your soil observations and tests, discussed in Chapter 1)
 - areas where soil should be protected
 - areas to be amended
 - areas to store soil during construction
 - areas of highly compacted soils
 - erosion problems
 - wet soils
 - sandy soils
 - areas of thin soils or exposed ledge
 - other
- Existing plants - place existing plant materials on your map to the best of your ability. Include species, size, condition and location. Begin to reference areas of value or interest, such as a grouping of lady slippers, a snag with nesting holes or a specimen tree.

Weather patterns and microclimate

Now you're ready to reference climate indicators on your base map. (See Figure 4-3b.) With big arrows, denote the following:

- winter and summer prevailing winds
- angle of the sun throughout the day and in different seasons
- screens, windbreaks, natural openings
- shadiest to sunniest areas (you can use crosshatching to indicate shade)
- microclimates, areas where the temperature, humidity and exposure vary from the dominant conditions enough to increase human comfort or the diversity of plantings.

Views

From the building's interior, look out in all directions to help decide where to keep views open and where you need plants for screening. Elevation views from building plans may help with this task as they show first and second-story windows. With a light touch of a pencil indicate these views on the base plan. Later in the process you will refine, enhance and preserve views.

With your inventory in hand

Think of this stage as putting another layer of critical details on the base plan. Use a colored pencil to transcribe more findings from your inventory to the base plan: areas of erosion, lawn area needed for certain activities, buffers that can be increased, a neighbor's garage you want to screen from view, etc. At this point the relationship between your inventory and the base plan should begin communicating with each other.

Adding layers to your base plan

Analyze your site: trace paper overlay #1

Now that you've completed your base plan, it's time to add a layer of existing details. (See Figure 4-3c.) Place a sheet of trace paper over your base plan. Using a different-colored pencil, add in broad strokes, shading, circles, etc. to show critical uses, including:

- circulation paths, the way you move through your site, including pathways to shoreline
- parking and vehicular pathways
- public views, areas seen by the public
- front yard and backyard
- service area(s), functional areas that serve needs such as storage, laundry, utility sheds, fuel delivery, etc.
- access to water, such as outdoor spigots, hoses, wells and anywhere from which you draw water
- flat, useable space
- entertainment areas
- sitting areas
- quiet spaces
- recreational area

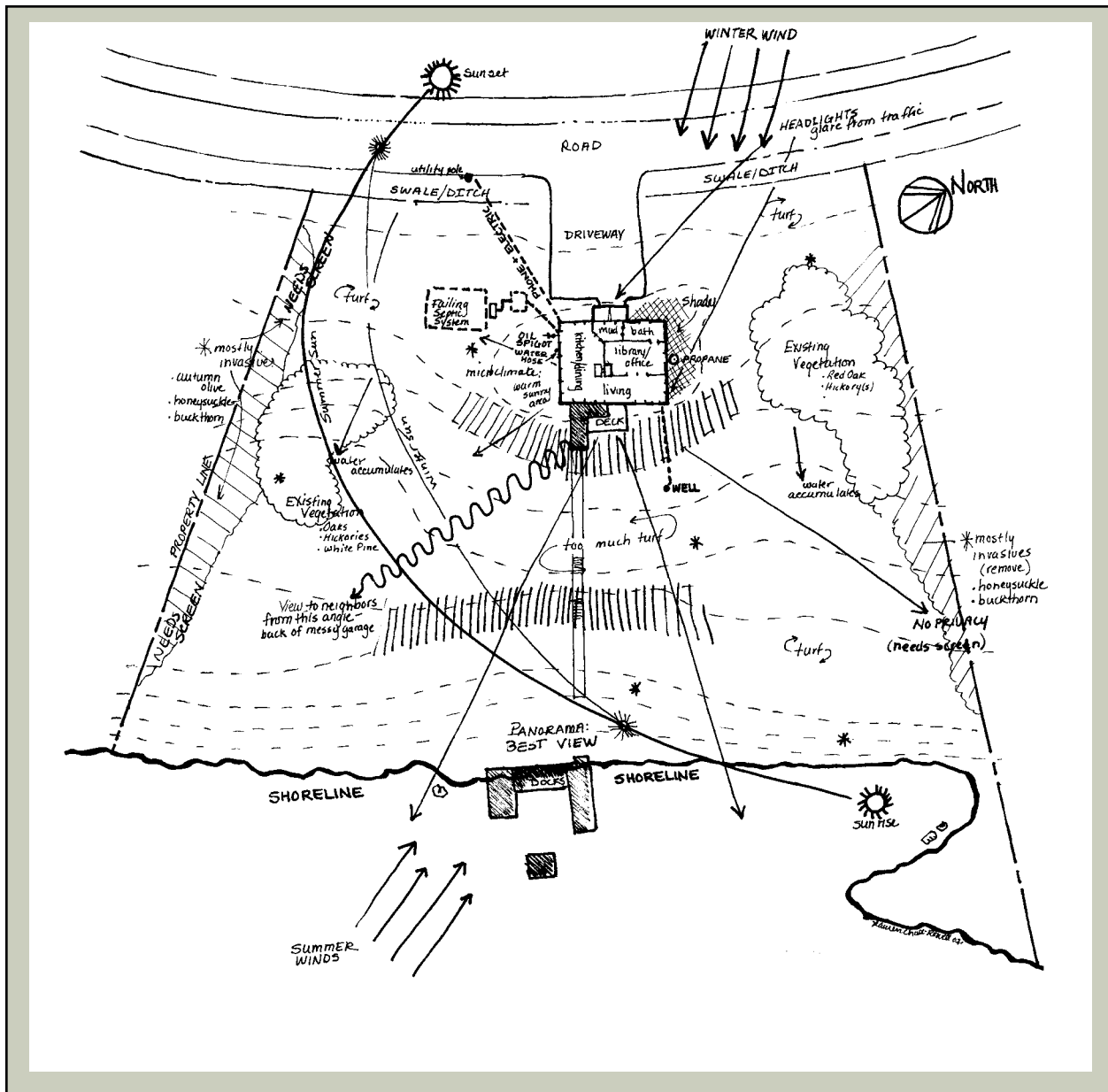


Figure 4-3b. Continuation of the base plans showing existing plants, utilities, indications of wildlife, weather patterns, microclimates and views. The interior layout, or floor plan, is necessary to determine indoor and outdoor relationships of function and space. Inventory details are added.

- areas to be protected, including mature vegetation (undisturbed for 40 years or more), vernal pools, root zones of existing large trees, etc.
- vegetable and flower gardens
- compost bins
- other

Add your list of needs and desires

Needs and desires depict the property owners current and intended uses of space, personal likes and critical needs, as well as wish list items. Create a list on a separate paper of things such as:

- pet areas
- storage and temporary parking for small boats, rafts, water toys, etc.
- firewood storage
- clothesline
- various play areas (swings and slides, basketball backboard, badminton or volleyball field)
- swimming areas
- patios, and outdoor cooking area
- relaxation areas such as gazebo, screen house, or deck
- food gardens
- flower gardens
- compost bins
- windbreaks, natural openings
- habitat features to attract wildlife
- docks and/or boat access and storage
- views to be screened (for example a neighbor's garage, a dumpster, etc.)
- buffers to be increased
- others

With your list in hand, use a third colored pencil to locate areas for meeting your needs and desires on Overlay #1. (See Figure 4-3c.) This begins to fill in the details of how you will use your shoreland property and helps determine how indoor and outdoor functions relate to each other. For example, you might locate herb gardens and entertainment areas such as outdoor dining in close proximity to the kitchen, firewood storage close to the fireplace or woodstove, and quiet or natural areas close to the bedrooms.

Next, you will need a second piece of trace paper to create a third layer.

Create a functional bubble diagram: trace paper overlay #2

Take some time to take in all the information on the base plan and Overlay #1. Begin to think about grouping similar functions into units of space. For example, a vegetable garden, compost bins, access to a hose and a tool shed go together. Another grouping combines the driveway, walkway to the door, and the mud room. Each group of functions can be mapped on to the second layer of trace informal circles and shapes (bubbles). Consider the following:

- front lawn/public view
- parking
- screens
- private/quiet areas

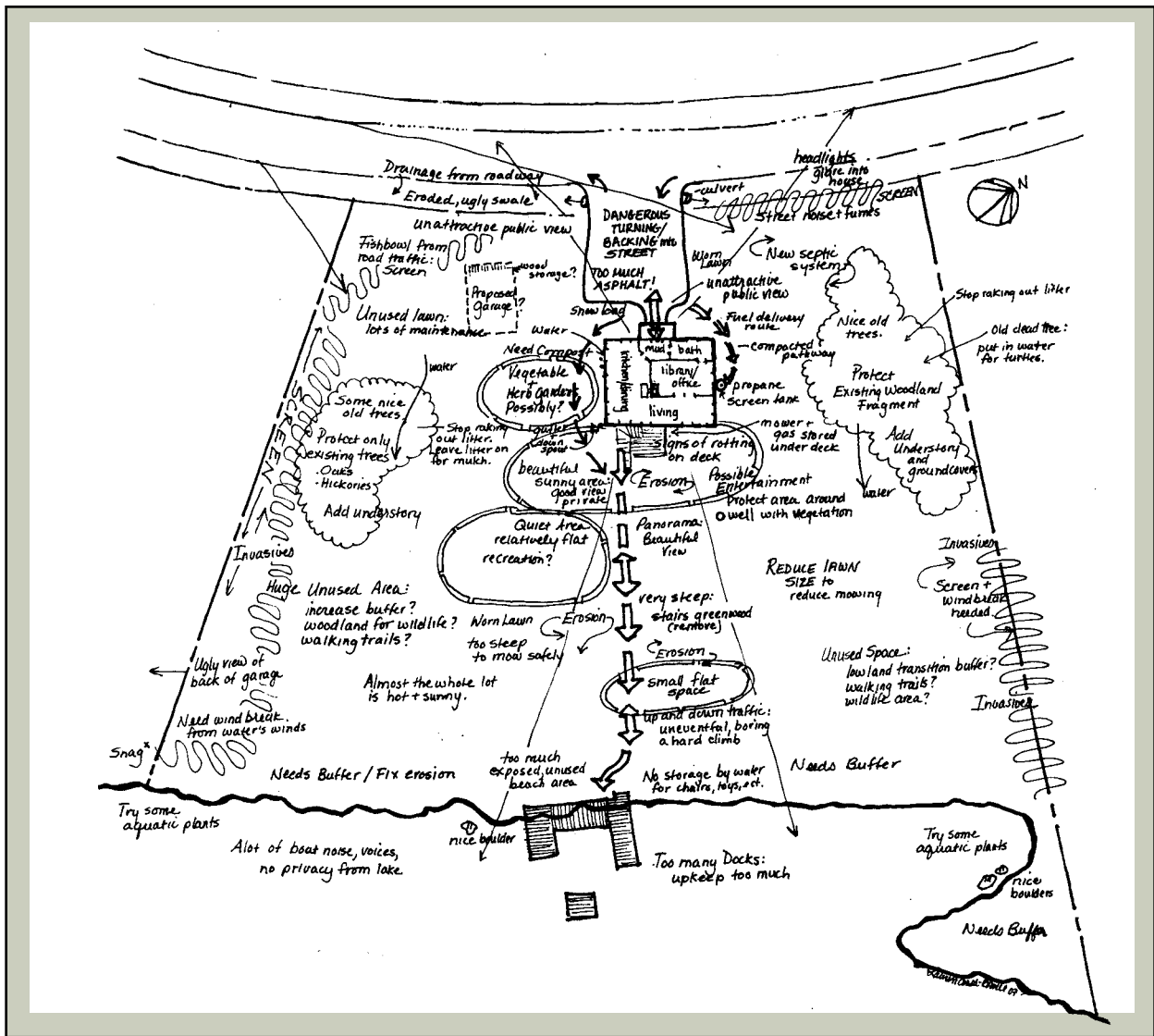


Figure 4-3c. Site analysis is a thorough gathering of information depicting current functions, uses of space and the relationships between them. Capabilities, limitations and interacting elements are recorded.

- outdoor work area
- outdoor storage area
- play lawn/recreational space
- entertainment/terrace/patio areas
- kennel/pets/animals

Functional bubble diagrams bring attention to the interrelationships between indoor and outdoor spaces and uses. Your entire property is a valuable living space and an extension of your home’s interior layout. Bridge together as many indoor-outdoor links as possible.

In adding this layer of information you may discover valuable spaces you never before considered, such as a small pocket of unused space outside of your bedroom that could be used for a quiet sitting area. It also helps you to see functions that won’t work together. For example, as you look through the bubble diagram at the different layers, you might notice that the area outside of your kitchen where you hoped to locate a patio for cooking has underground utilities. Instead, you decide to move the patio to the area outside your dining room where there is no conflict; in the space outside the kitchen you could put in an herb garden with perennials and annuals whose shallow roots won’t interfere with the utilities.

The final step: your conceptual plan

Your conceptual plan becomes your final design. After spending time contemplating the three layers of information you have completed, transfer onto paper or vellum all the features you want to carry over onto your final design. (See Figure 4-3c.)

Determine outdoor spaces you want to develop. You may want to think of them as “outdoor rooms.” Begin to place “rooms” and carve out open spaces for recreation, quiet spaces, patios, paths, utilities or other uses. Look at the interrelationships between and among all the rooms, both indoor and out.

For shoreland properties it’s best to keep areas outside the “rooms” heavily vegetated. Trees, shrubs, flowers and grasses, along with built structures, can help form the “walls” to your rooms. Locate these walls or vegetated areas on your concept plan (fourth layer). Although you don’t need to designate specific plants yet, you will want to record the amount of space available for them.

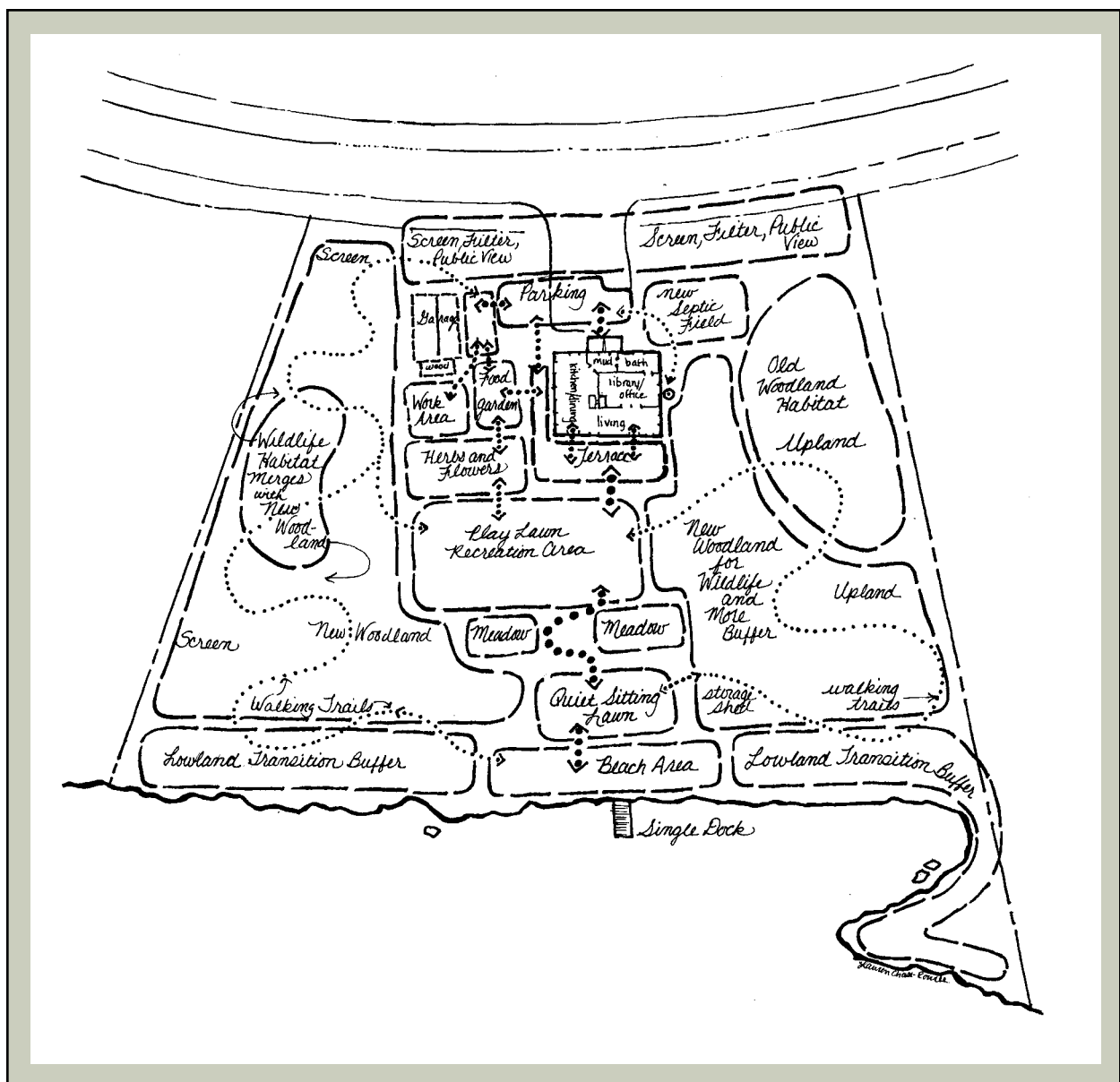


Figure 4-3d. In helping the design to flow, functional bubble diagrams map out indoor functions, outdoor activities and circulation patterns based on the capabilities and limitations of the site analysis.

You may want to try to imagine how your property looked before it was developed. Look for undisturbed patches of vegetation to help you visualize what your land might have been like and incorporate these into your outdoor walls or rooms. Existing vegetation will also provide clues later to help you determine which plants will grow well with minimum care on your site.

Visual design tips

- Curves replicate nature better than straight lines. Curved lines make spaces seem larger or more distant. Straight lines suggest more formality.
- A small space looks more confined when its edges are obvious. Use vines or shrubs to soften the straight lines of a fence.
- Sun exposure:
 - Full sun means more than six hours of direct sun each day
 - Partial sun means less than six hours of direct sun, or long periods of filtered light (dappled shade)
 - Shade means little or no direct sunlight and/or less than six hours of filtered light each day.
- People generally like to gather in areas that provide a feeling of security, such as having a structure behind them, rather than being out in an open area with nothing around them.
- Plants generally look more natural when planted in clumps of three, five or seven. Stagger centers and avoid planting in straight lines.
- Cool colors (green, blue, violet) retreat visually, giving the impression of greater space. Warm colors (orange, red, yellow) seem to surge forward, making the space look smaller. When planting warm and cool colors together, use four times more cool color to balance the warm.
- Views need not just be wide-open expanses overlooking large lawn areas. You can create views by framing them with vegetation, which attracts the eye and adds depth to the view. “Windows” through vegetated areas, made by selective thinning of trees or pruning of branches, provide a filtered view of the water or a land form, without decreasing privacy.
- You can also frame a view to draw attention away from less attractive landscape components. Placing plants to create a framing effect can lead the eye to an attractive spot such as a single tree.

Plant systems and plant selection

Once you’ve formed the rooms, it’s time to select groups of plants appropriate for the site and functions designated. Plant systems, as we define them here, mean using combinations of plants that typically grow in layers and that mimic naturally occurring landscapes.

Why design in plant systems rather than simply installing a few of your favorite plants here and there? Because many-layered plantings:

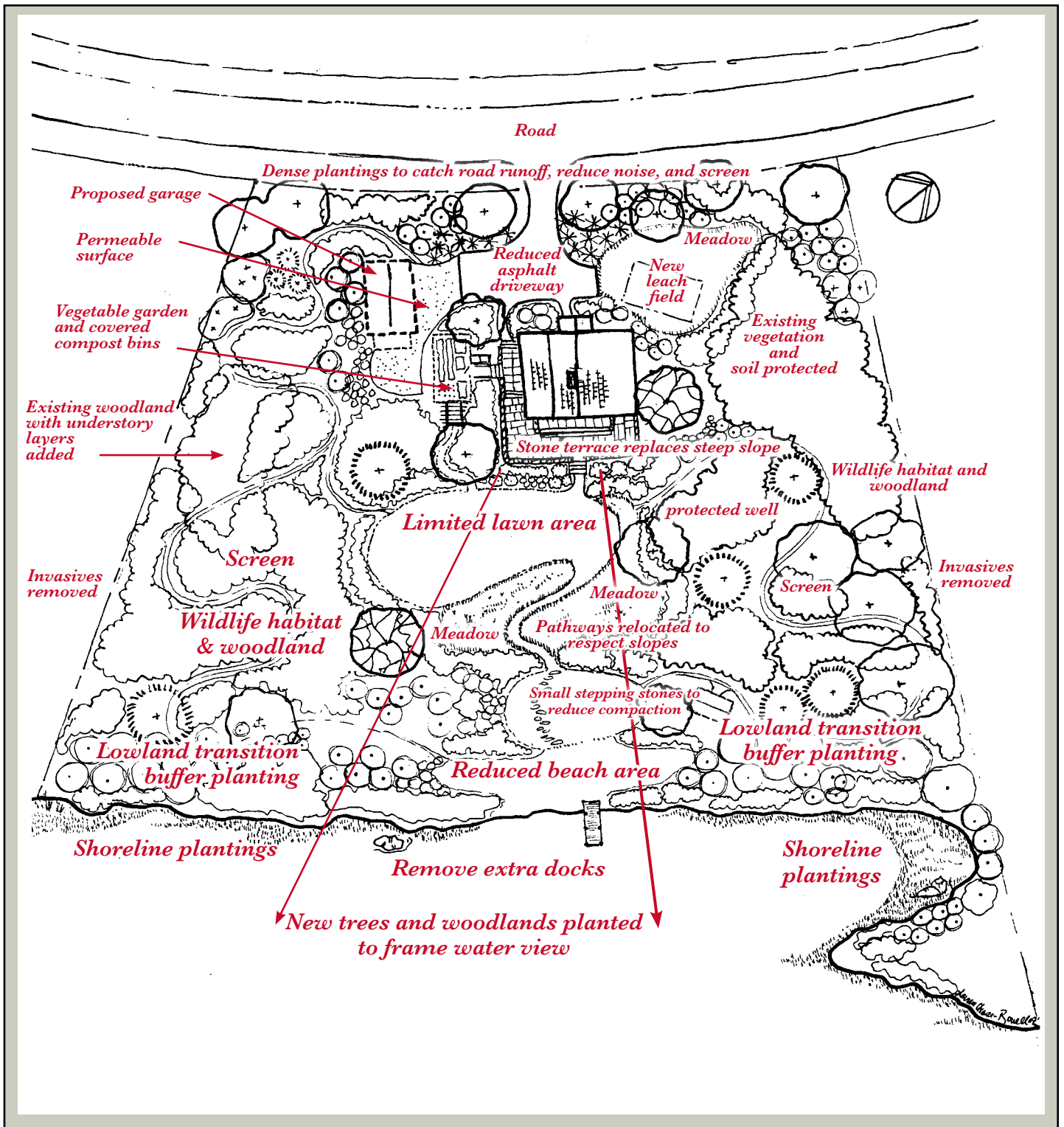


Figure 4-3e. The conceptual plan provides a visual overview of all the features, vegetation and actions planned to establish an ecological landscape that protects water quality, provides a diverse wildlife habitat, and is pleasing and functional for human use.

- Invite biodiversity
- Increase root mass and soil stabilization
- Enhance soil quality
- Conserve rainfall, reduce runoff and protect water quality

- Recycle organic matter and nutrients
- Enhance wildlife habitat
- Resist pollution, pests and drought
- Create a sense of place

These biological benefits are reflected in the 10 landscape design principles. People also benefit from layered plant systems, which:

- Provide shade in summer and windbreaks in winter
- Can help channel snow away from walks and driveways
- Reflect the character of the surrounding area
- Offer year-round interest (through plant structure, fruit, bark and flowers) and sequential bloom throughout the growing season
- Minimize maintenance costs and labor
- Still allow you to include your favorite plants in the mix

When designing plant systems for a new landscape, you'll need to select and arrange plants depending on the shape of the area that you are working with. For instance, if you are planting alongside a shoreline or a structure such as a wall, arrange the plants in a more linear fashion, with the taller plants in the background. In a large, open area you'd put the tallest plants in the middle.

In another example, you may want to open up a view to the water from certain rooms in the house. To achieve this you might choose a mixture of plant species that stay under three feet tall, while other areas will need more vertical layers of plants that include understory and overstory trees.

There are many wonderful plants suitable to any region in New Hampshire. Use the plant lists in Appendix C as a reference to help you select appropriate plants for low-maintenance shoreland landscapes. It groups plants by mature size and provides additional information on plant characteristics, light and soil preferences, as well as identifying native plants and those with wildlife value. Figures 4-4 (a-d) illustrate how plants from different height categories can be combined together into attractive and functional plant systems.

Use your imagination to think of additional ways that plant systems could enhance your existing landscape. For example, if you have a tree or shrub standing by itself in a lawn area, select a few ground covers, perennials or understory shrubs to complement the lone plant.



Figure 4-4a.

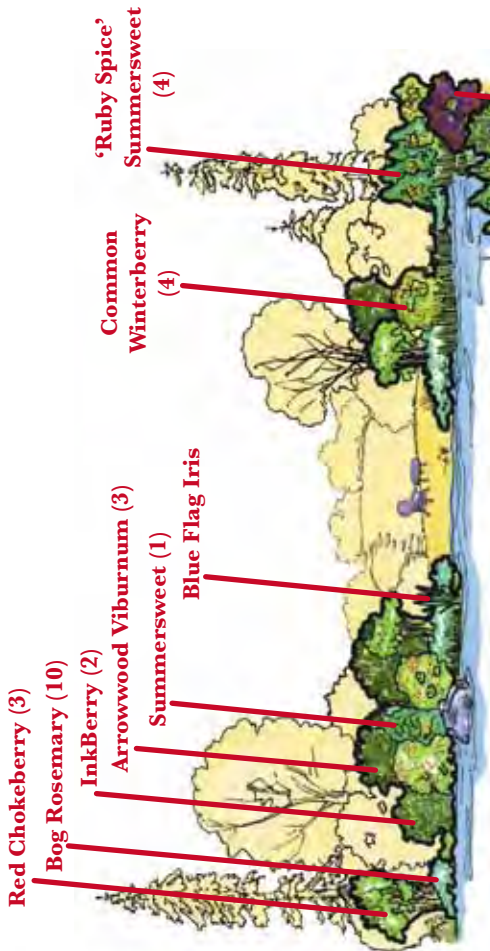


Figure 4-4b. Groundcovers and shrubs under ten feet mature height.

- Red Chokeberry (3)
- Bog Rosemary (10)
- InkBerry (2)
- Arrowwood Viburnum (3)
- Summersweet (1)
- Blue Flag Iris
- 'Ruby Spice' Summersweet (4)
- Common Winterberry (4)

- Common Cattail
- 'Hummingbird' Summersweet (3)
- 'Black Beauty' Elderberry (1)

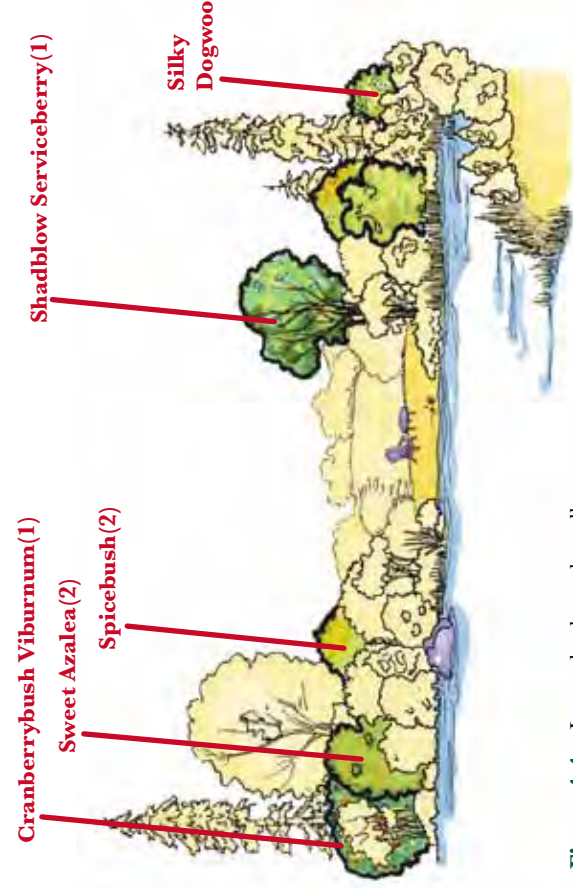


Figure 4-4c. Large shrubs and small trees between ten and 25 feet at maturity.

- Cranberrybush Viburnum (1)
- Sweet Azalea (2)
- Spicebush (2)
- Shadblow Serviceberry (1)
- Silky Dogwood (2)



Figure 4-4d. A few large trees over 25 feet at maturity.

- Black Spruce (3)
- Green Ash (1)

Figure 4-4 a-d: A view of the landscape from the water shows that plants are arranged in layers by height. Drawings b-d pull apart this overview into three layers to illustrate how plants can be selected and arranged in a pleasing and functional manner. Appendix C lists many alternative plant choices for each height category.



Planting and Maintaining the Shoreland Landscape

Start by choosing a small area to work on, then measure and calculate the approximate square footage of the area. Make sure you understand the existing site conditions and plant characteristics to find the right plant material for the site. Select appropriate plants to develop each layer of vegetation, including dominant canopy trees, understory trees and shrubs, herbaceous plants and groundcovers.

Consider the mature size of each plant to calculate how many plants will fit into the area. For example, if you want to plant three winterberry hollies whose mature size is eight to ten feet wide, you will want to give the plants enough room to grow by planting them approximately nine feet apart. At their mature size, their branch tips will just touch each other.

Begin by planting the largest plants first, trees, then large and medium shrubs, and so on. After you've installed the large plants, add structural elements such as boulders, stairways, patios, and fences. Complete the plant system by adding groundcovers, grasses and/or perennials that will hold the soil in place. Always provide two or three inches of mulch to cover and protect any exposed soil. As the groundcover fills in and natural leaf litter accumulates over time, you'll eventually reach the point where you won't need to continue adding mulch. Nature will most likely add another wonderful layer of mosses, lichens and ferns.

Your starting point

You can phase in your plan according to its complexity and your available budget. How you proceed will depend on what you start with: bare or weedy ground, established turfgrass, or wooded areas.

Starting with bare ground

Eroded areas, beach areas, and newly cleared land may be bare when you start. In this case, the essential first step is to establish a vegetative cover immediately, which will stop soil erosion, reduce runoff, and start to allow the natural soil biology to re-establish itself. You can get a quick, temporary cover with annual ryegrass seeded at a rate of ten pounds per 1,000 square feet. It will hold the soil in place through the winter, then die off the following spring. At that time you should be prepared to plant permanent vegetation.

You can try seeding some wildflowers or a meadow mix along with annual ryegrass or oats as a “nurse crop” to keep a cover on the soil while the wildflowers slowly germinate and fill in. Establishing a wildflower garden is very challenging and good site preparation is one key to success. Fall is the best time to seed wildflowers, since many of them need a cold period before they can germinate. Many perennial wildflowers planted from seed will not come into bloom until the third season. Unfortunately, weed often prove much more vigorous than the wildflowers and will overgrow them unless you are very diligent. Meadows and wildflowers do require annual maintenance such as mowing in early spring.

Planting live perennials from plugs, pots or as bare-root plants is usually an easier, more successful way to create a meadow look or simply add some color to the landscape, but it can be expensive to cover large areas. You can also create color points with selected ornamental grasses, shrubs, and trees. There will be large gaps at first, which need to be covered with a layer of mulch until the plant cover grows together.

Starting with turf or weedy ground

One way to establish a more diverse vegetative buffer in grassy areas is to simply stop mowing the grass and allow vegetation to come in naturally. This takes some time but costs nothing. Herbaceous plants will fill in quickly, followed by woody shrubs and seedling trees.

Learn to identify the plants that spring up and selectively remove the invasive and undesirable species or plants coming up in undesirable spots. If you want to maintain a grassy meadow look rather than allow a gradual transition to woods, mow the area occasionally to cut back woody plants.

Sometimes it is desirable to suppress established weeds and/or grass to make way for improvements. You can usually accomplish this by mowing and mulching. First, mow the area as close as possible, then cover it with an opaque material such as black plastic, commercial landscape fabric, thick cardboard, or thick layers of newspaper. Wood chips or other organic mulches aren't as effective at killing existing plants, but covering the opaque layer with a layer of shredded bark or wood chips can make it more attractive. You can spread compost on top of level cardboard or newspaper so it will enrich the soil as the paper degrades. Leave the mulch layer in place all summer to get good weed control. September is a good time to remove the mulch and plant.

Some property owners don't have the patience to wait while a meadow grows in or to spend an entire season waiting for weeds to die. If that describes you, remove sod with a sod cutter, then prepare and plant the bare area.

Killing existing turf and/or weeds with a nonselective, post-emergent herbicide is another possible strategy. If you're considering this method, consult with a licensed commercial pesticide applicator or your county Extension educator for advice and be sure to comply with all state regulations pertaining to setbacks from surface water (Appendix A).

Starting with woodland

Existing natural or naturalized areas are extremely important in sustainable landscapes and should be preserved and protected. Near the water they serve as buffers, protecting the water body from accumulating silt, nutrients and other undesirable substances carried by erosion and runoff.

Wooded areas also provide privacy and reduce the noise from neighboring properties, roads and other access points. If your property already contains natural areas, keep them intact and consider expanding them if space allows. They should not be fertilized, sprayed, mowed, raked or disturbed, other than to remove weedy or invasive plants. The forest floor is a functional ecosystem with a balance of soil organisms, litter-dwelling insects, and groundcovers containing many delightful native plants that are easily destroyed by disturbance, so provide a few pathways for access and leave the rest untouched.

It's okay to "edit" the existing vegetation by selectively removing trees, shrubs or branches to open up desired views and/or access to the water. Selective thinning protects soil and water quality better than patch cutting. The Comprehensive Shoreland Protection Act restricts the amount of vegetation that can be removed from shoreland property (Appendix A).

Evaluate existing plants, deciding what to keep and what to remove, prune, or replace. You may remove dead trees and large branches selectively to improve aesthetics or to minimize fire danger, although snags left standing provide excellent wildlife habitat. Make sure to photo-document removals of dead or dying trees so you'll have a record of compliance with state regulations.

Use trees to frame views by cutting windows within the foliage or thinning to provide a filtered view of the water body, while still protecting privacy. Proceed thoughtfully over several seasons, reconsidering as the view changes from summer to winter. It's easy to cut down a tree or branch, but impossible to put it back up!

You can augment the buffer with new plants you want in the mix, but remember that the root systems of existing trees are spreading and shallow, with most located in the top several inches of soil. Rather than disturbing larger areas, do spot-planting whenever possible. Avoid breaking or cutting numerous roots from existing trees. Don't remove old mulch, because many fine feeder roots are growing in the mulch layer. Allow the leaf litter and mulch layer to collect and break down naturally.

Soil and site preparation

The nutrient and lime recommendations that come with the results of your soil test are meant for more highly maintained upland areas away from water bodies. On shorefront properties, fertilizing is prohibited within 25 feet of the reference line and is restricted to the use of slow-release nitrogen and low- or no-phosphorus fertilizers beyond this while within the waterfront buffer zone (Appendix A). If adding new plants to the vegetative buffer, you should select plants that are native or adapted to exist on low nutrient levels and moist to wet soils.

Lime is allowed if needed, based on the soil test and the needs of the plants you choose. Lime is most effective if mixed into the top several inches of soil, so incorporate recommended amounts when preparing the site, or add it to the backfill soil when planting individual shrubs or trees.

Beyond the waterfront buffer zone, consider planting groups (or systems) of plants rather than individual plants. If the soil requires amendment, it is most efficient to prepare a plant bed where you can till in lime, an inch or two of compost, and recommended fertilizers to provide a slow-release source of nutrients. Work the amendments in to a depth of six to eight inches if possible, unless doing so rips up numerous roots from trees in the surrounding area.

Adding too much compost can overload your soil with phosphorus, which, if transported into lakes and streams via runoff and erosion, contributes to water quality degradation. Use common

sense and avoid applying compost or manure on a steep slope or within 25 feet of the water. Don't apply more than two inches of compost, and mix it into the soil as soon as possible to stabilize it.

If planting individual trees or shrubs, follow the same restrictions as above, but outside the 25 foot zone you may apply recommended nutrients such as low-phosphorus and potassium fertilizers by mixing them thoroughly into the backfill soil. Don't add organic amendments, such as peat moss or compost, to the backfill, because they won't provide benefits during the short period the roots stay within the amended volume of soil.

Planting and after-care

Woody shrubs and trees are generally purchased in containers or as balled-and-burlapped nursery-grown plants. Perennials are readily available as container grown plants or may be mail-ordered as bare-root dormant plants.

You can plant containerized plants any time the ground isn't frozen. Bare-root plants must be planted while dormant in early spring, and balled-and-burlapped trees and shrubs are best planted early in the season or in the fall (September to early October). Evergreens such as rhododendrons and conifers should be planted early, because they are highly susceptible to winter "burn" or desiccation if roots haven't grown out before the ground freezes, especially if they have full-sun and/or wind exposure. There are also some species of deciduous trees which have better survivability when planted in spring rather than fall: oaks, ginkgo, beech and birch, to name a few.

Water is the single most important resource for successfully establishing new plants. Before you plant, make sure water is immediately available for the plants and for the rest of the growing season.

Rake back any litter or mulch, saving it to reuse later as a mulch. Then, dig a planting hole two or three times as wide as the container or root ball, but no deeper (Figure 5-1). The bottom of the hole can be slightly narrower than the top, as most new roots will grow from the top half of the rootball and will benefit most from loosening the top several inches of soil. If you've tilled the entire planting bed, you can make the individual planting holes smaller.

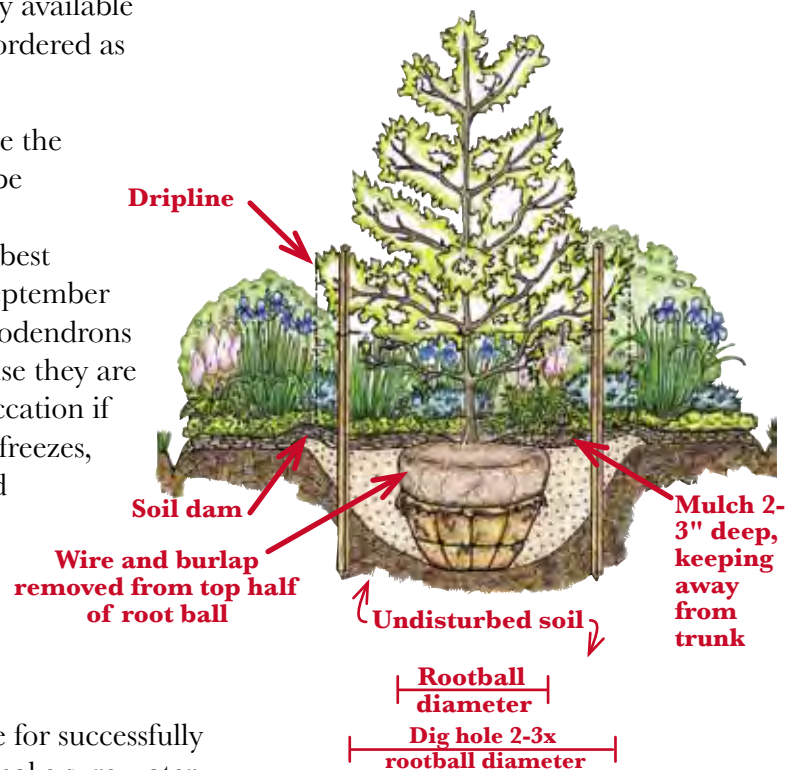


Figure 5-1. A properly-planted tree is set in a hole that is wide but no deeper than the rootball. Burlap, wire, ties and plastic are removed from the upper half of the rootball to allow unrestricted root growth. Staking is done only if necessary, and should allow the trunk to flex in the wind. The soil dam at the edge of the planting hole creates a saucer to keep water where it's most needed. A wide layer of mulch, 2-3" deep is kept a few inches away from the trunk.

If you purchased potted or container-grown plants:

- Remove each plant from the container and inspect the roots. Plants should not be rootbound or have many circling roots, but chances are you'll find some circling roots on the outer surface of the rootball. For woody plants (trees and shrubs) it is very important to correct root defects before planting.
- If the circling roots are small in diameter, slice the rootball in three or four places from top to bottom with a sharp knife, slicing about an inch deep. Cut any larger circling roots with pruners, cutting back before they begin to bend. This will cause new roots to form from the cut surface and grow outwards into the new soil.
- If there is a mat of roots at the bottom of the container, remove it.
- Check to make sure the plant was not too deep in the container – you should be able to find the root flare (where the uppermost woody roots are attached to the trunk or stem) within an inch of the surface. If not, remove potting soil and any small roots that are above the root flare.
- Rough up the surface of the rootball with your fingers and set the plant in the hole at the proper depth. Distribute the roots evenly around the plant, pulling loose roots outwards like spokes on a wheel.
- Backfill with the soil you dug from the hole. Firm the soil around the roots and use water from a hose to help soil settle.
- Do not put extra soil on top of the rootball. The finished soil level should be just above the root flare. Planting too deep, especially in poorly drained areas, is the cause of many plants' demise.



This container-grown tree is not rootbound, but the largest circling roots should be cut or teased out when planting.

If you purchased balled-and-burlapped plants:

- Set each plant in its hole, again making sure it's not too deep.
- Cut the straps or ties and pull back the burlap from the top of the rootball.
- Probe with a screwdriver or other small object to find the uppermost roots, which should be within an inch of the surface. If there is more than an inch of soil on top of them, carefully remove it.
- Raise the plant if necessary, adding soil underneath to get the correct final planting depth. If there is a wire basket or netting around the roots, cut it and remove it from the top half of the rootball so it won't restrict the roots as they grow.
- Remove as much of the burlap as possible, but more importantly, cut and remove all the rope, twine, straps or other ties wrapped across the top of the rootball and around the stem. Also remove any plastic that may have been used to package the rootball.



Left uncorrected, circling roots may continue to grow in diameter and may girdle the trunk, causing decline and eventual death of the tree.



This tree was planted at least six inches too deep and the straps had not been removed from the rootball. Branches at the top were dying back as a result.

Pruning

Don't prune branches or portions of the plant top at planting time, unless you are simply removing broken or injured branches. The leaves serve as the source of energy for root establishment and growth, so leaving the shoots intact is very beneficial to the plant. A well-grown nursery plant should have good structure and need little pruning during the first few years. Train trees to have a central leader (one straight trunk). Refer to UNH Cooperative Extension fact sheets for more information on pruning evergreens, deciduous trees and shrubs (Appendix B).

Watering

Water slowly and deeply right after planting. For the first week after planting, water daily, then every other day for the next two weeks. After that, continue to water twice a week during the first growing season (until the ground freezes), gradually backing off to once a week in the fall.

How much? An inch of water twice a week is a good guideline (a little more than half a gallon per square foot of soil surface under the dripline). For new trees, apply two to three gallons of water per inch of trunk diameter (measured at the base) each time you irrigate.

Constructing a shallow, donut-shaped soil dam at the edge of the rootball allows the water to infiltrate where it can do the most good. Break down the ring in the fall so water won't collect and freeze there during the winter.

Other good irrigation aids include drip or micro-sprayer types of systems, soaker hoses, plastic tree rings or "gators," heavy, perforated plastic containers you fill with water that drips out slowly over the rootball. You could even make your own "drip bucket" by drilling several small holes in the bottom of a five-gallon bucket and placing it over the root zone, moving it to the other side the next time you water.

Trees have a long establishment period during which you won't notice much growth. The tree needs to use its resources to grow roots out into the surrounding soil before it will put on shoot growth. Expect small trees and shrubs to take one year to establish roots. Larger trees need a year for each inch of trunk diameter when planted. For example, a three-inch-diameter tree needs three years to grow a normal root system. For this reason, it isn't always best to buy the largest tree or shrub you can afford.

Branch tips dying or leaves discoloring or dropping out of season are symptoms that the roots aren't functioning well. Stress from extreme heat, cold, drought or flooding can impair the plant. During the entire establishment period, the only thing that will ensure survival is water—at least an inch a week. Don't depend on lawn irrigation systems to provide adequate water for newly planted trees. Once established, trees and shrubs should be able to go two weeks without rain or irrigation.

Most plants won't tolerate poorly drained soils. If water stands for more than a few hours after rain or irrigation, avoid planting in that area, or choose a tolerant species such as willow or winterberry holly.

Mulching

Spread two to three inches of mulch over the root zone of a newly planted tree or shrub, but keep it a few inches away from the stem or trunk. Use only an inch or two of mulch on perennial beds. Because wood chips may float or be washed downslope, mulch sloping areas with shredded pine bark or other material that won't move as easily. Mulching too deeply is a common mistake that may actually inhibit water penetration into the soil, encourage diseases and some insects, and interfere with air exchange in the soil. Mulch piled up against the stem or trunk keeps it too wet, encouraging certain insects and diseases and providing a haven for rodents who may chew the bark, especially during the winter.

Staking a new tree is necessary only if you have a windy site and the tree is top-heavy. If you do stake a tree, be sure to remove the stakes and fasteners the following year. Leaving wire, plastic or other non-degradable ties around the trunk or branches will constrict and damage the wood as it grows, resulting in a stunted and disfigured tree.

Fertilizing

Generally, woody landscape plants need no nitrogen fertilizer during the first growing season, unlike vegetables and annual flowers, which depend on nitrogen for vigorous growth. Lime, phosphorus, and potassium—only if needed, based on a soil test—are best applied during site preparation and planting, as discussed above. Minimize all subsequent use of fertilizers on



This tree on a commercial site has been properly planted and staked with flexible ties. The next step is to add mulch 2-3 inches deep over the entire bed, but keeping it away from the trunk.



Instead of seeding grass between the new shrubs and trees, plant with a low groundcover and mulch the entire area until the bare soil is covered with vegetation.

waterfront properties, taking into consideration the soil, slope, site sensitivity, plant requirements, maintenance level, and of course, the restrictions in the Comprehensive Shoreland Protection Act (Appendix A).

Use fertilizer conservatively on any property near a water body, basing the amounts on soil test recommendations and following best management practices to prevent spills, leaching and runoff. Fertilizers containing slow-release forms of nitrogen are less likely to result in peaks of nitrogen that are subject to leaching. One or two pounds of slow-release nitrogen per 1,000 square feet in a plant bed is generally sufficient for plant growth. The fertilizer should contain little or no phosphorus, unless specifically recommended after soil analysis. If the soil is already high in phosphorus, none will be recommended and you should look specifically for a no-phosphorus fertilizer.

Whether you choose to use synthetic fertilizers or organic products is entirely up to you. Natural organics are materials that decompose slowly, releasing nutrients over a long period of time; however, the nutrients they contain aren't always in the recommended ratio, so it is still possible to over-apply some nutrients. Heavy dependence on manures and compost to meet the nitrogen requirement will often result in overapplication of phosphorus. When using any fertilizer, even organic and slow-release products, pay particular attention to the amount of phosphorus in the product and avoid over-application. Further information on fertilizers is available on the UNH Cooperative Extension website (Appendix B).

Managing weeds and other pests

Once the ground is covered with plants and mulch, weeds should be a minor problem that you can deal with by hand pulling. Allow natural leaf litter to add to the mulch layer in plant beds and buffer areas. Some people prefer to collect the leaves in the fall, shred and compost them, and then reapply them as mulch the following season. Invasive plants and other particularly aggressive weeds may warrant special control measures, perhaps best provided by a licensed professional.

Diseases and insects should also be minor problems if you've done a good job selecting and planting plants adapted to the site and resistant to pests. However, new insects and diseases may emerge to cause unanticipated threats. For example, recent outbreaks of hemlock woolly adelgid continue to threaten eastern hemlocks, and the arrival of lily leaf beetle in the state has killed many a garden lily.

Use an integrated pest management (IPM) approach. Inspect plants regularly, focusing on high-value or highly visible plants. Try to identify plant pests early before they do significant damage. Whenever possible, try to give natural parasites and predators a chance to suppress them. It may require some research on the pest to determine when further control might be justified, and what control strategy, cultural, mechanical, or chemical, will work best.

Can you remove the plant damage and/or pest organism by hand, by pruning, or with a jet of water? Look for cultural solutions to problems, such as adjusting irrigation schedules to minimize leaf wetness, thereby reducing leaf diseases. High-nitrogen fertilization can increase susceptibility to many insect pests, such as aphids.

Only use a pesticide if the organism reaches unacceptable levels and can't be controlled by other means—and even then, use pesticides only outside the 25-foot shoreland protection zone. Select the least toxic and most environmentally safe pesticide available for the purpose. If a plant continuously has problems, perhaps replacing it with a less problematic plant is the best strategy.



Environmentally-Friendly Lawn Care

Most property owners appreciate a well-designed landscape that includes areas of green, open space to picnic, gather and play. Like all plant communities, lawns offer a number of environmental benefits:

- They help purify water entering underground aquifers by acting as a filter to capture and break down many types of pollutants and nutrients.
- With up to 90 percent of the weight of a grass plant in its roots, a healthy lawn efficiently prevents soil erosion and also helps remove soil particles from runoff water, absorbing 15 times more runoff than bare ground.
- Turfgrasses absorb carbon dioxide (one of the primary gases associated with global warming) and release oxygen. A 50-foot by 50-foot lawn releases enough oxygen to meet the needs of a family of four.
- An average-size lawn (10,000 square feet) has twice the cooling effect of the average-sized central air conditioning unit.
- Lawns absorb and reduce noise.

Designing and maintaining a lawn on a shoreland site entails some special considerations to help protect the quality of the water. The key is to use proper cultural practices so your lawn will sustain itself with a minimum amount of inputs such as fertilizers, water and pest management products.



Low maintenance construction and landscaping is preferred to a no maintenance approach such as this.



The fibrous root system of turfgrass absorbs nutrients and pesticides and helps reduce soil erosion.

Selecting grass varieties

Grasses vary in the climate they prefer, the amount of water and nutrients they need, their resistance to pests, their tolerance for shade, and the degree of wear they can withstand. Choose types of grass well adapted to your site and your needs. The correct selection of grass species and subsequent proper maintenance will improve your chances of growing a dense, healthy lawn.

What do we mean by a “high quality” lawn? Generally, it is a fine-textured dark green monoculture of grass. To achieve this “green carpet” requires the correct grass choice and high maintenance levels – water, fertilizer, mowing and other cultural practices. Most people are satisfied with less perfect lawns in return for more moderate maintenance requirements – less mowing, less inputs. On shoreland properties, high quality, high maintenance lawns should be limited to small areas separated from the water by a vegetative buffer.

Listed in Table 6-1 are suggestions for grass mixtures (including partial listing of varieties) recommended for use in our area. The mixtures combine the four common grass types listed here, and some contain white clover. White clover is a broadleaf legume that adds diversity and will help provide nitrogen to the grasses; it should not be used where broadleaf herbicides will be used on the lawn.

Tall fescue: With very good tolerance to wear, drought, heat and water, this grass is adapted to a range of uses in various general purpose areas. Tall fescue has moderate shade tolerance and a bunch-type growth habit. It survives on low-maintenance sites. (Varieties; Silverstar, Jaguar 3, Turbo, Apache, Forte)

Fine-leaf fescue: Grows well in shade or sandy soils. It has a very fine leaf blade and is a frequent component in lawn mixtures for sunny and shaded sites. Since the fescues (both fine-leaf and tall) are considered low-maintenance species, their use is especially encouraged near the waterfront. (Varieties; Berkshire, Musica, Oxford, Ambassador, Longfellow II)

Perennial ryegrass: Forms a dense, medium-textured turf with moderate shade tolerance, rapid establishment, bunch-type growth habit. It is used in overseeding (seeding on top of an existing lawn) and in high traffic areas. (Varieties: Mach 1, Brightstar SLT, Pizzazz, Citation Fore, SR 4420).

Kentucky bluegrass: Provides a high-quality lawn with moderate-to-high maintenance. It is slow to germinate in cool soils and requires at least four hours of full sun per day. It is often included with other grass species to produce a multipurpose lawn. The varieties listed are those which perform well under lower maintenance levels. (Varieties: Moonlight, Midnight II, Bluemax, Perfection, Quantum Leap, Tsunami).

Caring for your shorefront lawn

Fertilizing

To maximize a lawn’s environmental benefits, it’s important to maintain soil fertility and turf health so the grasses will produce a dense mat of roots. Start by getting your soil tested to determine its nutrient status and pH value. Keep in mind that a soil test doesn’t indicate the amount of nitrogen present. Fertilizer recommendations for nitrogen are based on previous field studies and experience under local conditions.

Few New Hampshire soils contain enough natural nitrogen and other essential nutrients to maintain high turfgrass quality and recuperative ability throughout the growing season. Nitrogen is the nutrient most needed by turfgrasses, but the nitrate form of nitrogen is mobile in soils and can leach into groundwater, as discussed in Chapter 1. Here are a few suggestions to help prevent or reduce nitrate leaching from lawn areas:

Reduce quantity of nitrogen fertilizers.

Nature supplies some nitrogen via rain, snow, lightning, and the decomposition of thatch and clippings. Dutch White Clover is a legume capable of using nitrogen from the atmosphere and can provide a source of nitrogen in a lawn. For low-maintenance lawns (those receiving infrequent mowing, and little or no additional water or fertilization), these nitrogen sources alone might suffice. However high-maintenance lawns (receiving three fertilizations per year,

irrigated as needed to maintain a green turf, mowed twice per week, and given additional attention) need about three pounds of added nitrogen per 1,000 square feet per year.

Use slow-release nitrogen sources. There are a number of slow-release nitrogen fertilizers on the market from either natural or manufactured (synthetic) sources. Nitrogen from natural organic sources, such as composts, manures and leguminous cover crops, is converted to the nitrate form at a slower, more gradual rate than nitrogen from inorganic fertilizers such as ammonium sulfate. Synthetic organics (Nitroform, Nutralene, etc.) also

TABLE 6-1: SUGGESTED GRASS SEED MIXES FOR NEW HAMPSHIRE LAWNS		
Use	Species Mix (% by weight)	Seeding Rate (Lbs/1,000 sq/ft)
Sun: Low to moderate maintenance	80% Tall Fescue 20% Kentucky bluegrass	6-8 lbs 1-2
	or 50% Fine leaf fescue 20% Perennial ryegrass 20% Kentucky bluegrass 10% Dutch White Clover	4-5
Sun: Moderate to high maintenance	75% Kentucky bluegrass 25% Perennial ryegrass or Sod (90% Kentucky bluegrass, 10% Fine leaf fescue)	3-4
Sun/shade: Moderate maintenance	80% Tall Fescue 20% Kentucky bluegrass	6-8 1-2
	or 33% Kentucky bluegrass 33% Perennial ryegrass 33% Fine leaf fescue	3-4
Shade: (Less than 4 hours full sun/day)	60% Fine leaf fescue 30% Perennial ryegrass 10% Dutch White Clover	3-4

offer a slower, more gradual release of nitrogen, similar to that of natural organic fertilizers. On the back of a fertilizer bag, slow-release nitrogen is listed as “water insoluble nitrogen.” We recommend that at least 50 percent of the nitrogen be water insoluble to protect against surges of nitrate leaching.

Reduce application rates. Most fertilizer applications typically deliver one pound of nitrogen per 1,000 square feet. An alternative to using slow-release sources that also lessens the potential for nitrate leaching involves applying between 0.25 and 0.5 pounds of nitrogen per 1,000 square feet at any one time. By applying these lower amounts more frequently, smaller amounts are available at any one time to be carried off by rain or irrigation water. This is an alternative to using slow-release sources.

Don’t apply fertilizer to frozen ground or whenever the lawn isn’t actively growing. The fall fertilizer application should be made by mid-September.

Calibrate spreaders. Most fertilizer bags tell you how to set your spreader to deliver the recommended amount of nutrients. If you want to double-check your spreader calibration, refer to the fact sheet “Does Your Lawn Measure Up?” (Appendix B).

Fill granular fertilizer spreaders on a level hard surface, away from the water, where you can easily sweep up any spills.

Return grass clippings. Don’t mow or rake clippings into street gutters or onto sidewalks and driveways where they may be carried in runoff to surface water areas. And never use stream beds or banks or surface waters as places to dispose of clippings and leaves! Leave the clippings on the lawn to decompose and recycle nutrients by using a mulching mower or a regular mower without the bag attachment. If you prefer to remove the clippings from the lawn, compost them for later use as mulch in the garden or landscape.

Irrigate lightly (1/4 inch of water) when necessary to avoid water movement beyond the root zone. Deeper watering is usually recommended for most turf areas, but this lighter rate reduces the likelihood of nutrient or pesticide leaching, while still helping to promote a healthy root system.

Space fertilizer applications at least 21 days apart to avoid overloading the system with excess nutrients.

Never wash off fertilizer spreaders on hard surfaces such as driveways or sidewalks where the wash water may carry residues into storm sewers or nearby water. Clean the spreaders over turf.

As mentioned earlier, nitrogen isn’t the only nutrient of concern in shoreline landscaping. To protect water quality, don’t add phosphorus-containing fertilizers unless a soil test indicates a phosphorus deficiency. Low- or no-phosphorus fertilizers are becoming more readily available; ask your fertilizer dealer or landscape company to use them!

Mowing

Most home lawns should be mowed at a height of 2 1/2 -3 inches every five to seven days during the growing season. In midsummer, a mowing height of three inches helps prevent drought injury. To avoid “scalping” the lawn, don’t remove more than a third of the leaf blade at one time.

Leave your grass clippings on the lawn to decompose and recycle nutrients and water back to the turf area. The clippings help feed soil microbes, important for maintaining a healthy soil.

Irrigating

Most lawns require an inch of water per week during the summer to remain green and healthy. Use a rain gauge or place a coffee can on the site being irrigated to monitor the amount of rain and irrigation water the lawn receives each week.

When irrigating, use light (1/4-inch) application rates to help reduce the threat of nitrate leaching through the root zone. Sloped areas may require more frequent, but smaller, amounts of water per application as they are more vulnerable to runoff.

The most efficient time to water is early morning. While evening irrigations are often more convenient for homeowners, they increase the potential for disease infection. Mid-day waterings don't injure the grass, but they lose more water to evaporation.

A professionally designed irrigation system, if operated efficiently, can save water by ensuring uniform application rates. Have maintenance performed on the irrigation system each year to fix broken heads, leaks, etc. If your system is on a timer, install a rain shut-off device to prevent it from running when not needed.

Lawns go semi-dormant and turn brown during hot, dry periods of summer if they aren't irrigated, though they generally make a full recovery once temperatures cool and the turf receives irrigation or rainfall.

Dethatching and aerifying

As part of the natural growth cycle, turfgrasses annually produce new roots that gradually die and are decomposed by soil bacteria to form a layer of organic matter known as thatch. Moderate thatch layers up to half an inch thick are beneficial for improving lawn quality and also serve as an effective filter for absorbing certain pesticides and nutrients.

It is a common misperception that leaving clippings on the lawn contributes to excess thatch; however, that is not the case. Clippings decompose very quickly and, unless excessive, are not a problem.

Thick thatch layers may build up over time on heavily fertilized and watered lawns. Excess thatch promotes shallow rooting, which makes turf more susceptible to drought and pest problems. When thatch levels exceed an inch, power rakes (dethatchers or vertical thinning machines) are effective in removing excess organic matter. Early spring or fall mechanical thinning permits turf to recover faster than summer thinning.

Soils high in clay are especially vulnerable to compaction. Compaction reduces turfgrass vigor, resulting in impaired growth and increased pest pressure, as well as increasing the likelihood of nutrient and pesticide runoff. You can loosen compacted soils with aerifiers (machines that poke holes approximately three inches deep in the soil). Aerification can be done successfully anytime during the growing season, but spring aerification promotes infestation of crabgrass and other weeds germinating during that period and taking advantage of the open spots created by aerifying.

Seeding and sodding

Whether you're seeding a new lawn or installing sod, follow this sequence of soil preparation steps:

1. Till the soil deeply (six inches).
2. Add necessary amendments and fertilizers.
3. Grade and level for a smooth surface.
4. Remove all debris.
5. Lightly pack and moisten.

Once the soil has been tilled, do the remaining preparation and seed the ground as quickly as possible. The soil is vulnerable to erosion at this point, especially on slopes or if heavy rains occur. After seeding, especially if your lawn is on a slope, apply an organic mulch (straw, paper, etc.) to the surface to reduce erosion and runoff. Apply mulch to bare ground before or if a late fall seeding hasn't fully established itself.

To hasten germination and allow time for a fibrous root system to develop, seeding should be done between August 15 and September 10. The warm soil temperatures, abundant moisture, and lack of weed competition at this time create ideal conditions for turf establishment.

One advantage of sod, besides the immediate beauty of a mature lawn, is its ability to accept heavy rain without erosion and reduce the threat of runoff into lakes and streams. In addition, sod can successfully be installed from early spring to late fall, even on frozen ground.

Turf Pest Management

Weed control

Effective weed management involves the use of recommended cultural practices, producing a dense and healthy turf that can out-compete weeds. Most weeds are opportunistic and will invade and eventually dominate areas of thin or unhealthy turf. Mechanical removal of weeds (hand-weeding) is effective in certain situations, such as on small turf areas or where weed invasion is light.

Research continues to explore alternative strategies to replace conventional herbicides. Examples include the use of herbaceous groundcovers as alternatives to grass, certain cultivars of fine and course fescues, corn-gluten-meal-based products, clove oil derivatives and mixtures of acetic acid and lemon juice. Generally these alternative products (and others not mentioned) either have not provided a satisfactory degree of weed control or have other limitations that restrict their use.

Manufactured herbicides generally provide excellent weed control as long as you follow label directions. While research has shown that pollution of surface and ground water from turfgrass pesticides is uncommon, herbicides do vary in their longevity and leaching potential. Herbicides that are highly water-soluble, relatively persistent, and not readily absorbed by soil have the greatest potential for leaching.

Leaching is only one of many considerations in selecting a pesticide. Some pesticides with low leaching potential may be highly toxic to fish and other wildlife, necessitating extra precautions when using them on shoreland properties. The label should note these precautions. Always follow setbacks and other restrictions and when applying chemicals near water or wells (Appendix A).

For a list of herbicides with low leaching potential, landscape professionals can call their local UNH Cooperative Extension office. Individual landowners should call the toll-free Info Line at Extension's Family, Home & Garden Education Center: 1-877-398-4769.



Quick establishment of turfgrass is critical on this recreational area along a river to prevent further soil erosion and runoff.

Preventing and controlling disease

As with weed prevention, sound cultural practices serve as the foundation of disease management. Under a balanced, low-to-moderate maintenance program, most turfgrass diseases will be held in check. This balance may become disrupted by extreme weather conditions, or improper fertilization, watering or mowing practices, as well as disease-susceptible grass varieties. In addition, soil compaction, inadequate soil preparation, poor drainage and thatch buildup also weaken the turf and provide a greater opportunity for disease invasion.

Research has shown that compost has the potential to reduce the severity and incidence of a wide variety of turfgrass diseases, particularly when applied either as a topdressing, a dormant turf cover or a root zone amendment. In studies conducted at Cornell University, amending sand-based root zones with either municipal biosolids compost, brewery sludge compost, or reed sedge peat was effective in suppressing pythium root-rot disease. One of the greatest obstacles to the widespread use of compost for turfgrass disease control has been its inconsistent performance from site to site, batch to batch, and year to year.

Fungicides should never be a routine part of lawn and grounds care, but sometimes disease-conducive environmental conditions overcome even the best cultural practices. If a turf sample diagnosis reveals a serious disease and the plant health specialist recommends treating with a fungicide, make sure to use one with low leaching and runoff potentials. UNH Cooperative Extension operates a Plant Diagnostic Lab that can identify problems and recommend appropriate management strategies. (Appendix B).

Dealing with lawn insects

Environmentally-friendly insect control on lawns relies on the principles of Integrated Pest Management (IPM). IPM involves using a variety of techniques, including cultural, biological, mechanical and chemical controls to reduce pests below damaging levels with the least impact to the environment.

The first step in IPM is proper identification of the problem. Many arthropods (insects and spiders) found in and around turf aren't serious lawn pests. Be sure to get the organism properly identified before you decide to treat.

Before deciding to use a pesticide, ask yourself: Do I know what pest I am trying to control? Are there other cultural strategies I should try first? Are the environmental risks worth it? Damaged lawns can always be reseeded or converted to ground cover or other vegetation.

If you do use a pesticide, make sure to follow all label directions and comply with all applicable federal and state laws. Choose the lowest-risk treatment whenever possible. Use extreme care when applying any pesticide near water. Don't use pesticides on steep slopes. Don't apply pesticides to saturated soils or when heavy rain is forecast. Observe a pesticide-free buffer that extends further than the legal minimum of 50 feet from the shoreline. Although New Hampshire has no required buffer around private drinking wells, the NH Department of Environmental Services recommends maintaining a pesticide-free zone 100 feet in all directions from shallow (dug) wells.

Because pesticides change from year to year, if you do decide to use a chemical control, call your UNH Cooperative Extension county educator or Extension's toll free Info Line at our Family, Home & Garden Education Center (1-877-398-4769) for the latest recommendations for controlling your problem insect. They can also help with pest identification.

Three groups of insects have the potential to cause significant harm to lawns in New Hampshire. Each is described here, along with potential control measures and the appropriate times and ways to use them.

Grubs

Grubs are white, C-shaped larvae that live in the soil. Grubs feed on organic matter and grass roots and can completely destroy a lawn if they are numerous. The three most important species in New Hampshire are the Japanese beetle, Oriental beetle and the European chafer. The Asiatic garden beetle grub is of lesser importance, although it's often found in home lawns.

These grubs have a one-year lifespan. They overwinter as large grubs in the soil. In April and May they rise to the surface and begin feeding. The adults emerge in June or July to lay eggs, and a new generation of larvae emerges to feed until late fall, when they go deep in the soil to overwinter.

European chafer adults are brown beetles about 5/8-inch long. They fly at night and don't feed much, so they often go undetected by homeowners. The Japanese beetle adult flies by day. Well known for its voracious appetite, it feeds on more than 300 species of plants. The adult beetle is about 1/2-inch long and metallic green with copper-colored wings. The Oriental beetle is about four-tenths of an inch long, buff colored with black markings. It flies during the day and feeds little. The Asiatic garden beetle adult is brown, about the size and shape of a coffee bean. It flies and feeds at night and hides in the soil by day.

Most home lawns can tolerate about five European chafer and ten Japanese beetle or Oriental beetle grubs per square foot before they do visible damage. However, skunks and crows may tear up turf to feed on grubs and do more damage than the grubs. Moles also feed on grubs, but trying to reduce mole damage by controlling grub populations may not work, since moles also feed on other soil organisms. They especially enjoy earthworms, so moles often appear in fertile soils with high earthworm populations. We don't suggest trying to control earthworms, of course, since they are so beneficial to the soil.

The Asiatic garden beetle grub is usually less damaging to lawns than the European chafer, Japanese beetle, or Oriental beetle because it is smaller, feeds deeper, and often prefers weeds. The Asiatic garden beetle adult hides during the daylight hours and emerges at night. It can be a serious pest of flowers, other ornamentals and vegetables by feeding on the leaves. It can also be a nuisance by flying into lighted areas at night.

- **Cultural controls for grubs:** Well-watered lawns can tolerate higher grub populations, as the lawn is less likely to show drought stress from fewer roots as a result of grub feeding. It's best to increase mowing height to three inches or more. Taller grass has a more extensive root system and can tolerate more feeding than short grass.
- **Mechanical control:** The Japanese beetle adult is attracted to an artificial sex lure in commercially available traps. Although these traps will catch many beetles, traps placed close to ornamental shrubs will increase adult feeding damage. If you do buy traps, place them away from valuable plants. Large captures of beetles in traps do nothing to reduce turf damage from grubs. There are no traps available for the European chafer, Oriental beetle or Asiatic garden beetle. Fortunately, European chafer and Oriental beetle adults do very little feeding.
- **Biopesticides and biological controls:** Biopesticides (biological pesticides) are reduced-risk products based on biological or naturally derived chemicals. Biological controls are living organisms used to control pests. Milky disease (*Bacillus popilliae*), sometimes called milky spore, is a bacterium that infects and sometimes kills Japanese



Turf pulled back to expose grubs.



European chafer grub.



European chafer adult.

Life stages of the Japanese beetle, from left to right: egg, 3 larval stages, pupa, adult.



beetle and European chafer grubs. However, based on UNH research, milky disease doesn't work well in New Hampshire because our spring soils are so cold. The Oriental beetle grub is not controlled by milky disease. New strains of *Bacillus thuringiensis* are in development that were very effective against grubs in our trials. These *B.t.* strains should be in the marketplace soon.

Presently, the most practical biological control for grubs is nematodes, small roundworms that are parasitic on many insect larvae. These are not the same nematodes that feed on plant roots. The nematodes swim through the soil searching for the grubs. Once inside of the grub, the nematode releases bacteria which kill the grub. The nematode feeds on the dying grub and reproduces.

Unfortunately, the nematode species currently available don't overwinter well in our climate and must be reapplied every year.

Based on various university studies, grub control by nematodes varies widely, from 50 percent to 90 percent. A 70 percent level of control is usually adequate for most home lawns. Nematodes are also more costly than traditional chemicals.

Nematodes are most effective if you follow these procedures:

1. Buy what you need and use them that season; nematodes are living organisms and don't store well. Store them in a refrigerator, not in the freezer or in the garage.
 2. Because nematodes are killed by sunlight and heat and dry up quickly, apply them in the morning or evening. Water them into the soil with at least 1/4-inch of water.
 3. Keep soil moist so nematodes can swim to their prey. Water the lawn well at least once weekly for four weeks after application, but don't saturate soils.
 4. Ideally, apply them in August or September, when soil temperatures are warm but not hot.
 5. Once the nematodes are mixed with water, apply them immediately to the lawn. Nematodes left in a spray tank too long will die from lack of oxygen.
- **Synthetic chemical control:** Use a chemical grub control only if the lawn has a history of grub damage or when you have confirmed large numbers of grubs are present. Most home lawns have low grub populations. Make sure you have a problem before you apply a grub control.

Timing is critical for grub control. Over-wintering grubs emerge to feed in April or May. These spring grubs are large and difficult to control, even with chemicals. June through mid-August is a better time to apply chemical grub controls, because the chemical will be in the soil while the summer generation of grubs are small and easily controlled. By September and October the grubs have grown large and may cause visible lawn damage. Visible damage is first noticed as patches of dying grass that can be easily pulled up due to a lack of roots. In September it's more difficult to get good control. By late fall, grubs have grown too large for effective chemical control.

There is good news. The new synthetic chemicals are less hazardous to the environment. For example, chlorantraniliprole, when used as a turf insecticide, states on the label "when used as directed does not present a hazard to humans or domestic animals."



Asiatic garden beetle adults. The larvae are grubs similar to other beetle larvae.

Chinch Bugs

Chinch bugs are small, sucking insects that feed on fescues, ryegrass and Kentucky bluegrass. Adults are about 1/16-inch long, black with white wings. Nymphs (immatures) are much smaller and appear red. There are two generations per year in New Hampshire. Adults overwinter at the edges of lawns and emerge in May to mate and lay eggs. The nymphs feed until they mature in July. A second generation of nymphs feeds from late July through September. The most turf damage occurs in late June and early July for the first generation and in August for the second generation. The nymphs do the most damage.

At first the damage appears as small patches of yellow grass; eventually the entire lawn may die. Chinch bugs prefer dry, sunny areas. Chinch bug damage is different from grub damage. Grubs sever the roots and grass can be pulled up like a rug.

- **Cultural Controls:** Avoid drought-stressed lawns. Chinch bugs prefer dry lawns. A well-irrigated lawn rarely has chinch bug damage and can withstand any feeding damage better than a drought-stressed lawn. Fertilize sensibly, as over-fertilization will encourage chinch bugs. Check for excessive thatch and control if needed. Thatch provides a hiding place for the young nymphs.

Choose endophytic ryegrass and fescue varieties that are resistant to chinch bug. Endophytes are fungi that live within the leafy portion of the turf and make the plants less attractive to chinch bugs. You don't need to seed the entire lawn to an endophytic variety. If half the seed mix has endophytes, the lawn will have some chinch bug resistance. Kentucky Bluegrass doesn't contain endophytes but you can include it in the mix.



- **Biopesticides and biological controls:** Several biopesticides will help control chinch bugs, but all these products are short-lived, so you may need to apply them more than once.

The fungus *Beauveria bassiana* has done reasonably well in a UNH trial, providing 70 percent chinch bug control, sufficient for most home lawns. This fungus requires moisture, so the applicator must:

1. Water the turf before application.
2. Apply the fungus diluted in water.
3. Water the turf after the application.
4. Not allow the turf to dry out for two weeks.

Neem oil, an extract from the neem tree from India, contains azadirachtin, a natural chemical which acts as a repellent as well as an insecticide to control insects.

Pyrethrum is an extract from the chrysanthemum plant from Africa. Although it is a botanical insecticide, it is still slightly toxic and should be used with caution.

Insecticidal soaps and soap/neem oil combinations are also available.

Sod webworms

Sod webworms are caterpillars that feed on grass foliage. The caterpillars are grey/black and may grow to an inch long. The first sign of damage is small brown spots scattered throughout the lawn. You may find the caterpillar hidden in a tunnel at the center of the dead area. Birds may tear up the lawn searching for the webworms. The adults are moths about 1/2-inch long, tan, and fly in an erratic pattern over the lawn. There are two periods when damage occurs. Overwintering larvae will start causing damage in late June. The offspring of these larvae will again cause damage in August.

- **Cultural controls:** Use resistant turf varieties which contain endophytes as described under chinch bugs.
- **Biopesticides and biological controls:** Use nematodes, neem oil, or pyrethrum as previously described. The bacterium *Bacillus thuringiensis* variety *kurstaki* is also effective. Spinosad, a chemical derived from a soil microorganism and is one of the few chemicals approved for organic food production will provide excellent control.
- **Synthetic chemical control:** Homeowners should call UNH Cooperative Extension's toll-free Info Line at 1-877-398-4769 for up-to-date recommendations of pesticides that will control sod webworms. Developers or commercial landscapers should call their county UNH Cooperative Extension office and ask for the agricultural resources educator.



Sod webworm adult, right, and larva (caterpillar) top.

APPENDIX A

**State Regulatory Agencies and Selected
Shoreland Rule Summaries**

NH Dept of Agriculture, Markets and Food agriculture.nh.gov

Division of Pesticide Control agriculture.nh.gov/divisions/pesticide_control/

603-271-3550

Pesticide Laws and Rules nh.gov/agric/rules/index.htm

Summary of Setback Distances from Wells and Surface Waters (see page 76)

Division of Plant Industry agriculture.nh.gov/divisions/plant_industry/

State Entomologist 603-271-2561

Invasive Species Committee

agriculture.nh.gov/divisions/plant_industry/documents/Webpage_introduction.pdf

NH Department of Environmental Services des.nh.gov/

603-271-2975

Water Division des.nh.gov/organization/divisions/water/index.htm

603-271-3503

Wetlands Bureau des.nh.gov/organization/divisions/water/wetlands/index.htm

603-271-2457

Shoreland Program des.nh.gov/organization/divisions/water/wetlands/cspa/index.htm



RSA 483-B Shoreland Water Quality Protection Act (SWQPA) *A Summary of the Standards*

A **STATE SHORELAND PERMIT** is required for most new construction, excavation and filling activities within the **Protected Shoreland**. (See definitions below) Forest management not associated with shoreland development or land conversion and conducted in compliance with RSA 227-J:9 and agricultural activities and operations defined in RSA 21:34-a and governed by RSA 430 are exempt from the provisions of the SWQPA. Projects that receive a permit under RSA 482-A, e.g., beaches and retaining walls do not require a shoreland permit. A complete list of activities that **do not** require a shoreland permit can be found on the [Shoreland Program Page](#) by visiting www.des.nh.gov.

250 feet from Reference Line — THE PROTECTED SHORELAND:

Impervious Surface Area Limitation. If a homeowner or developer wishes to exceed 30% impervious surface coverage of the area of the lot within the protected shoreland, a stormwater management system designed and certified by a professional engineer that will not concentrate stormwater runoff or contribute to erosion must be implemented and if any grid segment within the waterfront buffer does not meet the minimum required 50 point tree, sapling, shrub and groundcover score, each deficient grid segment must be planted with additional vegetation to at least achieve the minimum required score. If a homeowner or developer wishes to exceed 20% impervious area, a [stormwater management plan](#) must be implemented to infiltrate increased stormwater from development.

Other Restrictions/ Notes:

- No establishment/expansion of salt storage yards, auto junk yards, solid waste and hazardous waste facilities.
- Setback requirements for all new septic systems are determined by soil characteristics.
 - 75 feet for rivers and areas where there is no restrictive layer within 18 inches and where the soil down gradient is not porous sand and gravel (perc > 2 min.).
 - 100 feet for soils with a restrictive layer within 18 inches of the natural soil surface.
 - 125 feet where the soil down gradient of the leachfield is porous sand and gravel (perc rate equal to or faster than 2min/in.).
- In accordance with RSA 485-A, when selling developed waterfront property, a *Site Assessment Study* is required for all properties with on-site septic that are contiguous to or within 200 feet of waterbodies jurisdiction under the SWQPA. For more information relative to site assessments, contact the NH [Subsurface Systems Bureau](#) at (603) 271-3711.
- In accordance with RSA 485-A:17, an Alteration of Terrain Permit is required for any project that proposes to disturb more than 50,000 sq ft of contiguous terrain if any portion of the project is within the protected shoreland or disturbs an area having a grade of 25% or greater within 50 feet of any surface water.

150 feet from Reference Line — NATURAL WOODLAND BUFFER LIMITATIONS:

- At least 25 percent of the area between 50 feet and 150 feet from the reference line must be maintained in an unaltered state.

50 feet from Reference Line — WATERFRONT BUFFER and PRIMARY BUILDING SETBACK:

- All primary structures must be set back at least 50 feet from the reference line. Towns may maintain or enact greater setbacks.
- Within 50 feet from the reference line, a waterfront buffer must be maintained. Within the waterfront buffer, tree coverage is managed with a 50 x 50 foot grid and point system. Trees and saplings may be removed provided the sum score of the remaining trees, saplings, shrubs and groundcover within the affected grid segment is at least 50 points. (see [Vegetation Maintenance within the Protected Shoreland FACT SHEET](#))
- No natural ground cover shall be removed except for a footpath to the water that does not exceed 6 feet in width and does not concentrate stormwater or contribute to erosion.
- Natural ground cover must remain intact. No cutting or removal of vegetation below 3 feet in height (excluding previously existing lawns and landscaped areas). Stumps, roots, and rocks must remain intact in and on the ground unless specifically approved by the department.
- Pesticide and herbicide applications can be applied by a licensed applicator only.
- Only low phosphorus, slow release nitrogen fertilizer can be used beyond 25 feet of the reference line. Only limestone may be used within 25 feet of the reference line.

“REFERENCE LINE”- The reference line is the point from which setbacks are determined. For *coastal waters* it is the highest observable tide line; for *rivers* it is the ordinary high water mark and for *lakes and ponds* it is the surface elevation listed on the [Consolidated List of Waterbodies subject to the SWQPA](#).

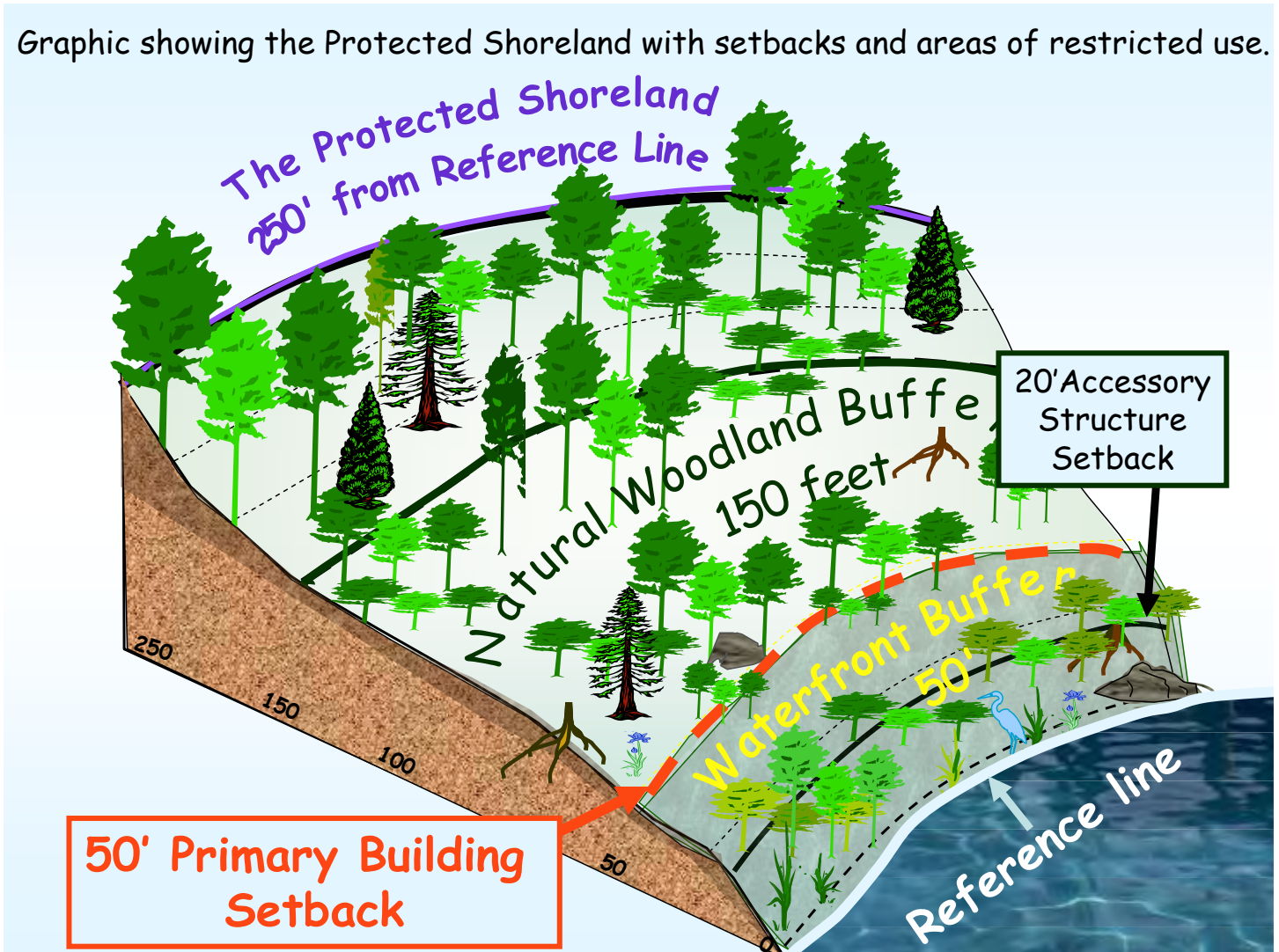
“CONSTRUCTION”- Erecting, reconstructing or altering any structure(s) that result in an increase in impervious area.

“EXCAVATION” - To dig, remove, or form a cavity or hole within the ground with mechanized equipment.

“FILL” - To place or deposit materials such as rocks, soil, gravel, sand or other such materials.

“UNALTERED STATE” - vegetation allowed to grow without cutting, limbing, trimming, pruning, mowing, or other similar activities except as needed for plant health, normal maintenance and renewal.

Graphic showing the Protected Shoreland with setbacks and areas of restricted use.



Source: NH Department of Environmental Services, Water Division, Wetlands Bureau, Shoreland Program

The summary and graphic presented here provide a quick reference guide to the major provisions in the CSPA but cannot cover every circumstance. Anyone doing construction, excavation, landscape modification or related work within the protected area should read New Hampshire Statutes RSA 483-b and NH Code of Administrative Rules Chapter Env-Wq 1400 and contact NH DES with any questions.

RSA 483-b: <http://www.gencourt.state.nh.us/rsa/html/nhtoc/nhtoc-l-483-b.htm>

Env-Wq 1400: <http://des.nh.gov/organization/commissioner/legal/rules/documents/env-wq1400.pdf>

Pesticide Setback Distances from Wells and Surface Waters

Source: NH Department of Agriculture, Markets & Food, Division of Pesticide Control

APPLYING

PUBLIC WELLS Pes 502.06	400 ¹ 250 ¹
Gravel Packed Non Gravel Packed	
PUBLIC WATER SUPPLY SURFACE WATERS Pes 502.05(a)	250 ¹
Within Watershed—out to 5 miles	
SURFACE WATER (Other Than Public Water Supplies) PART Pes 1001	
Surface Water ⁴ - Pes 1001.01(a)	25 ²
Beyond 25 feet - Pes 1001.01(b) - NOT in a manner that will result in presence of pesticide within 25 feet of the REFERENCE LINE³.	
<p>1 Exceptions to these distances may be requested through a SPECIAL PERMIT.</p> <p>2 EXCEPTION under 1001.02 (a) for indoor treatment (b) outdoor termite control & (c) other outdoor applications under SPECIAL PERMIT.</p> <p>3 REFERENCE LINE (Pes 101.28) - For natural fresh water bodies the natural mean high water level (DES) or the high water mark; for artificially impounded fresh water bodies, the elevation of the top of the impoundment; for coastal waters, highest observable high tide; for rivers, ordinary high water mark.</p> <p>4 See footnote 4, center section.</p>	

MIXING AND LOADING

PUBLIC WELLS Pes 805.01(b)	400 250
Gravel Packed Non Gravel Packed	
SURFACE WATER Pes 805.01(c)	75
All ⁴	
PRIVATE WATER WELLS Pes 805.01(c)	75
All ⁵	
<p>4 SURFACE WATER (Pes 101.36) “means streams, brooks, creeks, rivers, lakes, ponds, wetlands and tidal waters within the jurisdiction of the state, including all streams, lakes or ponds bordering on the state, marshes, watercourses and other bodies of water, natural or artificial.” (Note in left panel the definition of REFERENCE LINE as it pertains to surface waters).</p> <p>5 Note, this includes inactive wells, even if no longer connected.</p> <p>NOTE: All distances are expressed in FEET.</p>	

STORAGE

GENERAL Pes 802.03(k)	400 75
Public Wells (all types)	
Private Water Wells ⁵	
Surface Water (high water mark)	75
BULK STORAGE AND DISPENSING AREAS Pes 804.05(d)	
Public Water Wells	400
Public Surface Water Supplies (high water marks)	400
Private Water Wells	75
Other Surface Waters (high water marks)	75
<p>5 See footnote 5, center section.</p>	
<h2>ADDITIONAL INFORMATION</h2> <p>Pesticide Rules and Regs are available on-line at: http://agriculture.nh.gov/rules/index.htm</p> <p>Maps showing locations of Public Water Supply Watersheds and intakes may be found on-line at: http://www2.des.state.nh.us/gis/onestop/</p> <p>Requests for SPECIAL PERMIT applications should be made to the Division at (603) 271-3550.</p> <p>NOTE: YOU MUST ALWAYS MEET OR EXCEED LABEL SETBACKS</p>	

UNH Cooperative Extension

Family, Home & Garden Education Center

extension.unh.edu/FHGEC/FHGEC.htm

Toll free number: 1-877-EXT-GROW (1-877-398-4769)

The Family, Home & Garden Education Center at UNH Cooperative Extension in Manchester provides practical solutions to everyday questions for the citizens of New Hampshire. It is staffed by professionals and intensively trained volunteers available to answer your questions about gardens, lawns and landscapes, household food safety and food preservation, water quality, integrated pest management, tree planting and care, backyard livestock and more. The center is staffed 9 a.m. to 2 p.m. Monday through Friday and Wednesday evenings 5 p.m. to 7:30 p.m.

County Extension Offices extension.unh.edu/Counties/Counties.htm

Belknap

Belknap County Complex
36 County Drive
Laconia NH 03246-2900
Phone: 603-527-5475

Carroll

73 Main Street
PO Box 1480
Conway, NH 03818
Phone: 603-447-3834

Cheshire

800 Park Avenue
Keene, NH 03431
Phone: 603-352-4550

Coös

629A Main Street
Lancaster, NH 03584-9612
Phone: 603-788-4961

Grafton

3855 Dartmouth College Highway, Box 5
North Haverhill, NH 03774-4936
Phone: 603-787-6844

Hillsborough

329 Mast Road
Goffstown, NH 03045
Phone: 603-641-6060

Merrimack

315 Daniel Webster Hwy
Boscawen, NH 03303
Phone: 603-225-5505

Rockingham

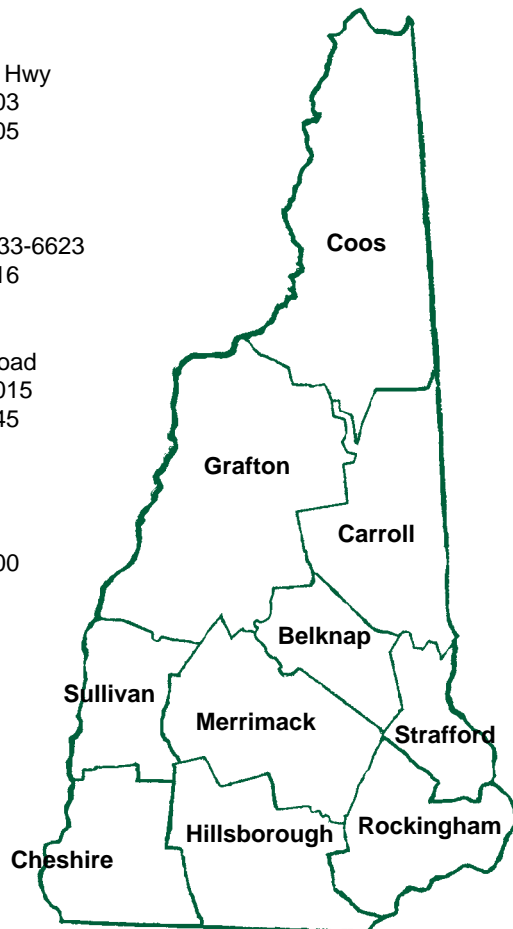
113 North Road
Brentwood, NH 03833-6623
Phone: 603-679-5616

Strafford

268 County Farm Road
Dover, NH 03820-6015
Phone: 603-749-4445

Sullivan

24 Main Street
Newport, NH 03773
Phone: 603-863-9200



UNH Cooperative Extension Diagnostic and Testing Services

For information, contact the Administrative Assistant,
G28 Spaulding Hall 38 Academic Way, Durham NH 03824
Phone 603-862-3200 Fax 862-2717

Insect Identification – Arthropod Identification Center

extension.unh.edu/Agric/AGPDTS/IDform.pdf

Soil Testing Service

extension.unh.edu/Agric/AGPDTS/SoilTest.htm

UNH Plant Diagnostic Laboratory

extension.unh.edu/Agric/AGPDTS/PlantH.htm

Information on Specific Topics Mentioned in this Book

Soils and Fertilizers

Does Your Lawn Measure Up

extension.unh.edu/Pubs/HGPubs/lawnmeup.pdf

Fertilizing the Home Lawn

extension.unh.edu/pubs/HGPubs/fertlawn.pdf

Slow-Release Fertilizers for Home Gardens and Landscapes

extension.unh.edu/Pubs/HGPubs/slowfert.pdf

Understanding your Soil Test Results

extension.unh.edu/Pubs/HGPubs/soiltest.pdf

Erosion and Runoff Controls

Shoreline Stabilization Handbook, Lake Champlain Basin Program and Univ. Vermont Sea Grant:

nsgd.gso.uri.edu/lcsg/lcsg04001.pdf

Environmental and Conservation Fact Sheets Series, Portland Water District/Cumberland County Soil Conservation District:

pwd.org/news/publications.php

Rain Gardens

University of Rhode Island Cooperative Extension:

uri.edu/cc/healthylandscapes/raingarden.htm

University of Maine Extension fact sheet

umext.maine.edu/onlinepubs/PDFpubs/2702.pdf

Invasive Species

Invasive Plants and Insect Species (HB1258-FN)

nh.gov/agric/divisions/plant_industry/documents/hb1258_n.pdf

List of Invasive Species

nh.gov/agric/divisions/plant_industry/documents/list_of_invasive_species.pdf

Guide to Invasive Upland Plant Species in New Hampshire

nh.gov/agric/divisions/plant_industry/documents/InvasivesBooklet2005.pdf

Alternatives to Invasive Landscape Plants

extension.unh.edu/Pubs/HGPubs/altinvs2.pdf

Identifying and Monitoring Wildlife and Native Plants

Landowners' Guide to Inventorying and Monitoring Wildlife in New Hampshire

To order guide:

extension.unh.edu/Forestry/Pubs/wildform.pdf

To download document:

extension.unh.edu/Forestry/Pubs/wilguide.pdf

Rare or Endangered Plants and Wildlife

N.H. Wildlife Action Plan

wildlife.state.nh.us/Wildlife/wildlife_plan.htm

Endangered and Threatened Wildlife in N.H.

wildlife.state.nh.us/Wildlife/Nongame/endangered_list.htm

N.H. Natural Heritage Bureau

dred.state.nh.us/divisions/forestandlands/bureaus/naturalheritage/index.htm

Plant Selection and Maintenance

The Best Plants for New Hampshire Gardens and Landscapes

extension.unh.edu/Pubs/PubsAG/bestplnt.pdf

Integrated Landscaping: Following Nature's Lead

https://www.events.unh.edu/RegistrationForm.pm?event_id=2703

Pruning Deciduous Shrubs in the Landscape

extension.unh.edu/Pubs/HGPubs/PrunDec.pdf

Pruning Evergreens in the Landscape

extension.unh.edu/Pubs/HGPubs/PrunEverg.pdf

Pruning Shade Trees in the Landscape

extension.unh.edu/Pubs/HGPubs/prunshad.pdf

APPENDIX C

Recommended Plant Lists

Selecting Woody Plants for Shoreland Landscapes

The plants listed are those that occur near water in their natural habitats. They are recommended for use in multi-layered plant systems as described and illustrated in Chapter 4. Some of these plants may be uncommon and difficult to find in a nursery, but many are readily available. Choose plants that are suitable for your site conditions, soils, sun exposure, and cold hardiness zones.

For more information and for herbaceous plant recommendations, please refer to *The Best Plants for New Hampshire Gardens and Landscapes*, published by the New Hampshire Plant Growers Association and UNH Cooperative Extension, 2003.

Height Class	Common Name	Scientific Name	Mature Height	USDA Cold Hardiness Zone
Under 3'				
	Bog Rosemary	Andromeda polifolia	1 - 2'	2
	Bearberry	Arctostaphylos uva-ursi	1'	2
	Leatherleaf	Chamaedaphne calyculata	1 - 3'	2
	Bunchberry	Cornus canadensis	6 - 9"	2
	Bearberry Cotoneaster	Cotoneaster dammeri	12 - 18"	5
	Rockspray Cotoneaster	Cotoneaster horizontalis	2 - 3'	5
	Rose Daphne	Daphne cneorum	6 - 12"	4
	Slender Deutzia	Deutzia gracilis	2'	5
	Dwarf Greenstem Forsythia	Forsythia viridissima 'Bronxensis'	1 - 2'	5
	Creeping Wintergreen	Gaultheria procumbens	6"	3
	Little Henry Sweetspire	Itea virginica 'Little Henry'	2 - 3'	5
	Sheep Laurel	Kalmia angustifolia	1 - 3'	2
	Bog Kalmia	Kalmia polifolia	3'	2

KEY

Vegetative Buffer Zone(s)	Native & Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
LL=Lowland transition SL=Shoreland UPL=Upland	Y=Yes	WD=well-drained W=wet (bog) A=acidic M=moist	PS=partial sun S=full sun Sh=shade	Sp = spreading EG=evergreen

Vegetative Buffer Zone(s)	Native	Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
SL	Y		W A	S PS	EG, Sp, cvs. 'Montana', 'Angustifolia', 'Compacta', 'Grandiflora'
UPL	Y	Y	A	S PS	EG, Sp, salt tolerant, does well in very poor soils
SL	Y		W A	PS	EG, cvs. 'Nana', 'Cascade' and 'Tiny Tim' under 3' tall
LL UPL	Y	Y	M A	PS Sh	Sp, excellent groundcover
UPL			WD	S	EG, Sp, good bankcover, very fast
UPL			WD	S	Sp, good bankcover
UPL			M WD	PS Sh	EG, fragrant flowers
UPL			WD	S	cv. 'Nikko' recommended for compact growth form
UPL				S	Sp, groundcover type forsythia
LL	Y		M A	Sh PS	EG, Sp, groundcover
LL	Y		M	S PS Sh	This is a compact cv.; others are listed in 3-6' height class
SL LL UPL	Y		A W or M	PS	EG, Sp, does well in poor soils, poisonous to livestock
SL LL	Y		W A		

Height Class	Common Name	Scientific Name	Mature Height	USDA Cold Hardiness Zone
	Coast Leucothoe	Leucothoe axillaris	2 - 4'	5
	Creeping Mahonia	Mahonia repens	10 - 18"	5
	Paxistima	Paxistima canbyi	1'	3
	Gro-Low Fragrant Sumac	Rhus aromatica 'Gro-Low'	2'	3
	Lowbush Blueberry	Vaccinium angustifolium	1 - 2'	2
	American Cranberry	Vaccinium macrocarpon	4 - 6"	2
	Mountain Cranberry	Vaccinium vitis-idaea var. minus	4 - 8"	2
3' - 6'				
	Regent Serviceberry	Amelanchier alnifolia 'Regent'	4 - 6'	3
	Summersweet Clethra	Clethra alnifolia	3 - 8'	4
	Sweetfern	Comptonia peregrina	3 - 5'	2
	Spike Winterhazel	Corylopsis spicata	4 - 6'	5
	American Hazelnut	Corylus americana	3 - 9'	4
	Dwarf Bush Honeysuckle	Diervilla lonicera	3 - 5'	3
	Atlantic Leatherwood	Dirca palustris	3 - 6'	3
	Dwarf Fothergilla	Fothergilla gardenii	3 - 4'	5
	Huckleberry	Gaylussacia sp.	3 - 5'	3
	Smooth Hydrangea	Hydrangea arborescens	3 - 5'	3
	Oakleaf Hydrangea	Hydrangea quercifolia	3 - 6'	5
	Inkberry	Ilex glabra	3 - 6'	5

Vegetative Buffer Zone(s)	Native	Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
LL			A M WD	Sh	EG, choose small cvs. for this size class
UPL			A M WD	Sh PS	EG, Sp, groundcover
UPL			M WD	S PS	EG, tolerates high pH
UPL	Y		A WD	S PS	Sp, other cvs. get much larger; good fall color
LL UPL	Y	Y	A		Edible blueberry, does well in very poor soils
SL LL	Y	Y	M A	S	EG, Sp, edible cranberry
LL	Y	Y	M A	S	EG, Sp, edible Ligonberry
LL UPL	Y	Y	M WD A	S PS	Sp, edible berries; other cvs. are larger
SL LL	Y	Y	M A	S PS	Fragrant, salt tolerant; nice cvs. include 'Hummingbird', 'Sixteen Candles', 'Compacta', 'Ruby Spice'
UPL	Y	Y	WD	S PS	Sp, does well in poor dry sandy soils
UPL			M WD	S PS	
UPL	Y	Y		S PS	Sp, edible nuts
UPL	Y			S PS	Sp, very tough plant
SL LL	Y		W	Sh	
UPL	Y		M WD A	S PS	Excellent fall color
UPL		Y	WD A	PS	EG, Sp, edible berries
LL UPL	Y		M WD	S PS	Sp, cvs. include 'Annabelle', 'Grandiflora', 'White Dome'
LL			M WD	S PS	
LL	Y	Y	M A	S PS	EG, Sp, avoid sites with winter sun wind exposure, many cvs. include 'Compacta', 'Viridis', 'Nigra'

Height Class	Common Name	Scientific Name	Mature Height	USDA Cold Hardiness Zone
	Red Sprite Common Winterberry	<i>Ilex verticillata</i> 'Red Sprite'	3 - 5'	4
	Virginia Sweetspire	<i>Itea virginica</i>	3 - 5'	5
	Sweetgale	<i>Myrica gale</i>	3 - 4'	1
	Rhodora	<i>Rhododendron canadense</i>	3 - 4'	2
	Pinxterbloom Azalea	<i>Rhododendron periclymenoides</i>	4 - 6'	4
	Meadowsweet	<i>Spirea latifolia</i>	3 - 5'	3
	Steeplebush	<i>Spirea tomentosa</i>	2 - 4'	3
	Common Snowberry	<i>Symphoricarpos albus</i>	3 - 6'	3
6' - 9'				
	Red Chokeberry	<i>Aronia arbutifolia</i>	6 - 10'	4
	Black Chokeberry	<i>Aronia melanocarpa</i>	5 - 10'	3
	Sweetshrub	<i>Calycanthus floridus</i>	6 - 9'	4
	Silky Dogwood	<i>Cornus amomum</i>	6 - 10'	4
	Red-Osier Dogwood	<i>Cornus sericea</i>	8 - 10'	2
	Large Forthergilla	<i>Fothergilla major</i>	6 - 9'	4
	Vernal Witchhazel	<i>Hamamelis vernalis</i>	6 - 10'	4
	Common Winterberry	<i>Ilex verticillata</i>	6 - 10'	3-4
	Northern Bayberry	<i>Myrica pensylvanica</i>	6 - 10'	3
	Mountain Holly	<i>Nemopanthus mucronata</i>	6 - 10'	4
	Common Ninebark	<i>Physocarpus opulifolius</i>	5 - 10'	2

Vegetative Buffer Zone(s)	Native	Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
SL LL	Y	Y	M A	PS S	Compact cv., others listed in 6-9' class; plant with male pollinator
SL LL	Y		W or M	S PS Sh	Fragrant flowers; 'Henry's Garnet' recommended
SL	Y	Y	W	S	Aromatic
SL LL	Y		M A	PS Sh	Deciduous azalea
UPL	Y		WD	PS	Deciduous azalea; try cvs. 'Album', 'Roseum'
LL UPL	Y		M WD	S	Sp
SL LL	Y		M	S PS	
SL LL		Y		S PS Sh	Sp, fills in large areas, adaptable to many conditions
LL UPL	Y	Y		S PS	Sp, cv. 'Brilliantissima' has beautiful red fall foliage
LL UPL	Y	Y		S PS	Sp, cv. 'Autumn Magic' has good fall color and compact form
LL UPL				S PS	Fragrant, adaptable to many conditions.
SL LL	Y	Y	M	PS	
SL LL	Y	Y	M	S PS	Sp, colorful winter twigs
SL LL UPL	Y		M A	PS S	Excellent fall color
SL LL	Y	Y	M	S PS	Sp, late winter flowers
SL LL	Y	Y	M A	S PS	Sp, many improved cvs., plant with male pollinator
FAC	Y	Y	WD	S PS	Sp, salt tolerant, does well on poor soils
SL	Y	Y	M		Sp, forms thickets
UPL	Y		WD	S PS	Tough plant; new purple-leaved cvs. popular; 'Nanus' is dwarf form

Height Class	Common Name	Scientific Name	Mature Height	USDA Cold Hardiness Zone
	Roseshell Azalea	Rhododendron prinophyllum	2 - 8'	3
	Pinkshell Azalea	Rhododendron vaseyi	5 - 9'	4
	Swamp Azalea	Rhododendron viscosum	6 - 9'	4
	Swamp Rose	Rosa palustris	6 - 8'	4
	Elderberry	Sambucus canadensis	6 - 12'	3
	Wild Raisin Viburnum	Viburnum cassinoides	6 - 10'	3
	Arrowwood Viburnum	Viburnum dentatum	6 - 9'	2
10' - 15'				
	Buttonbush	Cephalanthus occidentalis	8 - 15'	5
	Gray Dogwood	Cornus racemosa	10 - 15'	3b
	Chinese Witchhazel	Hamamelis mollis	10 - 15'	5
	Panicle Hydrangea	Hydrangea paniculata	10 - 20'	3
	Spicebush	Lindera benzoin	10 - 12'	4
	Rosebay Rhododendron	Rhododendron maximum	5 - 15'	3
	Purpleosier Willow	Salix purpurea	8 - 15'	3
	Highbush Blueberry	Vaccinium corymbosum	6 - 12'	3
	Blackhaw Viburnum	Viburnum prunifolium	12 - 15'	3
	American Cranberrybush Viburnum	Virburnum trilobum	8 - 12'	2

Vegetative Buffer Zone(s)	Native	Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
UPL	Y			PS Sh	Deciduous azalea, tolerates high pH, dry open woods
LL			M A	PS Sh	Deciduous azalea
SL	Y		W	PS Sh	Deciduous azalea
SL	Y	Y	W	S	
SL LL UPL	Y	Y		S	Sp, 'Aurea' has yellow foliage, Sambucus nigra 'Black Beauty' has dark foliage; edible fruit; tolerates wet or dry soils
SL LL	Y	Y		S PS	
LL UPL	Y	Y	WD	S PS	Sp, many new cvs. selected for berry set and fall color
SL	Y	Y	W	S PS	
SL LL	Y	Y	M	S PS	Sp, fills in large areas
LL UPL				S PS	Fragrant, very early spring flowers; cv. 'Pallida' has excellent fall color
LL UPL			M WD	S PS	Many cvs. available including 'Pink Diamond' and 'Limelight'
SL LL	Y	Y	W or M	S PS	Fragrant
LL UPL	Y		M A WD	PS Sh	EG, avoid winter exposure
SL			W	S PS	Sp, good for bank stabilization; 'Nana' a compact cv.
LL UPL	Y	Y	M A WD	S PS	Edible blueberry
UPL		Y	WD	S PS	Good in dry soils
LL UPL	Y	Y	M WD	S PS	Cv. 'Wentworth' recommended for fruits for jellies, 'Alfredo' for fall color and compact form

Height Class	Common Name	Scientific Name	Mature Height	USDA Cold Hardiness Zone
16' - 25'				
	Striped Maple	<i>Acer pensylvanicum</i>	15 - 20'	3
	Speckled Alder	<i>Alnus rugosa</i>	15 - 25'	4
	Downy Serviceberry	<i>Amelanchier arborea</i>	15 - 25'	4
	Shadblow Serviceberry	<i>Amelanchier canadensis</i>	10 - 20'	3
	Allegheny Serviceberry	<i>Amelanchier laevis</i>	20 - 25'	4
	White Fringetree	<i>Chionanthus virginicus</i>	15 - 25'	4
	Pagoda Dogwood	<i>Cornus alternifolia</i>	15 - 25'	3
	Corneliancherry Dogwood	<i>Cornus mas</i>	20 - 25'	4
	Common Witchhazel	<i>Hamamelis virginiana</i>	20 - 25'	3b
	Sweet Azalea	<i>Rhododendron arborescens</i>	8 - 20'	4
	Flameleaf Sumac	<i>Rhus copallina</i>	10 - 20'	4
	Pussy Willow	<i>Salix</i> spp.	10 - 20'	3
25' - 45'				
	Eastern Redcedar	<i>Juniperus virginiana</i>	20 - 40'	3b
	Black Spruce	<i>Picea mariana</i>	30 - 40'	3
	Hophornbeam	<i>Ostrya virginiana</i>	30 - 40'	3b
	American Hornbeam	<i>Carpinus caroliniana</i>	25 - 35'	3b
	Eastern Redbud	<i>Cercis canadensis</i>	20 - 30'	5
	Sweetbay magnolia	<i>Magnolia virginiana</i>	15 - 30'	5
	Kousa Dogwood	<i>Cornus kousa</i>	25 - 35'	5
	Red Mulberry	<i>Morus rubra</i>	30 - 45'	5

Vegetative Buffer Zone(s)	Native	Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
LL UPL	Y		M WD	PS	
SL LL	Y		M	S	
LL UPL	Y	Y	M WD A	S PS	
SL LL	Y	Y	M A	S PS	Sp
SL LL	Y	Y	M A	S PS	
LL		Y	M	PS S	Silky white flowers, large blue berries
UPL	Y	Y	M WD A	PS	
UPL		Y	WD	PS S	Very early yellow flowers, red fruit
LL UPL	Y		M	S PS	Flowers late fall, fragrant
LL	Y		M A	PS Sh	Deciduous azalea
UPL	Y			S	Sp, forms large colonies, red fall foliage
SL LL			M	S PS	For nice catkins use <i>S. caprea</i> or <i>S. chaenomeloides</i> ; the native <i>S. discolor</i> is not as good, subject to canker
UPL	Y	Y	M WD	S	EG, tolerates poor dry conditions
LL	Y		M	S	EG
UPL	Y	Y	M WD	S PS	
LL	Y		M	PS Sh	
LL UPL	Y		M	PS S	Cold hardiness depends northern seed source
LL	Y		M A	PS	EG, avoid winter exposure; large fragrant flowers
UPL		Y	WD A	PS	Good substitute for flowering dogwood, white flowers on hardiest vars.
LL		Y	M		

Height Class	Common Name	Scientific Name	Mature Height	USDA Cold Hardiness Zone
Over 45'				
	Red Maple	<i>Acer rubrum</i>	40 - 60'	3b
	Yellow Birch	<i>Betula alleghaniensis</i>	50 - 70'	3
	River Birch	<i>Betula nigra</i>	40 - 70'	3b
	Atlantic White Cedar	<i>Chaemaecyparis thyoides</i>	40 - 50'	4
	Green Ash	<i>Fraxinus pennsylvanica</i>	50 - 60'	2b
	American Larch	<i>Larix laricina</i>	40 - 80'	2
	American Sweet Gum	<i>Liquidambar styraciflua</i>	60 - 80'	5
	Dawn Redwood	<i>Metasequoia glyptostroboides</i>	50 - 100'	5
	Black Gum	<i>Nyssa sylvatica</i>	30 - 50'	4
	American Plane Tree	<i>Platanus occidentalis</i>	75 - 100'	4
	Swamp White Oak	<i>Quercus bicolor</i>	50 - 60'	4
	Pin Oak	<i>Quercus palustris</i>	60 - 70'	4
	Eastern Arbutvitae	<i>Thuja occidentalis</i>	40 - 60'	2

Vegetative Buffer Zone(s)	Native	Wildlife Value	Soil	Sun	Comments and Cultivars (cvs.)
SL LL	Y		M A	S PS	Many cvs. selected for good fall color, some are more hardy than others
LL	Y	Y	M	S PS	
LL UPL			M	S PS	Recommended over paper birch for landscape use due to pest resistance; 'Heritage' most popular cv.
SL LL	Y		W or M	S	EG
LL UPL	Y			S	Tolerates many soil conditions; use seedless cvs. near lawns and walkways
LL	Y		M WD A	S	
LL			M	S	
SL LL			M	S	
LL	Y	Y	M A	S PS	Excellent fall color
LL	Y		M	S	Very large, messy - plant only in naturalized areas
SL LL	Y	Y	M A	S	
LL UPL	Y	Y	M A	S	
LL UPL	Y	Y	M WD	S	EG; cvs. 'Techny', 'Nigra' 'Emerald' for cold climates

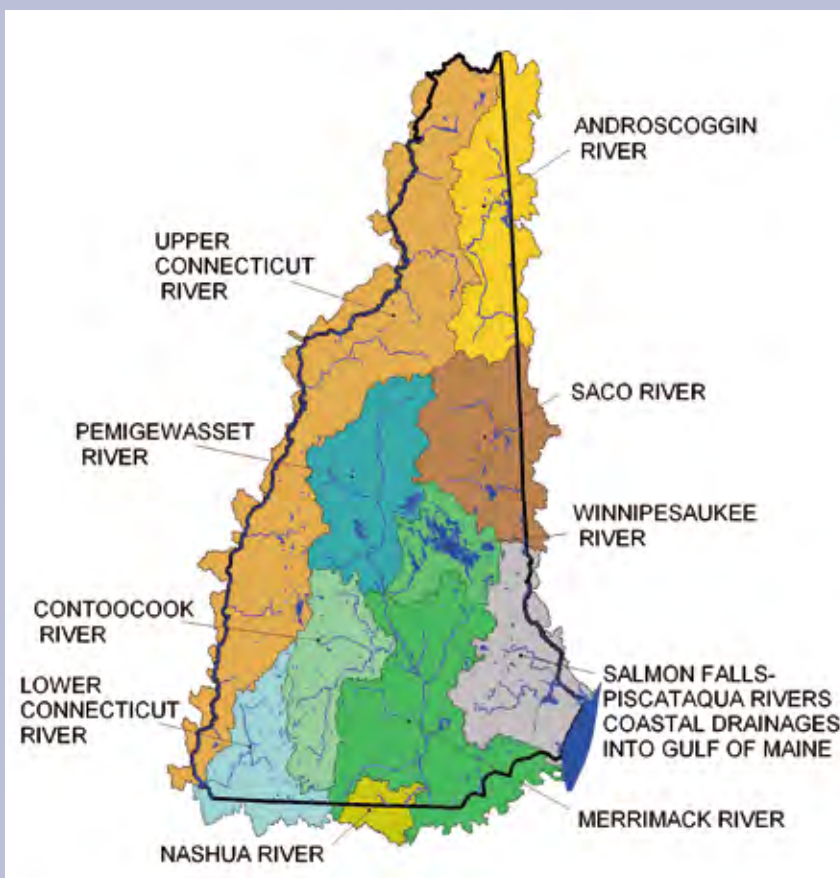
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No matter where you live in New Hampshire, the actions you take in your landscape can have far-reaching effects on water quality. Why? Because we are all connected to the water cycle and we all live in a watershed. A watershed is the land area that drains into a surface water body such as a lake, river, wetland or coastal estuary.

Landscaping at the Water's Edge is a valuable resource for anyone concerned with the impact of his or her actions on the environment. This book brings together the collective expertise of many UNH Cooperative Extension specialists and educators and an independent landscape designer.

Unlike many garden design books that are full of glitz and glamour but sorely lacking in substance, this affordable book addresses important ecological issues and empowers readers by giving an array of workable solutions for real-world situations. ~Robin Sweetser, Concord Monitor columnist, garden writer for Old Farmer's Almanac, and NH Home Magazine

Landscaping at the Water's Edge provides hands-on tools that teach us about positive change. It's an excellent resource for the gardener, the professional landscaper, designer, and landscape architect—to learn how to better dovetail our landscapes with those of nature. ~Jon Batson, President, NH Landscape Association



Pictured here are the major river watersheds in New Hampshire. This guide explains how our landscaping choices impact surface and ground waters and demonstrates how, with simple observation, ecologically based design, and low impact maintenance practices, you can protect, and even improve, the quality of our water resources.

