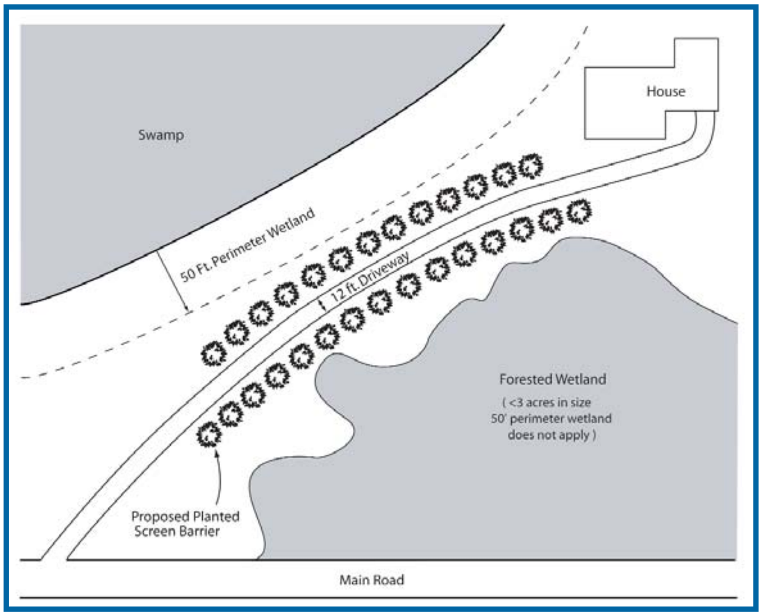
Wetland BMP Manual:

Techniques for Avoidance and Minimization



Rhode Island Department of Environmental Management
Office of Water Resources
Freshwater Wetlands Program

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NEIWPCC
New England Interstate Water Pollution Control Commission

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Dedication

The Wetland BMP Manual: Techniques for Avoidance and Minimization

is dedicated to the memory of

Carl A. Ruggieri (1963 - 2006)

in honor of his fifteen years of dedicated service to the

Rhode Island Department of Environmental Management Freshwater Wetlands Program.

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Introduction

Background and Purpose

The Wetland BMP Manual: Techniques for Avoidance and Minimization is a final product of a multi-year effort to improve the Department of Environmental Management's Groundwater and Freshwater Protection Program, prompted by recommendations of the Wetlands Task Force (2001) and by Program staff. The Program has completed many other projects based on those recommendations, including: restructuring the Rules and Regulations and the application instructions, developing outreach materials, and providing numerous training workshops for consultants and municipal officials. This Manual is intended to be used in conjunction with other available materials. The target audience for this Manual is applicants and professional consultants who prepare applications for submittal to the Rhode Island Wetlands Program, as well as builders and contractors.

The Wetland BMP Manual is a compilation of Best Management Practices (BMPs), including text, tips, and examples that were researched and compiled from staff input and from the DEM wetland files. The Manual is intended to help answer questions posed by Task Force members and applicants, namely "How does an applicant know what DEM wants?" and "How does an applicant know whether he or she is going to get a permit?" To help answer these questions and to help applicants "get it right the first time," this Manual provides examples of acceptable and permitted wetland-friendly designs and practices that could be used by applicants when designing projects. The Wetland BMP Manual is another tool to help applicants and consultants to prepare more complete applications, in order to adequately avoid and minimize impacts to wetlands and to facilitate applicants receiving speedier decisions from the Department. The Manual includes project-specific examples and details that are applicable to many project types that have been successfully permitted in Rhode Island or in nearby states.

Guide to Using the Wetland BMP Manual

The Wetland BMP Manual can be approached in various ways. The authors recommend that the introductory pages and Chapter 1 be read first, before delving into the project-specific chapters.

A review of the Table of Contents reveals that, after the introductory pages, the Manual is largely organized around project types that are the subject of wetlands applications commonly submitted to the Wetlands Program. Each chapter begins with an introduction to the project type, followed by numerous bulleted tips on avoidance and minimization techniques and practices; and in many chapters the tips are followed by "before" and "after" example illustrations. The examples are not intended to be complete site plans, but rather they are simplified illustrations the readers will find helpful. The "before" examples depict proposed projects without consideration of wetland avoidance and minimization practices, and the "after" examples depict projects which were modified to include the consideration of avoidance and minimization. Bulleted lists accompany the "after" illustrations and describe how the initial proposal was improved with respect to wetland protection. Throughout the Manual the reader will also find helpful details that would be applicable to various project types.

Some of the "after" examples in Chapters 2 through 8 illustrate some remaining encroachment into regulated wetland areas, including Perimeter Wetland and Riverbank Wetland. Such encroachments have been permitted by the Program in the past, but only after the applicants have demonstrated to the Program that the alterations were truly unavoidable and that remaining impacts were not detrimental. These examples are included because they are based on real-world projects; however, applicants should keep in mind that decisions to permit encroachments are very site specific.

Chapter-by-Chapter Guide

Chapter 1 is a primer on the importance of protecting Rhode Island's wetlands, whose functions and values the Department is charged with protecting according to Rhode Island General Law. This chapter lists various activities or alterations that may be posed in or near wetlands and that may adversely impact these functions and values both hydrologically and ecologically, especially over time. This builds the case for the critical need for (1) the avoidance of wetlands altogether and (2) the minimization of truly unavoidable impacts.

Chapters 2 through 8 focus on specific project types, beginning with Single-Family Lots and progressing to Utility Projects. Each chapter can stand alone, however, the reader will note some repetition in the text and in the bullets from chapter to chapter, since some common techniques and practices are pertinent to more than one project type. The reader may also find relevant examples and tips within specific chapters that may also apply to another project type (ex. lighting). A review of the list of examples will help the reader identify which examples may be of use to them and where to find them.

The authors recommend that all Manual users read the final three Chapters entirely, namely Chapter 9 - Wetland Crossings, Chapter 10 - Plantings, and Chapter 11 - Construction and Maintenance Tips, since these Chapters address activities that are common to many project types.

Chapter 9 describes wetland crossings. A crossing is rarely a stand-alone project type, but rather a common component of other projects and one of the more frequent alteration types resulting in direct wetland alteration and loss. Applicants will propose crossing wetlands, including rivers and streams, to gain access to upland portions of properties on which to build their projects. Chapter 9, largely through illustrations of culverts and bridges, emphasizes the importance of maximizing span width and maintaining the existing hydrology and substrates of the wetland proposed to be crossed. During the development of the Wetland “BMP” Manual, other New England states, under the direction of the U.S. Army Corps of Engineers New England Division, have developed wetland-crossing standards, including requirements for span width, opening size, etc. However, the Wetland Program prefers to maximize flexibility for applicants through case-by-case design and review.

Other DEM Resources

This Wetland BMP Manual should be used by applicants and consultants in conjunction with the Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act and other guidance materials developed by the Program and the Department, including.

- What's the Scoop on Wetland's? Frequently Asked Questions about DEM's Freshwater Wetlands Program (revised 2008);
- The DEM Wetland Fact Sheet Series;

- Guidance for Preparation of Subwatershed Maps (2007);
- Hydrologic and Hydraulic Modeling Guidance (2007);
- Guidance for the Preparation of Stormwater Best Management Practices (BMP's) (2007); and
- Floodplain Impacts: Regulatory Provisions Pertaining to Floodplains and Floodways (2007).

Concurrent with the internal development of the Wetland BMP Manual, the DEM Office of Strategic Planning and Policy has developed the following colorful and informative land development guidance manuals, which when implemented should also result in improved wetland protection:

- The Rhode Island Conservation Development Manual: A Ten-Step Process for Planning and Design of Creative Development Projects (2003);
- Rhode Island Rural Design Manual (2000, rev. 2004); and
- Urban Environmental Design Manual (2005).

Currently, the Department and the Coastal Resources Management Council are updating the Rhode Island Stormwater Design and Installation Standards Manual, including Low Impact Development (LID) requirements. That Manual will become the over-arching development guide for many project types, and it is possible that some updates to this Wetland BMP Manual may become necessary once the Rhode Island Stormwater Manual is finalized. The Rhode Island Soil Erosion and Sediment Control Handbook (1989) which, while dated, is also a very relevant source of information for wetland applicants and consultants.

Finally, the Department would like to receive your feedback about the usefulness of this Manual. Do you find it helpful? What additional information would you like to see? Please send your comments to Wetland BMP Manual @ DEM Office of Water Resources, 235 Promenade Street, Providence, RI 02908 or via email to waterresources@dem.ri.gov.

1. The Importance of Protecting Wetlands

Avoidance and minimization of impacts to wetlands should be an integral part of designing and building any project that is located in or near a wetland. Before designing a permittable project, it is important for an applicant to understand the functions and values of wetlands that need to be protected. These functions and values are described in the Rules. The list includes: protection from flooding, groundwater protection, valuable wildlife habitat, recreation value, and water quality maintenance. Once an applicant understands how valuable and important wetlands are in the landscape, it will be easier to understand why they must be protected. The following text elaborates on the five functions and values that are listed in the Rules.

1. Protection from Flooding

One of the most important functions of freshwater wetlands is their capacity to control flooding, thereby protecting people and property. Wetlands help control floodwaters by storing excess water during heavy periods of rain and snowmelt. During storm events and spring thaws, vegetated wetlands receive runoff from upland areas and water that overflows from rivers and streams, and lakes and ponds. Freshwater wetland trees, shrubs, roots, soil, and other vegetation temporarily hold and store excess water, sometimes for long periods, until it can be slowly released into nearby rivers and streams. While this water is being stored in wetlands, it reduces the risk of flooding nearby houses, roads, parking lots, etc., and it also lessens the threat of downstream flooding.

When heavy rain occurs in a watershed where vegetated wetlands have been altered or destroyed, the rainwater flows more quickly over the land and causes quick rises and falls in river and stream levels, which in turn can cause flash flooding in the vicinity or downstream. In a watershed with healthy, functioning wetlands, rainwater may be temporarily stored in wetlands, thus moderating the river and stream levels and both delaying and reducing the flood peak of the storm.

Without question, it is easier and less expensive to protect existing wetlands and their natural flood control function, than to pay for flood damages or to build storm water and flood control structures to manage the water. If wetlands are filled, their ability to store floodwater is diminished, thus putting lives and properties at risk.

2. Groundwater Protection

The connection between wetlands and the groundwater system is especially important in Rhode Island where many people rely on groundwater for their source of drinking water, for agriculture, and for other uses. Depending upon their position in the watershed and the underlying geology, some wetlands may feed or recharge the groundwater system, while other wetlands may be areas where groundwater discharges to the surface. Both wetland-groundwater relationships are important.

In the first situation, wetlands convey some of the runoff and floodwaters that they have temporarily stored into the ground, thereby contributing water to the aquifer system below.

The aquifer may be a public or private water supply source. The second more common situation is where groundwater discharges to the surface of wetlands, which may help to cool surface waters, maintain habitat, and maintain river and stream levels.

As groundwater aquifers are developed for water supplies, their impacts to wetlands must be carefully considered. If an aquifer is located beneath a wetland, then pumping it may result in induced groundwater recharge from the wetland, thus resulting in potential long-term changes to the wetland's natural hydrology. If the wetland becomes polluted, then the groundwater that is pumped from the aquifer for drinking water may also become polluted. Therefore, protecting wetlands will in turn help protect our groundwater and our drinking water.

3. Valuable Wildlife Habitat

One of the best-known functions of wetlands is the habitat they provide for a wide variety of wildlife. Many mammals, birds, reptiles, and amphibians depend on wetlands for feeding, nesting, escape cover, migration stopovers, and wintering habitat; while other wildlife do not require wetlands to meet their life needs, they do utilize them. Certain specially adapted plants also grow and flourish in wetlands. Even small wetlands that appear dry much of the year are crucial to the survival of certain species, and in urban areas they may be the only remaining habitat for wildlife.

More than one-third of all threatened and endangered wildlife species in the United States live only in wetlands, and nearly 50% of all threatened or endangered species use wetlands at some point in their lives. Many rare plants and animals of Rhode Island also depend on wetlands for survival.

4. Recreational Value

Wetlands support a wide range of active and passive recreational activities, including hunting, hiking, photography, bird watching, research, and nature study. Other open water activities include swimming, fishing, and boating. Some of these activities may not be entirely dependent on the presence of water, but they are often enhanced by and focused around wetlands.

The quality of a recreational activity depends, to a great extent, on the health of the wetland system. For example, the fish in a pond will only be healthy if the streams and groundwater that feed the pond are healthy. Fish from ponds and streams that are contaminated with urban or industrial runoff may no longer be safe to eat. Therefore, protecting wetlands helps to provide the consumer with safe and healthy fish.

Wetlands are also important because they provide attractive open space in increasingly urbanized areas. In addition, many wetlands contain unusual physical features or have a particular historical significance.

5. Water Quality Maintenance

Wetland soils and plants have the capacity to naturally treat surface water and groundwater by filtering nutrients, absorbing pollutants, removing sediment, up taking pollutants and by other natural chemical and physical processes. This natural treatment capacity is limited, but it does help to protect and improve groundwater quality and the water quality in our rivers and streams. It is limited because if wetlands are used solely for this treatment purpose (and therefore become overburdened), they can become degraded themselves, thus eliminating or impacting their other benefits to people and to wildlife.

In addition to the functions and values described above, wetlands provide other important contributions, such as the production of commercially viable products. They also serve as sites for scientific research and education, and they are scenic areas and provide open space, which are also important reasons to protect wetlands. Understanding all of the services freshwater wetlands provide should help readers understand the benefits of avoiding and minimizing wetland impacts and the costs of not doing so.

Understanding Impacts to Wetlands

Many applicants may find it helpful to understand some of the direct results of altering freshwater wetlands. The following are a few examples:

- If wetlands are filled in order to build a new development the entire area may be at risk for increased flooding. Plus there will most likely be a loss of open space to be enjoyed by the community, and wildlife populations may decrease due to displacement and increased noise, light and other human disturbance.

- If wetlands are excavated or drained there is a loss of wildlife habitat for food, nesting, and shelter. Plus an area may be much less scenic or have degraded aesthetic value, and the opportunity for outdoor recreation, such as canoeing, birdwatching or fishing may disappear.

- If upland vegetation adjacent to a river or stream is removed, erosion and sedimentation of the riverbank may occur. Polluted stormwater will then have no barrier to flowing directly into the river or stream, thus causing a decline in water quality.

- If stormwater runoff is channeled directly into a wetland, the pollution and sediment from the stormwater may cause a change in the water chemistry. As a result, plants and animals may no longer be able to survive in the area, especially if they are already threatened or rare.

Wetland Alteration Examples

- Cutting and clearing of vegetation
- Filling in wetland or grading of soils
- Excavation of wetland soils
- Addition of sediments to wetland from runoff
- Ditching in to lower water levels
- Damming or impounding surface water
- Diking to keep water out
- Diversion of rivers or streams
- Removal of surface water by pumping
- Discharge of stormwater or wastewater into wetlands
- Diversion of groundwater flow or removal of groundwater by pumping
- Reduction of groundwater recharge in wetland
- Cutting and clearing of upland vegetation adjacent to wetlands
- Filling in upland adjacent to wetlands
- Excavation of soils or grading in upland adjacent to wetland

All of these types of alterations can, over time, result in cumulative impacts to the degree that entire watersheds are affected and the benefits that natural wetlands can provide are greatly diminished. Thus, it is important to remember that even on small projects, you must avoid and minimize impacts. A handful of small alterations or changes to a wetland can add up to a significant change in a wetland's functions and values.

When considering a parcel of land for development that contains wetlands, it is advisable to begin by planning ways to avoid the wetland areas entirely. This may be simple if the wetland is only on one side of the property or if an upland portion of the property can be easily accessed. It might be necessary to consider designs for a house, building, or trail so as to avoid the wetland, even if they are different from the original project design. After avoiding the existing wetlands, the next step is to minimize any remaining impacts from project development. These steps will help to preserve important wetland functions and values. The same is true for a redevelopment or a land reuse project. Such projects will present various challenges, but also many opportunities to avoid and minimize, as well as to restore.

Project Development: Avoidance and Minimization

Every project submitted by a property owner is evaluated by DEM to see whether all steps have been taken to avoid alterations in or near wetlands. The following questions may help determine whether or not wetland impacts have been sufficiently avoided and minimized:

- Are there other properties available on which to build that do not contain wetlands? (This is a good first question to ask before buying property with wetlands)
- Does the project have to be located where it is, or could it be located elsewhere on the property farther away from the wetlands?
- Are there alternative layouts, designs or technologies that would avoid detrimental wetland impacts and still meet the project purpose by building up instead of out?
- Are there any other project alternatives that would not adversely impact health, safety or the environment?
- Could an easement be obtained from a neighbor for a driveway or to access upland that would allow the project to be built further away from the wetlands?
- Could one obtain a zoning variance?

The following are key avoidance and minimization techniques common to many project types. These techniques are elaborated on and expanded in each of the subsequent sections:

- Avoid filling wetlands or removing trees or other vegetation from within wetlands.
- Keep disturbed areas to a minimum, and preserve natural areas around wetlands as much as possible.
- Design with the grade of the land to avoid earthwork as much as possible and to maintain existing drainage characteristics.
- For large projects consider a design that limits road and utility crossings.
- Locate unavoidable crossings at the narrowest section of the wetland, or utilize existing crossings, such as from a farm road or cart path, for access to upland.
- Consider designing a shared driveway to limit the number of wetland crossings in a subdivision or neighborhood.
- Minimize surface area of roads, parking, paving or other artificial surfaces.
- Utilize boulders, gabions, or retaining walls where appropriate to reduce the amount of filling needed for slopes.
- Use pervious materials, such as crushed stone or gravel, for driveways and roadways.
- Use light shields to direct artificial lighting away from wetlands.
- Avoid water withdrawal from wetlands.
- Install dense plantings of trees and shrubs within the limits of work to help buffer the wetland from noise, lighting and other disturbances post construction.

2. Single-Family Lots

Single-Family House lots are by far the most common project type that DEM reviews. One of the first things for an applicant to consider is whether or not the size of home you desire will fit on the lot you have chosen, particularly if there are wetlands you need to avoid. Prior to purchasing the property it is advisable to have the current owner complete a Determination or Verification Application with the DEM. In response, DEM willl determine the presence of wetlands on a property or verify the delineated edge of a wetland when one is already known to exist. The following recommendations are provided for the applicant:

> **Limits of Clearing and Disturbance (LOD)**
>
> Realistic Limits of Clearing and Disturbance will vary from project to project. For some it may be 10-15 feet from a structure, for others it may be 20-25 feet. DEM encourages the applicant to thoroughly consider the location of the LOD before submitting the application to avoid future enforcement problems if the LOD is not adhered to.

Site Design

- Avoid building in or near wetlands if at all possible.
- Locate the house or building closer to the road. To avoid a wetland it may be necessary to apply for a variance from the town on the required setback from the road.
- If you cannot avoid a wetland, consider obtaining an easement from a neighbor to share a driveway and reduce wetland encroachment.
- Remember to provide realistic Limits of Clearing and Disturbance that will encompass all proposed work and land uses on the site. Consider room for construction vehicles and space for future maintenance (e.g. a backhoe for grading around the house) and use.
- Consider installing a retaining wall, gabions or terracing at the Limits of Clearing and Disturbance to reduce filling.
- The site design should allow for adequate yard space for future uses, such as decks, sheds, gardens, or swing sets outside wetland areas.
- To avoid flooding, determine the boundaries of the 100 Year Flood Plain as well as lesser intensity flood event levels and place the house, driveway, and parking areas outside the flood zone.

House Design

- Reduce the size of the house to be built, or consider building "up" instead of "out."
- Design the garage to be incorporated as part of the first story of the house instead of as a separate structure.
- Decks and other property accessories may need to be reduced in in size or eliminated to inimize wetland impacts.

Driveways

- Use retaining walls, terracing, or gabions to reduce the area of fill needed.

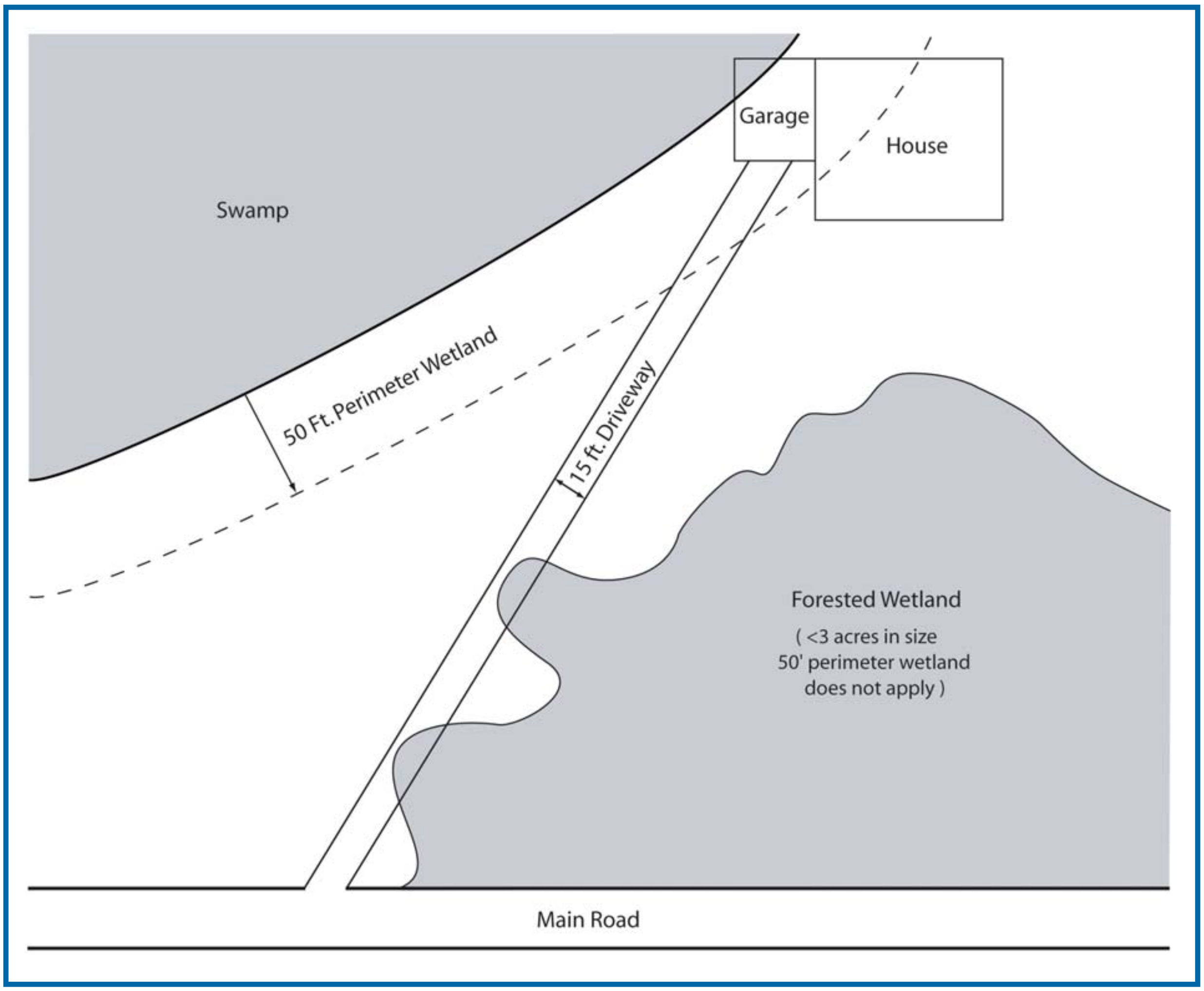
- Maintain existing grading as much as possible.
- Preserve as many large trees and as much of the tree canopy as possible.
- Avoid crossings by locating the driveway outside of wetland areas.
- Minimize the driveway width as much as possible.

Screens and Plantings

- Create a thick buffer by increasing plantings at the Limits of Clearing and Disturbance adjacent to wetlands to reduce noise and disturbance to wildlife. Use 2-3 rows of plantings, instead of just one. If additional rows involve an increase in clearing or soil disturbance in wetland areas, a single row is preferable. Typically, evergreens are preferred because they retain their leaves or needles all year.
- Avoid the use of fertilizers, pesticides, herbicides, or pollutants - chemical or organic - within wetlands.

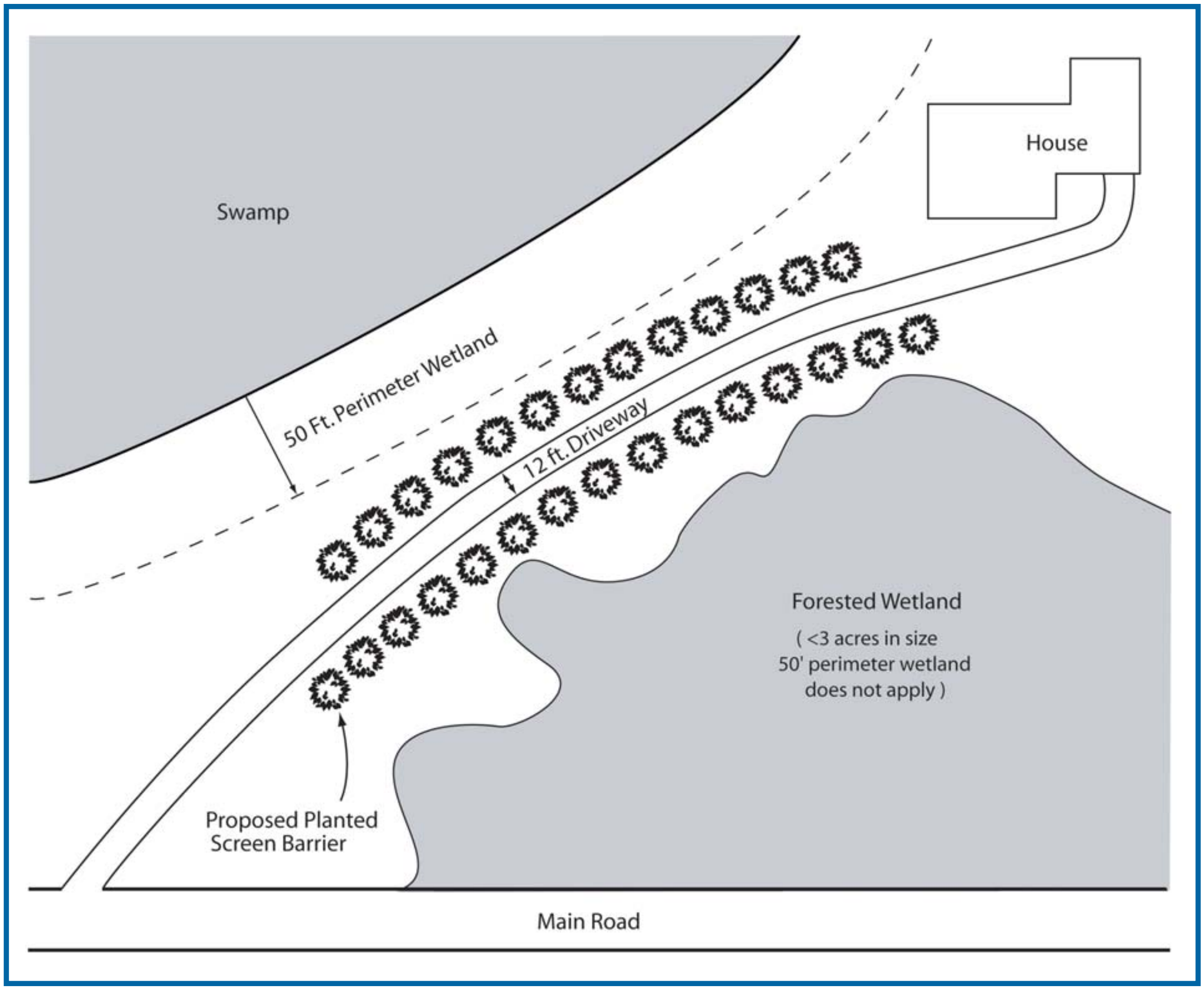
Example 1a: **Original Plan for a Single-Family Home**

In this example, the proposed house and driveway encroach into the Perimeter and Forested Wetland. The project calls for clear-cutting of the wetland vegetation adjacent to the house and driveway, as well as some filling along the Swamp edge for the garage construction.



Example 1a

Example 1b: Revised Plan for a Single-Family Home with Avoidance and Minimization



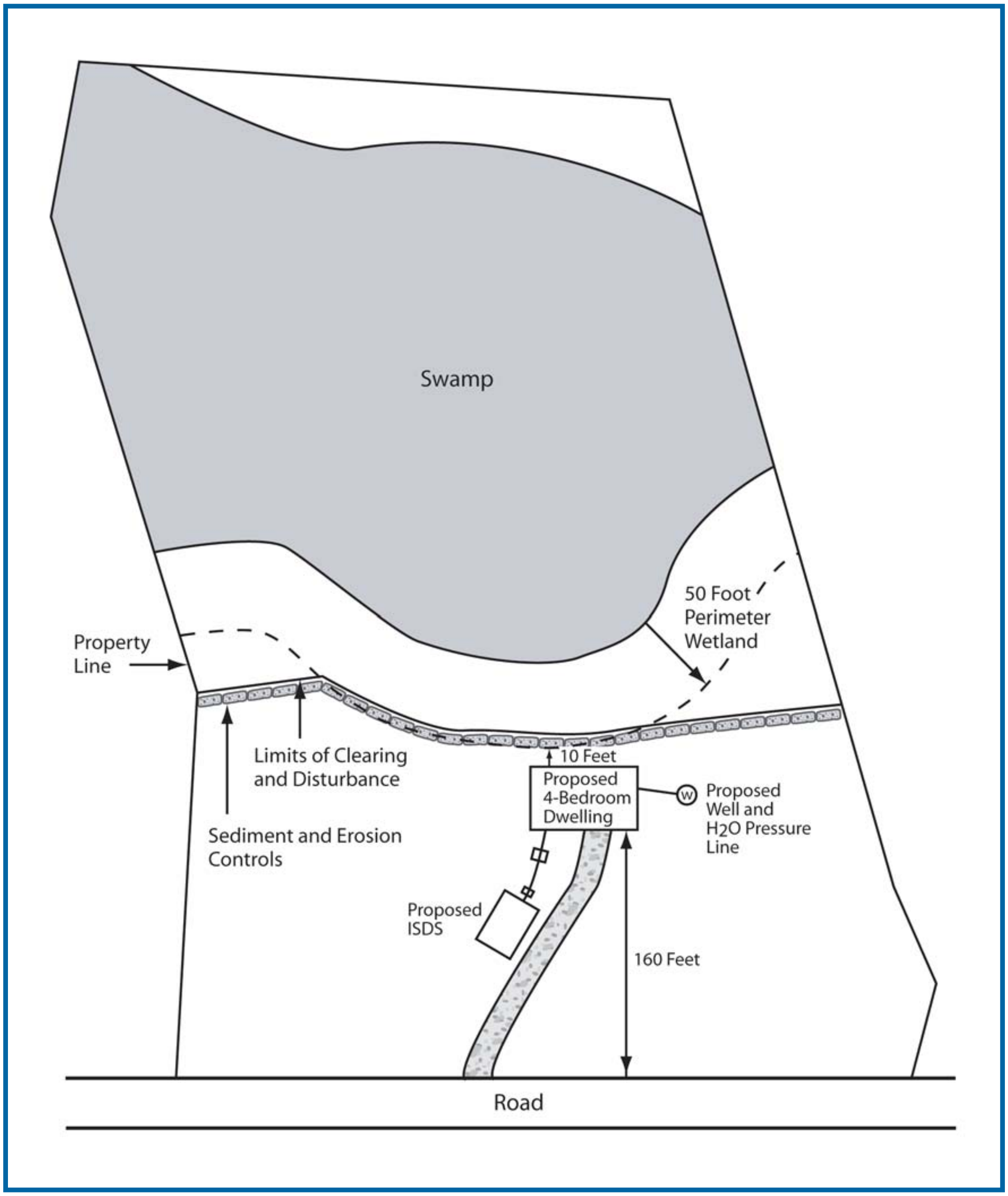
Example 1b

How wetland impacts were minimized:

- ✓ The driveway was moved between the two wetland areas to reduce wetland impacts.
- ✓ The house and driveway were moved out of the Swamp and Perimeter Wetlands, thereby maintaining the original tree canopy in those areas.
- ✓ The garage was incorporated as part of the first story of the house, instead of as a separate structure.
- ✓ Additional plantings were voluntarily proposed adjacent to the driveway to filter noise and light from the wetlands.

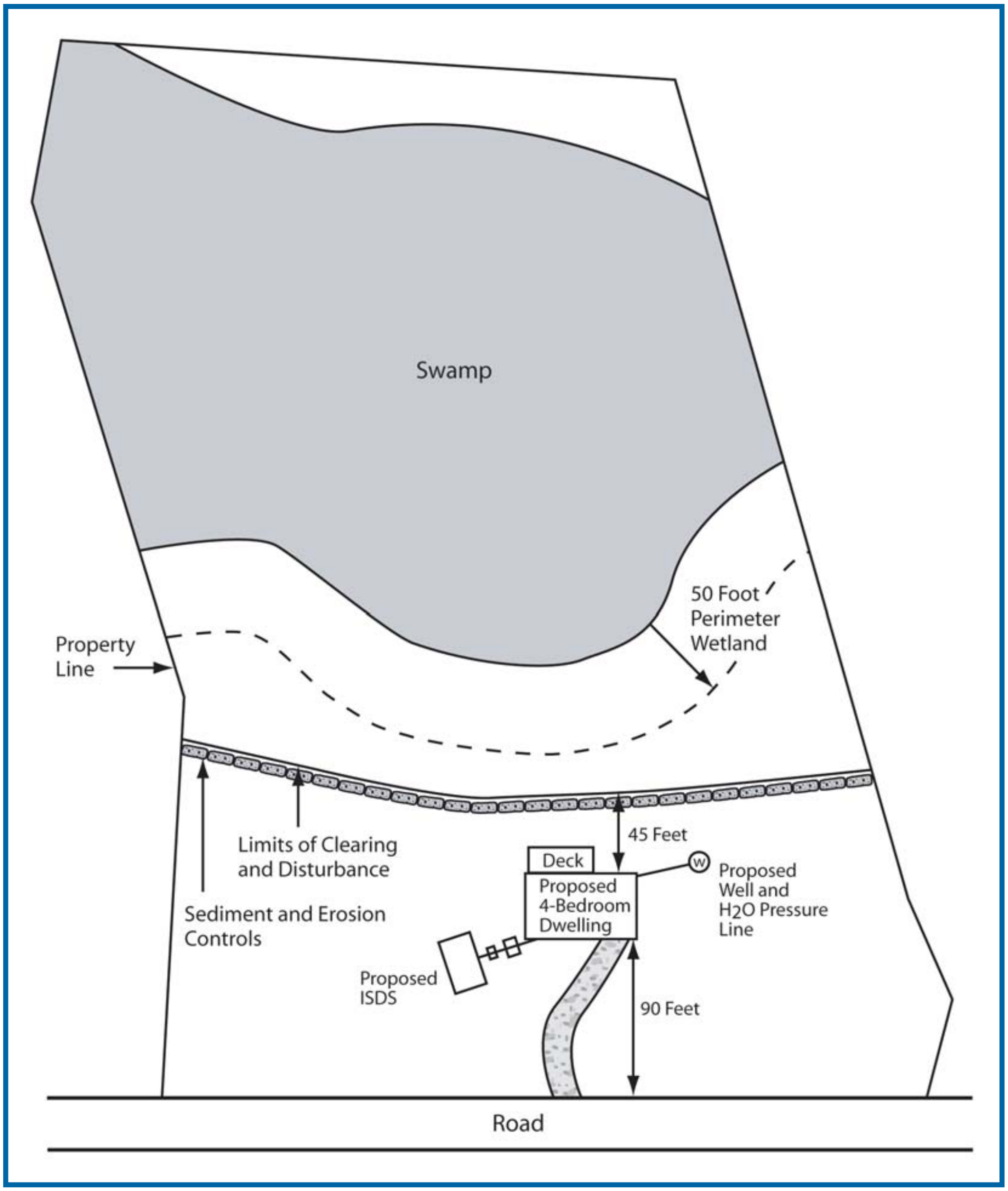
Example 2a: **House Placement Original Design**

In this example, the house is located more than 160 feet back from the road and only 10 feet from the edge of the Perimeter Wetland.



Example 2a

Example 2b: **House Placement Revised Design**



Example 2b

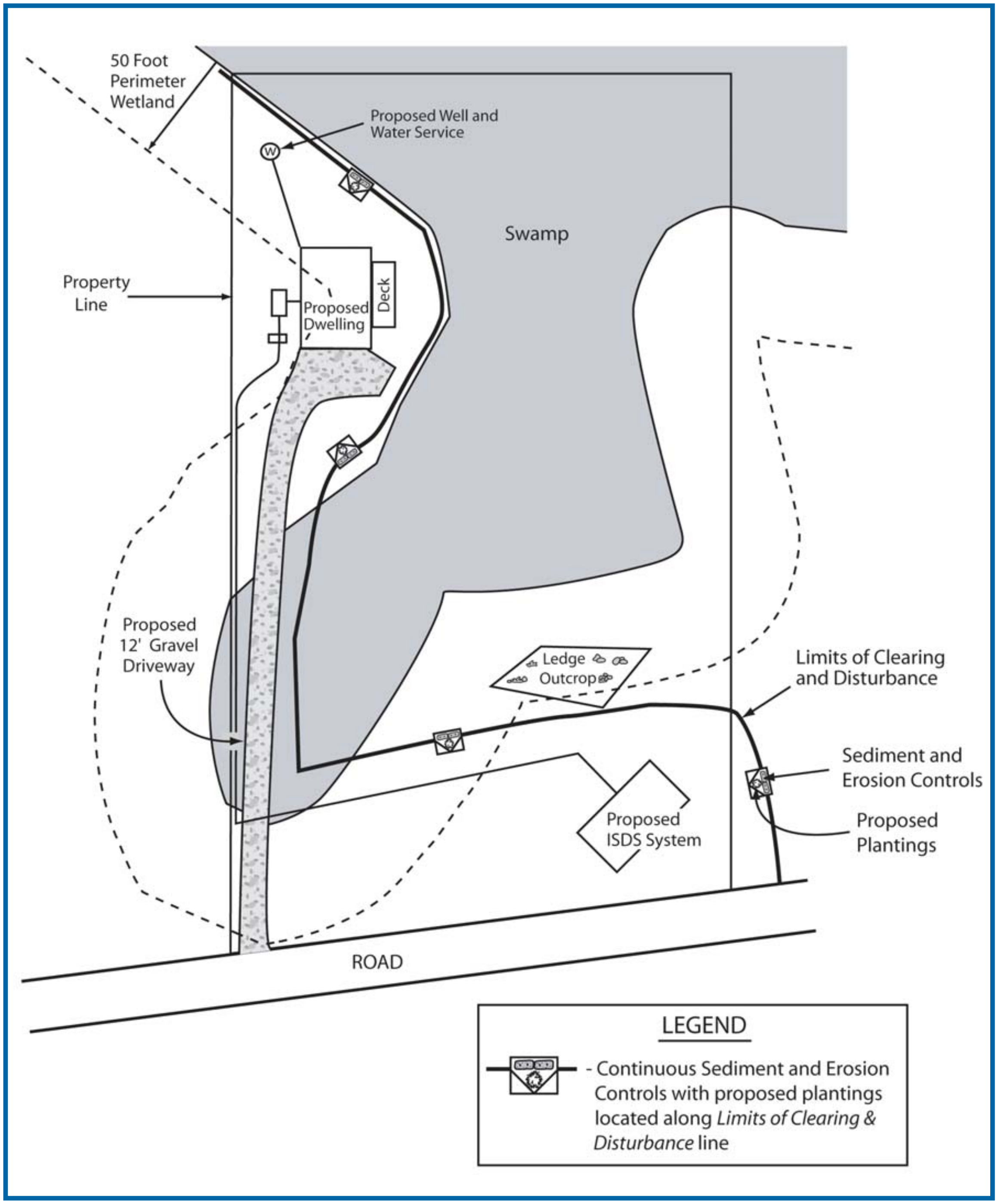
How wetland impacts were minimized:

- ✓ By moving the house closer to the road (still well within the town setback requirements), the dwelling remained the same size and a deck was added, given the extra space.
- ✓ Adequate backyard space does not encroach into the Perimeter Wetland.
- ✓ In this case, the dwelling and limits of disturbance were far enough away from the wetland that the owner did not even need to apply to DEM for a wetland determination or permit.

On a large lot with plenty of room to build, it is possible to avoid wetlands altogether. Project plans that demonstrate provisions to avoid & minimize impacts to wetlands may eliminate the need for a permit.

Example 3a: **Lot Layout Original Design**

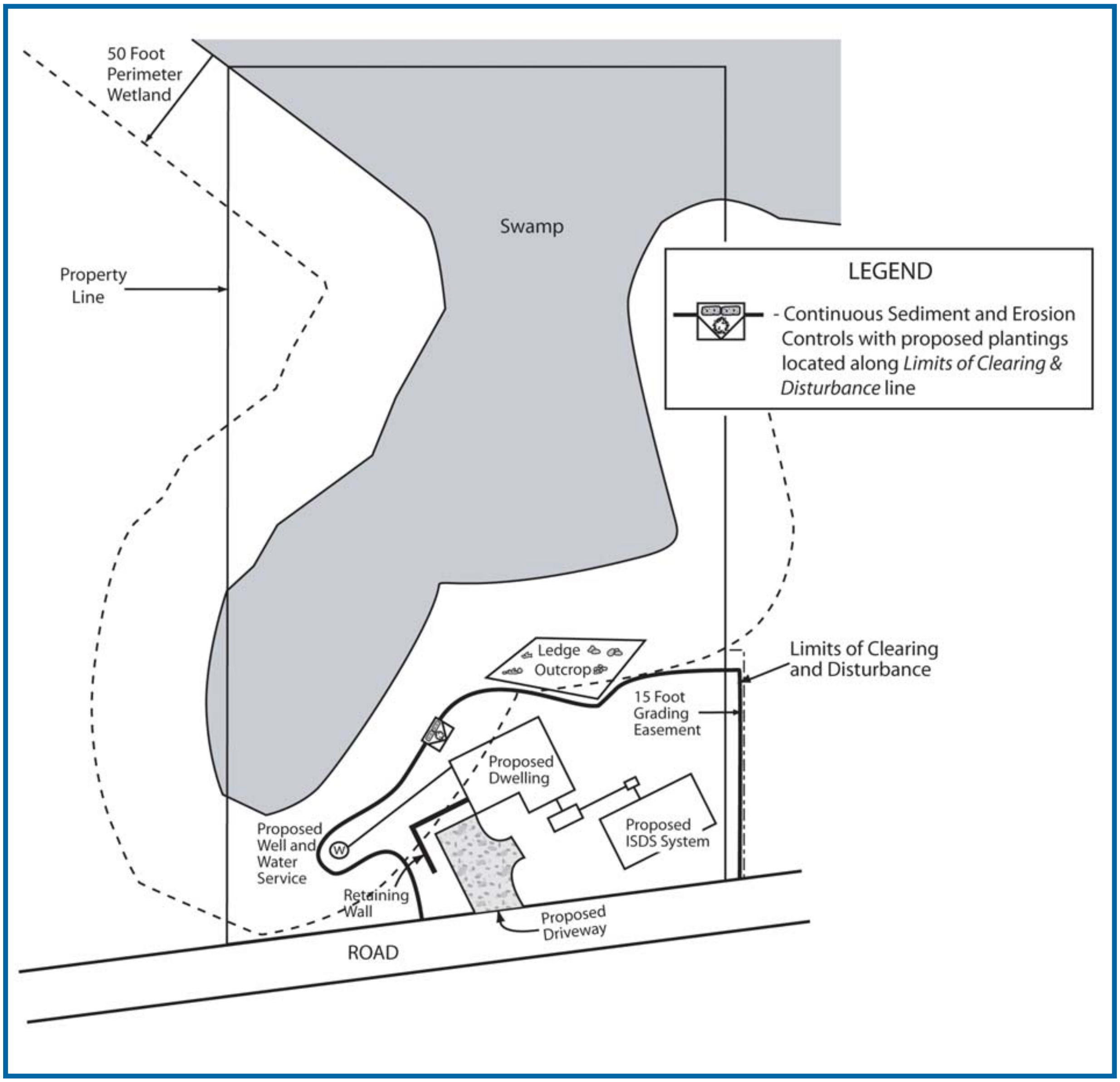
This lot is primarily wetland, making it difficult to locate a house and septic system. In the original design, the proposed dwelling, driveway and deck are within the Swamp and Perimeter Wetland areas. The proposed Individual Sewage Disposal System (ISDS) is located far away from the house thus causing a larger area to be disturbed.



Example 3a

Example 3b: **Lot Layout Revised Design**

The revised design, while not ideal, proposes significantly less encroachment into wetland areas by relocating the house.



Example 3b

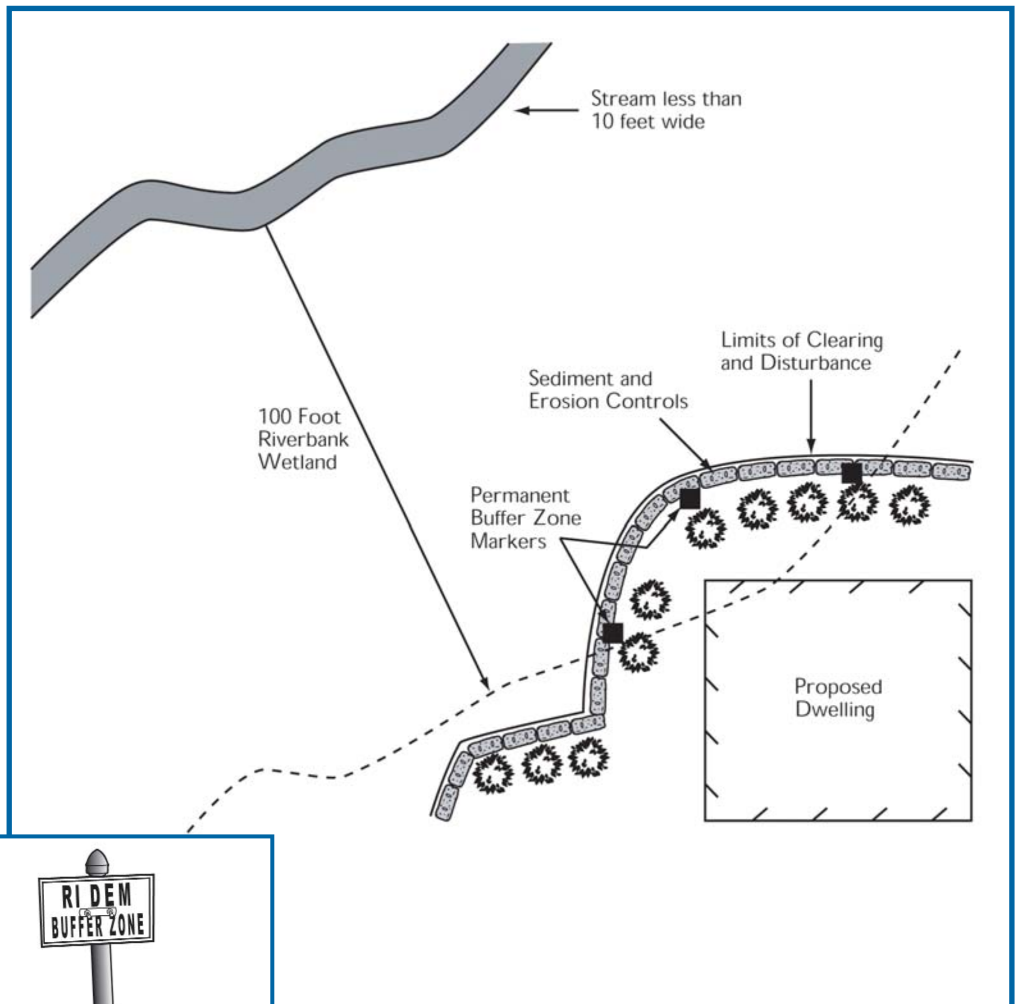
How wetland impacts were minimized:

- ✓ The house and driveway were relocated to the front of the lot resulting in far less wetland encroachment, while still adhering to town setback requirements.
- ✓ The deck was omitted to allow for a larger backyard.
- ✓ The driveway retaining wall reduced the need for grading in the perimeter wetland.
- ✓ Proposed plantings shield the wetland from noise and light disturbance.
- ✓ A grading easement was obtained from the owners of the neighboring lot to allow for more practical Limits of Clearing and Disturbance (LOD).

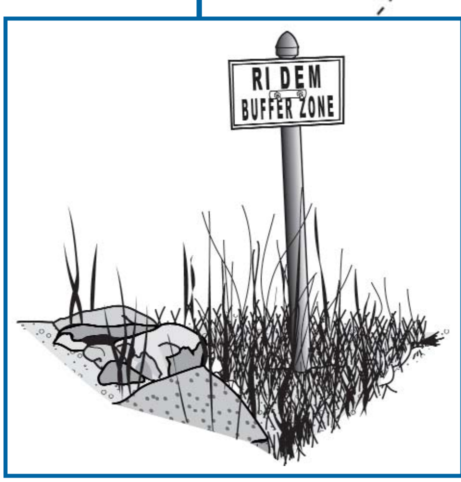
Example 4: **Marking the Buffer Zone**

This example illustrates **Buffer Zone Markers**. Often on lots that contain a large amount of wetland, and where proposals have narrow backyards and limited building space, DEM requires as a permit condition that permanent buffer zone markers be installed along the Limits of Clearing and Disturbance. The markers serve as a reminder to homeowners that no disturbance can occur past the line without a permit or specific exemption. Also, if the property is sold, the markers serve as permanent visual reminders that a wetland permit exists for the property.

Acceptable permanent type markers include 4" x 4" pressure treated timber posts, galvanized fence posts with cap, or granite or concrete bounds. Markers should extend a minimum 24" above grade. A permanent-type tag or sign labeled "RIDEM Buffer Zone" must be placed on each marker. A permanent-type fence at least 24 " tall and similarly labeled may be used instead if preferred.



Example 4a



Example 4b

3. Subdivisions

Whole subdivisions cover large parcels of land that often contain wetlands. There may be a need to include a crossing or some other type of encroachment into these areas. Very seldom is a subdivision planned, designed and constructed without in some way affecting nearby wetlands. Large projects may include a number of small encroachments, which may accumulate to create larger overall impacts to wetlands that could be avoided. Following are many ways to avoid and minimize impacts to wetlands through alternative designs by considering the following items:

Lot Design

- Configure the lots to completely avoid wetland encroachment.
- Reduce the number of lots to avoid wetland disturbance.
- Provide adequate yard space for future homeowners to add a deck, shed, or pool to their property without impacts to adjacent wetlands.
- Avoid subdividing lots such that they create a self-imposed hardship.

Driveways and Roads

- Design roads and driveways to be as narrow as possible.
- Avoid or limit the number of wetland crossings. If a crossing is unavoidable, design it so that the narrowest section of wetland is traversed or so that it crosses in a previously destroyed or degraded area. (See Chapter 9 for Crossing BMPs).
- Consider shared driveways for entrance and exit to small subdivisions.
- Avoid illumination, or use lamps that deflect light away from the wetland.

Screens and Plantings

- Increase plantings along roadsides within the Limits of Clearing and Disturbance to reduce noise and disturbance, especially along wetland crossings, and to provide replacement habitat for wildlife.

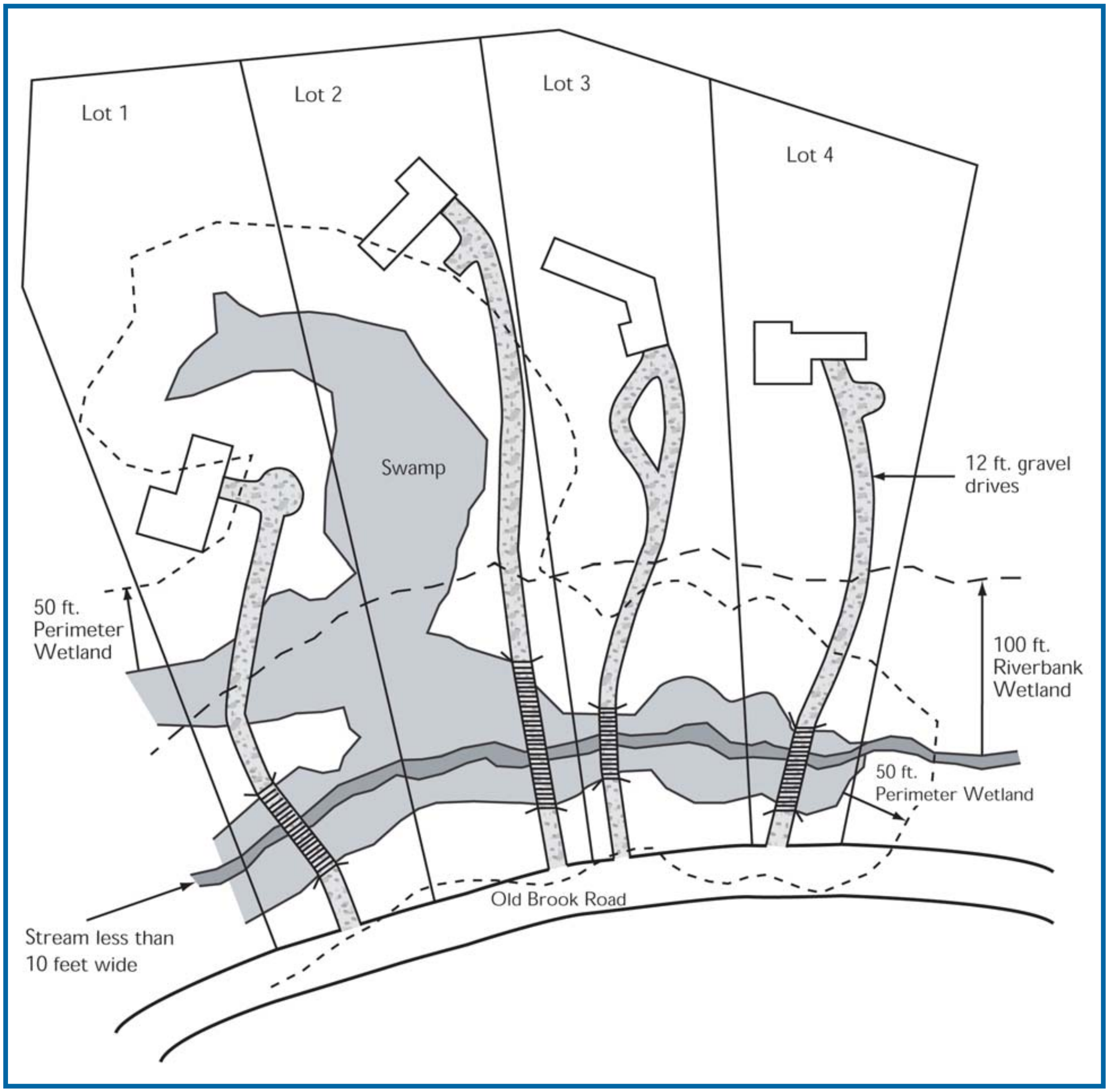
Engineering Considerations

- Work with the grade of the land to avoid or minimize earthwork and to maintain the natural topography and hydrology.
- Decrease impervious surfaces and maintain existing drainage patterns.
- Reduce stormwater runoff from impervious surfaces, and infiltrate to compensate for loss of groundwater recharge.
- Place detention basins and other stormwater controls completely outside of all regulated wetland areas.
- Avoid filling in the 100-year floodplain of any nearby streams or rivers.

- Avoid concentrating flow where possible.
- Consider the use of stone riprap channels to guide stormwater flow over steep or erosive slopes.
- Mitigate peak runoff rates and volumes of stormwater that will reach wetlands. This will help prevent erosion and negative water quality impacts to wetlands.
- Consider flood elevations from the100-year and lesser flood events when deciding on road location and placement of other structures. (See the overtopping paragraph in Chapter 9).

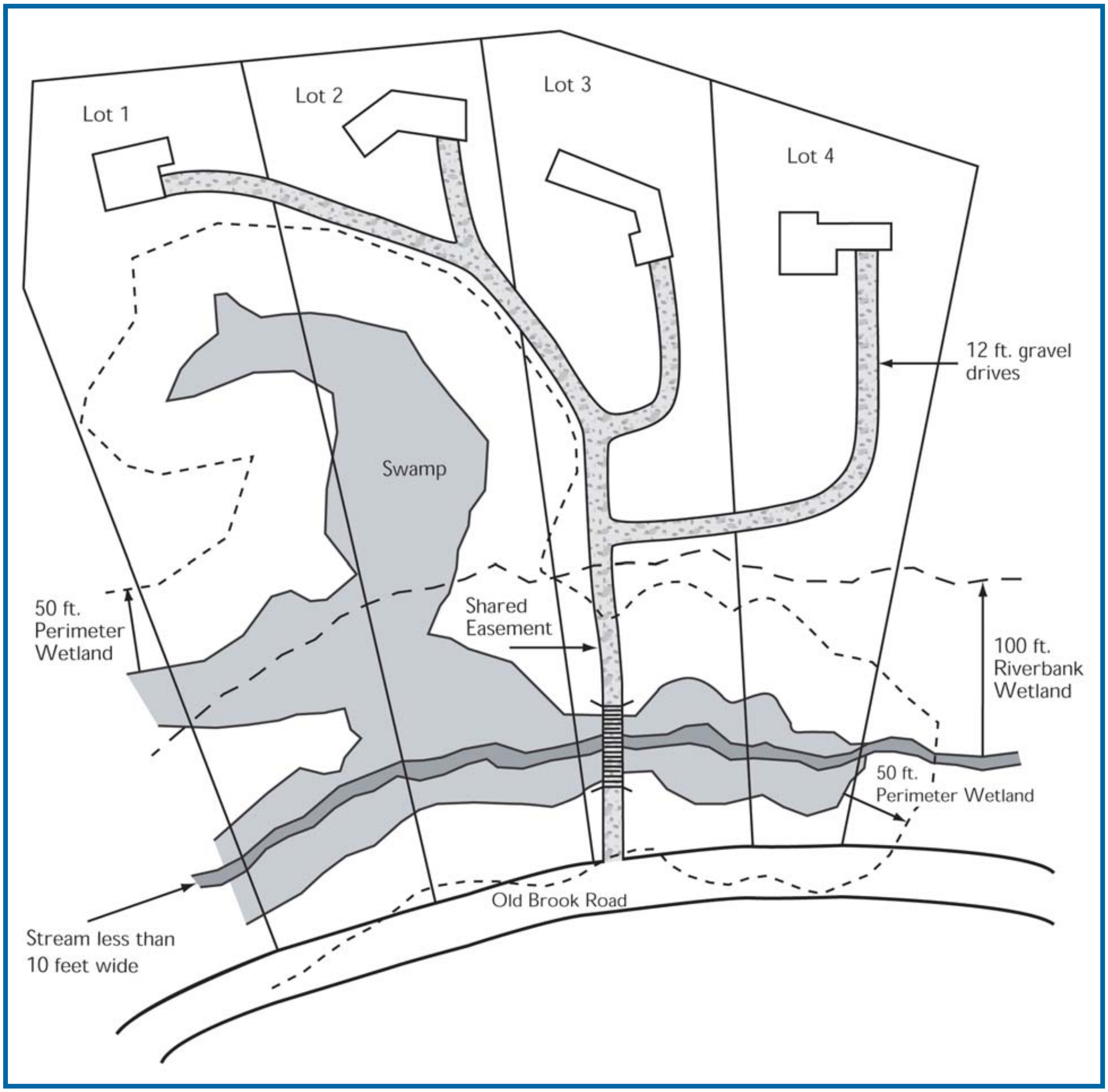
Example 5a: **Original Subdivision Plan**

This subdivision was purchased as one large lot and subdivided as illustrated. The original plan was designed with four separate wetland and stream crossings. The proposed driveways in all four lots disturb the Stream, Swamp, Perimeter and Riverbank Wetlands.



Example 5a

Example 5b: **Revised Subdivision Plan with Avoidance & Minimization (Option 1)**

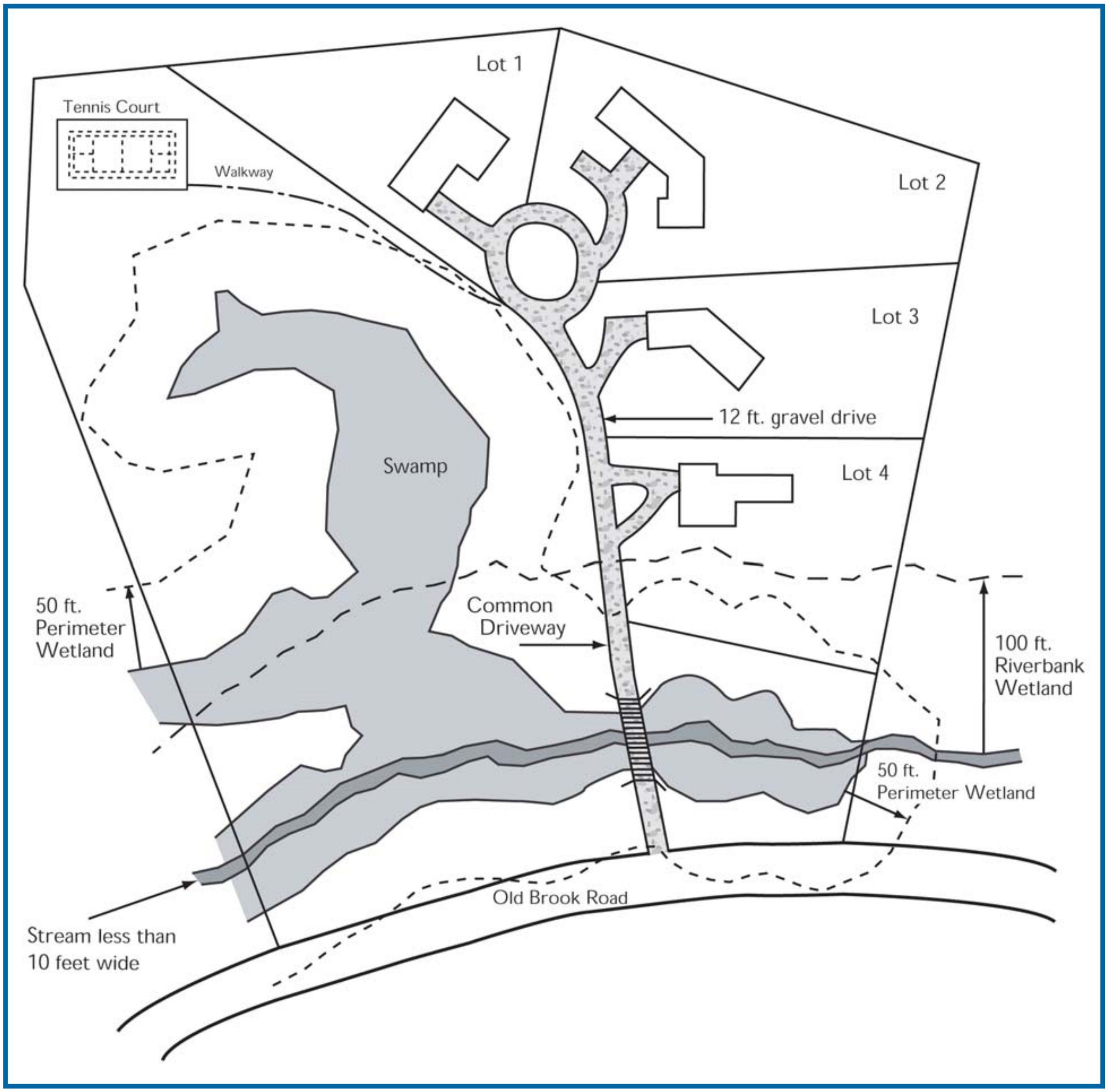


Example 5b

How wetland impacts were minimized:

- ✓ The developer designed a shared easement, reducing the number of crossings from four to one.
- ✓ The house on Lot 1 is no longer sandwiched between areas of wetland thus eliminating all encroachment into Swamp and Perimeter Wetlands and allowing for a more realistic and useful yard.
- ✓ The house on Lot 2 was moved back farther from the Swamp and Perimeter Wetlands.

Example 5c: **Revised Subdivision Plan with Avoidance and Minimization (Option 2)**



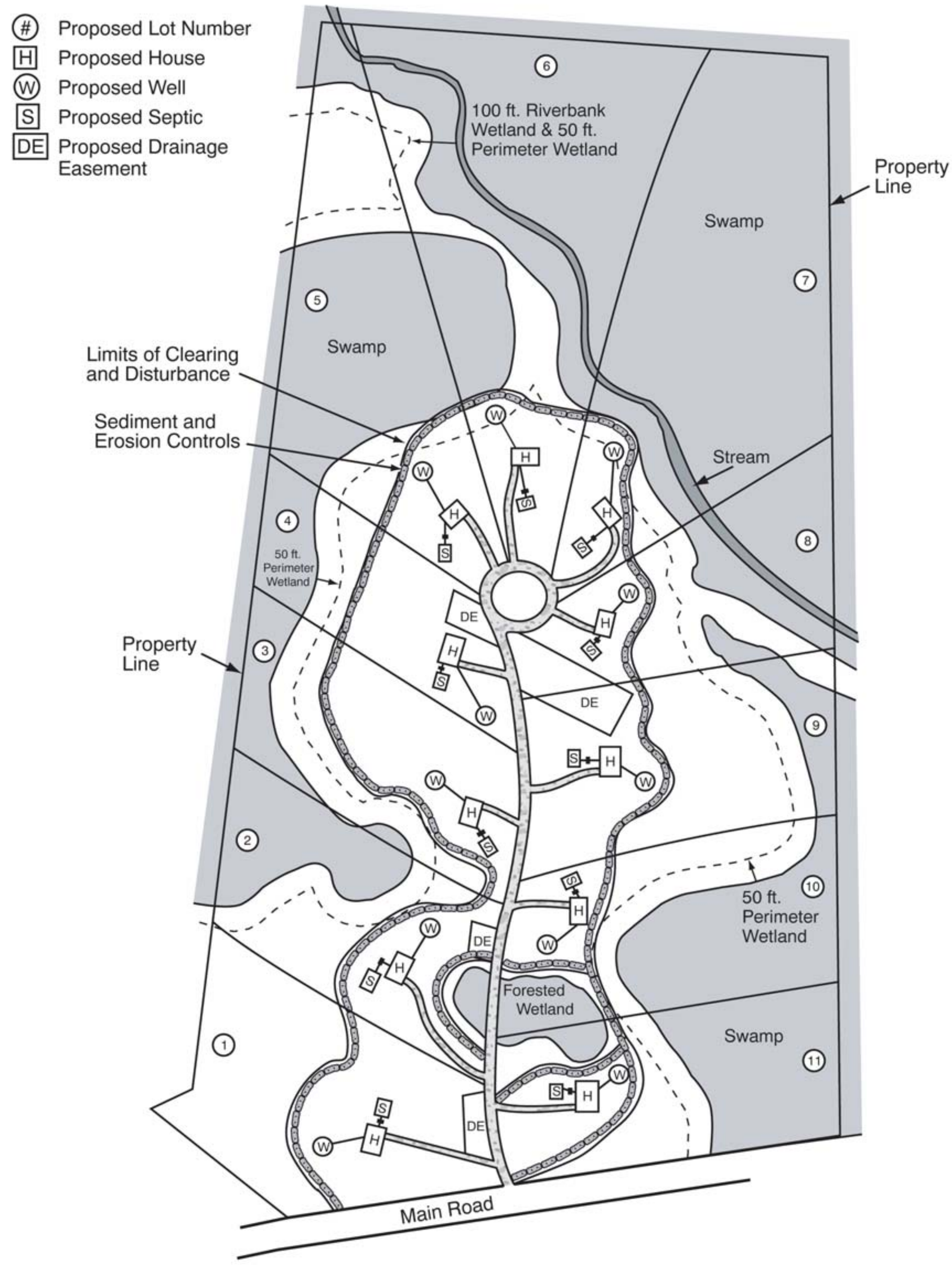
Example 5c

How wetland impacts were further minimized:

- ✓ This is a better, and more realistic, example of impact avoidance and minimization because it incorporates techniques of cluster development and open space preservation, thereby disturbing less land.
- ✓ The lots are now rearranged to limit encroachment into vegetated wetlands with one narrow crossing instead of several crossings.
- ✓ The amount of land disturbed was also partly reduced by using shorter driveways.

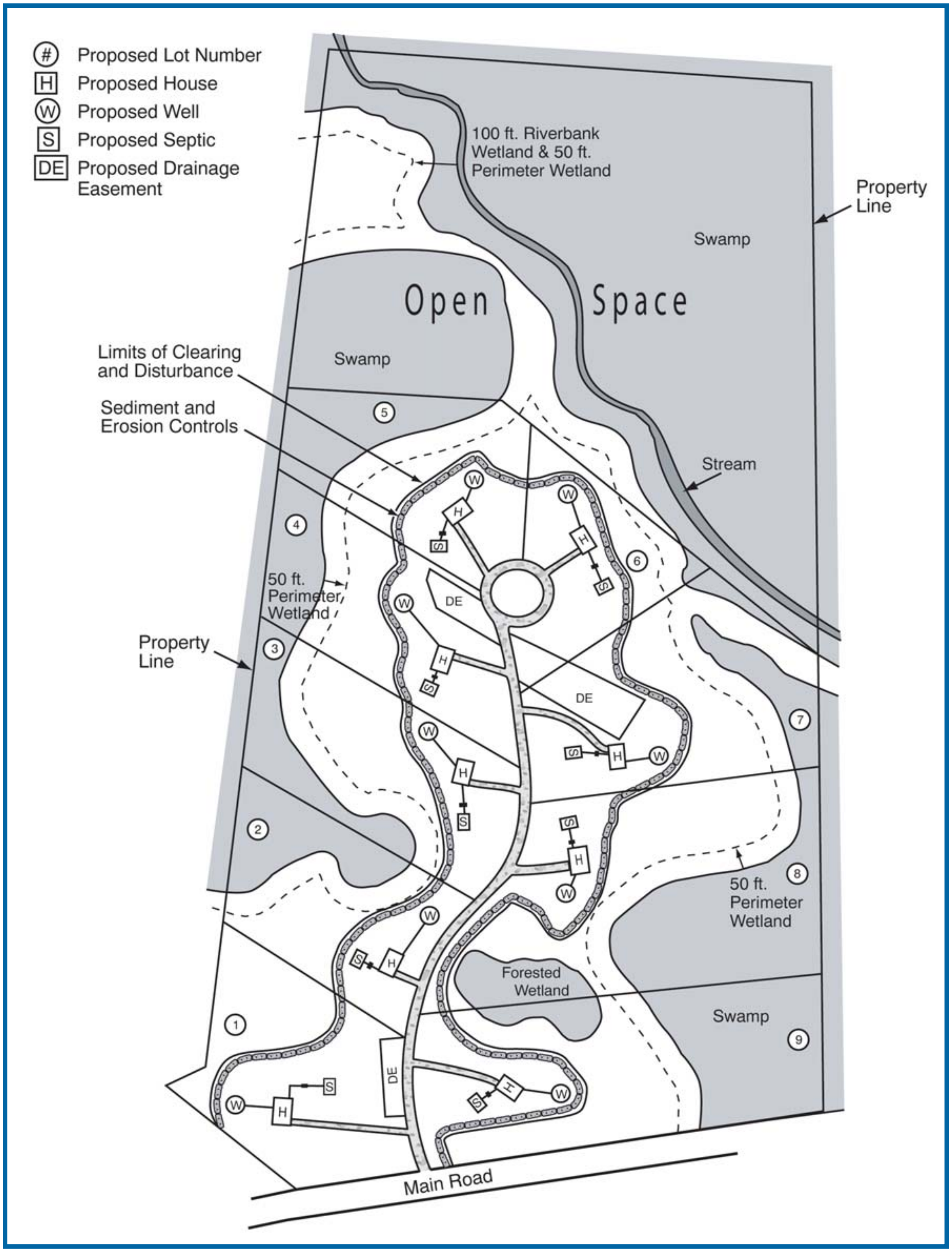
Example 6a: **Subdivision Layout Original Design**

A comparison of examples 6a and 6b illustrates simple ways to avoid and minimize direct impacts to wetlands. In the original example, the main road to the subdivision fragments a Forested Wetland. It is also designed for 11 separate dwellings, many of which have very limited yard space, especially the ones located near the Stream. In addition, one of the drainage easements is directly adjacent to the Forested Wetland.



Example 6a

Example 6b: **Subdivision Layout Revised Design**



Example 6b

How wetland impacts were minimized:

- ✓ The developer received a variance from the town to allow for only one entrance and exit to the subdivision which initially avoided wetland impacts.
- ✓ Fragmentation of the Forested Wetland was completely avoided by curving the main entrance road.
- ✓ The drainage easement closest to the Forested Wetland was eliminated by making the other two easements slightly larger.
- ✓ The developer opted to reduce the Limits of Clearing and Disturbance on lots 3. 4. and 5 to leave a larger natural buffer between the backyard and the wetland.
- ✓ The lot shapes were reconfigured to propose only 9 dwellings, thereby maintaining a vegetated buffer to the left of the Stream and helping to protect wetland functions and values.
- ✓ Open space was dedicated via a municipal land trust on both sides of the Stream, thus helping to protect valuable wetland functions and values.

Conservation Development

Wetland impacts may be further minimized by adhering to the ten-step Conservation Development Process and associated techniques, as described in *The Rhode Island Conservation Development Manual* (Flinker 2003). The Conservation Development process begins with site analysis and concludes with open space management.

4. Commercial and Industrial Projects

Applicants proposing commercial projects, like all others, must first address the avoidance and minimization requirements. Choosing a parcel that has plenty of upland surface area is important. If upland area is not readily available, developers should explore local zoning variances in order to avoid impacting freshwater wetlands.

By the nature of their use, commercial projects may require more mitigation for noise and light than other projects. Due to the amount of impervious surface that is often required, including driveways, large parking areas, and buildings, it is especially important to utilize effective stormwater management practices. The following practices can help reduce the impacts that these impervious surfaces may have on nearby wetlands.

Site Layout and Design

- Minimize wetland encroachment as much as possible by reducing the size or scope of the project.
- Avoid fragmenting wetland habitat and corridors.
- Locate projects in previously disturbed areas of upland.
- Be aware of how the project may affect ground or surface waters that drain to wetlands as a result of impervious surfaces.
- Incorporate appropriate soil erosion and sediment controls into the design following guidelines in the Rhode Island Soil Erosion and Sediment Control Handbook.

Paved Surfaces: Parking, Roads and Driveways

- Reduce the amount of impervious surface as much as possible.
- Design roads and entrances to be as narrow as possible through or adjacent to wetlands.
- Avoid or limit the number of wetland crossings. If a crossing is unavoidable, designing it so that the narrowest section of wetland is traversed usually results in reduced impacts. (See Chapter 9 for Crossing BMPs and Chapter 7 for Road BMPs).
- Consider a multi-level parking garage to minimize impervious surfaces (and runoff) and protect naturally vegetated zones.
- When designing a commercial or industrial subdivision, include details on the amount of impervious surface on each lot.
- Provide sufficient stormwater controls and treatments. Utilize Stormwater best management practices specified in the *Rhode Island Stormwater Manual* (pending revision 2010).

Lighting

- Avoid outdoor illumination, or use lamps or shields that deflect light away from the wetland.
- Install lamps at a greater height with a narrow beam to focus the lighting away from wetlands, or place the light next to the wetland and aim it in the opposite direction.
- Utilize motion-sensor lighting to limit the amount of time the area is illuminated.

Screens and Plantings

- Increase plantings along road sides within the Limits of Clearing and Disturbance, especially along wetland crossings, to reduce noise and disturbance and to provide replacement habitat for wildlife.
- Utilize retaining walls, berms or barriers to avoid filling into wetlands. Be sure to incorporate plantings into the design.
- Consider adding a roof garden, especially in redeveloped or urbanized areas, to help manage stormwater.

> **Pervious Surfaces**
>
> Use of pervious surfaces are a good way to reduce impacts from development by reducing the amount of runoff. This alternative enables groundwater recharge and facilitates treatment of pollutants via the underlying soil. Common pervious surfaces include porous pavement, gravel, and geotextile grids.

Construction and Maintenance

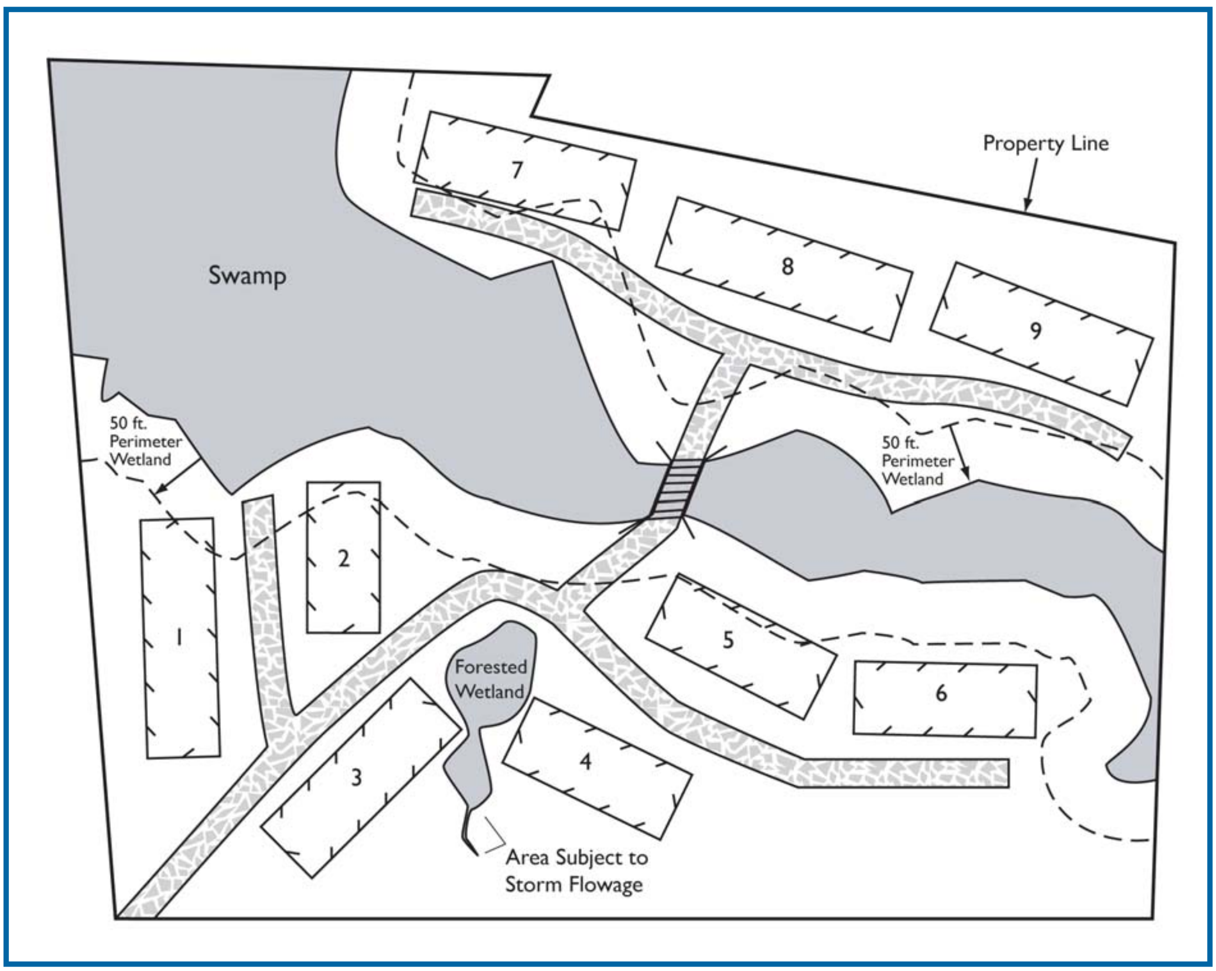
Development of commercial projects often involves the disturbance (clearing, grading, filling) of large tracts of land. As a result, it is vital that sediment and erosion controls are properly installed and maintained throughout the life of the project to prevent construction-related wetland impacts.

- To properly install controls on site, make sure silt fences are toed into the soil and bales of hay are securely staked into the ground and trenched into the soil.
- Install sediment and erosion controls as illustrated on design plans. Supplement these controls, within the approved Limits of Clearing and Disturbance, as the need arises (e.g., around soil, stockpile areas, matting/jute mesh on steep slopes, etc.).
- Schedule regular inspection of sediment and erosion controls (daily to weekly after storm events), and replace or repair them as conditions dictate.
- Specify inspection and maintenance requirements on all stormwater control elements, both during and post construction.
- Catch basin cleanup, regular parking lot sweeping, and litter cleanup should be specified where needed.
- Consider snow removal procedures, and designate a location for snow to ensure proper protection of wetlands.
- Place construction access roads and locate soil stockpiles as far away from wetlands as possible.
- Perform work near wetlands outside the breeding and migratory season of sensitive wetland species as much as possible.

Example 7a: **Storage Facility Original Design**

This example illustrates a proposed storage facility near a large Swamp, a Forested Wetland, and an Area Subject to Storm Flowage. Both the original and revised designs included proposed plantings around the Forested Wetland, although they are not shown in this illustration. However, the original design does not avoid and minimize in the following ways:

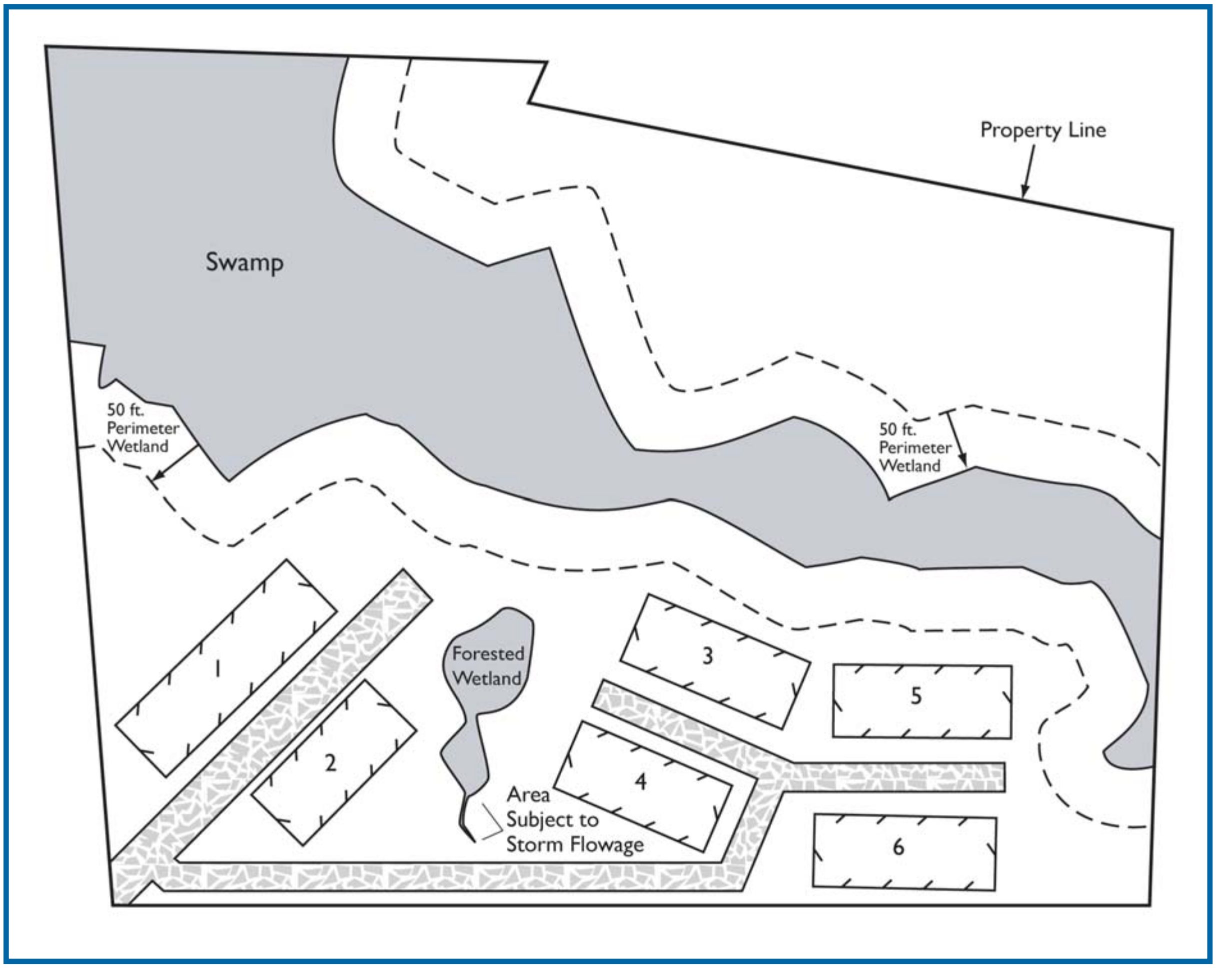
- The proposed buildings encroach into the Perimeter Wetland.
- A crossing disturbs the Swamp and Perimeter Wetland.
- The proposed driveway to the different buildings bisects the wildlife travel corridor between the Swamp and the Forested Wetland.
- The buildings are proposed within 10 feet of the Forested Wetland, which offers very little buffer against noise and light.
- There is little room to install sediment and erosion controls without disturbing the actual Swamp and further encroaching into the Perimeter Wetland.



Example 7a

Example 7b: **Storage Facility Revised Design**

Sometimes it is necessary to scale back on a design in order to minimize impacts to wetlands and to have a permittable project. This design improved upon the original design and still met the project purpose.



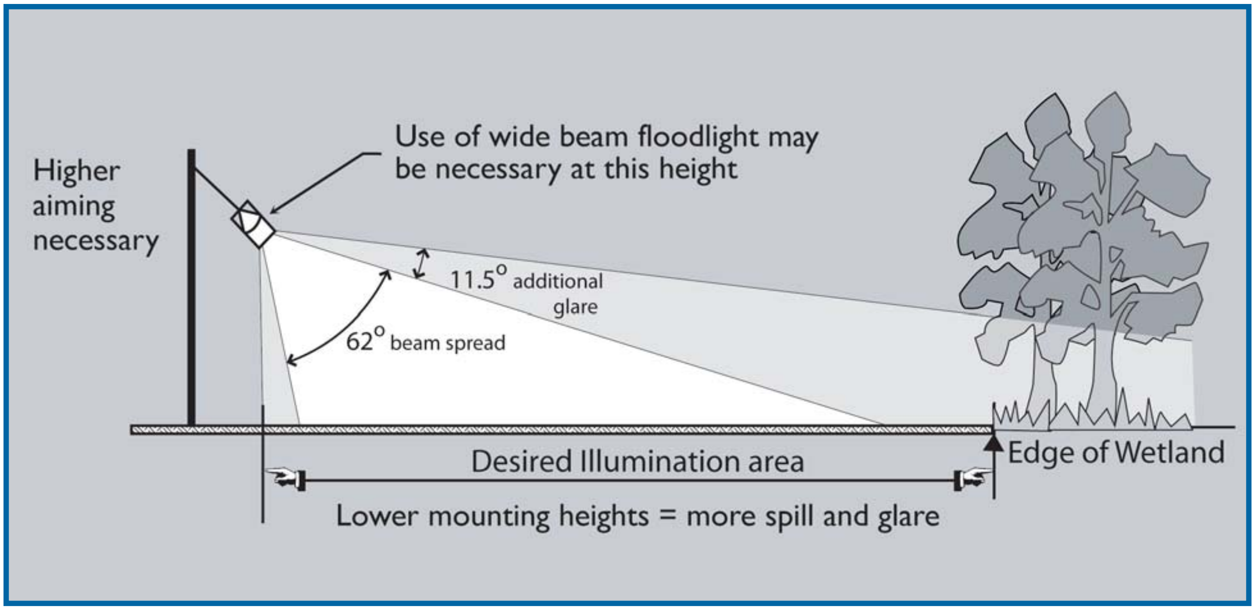
Example 7b

How wetland impacts were minimized:

- ✓ The buildings were moved farther away from all the wetland areas.
- ✓ The crossing and buildings above the Swamp (7, 8, & 9) were removed to minimize impacts and to avoid isolating the Forested Wetland from the Swamp.
- ✓ The footprint of the storage building to the left of the Forested Wetland was reduced, thereby increasing its distance from the Forested Wetland.
- ✓ The roadway was moved to avoid bisecting the travel corridor between the Swamp and the Forested Wetland.

Example 8: **Lighting**

This example illustrates a problem that can occur when directing lighting on commercial projects. If the correct lighting techniques had been used in this example, light would not have spilled from the parking areas into the Wetland. It is important to keep the light focused away from wetland areas so that wildlife is not adversely impacted by the project. The extent of the area to be lit is a function of the location of the lamppost, the height of the lamp, and where the light is directed to.



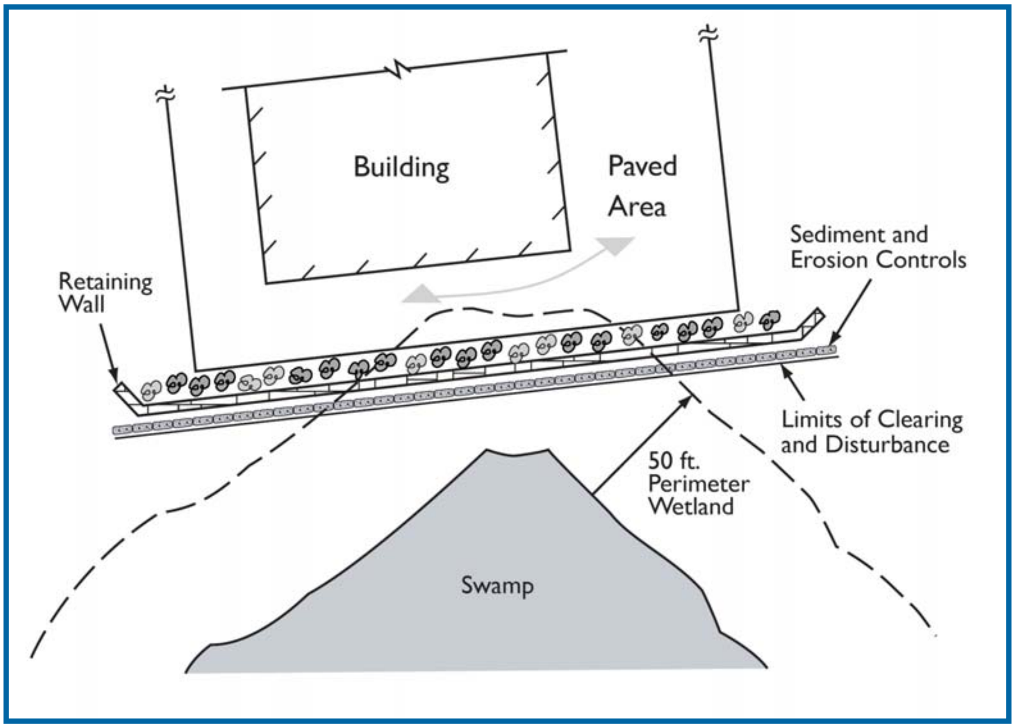
Example 8

How wetland impacts could be minimized:

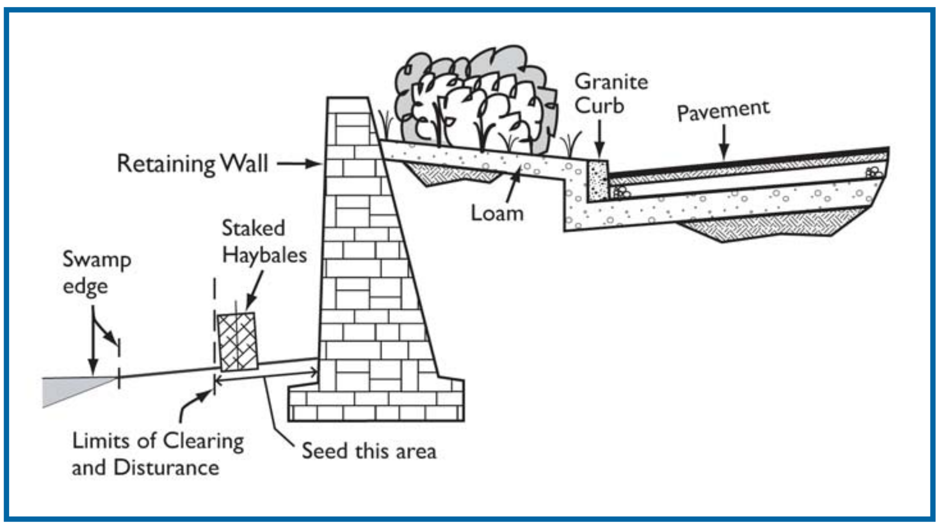
- ✓ The light could be mounted at a greater height and with a narrower beam to focus the light away from the wetlands, thus eliminating the spill and glare into the Wetland area.
- ✓ The light could be placed next to the wetland and aimed in the opposite direction to direct the light away from the Wetland area completely.
- ✓ If it is not possible to direct light away from the vegetated wetland areas, the use of deflectors to concentrate lighting away from vegetated wetlands must be employed.

Example 9: **Retaining Wall**

This drawing illustrates a commercial building project located very close to a Swamp and within the Perimeter Wetland. In this case, there were no alternatives available.



Example 9a



Example 9b

How wetland impacts were minimized:

✓ The retaining wall reduced the amount of fill needed to construct the parking/driving area around the building, thereby reducing encroachment into the wetlands.

✓ Plantings were installed on the upland side of the retaining wall to help provide additional screening against noise, light, and other disturbances.

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5. Golf Courses

It is very difficult to plan, design and construct a golf course without affecting wetlands in some way. Courses encompass such large areas of land that they often include numerous wetland crossings and encroachments. It is DEM's responsibility to ensure that applicants avoid wetland alterations and minimize impacts for every golf course design.

Site Selection and Planning

When choosing a site, it is important for the planner to consider whether there is sufficient buildable area for a course, whether there is access to adequate amounts of water, and whether the topography is appropriate. A site that includes large areas of wetland may not be a good choice if construction will result in many impacts to wetlands. Sometimes a beautiful site may not be feasible due to wetland constraints or the finances needed to develop the golf course in an environmentally sound way. The planner should therefore:

- Evaluate alternative sites before making a final selection.
- Attempt to locate the course on previously used or abandoned properties, such as landfills, sand and gravel operations, or farms.
- Evaluate if the proposed site will be able to supply the amount of water necessary for the course through the development of a water budget and a drought contingency plan that establishes alternate water sources. The water budget should not deplete nearby wetlands or streams.

Course Design

Once a site is chosen, the course designer must give careful consideration to all wetland areas. Protecting these areas can and should be considered together with course playability and aesthetics. The designer should therefore:

- Design fairways, tees, greens, and golf cart paths to avoid wetlands and filling of floodplains.
- Complete a Floodplain Evaluation if filling a floodplain is unavoidable.
- Be sure to consider alternative sizes if upland space is limited. Consider a 9-hole course instead of an 18-hole course.
- Protect existing wetlands, and improve or restore previously degraded areas if possible.
- Create and maintain buffer zones around wetlands to protect their functions and values.
- Design a course that will naturally "hold" water, maintain wetland hydrology, and require minimal topographic changes.
- Ensure that irrigation, drainage, and retention systems encourage efficient use of water and protect wetland water quality.
- Maintain interconnected, naturally vegetated wildlife corridors and passages in the golf course design.

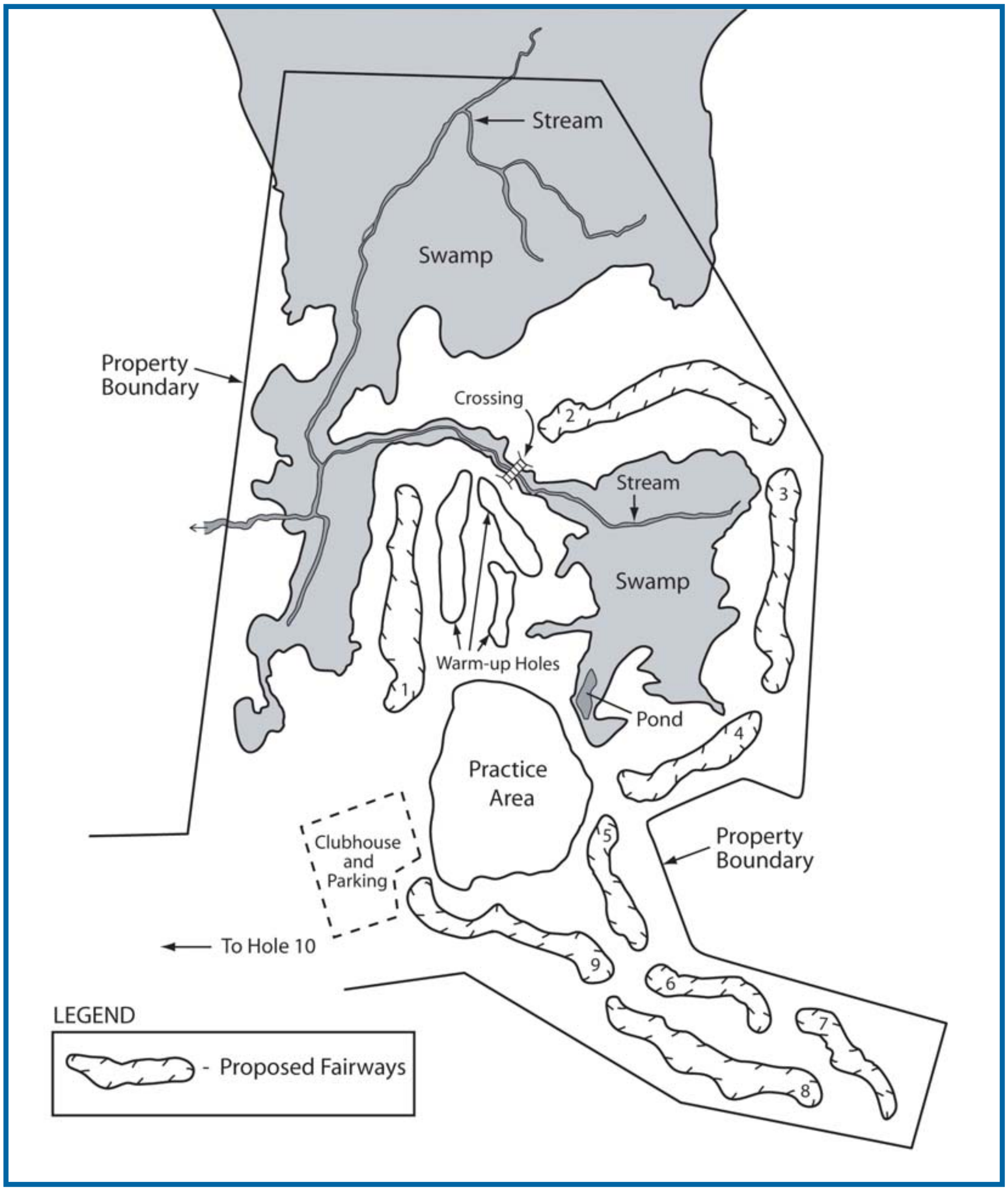
- Include plantings that serve as noise and lighting shields for wetland wildlife.
- Avoid the use of lighting in or around wetlands, especially near bodies of water.
- Design signs and barriers to keep golfers out of sensitive areas. Designate sensitive wetland areas as "no play" zones.
- For unavoidable wetland crossings, design bridges that can be installed as a complete unit from overhead or can be built one section at a time to limit work in wetlands.
- Incorporate low-impact pervious surfaces for roads and paths which help infiltrate surface water.
- Utilize geographically native and drought-resistant grasses for the turf. These types of grasses benefit wetland wildlife habitat by requiring less water and less pesticide and fertilizer application, which maintain good wetland water quality. (URI's Department of Plant Sciences and Entomology) is a good resource for turfgrass management information: http://www.uri.edu/cels/pls)
- Develop a stormwater management and pollution prevention plan that takes into consideration runoff, infiltration rates, topography, and pollutants. See the *Rhode Island Stormwater Manual* (pending revision 2010).
- Develop a practical and long-term maintenance plan for stormwater controls that can be followed effectively.

Wetland Flyovers

"Flyovers" of wetlands within fairways, especially wetlands dominated by woody vegetation, should be avoided. Wetland flyovers commonly require that wetland trees and shrubs be cut to ~ 4 to 8 feet in height. The tree topping and cutting severely alters the wetland wildlife habitat and may also change the wetland's hydrology. In addition, flyovers necessitate ongoing maintenance and repetitive encroachment into the altered wetland in order to maintain the desired tree height. It is easier, less environmentally damaging, and may be less costly to simply avoid fairway allignments that require flyovers of wetlands.

Example 10: **Avoiding a Large Wetland Complex**

This example is an aerial view of one-half of an existing golf course. The challenge with upgrading this site was to avoid the large Swamp.



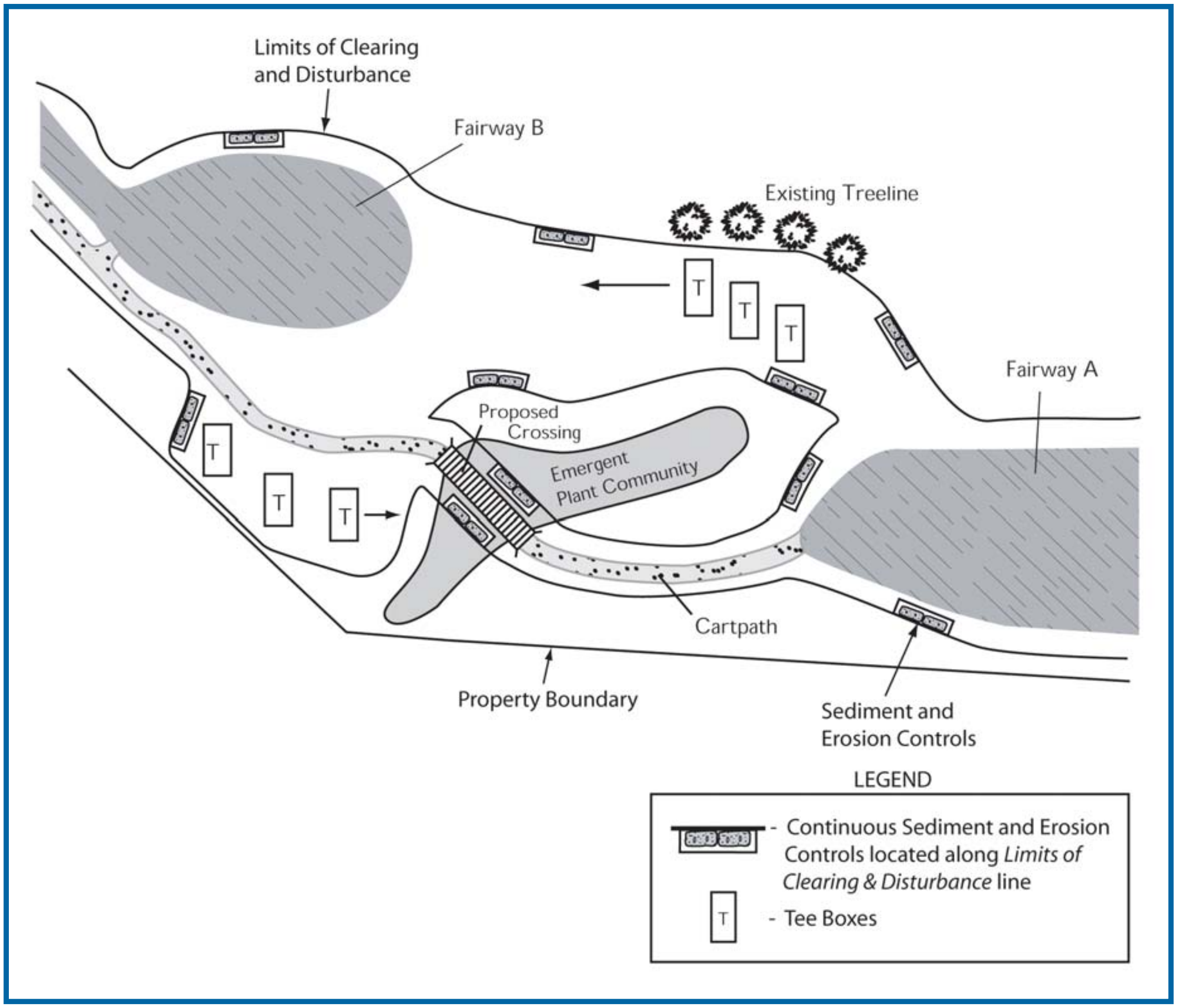
Example 10

How wetland impacts were minimized:

- ✓ The fairways were located outside the wetlands near the edges of the property.
- ✓ A wetland corridor was maintained within the interior of the property, thus preserving wildlife habitat.
- ✓ A crossing was located at a narrow spot while spanning the entire Stream and Swamp to minimize disturbance of another wetland corridor
- ✓ Whenever possible, additional vegetated corridors beyond the Perimeter or Riverbank Wetlands were maintained around the wetland areas.

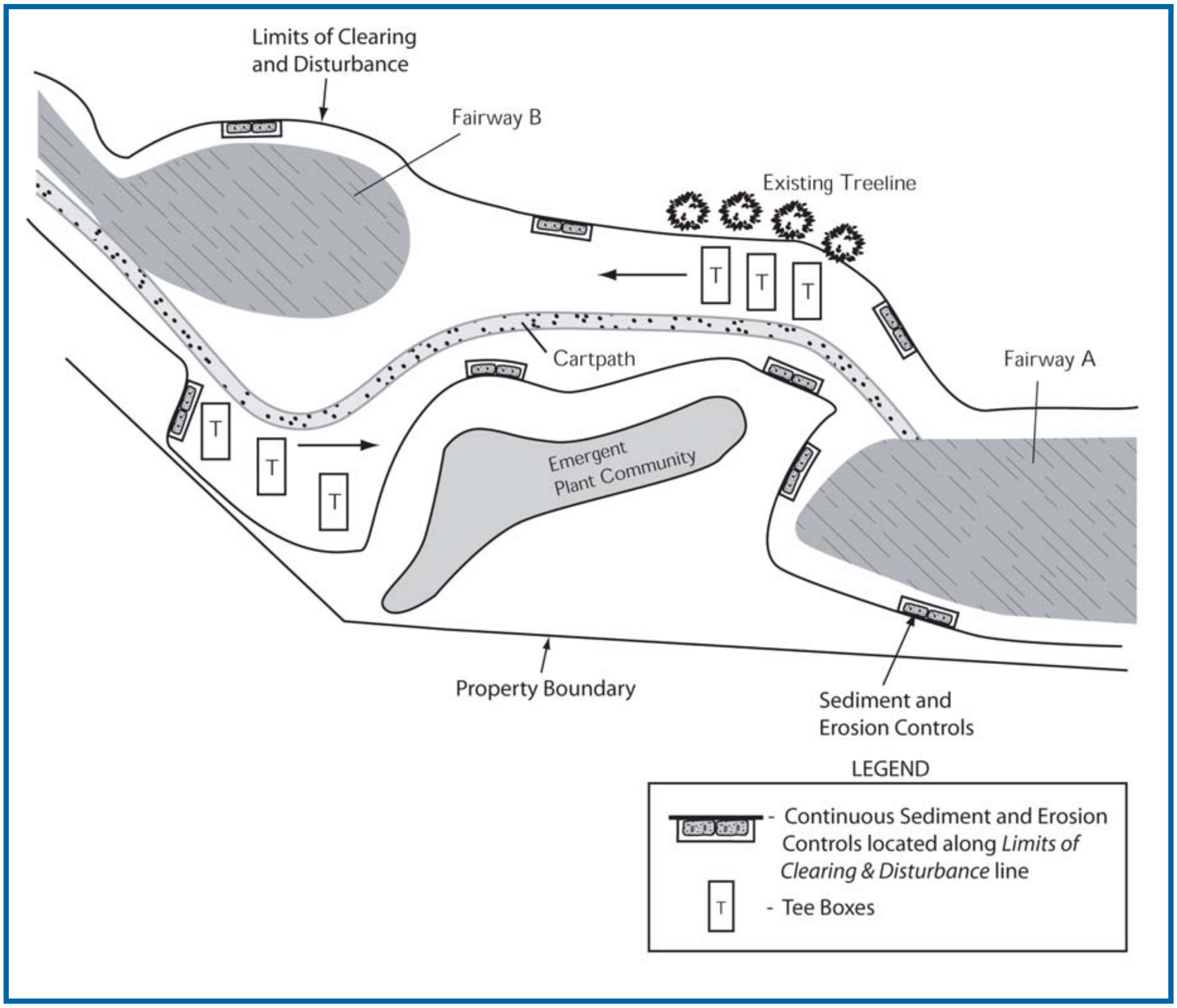
Example 11a: **Original Design for Emergent Plant Community Crossing**

This example illustrates a golf course section that encroaches on an Emergent Plant Community. This particular course is proposed to be built on old farmland. The plant community illustrated only has low ground vegetation, without any large trees that would need to be trimmed for flyovers. This original design bisects the Emergent Plant Community wetland with a crossing for a cart path from Fairway A to Fairway B.



Example 11a

Example 11b: **Revised Design at Emergent Plant Community**



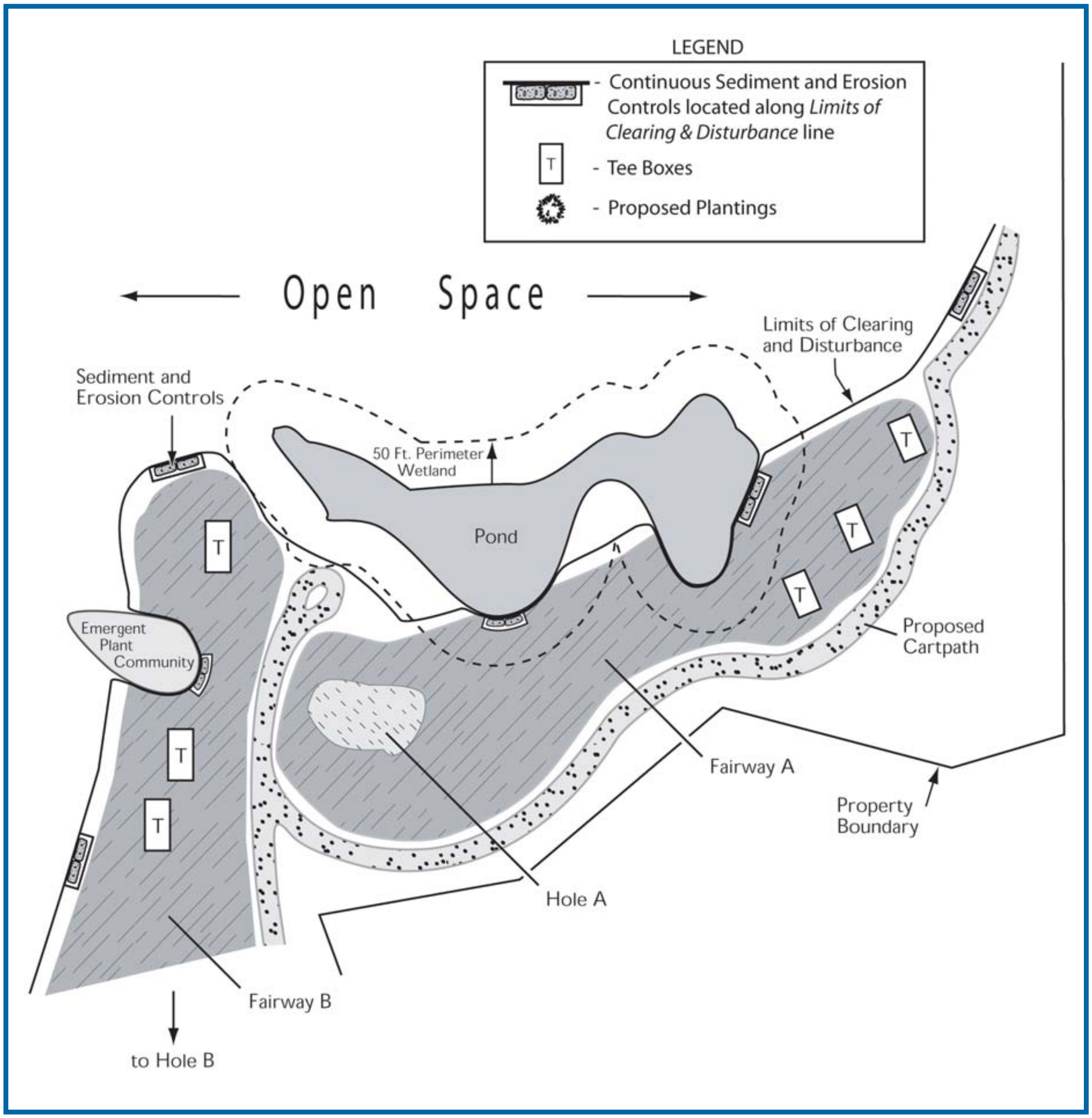
Example 11b

How wetland impacts were minimized :

- ✓ The cart path was moved around the wetland thus avoiding the Emergent Plant Community and eliminating the crossing.
- ✓ Narrow but reasonable Limits of Clearing and Disturbance were maintained.
- ✓ The existing tree line was maintained where possible.
- ✓ Existing vegetation surrounding the Emergent Plant Community was maintained to buffer the wetland from noise and light.

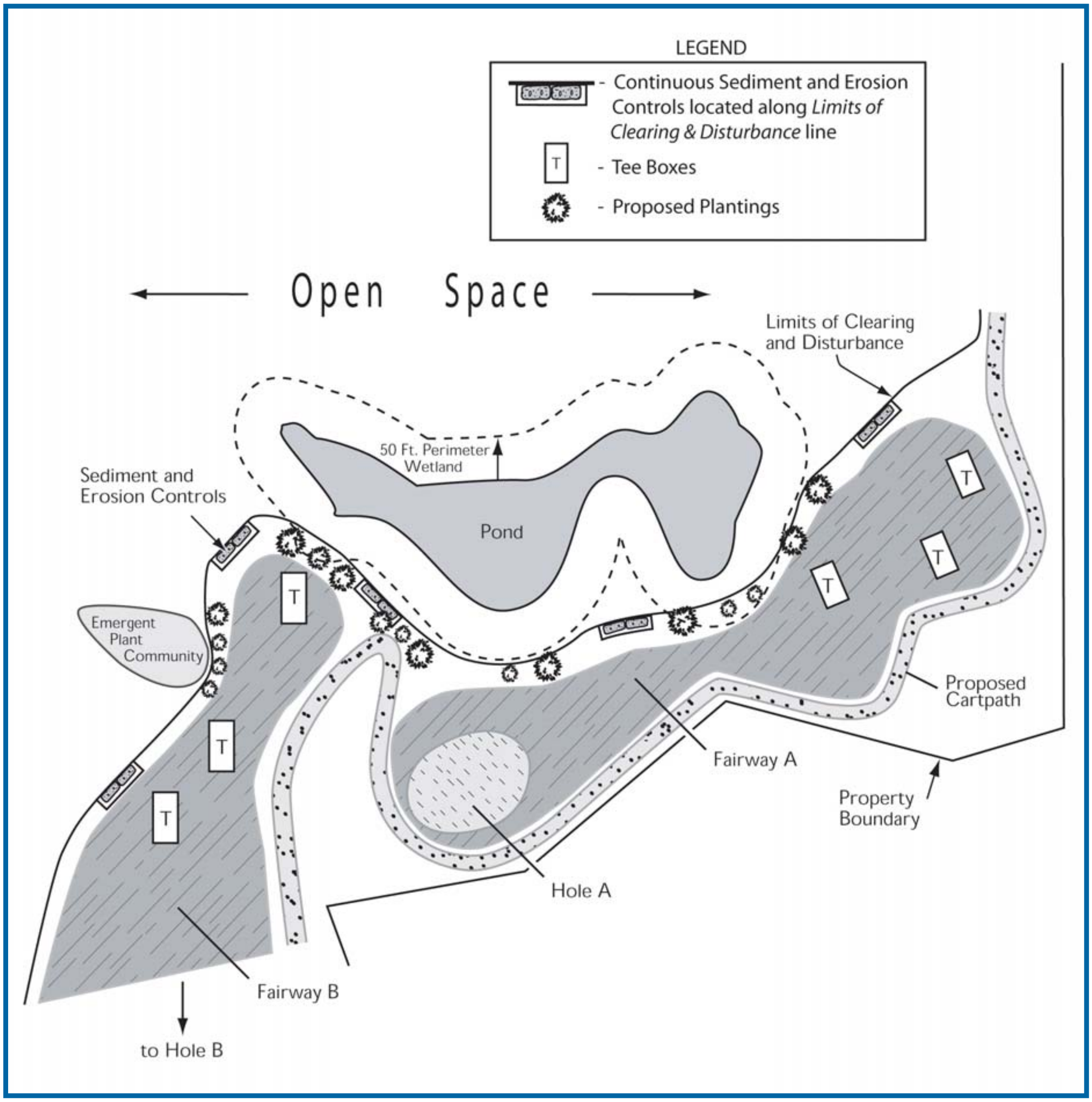
Example 12a: **Original Design with Multiple Wetlands**

In this second example, it was much more difficult to design a course that avoided impacting wetlands. In the middle of this property lies a series of wetlands – a Pond, a Perimeter Wetland and an Emergent Plant Community. This original design for Fairways A and B greatly impacts these wetland areas.



Example 12a

Example 12b: **Revised Design with Multiple Wetlands**



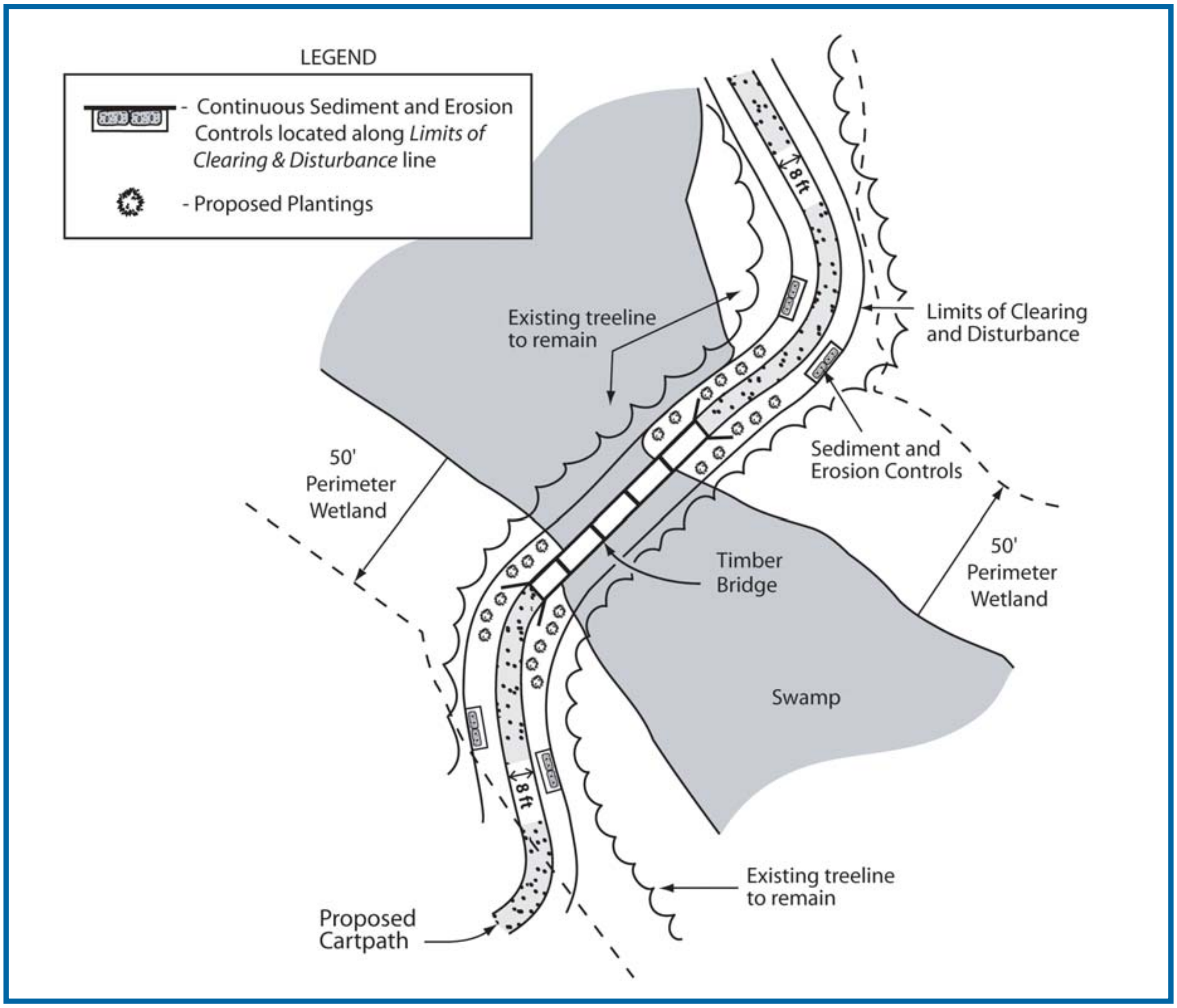
Example 12b

How wetland impacts were minimized:

- ✓ Fairway B and its tee boxes were moved to avoid the Emergent Plant Community.
- ✓ Fairway A and its tee boxes were adjusted to avoid bisecting corners of the Pond and to preserve the Perimeter wetland.
- ✓ Narrow but reasonable Limits of Clearing and Disturbance were maintained.
- ✓ Open space for wildlife habitat corridors was maintained adjacent to the Pond.
- ✓ The existing vegetation was maintained, and plantings were installed, as appropriate, along the Limits of Clearing and Disturbance line within and adjacent to wetland areas to buffer impacts from loss of wildlife habitat and to reduce the effects of disturbance to wildlife.

Example 13: **Crossings**

Roads and cart path crossings are other common elements proposed in golf course applications. The designer should first try to avoid any crossings. If crossings are unavoidable, their impacts should be minimized. In this particular golf course, a cart path crossing was proposed to access upland for another part of the course. The path and crossing were laid out within an already cleared area, which minimized further wetland encroachment and preserved the wetland corridor.



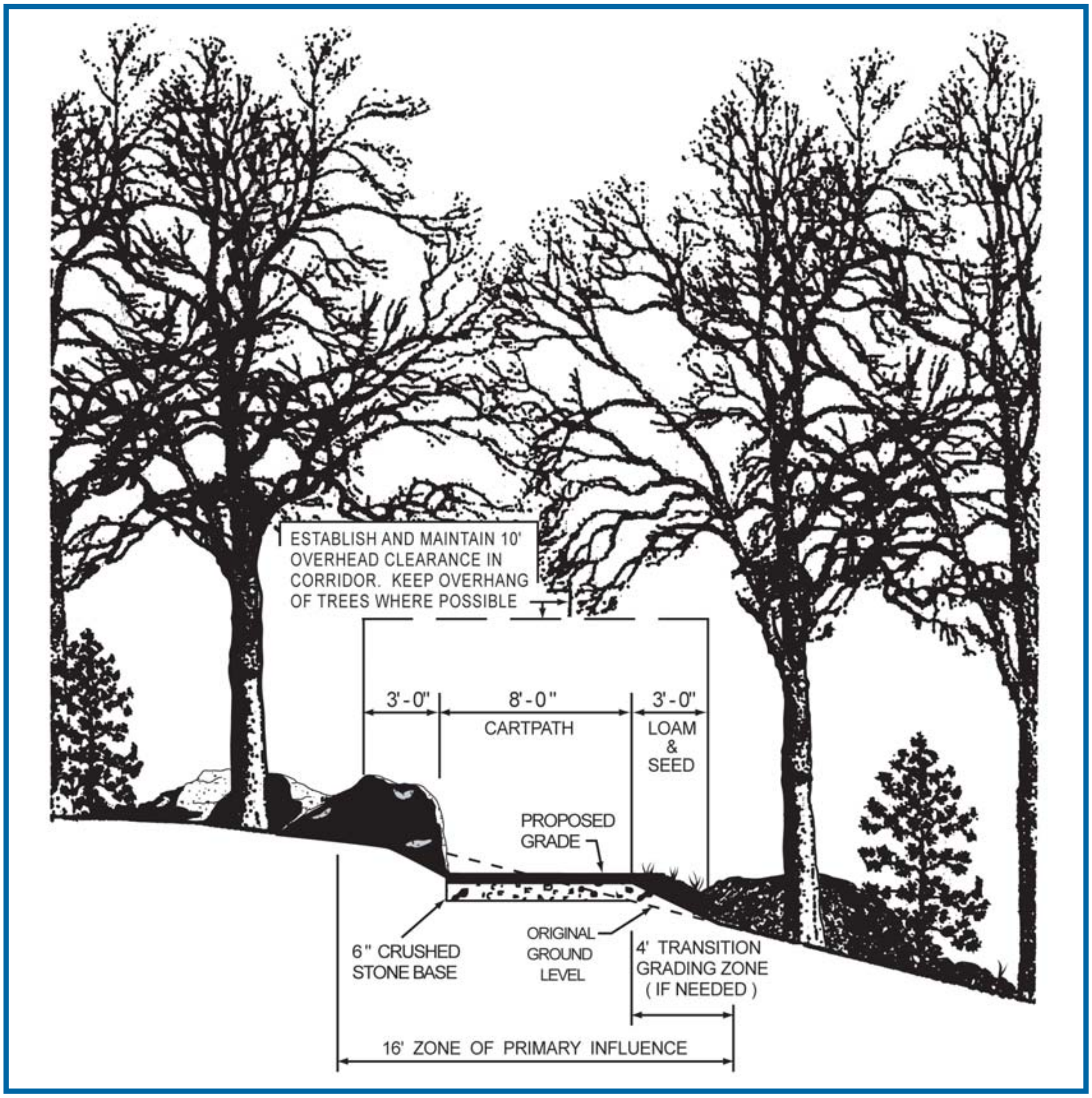
Example 13

How wetland impacts were minimized:

- ✓ The cart path and Limits of Clearing and Disturbance are narrow and utilize an already disturbed area to maintain habitat.
- ✓ The bridge crosses the Swamp at its narrowest point and spans a small portion of Perimeter Wetland on either side to allow a clear passage for water and wildlife.
- ✓ The timber bridge structure was installed in sections which limited impacts to the Swamp and Perimeter Wetland.
- ✓ Proposed plantings were installed along the Limits of Clearing and Disturbance line within and adjacent to wetland areas to buffer impacts from loss of wildlife habitat and reduce the effects of disturbance to wildlife.

Example 14: **Cart paths**

Quite often cart paths are proposed in or near wetlands, including Forested, Perimeter and Riverbank Wetlands. It is always best to try to avoid these areas; however, if it is not possible, then impacts should be minimized. The following example illustrates a conscientious design.



Example 14

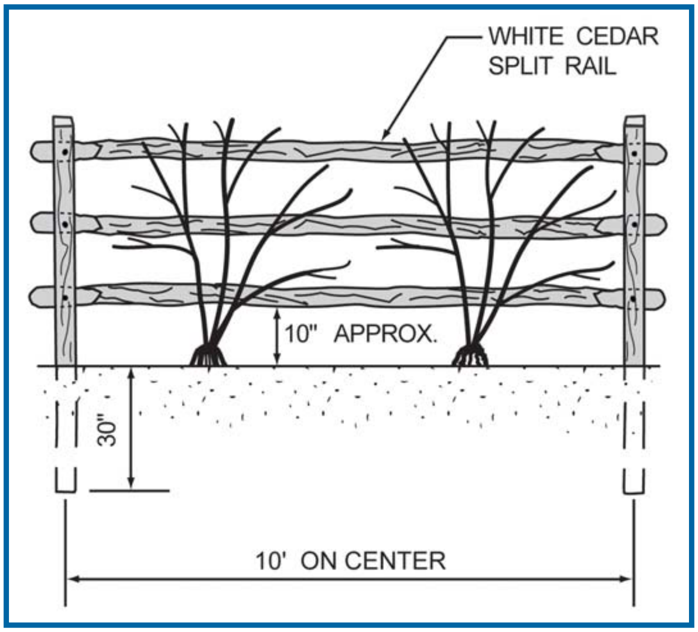
How wetland impacts were minimized:

- ✓ Only a minimum width of forest was disturbed, including a narrow path and area of influence.
- ✓ The overhead tree canopy was preserved.
- ✓ The surface of the proposed path was covered with crushed stone,shells, or other porous material that helps recharge groundwater and prevent the incorporation of pollutants into surface runoff.
- ✓ Minimum grading was required.

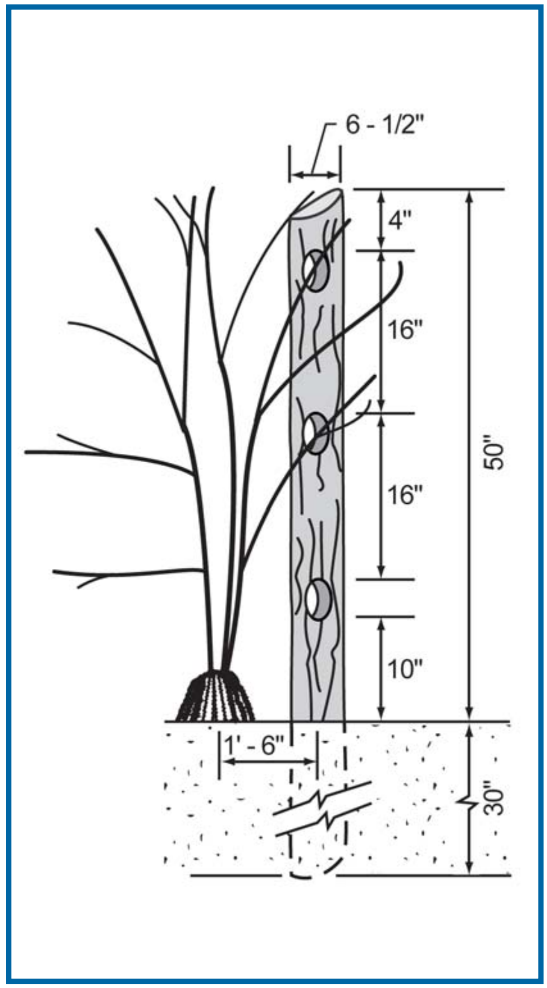
Other porous materials include wood chips, and leaf litter. Cart paths should be installed as close to existing grades as possible. This will prevent future erosion and sedimentation impacts to nearby wetlands.

Example 15: **Preserved Areas**

Commonly, golf course designs include fairways and flyovers around sensitive wetland and wildlife areas. Golf balls are often shot over and around these areas thus creating a need to keep people from trampling through preserved areas for lost golf balls. A rail fence, with native non-invasive rose plantings, is one way to keep people out of sensitive areas. In addition, signs are often posted that read: Conservation Area: Do Not Enter.



Example 15a



Example 15b

How wetland impacts were minimized:

- ✓ The fence is nearly four feet tall, thus making it very difficult for anyone to climb over to retrieve a ball and thus preventing regular foot or cart traffic through the wetland.
- ✓ Native rose bushes or other thorny shrubs are planted to further discourage entrance to the protected areas.

Construction

DEM often finds that projects are not constructed as shown on the approved plans, nor are all the permit conditions met. It is especially important on large projects, such as golf courses, for plans and conditions to be strictly followed. It is helpful to utilize design consultants who are experienced with golf course construction, as well.

- Install proper soil erosion and sediment controls prior to the initial phase of construction (phased or overall project).
- At a pre-construction meeting with all contractors and subcontractors, take note of sensitive wetland/habitat areas that must be avoided per DEM approved permit plans and conditions.
- Establish and stabilize material storage and staging areas prior to construction. Install and maintain proper soil erosion and sediment controls around such areas during the life of the project. Stockpile erosion controls for ready replacement of those that deteriorate.
- Phase any clearing that is necessary, instead of cutting and clearing all vegetation at the same time. This will help to control erosion and protect the wetland and wildlife.
- Keep heavy equipment use to a minimum, especially near wetlands or other sensitive areas to reduce soil compaction.
- Recycle any trees and stumps that are removed into mulch or woodchips to be used on site. Woodchips and mulch are not to be placed in a wetland.

Course Use and Maintenance

Water: A water budget and a drought and dry weather contingency plan that establishes alternate water sources and a method for scaling back irrigation should be developed. A complete application package should include information on irrigation rates or other ways the water withdrawal may affect wetlands.

Pesticides and Fertilizers: DEM is responsible for protecting wetland areas that could become degraded from runoff carrying pesticides or fertilizers. All pesticides used in Rhode Island must be registered with the EPA and RIDEM/Division of Agriculture & Resource Marketing. Pesticides must be applied in accordance with label instructions and any state Pesticide Management Plan for that pesticide. Pesticide Applicators must be licensed or certified by RIDEM/Division of Agriculture & Resource Marketing and file the appropriate Pesticide Use report with the Division annually.

References

This list provides additonal sources for information on golf courses. (Also see Chapter 12.)

- *Environmental Guidelines for the Design and Maintenance of Golf Courses* by R. O. Powell and J. B. Jollie (1990)
- *Environmental Principles for Golf Courses in the U.S.* by The Center for Resource Management (1996)
- *Golf Courses and the Environment* by the Massachusetts Audubon Society (1999)
- *Manual of Environmental Best Management Practices for Construction and Maintenance of Golf Courses* by Mason & Associates, Inc. (Unpublished, 2002)

6. Bike Paths, Foot Paths, Trails and Boardwalks

Bike paths, foot paths, trails and boardwalks are excellent means of showcasing wetlands and the natural environment, especially for people who may not otherwise enjoy natural areas. It is the Department's responsibility to protect wetland areas from unnecessary and undesirable impacts and intrusions into wildlife habitat. Good project planning and design simultaneously protect wetlands and provide opportunities for recreational use of the environment.

Planning and Site Selection

Bike paths are unique in that they require long, undivided stretches of land. These are most commonly in the form of former railroad beds or utility easements. It is not a surprise that these stretches of land may include many wetlands and may even follow a larger river or stream. Other smaller trails and paths may specifically be proposed to enhance an area that is set aside for conservation or recreation, which is also likely to have wetland habitat. For all projects, in order to protect wetlands and their functions and values, it's important for the planner to do the following:

- ✓ Research and evaluate the area to decide if the trail will be able to accommodate all projected users without degrading the natural resources. Not all wetland areas can support all types of paths while maintaining wildlife values. If this can't be accomplished, it may be necessary to downsize the project or look for an alternative route for the path or trail. Be sure to take safety standards into consideration when choosing a site.

- ✓ Create a design that works with the natural environment. Look for existing disturbed corridors and popular routes, and research the area to find out what types of wildlife are the most sensitive and will need the most protection.

- ✓ Avoid areas with steep slopes and rough terrain, as they will be more expensive to convert to a suitable surface and to maintain. If these areas cannot be avoided, it may be necessary to limit the scope of the project or the possible uses of the path. Fewer grade changes will help limit wetland impacts.

- ✓ Evaluate the site for engineering constraints such as poor drainage and the presence of floodplains. If floodplain wetlands cannot be avoided, strive to balance cuts and fills within the project limits.

Design

Good trail design is critical to help prevent unnecessary and detrimental impacts to wetlands, whether the trail is constructed on a previously disturbed railroad bed or on an undisturbed natural area. The following are general tips to protect wetlands and minimize impacts:

✓ Grading

- Utilize natural land contours to avoid excessive fill.
- Design retaining walls in areas of steep or irregular topography to minimize amount of cut and fill needed alongside a path.

✓ Maintain habitat values

- Preserve the natural character of the area, while making it available for recreational use.
- Skirt sensitive wetland areas, and provide for views from the periphery instead of bisecting wetlands.
- Preserve natural buffers within and around wetlands.
- Use lookouts and overlooks to enjoy wetlands instead of crossing sensitive areas.
- Be sensitive to the wildlife that use the area.
- Propose limited access to sensitive areas for bird-watching, nature study and non-motorized boating.
- Build outside of areas used by sensitive species and critical wetland areas, such as special aquatic sites.
- Avoid disturbing all rare plants and wildlife.

✓ Wetland Crossings (see Chapter 9 for more details)

- Utilize existing structures and pathways, wherever possible.
- If crossing a sensitive habitat or creating a new trail, keep the crossing as narrow as possible.
- Timber bridges and elevated boardwalks are good options.
- Utilize wildlife passage structures.
- Elevate boardwalks, observation decks, and bridges to minimize disturbance to wetland vegetation, as well as to protect wetlands underneath.
- Allow spacing between slats in boardwalks to allow light penetration underneath.

✓ View corridors and recreational access areas

- Utilize existing disturbed or thinned areas for rest areas, or for canoeing or fishing access.
- If necessary, thin trees and shrubs sparingly for a view of the wetland area.
- Keep recreational corridors narrow.
- Create a minimum number of well-chosen corridors.

✓ Path dimensions

- Paved multi-use paths in the vicinity of wetlands should not be any wider than 10 feet with 2-4 feet of clearance on either side for a safety and work zone, unless specific circumstances dictate otherwise. In Rhode Island they have been permitted up to 14 feet to allow for emergency vehicle passage.
- Foot paths in the vicinity of wetlands should not be wider than 3-5 feet.
- Height clearance is recommended at 7 feet for pedestrians/bicycling and 10 feet for horseback riding.
- Selective thinning of trees and shrubs may be necessary adjacent to the primary path in order to provide the necessary height clearance for multiple path uses.

✓ Signage - Place informational signs at the entrance to sensitive habitat areas.

✓ Pervious surfaces

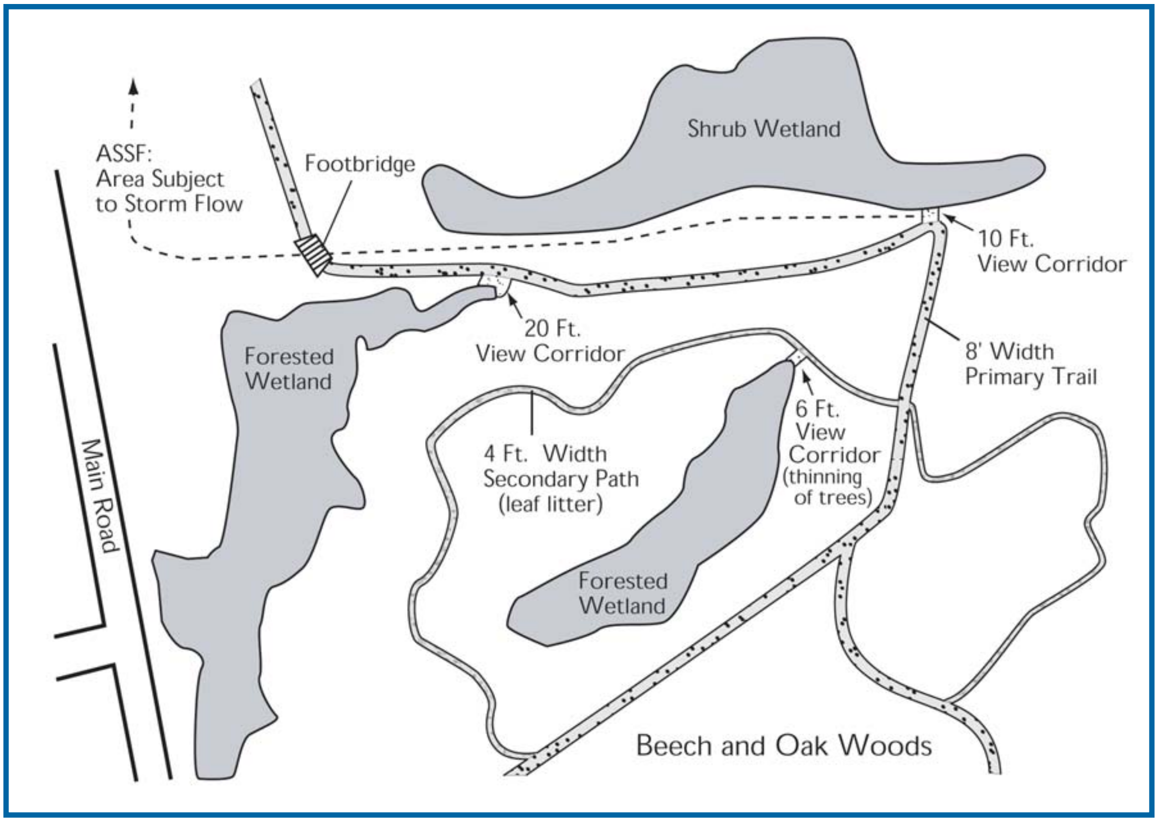
- Examples include: shells, stone dust, bark mulch, wood chips, leaf litter, or plastic grates filled with stone.
- These alternative surfaces are more natural and often encourage water infiltration.
- Many surfaces are safe and sturdy enough for bikes and wheelchairs.
- Alternative surfaces require smaller equipment to construct, thus allowing for a narrower area of disturbance.

✓ Plantings and buffers

- Plantings should screen sensitive wetland areas from human disturbance: 1-3 rows of evergreen shrubs and/or trees (6 ft minimum height) work well. (Also see Chapter 10.)
- Consider using fences at the limits of work to visually screen human activity.
- Use vegetation, such as native non-invasive thorny plants or a dense evergreen screen, to discourage entry to sensitive areas.
- Propose vegetation on both sides of the path to provide a buffer between the wetland and developed areas.
- Propose planting schemes that are both aesthetic and attractive to wildlife, such as berry producing trees and shrubs.
- Preserve and enhance existing tree cover and shrubs. Where possible, consider weaving paths around existing trees to help maintain canopy cover and to preserve large diameter trees.
- Avoid using invasive species such as Honeysuckle, and try to control existing non-native and invasive species such as Bittersweet.

Example 16: **Path Layout and Design**

The following example is a portion of a forested conservation area with a proposed trail system. The trails will be used for walking and nature study. The design incorporates many mitigation measures that are described below.



Example 16

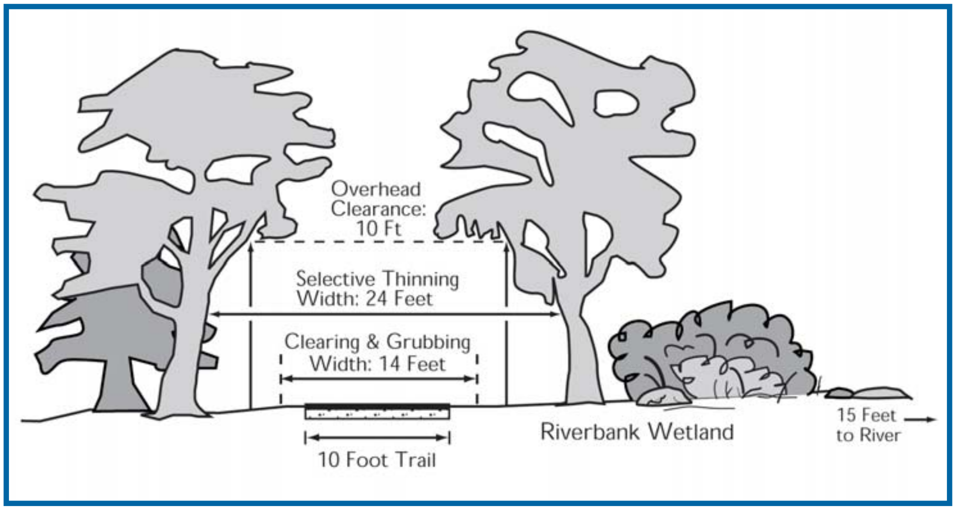
How wetland impacts were minimized:

- ✓ The trails avoid almost all of the wetland areas and are narrow so that less vegetation was cut.
- ✓ The primary trails were centered on old farm roads and previously disturbed areas.
- ✓ The secondary trails were built by trimming woody vegetation, but no trees were removed.
- ✓ Trails are composed of soil, leaf litter or wood chips, depending on the existing ground conditions. All materials are permeable and allow natural stormwater flow and absorption.
- ✓ No grade changes were needed for path construction.
- ✓ Trails are maintained by mowing or hand removal of larger vegetation.
- ✓ The path crossed an Area Subject to Storm Flowage wetland but avoided a more sensitive Forested Wetland.
- ✓ Instead of installing a simple culvert, the footbridge was built with timber decking, which required less fill material and caused less disturbance during construction.
- ✓ View corridors are not numerous and were kept narrow with proposed signage to explain the sensitive habitat.

Example 17: **Path Width and Buffers**

This cross-section illustrates the ideal placement of a multi-use path in a Forested, Riverbank or Perimeter Wetland in a **suburban or rural** area.

How wetland impacts were minimized:



Example 17

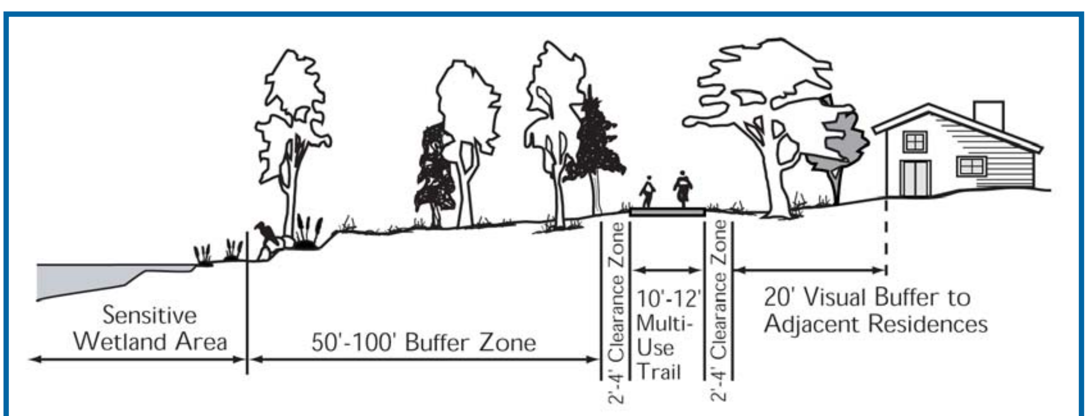
- ✓ The path is wide enough to support multiple uses, such as bikes and pedestrians.
- ✓ The River has a large buffer zone to protect wildlife habitat and water quality values.
- ✓ The neighboring areas are also buffered from noise along the path.
- ✓ The path and cleared areas are narrow to keep wildlife impacts to a minimum.
- ✓ Only minimal clearing was done to provide the necessary height for the multiple-use trail.

In order for path users to fully appreciate the wetland area that is being protected, view corridors might be added at a few select points along the trail that would bring users closer to the edge of the wetland, with signage provided about the wetland and its importance.

For an **urban** path, the cross-section would likely look very different with less vegetation and existing development on either side. It is still important to establish a buffer on both sides of the trail to protect the wetland as much as possible and to help screen out the encroaching development.

Example 18: **Vegetative Clearing**

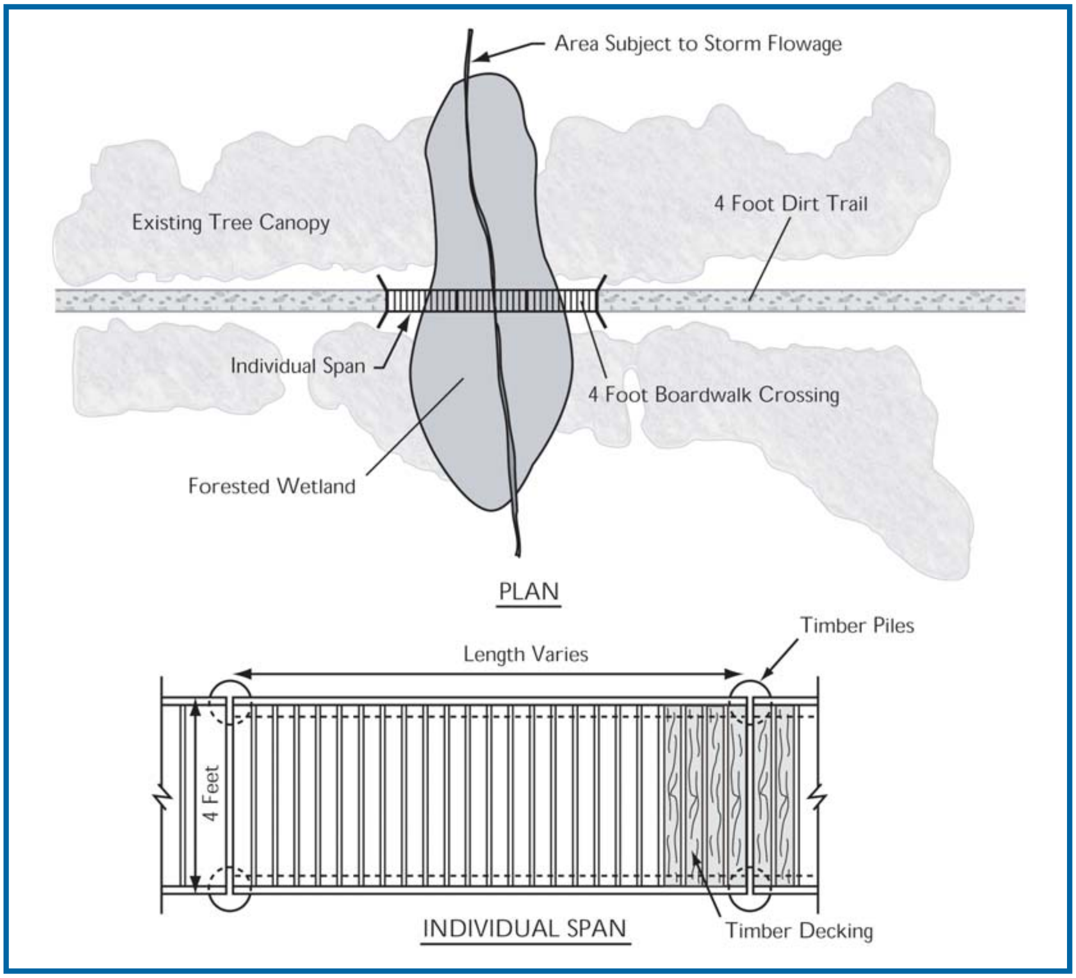
This drawing illustrates the width of clearing for a trail. The dimensions listed here are sufficient for a multiple-use trail for bikers and pedestrians.



Example 18

Example 19: **Wetland Crossings**

Wetland crossings are sometimes unavoidable in path and trail applications (please see Chapter 9 for more details on crossings). Wooden bridges, platforms, boardwalks and small footbridges are often the best ways to cross wetland areas, if they must be crossed, or to provide viewing platforms at the edge of wetlands. The following example is a conservation area with existing dirt trails. The Forested Wetland and Area Subject to Storm Flowage needed to be spanned to allow passage through these seasonally flooded areas. The trail is primarily used for wildlife viewing and environmental education.



Example 19

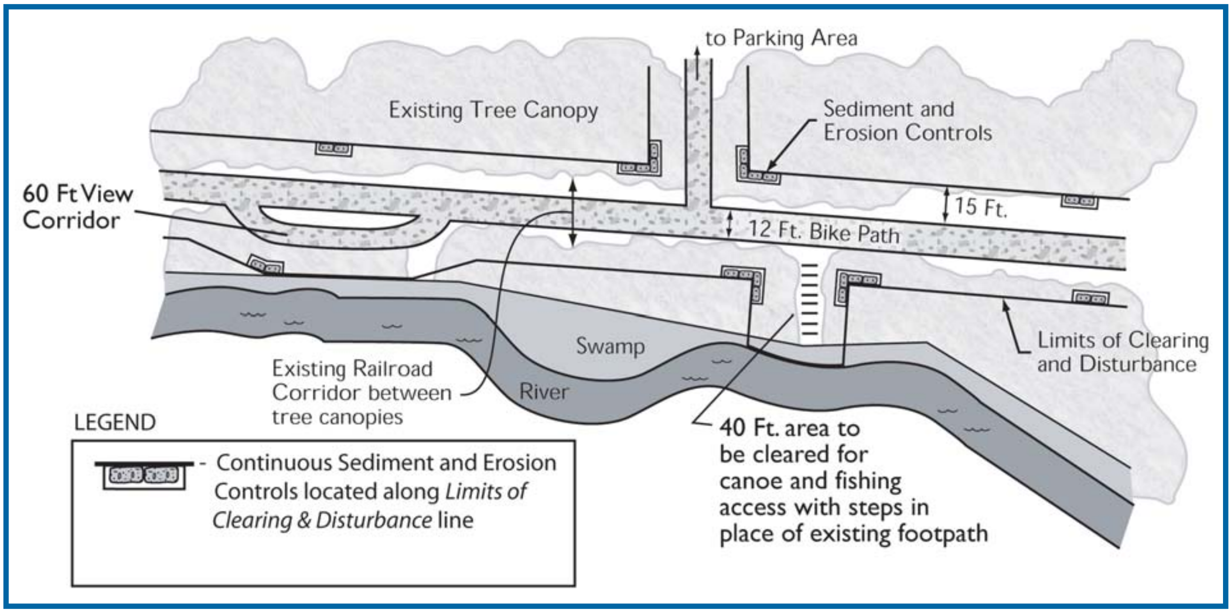
How wetland impacts were minimized:

- ✓ The path and boardwalk crossing are very narrow - only 4 feet across.
- ✓ The existing tree canopy was maintained, and only a small area of ground cover was cleared for the path.
- ✓ The boardwalk was placed on raised timber piles to maintain ground cover and to allow the passage of small mammals underneath.
- ✓ The slats were spaced a half inch apart to allow light to penetrate underneath.
- ✓ The boardwalk was built in sections, starting from one end, while working from above.

Example 20a: **View Corridors and Access Areas**

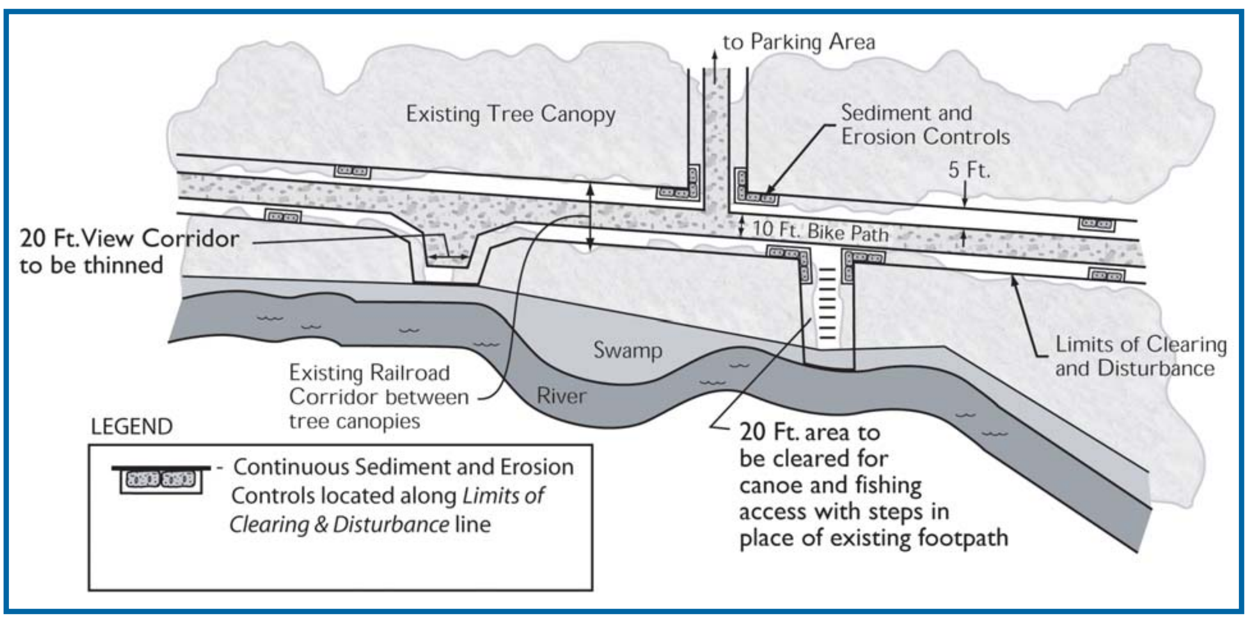
Viewing and recreational access areas are very popular features to incorporate along bike trails and foot paths. It's important to keep in mind that, while these features are acceptable, their placement, width and number should be carefully considered and designed. These corridors often encroach directly into regulated wetlands and may add to the disturbance and degradation of wildlife habitat and wetland quality.

This example illustrates a section of bike path along an abandoned railroad bed. There is existing buffer vegetation on either side of the railroad corridor, although some sections are sparse. A small footpath exists in the location where the canoe and fishing access is proposed to be widened to 40 feet. There is an additional view corridor 140 feet away that overlooks the River and is 60 feet wide. The 12-foot bike path was designed to cut through portions of the existing buffer.



Example 20a

Example 20b: **Revised Design A**

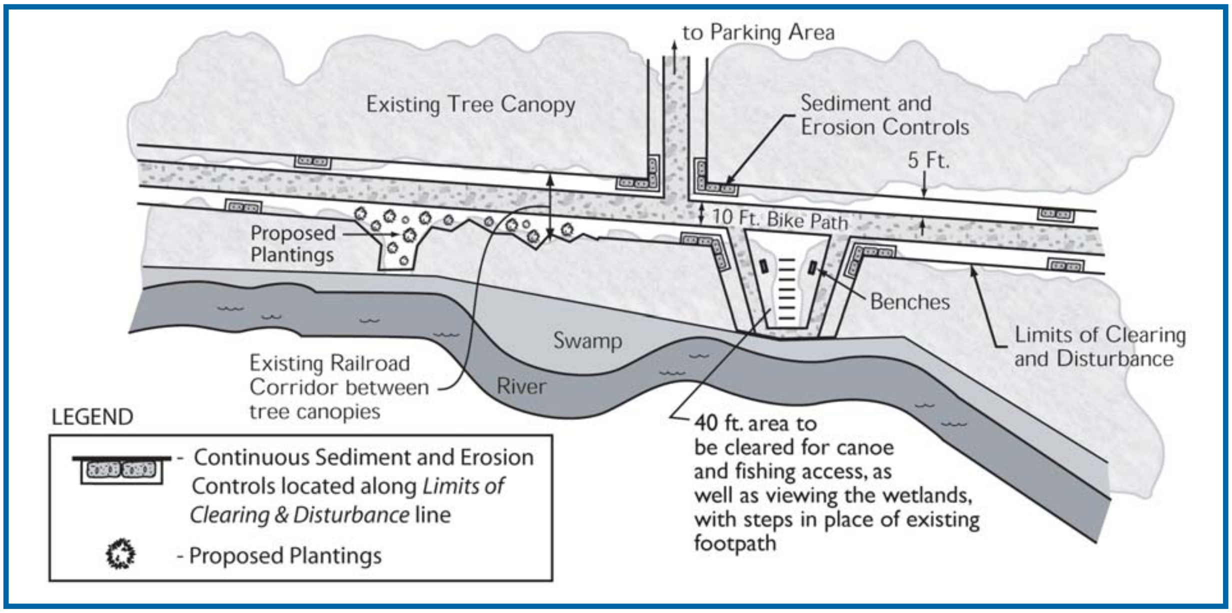


Example 20b

How wetland impacts were minimized (Design A):

- ✓ The canoe and fishing access area was narrowed, as these activities do not require more than 20 feet.
- ✓ The view corridor was narrowed to 20 feet.
- ✓ The bike path was relocated and narrowed to 10 feet in the wetland area to maintain the vegetative buffer on either side.
- ✓ The Limits of Clearing and Disturbance were narrowed on both sides of the path to five feet.

Example 20c: **Revised Design B**



Example 20c

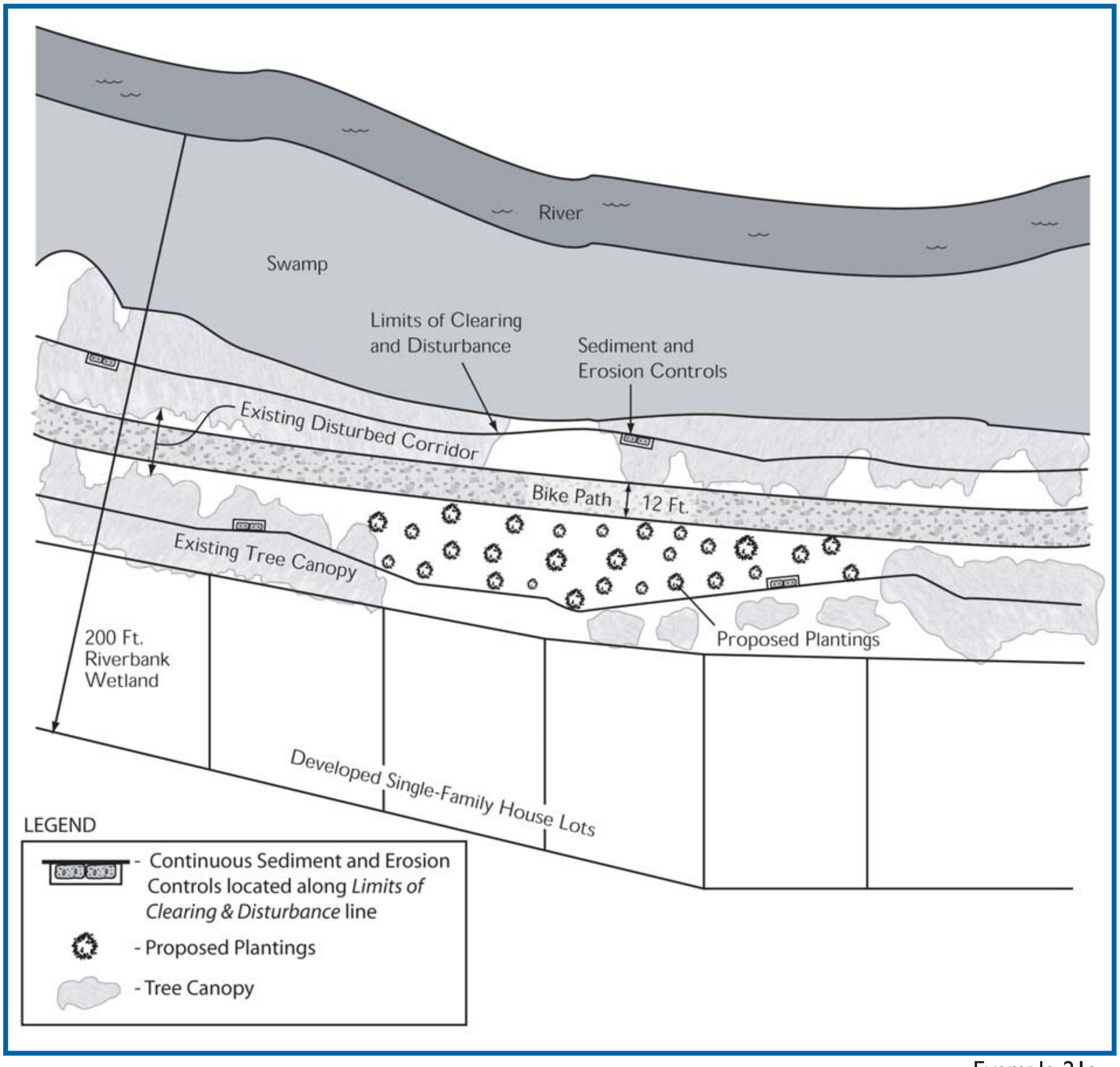
How wetland impacts were further minimized (Design B):

- ✓ The view corridor was incorporated into the canoe and fishing access area, thereby limiting human disturbance to one 40-foot area instead of two separate 20-foot areas.
- ✓ The habitat remains unfragmented and intact.
- ✓ Buffer plantings were added in areas where the existing vegetation was sparse.

Example 21a: **Original Planting Design**

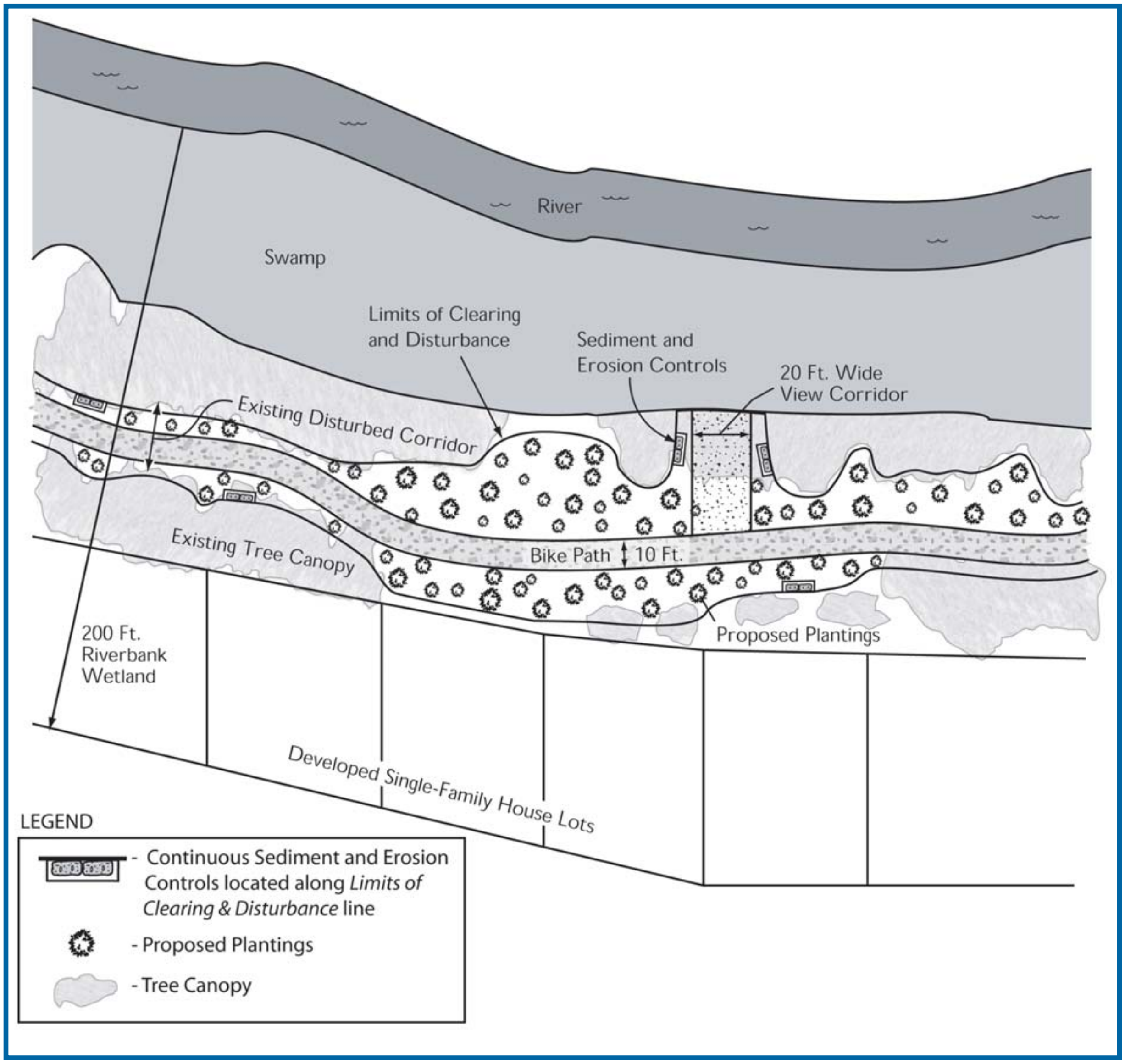
Plantings are an integral part of path and trail design, especially in urban and suburban areas which may have less vegetation than in rural areas. It's important to remember that not only will trail users and nearby residents and businesses enjoy a path more if development is screened, but the wetland itself will attract more wildlife and may improve water quality if the vegetative buffer is enhanced. This may mean it will be necessary to increase native plantings on both sides of the trail. The users' clear view to the wetland may be best achieved through properly located and designed view corridors.

This proposed design illustrates a 12-foot bike path through an urban area on a previously disturbed railroad bed and utility easement area. Due to development, much of the original vegetated buffer had been removed from the edge of the Swamp. Plantings were to be installed only on the side of the path where the tree canopy was thin.



Example 21a

Example 21b: **Revised Planting Design**



Example 21b

How wetland impacts were minimized:

- ✓ Plantings were installed on both sides of the path, which was reduced to 10 feet wide in the regulated area. The plantings are especially thick where there was no tree canopy to provide wildlife habitat.
- ✓ The existing tree canopy was preserved by moving the path farther away from the River and Swamp.
- ✓ A view corridor was added to allow users to see the wetlands without encroaching upon it. The corridor has sparse vegetation which allows a clear view without severely diminishing habitat values.

Construction

Due to the proximity of many paths and trails to wetlands, it is extremely important to use environmentally sound construction practices in order to protect the natural resources. The following are some tips especially important for trail construction. (See also Chapter 11 on Construction and Maintenance Tips.)

- Properly install and maintain sediment and erosion controls.
- Limit construction activities within watercourses, vegetated wetlands, and flowing and standing water wetlands to within the low flow period of July - October.
- Restrict construction activities to outside the breeding season/migratory seasons of wildlife that will utilize the area.
- Preserve the existing tree canopy, and use selective clearing to keep vegetative removal to a minimum.
- Replant disturbed soils, and restore the area to its original topography and hydrology.

Maintenance Tips

- Minimize or eliminate the use of pesticides, fertilizers and other chemical applications near wetlands.
- Propose limited mowing, especially near wetland areas.
- Utilize native grass species, which will require little or no watering yet will provide adequate soil stabilization.

References

This list provides additional sources for information on paths and trails. See Chapter 12 for complete citations arranged by author.

- *Assessing the Cumulative Effcts of Linear Recreation Routes on Wildlife Habitats on the Okanogan and Wenatchee National Forests* by W.L. Gaines et al. (2003)
- *Designing Sidewalks and Trails for Access: Part I of Best Practices Design Guide* by J.B. Kirschbaum et al. (1999)
- *Designing Sidewalks and Trails for Access: Part II of Best Practices Design Guide* by J.B. Kirschbaum et al. (2001)
- *Effects of Non-Consumptive Recreation on Wildlife: A Review* by S.A. Boyle and F.B. Samson (1985)
- *Managing Degraded Off-Highway Vehicle Trails in Wet, Unstable, and Sensitive Environments* by K.G. Meyer (2002)
- *Trails for the Twenty-First Century: Planning, Design, and Management Manual for Multi-Use Trails* by C.A. Flink and P. Lagewey (1993)

7. Roads and Bridges

Roads, as linear structures, often traverse nearby wetlands. As road travel increases, it is often necessary to upgrade roads for safety and ease of travel. Improvements might include new surfaces, lane widening, new drainage structures, bridge reconstruction, or the addition of safety features. As with any project, one of the first steps when designing a new or upgraded road is to avoid wetland areas, and, if this is not possible, then to minimize impacts to wetlands as much as possible.

Design

During the design stage, it is vital to identify techniques to protect wetland characteristics, functions and values. It is often times a challenge to balance safety and design standards with wetland protection. These mitigation techniques may be implemented before, during or after construction. Although an activity may not be employed until post-construction, it should still be included on design plans submitted with the wetland application.

New roads and road upgrades often go hand in hand with subdivisions or new commercial projects. For a new road, nearby resources and geographical features must be identified in order to find the most suitable location for the road. It's also important to consider how the road may affect nearby wetlands and how to best eliminate or minimize those effects. Adding a thick buffer of varied vegetation between the road and the wetland is one of the best practices. A buffer will help to absorb light and sound pollution, in addition to offering food and shelter for wetlands wildlife. It will also act as an additional treatment for water and sediment runoff from the road. The following list gives a few more best management ideas.

- Avoid widening or extending roads into wetlands.
- Consider shifting the geometry or alignment of the road to avoid wetlands.
- Plan new roads to follow the contours of the existing land, which will minimize grading.
- Span as much of a wetland as possible if crossing is necessary in order to maintain connections between wetland systems.
- Consider alternative designs that will fulfill the same purpose.
- Propose steeper road side-slopes, such as a 2:1 grade instead of a 4:1 grade to avoid excess fill into wetlands.
- Utilize slope alternatives that avoid filling, yet prevent erosion and sedimentation into wetlands.
- Consider keeping existing bridge abutments by building new abutments behind the old ones if it will help to reduce wetland impacts.
- Plan ahead for temporary crossings that may be needed for construction access, travel, or utilities.

Roads & Driveways

Please see Chapters 2 and 3 for several examples of road and driveway designs that avoid wetland areas.

Please refer to the *Rhode Island Stormwater Manual* (pending revision 2010) for complete Best Management Practices.

Drainage concerns

- Reduce the amount of paving by decreasing lane width and shoulders.
- If possible, avoid installing sidewalks to limit the amount of paving, or consider installing sidewalks on only one side of the road.
- Maximize infiltration through the use and maintenance of open drainage systems, which also prevent small mammal and amphibian entrapment.
- To lower runoff volumes and maximize infiltration, consider use of porous pavements.
- Avoid discharging stormwater directly into wetlands.
- If discharging into a wetland is unavoidable, the discharge must be treated.
- Make sure temporary dewatering basins are correctly located and large enough to support the project.

Birdproofing Bridges

Bridges crossing over wetlands should be designed to discourage the nesting or congregating of birds. Pigeons and starlings are especially problematic due to the large amount of droppings they produce which pollutes wetlands. Some good structure options include:

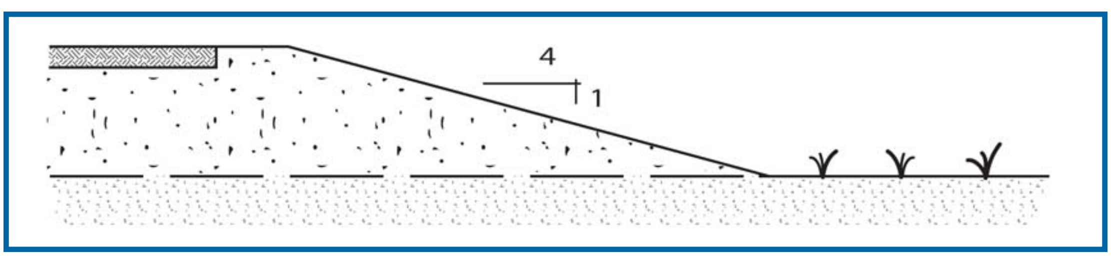
- Concrete box culverts
- Concrete arch culverts
- Concrete rigid frames
- Concrete slabs
- Prestressed concrete slabs
- Prestressed concrete butted boxbeams

These structure types, by design, have fewer places for birds to perch or roost. Other treatments are available to further discourage birds from perching on the beam seats, such as screening with mesh chain link fence.

Example 22: Typical Slope Treatments

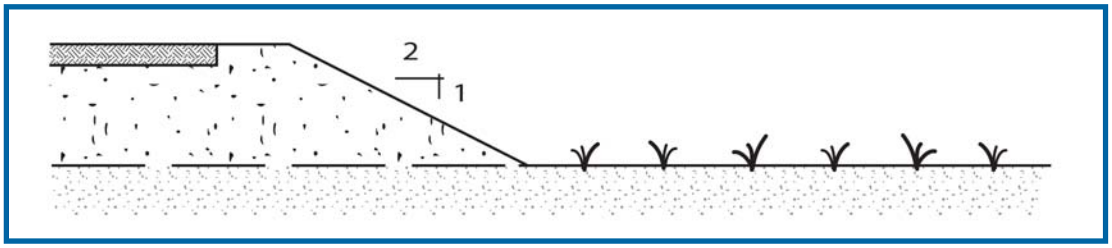
The following illustrations show a variety of slope treatments.

1. **Gradual Slope:** In upland areas with plenty of space a 4:1 slope may be preferred because it's easy to plant, mow, and maintain. However, it requires a large amount of fill to create the gradual slope and is not preferred if there are wetlands immediately adjacent to the road.



Example 22a

2. Steeper Slope: Generally, the steepest slope that can be vegetated to reduce erosion is a 2:1 slope. At this ratio, a grass cover can still be planted and maintained and less fill is needed, thus reducing the amount of wetland impact.

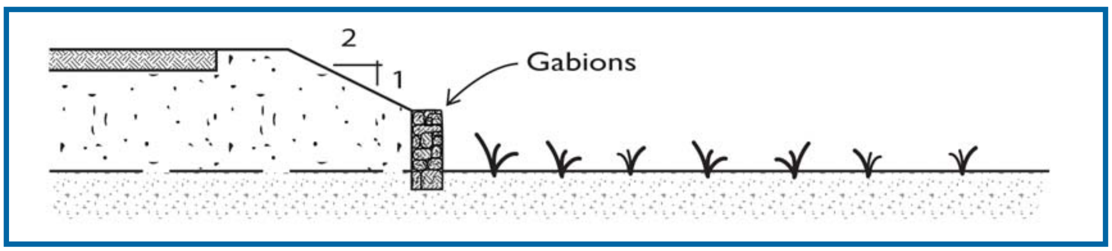


Example 22b

3. Gabions: To further reduce the amount of wetland fill required to construct a small road, the use of gabions is another option. Gabions are a type of rock-filled wire mesh berm that contains the earthen material. They can be lightly vegetated; often ivy and grasses will grow to cover up the wire. If a wetland is directly adjacent to the road, gabions can cut the amount of fill required nearly in half.

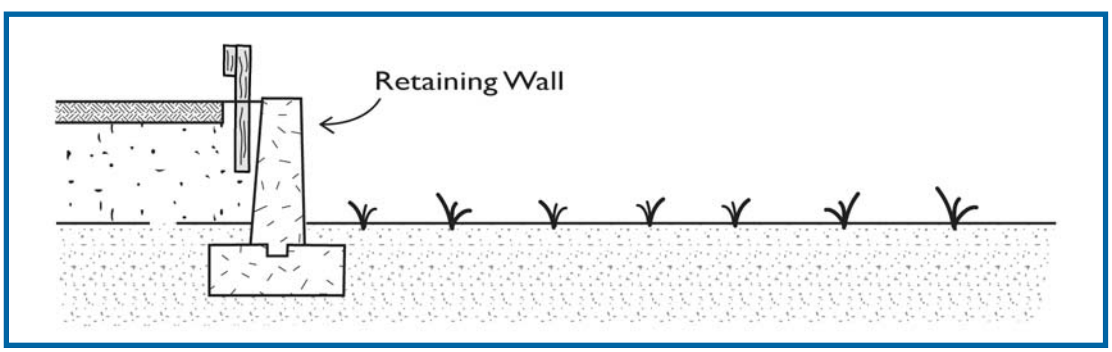
Gabions and Walls

Gabions and Retaining Walls can also be used in your backyard at the Limits of Clearing and Disturbance line to reduce the amount of fill. (See Example 9 in Chapter 4.)



Example 22c

4. Retaining Walls: A final method illustrated below is a retaining wall, which can be stone masonry, boulders, concrete, reinforced earth, or bioengineered materials. Retaining walls can function in place of slopes, thereby eliminating the areas of wetland alteration caused by slopes. However, retaining walls may not be appropriate in many circumstances where their installation will interfere with wildlife travel and dispersal. Fill slopes (2:1) may actually be more beneficial to wetland wildlife.



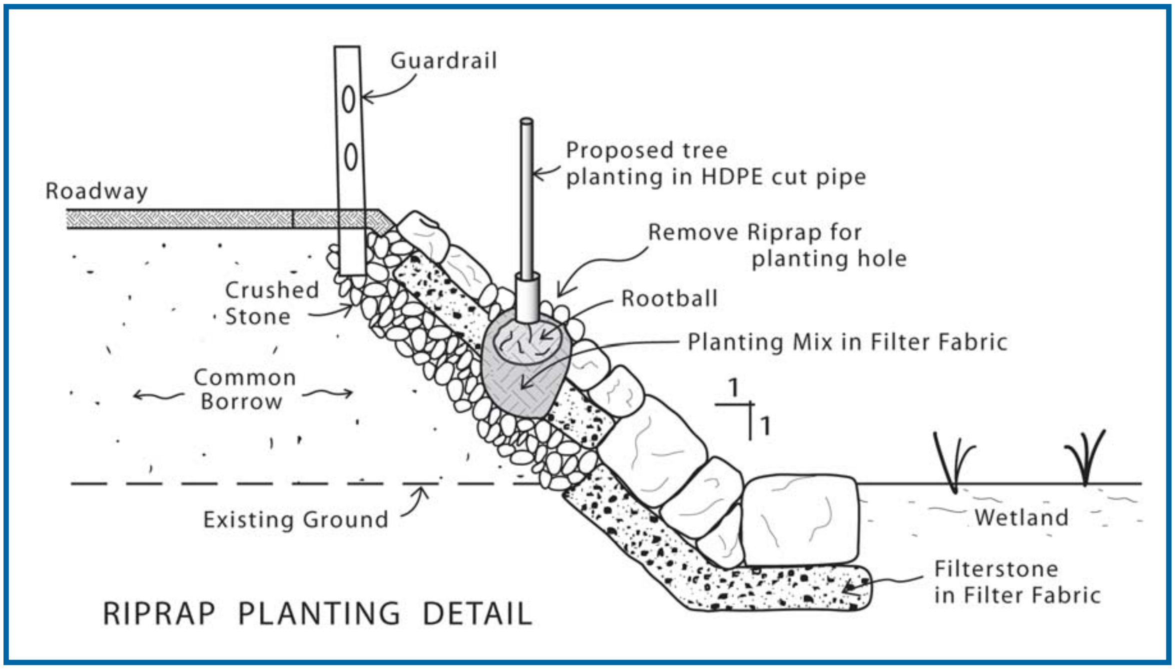
Example 22d

Example 23: **Special Slope Treatments**

The following illustrations show two special slope treatments. These methods, modified from a permitted project, may be used for a new road where the wetland cannot be entirely avoided.

This first example shows a steep 1:1 slope that resulted in minimal wetland fill beyond the roadway. Although the slope cannot be directly vegetated, trees were planted through the use of an HDPE-cut pipe and planting mix in the filter fabric. A guardrail was installed for safety along the side of the road, then the slope was covered with a mixed rock and larger cut rock riprap. This example is good because:

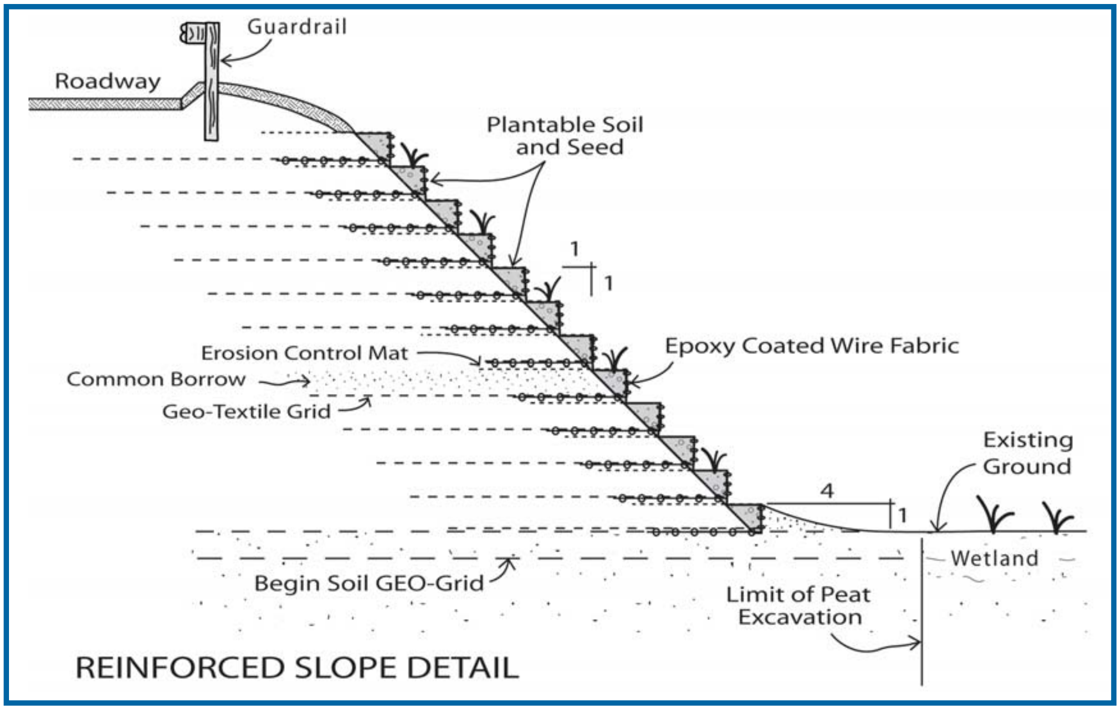
- Fill was reduced.
- A vegetative screen was planted (preferably with more than a single row of plantings).
- Sediment and erosion were controlled through the use of the stones on the slope.



Example 23a

For an even larger roadway, a reinforced slope, such as the one shown at right, is another option. A plastic geotextile grid was used to establish a flat surface, the common borrow was placed on top of this, and an erosion control mat on top in repetitive layers. A wire fabric material was then wrapped around the outside steps that were exposed. This layering system helped to create a steep slope with plantable soil. This example illustrates:

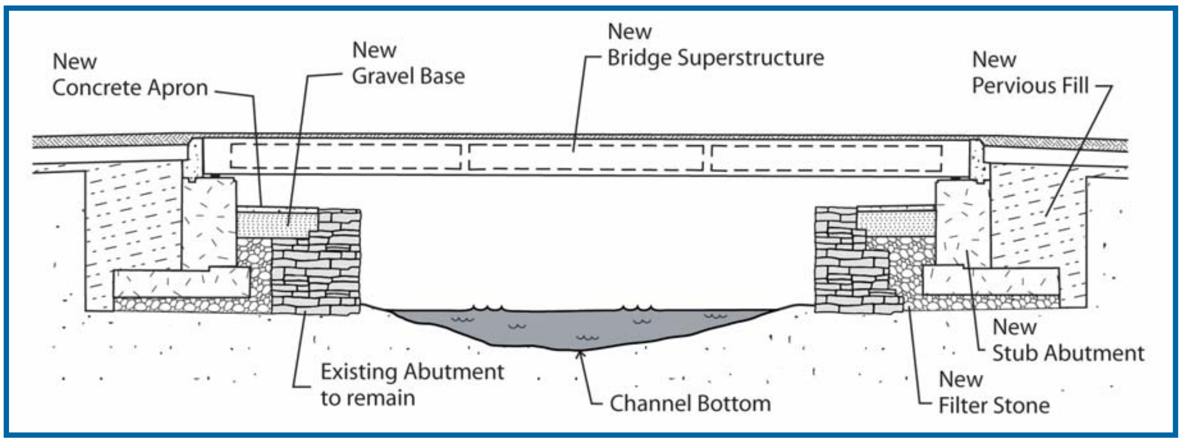
- Minimized wetland fill.
- A fully plantable slope.
- Extensive sediment and erosion control measures through the use of the wire fabric, geotextile grids, and common borrow.



Example 23b

Example 24: **Bridge Upgrade**

This is an example of a multi-lane bridge that was in disrepair and needed to be upgraded for traffic and safety. While there are many ways to replace or reconstruct bridges, while also protecting wetlands, this example minimizes impacts in specific ways. In some situations it can be beneficial to carefully remove the old abutments and restore the area adjacent to the watercourse.



Example 24

How wetland impacts were minimized:

- ✓ The new abutments were built behind the old ones, allowing for less wetland fill and disturbance.
- ✓ The old abutments remained in place to avoid disturbance of the watercourse.
- ✓ The bridge superstructure was dropped into place from overhead to further avoid disturbance of the watercourse.
- ✓ The bridge design preserved the hydraulic characteristics of the original opening.
- ✓ No further obstruction to the floodway was necessary.
- ✓ The butted prestressed concrete box beams helped prevent bird nesting and roosting.

Construction

- Before widespread clearing and grubbing occurs, sediment and erosion controls must be properly installed.
- Place bales of hay a foot out from the toe of the proposed slope to prevent erosion when they are removed.
- Do not clear any more land than is absolutely necessary for the project.
- Cofferdams, sandbags, silt curtains, or a combination of the three should be installed if working in a watercourse.
- Work in the watercourse should be confined to the low flow season (July - Oct.) if possible.
- Drive sheeting right before beginning work in the area, and remove it immediately afterward to minimize disturbance to the watercourse as much as possible.
- Take advantage of already cleared areas for staging areas and for material and equipment storage that are outside of regulated wetland.

Maintenance

- All drainage structures and the surrounding area must be cleaned and maintained so that they do not clog and become ineffective.
- A responsible party should be named in the plan notes to ensure long-term maintenance and inspection.

References

This list provides additional sources for information on roads and bridges. See Chapter 12 for complete citations arranged by author.

- *Best Management Practices for Routine Roadway Maintenance Activities in New Hampshire* by K.T. Nyhan (2001)
- *Ecological Road-Effect Zone of a Massachusetts Suburban Highway* by R.T.T. Forman and R.D. Deblinger (2000)
- *Estimate of the Area Affected Ecologically by the Road System in the United States* by R.T.T. Forman (2000)
- *Highway Traffic Noise* by Federal Highway Administration (undated)
- *Overview of Transportation Impacts on Wildlife Movement and Populations* by S.D. Jackson (2000)
- *Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities* by S.C. Trombulal and C.A. Frissell (2000)
- *Rhode Island Standard Details* by Rhode Island Department of Transportation (2008)
- *Roads and Their Major Ecological Effects* by R.T.T. Forman and L.E. Alexander (1998)
- *Strategy for Mitigating Highway Impacts on Wildlife* by S.D. Jackson and C.R. Griffin (2000)

8. Utilities

Projects may include: gas, water, sewer, electric, telephone, cable, or other fiber optics

Utility installations are similar to other long and linear projects that DEM permits, such as trails or roads. Utility lines can be installed either underground or above ground in pipes or overhead as wires (such as an electric line). After the line is installed, an easement area remains. Although all utility easements need to be accessible for maintenance purposes, they are not subject to continual human disturbance like trails or roads. As a result, many easements can be at least partially revegetated. Even overhead utility easements can be restored as long as the vegetation does not interfere with or compromise the stability of the poles or the utility wires. Utilities are also unique in that a variety of construction methods are available, which can greatly reduce wetland impacts.

Common Construction Installation Methods

- Horizontal directional drilling
- Elevation over wetland
- Trench method
- Overhead poles
- Attachment to bridge or other structure
- There may be others or variations on these common methods.

Planning and Design

One of the first steps in the design of an underground utility that will cross a wetland area is to consider how to install the piping. The most wetland-friendly methods are by horizontal directional drilling or another type of trenchless technology. These methods, while expensive, will avoid or greatly minimize impacts to wetlands. In some situations it is possible to elevate the utility line over a wetland. This method might be unsightly and is only appropriate to reduce impacts in certain situations. A better solution may be to attach the piping to a bridge or other structure that spans the wetland. The trench construction method is common and often very invasive, but has been used depending on the type and sensitivity of the wetland. For overhead utilities, the installation is fairly standard. The location of the poles is the most important aspect to limiting wetland impacts and excessive clearing.

During the planning and design stages, it is vital to identify techniques to protect wetland functions and values. These techniques can be implemented before, during, or after construction. Although a technique may be employed post-construction, it should still be part of the original planning and design process. For example, construction sequencing and post-construction maintenance scheduling (including means for emergency repairs) should be considered during the design stage and must be part of a final application submitted to and reviewed by DEM.

It is important to follow these basic **Avoidance and Minimization** techniques:

- Avoid both above and below-ground wetland crossings unless absolutely necessary.
- If a crossing is unavoidable, take advantage of already disturbed areas such as easements, roads, roadway shoulders, bridges, or old railroad beds.
- Try to avoid disturbing stream beds; if they must be disturbed, utilize a straight and narrow section with low banks.

- Consider spanning a wetland by locating utility poles on either side of the wetland, instead of disturbing the interior.
- Zig-zag utility poles across roadways to keep overhead lines within the roadway corridor and to keep the Limits of Clearing and Disturbance out of the wetland (See Example 26).
- If attaching utility lines to a bridge or other structure, be aware of possible floodplain constraints.
- If underground piping cannot be avoided, consider installing it in a crack-proof casing so that the area above the piping can be replanted with larger woody vegetation.
- Keep the size of cleared maintenance areas above and around utility lines to a minimum.
- For electric lines, consider suspending the wires above the wetland tree canopy.
- Avoid diversion of surface water and groundwater sources, which could affect nearby wetlands. Subdraining effects from trench installation must be especially guarded against.

Construction Tips

The following Construction Best Management Practices help limit wetland impacts. A complete application package will include details for these practices, which should be considered during the initial planning and design phases even though they may not be utilized until during or after project construction.

Before Construction

- Ensure that soil erosion and sediment controls are properly installed and maintained.
- Avoid disturbing soils, especially on steep slopes.
- Stabilize exposed soils by seeding and applying a thick mat of spread hay mulch.
- Use erosion control blankets, such as jute or other types of non-plastic matting to prevent erosion on steep slopes.
- Have all necessary materials on hand before beginning work.
- Especially for house lots, try to plan for driveway and utility installation to occur within close time proximity to limit the length of disturbance to nearby wetlands.

During Construction

- Limit construction to outside the breeding and migratory seasons of wetland wildlife.
- Limit construction activities to the low flow period (July - October) or to when the soil is frozen.
- Preserve existing tree canopies and natural areas in and around wetlands as much as possible.
- Use structures or devices to prevent subdraining or groundwater movement along pipelines such as anti-seepage collars, intermittent clay barriers, trench plugs, or clay saddles.
- If cutting of wetland vegetation cannot be avoided, complete the work by hand (chain or hand saw) instead of using large equipment.

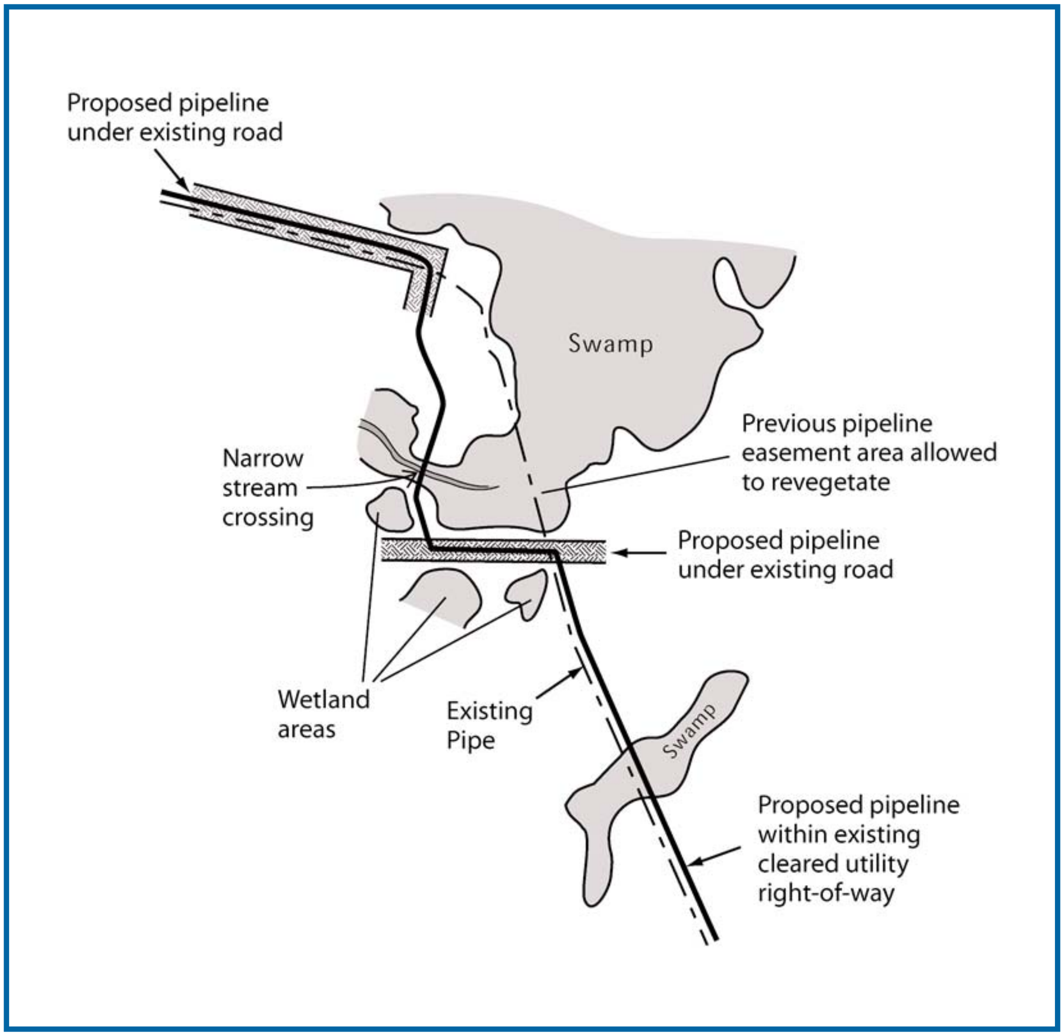
- For underground utilities through wetlands, install pipe sleeves that wires or smaller pipes can be placed within to allow for easy access for future utility maintenance and repair.
- Use wide-tired vehicles when working in or near wetlands to cause less rutting and soil disturbance.
- Use timber mats when working in or near wetlands.
- If dewatering of trenches is necessary, water must be pumped to an acceptable, properly designed dewatering basin - please see the *Rhode Island Soil Erosion and Sediment Control Handbook.*

Restoration and Maintenance efforts must also be considered during the initial planning and design phases and must be included in the application submittal.

- Plan for restoration to be completed before the end of the growing season and as soon as possible after laying the pipeline.
- Utilize a wildlife conservation seed mix on all disturbed surfaces within wetlands.
- Stabilize all disturbed areas outside of the cleared maintenance zone with grasses, and restore them with trees, shrubs or other vegetation.
- Restore wetland soils and hydrology to existing conditions or grades.
- Restore disturbed stream channels to original width and substrate.
- Maintain the area by hand cutting or mowing.
- Avoid the use of fertilizers, pesticides, herbicides, or pollutants - chemical or organic - within wetlands.
- Include a detailed maintenance schedule and a responsible entity for cutting/trimming/mowing and use of chemicals or prescribed burning.
- Include methods for completing regular and emergency repairs to utility lines.

Example 25: **Enlarged Pipeline Avoidance and Minimization**

This overhead view of a proposed enlarged pipeline illustrates several avoidance and minimization techniques that were used in the initial project design, as well as additional techniques proposed to further minimize wetland impacts.



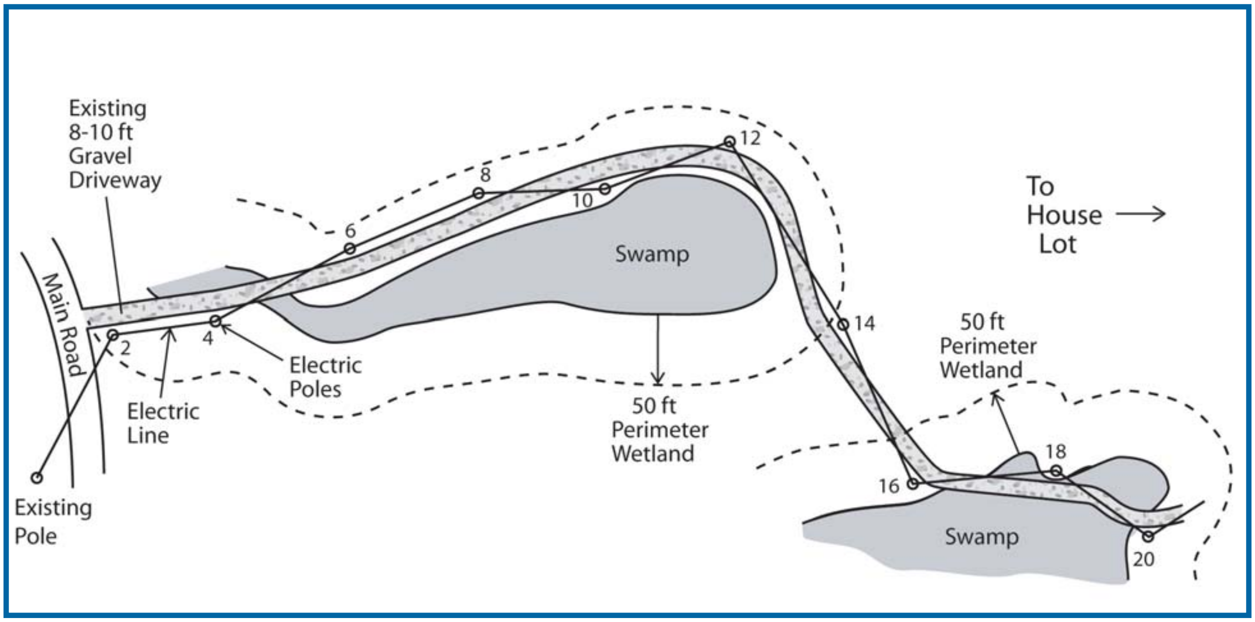
Example 25

How wetland impacts were further minimized:

- ✓ Existing utility easements and already disturbed road corridors were used to install new pipe.
- ✓ A narrow Stream area was crossed to avoid bisecting the large Swamp.
- ✓ Several other small wetland areas near the Swamp were skirted to reach the narrow crossing.
- ✓ The existing utility easement through the large swamp was allowed to revegetate.

Example 26: **Above-Ground Installation**

This example shows the installation of an overhead utility to a single-family house. The electrical wiring follows an existing gravel driveway that was constructed over 30 years ago. The electric poles were installed at the same time that the driveway was upgraded, to limit construction disturbance.



Example 26

How wetland impacts were minimized:

- ✓ The electric wires cross at narrow sections or skirt the edge of the Swamps.
- ✓ None of the approved poles were located in the Swamps, but several were installed in the Perimeter Wetlands.
- ✓ The proposed electric lines were located along an existing disturbed area.
- ✓ The electric lines zigzag back and forth across the driveway, which limits the amount of wetland and buffer area disturbance.
- ✓ Most guy wires were installed further outside of the wetland areas.
- ✓ Wooden mats were used to reduce disturbance to wetland soils in especially sensitive areas when needed.
- ✓ The existing tree canopy was maintained along both sides of the gravel driveway.
- ✓ The approved tree cutting and brush cutting were completed by hand to limit disturbance to the wetland.

Construction Methods

There are a variety of methods that can be utilized to install utility pipes. DEM needs to know what method will be utilized to determine the amount of impact a project will have on wetlands. The majority of utilities, with the possible exception of overhead electrical or phone cable wires, are installed below ground. The below-ground piping is covered by soil, and much of the area (outside of the maintained zone) is replanted. The following examples show various ways to avoid and minimize wetland impacts.

Example 27: Trenching

The diagram on the following page illustrates a proposed natural gas pipeline through a wetland area. The applicant has proposed the trenching method* to install the pipeline. Often the trenching method requires a wide construction right-of-way - sometimes over 100 feet for equipment and staging areas outside of the wetland. In order to minimize impacts in this project, the proposed width of the disturbed area was limited to less than 20 feet. This was accomplished by using one small machine to dig, lay the pipe and backfill, instead of a larger machine that requires a greater width to operate.

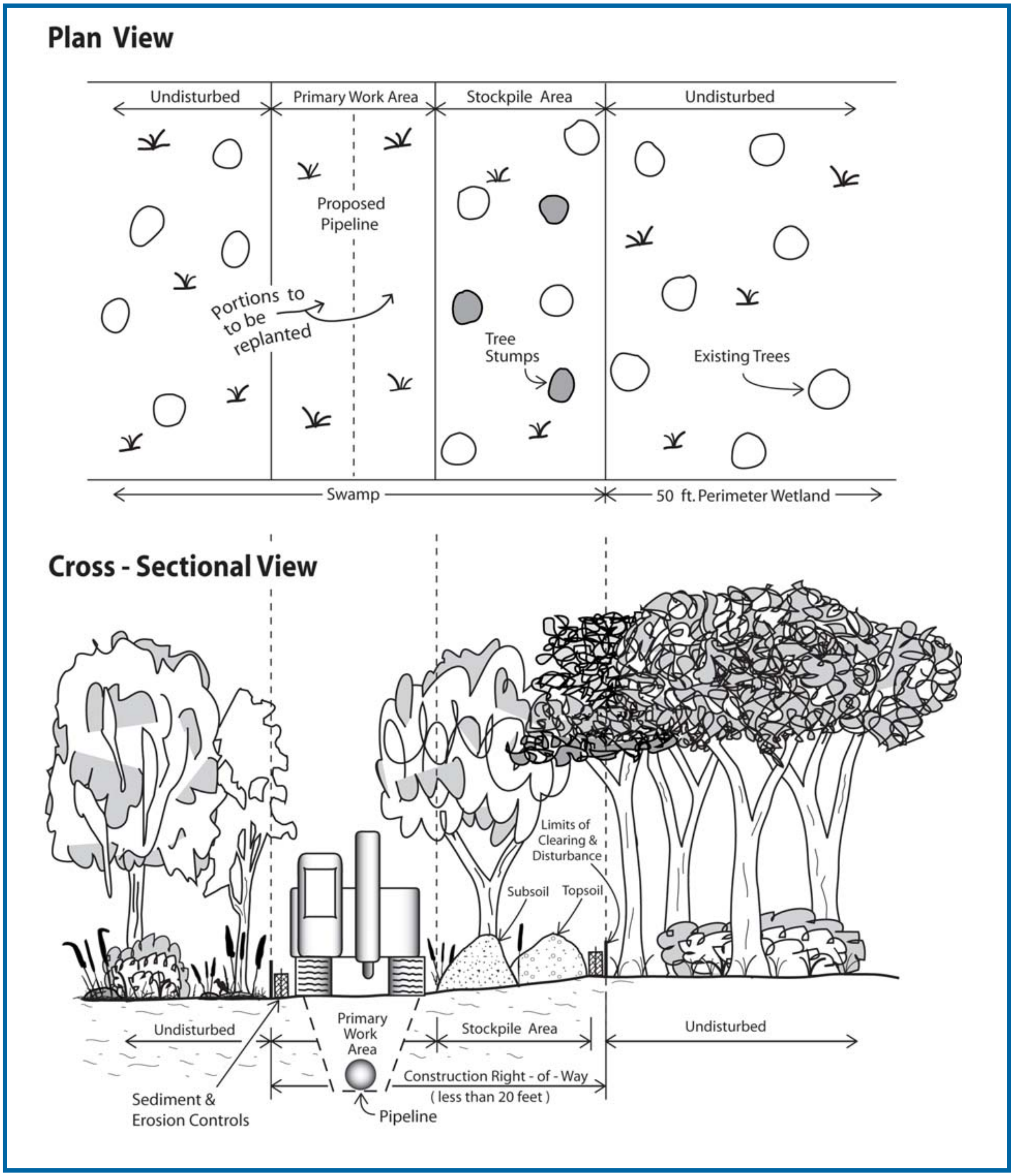
How wetland impacts were minimized:

- ✓ The primary work and stockpile areas were narrow.
- ✓ Limited vegetation was cleared for the stockpile area.
- ✓ Tight Limits of Clearing and Disturbance on either side of the construction right of way were maintained.
- ✓ The existing tree canopy was maintained.
- ✓ The amount of overall disturbance was reduced by the use of small machinery in the wetland area.
- ✓ Tree stumps were left in place to allow for re-growth after the completion of the project.
- ✓ Separation of excavated topsoil from subsoil allowed for easy and correct replacement after the pipe was installed.

The stockpile area was completely replanted upon completion of the project. The primary work area was lightly revegetated (no large woody vegetation), thereby allowing a narrow corridor to be maintained for access to the pipeline.

***Variation:** A variation of the trench method can be used when installing pipe across large bodies of water. Often if a trench is dug up to the wetland area, then the pipe can be floated into place across the wetland by attaching buoyant devices to the pipe. Once these are removed the pipe will sink into place.

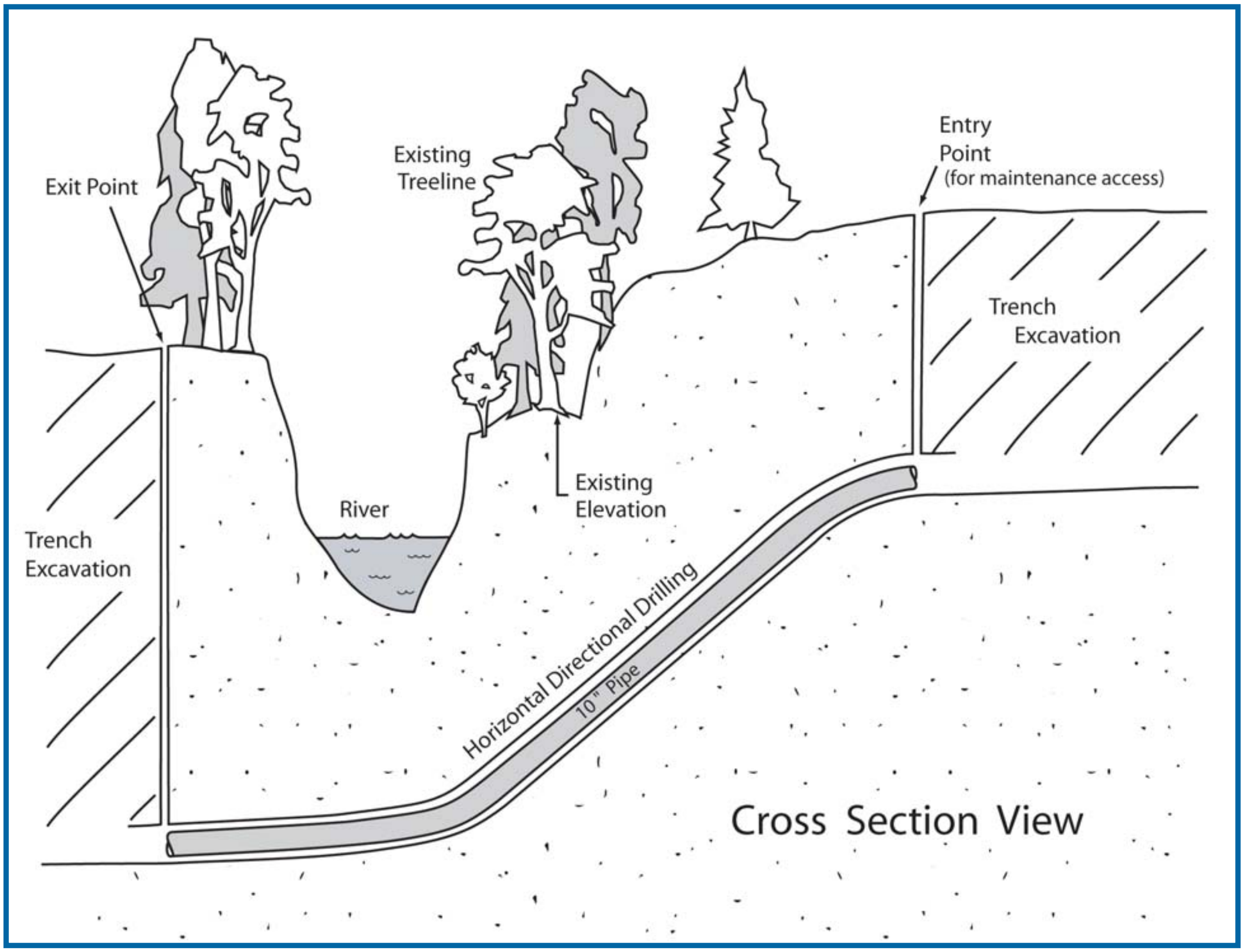
Example 27: **Trenching**



Example 27

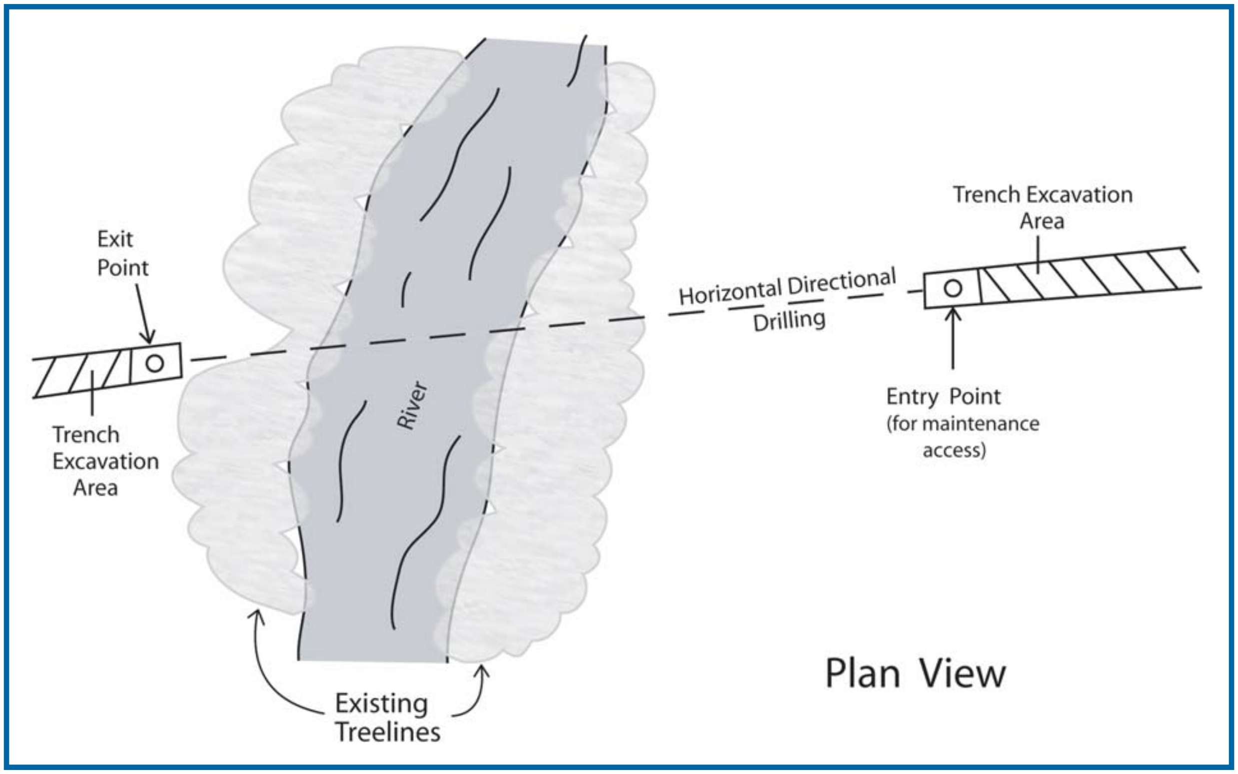
Example 28: **Horizontal Directional Drilling**

This example shows a cross section of land where the horizontal directional drilling method was used to install piping. Although expensive, this method was completed with the least amount of wetland impact. A guided drillhead bore down horizontally under roads, wetlands, vegetation and buildings. This method is most commonly used for short spans under wetlands. Boring machines are able to drill through nearly any type of soil; however, the pipe installation method depends on the substrate, as well as the season. Once installed, the pipeline will be maintained in the same way using a guided drillhead (often with a camera attached) to find the problem area. A broken pipe may be replaced with a new pipe or sealed with chemical compounds.



Example 28a

Example 28: **Horizontal Directional Drilling Continued**



Example 28b

How wetland impacts were minimized:

- ✓ There was no disturbance to wetland, wildlife, habitat or vegetation because entry and exit points were located outside of wetland areas.
- ✓ The pipe was installed a minimum of 10 feet below the river bottom to avoid impacts to the River.
- ✓ A small work area was required for the initial hole, and limited equipment was used.
- ✓ The work area was located outside of the 100-year Floodplain Wetland.
- ✓ There is no cleared corridor to maintain.

Sometimes a pipe-bursting technique is used to destroy an old pipe, then a new (sometimes larger) pipe is installed through a push and pull method.

9. Wetland Crossings

Well-designed crossings allow wildlife unrestricted access to a watershed, maintain natural conditions without becoming barriers to fish, and help protect roads and property from the damaging effects of floods. If it is determined that a wetland cannot be avoided and must be crossed to access an upland area, it is essential to design an appropriate crossing that minimizes adverse effects.

If not properly designed and constructed, wetland crossings can fragment linear habitat corridors, disturb or block fish and wildlife passage, alter ecosystem processes and aquatic communities, flood roads and property, and compromise water quality. Problems are often encountered when crossings are undersized, perched, or result in water depths that are too shallow. The following negative consequences commonly result from poor design, improper structure selection, or careless construction:

- Water velocities increase in undersized crossings, thus degrading fish and wildlife habitat while also possibly weakening the integrity of a structure
- High water velocities scour and erode natural substrates, thus degrading habitat;
- Water can pond upstream of undersized culverts which can cause changes to the existing habitat while also leading to property flooding and road and stream erosion;
- Undersized crossings may also become blocked with debris and be time-consuming and costly to regularly maintain;
- Perching of a crossing outlet leaves the structure above the natural bottom and thereby acts as a barrier; and
- Water depths that are too shallow for fish and wildlife movement may occur, especially during seasonal low flows.

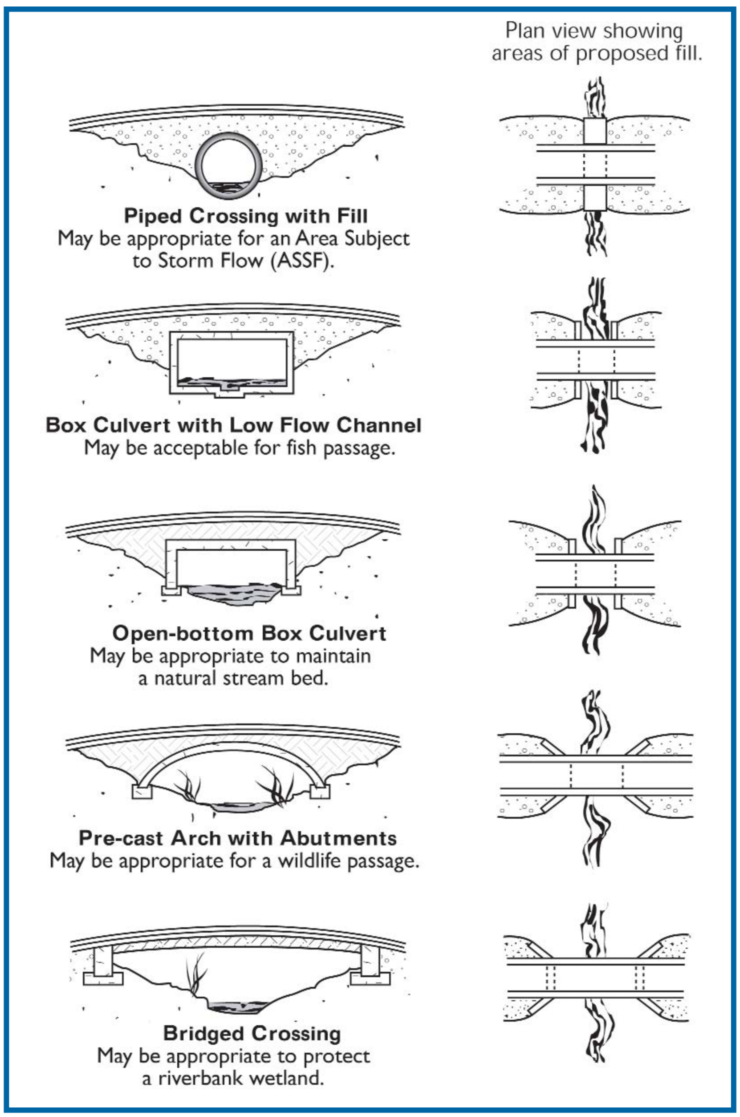
Best Practices for All Types of Crossings

- Avoid crossing open bodies of water, rivers, streams or other wetlands if possible.
- Where crossings are unavoidable, design them to traverse a narrow section of wetland.
- Use or upgrade existing paths, cart paths, roads, or other authorized disturbed areas so as to avoid previously undisturbed locations.
- Design a crossing that keeps disturbance to a minimum and spans as much of the wetland and perimeter or riverbank, floodplain, and floodway wetland as possible.
- Avoid disturbance to streambeds, wetland soils, and other vegetation.
- Avoid fragmenting wetland wildlife habitat by building away from wildlife travel corridors.
- Avoid crossing through or bisecting a wetland wildlife breeding area.
- Minimize light and noise disturbance on roadways by installing plantings to act as a buffer on the sides of roadways.

- Consider using pre-cast bridges, especially for long spans, that allow installation to be completed with minimal contact with the wetland.
- Design and construct wildlife crossings that attempt to preserve existing light conditions and maintain soil moisture levels similar to existing natural conditions.
- Maintain existing elevations, or consider installing retaining walls to reduce disturbance and side slope fill.
- Restore stream channels to natural conditions if disturbance of the channel is unavoidable.
- Avoid impounding water up-gradient of the crossing.
- Maintain existing side slope grades, as much as possible, to minimize fill and any wetland loss.
- Minimize the extent of fill needed on top of a crossing structure by limiting the increase of the road grade as it approaches the crossing point.

Crossing Structure Selection

A number of different structures can be used to cross wetlands, including rivers and streams. Each project and wetland to be crossed is different, and a structure that may be appropriate in one situation may not be sufficient for another.



This illustration was modified from a State of Connecticut manual on site design practices (Callahan et al. 1992). It depicts various crossing options, from the most constraining for fish and wildlife to the least constraining.

Arch culverts and bridge spans or open-bottom culverts are clearly preferred for maintaining wetland continuity and protecting existing habitat conditions and quality.

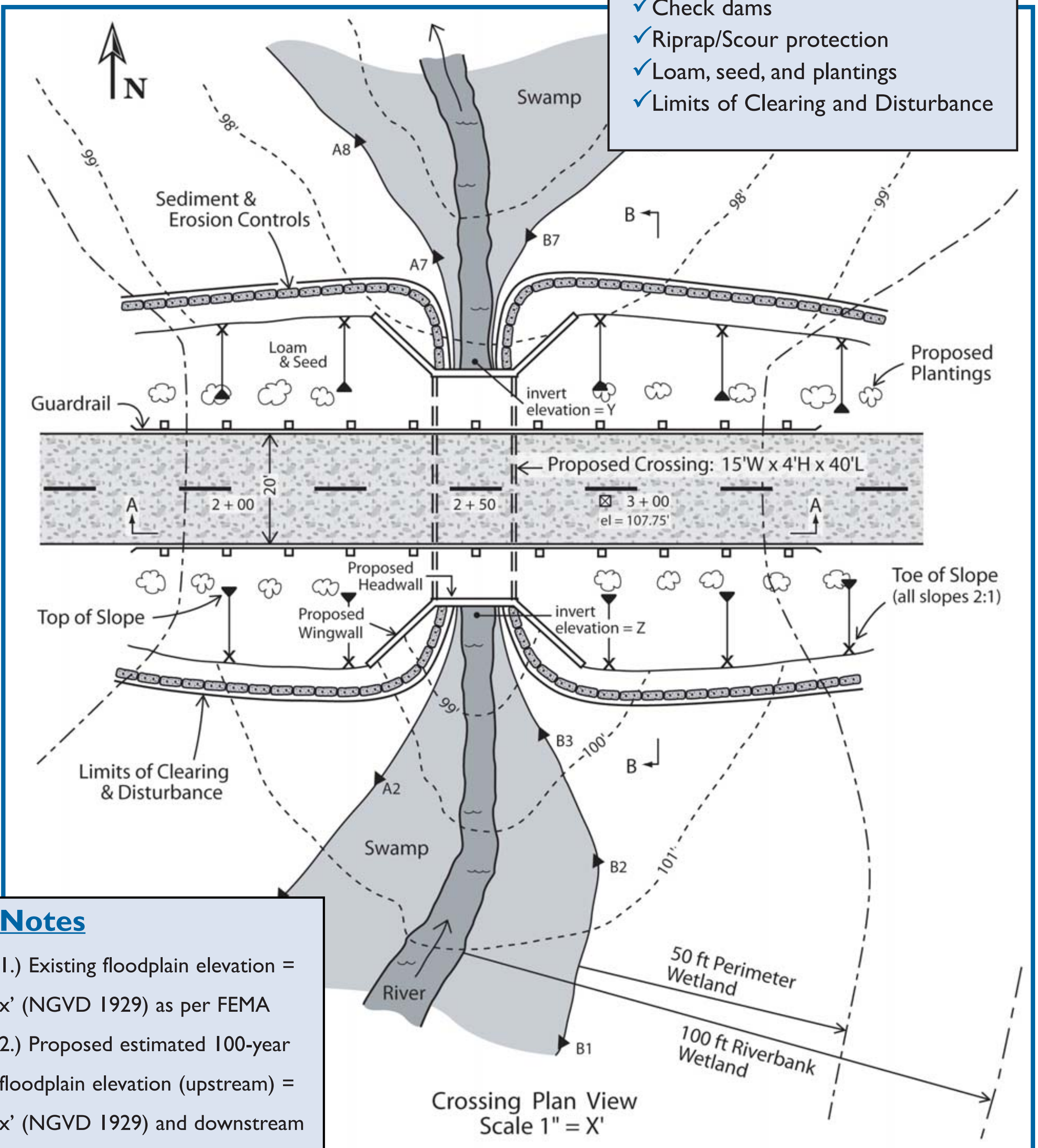
Example 29

Example 30: **Detailed Labeling Required for Crossings**

In addition to the labels required on a full site plan, all plan details included in a wetland application submittal must be completely labeled, as in the example below. Other views, such as a cross section or profile view, may need additional labels for elevations and dimensions.

Crossing Labels

- ✓Existing and proposed contours
- ✓Spot elevations
- ✓Floodplain information
- ✓Cross section locations
- ✓Surface course
- ✓Invert elevations
- ✓Structure dimensions
- ✓Toe of Slope
- ✓Check dams
- ✓Riprap/Scour protection
- ✓Loam, seed, and plantings
- ✓Limits of Clearing and Disturbance



Crossing Plan View
Scale 1" = X'

Notes

1.) Existing floodplain elevation = x' (NGVD 1929) as per FEMA

2.) Proposed estimated 100-year floodplain elevation (upstream) = x' (NGVD 1929) and downstream elevation = y' (NGVD 1929)

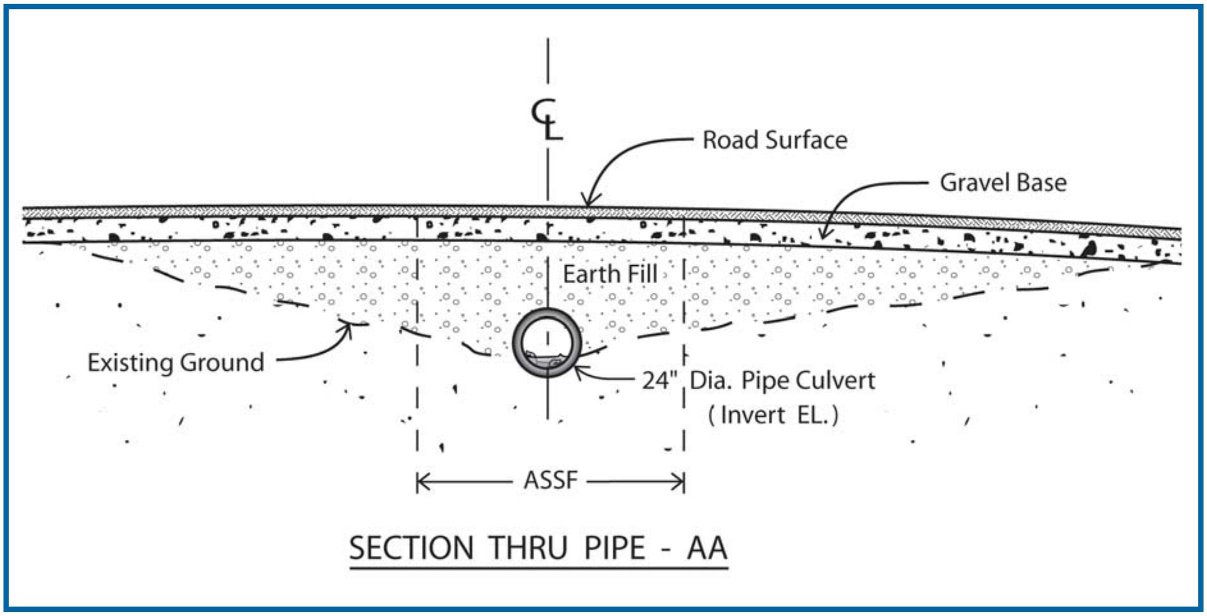
Example 30

Overtopping

Each of the following three examples, as well as the wildlife crossings, carries the potential for "overtopping" during severe rain periods. Consider the quantity of flow involved, such as in a 100-year storm event. If the profile of the road is gentle, creating a broad, shallow weir, flow will overtop in a broad shallow depth. This will minimize potential for washout of the road surface and may be less dangerous in a major flood event.

Example 31: Piped Culvert Crossing

Driveway construction that traverses a wetland is one of the most common types of proposed crossings. The proposed driveway in this example skirts the edge of a piece of property to cross a wetland in a narrow section, in order to reach a large upland area on the southern end of the property. A proposed pipe culvert channels the water from an Area Subject to Storm Flowage (ASSF) underneath the new driveway crossing. A culvert of this type is sufficient for this crossing because the area is not consistently wet.



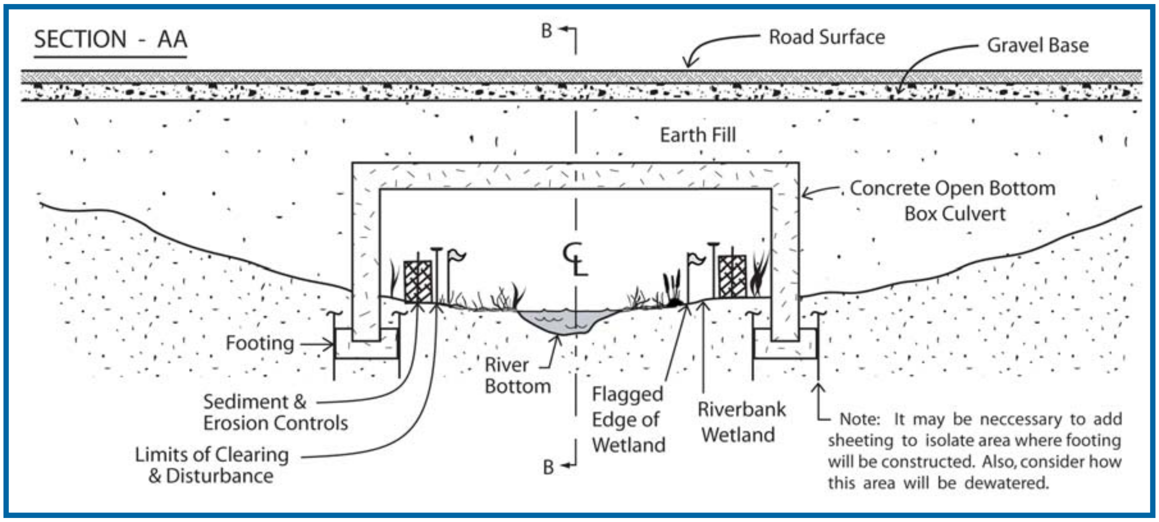
Example 31

How wetland impacts were minimized:

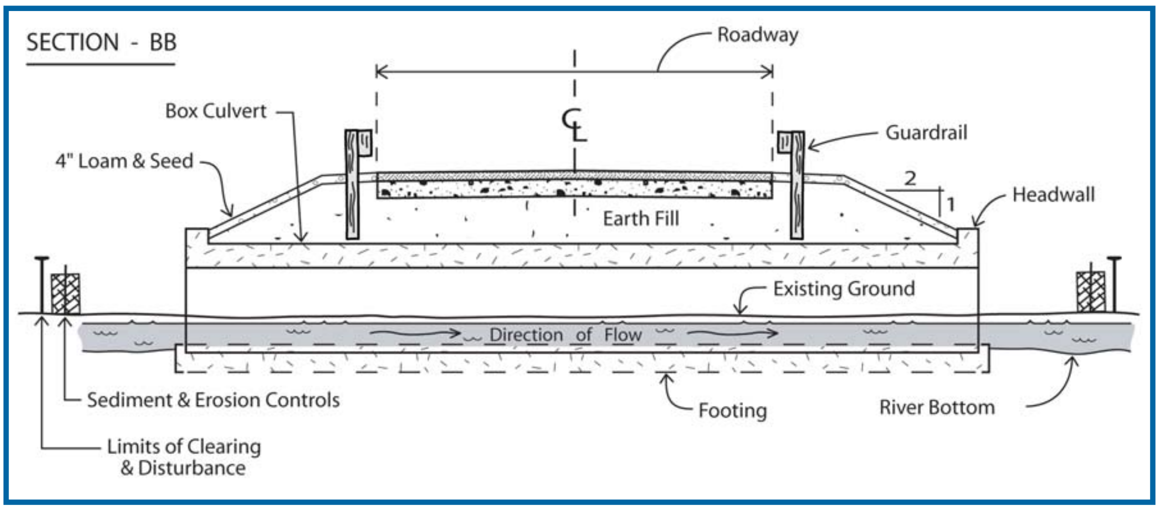
- ✓ The crossing traverses a narrow part of the Area Subject to Storm Flowage.
- ✓ The driveway is fairly narrow, so that no more wetland is disturbed than necessary.
- ✓ The earth fill over the culvert is kept to a minimum and is sufficient to satisfy the structural capacity of the pipe.
- ✓ The buffer plantings on either side of the driveway help prevent sedimentation of the wetland and erosion of the slope.
- ✓ Narrow Limits of Clearing and Disturbance are maintained.

Example 32: Open-Bottom Box Culvert Crossing

A subdivision roadway is a common type of wetland crossing. The roadway in this example skirts several properties to reach the upland north of the River and Swamp, thus placing the new subdivision more than 200 feet from the wetland area to be crossed. This example illustrates an open-bottom box culvert used to cross the River and Swamp. While acceptable, the best type of crossing design would span a greater portion of upland on either side of the River and Swamp and require less fill. A different type of structure might be necessary to accomplish such a design.



Example 32a



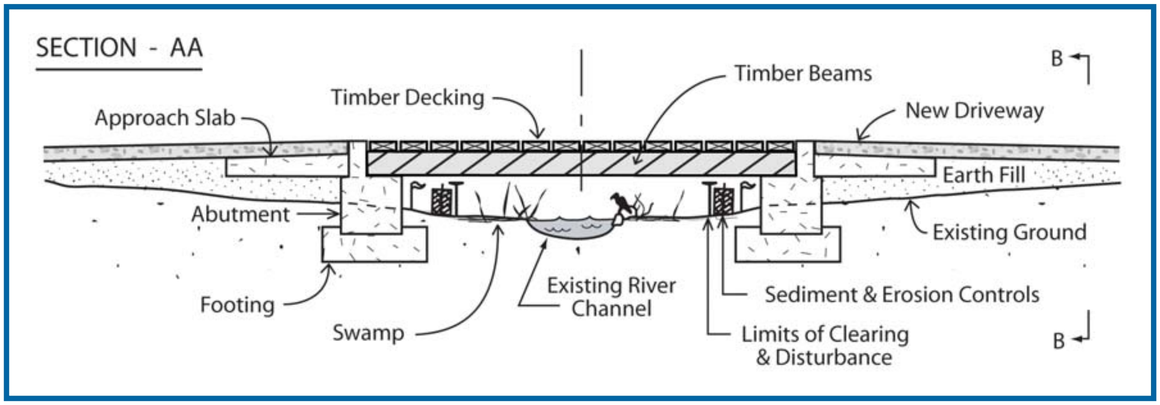
Example 32b

How wetland impacts were minimized:

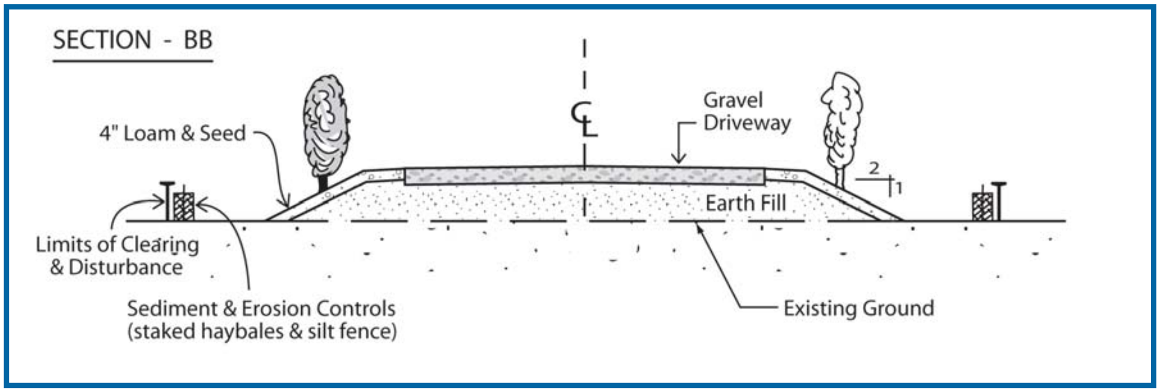
- ✓ The open-bottom culvert allows the Stream to flow freely in the natural streambed.
- ✓ Plantings along the edge of the road buffer the wetlands from noise and light.
- ✓ Narrow Limits of Clearing and Disturbance were maintained.
- ✓ Sediment and erosion controls were used to enclose and isolate the construction zone to prevent sediment from flowing downstream.
- ✓ Upon completion of the project the adjacent Riverbank Wetland was returned to its previous condition.

Example 33: Timber Bridge Crossing

This is an example of a residential driveway that crosses a River and Swamp to reach an upland area. This proposed design uses a timber bridge to cross the wetland complex. This crossing could be improved with a wider span that would also breach some of the upland on either side.



Example 33a



Example 33b

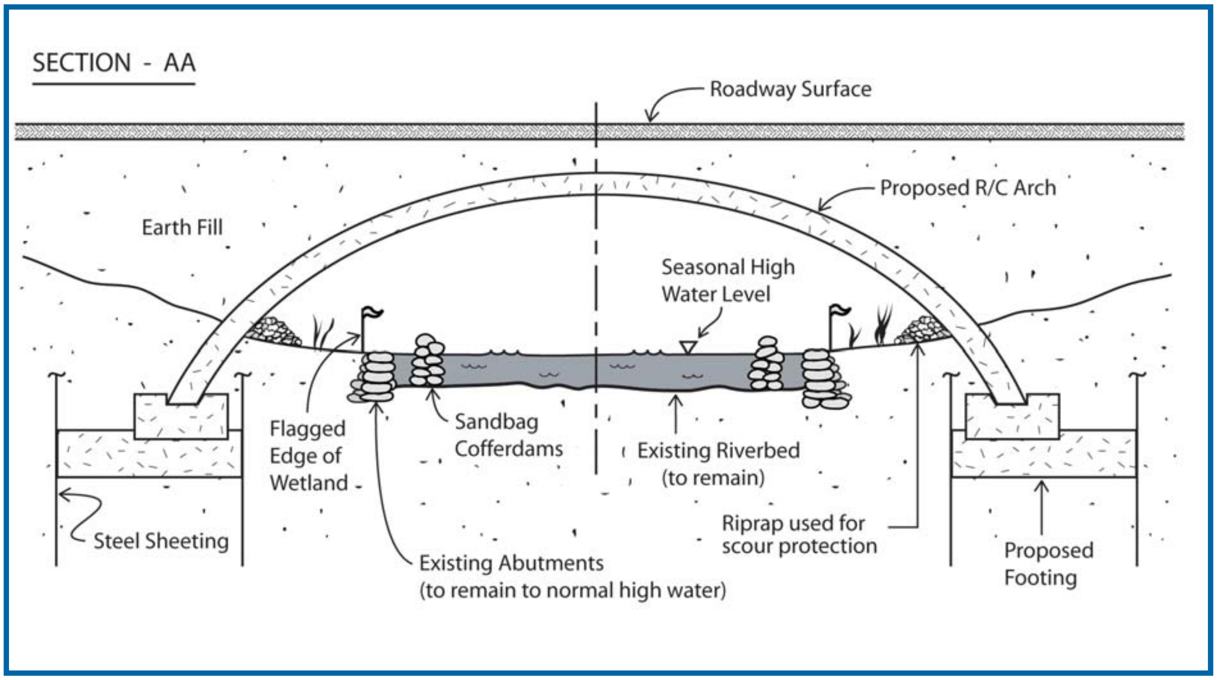
How wetland impacts were minimized:

- ✓ A narrow section of the wetland was utilized for the crossing.
- ✓ The Limits of Clearing and Disturbance on either side of the driveway were kept narrow considering the grade change necessary to cross over the wetland.
- ✓ The bridge spans the entire Swamp and River to allow for the free flow of water for fish and adequate passage for wildlife.
- ✓ Plantings along the edge of the road buffer the wetland from noise and light.
- ✓ The driveway leading up to the bridge was constructed of gravel, a porous material, which promotes water infiltration, reduces runoff and provides groundwater recharge.
- ✓ Sediment and erosion controls were used to enclose and isolate the construction zone to prevent sediment from flowing downstream.
- ✓ Upon completion of the project the adjacent Riverbank Wetland was returned to its previous condition.

Note: DEM prohibits the use of creosote to treat wood used near wetland crossings. However, CCA is acceptable for treatment.

Example 34: **Concrete Arch Crossing**

This example depicts a road upgrade that accommodates increased travel and increased wetland protection through a wider span of the wetland. The existing bridge was removed and replaced with a reinforced concrete arch.



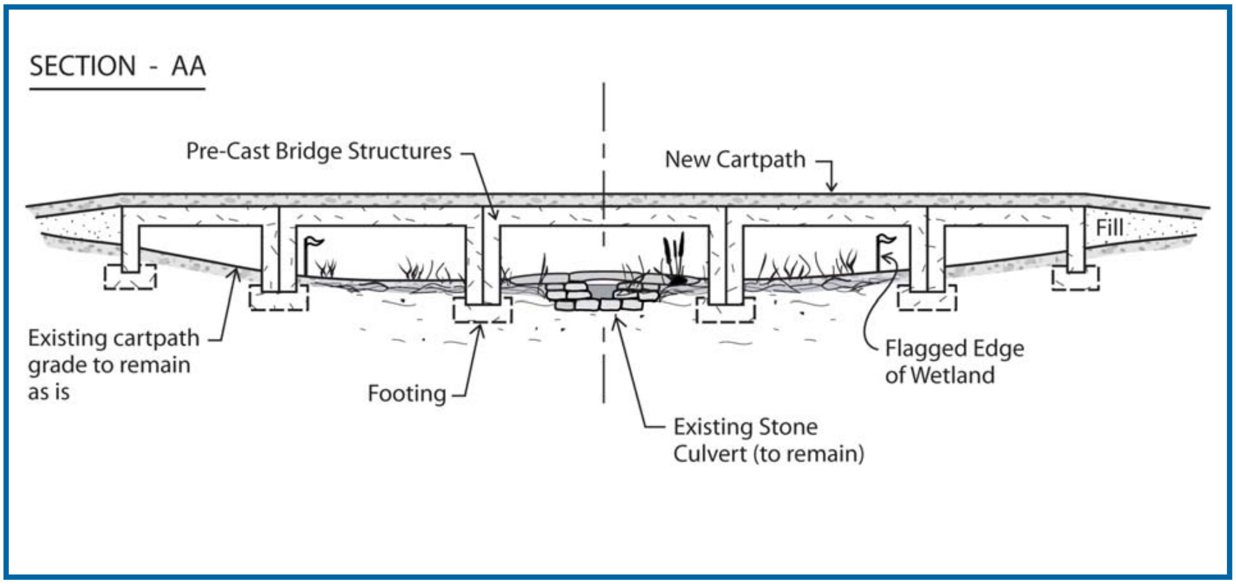
Example 34

How wetland impacts were minimized:

- ✓ The new bridge spans the entire River and a portion of the Riverbank Wetland will be restored on either side, allowing for the free flow of water and restoring a passage for wildlife.
- ✓ The Limits of Clearing and Disturbance on either side of the road are narrow.
- ✓ The arch was pre-cast and then installed from overhead, thus minimizing contact and disturbance to the wetland during installation.
- ✓ Retaining walls on either side of the road limit fill and reduce noise and light disturbance to the wetland.
- ✓ The temporary sandbag cofferdams helped to contain sediment during construction.

Example 35: **Multi-Span Bridge Crossing**

This driveway crossing was elevated above the existing grade of an old cartpath which leads to a small upland area near the rear of the property. By utilizing the existing crossing, the applicant avoided almost all other wetland impacts on a large piece of property. While not always typical for driveway crossings, this example does a great job of spanning the wetland.



Example 35

How wetland impacts were minimized:

- ✓ The driveway was built on an old cartpath where the vegetation had been previously disturbed.
- ✓ The existing crossing culvert remained in place to reduce disturbance to the wetland and to maintain existing hydrological conditions.
- ✓ All of the River and Swamp, and some of the Perimeter and Riverbank Wetland were spanned.
- ✓ The original tree canopy was maintained where possible, and there were a number of buffer plantings added surrounding the disturbed area.
- ✓ The pre-cast bridge structures were installed from overhead by crane, which limited the length of time the wetland area was disturbed.
- ✓ The driveway leading up to the bridge was constructed of gravel, a porous material, which promotes water infiltration, reduces runoff and provides groundwater recharge.
- ✓ Limits of Clearing and Disturbance were confined to within the existing cartpath corridor.

Construction Considerations

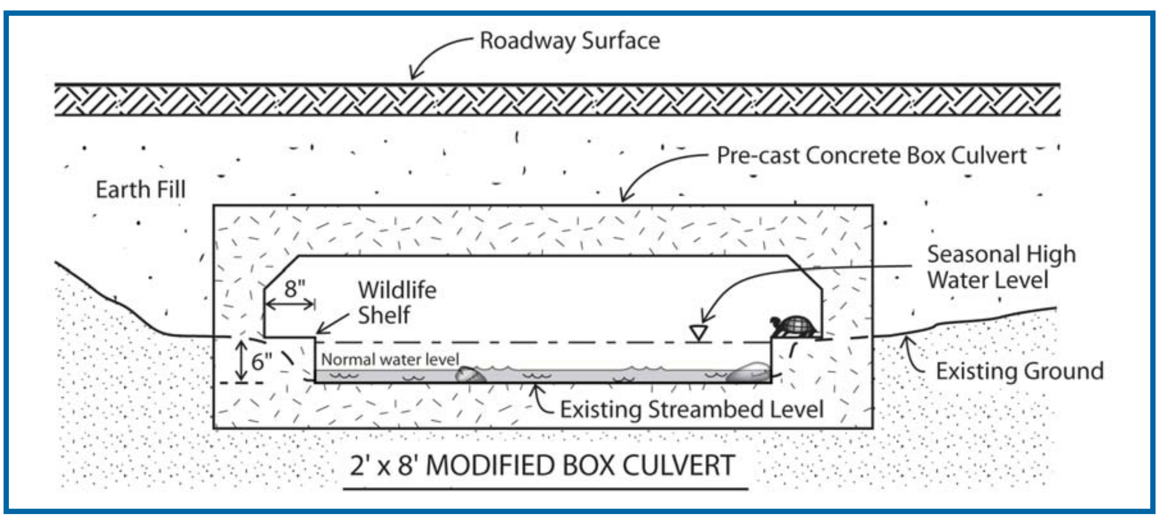
- Sequence and duration of project - Work within waterways should be limited to the low flow period of July 1 - October 31.
- Diversion of flow - In some crossing situations, river or stream flow may need to be diverted during construction. If unavoidable, plan ahead and include information on the plans about flow diversion to minimize impacts while considering the following issues:
    - Duration of the proposed construction;
    - Dewatering;
    - Quantity of flow; and
    - Design of the diversion device.

  To ensure minimization of wetland impacts, it is important to plan ahead and include information about flow diversion in a wetland application package.
- Phasing of work - Include information in the application if a project will be constructed in phases, and try to limit the amount of time wetlands will be impacted.
- Sediment and erosion controls for dewatering - All controls must be in place prior to beginning of work and must be maintained for the life of the project.

Wildlife Crossings

The following are two examples of wildlife crossing structures that could be used in conjunction with or alongside another wetland crossing. Wildlife crossing structures can be used when a wetland is being crossed, or when any wildlife habitat is being bisected. It is important to first research what types of wildlife live in the area and what paths they travel. This information helps determine where to locate a wildlife crossing and what type of structure is most suitable. It has been reported that if wildlife can see through to the other end of a crossing, they are more likely to use it. Please consider this when designing a wildlife crossing structure. It is also important to consider design elements, such as the volume of water during various storm events, that the wildlife crossing structure will need to accommodate.

Example 36a: **Modified Box Culvert**



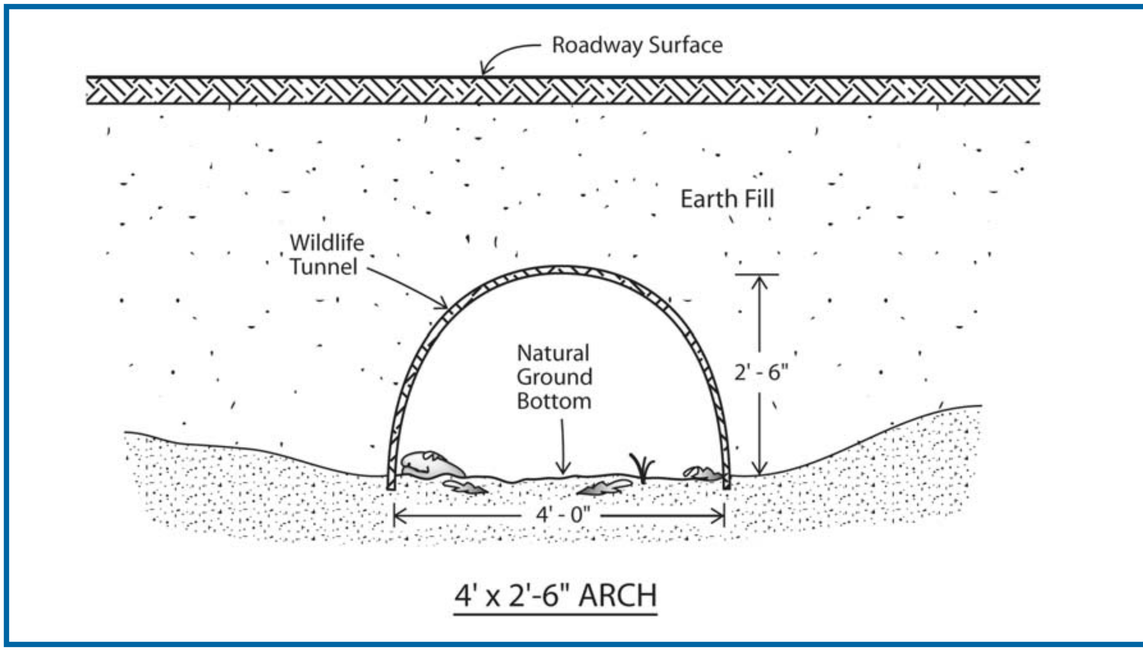
Example 36a

How impacts to wetland wildlife were minimized:

- ✓ This structure allows movement of water.
- ✓ There is a shelf for small amphibians (frogs, salamanders, etc.) to use for travel inside the structure.
- ✓ The shelf is level with the final soil grade, which allows small mammals easy access and use.
- ✓ The shelf adds little cost to the overall project when incorporated from the beginning.

While a modified box culvert with a shelf may need to be special ordered, they are available or can be built. The designer may consider adding concrete or stone blocks inside a standard culvert to build wildlife passage shelves.

Example 36b: **Polyethylene Arch**



Example 36b

How impacts to wetland wildlife were minimized:

- ✓ The arch was built alongside a wetland driveway culvert.
- ✓ A natural ground bottom allows easy travel for small and medium-sized animals.
- ✓ A larger tunnel allows more light to filter inside, which creates a more natural environment.

References

This list provides additional sources for information on wetland crossings. See Chapter 12 for complete citations arranged by author.

- *Ecological Considerations in the Design of River and Stream Crossings* by S.D. Jackson (2003)
- *Massachusetts Stream Crossings Handbook* by Massachusetts Riverways Program (2005)
- *Overview of Transportation Impacts on Wildlife Movement and Populations* by S.D. Jackson (2000)
- *Proposed Design for an Amphibian and Reptile Tunnel* by S.D. Jackson (1997)
- *Road Ecology, Science and Solutions* by R.T.T. Forman et al. (2003)
- *Strategy for Mitigating Highway Impacts on Wildlife* by S.D. Jackson and C.R. Griffin (2000)
- *Stream Crossing Guidelines* by Connecticut Department of Environmental Protection (2008)
- *Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings* by United States Forest Service (2008)

Perched Crossing

Illustration by Christopher Rowe, adapted from the Massachusetts Stream Crossings Handbook

10. Plantings

Plantings are an extremely important part of any project proposed in or near wetlands. They help screen and protect wetland wildlife from human presence, light, and other disturbances. Several dense rows of plantings can form an effective fence when planted at the edge of a disturbed area. A planted buffer also helps slow the flow of water, promote infiltration of runoff, and allow sediment to settle out before it reaches the wetland. A dense ground cover of grasses can also help filter polluted water before it enters the wetland. A careful selection of plantings provides shelter, food, and breeding sites for wildlife, and a tree canopy helps regulate temperatures in a wetland by shading the water during summer. For these reasons and others, please consider the following when designing and installing a planting scheme:

Planning and Design

- Take into account the physical conditions of the site, including light levels and soil moisture, to help in plant selection.
- Consider restoring previously disturbed areas with plantings, even if the disturbance is not a result of the current project.
- If a limit of disturbance borders a thickly wooded area, additional plantings may not be necessary; however, plantings in a previously cleared area can provide added protection to the wetland.
- Two or more rows of plantings provide a thick buffer; however, sometimes a single row is sufficient if the project is next to an already vegetated area that currently buffers the wetland.
- Generally, trees should be planted 6-10 feet on center and shrubs 5-6 on center. Depending on the purpose of the plantings, recommended spacing will vary.
- Only native plant stock should be used. Invasive or exotic species can overtake and eliminate native vegetation.
- Consider eliminating any invasive species that are currently growing in areas to be planted because they often overtake native species. Also, be mindful of exposed mineral soils that are especially susceptible to invasive species.
- Generally the best time to plant is during spring (May 1 - June 15) or fall (September 1- November 15). Plantings can be installed during the dry summer months if they are balled and burlapped and regularly watered. Transplanted trees or shrubs should be planted during early spring before leaves appear, in late fall, or in early winter. Be sure to check each species for the recommended planting season.
- To ensure proper plant selection and viability, the use of a landscape professional is recommended.
- Avoid planting large woody vegetation, such as trees and tall shrubs, on detention or infiltration basin fill embankments and near basin outlet structures.
- Avoid planting trees within at least ten feet of underground infiltration systems.

Site Restoration after Planting

- After site construction is complete, final grading and landscaping should be completed as soon as possible to minimize erosion and help ensure that invasive species don't take root and spread. It is important to plan project completion and planting installation for the appropriate season.
- All sediment and erosion controls should be removed once planting is completed, and all disturbed surfaces must be adequately stabilized.
- All disturbed surfaces that require stabilization should be covered with a plantable soil or loam, seeded with a native wildlife conservation grass seed mix, or stabilized with a mat of loose hay mulch after the project is completed.
- If a surface area in or near a wetland does not require stabilization, then it must simply be allowed to revert to a wild condition after plantings are complete.
- Steep surfaces may require extra matting, such as excelsior matting or jute mesh.
- Within jurisdictional areas, no future clearing, mowing, cutting or trimming of restored areas should occur.

Maintenance

- All plantings should be monitored to ensure that they survive through one growing season (longer for certain projects); if not, they must be replaced with the same species.
- Consider that new plantings will require watering and care to ensure survival.

Information to Include on the Site Plan

- A planting legend should be included if several different varieties of trees and shrubs are proposed; otherwise, the type of tree or shrub should be clearly labeled.
- Proposed planting heights, species (both common and scientific names), spacing, and quantity should also be included.
- It is also necessary to include detailed notes on when the plantings will be installed, the purpose of the plantings (either screening or wildlife food and cover), and how the plantings will be maintained (such as being left unmanicured).
- Planting diagrams should be included to illustrate how plantings will be installed. The Rhode Island Standard Details from the Department of Transportation is a good information source.

Categories of Plantings

Planting proposals for Wetland application submittals generally fall into two categories: 1) Plantings used for screening to block noise, light, and other disturbances from the wetlands; and 2) Plantings that provide food, cover, and nesting habitat for wildlife.

A good planting scheme should use both categories to adequately mitigate impacts to wetlands. Screen plantings are commonly used to either mark an edge of the Limits of Clearing and Disturbance or to create a thick buffer between the project area of continuous use and a wetland. They are most often evergreen trees because evergreens provide a thick year-round buffer. Other plantings (deciduous or evergreen) that are intermixed or behind the screen plantings offer a variety of food, cover and nesting options for wetland wildlife. Deer resistant types of evergreen plants are a good choice for plantings, either alone or in combination with berry producing shrubs.

It is also important to use native, naturalized, and locally grown plantings as often as possible, instead of cultivars plantings, or others that have been genetically modified or imported from another region or country. It is important to plan ahead and have plantings ready because it is sometimes difficult to find appropriate species. The following is a list of trees, shrubs, vines, and groundcover for potential use in Wetland Application submittals to DEM. This list is not all-inclusive, but it should be used as a guideline when choosing plantings.

Guidelines for Choosing Appropriate Plantings

Moderate to fast growing

Trees

- Eastern white pine, *Pinus strobus*
- *Thuja occidentalis nigra*
- Eastern hemlock, *Tsuga canadensis*
- *Juniperus spp.*
- White spruce, *Picea glauca*

Shrubs

- Southern arrowwood, *Viburnum dentatum*
- *Cornus spp.*

For a flowering, fruiting or evergreen hedge

Trees

- Eastern white pine, *Pinus strobus*
- Eastern hemlock, *Tsuga canadensis*
- *Thuja occidentalis nigra*
- *Cornus spp.*
- *Juniperus spp.*

Shrubs

- Northern bayberry, *Myrica pensylvanica*
- Southern arrowwood, *Viburnum dentatum*
- *Aronia spp.*

For a wet location

Trees

- Red maple, *Acer rubrum*
- Red ash, *Fraxinus pennsylvanica*
- Sweet gum, *Liquidambar styraciflua*
- Black gum, *Nyssa sylvatica*
- Sycamore, *Platanus occidentalis*
- Swamp white oak, *Quercus bicolor*
- Pin oak, *Quercus palustris*
- American Elm, *Ulmus Americana*
- *Thuja occidentalis nigra*
- *Amelanchier spp.*
- *Salix spp.*

Shrubs

- Red chokeberry, *Aronia arbutifolia*
- Swamp-azalea, *Rhododendron viscosum*
- Fringe-tree, *Chionanthus virginicus*
- Sweet pepperbush, *Clethra alnifolia*
- Silky dogwood, *Cornus amomum*
- Gray dogwood, *Cornus racemosa*
- Red osier dogwood, *Cornus sericea*
- Inkberry, *Ilex glabra*
- Winterberry, *Ilex verticillata*
- Northern spicebush, *Lindera benzoin*
- Swamp-rose, *Rosa palustris*
- Large pussy willow, *Salix discolor*
- Highbush blueberry, *Vaccinium corymbosum*
- Southern arrowwood, *Viburnum dentatum*
- Sweet viburnum, *Viburnum lentago*
- Purple osier (basket) willow, *Salix purpurea*
- Buttonbush, *Cephalanthus occidentalis*
- Highbush cranberry, *Viburnum opulus*
- *Alnus spp.*

Guidelines, continued

For a drier location

Trees
- Sugar maple, *Acer saccharum*
- Honey-locust, *Gleditsia triacanthos*
- Yellow poplar, *Liriodendron tulipifera*
- Sweet gum, *Liquidambar styraciflua*
- Sassafras, *Sassafras albidum*
- Northern white cedar, *Thuja occidentalis*
- *Carpinus spp.*
- *Fraxinus spp.*
- *Juniperus spp.*
- *Pinus spp.*
- *Quercus spp.*
- *Picea spp.*

Shrubs
- Gray dogwood, *Cornus racemosa*
- Northern bayberry, *Myrica pensylvanica*
- Beach plum, *Prunus maritima*
- New England rose, *Rosa nitida*
- Lowbush blueberry, *Vaccinium angustifolium*
- *Juniperus spp.*
- *Rhus spp.*

For partially shaded locations

Trees
- Serviceberry, *Amelanchier canadensis*
- Fringe-tree, *Chionanthus virginicus*
- Black gum, *Nyssa sylvatica*
- Eastern hemlock, *Tsuga canadensis*
- *Carpinus spp.*
- *Cornus spp.*

Shrubs
- Sweet pepperbush, *Clethra alnifolia*
- Mountain laurel, *Kalmia latifolia*
- Northern spicebush, *Lindera benzoin*
- Giant rhododendron, *Rhododendron maximum*
- Southern arrowwood, *Viburnum dentatum*
- Sweet viburnum, *Viburnum lentago*
- *Aronia arbutifolia brilliantissima*
- *Hamamelis spp.*
- *Ilex spp.*
- *Leucothoe spp.*

Deer resistant plants

Trees
- White spruce, *Picea glauca*
- White pine, *Pinus strobus*

Shrubs
- American holly, *Ilex opaca*
- Inkberry, *Ilex glabra*
- Mountain laurel, *Kalmia latifolia*

Berry-bearing, especially attractive to birds

Trees
- Serviceberry, *Amelanchier canadensis*
- Fringe-tree, *Chionanthus virginicus*
- Black gum, *Nyssa sylvatica*
- Eastern red cedar, *Juniperus virginiana*
- Sassafras, *Sassafras albidum*
- American holly, *Ilex opaca*
- *Crataegus spp.*
- *Cornus spp.*

Shrubs
- Northern spicebush, *Lindera benzoin*
- Common elderberry, *Sambucus canadensis*
- Highbush blueberry, *Vaccinium corymbosum*
- *Aronia arbutifolia brilliantissima*
- *Cornus spp.*
- *Ilex spp.*
- *Rosa spp.*
- *Viburnum spp.*

Vines
- Native grapes, *Vitas spp.*
- Virginia creeper, *Parthenocissus quinquefolia*

Note: Vines should be planted so that they can climb on something, such as a fence or wall. They can be problematic for adjacent shrubs and trees if used as groundcover.

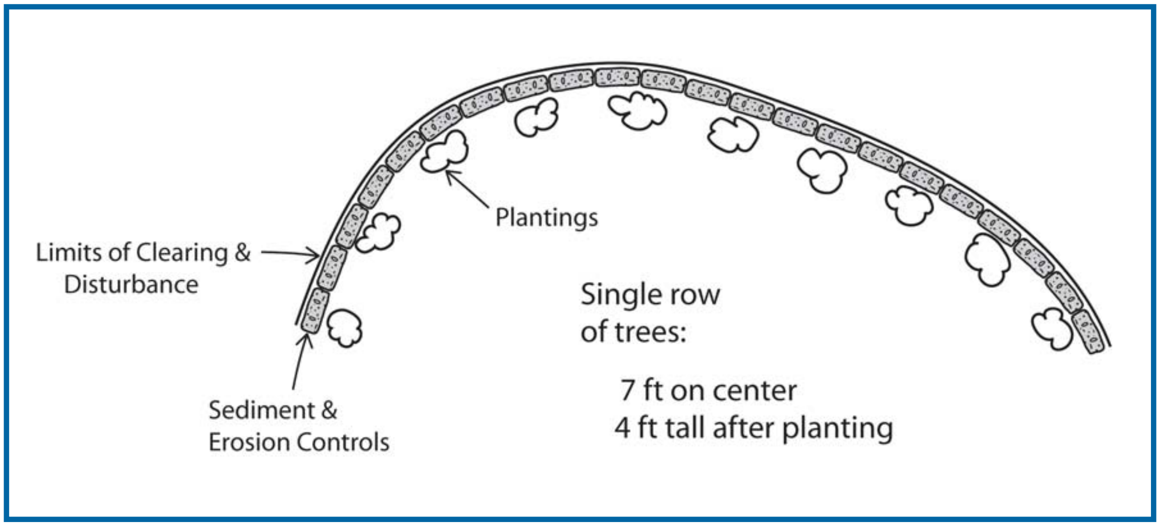
Guidelines, continued

Native Groundcover: A native, non-invasive wildlife conservation grass mix within buffer areas or wet mix within a wetland can be used.

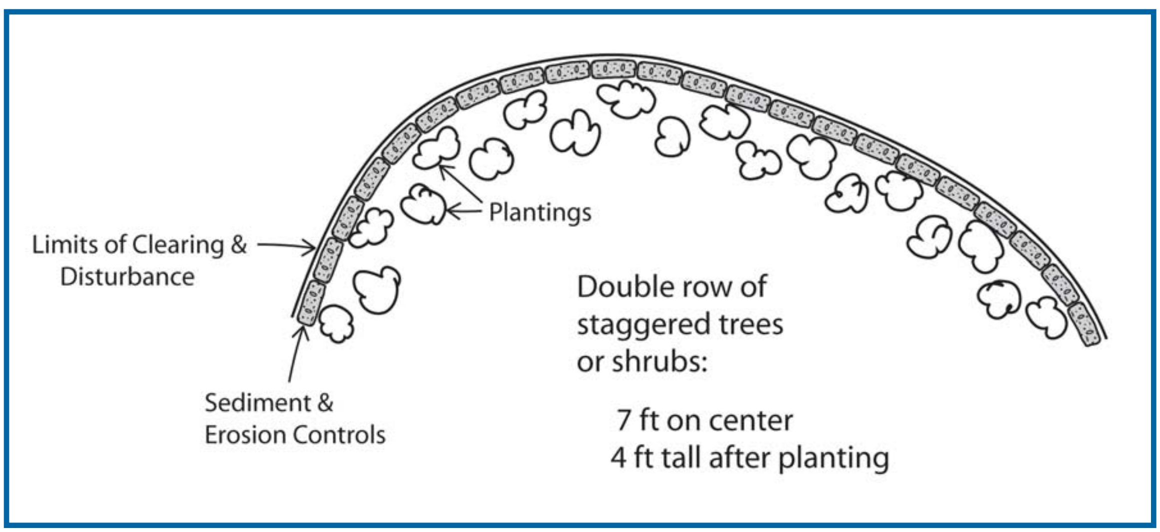
Source of plant names: *Vascular Flora of Rhode Island; A List of Native and Naturalized Plants*, Volume 1 of *The Biota of Rhode Island* by the Rhode Island Natural History Survey.

Example 37: Planting Methods

The following drawings illustrate two possible methods of installing plantings and the relationship of the plants to the wetland project's Limits of Clearing and Disturbance and the sediment and erosion controls.



Example 37a



Example 37b

Example 38: **Planting Schedule**

The following table is an example of an easy to follow planting legend with much of the required planting information. A detailed drawing and planting notes would also accompany this table as part of a complete wetlands application package.

Tree & Shrub Species Planting Schedule

Symbol	Common/Latin Name	Estimated Quantity	Planting Remarks
	Highbush blueberry, *Vaccinium corymbosum*	85	Balled and burlapped, 5 ft. on center spacing, 3 ft. tall after planting
	Sweet pepperbush, *Clethra alnifolia*	52	Balled and burlapped, 5 ft. on center spacing, 3 ft. tall after planting
	Winterberry, *Ilex verticillata*	72	Balled and burlapped, 5 ft. on center spacing, 3 ft. tall after planting
	Red chokeberry, *Aronia arbutifolia*	54	Balled and burlapped, 5 ft. on center spacing, 3 ft. tall after planting
	Spice bush, *Lindera benzoin*	54	Balled and burlapped, 5 ft. on center spacing, 3 ft. tall after planting
	Red maple, *Acer rubrum*	32	Balled and burlapped, 8 ft. on center spacing, 3 ft. tall after planting
	Weeping willow, *Salix babylonica*	18	Balled and burlapped, 8 ft. on center spacing, 3 ft. tall after planting
	Northern white cedar, Thuja occidentalis	60	Balled and burlapped, 8 ft. on center spacing, 3 ft. tall after planting

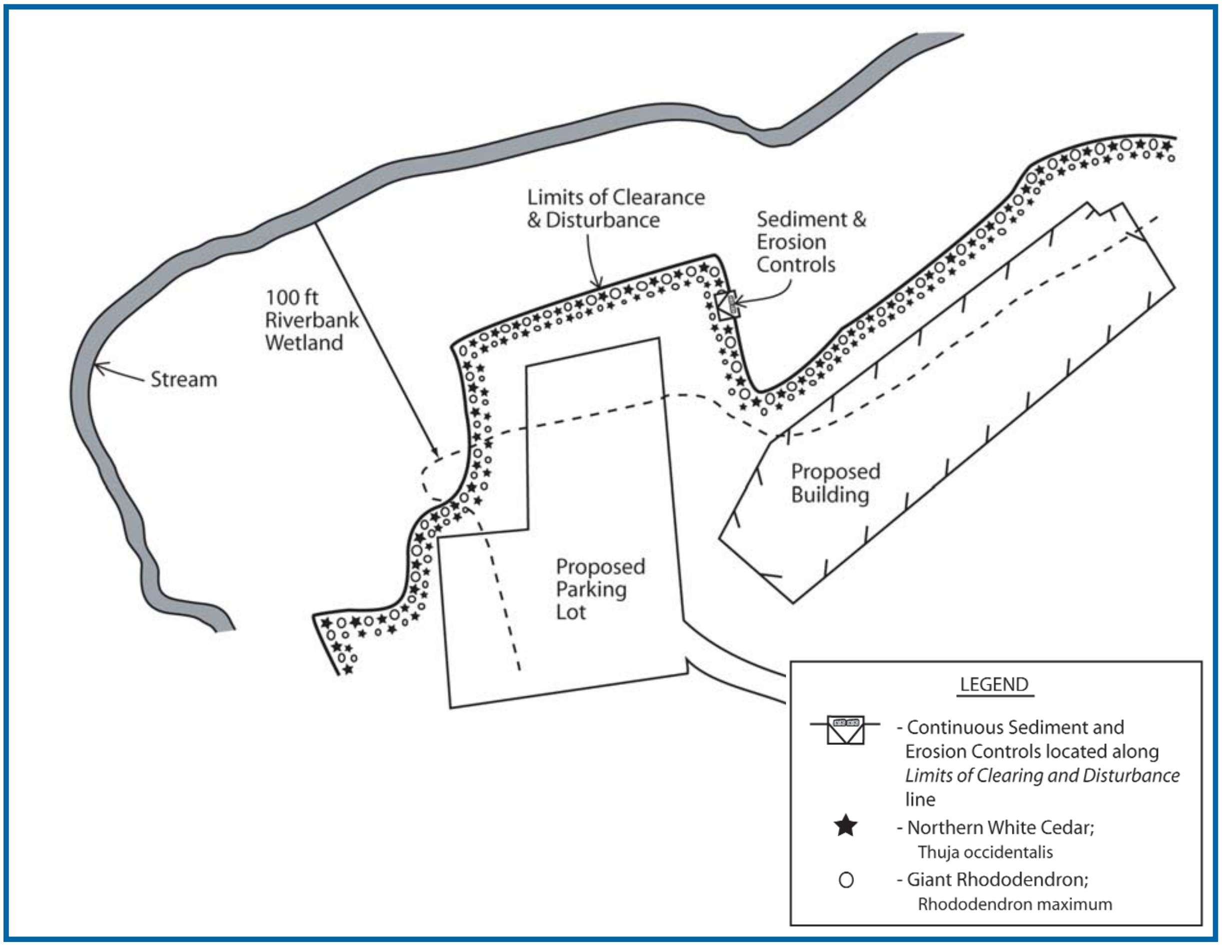
Example 38

Planting Notes

Detailed planting notes must be provided to complete the wetland application package. The planting notes should list the species that will be planted and should describe the planting methods that will be used. These notes should also describe site preparation, sediment and erosion controls, and planting site maintenance, including mulching, fertilizing, inspections, and replanting when necessary.

Example 39: **Mixed Plantings**

This example illustrates a long row of mixed plantings along the limit of disturbance associated with a commercial project in which the applicant could not entirely avoid the Riverbank Wetland. The density of the plantings makes it particularly effective because of the multiple uses and activities, such as people, lighting, and traffic often associated with most development, especially commercial projects.



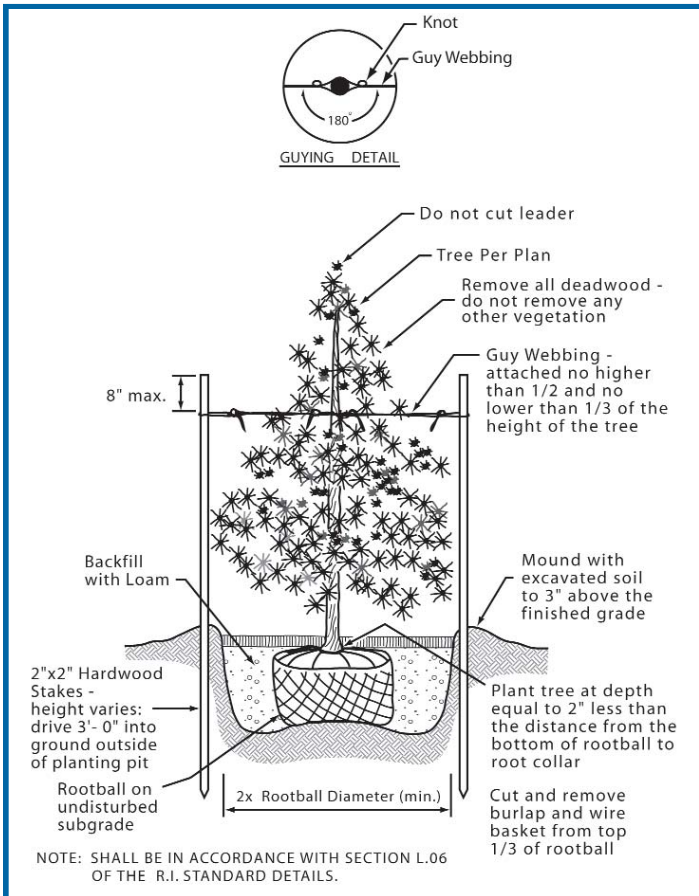
Example 39

How wetland impacts were minimized:

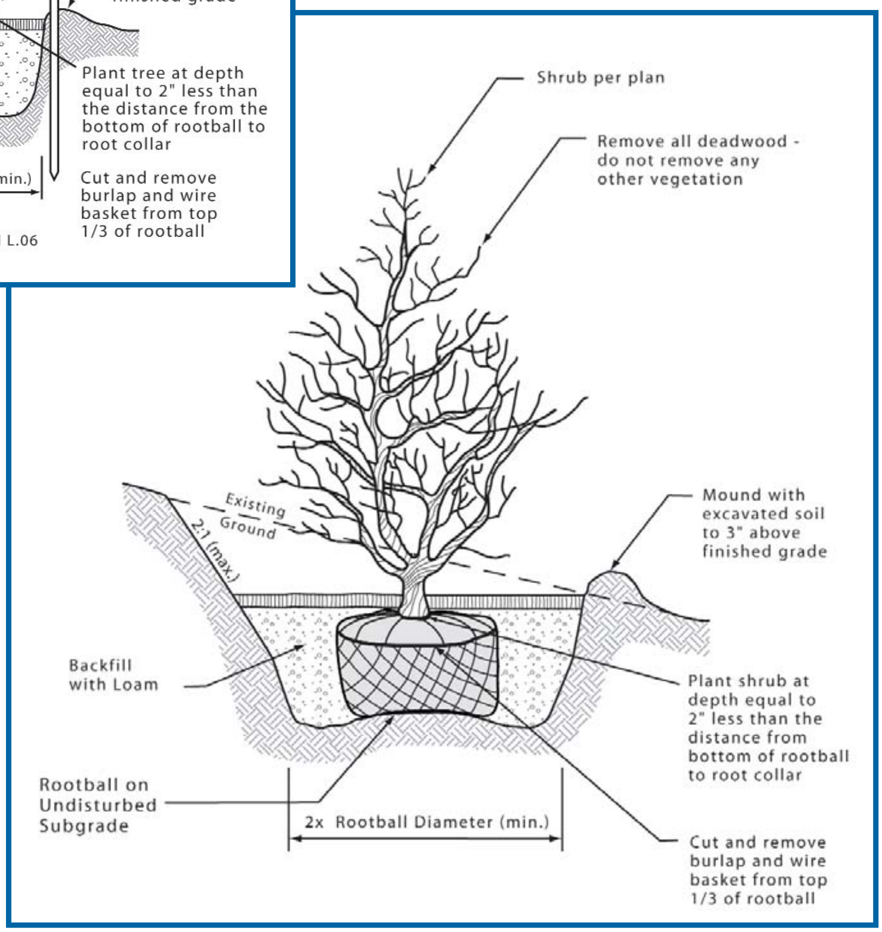
- ✓ The variety of native evergreen trees and shrubs provide a thick year-round buffer to block out noise, light, and other disturbances created by the project.
- ✓ The rows of plantings serve as a visual reminder of the Limits of Clearing and Disturbance.

Example 40: **Tree and Shrub Installation**

The following examples illustrate best management practices for planting a tree and for planting a shrub on a slope taken from the *Rhode Island Standard Details* by the Department of Transportation. The Standard Details book includes many other diagrams and illustrations that are good examples for planting installation. Be sure to verify any specific growth requirements for the species proposed to be planted.



Example 40a



Example 40b

References

This list provides additional sources for information on plantings. (See Chapter 12 for complete citations arranged by author.) Please be aware that not all native or naturalized plants will be appropriate in all circumstances. On certain projects a landscape architect may be required. Otherwise a local nursery may be able to help make recommendations.

- *American Wildlife & Plants: A Guide to Wildlife Food Habits* by A. C. Martin et al. (1951)
- *Conservation Plants for the Northeast* by D. G. Lorenz et al. (1989)
- *Landscaping for Wildlife* by C. L. Henderson, Minnesota Department of Natural Resources Nongame Wildlife Program (1994)
- *Native Plants for Attracting Wildlife* by C. M. McDonough (2000)
- *Native Shrubs for Landscaping* by S. L. Taylor et al. (1987)
- *Sustainable Trees and Shrubs*, 3rd Edition, by B. Maynard et al. (1999)
- *Trees, Shrubs and Vines for Attracting Birds* by R. DeGraaf and G. Witman (2002)
- *Wetland Planting Guide for the Northeastern United States: Plants for Wetland Creation, Restoration, and Enhancement* by G. Thunhorst (1993)
- *Vascular Flora of Rhode Island; A List of Native and Naturalized Plants*, Volume 1 of *The Biota of Rhode Island* by the Rhode Island Natural History Survey (1998)

11. Construction and Maintenance Tips

Good construction and maintenance planning are essential to the successful completion of any project. Although it may not seem necessary to think about construction or maintenance until the actual work begins on a project site, detailed forethought will prevent problems, save time, and ensure a successful project. Construction and maintenance planning are especially crucial with larger projects due to the larger area of impacted land. The applicant must remember to stay in regular contact with the construction crews as they are implementing the approved permit design. If the plans are not followed as approved, the applicant is responsible for any wetland impacts that may occur. Many best management practices to help the applicant limit construction impacts and properly maintain the project site are discussed on the next few pages.

Prior to Construction the Applicant Should

- Make sure to read all the permit conditions and ask questions if they are unclear.
- Post a sign with the permit number in a visible location.
- Have a copy of the approved plans and permit at the site.
- Include all contractors in all pre-construction meetings. Make sure all contractors are aware of sensitive wetlands/habitat areas that must be avoided per DEM approved permit plans and conditions.

Common Construction & Maintenance Problems

- Soil erosion from clearing and grading a large area.
- Unauthorized work in areas outside the Limits of Clearing and Disturbance depicted on the approved plan.
- Sedimentation of a wetland from poorly installed sediment and erosion controls, lack of erosion control maintenance, and the failure to stabilize disturbed soils.

Protection During Construction

- Properly install all sediment and erosion controls.
- Consider the use of silt fencing and staked bales of hay if working on land, and consider cofferdams and silt curtains if working in a watercourse or pond or lake.
- Use other recommended sediment and erosion controls as described in this manual and the *Rhode Island Soil Erosion and Sediment Control Handbook.*
- Check all sediment and erosion controls and maintain them on a daily to weekly basis and after any storm event.
- Place baled hay at least a foot out from the proposed (planned) toe of the slope to prevent erosion once they are removed.
- Stabilize exposed soils by seeding and applying a thick mat of straw mulch.
- Use erosion control blankets, such as jute or other types of non-plastic matting to prevent

erosion on steep slopes.

- Divert runoff around excavations by using check dams, ditches, and filter structures made of stone, gravel, or sandbags. Install gravel trenches along driveways or patios to collect water and allow it to filter into the soil.
- Use wide-tire vehicles when working in or near wetlands to cause less rutting and soil disturbance.
- Use timber mats when working in or near wetlands, especially where heavy equipment access is required.
- If dewatering of trenches is necessary, pump all water to an acceptable, properly designed filter fabric basin - please see the *Rhode Island Soil Erosion and Sediment Control Handbook*.
- No excess cement washwater, excess cement, or other building materials (such as paint) should be flushed into or near a gutter or storm drain or near any wetlands.
- Utilize tree protection devices during construction.
- Please also see the *Rhode Island Soil Erosion and Sediment Control Handbook* for complete examples and descriptions of how to protect wetland areas during construction.

Clearing

- Especially on large projects, clear lots in phases so that the land is not stripped of vegetation all at once.
- Once an area has been cleared, try to schedule all work in close time proximity to avoid repeated disturbance to nearby wetlands and so the area can be stabilized quickly.
- Minimize the amount of exposed soils, especially on steep slopes, and limit the length of time that any soil is exposed.
- Avoid removing trees or other vegetation from, or in the vicinity of, the wetland.
- Preserve the existing tree canopy, and use selective clearing to minimize clearing of vegetation.
- Avoid impounding water.
- Limit grading to small areas.
- If cutting of vegetation in the wetland cannot be avoided, complete the work by hand (chain or hand saw) instead of using large equipment.
- When removing trees and brush, use cranes to lift them out of the area, or use chains or cables to drag them upslope to reduce the potential for erosion and sedimentation impacts from vehicle tires or treads.
- See the *Rhode Island Soil Erosion and Sediment Control Handbook* for examples and descriptions of how to protect cleared areas during construction.

Timing and Sequence

A good project design can be overshadowed by poor sequencing of construction if the construction activities fail to avoid or reduce wetland impacts. While sequence and timing of construction work is often dependent on the contractors schedule, it is always important for them to employ best management practices.

- Limit construction activities within vegetated wetlands and flowing and standing water wetlands to the low flow period of July through October, unless there are overriding breeding or migratory issues.
- Schedule all construction adjacent to or within wetlands during dry periods - or at least not immediately prior to during rain events.
- Avoid work during the breeding and migratory seasons of sensitive wildlife species that utilize the area.
- Plan utility installations to occur during other project construction activities to limit the length of disturbance to nearby wetlands.

Recommended Construction Sequencing

- Acceptable soil erosion and sediment controls and buffer zone markers must be installed before the start of all construction activities, including clearing.
- Wetland restoration or mitigation areas should be completed prior to building of the actual project portion of the construction.
- Stormwater drainage systems and control facilities should be installed and properly functioning prior to paving activities.
- Floodplain compensation areas must be constructed and functional prior to, or in concurrence with, any floodplain filling/displacement as part of a project design.
- Mitigation plantings must be installed before on-site occupancy.

Construction Sequence Notes: All construction notes must be detailed enough so that they can demonstrate to DEM that the applicant has thought through the construction activities and their sequence with respect to the protection of wetlands. The notes should specify all construction steps that may affect wetlands and the order in which the steps will occur, including the following: 1. Installation of erosion and sediment controls; 2. Site preparation; 3. Removal and disposal of items; 4. Dewatering; 5. Grading; 6. Construction and building of structures and drainage systems; 7. Temporary and permanent site stabilization; 8. Restoration and plantings; and 9. Removal of temporay controls.

Materials

- Have all necessary materials on hand before beginning work.
- Establish a materials storage area and staging area prior to construction. Install and maintain proper soil erosion and sediment controls around areas for the life of the project.
- Place construction access roads and locate soil stockpiles as far from wetlands as possible.
- Keep the construction site clean of loose dirt, litter, toxic chemicals and other debris.
- Cover stockpiles and landscaping materials with tarps.

Site Stabilization, Restoration and Maintenance efforts must be considered during the initial planning and design phases and should be included in the application submittal. A project site must be effectively stabilized, revegetated, and maintained to prevent soil erosion and to prevent sediment from running into wetlands. Below are some good tips to follow:

Temporary Seeding

If land is cleared and soil is exposed before construction will occur, it is a good practice to temporarily stabilize the soil by seeding.

- Seeding can begin in the spring, but should be completed by early fall for seeds to germinate before the weather becomes too cold.
- Seeding should be done as soon as an area is exposed if it will not be built on immediately.
- Areas to be seeded should be smooth and fairly level.
- Steep slopes should be covered with erosion control blankets or mulch in addition to seeding.
- Seeding must be kept within the Limits of Clearing and Disturbance.
- Seeded areas should be watered during the summer.

Restoration

- Complete restoration efforts immediately after completing the construction of the project.
- Replant disturbed soils and restore the area as close as possible to its original topography and hydrology if required.
- Replant any and all disturbed vegetation with native, non-invasive vegetation.
- Restore stream channels to original, natural conditions if disturbance to the channel is unavoidable.
- Utilize a wildlife conservation seed mix on all disturbed surfaces within wetlands.
- Stabilize all disturbed areas outside of the cleared maintenance zone with trees, shrubs or other vegetation.
- Consider creating tree cover, nesting sites, or providing wildlife plantings adjacent to wetlands.
- See the *Rhode Island Soil Erosion and Sediment Control Handbook* for examples and descriptions of how to protect and restore disturbed areas during construction.
- Completely remove all sediment and erosion controls after a project is completed and the soil is stabilized.

Maintenance

- Maintain the area within the approved Limits of Clearing and Disturbance by hand-cutting or mowing, if permitted.
- Minimize or eliminate the use of any fertilizers, pesticides, or herbicides near wetlands.
- If the use of chemicals is unavoidable and if they are permitted, use natural pesticides and fertilizers, or use chemicals that tend to be less mobile in the environment and as a result will not move off site or degrade before movement can occur. Also ensure that any chemicals used are non-toxic to aquatic organisms.
- Replant any trees, shrubs or other groundcover that does not survive the required length of time (or at least one full growing season).

- Include methodology for completing regular maintenance and emergency repairs to any parts of the project that require access in or through wetland.
- Inspect and maintain all stormwater controls on a regular basis.
- Complete regular sweeping and litter clean up in parking lots and other impervious surfaces.

Maintenance Notes: Maintenance notes are a required part of a complete application. They often detail how engineering structures or grass or otherwise vegetated areas will be maintained. The notes will help program staff determine whether a project will impact wetlands, and they will ensure that the area will continue to be protected and that the structures will operate effectively after the project is constructed. Sometimes projects may only require a few specific notes on maintenance, such as a mowing note.

Below is a partial list of what to include in maintenance notes, as applicable to a specific project:

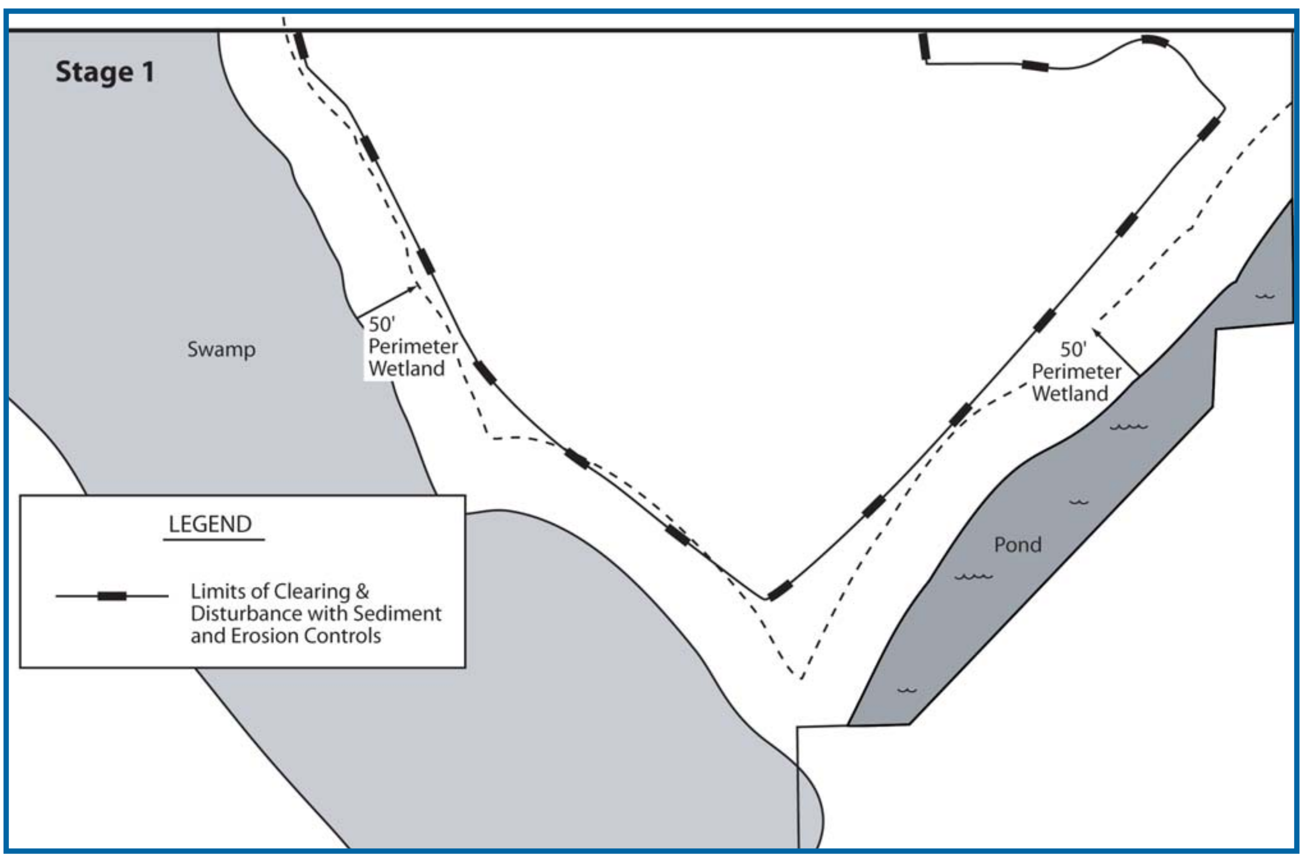
- Long term inspection and maintenance plan.
- Party responsible for long term maintenance.
- Sediment storage and disposal information.
- How hazardous materials will be handled.
- How engineering structures will be cleaned and maintained to prevent clogging.
- Frequency of mowing (i.e. mowing will be done at least once per growing season after August 15 to protect ground nesting birds and other animals), regrading, or revegetation.,
- Treatment for mosquito abatement.
- Provisions for removal of litter and debris.
- Use of herbicides, pesticides or fertilizers.

Example 41: **Construction Sequencing**

In addition to site layout and design, the proper sequencing of construction events during a project will further help to minimize impacts to wetlands. Information on construction sequencing is always helpful to the biologist and engineer who review the application. For some projects this information is an absolute requirement; for other projects it may not be as critical but is still very useful. Often large projects, or projects that include crossing a wetland, will require the construction sequencing information. The following example is an old farm, much of which was previously disturbed prior to the Freshwater Wetland Act. Not shown is an existing abandoned home and barn and some existing vegetation, which is maintaining ground stabilization and providing a woody habitat. The applicant is proposing to clear the site to build a condominium complex and has utilized a good construction sequence to protect the wetland areas. Although the vast majority of the construction and disturbance will occur outside of the 50 Foot Perimeter Wetland, this project will still need a wetland permit due to the change in stormwater runoff patterns that are created by the development of this lot.

Stages:

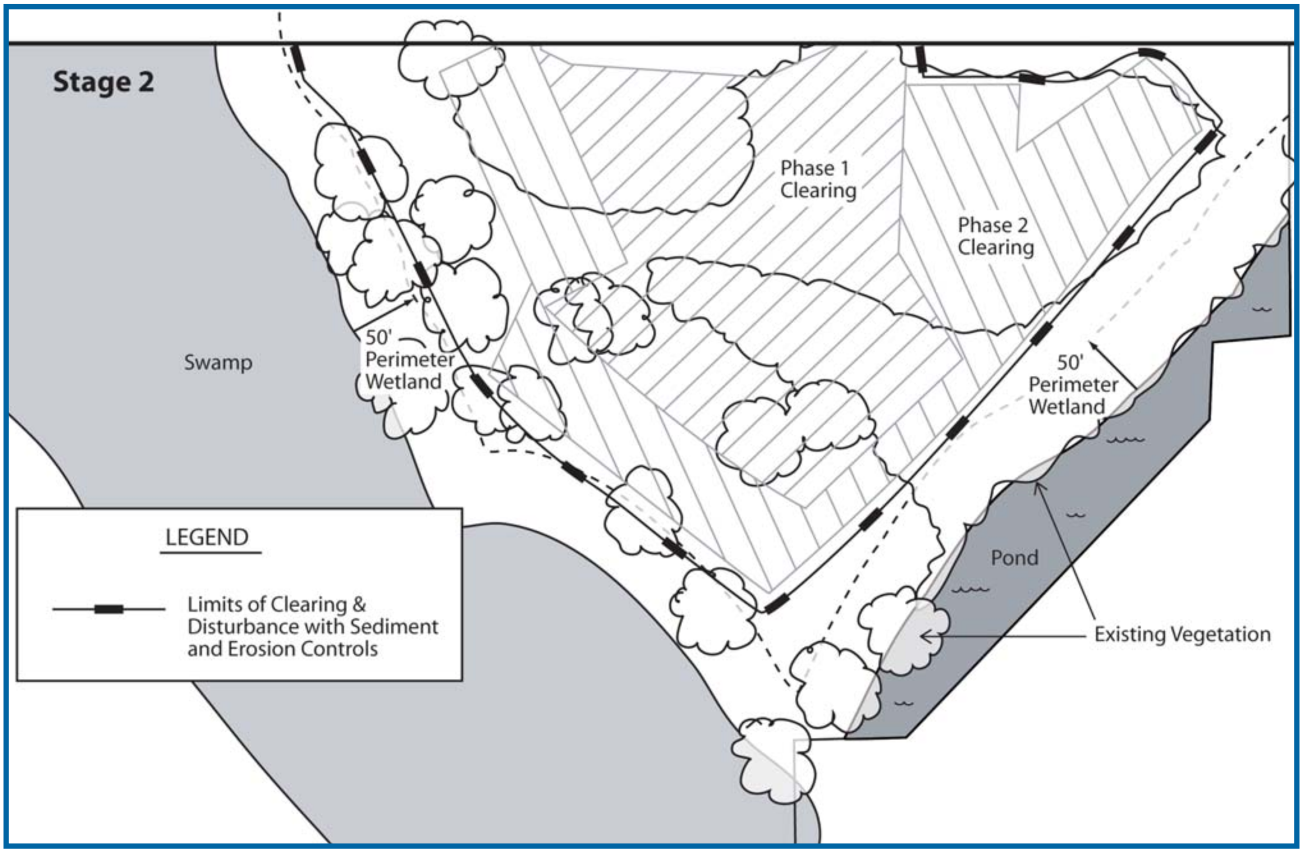
1. Sediment and Erosion Controls: These controls should be installed first, before beginning ANY type of construction, including clearing of a project site. The controls must encompass all work, and must be within the Limits of Clearing and Disturbance (most often they are at the limit of clearing and disturbance). Sediment and erosion controls will prevent sediment from passing into adjacent wetlands and will prevent erosion of exposed ground. This example shows a line of sediment and erosion controls that encompass the entire project for the construction work.



Example 41a

Example 41: **Construction Sequencing Continued**

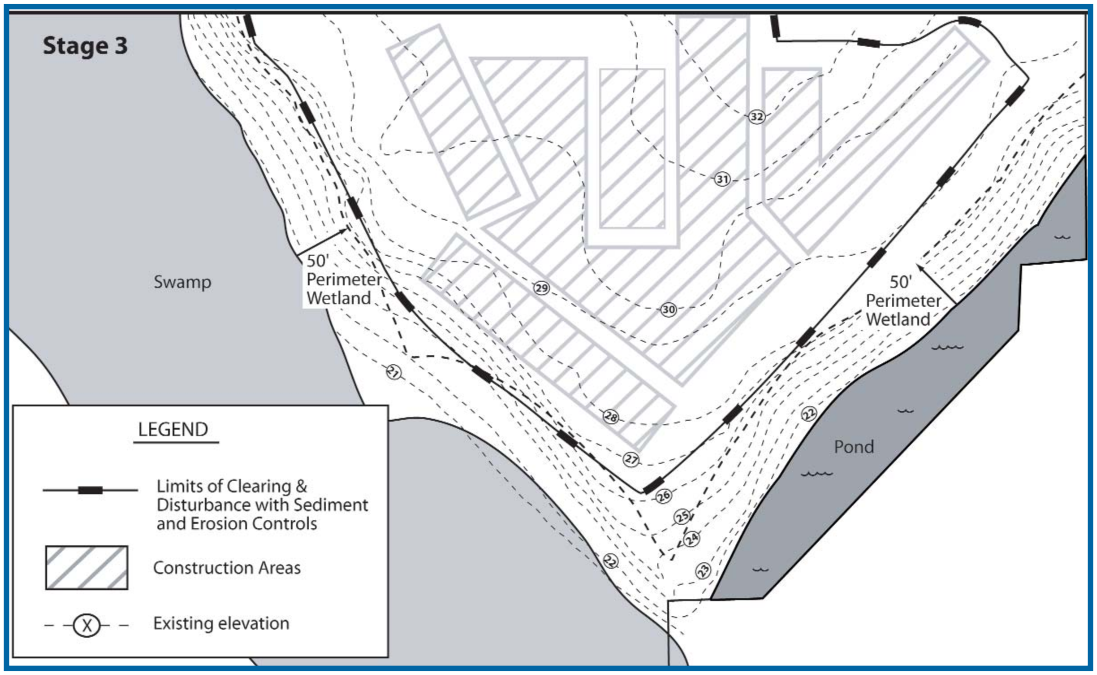
2. Phased clearing: It is important, especially on a large site to clear in such a way that the entire site is not exposed all at once. If more ground is cleared and exposed than will be built upon immediately, it will be necessary to temporarily cover, seed and stabilize the soil. This example shows clearing in two phases, as the building will be done in two phases.



Example 41b

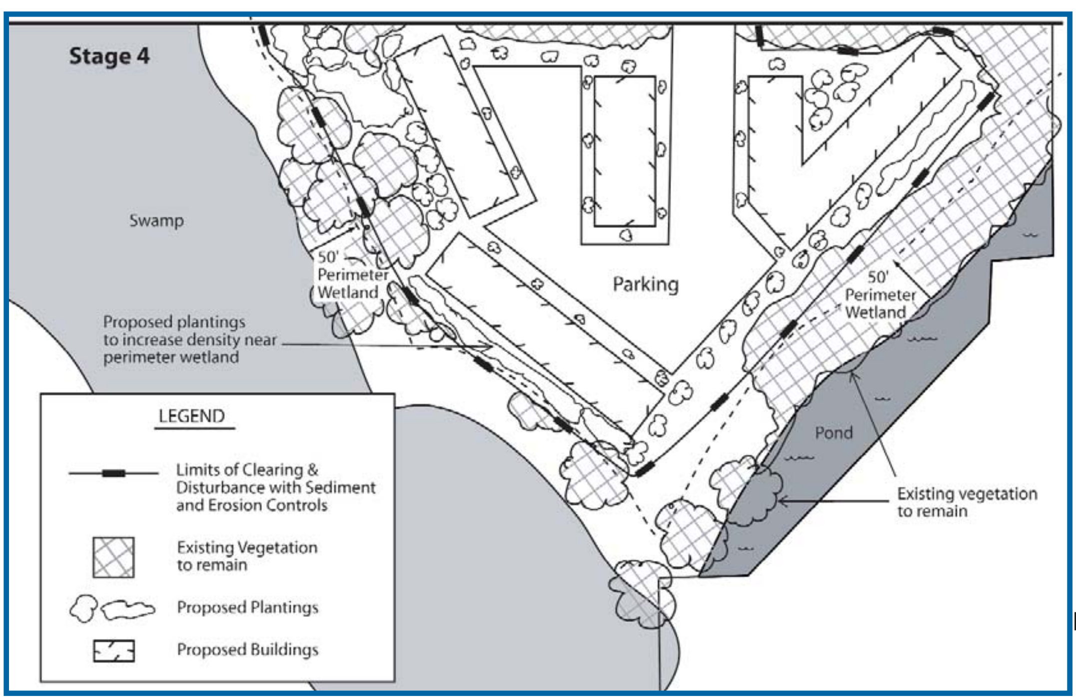
Example 41: **Construction Sequencing Continued**

3. Grading: When grading a project, gradual slopes are preferable to steep slopes because they are less susceptible to erosion. However, a site should not be graded so low as to intercept the groundwater table. In this example the project avoids the steeply sloped Perimeter Wetland and will maintain the original upland topography as much as possible, with gradual grading in the necessary areas. The final project contours are not shown.



Example 41c

4. Stabilization and Restoration: Generally all project sites will need some sort of restoration work after construction to keep soil from eroding, to provide a noise and light buffer to the wetland areas, and to reestablish lost habitat for wetland wildlife species. This example site has extensive plantings to minimize negative effects that the development will have on the wetland water quality and wildlife habitat, as well as to minimize flooding and maintain healthy wetlands.



Example 41d

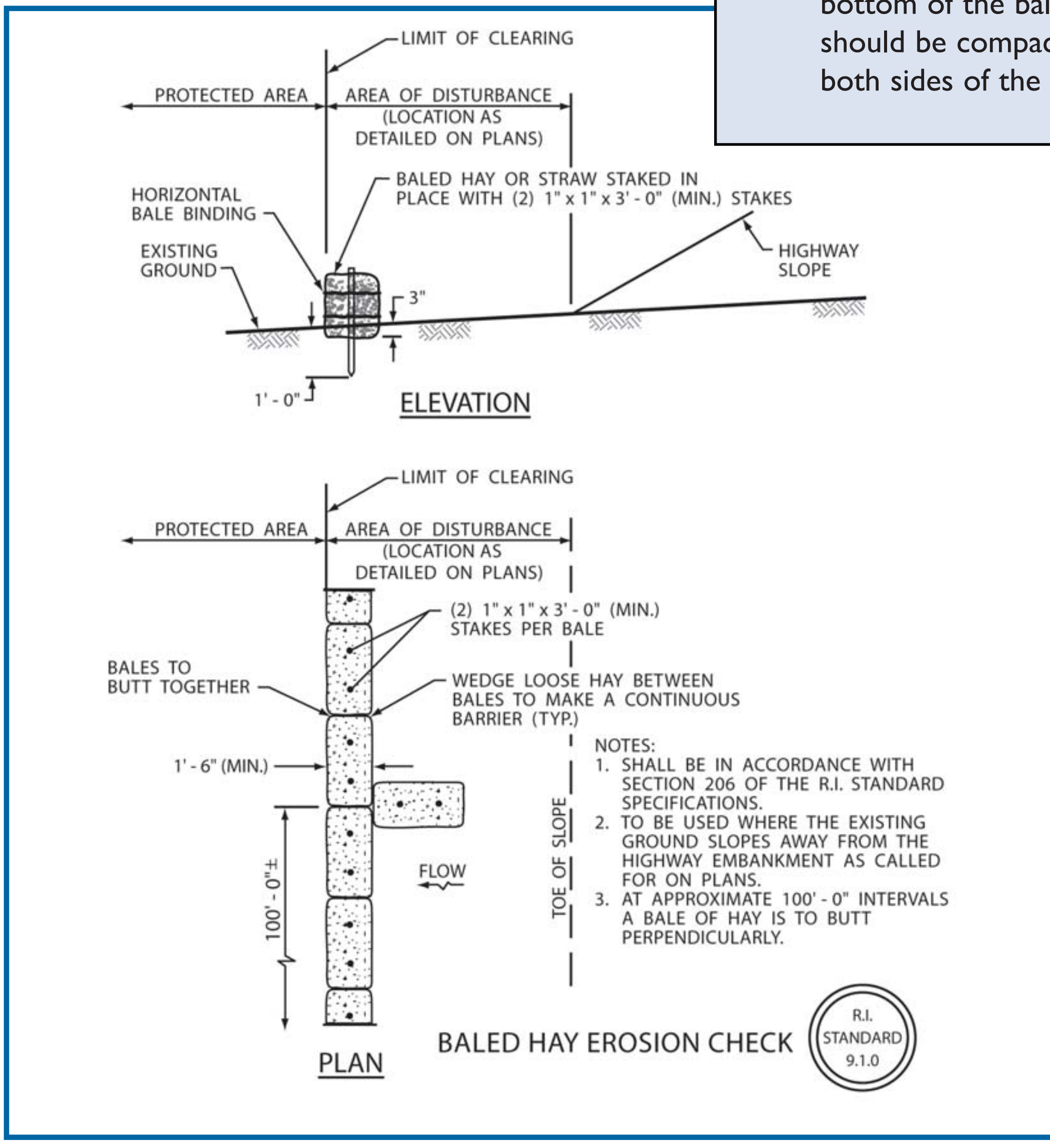
Example 42: **Erosion Checks**

The following illustrations are from the *Rhode Island Standard Details* (RI DOT 2008). They clearly illustrate how to install baled hay, silt fence, and combination erosion checks. Bales of hay and silt fences are commonly used in many projects to help protect wetlands. Certain projects may only require one type of erosion check, and some may require both.

All sediment and erosion controls must be checked and maintained on a daily to weekly basis and after any storm event. They should be cleaned when accumulated debris and sediment reach approximately one-half the height of the controls.

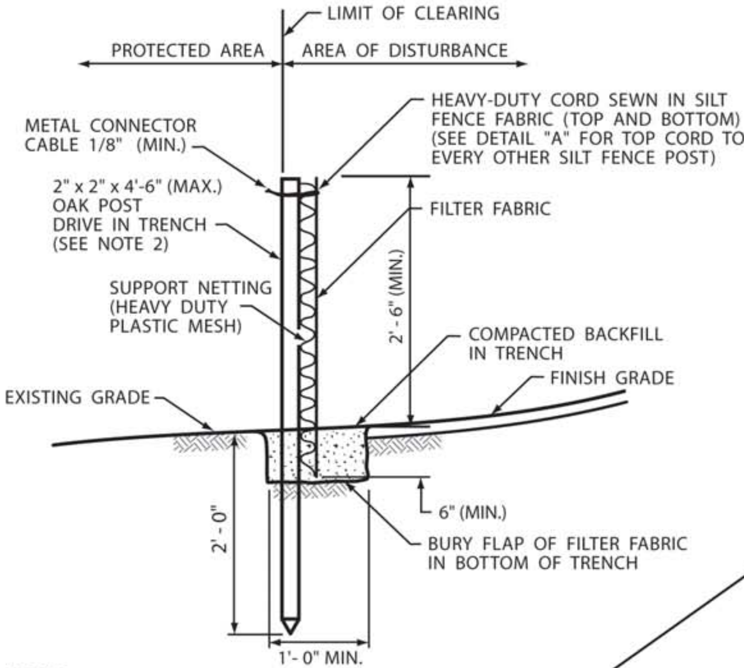
Baled Hay Erosion Check Tips

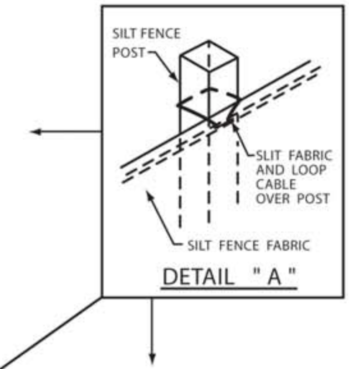
- Create a clean, square trench by cutting the roots and removing stones.
- Baled hay should sit flat and solid in the trench and firmly touch the next bale.
- Bales should be solidly staked and not be easily removed by hand.
- The substrate around the bottom of the baled hay should be compacted on both sides of the bale.



Example 42a

Example 42: Erosion Checks Continued

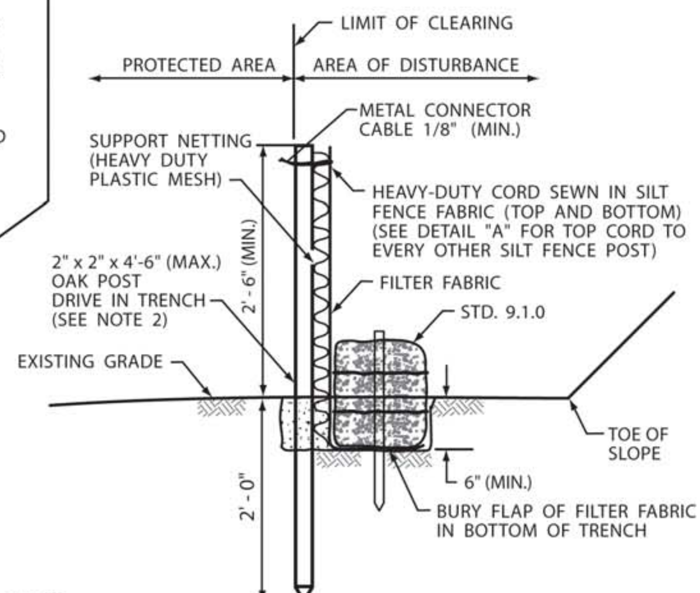




NOTES:
1. SHALL BE IN ACCORDANCE WITH SECTION 206 OF THE R.I. STANDARD SPECIFICATIONS.
2. 2" x 2" x 4'-6" (MAX.) OAK POSTS FOR SILT FENCE SHALL BE LOCATED 8'-0" (MAX.) O.C. IN WETLAND AREAS AND 4'-0" (MAX.) O.C. IN WETLAND RAVINE, GULLY OR DROP-OFF AREAS AS SHOWN ON PLANS.
3. 1" x 1" x 4'-6" (MIN.) POSTS PERMITTED FOR PRE-FABRICATED SILT FENCE.
4. SILT FENCE SHALL BE INSTALLED BEFORE ANY GRUBBING OR EARTH EXCAVATION TAKES PLACE.

SILT FENCE DETAIL

R.I. STANDARD 9.2.0



NOTES:
1. SHALL BE IN ACCORDANCE WITH SECTION 206 OF THE R.I. STANDARD SPECIFICATIONS.
2. STD. 9.1.0 IS INSTALLED "TIGHT" AGAINST SILT FENCE. THOROUGHLY COMPACT EXCAVATED SOILS BACK INTO TRENCH AFTER INSTALLATION OF EROSION CONTROL DEVICE. SILT FENCE FABRIC SHALL NOT BE SLIT. STD 9.1.0 POST SHALL BE DRIVEN THROUGH SILT FENCE FABRIC. 2" x 2" x 4'-6" (MAX.) OAK POST FOR SILT FENCE SHALL BE LOCATED 8'-0" (MAX.) O.C. IN WETLAND AREAS AND 4'-0" (MAX.) O.C. IN WETLAND RAVINE, GULLY OR DROP-OFF AREAS AS SHOWN ON PLANS.
3. 1" x 1" x 4'-6" (MIN.) POSTS PERMITTED FOR PRE-FABRICATED SILT FENCE.
4. SILT FENCE AND BALED HAY SHALL BE INSTALLED BEFORE ANY GRUBBING OR EARTH EXCAVATION TAKES PLACE.

BALED HAY EROSION CHECK AND SILT FENCE COMBINED

R.I. STANDARD 9.3.0

Silt Fence Erosion Check Tips

- Create a clean, square trench by cutting the roots and removing stones.
- Silt fence should be pulled tight and line up with the outside of the trench, and the stakes should pierce the material.
- Install posts at specified intervals, such as 4 feet on center.
- Fence sections should be overlapped to contain runoff.
- Fill around the bottom of the fencing should be compacted on both sides.

Example 42b

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