Town of Northbridge, Massachusetts

BEST DEVELOPMENT PRACTICES GUIDEBOOK



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INTRODUCTION

The Town of Northbridge has prepared this *Guidebook* for developers and designers as well as project reviewers and municipal boards and commissions, to improve the quality of development and to expedite the local approval process. The objective of the *Guidebook* is to advance sustainable and low impact design for commercial, industrial, residential and institutional development that comes before the Northbridge Planning Board, Conservation Commission, Department of Public Works, Board of Health and Building Inspector for approval.

The *Best Development Practices Guidebook* has been prepared in accordance with Chapter 43D of the Massachusetts General Laws and funding through the Massachusetts Executive Office of Housing and Economic Development. The *Guidebook* is directed toward expediting permitting by providing clear guidance that may reduce the number of meetings or hearing continuances for local approval. It also provides guidance for owners and municipal inspectors, both during and after construction. The *Guidebook* supports the Town's goals to achieve the following:

- **Preserve and restore natural resources.** Development should reflect the Town of North-Bridge's location within the heart of the Blackstone River watershed and two of its major tributaries, the Mumford and West Rivers. Restoration of and celebration of these waterways, wetlands and upland habitat has helped direct the preparation of this *Guidebook*.
- **Enhance the quality of site planning and design.** Site design that reflects community character and cultural resources while encouraging walkable, compact development is preferable to a sprawling pattern of development, especially in Northbridge's many villages.
- **Support economic development through balanced growth.** Economic health and growth are essential to assuring that the Town of Northbridge celebrate its heritage and maintain the long-term stability and prosperity of the community.

The *Guidebook* describes the required and preferred design, construction and maintenance practices relating to Site Planning, Landscape Design, Stormwater Management, and Erosion and Sediment Control applicable for a range of uses and development scales. Strategies focus on compact development to protect valuable wetland and upland habitat, reduce exposure of soils to erosion, and encourage energy-efficient design. Sample diagrams and typical design details are provided in an easy to read and user-friendly format. The intent is to incorporate local, state and federal requirements for site development in a comprehensive yet broad-based approach. Additional information for project designers and others requiring more detailed information can be obtained through references and web site links provided in the appendix. Key sources for this *Guidebook* include the following:

- **Massachusetts *Smart Energy/Smart Growth Toolkit.***[1]
- ***Massachusetts Erosion and Sediment Control Guidelines.***[2]
- ***Massachusetts Stormwater Handbook.***[3]
- **US EPA Menu of Stormwater Best Management Practices.**[4] Much of this information supports Massachusetts guidance. When in conflict, however, information from state sources takes precedence over federal sources.

Information presented is based on material provided by Northbridge town boards, commissions, and departments responsible for the review and approval of proposed development. Although the *Guidebook* is being prepared concurrently with the Town of Northbridge Master Plan Update, due to project timing it is likely that the *Guidebook* will serve as direction for many of the goals and action items in the updated master plan.

The *Guidebook* is the Town of Northbridge's companion document to the Blackstone River Coalition's *Blackstone Valley Guide to Low Impact Development Practices*. The Blackstone Valley Guide outlines strategies for new development to minimize impacts on Blackstone Valley water resources. Strategies include careful site planning and Low Impact Development (LID) to maximize stormwater infiltration, reduce paved surfaces, and use decentralized stormwater management techniques to handle runoff.

The *Guidebook* includes the following elements:

- **Section 1: Site Planning** process to reflect the neighborhood context, preserve important site resources, minimize site disturbance, and reduce project costs through compact design.
- **Section 2: Landscape Design** strategies that provide sustainable development with native species vegetation which reduces water consumption and enhances energy conservation.
- **Section 3: Stormwater Management** techniques that limit the quantity and improve the quality of stormwater discharge from the site through Low Impact Development (LID).
- **Section 4: Erosion and Sediment Control** guidance for use during design for construction and operation phase activities, to minimize transport of soil from a construction site. This is applicable not just to sites located within Town of Northbridge Conservation Commission jurisdiction, but to upland sites as well.

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[1] *Smart Growth/Smart Energy Toolkit: www.mass.gov/envir/smart_growth_toolkit*

[2] *Massachusetts Erosion and Sediment Control Guidelines, www.mass.gov/dep/water/laws/policies.htm#storm*

[3] *Massachusetts Stormwater Handbook, www.mass.gov/dep/water/laws/policies.htm#storm*

[4] *US EPA Menu of Stormwater BMPs, www.cfpub.epa.gov/npdes/stormwater/menuofbmps/*

- **Appendix** with references for more information and a glossary of terms.

Each element includes an overview and policies, best practices, additional considerations, and operations and maintenance considerations, as applicable. A checklist for designers and reviewers at the end of each section includes a synopsis of goals, strategies and a checklist for best development practices. Illustrations provide information on many of the practices presented.

Utilization of these guidelines by developers and by municipal review boards will help define the Town of Northbridge as a community that welcomes appropriate sustainable development through a predictable permit program that preserves and enhances natural and cultural resources.

SECTION 1: SITE PLANNING

Site Planning Overview and Policies

The Town of Northbridge is committed to preserving its natural, cultural, and aesthetic features by establishing a comprehensive site planning process for many of the smaller commerical and residential development sites in town that do not require subdivision. A similar process may be used for larger scale development. This process should preserve and protect the site's historical context and important natural resources while minimizing site disturbance.

As a John H. Chaffee Blackstone River National Heritage Corridor community, the Town of Northbridge has been shaped over time by agricuture and then by industry powered by the rivers and streams that dominate the landscape. These 'heritage landscapes' not only reflect the history of Northbridge, they provide a sense of place by defining the character of the community. The Town of Northbridge is committed to preserving its natural, cultural, and aesthetic features by establishing a comprehensive site planning process, created for designers and developers.

Site planning is the arrangement of buildings and structures (built environment) on the land (natural environment) and shaping the spaces in between, in accordance with the Town of Northbridge's Zoning Bylaws and best planning practice. Every site imposes limitations and offers possibilities. How one responds to the natural environment in the placement of structures is critical to the success of any good site plan.

The Executive Office of Energy and Environmental Affairs (EEA) has developed a Smart Growth/Smart Energy Toolkit[1] to assist municipalities and developers implement policies for sustainable development. The Town of Northbridge's site planning policy has been adapted to incorporate the Smart Growth/Smart Energy and Sustainable Development

Smart Growth/Smart Energy Sustainable Development Principles

- Concentrate Development and Mix Uses
- Advance Equity
- Make Efficient Decisions
- Protect Land and Ecosystems
- Use Natural Resources Wisely
- Expand Housing Opportunities
- Provide Transportation Choice
- Increase Job and Business Opportunities
- Promote Clean Energy
- Plan Regionally

[1] Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs *Smart Growth/Smart Energy Toolkit*

Principles outlined in the text box, as well as to further the Town's site planning goals as outlined in the Zoning Bylaw, presented in the box below.[2]

Northbridge Site Plan Goals

- Protect the environment
- Preserve the Town's character and quality of place
- Protect and enhance existing growth patterns
- Maintain the social and economic diversity of the community
- Protect the Town's historic, cultural, and natural resources

Northbridge Site Planning Strategies

- Maximize consistency of the development with the regional, community and site context
- Minimize site disturbance
- Preserve important site resources including steep and erosion-prone soils
- Promote energy efficiency, walkability and cohesive neighborhoods

Site Planning Best Development Practices

The site planning process includes two broad phases, **Data Collection/Analysis** and **Site Design**. The developer and designer's level of effort will be dependent upon the type and scale of the proposed project. Developers and designers are encouraged to follow the process outlined below.

A. Data Collection/Analysis

Fundamental to the design of any site is an analysis of the site and its natural processes.

1. Developers and designers are encouraged to understand the ***Locational Context*** of a proposed project on three contextural levels: regional, community, and site. It is important to consider the condition/capacity of regional infrastructure including roads, sidewalks, open space, school bus stops, and natural and cultural resources such as those representative of the Blackstone River Valley National Heritage Corridor. Considerations on the community level include the condition/capacity of community infrastructure such as sewer and water; public facilities/services including schools, emergency services, and parks; development patterns such as the density of development and massing of buildings in the community; and land use controls/regulations including the Town of Northbridge Zoning Bylaws, Subdivision

[2] *Code of the Town of Northbridge Massachusetts, v9, Updated 12-15-07.*

Rules and Regulations, and Master Plan. On the site level it is important to consider the land and its natural features, as outlined below.

2. A thorough analysis of mapped ***Natural Resources, Cultural Factors,*** and ***Man-Made Features*** can reveal both opportunities and constraints at the site level. Developers and designers are encouraged to map the entire site and appropriate adjacent areas to adequately convey the interrelationships of the following resources, factors and features:

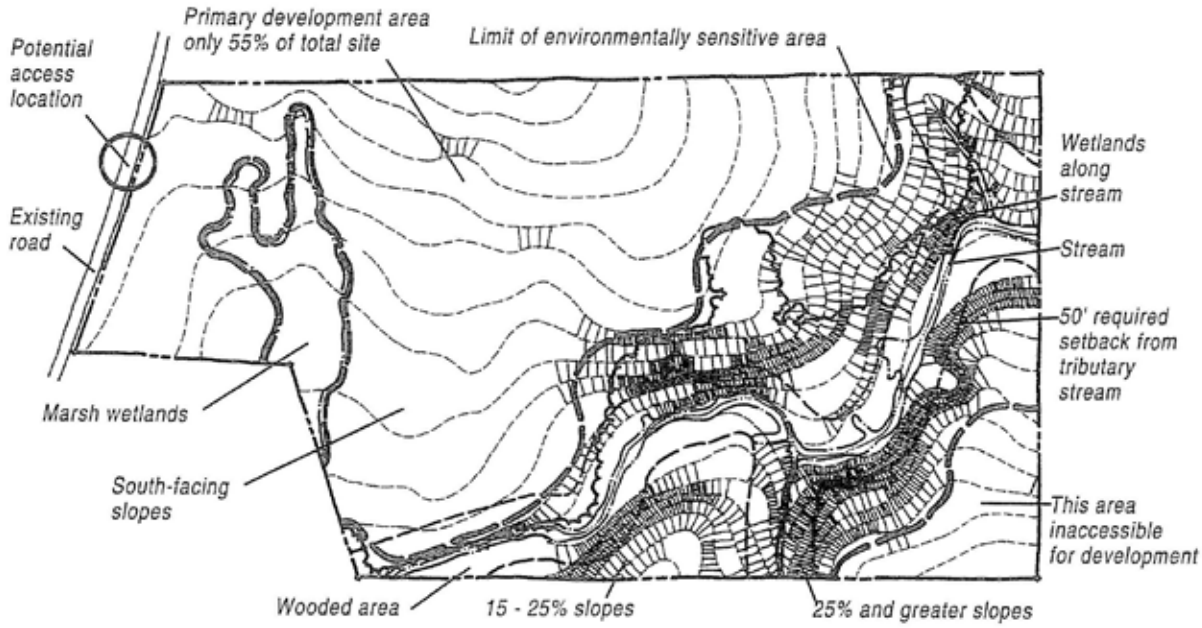
   - Natural Resources
     - Land: steep slopes, bedrock, soils, topography
     - Water: streams/rivers, ponds/lakes, wetlands, floodplains
     - Vegetation: native plantings, specimen trees
     - Wildlife: rare/endangered species habitats
     - Climate: prevailing winds; and
     - Views/viewsheds
   - Cultural Factors
     - Social influence: neighboring uses, historic/archeological values
     - Political/legal constraints: master plan requirements, easements, environmental regulations
     - Economic: land values, growth potential, off-site improvements
   - Man-Made Features
     - Buildings: existing structures, outbuildings, foundations
     - Transportation: road network, school bus stops, pedestrian/bicycle connections, desire lines/unpaved pedestrian paths
     - Infrastructure: water/sewer, schools, communication utilities

3. Development of the ***Program*** will serve as a guide for site design that is sufficiently detailed to provide direction, but allows flexibility to allow new ideas and directions to emerge as the design evolves. The program should support Smart Growth/Smart Energy sustainable development principles. Consideration should be given to protection of valuable site features, reduction of the development footprint, and encouragement of healthy/active lifestyles. Opportunities should be provided to reduce vehicle trips, integrate mixed-use developments with interconnected networks of intermodal transportation alternatives, and incorporate off-road pedestrian/bicycle paths, as appropriate to the development.

4. The ***Site Analysis Plan*** illustrates the interrelationship of a site's spatial, natural and cultural conditions and serves as the basis for site design. Figure 1 is a typical Site Analysis Plan, referenced from *Site Planning and Community Design for Great Neighborhoods*.[3] Although the image is generally applicable to residential subdivisions, site analysis is also appropriate for smaller commercial projects.

[3] Jarvis, Fredrick D., *Site Planning and Community Design for Great Neighborhoods,* Home Builder Press, 1993.

Figure 1: Typical Site Analysis Plan Identifies Environmentally Sensitive Areas



B. Site Design

Site design is an important step in the development of both small (generally several acres or less) and large-scale properties for subdivision. Although these *Guidelines* primarily address development of smaller commercial developments, much of the following design process for larger residential subdivisions is applicable. Additional site design concepts are addressed in **Section 2: Landscape Design** and **Section 3: Stormwater Management**.

Figure 2: Existing Site Sketch

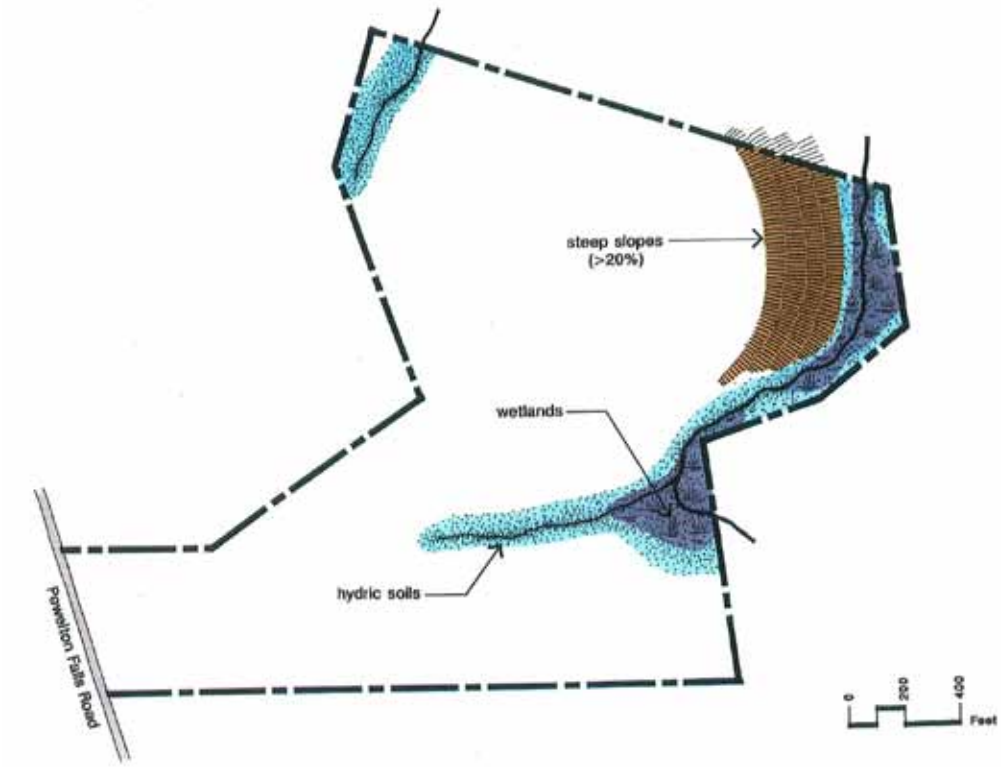
Applicants for residential subdivisions are encouraged to incorporate the process outlined in *Conservation Design for Subdivisions, A Practical Guide to Creating Open Space Networks* by Randall G. Arendt.[4] This book illustrates concepts appropriate for residential development in Northbridge's Flexible Development Overlay District zoning, utilizing a four-step process that maximizes the quality of development while reducing the construction footprint. This is in support of Town of Northbridge goals. Figure 2 presents a birdseye sketch of existing site conditions.

[4] Arendt, Randall G., *Conservation Design for Subdivisions, A Practical Guide to Creating Open Space Networks,* Island Press, 1996.

Step 1 — Identify Potential Conservation Areas to locate most suitable areas for conservation and development.

- Minimize visual/environmental impacts and allow primary conservation areas (the natural landscape) to predominate by identifying wetlands, floodplains, and steep slopes. Figure 3 identifies primary conservation areas.

Figure 3: Primary Conservation Areas

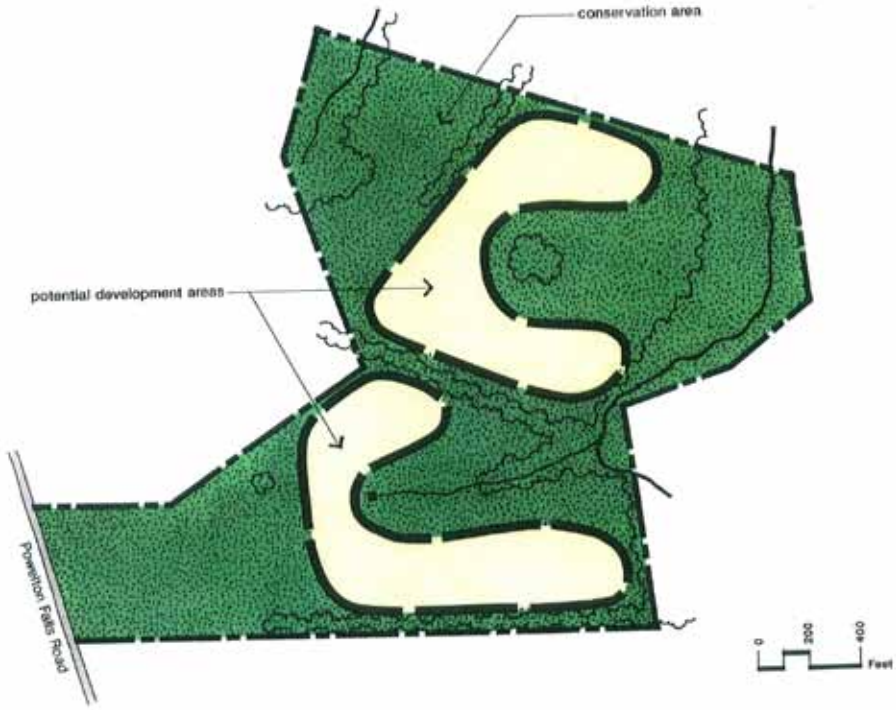


- Recognize secondary conservation areas and preserve views/vistas both into and out of the site. As indicated in Figure 4, this includes unique site features as well as non-regulated, but important for environmental protection (views/viewsheds, greenways).

Figure 4: Secondary Conservation Areas

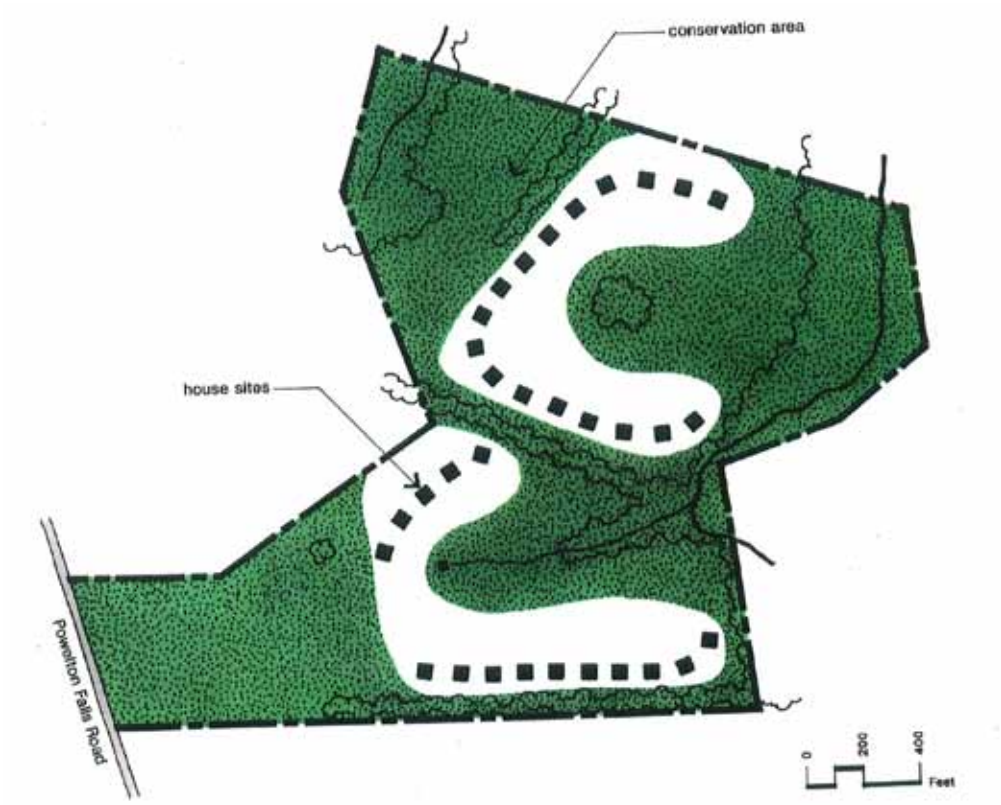
- As the development envelope evolves, developers/designers can begin to look at setbacks, access and frontage as indicated in Figure 5.

Figure 5: Development Envelope



Step 2 — Locate building sites to meet program development objectives, as indicated in Figure 6.

Figure 6: Building Locations on the Site

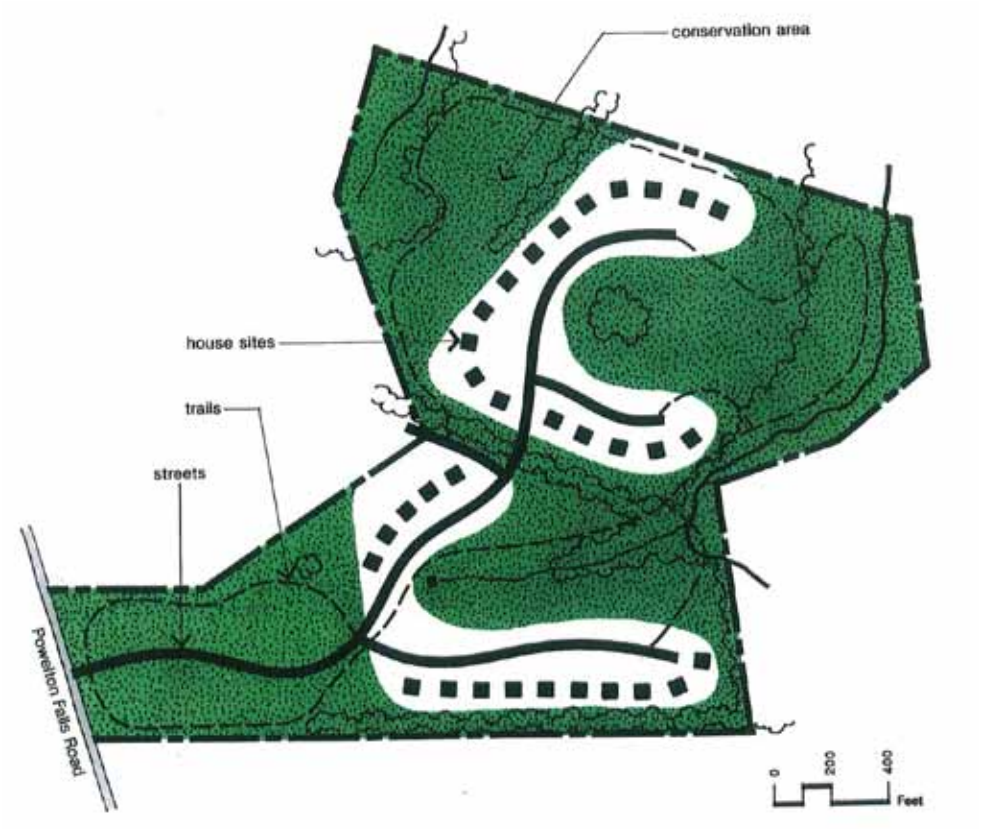


- Relate building scale to street type so buildings and landscape frame the street for safety and a sense of enclosure. This calms traffic, encourages walking, and fosters sense of community.
- Blend the building into the existing topography to minimize disruption to landforms and drainage patterns. Additional objectives include creating opportunities to engage the street with porches/primary facades open to the street and to provide a level of privacy for homeowners (side/rear yards).
- Orient the building with attention to solar and wind direction/microclimate to measurably decrease energy consumption and costs. See **Section 2: Landscape Design** for further details.
    - Primary daytime living space should face south
    - Outdoor decks/patios should not be on the north of a structure
    - Openings on north faces should be reduced, particularly where winter winds are from that direction

- Westerly openings should be protected from late summer sun by deciduous vegetation or other screen
- Winds should be broken near entrances and openings
- Cross-ventilation should be provided to all living and sleeping spaces

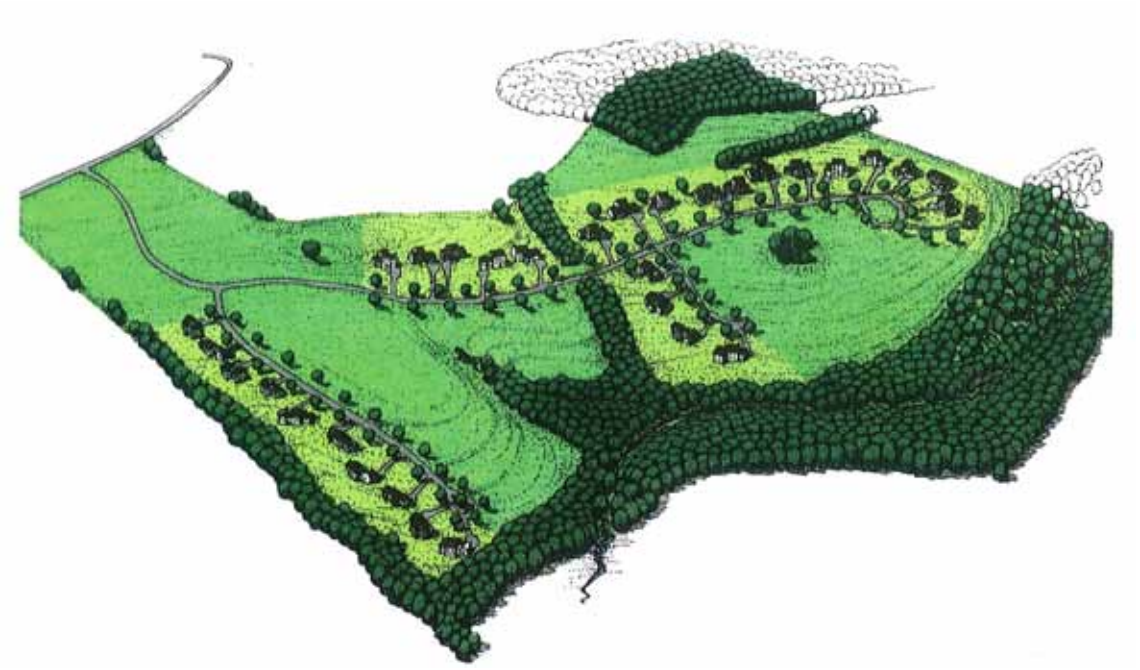
Step 3 — Provide safe vehicular transportation patterns as well as a variety of links to facilitate pedestrian and bicycle travel. Roadway alignments with curvilinear roads or short straight segments are preferable from an aesthetic and speed control perspective to straight roads as illustrated in Figure 7. Roadways and sidewalks should incorporate any terminal vistas of open space elements and/or unique features to contribute to the visual impact of the driving and/or pedestrian experience. Trails, bikepaths, and greenways should form continuous connections between the site and destinations.

Figure 7: Roadway Alignment



Step 4 — Produce a Conceptual Development Plan that generally reflects a combination of alternative concepts evaluated throughout the site design process that satisfies program requirements, quality of place objectives, and provides reasonable cost benefits. A conceptual development plan is presented in Figure 8.

Figure 8: Conceptual Development Plan



Additional Design Considerations

A. Night Sky View Preservation

The International Dark-Sky Association (www.darksky.org) defines light pollution as *"any adverse effect of manmade light. It is often used to denote urban sky glow."* The association has identified several types of light pollution, including glare, light trespass and energy waste.

In accordance with the Town of Northbridge Site Plan Review process (Article X, Administration and Enforcement, Section 173-49, Site Plan Review - Submission Requirements), all Site Plans must include "the location, height, intensity, and bulb type (e.g. fluorescent, sodium incandescent) of all external lighting fixtures. The direction of illumination and methods to eliminate glare onto adjoining properties must also be shown." The Town of Northbridge also encourages designers/developers to consider the following recommendations when developing a site plan:

- Incorporate full cut-off fixtures casting light directly downward at 90 degrees to the horizontal plane to obscure the source of illumination and minimize glare in the night sky and light trespass to adjacent properties

- Reduce candlepower and refrain from use of high-pressure sodium vapor lights that produce an orange/pink glow in the night sky in areas where reflected glow might be observed from a distance
- Incorporate limits or scheduled hours of recreation field or parking lot lighting

B. Floor Drain Regulations

As a preventative measure for the purpose of preserving and protecting the Town of Northbridge's drinking water resources from discharges of pollutants to the ground via floor drains in commercial or industrial buildings, and minimizing the threat of economic losses to the Town due to such discharges, the Town of Northbridge Board of Health has adopted regulations (pursuant to authorization granted by Massachusetts General Law c.111 s.31 and s.122) regarding the installation of new/modification of existing, monitoring and maintenance of floor drains (see Northbridge Board of Health Code of Regulations, § 201-24).

C. Grease Traps

To protect the residents and business owners within the Town of Northbridge from blockages of the Town's sanitary sewer caused by grease discharged from food service establishments located in the Town, the Northbridge Board of Health (acting under the authority of Chapter 111, § 31 of the Massachusetts General Laws and any amendments and additions thereto, and by any other power thereto enabling), has adopted the rules and regulations regarding the installation and maintenance of grease traps and removal of grease from food establishments (see Northbridge Board of Health Code of Regulations, § 201-21).

D. Excavation and Trench Safety

To protect the general public from the hazards inherent in open, unattended trenches, the Massachusetts Department of Public Safety, jointly with the Division of Occupational Safety (pursuant to Chapter 82A, § 14.00 of the Massachusetts General Laws), requires all excavators, whether public or private, to obtain a permit prior to the excavation of a trench made for a construction-related purpose on private property and on public property not within the layout of a public way. Rules and Regulations governing work performed within the layout of public roadways are found in Chapter 197 of the Code of the Town of Northbridge, Article I, Road Opening Permit Rules and Regulations.

E. Road Opening Permit

To protect the integrity of all public rights-of-way, assure protection of all structures and utilities within and adjacent to these rights-of-way, and provide optimum safety and convenience for the public, the Town of Northbridge (acting under the authority of Chapter 82A, §§ 1-5 of the Massachusetts General Laws and 520 CMR 14.00), has adopted the rules and regulations regarding trench excavation within a public way (see Code of the Town of Northbridge §§ 5-107, 6-101, 6-102, and 6-110).

Designer and Reviewer Checklist - Site Planning

This checklist is provided to expedite the development review process, to assure that Town of Northbridge goals and strategies for site planning are achieved through best development practices.

Northbridge Site Plan Goals

- Protect the environment
- Preserve the Town's character and quality of place
- Protect and enhance existing growth patterns
- Maintain the social and economic diversity of the community
- Protect the Town's historic, cultural, and natural resources

Northbridge Site Planning Strategies

- Maximize consistency of the development with the regional, community and site context
- Minimize site disturbance
- Preserve important site resources including steep and erosion-prone soils
- Promote energy efficiency, walkability and cohesive neighborhoods

Best Development Practices	Incorporated into Project?
Data Collection / Analysis	
▪ Has the locational context (regional, community and site) been considered?	❑
▪ Have natural resources, cultural factors, and man-made features been mapped?	❑
▪ Has a program been developed with the following objectives:	
○ Protect valuable site features?	❑
○ Reduce development footprint?	❑
○ Provide pedestrian and bike paths to encourage active, healthy lifestyles?	❑
Site Design	
▪ Has a site analysis plan been completed?	❑
▪ Have potential conservation areas been identified?	❑
▪ Have buildings been located to meet program development objectives?	❑
▪ Does project provide safe vehicular, pedestrian, and bicycle transportation patterns?	❑
▪ Has a conceptual development plan been prepared?	❑
Additional Design Considerations	
▪ Have requirements of the local Board of Health, Department of Public Works, and Conservation Commission been met, as warranted?	❑

SECTION 2: LANDSCAPE DESIGN

Landscape Design Overview and Policies

The primary purpose of landscape design is to incorporate context sensitive design that *blends the man-made (built environment) into the natural environment* and creates quality of place. A visually pleasing landscape may be one of the most important considerations in the design process. Of equal importance, particularly to the property owner, is cost. Under a conventional approach, functionality, maintenance, and the environment have been less important to the design process. The Town of Northbridge supports a **sustainable design** approach that rethinks the priority of the five primary considerations of landscape design, relying on a sound design that reflects the following to yield desired aesthetics:

- Functional – ease of movement, work, recreation and leisure
- Maintainable – ease of maintenance also reduces the need for/input of fertilizers, pesticides, equipment, and water
- Environmentally Sound – well-adapted to the regional climate also reduces the need for/input of fertilizers, pesticides, equipment, and water
- Cost Effective – regulated by the quality of the processes and plants used in implementation
- Visually Pleasing – aesthetic quality

Sustainable landscape principals are important to the Commonwealth of Massachusetts *Smart Growth/Smart Energy Toolkit*,[1] to the Leadership in Energy and Environmental Design (LEED) rating system[2], and to other programs which encourage a thorough understanding of the interactions between geology, topography, hydrology, soils, plants, animals and humans to lead to an ecologically-grounded design. Integration of native species, increased shading through vegetative canopy, and vegetated stormwater management strategies including low impact development (LID) techniques help reduce water demand for attractive landscapes and minimize the hydrologic impacts of development.

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[1] Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, *Smart Growth/ Smart Energy Toolkit:* www.mass.gov/envir/smart_growth_toolkit.

[2] US Green Building Council Leadership in Energy and Environmental Design (LEED) *New Construction Reference Guide,* Version 3.0, April 2009: www.usgbc.org

Northbridge's landscape design policy has been adapted to support LEED standards, sustainable development principles, and LID techniques to further the Town's objectives:

Northbridge Landscaping Goals

- Enhance the visual impact of the use upon the lot and adjacent property
- Retain existing landscaping where appropriate
- Minimize the impact of the property use on land and water resources
- Remove invasive vegetation from site to reduce impacts in the community and replace with native vegetation

Northbridge Landscape Design Strategies

- Minimize disturbance of existing site vegetation
- Utilize native plant material with low water demand
- Utilize plantings for energy conservation
- Avoid invasive species
- Implement effective and efficient watering practices
- Minimize disturbance of existing non-invasive vegetation

Sustainable Landscape Practices

A. Conserve Water through Landscaping

Limited groundwater and surface water supplies coupled with population increases and the rise in impervious surfaces has led to a growing concern over current and future water shortages across the nation. The highest priority for conserving water resources on greenfield (previously undeveloped) sites is to minimize grading, disturbance, and clearing of natural vegetation. **Section 1: Site Planning** and **Section 3: Stormwater Management** of this *Guidebook* provide descriptions and design considerations to meet this objective. Typically, this includes an increase in the preservation of native vegetation with minimization of turf/lawn and garden areas. Site plans and landscape plans should incorporate the following:

- Preserve existing vegetation to the maximum extent possible by reducing site grading
- Preserve soil permeability during development
- Retain and recharge water onsite
- Minimize use of turfgrass in landscaping
- Utilize efficient watering practices such as drip, micro misters, and subsurface irrigation systems with smart irrigation controllers as a preference to conventional preprogrammed sprinkler systems

B. Replicate Nature with Mulch

Mulch conserves soil moisture by replicating nature. A typical layer of mulch greatly reduces the evaporation of water from the sun and moving air, reduces soil compaction from falling rain, and decreases erosion rates. The stability of soil temperature is another plus with mulch. In the summer, lower uniform soil temperatures favor root growth and beneficial bacterial activity in the soil. In winter, a mulched area is less likely to experience frost penetration, preventing the soil water from freezing and becoming unavailable to plants. Table 1 presents a range of mulch applications as a guide.

Table 1: Mulch Options

Material	Depth to Apply	Comments
Rotted Manure	1 - 2 inches	Should be well composted to prevent burn.
Ground Corn Cobs	2 - 3 inches	Excellent for improving soil structure.
Pine Needles	3 - 6 inches	Will not mat down. Fairly durable. Great for winter protection on perennials.
Peanut Hulls	2 - 3 inches	Supplies plant nutrients and improves soil structure. Fairly durable.
Whole/Shredded Tree Leaves	3 - 6 inches	Excellent source of humus. Rots rapidly. Relatively high in nutrients.
Hay	3 - 6 inches	Unattractive but readily available.
Grass Clippings	1 - 2 inches	Grass clippings tend to mat and can repel water if they dry out.
Hay Straw	6 inches	Same as above, but lower in nutrients although furnishes considerable potassium.
Pecan Hulls	1 - 2 inches	Extremely durable. Availability limited. Will stain concrete.
Gravel	1 - 2 inches	Limited use but particularly good for rock garden plantings.
Stone Chips	1 - 2 inches	Extremely durable; holds down weeds but does not supply plant nutrients or humus.
Newspaper	½ - 1 inch	Good in open woodland, particularly under pines, to control weed growth. Should be covered with another mulch to improve appearance and prevent scattering.
Bark	2 - 3 inches	Ground and packaged commercially. Especially attractive in this form.

Source: Alabama Cooperative Extension Service, Mulches for the Landscape[3]

[3] *Mulches for the Landscape:* www.aces.edu/pubs/docs/A/ANR-0385

It is important to note that heavy mulching over a period of years may result in a buildup of soil over the crown area of most plants. It is recommended that old mulch be raked-off and replaced after 3 years to prevent plant roots from developing within the mulch material.

C. Energy Conservation through Landscaping

In addition to visually improving the landscape, plants have the ability to make our environment cleaner and more comfortable. A significant amount of solar energy can be gained from the sun through south-facing windows in the winter when the sun is lower in the sky. In the summer, twice as much solar energy enters through east and west windows when the sun is higher in the sky. Properly placed trees, windbreaks, and foundation plantings can reduce heating and cooling costs substantially.

1. Tree-Planting Considerations

- Create windbreaks to block cold winter winds, but allow cool summer breezes to flow through, as illustrated in Figure 9.
- Increase the tree canopy to cool the surface area of building facades, roofs and parking lots and reduce heat island effects.
- Shade east and west windows in the summer as illustrated in Figure 10 to reduce cooling demand.
- Avoid shading south windows in winter.

Figure 9: Coniferous trees create windbreaks

2. Shrub-Planting Considerations

- Utilize vegetation to create windbeaks and dead-space insulation between plants and building foundations as illustrated in Figure 11.
- Utilize a combination of deciduous and evergreen shrubs to control the location of snow drifts as illustrated in Figure 12. See **Section 3: Stormwater Management** for additional snow disposal considerations.

Figure 10: Deciduous trees create shade in summer

Figure 11: Foundation plantings create external building insulation

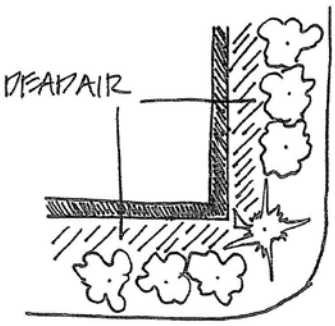


Figure 12: Vegetation controls drifting snow

D. Native Plant Species Advantages

Native plants have evolved over time by adapting to the geography, hydrology, and climate of a particular region. These indigenous plants provide a variety of habitats for a wide range of native wildlife species. Native plants provide a beautiful, hardy, drought resistant, low maintenance landscape while also benefiting the environment.

The introduction of non-native plants (also called non-indigenous, invasive, exotic species, or weeds) into complex native communities has been both accidental and deliberate. Non-native plants have no enemies to control or limit their spread. As they move into complex native plant communities they quickly replace native species. As the community of plants and animals continues to be simplified, the diverse community becomes a monoculture. A monoculture may provided limited habitat or food sources for wildlife.

The Town of Northbridge is committed to protecting the environment through the maintenance and re-establishment of a healthy ecosystem that encourages the use of native plant species. Native species are more likely to integrate into a healthy local ecosystem from where they came, while non-native species will be simplified out, creating a monoculture. Native plants offer the following benefits:

- Do not require fertilizers
- Require fewer pesticides than lawns
- Require less water than lawns
- Help reduce air pollution
- Provide shelter and food for wildlife
- Promote biodiversity and stewardship of our natural heritage
- Save money

Homeowners, landscape architects/designers and contractors are encouraged to use the following lists as guidance to select the most appropriate species. The following species are native and well-adapted to the geography, hydrology, and climate of Northbridge. Additional Suitability Tolerances have also been included for ease of selection.[4]

[4] Hightshoe, Gary L., Native Trees, Shrubs, and Vines for Urban and Rural America, A Planting Design Manual for Environmental Designers, John Wiley and Sons, Inc., 1988.

Native Species

Native Species Suitability Tolerance Key	
ST – Salt Tolerant	The extensive use of deicing salts, particularly in the Northeast has created a saline environment. Salts are deposited by aerial drift on buds, twigs and leaves of plant species along roadways and adjacent to parking areas, while also leaching into the root zone.
MT – Moisture Tolerant	The capacity of most plants to resist the frequency and duration of periods of saturation or partial saturation are limited.
DT – Drought Tolerant	The capacity of most plants to resist the detrimental effects of excessive heat and prolonged drought are limited.
UT – Urban Tolerant	Limiting factors of the urban environment include air pollution, too little soil moisture, improper drainage, compacted soils, infertile soils, night lighting and salt spray.
H – Habitat Forming	Cover is a vital requirement of life, particularly in critical periods – during inclement weather, during rearing of young, or when subjected to attack by enemies.
FB – Fruit Bearing	Food is also a primary necessity of life. Grass, shrub and tree species provide fruits, seeds, leaves, twigs, bark, stems and roots for many kinds of wildlife.
EC – Erosion Control	Steep slopes or unstable, erodible soils often require specific species to stabilize the ground and mitigate erosion.

Trees - Shade

Botanical Name	*Common Name*	*Tolerance*
Acer rubrum	Red Maple	UT/MT/H
Acer saccharum	Sugar Maple	UT/H
Betula lenta	Sweet Birch	ST
Betula alleghaniensis	Yellow Birch	ST
Carya ovata	Shagbark Hickory	
Castanea dentata	American Chestnut	
Fagus grandifolia	American Beech	
Fraxinus americana	White Ash	ST
Fraxinus pennsylvanica	Green Ash	UT/DT
Juglans cinerea	Butternut	
Liquidambar styraciflua	Sweetgum	UT
Liriodendron tulipifera	Tulip Tree	
Nyssa sylvatica	Black Tupelo	ST/UT/MT/H
Platanus occidentalis	American Sycamore	
Quercus alba	White Oak	ST/DT/H
Quercus bicolor	Swamp White Oak	DT
Quercus coccinea	Scarlet Oak	DT
Quercus palustris	Pin Oak	DT/H
Quercus rubra	Northern Red Oak	DT/H
Salix nigra	Black Willow	
Sassafras albidum	Common Sassafras	MT
Tilia americana 'Redmond'	Redmond Linden	
Ulmus americana	American Elm	

Trees - Evergreen

Botanical Name	*Common Name*	*Tolerance*
Ilex opaca	American Holly	MT
Juniperus virginiana	Eastern Red Cedar	ST/DT/H/FB
Pinus rigida	Pitch Pine	ST/DT/H/FB
Pinus strobus	Eastern White Pine	DT/H
Thuja occidentalis	American Arborvitae	
Tsuga canadensis	Canada Hemlock	H

Trees - Ornamental

Botanical Name	*Common Name*	*Tolerance*
Alnus rugosa	Hazel Alder	
Amelanchier canadensis	Shadblow Serviceberry	ST/MT/H
Amelanchier laevis	Allegany Serviceberry	MT
Betula nigra	River Birch	UT/MT/H
Betula papyrifera	Paper Birch	ST/H
Betula populifolia	Gray Birch	ST/MT/DT/H/FB
Carpinus caroliniana	American Hornbeam	DT
Cercis canadensis	Eastern Redbud	
Cornus alternifolia	Pagoda Dogwood	H
Cornus florida	Flowering Dogwood	MT/H
Crataegus punctata	Dotted Hawthorn	
Hamamelis virginiana	Common Witchhazel	MT
Larix laracina	American Larch	MT
Ostrya virginiana	American Hornbeam	UT
Prunus pensylvanica	Pin Cherry	ST
Prunus virginiana	Common Chokecherry	ST
Salix discolor	Pussy Willow	ST/MT/H
Viburnum lentago	Nannyberry Viburnum	

Shrubs - Deciduous

Botanical Name	*Common Name*	*Tolerance*
Arctostaphylos uva-ursi	Bearberry	ST/DT
Aronia melanocarpa	Black Chokeberry	ST/H
Aronia prunifolia	Purple-Fruited Chokeberry	MT/DT/H/FB
Clethra alnifolia	Summersweet Clethra	MT
Comptonia peregrina	Sweetfern	DT
Cornus alterniflora	Pagoda Dogwood	H
Cornus amomum	Silky Dogwood	MT/H/EC
Cornus racemosa	Gray Dogwood	MT/DT/H/EC
Cornus rugosa	Redleaf Dogwood	H/EC
Ilex verticillata	Common Winterberry	UT/MT
Ilex verticillata 'Nana'	Dwarf Common Winterberry	ST/MT/H/FB
Lindera benzoin	Common Spicebush	ST/MT
Myrica pennsylvanica	Northern Bayberry	ST/MT/DT/H/FB/EC
Rhododendron nudiflorum	Pinxterbloom Azalea	DT
Rhododendron roseum	Roseshell Azalea	
Rhododendron viscosum	Swamp Azalea	
Rhus glabra	Smooth Sumac	ST/DT/FB
Rhus typhina	Staghorn Sumac	ST/DT/FB
Rosa carolina	Carolina Rose	EC

Rubus odoratus	Flowering Raspberry	
Salix humilis	Prairie Willow	ST/MT/DT/H/FB
Salix lucida	Shining Willow	
Sambucus canadensis	American Elder	MT/DT
Vaccinium corymbosum	Highbush Blueberry	ST/MT
Viburnum acerifolium	Mapleleaf Viburnum	
Viburnum cassinoides	Witherod Viburnum	ST
Viburnum dentatum	Arrowwood Viburnum	ST/H
Viburnum trilobum	American Cranberrybush Vib.	

Shrubs - Evergreen

Botanical Name	*Common Name*	*Tolerance*
Juniperus communis 'Compressa'	Dwarf Common Juniper	DT/EC
Kalmia angustifolia	Sheeplaurel	
Kalmia latifolia	Mountainlaurel Kalmia	
Taxus canadensis	Canada Yew	ST

Groundcovers

Botanical Name	*Common Name*	*Tolerance*
Cornus canadensis	Bunchberry Dogwood	
Gaultheria procumbens	Checkerberry Wintergreen	
Mitchella repens	Partridgeberry	
Vaccinium angustifolium	Lowbush Blueberry	ST/MT/H/FB
Vaccinium macrocarpum	Cranberry	

Meadow Grasses/Wildflowers

Botanical Name	*Common Name*
Andropogon gerardii	Vitman Big Bluestem
Antennaria alpine	Alpine Pussy-Toes
Aristida dichotoma	Poverty Grass
Aster linariifolius	Bristly Aster
Calamagrostis canadensis	Blue Joint Reedgrass
Eragrostis spectabilis	Purple Lovegrass
Festuca elatior	Tall Fescue
Houstonia caerulea	Bluets
Juncus bufonius	Toad Rush
Lolium perenne	Palmer II Perr. Ryegrass
Panicum	Blackwell Switchgrass
Schizachyrium scoparium	Little Bluestem
Senecio aureus	Golden Ragwort
Sorghastrum nutans	Indian Grass

Perennials – Moisture-Tolerant

Botanical Name	*Common Name*
Aconitum carmichaelii	Monkshood
Amsonia hubrechtii	Star Flower
Aruncus dioicus	Goatsbeard
Clatha palustris	Marsh Marigold
Chelone lyonii	Turtlehead

Cimicifuga	Snakeroot
Epimedium	Bishops' Cap
Ferns	Ferns
Filipendula ulmaria	Meadowsweet
Gillenia trifoliate	Bowman's Root
Helleborus niger	Christmas Rose
Hemerocallis	Daylilly
Hibiscus moscheutos	Rosemallow
Iberis sempervirens	Candy Tuft
Kirengeshoma palmate	Yellow Waxbells
Liatris spicata	Gayfeather
Limonium latifolium	Sea Lavender (for salt marsh only)
Lobelia cardinalis	Cardinal Flower
Lobelia siphilitica	Big Blue Lobelia
Monarda didyma	Beebalm
Petasites	Butterbur
Phlox divaricata	Woodland Phlox
Platycodonj grandiflorus	Balloon flower
Polygonatum	Solomon's Seal
Tradescantia x andersonianan	Spiderwort
Trillium	Wakerobin
Trollius	Globeflower

Perennials – Drought-Tolerant

Botanical Name	*Common Name*
Anthemis tinctoria	Golden Marguerite
Artemisia	Wormwood
Armeria maritime	Thrift
Asclepias tuberose	Butterfly Milkweed
Aubrieta deltoidea	False Rock Cress
Aurinia saxatilis	Basket-of-Gold
Callirhoe involucrate	Poppy Mallow
Centaurea Montana	Mountain Bluet
Cerastium tomentosum	Snow-in-Summer
Echinacea purpurea	Coneflower
Echinops ritro	Globe Thistle
Eryngium planum	Sea Holly
Eupatorium	Hardy Ageratum
Gaillardia x grandiflora	Blanket Flower
Geranium dalmaticum	Cranesbill
Geranium macrorhizum	Bigroot
Gypsophila	Baby's Breath
Helianthus grosse-serratus	Sawtooth Sunflower
Hemerocallis fulva	Daylilly
Lamium maculatum	Spotted Dead Nettle
Lewisia cotyledon	Bitter Root
Nepera x faassenii	Persian Catmint
Oenothera	Evening Primrose
Opuntia humifusa	Prickly Pear
Papaver orientale	Poppy
Phlox subulata	Moss Pink
Polemonium caereum	Jacob's Ladder

Rudbeckia	Coneflower
Salvia verticillata	Purple Rain
Santolina chamaecyparissus	Lavender Cotton
Sedum	Stonecrop
Sempervivum	Houseleek
Stokesia laevis	Stoke's Aster
Thymus serpyllum	Mother-of-Thyme
Yucca	Desert Candle

E. Wetland Species

The following list of species is generally well-suited for planting in constructed wetlands, swales, and stormwater management areas that will typically be wet. The list represents species identified on the *National List of Vascular Plant Species That Occur in Wetlands: 1996 National Summary* cross-referenced with the native species plant list. Selection of species for planting within each section of the wet area should be selected based upon hydrologic conditions of the specific area. **Section 3: Stormwater Management** has additional information regarding design considerations and maintenance requirements for Constructed Wetlands.

Trees

Botanical Name	*Common Name*
Acer rubrum	Red Maple
Betula nigra	River Birch
Fraxinus americana	White Ash
Fraxinus pennsylvanica	Green Ash
Nyssa sylvatica	Black Gum
Quercus bicolor	Swamp Oak

Shrubs

Botanical Name	*Common Name*
Clethra alnifolia	Summersweet Clethra
Cornus amomum	Silky Dogwood
Ilex verticillata	Winterberry
Kalmia angustifolia	Sheep Laurel
Lindera benzoin	Spicebush
Rhododendron viscosum	Swamp Azalea
Vaccinium corymbosum	Highbush Blueberry

Woody Wetland Plants

Botanical Name	*Common Name*
Alnus rugosa	Hazel Alder
Ilex opaca	American Holly
Salix nigra	Black Willow
Sambucus canadensis	Elder

Herbaceous Plants

Herbaceous Plants Water Depth Key:

- Transitional: seasonally flooded
- Shallow: seasonally flooded to permanently flooded to 15 cm
- Medium: 15 to 50-cm water depths
- Deep: 50 to 200-cm water depths

Botanical Name	*Common Name*	*Water Depth*
Acorus calamus	Sweet flag	Medium
Brasenia schrebrri	Watershield	Deep
Calla palustris	Water arum	Medium
Caltha leptosepala	Marsh Marigold	Shallow
Iris versicolor	Blue Flag Iris	Medium
Lobelia cardinalis	Cardinal Flower	Shallow
Lobelia siphilitica	Great Lobelia	Shallow
Nuphar luteum	Spatterdock	Deep
Nymphea odorata	Fragrant White Lily	Deep
Osmunda cinnamomea	Cinnamon Fern	Transitional
Osmunda regalis	Royal Fern	Transitional
Peltandra cordata	Arrow Arum	Medium
Polygonum coccineum	Pennsylvania Smartweed	Shallow
Ponetederia cordata	Pickerelweed	Medium
Potamogeton pectinatus	Sago Pondweed	Deep
Ranunculus aquatilis	White Water Buttercup	Deep
Ranunculus flabellaris	ellow Water Buttercup	Deep
Scirpus americanus	Three-Square	Medium
Scirpus cyperinus	Woolgrass	Shallow
Scirpus fluviatilis	River Bulrush	Medium
Scirpus validus	Bulrush	Deep
Sparganium eurycarpum	Burreed	Medium
Symplocarpus foetidus	Skunk Cabbage	Transitional
Thelypteris palustri	Marsh Fern	Shallow
Vallisneria americana	Tapegrass	Deep

F. Prohibited Invasive and Noxious Weed Species

Following is a list of plant species for which the importation and propagation is currently prohibited within the State of Massachusetts.[5] As of January 1, 2009, the sale, trade, purchase, distribution and related activities for the following species are prohibited:

Botanical Name	*Common Name*
Acer platanoides	Norway Maple
Acer pseudoplatanus	Sycamore Maple
Aeginetia spp.	Aeginetia

[5] *USDA Natural Resources Conservation Service Massachusetts State Listed Noxious Weeds:* http://plants.usda.gov/java/noxious?rptType=State&statefips=25

Aegopodium podagraria	Goutweed
Ageratina adenophora	Crofton Weed
Ailanthus altissima	Tree of Heaven
Alectra spp.	Alectra
Alliaria petiolata	Garlic Mustard
Alternanthera sessilis	Sessile Joyweed
Ampelopsis brevipedunculata	Porcelain Berry
Anthriscus sylvestris	Wild Chervil
Arthraxon hispidus	Hairy Joint Grass; Jointhead; Small Carpetgrass
Asphodelus fistulosus	Onion Weed
Avena sterilis	Animated Oat
Azolla pinnata	Mosquito Fern
Berberis thunbergii	Japanese Barberry
Berberis vulgaris	Common Barberry
Cabomba caroliniana	Fanwort
Cardamine impatiens	Bushy Rock-cress; Narrowleaf Bittercress
Carex kobomugi	Japanese Sedge; Asiatic Sand Sedge
Carthamus oxyacanthus	Wild Safflower; Jeweled Distaff Thistle
Caulerpa taxifolia	Caulerpa
Celastrus orbiculata	Oriental Bittersweet
Centaurea maculosa	Spotted Knapweed
Chrysopogon aciculatus	Pilipiliula
Commelina benghalensis	Benghal Dayflower
Crupina vulgaris	Common Crupina
Cuscuta spp.	Dodder
Cynanchum louiseae	Black Swallow-wort
Cynanchum rossicum	Pale Swallow-Wort
Digitaria abyssinica; D. scalarum	African Couchgrass
Digitaria velutina	Velvet Fingergrass
Drymaria arenarioides	Alfombrilla
Egeria densa	Giant Waterweek
Eichhornia azurea	Anchored Water Hyacinth
Elaeagnus umbellate	Autumn Olive
Emex australis	Three-Cornered Jack
Emex spinosa	Devil's Thorn
Epilobium hirsutum	Hairy Willow-herb
Euonymus alatus	Winged Euonymus
Euphorbia cyparissias	Cypress Spurge
Euphorbia esula	Leafy Spurge; Wolf's Milk
Festuca filiformis	Hair Fescue; Fineleaf Sheep Fescue
Frangula alnus	European Buckthorn; Glossy Buckthorn
Galega officinalis	Goatsrue
Glaucium flavum	Sea Poppy
Glyceria maxima	Tall Mannagrass; Reed Mannagrass
Heracleum mantegazzianum	Giant Hogweed
Hesperis matronalis	Dame's Rocket
Homeria spp.	Cape Tulip
Humulus japonicus	Japanese Hops
Hydrilla verticillata	Hydrilla; Water-Thyme; Florida Elodea
Hygrophila polysperma	Miramar Weed
Imperata brasiliensis	Brazilian Satintail
Ipomoea aquatica	Chinese Waterspinach
Iris pseudacorus	Yellow Iris

Ischaemum rugosum	Murain-Grass
Lagarosiphon major	Oxygen Weed
Lepidium latifolium	Broad-Leafed Pepperweed; Tall Pepperweed
Leptochloa chinensis	Asian Sprangletop
Ligustrum obtusifolium	Blunt-leaver Privet
Limnophila sessiliflora	Ambulia
Lonicera japonica	Japanese Honeysuckle
Lonicera maackii	Amur Honeysuckle
Lonicera morrowii	Morrow's Honeysuckle
Lonicera tatarica	Tatarian Honeysuckle
Lonicera x bella	Morrow's x Tatarian Honeysuckle
Lycium ferrocissimum	African Bboxthorn
Lysimachia nummularia	Moneywort
Lythrum salicaria	Purple Loosestrife
Melaleuca quinquenervia	Melaleuca
Melastoma malabathricum	Malabar Melastome
Microstegium vimineum	Japanese Stilt Grass; Nepalese Browntop
Mikania cordata	Mile-a-Minute; Heartleaf Hempvine
Mikania micrantha	Mile-a-Minute; Bittervine
Mimosa diplotricha; M. invisa	Giant False Sensitive Plant
Mimosa pigra	Catclaw Mimosa
Miscanthus sacchariflorus	Plume Grass; Amur Silvergrass
Monochoria hastata	Monochoria
Monochoria vaginalis	Pickerel Weed
Myosotis scorpioides	True Forget-Me-Not
Myriophyllum heterophyllum	Variable Water-Milfoil
Myriophyllum spicatum	Spiked Water-Milfoil
Najas minor	Lesser Naiad
Nassella trichotoma	Serrated Tussock
Nymphoides peltata	Yellow Floating Heart
Opuntia aurantiaca	Jointed Prickly Pear
Orobanche spp.	Broomrape
Oryza longistaminata	Longstamen Rice; Red Rice
Oryza punctata	Red Rice
Oryza rufipogon	Brownbeard Rice; Red Rice
Ottelia alismoides	Duck-Lettuce
Paspalum scrobiculatum	Kodo-Millet
Pennisetum clandestinum	Kikuyugrass
Pennisetum macrourum	African Feathergrass
Pennisetum pedicellatum	Kyasuma Grass
Pennisetum polystachyon	Missiongrass
Phalaris arundinace	Reed Canary Grass
Phellodendron amurense	Amur Cork-Tree
Phragmites australis	Phragmites
Polygonum cuspidatum	Japanese Knotweed
Polygonum perfoliatum	Mile-a-Minute Vine or Weed; Asiatic Tearthumb
Potamogeton crispus	Curly or Crisped Pondweed
Prosopis pallida	Kiawe
Prosopis reptans	Tornillo
Prosopis strombulifera	Argentine Screwbean
Prosopis velutina	Velvet Mesquite
Pueraria montana	Kudzu; Japanese Arrowroot
Rhamnus cathartica	Common Buckthorn

Ranunculus ficaria	Lesser Celandine; Fig Buttercup
Ranunculus repens	Creeping Buttercup
Robinia pseudoacacia	Black Locust
Rorippa amphibia	Water Yellowcress; Great Yellowcress
Rosa multiflora	Multiflora Rose
Rottboellia cochinchinensis	Itchgrass
Rubus fruticosus	Wild Blackberry complex
Rubus moluccanus	Wild Blackberry
Rubus phoenicolasius	Wineberry; Japanese Wineberry; Wine Raspberry
Saccharum spontaneum	Wild Sugarcane
Sagittaria sagittifolia	Arrowhead
Salsola vermiculata	Wormleaf Salsola
Salvinia auriculata	Giant Salvinia; Eared Watermoss
Salvinia biloba	Giant Salvinia
Salvinia herzogii	Giant Salvinia
Salvinia molesta	Giant Salvinia; Kariba-Weed
Senecio jacobaea	Tansy Ragwort; Stinking Willie
Setaria pallidifusca	Cattail Grass; Yellow Foxtail
Solanum tampicense	Wetland Nightshade
Solanum torvum	Turkeyberry
Solanum viarum	Tropical Soda Apple
Sparganium erectum	Exotic Bur-Reed
Spermacoce alata	Borreria
Striga spp.	Witchweed
Trapa natans	Water Chestnut
Tridax procumbens	Coat Buttons
Tussilago farfara	Coltsfoot
Urochloa panicoides	Liverseed Grass

Designer and Reviewer Checklist - Landscape Design

This checklist is provided to expedite the development review process, to assure that Town of Northbridge goals and strategies for site planning are achieved through best development practices.

Northbridge Landscaping Goals

- Enhance the visual impact of the use upon the lot and adjacent property
- Retain existing landscaping where appropriate
- Minimize the impact of the property use on land and water resources
- Remove invasive vegetation from site to reduce impacts in the community and replace with native vegetation

Northbridge Landscape Design Strategies

- Minimize disturbance of existing site vegetation
- Utilize native plant material with low water demand
- Utilize plantings for energy conservation
- Avoid invasive species
- Implement effective and efficient watering practices
- Minimize disturbance of existing non-invasive vegetation

Best Development Practices	Incorporated into Project?
▪ Does project preserve existing vegetation to the maximum extent possible?	❑
▪ Have measures been taken to preserve soil permeability during development?	❑
▪ Is stormwater retained and recharged onsite? (see Section 3)	❑
▪ Has the use of turfgrass been minimized in landscaping?	❑
▪ Have efficient watering practices been utilized?	❑
▪ Is mulch used to retain moisture?	❑
▪ Has landscaping been used to conserve energy?	❑
▪ Have native species appropriate to the microclimate been specified?	❑
▪ Have known invasive species been removed?	❑

SECTION 3: STORMWATER MANAGEMENT

Stormwater Management Overview and Policies

The Town of Northbridge is located entirely within the Blackstone River Valley Watershed in south central Massachusetts. The Blackstone River originates in Worcester, flows approximately 50 miles to the south into Rhode Island, and empties into the Seekonk River at the head of the Narragansett Bay. The watershed encompasses approximately 540 square miles. As a result of intense industrial development since the Industrial Revolution, the river's waters have been left polluted. In 1990, an EPA-sponsored report termed the River "the most polluted river in the country with respect to toxic sediments."[1] While considerable water quality improvements have been made on the river, it still does not meet the water quality standards that the Clean Water Act of 1972 mandated to be met by 1987.

The condition of the Blackstone River and its tributaries compels the need for innovative stormwater management techniques to be used throughout the watershed, including within the Town of Northbridge. This *Guidebook*, based on the Town's Stormwater Management Bylaw[2] and the Massachusetts Stormwater Management Standards[3], has been developed to ensure a minimum level of stormwater management is met for development and redevelopment projects within the Town. All projects should adhere to the following standards:

- All new stormwater conveyances must treat stormwater before discharging it to wetlands or waters of the Commonwealth.
- Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development discharge rates.
- The annual groundwater recharge from the post-developed site should approximate the annual recharge from the pre-developed site, based on soil conditions.
- For new development, stormwater management systems must be designed to remove 80% of the average annual load of total suspended solids (TSS) from the post-development stormwater.
- Stormwater discharges from areas with higher potential pollutant loads and discharges to critical areas must utilize certain stormwater Best Management Practices (BMPs).

[1] Blackstone River Coalition, http://zaptheblackstone.org

[2] Town of Northbridge, *Stormwater Management Bylaw,* Adopted May 06, 2008

[3] Massachusetts Stormwater Handbook, http://www.mass.gov/dep/water/laws/policies.htm#storm

- Redevelopment sites must meet the standards to the maximum extent practicable.
- Erosion and sediment controls must be implemented to prevent impacts during construction or land-disturbance activities.
- All stormwater management systems must have an operation and maintenance plan to ensure that the systems function as designed.

These standards address the Town of Northbridge's Stormwater Management goals.

Northbridge Stormwater Management Goals

- Protect water and aquatic resources
- Promote groundwater recharge to protect surface and groundwater drinking supplies
- Maximize groundwater recharge to retain a viable local groundwater supply
- Reduce flooding, stream bank erosion, siltation, nonpoint source pollution, property damage
- Maintain the integrity of stream channels and aquatic habitats

Northbridge Stormwater Management Strategies

- Encourage and promote the use of Low Impact Development (LID) techniques wherever feasible
- Permit conventional collection, conveyance, and end of pipe treatment of stormwater only where LID techniques are not possible

Low Impact Development (LID)

There is a growing trend in the stormwater management industry to seek a more natural alternative to conventional systems of stormwater collection, conveyance, and end-of-pipe treatment. Conventional systems are no longer sufficient to treat stormwater as they limit groundwater recharge, degrade the water quality of receiving waters, increase runoff volumes (since they remove stormwater from the site as fast as possible), and potentially increase peak discharges and flow velocities. The new approach to managing stormwater is through LID techniques. LID is a comprehensive approach to managing stormwater, including land planning and design, technology to conserve and protect natural systems, and minimization of the hydrologic impacts of development. The benefits of LID systems include:

- Reduction in infrastructure costs through the use of non-structural, on-site treatment of stormwater
- Maintaining or increasing property values
- Reduction in runoff volume through the use of less impervious cover
- Preservation of natural areas and native vegetation

- Development of multifunctional, more aesthetically pleasing, and naturally attractive site layouts by integrating stormwater management into the landscape design
- Management of stormwater runoff through more and smaller (pocket) drainage areas
- Reduction in remediation costs of environmental resources
- Reduction of long-term operation and maintenance costs of stormwater management system
- Increase in recreational open space
- Increased safety for the community since LID techniques tend to be shallower with gentler side slopes
- Reduction in land consumption for use of stormwater management

LID forms the basis of the Northbridge Stormwater Management Strategies: 1) to encourage and promote the use of Low Impact Development (LID) techniques wherever feasible and 2) to permit conventional collection, conveyance, and end of pipe treatment of stormwater only where LID techniques are not possible.

A. Soil Classification

Section 1: Site Planning outlines the steps to identify constraints and opportunities for development. Information from this process may be used to identify the suitability of a site for any of the LID techniques outlined in this section. Design considerations in locating stormwater BMPs on a project site include the characteristics of existing soils, presence of ledge, and the availability of receiving waters for discharge of stormwater following pretreatment. The suitability of soils for LID techniques is described below. Ledge and rock outcrops may limit the suitability of the site for some but not all techniques. Techniques which discharge treated stormwater to natural wetlands or other receiving waters may not be suitable for upland sites.

Soils are classified by the Natural Resource Conservation Service (NRCS) into four Hydrologic Soil Groups (HSG) based on the soil's runoff potential. HSG A has the lowest and HSG D has the highest runoff potential. Group A soils are typically sand, loamy sand, or sandy loam and are characterized by their high infiltration rate. Group B soils are typically silty loam or loam and have a moderate infiltration rate when thoroughly wet. Group C soils consist of sandy clay loam and have a slow infiltration rate. Group D soils include clay loam, silty clay loam, sandy clay, silty clay, and clay and have a very slow infiltration rate. For design purposes, stormwater BMPs that are designed to promote infiltration should be located where the in-situ soil types are within HSG A and B. As indicated in the text box, 60% of soils in Northbridge are classified in Group A or B. Stormwater BMPs located within HSG C and D should be designed appropriately to account for the lack of in-

Northbridge Hydrologic Soil Group Distribution

- Group A 20%
- Group B 40%
- Group C 30%
- Group D 3%
- Water 7%

filtration within the in-situ soils. Design considerations may include subdrains leading to secondary stormwater facilities, impermeable liners, and additional maintenance considerations. Each project should address the existing soil conditions within the project limits. The hydrologic soil group of a specific site can be determined using the *Web Soil Survey*. [4]

B. LID Practices

It is the Town's policy to encourage use of one or more of the following eleven LID stormwater management practices where conditions warrant. Table 2 provides an overview of how LID and conventional practices meet Town policy and summarizes the advantages / benefits and disadvantages / limitations of each. Each type of LID practice is discussed in more detail in the following sections; conventional practices are presented on page 48. For more information, please consult the *Massachusetts Stormwater Handbook*.

[4] US Department of Agriculture Natural Resources Conservation Service *Web Soil Survey:* http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Table 2: LID and Conventional Practices Summary

	Northbridge's Policy	Advantages and Benefits	Disadvantages and Limitations
Sediment Forebays	Strongly encouraged	▪ Slows velocities of incoming stormwater ▪ Easily accessed for maintenance ▪ Longevity is high with proper maintenance ▪ Cost effective	▪ Removes only coarse sediments ▪ No removal of soluble pollutants ▪ No control of runoff volume
Vegetated Filter Strips	Strongly encouraged	▪ Reduces runoff volumes and peak flows ▪ Can mimic natural hydrology ▪ Ideal for residential settings and small parking lots and roads	▪ Concentrated flows can cause system to fail ▪ Large land requirements ▪ Requires less than 6% slopes ▪ Improper grading greatly diminishes pollutant removal
Bioretention and Raingardens	Strongly encouraged	▪ Provide groundwater recharge ▪ Supplies shade, absorbs noise, provides windbreaks, pollutant removal ▪ Can be used on small lots with space constraints	▪ Requires careful landscaping ▪ Not suitable for large drainage areas
Constructed Stormwater Wetlands	Strongly encouraged	▪ High pollutant removal ▪ Enhances aesthetics of site ▪ Provides recreational benefits ▪ Provides wildlife habitat	▪ Land requirements ▪ Relatively high construction costs ▪ Potential breeding habitat for mosquitoes ▪ May present safety issue for pedestrians
Sand and Organic Filters	Strongly encouraged	▪ Applicable to small drainage areas ▪ Long design life ▪ Good for densely populated urban areas and parking lots with high intensity	▪ Pretreatment required to prevent clogging ▪ Relatively costly to construct ▪ May not be effective in winter

	Northbridge's Policy	Advantages and Benefits	Disadvantages and Limitations
Water Quality Swales	Strongly encouraged	▪ Generally cost effective when compared to curb and gutter systems ▪ Accents natural landscape ▪ Improves water quality	▪ Subject to damage from off-street parking and snow removal ▪ Subject to erosion during large storms ▪ Impractical in areas with extremely flat or steep topography or poorly drained soils
Dry Wells	Encouraged	▪ Applicable for runoff from roofs ▪ Can reduce size and cost of downstream BMPs and/or storm drains	▪ Primarily for residential and small commercial applications to avoid clogging ▪ Drainage area must be 1 acre or less ▪ Potential for water seepage into cellars or cracking / heaving in slabs
Infiltration Basins and Trenches	Strongly encouraged	▪ Reduces local flooding ▪ Can be used for larger sites	▪ Improper siting, inadequate pretreatment, lack of maintenance cause high failure rates ▪ Not appropriate for treating significant loads of sediment and other pollutants
Green Roofs	Encouraged	▪ Reduces heating and cooling costs for buildings ▪ Conserves space ▪ May extend roof life expectancy ▪ Provides sound insulation	▪ Precipitation is not recharged to groundwater ▪ Irrigation may be required ▪ May require additional structural strengthening
Porous Pavement	Encouraged	▪ Reduces runoff volume from paved surfaces ▪ Reduces pollutant transport through direct infiltration ▪ Long-lasting with proper design, installation, and maintenance ▪ Improved site landscaping benefits	▪ Prone to clogging ▪ No winter sanding allowed ▪ Winter road salt and deicer present concerns when near drinking water supplies ▪ Special care required to avoid compacting underlying soils
Rain Barrels and Cisterns	Encouraged	▪ Reduces water demand and saves money by using stored water for irrigation ▪ Public water systems may experience lower peak demand in summer ▪ Reduces runoff volume for small storms	▪ Must be properly sealed to mitigate mosquito-breeding habitat ▪ Needs to be disconnected and drained in winter to avoid cracking of storage structure
CONVENTIONAL TECHNIQUES			
Curb/ Catch Basin, Detention Basin, etc.	Strongly discouraged	▪ Limited benefits	▪ Limits groundwater recharge ▪ Degrades water quality of receiving waters ▪ Increases runoff volumes ▪ Potentially increases peak discharges and flow velocities

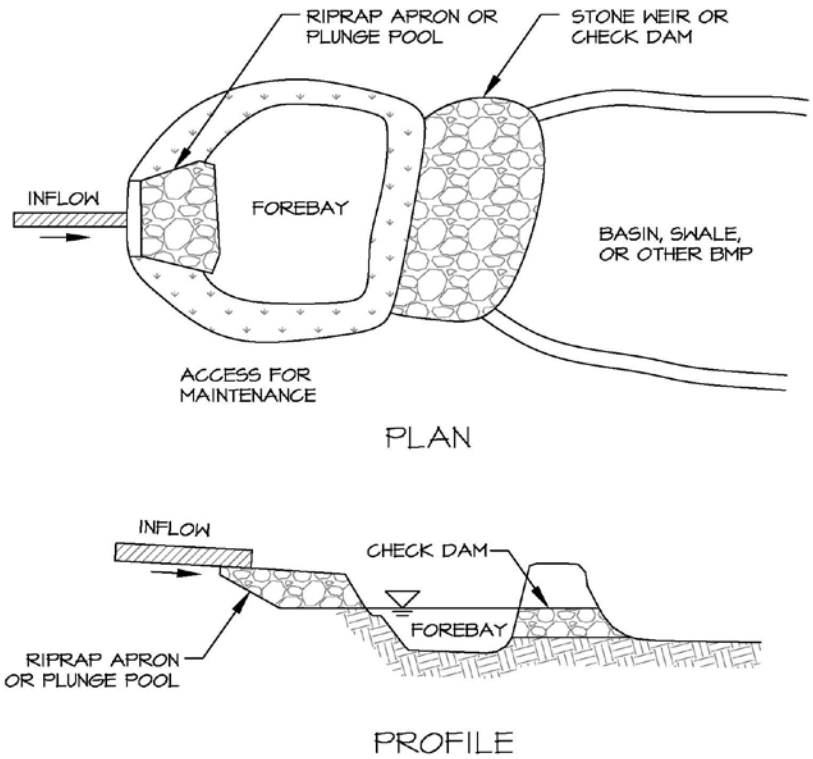
1. **Sediment Forebays**

Description: A sediment forebay is a practice consisting of an excavated depression, bermed area, or structure combine with a weir, designed to slow incoming stormwater runoff and allow suspended solids to settle via gravity as illustrated in Figure 13. Figures 13 through 23 are adopted from the *Massachusetts Stormwater Handbook*.

Design Considerations: Sediment forebays are typically designed as the primary water quality treatment cell, inline and prior to a secondary best management practice. At a minimum, the forebay should be sized to hold 0.1-inch per impervious acre to pretreat the water quality volume. The forebay should be designed to prevent scouring and erosion, based on the anticipated velocity entering the system. To provide stabilization and maintain the storage volume, the side slopes should not be steeper than 3:1 and the sides and bottoms of the system should be stabilized with grass seed mixes recommended by the NRCS. To facilitate removal of accumulated sediment, the bottom of the facility may be stabilized with concrete or stone.

Inspections of forebays should be performed monthly. Sediment markers should be included within the system to denote when the sediment depth is between 3 and 6 feet and needs to be removed. During the inspections, erosion within the system should also be noted and repaired as needed.

Figure 13: Sediment Forebay



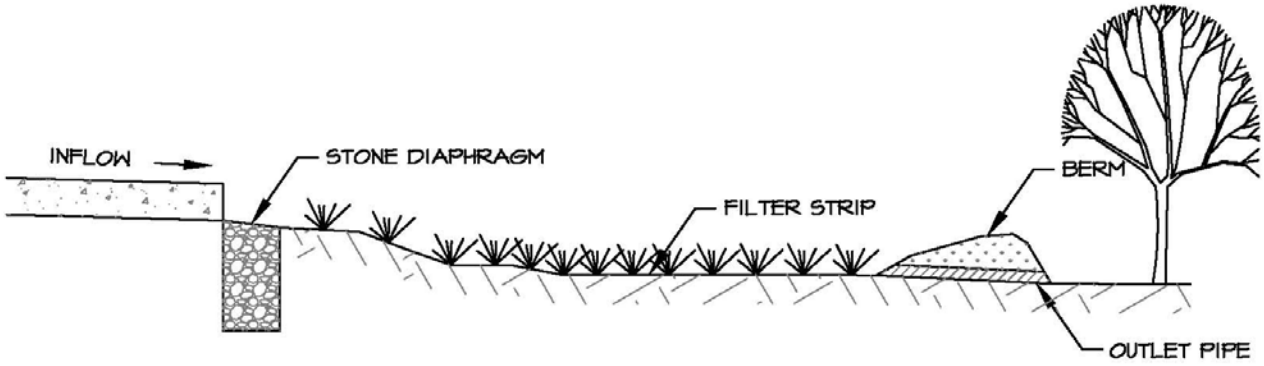
2. Vegetated Filter Strips

Description: A vegetated filter strip is a uniformly graded vegetated surface that receives runoff from adjacent impervious areas, as illustrated in Figure 14.

Design Considerations: Vegetated filter strips are typically used to pretreat sheet flow from roads, driveways, and small parking lots. They function best for drainage areas of one acre or less with gentle slopes. They are designed to slow runoff, trap sediment, and promote infiltration where possible. They should be located in soils with little to no clay content that will allow the runoff to infiltrate. Runoff should enter the strip via a level spreader to evenly distribute the flow. Filter strips should have slopes between 2 and 6 percent. The strip should drain within 24 hours after a storm event and ponding should not exceed 0.5-inch.

Maintenance of the filter strip should include regular mowing, removal of sediment, and reseeding as needed. Semi-annual inspections should be performed for the first year after construction and be continued annually during subsequent years.

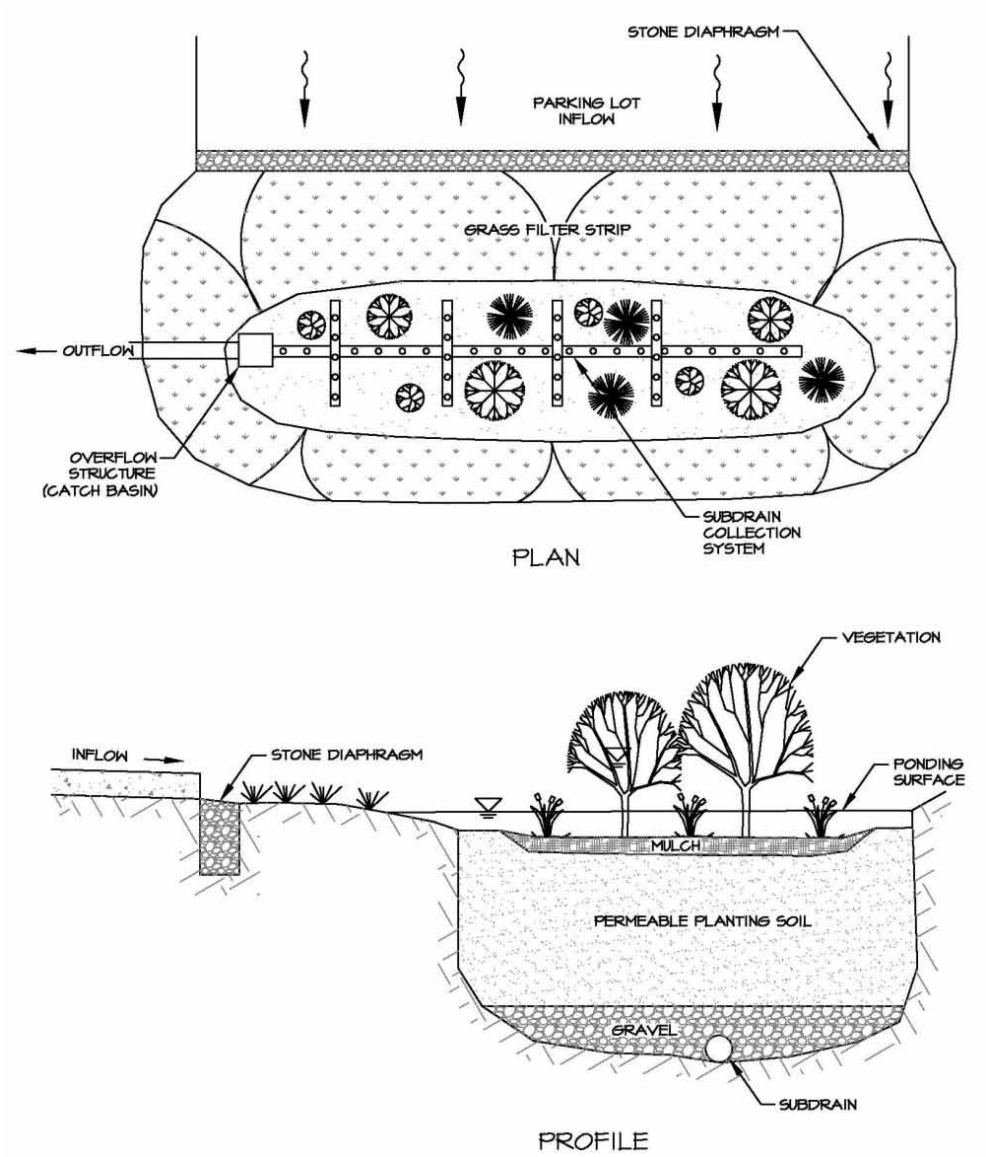
Figure 14: Vegetated Filter Strip



3. Bioretention and Raingardens

Description: Bioretention areas or raingardens are shallow depressions designed with specified soil mixes, topped with mulch or compost, and planted with specified, native vegetation, as illustrated in Figure 15. Stormwater runoff is directed into the area via pipe or sheet flow and filters through the soil media; some of the water is also taken up by the vegetation. There are two types of bioretention areas: ones that only filter and ones that both filter and exfiltrate. A filtrating bioretention area has an impermeable liner and subdrain that intercepts the runoff so that it may be conveyed to another BMP or outlet. An exfiltrating bioretention area is designed to promote groundwater recharge.

Figure 15: Bioretention and Raingardens



Design Considerations: The bioretention area should be sized to be approximately 5 to 7% of the area draining to it. The depth of the soil media should be between 2 and 4 feet. Filter fabric should not be used within bioretention areas, as it is prone to clogging. For a bioretention area that is designed to exfiltrate, the soil media should be a mixture of sand, compost, and soil (40% sand, 20 – 30% topsoil, 30 – 40% compost). The area should be graded to allow a ponding depth of approximately 6 to 8 inches. Vegetation within the bioretention area should be based on the depth of the soil media and include a mix of herbaceous perennials, shrubs, and possibly understory trees that can tolerate intermittent pond-

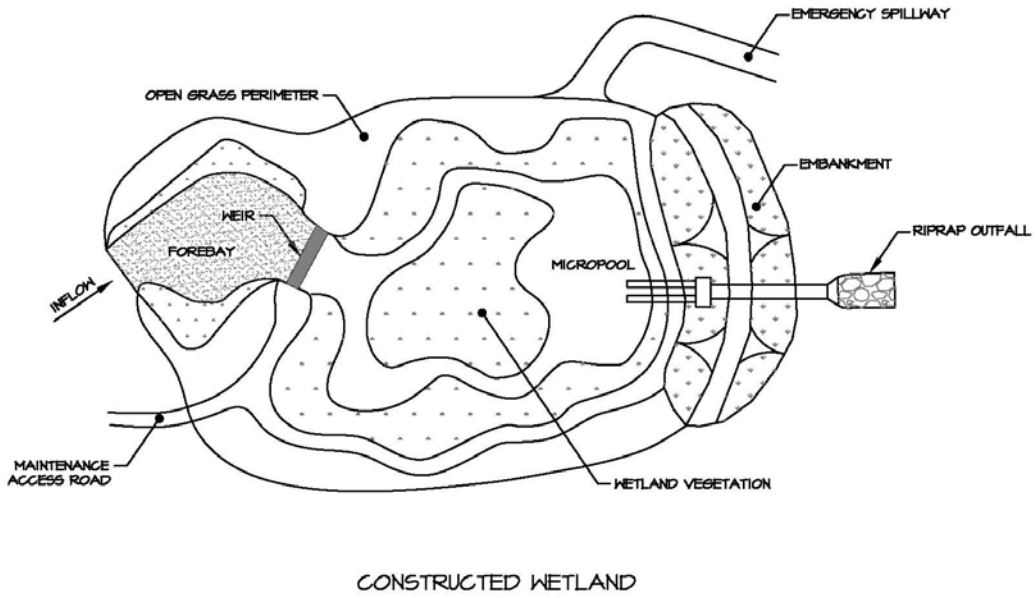
ing, extended dry periods, and other site specific conditions. The area must be designed to drain within 72 hours. They may be designed to drain faster to inhibit the potential for breeding mosquitoes. Pretreatment, via a stone or pea gravel diaphragm or vegetated filter strip, is required when designing a bioretention area. Most bioretention areas have an overflow drain that allows ponded water above the ponding depth to outlet to a subdrain. If the system is designed to exfiltrate, the subdrain terminates within the bioretention area; if the system is not designed to exfiltrate, the subdrain is connected to an outlet to a downstream location.

Premature failure of bioretention areas may be caused by a lack of regular maintenance. Ensuring long-term maintenance involves sustained public education and deed restrictions or covenants for privately owned areas. Pretreatment devices and bioretention areas should be inspected regularly for sediment build-up, structural damage, and standing water. The areas may need repairs due to erosion, re-mulching of void areas, removal of litter and debris and diseased and/or dead vegetation.

4. Constructed Stormwater Wetlands

Description: Figure 16 illustrates that constructed stormwater wetlands are systems that maximize the removal of pollutants from stormwater runoff through wetland vegetation uptake, retention, and settling. They temporarily store runoff in shallow pools with suitable conditions for the growth of wetland plants.

Figure 16: Constructed Stormwater Wetland



Design Considerations: There are five basic types of constructed stormwater wetlands: shallow marsh systems, basin/wetland systems, extended detention systems, pocket wetlands, and gravel wetlands. For more information and details regarding the design of each of the systems, please refer to the *Massachusetts Stormwater Handbook*. A constructed stormwater wetland may be designed as a linear system with permanent pools for both treatment and storage of peak flows. They may also be designed as off-line systems where the higher flows are diverted around the system. The system must be sized to account for the required water quality volume. Pollutant removal within the wetland is highly dependent upon the ratio of the surface area of the wetland to longer flow paths through the wetlands to the contributing drainage area. Constructed stormwater wetlands consist of four "depth zones." Each of the zones has varying depths based on the type of constructed stormwater wetland. The four basic zones are: semi-wet zone, high marsh zone, low marsh zone, and deep-water zone.

Small-scale maintenance at regular intervals is required to evaluate the health and composition of the vegetation within the wetland. Maintenance should be performed twice per year for the first three years post-construction and annually subsequently. Invasive species should be removed during the regular inspections.

5. **Sand, Organic, & Tree Box Filters**

Description: Sand and organic filters consist of self-contained beds of sand or peat with perforated subdrains or cells and baffles with inlets and outlets, as illustrated in Figure 17A. Stormwater runoff is filtered through the sand and may be subject to biological uptake. Runoff is discharged or conveyed to another BMP for additional treatment. Tree box filters are included in this category of BMPs. As illustrated in Figure 17B, a tree box filter consists of an open bottom concrete well that is filled with a porous soil media. A subdrain is placed in crushed gravel below the soil media and a tree is planted in the well. Stormwater is directed from surrounding impervious areas through the top of the soil media to be percolated through the soil media for treatment.

Figure 17A: Sand and Organic Filter

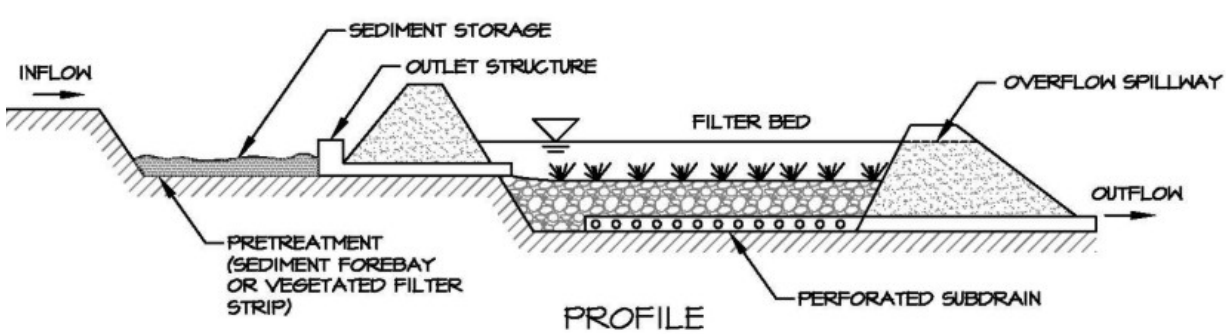
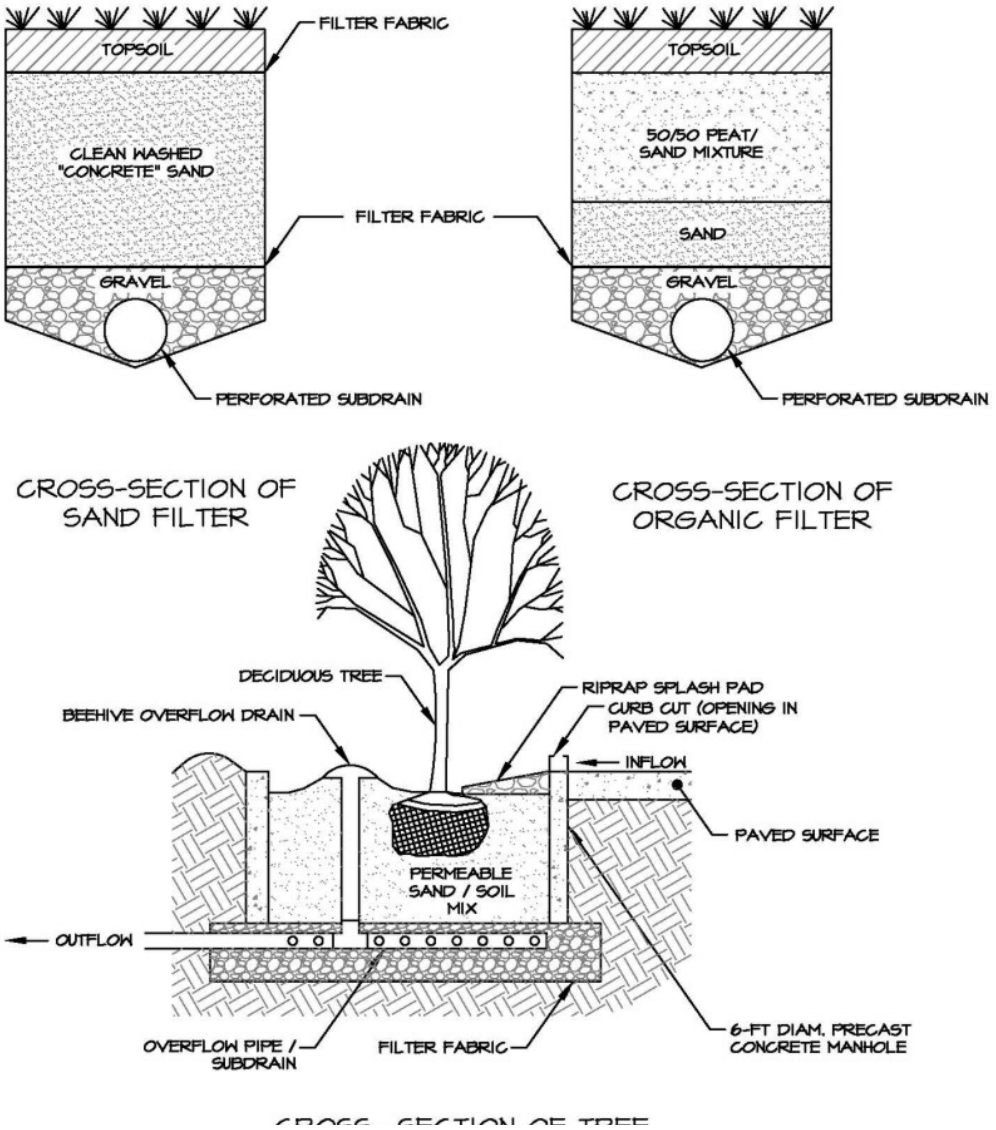


Figure 17B: Tree Box Filter



Design Considerations: Sand and organic filters are off-line systems generally designed with two components: pretreatment and filtering. The pretreatment device may be a sediment forebay or vegetated filter strip. Filters are designed to be stormwater quality devices and generally do not provide detention. A design infiltration rate of 2 inches/hour has been shown to reflect actual rates achieved by sand filters in urban areas. The filter should be designed to complete drain within 24 hours or less. The media within the system should consist of 18 inches of 0.02 to 0.04-inch diameter sand. There are several possible configurations of the soil media within the system. A typical system has a gravel bed at the bottom overlaid with a layer of filter fabric, then a layer of sand and/or peat, leaf compost and top-

soil, and grass. The top surface layer of the system should be level to provide equal distribution of runoff within the bed.

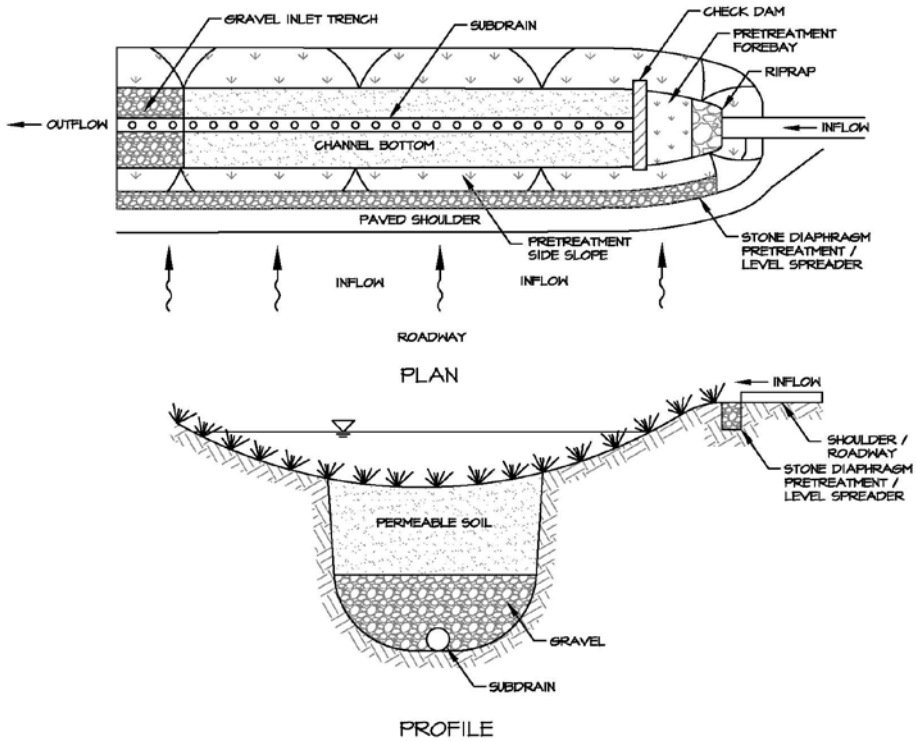
Sand and organic filters should be inspected after every major storm in the first few months after construction to ensure proper function. They require frequent manual maintenance, including raking the sand and removing sediment, trash, and debris. Over time, fine sediments may enter deeper into the system, requiring replacement of some or all of the sand. Discolored sand indicates the presence of fine sediments.

Tree box filters are a specific type of filter which treat small volumes. They consist of an open bottom concrete barrel filled with a porous soil media, a subdrain, and a tree. See **Section 2: Landscape Design** for acceptable tree species. Stormwater runoff is directed from surrounding impervious surfaces to the top of the media and percolates through the media into underlying soils. A subdrain within the system collects overflow, which may be directed to a storm drain, surface water discharge, or recharged into the ground.

6. Water Quality Swales

Description: Water quality swales are vegetated open channels designed to treat the water quality volume and incorporate specific features to enhance their stormwater pollutant removal effectiveness. They can be used to replace more expensive curb and gutter systems. There are two types of water quality swales: dry and wet. Water quality swales are illustrated in Figure 18.

Figure 18: Water Quality Swales



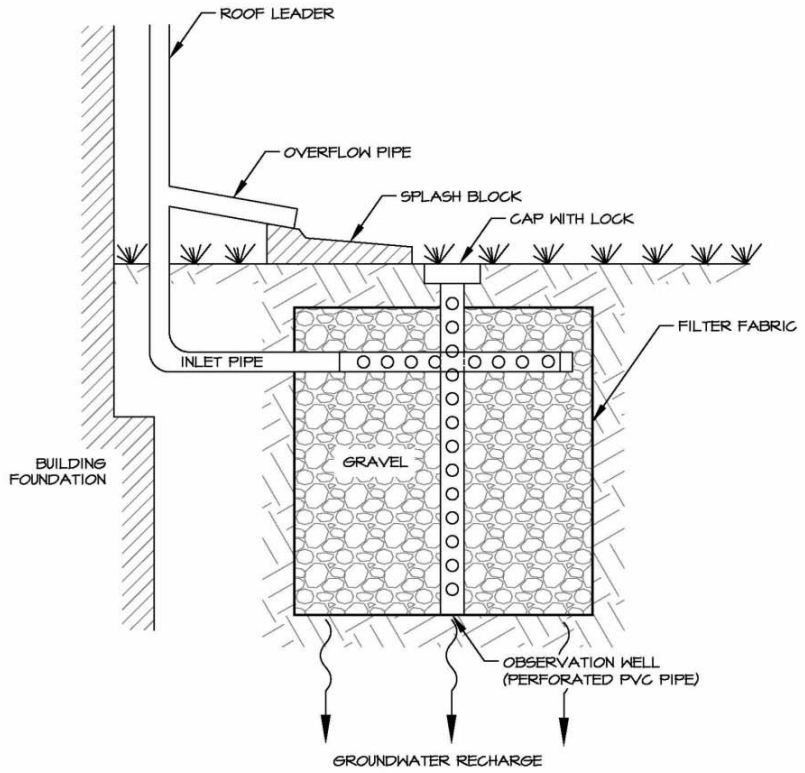
Design Considerations: Water quality swales should be used as part of an interconnected network and are often feasible for redevelopments and urban applications, including residential and institutional settings. They are ideal when used adjacent to roadways or parking lots, where runoff from impervious surfaces can be first directed via sheet flow into a vegetated filter strip or via pipe flow into a sediment forebay for pretreatment. They should have maximum side slopes of 3:1. The swales have a typical bottom width between 2 and 8 feet. Dry swales should have a soil bed that is a minimum of 18 inches deep and composed of a 50/50 mixture of sand and loam and should completely drain between storm events (with a maximum draindown time of 72 hours). Wet swales should only be used where the water table is at or near the soil surface or where soil types are poorly drained.

Access should be provided to the swale for maintenance. Regular maintenance tasks include mowing, fertilizing, watering, weeding, and pest control. Grass should be cut to a height between 3 to 6 inches. Trash, debris, and sediment should be removed as needed. Regular maintenance should also be performed within the pretreatment area. This may include regular inspections especially after large storms. Erosion and low spots should be noted and repaired as needed.

7. Dry Wells

Description: Dry wells are small, excavated pits that are backfilled with aggregate and used to infiltrate uncontaminated runoff from roofs. A dry well is illustrated in Figure 19.

Figure 19: Dry Well



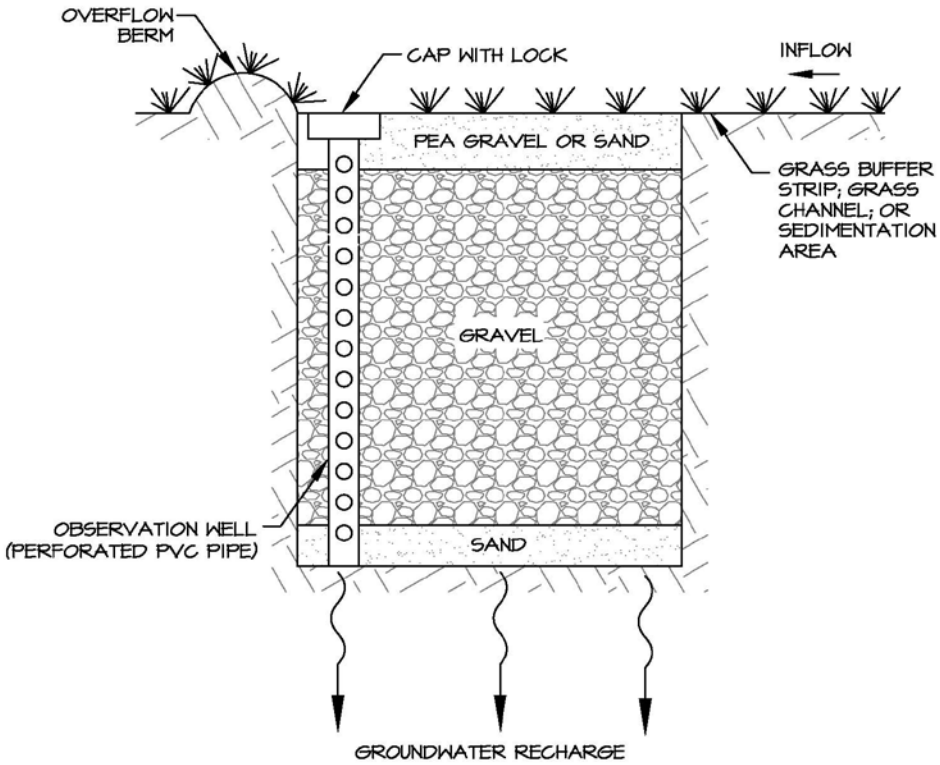
Design Considerations: Dry wells should not be used to infiltrate any runoff that could be significantly contaminated with sediment and other pollutants (i.e. parking lots). They are typically used for residential roof runoff or small commercial structures.

The dry wells should be inspected regularly to ensure they are functioning as designed.

8. Infiltration Trenches and Basins

Description: Infiltration trenches and basins are stormwater runoff impoundments that are constructed in areas with permeable soils. Runoff from the design storm is stored within the trench or basin and allowed to exfiltrate through the floor of the system. Figure 20 illustrates an infiltration trench.

Figure 20: Infiltration Trench



Design Considerations: The suitability of infiltration trenches and basins for a project site is restricted by several factors, including soil, slope, depth to water table and bedrock, the presence of impermeable soils, the contributing drainage area, and proximity to wells, surface waters, and foundations. Generally, infiltration trenches and basins are suitable at sites with gentle slopes, permeable soils, a minimum depth of 2 feet to seasonal high groundwater, bedrock, and/or impermeable layers, and a contributing drainage area of approximately 2 to 15 acres. Pretreatment and pollution control are essential to ensure infiltration basins

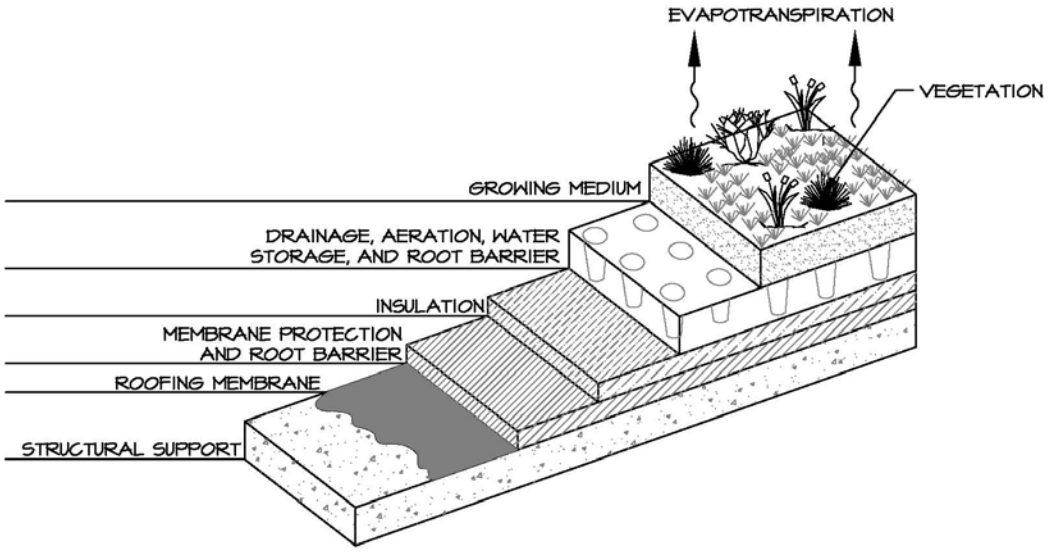
properly function. Soil borings or test pits should be dug (1 for every 5,000 square feet of basin area) with a minimum of three borings for each infiltration basin to determine the on-site soil conditions. Immediately after construction of the basin, the bottom and side slopes should be stabilized with a dense turf of water-tolerant grasses. Plants and shrubs should never be planted within the trench or basin or on the impounding embankments as they increase the chance of failure due to root decay or subsurface disturbance.

Since infiltration trenches and basins are prone to clogging and failure, an aggressive maintenance plan is imperative. Pretreatment BMPs significantly reduce the maintenance requirements for the trenches and basins.

9. Green Roofs

Description: A green roof is a permanent rooftop planting system that contains live plants in an engineered soil medium designed to retain precipitation where the water is taken up by the plants and transpired into the air. Green roofs lessen the stormwater runoff generated as compared to conventional roofs. Figure 21 illustrates a green roof.

Figure 21: Green Roof



Design Considerations: Green roofs are appropriate for commercial, industrial, and residential structures, especially those with wide roofs. They can be incorporated into new construction or added to existing buildings during renovation or re-roofing where sufficient structural support exists. Most green roofs are installed on flat or low-angle roofs; however, it is possible to install a green roof on pitched roofs up to 40% slope with adequate sun exposure and additional design features to prevent slumping and ensure plant survival.

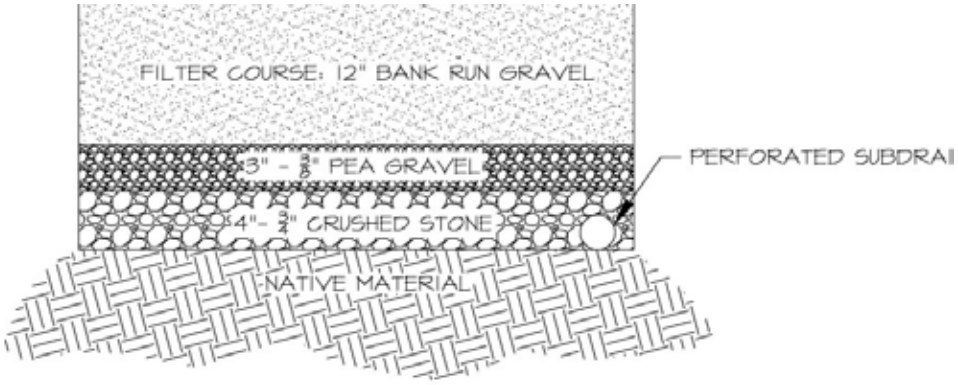
Green roofs are ideal in locations of dense, urban development, in areas where infiltration is difficult, or on site where infiltration is undesirable due to existing soil contamination. They often lower heating and cooling costs because air trapped in the layers provides additional insulation for the roof of the building. In addition, because green roofs shield the roof from intense heat and direct sunlight, the roofing system has a longer lifespan than conventional roofs.

Active maintenance is required of green roofs to maintain the vegetation in good health, removing and replacing vegetation as needed.

10. Porous Pavement

Description: Porous pavement is a paved surface with a greater percentage of void space, which allows water to pass through the surface and infiltrate into the subsoil. It can be used in the place of traditional pavement, allowing parking lots, driveways, and roadway runoff to infiltrate directly into the soil. Permeable paving techniques include porous asphalt, pervious concrete, paving stones, and grass pavers. Porous pavement is presented in Figure 22.

Figure 22: Cross Section of Typical Porous Pavement



Design Considerations: Porous pavement is typically appropriate for pedestrian areas and low-volume, low-speed areas, including overflow parking, residential driveways, parking stalls, bikepaths, walkways, and patios. It is an ideal technique to be used in dense, urban areas since it does not require any additional land. Through the use of permeable paving techniques, the need for large stormwater management structures can be greatly reduced.

It is important to maintain several design considerations when using porous pavement. The slope should be less than 5%. Two feet of vertical separation should be maintained between

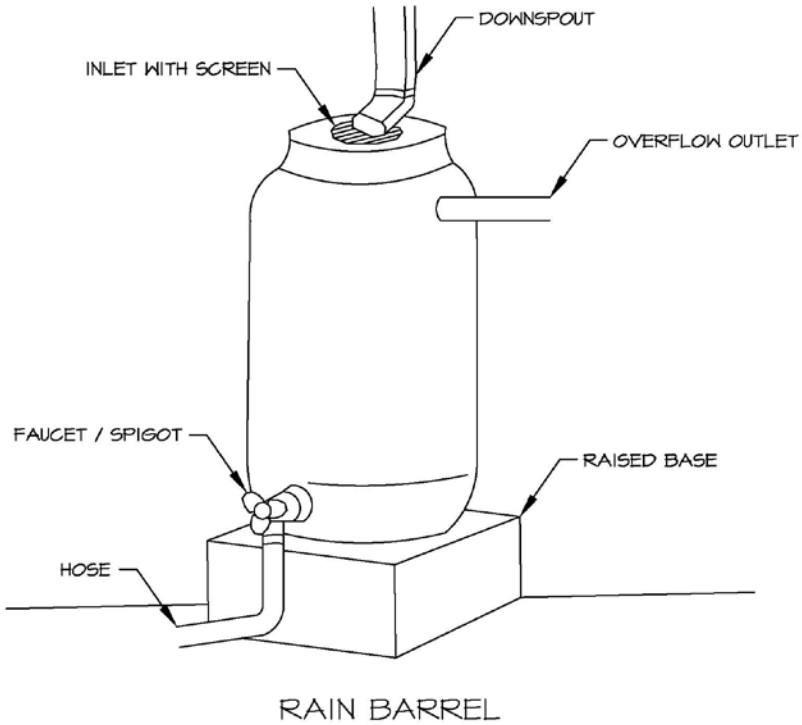
the bottom of the storage layer and the seasonal high groundwater. Presence of bedrock near the land surface greatly reduces the ability of the soils to exfiltrate the runoff into the groundwater.

Frequent cleaning and maintenance of the pavement surface is critical to prevent the system from clogging. Frequent vacuum sweeping and jet washing of porous asphalt and concrete is required. Winter sanding should never be conducted on porous surface as it can lead to clogging of the system.

11. Rain Barrels and Cisterns

Description: Rain barrels and cisterns are structures that store rooftop runoff for non-potable reuse, for example, for landscaping watering or irrigation. A rain barrel is illustrated in Figure 23.

Figure 23: Rain Barrel



Design Considerations: The most common approach to this technique is to direct roof downspouts into rain barrels equipped with spigots at the bottom of the barrel. A hose may be attached to the rain barrel and water is distributed by gravity pressure. A more sophisticated approach to this technique is to utilize an underground storage structure that distributes water via a pumping system. Stored rainwater can be used for lawn irrigation, gardens, car washing, cleaning windows, and any other non-potable uses.

When using rain barrels, the amount of runoff generated by a site is reduced since runoff generated by the roof is being collected. Cisterns and rain barrels can be used at most commercial and residential sites wherever gutter and downspout systems exist. This technique is ideal for retrofit situations.

Maintenance requirements for rain barrels are minimal. The system should be inspected on a regular basis to ensure all accessories and parts can flow freely. Gutters and downspouts should be cleaned as needed to ensure trash and particulate matter does not enter the rain barrel. During the winter months, the barrel should be removed or detached from the gutter to prevent freezing and cracking of the barrel.

C. LID Summary

Table 3 summarizes how each LID technique may improve the quality of stormwater discharge through removal of total suspended solids, nutrients, metals and pathogens.

Table 3: LID Treatment / Removal Rates

	Total Suspended Solids	Total Nitrogen	Total Phosphate	Metals	Pathogens
Sediment Forebays	0-25%	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Vegetated Filter Strips	10-25%	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Bioretention and Raingardens	90% with pretreatment	30-50%	30-90%	40-90%	Insufficient data
Constructed Stormwater Wetlands	80% with pretreatment	20-55%	40-60%	20-85%	Up to 75%
Sand and Organic Filters	80%	20-40%	10-50%	50-90%	Insufficient data
Water Quality Swales	70%	10-90%	20-90%	Insufficient data	Insufficient data
Dry Wells	80%	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Infiltration Basins and Trenches	80% with pretreatment	40-70%	40-70%	85-90%	Up to 90%
Green Roofs	0%	None to increase	None to increase	Insufficient data	Insufficient data
Porous Pavement	80% with pretreatment	Insufficient data	Insufficient data	Insufficient data	Insufficient data
Rain Barrels and Cisterns	Can account for TSS generated by roof runoff with proper conditions	Insufficient data	Insufficient data	Insufficient data	Insufficient data

Table 4 at the end of this section presents information on LID techniques, including the ability of each to attenuate peak flow and recharge groundwater. The table also includes site suitability criteria such as soil requirements and depth to groundwater, maintenance considerations, and the applicability of the technique for a site that has been previously developed. Applicants are referred to the *Massachusetts Stormwater Manual* for additional details. See also the Developer and Reviewer Checklist at the beginning of this section for a quick summary of how these techniques may be applied to different sites.

Extensive resources are available with detailed information about LID practices. See the "References" section of the appendix for a listing of valuable sources and website links.

Conventional Stormwater Management Techniques

Conventional alternatives to LID practices may include deep sump catch basins, oil/grit separators, proprietary separators, extended dry detention, wet basins, proprietary media filters, leaching catch basins, and subsurface structures. Although there are some circumstances where these practices may be required, it is the Town's policy to encourage LID alternatives unless it is clearly demonstrated that conditions preclude use of LID techniques. Use of conventional systems may be minimized by reducing the amount of impervious surfaces, disconnecting impervious runoff, and utilizing one of the many BMPs discussed in the preceding sections.

Additional Stormwater Management Considerations

A. Snow Disposal

The Massachusetts Department of Environmental Protection (MassDEP) provides guidance for snow disposal that applies to private businesses as well as public agencies. Collected snow that is contaminated with road salt, sand, litter, and automotive pollutants such as oil may threaten public health and the environment. Runoff may carry these pollutants to surface water and to groundwater, contaminating drinking water supplies and creating sand bars or fill in wetlands and ponds where they can impact aquatic life, cause flooding, and affect our use of these resources. Information on site selection, site preparation and emergency snow disposal is presented in DEP Guideline No. BRPG01-01.[5]

Snow disposal sites should be located adjacent to or on pervious surfaces in upland areas away from water resources and wells. At these locations, the snow meltwater can filter in to the soil, leaving behind sand and debris that can be removed in the spring. Avoid disposing of snow on top of storm drain catch basins or in stormwater drainage swales or ditches. Snow combined with sand and debris may block a storm drainage system, causing localized flooding. See *Figure 12* in **Section**

[5] Massachusetts Department of Environmental Policy Guideline No. BRPG01-01, effective March 8, 2001. http://www.mass.gov/dep/water/laws/snowdisp.htm

2: Landscape Design for how vegetation can be used to control snow drifting from disposal sites. Selection of sites should be reviewed by the Department of Public Works, Conservation Commission, and the Board of Health to confirm that snow will not be dumped into a waterbody, within a Zone II or Interim Wellhead Protection Area of a public water supply well or within 75 feet of a private well, or within a MassDEP-designated high or medium-yield aquifer.

A silt fence or equivalent barrier should be placed securely on the downgradient side of the snow disposal site. A 50-foot vegetative buffer strip should be maintained during the growth season between the disposal site and adjacent waterbodies. Debris should be cleared from the site prior to use for snow disposal and at the end of the snow season (no later than May 15).

Emergency snow disposal may be considered near water bodies if all upland sites have been exhausted. In accordance with DEP Guideline No. BRPG01-01, please contact the Conservation Commission and the MassDEP Regional Service center before disposing of snow in a waterbody.

B. Post Construction

Adequate inspection and maintenance are critical for stormwater management, regardless of the system selected. Generally best management practices (BMP) inspection and maintenance falls into two categories: expected routine maintenance and non-routine (repair) maintenance. Routine maintenance is performed regularly to maintain both the aesthetics of the BMPs and good working order. Routine inspection and maintenance helps prevent potential nuisances (odors, mosquitoes, weeds, etc.), reduces the need for repair maintenance, and reduces the chance of polluting stormwater runoff by finding and fixing problems before the next rain. Routine maintenance may include regular mowing (similar to any lawn) or replanting vegetation and landscape material. Inspections following major rainfall events are important to assure BMPs are working as designed. The failure of structural stormwater BMPs can lead to downstream flooding, which can cause property damage, injury and even death. [6] Table 4 outlines maintenance considerations for the eleven LID techniques.

Applicants are required to submit to the Town of Northbridge an Operations and Maintenance (O&M) plan which outlines both routine and non-routine maintenance. The plan shall specify the responsible parties. Information provided in the O&M plan shall serve as the basis of inspections by Town staff, as warranted.

[6] http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse

Table 4: LID Stormwater Management Technique Suitability

	Peak Flow Attenuation	Groundwater Recharge	Soils – See NRCS Hydrologic Soil Group Suitability	Depth to Seasonal High Groundwater Table (SHGWT) and Bedrock	Maintenance Considerations	Suitable for Redevelopment
Sediment Forebays	None	None	N/A	Bottom of system at least 2 feet above SHGWT3 and 2 to 4 feet above bedrock	Frequent maintenance required	With available space
Vegetated Filter Strips	Some	Yes	N/A	Bottom of system at least 2 feet above SHGWT and 2 to 4 feet above bedrock	Low maintenance requirements	With available space
Bioretention and Raingardens	Some	Yes	▪ Planting soils to meet specified criteria; ▪ Surrounding soils to infiltrate between 0.5 and 5 in/hr if system designed to exfiltrate	When designed to exfiltrate, must ensure bottom of system at least 2 feet above SHGWT	Frequent maintenance required	With appropriate pretreatment
Constructed Stormwater Wetlands	Can, if designed with flood storage above the wetland surface	None	Highly permeable soils may require a liner to sustain a permanent pool of water	N/A	Relatively low maintenance costs	With available space
Sand and Organic Filters	None	None	▪ Filtering soils to meet specified criteria; ▪ Surrounding soils to infiltrate between 0.5 and 5 in/hr if system designed to exfiltrate	When designed to exfiltrate, must ensure bottom of system at least 2 feet above SHGWT	Frequent maintenance required	With appropriate pretreatment
Water Quality Swales	Some reduction at small sites	None	N/A	▪ Dry swales: Bottom of system 2 to 4 feet from SHGWT ▪ Wet swales: system located within water table	Higher maintenance requirements than those of curb and gutter systems	With available space
Infiltration Basins and Trenches	Yes	Yes	Must have infiltration rate between 0.5 and 5 in/hr	N/A	Frequent maintenance required	With available space
Dry Wells	Some	Yes	Must have infiltration rate between 0.5 and 5 in/hr	Bottom of system at least 2 feet above SHGWT and greater separation from bedrock (site analysis required)	Minimal maintenance required	For rooftop runoff (mainly residential)
Green Roofs	Yes, for small storms	None	N/A	Bottom of system at least 2 feet above SHGWT and greater separation from bedrock (site analysis required)	Frequent maintenance required	Ideal

	Peak Flow Attenuation	Groundwater Recharge	Soils – See NRCS Hydrologic Soil Group Suitability	Depth to Seasonal High Groundwater Table (SHGWT) and Bedrock	Maintenance Considerations	Suitable for Redevelopment
Porous Pavement	Yes, for small storms	Yes	Must have permeability of at least 0.17 in/hr	N/A	Minimal maintenance required	Ideal
Rain Barrels and Cisterns	Yes, for small storms	None	N/A	Bottom of system at least 2 feet above SHGWT and greater separation from bedrock (site analysis required)	Minimal maintenance required	Ideal

Designer and Reviewer Checklist - Stormwater Management

This checklist is provided to expedite the development review process, to assure that Town of Northbridge goals and strategies for stormwater management are achieved through best development practices. Town inspectors will also utilize the Operations and Maintenance plan, filed with the Town, to assure that engineered stormwater management techniques are maintained in working order.

Northbridge Stormwater Management Goals

- Protect water and aquatic resources
- Promote groundwater recharge to protect surface and groundwater drinking supplies
- Maximize groundwater recharge to retain a viable local groundwater supply
- Reduce flooding, stream bank erosion, siltation, nonpoint source pollution, property damage
- Maintain the integrity of stream channels and aquatic habitats

Northbridge Stormwater Management Strategies

- Encourage and promote the use of Low Impact Development (LID) techniques wherever feasible
- Permit conventional collection, conveyance, and end of pipe treatment of stormwater only where LID techniques are not possible

Best Development Practices	Incorporated into Project?
▪ Have Hydrologic Soil Groups been identified?	❑
▪ Does site have constraints to selection of LID techniques such as ledge, steep slopes or lack of receiving waters?	❑
▪ Is the site suitable for LID practices?	
○ Sediment Forebays (cost effective)	❑
○ Vegetated Filter Strips (ideal for residential use, small parking lots, and roads)	❑
○ Bioretention and Raingardens (can be used on small lots with space constraints)	❑
○ Constructed Stormwater Wetlands (provide high pollutant removal)	❑

Best Development Practices	Incorporated into Project?
○ Sand, Organic and Tree Box Filters (good for densely populated urban areas and high use parking lots)	❑
○ Water Quality Swales (for redevelopments and high density residential or institutional use)	❑
○ Dry Well (suitable for capturing roof runoff from residential and small commercial structures)	❑
○ Infiltration Trench and Basin (can be used for larger sites)	❑
○ Green Roof (may be suitable for wide, low pitched residential, commercial or industrial use roofs)	❑
○ Porous Pavement (suitable for low volume, low-speed areas)	❑
○ Rain Barrels and Cisterns (may be used for residential or office use)	❑
▪ If Conventional Systems are used, has it been demonstrated that the site is not suitable for LID techniques?	❑
▪ If Conventional Systems are used, has it been demonstrated that the site is not suitable for LID techniques?	❑
▪ Has an Operations and Maintenance (O&M) Plan been filed with the Town?	❑

SECTION 4: EROSION AND SEDIMENT CONTROL

Erosion and Sediment Control Overview and Policies

The removal of vegetation and the disturbance of soil for construction projects can result in potentially serious consequences to the environment. Where soil is exposed to rainfall, snowmelt, wind, or vehicle tracking, erosion and sedimentation will result unless proper controls are implemented. Because erosion and sedimentation can damage wetlands, surface waters and other sensitive areas, block drainage systems, affect aesthetics, and have other negative impacts, the prevention of erosion and sedimentation is of prime importance to the Town of Northbridge. This is also a consideration for upland sites where erosion and sediment transport has the potential to adversely affect adjacent properties during construction.

Design of soil and sediment control are important to limit impacts during construction and later, during site operation and maintenance. The most important means to control erosion and sedimentation is to limit opportunities for it to occur. By protecting erosion-prone soils from development, reducing the area of disturbance, and implementing strategies to control erosion during construction, not only will area waters be protected from sediment deposition, but construction areas (and adjoining properties) may be subject to less dust, mud and other sediments.

Northbridge Erosion and Sediment Control Goals

- Protect the quality of the Town's drinking water supply
- Protect the aesthetic and recreational value of our water resources
- Protect the Town's environment

Northbridge Soil and Erosion Control Strategies

- Require effective erosion and sediment controls on all construction projects, including upland sites as well as areas subject to Conservation Commission jurisdiction
- Minimize grading on steep slopes, erosion-prone soils, or where sensitive vegetation grows
- Concentrate development on previously disturbed sites
- Clearly limit areas of disturbance on construction sites

The following is a limited treatment of the topic of erosion and sedimentation control and the user is encouraged to investigate the subject further. For this purpose a listing of some commonly available resources is provided in the appendix.

Erosion and Sediment Control Principles

- **Protect steep slopes and erosion-prone soils from disturbance**

  During the Site Planning process identified in **Section 1**, it is important to identify those fragile ecosystems where erosion would be likely to occur during construction. By identifying these areas as not suitable for development, they may be protected from disturbance.

- **Minimize the amount of area disturbed at any given time**

  By far the most effective way to control erosion is to minimize the amount of area disturbed at any given time. Retaining existing vegetation shields the soil surface from the rainfall impacts, promotes infiltration, and slows the velocity of runoff. For large subdivisions or developments that can be phased, only those portions of the site slated for immediate construction should be disturbed. For example, it is preferable to clear just enough land for the roadways and infrastructure in a residential subdivision, leaving the individual house lots undisturbed until they are ready for construction. Clear cutting should be avoided.

- **Minimize slope length and steepness**

  Runoff velocity and erosion potential increase as slope steepness and slope length increase. Through the site planning process (see Section 1), efforts should be made to minimize disturbance to steep slopes and to areas where soils may be subject to erosion. During construction, slope length can be minimized by utilizing temporary diversions such as weed free straw bale barriers, earth berms, or shallow trenches to slow velocities and divert surface runoff to a stable discharge location.

- **Stabilize exposed soil as soon as possible following disturbance**

  Although permanent soil stabilization is ultimately the best erosion prevention measure, permanent stabilization may not be possible immediately following disturbance and grading. In such cases, temporary stabilization should be provided. This can be achieved with temporary seeding and/or mulching.

- **Capture any eroded soil material before it leaves the site or enters a sensitive resource (e.g., wetlands)**

  Capture of eroded sediments should be considered the last line of defense, not the first. Ideally, preventing erosion entirely would eliminate the need to capture sediment, however this is not always practical, and sediment controls should always be part of an erosion and sedimentation

control plan. Such controls typically consist of sediment barriers (e.g., weed free straw bales, silt fence), but also include sediment basins and traps, check dams, and filter strips.

Types of Erosion

The two major types of erosion on construction sites are rainfall- and runoff-induced erosion and wind erosion. Rainfall- and runoff-induced erosion results from the exposure of erodable materials to raindrop energy and flowing water, including surface water runoff, ice and snow melt, and human produced flows (e.g., pump discharge, water line flushing). Wind erosion results from exposure of erodable materials to wind energy. The major categories of rainfall- and runoff-induced erosion are Raindrop Erosion, Rill Erosion, and Gully Erosion.

Raindrop erosion results from the physical impact of raindrops on exposed soils. The energy of the falling water can dislodge individual soil grains and small aggregates and transport them short distances. More importantly, the dislodged soil particles are more susceptible to further transport by wind or flowing water, and the raindrop impact tends to compact the underlying material, enhancing runoff potential. Sheet erosion is the unconcentrated downhill movement of the dislodged particles due to flowing water.

Rill erosion occurs where runoff begins to concentrate. It takes the form of shallow, well defined, generally parallel erosion channels. Erosion is accelerated as more surface area is exposed to the increased velocity and greater energy of channelized flow.

Gullies are basically larger rills, and develop as individual rills concentrate and combine. Gully erosion is characterized by deep (generally greater than 1 foot) channels and can be responsible for a large proportion of eroded material. Gullies tend to move headward (uphill) and typically require heavy construction equipment to repair.

Erosion and Sediment Control Plan

As part of the design and permitting phase of any land development project (upland or within Wetlands Protection Act jurisdiction), an erosion and sedimentation control plan should be prepared by the developer or his consultant for approval by relevant regulatory agencies. The plan should follow the general guidelines set forth in the *Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas*.[1] This manual provides extensive guidance on Best Management Practice (BMP) selection and design for large sites as well as individual house lots or small parcels. The erosion and sedimentation control plan should be tailored to specific site conditions and contain sufficient detail for the site operator to implement, monitor, maintain and document erosion and sedimentation control practices during construction. Related

[1] Executive Office of Environmental Affairs, *Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers and Municipal Officials,* Reprint 2003.

regulatory requirements and complementary planning tools include, but may not necessarily be limited to, the following:

- Stormwater Pollution Prevention Plan (SWPPP) required by the National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activity (Construction Stormwater General Permit, US EPA effective January 8, 2009) [2]
- The Town of Northbridge Stormwater Management Program Plan under the NPDES Small Municipal Separate Storm Sewer Systems (MS4) General Permit[3]
- Town of Northbridge regulations under the Wetlands Protection Bylaw[4] and Stormwater Management Bylaw[5]
- *Massachusetts Stormwater Handbook*[6]
- Massachusetts Wetlands Protection Act[7]

The Northbridge Conservation Commission (NCC) has developed Standard Conditions addressing erosion and sedimentation control that are applicable to projects subject to the Massachusetts Wetlands Protection Act and the Northbridge Wetlands Protection Bylaw. These practices are a good starting point for an erosion and sedimentation control plan, and should be implemented on all construction projects, regardless of NCC jurisdiction.

Recommended Construction Phase Erosion Control Practices

A. Mulching During Construction (see Section 2: Landscape Design)

- Mulch is material that is spread on exposed surfaces to prevent erosion.
- Mulch can consist of organic material (e.g., straw, compost, wood chips), or inorganic material such as stone or synthetic netting.
- Stone mulch can be used for permanent treatment where vegetation establishment is not possible.
- In addition to preventing raindrop erosion mulch is used to protect seeding and to help retain soil moisture.
- It is often desirable to anchor straw mulch to prevent movement.

B. Seeding (see Section 2: Landscape Design)

- Vegetation prevents erosion by binding soil particles, reducing runoff velocity, and promoting infiltration.

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[2] Available at www.epa.gov/npdes/pubs/cgp2008_finalpermit.pdf

[3] National Pollutant Discharge Elimination System PII Small MS4 General Permit, Town of Northbridge, MA, EPA NPDES Permit Number MAR041144

[4] Town of Northbridge Wetlands Bylaw Section 7-700

[5] Town of Northbridge Stormwater Management Bylaw (Adopted May 06,2008 - Spring Annual Town Meeting, Article 22

[6] Massachusetts Department of Environmental Protection, *Massachusetts Stormwater Handbook,* February 2008

[7] Massachusetts Department of Environmental Protection, Wetlands Protection Act, 310 CMR 10.0.

- Specification of seed mixes for a particular site is dependent on several factors, including whether the mix is for permanent or temporary cover, anticipated growth season, site aspect, slope, soil condition, and moisture regime.
- Temporary seeding is used to provide interim vegetative cover in areas that are expected to be re-disturbed within a short timeframe (i.e., weeks).
- Temporary seeding typically consists of annual grasses such as annual ryegrass, millet, or winter rye grass.
- Permanent seeding or landscaping is a preferred means of permanent stabilization of areas not to be otherwise treated.
- Permanent seeding may consist of grasses, wildflowers, legumes, or a mixture of these. Legumes are important for their ability to fix nitrogen.
- Seeding for same-season growth should take place between April 1 - May 31 and August 1 – September 10 .

The Northbridge Conservation Commission has developed the following standard conditions for temporary and permanent seeding:

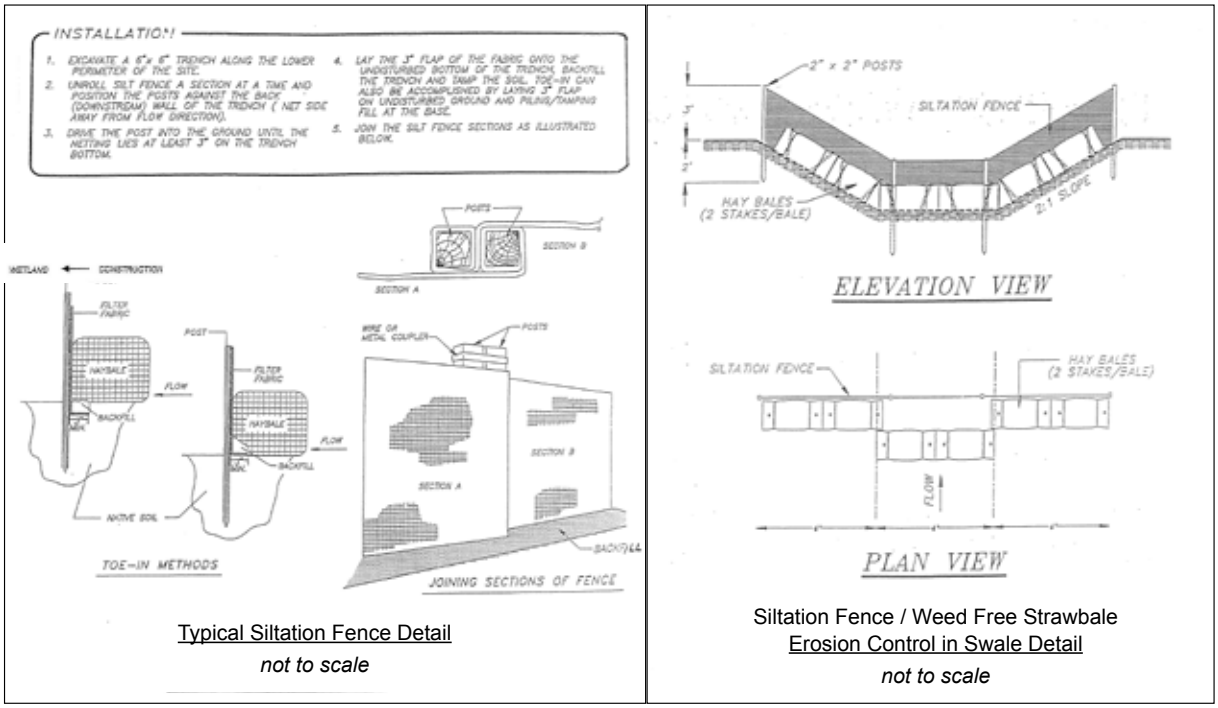
> "Exposed soil shall be seeded with Mass Highway Specification M6.03.0 or a conservation mix for rapidly growing cover as soon as possible following the final grading."
>
> "All disturbed areas shall be permanently stabilized with healthy, vegetative ground cover of no less than 70% coverage within thirty (30) days of project completion."

Recommended Construction Phase Sedimentation Control Practices

A. Weed Free Straw Bale / Silt Fence Barrier

Figure 24 presents a typical siltation fence detail with and without weed free straw bales.

Figure 24: Weed Free Straw Bale Silt Fence Installation Detail from the Town of Northbridge Conservation Commission



Typical Siltation Fence Detail
not to scale

Siltation Fence / Weed Free Strawbale
Erosion Control in Swale Detail
not to scale

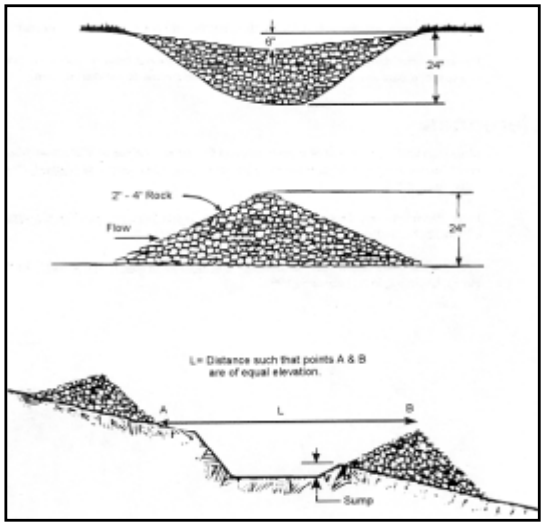
- Applicable for low flow conditions where the contributing drainage area is less than 1 acre.
- Should be used in conjunction with other practices.
- Proper installation is essential for adequate performance.
- Labor intensive to install.
- Requires frequent inspection and maintenance due to rotting.
- Use bales made from native grass species only (weed free straw bales).
- Weed free straw bales alone may be used as a diversion.
- Weed free straw bales alone may be used for catch basin inlet protection.
- Silt fence consists of Geotextile fabric supported by stakes.
- May be backed with synthetic or wire mesh to increase strength.
- Silt fence should be removed from the site once the contributing area has been permanently stabilized.

B. Stone Check Dams

Stone check dams are used in waterways, drainage ditches, and swales to slow velocity and allow sediment to settle out. Figure 25 includes a typical detail of a stone check dam. Considerations include the following:

- May consist of crushed stone, small rip rap, or a combination.
- Check dams should be spaced so that the toe of the upstream dam is slightly higher than the crest of the downstream dam.
- May require frequent maintenance.
- The center of the dam should be lower than the edges to prevent flow bypass.
- Provide stone apron downstream from the dam to prevent scour.
- Can be labor-intensive to install.

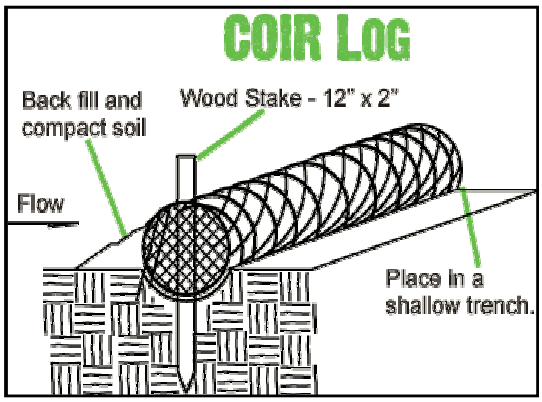
Figure 25: Stone Check Dam (Image from Massachusetts Erosion and Sedimentation Control Guidelines)



C. Coir Logs

Coir fibers are found between the husk and the outer shell of a coconut. These fibers are gathered and covered with coir netting to create flexible, durable "logs" that can be used as sedimentation barriers, for streambank stabilization, and to absorb wave and current energy. Figure 26 includes an image of a coir log. This sediment control device has the following advantages:

Figure 26: Coir Log (Image from http://lancaster.ne.gov



- Suitable for perimeter control, inlet protection, check dams, and other sediment control uses. Standard sizes range from 12” to 20” diameter, and 10’ or 20’ lengths.
- Biodegradable.
- Relatively easy to install.
- Provides good medium for plant establishment.
- May be stacked and used as a check dam.
- Require staking when used as a sediment barrier.

D. Compost Sock

These proprietary systems use permanent or biodegradable “socks” into which engineered compost material is blown. Figure 27 includes an image of a compost sock. Considerations include the following:

Figure 27: Compost Sock (Image from www.integratedgroup.com.au

- Suitable for perimeter control, inlet protection, check dams, and other sediment control uses.
- Sizes ranges from 8” to 32” diameter and essentially unlimited length.
- Must be installed by a certified installer.
- May not be suitable for rocky or uneven surfaces.
- Incorrect mulch gradation may inhibit performance.

E. Sediment Basin

Sediment basins may be constructed by excavation or by constructing an earthen embankment. This techniques is used where other erosion control measures are not adequate to prevent off-site sedimentation. Considerations include the following:

- Requires sufficient space and appropriate topography.
- May be capable of trapping smaller-sized sediment particles than other practices.
- Most effective, however, when used in conjunction with other practices.
- A properly designed spillway outlet and adequate freeboard is essential.
- Should be installed before clearing and grading begin.
- Future stormwater management basins may be used during construction as sedimentation basins if they are cleaned and finish graded prior to project completion.
- Contributing area should be not more than 100 acres.
- Minimum volume should be 1,800 cubic feet for each acre of drainage area.
- Length-to-width ratio should be 2:1 or greater.

Additional Practices

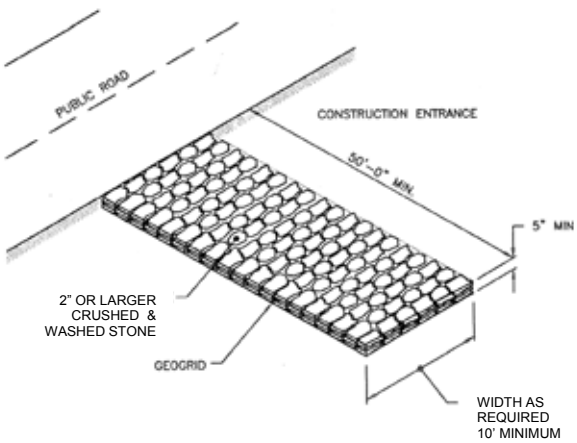
A. Anti-Tracking Pad

Tire scrubbers or anti-tracking pads reduce the potential for construction vehicles to track sediment (mud) from the worksite to local roads. The Northbridge Conservation Commission has developed the following standard condition:

> "A twenty five foot (25') long tire scrubber (anti-tracking pad) comprised of two-inch (2") or larger washed stone, shall be maintained at the site entrance(s) from all paved areas as shown on the approved plans. The scrubber shall be refreshed as needed to maintain effectiveness".

- Definition: A temporary stone pad located at points of vehicular ingress and egress on a construction site. A typical detail is presented in Figure 28.
- Provides a stable entrance and exit from a construction site and keeps mud and sediment off public roads.
- The minimum length of the gravel pad should be 50 feet.
- A 30-foot minimum length may be allowed for a single residential lot.
- Minimum width is 10 feet.
- Maintenance typically includes periodic topdressing with additional crushed and washed stone.

Figure 28: Anti-Tracking Pad - after RIDOT Standard Detail 9.9.0



B. Dewatering Treatment

Many subsurface construction activities such as utility installation or foundation excavation may require removal of groundwater or dewatering. Sediment in these turbid waters should be settled out before discharging clearer water from the site. A sediment containment devise such as a weed free straw bale enclosure, portable pool, tank or other container surrounded by weed free straw bales may be used to settle out sediment from dewatering wastewaters. The settling tank should be located outside of all wetland areas and located such that the treated discharge will infiltrate into the ground to the maximum degree feasible. The device shall be sized to allow a 2-hour retention time according to the following formula:

Required Volume (cubic feet) = pump discharge rate (gpm) x 16.

The maximum pump discharge rate may be determined by the following formula:

Maximum Discharge Rate (gpm) = Available Storage Area (cf)/16

In all instances the discharge locations into and out of the settling basin should be provided with rip rap or other suitable material to dissipate flow energy and assure that the discharge does not cause scouring or erosion.

C. Stockpile Management

Stockpiled soil must be adequately managed to prevent erosion and sediment transport on any construction site, regardless of proximity to sensitive wetlands or other resource areas. The following considerations should be addressed to prevent damage from erosion of stockpile material:

- Locate stockpiles so that natural drainage is not obstructed.
- Maximize the distance of stockpiles from wetlands and other sensitive resources.
- Install a sediment barrier approximately 10 feet from the proposed toe of the slope.
- Side slopes should be no steeper than 2:1.
- Stockpiles that are not to be used within 30 days need to be seeded and mulched.

The Northbridge Conservation Commission has developed the following standard condition pertaining to the location of stockpiling areas:

> "No soil, topsoil or other material may be stockpiled in the 100 foot buffer zone. All stockpiles will be stabilized to prevent erosion and runoff into the resource areas".

Construction site waste must be adequately managed to protect water quality. The site plan should describe the type of construction stockpiles anticipated at the site such as discarded building materials, concrete truck washout, chemicals, litter and solid waste and how that waste will be controlled to minimize adverse impacts to water quality and aesthetics. For example, concrete washout and trash storage areas should be clearly labeled on the plan and should be located away from waterbodies and catch basin inlets.

Monitoring and Maintenance

Monitoring and maintenance during construction are essential for the proper functioning of erosion and sediment control practices. The Northbridge Conservation Commission has developed the following standard conditions for erosion and sediment control monitoring and maintenance that should apply to upland sites as well

> "The Design Engineer or other Professional Engineer shall be designated as an erosion control monitor to oversee any emergency and/or regular inspection and replacement of erosion or sediment control devices. The name and phone number of this person must be provided to the NCC so that this person may be contacted in an emergency at the site, during any 24-hour period. This person shall be given authority to stop construction for erosion control purposes. The erosion control monitor will be required to inspect all such devices and oversee cleaning and the proper deposition of waste products."

> "All erosion control devices shall be regularly inspected and cleaned and/or replaced as needed, during construction. The devices shall remain in place until all areas that may impact the resource areas are permanently stabilized."
>
> "An adequate supply of erosion control materials shall be on site at all times for emergency and routine replacement and repair."

The *Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas* should be consulted for specific monitoring and maintenance guidelines for various erosion and sedimentation control practices.

Each stormwater management plan should clearly describe the construction site operator's erosion and sedimentation control inspection and maintenance schedule, including the responsible party for site insepction and how often and under what conditions inspections will be conducted. A sample inspection form should be included with the site plan. Inspections should occur at regular intervals and immediately before and after rain events. The plan should describe how erosion and sedimentation control techniques will be maintained. See the National Pollutant Discharge Elimination System (NPDES) fact sheets for the EPA's stormwater menu of BMPs:
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse

Designer and Reviewer Checklist - Erosion and Sediment Control

The following checklist for developers and municipal reviewers will assure that Town of Northbridge goals and strategies are achieved during construction. Town staff will use this checklist for inspection of upland construction sites as well as sites subject to wetland jurisdiction.

Northbridge Erosion and Sediment Control Goals

- Protect the quality of the Town's drinking water supply
- Protect the aesthetic and recreational value of our water resources
- Protect the Town's environment

Northbridge Soil and Erosion Control Strategies

- Require effective erosion and sediment controls on all construction projects, including upland sites as well as areas subject to Conservation Commission jurisdiction
- Minimize grading on steep slopes, erosion-prone soils, or where sensitive vegetation grows
- Concentrate development on previously disturbed sites
- Clearly limit areas of disturbance on construction sites

Best Development Practices	Incorporated into Project?
▪ Have steep slopes and erosion-prone soils been protected from disturbance?	❑
▪ Has the area of disturbance at any give time during construction been minimized?	❑
▪ Have slope lengths been minimized?	❑
▪ Will exposed soils be stabilized as soon as possible following disturbance?	❑
▪ Have practices been identified to capture any eroded soil material before it leaves the site or enters a sensitive resource?	❑
▪ Have construction phase erosion control practices been identified?	
○ Use of mulch	❑
○ Seeding	❑

Best Development Practices	Incorporated into Project?
▪ Have construction phase sedimentation control practices been identified?	
○ Weed free straw bale/silt fence barrier	❑
○ Stone check dams	❑
○ Coir logs	❑
○ Compost sock	❑
○ Sediment basin	❑
▪ Are additional practices required on the site?	
○ Anti-tracking pad	❑
○ Dewatering treatment	❑
○ Stockpile management, including construction waste	❑
▪ Is site subject to the jurisdiction of the Wetlands Protection Act?	❑
▪ Has an Erosion and Sedimentation Control maintenance and inspection plan and form been filed with the Town?	❑

APPENDIX

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US Green Building Council Leadership in Energy and Environmental Design New Construction Reference Guide, Version 3.0, April 2009: www.usgbc.org

GLOSSARY

Referenced from the Commonwealth of Massachusetts Smart Growth/Smart Energy Toolkit Glossary of Terms with amendment for the Northbridge Best Development Practices Guidebook.

Aquifer: A water-bearing geologic formation sometimes confined between clay layers and sometimes on the surface; the source of ground water for drinking and irrigation.

Biodiesel: Biodiesel is diesel fuel combined with a certain percentage of vegetable oil. B5 refers to a blend of diesel with 5% vegetable oil. Many diesel engines can run on blends up to B20 without modifications.

Bioretention System: The bioretention system (also referred to as a “rain garden” or a “biofilter”) is a stormwater management practice to manage and treat stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. The system consists of an inflow component, a pretreatment element, an overflow structure, a shallow ponding area (less than 9” deep), a surface organic layer of mulch, a planting soil bed, plant materials, and an underdrain system to convey treated runoff to a downstream facility.

BMP: Best Management Practice (BMP) refers to the practice considered most effective to achieve a specific desired result for protection of water, air and land and to control the release of toxins.

Buffer Zone: A strip of land created to separate and protect one type of land use from another; for example, as a screen of planting or fencing to insulate the surroundings from the noise, smoke, or visual aspects of an industrial zone or junkyard. Under the Massachusetts Wetlands Protection Act, the Buffer Zone means that area of land extending 100 feet horizontally outward from the boundary of any area specified in 310 CMR 10.02(1)(a).

Built Environment: The urban environment consisting of buildings, roads, fixtures, parks, and all other improvements that form the physical character of a city.

Carrying Capacity: The level of land use or human activity that can be permanently accommodated without an irreversible change in the quality of air, water, land, or plant and animal habitats. In human settlements, this term also refers to the upper limits beyond which the quality of life, community character, or human health, welfare, and safety, will be impaired, such as the estimated maximum number of persons that can be served by existing and planned infrastructure systems, or the maximum number of vehicles that can be accommodated on a roadway.

Catch Basin: A conventional structure for the capture of stormwater utilized in streets and parking areas. It includes an inlet, sump, and outlet and provides minimal removal of suspended solids. In

most cases a hood also is included to separate oil and grease from stormwater. Catch basins are differentiated from drainage "inlets", which do not contain sumps or hoods.

Cluster Development: A pattern of development in which industrial and commercial facilities and homes are grouped together on parcels of land in order to leave parts of the land undeveloped. Cluster development is often used in areas that require large lot sizes, and typically involves density transfer. Zoning ordinances permit cluster development by allowing smaller lot sizes when part of the land is left as open space.

Comprehensive Plan: Regional, state, or local documents that describe community visions for future growth. Comprehensive plans describe general plans and policies for how communities will grow and the tools that are used to guide land use decisions, and give general, long-range recommendations for community growth. Typical elements include, land use, housing, transportation, environment, economic development, and community facilities.

Conservation Areas: Environmentally sensitive and valuable lands protected from any activity that would significantly alter their ecological integrity, balance, or character, except in cases of overriding public interest.

Conservation Easements: Conservation easements are voluntary, legally binding agreements for landowners that limit parcels of land or pieces of property to certain uses. Land under conservation easements remains privately owned, and most easements are permanent.

Context Sensitive Design: A collaborative, interdisciplinary approach that involves all stakeholders to develop a facility that fits its physical setting and preserves scenic, aesthetic, historic, and environmental resources. This approach considers the total context within which a project will exist.

Density: The average number of people, families, or housing units on one unit of land. Density is also expressed as dwelling units per acre.

Density bonus: Allows developers to build in specified areas densities that are higher than normally allowed.

Design Standards: Design standards or guidelines can serve as a community's desire to control its appearance, from within and without, through a series of standards that govern site planning policies, densities, building heights, traffic and lighting.

Detention Ponds: (Extended Detention Basins) An area surrounded by an embankment, or an excavated pit, designed to temporarily hold stormwater long enough to allow settling of solids and reduce local and downstream flooding.

Development Rights: Development rights give property owners the right to develop land in ways that comply with local land use regulation.

Ecological Footprint: The impact of humans on ecosystems created by their use of land, water, and other natural resources. Ecological footprint used as a complex sustainability indicator that answers the question: How much of the Earth's resources does your lifestyle require?

Ecosystem: The species and natural communities of a specific location interacting with one another and with the physical environment.

EPA (Environmental Protection Agency): The federal body charged with responsibility for natural resource protection and oversight of the release of toxins and other threats to the environment.

ERI (Environmental Resource Inventory): A listing and description of natural resources and general environmental characteristics of a given geographic area.

Endangered: Species that are in danger of extinction. It also is a category that denotes protection under federal law (Endangered Species Act).

Erosion: The wearing away of the land surface by running water, wind, ice, or other causes.

Eutrophication: The natural aging process of water bodies, by siltation and organic decomposition, which reduces both water volume and oxygen levels. Surface run-off or airborne deposition of nitrogen and phosphorus accelerate this.

Flood Hazard Area: Total stream and adjacent area periodically covered by overflow from the stream channel containing 1) the floodway which is the channel itself and portions of the immediately adjacent overbank that carry the major portion of flood flow, and 2) the flood fringe beyond it which is inundated to a lesser degree.

Flood Plain: The land adjacent to a water body, stream, river, lake or ocean that experiences occasional flooding.

GIS (Graphic Information Systems): GIS technology is used to develop maps that depict resources or features such as soil types, population densities, land uses, transportation corridors, waterways, etc. GIS computer programs link features commonly seen on maps (such as roads, town boundaries, water bodies) with related information not usually presented on maps, such as type of road surface, population, type of agriculture, type of vegetation, or water quality information. A GIS is a unique information system in which individual observations can be spatially referenced to each other.

Greenfields: Newly developed commercial real estate on what was previously undeveloped open space.

Greenway: A linear open space; a corridor composed of natural vegetation. Greenways can be used to create connected networks of open space that include traditional parks and natural areas.

Groundwater: All water below the surface of the land. It is water found in the pore spaces of bedrock or soil, and it reaches the land surface through springs or it can be pumped using wells.

Habitat: Living environment of a species, that provides whatever that species needs for its survival, such as nutrients, water and living space.

Habitat Fragmentation: Division of large tracts of natural habitat into smaller, disjunct parcels.

Heat Island Effect: Thermal gradient differences between developed and undeveloped areas.

Historic Area: An area or building in which historic events occurred, or one which has special value due to architectural or cultural features relating to the heritage of the community. Elements in historic areas have significance that necessitates preservation or conservation.

Imperviousness Overlay Zoning: One form of the overlay zoning process. Environmental aspects of future imperviousness are estimated based on the future zoning build-out conditions. Estimated impacts are compared with environmental protection goals to determine the limit for total impervious surfaces in the watershed. Imperviousness overlay zoning areas are then used to define subdivision layout options that conform to the total imperviousness limit.

Impervious Surface: Any surface through which rainfall cannot pass or be effectively absorbed. (Roads, buildings, paved parking lots, sidewalks etc.)

Infrastructure: Water and sewer lines, roads, urban transit lines, schools and other public facilities needed to support developed areas.

Land Use: The manner in which a parcel of land is used or occupied.

LEED: Leadership in Energy and Environmental Design Green Building Rating System is a nationally accepted benchmark for the design, construction, and operation of high performance green buildings. Administered by the U.S. Green Building Council LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

Level Spreader: A device that receives concentrated flow from channels, outlet structures, or other conveyance structures and converts it to sheet flow where it can disperse uniformly across a stable slope.

Lot Area: Area is the total square footage of horizontal area included within the property lines. Zoning ordinances typically set a minimum required lot area for building in a particular zoning district.

Low Impact Development (LID): An approach to environmentally-friendly land use planning. It includes a suite of landscaping and design techniques that attempt to maintain the natural, pre-developed ability of a site to manage rainfall. LID techniques capture water on-site, filter it through vegetation, and let it soak into the ground where it can recharge the local water table rather than being lost as surface runoff. An important LID principle includes the idea that stormwater is not merely a waste product to be disposed of, but rather that rainwater is a resource.

MassGIS: The Commonwealth's Office of Geographic and Environmental Information, within the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA). Through MassGIS, the Commonwealth has created a comprehensive, statewide database of spatial information for environmental planning and management.

Master Plan: A statement, through text, maps, illustrations or other forms of communication, that is designed to provide a basis for decision making regarding the long term physical development of the municipality.

Mixed Use Development: Development that is created in response to patterns of separate uses that are typical in suburban areas necessitating reliance on cars. Mixed use developments include residential, commercial, and business accommodations in one area.

Mitigation: Process or projects replacing lost or degraded resources, such as wetlands or habitat, at another location.

Neo-Traditional Development: A traditional neighborhood, where a mix of different types of residential and commercial developments form a tightly knit unit. Residents can walk or bike to more of the places they need to go and municipal services costs are lower due to the close proximity of residences. A more compact development also reduces the amount of rural land that must be converted to serve urban needs.

New Urbanism: Neighborhood design trend used to promote community and livability. Characteristics include narrow streets, wide sidewalks, porches, and homes located closer together than typical suburban designs.

Non-Point Source Pollution (NPS): Pollution that cannot be identified as coming from a specific source and thus cannot be controlled through the issuing of permits. Storm water runoff and some deposits from the air fall into this category.

Open Space: Used to describe undeveloped land or land that is used for recreation. Farmland, as well as all natural habitats (forests, fields, wetlands etc.), are included in this category.

Open Space Residential Design (OSRD): A form of residential subdivision that maximizes resource protection and conservation of natural areas through the use of design strategies that result in permanent open space preservation.

Overlay Districts: Zoning districts in which additional regulatory standards are superimposed on existing zoning. Overlay districts provide a method of placing special restrictions in addition to those required by basic zoning ordinances.

Quality of Life: Those aspects of the economic, social and physical environment that make a community a desirable place in which to live or do business. Quality of life factors include those such as climate and natural features, access to schools, housing, employment opportunities, medical facilities, cultural and recreational amenities, and public services.

Receiving District: An overlay zoning district established by the Town Meeting/Town Council upon recommendation from the Planning Board as an area suitable to receive transferred development rights.

Recharge: Water that infiltrates into the ground, usually from above, that replenishes groundwater reserves, provides soil moisture, and affords evapotranspiration.

Riparian Area: Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding.

Runoff: The water that flows off the surface of the land, ultimately into our streams and water bodies, without being absorbed into the soil.

Sedimentation: Deposition of soil particles that have been transported by water and wind.

Siltation: Process by which loose soil is transferred and builds up in streams, rivers, and lakes, causing changes in stream channels and in depth. It may result in filling in an area and/or causing flooding.

Site Plan: A scaled plan showing proposed uses and structures for a parcel of land. A site plan could also show the location of lot lines, the layout of buildings, open space, parking areas, landscape features, and utility lines.

Smart Energy: The use of renewable resources to create electricity and to heat and cool buildings, as well as more efficient use of energy through conservation and high efficiency technologies.

Smart Growth: Well-planned development that protects open space and farmland, revitalizes communities, keeps housing affordable and provides more transportation choices.

Soil: Mixture of particles of sand, silt, clay, and organic material in varying proportions.

Sprawl: Development patterns where rural land is converted to urban/suburban uses more quickly than needed to house new residents and support new businesses, and people become more dependent on automobiles. Sprawl defines patterns of urban growth that includes large acreage of low-density residential development, rigid separation between residential and commercial uses, residential and commercial development in rural areas away from urban centers, minimal support for non-motorized transportation methods, and a lack of integrated transportation and land use planning.

Stream Corridor: The area (containing wetlands, flood plains, woodlands, unique habitats, and steep slopes) which lies between relatively level uplands and stream banks and through which water, draining from the uplands, flows and is naturally cleansed and stored. Base flow for streams comes from ground water as springs and seeps.

Streetscape: The space between the buildings on either side of a street that defines its character. The elements of a streetscape include: building frontage/façade; landscaping (trees, yards, bushes, plantings, etc.); sidewalks; street paving; street furniture (benches, kiosks, trash receptacles, fountains, etc.); signs; awnings; and street lighting.

Sustainable Development: Development with the goal of preserving environmental quality, natural resources and livability for present and future generations. Sustainable initiatives work to ensure efficient use of resources.

Subdivision: A subdivision occurs as the result of dividing land into lots for sale or development.

USGS (United States Geological Survey): A federal agency which provides mapping of topography, aquifer levels, and areas where aquifers are recharged.

Watershed: The geographic area which drains into a specific body of water. A watershed may contain several sub-watersheds.

Wetlands: Area having specific hydric soil and water table characteristics supporting or capable of supporting wetlands vegetation.

Zoning: Classification of land in a community into different areas and districts. Zoning is a legislative process that regulates building dimensions, density, design, placement, and use within each district.

Town of Northbridge, Massachusetts