Landscape Guide

for

Vermont Roadways & Transportation Facilities

Prepared for

The Vermont Agency of Transportation

by the

Vermont Chapter of the
American Society of Landscape Architects

June 2002

**Honey locust tree thriving in a curb extension island,
Essex Junction, Vermont.**

**<u>Cover Photo</u>: Court Square, Middlebury Inn and
Congregational Church, Middlebury, Vermont.**

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Review committee members from the Vermont Agency of Transportation included Robert Shattuck, Jane Brown, Craig Dusablon, Wayne Davis, Amy Bell, Alex Portalupi and Art Bombardier. Steve Sinclair represented the Department of Forests and Parks and Recreation. Mark Richter of the Federal Highway Authority provided very useful review comments relating to federal policy issues.

The consultant team representing the Vermont Chapter of the American Society of Landscape Architects included David Jacobs, William Jewell and Kathleen Ryan.

Related Documents

The Vermont Agency of Transportation is developing the following related documents:

Bicycle and Pedestrian Facilities in Vermont:
A Planning and Design Manual

Traffic Calming Details
to be included in the VTrans Standard Roadway Details.

Vermont Traffic Calming Process

The Vermont Department of Forests, Parks and Recreation, Urban and Community Forestry Program has developed these related documents:

Recommended Trees for Vermont Communities, 2001

Planting Sustainable landscapes- A Guide for Reviewers, 2001
By the Vermont Chapter of the American Society of Landscape Architects

Contents

Street trees improve the travel experience for all who use this roadway corridor in Scituate, Massachusetts.

LANDSCAPE GUIDE

FOR VERMONT ROADWAYS AND TRANSPORTATION FACILITIES

I Introduction

PURPOSE OF THE DOCUMENT

This document is a guide for integrating landscaping into Vermont's transportation projects. It outlines why, when and where trees can be used to enhance the state's transportation system. It covers the benefits of street trees and landscaping, the roadway conditions under which trees and plants will thrive, how they should be installed and maintained, and what is required to preserve existing trees in the roadway corridor. This guide places emphasis on the planning of landscape improvements as an element of the roadway corridor at the early stages of the transportation planning process.

Users

Intended users of this guide include the Vermont Agency of Transportation, The Chittenden County Metropolitan Planning Organization, regional planning commissions, regional transportation advisory committees and councils, town planning commissions, public works directors, and other town staff. Local citizens should find it useful when deciding how street trees and plantings can be integrated into local transportation projects. Consulting transportation planners and engineers should also find this document useful both as a design resource and as a communication device when working with local communities and state agencies.

Background

Over the last decade, the direction of transportation planning in Vermont has changed. Much of the initial project planning now takes place at the regional level, having grown out of local concerns. Federal and State planning strategies now affirm a connection between transportation and land use, the need to balance all transportation modes that use the roadway corridor and the need for projects to respect their surroundings. Landscaping will play a role in this effort. To be successful, this transition in transportation design will require integrating the skills of transportation engineers, town planners and landscape architects in shaping the roadway corridor.

The Agency of Transportation's *Vermont State Standards for the Design of Transportation Construction, Reconstruction and Rehabilitation on Freeways, Roads and Streets – 1997* (hereafter referred to as the "*Vermont State Standards*") began that process by introducing design parameters that allow sensitivity to a local context.

This document recommends landscaping practices and prototypes suitable for the various roadway conditions outlined in the *Vermont State Standards* as well as

landscaping for sidewalks, shared-use paths, park-and-rides, and other transportation facilities.

At the federal level the *Presidential Executive Memorandum (E.M.) on Environmentally Beneficial Landscape Practice, 1995* gives a framework for environmentally and economically beneficial landscaping activities on federal lands and for federally-assisted projects. Five principles are outlined: use regionally native plants, design, use and promote construction practices to minimize adverse effects on natural habitat, seek to prevent pollution, implement water and energy efficient practices, create outdoor demonstration projects. In 1999, President Clinton signed the *Executive Order on Invasive Species 13112 (E.O),* a call to prevent and control the introduction and spread of invasive species. Federal Highway Authority (FHWA) actively promotes these directives.

BENEFITS OF TREES

Street trees have long played a role in Vermont's transportation network. Historic photos of Vermont towns often show tree-lined streets and shady town commons. Although transportation has greatly changed in the last century, many communities wish that historic landscape elements could continue to enhance their town's roadways for the enjoyment of pedestrians and drivers.

It may not be easy to justify landscaping solely on the basis of aesthetics, due to limited funds for transportation improvements. Fortunately, significant cost & benefit analyses have shown that trees are well worth the financial investment.

A postcard shows the village common and tree-lined streets in Morrisville at the turn of the last century.

Vehicular Transportation Benefits

- **Safety**
  Street trees have been shown to be an important part of traffic-calming measures that slow down traffic in town centers and residential neighborhoods, thereby improving traffic and pedestrian safety.[1] Formal rows of street trees at the gateway to a community can visually change the roadway environment and alert drivers that they are entering a town center. Street trees used in combination with curbs and sidewalks have been shown to slow traffic

[1]Poe, Christopher. *Traffic Calming and Low-Speed Urban Street Design,* Pennsylvania Transportation Institute, Pennsylvania State University, Research Office Bldg., Univ. Park, PA 16802. Dec. 4-6, 1995 TD100: PA95-9512.

by narrowing the appearance of the roadway and defining the village setting.

- **Wayfinding**
  Roadside trees or groups of trees, especially those with light-colored bark that reflects headlights, can serve as landmarks along the roadway and even alert drivers to a turn in the road. Landscaping in a traffic island or roundabout adds a three-dimensional element that makes the island or divider more recognizable to approaching drivers.


Shade trees make walking appealing on this Route 7 sidewalk in Middlebury.

- **Multimodal Benefits**
  Pedestrians derive great benefit from the summer shade and cooling of street trees. The overhead branches provide a leafy canopy and the tree stems provide both a physical and a psychological separation from the roadway. Trees can encourage pedestrian use of village sidewalks by greatly improving pedestrian comfort, thereby enticing drivers to become pedestrians. In a downtown setting, this has economic benefits to the community.
  Roadway traffic can be reduced when vehicle trips become pedestrian trips.

  Depending on the setting, landscaping can be useful for multi-use paths as well. Large trees provide shade for cyclists, walkers and bladers. Hedges can be used for screening adjacent uses and providing "soft" barriers at tops of slopes. Shrubs can be used to stabilize banks while enhancing the setting.

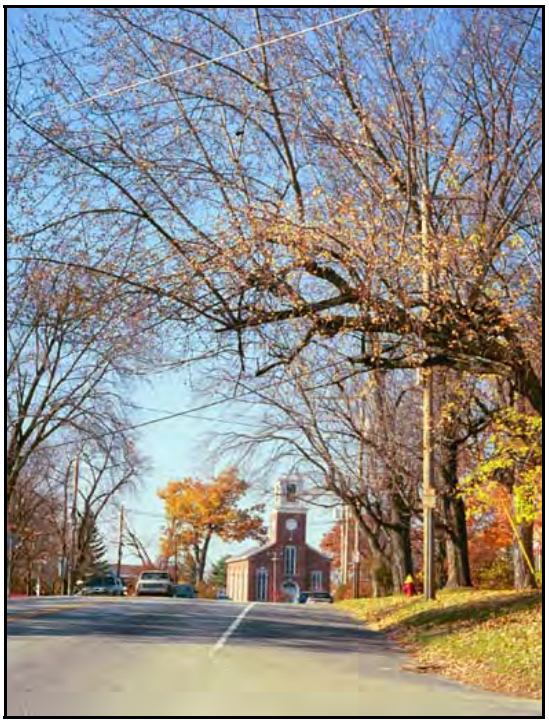
  Shade trees lose their leaves, allowing winter sun to melt ice and warm the sidewalks, paths and roadways.

Community Benefits

- **Economic**
  The economic benefits of trees are closely linked to the aesthetic, psychological, and social benefits they provide. Despite the difficulty of placing a value on such intangible factors, research has determined that communities do better economically when they protect their existing trees and continue to plant new ones. [2]

[2] Dwyer, John F. *Economic Benefits and Costs of Urban Forest*, Abstract; Proceedings of the Fifth National Urban Forest Conference.

Numerous studies have used complex cost/benefit models to determine how and why trees benefit communities and increase land values. In essence, these studies have determined that people enjoy and prefer an environment with trees. Because of this fact, they are more likely to stay and shop in a downtown with tree-lined streets and, controlling for other factors, will pay more for both residential and commercial land on streets with mature trees.



Large trees frame the view of an historic church on Route 7 in Brandon village.

- **Aesthetic and Quality of Life**

Defining Community Character

Trees help define the regional character of the roadway giving a sense of permanence to an area. The character of vegetation varies from state to state: southern states are known by Live Oak and southern California by its palms. Vermont landscapes are known worldwide for their beauty. This reputation includes the image of its rolling hills, farmland and fall color, as well as small villages with tree-lined streets and historic buildings framed by stately trees. The character of vegetation varies somewhat from community to community even within Vermont. For example, several tree species, such as American Sycamore, can be found growing in the warmer zone of Brattleboro but not in St. Johnsbury.

Defining the Entrance or Gateway to a Community

Trees can mark the transition of a roadway from country to town (sometimes marking a speed change as well). A formal arrangement of trees at the edges of town contrasts with the informal, natural growth of vegetation along the open road and defines the gateway to town.

Screening

Trees and shrubs function to screen undesirable views, the glare of lights and the headlights of oncoming cars.

Framing Views

Mature trees can frame views and create a foreground that enhances a picturesque view.

Noise Attenuation

Research has determined that trees and landscaping alone provide little noise reduction as measured in decibels; however, the soothing sounds of wind rustling through the leaves provides a kind of "white noise" that masks roadway noise to some degree. Some designers believe that visually screening a roadway and related sounds can also have some psychological benefit as an "out of sight, out of mind" tactic.

- **Ecological**

  More easily quantified are the environmental benefits, but these too are coupled with economic gain. Studies have placed monetary value on individual trees in urban settings by quantifying the following benefits:

  Air Quality

  Trees provide oxygen to breathe but also absorb carbon dioxide, airborne chemicals and particles. By controlling air pollution through absorption of gases and particulates, trees contribute to public health and reduce health costs. [3]

  Water Resources

  Plantings absorb rainfall and reduce runoff, thereby functioning as a stormwater retention device such as those encouraged by the Agency of Natural Resources. Decreased or decelerated runoff can reduce the cost of treatment facilities and reduce stream bank erosion.

  Cooling and Energy Savings

  The shade and cooling effect of trees reduces the energy needed to keep homes and businesses cool in summer months. This cost savings can be substantial. One study found that cooling costs could be reduced by as much as 30 percent by strategically placed trees.[4] While these figures do not directly apply to Vermont, they indicate the cooling potential of large shade trees.

  Wind and Snow

  Evergreen trees and shrubs, correctly placed, can block cold north winds, to save heat energy in winter. Evergreens can also act as snow blocks, to prevent snow drifting across roads and driveways.

  Wildlife

  Bird species add pleasant sound, color and movement to a downtown environment even though some species such as pigeons may be considered pests.

[3] McPherson, E.G., *Economic Modeling for Large Scale Tree Plantings*. In E. Vine, D. Crawley, and P. Centolella (eds.) *Energy Efficiency and the Environment: Forging the Link*, Chapter 19, American Council for an Energy Efficient Economy, Washington DC, 1991.

[4] Forest Report R8-FR 17 *Benefits of Trees* USDA Forest Service Southern Region, 1740 Peachtree Road, NW, Atlanta, GA.

II Landscaping for VTrans Projects

From Planning through Maintenance

INTEGRATING LANDSCAPING INTO PROJECT PLANNING

While the *Vermont State Standards* do not make specific recommendations for planting, the dimensional guidelines do allow for a project to respect the small size and scale of Vermont villages through the use of narrower roads, tree belts with protective curbs, and narrow street tree setbacks. All of these make it easier to fit landscaping into the roadway corridor. The *Vermont State Standards* also includes "*Special Vermont Guidelines"* for each functional classification of roadway. These guidelines cite the important role of landscaping and street trees in preserving and enhancing Vermont's natural, scenic and town landscape.

Landscaping is an important part of recent, roadway projects in Vermont, including a modern roundabout in Brattleboro, an urban boulevard-style design for Dorset Street in South Burlington and a tree-lined Main Street in Burlington.

When given the opportunity, most citizen planners and officials at the grass-roots level choose to include planting and street trees in the new and reconstructed transportation systems in their town. However, the goal of a landscaped transportation project can be lost in the process of bringing the project from the initial concept through the many engineering stages and on to final construction unless all participants are mindful of landscaping requirements. A well-landscaped roadway or path can be more acceptable to the community, and more successful for all users.

New trees on Dorset Street in South Burlington will mature to become an amenity for pedestrians, cyclists and drivers.

Continuity is key. To be successful, landscape and streetscape design needs to become an integral part of the transportation planning process from the outset and the landscaping must be given equal emphasis all the way through to final construction. The State acknowledges the need for early involvement in the following statement:

> "These *Vermont State Standards* are based upon the assumption that contextual and situational issues for each project must be identified early in the design process, before geometric values are

selected. These issues are then considered at each step throughout the design process."

Landscaping is one of these contextual issues. Existing trees and new plantings both need to be viewed as elements of the roadway design, similar to curbs, drainage and lighting. Decisions made in the very early stages of corridor planning often will determine whether planting can or cannot become an effective part of the project.

Steps in the VTrans Planning and Design Process

The public often finds transportation planning a slow and confusing process. Sometimes citizens become aware of a project only when they learn that the mature maple in front of their house is going to be removed to make way for a widened roadway. Knowledge of the project planning process can ensure better local involvement and a better understanding of how to address landscaping concerns at the appropriate time. VTrans is also trying to address local concerns earlier in its design process.

It may be possible to save important trees by adjusting the roadway alignment in the early phases of the project. This photo shows Route 7 and the green in Brandon in front of the Brandon Inn.

PROJECT PHASES

The chart on the following page shows the customary planning phases, the participants usually involved, and the landscaping issues that can be addressed at each phase. This is one typical scenario. *Not **all** projects use this progression.*

The purpose of this chart is to illustrate to community residents the many steps that are required and show the need for them to stay involved and follow through from beginning to end by voicing their wishes and preferences for a landscaped transportation corridor.

CHART - Transportation Project Development Phases

Identify transportation need

Develop Project

Phase	Primary Participants	Landscaping Input Needed
Local Planning	♦ Local residents ♦ Town officials and staff ♦ Consulting planners & engineers ♦ VTrans staff [Planning Division and/or Local Transportation Facilities (LTF)]	♦ Establish landscaping and tree preservation goals ♦ Determine local support for *maintenance* of landscaping
Regional Planning	♦ Regional transportation planning committee ♦ Regional planning staff ♦ Consulting planners and engineers ♦ VTrans staff [Planning Division and/or Local Transportation Facilities]	♦ Carry forward landscape and tree preservation goals ♦ Refine ideas and determine regional support for concepts ♦ Consider existing trees when planning corridor
Scoping	♦ VTrans or consulting engineers - review purpose and need for planting, present alternative designs, review environmental constraints with public input from local communities	♦ Carry forward previous concepts ♦ Address need and space for landscaping and streetscape amenities ♦ Assess planting opportunities for screening and enhancing views to meet aesthetics criteria and local concerns ♦ Assess impact of each alternative on existing trees to be saved
Project Development	♦ VTrans or consulting engineers - design final project with input from local community	♦ Coordinate planting with lighting, utilities and overall project design ♦ Select plant species ♦ Define plant locations ♦ Coordinate soil specifications with engineering requirements ♦ Develop tree preservation specifications
Construction & Maintenance	♦ General Contractor builds project with supervision by state engineers ♦ Town takes on maintenance where requested	♦ Carefully supervise: -preservation of trees to remain -selection and installation of plants -preparation of planting environment ♦ Ensure proper maintenance

Project Identification Phases

It is important for a knowledgeable advocate for transportation landscaping to be present at the design table when projects are first identified. Advocacy for landscaping should continue through all stages of the project, especially when roadway cross-sections are being drawn and space is being allocated. Since plants require adequate growing space and soil within the right-of-way, adequate planting space is essential. The road right-of-way is often limited, especially in a village setting. Cars, cyclists, pedestrians, parallel parking lanes, utility lines and trees all need to share the corridor. Assignment of precious right-of-way space starts in the early stages of planning a transportation project.

- **Local and Regional Planning Phase**

  A transportation project is sometimes identified, considered or prioritized at the local or regional level. This is the time for local citizen planners, town officials and planning consultants to establish landscape goals. Professional planners can translate the community's landscaping concepts into plans and graphics to help them visualize their ideas and bring the community to agreement. The consultant should have the skills and knowledge to understand the planting requirements and show feasible landscape and streetscape options to the community.

  When the maintenance of landscaping will become the responsibility of the town, the community should approximate the cost of such maintenance and determine if there is local support for this expense.

- **Scoping Phase**

  The landscape design concepts planned at the local and regional levels are carried into the scoping phase when engineering is begun and the roadway corridor limits become more defined. Steps of the scoping process include determining the purpose and need for the project, developing the roadway or path alternatives and completing environmental, archeological and historic preservation review. While there is no specific requirement for the preservation or inclusion of landscaping, scoping considers existing vegetation, natural resource impacts, aesthetics and historic preservation.

  Scoping is usually completed by VTrans or a consulting engineer who may not have been previously involved in the project. Project engineers need to research past plans to determine any previous landscape concepts from the early planning stages. They can then see how to incorporate these goals and concepts into alternative designs in the scoping phase. Many times the engineering team includes a landscape architect to do this work.

  Preservation of existing trees may begin at this stage. Certain proposed alignments may work better than others to preserve individual trees or groups of trees. It may be necessary to assess tree condition by a certified arborist.

Project Development Phases

- **Project Design Phase**
  The final width, alignment, details and grades of the roadway, which are developed in this phase, can have an effect on both the preservation of existing trees and the viability of new planting. Any conflicts involving the location of utilities, lighting, signs and landscaping are also resolved at this point. If a community has committed to the importance of including landscaping in its transportation project, it must advocate for its interest and be sure that thorough attention is being given to landscape design and detailing during this final design stage.

  Landscaping specifications developed in this phase are critical to the proper selection, installation, and survival of plant material. A good planting site requires materials that are very different from the gravel base used for roadways, curbs and sidewalks. Therefore, standard VTrans earthwork specifications will need to be modified wherever landscaping is installed.

- **Construction**
  Plantings are generally installed near the end of the construction phase. Unless the planting environment has been properly prepared and the landscaping is correctly installed, plants will not survive, and all the investment in landscape planning, design and plant materials is lost. Proper supervision and inspection of the contractor's work is crucial. If inspection is performed by a resident engineer, that person requires an understanding of good planting practice and landscape specifications. For large projects, a horticulturist or a landscape architect should be hired to inspect the site and supervise installation.

- **Maintenance**
  The VTrans contract with the contractor requires maintenance of the landscaping until plantings are accepted (usually after two inspections at 30 and 60 days) and requires that the plants be guaranteed for one year from installation. One year after the guarantee, the town or a local garden club, may take over responsibility for maintaining all plants. VTrans requires a signed finance and maintenance agreement to ensure a commitment by the community and to allow work in the right-of-way.
  State law enables each town to appoint a local tree warden whose role it is to advise communities on care of street trees and town forests. Towns vary on how they use this position. Although the tree warden does not have legal authority within the state right-of way, he or she can play an important role as an advocate for street trees and the "urban forest." Some towns have citizens' groups that play this role.

Perennials and shrubs add welcome color and texture but require maintenance until well established. (Photo - Main Street, Burlington)

III Transportation and Landscape Design

THE LANDSCAPE SITE

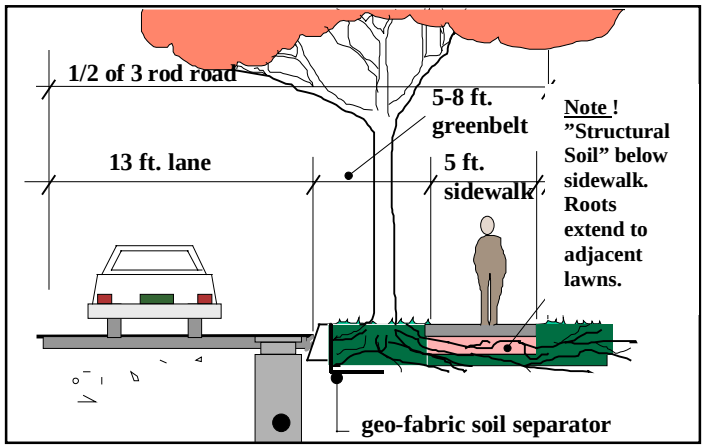
Planting Bed

The most important task in landscaping a transportation project is to establish a good plant bed. For plants to thrive, they require viable rooting space where sufficient soil, water and air is available to nourish the plant. The size of this plant bed should relate to the mature size of the plant species. Formulas have been established through urban forestry research that set parameters for the correct size of plant beds.[5]

Trees planted in urban environments, in sidewalks and in roadway corridors have a difficult time surviving due primarily to lack of good soil. However, recent advances in urban forestry have developed soil material that may make it possible for trees to share root space with the base material under pavement. So-called "structural soil" may be used in the future under sidewalks and roadways, allowing trees to spread their root systems and find moisture, nutrients and air where they traditionally encountered only dense compacted gravel.

Structural Soil

Cornell University has developed and patented an artificial structural soil plant mix for use in urban areas (CU Structural Soil). The mix consists of a specific blend of coarse stone, some clay soils and a gel binder. The structure of the soil is designed to provide a base course under pavement to carry the weight of traffic while providing the necessary components for healthy trees. Research at Cornell's Department of Urban Forestry indicates that these soil mixes work well. The mixes are primarily designed for difficult growing conditions where trees share space with streets, sidewalks and parking lots. (See p. 49 for information on this proprietary item.)



Advances in urban forestry may improve conditions for village trees in narrow greenbelts.

Right-of-way Acquisition

Available road right-of-way is often limited. If a planting need is identified but space for the tree or the tree's root systems is not available, acquiring additional right-of-way should be considered. Although this is normally not federally fundable, a willing property owner and enhancement funding may present possibilities for expanding planting space within the corridor.

[5] Urban, James. "Bringing Order to the Technical Dysfunction Within the Urban Forest." *Journal of Arborculture*, March 1992.

Planting on Private Property

In some cases, such as areas where the right-of-way is narrow, the state can purchase a planting easement from a willing private property owner to install street trees, screen planting or other landscaping. In such cases the planting is maintained by the property owner, who signs a maintenance agreement.

Tree Preservation

Mature trees have both aesthetic and monetary value. Preserving a tree requires saving and protecting at least two-thirds of the root system. The previous rule of thumb that a tree's root system lies beneath the drip line of its branches is usually not true. In fact, research shows that the root system of a healthy tree growing in normal soil conditions may be four to seven times the size of the tree canopy. Removing roots or re-grading around the root system during roadway construction will impact the health and life of a tree. Trees in the transportation corridor should be assessed by an experienced arborist at the outset of the project to determine their condition, their value and the feasibility of protecting them. (See Section V, page 48, for further discussion.)

Not all trees can be saved or are worth saving. Some may be diseased or at the end of their life cycle. Unless the tree and its root system can be avoided or adequately protected, it may be better to remove it as part of the project and replace it with a new tree than to leave the town or property owner with a tree that will slowly decline and die due to construction impact. The advice of a qualified arborist should be sought to evaluate the tree and its potential for survival.

Slight adjustment to the roadway or pathway alignment should be considered if it will preserve an important specimen or a group of trees.

CONSTRAINTS AND ISSUES

Placement of landscaping must accommodate the safety of drivers and pedestrians as well as other elements of the road or path. Trees come in all potential sizes, shapes and species, and location of plantings must consider the following:

Sight Lines

Sight distances recommended by AASHTO (American Association of State Highway and Transportation Officials - *A Policy on Geometric Design of Highways and Streets*) limit the use of planting in areas where the driver's view of oncoming cars must be maintained to avoid collisions. Sight distances increase with the design speed of the road. These guidelines apply primarily to intersections. Visibility of crosswalks is a particular concern. Shrubs that grow over 3 feet in height or trees with thick trunks or low branches are considered a problem. The sight distance recommendations of AASHTO often come in conflict with village streetscape designs creating a classic tree-lined street. In resolving these conflicts, it is important for engineers and the public to understand that street trees come in many shapes and forms and do not always block sight lines.

New street trees with high clear stems allow unobstructed sight lines at this intersection on Main Street in Burlington.

Nurseries grow trees especially for use as street trees that have clear stems (no branches on the trunk) to heights of 6 or 7 feet. Such trees allow clear visibility below the tree canopy for drivers of most vehicles. As trees mature, the lower branches can be removed to raise the canopy further. In general, engineers design for the "worst case scenario" in which trees may not be pruned, but each design should consider specific site and maintenance conditions. Lowering a road's design speed through a village setting reduces the sight distance requirements and allows more planting flexibility. Each site and situation must be evaluated individually. Bike paths require a minimum of 10 feet of "head room" above the pavement that must be clear of obstructions, including branches.

Clear Distance

Proposed landscaping must be set back from the roadway a prescribed distance to avoid creating a hazard for cars that swerve off the road. In an urban or village setting where roads are curbed, landscaping can be located in a greenbelt within a few feet of the curb.

Planting must also accommodate other elements within the roadway corridor such as signs and signals. Locations of some signs are slightly flexible. The bottom of roadway signs must be 7 feet above grade.

Setback distances found in the *Vermont State Standards* state the minimum clear-zone setback criteria for curbed and uncurbed roadways. These guidelines may be applied to all new tree plantings whose trunk diameter at maturity will be 6 inches or greater. Setback distances or vehicle recovery areas are related to type of slope, slope ratio, traffic volumes, and design speed of the highway. The setback is measured from the "traveled way," which is the portion of the roadway used for vehicle travel, exclusive of shoulders and auxiliary lanes.

Variations in site-specific conditions need to be considered and may warrant special treatment. Existing historic, aesthetic or environmentally important trees may be retained within the recovery area if they are protected or are not in a target position, such as the inside of horizontal curves. Low shrubs and ground cover may be planted in the recovery area for safety and aesthetic purposes. VTrans has established a process for requesting a variance from the standards when needed.

Lighting

Spacing of trees will have to accommodate the location of light fixtures and the recommended illumination levels of the road and sidewalk. As with sight lines requirements, AASHTO lighting recommendations are generic and do not necessarily address the needs of a particular roadway site. The landscape design should consider pole heights, light cones, the shape of the tree and the horizontal location of poles relative to tree stems to determine the compatibility of illumination and planting.

Utility Conflicts

- **Underground Utilities**

  It is preferable in a village setting to have a greenbelt dedicated solely to growing trees. However, given the limited right-of-way in most towns and villages, that is rarely possible. There are two concerns often cited where underground utilities share a tree belt.

  One concern is the potential for root systems to invade water and sewer pipes. In Vermont, water and sewer lines are usually located well below the normal depth of tree roots. Current research[1] has determined that under normal conditions tree roots grow within 18 inches of the surface, primarily to obtain oxygen. Only in rare cases (when denied access to water) do tree routes dive to seek available moisture and nutrients from a cracked pipe or leaking joint. New, well-sealed utility systems located below trees growing in large greenbelts that provide sufficient moisture and nutrients should not experience this problem.

  Another concern is sometimes voiced about locating trees in a greenbelt above existing underground utilities which may someday need to be excavated for repair or replacement. This concern is usually not well-founded for the following reasons: 1) Such excavations are very infrequent. 2) While in place, the urban tree provides many welcome benefits. 3) If excavation does become necessary, the cost of replacing a tree or group of trees is relatively low.

  Gas lines and other small utility lines can be replaced by routing pipes below the root system. This practice of horizontal boring and "jacking" pipes can be used for pipes up to 10" in diameter. Blanket regulations concerning trees and below-ground utilities should be avoided and each installation considered individually. Often the decision will consider the immediate and long-term costs and the value a town may place on having a tree-lined roadway.

[1] Urban, James. Bringing Order to the Technical Dysfunction with the Urban Forest." Journal of Arborculture as well as many other publications by Urban and others over the last 15 years too numerous to mention here.

- **Overhead Utilities**

  Utility poles and wires present a challenge for the urban forester and landscape designer. The increased use of phone and cable makes utility wires more prominent than ever. Placing wires underground is too costly an option for most towns. Street trees can effectively help screen utility poles and wires or at least distract from their presence. To prevent damage, trees sharing the utility belt must be planted so that branches do not interfere with wires.

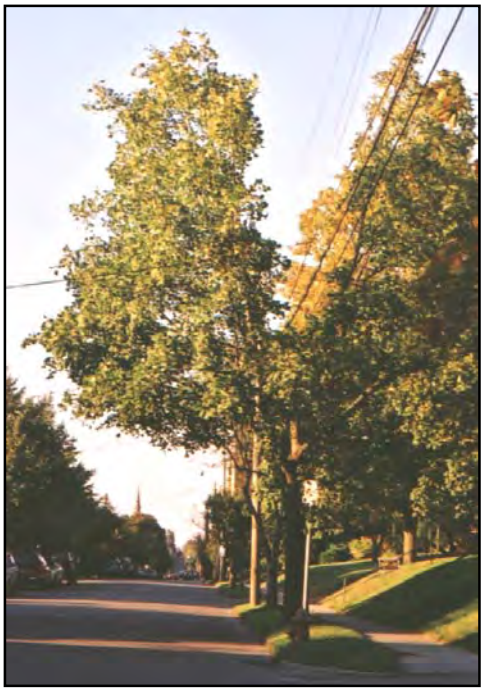
  Most urban forestry literature encourages the use of small trees under utility wires. Very small trees may be appropriate for some roadway settings, but trees that do not exceed 10 to 15 feet in height when mature are woefully out of scale with most state highways. In addition, if pruning the lower branches of small trees is required to make way for passing trucks on the roadway and pedestrians and snowplows on the sidewalk, the upper crown of the tree is further reduced. These small misshapen trees have few of the benefits outlined in the first section of this guide. Small trees also have a shorter life span than larger trees, making larger trees a better investment.

  Many landscape architects and urban planners encourage the use of slightly larger types of street trees that reach mature heights of 25 to 30 feet. The small upper branches of these trees may brush the wires and if necessary can be pruned, but the heavy limbs, capable of breaking wires, remain well below wires. The slightly larger trees have enough size and presence to visually compete with the width of the roadway and adjacent buildings. As trees mature they form a canopy over the sidewalk and road, diverting attention from overhead utilities. They also provide a wider canopy and more shade.

  Flowering pear trees coexist with utility lines on North Avenue in Burlington.

  Another option is to plant trees with an open crown that can be “crotch pruned” to avoid the wires. This has been a common practice, and the results can be seen in many towns that have older mature trees planted under utility lines. From some angles the distorted crown of the tree is apparent. But pedestrians and drivers using the road and sidewalk below still enjoy the shade of the lower branches and the canopy of the tree-lined street.



From some perspectives the crown of this "crotch pruned" shade tree shows its distorted shape…

…but the same shade tree, as seen from the pedestrian's view, provides shade and a broad canopy that could not be provided by a small tree. These photos are taken on South Union Street in Burlington.

Many varieties of columnar shade trees have been developed in recent years as suitable street tree types. These varieties, with tall, narrow crowns, may be useful in specific locations where overhead utilities exist and the right-of-way is narrow. Columnar trees set back behind poles and lines can also diminish their stark appearance against the sky. Columnar trees may play a useful role in tight spots since they need less rooting area then required by trees with full sized crowns. Familiar trees such as oaks, maples and gingkoes now have columnar varieties.

- **Shade and Freezing**

Trees planted close to the roadway should be of a deciduous type to avoid creating heavy winter shade that causes the pavement to freeze sooner and thaw later. Even large deciduous trees with dense twig patterns can have some effect on freezing and thawing cycles. Tree types should be carefully selected.

- **Maintenance / Mowing**

A clear understanding of the maintenance work required in new landscaping should be part of the initial project planning. Long-term maintenance is frequently the job of the town. The town will be required to sign a finance and maintenance agreement with the state for such items as landscaping, median-island maintenance and sidewalks prior to installation. While the Agency of Transportation District Maintenance staff typically mow state highway medians and r.o.w., more frequent mowings and weeding is needed where landscaped medians act as highly visible village gateways and traffic calming devices.

- **Street Trees**
  Street trees will require pruning on a five- to seven-year interval. Watering may be required in the first few years or during a particularly dry year. A local fund should be established for long term maintenance and tree replacement.

- **Median Planting**

  Low plantings of shrubs or perennials in medians or islands need extensive weeding (three to four times per growing season) for approximately the first three years to establish a dense cover then yearly weeding should be sufficient. Planted island medians also need to be kept clean of roadside trash. A maintenance agreement should be worked out in advance. (See page 16.)

- **Naturalized Planting, Native and Invasive Species**
  Landscaping in rural areas should be designed to blend with existing, native vegetation. Plants should be selected for their ability to survive roadside conditions and lack of maintenance. Regionally native plant selection and construction practices to minimize adverse effects on the natural habitat are strongly promoted by the Federal Highway Administration (FHWA) through the *Presidential Executive Memorandum on Environmentally and Economically Beneficial Landscape Practices*, 1995.

  - **Invasive Species** It is important to avoid the introduction or spread of invasive species as promoted by the Federal Highway Administration (FHWA) through the document the *Executive Order on Invasive Species, 1999.* A review of updated, national and regional lists of invasive plants in the design phase will avoid spread of these invasive plants.

On streets where fine architecture commands the streetscape, space is limited, and parallel parking provides a buffer between pedestrians and traffic, street trees may not be needed. In fact, trees may obscure architectural detail and block views and light from upper stories. This street in Portland, Maine, is an excellent example.

ROADWAY PLANTING OPPORTUNITIES

Planting options and opportunities will differ based on the roadway classification, the setting (urban vs. rural), and the context of the corridor. Landscape plans should be designed to fit the roadway and its setting.

Roadway Classification

Vermont's state highways are all classified according to the role they play in the statewide system. Through roads, such as the interstate system that serves long-distance travel, are at the top of the hierarchy, and local roads serving primarily local vehicle trips are at the bottom. In some Vermont towns higher classifications conflict with local uses. In towns such as Plainfield, for example, the local "Main Street" (US Route 2) also happens to be a major route serving interstate commerce.

Classifications are as follows:

- Freeways
- Principal Arterials
- Minor Arterials
- Collectors, Major and Minor
- Local Roads

Vermont's interstate highway system (Freeway category) has won design awards for its scenic qualities. The acclaim was for both the roadway's design and its setting of scenic valleys and hills. A wide scenic corridor of existing vegetation and ledge outcropping was set aside to serve as the backdrop for the highway. Act 250 has further protected scenic aspects along some sections of the interstate, as has Vermont's billboard law.

Due to the scenic rural environment in Vermont, little landscaping was needed for the interstate system. Naturally occurring wildflowers appear in the medians in addition to VTrans' successful and very popular seeded wildflower patches. The median planting originally installed has had mixed success. Some short-lived shrubs have been removed, but others do remain to add seasonal color.

Some expansion of the interstate system will occur with added exits. Several limited-access bypasses are also being planned. When these additions to the interstate are built, landscaping should certainly be considered.

This guide focuses on the remaining classifications, multi-use paths and park-and-ride lots. The requirements for each vary. The criteria most related to landscaping are:

- **Lane and Shoulder Widths** - These will affect the space available in the right-of-way for landscaping.
- **Sight Distance** - May affect the placement of trees at intersections and other locations.
- **Clear Distances** - Will affect the distance that most plantings can be placed from the traveled way.

- **Lane Requirements for Shared Use by Bicycles -** Increased lane widths to accommodate cyclists may affect space available in the right-of-way for landscaping.

Roadway Setting

- **Town/Village vs. Rural**
  The *Vermont State Standards* differentiate between rural and urban within each roadway classification. Planting designs should consider these distinct roadway settings.

  Planting design for town and village settings, in all roadway classifications, will likely follow a more traditional, formal pattern of street tree plantings and landscaped greens and islands. Planting for rural settings will tend to be more informal and naturalistic. On many rural roadways no planting at all is needed if the project fits well into its surroundings and suitable indigenous planting remains or re-vegetation of native species will naturally occur on cleared areas and embankments. However, planting may be useful in stabilizing slopes and preventing erosion.

- **General Considerations in a Town/Village Setting**
  A constraint for planting in a town/village setting is typically the lack of right-of-way space for a greenbelt. A greenbelt of 6 feet or greater will be needed to sustain a shade tree. The use of "structural soil" may create options for narrower greenbelts but increases project costs.

  There is more opportunity to assign right-of-way space for street tree planting in a town setting if the speed limit is set at 30 to 25 mph. Lower speed allows for narrower lane widths, shoulder widths, and clear distances as well as better conditions for pedestrians and bicycles. When curbs are installed, trees can be planted nearer to the traveled way.

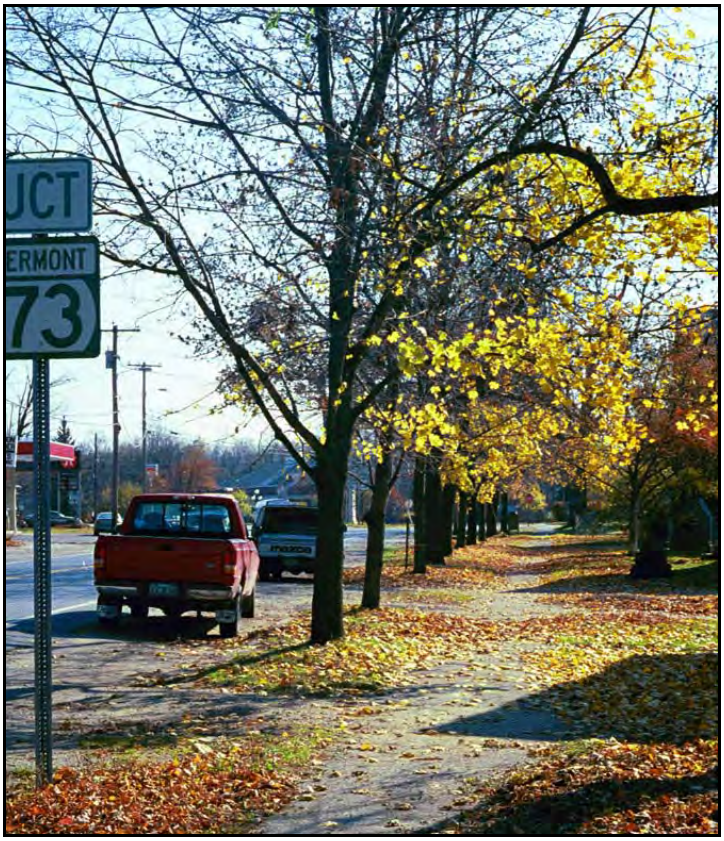
  The greenbelt does not have to be continuous. Greenbelts can be omitted where obstructions occur. Parallel parking is often needed to serve local businesses located along part of the roadway. Parallel parking can be substituted for the greenbelt in front of some businesses or for extended sections of road frontage. Greenbelts should not be installed between parallel parking lanes and a sidewalk where heavy pedestrian traffic is anticipated. Foot traffic will compact the soil and compromise the tree's root system. Tree stems can conflict with the swing of car doors. However, careful greenbelt design can sometimes overcome these problems. If lawn space is available, trees can be planted on the outside of the sidewalk, away from the street.

Planting Options for Typical Roadways

The sections and plans on the following pages illustrate several options for planting along arterials, collectors and local roads. These sections follow the roadway dimensions recommended in the *Vermont State Standards* and they assume that in some cases minor adjustment of the center line is possible. They also assume that the traffic volume exceeds 2000 vehicles per day (AADT).

- **Curbed Roadways**

  All of the diagrammed options for planting in town centers show a curbed roadway cross-section. Most small Vermont towns do not have curbs. Some believe that adding curbs will destroy their town's rural image. However, a curbed roadway cross-section has many advantages. Due to clear distance requirements in the *Vermont State Standards* it is often unfeasible to install street trees in a typical compact village setting with no curb. However, street trees can be planted within 2 feet of a curbed roadway. Curbs also prevent cars from parking on the greenbelt, an increasingly common occurrence in most villages where parking spaces are limited. Although there are a few exceptions (Historic Williston Village on Route 2, Westminster Village on Route 5, to name two), the compact nature of most Vermont villages dictates that curbs be installed to protect greenbelts and trees.



The demand for on-street parking in most towns calls for curbs to define the greenbelt and to protect trees from cars seeking parking on greenbelts. This photo is taken on Route 7 in Brandon near Route 73.

Westminster Village, which fronts on Route 5, is an exception to the typical compact village form. Westminster's "Main Street" has a wide right-of-way that provides room for trees, drainage over gentle swales and village parking. Curbs are not needed.

- **Utility Lines**
  Overhead and below-grade utility lines are not shown on the diagrams that follow. It is assumed that electric lines are located above grade, along the streets of most towns. Where lines are present, the street trees can be sized appropriately so as not to interfere with wires. (See pages 14-15 for discussion.)

- **Construction Easements**
  Some typical diagrams show all the right-of-way used for sidewalk, greenbelt and roadway with no space for transition from private property. In fact, grading of sidewalks and roadway sometimes requires such a transition space. In that situation a construction easement would be required to grade onto adjacent private property. The greenbelt itself can also be sloped up to about 1:4 to accommodate grade changes.

Trees planted behind the sidewalk on Route 11 in Springfield, VT, enhance the roadway but do not shield pedestrians from fast-moving traffic on this arterial roadway.

Village, Town and City Typical Roadways

A roadway through the heart of a town's civic or commercial area must accommodate the needs of many users. Cars and trucks passing through, local traffic, parking for local businesses, bicycles, and pedestrians all share the corridor. In addition, the often narrow right-of-way must accommodate above- and below-ground utility lines. By making the corridor more inviting for all, street trees and other plantings can help meet the divergent needs of users. Landscaping can have a place in the right-of-way if it is planned for from the start of the project.

The *Vermont State Standards* differentiate between "rural" and "urban" roadway environments and specify urban standards that allow the roadway corridor to adapt to the varied needs and users in town centers.

- **Urban Arterials - Principal and Minor**

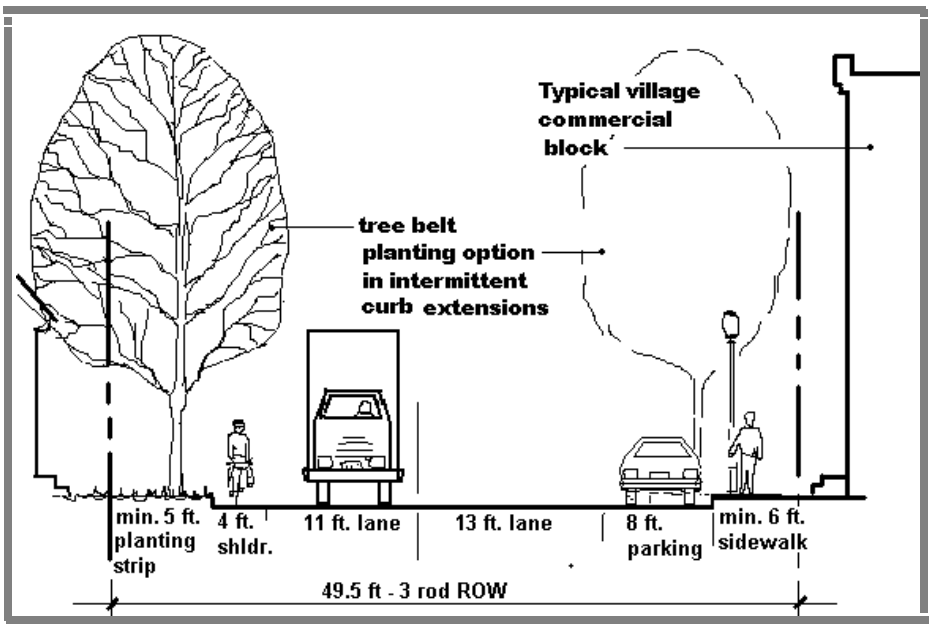
  The highest status roadways within this classification are the National Highway System (NHS) roads. Many fine historic Vermont towns and villages are located on these routes. They include Swanton, St. Johnsbury, Danville, Marshfield, Plainfield, Shelburne, Middlebury, Brandon, Woodstock and Wilmington, along with many other smaller towns. As traffic has increased along these routes, paving has kept up with the needs of through traffic, but the village streetscape, sidewalks and historic plantings have deteriorated. As a result the roadway corridor no longer serves many needs of the local residents and businesses. Many of these communities would benefit from street tree improvements along with streetscape and sidewalk enhancements that maintain the appearance and livability of their town centers and help counter the impact of the increased traffic.

  While road rights-of-way are generally wider on Arterials, this is not always the case. When surveys are completed, they sometimes reveal that historic buildings are located within the right-of-way.

  Even under narrow right-of-way conditions it is usually possible to fit planting into a roadway improvement project. The following diagrams illustrate several options for including planting along Arterials, Collectors and local roads in town centers. These sections assume that in some cases minor adjustment to the centerline is possible.

STREETSCAPE

DEFINITION: All the elements of the built environment within the roadway corridor that affect how we experience the street. These elements include structures (buildings, walls, bridges), trees, open spaces, pavement and wall surfaces, lights and lighting effects, signs and signals, storefronts and windows, vehicle parking and other roadway elements.



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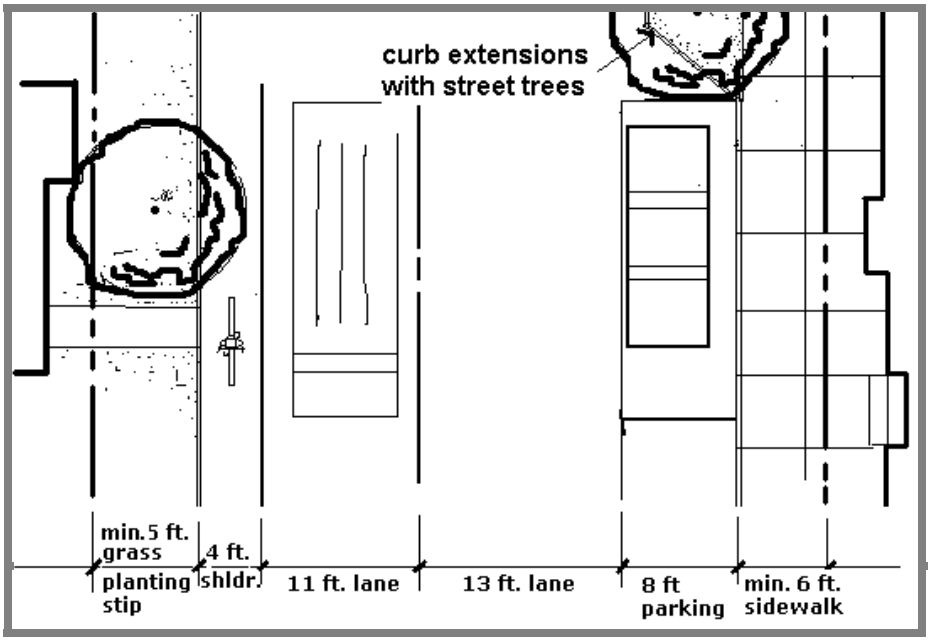


Plan

1. URBAN SETTING - Town/Village ARTERIAL - Typical Planting for Roadway Within a **3 Rod** (49.5 feet) Right-of-Way Design Speed of 25 mph

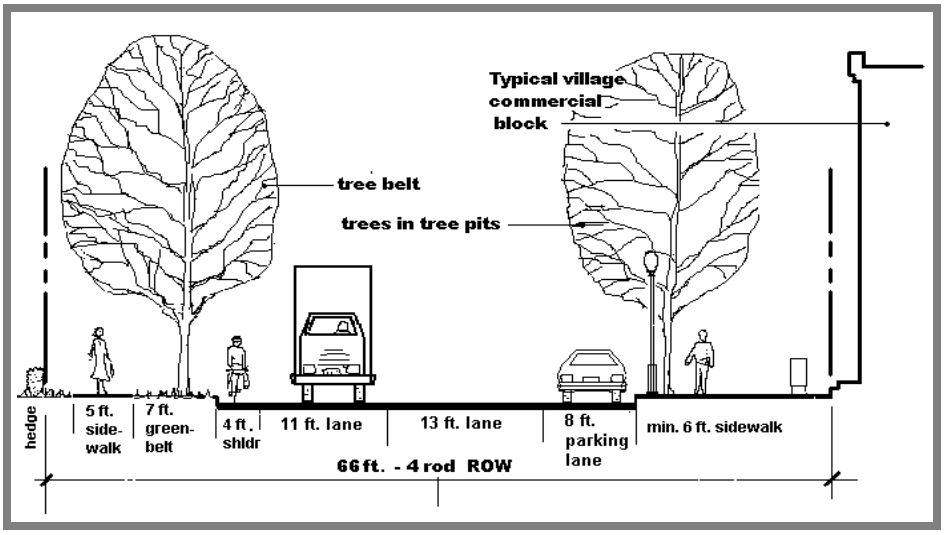
Side 1 OPTION	**Side 2 OPTION - Intermittent curb extensions**
No sidewalk	6-foot minimum sidewalk -
Trees in minimum 5-foot planting strip	**Trees in sidewalk tree pits or curb extensions**
6-inch curb	6-inch curb
4-foot shoulder/bike route - no parking	8-foot parallel parking/intermittent greenbelt
11-foot lane	13-foot lane - share with bikes[1]
Total = 20.5 feet one side	Total = 27.5 feet
Total width of built roadway corridor 48 feet. Roadway pavement width 36 feet.	

[1] Table 3.9 Min. Width of a Shared Use Curb Lane. Vermont State Standards Oct 22 1997

Street trees and parallel parked cars protect pedestrians from traffic on this principal arterial roadway (Route 4) in Woodstock. Current urban forestry practices could improve growing conditions for these street trees.

1. URBAN SETTING - Town/Village ARTERIAL

Typical Planting for Roadway
Within a **3 Rod** (49.5 feet) Right-of-Way Design Speed of 25 mph



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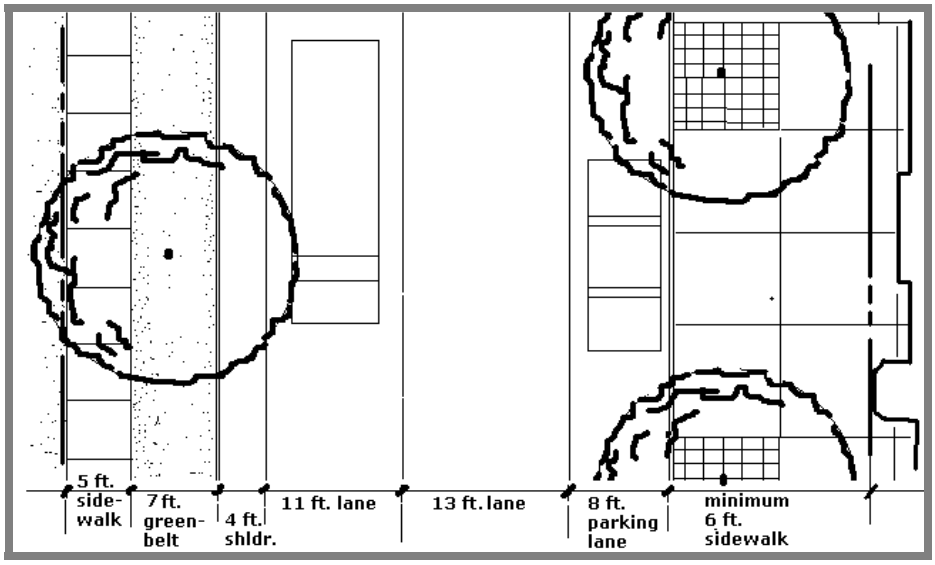


Plan

2. URBAN SETTING - Town/Village ARTERIAL - Typical Planting for Roadway

Within a **4 Rod** (66 feet) Right-of-Way Design Speed of 25 mph

Side 1 OPTION - With greenbelt	*** Side 2 OPTION - With parking, wide sidewalk & tree pits**
5-foot sidewalk	**minimum 6-foot sidewalk with street trees in tree pits**
6-inch curb	6-inch curb
7-foot greenbelt	8-foot parallel parking
4-foot shoulder/bike route[1]	13-foot lane - share with bikes [2]
11-foot lane	
Total = 27.5 feet	Total = 27.5 feet
Total width of roadway corridor 54 feet. Pavement width 35 feet.	
*****Side 2 option works well on a dense commercial block. A greenbelt can be substituted for parallel parking where parking is not needed. Trees in sidewalk tree pits may require sidewalks to be built on structural soil.	

[1] Table 3.8 Min. Width of Paved Shoulder, Vermont State Standards Oct 22 1997

[2] Table 3.9 Min. Width of a Shared Use Curb Lane. Vermont State Standards Oct 22 1997

Wide greenbelts provide adequate root space for growing these mature ash trees that provide a buffer between pedestrians and heavy traffic on Pleasant Street (Route 4) in Woodstock.

2. URBAN SETTING - Town/Village ARTERIAL

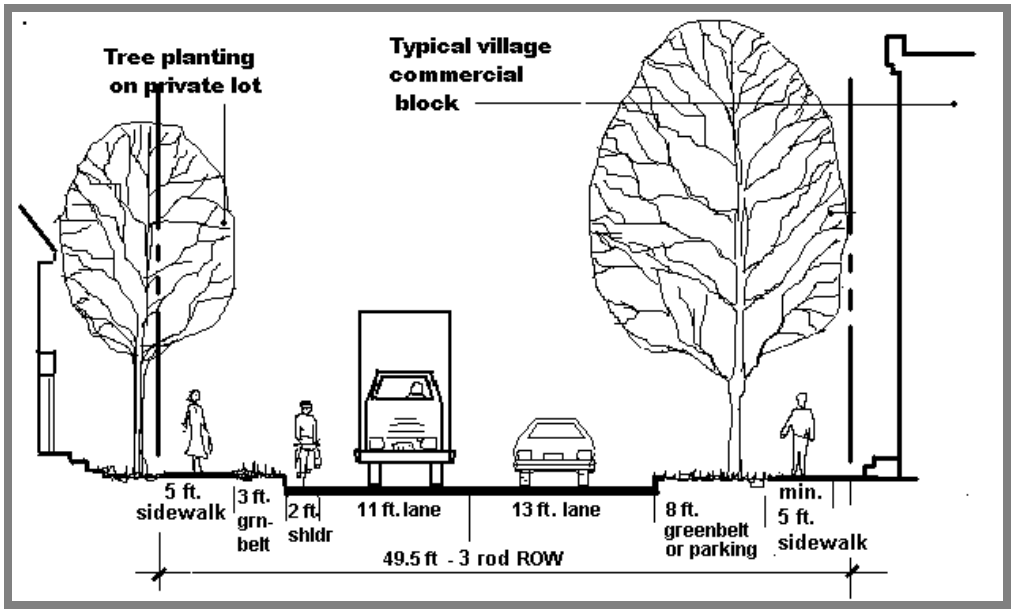
Typical Planting for Roadway
Within a **4 Rod** (66 feet) Right-of-Way Design Speed of 25 mph

- **Collectors - Major/Minor**
  The "Main Street" of most smaller Vermont towns and villages falls under the classification of a Collector. As an example, Waterbury's Main Street (Route 2/100) is classified as a Collector. In this case the nearby interstate handles most of the through traffic, leaving Main Street to meet local transportation needs.

  The road design of villages on Route 5 along the Connecticut River, those on much of Routes 12 and 14 and some on Route 2 could follow the road design guidelines of Collector. Right-of-way widths vary from 49½ feet (3 rod) to 99 feet (6 rod). Route 2 in historic Williston village is an example of a 99 foot ROW.

Route 5, which runs through many towns on the Connecticut River, is classified as a Collector. Bellows Falls is considering roadway planting and other improvements for this intersection of Routes 5 and Route 121, one of several gateways to its downtown.

Mature trees growing in a wide, Route 7A greenbelt in Arlington form a canopy over the street and sidewalk, adding character to this Vermont village.



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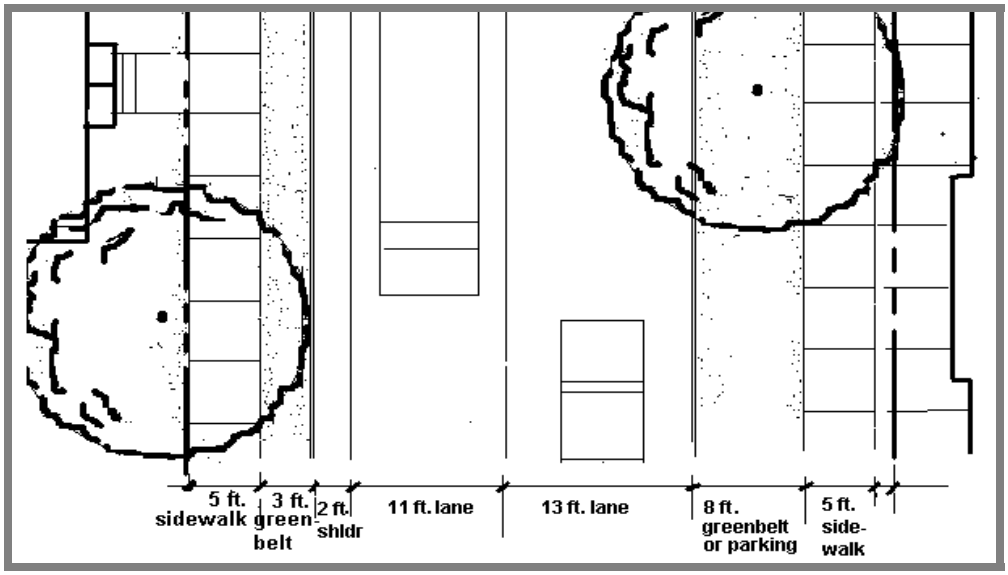


Plan

3. URBAN SETTING - Town/Village Collector - Typical Planting for Roadway Within a **3 Rod (49.5 ft.)** Right-of-Way Design Speed of 25 mph

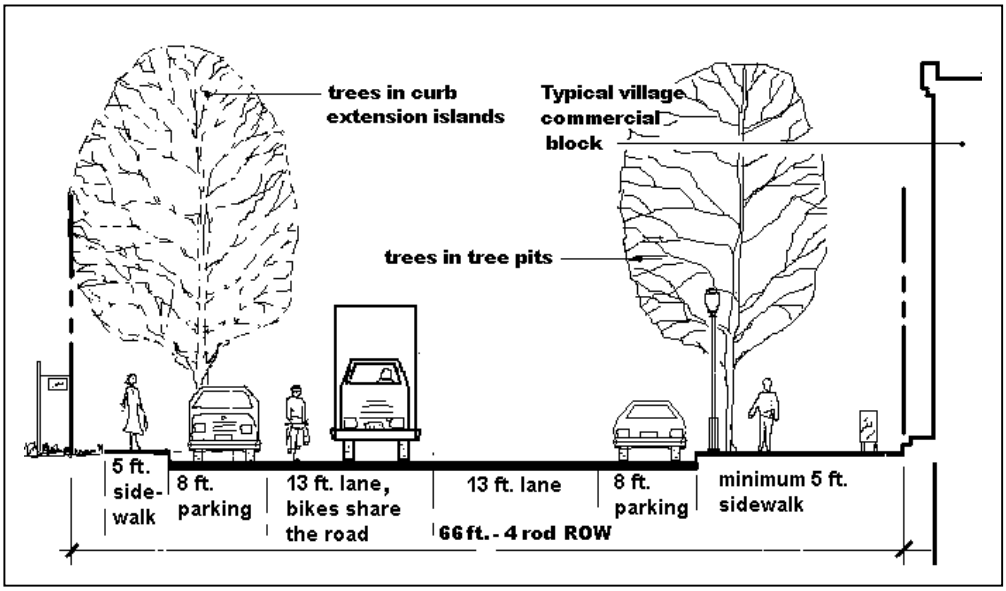
Side 1 OPTION - With sidewalk and narrow greenbelt	***Side 2 OPTION - With greenbelt or parking**
Trees installed on planting easement	
5-foot sidewalk	5-foot sidewalk
3-foot greenbelt for snow storage	**8 foot greenbelt** or parallel parking
6-inch curb	6-inch curb
2-foot shoulder/bike route	13-foot lane - share with bikes
11-foot lane	
Total = 21.5 feet	Total = 26.5 feet
Total width of built corridor 48 feet. Pavement width 26 or 34 feet.	

*This option good for dense commercial block. Where parallel parking is needed to support local businesses, the greenbelt can be replaced by a parking lane.

Trees and plantings on private property adjacent to sidewalk on Suzie Wilson Road in Essex.

3. URBAN SETTING - Town/Village Collector

Typical Planting for Roadway
Within a **3 Rod (49.5 ft.)** Right-of-Way Design Speed of 25 mph



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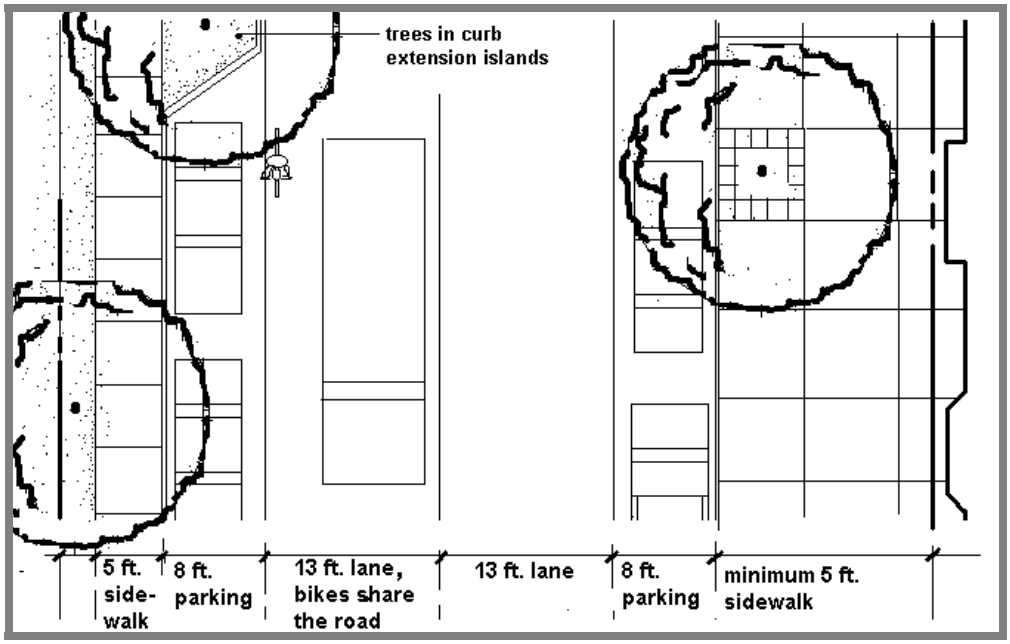


Plan

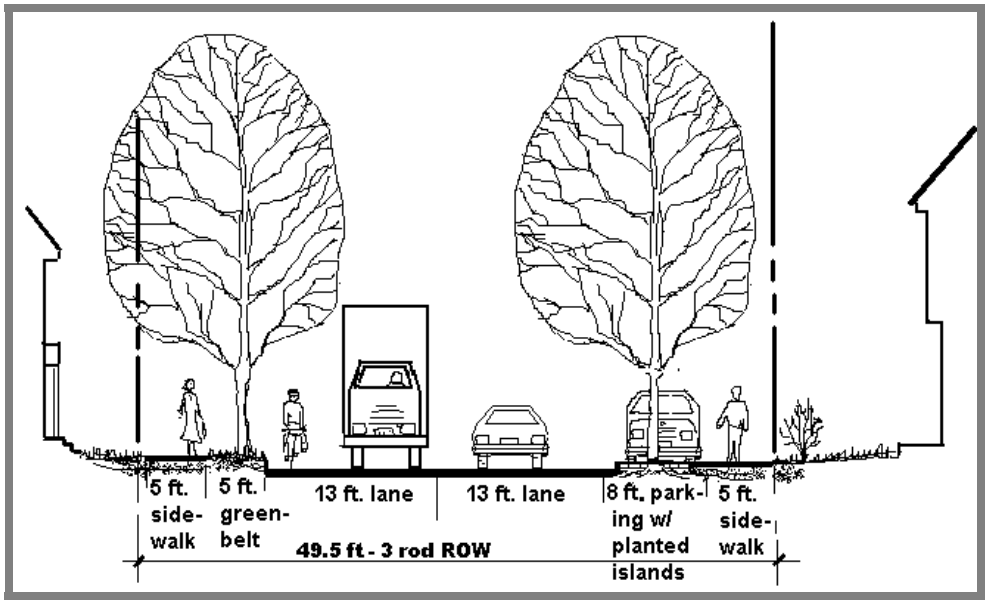
4. URBAN SETTING - Town/Village Collector - Typical Planting for Roadway

Within a **4 Rod (66 feet)** or greater Right-of-Way Design Speed of 25 mph

Side 1 OPTION - With parking and islands	**Side 2 OPTION - With parking, sidewalk and tree pits**
5-foot sidewalk	5-foot minimum sidewalk with trees in tree pits
6-inch curb	6-inch curb
8-foot parking with trees in intermittent curb extension islands or in grass lawn at edge of ROW	8-foot parallel parking
13-foot lane - bikes share road	13-foot lane - bikes share road
Total = 26.5 feet	Total 26.5 feet
Total corridor width approximately 53 feet. Pavement width 42 feet.	
NOTE! Having trees in sidewalk tree pits may require that sidewalk be built on structural soil.	

The wide corridor of Route 7A through Arlington village supports wide greenbelts and parallel parking on both sides of the road.

4. URBAN SETTING - Town/Village Collector - Typical Planting for Roadway Within a **4 Rod (66 feet)** or greater Right-of-Way Design Speed of 25 mph



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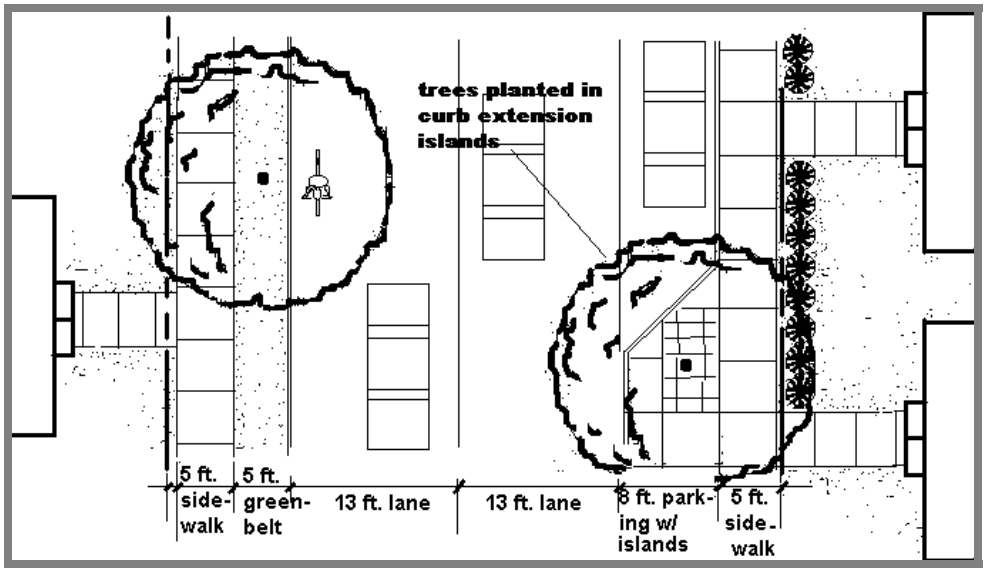


Plan

5. URBAN SETTING - **Local Road -** Typical Planting for Roadway

Within a **3 Rod (49.5 feet)** Right-of-Way Design Speed of 25 mph

Side 1 OPTION - With sidewalk and greenbelt	**Side 2 OPTION - With greenbelt/parking**
5-foot sidewalk	5-foot sidewalk
5-foot tree belt with structural soils below sidewalk that allow roots to reach lawn areas	6-inch curb
6-inch curb	8-foot parallel parking with curb extension planted islands.
12-foot lane - bikes share road	12-foot lane - bikes share road
Total = 22.5 feet	Total =25.5 feet
Total corridor width 49 feet. Pavement width 24 or 32 feet with parking one side.	
NOTE! Having trees in paved curb extension islands may require that sidewalk be built on structural soil.	

Planted curb extension island on a local road in Essex Junction protects parked cars and improves the roadway crossing for pedestrians.

5. URBAN SETTING - Local Road

Typical Planting for Roadway

Within a **3 Rod (49.5 feet)** Right-of-Way Design Speed of 25 mph

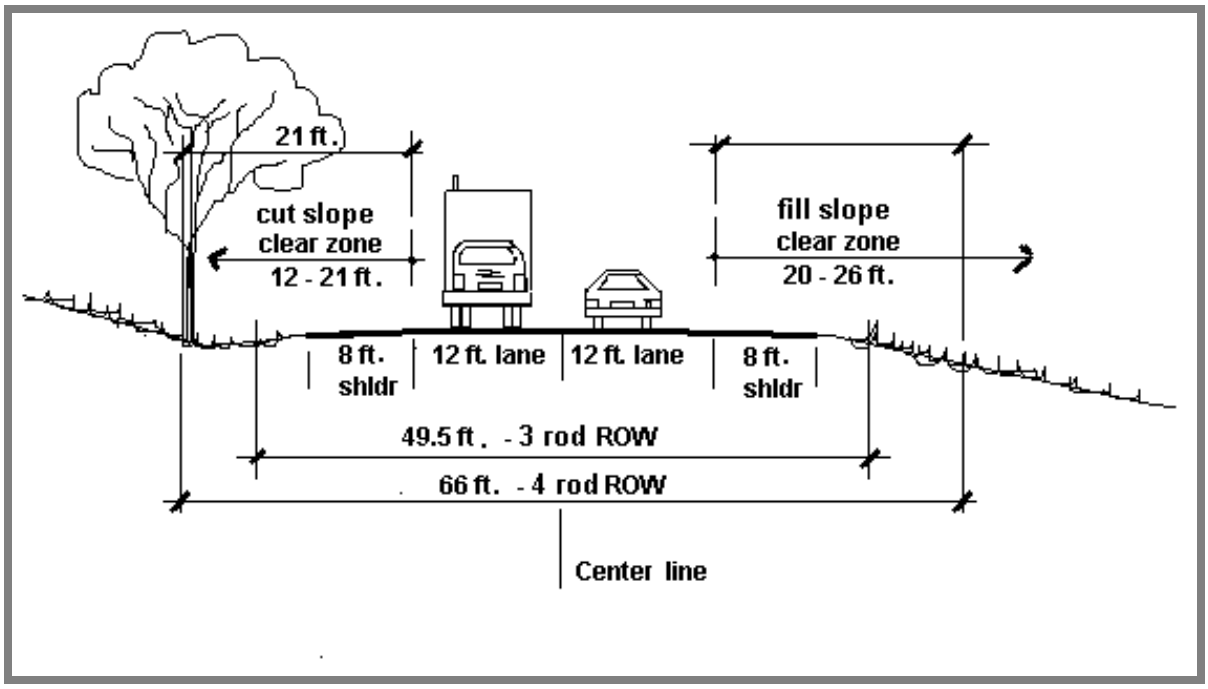
Typical Planting for Rural Roadways

Rural roadways that make connections between towns and villages generally have wide shoulders, no curbs and higher posted speed limits than roads through town centers. Clear distances prescribed in the *Vermont State Standards* limit the space available for major plant installations on most rural roadways. This is not usually a problem. In most cases the setting of these corridors is the open, rural landscape of Vermont. As with the interstate, the backdrop of these state roads is the native vegetation, rock outcroppings and views welcomed by drivers.

Rural roadways at the edge of towns that have no curb or sidewalk, where auto-oriented development has occurred or will occur, should be considered for street trees or other landscaping. Business owners' concerns about trees obstructing signs can be addressed with a visual analysis of carefully placed clear-stem trees.

This section of Route 30 in Windham County is typical of many rural state highways where natural vegetation and rock outcroppings are abundant and landscaping is not required.

Landscaping could help this section of Route 15, at the edge of Morrisville. Street trees and greenbelts would help integrate the road with its rural surroundings.



Section

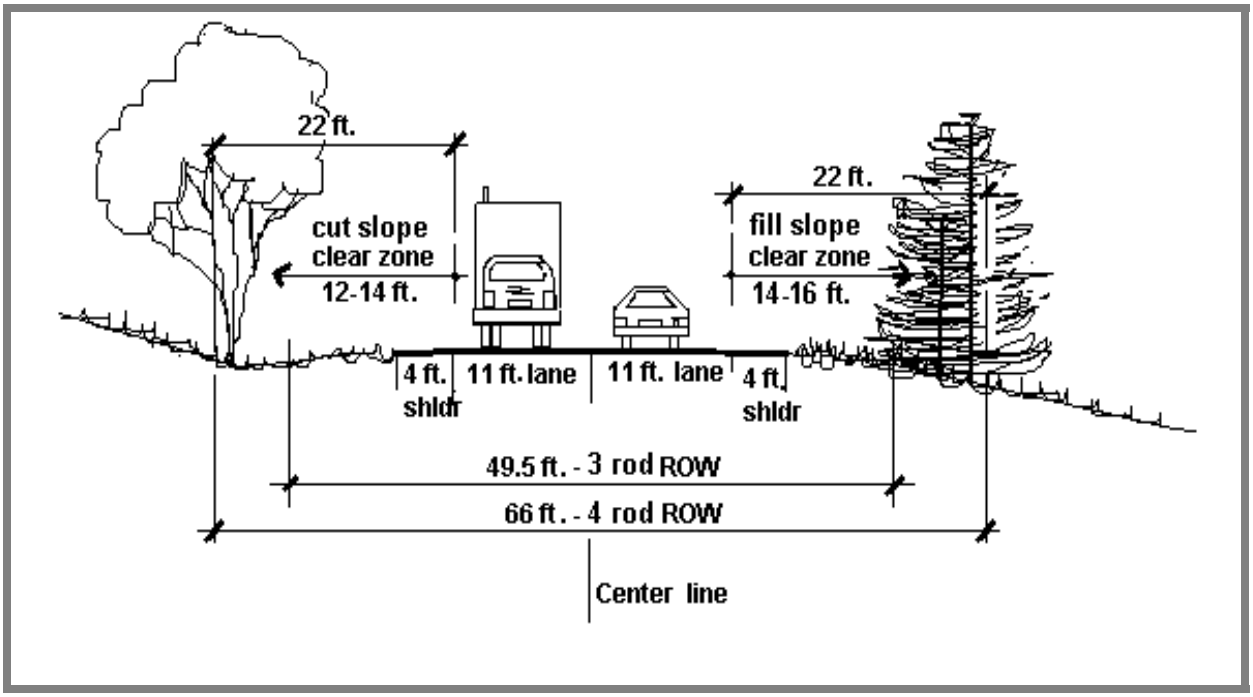
1. RURAL SETTING - Principal Arterial

Typical Planting for Roadway
Within a **3 Rod** (49.5 feet) or **4 Rod** (66 feet) Right-of-Way
Design Speed of 50-55 mph*

Side 1 - Cut slope condition	**Side 2 - Fill slope condition**
No sidewalk	No sidewalk
8-foot shoulder/bike route	8-foot shoulder/bike route
12-foot lane	12-foot lane
Clear distance to trees 12 to 21 feet	Clear distance to trees 20 to 26 feet
Total pavement width 40 feet.	
Total edge-to-edge clear width 56 to 71 feet for a 55 mph roadway	

CLEAR DISTANCE REQUIREMENTS ALLOW NO TREE PLANTING IN 3 ROD ROW, MINIMAL TREE PLANTING IN 4 ROD ROW

**Assumes traffic volumes over 1500 AADT*



Section

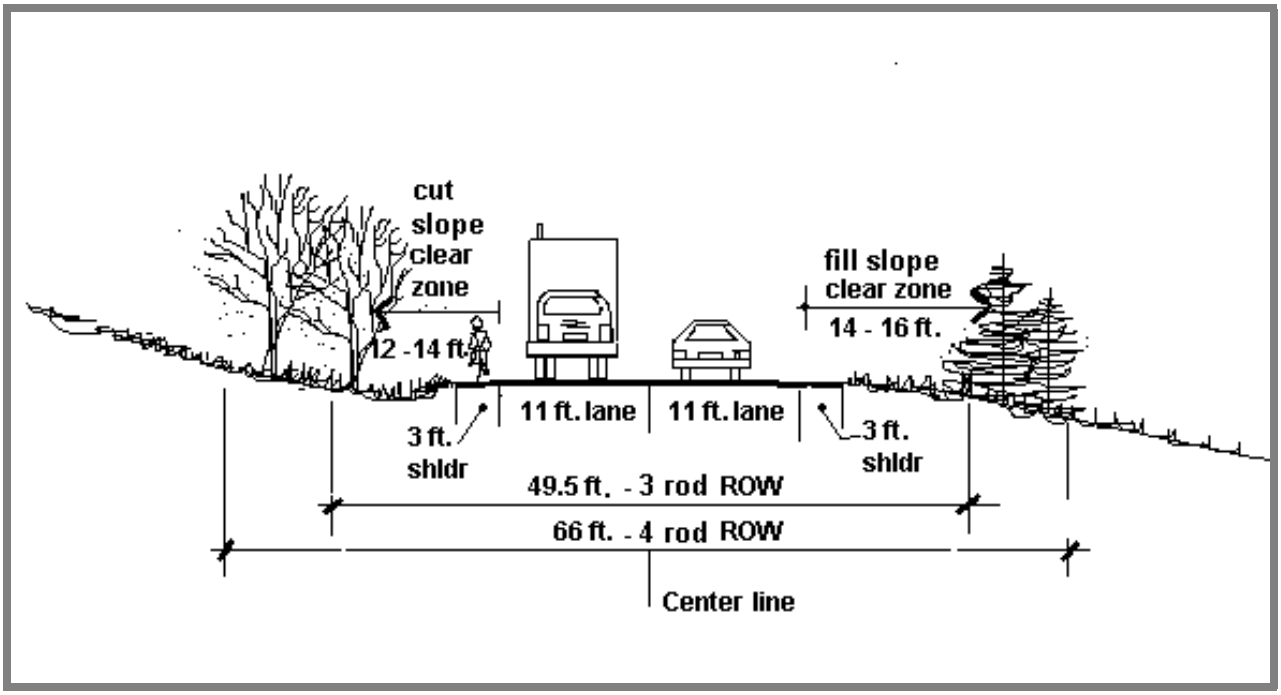
2. RURAL SETTING - Minor Arterial

Typical Planting for Roadway
Within a **3 Rod** (49.5 feet) or **4 Rod** (66 feet) Right-of-Way
Design Speed of 45 mph*

Side 1 - Cut slope condition	**Side 2 - Fill slope condition**
No sidewalk	No sidewalk
4- to 5-foot shoulder/bike route	4- to 5-foot shoulder/bike route
11-foot lane	11-foot lane
Clear distance to trees 12 to 14 feet	Clear distance to trees 14 to 16 feet
Total pavement width 30 feet.	
Total edge-to-edge clear width from 48 to 52 feet for a 45 mph roadway	

NO TREE PLANTING IN 3 ROD ROW
APPROXIMATELY 6-FOOT BAND FOR TREE PLANTING IN 4 ROD ROW

**Assumes traffic volumes over 1500 AADT*



Section

3. RURAL SETTING - Collector

Typical Planting for Roadway
Within a **3 Rod** (49.5 feet) or **4 Rod** (66 feet) Right-of-Way
Design Speed of 45 mph or less*

Condition is approximately the same as for Local Roads over 2000 AADT

Side 1 - Cut slope condition	**Side 2 - Fill slope condition**
No sidewalk	No sidewalk
3-foot shoulder/bike route	3-foot shoulder/bike route
11-foot lane	11-foot lane
Clear distance to trees 12 to 14 feet	Clear distance to trees 14 to 16 feet
Total pavement width 28 feet.	
Total edge-to-edge clear width from 48 to 52 feet at 45 mph	

MINIMAL TREE PLANTING AREA IN 3 ROD ROW
8 TO10 FOOT BAND OF TREE PLANTING POSSIBLE IN 4 ROD ROW

**Assumes traffic volumes over 1500 AADT*

PLANTING FOR SHARED-USE PATHS

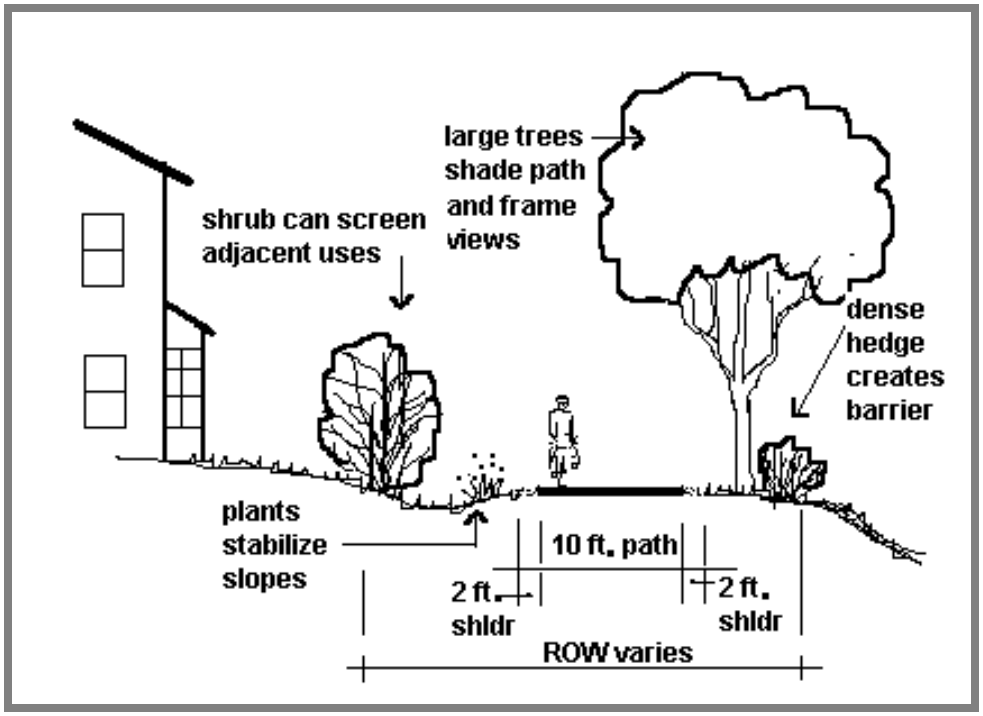
Plantings can benefit shared-use (or multi-use) paths in many of the same ways that they benefit roadways. They add shade, add screening, frame views, define the direction of the path, and enhance the path in many more ways.

Shrubs can be used in conjunction with fencing to create barriers where needed to control flow or provide a safety barrier at the top of an embankment.

Current AASHTO guidelines recommend that all posts and barriers, including tree stems, be 1 meter or about 3 feet away from the traveled way of a path. Overhead branches should be a minimum of 2.5 meters or 8 feet away, but 3 meters or 10 feet is recommended to allow for the passage of maintenance vehicles.

VTrans is currently preparing a document to be titled *Bicycle and Pedestrian Facilities in Vermont: A Planning and Design Manual*, which may have some recommendations for planting along these paths.

Paths that use old railroad beds (Rail to Trail paths) can be visually monotonous. These paths may benefit from selective clearing of existing vegetation to open up views of the surrounding countryside.



Section - Shared-Use Path

Side 1 - Cut slope condition	Side 2 - Fill slope condition
5-foot bike/travel lane	5-foot bike/travel lane
2-foot gravel shoulder	2-foot gravel shoulder
Clear distance to trees 3 feet	Clear distance to trees 3 feet
Total pavement width 10 feet.	
Total clear width 16 feet.	

PLANTING FOR CENTER MEDIANS

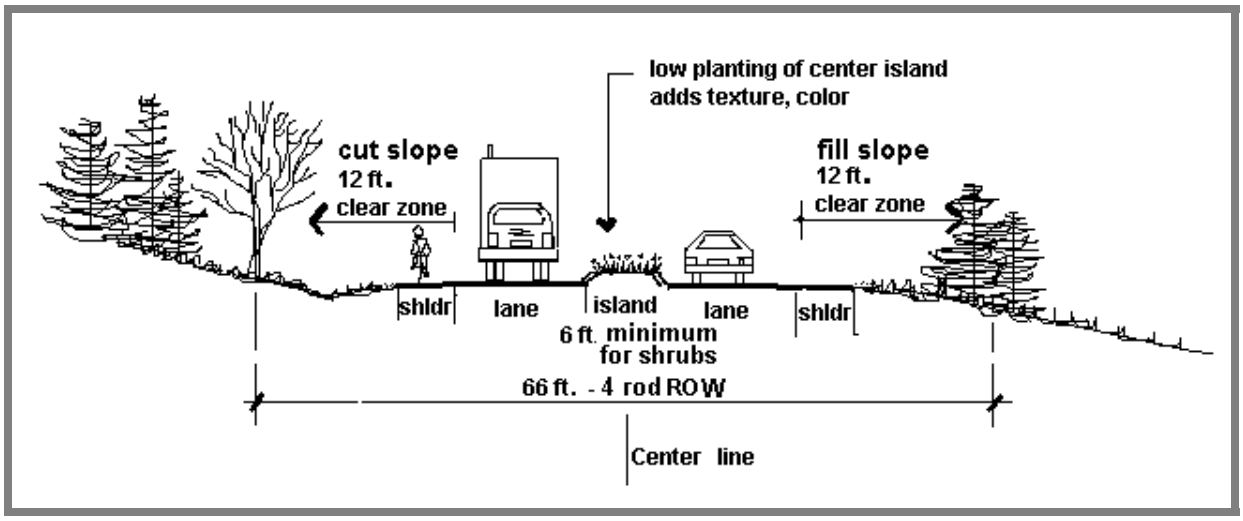
Planting of a center median adds texture, color and three-dimensional volume, all of which make the island more visible and enhance the appearance of the roadway.

Trees, shrubs and perennials may all be considered for median planting, but site distance and clear zone requirements must be met.

As with all transportation planting, a plan for ongoing maintenance must be developed. Unlike greenbelts, which are easily mowed by a neighboring property owner, center medians are hard to access and if planted with perennial or low shrubs may need a town or garden club caretaker. Snow removal plans need to be coordinated either with the Vtrans Disrtict Maintenance staff or the local governing body.

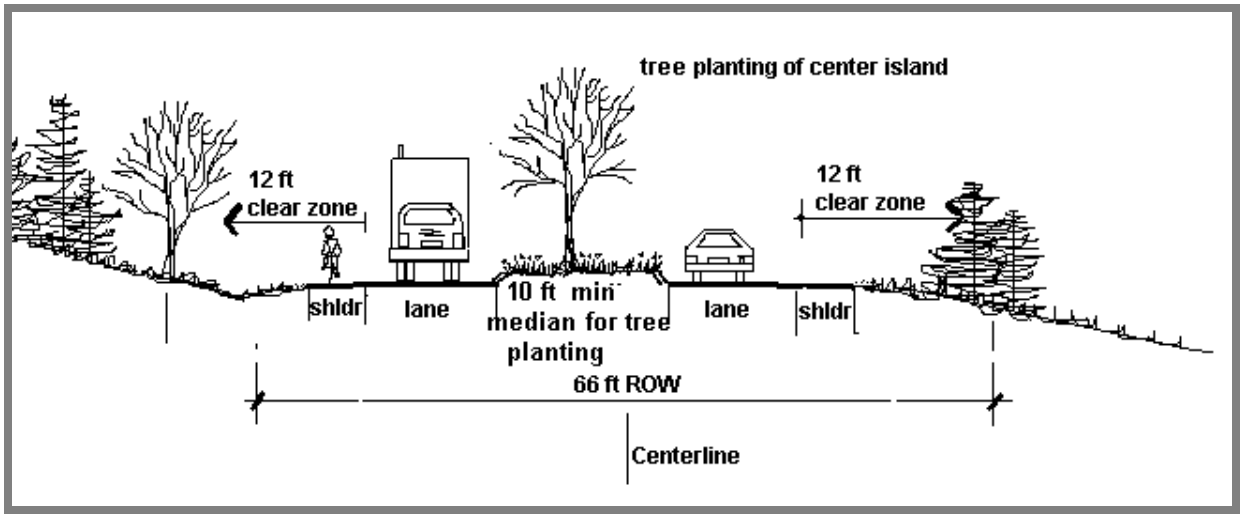
VTrans is in the process of adopting traffic-calming details that will become part of the *VTrans Standard Roadway Drawings*, which includes standards for center medians and raised medians.

Rosa rugosa shrubs and mixed perennials planted in the center island of Main Street, Burlington.



Shrub Planting for Center Median

New trees planted in center median on US Route 15 in Essex.



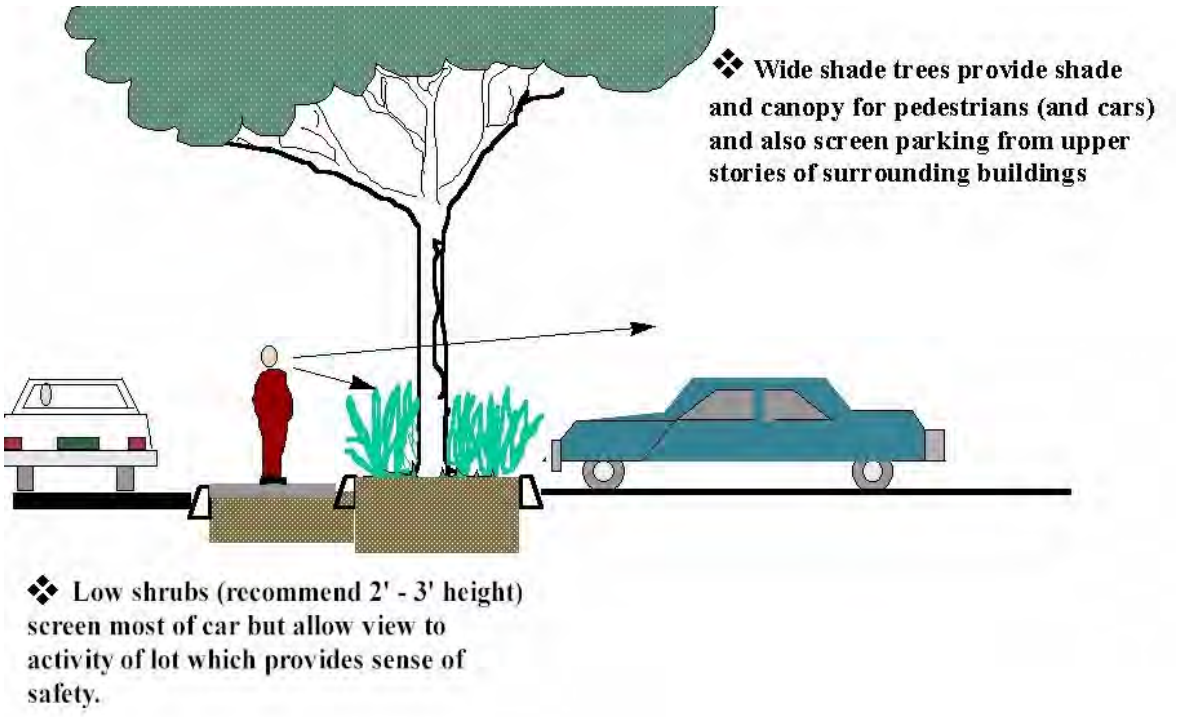
Tree Planting for Center Median

PLANTING FOR PARK-AND-RIDE LOTS

The objectives of planting for park-and-ride lots are somewhat different from planting for roadways or shared-use paths.

Goals for planting for a park-and-ride lot should include:

- Integrating the lot with its surroundings. Use native species where possible.
- Providing shade for users and cooling for cars that may be exposed to the sun all day. Shade trees should be planted within the lot as well as on the perimeter.
- Screening the cars from the neighboring properties. Use evergreens and large shrubs between the lot and the adjacent land uses but not within the lot or between the lot and the public way. Consider users' concern for visibility and perceived safety.
- Breaking up the expanse of cars in the parking lot.
- Allow eye-level views into and out of the lot to give users a sense of security.



Typical Planting for Park-and-Ride Lots

IV Other Design Considerations

Context
The landscape design should be guided by the roadway's setting. In general, the plan for a village center should consider the historic context and therefore follow a more formal pattern. A rural setting may dictate a naturalistic design that takes cues from the surrounding landscape and the native plants. However, this should not be a hard-and-fast rule. Historically, the interior spaces of many village greens were planted in a random pattern. A classic motif is the Vermont country road lined with formal rows of maple trees.

Continuity
The fear of a tree blight similar to Dutch Elm Disease sometimes drives towns to plant a wide mix of tree species along their streets, resulting in a chaotic appearance. It is best to be consistent with a tree species, at least within a given block.

The design should consider the plant's hardiness and its adaptability to the native soils. Plants should be native species when possible or at least a species that will not be highly invasive of surrounding wooded areas.

Spacing
A row of street trees will lose the corridor effect if spaced too widely; too tight and they will be difficult to prune. Consider the growth habits of the trees to be planted, anticipating their mature sizes. Trees should not be planted so close to buildings, walks and driveways that removal or pruning will be necessary when they mature. Trees on a commercial block should shade sidewalks and buildings but not block windows entirely.

Screening
Planting can be used to block the view of unattractive adjacent land uses and can also block the view of the roadway from nearby rural recreation or natural areas, residences or offices that may be compromised by a nearby highway.

Plantings can be very effective in screening headlight glare. Glare can cause temporary blindness to oncoming vehicles and can lead to accidents. Headlight glare can be a problem between interchange loops, and from frontage roads, service roads and parking areas. Planted medians areas can screen headlight glare on highway curves.

Views
In a rural setting, trees and shrubs can be used to frame special views or screen unsightly views. Plants can help direct and channel traffic at bends in the road and at upcoming islands and "T" intersections in the road.

Placement and spacing of street trees should consider their mature size and their relation to nearby buildings. This photo in Essex Junction shows the historic town office buildings obscured by mature linden trees.

Street trees planted in urban settings should consider the view of historic buildings as well as views from the windows of commercial and residential buildings. Some blocks with narrows greenbelts and side-walks may not be appropriate for street trees.

Visual Appeal

Flowering and specimen trees, and those with fall color, used singly or in groups, can add visual appeal to the roadway and act as landmarks that provide orientation for the driver.

Trees for Canopy and Shade

Shade is one of the most important benefits trees provide. Trees on a rural roadway can provide shade and reduce glare, lessening driver fatigue. Large trees provide the most shade benefit. Leaf size and the density of a tree's canopy also determine the amount of useful shade given by a tree. Large trees will shade the roof of a two-story house; medium-sized trees shade the roof of a one-story dwelling or the walls of a two-story building; small trees may offer some shade to the wall of a one-story house. Large trees that grow 60 feet in height will provide a shade canopy for a two-lane road. Small trees, 18 to 25 feet, will shade a sidewalk and a row of parallel parked cars.

Scale

Trees add a sense of scale to Vermont roadways. Wide town roadways of three or four lanes require the use of large trees to equal the scale of the roadway. The driver on high-speed rural roadways perceives form and texture but little detail. Plantings that will be viewed at 50 mph need to be installed in large groups and masses. Widely spaced plantings of individual trees or shrubs will be spotty and ineffective.

Snow

Consideration must be given to snow removal and storage and the detrimental effects of deicing chemicals. Roadside trees and plants must be salt tolerant. Snow can sometimes be stored in green belts between the tree trunks. Trees should be located far enough away from both the curb and the sidewalk to avoid damage from snowplows. Shrubs used at roadsides and in medians must be dense, twiggy species to withstand severe pruning resulting from snow storage or from vehicle damage. Shrub rows may be effective in blocking snow from drifting onto roadways, although positioning shrubs for such a purpose must be carefully

studied. Trees with tough bark are appropriate where snow will be stored. The local municipality and the VTrans Maintenance Engineer should be consulted in locations where snow plowing is an issue.

Tree Preservation

It may be necessary or desirable to retain an existing tree or group of trees. A tree may be a focal point or a significant feature along a roadway corridor; some trees may be considered by the Division of Historic Preservation to be an integral part of an historic district or site, or they may be covered by other statutory protections. Any measures to preserve trees should be preceded by a thorough evaluation, as it can be costly to retain trees. In general this is a complex subject that warrants the advice of a certified arborist.

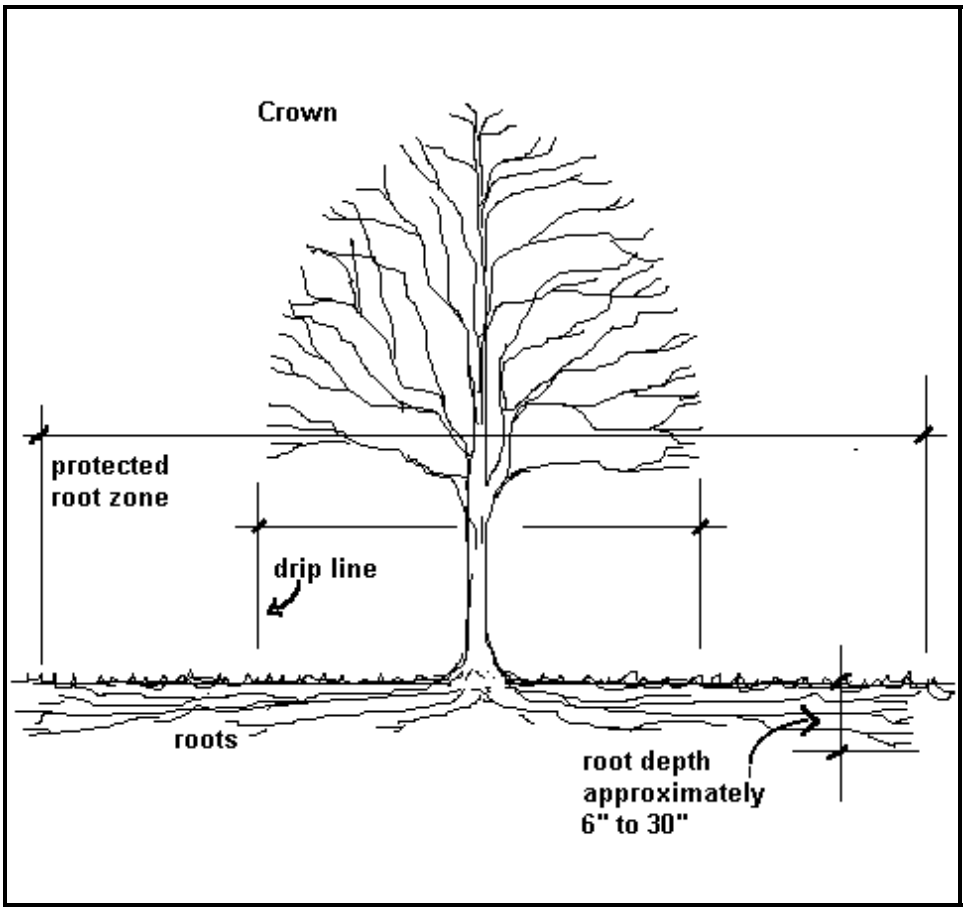
Preservation of existing trees requires careful planning to protect root systems during roadway construction. These trees on Route 7 in Brandon will be impacted by reconstruction.

The value and desirability of the tree and the cost of protection should be weighed against the potential of a newly installed nursery-grown tree. Roadway construction and changes to the surrounding site may be so damaging that tree preservation efforts could be wasted.

As tree root systems vary a great deal, it is difficult to lay down general rules on excavation. Digging exploratory soil pits will give information on an individual tree's roots, particularly with an arborist to interpret findings. Mature trees cannot withstand very much root loss. A vigorous, young, healthy tree may be able to cope with the loss of up to 30 percent of its root system without obvious ill effects, whereas a loss of 5 to 10 percent to a fully grown tree is likely to result in at least some dieback in the crown.

Before any work commences, the trees to be retained must be inventoried and clearly marked with numbers corresponding to a tree schedule and plan. Trees in poor condition should be marked for removal for reasons of safety, etc.

The expert analysis and exploratory work should result in the establishment of a Protected Root Zone (PRZ). Drawings and specification should clearly show the PRZ and state that construction activities shall be restricted within it. To preserve trees, the contractor should be notified well in advance of all special project specifications and restrictions in order to present and carry out an operations plan that will avoid impacting trees and root zones during construction.



Protected Root Zone

- **Protected Root Zone (PRZ)**
  The below-ground area occupied by a tree's root system varies greatly depending on the soil, nutrient and moisture conditions, and presence of below-grade barriers such as curbs or walls near the tree. The old rule of thumb for determining the protected root area was based on the drip line of a tree (the circle formed by the edge of the tree's crown). Research shows that roots extend four to seven times beyond this point. The determination of the PRZ must be based on a professional assessment of each tree and its site.

- **Tree Protection**
  Trees and root systems to be saved must be well protected with sturdy barriers installed before heavy equipment is brought onto the construction site. Clear and stringent procedures for cutting and covering roots should be a part of the project's construction specifications.

Maintenance

The plants used must be capable of growing relatively well with minimum maintenance to serve their purpose under the particular highway conditions that may be encountered.

V Plant Installation, Preservation and Maintenance

The best planting design will not survive unless it is correctly installed and maintained. This section provides an overview of the technical aspects of landscape installation, preservation and maintenance. It is not the complete set of planting specifications that would be required for construction, but, it outlines the technical requirements of selecting, installing, preserving and caring for plantings. This section will give the planner, engineer, or member of the local community some background information that will help in making design and planting decisions during all stages of the transportation project.

PLANT SELECTION AND INSTALLATION

Selection

Selection of trees, shrubs and ground cover is very important for any transportation project and especially in Vermont where the climate and conditions are harsh. Careful consideration should be given to the factors below.

- Cold hardiness is based on average minimum winter temperatures. Use the USDA hardiness zone map to determine the zone of the site and select plants.
- Select native species and avoid invasive species (See page 2)
- The hardiness zone of a locality may be altered by micro-climatic factors like reflected heat, cold pockets or excessive winds.
- Plant size and form should be appropriate for location.
- Check with nurseries on plant availability. (See proprietary item info page 49.)
- Quantify the available sunlight at the site.
- Soil type and site characteristics such as drainage characteristics, texture, wetness/dryness, pH levels and exposure to salt all affect plant selection.
- Select the right plant for the anticipated level of maintenance.
- Choose cultivars with proven resistance to pests and disease.
- Air pollution, water pollution, and the effects of pavements and buildings are urban conditions that dictate tolerant plant selection.

Selection, Delivery and Storage

- Selection and tagging of plant material should be done at the nursery by a landscape architect or knowledgeable plantsperson. American Nurserymen's Standards should be followed in choosing plant material.
- Plants must be protected from drying, mechanical damage, temperature extremes and frost during digging, handling, delivery and storage.

Soils

Good, plentiful soil gives a plant life and produces the best growing environment for plants installed in the transportation corridor. However, the soil requirements for paving are usually quite the opposite of those needed for plants. Durable pavements require well drained, compacted soil with little organic material. Desirable and undesirable soil characteristics for plantings are as follows:

Desirable Characteristics of Existing Soils

- Adequate fertility: proper nitrogen, phosphorus and potassium levels and adequate organic content.
- Aeration: ability to provide adequate oxygen to plants.
- Structure: free soil water infiltration and percolation.
- Water holding capacity: capable of holding 10 to 15 percent.
- pH levels that suit plant selection.

Undesirable Characteristics of Urban and Disturbed Soils.

Trees in towns often encounter soil with these characteristics:

- Great vertical variability, i.e., abrupt changes from layer to layer.
- Spatial variability, i.e., changes from plant site to plant site.
- Modified soil structure leading to compaction.
- Modified soil pH, usually elevated.
- Restricted aeration.
- Poor drainage caused by compaction.
- Low nutrient levels and lack of soil organism activity.
- Presence of anthropic materials and contaminants.
- Modified temperature regimes.
- Diversity in soil material textures that create serious moisture flow problems.

Soil Modification

Poor soils should be modified mechanically by using drainage or by adding necessary soil amendments, or they should be replaced entirely.

Structural Soil

Cornell University, in Ithaca, New York, has developed a patented soil product referred to as CU Structural Soil. It is a specific recipe mix that includes coarse stone, clay soil and a polymer binding gel. The soil product is designed to meet the requirements for both a base course under pavement that will carry the weight of traffic and a medium for growing healthy trees. The findings to date indicate that this soil mix works extremely well. The mix is particularly designed for use in urban areas where trees must share space with streets, sidewalks and parking lots. Structural soil products are being used in roadway projects in Philadelphia, Pennsylvania; Boston, Massachusetts; and Burlington, Vermont. The New York State Department of Transportation has adapted the CU Structural Soil formula and has included it in its planting specifications.

For all proprietary items proposed for federally funded projects, follow the recommendation in FHWA Guidelines, 23 CFR Ch. 1 (4-1-01 Edition), Section (2) of Chapter 635.411: *(2) The State Highway agency certifies either that such patented or propriety item is essential for synchronization with existing highway facilities or that no equally suitable alternative exists or (3) Such patented or proprietary item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.*

Characteristics of Root Growth

Large woody tree roots grow horizontally through the soil and are perennial. The feeder roots are predominantly located in the top 36 centimeters (16 inches) of soil; structural roots will extend to depths of 1 to 2 meters (3 feet to 7 feet). They often extend outward from the trunk of the tree to occupy an area 4 to 7 times the area of the crown, an irregularly shaped area with an average diameter usually equivalent to one to two times the height of the tree.

There is no such thing as a "shallow rooted" or a "deep rooted" species of tree. Wet site species such as cypress, tupelos, maple and willow trees will grow down deeply into the soil, down cracks, and down sewer lines if oxygen and water supplies are inadequate. Conversely, the roots of pines, hickories and other upland species will scramble along the surface if the soil is too compacted and hard or if oxygen cannot penetrate deeply.

Installation

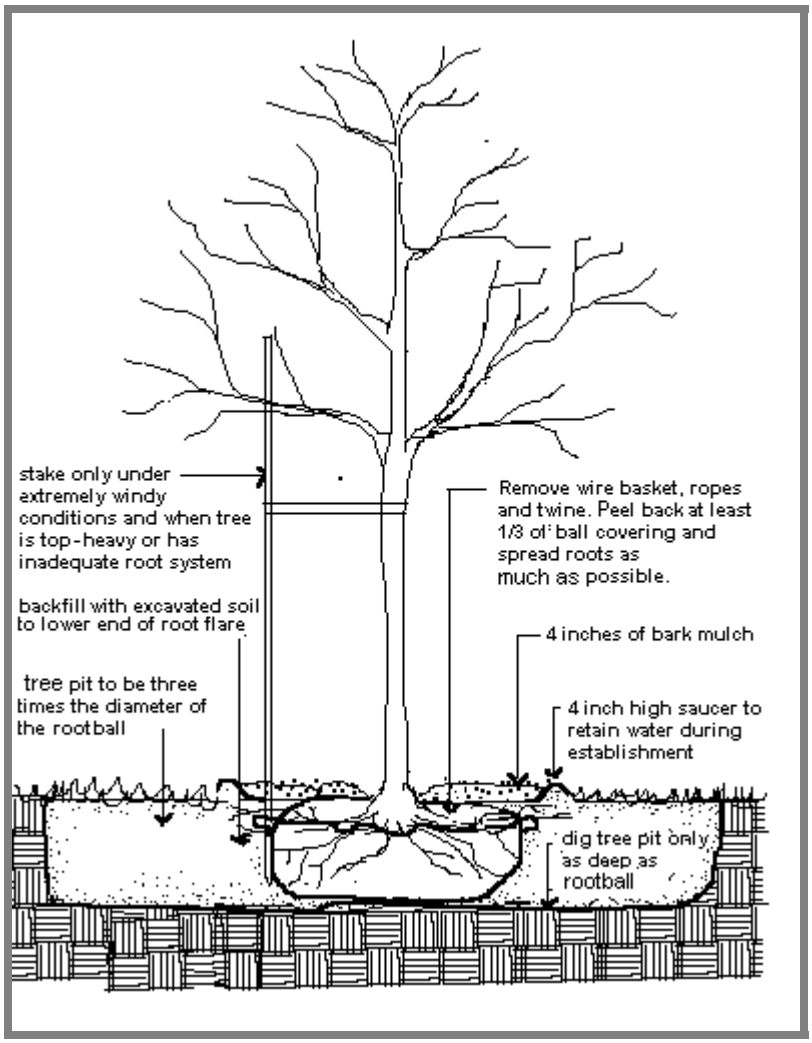
Consider the following:

Rooting Volume and Configuration

- Plants require soil volume based on their ultimate mature size. At planting, soil volume should be provided that is at least three times the width of the rootball and wherever possible should be connected to other areas of soil for future growth. On highway projects, where native soils have been removed, the placement of an adequate volume of good soil in greenbelts and planting beds is especially important.
- Adequate root volume configurations include continuous pits, i.e., between sidewalks and curbs, raised planting areas, island groupings and areas that are connected to existing soil areas using structural soil.
- Avoid deep/narrow and broad/shallow planting area configurations.
- Composition of rooting volume - Test existing and imported soils for fertility, pH level and organic content.
- Mycorrhizal fungi may be added to stimulate root growth of all new plantings.

James Urban Methodology for Planting in Urban Areas

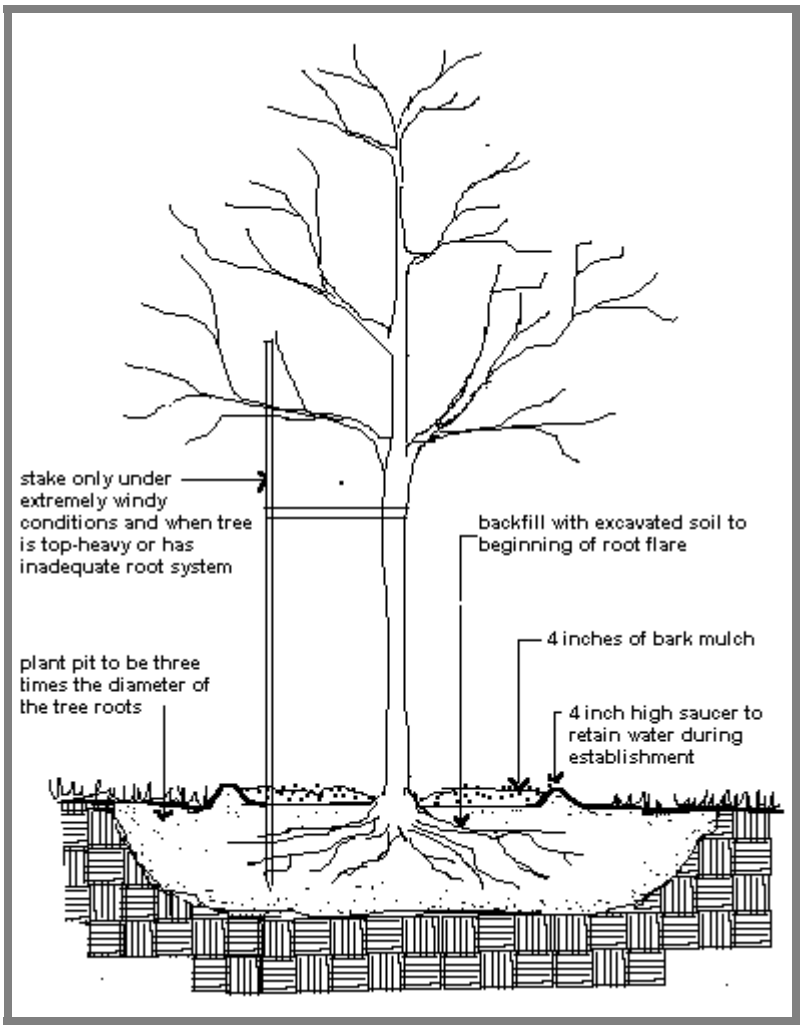
Urban forestry expert James Urban has developed a methodology that sets standards for the design of planting sites and level of site modification necessary to support large trees. The method is based on an assessment of existing site conditions, the mature size of the species to be installed and the amount of soil needed to sustain the tree and its root system. This work is based on extensive research of soil quality and quantity.



Tree Planting Detail - B&B tree in favorable soil conditions

Balled and Burlapped (B&B) Tree Planting

- Plant hole width should be three times the diameter of the rootball or greater where possible.
- Synthetic rootball coverings should not be allowed. The top third of natural fiber coverings should be removed without disturbing the rootball. Wire baskets should be removed or cut after tree is placed in the hole. Cuts should be sufficient to prevent root girdling.
- The tree must be placed upright in the planting hole at the depth that places the beginning of the root flare at, or slightly above, finished grade. Place tree slightly above finished grade especially where soils are wet.
- Partially backfill the hole, then lightly firm or water to settle the soil, then repeat until backfilled to finish grade. Avoid compacting the soil around the plant.



Tree Planting Detail - Bare Root tree in favorable soil conditions

Bare Root Planting

Bare root trees are one-third to one-half as expensive as balled and burlapped (B&B) trees and have more roots than B&B trees. If properly handled and planted they have many advantages. Bare root trees and plants should be considered for transportation projects where the reliability of the installer is certain and the plants come with a guarantee. Some species are not tolerant of bare root transplanting. Bare root planting is more appropriate for an informal planting design where large plants are not needed. If a few plants do not survive, the design will be less compromised than with a formal or symmetrical planting design. Street trees in a downtown setting require the installation larger sizes than those typically installed as bare root plantings. Bare root installation is best done in the dormant period.

The **dormant period** is between late fall when trees have lost their leaves and early spring before budding

Tree Installation

Both B&B and bare root tree installations require the following:

Mulching

The reasons for mulching are water retention, weed control, surface protection, increase in soil fertility, improved soil structure, moderation of soil temperature and protection against mower and trimmer damage. Mulch should be applied at a loose depth of 4 inches. Mulch should be kept away from the stem of the tree. (See detail pages 51 and 52.)

Season and Conditions for Planting

The dormant period (see previous page) is the best time for planting and the only acceptable time for bare root stock. It is feasible to plant B&B and container stock during other seasons as long as plants are watered properly. Evergreen stock is best planted in spring or before Oct. 15 in fall. Do not plant when soil is waterlogged owing to wet weather, when drought conditions prevail, when weather is frosty or when persistent cold or drying winds are likely to occur.

Watering

Watering after planting is very important because of the reduction in root surface area that occurs with transplanting. Irrigate trees, shrubs and ground covers enough to keep the root ball moist, but not wet. The general rule of thumb is to water at least twice a week for eight weeks, then once per week for the remainder of the growing season. This will vary with soil and weather conditions.

Rodent Protection

Use ¼ inch hardware cloth, installed around the trunk of newly planted trees from the below-grade root flare to a height of 12 inches on the tree trunk. The hardware cloth will protect the tree against burrowing rodents that may chew the bark and girdle the tree. Install only if there is a rodent problem and be sure to remove the wire after two growing seasons.

Staking

In general it is best not to stake trees. Trees should be staked only when planted in excessively windy or exposed conditions or when they are top-heavy at the time of planting. All staking should be removed after one year.

Wrapping

Tree wrap hides trunk damage and provides insect nesting sites. In most cases it is not necessary to wrap trees at the time of planting.

Selection

Selection of shrubs and ground covers follows the same rules as tree selection. Roots, soil volume and composition for shrub and ground cover roots vary widely; however, their roots will require soil composition and volumes similar to trees'. Consider the shade tolerance of shrubs that will eventually be under the canopy of trees.

Shrubs used for stabilizing a slope planted in grid pattern.

Shrub Installation

Shrubs and ground covers can be used effectively for roadside and median plantings. Upon completion of site analysis, shrubs and ground covers may chosen that match existing soil, sun and wind conditions. Shrubs are useful for the following:

- Slope stabilization treatments.
- For bio-engineering slopes or shoreline.
- Able to colonize and spread
- Large areas can be planted easily
- Compatible w/ other root zones of plants
- Seasonal interest not found in grasses.
- Tolerance to wear and tear
- Good at edge of sidewalks & in snow
- Short time to maturity, 5 to 10 years.

Spacing and Massing

The general rule for spacing is to plant the same distance apart as the ultimate height of the plant. Plants could be spaced closer if slow-growing or if more immediate effects are desired.

Maintenance

With proper selection, shrubs and ground covers will require little maintenance after one or two years of establishment. During the establishment period they will need watering as trees do. Deciduous flowering shrubs often look better if allowed to grow to their natural form without pruning. Under certain conditions, flowering shrubs may require cutting back to maintain a neat appearance, as is the case for hardy roses planted in an urban median strip. When planted in good soil, shrubs and ground covers will rarely need fertilization after the first year.

Perennial Installation

Perennials are not widely used in roadside plantings; however, they have certain advantages. They come to full size in short periods of time, some are tolerant of salt and roadside abuse and they provide color and interest when many trees and shrubs do not. Since they die back to the ground in winter, they can be installed in areas used for snow storage. The disadvantage of perennial use is that many require intensive maintenance or weeding for the first few years until they are fully established. Generally, native species have a better chance of survival.

Selection of perennials is consistent with tree selection; however, consider also the benefit of seasonal interest and the trade-off of maintenance versus the color and interest that perennials provide in the landscape. Select aggressive varieties where

colonization of large areas is desired, less aggressive varieties where plants must be contained.

Most perennials require continuous soil depth of 12 to 18 inches. It is best to match the plant to existing soil conditions, but where soil must be imported it should be a well-drained loam soil with an organic content between 5 and 20 percent.
Perennials will not do well in heavy clay soils. Although most perennials require a pH of 6.5 to 7.0, native perennials in Vermont tolerate more acid soils. This tolerance helps them out-compete non-native grasses. Native grasses grow with spaces between plants that accommodate perennials. Some experiments using pelletized sulfur instead of lime have proved successful in establishing perennial plantings. The most important nutrient for perennials is phosphorus for strong roots and stems. Fertilizer is not usually required for planting of native perennials but, if necessary, a 20-20-20 fertilizer is best used at planting time.

Special maintenance requirements include weeding during establishment, dead-heading certain varieties, watering during establishment and drought conditions, removing stems and leaves before winter, and mowing. Rural planting locations may require less cleanup of dead stems than urban locations. Certain perennials tolerate and benefit from having their dead stems and leaves remain in winter and into the next growing season. Urban or village locations may have the local resources to provide the maintenance necessary for a wider variety of perennials like those that require dividing, deadheading or cleanup in the fall.

Ornamental Grasses
Ornamental grasses are another low-maintenance selection that has not been widely used in Vermont. Cold hardiness limits the palette, yet there are still many interesting varieties that could be used, including native species, that require little care and mowing.

Topsoil
Topsoil used for lawns and other planting, whether existing on site or imported, should be tested for organic content, pH, nutrient content (nitrogen, phosphorus, potassium) and textural content (sand, silt, clay).
Topsoil has minimum requirements: 5 to 20 percent organic (test), pH 5.5 to 7.5, free of any material greater than 1 inch in any dimension, adequate fertility, sandy loam to loam texture.
Placement Depths or Amounts depending on application:

- tree pits - mix with native soils as specified
- shrub mass planting - mix with native soils as specified
- ground cover and perennial beds - mix with native soils as specified
- seed beds - 4 to 6 inches depending on type of native soil

Structural Soil **(See page 49)**
Structural soil should be used as a planting medium/base material under paved areas adjacent to tree pits or greenbelts when and where there is an insufficient

volume of native or imported soil necessary to maintain the root system of a tree. Structural soil should not be used in tree pits or greenbelts. This is a patented item requiring specific proportions and mixing methods and specifications.

MAINTENANCE

Pruning and Fertilization

Pruning improves the health, structure, aesthetics and safety of plants. It is best to establish a pruning program when plants are young for good structure and appearance well before maturity. Due to lack of staff, most communities do not keep up with pruning schedules. Street trees should be pruned on a five to seven year cycle. Shrub types that require regular pruning should not be selected. Plants will not need fertilization in the first year after planting if proper soil volume and composition are provided. Plants that have been planted in poor soils and newly established plants will need fertilization to aid in maintaining vigor, to promote new growth and to resist problems associated with insects, disease, wounds or the environment. Mycorrhizal fungi in the soil mix may help to stimulate root growth.

Snow Plowing

Snow removal needs to be considered in all landscape planning and design. Coordination with the VTrans District Maintenance staff and the local municipality to address snow storage, removal and plowing issues should be worked out in advance especially when traffic calming techniques are to be employed.

General Maintenance Guidelines

If trees are staked, stakes must be removed after one growing season or sooner if roots are established. Tree wrap, if used, must be removed after one growing season to discourage bark rotting and insect nesting and to keep the wrapping material from restricting trunk growth. (See page 16.)

Watering

Tree survival and growth will depend upon watering during the dry periods of the first two growing seasons (including the fall months). Trees need the equivalent of 1 inch of rain every 7 to 10 days. Watering deep twice a week during dry periods is adequate if the tree is properly mulched. Overwatering or too-frequent watering eliminates air from the soil, causing root injury and eventual death. The soil should not stay saturated, but should have time to dry out between waterings. The landscape industry has recently developed watering bags or pouches (so-called *gaiter bags*) that allow a quick fill-up and slow release of water to enable better absorption by the soil. Maintenance time is reduced by the use of these bags.

Container-grown and B&B trees require special attention with regard to watering. The rootballs of these trees tend to dry out much faster than the surrounding soil. It is crucial to check the rootball to determine when re-watering is needed because the moisture content of the surrounding soil can be misleading.

LAWNS/WILDFLOWER MEADOWS/GRASSES

Perennial and Grass Seeding

Follow guidance found in Federal Highway Authority, FHWA 23 CFR Ch. 1 (4-1-01) Section 771.105 (b) for wildflower seeding: *Federal–aid highway funds may participate in any landscaping project undertaken pursuant to paragraph (a)pursuant that one quarter of one of one per-cent of funds expended for such landscaping project is used for wildflower seeds or seedlings or both.* A wai*ver can be granted if wildflowers can not be grown satisfactorily, there is a shortage of available planting area, if land is used for agricultural purposes*

Seeding types vary. Some types of seeding are: general highway, urban, native grass, wildflower, wetland, temporary (annual grasses).

Topsoil application depends on type of seed and native soil conditions.

Placement of topsoil should occur only after subgrade is prepared. Scarify lawn/meadow area to a depth of 2 inches, remove rocks and objects greater than 1 inch in any dimension.

Seeding times should be to the advantage of the plant type. Usually perennials are planted in spring or fall. Always check with recommendations of supplier.

Preparation of seed bed includes scarifying and raking, either by hand or with a power rake, adding soil, and adding nutrients. The final rake should be parallel to the slope of the land. Preparation of wildflower beds always requires the use of herbicide or other methods of removing competing grasses and seeds.

Sowing methods include hydroseeding, slit seeding, drop or broadcast spreading.

Seed and seed stabilizers include cellulose fiber, hay, straw, jute mesh, netting, excelsior matting, erosion control blankets.

Aftercare includes keeping the seed moist with watering, removing invasive species, deadheading or mowing.

Native Grasses

Native grasses have great versatility and are well adapted to a variety of planting conditions and climates. Native species have been little used for roadway planting and should be further explored. Information is available through the Natural Resource Conservation Service, U.S. Department of Agriculture.

EXISTING TREE PRESERVATION

Selecting Trees to Be Saved

Identify

Determine which trees in the project area are suitable for retention based on the opinion of a qualified person such as a certified arborist, community forester or other tree care specialist. Include key design/ development people in the tree selection process, including town officials and property owners. Determine what impacts from construction will occur and how the tree will respond.

Protected Root Zone (PRZ)

The root zone of a tree is the most vulnerable part of the tree's system. The PRZ is usually considered 3 feet beyond the drip line of the tree; however, each tree site should be evaluated to determine the most likely area of root growth (see pages 46 and 47). If the construction zone falls within the PRZ, change the design, if possible, or remove the tree.

Protecting Trees to Be Saved

Soil Compaction

The effect of even small machinery passing over a tree's root system is to compact and damage soil structure; consequently no machinery should be allowed over the root spread of retained trees. Temporary access routes should be sited outside the PRZ. If this is not possible, access routes should be constructed of timber sleepers or other mechanisms to spread the weight of vehicles.

Other Equipment Damage

Other types of equipment, particularly cranes and the arms of excavation equipment, can cause damage to bark and branches. Branches likely to interfere with the working of such equipment should be tied back or removed at an early stage. No machinery or vehicles should be parked near the PRZ of preserved trees because of the risk of fuel leakage.

Materials Handling, Storage and Fires

No materials should be stored and no liquids spilled over the root spread of trees. Fires are not allowed near the PRZ.

Barriers

Specifications for protective barriers should be clearly defined in the construction drawings and specifications. Install bright orange polypropylene fencing and post "OFF LIMITS" signs at the PRZ of the protected trees. If protected trees are at the edge of the contract limit lines, more sturdy, less movable barriers should be constructed. If barriers are not possible, install a root system bridge to reroute traffic, or spread several inches of wood chips on the soil within the PRZ.

Properly handle and dispose of any materials used during construction that may cause harm to the tree roots. Cleaning tools and remaining equipment should be well out of the PRZ. Avoid changes in pH (alkalinity). Increases in pH are particularly dangerous to many tree species. Alkaline clays or limestones should not be used for fill, and concrete should be mixed outside the PRZ. Mixing trucks should never be rinsed on the site in the vicinity of the PRZ.

Extent of Impact

Grade Changes

Cutting, filling or moving large amounts of soil within the PRZ usually kills a tree. Except where absolutely necessary, avoid disruptions to the natural contour of the site. It may be possible to protect compaction-tolerant trees from additions of 6 inches or less of soil by using a porous fill within the PRZ. Porous fill can be made by mixing one part loam, one part coarse sand, and one part shredded bark. Deeper

fills require more extensive measures. A retaining wall or walls may protect some trees. However, as a general rule of thumb it is best to remove trees that would be buried by 6 or more inches of fill around the base. Careful analysis of the proposed design will be critical to plan for preservation of trees near a grade change.
Damage caused by shallow cuts (less than 2 inches) at least 3 feet away from the base of the tree may be minimal but still can be a shock to a tree's vigor. If possible, avoid making the cut during hot, dry weather; water the tree (undisturbed portions) before and after soil removal; and allow only hand-digging inside the PRZ. A shallow layer of mulch (pine needles, wood chips, or coarsely chopped twigs and bark) and clean root cuts will help wound closure and regrowth. Deeper cuts within the root zone will require construction of a retaining wall no closer than the limit of the PRZ.

Excavation
Tunneling or "jacking" pipes is recommended where underground utility lines must cross the PRZ. When digging a trench near the PRZ, tunnel when roots larger than 1 inch in diameter are encountered.

For all digging operations in or near the PRZs, exposed roots must be cut cleanly to promote quick wound closure and regeneration. Keep plants well watered before digging and cover exposed roots with soil, mulch or damp burlap as soon as possible.

After construction has been completed, have the landscape inspector evaluate the condition of the remaining trees. Look for signs of damage or stress. It may take several years for severe problems to appear. Careful monitoring and preventive treatment (e.g., watering) may help minimize damage.

Changes in Drainage and Water Table
Drainage patterns may change as a result of roadway construction. The water table may be raised or lowered and runoff may be reduced or increased. Infiltration is reduced by impermeable pavements and storm water drainage systems. The effects of changes in drainage patterns on existing mature trees must be evaluated by a tree professional.

CONSTRUCTION PHASE

Inspections
It would be in the best interest of the Agency of Transportation to provide for quality assurance in landscape/planting operations. Inspections should be performed by qualified horticulturists, by landscape architects who are knowledgeable in plants and planting operations or by certified arborists. Inspections should be scheduled throughout the project from pre-construction plant protection to the establishment and guarantee period (two years after planting). The VTrans resident engineer who supervises a construction project should be trained to recognize critical aspects of successful transportation landscaping and work closely with the landscape inspector to ensure that installation, preservation and

maintenance operations are performed correctly. VTrans planting specifications have a schedule for landscape inspections, which can be modified for a given project if necessary.

COSTS

Planting

A typical method of pricing planting installations is multiplying the wholesale price of the tree, shrub or ground cover by three. The result covers material, labor and guarantee. There are exceptions to this method including cases the planting site requires extensive alteration. Consult VTrans Unit Price List for unit costs.

Other Operations

Topsoil Unit cost based on type of soil needed.
Seeding Unit cost based on type of seed and seeding process needed.
Seed Stabilization based on type.
Perennials Unit cost based on type.
Planting Protection Based on protection method and size of existing plant.
Maintenance Include one to two years of aftercare in contracts or inform towns or private owners of the costs beforehand and have them take ownership.
Watering Watering is required for at least two years but is not likely to occur under the VTrans contract. Towns should budget for watering of street trees during this critical period.
Pruning Corrective pruning should start early in the second growing season. A tree should be pruned on a five- to seven-year cycle. Since VTrans does not have funds to perform these operations, towns should budget for pruning for street trees in their town centers.
Fertilization If the proper tree has been selected, fertilization should not be needed. Older trees may need fertilization in a PRZ through the construction period.
Removal of Protection Materials Remove stakes, guys, rodent protection and wrap, if used, as soon as possible after the protection is no longer needed. This operation should be but is not likely to occur under the VTrans contract. Towns should budget for removal of protection materials.

GUARANTEES

Plants should be guaranteed for at least two growing seasons. Plant material problems may not surface until the second or even the third growing season. Bare root tree plantings should be guaranteed for the same period; however, due to higher mortality rates and the ability to plant more for less cost, the guarantee should be based on 80 percent survival. Seeded areas should be guaranteed to be 95 percent free of bare spots after two mowings and 99 percent free after the first growing season. Protected plants should be guaranteed against root damage in the PRZ.

Glossary

AASHTO (American Association of State Highway and Transportation Officials): AASHTO is an organization that produces a guide for road and highway design called *A Policy on Geometric Design of Highways and Streets* used as a basis for highway design in Vermont.

AADT (Average Annualized Daily Traffic): The amount of traffic through a section of road on a daily basis - Monday through Friday, averaged over a year.

VTRANS: Vermont Agency of Transportation.

ARTERIALS: A roadway classification relating to through-traffic facilities.

BALLED AND BURLAPPED (B&B): Nursery stock in which the plant has been undercut to produce a fibrous rootball. Once dug up, the rootball is wrapped with burlap and tied securely with string or placed in a wire basket.

BARE ROOT: Another type of field-dug tree (usually deciduous). Soil is absent from the roots; therefore, root defects are easily detected. These are available only during winter or early spring (dormant) seasons.

BICYCLE LANE: A striped lane for one-way bike travel on a street or highway.

BICYCLE ROUTE: A route, path or segment used for bicycle circulation. It may share use with pedestrian or motor vehicle traffic.

BUFFER STRIP: An area that provides a degree of separation or shielding of highway or transportation facilities from adjacent private property or protected natural resources and vice versa.

CLEAR ZONE: The roadside border area, starting at the edge of the traveled way, that is available for corrective action by drivers who lose control of their vehicle.

COMMUNITY CHARACTER: The attributes or features that make up a community. This may include the style, age and condition of architecture and height maturity of vegetation.

CONTAINER-GROWN: Nursery stock grown in pots or containers throughout their nursery life.

CONTEXT/CONTEXTUAL: The interrelated conditions in which something exists.

CORRIDOR: A strip of land between two termini within which traffic, topography, environment and other characteristics are evaluated for transportation purposes; also a strip of land for transmission of a utility.

COST/BENEFIT ANALYSIS: Comparison of costs associated with specific action and the benefits derived from its action.

CROSS-SECTION: A section perpendicular to the alignment; a highway cross-section would include the traveled way, shoulders, cross slopes, side slopes, medians, and elements such as barriers, guardrails, fences, walls, longitudinal ditches, curbs, gutters, sidewalks, parking, planting strips and lighting.

CROSSWALK: Crossing zone designated for pedestrian traffic across a street or highway.

CROTCH PRUNING: A pruning technique for large trees growing under utility lines that cuts out center branches to form an open “V” through which lines can pass without interference with branching.

DRIP LINE: The vertical line extending from the outermost edge of the tree canopy to the ground. Once thought to be the limit of concern for protecting trees before increased understanding of tree root systems.

EASEMENT (CONSTRUCTION, DRAINAGE, PLANTING, SCENIC, SIGHT LINE, AND SLOPE): A right to use or control a property, or its functions, for designated highway purposes. **Construction Easement -** An easement used to permit the full development of the roadway. **Drainage Easement -** An easement used for directing the flow of water. **Planting Easement** - an easement for reshaping roadside areas and establishing, maintaining and controlling plant growth. **Scenic Easement -** An easement used for conservation and development of roadside views and natural features.

EMBANKMENT: Slope or raised area created with fill material.

ENCROACHMENT: Use of highway right-of-way or easements for signs, fences, billboards, buildings, driveways, utilities or other non-highway activities. Usually allowed by permit only.

ENVIRONMENT: The aggregate of all supporting conditions and influences affecting the life and development of an organism or a group of organisms.

EROSION: The wearing away of a land surface by detachment and transporting of soil and rock particles by the action of water, wind, frost or other agents.

EROSION CONTROL: Includes protection of soil from dislocation by water, wind or other agents. Includes the proper handling of grading and drainage and the utilization of vegetation and/or other materials to absorb the impact of rainfall, slow the velocity of runoff or hold the soil.

FILL/BACKFILL: A medium (e.g., gravel or soil) used to raise ground level.

GATEWAY: An entrance to a town or village.

GREENBELT: A portion of the road or path corridor designated to growing vegetation. Also: a green strip around an object or town.

GROUND COVER: Herbaceous vegetation and relatively low-growing woody plants that form an earth cover.

GROWING SEASON: The time during which a plant is actively producing growth. It is a plant life-cycle period that will vary depending on the climate and environmental conditions. It is utilized for establishing vegetation.

HARDINESS: Refers to the cold-tolerance of a plant within its climatic environment, not its ability to withstand abuse or difficult growing conditions.

HISTORIC OR SPECIAL INTEREST TREE: A tree that has been found by the tree warden or Selectboard to be of notable interest because of its age, type, size or historic association.

HISTORIC SITE: A building, monument, park, cemetery or site having national, regional, state or local significance, the preservation of which should be considered in the location and design of a highway.

HORIZONTAL CURVE: A curve that provides direction changes in the horizontal alignment of a road.

INVASIVE PLANTS: Undesirable vegetation that spreads aggressively.

LANDMARK: A conspicuous object on land that identifies a locality, or a designated preservation site, such as a building, monument or landscape.

LANDSCAPE ARCHITECTURE: The design profession concerned with shaping and enhancing the landscape for human use and enjoyment through functional and attractive arrangement of structures, vehicular and pedestrian ways, landforms and plantings.

LANDSCAPING: The modification of the natural environment. It covers all site work and includes grading, drainage, erosion control, roads, walks, screening, planting and lighting.

MAINTENANCE: In reference to planting includes pruning, mulching, mowing, spraying, fertilizing, propping, bracing, treating for disease or injury, removing snow and any other similar acts that promote the life, growth, health or beauty of the landscape vegetation for the duration of the plants' useful life.

MEDIAN: The portion of a divided highway separating the traveled ways for traffic moving in opposite directions.

MICROENVIRONMENT (OR MICROCLIMATE): May be the sum total of the conditions and influences within a small area; may be altered by design elements.

MULCH: A top dressing of organic material on the soil around a plant to reduce weed growth and conserve moisture (may also be applied for aesthetic reasons).

SHARED-USE PATH: A path, usually paved, striped and separated from the highway, designed specifically for the use of bicycles and other non-motorized vehicles.

NATIVE PLANTS (SEE INDIGENOUS): An original species in a region, as distinguished from an invading, imported or cultured species. "A native plant that occurs naturally in an area without direct or indirect human actions" FHWA, *Exec. Memorandum on Landscaping* 1994.

NATURAL AREAS: Areas containing natural objects and features in an undisturbed condition.

NHS: National Highway System.

ORNAMENTALS: Plants grown for their aesthetic value rather than commercial usefulness or food value.

PARK-AND-RIDE LOTS: Parking lots or portions thereof specifically designed and used as transfer areas for commuters to park their personal vehicles and utilize other modes of transportation into the urban center such as buses, subways, pool vans, other high-occupancy automobiles, etc.

PARKWAY: An arterial highway for noncommercial traffic, with full or partial control of access, usually located within a park or a long, narrow area of park-like character.

pH: A measure of the hydrogen ion concentration in the soil; denotes a range from acidity to alkalinity.

PLANNER: A person trained in comprehending and arranging the elements of a design or objective into an orderly and cohesive product or action.

PLANT COMMUNITY: A group of plants with similar environmental requirements growing in a particular area.

PLANT ESTABLISHMENT: The agronomic and horticultural practices within an acceptable and specified period of time following plant installation, necessary to enable plants to adjust to their new environment.

PLANT NUTRIENT: Any organic or inorganic material needed for plant growth.

PLANT REGENERATION: The development of volunteer vegetation from seed or by other natural reproductive process from plants existing nearby.

PLANT SUCCESSION: The natural evolutionary process of successive plant communities, starting with tolerant species on raw soils and culminating with plants that can only succeed themselves as dominants.

PLANTING: A group of plants or trees. The movement and establishment of a plant in a new location.

PLANTING BED, PLANTING SPACE: A place where the soil and other elements required for the health of plants has been prepared.

PLANTING EASEMENT (SEE EASEMENT)

PLANTING SEASON: The period of the year within a climatic region when planting and/or transplanting is considered advisable from the standpoint of successful establishment and good horticultural practices.

PLANTING STRIP: A long thin area prepared for vegetation.

PROJECT DEVELOPMENT: The evolution of specific information about details of a project.

PROTECTED ROOT ZONE (PRZ): An area around a tree in which no construction activity shall occur. The type and location of the tree determines the protected root zone and should be determined by a professional with knowledge of trees. Where there is a group of trees or woodlands, the tree protection zone is the combination of the PRZ for the individual trees.

PRUNING: Removing dead or living parts of a plant to improve growth, condition, or appearance.

RIGHT-OF-WAY: A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to transportation or utility purposes.

RIP RAP: A foundation or wall of broken stones placed together for erosion control.

ROAD ALIGNMENT: The vertical and horizontal placement of a road.

ROADSIDE: A portion of the right-of-way adjacent to the roadway or paved shoulder and extending to the highway right-of-way line and non-paved medians on multi-lane highways.

ROOTING VOLUME: The volume of soil required for the best growth and health of a plant.

ROUNDABOUT (MODERN ROUNDABOUT): A road pattern for slow speed integration and dispersal of traffic at an intersection.

RURAL: Relating to open country, agriculture, forests and a minimum of residential or other development; as differentiated from urban, village or town.

SCALE: The size of one object relative to another. The ratio of the representation on a map to the actual distance. As in 1" = 10'.

SCENIC CORRIDOR: An area of land for restoring, preserving, and enhancing the scenic beauty adjacent to a highway. It may contain a significant feature, provide an opportunity for an unobstructed view of a feature or provide insulation from an adverse use.

SCHEMATIC PLANS: A sketch or diagram used in developing a plan.

SCOPING: The process of determining the impact of building a transportation project on its surroundings. Part of the VTrans Project Development process.

SCREEN, SCREENING: The use of trees, shrubs, berms, fences, or other materials to obscure an objectionable view or action or to reduce an objectionable sound.

SHADE TREE: A tree grown primarily to produce shade or shelter from the sun.

SHOULDER: A portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

SHRUB: A woody, multi-stemmed plant usually less than 15 feet in height.

SIGHT DISTANCE (SIGHT LINES): The visual distance required for a motorist to safely operate his or her vehicle as required by the highway design.

SPECIES: A taxonomic subgroup of animal and plant genera that are uniformly distinctive from other groups of individuals under natural conditions.

STREET TREES: Trees grown primarily for use along roads and streets. Usually limbed up to 8 feet.

STREETSCAPE: The visual effects produced by all the elements within a linear corridor in the built environment, seen either from a stationary point or while moving. The total visual community of structures (buildings, walls, bridges), trees, open spaces, pavement and ground surfaces, lights and lighting effects, signs and signals, storefronts and windows, vehicle parking lots, and other highway appurtenances.

STREETSCAPE DESIGN: Planning for the visual effects produced by all the elements within a linear corridor in the built environment, seen either from a stationary point or while moving.

STRUCTURAL SOIL: A material that provides a load-bearing pavement base material and also provides a rooting medium for street trees.

TOPSOIL: The upper layer of soil, containing organic matter and suited for plant survival and growth.

TRAFFIC CALMING: A strategy to reduce the speed of traffic by using a device or combination of devices.

TRAFFIC LANE: The portion of the traveled way for the movement of a single lane of vehicles.

TRAVELED WAY: The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

TREE: Perennial woody vegetation usually with a single stem that has few or no branches on the lower stem.

TREE CANOPY: The spreading branching portion of a tree.

TREE GRATES: Metal or composite grates used to protect the base of the street tree from compaction and reduce weeding and other maintenance requirements. It is not always great for a tree to be grated. It is possible to increase the size of the grate opening around the tree trunk, but in practice this task is rarely done and the tree is eventually girdled.

TREE REMOVAL: The cutting or removing of 50 percent or more of the crown, trunk or root system of a tree, or causing the death of a tree through damaging, poisoning or other direct or indirect action.

URBAN: Relating to a city, town, community or other highly developed, heavily populated concentration of residences, commerce and industry.

UTILITY: A specific needed service such as the provision of water, power or light, and the equipment and material required for this service.

VERMONT STATE STANDARDS: *Vermont State Standards for the Design of Transportation Construction, Reconstruction and Rehabilitation on Freeways, Roads and Streets.*

VISTA: A view, usually distant, seen either from a moving vehicle or from a stationary location or vantage point.

VISUAL ELEMENT: An individual feature within a visual unit.

VISUAL IMPACT: The degree of change or influence an action or modification has on a view, scenic resources(s) or designed features. The result may be negative or positive.

VISUAL QUALITY: An attribute or characteristic of a subject as perceived by sight.

VISUAL SENSITIVITY: The degree of human reaction to and values regarding visual elements.

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