PART IV. SELECTING THE RIGHT PLANTS

> ***" Vegetative material used in reclamation shall consist of grasses, legumes, herbaceous or woody plants, shrubs, trees or a mixture thereof which is consistent with site capabilities such as drainage, pH, soil depth, available nutrients, soil composition and climate. Such vegetation should be designed to provide a cover consistent with the stated land-use objective and which does not constitute a health hazard."***
>
> --- 6NYCRR Part 422.3(d)(2)(vi)(b)

The purpose of revegetation as required by the New York State Mined Land Reclamation Law (MLRL) is to: 1) return the land affected by mining to a condition and productive use as similar as practical to its pre-mining condition and use, or 2) create a site-specific desired plant community as described in the approved reclamation plan. This chapter is intended to provide a basic understanding of important ecological considerations of plant species selection for revegetating mined land and point out additional information resources.

1.0 Types of Plants Used in Mine Reclamation

The most common problems associated with revegetation failure are :1) improper selection of plant species, and 2) improper species mixtures. Most of the time, the selected species are either not adapted to the site conditions or to the proposed land uses.

Land-use objectives and soil properties are the two most important factors influencing species selection. However, climate, topography, plant growth requirements and plant traits are also very important factors to consider in selecting plants suited to a particular reclamation project. Each species has its own unique capabilities such as erosion control, forage value or aesthetic beauty.

Whatever your specific situation, decide what types of plants are desired for the projected land use and determine which species will grow best given the site-specific factors.

Favor Native Plants
Avoid Invasive Species

The Mined Land Reclamation Program strongly recommends selecting Native Plant Species and avoiding Invasive Plants. See Sections 2.6 and 2.7 in this chapter and the related information in Appendices II-V.

The extra research effort devoted to matching plants to the site will result in improved disease and pest resistance and improved plant survival rates.

Four general types of plants are commonly used for revegetation of mined areas: grasses, forbs, legumes and woody plants (trees and shrubs):

1.1 Grasses

Grasses are the most common seeded plants used in revegetation programs. They produce large amounts of biomass and are adapted to a variety of environmental and soil conditions. The wide range of available species, in addition to the relative ease of establishment and subsequent management, make grasses an ideal foundation for revegetation and reclamation planting. Grasses have fibrous root systems and provide a relatively dense cover which is important for successful erosion control. For these reasons, a good revegetation program often contains grasses as a major component of the seed mix. Section 3.0 (page 37) in this chapter provides more information on selecting the correct type of grass (cool versus warm season) for a particular site and Appendix II (page 61) gives more details on individual grass species. Part V (page 43) covers general seeding techniques and helpful tips for planting warm season versus cool season grasses.

1.2 Forbs

Forbs are herbaceous plants other than grasses, sedges, rushes and other similar species. Forbs include a broad range of annual and perennial flowering and nonflowering plants, but the term is commonly used as meaning wildflowers. Forbs are easily established from seed and most tolerate a wide range of soil drainage conditions as well as infertile planting sites. Small amounts of selected forb seeds are usually added to a seeding mixture as a companion crop. This practice helps prevent erosion during the critical time period when a new seeding is vulnerable.

The Appendices do not include details on recommended Forbs species, though the information may appear in future versions of this manual. However, Table 4 on the next page lists some of the forbs commonly mixed with grasses to reclaim mined land. These forbs provide valuable cover and food sources for birds and other forms of wildlife. Appendix V (page 85) lists several forbs that should not be planted on reclaimed land because they are invasive species (example - purple loosestrife).

1.3 Legumes

Legumes are forbs that are capable of using nitrogen (N) from the air to meet their N nutrition requirements. Legumes are especially important for revegetating mined lands because they can transfer this "fixed" N to other components of the plant/soil system. A healthy population of legumes is essential to successful revegetation, especially on sites where topsoil replacement is insufficient.

Section 3.2 (page 38) of this chapter contains useful information on recommended mixtures of legumes and grasses. Appendix IIC (page 68) has more details on growth requirements and the advantages and disadvantages of individual legume species.

Table 4 - Forbs* Species Used in Mined Land Reclamation

Species Common Name	Scientific Name	Planting Date	Site Drainage Condition	Pure Live Seed Lbs/Acre
New York Aster	*Aster novii -belgii*	May - Sept.	Moderate-poorly	0.1-0.2
New England Aster	*Aster novae-angliae*	May - Sept.	Moderate-poorly	0.1-0.2
Black eyed Susan	*Udbeckia hirta*	May - Sept.	Well drained	0.1-0.2
Ox-eye Daisy	*Chrysanthemum leucanthemum*	May - Sept.	Well drained	0.1-0.2
Wild Bergamot**	*Monarda fistulosa*	May - Sept.	Well drained	0.1-0.2
Chicory	*Cichorium intybus*	May - Sept.	Well-moderate	0.1-0.2
Yarrow	*Achillea millefolium*	May - Sept.	Well-moderate	0.1-0.2
New York Ironweed	*Vernonia noveboracensis*	May - Sept.	Well-moderate	0.1-0.2
Common St Johnswort	*Hypericum perforatum*	May - Sept.	Well-moderate	0.1-0.2
Roundhead Lespedeza	*Lespedeza capitata*	May - Sept.	Well-moderate	0.1-0.2
Canadia Goldenrod	*Solidago altissima*	May - Sept.	Well-moderate	0.1-0.2
Butterfly Milkweed	*Asclepias tuberosa*	May - Sept.	Well-moderate	0.1-0.2
Blue False Indigo	*Baptisia australis*	May - Sept.	Well drained	0.1-0.2
Wild Indigo	*Baptisia tinctoria*	May - Sept.	Well drained	0.1-0.2
Leadplant	*Amorpha canescens*	May - Sept.	Well drained	0.1-0.2

*This table does not include legumes which are technically a subcategory of forbs.
** Alkaline soil only

1.4 Trees and Shrubs

Trees and shrubs are woody plants that can be used when forested or wildlife habitat land uses are desired after mining. Their height can help articulate space and provide visual screening. They can also provide aesthetic value for other final land uses such as recreation areas, residential development, etc.

Trees and shrubs provide food, cover, and nesting places for wildlife. They also protect the soil surface against wind and water erosion. Tree and shrub plantings will complement any grass-legume seed mixture, but should be planted after the grasses have been established. Tree and shrub selections should be based on their suitability for the site's plant hardiness zone and reconstructed topsoil conditions, particularly the soil's drainage or water holding capacity.

Appendices III-IV, starting on page 71, list some of the shrub and tree species commonly used in mined land reclamation along with information on their individual characteristics and requirements. Note, however, that 8 of "The Top 20 Invasive Plants in New York State" covered in Appendix V (page 85) are trees and shrubs that should be avoided under most circumstances.

2.0 Factors in Selecting Plants/ Overview

The most critical element in a revegetation project is the selection of appropriate plant species. If the plants are not adapted to the site conditions, the revegetation effort will undoubtedly fail. A variety of factors must be considered in selecting individual plants or species mixtures, including the:

- Mined land-use objective,
- Site-specific conditions (soil, climate, etc), and
- Plant growth requirements and plant traits.

The selection of adaptable species that will provide the desired short-term and long-term results requires careful consideration and analysis of these factors. When revegetation takes place on a mine site that is regulated under the MLRL, the requirement to complete successful reclamation within a 2-year period must also be considered.

2.1 Land-Use Factors

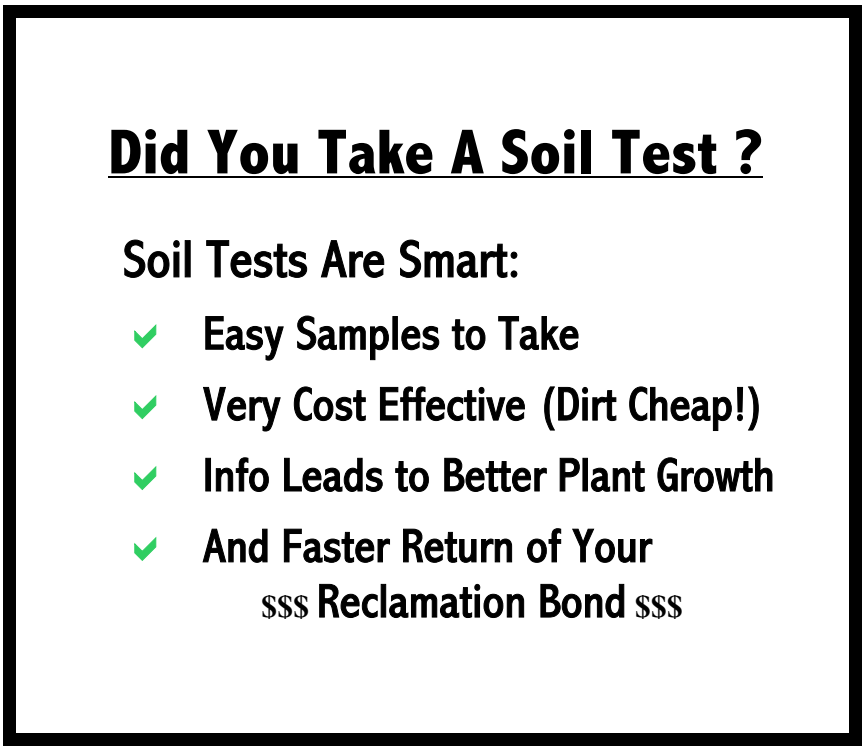
Mined land-use objectives have a significant influence on species selection. Final uses of mined land can vary considerably depending on location, size and depth of the site, surrounding land uses and local zoning. The species planted to revegetate a site should be capable of accommodating the final goal. Typical uses include forestry, grazing, crops, wildlife habitat and recreation. Each of these uses would most likely require different plant selections. For example, if wildlife habitat is the primary land-use objective, plant species should be selected that will provide a variety of cover and food sources. On the other hand, if grazing is the primary objective, total biomass production and plant nutritional values are important.

2.2 Soil-Related Factors

Information concerning soil conditions at the site must be considered when selecting plant species for revegetation. Baseline data on soil that was obtained before mining operations started can be very valuable at the reclamation stage. However, chemical and physical soil properties, such as pH, texture, depth, organic matter, and soil nutrients, are often adversely affected by mining operations. Therefore, it is important to select plant species that are suited to the soil's real post-mining conditions (taking into account any planned soil treatments).

Soil Testing - Soil tests can be done using kits of varying degrees of sophistication or by hiring consultants. However, Local County Cooperative Extension Offices provide a popular service by coordinating the soil testing services offered by Cornell University. Just follow the simple instructions for collecting the soil sample and take it to your Local Cooperative Extension Offices or mail it to Cornell University, Cornell Nutrient Analysis Laboratories, Department of Crop and Soil Sciences, 804 Bradfield Hall, Cornell University, Ithaca, NY 14853, phone (607) 255-4540.

Their nutrient analysis tests cost less than $20 and show the soil's pH and the levels of calcium, potassium, phosphorous, magnesium, nitrate (nitrogen), organic matter, zinc, iron, aluminum and manganese. The Lab also provides fertilizer recommendations based on the type of plants to be grown.



Major Soil Properties to Consider - In various places this manual gives information on important soil properties that should be considered for individual plants. Tables 4 and 8 in this chapter contain information on the soil drainage needs of forbs, grasses and legumes. Appendices II-IV contain information on the required soil texture, soil pH and soil fertility. In the case of trees and shrubs in Appendix III-IV, a minimum root depth is listed which is related to the extent of the soil and subsoil layers.

Soil Texture/ Grasses and Legumes - Soil texture refers to the relative proportions of soil particles of different sizes that are present in a soil sample. Soil texture varies from site to site, dependent in large part on the parent material that the soil developed on. Soil texture is a very important factor in plant selection. For reclamation, it comes up most often in deciding between cool and warm season grasses.

Determining soil particle size through a standard sieve analysis is a critical step before making reclamation decisions, particularly for deciding between warm and cool season grass species. Mine operators can hire a consultant, use the Cornell University tests or try it themselves. This inexpensive

test gives the percentage by weight of the fine soil particles that pass through a #200 mesh sieve. Table 6 shows the system that engineers, geologists, soil scientists and land reclamationists in the United States use to determine soil particle size.

Table 6 - Sieve Sizes Used For Detailed Soil Particle Analysis

Particle Grade	U. S. Standard Sieves	Mesh Opening (mm)
Boulder	12 inches	305 mm
Cobble	3 inches	75 mm
Gravel	No. 4	4.75 mm
Sand Coarse	No. 10	2.00 mm
Sand Medium	No. 40	0.425 mm
Sand Fine	No. 60	0.254 mm
Sand Very Fine	No. 140	0.100 mm
Silt	No. 200	0.074 mm
Clay		0.002 mm

Dietrich, R. V., J. T. Dutro Jr., R. M. Foose, June 1982, "Grain Size Scale Used by Engineers." American Geologic Inst. Data Sheets, Second Edition, Falls Church,VA.

Soil Texture/ Trees and Shrubs - Appendices III-IV in this manual, starting on page 71, list soil texture requirements for trees and shrubs as either fine, medium or coarse. While these are rough categories, in general:

- Fine textured soil would be any soils containing clay or a significant proportion of clay
- Medium soil texture would be considered silts up through very fine sandy loams, and
- Coarse textured soil would be considered sand, loamy sands and sandy loams (except very fine sandy loams).

Soil Fertility - Soil fertility is a simple phrase representing a very complex topic. A full assessment of fertility could easily require checking 10 different soil parameters that reflect both the level of essential nutrients in the soil and the availability of those nutrients to plants. As a simplified example, a soil may contain plenty of an essential element, but it may be relatively unavailable to a plant because the pH is wrong, the cation-exchange capacity is low, the element is tied up in organic or inorganic complexes, or a number of other reasons.

However, many references used to guide plant selection simply list plant fertility requirements as "low", "medium" or "high". With the assumption that experts will be consulted as needed, the following tips are meant to help a mine operator get an initial idea of a soil's general fertility range. When this matter is settled, the mine operator can then either select plants tailored to the soil's existing traits, or consider soil amendments (see Section 5.0, page 18) to suit a desired plant species.

How Fertile is My Soil ?

- **Tip #1/Mine Type** - Sand and gravel mines are the most common type of mine in New York. Native topsoil stripped from land that was mined for sand and gravel usually (though not always) has low fertility.

- **Tip #2 /Organic Matter Levels** - The level of organic matter in soil has a direct relationship to the soil's fertility. Most soils overlying well-drained gravelly outwash deposits, such as found in sand and gravel mines, are typically low in organic matter. A Cornell nutrient soil analysis will give the percent of organic matter. Organic matter typically ranges from <0.5% to 10% with 2% or less generally considered "low".[4]

- **Tip #3/ Drainage, Organic Matter and Nutrient Relationships** - Most soils overlying gravelly outwash deposits, such as found in sand and gravel mines, tend to be well to excessively well-drained. This also means they tend to lack good nutrient retention properties. Conversely, poorly-drained soils are more likely to have favorable levels of organic matter. However, the hydric conditions will limit the soil's suitability for many plants.

- **Tip #4 Major Nutrients** - It can be helpful to look at the level of four major nutrients in the test: calcium, magnesium, potassium, phosphorous. Using the rankings in Cornell's nutrient lab analysis as an example, if any of these components are ranked "low" or "very low", it is safe to assume the soil is low in fertility.

  Nitrogen is another very important plant nutrient and it is well known that a shortage of nitrogen hurts plant growth. However, excess nitrogen can lead to both vegetation and water quality problems. To further complicate the topic, nitrogen may be present in soil in several different forms, but not all of them are available to plants. Assessing the relationship between measured nitrogen levels and soil fertility is a job for experts. Experts should also be consulted regarding the level of nitrogen fertilizer or nitrogen-containing soil amendments that can be added to a site.

- **Tip #5/ Soil pH** - Soil pH is a measure of how basic or acidic the soil is. When the pH falls below 5.5 most major plant-nutrient minerals become insoluble and hence unavailable to plants. But in turn cationic nutrients become more soluble, more available and may even become toxic. The pH range also affects helpful soil bacteria and fungi, as well as diseases. For these complex reasons it generally takes a professional to assess the impact of pH on soil fertility.

Experts can help you select the right types and quantities of soil

[4] Ketterings, Quirine M., Cornell University, Department of Crop and Soil Sciences, Nutrient Management in Agricultural Systems, personal communication October 3, 2004

2.3 Climate and Topographic Factors

The climate at the mine site as well as the geographic location, elevation, topography, drainage patterns and aspect (north-facing vs. south facing) all influence plant growth and reclamation success. Also it is important to remember that some of these site features, such as drainage patterns and microclimates, can be altered during the mining process and must be reassessed at the end of operations.

Coldest Winter Temperatures - Figure 2 shows minimum winter temperatures that can be expected in different areas of New York State and is based on the USDA Plant Hardiness Zone Map. While knowing the lowest expected temperature is essential to selecting the correct plant, remember that plants will be less likely to meet their advertized hardiness rating if they are stressed by other site conditions beyond their normal tolerance range, or have been damaged by animals or disease.

Average Summer Temperatures - Heat, like cold, can limit successful growth of certain plants. While less overall research has been done in this area, the impacts of temperature on growth of warm versus cool season grasses have been well documented. Figure 3 shows the average summer temperatures that can be expected in different areas of New York State based on 30 years of records for the months of June to September (US Dept of Commerce records).

Figure 2

New York State
Winter Temperature Zones

December to March

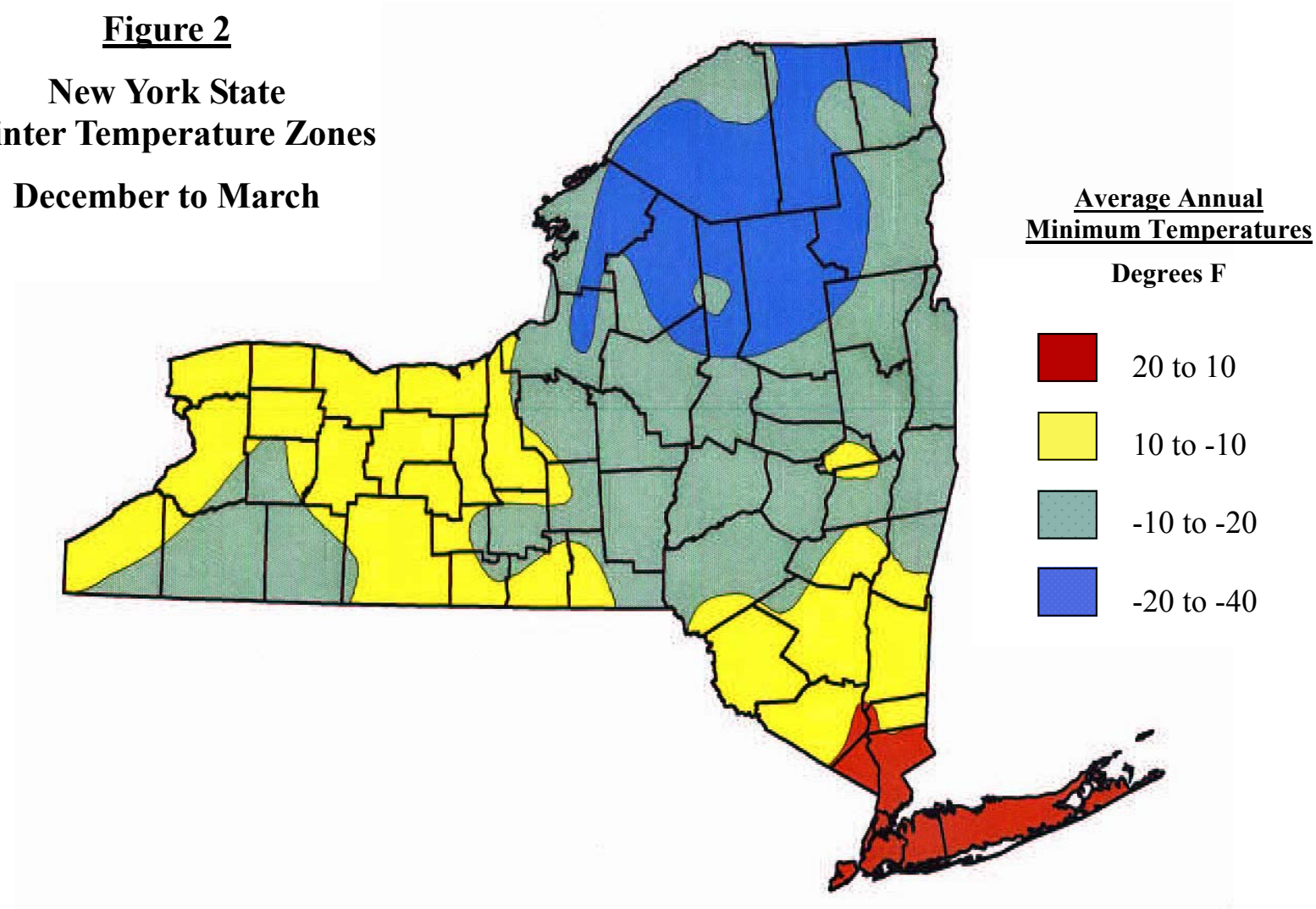
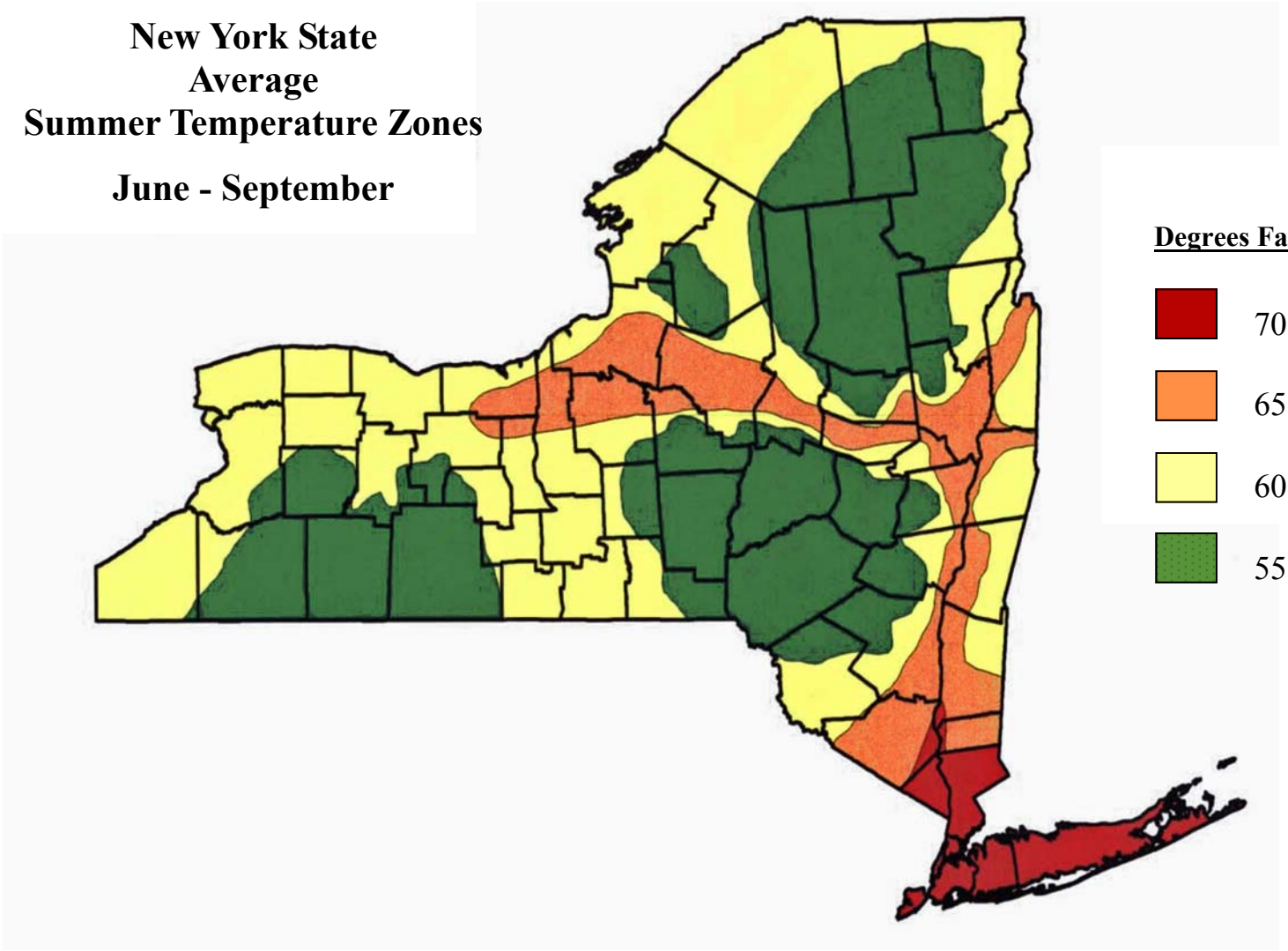


Figure 3

New York State
Average
Summer Temperature Zones

June - September



Growing Degree and Frost-Free Days - The average number of frost-free days in New York ranges from 165 in mountainous regions to 195 on Long Island. In general, New York has sufficient frost free days to grow all the species recommended in this manual provided they are planted at the proper time.

Growing degree days (GDD) vary from plant to plant depending on their minimum base temperature (temperature below which growth either slows or stops). Agricultural Agents in most Cornell Cooperative Extension Offices maintain GDD records and can provide help in determining the length of the growing season for a particular plant in their county. See Part V (page 43) for information on the GDD and frost-free day requirements of grasses and when they should be planted.

Site-Specific Factors and Microclimates - When assessing a mine site, remember to pay attention to how site-specific topography creates microclimates. For example, a site in a cooler temperature zone may be able to support plants suited to somewhat warmer zones on a southern facing slope. Conversely, northern facing slopes are likely to have cooler temperatures than surrounding areas. Open areas of the mine site exposed to steady wind are likely to have different frost conditions and season lengths compared to sheltered areas. The nearby presence of a body of water can also be a significant factor in the local climate. Consult with local experts, particularly when dealing with plants near the limit of their range.

2.4 Plant Traits and Growth Requirements

Growth Requirements - Most people who deal with plants are aware that different species have differing needs for light, moisture and nutrients and varying abilities to tolerate shade, drought, wet-soil conditions, salt and other limiting environmental factors. Information on some of these plant limitations is provided in the appendices. For additional information consult with local experts such as your Regional Mined Land Reclamation Specialist or Cornell Cooperative Extension Agent. Both your nursery supplier and the USDA Plants Database can also be helpful.

Other Plant Traits - While the environmental factors listed in the paragraph above will heavily influence how well a plant grows, the plant's own intrinsic traits must also be taken into account when selecting species for a site, such as:

- Seed germination rates,
- Ease of transplanting,
- Growth rates,
- Permanence (annual versus perennial),
- Tendency to spread by seed or root, and
- Susceptibility to pests and disease.

For example, on a mine site where rapid erosion control is needed to protect waterbodies and wetlands, a plant's seed germination rate, transplant success rate and/or speed of growth could all be critical factors. The relative growth rates of different plants may also be an issue in some species mixes. For example, a tree's shade intolerance might be a concern if it is paired with other faster growing herbaceous or woody plants. This may indicate a need to "weed" around the trees in the first few years, or to consider another more shade-tolerant tree.

2.5 Single Plants vs. Plant Mixtures

Selecting a mixture of plant species for a reclamation project increases the ecological diversity of the site's vegetative cover and more naturally mimics natural conditions. The species planted should be selected to minimize possible competition for sunlight, nutrients, water, and root space. Using a diverse mixture of plants also reduces the chances of reclamation failure from disease, insect and animal pests and environmental stress (e.g. unusually hot, cold, dry or wet years). While planting a wider range of species is usually desirable (except in crop situations), as noted in the paragraph directly above, some plants may compete with each other for necessary resources. Information on some of the more common grass and legume mixtures is provided in Tables 7 and 8. Appendices III-IV contain some general wildlife browse palatability information for trees and shrubs which may indicate the potential for wildlife damage to reclamation plantings. To fine-tune species mixtures for a particular site, consult with local experts such as your Regional Mined Land Reclamation Specialist or Cornell Cooperative Extension Agent.

2.6 Beware of Invasive Species

Invasive plants are plants that have been introduced into a new area in which they did not evolve and thus usually have no natural enemies or competition to limit their spread. Fast growth characteristics and high reproductive rates allow them to "invade" new areas where they aren't wanted and wipe out native species and the associated natural habitat.

See Appendix V
on the
Top 20 Species of Invasive Plants in NY State.

Be alert to other terms that may indicate that the plant you are considering is an invasive plant such as: "non-native", "exotic", "alien", "weed", "non-indigenous", "harmful species" and other names. Plants that fall in these categories are not always invasive, but they could be. For example, a rare "exotic" equatorial plant that escaped a greenhouse during a warm summer rainy period is unlikely to survive long enough in New York to become an invasive plant. On the other hand, another "exotic" plant that can tolerate NY conditions could outcompete all other plants and create a monoculture.

Some states have laws that prohibit planting certain species that have proved to be a problem in their area. In New York many species have been identified in recent years as being problem invasive plants. Appendix V (page 85) lists the top 20 invasive plants in New York State. Some of these invasive plants have been used or may be used for revegetating mined land. Although this list does not have legal status, mining operators should avoid the use of such species in their revegetation project without first contacting the Regional Mined Land Reclamation Specialist.

2.7 Favor Native Over Non-Native Species

Native plant species are those that have adapted to the environmental and geographic characteristics of a particular region over a long period of time. As a group they have become recognized for their intrinsic value as part of ecosystems in a region (e.g. natural forest, field, and wetland) and there is great concern over their potential loss and the subsequent impacts on related parts of the environment.

Native Plants

The NY State Mined Land program encourages the use of native plants to revegetate mines except when introduced species are necessary to meet the end land use specified in the approved reclamation plan.

Non-native species, on the other hand, have been widely used in seed mixes for revegetation because of their rapid establishment and aggressive growth characteristics. Non-native species often provide a quick, temporary, and stabilizing cover that helps control erosion. However, they have the potential to alter natural communities when they invade non-disturbed areas. The loss of native plant species may negatively impact the way an ecosystem functions.

In general the overall benefits from favoring native species include: increased biodiversity, excellent long-term stability, and eventual savings in time and money. Native species are better adapted physiologically to local conditions and therefore require little maintenance. Initial growth of some native species may be slower, but once established, they tend to have better long-term survival than non-native species.

Appendices II-IV contain information in the upper righthand corner of each entry indicating whether the specific plant is a native or introduced species according to the New York State Museum's Revised Checklist of New York State Plants.

However, the matter of what qualifies as a native plant is not cut and dried. The easiest approach is to pick a point in time and say "plants in this place before this date are native"; the start of European settlement is often the date selected. Boundaries are problematic also. To say a plant is "native to North America" or native to "New York State" might be interpreted to mean it is suitable for growing throughout North America or New York, when in fact it may only occur naturally in limited microclimates and be suitable only for limited situations. Geographic variations in plants native over a wide area can also be an issue (See Cornell website on native plants listed in Appendix VI (page 90).

While the Mined Land Program encourages the use of native plants, we recognize that the status of a plant as either "Native" or "Introduced" is only an initial indicator of its suitability for a particular reclamation project and individual situations must be carefully assessed.

There can be problems finding a source for desired native species, and sometimes seeds must be gathered in the wild or from the topsoil stockpile. However, as use of native plants in reclamation continues to increase, the problem should improve.

Why Do I Have to Plant Anything ?

Can't Nature Just Take Care of It ?

Natural revegetation is a passive process where surrounding vegetation serves as a seed source for adjacent disturbed areas. It is not an allowable option for reclaiming mined land in New York State.

At mine sites the conditions are often drastically different than in the surrounding area. This means while a desirable assortment of seeds might reach the mine site, only those able to tolerate harsh conditions survive. The end-result is likely to be weeds and other undesirable species, instead of plants best tailored to the final land use.

Failure to plant vegetation, as required by law, also increases the odds of erosion and other undesirable environmental impacts and can lead to loss of the reclamation bond.

3.0 Selecting the Correct Grasses and Legumes

Grasses are the most commonly used seeded plants in mine revegetation programs due to their adaptability to a wide range of conditions and their relative ease of establishment compared to other plant forms (e.g. shrubs, trees, etc). The grasses are often mixed with a smaller quantity of legume seed. See Sections 1.1 and 1.3 for further background on the general traits of grasses and legumes that make them such an essential part of land reclamation. Details on the traits of individual grass and legume species are provided in the tables on pages 39-42 in this section and in Appendix II (page 61).

3.1 Deciding Between Cool vs. Warm Season Grasses

Grasses are divided into two main categories based on how temperature regulates their growth patterns. Cool season grasses begin their growth in late winter and early spring and bloom in the early summer. They may enter dormancy during summer heat and resume growth or even bloom again in the fall if adequate moisture is available. Established warm season grasses start growing in late spring, usually in late May to early June, and grow the most during the warmest part of the summer. They usually enter dormancy with the onset of winter.

Major Factors in Grass Selection - In deciding between warm and cool season grasses for a reclamation project, the most important selection factors to consider are:

- Temperature - Geographic zones that tend to have higher average temperatures (65 - 75° F) are generally better for warm season grasses than colder zones (See Figure 3 map on page 32). Warm season grasses should not be precluded from use in cooler zones, but the site must be looked at closely to evaluate how well its specific characteristics will support warm season grasses and lead to successful reclamation. For example, a site that is located in a cooler zone, but has southern exposure, is not shaded by an adjacent forest, and has a soil type with less than 20 percent fines, may be suitable for warm season grasses.

- Soil Texture - When a reconstructed topsoil profile displays less than 20 percent fines passing a #200 mesh sieve, planting a warm season species is most desirable. If the percent fines of a topsoil sample are 20 percent and above, seeding with cool season grass species is more advisable.

Additional Factors in Grass Selection - Cool and warm season grasses also differ in several other important respects that should be considered when selecting plants for reclamation:

- Agriculture and Wildlife - Warm season grasses provide forage for animals throughout the summer months when cool season grasses become less productive. Well-established warm season grasses also offer superb wildlife habitat throughout the year. However, because of the relative expense and difficulty in establishing warm season grasses and their lower net nutritional value, they are not as well suited for crop rotation compared to cool season grasses. Warm season grasses are best suited to permanent sod pastures or hay fields.

- Development Rate - Stands of warm season grasses are generally much slower to develop than cool season stands because they establish their root system first while cool season grasses favor development of their aboveground vegetation first. The success of a warm grass seeding is often difficult to judge until mid-season of the second year and this trait has been know to create the false impression that the seeding was a failure. In spite of their slow start, when properly managed, a vigorous or healthy stand of warm season grasses can last for many years and provide significant benefits.

- Low Fertility and Drought Tolerance - It is critical that a new seeding receive ample moisture during early stages of development. That said, warm season grasses survive and adapt better than cool season species to droughty and low fertility soil conditions.

- Varieties - Some varieties or cultivars have distinguishing characteristics that make them better adapted to certain site conditions or land uses.

3.2 Selecting a Mix of Grasses and Legumes

Seed mixes used to reclaim mined land include several species to take advantage of their varying growth patterns (establishment rate, spreading ability, persistence, etc.) and to accommodate variations in site conditions. Legumes, such as clover, trefoil, vetch, alfalfa and lupine, should be used at most mine sites for their nitrogen fixing ability and aesthetic value. However, on drier sites the percent of legumes should be reduced because of their higher moisture requirements.

The following tables provide information on grasses and legumes that may be suitable for revegetating mined lands. There is overlapping information between the three tables in this section, and each has its strengths:

- Table 6 is adapted from information presented by the USDA Plant Materials program at a 1999 Warm Season Grass Workshop held in New York. This table does not recommend specific mixtures, but does indicate which species of grasses and legumes are suited to different soil textures.

- Tables 7 and 8 are adapted from the New York sources listed below so the recommend mixtures are suited to New York State. However, Table 7 is based on soil texture and Table 8 on soil drainage:

    - Gaffney, F. B. et al, 1991, *A Guide To Conservation Plantings On Critical Areas For New York,* United States Department of Agriculture - Soil Conservation Service, Syracuse, N.Y.

    - Standards and Specifications for Vegetative Stabilization of Sand and Gravel Pits, *N.Y. Guidelines for Urban Erosion and Sediment Control*, pp. 3.37-3.38, 1997 - 4th Printing.

Table 6 - Grasses and Legumes Based on Soil Texture (Adapted from Dickerson, J.A., 1999)		
Percent Soil Fines*	**Suitable Plant Categories**	**Suitable Plants/ Cultivars**
0-5%	Warm Season Grasses	Sand Bluestem/Goldstrike Little Bluestem/Camper
0-15%	Warm Season Grasses	Buffalograss Big Bluestem/Niagara Bermuda Grass Blue Grama Sideoats Grama Weeping Lovegrass Sand Lovegrass[C] Switchgrass/Shelter Deertongue/Tioga Indiangrass Coastal Panicgrass/Atlantic[C]
15-20%	Warm Season Grasses *and* Perennial Legumes	See Row Above Alfalfa** White Clover** Red Clover** Birdsfoot Trefoil/Viking** Crown Vetch/Penngift** American Vetch Partridge Pea Wild Lupine
20-30%	Perennial Legumes *and* Cool Season Grasses	See Row Above Tall Wheatgrass Slender Wheatgrass Creasted Wheatgrass Red Fescue/Ensylva*** Creeping Bentgrass
30%+	Cool Season Grasses	Redtop/Streaker*** Canadian Bluegrass Perennial Ryegrass/Sherwood***

* Passing No. 200 mesh sieve
** Pure Live Seed must be inoculated with Rhizobium
*** Endophyte-infected preferred

C - Coastal Atlantic only. Inland substitute Indiangrass or Eastern Gamagrass.

Table adapted from Dickerson J. A., May 1999, USDA NRCS Plant Materials Program. Warm Season Grass Workshop, Saratoga Springs Park & NYSDEC Tree Nursery, Saratoga Springs, New York.

Table 7 - New York Seed Mixtures Based on Soil Texture			
Percent Soil Fines*	**Species in Mix**	**Varieties in Order of Preference**	**Seed (Lbs/Acre)****
< 15 % range	Mix #1		
	Switchgrass	Blackwell, Shelter, Cave-In-Rock	4.0
	Big Bluestem	Niagara, Kaw	4.0
	Little Bluestem	Camper, Aldows, Blaze	2.0
	Sand Lovegrass[C]	NE-27, Bend	1.5
15-20% range >20% range	Mix #2		
	Flatpea	Lathco	10.0
	Perrenial Pea	Lancer	2.0
	Crownvetch	Penngift, Chemung	10.0
	Tall Fescue***	Ky-31, Rebel, Ken-Hi	10.0
> 20% range	Mix #3		
	Orchardgrass	Pennlate, Kay, Potomac	5.0
	Tall Fescue***	Ky-31	10.0
	Redtop	Streeker	2.0
	Birdsfoot Trefoil	Viking, Empire	5.0

* Passing No. 200 mesh sieve
** Warm season grass seed is sold and planted on the basis of pure live seeds (PLS).
*** See warning about endophyte- infected Tall Fescue on page 41.

C - Coastal Atlantic Region only. For inland New York areas substitute Indiangrass or Eastern Gamagrass.

References for Tables 7 and 8:

- Gaffney, F. B. et al, 1991, *A Guide To Conservation Plantings On Critical Areas For New York,* United States Department of Agriculture - Soil Conservation Service, Syracuse, New York

- Standards and Specifications for Vegetative Stabilization of Sand and Gravel Pits, pages 3.37-3.38, *New York Guidelines for Urban Erosion and Sediment Control*, April 1997 - Fourth Printing.

Note **Mix #2** in the soil-texture based Table (7) above is identical to **Mix E** in soil-drainage based Table (8) on page 42.

Warm Season Grass Tip

Warm season grasses will not sprout until there is a prolonged period of moisture and enough warmth in the soil. Also, warm season grasses establish their extensive root systems first. So during the first year the top growth may amount to just one small narrow leaf that is difficult to see.

It does not mean the revegetation has failed!
Warm-season grasses are worth the patience!

Endophyte-Infection Tip

Endophytes are symbiotic fungi present in some grasses that improve the plant's survival. This can be a big plus in less-than-optimal conditions found in mine site reclamation. Therefore, Table 6 recommends endophyte-infection for Perennial Ryegrass, Red Fescue and Redtop.

However, endophyte-infection is **not recommended for Tall Fescue** because it can make livestock seriously ill. Research currently underway may lead to novel endophyte-infected varieties of Tall Fescue that do not have this problem. Stay Tuned!

Table 8 - New York Seed Mixtures Based on Soil Drainage			
Species in Mix	**Varieties**	**Seed Lbs. per Acre***	**Percent Soil Fines****
Very Poorly to Moderately Drained			
Mix A			>20% range
White Clover	Common	10.0	
Perennial Ryegrass	Turf Type (diploid)	2.0	
Native Wildflowers	Assorted	Varies	
Moderately to Excessively Drained			
Mix B			>20% range
Creeping Red Fescue	Ensylva	10.0	
Tall Fescue***	Ky-31	15.0	
Smooth Bromegrass	Saratoga, Baylor	15.0	
Crownvetch	Penngift, Chemung	15.0	
Mix C			>20% range
Creeping Red Fescue	Ensylva	15.0	
Flatpea	Lathco	30.0	
Mix D			>20% range
Switchgrass	Shelter, Blackwell	20.0	15-20% range
Mix E			>20% range
Flatpea	Lathco	10.0	15-20% range
Perennial Pea	Lancer	2.0	
Crownvetch	Penngift, Chemung	10.0	
Tall Fescue***	Ky-31, Rebel	10.0	
Mix F			15-20% range
Switchgrass	Trailblazer, Blackwell	3.0	< 15% range
Coastal Panicgrass[C]	Atlantic	3.0	
Big Bluestem	Niagara	4.0	
Little Bluestem	Aldous, Camper	2.0	
Sand Lovegrass[C]	NE27, Bend	3.0	
Sand Bluegrass	Goldstrike	2.0	
Deertongue	Tioga	2.0	

C - Atlantic Region only

* Warm season grass seed is sold and planted on the basis of pure live seeds (PLS)

** Passing No. 200 mesh sieve

*** See warning about endophyte-infected Tall Fescue on page 41.

See references listed for Table 7.

PART V. SEEDING AND PLANTING TECHNIQUES

> ***"Plant material to be utilized in revegetating the affected land shall be planted during the first planting season following the preparation of the land for such purpose."***
>
> --- 6NYCRR Part 422.3(d)(2)(vi)(c)

1.0 General Planting Requirements

Revegetation applications, including fertilization, liming, seeding and mulching, should be completed within 48 hours of the final grading. In addition to this simple 2-day timeframe, there are other time-related issues that must be taken into account. Will the length of the growing season be enough to safely establish the selected plants? Will the upcoming seasonal weather provide the required moisture and temperatures? Should revegetation efforts be staged to avoid plant competition problems or address the varying seasonal needs of the plants involved?

2.0 Planting Seeds

Effective seed germination which leads to a successful revegetation project depends on:

- Available moisture after the seed is in the ground.
- Warmth or heat units essential for healthy plant emergence and continued growth.
- Length of the growing season for the new seeding to become well established before the first stage of dormancy.[5]

Warm-Season Grasses - Warm season grasses, in general, require a soil temperature of at least 50° to 60° F to germinate and experience maximum growth during the summer. The correct planting timeframe is April 1 - June 1. Planting warm season grasses as soon as possible in the spring should guarantee that there are 100 to 120 frost free days and an estimated 1,400 growing degree days (GDD) that these plants require.[6]

Cool-Season Grasses and Forbs - If seeding between April 1 and June 1 is not possible, then reclamation seeding should be scheduled for fall growth with the seeds planted between August 15th and September 15. Only cool season grasses with their lower germination temperature should be used for fall plantings. Forbs may also be added to the mixture.

Summer Plantings - Summer seeding between June 1 and August 15 is not recommended for either warm or cool season grass species because of the potential lack of available soil moisture and/ or

[5 & 6] Dickerson J.A. & B. Wark, Vegetating with Native Grasses in Northeastern North America. USDA NRCS Plant Materials Program and Ducks Unlimited of Canada

precipitation. However, birdsfoot trefoil should be seeded in late July because it needs at least 6 weeks of fall growth before a hard freeze.

2.1 Seeding Techniques

At the end of final site grading, additional steps should be taken to improve seeding success. On flatter terrain, cultipacking or rolling the soil before and after planting creates a firm bed for planting the seed and increases seed-to-soil contact. The firm seedbed also helps to control the depth of seeding, retain moisture near the surface, and provide anchorage for young plant roots. USDA has cited a loose seedbed as being the primary cause of failure of warm season grasses to germinate. However, remember not to cultipack wet soil because the resulting crust will make it hard for germinating plants to break the surface.

On side-slopes, topsoil should be graded using a cleat track equipped machine to increase surface roughness. This will help prevent seeds from being washed downhill during storm events and improve soil moisture retention.

Most of the established techniques for seeding agronomic grass and legume species are also useful for revegetating mined land. The three main methods are: dry seeding, wet broadcast seeding and hydroseeding. The most suitable method is based largely on the soil materials, slope and local climate.

Dry Seeding - Dry seeding may be done by hand broadcasting, motor-driven seeders and air blowers:

- Hand Broadcast seeding can be used on flat or gently sloping areas. Hand-operated rotary type seeders are inexpensive and simple to use, but walking speed, cranking speed and seeder spill rate will affect the application rate and coverage of the area. Therefore, the seeder may need to be calibrated. Fertilizers and other soil amendments must be applied separately.

- Motor-driven seeders are the most commonly used seeding equipment in revegetating mined land due to their speed of application and the level of control over seeding rates. Seed, lime and fertilizer must still be spread separately because the seeder must be calibrated differently for each application.

- Air-blowers are best suited for roadsides because the equipment requires vehicle transport. An air compressor can blow seeds or fertilizers up to 30 feet. It is very important to calibrate the application rate because seed is delivered quickly. Apply fertilizer and seed separately.

Hydroseeding - Hydroseeding (hydraulic seeding) is the application of a water slurry of seed, fertilizer and soil binding agent, with or without mulch. This method is best for steep, inaccessible areas where dry seeding equipment is difficult to use. The equipment consists of a mixing tank with mechanical or hydraulic agitation and a volume pump. Hydroseeding can spread seed up to a distance of 200 feet.

Wet Broadcast Seeding - This method mixes grass and legume seeds with water and discharges it to the area to be seeded. It covers a larger surface area, the operator has better control of seed dispersal, and seed germination is enhanced by the accompanying water. The best time for wet broadcast seeding is immediately after the site has been regraded, when the roughened surface aids seed retention. Also immediately after regrading the soil medium is still not compacted, and aeration and water percolation will be more conducive to seed germination and plant development.

2.2 Legume Inoculation

Inoculation is the practice of adding bacteria to legume seed before planting to assure adequate nodulation and promote nitrogen fixation. This is generally done by coating the seed with a water-based slurry just before planting. The carrier is enriched with sugars, gums and polysaccharides that promote adhesion to the seeds, provide nutrition and protect the bacteria. Commercial preparations of bacteria with a peat carrier are usually available from local seed dealers.

The practice of inoculating legume seeds with the appropriate strain of *Rhizobia* is important, especially where native *Rhizobia* are not present in the soil. This is likely to occur when topsoil has been stockpiled for an extended period and most or all of the native bacteria have died.

The genus *Rhizobia* is divided into several strains which are fairly specific as to which legume species they will infect. *Rhizobia* bacteria are very sensitive to hot and dry conditions. Inoculation should take place just before planting to decrease the length of time the inoculated seed is exposed to air and sunlight. Some common legumes and the *Rhizobia* species which infect them are listed in Table 9.

Table 9 - Strains of Rhizobium and the Legumes They Infect

Legumes - Common Name (*Genus*)	**Strain**
Alfalfa (*Medicago*), Sweet Clover (*Melilotus*)	*Rhizobium mililoti*
Clover (*Trifolium*)	*Rhizobium trifolii*
Crownvetch (*Coronilla*), Cowpea (*Vigna*), Lespedeza (*Lespedeza*)	*Rhizobium (cowpea group)*
Flat Pea (*Lathyrus*), Vetch (*Vicia*)	*Rhizobium leguminosarum*
Lupine (*Lupinus*), Trefoil (*Lotus*)	*Rhizobium loti*

3.0 Planting Trees and Shrubs

The successful establishment of trees is highly dependent on selecting good nursery stock, proper handling before planting and proper planting techniques. Planting tress and shrubs by seed is not recommended; the newly sprouted seedlings generally cannot compete effectively with the other vegetation required to reclaim the land. It is assumed there is no pre-existing ground cover on the mine site, so vegetative control methods to reduce competition with new trees and shrubs are not discussed.

Nursery stock is available in four basic forms: bareroot, ball-and-burlap, containerized and cuttings. Experts may be able to provide information on which types of nursery stock tend to work best for specific plant and tree species. For example, gray dogwood and crabapple are generally considered easy to plant bareroot. For some other species, such as willow, cuttings may be the preferred method in a particular setting. Container grown trees are generally the most expensive and can be subject to circling roots that reduce the plant's vigor. Also if a lightweight growth medium is used, it may loose water too readily to surrounding native soil. The two most common forms of shrubs and trees used in mine reclamation, bareroot and ball-and-burlap, are discussed below.

3.1 Bareroot Plants

Generally, it is best to plant bareroot seedlings in the spring before the buds open and new growth begins. The time period between taking seedlings from their nursery "beds" and planting them at their permanent sites is critical and anything to shorten this time period increases the plant's survival rate. Keep packaged seedlings out of direct sunlight and plant them immediately after they are removed from their packing. Remember to also protect seedlings at the planting site. Exposing roots to hot sunlight and drying winds for just 3-5 minutes can cause seedling mortality.

If planting must be delayed after the seedlings arrive from the nursery, it is very important to open the packing, wet the rootstock and store the plants in a cool and dark environment. Timing is critical. Factors which contribute to early mortality are dehydration, heat and mold, which grows at temperatures over 40 degrees[7]. Planting within one week of delivery is crucial.

Regular bareroot seedlings, semi-transplants or transplant-aged trees can be planted by hand or using a mechanical tree planter. The following are all delivered with no soil around the roots:

- Bareroot trees and shrubs seedlings are harvested when dormant.
- Semi-transplants are root-pruned and thinned-out in the original seedbed. The root system is improved and the stem caliper is usually heavier than a regular bareroot seedling.
- Transplant-aged trees will have the best branching and a strongest root system (5 to 10 times the root system of a semi). A 5-year transplant coded 2(3) means 2 years in the original seedbed and 3 years in the transplant bed.

7 Burger, J. A. and C.E. Zipper, 2002, *How to Restore Forests on Surface Mined-Land*, Virginia Cooperative Extension and Powell River Project Publication No. 460-123.

When planting 1,000 or more trees and shrubs, a commercial tractor-operated tree planter is recommended. Consultant foresters often provide this service and generally charge by the acre or per thousand. Smaller quantities of trees and shrubs can easily be planted by hand using a mattock, planting bar or tile spade. When using these hand tools, there are a few important things to remember:

- It's best to plant, during or just after a good rainstorm, when soil moisture is high. However, efforts should be made to minimize unnecessary soil compaction on the site.

- After opening the slot in the topsoil for planting, place the bareroots as vertically as possible within the opening to avoid "J" rooting. The soil should be level with the root flare (point just above where the uppermost roots attach to the trunk).

- Using the planting tool, close the opening against the root mass, then use your boot heel or toe to press around the seedling and thoroughly close the opening. Air pockets inhibit root growth.

- Mulch as described in Section 4.0.

3.2 Balled-and-Burlap Plants

Balled-and-burlap trees and shrubs are older and larger, but their handling and care before planting is still very important. It is best to plant during the spring while trees and shrubs are still in the dormant stage. Take care not to drop the ball or damage the bark on the tree trunk which would provide an opening for insects and disease. Dropping the ball could fracture or damage the roots.

Place the root ball in the location you want to plant it and score the topsoil with a shovel around the perimeter. Move the ball to one side and dig a hole twelve inches larger than the outline of the ball. Measure the depth of the ball up to the zone of root flare and dig the hole to that depth.

Place the ball on undisturbed soil at the bottom of the hole to help stabilize the tree until new root growth permanently anchors it in place.

If the ball has been reinforced with a galvanized wire basket, remove it before placing the plant in the prepared hole. If this is not done, eventually the roots will grow and expand and may become girdled and cause the tree to die.

Once the ball has been placed into the hole, make sure the trunk is standing plum. Before backfilling untie and roll down the burlap covering and tuck into the ground. Backfill around the entire ball with soil. The soil should be level with the root flare. To complete the planting process moderately tamp the soil around the ball (mulch as described in Section 4.0).

Generally there will be extra soil available that can be used to make a two to four-inch circular reservoir above the cut to help retain rainwater. At this point it is recommended to thoroughly soak the roots with a water solution of root growth stimulant in the proper amount. Repeat this again in a week for best results.

4.0 Mulching: An Essential Step

Covering a new seeding with some form of mulch is a very important last step, especially on final graded side slopes and critical areas that will experience concentrated surface water runoff during storm events. Applying mulch to the soil surface also helps to conserve soil moisture, moderate soil temperatures and reduce frost heaving in the spring. In addition, mulch also helps to prevent soil compaction, control undesirable weed invasion, rebuild organics in the soil and improve nutrient retention.

Materials used for mulching include: small grain straw, weed-free hay, wood chips, and shredded recycled newspaper. Some more technologically advanced forms of mulching materials and methods are commercially available. They often use biodegradable geotextile materials impregnated with certain grass seed mixtures and fertilizers. These materials are more labor intensive to use because they must be anchored on the surface to prevent movement, but provide superior results when installed properly. Depending upon the type of mulch selected and site location, mulch can be applied with a hydroseeder or manual distribution.

Tips for specific types of plantings:

- Cool Season Grass seedings tend to perform better when mulched because of the cooler soil temperature that is maintained under the layer of mulch. The most economical and efficient material available is small-grain straw or hay. Straw or hay should cover 75 - 90 % of the exposed ground at recommended rates of 1.5 - 2.5 tons/acre.

- Warm Season Grass seedings do not perform well when thick layers of mulch are applied since the mulch hinders the soil warming required for seed germination. In fact, mulching of warm season grasses may not be necessary at all except in cases where runoff and erosion control is necessary. Then mulch with 3,000 lb/acre of small grain straw (not grass hay).

- Trees and Shrubs - Thicker mulches up to 1 to 3 inches may have a unique application to a tree and shrub revegetation project. However, the mulch should not be placed above the root flare zone and should also be kept back from the trunk a few inches to avoid killing the plant.

  Woodchips and tree bark are generally the preferred mulch material for thicker applications. These woody materials will last longer than materials such as straw, which decompose rapidly.

PART VI. ASSESSMENT OF REVEGETATION SUCCESS

> ***"An acceptable vegetative cover shall be considered to be a permanent stand or a stand capable of regeneration and succession sufficient to assure 75 percent coverage of the areas planted if only ground cover (no trees) is utilized, or a 60 percent survival rate for shrubs and trees which are utilized, by the end of the second growing season after planting. If revegetation is not completely successful, the areas of failure must be randomly distributed, shall not exceed one-half acre in every two acres so treated and shall not endanger the success of revegetation in adjacent areas within the affected land."***
>
> **--- 6NYCRR Part 422.3(d)(2)(vi)(d)**

This section covers the regulatory requirements for revegetation success and some acceptable methods for determining whether adequate revegetation has been achieved. Using the methods described in this section will ensure consistent and objective collection and analysis of vegetation data. This section does not apply, however, to revegetation assessments for reclamation of row cropland or wetlands.

1.0 Criteria for Revegetation Success

There are three major aspects to vegetation that can be assessed: composition, structure, and function. Functional restoration is not a requirement of revegetation in the New York State Mined Land Reclamation Law. Therefore, this manual does not cover the methods to verify plant community functional development, just composition and structure.

2.0 Measuring Revegetation Success

Quantitative information on the structure of a plant community is desirable for planning and evaluating the success of revegetation projects. The plant community to be established by revegetation projects on surface mined lands is typically either grasslands or shrublands. Ground cover is a widely used measurement for composition and structural aspects in grasslands and shrublands. In the rarer cases where shrubs and trees are utilized to revegetate mined lands, survival rate will be used to evaluate revegetation success.

Ground cover can be sampled by four general methods: quadrat sampling, line-transect sampling, point sampling, and sampling with photographs. Each technique has its advantages and disadvantages. The selection of an appropriate sampling technique depends upon the type of data needed, the size of the sampling site and other available resources. Sampling should be undertaken by the end of the second growing season after planting, or when vegetation is established.

The following section presents several vegetation cover sampling and measuring techniques. Survival data can be collected at the same time that ground cover is sampled.

2.1 Quadrat Sampling

A quadrat is a plot of a standard size in which vegetation cover can be estimated, plants counted, or species listed. Sampling with quadrats can be used for most plant communities. Quadrats can be established randomly, regularly, or subjectively within a revegetated mine site.

A quadrat can be a long, narrow plot, a square plot or a round plot. Since plants often grow in clumps, long, narrow plots often include more species than square or round plots of equal area. However, accuracy may decline as the plot lengthens. Round quadrats can be most accurate because they have the smallest perimeter for a given area.

The appropriate size for a quadrat depends on the items to be measured. If ground cover is the only factor being measured, size is relatively unimportant. A plot size should be large enough to include significant numbers of individuals, but small enough so that plants can be separated, counted and measured without duplication or omission of individuals.

Ground cover is the percentage of quadrat area beneath the canopy of a given species. For the practical estimation of cover, holes in the canopy can be treated as "nonexistent". Plants rooted outside the quadrat are included in cover measurements to the extent that their canopy projects into the quadrat space. If the plants are above eye level, it may be difficult to accurately estimate the ground cover.

2.2 Line-Transect Sampling

A line transect is simply a line between two points, generally using a measuring tape. Line transects are used to sample ground cover of all species. Once a line transect is established, canopy cover can be easily sampled along it. Simply position yourself directly over a portion of the transect and record the amount of the transect between the two finite points that is covered by the canopy for each species.

The line-intercept method is just as accurate as the quadrat method, but is much less time consuming. Ground cover is calculated as the percent of transect line covered by each species. The chance of an individual being encountered by the transect line is proportional to its width perpendicular to the transect line, so density can also be calculated.

2.3 Point-Frame Sampling

Ground cover data can also be sampled with the point-frame method. The point-frame method determines the number of points, distributed randomly or regularly in the survey area, where parts of a plant are above ground. The points can be established with a regular grid, randomly chosen coordinate pairs, or regular or random points along a measuring tape (transect line). For coordinate pairs and regular grids, x and y axes are established along the edges of the survey area. Random points are selected using a random number generator (on most calculators) or from a random number table. The number of points necessary for an adequate assessment is partly dependent on the species cover within a survey area. This technique results in very accurate cover data, but its use is largely limited to relatively low-growing plants.

PART VII. REVEGETATION EXAMPLES FOR SELECTED LAND USES

1.0 Cropland

Cropland means land which is used for the production of crops for harvest, alone or in rotation with grasses and legumes, and includes row crops, small grain crops, hay crops, and other specialty crops. Most of the discussion in this section will focus on hayland and pastureland revegetation. Hayland and pastureland means land used for long-term production of forage plants to be cut for livestock feed or grazed by livestock. Annual crops such as corn and sorghum for forage are not covered here.

Site Preparation - If the site is planned for hay production or pasture, and occasional cultivation will be necessary, the maximum slope should not exceed 5:1 in order to avoid severe topsoil erosion and to allow safe and efficient farm machine operation. Graded slopes should be blended into adjacent areas to prevent shelves or steep troughs. A minimum of 6 inches of topsoil must be placed for cropland revegetation, or as a general rule, the depth of topsoil replacement should be the same as the topsoil depth prior to mining.

Plant Material Selection - Native species and species of grasses and legumes adapted to the local site conditions should be used. Legume-grass combinations will usually result in better forage production and animal performance than will a single species grown alone. Selection of species should be based on: 1) species adaptation to the site; 2) potential forage yield and seasonal distribution; 3) nutritional value and palatability; and 4) persistence.

Grasses, birdsfoot trefoil, and crownvetch do not cause livestock bloat. However, with other legumes bloat can be a problem. Short-growing species such as Kentucky bluegrass or white clover should be used if pastures are to be grazed heavily and continuously. Tall-growing species such as birdsfoot trefoil, alfalfa, red clover, timothy, bromegrass, and orchardgrass provide maximum yield. These species are best suited for hay production. (See Appendix II for more info on grass and legume traits.)

Planting Techniques - Rolling or cultipacking the soil before and after planting will result in better germination and establishment. Cool season grasses should be seeded by mid-August in northern New York or by late August in southern New York. Birdsfoot trefoil should be seeded in late July because it needs at least 6 weeks of fall growth before a hard freeze. For more details on timing and methods for planting grasses and legumes, see pages 43-45

Assessment of Revegetation Success - Measurements for forage production and ground cover can be used to evaluate revegetation success of the reclaimed land. Assessment should be implemented by the end of the second growing season after planting. Forage production can be determined by field sampling or actual harvesting. Average yield in the region or the yield obtained from surrounding areas for the appropriate hayland and pastureland can be used to develop productivity standards for reclaimed hayland and pastureland. A minimum 75% of the standard production should be considered a successful revegetation. Ground cover can be determined by the point frame method, line transect or quadrat methods. All species used in determining ground cover must be perennial species. Both live

and litter cover must be included. At least 75% total cover is required to conclude that a revegetation effort is successful.

2.0 Wildlife Habitat

Wildlife habitat reclamation can be adapted to almost any area in New York State and almost any type of surface mining site. Wildlife habitat reclamation can be implemented on sites where agriculture, forestry, or residential/commercial uses are impractical. Even if other land uses are the primary objective of the site reclamation, the creation of wildlife habitat may be included as a secondary objective. Wildlife habitats range from upland to wetlands. This manual focuses largely on upland habitat revegetation. More information on wetland habitat revegetation can be obtained from "Technical Guidance for Creating Wetlands as Part of Unconsolidated Surface Mining Reclamation".

Site Preparation - In most situations, rolling, irregular terrain is more suitable for wildlife than recontoured flat and uniform land. However, some grading and contouring is generally necessary to control erosion, prevent slope collapse, and blend the reclaimed area with the adjacent natural landforms. Rough to rolling terrain provides a variety of landforms, increases snow accumulation, retains rainfall and runoff, and thus prevents surface erosion. It also provides a variety of sites for plants to be established and increases the plant diversity in the reclaimed area. Rolling landforms can also provide wildlife with visual protection from humans and predators.

These landform features can be developed during mining operations or during the grading and recontouring of the reclamation area. Waste piles, for instance, can be used to create a rolling "knob and kettle" terrain. The existing depressions and irregular mining floor can be likewise be maintained. When regrading the mining face, slopes and contours should remain irregular. See page 13 and Figure 1 on page 14 for information on creating meandering toe and crest contours.

Plant Material Selection - Grasses and forbs provide an important food source for many wildlife species as well as nesting cover for some birds and habitat for small mammals. Trees and shrubs provide wildlife with food, places to hide, shade from the summer sun, and protection from winter winds and low temperatures. A number of birds and small mammals may also nest in larger trees and shrubs.

Although use of warm season grasses is currently uncommon in New York, the results from using them in wildlife habitat restoration projects has been extraordinary. Most warm season grasses grow in clumps, providing movement corridors for young wildlife to avoid predators. Legumes have long been recognized as a valuable component for wildlife habitat. Some legumes are also important food source for birds. The Department of Environmental Conservation operates the State Tree Nursery in Saratoga Springs to produce tree and shrub seedlings for conservation plantings on private and public lands.

There are several shrub mixes available at the State Nursery:

Wildlife Mixed Species Packet 1:	Wildlife Mixed Species Packet 2:
Highbush Cranberry	Highbush Cranberry
Silky Dogwood	Silky Dogwood
Toringo Crabapple	Toringo Crabapple
	Rugosa Rose

Long Island Shore Species Packet 3: The Long Island shore packet is also designed for erosion control. The species included are salt-tolerant and can survive the relatively dry environment of the seashore:

Eastern Red Cedar
Bayberry
Rugosa Rose
Pitch Pine

Riparian Species Packet 4: Contact the nursery for plant recommendations for streambank stabilization.

Planting Techniques - See Part V for information on planting the grasses and legumes. Plant shrubs selected for wildlife planting no closer than 6 feet apart as hedgerows or borders around conifer and hardwood stands. For streambank stabilization, plant dogwood and streamco willow, 2 to 3 feet apart near the waterline. Plant toringo crabapple 12 feet apart. Wildlife habitat improvement packets provide a continual food supply for songbirds and other wildlife from late summer through the winter. Plant species together to improve pollination and fruit production. For further information consult with the State Tree Nursery and/or other nursery providing planting stock for the project.

Assessment of Revegetation Success - Assessment of revegetation success in a wildlife habitat reclamation project should include species diversity, seasonal variety, and regenerative and succession capacity based on the approved mined land-use plan. If no trees are used, ground cover must be at least 75% of the area planted. Both live plants and litter should be included in determining ground cover. All species used in determining ground cover must be perennial species. If the primary vegetation is shrubs and trees, a 60% survival rate is required for successful revegetation. Measurements should be taken by the end of the second growing season after planting. In addition, species diversity, seasonal variety and regenerative capacity must meet the approved revegetation plans.

3.0 Woodland

Woody plants include trees, shrubs, half-shrubs, and woody vines. For the purpose of revegetation, woodland discussed in this section means the land where the primary natural vegetation is trees. In general, woodland reclamation should be considered only in areas where woody plants also exist in the surrounding areas. Adjacent areas where the primary vegetation is not woody plants should be evaluated based on the requirements of the appropriate land uses.

Site Preparation - Trees have different soil requirements than forage grasses and legumes, both in terms of soil quality and depth. Most grasses and legumes can tolerate compacted surfaces, but trees cannot. Overburden materials containing rocks and boulders may be used as topsoil substitutes in woodland reclamation, but special soil and water management measures may be required to ensure successful establishment of the tree stands. Grading or reshaping should minimize compaction of soils to ensure the establishment and long term growth of trees. The combination of the microtopography with small depressions, hills, or gullies may benefit a diverse forest community, both flora and fauna.

Plant Material Selection - Tree species include hardwoods and conifers. Selecting tree species should be based on site conditions and the desired use for the tree products. Species adapted to the local site condition and climate should be used. A woody species combination with a cover of grasses, legumes, or forbs will provide a diverse, effective, and permanent vegetative cover with seasonal variety, succession, and regenerative capabilities. The New York State DEC Tree Nursery in Saratoga Springs maintains the following conifer species and hardwood species.

Conifer Species:		**Hardwood Species:**	
White Pine	Scotch Pine	Sugar Maple	Red Maple
Red Pine	Austrian Pine	Black Walnut	Hybrid Poplar
Pitch Pine	Norway Spruce	White Oak	Red Oak
White Spruce	Red Spruce	Black Locust*	
Japanese Larch	European Larch		
Douglas Fir			

* Warning, on the Invasive Plant list, App.V

Planting Techniques - The Division of Land and Forests of New York State Department of Environmental Conservation recommends that spacing for conifer species should be 8 feet x 8 feet (680 trees per acre) and 12 feet x 12 feet (300 trees per acre) for hardwood species. For further consult with the State Tree Nursery and/or other nursery providing planting stock for the project.

Assessment of Revegetation Success - Evaluation of revegetation success in woodland is determined by the survival rate for the trees planted. The number of trees established should be adequate to meet density standards. The trees counted in determining survival rate must be healthy and have been in place for at least two growing seasons. A minimum of 60% survival rate is required to conclude revegetation success in a woodland reclamation project. In addition to the tree numbers, vegetative ground cover, and an evaluation of species diversity, seasonal variety, and regenerative capability of the vegetation should be included in determination of success.

State Tree Nursery Contact Information

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