

Asphalt, Concrete, and Turf Maintenance and Preservation Workshop Highlights

In May 2003, the Airport Technical Assistance Program, also known as AirTAP, sponsored a one-day workshop on airport pavement maintenance at Flying Cloud Airport in Eden Prairie, Minnesota. Participants learned about preventive maintenance, pavement distress and identification, and best practices for the maintenance of concrete, asphalt, and turf pavements. The workshop focused on the special materials required at airports, and how aircraft loading conditions result in specific distresses. It also covered the special maintenance needs associated with turf runways and taxiways.

Workshop instructors were Ann Johnson, P.E., and Gene Skok, Ph.D., both instructors at the University of Minnesota. Johnson has worked as an airport designer and resident engineer for several years and is president of Professional Engineering Services. Skok teaches pavement courses in the University's Infrastructure Management program and has worked on pavement research and design for over 30 years.

This "highlights" document summarizes much of the information shared during this training session. If you were unable to attend, we hope this will provide you with useful new information. For those of you who attended the seminar, use these highlights as a reference for the information presented during the sessions.

AirTAP is a statewide assistance program for aviation personnel that offers a range of information resources and practical instruction by knowledgeable and experienced trainers. AirTAP's efforts include providing training programs, technical assistance, access to experts, and printed materials.

AirTAP was developed through the joint efforts of the Minnesota Department of Transportation (Mn/DOT), the Minnesota Council of Airports (MCOA), and the Center for Transportation Studies (CTS) at the University of Minnesota.

To receive more information about the program or copies of the AirTAP materials mentioned in these highlights, please contact:

Jim Grothaus, Technology Transfer Engineer
AirTAP/Center for Transportation Studies
University of Minnesota
612-625-8373 (Fax: 612-625-6381)
jgrothaus@cts.umn.edu

Jeff Stewart, P.E., Program Consultant
WSB and Associates, Inc.
763-287-7184
jstewart@wsbeng.com

Preventive Maintenance

Preventive maintenance is a program of activities designed to preserve the investment in pavements, extend pavement life, enhance pavement performance, and reduce user delays. This program includes corrective and preventive maintenance and minor rehab, and is often used to repair environmental damage. Preventive maintenance narrows the focus to the application of one or more treatments and must be applied to the surface of a structurally sound pavement.

Preventive maintenance is basically performing the right treatment on the right road (or runway) at the right time.

When to act?

Several tools are available to help airport staff determine the best time to perform pavement maintenance and the maintenance technique that will be most effective. These tools are:

- **Pavement management programs.** A pavement management system is the name given to one of the tools or methods that assist in optimizing strategies for providing and maintaining pavements in a serviceable condition over a given period of time. One of the primary benefits of a pavement management system is that it offers assistance in selecting cost-effective alternatives for pavement maintenance and rehabilitation.

Many local agencies use an informal method for determining which pavements receive a specific maintenance treatment at any time. The large variation in system size and pavement type across the state results in the many types of pavement management systems in use, many of which are very effective regardless of their size or format.

- **Condition surveys.** One of the key components of any pavement management system is the pavement rating system. These systems involve calculating a numerical score or index based on the visible pavement distress (cracks, patches, rutting, etc.), which allows for an unbiased comparison to be made between roadway segments based on their condition. One system calculates a numerical index between 0 and 100 called the Pavement Condition Index (PCI). A pavement with a score of 100 would have no distress of any kind. Pavements in worse condition would have ratings lower than 100. Mn/DOT can assist agencies with identifying and selecting an appropriate management system.
- **Non-destructive testing.** A Road-Rater or Falling Weight Deflectometer (FWD) can be used to conduct non-destructive testing on asphalt or concrete pavements. Both machines impose a load on the pavement, and sensors measure the resulting deflection. The deflection values, along with pavement layer materials and thicknesses, are used to estimate pavement strength and capacity. This can be a very useful tool for airports wanting to upgrade their air service.

Pavement Distress and Rehabilitation

Common forms of concrete and asphalt pavement distresses are listed below, along with their appearance and causes.

Three primary causes of pavement distress are environmental damage, inadequate construction methods or materials, and traffic loading. Most airport pavement distress is caused by environmental damage or poor construction techniques. Complete descriptions of each of the pavement distresses can be found in the flexible and rigid pavement distress manuals, published by Mn/DOT and the Minnesota Local Road Research Board.

Asphalt (Flexible) Pavement Distresses

Distresses caused by environmental damage

- **Block cracking**
Block cracks are cracks in all directions on the pavement, dividing the pavement into blocks 1 to 12 feet square. They are found throughout the pavement. Block cracks are indicators of a hard or brittle asphalt and are not load related. Block cracks should be repaired by crack sealing or with a seal coat or thin overlay as they progress.
- **Reflection cracking**
Reflection cracks are caused by the cracking of an overlay above underlying joints or cracks. The pavement may be spalled (chipped) along the crack. These cracks should be repaired with joint sealant materials, or the entire surface may be overlaid in more severe cases.
- **Swelling/frost heaves**
A frost heave is an upward bulge in the pavement surface that can be accompanied by surface cracking. No repair is required for low-severity frost heaves, which may settle when the weather warms. For medium- and high-severity swelling, full-depth patching with subgrade correction may be required.
- **Transverse cracking**
Transverse cracks extend across the pavement at right angles to the centerline and are not load related. They should be repaired with joint sealant materials. More severe transverse cracks may have secondary cracking, indicating loss of support in the underlying base layer. These cracks should be repaired full-depth.

Distresses caused by construction problems or design deficiencies

- **Bumps and sags**
Bumps and sags are small, localized, upward or downward displacements of the pavement. More severe bumps should be removed and the pavement patched. Low-severity bumps or sags do not require repair.
- **Corrugation**
This distress may also be called washboarding, as the pavement surface resembles a washboard. It is a series of closely spaced transverse bumps perpendicular to traffic direction, and it usually occurs at intersections where traffic is starting and stopping. No repair is required for minor corrugation, but partial- and full-depth patching of the surface layer, or a mill and overlay, may be used to repair more severe distress.
- **Depression**
A depression in the pavement is sometimes referred to as a birdbath, because it may collect water. Low-severity depressions do not need repair, but those that cause more ponding must be removed and replaced.

- **Edge cracking**
Edge cracks run parallel to and are usually within one to two feet of the outer edge of the pavement surface. They may cause alligator cracking along pavement edge. As these cracks become more severe, they should be sealed or the entire pavement edge should be patched.
- **Flushing (or Bleeding)**
Flushing is caused by an unstable asphalt mixture. Traffic loadings cause the asphalt oil in the pavement to bleed up through the surface. No repair is required on low-severity flushing, but pavements with high-severity flushing may lose their skid resistance and should be milled and overlaid.
- **Lane/shoulder drop off**
This distress is the difference in elevation between pavement edge and shoulder, caused by settlement of the traffic lane or shoulder. On airport pavements, where an edge drop is required, no repair is needed for this distress. At intersections or in areas where planes are required to cross drop off areas, a level course may be placed.
- **Polished aggregate**
Polished aggregate occurs when the pavement surface becomes smooth to the touch. This results in low skid resistance. An overlay, pavement grooving, or grinding may restore the surface friction.
- **Raveling**
Raveling is the disintegration of the pavement from the surface down caused by loss of asphalt binder and dislodged aggregate pieces. No repair is required for low-severity raveling; an overlay may be placed to correct higher severity distress.
- **Shoving**
Shoving is permanent movement of a localized pavement area caused by traffic loading. Shoving is movement parallel to the direction of traffic. No repair is required for low-severity shoving. Full-depth patching can be used to repair more severe shoving.
- **Slippage cracking**
Slippage cracks are crescent- or moon-shaped, and are caused by a low-stability asphalt mixture or a poor bond between asphalt pavement layers. No repair is required for low-severity slippage; patching or reconstruction can correct higher severity distress.

Distress caused by traffic load

- **Alligator cracking**
Alligator cracks are a series of interconnected cracks resembling alligator skin. They are caused by failure of the pavement under repeated loading, and are considered major structural distress. The only way to repair alligator cracking is to remove the pavement with patching or reconstruction.
- **Longitudinal cracking**
Longitudinal cracks occur parallel to traffic. They may or may not be load-related. Cracks should be sealed or patched, depending on severity.
- **Potholes**
Potholes occur as a result of insufficient pavement strength. Pavement must be removed either partially or full-depth, depending on severity.
- **Rutting**
Rutting is a longitudinal surface depression in the wheelpath. It may be dangerous for aircraft. For

low-severity rutting, a partial-depth patch may be used to restore the pavement surface. Higher severity rutting may require a mill and overlay or reconstruction.

Concrete (Rigid) Pavement Distresses

Distresses caused by environmental damage

- **Buckling/shattering**

Buckling or shattering usually occurs in hot weather, at a transverse crack. The loss of crack sealant allows rocks and other debris to get lodged in the crack, and the crack is then not wide enough to permit slab expansion. During warm temperatures and concrete expansion, the only way for the slabs to move is upward, and a “blow-out” occurs.

To repair this distress, use a partial- or full-depth patch, depending on severity. Note that preventive measures, such as maintaining good joint sealers and placement of expansion joints, will control blow-ups.

- **Faulting**

Faulting is the vertical movement of abutting slabs at joints or cracks. No repair is required on low-severity faulting; grinding, slab jacking, or replacement may be used to repair medium- to high-severity faulting.

Distresses caused by construction problems or design deficiencies

- **Durability (D) cracking**

Durability cracks are a pattern of cracks running parallel and close to a joint or linear crack. They appear as a series of fine, hairline cracks usually cracking across the slab corners. This type of crack can eventually lead to disintegration of the entire slab.

No repair is required on low-severity durability cracking. Partial- or full-depth patching can be used on pavements in worse condition. Total slab replacement may be required on pavements with high-severity durability cracking.

- **Joint seal damage**

Joint seal damage is any condition that enables incompressible materials (such as rocks or sand) to accumulate in the joints or allows water infiltration. For low-severity damage, no repair is required. Joint sealing will control medium- to high-severity joint damage.

- **Lane/shoulder dropoff**

This distress is the difference in elevation between pavement edge and shoulder caused by settlement of the traffic lane or shoulder. On airport pavements, where an edge drop is required, no repair is required for this distress. At intersections or in areas where planes are required to cross drop-off areas, a level course may be placed.

- **Polished aggregate**

Polished aggregate occurs when the pavement surface becomes smooth to the touch, resulting in low skid resistance. An overlay, pavement grooving, or grinding may be done to restore the surface friction.

- **Popouts**

Popouts appear as a small piece of pavement that breaks loose from the surface. They generally occur early in the pavement life. Since they do not result in severe distress, no repair is recommended.

- **Scaling/map cracking**

This distress appears as a network of fine, shallow, or hairline cracks that extend only through the

upper surface of the concrete. Map cracking may lead to surface scaling, which is the progressive disintegration and loss of the wearing surface. No repair is required for low-severity scaling. As the distress progresses, a partial-depth patch will eliminate the problem. For high-severity scaling, full-depth patching and bonded overlay may be necessary.

- **Shrinkage cracks**
Shrinkage cracks are hairline cracks usually a few feet long and not extending across slab. They generally occur early in a pavement's life, and do not lead to severe distress. No repair is recommended.
- **Joint and corner spalling**
Spalling is the breaking or chipping of the slab at a corner or joint. It is also the disintegration of the slab edges. These cracks do not extend vertically through the slab. This distress should be repaired, as loss of the seal at the concrete joints will lead to water and incompressible materials penetrating the pavement. That can lead to much more severe damage. Depending on severity, a partial- or full-depth patch is required.

Distresses caused by traffic loads

- **Corner break**
Pavements with this distress have a corner of the slab broken in a triangular piece. No repair is required for low-severity corner breaks, but crack sealing or full-depth patching may be performed for slabs in worse condition.
- **Linear cracking**
Linear cracks divide the slab into two or three pieces and are caused by repeated traffic loads, curling, or subgrade heaving. Low-severity cracking doesn't warrant any repair, but sealing, partial- or full-depth patching, or slab replacement may be needed when the distress becomes more severe.
- **Pumping**
Pumping is the ejection of water or silt from the slab foundation through pavement joints or cracks. When pumping occurs, cracks should be sealed or repaired, and edge drains may be installed to remove water from the pavement subgrade.
- **Punchouts**
A punchout is a localized area of the slab that has broken into pieces. No repair is needed for low-severity punchouts, but more severely damaged pavements may require sealing, full-depth patching, or total slab replacement.

Best Practices for Asphalt Pavement Maintenance

Best practices for asphalt pavements are outlined below. Specific best practices are outlined in detail in the *Asphalt Pavement Maintenance Handbook*, published by CTS, Mn/DOT, and the Minnesota Local Road Research Board.

Crack repair with sealing: a localized treatment method used to prevent water and debris from entering a crack, which might include routing to clean the entire crack and to create a reservoir to hold the sealant. This treatment, which is very effective at prolonging pavement life, includes the following three crack repair methods:

- Clean and seal: used on all types of cracks, and involves using a hot air lance or compressed air to blow out the debris in the crack, followed by filling with a sealant.
- Saw and seal: involves using a pavement saw to create transverse joints at regular intervals along a newly placed pavement, followed by filling with a sealant.
- Rout and seal: used on transverse and longitudinal cracks. Involves using a pavement saw or router to create a reservoir centered over existing cracks followed by filling with a sealant.

Crack filling: differs from crack sealing, mainly in the preparation given to the crack prior to treatment, and the type of sealant used. Crack filling is most often reserved for more worn pavements with wider, more random cracking.

Full-depth crack repair: a localized treatment method to repair cracks that are too deteriorated to benefit from sealing. Secondary cracking requires the reestablishment of the underlying base materials.

Fog seal: an application of diluted emulsion (typically at a rate of 1:1) to enrich the pavement surface and delay raveling and oxidation. This practice is considered a temporary treatment.

Seal coat: used to waterproof the surface, seal small cracks, reduce oxidation of the pavement surface, and improve friction.

Slurry seal: a mixture of fine aggregate, asphalt emulsion, water, and mineral filler, used when the primary problem is excessive oxidation and hardening of the existing surface. Slurry seals are used to retard surface raveling, seal minor cracks, and improve surface friction.

Micro-surfacing: commonly referred to as a polymer modified slurry seal; however, the major difference is that the curing process for micro-surfacing is a chemically controlled process, versus the thermal process used by slurry seals and chip seals. Micro-surfacing also may be used to fill ruts.

Thin hot mix overlays: include dense, open, and gap-graded mixes that are used to improve ride quality, reduce oxidation of the pavement surface, provide surface drainage and friction, and correct surface irregularities.

Pothole and patching: includes using cold and hot asphalt mixtures, spray-injection methods, and slurry and micro-surfacing materials to repair distress and improve ride quality.

Table 1. Recommended Applications for Crack Sealant and Fillers

Material	Mn/DOT Spec.	Recommended Action
Low Modulus Rubberized Asphalt	3720 3725	Crack sealer —During the evolution of the rout and seal method, the use of a lower-modulus sealant with a 3/4" x 3/4" reservoir size and less overband has shown to be very effective. Initially, material meeting the specifications of Mn/DOT 3720 was the product of choice for this system. Mn/DOT specification 3725, which has slightly higher resiliency properties, is now the recommended sealant for rout and seal. It is also the recommended sealant for saw and seal.
Rubberized Asphalt	3723	Crack filler/crack sealer —Material meeting the specifications of Mn/DOT 3723 has been the common sealer for rout and seal until recently. This product exhibits good adhesion qualities. This material can be used for rout and seal in situations where wider reservoir widths are needed. This product can also be used for the clean and seal (formerly known as the “blow and go”) method.
Crumb Rubber	3719	Crack filler — Crumb rubber is very effective in the clean and seal method. This process works best in the early spring or late fall when the cracks are open. Although crumb rubber will crack in the winter, it will re-heal during warmer weather. A double jacket melter is needed to maintain proper temperature of the product during application.
Asphalt Emulsion	CSS-1 CSS-1H CRS-2P HFMS-2	Crack filler —Asphalt emulsion can be used as a crack filler. The primary purpose would be to coat the edges of the crack and fill some of the crack. Since emulsions are 33 percent water, the quantities will shrink with curing. Emulsions are safe and easy to use, but limited to use in warmer seasons.
Asphalt Cement	AC-3	Crack filler —AC-3 is an air-blown asphalt that can be used to coat the edges and fill the crack. This product will get quite brittle in the winter and will track in warmer weather.
Cutback Asphalt	RC MC SC	Crack filler —Cutback asphalt, like emulsions, can be used primarily to coat the edges of cracks. Cutbacks are not as readily available and are not as safe as emulsions, but can be used in the winter months.

Table 2. Effective Sealing Tips

Technique	Tip
Saw and seal	The sealant should be placed flush to the pavement surface. The strike off will create a “slight overband” that provides better adhesion of the sealant to the pavement surface/reservoir edge corner.
Rout and seal	The total width of the overband should be about 2 1/2" (3/4" rout plus 3/4" overband on each side of the rout.) The overband thickness should be as thin as possible.
Clean and seal (formerly “blow and go”)	Cracks must be clean and dry before placing sealant. This process works best when done in late fall or early spring when cracks are open. Take care to not burn pavement with hot air lance. Follow manufacturer’s recommendations for sealant application temperatures.

Table 3. Recommended Applications for Surface Treatments

Material	Mn/DOT Spec.	Recommended Action
Fog Seal	2355	CSS-1 or CSS-1h diluted with 50% water usually applied at 0.05 to 0.15 gal/sy, depending on the pavement texture, weather conditions, and traffic. A spraying temperature of 125 to 160 ° F and surface temperature of at least 50 ° F is recommended.
Seal Coat	2356	See the <i>Seal Coat Handbook</i> (Mn/DOT document number 1999-07) for design methodology and application rates.
Double Chip Seal	None	Use the design application rates. Pavement should be dry and clean, and all necessary repairs or reconditioning work should be completed prior to placement of the double chip seal. Chip seals should not be placed in cool weather or on days with high humidity. They should also not be placed when there is a chance of rain.
Slurry Seal	None	Pavement should be dry and clean, and all necessary repairs or reconditioning work should be completed prior to placement of the slurry seal. Place when the air and pavement temperature are both at least 50 ° F and there is no chance of freezing within 24 hours after placement. Do not place during rain.
Micro-surfacing	Special Provision	Mix design must be followed carefully. Ideal for high volume roads. Pavement should be clean, and all necessary repairs or reconditioning work completed prior to placement of the micro-surfacing.
Thin Hot Mix Overlay	2350 LV Type 5	It is important to use a quality mix. Density is vital to performance. Sand mixes (aggregate size 3/8" minus) are not recommended. Place with paver, not blade.

Table 4. Recommended Applications for Patching

Material	Mn/DOT Spec.	Recommended Action
Cold mix	2381	Cold mix is normally used during winter months. Important to use high quality material and to compact properly. Emulsions are recommended for safety and environmental reasons.
Spray Injection	None	This process is best suited for transverse crack repair and pothole filling. Fairly high production, but operator dependent. A primary cause of poor patch life is insufficient density. Since asphalt emulsion is compatible with water, the crack needs not be perfectly dry to obtain long patch life.
Hot Mix	2350 LV type 5	Clean reservoir. Done in good weather. Compaction is essential for every patch, even if it is accomplished by driving over the patch with a truck. Material should be placed in the patch area, not thrown in.
Slurry and Micro-surfacing material	None	Based on availability of equipment to be used for transverse crack leveling. This process is a high-production operation that should create a level surface. Micro-surfacing gives a more durable patch, but is more sensitive to placement activities. Because of the required cure period, slurry should not be used to fill deep cracks or cracks that have developed large potholes.

Table 5. Effective Patching Tips

Technique	Tip
All	Quality control and density are very important to obtaining good performance. Use high-quality patching materials, which are cost-effective compared to less expensive products. Lower cost materials end up costing more because they don't last.
Cold mix	When using cold mix in heated hoppers, watch temperatures. Material should not be heated over 100° F. When heated to higher temperatures, binder will harden.

Best Practices for Concrete Pavement Maintenance

Best practices for concrete pavements are not as well defined as those for asphalt pavements. Specific best practices will be outlined in detail in the *Concrete Pavement Maintenance Handbook*, to be published by the Minnesota Local Road Research Board this fall.

Transverse mid-panel crack repair: a localized treatment method used to repair damage and prevent water and debris from entering a crack. This treatment is very effective at prolonging the pavement life, and may involve a partial- or full-depth crack repair.

Transverse joint repair: a localized treatment method used to restore the working joint and prevent water and debris from entering the pavement structure. This treatment is very effective at prolonging the pavement life, and may include partial- or full-depth joint repair.

Patching: a localized treatment method used to repair damage and restore the pavement surface. May be required for safety purposes.

For all of the above rehabilitation techniques, the following best practices apply:

Curing

Shrinkage cracks can develop if concrete is not cured properly. Hot-weather curing methods include a curing compound, moist burlap, or polyethylene. Cold-weather curing methods include use of an insulating blanket or tarp.

Follow manufacturer's recommendations for proprietary materials.

Joint sealant repairs

Completely remove old sealant.

Clean out joint completely using water blasting, sand blasting or compressed air.

Repair adjacent concrete as needed, using a form to leave straight vertical edge for sealant installation.

Place new sealants according to manufacturer's recommendations.

Crack and joint repairs and patching

Completely remove damaged pavement using hammer or saw.

Repair edges must be sawed clean with sharp saw blade.

Clean out patch areas completely.

Restore underlying base materials, replace materials as needed, and compact to specification.

A good bond with the existing concrete is required, and a bonding agent may be needed.

Use a form to leave a straight vertical edge for sealant installation when replacing the concrete materials.

Note that Mn/DOT and the Concrete Pavers Association have standard concrete joint repair and patching details and specifications for your use.

Turf Runway and Taxiway Maintenance

Best practices for seeding and turf establishment

- Use the Mn/DOT standard mix for roadsides.
- Place seed at the Mn/DOT application rate and mulch afterwards. Hydraulic mulch works well for airports and doesn't blow around.
- Get assistance from Mn/DOT if you choose to use native grasses to make sure you are planting a non-clumping species.
- Rather than using the FAA seeding specification, contact Mn/DOT for its expertise in seed selection for your local area and conditions.

According to Bob Jacobson, Mn/DOT Office of Environment Services, "A mix of several species is always better than a monoculture or just a couple of species." Jacobson says the selection depends on whether there is a definite height requirement or not. If height is limited, "then a mix of buffalo grass and blue grama with cover crop would be acceptable. June grass might work; Kalm's brome with some purple prairie clover tossed in for nitrogen fixation would be good, too."

Note that most native grass species are clump forming, and clumping species are not appropriate for runway areas. Buffalo grass is considered a weak sod former.

Table 6. Seed Options

Seed/grass selection	Mn/DOT Mix No.	Description	Fertilizer	Removing dead growth	Attractiveness to animals
Turf grasses					
Kentucky "certified park" bluegrass	60B	Low maintenance Lawn appearance	Slow-release organic	Raking	High
Canada bluegrass	60B		Slow-release organic	Raking	High
Kentucky low-maintenance bluegrass	60B	Low maintenance		Raking	High
Native grasses					
Grama species	Native mix	Non-clumping Likes dry, drought conditions	None	Burning every 3–5 years	Dormant in spring and fall, so doesn't attract deer
Buffalo grass	Native mix	Non clumping Likes dry, drought conditions Doesn't like sandy soils	None	Burning every 3–5 years	Dormant in spring and fall, so doesn't attract deer
Sideoats grama	Native mix	Seed heads grow to 18"	None	Burning every 3–5 years	Dormant in spring and fall, so doesn't attract deer

Using native grasses

Seeding native grasses and forbs (wildflowers) can be accomplished using a number of different methods. However, due to the complexity of seed sizes, textures, and densities, a great deal of care needs to be taken to ensure that the site is well prepared and that seed is placed properly. A number of different types of drills may be used to place seed, but be aware that many “older style” drills will clog easily with fluffy seeds. Broadcast seeding and hydroseeding also work well, but remember that natives cannot be seeded in exactly the same way as turf grasses. There are several general “rules of thumb” to keep in mind when seeding natives:

- Native seeds prefer a firm seedbed.
- Large and/or fluffy seeds should be buried approximately 1/4-inch deep.
- Small and/or fine seeds (most forbs) should be scattered over the soil surface.
- Seed should be lightly covered with soil; harrowing or raking works well.

The benefits of using native grasses include:

- Less money spent on herbicides, fertilizers, and maintenance because native plants are self-sustaining and require less maintenance. Dense roots force out competing plants, requiring less herbicide use.
- More effective application of herbicides through better use of equipment and spot spraying only the weeds; optimizing chemical use by using the best products at the right time.
- Less soil erosion. The dense and deep root systems (typically 6–8 feet, and as deep as 12–14 feet) for these grasses not only force out competing weeds, but also hold soil to prevent erosion and slope failure.
- Dramatic reduction in mowing and spraying needs.
- Reduced environmental impacts from maintenance operations.

Prairie plants can adapt to a wide range of soil types, moisture levels, and climatic conditions. Most prairie grasses and wildflowers grow best during hot, dry summer months, providing excellent erosion control during the fall and spring. Deep roots also prevent the invasion of noxious weeds and reduce the number of undesirable and competing shrubs and trees.

Maintenance needs for native grasses

Burning and haying are the two primary management techniques for use with prairie vegetation.

Burning is beneficial in that it:

- Stimulates the growth of many native prairie plants.
- Controls weeds and woody invaders.
- Removes thatch.
- Recycles nutrients.
- Warms the soil and gives warm-season plants an earlier start.

Consider safety, weather conditions, equipment, and manpower before burning. Timing is important; burning is most beneficial from mid-April to early May for warm-season grasses. As with spraying growing weeds, burning earlier is better for wildflowers, as waiting does more harm than good. Any burning plan must include smoke management for safety purposes. **Close the airport during burning operations.**

Additional information regarding proper burning procedures can be obtained from the Fire Management and Research Program at the Nature Conservancy (850-668-0827), the DNR Division of Forestry, or the county fire marshal.

Seed sources and harvesting

Native grass and wildflower seed is expensive, costing approximately \$50–\$100 more per acre than turf grass seed. Once a stand of native grasses has been established, it is possible to harvest seed. Harvest the

seed in the fall, either by hand, which can be done by volunteer organizations, or using farming equipment. Some weedwhipper-style equipment is effective, and combines and flail vacs are practical for larger areas.

Several books provide information on harvesting dates, seed storage, and propagation. It is important to obtain permission before collecting seed on state and county preserves, private land, and state rights-of-way. Also, never take all of the seed; leave at least 80 percent for regeneration.

It is very important to use seed that has adapted to local climate and environmental conditions. Through natural selection, genetic variants within species have developed to do so. These variants, known as ecotypes, are suited to local climate, soil type, diseases, and pests. To date, the Midwest has relied heavily on western varieties for prairie plantings. These varieties have been typically selected from a limited gene pool, and were developed as vigorous forage plants. For this reason, they can overtake less aggressive local populations. Due to their limited gene pool, these western varieties can lack resistance to local diseases, pests, and weather, causing them to be short-lived. They may also bring in diseases and threaten local populations.

A list of where to obtain local ecotype seed can be found on the Mn/DOT Office of Environmental Services Web site at www.dot.state.mn.us/environment/. Recently, most of the effort by seed producers has been on producing native prairie seed. Seed for natives from other vegetative zones, such as woodland edges is also being developed, and should be available within the next few years.

Starting a prairie planting

The following steps may be used as a guide to getting started using native grasses or wildflowers.

1. Survey the site, and consider drainage requirements, soil type, existing vegetation, sun and wind exposure, and adjacent land uses and management impacts.
2. Clear the existing vegetation by using a broad-spectrum herbicide, such as glyphosate (Roundup). Allow a week for the herbicide to work effectively, then mow or burn to remove the dead plant material. Seed may then be drilled or raked into the stubble.
3. If timing permits, an alternative to using herbicides is cultivation, or sequences of till, fallow, and till. Plow or harrow the soil several times prior to planting to destroy existing vegetation and eliminate germinating weeds. The last two cultivations before seeding should be just deep enough to remove any remaining weed seedlings.
4. Plant a native mix that includes fast cover and permanent establishment species, using as many species as are affordable (this adds to the beauty and diversity of the roadside). Achieving good seed-to-soil contact is the best insurance for successful establishment. For larger areas, use a native grass drill if available. If broadcasting seed, lightly rake, drag, or disk the seed to a depth of 1/4- to 1/2-inch. Roll or cultipack to firm the seedbed.
5. Unchecked weeds can shade out prairie seedlings during the first year. To prevent this, mow weeds at a height of 4–6 inches the first year on approximately June 1, July 15, and September 1. The second year, mow at a height of 7–9 inches in May, and 12–14 inches in June, if needed. These mowing heights will help prevent damage to emerging prairie plants. Additional spot mowing or hand weeding may also be helpful to control invasive weeds.
6. Burn as soon as there is enough leaf litter accumulated to carry a fire (this may be during the second or third year after planting.) This helps to destroy the weedy species and stimulate prairie vegetation. Burning every three to five years should be sufficient. If woody vegetation becomes a problem, burn more often. Burn in sections and at different times of the year to reduce adverse effects to any one prairie species. If burning is not possible, remove plant litter by some other means such as raking or mowing. **Note that most of the growth in the first two years is occurring below ground, and it may be three to four years before the growth above ground is well established.**

Examples of native grasses that may be appropriate for a turf runway are buffalo grass and blue grama. A complete list may be found on the Mn/DOT Office of Environmental Services Web site at

www.dot.state.mn.us/environment. The Web site also includes a list of appropriate wildflowers and their substitutes. Wildflowers are listed for each of four areas in Minnesota, as well as for wetland areas.

Application rates

Seeding rates shown in Mn/DOT standard specifications are based on installation on prepared and tilled roadside sites. If you are interseeding you can decrease rates by one-third to one-half. If you are seeding non-roadside sites such as wetland or prairie restoration sites, you can decrease rates as well. Table 7 shows Mn/DOT's standard seeding rates.

Table 7. Seed Mixture Application Rates

Seed Mixture Number	Application Rate (pounds per acre)	Application Rate (kg/ha)
120B, 125B	25 #/acre	27.5 kg/ha
5B, 10B, 15B, 20B, 25B, 26B, 33B, 38B	30 #/acre	33 kg/ha
28B	40 #/acre	44 kg/ha
50B, 80B, 90B	50 #/acre	55 kg/ha
30B, 30B-WF	60 #/acre	66 kg/ha
60B, 100B, 110B, 130B	100 #/acre	110 kg/ha

Season of planting

The season of planting for native grass and forb mixtures runs from spring to early summer and from fall until the ground freezes. Table 8 shows generally when seeding of various Mn/DOT mixes should be done. A note on dormant seeding: different species are dormant at different times of the year. Dormant seeding for warm-season grasses is early fall, as they require moisture and sustained soil temperatures of 65° F and above to germinate. Cool-season grasses will germinate at colder temperatures and generally in a shorter period of time. Many forbs will not germinate at all the first year when seeded in the spring as they require a freeze/thaw period (winter) to germinate, so they may not come in until the following spring. Dormant seeding is also somewhat risky because of vagaries in weather and predation, washing away, etc. However, plantings of cool-season grasses and forbs do appear to contain more diversity when installed in the fall.

Table 8. Season of Planting

Seed Mixture Number	Spring	Fall	Dormant Seeding	Dormant Seeding Max. Soil Temp. °F
5B, 10B, 15B, 20B, 25B, 26B, 28B, 30B, 30B-WF, 33B, 38B	April 15 to July 20	Sept. 20 to Oct. 20	Oct. 20 to Nov. 15	50
50B, 60B	April 1 to June 1	July 20 to Sept. 20	Oct. 20 to Nov. 15	40
80B, 90B	April 1 to Sept. 1	---	Oct. 20 to Nov. 15	40
100B		Aug. 1 to Oct. 1	---	---
110B	May 1 to Aug. 1	---	---	---
120B, 125B, 130B	April 1 to July 20	July 20 to Oct. 20	Oct. 20 to Nov. 15	35

Seeding methods are outlined in the *Mn/DOT Seeding Manual*, available online at www.dot.state.mn.us/environment.

Best practices for applying fertilizer

- Fertilize three times before seeding (recommended by Tom Foster, SEH, Inc.).
- Fertilize every year. Ask your local golf course superintendent what fertilizer he or she uses for local soils and conditions.
- Use slow-release organic fertilizer (recommended by Mn/DOT).
- See Table 6 for fertilizer requirements.

Frequently, fertilizers are not needed for native grass and forb plantings. Most agricultural soils already contain a sufficient amount of NPK for the native grasses and forbs to become established. In the case of planting in infertile soils, it is recommended that a soil test be taken and that a slow-release fertilizer be used based on deficiencies indicated by the soil fertility analysis. If you are going to use a generic fertilizer it is recommended to use a 22-5-10 NPK analysis fertilizer. A general rule of thumb is that native grasses and forbs require about half the rate of fertilizer as turf and forage species (from the *Mn/DOT Seeding Manual*).

Best practices for rolling and grading operations

- Construct and grade turf runways as if they were safety areas.
- Build base as a typical runway.
- Use FAA aggregate pavement specification (Spec Item P-217).
- Don't plow if you don't have to, as it causes washboarding.
- Using topsoil increases rutting. Turf aggregate doesn't rut as much, but isn't a good environment for growing sod. Improve the growing environment by using more fertilizer (three times before seeding).
- Roll corrugations with a heavy steel drum roller.
- Follow these closing procedures in spring/soft conditions:
 - Place yellow Xs and follow FAA Advisory Circular 150/5340-1H, Figure 20.
 - Issue a NOTAM.
 - Develop guidelines for when to close the airport.

Best practices for removing dead grasses

Thatching or raking is recommended for turf grasses. In addition, burn native grasses every three to five years. See the previous section on Maintenance Needs for burn requirements and safety considerations.

Developing a mowing policy and improved procedures

Developing a mowing policy will enable better use of maintenance staff time and assist in prioritizing areas to be mowed and not mowed. Mowing at the wrong time can be harmful to wildlife, and mowing when soils are saturated can damage soil structure and function.

Mn/DOT has developed a mowing policy, described in chapter five of the *Mn/DOT Maintenance Manual*.

The policy states that the primary purpose of maintaining vegetative cover is to prevent erosion.

Roadsides are to be generally maintained in conformance with adjacent land use, and spot mowing is to be used to control noxious weeds. Mowing on airports is done for different purposes, and leaving some areas unmowed may be unacceptable for safety reasons. For example, the presence of small brush or trees less than four inches in diameter along a roadside is significantly less hazardous to traveling vehicles than the same vegetation along an active runway or taxiway.

When developing a mowing policy, an airport owner should consider:

- Safe operating practices
- Prioritization of mowed and unmowed areas
- FAA safety requirements
- Noxious weed control
- Expected or required cost reductions

In addition, an airport owner should identify:

- The objective of mowing
- The impacts if mowing is reduced
- A communication plan between mower operators and weed sprayer operators
- Areas that could be left unmowed with little negative effect
- Ways to blend areas that are left unmowed with areas that are mowed
- The treatment of those areas left unmowed
- Mower operator training needs
- Other maintenance activities that could be done if less time is spent on mowing
- The magnitude of slopes to be mowed and not mowed
- The person or persons who will determine the areas to mow and not mow
- The best time to mow certain vegetation types, based on growth, time of year, or height
- Alternative vegetation that could be planted that does not have to be mowed
- Nesting times for local wildlife
- Location of saturated soils

Obtaining input from all mowing staff will result in a mowing policy that addresses safety concerns, identifies communication issues and procedures, and establishes the criteria for which areas are to be mowed and to what extent. Agreement on these issues, and inclusion in a written plan, will result in all staff working toward the same goal. Reducing the amount of mowing and the extent to which areas are mowed gives workers more time to complete other maintenance activities and increases the efficiency of all maintenance operations.