NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WINDBREAK/SHELTERBELT ESTABLISHMENT

(Ft)

Code 380

DEFINITION

Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSES

- Reduce soil erosion from wind.
- Protect plants from wind related damage.
- Alter the microenvironment for enhancing plant growth.
- Manage snow deposition.
- Provide shelter for structures, animals, and people.
- Enhance wildlife habitat.
- Provide noise screens.
- Provide visual screens.
- Improve air quality by reducing and intercepting airborne particulate matter, chemicals and odors.
- Delineate property and field boundaries.
- Improve irrigation efficiency.
- Increase carbon storage in biomass and soils.
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

Apply practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, odor, and visual resources. Use other tree/shrub practices when wind, noise and visual problems are not concerns.

CRITERIA

General Criteria Applicable to All Purposes

The location, layout and density of the planting will accomplish the purpose and function intended within a 20-year period. See REFERENCES section for historic wind roses and frequency data from the State Climatologist Office for Illinois.

The maximum design height (H) for the windbreak or shelterbelt shall be the expected height of the tallest row of trees or shrubs at age 20 for the given site.

The distance protection extends from the windbreak's leeward side is proportional to the overall height. The most effective zone of protection extends to a distance 2 to 5 times (2H - 5H) the height, while significant protection extends to 10H.

Species must be adapted to the soils, climate and site conditions. Only viable, high quality, and adapted planting stock or seed will be used.

Changes in soil properties within the planting site may require the species to change within the row or selection of species with a wide range of adaptability.

Species shall be suited for the planned practice purpose(s).

No plants on the Federal or state noxious weeds list shall be planted.

Multiple species, within rows, may be used if heights, growth rates and growth forms are similar.

Site preparation shall be sufficient for establishment and growth of selected species and temporary cover when planned, not contribute to erosion, and be appropriate for the site. Refer to conservation practice standard TREE/SHRUB SITE PREPARATION (Practice Code – 490).

The planting shall be done at a time and manner to insure survival and growth of selected species.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species.

Refer to conservation practice standard TREE/SHRUB ESTABLISHMENT (Practice Code – 612) for further guidance on planting trees and shrubs.

Spacing between individual plants shall be based on the needed growing space for plant type and species, the accommodation of maintenance equipment, and the desired characteristics of the stem(s), branches and canopy as required for a specific purpose.

Trees and/or shrubs will not be planted where they will interfere with structures and/or above or below ground utilities. Woody plants will be established without compromising the integrity of property lines, fences, utilities, roads, legal drains, easements or rights of way.

Allow at least a 16-foot maintenance strip from the outside row of trees or shrubs to adjacent property lines or contrasting land use areas.

Comply with applicable federal, state and local laws and regulations during installation, operation, and maintenance of the practice. Appropriate cultural resources review will be conducted before beginning any tree planting practice.

Where functional subsurface drains (tile lines) pass through a tree/shrub planting, sealed conduit will be installed through the planting and extend a minimum of 100 feet from rows of large trees (capable of reaching heights greater than 60 feet) and 75 feet from all other trees and shrubs. Trees and shrubs will not be planted within 50 feet of either side of existing subsurface drains.

When placing an opening through a windbreak, make the opening on an angle to reduce the loss of wind protection. Whenever possible locate access roads at the ends of windbreaks, beyond the area where snowdrifts form.

Local regulations concerning planting of trees and shrubs along roads and right of ways will be observed.

Additional Criteria to Reduce Wind Erosion and to Protect Plants from Wind Related Damage

The windbreak will be oriented as close to perpendicular to the troublesome wind as possible.

For wind erosion control, temporary measures including residue management, crop rotation, and cover crops will be considered to supplement the windbreak until it is fully functional.

Sites, fields, and plants are protected within an area 10 times the design height (H) on the leeward side and two times the design height (H) on the windward side of the windbreak.

The length of the windbreak will extend 50 feet beyond each end of the area to be protected to mitigate changes in wind direction and ensure maximum effectiveness. (Up to 50 feet when property boundary limitations do not allow)

The interval between windbreaks shall be determined using current, approved, wind erosion technology. Interval widths shall not exceed distances permitted by the soil loss tolerance (T), or other planned soil loss objective. Calculations shall account for the effects of other practices in the conservation management system. Base spacing between sets of windbreaks on the level of plant

protection desired. Some crops and their annual/acre tolerance to windblown soil are listed below.

- Tolerant (3 tons): barley, oats, rye, wheat
- Moderate tolerance (2 tons): corn, grain sorghum, sunflowers
- Low tolerance (1 ton): apples, cherries, peaches
- Very low tolerance (< 1 ton): alfalfa, cotton, vegetables, potatoes

Select plant species taller than the crops being protected.

Additional Criteria to Manage Snow Deposition (Living Snow Fence)

The windbreak will be oriented as close to perpendicular to the snow-bearing wind as possible.

For even snow distribution across a field, the windbreak density (during expected snow-producing months) shall not be less than 25% nor greater than 50%. The interval between barriers will not exceed 20H.

For snow accumulation, the minimum barrier density, during expected snow-producing months, will be 50%.

The windward row will be at least 80 feet (60 feet south of Interstate 64) from the area to be protected. The windward row will be no more than 250 feet from the area to be protected.

Windbreaks will be located in a manner to ensure snow deposition will not pose a health or safety problem or obstruct human, livestock, or vehicular traffic.

Where water erosion and/or runoff from melting snow are a hazard, it shall be controlled by supporting practices.

If snow damage in a windbreak is a problem, use the widest spacing, locate a shrub row windward 40-75 feet from the primary windbreak, and/or locate a shrub row on the leeward side.

Additional Criteria to Provide Shelter for Structures, Livestock, and People

The windbreak will be oriented as close to perpendicular to the troublesome wind as possible.

For wind protection, the minimum barrier density will exceed 65% during the months of most troublesome wind.

The area to be protected will fall within a leeward distance of 10H.

To mitigate snow accumulation and reduce turbulence, the windward row will be at least 80 feet (60 feet south of Interstate 64) from the area to be protected.

The length of the windbreak will extend 50 feet beyond each end of the area to be protected to mitigate the “end effect” of drifts, changes in wind direction, and ensure maximum effectiveness. (Up to 50 feet when property boundary limitations do not allow)

Drainage of snowmelt from the windbreak shall not flow into livestock areas.

Drainage of livestock waste from livestock areas shall not flow into the windbreak.

Additional Criteria for Providing or Enhancing Wildlife Habitat or Travel Corridors

Select plant species to benefit targeted wildlife species including pollinators. Refer to conservation practice standard HEDGEROW PLANTING (Practice Code – 422) for a list of recommended woody species for wildlife.

Design dimensions of the planting shall be adequate for targeted wildlife species. Minimum width is 30 feet. See “Conservation Corridor Planning” in listed REFERENCES for additional information on corridor design.

Add rows to a planting to increase wildlife benefits. A minimum of one evergreen and one shrub row should be included among the windbreak rows. Shrub rows should be located on outside rows. Wildlife usage is increased

with 5 rows, and becomes optimal with 10 or more rows.

Use plants of different sizes, growth forms, food-bearing capabilities and densities to increase diversity.

Additional Criteria for Noise Screens

Noise screens will be at least 65% dense during all times of the year. At least one row will be composed of the tallest-growing species adapted to the site. Establish the noise screen as close to the noise source as practicable.

The length of the noise screen will be twice as long as the distance from the noise source to the receiver.

For high-speed (> 50 mph) traffic noise, the barrier will be a minimum of 65 feet wide. The leading edge of the planting will be 80-150 feet from the edge of the roadway. The tallest tree row will be capable of attaining a mature height of at least 45 feet.

For moderate speed (< 50 mph) traffic noise, the barrier will be a minimum of 20 feet wide. The leading edge of the planting will be 50-80 feet from the edge of the roadway. The tallest tree row will be capable of attaining a mature height of at least 30 feet.

Trees and/or shrubs planted near paved roads subject to application of de-icing salt will be at least moderately tolerant to salt spray. See “Right Tree – Right Place” and “Salt Tolerant Trees and Shrubs” in listed REFERENCES.

Additional Criteria for Visual Screens

Visual screens shall be located as close to the observer as possible with a density, height and width to sufficiently block the view between the area of concern and the sensitive area during desired periods.

Additional Criteria to Improve Air Quality by Reducing and Intercepting Airborne Particulate Matter, Chemicals and Odors

Windbreaks planted to control chemical drift function by both reducing wind speed to limit drift and by absorbing spray drift on plant parts. Use at least one row of the tallest adapted species to maximize the effectiveness of the windbreak.

The windbreak interval shall be less than or equal to 10H depending on site conditions and related supporting conservation practices.

Windbreak density on the windward side of the problem source, (i.e. particulate, chemical or odor) shall be greater than 50% to reduce the airflow into the source area.

Windbreak density on the leeward side of the problem source, and windward of the area to be protected, shall be greater than 65%.

Keep inner row of windbreak plantings from all buildings and waste storage areas at least 10 times the exhaust fan diameter or 50 feet, whichever is farther.

Adjust windbreak porosities/densities to meet air movement needs for naturally ventilated livestock confinement systems.

Select and maintain tree and shrub species with foliar and structural characteristics to optimize interception, adsorption and absorption of airborne chemicals or odors.

Additional Criteria for Improving Irrigation Efficiency

For sprinkler irrigation systems, the windbreak shall be taller than the spray height.

The windbreak shall not interfere with the operation of the irrigation system.

Additional Criteria to Increase Carbon Storage in Biomass and Soils

Select plants adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

Use fast growing species in a mix with long-lived species.

Maintain optimal water and nutrient needs for the planting.

Maximize width and length of the windbreak to fit the site.

For optimal carbon sequestration, select plants with higher rates of sequestration in biomass and soils.

Plant and manage the appropriate plant spacing for the site to maximize above and below ground biomass production.

Minimize soil disturbance during establishment and maintenance of the windbreak/shelterbelt.

Additional Criteria to Reduce Energy Use

Orient the windbreak as close to perpendicular to the troublesome wind as possible

Use proper plant density to meet energy reduction needs.

Use plants with a potential height growth that will be taller than the structure or facility being protected.

CONSIDERATIONS

Selection of plants for use in windbreaks should favor species or varieties tolerant to herbicides used in the area.

Plants which may be alternate hosts to undesirable pests should be avoided.

Tree or shrub rows should be oriented on or near the contour where water erosion is a concern. Consider control of hazardous water erosion and/or runoff from melting snow with supporting practices.

Wildlife and pollinator needs should be considered when selecting tree or shrub species. Species diversity, including use of native species, should be considered to avoid loss of function due to species-specific pests.

A shelterbelt can be used as a travel corridor to connect existing patches of wildlife habitat.

Consideration should be given to adverse offsite effects such as shading and deposit of snow on adjacent areas.

In cropping systems select windbreak and shelterbelt species to minimize adverse affects to crop growth (e.g. shade, allelopathy, competing root systems or root sprouts).

Root pruning may eventually be necessary to reduce impacts on adjacent croplands. Refer to conservation practice standard WINDBREAK/SHELTERBELT RENOVATION (Practice Code – 650) for additional information on root pruning.

Windbreaks for odor and chemical control increase in effectiveness as the amount of foliage surface area increases. Multiple rows, wide plantings offer greater interception potential than do smaller plantings.

Refer to Illinois Fact Sheet “Using Windbreaks to Manage Odor from Livestock Facilities”, located in Section IV of the IL – FOTG, for additional information on odor management.

When using trees and shrubs for greenhouse gas reductions, prediction of carbon sequestration rates should be made using current, approved carbon sequestration modeling technology.

Species selection to allow for the production of nuts and fruits for human and/or wildlife consumption, wood products, seeds, floral products and other agroforestry products is appropriate where it does not reduce the effectiveness of the windbreak.

Consider using larger air-root pruned potted planting stock to speed establishment and growth. Balled and burlapped material, by comparison, is often much more expensive and grows slowly for several years after planting. For more information on air-root pruned potted stock see “Container grown” planting stock in conservation practice standard TREE/SHRUB ESTABLISHMENT (Practice Code – 612)

When designing and locating a windbreak or shelterbelt, consider the impact upon the landowner’s or public’s view of the landscape.

All plantings should complement natural features.

PLANS AND SPECIFICATIONS

Specifications for applying practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation. Minimum design documentation will include: Determination of adapted species or trees/shrubs, planned site preparation and weed control, species and number to be planted in each row, spacing within and between rows, plant protective measures to provide desired function, maps or drawings needed to show location and site layout.

Recommended species

For adapted species and cultivars, refer to the Illinois FOTG, Section II, E. Conservation Tree/Shrub Suitability Groups. A partial list of the more commonly used trees and shrubs for windbreaks in Illinois is in Table 1. Additional species that meet intended purpose and design specifications may be considered when shown to be adapted to the soil, climate and site conditions.

Density

Windbreak densities can be controlled through the type of plants, pruning activities, within row spacing, and the number of rows used. See "How Windbreaks Work" in listed REFERENCES for chart to estimate windbreak densities.

Specific row minimums and plant types are designed to achieve the minimum densities stated under individual criteria sections. Use the following chart to achieve the minimum density requirements and adjust plant spacing to meet specific objectives above these minimums.

Windbreak Type	Minimum # of Rows
Shelter	
farmstead/shelterbelt	3ai
feedlot	3ai
Screens	
high-traffic noise (>50 mph)	6cj
med-traffic noise (<50 mph)	3bj
visual	2ad
Wildlife	5ai
Field	1h or 3ei
Living Snow Fence	
snow distribution	1f or 1i
snow accumulation	2g or 2i
Air Quality	
reducing chemical drift	1j
odor control (windward side)	3ai*
odor control (leeward side)	2g or 2i

a = 1 row must be evergreen
b = 2 rows must be evergreen
c = 3 rows must be evergreen
d = 3 rows if all deciduous species are used
e = 2 rows deciduous trees and/or evergreens
f = 1 row of deciduous tree, e. redcedar or arborvitae
g = at least 1 row e. redcedar or arborvitae
h = e. redcedar, arborvitae or spruce spp.
i = 1 row of shrubs *(inside row for odor)
j = tallest tree species adapted to the site

Additional rows may be used to enhance wildlife values, meet landowner objectives, increase diversity, improve natural beauty, and/or increase density.

Plant Spacing

Stagger tree spacing so the trees in one row will be planted opposite the opening in the other row.

Example:

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     X     X     X     X
  X     X     X     X     X
     X     X     X     X
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Within Row Spacing:

Small shrubs (< 8' tall)	3 – 6 feet
Large shrub (8-25')	5 – 8 feet
E. redcedar and arborvitae	8 – 12 feet

Tall deciduous/evergreen trees	8 – 16 feet

Spacing Between Rows:

Shrub	6 – 12 feet
E. redcedar and arborvitae	10 – 16 feet
Tall deciduous/evergreen	12 – 30 feet
Between tree & shrub rows	10 – 20 feet

Using the closest within row spacing will give quicker results due to canopy closure but may necessitate thinning to maintain full crowns and prevent natural pruning of lower branches.

Using the widest spacing will reduce or eliminate the need for maintenance or renovation, especially thinning, but will greatly increase the time for crowns to close and the windbreak to reach maximum effectiveness.

Between row spacing should be at least 4 feet wider than any equipment planned for between-row maintenance.

Use the widest between row spacing if deciduous/evergreen trees are to be planted in adjacent rows of the same windbreak. Wide Spacing will prevent faster growing deciduous species from overtopping conifer species.

Use close within row spacing for windward rows and 2-row windbreaks. Wider spacing is best in middle and lee rows of multi-row windbreaks because plants will develop fuller crowns and require less maintenance.

If trees and/or shrubs are to be established by direct seeding, seed at a rate of approximately one seed for every 1.5 to 2 feet of row length. Plan to thin, reserving the best seedlings, to desired final spacing. Refer to conservation practice standard TREE/SHRUB ESTABLISHMENT (Practice Code – 612)

Living Snow Fence:

Additional specifications when planning for snow accumulation along roadways

- Snow barriers should extend 100 feet beyond the ends of the roadway areas to be protected when ownership and site conditions allow.
- Windward rows will be a maximum of 250 feet from the centerline of the roadway.
- Windward rows will not be closer than 80 feet from the centerline of the roadway. (60 feet south of Interstate 64)
- To mitigate icing and windthrow, Leeward rows (nearest the roadway) will be a distance from the road shoulder of at least 1.5 times the mature plant height for that row.

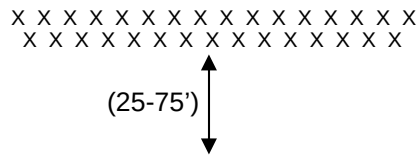
An area on the leeward side of a windbreak within 1H to 4H of the windward row will receive maximum snow deposition. Snow will also accumulate on the windward side for a distance of 1H to 2H. The deepest part of the snowdrift will be closest to dense windbreaks and progressively farther away from the windbreak as windbreak density decreases.

Twin Row High Density:

A windbreak design consisting of 2 closely spaced offset rows of trees or shrubs designed to grow together into a single thick row of vegetation.

- Each twin row set will contain the same species.
- The windbreak will contain a minimum of two twin row sets (4 rows total). To promote diversity each twin row set may be composed of a different species of tree or shrub.
- The spacing between twin rows will be 25 to 75 feet to achieve desired objectives.
- For plant spacing within twin rows, use the closest within row spacing for the appropriate species. Use the same spacing between rows and between plants within the twin row set.

Example: (2 twin row sets of different species)



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Site Preparation

Competing vegetation will be controlled by one or more of the following methods:

Fall site preparation prior to spring planting is preferred. A fall temporary seeding may be used where needed to control soil erosion, see conservation practice standard TREE/SHRUB SITE PREPARATION (Practice Code – 490).

If the existing cover is sod, alfalfa, or weedy cropland, control competing vegetation by:

- Strip tilling
- Strip chemical treatment
- Chemical or mechanical spot treatments

If cover is non-weedy cropland:

- Plant in stubble without prior preparation; or
- Lightly disk the area to evenly distribute crop residues.

All spot or strip treatments shall be at least 4 feet in diameter or width.

All chemicals will be used in accordance with label guidelines.

Planting

Refer to conservation practice standard TREE/SHRUB ESTABLISHMENT (Practice Code – 612) for planting guidelines.

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure the windbreak or shelterbelt functions as intended throughout the expected life of the practice. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance):

A weed-free area at least 2 feet in all directions from planted or seeded trees and/or shrubs will be maintained for at least the first 2 years after planting. Competing grass species will continue to be controlled in a 2-foot radius until woody plants are at least equal in height to competing grasses. Noxious weeds will be controlled. If mulches are to be used refer to conservation practice standard MULCHING (Practice Code – 484). If herbicides are to be applied read and follow all label directions.

Replacement of dead trees or shrubs will be continued until the windbreak/shelterbelt is functional. Replace any dead plants for the first 2 years. After 2 years at least 85% of plants will be surviving with no two adjacent plants missing.

Supplemental water or weed barrier fabric will be provided as needed.

Periodic applications of nutrients may be needed to maintain plant vigor.

Thin the windbreak/shelterbelt to maintain function.

Pruning should be done only for the purposes of removing dead, injured, or diseased wood and for creating desired levels of porosity.

Inspect trees and shrubs at least every 6 months and protect from adverse impacts including insects, diseases, competing vegetation, fire and damage from livestock and wildlife. Tree shelters may be necessary to protect trees and shrubs from damage by rabbits and/or deer.

Protect windbreaks from herbicides, especially during burn-down treatments on adjacent croplands. Use directed sprays around trees and develop a drift control strategy around windbreaks.

Windbreaks may be root pruned if woody plant roots are expected to compete for moisture with adjacent cropping systems. Refer to conservation practice standard WINDBREAK/SHELTERBELT RENOVATION (Practice Code – 650) for additional information on root pruning.

Properly maintained windbreaks will not require renovation for many years. Maintenance should begin after trees are well established and before crowding starts. Maintenance usually occurs between the tenth and fifteenth year depending on the species, rate of growth and spacing. Periodic removal of individual trees will relieve overcrowding and eliminate the need for major renovation. Care must be taken in removing trees in a windbreak to avoid reducing effectiveness. See conservation practice standard WINDBREAK/SHELTERBELT RENOVATION (Practice Code – 650) and "Windbreak Management" in listed REFERENCES for more information.

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http://www.isws.illinois.edu/atmos/statecli/roses/wind_climatology.htm

Table 1. Partial list of Trees and Shrubs capable of growing on many soil types throughout Illinois.[a]

TREE SPECIES	20 YR HEIGHT[1]	MATURE HEIGHT[1]	MATURE SPREAD [2]	CROWN SHAPE	SALT SPRAY TOLERANCE[3]
Common ninebark	<8	10	5-10	Spreading	Moderate
American hazelnut	<8	10	5-10	Spreading	Sensitive
Gray dogwood	<8	10	4-6	Spreading	Sensitive
Silky dogwood	<8	7	6-10	Spreading	Sensitive
Redosier dogwood	<8	12	6-10	Spreading	Sensitive
Roughleaf dogwood	8-15	25	5-10	Spreading	Sensitive
Common serviceberry	8-15	36	10-15	Spreading	Moderate
American plum	8-15	24	10-15	Spreading	Sensitive
Blackhaw	8-15	16	8-12	Spreading	Moderate
Common chokecherry	8-15	25	10-15	Spreading	Moderate
Arborvitae	16-25	50	4-10	Columnar	Moderate
Eastern red cedar	16-25	50	8-12	Pyramidal	Moderate
Persimmon	16-25	55	20- 35	Rounded	Moderate
Colorado blue spruce	16-25	100	10-20	Pyramidal	Tolerant
White oak	16-25	100	50-70	Rounded	Moderate
Hackberry	26-35	60	15-30	Oblong	Sensitive
Norway spruce*	26-35	>100	25-35	Pyramidal	Moderate
Bald cypress	26-35	>100	40-50	Pyramidal	Tolerant
Red pine	26-35	80	25-35	Pyramidal	Sensitive
Sweetgum	26-35	100	35-40	Pyramidal	Tolerant
Pin oak	26-35	100	35-40	Pyramidal	Sensitive
Swamp white oak	26-35	100	50-70	Rounded	Sensitive
Bur oak	26-35	100	50-70	Rounded	Moderate
Red maple	26-35	68	25-40	Rounded	Sensitive
Eastern white pine	>35	>100	50-60	Pyramidal	Sensitive
Yellow poplar (Tulip)	>35	>100	20-50	Oblong	Sensitive
Carolina poplar*	>35	>100	20-40	Oblong	Moderate
Eastern cottonwood	>35	>100	50-70	V-Shaped	Tolerant

* Not Native to Illinois

[a] Refer to Section II eFOTG for additional species and adaptability

[1] Mature height (feet) is an estimate and may vary dependent upon site

Information taken from USDA PLANTS Database: http://plants.usda.gov/java/

[2] Mature Spread (feet) is an estimate and may vary dependent upon adjacent competition and site

[3] Salt tolerance rating is for road salt spray,

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the Field Office Technical Guide.

variations may occur with soil-borne salt or other sources