CONSERVATION PRACTICE SPECIFICATION
Salinity and Sodic Soil Management - 610

Salinity and Sodic Soil Management - 610 shall be planned and installed in accordance with the NRCS Standard detailed in the Field Office Technical Guide (FOTG) – Section IV – Conservation Practices. This document provides conservation planners with additional parameters, procedures, and requirements for developing site-specific specifications for the design and installation of this practice. Reading NDSU Ext. Service Bulletin 57 "Salinity and Sodicity in North Dakota Soils" and NDSU Ext. Service' SF-1087 "Managing Saline Soils in North Dakota" revised Sept. 2003 are recommended for a better understanding of this practice.

Diagnosis

Weathering of primary minerals is the indirect source of nearly all soluble salts. There are a few instances where sufficient salts have accumulated in place to form a saline soil. Saline soils usually occur in areas that receive salts from other locations and water is the primary carrier. These soils have salt levels high enough that crop yields begin to suffer. Excess salts injure plants by disrupting the uptake of water into roots. Early detection and diagnosis of a saline area are important in designing and implementing control and reclamation practices to prevent further damage.

Detection of saline areas may be accomplished by onsite visual inspection, soil sampling or the use of an EM-38, i.e., electrical conductivity meter reading.

Off site means of detection include soil survey information, black and white photography, color slides and/or color infrared aerial photography. In order to generate Chemical Properties report, refer to FOTG – Section II – Soil Information – Soil Data Mart – Select State – Select County – Select Survey Area – Generate Reports – Select All or individual Map Units – Chemical Soil Properties from drop-down menu – Generate Report. For this practice, criteria for soils defined as saline are listed in Table 1.

- **Discharge Soils.** Discharge soils have subsoils that are high in calcium carbonate, have a dominant upward movement of water and occur around or near wetlands. During periods of seasonal high water tables, excessive evaporation is a concern when the soil surface is cultivated and/or lacks vegetation**.** As capillary water rises to the surface, evaporation removes water and salts remain. Salt accumulations gradually increase in the soil as this scenario is repeated. These areas may have salt crusts on the surface, support vigorous kochia or foxtail barley growth and poor seed germination. This condition is also common along road ditches, field ditches and next to lagoons.

Unique discharge soils exist in the Grand Forks County area. They are a result of a regional discharge of artesian groundwater from the Dakota Sandstone formation and have many of the same symptoms as mentioned above.

- **Saline Seeps/Recharge Area.** Saline seeps are most common south and west of the Missouri River but also occur on the Missouri Coteau and Drift Plain. Areas most prone to saline seeps have sloping stratified materials. Excess water from precipitation moves through the soil profile, dissolving salts as it percolates. Once it reaches an impermeable layer of finer textured material the deep percolating water moves laterally. Where the contact between the two different materials approaches the soil surface along a hill slope, the laterally moving water and dissolved salts create a wet spot (discharge area) that eventually becomes saline as water evaporates.

Initial symptom of a saline seep is prolonged soil surface wetness in small areas. Because of dissolved salts in the water and evaporation, these areas become increasingly saline. Salt crusts may form on the soil surface, and the seep area may have vigorous kochia or foxtail barley growth, poor seed germination, sloughed hillside covered by native vegetation, or stunted trees in a shelterbelt with leaf chlorosis. In areas lacking salt crusts or obvious vegetation loss, the salts are dissolved in the soil water and cannot be seen. The extent of the problem can only be identified with a soil test.

In general, most recharge areas are within 2,000 feet and many within 600 feet of the discharge area. The recharge area may be located directly upslope or at an angle across the slope from the discharge area. Where gravel beds and sandy soils are involved, the recharge area may be within 100 feet. Several procedures for identifying the recharge and discharge areas include:

1. Soil Survey - Soil survey may be used to locate gravelly or sandy soil areas up slope from the salt-affected area. These areas usually serve as recharge areas and should be examined carefully. Seeps were identified as Ad hoc symbols or saline soils in some soil surveys.
2. USGS Topographic Maps - These may be useful in identifying and delineating land characteristics and overland water flow patterns.
3. Comparing historic aerial photos with recent aerial photos.
4. Scattered salt crystals on a dry soil surface.
5. Drilling (auger or core) - Based on topographic maps, aerial photos and field observations, several holes are drilled in both the discharge and suspected recharge areas. Wells are carefully logged noting depths to dense and highly permeable zones. These wells will identify the water transmission zone. Information from well logs, water table levels, and topography are used to delineate the recharge area.

- **Naturally Occurring Saline/Sodic Soils.** Naturally occurring saline, sodic, and saline and sodic soils developed because of the soil forming factors and not from human intervention. These soils are moderately to strongly saline because of saline parent material, landscape position or a saline water source.

Soil survey information will be used for off site detection of these sites. Examples of naturally occurring saline soils are: Ojata. Examples of sodic soils are: Aberdeen, Nahon, Cresbard, Cavour, Belfield, Daglum, and Janesburg. Examples of saline and sodic soils are: Harriet, Miranda, Dogtooth, Stirum and Ryan The naturally occurring saline, sodic, or saline and sodic soils must be a first-named (dominant) component of the map unit (e.g., Daglum-Regent silt loam, 0 to 3 percent slopes) to qualify for this element of the practice. Appropriate onsite soil survey methods are also an acceptable method of detection. For soil sampling procedure, refer to NDSU Ext. Bulletin SF 990, “Soil Sampling for Fertilizer Recommendations”, Aug. 1998.

Table 1 - Classification of salt-affected soils.

Classification	****Electrical Conductivity and corresponding depth below surface***	***Sodium Adsorption Ratio***
Discharge Soils	≥4 dS/m at 0-18 inches	<13
Naturally Occurring Saline Soils	≥8 dS/m at 0-18 inches	<13
Sodic Soils	<4 dS/m at 0-16” and ≥8 dS/m below 16”	≥13**
Saline/Sodic Soils	≥8 dS/m within 16 inches	≥13**

**EC – Electrical conductivity of a soil extract used to measure salt concentrations. The results are reported in deciSiemens/meter (dS/m) or millimhos/cm (mmohs/cm). One dS/m is equivalent to one mmohs/cm. Salinity is measured in the surface layer.*
*** Most sodic soils meet this requirement, however some soils are also considered sodic with SAR values <13 and have a dense sodic subsoil.*

Treatment

The common treatment for this practice is establishing and maintaining permanent herbaceous vegetation. Permanent herbaceous plantings shall be designed and installed in accordance with the Standard and the Specification for one of the following practices (all conservation practices are located in FOTG – Section IV – Conservation Practices):

Range Planting – 550
Forage and Biomass Planting – 512
Wildlife Upland Habitat Management – 645.
Critical Area Planting – 342 (where erosion or other conditions are unusually adverse including strongly saline soils)

Prior to planting, soil testing to determine salinity level is recommended as a basis for selecting adapted species. Planting native species is preferred. Avoid invasive species such as creeping foxtail. Avoid planting trees and shrubs unless the water table is maintained below 48 inches, since they may aggravate the problem by trapping snow and raising the water table.
If the soil is bare after planting saline areas, immediately applying mulch is recommended. Apply mulch according to the Mulching – 484 Specification and the Standard including additional criteria to conserve soil moisture. Reducing evaporation is the key to reducing salt accumulation at the soil surface, which aids germination and seedling survival.
In some cases, subsurface drainage may help reduce groundwater that contributes to salinity problems. However, it may not be feasible due to excessive cost or lack of an acceptable outlet for the saline water. Technical assistance involving drainage for this practice must be in accordance with conservation practice Subsurface Drain – 606.
In some cases, salinity problems on flood-irrigated land can be managed by leaching. Apply leaching in accordance with Irrigation Water Management - 449 Specification and the Standard including additional criteria to manage salts in the crop root zone.

- **Discharge Soils.** The key to managing or reclaiming saline discharge soils is to control evaporation. This can be accomplished by establishing permanent vegetation. This will reduce groundwater discharge from the surface and limit dissolved salt accumulation.

- **Saline Seep Recharge Areas.** Controlling water in the recharge area is the first step in reclaiming saline seeps. This is accomplished by planting deep-rooted perennials such as alfalfa and tall wheatgrass to dry the soil profile. Deep-rooted perennial forages shall be seeded on as much of the recharge area as practical.

After excess groundwater has been removed, returning the recharge area to an annual cropping system is acceptable if all of the following conditions are met:

- the water table at the discharge area is held below five feet for at least one full year
- the discharge area is maintaining a healthy stand of perennial grass
- the crop rotation is designed in accordance with the Specification and Standard for conservation practice Conservation Crop Rotation – 328 and meets the additional criteria to improve water use efficiency and additional criteria to manage saline seeps

Table 2 Management Considerations*	
Management Considerations for Annual Cropping	***Management Considerations for Permanent Cover***
Salt Tolerant Crops	***Salt Tolerant Permanent Cover***
▪ Barley	▪ Alkaligrass, Nuttall
▪ Sugarbeets	▪ Alkali sacaton
▪ Safflower	▪ Tall wheatgrass
High Water Use Crops	***High Water Use Permanent Cover***
▪ Sweet clover	▪ Alfalfa
▪ Safflower	▪ Basin Wildrye
	▪ Intermediate Wheatgrass
Longer Growing Season Crops	***Longer Growing Season Permanent Cover***
▪ Corn	▪ Alfalfa
▪ Sunflowers	
** Refer to NDSU Ext. Bulletin SF-1087 and ARS, Mandan Crop Sequence Calculator for further information.*	

- **Saline Seep Discharge Areas.** Where saline soils are identified in the discharge area, permanent vegetation will be used. To control additional buildup of salt on the soil surface, vegetation should be established in the discharge area as soon as planting conditions allow. An EC test must be made to determine what vegetation can be established in the saline soil. When collecting soil, it is important to combine several samples from various parts of the discharge area to get an average sample. Depth of sampling is important. Saline soils should be sampled from 0-6 inches, 6-12 inches, and 12-24 inches. An EM-38 meter may also be used for determining EC of the site.

Undesirable vegetation should be controlled - preferably by herbicide - prior to vegetative establishment only if it will interfere with drill seeding operation. Seed should be planted with a drill whenever possible. Wet soils may be planted by broadcasting after weed control has been successful.

If the water table is within four feet of the soil surface, mow and remove all vegetation in the fall to prevent excess snow accumulation and rise of water table. If the water table is below four feet, vegetation can be left to catch snow. Resulting snowmelt will help leach the salt downward through the soil, improving growing conditions. Apply this technique every year.

- **Naturally Occurring Saline/Sodic Soils.** Treat these areas by seeding them to permanent vegetation. An EC test must be made to determine what plant materials can be established in the saline or saline/sodic soil.

In some cases, it is possible to treat sodic soil by applying a soil amendment such as gypsum. However, it is usually cost-prohibitive. Before application, a North Dakota-licensed professional soil classifier or NRCS soil scientist must delineate the area in need of treatment and approve the prescribed soil amendment type, rate, and manner of application.

Operation and Maintenance

Permanent vegetation plantings shall be maintained* in accordance with one of the following practices:

Forage Harvest Management – 511
Prescribed Grazing – 528
Upland Wildlife Habitat Management - 645

- On saline seep areas; if the water table is within four feet of the soil surface, mow and remove all vegetation in the fall to prevent excess snow accumulation and rise of water table. If the water table is below four feet, vegetation can be left to catch snow. Resulting snowmelt will help leach the salt downward through the soil, improving growing conditions. Apply this technique every year.

Areas returned to cropping or crop rotation. To ensure a salinity problem on a discharge area does not recur, monitoring the water table and soil salinity is required. If a recharge area is returned to cropping/rotation, its saline seep discharge area must be monitored.

Water table monitoring on discharge sites. Examine auger holes* at least five feet deep for free water each spring. Additional monitoring at other times of the year is suggested if there are indications the water table is rising or salinity is increasing. Monitoring more than one hole per seep is suggested on larger seeps or discharge areas. Monitor the water table at the same points each year. Record findings.

* PVC pipe - either slitted or drilled with many tiny holes to allow inflow of free water - may be inserted in the auger holes in lieu of augering new holes each year.

Salinity Monitoring. At least once every three years, monitor soil salinity in the fall with an EM – 38 meter or hand-held salinity meter, or by soil sampling in accordance with NDSU Extension Service Bulletin SF 990 - Soil Sampling for Fertilizer Recommendations. Monitoring is recommended in the fall of any year when an increase in soil salinity is suspected. Record findings.

References:

Managing Saline Soils in North Dakota
NDSU Extension Service –SF-1087, revised Sept. 2003

Plants for Saline to Sodic Soil Conditions (Plant Materials Technical Note No. 9, rev. Jan. 2004)
USDA Natural Resources Conservation Service - Boise, Idaho – Bozeman, Montana

Saline-Seep Diagnosis, Control, and Reclamation
USDA Agricultural Research Service
Conservation Research Report Number 30

Salinity and Sodicity in North Dakota Soils
NDSU Extension Service – EB 57, Nov. 1991

Soil Sampling for Fertilizer Recommendations
NDSU Extension Service Bulletin SF 990, Aug. 1998