

NATURAL RESOURCES CONSERVATION SERVICE
MONTANA CONSERVATION PRACTICE STANDARD

SALINITY AND SODIC SOIL MANAGEMENT (ACRE)

CODE 610

DEFINITION

Management of land, water and plants to reduce accumulations of salts and/or sodium on the soil surface and in the crop rooting zone.

PURPOSE

Improve soil health by reducing:

- salt concentrations in the root zone
- problems of crusting, permeability, or soil structure on sodium affected soils
- soil salinization and/or discharge of saline water tables at or near the soil surface downslope from saline seep recharge areas.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where one or more of the following conditions exist:

- The concentration or toxicity of salt limits the growth of desirable plants
- Excess sodium causes crusting and permeability problems
- Saline seep recharge and discharge areas.

CRITERIA

General Criteria Applicable to All Purposes

Localized ponding that persists for more than 24 hours after irrigation or precipitation events shall be alleviated by improvements to surface drainage.

In crop areas, shallow water tables shall be maintained below depths that cause salt accumulation in the root zone. Where depth to shallow water cannot be maintained by proper irrigation water management or by cropping practices, drainage shall be improved by one or more of the following:

Interception and diversion of the subsurface inflows.

Subsoiling where internal soil drainage is restricted by layers of contrasting permeability and soil moisture levels are low enough to allow shattering and mixing of soil layers.

Installation of surface and/or subsurface drainage systems.

Salt-affected soils have been internationally classified into general categories:

a) Saline Soils

EC > 4 dS/m at 25 °C
SAR < 15
pH < 8.5
ESP < 15

b) Saline-Sodic Soils

EC > 4 dS/m at 25 °C
SAR > 15
pH < 8.5
ESP > 15

c) Sodic Soils

EC < 4.0 dS/m at 25 °C
SAR > 15
pH > 8.5
ESP ≥ 15

NRCS, MT
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Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard contact the Natural Resources Conservation Service.

NOTE: This type of font (AaBbCcDdEe 123..) indicates NRCS National Standards.
This type of font (AaBbCcDdEe 123..) indicates Montana Supplement.

Criteria Applicable to Irrigated Lands

Soil electrical conductivity in the plant root zone shall be measured to determine the depth of water application necessary for flushing accumulated salts and maintaining a proper salt balance.

The suitability of applied water for irrigation and leaching shall be based on a representative water quality test report that includes electrical conductivity (EC), sodium adsorption ratio (SAR), and pH as well as the concentrations of the following individual constituents: calcium, magnesium, sodium, and sulfate concentrations.

The volume of irrigation water applied shall include the leaching fraction necessary to maintain root zone salinity and sodium levels within acceptable levels for crops and for soil quality. Leaching fractions shall be determined using methods in the National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements (see example 2-22, Page 2-120).

Criteria Applicable to Non-Irrigated Lands

Reclamation shall utilize vegetative methods, soil amendments, **organic matter** and/or enhanced drainage to effect a reduction in soil salinity. **Saline soils do not respond to chemical amendments.**

Leaching with a depth of water equal to a depth of soils to be reclaimed will typically remove about 70-80 percent of the soluble salts initially present in the saline soil profile.

Criteria to Reduce Problems of Crusting, Permeability or Soil Structure on Sodium-Affected Soils

For the root zone profile, soil tests from each quarter of the root zone shall report electrical conductivity (EC); hydrogen ion concentration (pH); exchangeable sodium percentage (ESP); and ion concentrations of sodium, calcium, magnesium, and sulfate-sulfur. Ion concentrations shall be determined from a saturated paste extract. Local conditions may indicate need for more exhaustive soil tests (e.g. potassium and potentially toxic ions).

The need for soil amendments to treat sodium affected soils shall be based on the sodium adsorption ratio of the soil water extract. Soil amendments shall be of a type that causes replacement of adsorbed soil sodium by calcium.

Gypsum (which is calcium sulfate, 22.5% calcium) is generally added to soil to provide either a calcium source to displace the sodium or a sulfur source is added that will enhance acidification of the soil.

For most soils in Montana, East of the Continental Divide, are high in calcium (carbonate). The decision to add soil amendments should be based on soil tests results at different depths, available water quality and quantity, crops grown, and economics. Management techniques such as removing excess water, increasing organic matter levels by continuous cropping, minimizing tillage and establishing tolerant plant species should be considered to ensure long-term reduction of salts and crop productivity.

In those cases where a producer elects to treat Sodic soil using soil amendments, refer to the Sodic Soils section in the construction specification under the FOTG, Section IV, Salinity and Sodic Soil Management (Code 610).

Application rates for soil amendments shall be based on SAR soil test results from the depth of the root zone to be treated; the purity of the applied amendment; and quality of the irrigation water.

Criteria Specific to Saline Seeps and their Recharge Areas

Mitigation shall include vegetative measures to reduce subsurface water and salt movement from the recharge area to the discharge area. Vegetative measures include establishment of deep rooted perennial crops such as wheatgrass and the deeper rooted cultivars of alfalfa.

The following measures shall be applied to reduce subsurface water and salt movement to the seep outlet:

- Establish deep-rooted, long season species in the recharge watershed area to utilize soil moisture and limit ground water movement to the seep area.
- Remove ponded surface water from the recharge area before it percolates below the root zone.
- Where practical, re-vegetation of the saline seep discharge area shall be accomplished with species adapted to utilize excess soil moisture and to prevent up-flux of water and salts.

CONSIDERATIONS

Tools such as electromagnetic induction (EMI), salinity probes (i.e., four electrode Wenner array), electrical conductivity instruments, and field soil test kits are appropriate for evaluating and for monitoring soil salinity levels.

Representative water chemistry reports for surface water sources may be available from USGS or from water districts.

Rigorous irrigation water quality tests for potassium, chloride, bicarbonate, and carbonate levels may be warranted in areas of high concern.

Consult published data for crop salt tolerances, and specific ion toxicities of crops for crop recommendations.

Local conditions and specific crop ion sensitivities may warrant water quality analysis for toxic salts (boron, chloride, etc.).

Sulfur or sulfuric acid applications enhance conversion of naturally occurring calcium carbonate to more soluble gypsum. Leaching should be delayed until the sulfur has oxidized and gypsum has formed.

Applications of a soluble calcium source such as gypsum in combination with irrigation leaching applications will help in displacing sodium from the root zone. **Seldom will the addition of gypsum or sulfur make much of a difference in Montana soils. Therefore leaching and increasing organic matter levels by continuous cropping, minimizing tillage, establishing tolerant plant species and removing excess water is more sustainable than adding soil amendments.**

Seasonal changes in source water quality may require water quality evaluations at several times during the season of use.

Drainage water discharges may have high concentrations of salt. Select appropriate outlets and consider effects to surface water and groundwater.

Subsoiling for improvement of internal soil drainage may not be effective in soils of uniform texture/permeability, or if soils are not dry during subsoiling operations.

Avoid inversion tillage that can bring salinity to the surface and negate the leaching process.

Incorporation of green manure crops or organic matter into the soil can improve soil structure and permeability.

Salt tolerant crops with vigorous growing, fibrous root systems (e.g., sorghum, sudangrass) can increase the carbon dioxide content of the soil water, increasing the solubility of calcium carbonate to facilitate leaching of sodium. For leaching of salts, water of slight to moderate salinity not dominated by sodium can be more effective than water of low salinity.

Crop residue management can improve the organic matter content of the soil, improve infiltration, and minimize surface evaporation and capillary rise of salts to the soil surface.

Select crop bedding shapes and planting methods that reduce the concentration of salinity near the plant root zone, especially for germinating seeds.

Foliar damage can be an indicator of specific ion toxicities.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria described in this standard and shall include the following items as applicable:

- Plan map showing location of:
 - Salinity/sodium affected areas
 - Saline seep recharge areas
 - Saline seep outlets or discharge areas.
- Geologic investigation showing:
 - location (depth, extent) of materials contributing to salinity/sodicity on saline seep recharge areas
 - impervious layers that cause hillside seeps.
- Soil tests required to determine current soil salinity/sodicity, plus previous test results to evaluate the effectiveness of the planned treatment and potential need for revision.

- Water tests required to determine suitability for irrigation and leaching.
- Leaching requirements for specific soils and crops, including the method and timing of water application.

OPERATION AND MAINTENANCE

The recharge area will be maintained in the designed land treatment cover until such time as the discharge area has been reclaimed or otherwise meets the objectives of the producer.

Noxious weeds will be controlled using appropriate methods as described in conservation practice, Pest Management (Code 595) in Section IV of the FOTG.

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