NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS

SALINITY AND SODIC SOIL MANAGEMENT

1. Scope

Specifications for Salinity and Sodic Soil Management shall describe the requirements for applying the practice to achieve its intended purpose(s) and shall be prepared for each site. Use approved specification Form KS-ECS-4, Grass Seeding, and narrative statements in the conservation plan. Practice application will be documented on Form KS-ECS-4, technical assistance notes, and in the conservation plan. See also Salinity and Sodic Soil Management Statement of Work (SOW) for additional information on design, installation, and certification requirements.

2. Identification of Saline and Sodic Problems

A soil analysis will identify the specific problem and its severity. One or more samples should be taken from the affected area. Each soil sample should be a composite of several sub-samples that are taken from different locations in what appears to be a relatively uniform area of the field. Sampling depth and number of samples need to be determined. If one sampling depth is used, the sample should be from the surface down to 12 inches. If two sample depths are used, the upper sample should be from the surface down to 6 to 8 inches and the second should be from 6 to 8 down to 16 inches.

If the quality of irrigation water is suspect, samples should be collected during the irrigation season. Contact the soil-testing laboratory that will be performing the analysis for specific protocol on sampling both for soil and water.

Salt affected soils are divided into three groups depending on the amounts and kinds of salt present. Classification depends on total salts (EC), soil pondus hydrogenii (pH), and exchangeable sodium percentage (ESP). See Table 1 for definitions. Understanding these factors is critical for the reclamation and management of these soils. These parameters may be obtained from the soil analysis report.

Table 1. Chemical Parameters Defining Saline and Sodic Soils.

Soil Condition	EC	ESP	SAR	pH
Saline	> 4.0	< 15	< 13	< 8.3
Saline/Sodic	> 4.0	> 15	> 13	< 8.3
Sodic	< 4.0	> 15	> 13	> 8.5
Normal	< 4.0	< 15	< 13	< 8.3

EC—Electrical Conductivity (mmhos/cm)
ESP—Exchangeable Sodium Percentage
SAR—Sodium Absorption Ratio

The SAR of irrigation water should be considered along with the EC in determining the ultimate suitability of water for irrigation. The higher the SAR, the greater the probability that infiltration rates and water flow through the soil will become a problem. See Table 2 for water salinity level ranking.

Table 2. Irrigation Water Classification

Water Classification	EC
Low Saline	0—.4
Moderate Saline	.4—1.2
Highly Saline	1.2—2.3
Very High Saline	2.3—5.0
Brackish Water	>5.0

EC—Electrical Conductivity (mmhos/cm)

3. Site Reclamation

An assessment of the site and irrigation water must be performed to determine appropriate measures to take to address the problem. Reclamation of the site may be uneconomical because of poor soil permeability, lack of adequate drainage, lack of sufficient moisture, or good quality irrigation water.

Saline soils may be reclaimed with the application of adequate amounts of low salt irrigation water or rainfall amounts sufficient to leach the salts from the upper soil profile. Internal drainage of the soil must be good and the downward leaching of the salts must not be hampered by a restrictive layer and/or an elevated water table. In some cases it may be necessary to facilitate the drainage of the area by deep ripping the site. This tillage should be performed only when the soil is dry.

In the case of an elevated water table, it may be necessary to install drains or ditches to lower the water level. Check to make sure that before any alternations are made with ditches or drains, that no Wetland Provisions are being violated.

Saline soils cannot be reclaimed by the addition of chemical amendments, conditioners, or fertilizers. In lieu of and in addition to the leaching of the salts, salt-tolerant crops may be planted. See Tables 3 and 5 for plant species salinity tolerance.

Sodic soils are treated by the replacement of sodium with calcium from a soluble source. Gypsum is considered the cheapest soluble calcium source for the reclamation of sodic soils. Reclamation of a foot depth of sodic soil on one acre requires 1.7 ton of pure gypsum for each milliequvalent of exchangeable sodium present per 100 grams of soil. For example, if a soil has a cation exchange capacity of 20 milliequivalents per 100 grams of soil and 30 percent exchangeable sodium, there would be 6 milliequivalents of sodium per 100 grams. Thus 10.2 tons of gypsum (6 x 1.7) per acre would be required to reclaim the soil. The numbers needed for this calculation would be provided by the soil analysis report. On soils high in calcium carbonate (C_aCO_3), elemental sulfur may be added to furnish calcium indirectly. However, oxidation of the sulfur is slow, so this method may be of limited value.

Once the gypsum is applied and incorporated, there must be enough precipitation and or good quality irrigation water to leach the displaced sodium below the root zone. The reclamation of sodic soils is slow because the soil is lacking in any structure and much time is needed for improvement. The addition of organic matter (straw, native hay, manure), or growing of a salt-tolerant crop (barley), improves water infiltration and permeability thereby speeding up the reclamation process.

Saline-sodic soils involve the replacement and leaching of the sodium along with the other excess salts present. If the excess salts are leached and calcium is not added to replace the sodium, the saline-sodic soil will become a sodic soil.

4. Vegetation Establishment

Soil analysis will indicate if establishment of vegetation is a feasible option. Unless the source of the salt problem can be reduced or eliminated, vegetation establishment will be impossible, or at best only temporary. See Tables 3 and 4 for interpretation of the effects of salinity on plant establishment.

Table 3. Interpretation of Electrical Conductivity

Salt Level (mmhos/cm)	Salt Rank	Interpretation
0-4	Low	Sensitive plants will show injury
4-8	Moderate	Non-salt tolerant plants will show injury/will not grow
8-12	High	Only salt tolerant plants will grow
12+	Excessive	Very unlikely for survival of any species

Table 4. Interpretation of Exchangeable Sodium Percent

Exchangeable sodium Sodium %	Interpretation
0—10	No adverse effect on soil
10 +	Soil dispersion resulting in poor soil physical condition and plant growth

Proper seedbed preparation will aid in plant establishment. A cover crop of salt-tolerant species, such as barley seeded at the rate of 3 bushels/acre or sorghum seeded at the rate of 30 pounds per acre, will provide protection from erosion as well as providing organic matter to improve permeability.

The application of a natural mulch (native hay, straw, etc.) applied at the rate of 2-3 tons per acre is beneficial from the standpoint of reducing erosion, improving permeability, and reducing surface evaporation. See Conservation Practice Standard and Specifications 484, Mulching, for information on mulch application.

Manure should be used to meet fertility needs because of its other beneficial qualities that aid in reclamation. Application rates of 15-20 tons per acre are desirable. Manure should be incorporated into the surface.

Species will be seeded using a grass drill (or properly equipped grain drill for introduced and legume species) equipped with double-coulter furrow openers with depth bands and press wheels or drag chains. Seed should be planted ¼ to ¾ inch deep. Broadcasting will be allowed where drilling is not physically feasible. Where broadcasting is used in lieu of drilling, the seed will be covered by cultipacking or other type operation.

For a listing of approved varieties of grasses, consult Kansas Plant Materials Technical Note 1 (Rev. 6), electronic Field Office Technical Guide (eFOTG) Section II, Pasture/Hayland Interpretations, and Conservation Practice Standard and Specifications 550, Range Planting. Where varieties are not available or are not adapted to the site, common (native harvest) seed from a source location as near to the area being seeded as possible can be utilized. The source of common seed shall not be more than:

South—250 to 400 miles (southern sources will be given preference over northern sources)
North—100 to 150 miles
Elevation Increase—1,500 feet
Seed sources must be identified as to the state and county level in order to certify mileage and elevation adequacy.

For seed quality information, refer to Conservation Practice Standard and Specifications 550, Range Planting.

For seeding periods:

Cool-season species: August 15—October 1; December 1—April 15
Warm-season species: March 15—May 15; December 1—May 15

The seed should be in the ground in time to use early spring precipitation (which dilutes surface salts), thus increasing the probability of germination and establishment.

For listing of adapted species, seeding rates, and for salinity tolerance, see Table 5. Mixtures that are comprised of the best adapted species for the site are recommended. Because saline soils are so variable, mixtures will better accommodate the site rather than a single species planting. Species within the mixture are able to establish on areas where they are best adapted.

If the salinity level is fairly uniform across the site, a single species may be planted, depending on the particular species and management objectives (pasture/hayland, versus rangeland, versus wildlife). For example, tall wheatgrass should be planted as a single species rather than in a mixture because of its nature to completely dominate a stand a few years after establishment and its palatability difference compared to other cool-season perennial grasses.

Following planting, the site needs to be continually monitored to assess the success of vegetation establishment and to determine if management practices are having an effect on the salinity levels.

Table 5. Species Seeding Rates and Salinity Tolerance

Species*	Full Seeding Rate (# pls/ac)	Salinity Tolerance Rating **	Remarks
Native			
Alkali sacaton	1	H	
Big bluestem	12	M	
Blue grama	3	M	Not allowed as single species planting
Buffalograss	8	H	Not allowed as single species planting
Indiangrass	12	M	
Sideoats grama	12	M	
Switchgrass	6	M	
Western wheatgrass	20	H	
Introduced			
Bermudagrass	5	H	Recommend as single species planting. If sprigged, recommend 20/30 bu / ac.
Meadow brome	16	L	
Intermediate wheatgrass	23	M	
Orchardgrass	4	L	
Reed canarygrass	4	M	
Smooth brome	16	L	
Tall fescue	10	M	
Tall wheatgrass	25	H	Recommend as single species planting
Legumes / Forbs			Limited to 25% of mixture
Alfalfa	14	L	
Alsike clover	10	L	
Birdsfoot trefoil	7	M	
Ladino clover	10	L	
Red clover	10	L	
Annuals			For use as cover crop
Barley	3 bu / ac	H	
Sorghum	30 pounds / ac	M	
Wheat	2 bu / ac	M	

*Consult Kansas Plant Materials Technical Note 1 (Rev. 6); FOTG Section II Pasture/Hayland Interpretations; Range Planting Specification (550) for species/varieties selection.
** See Table 3; L = low salinity tolerance; M = Moderate salinity tolerance; H = High Salinity tolerance.

References:

Kansas Plant Materials Technical Note 26, February 6, 2001. Plant Materials and Techniques for Brine Site Reclamation, 6 p.

Lamond, R.E. and D.A. Whitney, 1992. Management of Saline and Sodic Soils. Cooperative Extension Service, Kansas State University, 4 p.

Robbins, C.W. and R.G. Gaviak, 1989. Salinity and Sodium Affected Soils. Cooperative Extension Service, University of Idaho, 11 p.