Oklahoma Centennial Commemorative Medallion
Design by Betty Price, Executive Director
Oklahoma Arts Council

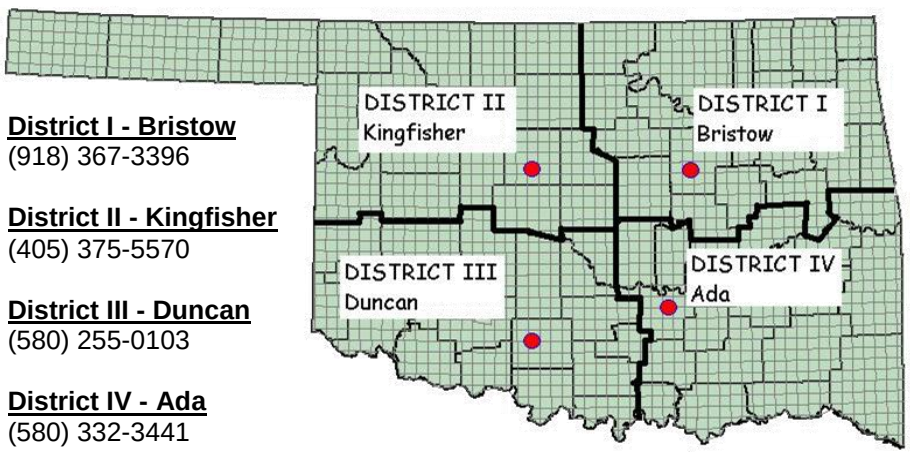
Guidelines for Responding to and Remediating New or Historic Brine Spills

From Oklahoma Corporation Commission Guardian Guidance
Includes Numerical Cleanup Limits

Report all new spills of 10 BBL or more to OCC District Field Operations staff.

New Release or Spill

1) Prevent further discharge or release.
2) Use containment (e.g. temporary dikes, pits, or tanks) to minimize area affected.
3) Remove (adsorbent material, vacuum system) fluids from the surface ASAP; even within a diked area; properly inject them into Class II or other permitted well.
4) Flushing the spill areas with fresh water may facilitate the removal of saltwater from the soil surface unless the soil is high in clays; then avoid fresh water.
5) Till in soil amendments such as hay, fertilizer, and/or gypsum.



District I - Bristow
(918) 367-3396

District II - Kingfisher
(405) 375-5570

District III - Duncan
(580) 255-0103

District IV - Ada
(580) 332-3441

Soil, New Release or Historic Impact

Sampling

Soil samples (composites) should be collected of both highly affected and less affected areas for lab analysis to determine whether soil remediation or removal is needed. Field kit tests can help you define these areas. A background sample from outside the affected area must also be collected. If sampled promptly, only surficial samples may be needed; if more than one week has passed, ample rainfall has occurred, or if plowed or sandy soils are present, collect soil samples at one-foot depth intervals to a depth of at least three feet.

Lab soil samples should be placed in suitable containers, chain-of-custody records completed, and the samples sent to a qualified (e.g. in NAPT program) lab. The samples should be analyzed for salinity parameters (e.g. OSU's Comprehensive Salinity package) including TDS or TSS (Total Soluble Salts), EC, ESP, SAR, Na, Ca, Cl, B, etc.

Remediation

Sample analysis exceeding 2640 ppm TDS or TSS usually indicates the need for soil remediation or removal. Remediation can take one to several years, depending on soil type (longer for clays) and site conditions; soil amendments usually speed the process. If the ESP is high, add calcium (gypsum or calcium nitrate [$Ca(NO_3)_2$]) to most soils to help in sodium removal, but do NOT use calcium nitrate over shallow aquifers. Lots of fine ground limestone (e.g. chat) works on high acid soils Adding organic matter (straw, low-salt manure) conditions soil to improve salt leaching. If more than five tons of gypsum is used, split treatment into separate applications 3 to 6 months apart

If soil removal is selected, excavate and remove soils with a TDS or TSS level of $\geq$2640 ppm to ~3 feet deep. Dispose of excavated material as per Corporation Commission Rule OAC 165:10-7-26 or 165:10-9-1. The area must then be restored to its original use by backfilling with compatible soil and establishing suitable vegetation.

Water, New Release or Historic Impact

If groundwater reachable by crop roots or shallow aquifer could be affected, it should also be sampled (e.g. OSU Irrigation Water test) via a monitoring well or geoprobe. Remediation may be necessary; see inside page.

If surface water is nearby, it should be sampled. If affected, onsite treatment or collection and proper disposal may be necessary. Restore the water body to the previous beneficial use ASAP.

Summary of Cleanup Levels for Brine Spills

1. Salinity -Soil[1]

The treatment for high EC/TSS is usually accomplished through soil leaching (can use lab tests/field kits to monitor progress); uptake by salt-tolerant plants can assist if such can be established. Tilling in organic matter (e.g. hay, fertilizer, low-salt manure) improves soil tilth for leaching to speed the process. High ESP sodic soils need added calcium, usually as crushed or powdered gypsum. **For deep salt impacts**, protect surface soils from salt rise by placing a layer of powdered gypsum @2-3' (~below crop roots) to create capillary break.

EC*/ESP@/TSS# Cleanup Table For Brine Contaminated Soils				
	EC ≤ 4000 or TSS ≤ 2640	EC ≤ 6000 or TSS ≤ 3960	EC ≤ 8000 or TSS ≤ 5280	EC > 8000 or TSS > 5280
ESP 0-15	Most plants can grow normally; Cleanup/leaching rarely needed	No treatment needed for cereal grains (e.g. wheat) and grasses. Treatment needed to grow: legume crops (e.g. soybeans), most fruits, some vegetables, rice, and alfalfa.	No treatment for salt tolerant grasses (e.g. Bermuda). Treatment needed to grow: legumes, fruits, cereal grains, alfalfa, and vegetables.	Soil treatment or replacement, to about 3' deep, needed for almost all uses
ESP >15 *Sodic soils*	To leach excess sodium you need to add calcium++			Soil replacement to ~3' needed.

* Electrical Conductivity, µmhos/cm (1000 µmho =1 mmho)

@ Exchangeable Sodium Percentage, %

Total Soluble Salts, in parts per million (ppm, mg/kg, mg/l)

++ Mix Gypsum or calcium nitrate into typical soils; add fine ground limestone (e.g. powdered chat) to high acid soils. Do NOT use calcium nitrate over shallow aquifers

Powdered gypsum
Photo from www.usagypsum.com

[1] While sodium and chloride can be toxic to plants, these EC/TSS and ESP limits usually ensure they are below toxic levels.

2. Salinity - Water

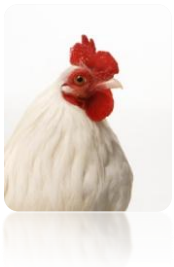
Remediation for salinity contaminated water usually consists of removing and treating (ion exchange resins, reverse osmosis) or injecting (into a Class II or other authorized injection well) the worst part. Replacement and/or natural inflow of clean surface and/or groundwater will dilute the remainder to acceptable levels.

Salinity Cleanup Standards for Surface Water and Groundwater – most uses

Surface Water	OWRB standards	Appendix F http://www.owrb.state.ok.us/util/rules/pdf_rul/Chap45.pdf
Surface and ground water for irrigation	OSU guidelines	OSU F-2401 Classification of Irrigation Water Quality http:// pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2223/F-2401web.pdf. SAR ≤4; EC ≤4 mmhos/cm, varies with Na percent.
Ground water at water well	EPA standards	EPA secondary drinking water standards include 250 ppm chlorides. http://www.epa.gov/safewater/consumer/2ndstandards.html
Groundwater	Other uses	Make sure groundwater will meet standards when it gets to the well or stream

Recommended Maximum Salt (as TSS/TDS) in Animal Drinking Water (young may need lower limits)

Poultry	Dairy cows, horses, swine	Beef Cattle	Sheep, goats
3,000 ppm, mg/L	7,000 ppm, mg/L (Cl & sodium–300mg/L cows; 500 horses)	10,000 ppm, mg/L	12,000 ppm, mg/L



3. Boron

High boron levels are found in some produced water. If boron is above the levels indicated below after a spill, it must be leached out to return to beneficial (crop) use. Contaminated irrigation water (or shallow groundwater within a deep root zone) above the levels below should be remediated (leaching etc.) before use on crops.

Maximum **Boron Limits Table[2] for High-Boron Brine Spills to Soil or Ground/Irrigation water					
Boron concentrations in soil and water indicate the maximum range each plant/group will tolerate					
≤1.1 soil ≤0.75 water	≤1.5 soil ≤1 water	≤3 soil ≤2 water	≤6 soil ≤4 water	≤9 soil ≤6 water	≤15 soil ≤10 water
• Blackberry (best <0.5ppm) • Grape • Most other fruits • Nut trees • Onion	• Grain crops (e.g. wheat, milo) • Corn • Pumpkin • Beans • Sunflower • Oats • Peanut • Strawberry	Vegetables like • Pepper • Peas • Carrot • Potato • Cucumber	• Clover • Oats • Bluegrass • Lettuce • Cabbage • Melon • Squash	• Sorghum • Alfalfa • Tomato • Vetch • Beet • Most grasses	• Cotton • Asparagus

[2] Source - Western Fertilizer Handbook, Eighth Edition; California Fertilizer Association; Interstate Publishers, Inc.