



Legacy Operating

**303 W Wall St Ste 1300
Midland, TX 79701**

Sodic Soil Analysis and Remediation Process Description

Produced Water Spill – Drickey Queen 808, New Mexico

Prepared By:

**Remediation and Applied Technology
18014 Isle Royale Ct
Humble TX 77346**

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December 30, 2014

Legacy
303 W Wall St Ste 1300
Midland, TX 79701

Attention: Freddie Gibbs

Re: Salt Water Soil Remediation – Drickey Queen 808, New Mexico

Attached is our proposal for the remediation of the salt affected areas, at the Drickey Queen 808 salt-water release site. This information is based on the maps and analytical data provided by R&A Technology.

DeSalt Plus™ is designed to remediate the salt-water contaminated soils and to restore the area to native vegetation. The site work and amendment applications are outlined in this proposal. After treatment with **DeSalt Plus™**, some new plant growth may be evident after a few months; the complete remediation process on site may require at least one full growing season to show best results.

The amendments and process described have been used in Texas, New Mexico, North Dakota, Wyoming, Louisiana, Oklahoma and Arkansas. Data on several case histories can be examined on the R&A web site at <http://www.remediationandappliedtechnology.com>

We appreciate this opportunity to work on this project as part of your team. If you have any questions please call at any time.

Sincerely,

Robert M. Johnston II
832-244-3811

18014 Isle Royale Ct, Humble TX 77346

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I. OVERVIEW

Remediation and Applied Technology, LLC (R&A) is pleased to submit this proposal to supply the required amendments and technical support for the onsite treatment of sodium impacted soils from the Drickey –Queen 808 flowline release. The soil samples were collected by R&A Technology and analyzed by Energy Labs in College Station, TX.

During the remediation process, the structure of the soil will be physically and chemically modified allowing improvement in the percolation, drainage and removal of undesirable salt contamination. Cationic amendment of the soil with a calcium reagent is essential to removing the sodium contamination as well as restoring the soil structure. Factors such as Exchangeable Sodium Percentage (ESP) and Cationic Exchange Capacity (CEC) influence the amount of exchanging cations required. These parameters are utilized to determine the specific amount of *DeSalt Plus™* amendment needed to remediate any site.

The *DeSalt Plus™* products are totally soluble and contain no nitrates. They have been proven effective on similar sites in New Mexico, Kansas, Arkansas, Oklahoma, Texas, and Louisiana.

II. DESCRIPTION OF THE EFFECTS OF SALT-WATER SPILLS, DESALT PLUS™ AND THE REMEDIATION PROCESS

DeSalt Plus™ is a soluble liquid amendment product that remediates severe salt (sodium chloride) contaminated soils caused from saltwater/produced water spills and leaks. *DeSalt Plus™* is a source of readily available cationic species for soil amending. The initial development of this product was conducted at Texas A&M University in Bryan, Texas. *DeSalt Plus™* is a primary amendment for sodic soil contamination as well as a source of vital nutrients for vegetation. The primary exchanging cations in DeSalt Plus are Ca^{++} and NH_4^+ (Calcium and a stabilized Ammonium). Both are stable and readily available, and both are important plant nutrients as well.

This specially designed solution, *DeSalt Plus™*, quickly displaces harmful sodium with a concentrated source of calcium and vital soil nutrients helping to restore salt contaminated soils and vegetation to their natural growing conditions. *DeSalt Plus™* improves soil structure for increased water infiltration and permeability. *DeSalt Plus™* contains no nitrates.

Effects of Sodium Damage in the Soil

Salt contamination of soils is a serious environmental issue facing the oil and gas industry today. Salts found in produced water spills and leaks can completely devastate surrounding vegetation. Until recently the remediation of sodium affected soils has been a time consuming, ineffective and often-expensive process. Good remediation technology offers a fast, easy and cost-effective way to remediate salt damaged soils.

Remediation of sodium-damaged soils in a timely manner necessitates replacing the exchangeable sodium with a stronger and more favorable cationic source. Research and experience have shown that the sodium (Na^+) levels in the soil structure can be reduced through electrolyte manipulation, replacing the damaging sodium with more desirable minerals. Gypsum, fertilizers or calcium nitrate have been used in the past to attempt to accomplish this. However poor results, due to the low solubility of gypsum, lack of sufficient cationic nutrients in fertilizers or the negative environmental impact of nitrates, make these poor, costly and even dangerous choices. Now, through chemistry developed in a joint effort between agriculture, the chemical and oil and gas industries, damaging sodium can be effectively replaced with the desirable ingredients in **DeSalt Plus™**. **DeSalt Plus™** is a stable product containing Calcium, Ammonium, and key plant nutrients with 100% cationic availability. Additionally, these beneficial ions are all plant nutrients, helping to restore soil fertility, and encouraging re-growth while removing the harmful sodium from the soil matrix! Proper soil conditions are then restored improving water absorption, soil fertility and vegetative growth.

New salt spills or saline soils can be treated rapidly and with minimal amounts of amendments. Due to a treatment of the **DeSalt Plus™** amendment to a new salt spill, the sodium cannot bind to the clay and will flush easily with **DeSalt Plus™** leaving a clean location.

As time passes on a salt spill and water is added to the salt contaminated location, through either external flushing or rainfall, the sodium will aggressively bind to the clay and convert the soils to sodicity. As the soils progress from salinity to sodicity they become more difficult to treat and require significantly more amendment to remediate.

Sodium affected soils have poor physical properties and commonly have crusted or compacted surfaces which prevent water percolation, causing runoff and erosion. The severity and depth of the damaged soil formation will increase sharply with increased sodium concentrations in the soil. As the sodicity increases over time, the amount of ***DeSalt Plus™*** required to treat the soil will increase rapidly.

Mechanism Of Action for De-Salt Plus

During a salt-water spill, sodium chloride ions are split almost immediately after hitting the ground. The chlorides begin to flush away and the sodium begins to bind through ionic transfer to the receptor points of the montmorillonite clays. It is the sodium ion binding to the clays that cause the sterilization of the soil. The bound sodium can only be removed by an ion that has a stronger binding affinity than the sodium. In a short period of time, the chlorides will flush away leaving the sodium bound to the clays.

DeSalt Plus™ satisfies the need for a soluble, readily available source of active ions. It is a water-soluble, liquid calcium rich solution that remediates soils contaminated with sodium chloride (NaCl). Salt waters and brine disrupt the uptake and utilization of nutrients that plants and crops require for normal growth. Sodium from produced waters and brine deteriorate soil structure resulting in reduced plant water availability, excess water runoff, and ultimately, erosion. A high sodium concentration in the soil causes plant “yellowing” and dehydration resulting in wilting or stunting of the plant.

In newer salt spills the ***DeSalt Plus™*** binds aggressively to the soil and prevents the sodium from binding to the clay partical, sterilizing the soil and quickly reduces harmful sodium levels within soils. In historic spills the active ion, stabilized ammonium, cleaves the bound sodium from clays through ionic transfer, allowing the salts to be flush away.

After treatment, the ***DeSalt Plus™*** will also flocculate soil particles for improved soil structure and water penetration, providing valuable nutrients for plant development and growth.

DeSalt Plus™

Chemically, **DeSalt Plus™** affects by ion exchange in the soil replacing the damaging sodium ions on the soil with desirable ion such as calcium, ammonium, or potassium. The more favorable ions replace the sodium ions present in the soil restoring the soil to a healthy state. The displaced sodium is then free to be flushed out of the root zone by water, allowing plant functions to return to normal. The sodium is toxic only to the plants.

The remediation affects of **DeSalt Plus™** begin immediately, and normal growing conditions may be soon regained. Substantial decreases in sodium concentrations are often measured within weeks.

Due to the scientific ability to measure, test and analyze the specific parameters of a salt-water spill and the effects of **DeSalt Plus™** on a salt-water spill, remedial progress can be tracked and monitored throughout the entire process.

Additional Amendments: (Optional)

Soil Restore™ is specially designed for generic soil restoration and rejuvenation projects as a pre-emergent growth stimulator and nutrient supplement for accelerated germination of crops and vegetation in areas previously affected by salt and hydrocarbon contamination. Soil Restore™ also strengthens cell wall structure for improved development during plant emergence. The principle goal is to provide basic nutrients for the soil, and basic microbes for the soil. The contents of this nanoparticulated formulation include:

Stabilized Soluble Nitrogen: The water-based product provides 23% stabilized nitrogen for improved plant growth.

Azomite: A complex silica ore (hydrated sodium calcium aluminosilicate) with an elevated ratio of trace minerals.

Montmorillonite: A very soft phyllosilicate group of minerals that typically form in microscop crystals, forming a clay.

Humic Acid: a principal component of humic substances, which are the major organic constituents of soil (humus), peat, coal, many upland streams, dystrophic lakes, and ocean water.

Fulvic Acids: These are humic acids of lower molecular weight and higher oxygen content

Seaweed Extract: a versatile component with its jelly like alginate content which helps to bind soil crumbs together, also contains all soil nutrients (0.3% N, 0.1% P, 1.0% K, plus a full range of trace elements) and amino acids.

Beneficial Soil Organisms: An essential component consists of many different soil microorganisms, which are responsible for nutrient recycling and other soil building and maintaining activities. A mixed culture of beneficial microorganisms such as photosynthetic bacteria (*Rhodopseudomonas* sp) lactic acid bacteria (*Lactobacillus* sp.), yeast (*Saccharomyces* sp.) and fermenting fungi can positively improve the soil fertility as well as plant productivity.

Soil Restore™ is a non-hazardous product that can be used in conjunction with any other soil remediation products.

III. SITE PREPARATION AND REMEDIATION

Initial preparation of the site will require turning the soil 3-4 feet and adding organic material to the soil will improve drainage and tilth. **Disking and Bulking of the soil is important to the remediation process as it insures retention and percolation of amendments and any rain or irrigation water.** Improved percolation accelerates removal of the contaminating sodium ions by the soil amendments and promotes new growth.

Once the site has been prepared the amendment chemicals will be applied as outlined in the procedure. Supplemental water is vital to the remediation process. If rainfall is not adequate, additional water could be applied to each site to insure adequate flushing. If irrigation water is required, *GeoRinse™*, a surfactant and surface tension reducer, which is also contained in the DeSalt™ amendments, may be added to improve percolation and flushing. One pail, 5 gallons, of GeoRinse™ should be added per 5,000 gallons of fresh water.

If soil nutrients are lacking, *Soil ReStore™*, a pre-emergent growth stimulant and nutrient package designed for nutrient depleted and stresses soils, may be used to help accelerate growth and supply a stabilized balance of vital nutrients for depleted and stressed soils.

The remediation process on the Drickey Queen 808 site will consist of 4 stages.

Stage 1 –Lab Analysis and Mapping

Lab analysis provides the information needed to calculate the amount of *DeSalt Plus*TM amendment needed to return the area to full vegetation. Testing allows us to treat the areas more accurately and save the company money. Mapping the analysis ensures that all areas are treated sufficiently. The Routine Salinity test includes Sodium Adsorption Ratio (SAR), Exchangeable Sodium Percentage (ESP), Cationic Exchange Capacity (CEC), Electrical Conductivity (EC), Sodium (ppm), chlorides, and soil pH. A total of 2 samples were taken. **Complete, see attached.**

Stage 2 – Site Preparation & Soil Bulking

Flip or turn the soil using a backhoe, turning some hay into the area.

Stage 3 – Amendment Application.

Once site preparation is completed and the soil disked and plowed, the *DeSalt Plus*TM will be applied generally with a dilution of fresh water, usually 5:1 dilution. *GeoRinse*TM a surface tension reducing surfactant is contained in the DeSalt Plus. Additional GeoRinse may be added to any dilution or irrigation water to improve soil penetration and flushing.

The *DeSalt Plus*TM amendment will then be applied to the contaminated area, based on the analytical needs determined by testing, using spray hoses and an application trailer.

The site may be periodically monitored to determine if any additional amendments application is necessary. Time on location 2-3 Days.

Stage 4 -- Nutrients & Test Seeding (Optional)

The final stage will include soil conditioning, if required (tilling/disking), an application of 55 gallons of *Soil ReStore*TM, irrigation, some test seeding of native grasses, and site analytical monitoring. As the area is observed, additional *DeSalt Plus*TM may be applied to any areas that need additional remediation.

IV. AMENDMENT CALCULATION

Based on the analytical information provided by Energy Labs, the estimated amount of *DeSalt Plus*TM amendment to treat the 0.25-acre area of salt contaminated soils to a depth of 3 feet would be 825 gallons of *DeSalt Plus*TM.

V. DESALT CALCULATION AND COST ESTIMATE

Drickey Queen 808, New Mexico				
ESP	CEC	Area	Cubic Yards	Gallons Of DeSalt
30%	6	0.25	1205	825
Cost Per Yard		\$	18.58	
	Gallons or Days	Cost/Gallon or Day	Shipping	Total
Desalt	825	\$16.00	\$2,500.00	\$15,700.00
Soil ReStore	55	\$18.00	\$250.00	\$1,240.00
Frac-Tank 3 days	3	\$125.00	\$1,500.00	\$1,875.00
Water 500bbl.	21000	\$0.08	\$1,000.00	\$2,575.00
Back Hoe-1 Day	1	\$500.00	\$500.00	\$1,000.00
Total				\$22,390.00

The estimated treatment of the site is approximately **\$18.58/Cubic Yard**. Any other bids should be compared on a similar Cost/Cubic Yard basis.

VI. STANDARD PROVISIONS FOR SOIL REMEDIATION SERVICES

Agreement. Acceptance of Remediation and Applied Technology's (R&A) Proposal and issuing of an order for services ("Order") by Buyer constitutes acceptance of these provisions by Buyer. All prior understandings are merged into the Order. Any additional or differing provisions in the Order, request for proposal (if any) or any other documents of the Buyer are expressly rejected, and R&A's beginning of performance shall not be construed as acceptance of Buyer's additional or differing provisions. The "Agreement" between the parties shall consist of R&A's Proposal including these Standard Provisions for Soil Remediation Services and Buyer's Order.

Services. The Services to be performed (including proprietary products to be used in performing the Services) are as stated in the Proposal. The Buyer understands R&A uses the information provided by the Buyer to determine necessary and appropriate testing and selection of the proprietary products required to remediate certain characteristics of the soil. R&A's "analysis," for the purposes of this Agreement, is specifically to determine soil types and salts in the soil and to develop a soil treatment process to bring the soils to be treated to a level that is conducive to vegetation growth or as specified in the proposal.

Disclaimer. R&A's testing program is designed to obtain information of certain specific characteristics of the soils as identified in its Proposal and is not designed, nor is R&A engaged to analyze for other constituents or contaminants. In the event R&A's testing infers suspect materials or debris in the soils under analysis, R&A will immediately notify Buyer of such inferences and halt its operations until specific directions are received from the Buyer. R&A's services are limited to the targeted soils and no inference is to be drawn nor does R&A make an inferences concerning the soils below the targeted soils or adjacent to the targeted soils or their impact upon the targeted soils. Therefore, R&A does not infer or warrant in any manner that the targeted and treated soils will remain at the contracted levels.

Invoicing and Payment. R&A may invoice monthly, upon completion of project, or upon shipment of products as it in its sole discretion determines. The price to be charged and paid shall be that as stated in the Agreement and is exclusive of any taxes that are to be collected from Buyer. Payments of invoices are due within 30 days of invoice receipt. If payment in full is not so received, Buyer shall be delinquent and shall be subject to a charge equal to the lesser of 1.5% per month or the highest rate chargeable by law on the delinquent balance. On order in excess of \$50,000, half of the amount may be required before product shipping.

Changed Conditions. R&A's Proposal is based upon information provided to it by Buyer. In the event the actual conditions are different, R&A shall be entitled to an equitable adjustment in price and performance period.

Indemnification. Buyer agrees to defend, indemnify, save and hold harmless R&A from and against any liability or any cause of action, whether in law or equity, arising out of the services performed except to the extent those liabilities or causes of action are caused by R&A's negligence, breach of contract or willful misconduct in performing the Services. Buyer shall be responsible for all preexisting environmental conditions of the site and the liability for remediation thereof and agrees to defend, indemnify, save and hold R&A harmless from and against any and all claims and causes of action, whether in law or equity, arising condition existing at the site.

Warranty. R&A warrants that all Services performed by it hereunder and all materials provided shall be free of defects in material or workmanship and shall meet or exceed all specifications at the time of inspection and acceptance. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED IN LAW, AND IS THE SOLE WARRANTY GRANTED.**

Buyer Warranty and Representations. Buyer warrants that to the best of its knowledge, the site information and characteristics provided to R&A are current, accurate and complete; that it is the present owner of the site and/or possesses the necessary rights to perform or have the Services performed; that it has or will obtain the easements or any other authorizations for R&A's access to the site and authorizations/permits to perform the Services (excluding those licenses required of R&A); that performance of the Services by R&A or any other entity will not violate any federal, state or local law, rule, or regulation; and that the Buyer is under no prohibition against the performance of the Services as provided herein.

Term. The term of this Agreement shall the performance period as stated in the Proposal.

Force Majeure. Except for the payment of monies due for services performed, delays or failure of either party in the performance of its required obligations shall be excused if caused by circumstances beyond the reasonable control of the party affected, including, but not limited to, acts of God, strikes, labor holiday, fire, flood, windstorm, explosion, riot, war, sabotage, transportation, provided that a prompt notice of such delay is given and the parties shall be diligent in attempting to remove such causes(s).

Applicable Law. This Agreement shall be governed by and construed in accordance with the laws of the State of Texas, excluding its conflicts of laws provisions.

Legal Fees. If any legal action is brought by either of the parties hereto, it is expressly agreed the party in whose favor a final

judgment entered shall be entitled to recover from the other party reasonable attorneys' fees, costs and expenses.

Non Waiver. No waiver by either party of any provision or condition of this Agreement shall constitute or be deemed a waiver of any other provision or condition of this Agreement, or a waiver of any subsequent breach of the same provision or condition.

Assignment. Buyer may not assign its rights, duties or obligation hereunder without the express, prior, written consent of R&A.

Confidentiality. Buyer agrees to keep all information obtained from R&A or acquired in connection with or as a result of performing Services hereunder in strict confidence during and for a period of 2 years following the termination of this Agreement. Buyer shall not divulge, nor permit any of its employees, officers, directors, shareholders, affiliates, agents or representatives to divulge such information or any part thereof to any party other than R&A without the prior written consent of R&A, and agrees it shall not use any of the information obtained from or provided by R&A for any purposes other than remediating the specific location identified in R&A's Proposal.