



CASE STUDY

DETOXIFYING SALT-CONTAMINATED SOILS

3 CASE STUDIES PERFORMED BY 3TIER TECHNOLOGIES, LLC AND
EDWARDS ENVIRONMENTAL CORPORATION

Note: Bioxy's SaltBinder product corresponds to "SA-1000" as
referenced in the case study.

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Detoxifying Salt Contaminated Soils Using SA-1000 Oklahoma Subject Site #1

**George Edwards, Edwards Environmental Corporation
Daniel J Burdette, 3 Tier Technologies LLC**

Introduction:

Today's energy industry is dependent on the use of fracking technology for the safe and efficient exploration of high demand gas/oil. A substantial byproduct of the fracking industry is the generation of a high salt wastewater. The management and disposal of this water is a relatively safe and simple process though as with any large handling systems small spills, pipe ruptures, valve failures, and even normal site operations may lead to the inadvertent release of small quantities of this waters on the soils in or around the exploration sites.

3 Tier Technologies, using over ten years of experience solving soil challenges including high salt and bi-carbonate issues in the turf and agriculture industries, brings our proven solution to the energy industry with our latest advancement in salt management – **SA-1000**. **SA-1000** is an organic solution for salt management that uses our proprietary Polyelectrolyte Enhanced Biopolymers (PEB). PEB is the newest generation for sodium and bi-carbonate remediation for soils and wastewater.

Objective:

3 Tier Technologies in association with Edwards Environmental Corporation, 3 Tier's distributor and technical product support in Oklahoma, identified several sites that had been impacted from frac water releases. It is common that the exploration sites are located in rural areas and that the previous land usage was for agricultural purposes. The various subject sites are agricultural sites and since the releases have exhibited loss of vegetation due to the excess sodium buildup in the relatively high clay soils. High salts will neutralize a soils ability to support vegetation of any kind though it can be safely regenerated and managed through the application of **SA-1000**. The objective of this research was to identify various sites that had been impacted by an inadvertent release of fracking wastewater and to regenerate the soils back to productive agricultural use.

Edwards Environmental Corporation identified the first subject site, a .58 acre tract of land which two years ago had a storage tank line rupture. Since the release, the site has not had any vegetation of any kind on it and it was the goal of the Energy Company and the land owner to correct the issues so that the land could be returned to a viable pasture and support various grasses for grazing.

Methods:

Edwards Environmental Corporation initiated the salt water remediation project on Subject Site #1, a .58 acre tract of land, on July 23, 2013.

1. Site Analysis:

It was determined that the principal impact of the soils was the top eight (8) inches. Initial soil samples were collected from a variety of locations within the non-vegetated area of the site. The soils collected were properly stored and delivered to Environmental Testing Inc. of Oklahoma City for analysis. The composite sample was tested for Total Soluble Salts using method SM 2520A and for Chlorides using EPA Method 300.0. Electrical Conductivity was estimated using comparative soil data from a variety of similar locations.

2. Site Preparation:

The subject site was well defined by the lack of any vegetation. In preparation to the corrective treatments, the area was cultivated using an agricultural disc method which loosened the soils to a depth of 4 to 6 inches. The discing was completed in several directions to effectively open the subject soils and insure proper penetration of the corrective treatment. After the initial corrective treatment, the site received one additional cultivation to mix the material and prepare for the final product application. All work was completed by the Energy Companies contractor.

3. Treatment Process:

SA-1000 is a liquid product that is applied by mixing with additional water to drench the soils of the subject site. The subject area had approximately 617 cubic yards of soil to be treated. The recommended application rate for this site was 12 ounces of **SA-1000** concentrate diluted in approximately 6.5 gallons of water. The site required 100 barrels of water (Approximately 4000 gallons of water). A 1000 gallon water truck was used to dilute and apply the treatment through a hose and fire nozzle. The entire site received an initial drenching (two truckloads), was then tilled one more time before the final drench was applied to the site (additional two truckloads). The entire process was completed in one day.

4. Additional Sampling:

Approximately 30 and 60 days after the treatment was applied to the site, the site was sampled in fifteen different areas to make a single composite soil sample that was then delivered to Environmental Testing Inc. and tested using the same methods as previously described. The site is scheduled for additional testing

Results:

The following is the specific Subject Site test data:

Test	Pre-Treat	30 Day	60 Day	+/-
Total Soluble Salts	13,900 ppm	2920 ppm	1960 ppm	-85.9%
Chlorides	6080 ppm	1080 ppm	674 ppm	-88.9%
Conductivity*	21,545 um/cm	4536 um/cm	1235 um/cm	-94.3%

The Subject site demonstrated significant Total Soluble Salt reduction of nearly **86%**, Chloride reduction over **88%**, and Conductivity reduction of over **94%** in less than 60 days. It is reasonable to expect that the site will exhibit some fluctuations for the next six months depending on moisture conditions though the levels of contamination will continue to reduce over time due with normal rain and cultural practices.

SA-1000 naturally binds the sodium molecule which eliminates the salt's ability to bind to soil particles especially clay which allows it to be safely leached and naturally filtered through the soil profile. Any salt residue that still exists in the growing profile has been detoxified so that it will not negatively affect new

plants from establishing and be supported by healthy active soils. **SA-1000** safely regenerates soil affected by salts and promotes improved soil structure for healthy, productive use of the site.

To confirm the performance of the treatment and viability of the soils after treatment, several of the new plants were carefully unearthed and collected for further examination. The collected varieties included Bermuda grass, Johnson grass, various weeds, and nettle growing in all quadrants of the site. The various samples were very healthy and growing quite rapidly in the treated area. A Bermuda grass sample had roots which measured 8 inches, a Johnson grass sample was harvested and the roots measured 7.25 inches, and a final sample of nettle was harvested and documented with a root length 7 inches which broke while harvesting so it was much longer. Shortly after these observations were made, the landowner cultivated the entire site and planted wheat which is growing as well in the treated areas as the unaffected areas of the site.

Both the Energy Company and landowner are very pleased with the cost effective and immediate results the treatment has provided.

Summary:

SA-1000 is a cost effective, natural solution for the management of salt in a variety of soil types. The above mentioned results are reasonable expectations on projects with similar soil structures. 3 Tier recommends a thorough soil testing that includes Conductivity, Total Soluble Salts, Chlorides, Calcium, and Manganese, though all site conditions must be considered to properly establish the best treatment solutions for each individual project. 3 Tier offers a suite of specialty remediation products which are designed to meet challenges of most contaminated sites.

The following information will be required by any 3 Tier Technical Representative to properly recommend a solution and determine the appropriate application strategy including product rates and methods of treatment:

- Type of contamination, levels of contamination, depth of contamination, how long has the site been contaminated, and how quickly does the remediation have to be completed.
- Soil type and makeup. 3 Tier recommends the soil testing regime established by Oklahoma State University for salt remediation projects.
- Regulatory standard that needs to be met if applicable
- Site accessibility for different treatment methods
- Time of year and related seasonal weather considerations
- Any previous treatments or processes done to the subject site.

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Edwards Environmental Corporation, contact George Edwards at byogeorge@aol.com or call 405-850-1630.

Detoxifying Salt Contaminated Soils Using SA-1000 Oklahoma Subject Site #2

**George Edwards, Edwards Environmental Corporation
Daniel J Burdette, 3 Tier Technologies LLC**

Introduction:

Today's energy industry is dependent on the use of fracking technology for the safe and efficient exploration of high demand gas/oil. A substantial byproduct of the fracking industry is the generation of a high salt wastewater. The management and disposal of this water is a relatively safe and simple process though as with any large handling systems small spills, pipe ruptures, valve failures, and even normal site operations may lead to the inadvertent release of small quantities of this waters on the soils in or around the exploration sites.

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Objective:

3 Tier Technologies in association with Edwards Environmental Corporation, 3 Tier's distributor and technical product support in Oklahoma, identified several sites that had been impacted from frac water releases. It is common that the exploration sites are located in rural areas and that the previous land usage was for agricultural purposes. The various subject sites are agricultural sites and since the releases have exhibited loss of vegetation due to the excess sodium buildup in the relatively high clay soils. High salts will neutralize a soils ability to support vegetation of any kind though it can be safely regenerated and managed through the application of **SA-1000**. The objective of this research was to identify various sites that had been impacted by an inadvertent release of fracking wastewater and to regenerate the soils back to productive agricultural use.

Edwards Environmental Corporation identified the second subject site, a 1.74 acre tract of land which in October 2012 had a storage tank line rupture. Since the release, the site has not had any vegetation of any kind on it and it was the goal of the Energy Company and the land owner to correct the issues so that the land could be returned to a viable pasture and support various grasses for grazing.

Methods:

Edwards Environmental Corporation initiated the salt water remediation project on Subject Site #2, a 1.74 acre tract of land, on July 24, 2013 for the first applications and August 6, 2013 for the final applications due to incorrect initial acreage information and additional product requirements.

1. Site Analysis:

It was determined that the principal impact of the soils was the top eight (8) inches. Initial soil samples were collected from a variety of locations within the non-vegetated area of the site. The soils collected were properly stored and delivered to Environmental Testing Inc. of Oklahoma City for analysis. The composite sample was tested for Total Soluble Salts using method SM 2520A and for Chlorides using EPA Method 300.0. Electrical Conductivity was estimated using comparative soil data from a variety of similar locations.

2. Site Preparation:

The subject site was well defined by the lack of any vegetation. In preparation to the corrective treatments, the area was cultivated using an agricultural disc method which loosened the soils to a depth of 4 to 6 inches. On 7/24/13 the initial discing was completed in several directions to effectively open the subject soils and insure proper penetration of the corrective treatment. After the first corrective treatment, the site received an additional cultivation to mix the material. On 8/6/13 the subject site was cultivated one additional time to prepare for the final product application. All work was completed by the Energy Companies contractor.

3. Treatment Process:

SA-1000 is a liquid product that is applied by mixing with additional water to drench the soils of the subject site. The subject area had approximately 1881 cubic yards of soil to be treated. The recommended application rate for this site was 14 ounces of **SA-1000** concentrate diluted in approximately 6 gallons of water per cubic yard of soil. The site required 260 barrels of water (11,000 gallons of water). A 1000 gallon water truck was used to dilute and apply the treatment through a hose and fire nozzle. On 7/24/13 the entire site received an initial 8 ounces of **SA-1000** concentrate diluted in 6 gallons of water per cubic yard. 6000 gallons of water was applied in total. On 8/6/13, the site was tilled one more time before the final 6 ounce per cubic yard of **SA-1000** concentrate was applied. 5000 gallons of water was applied in total. After all liquid application was complete, the contractor spread 40 pounds of ryegrass and 1.5 pounds of cow peas across the site. The entire process was completed in two days.

Note: Due to the soil type and structure and the identified rebound effective the site exhibited, the site received an additional treatment of **SA-1000** at 8 ounce rate using the same dilutions as before. The entire site was also covered with a 4 inch layer of hay for moisture management.

4. Additional Sampling:

Approximately 30 and 60 days after the treatment was applied to the site, the site was sampled in fifteen different areas to make a single composite soil sample that was then delivered to Environmental Testing Inc. and tested using the same methods as previously described. The site is scheduled for additional testing in the Spring.

Results:

The following is the specific Subject Site test data:

Test	Pre-Treat	30 Day	60 Day	+/-
Total Soluble Salts	15,000 ppm	3530 ppm	3990 ppm	-73.4%
Chlorides	6410 ppm	1170 ppm	1410 ppm	-78.0%
Conductivity*	36,540 um/cm	5472 um/cm	6240 um/cm	-82.9%

The Subject site demonstrated significant Total Soluble Salt reduction of nearly **74%**, Chloride reduction over **78%**, and Conductivity reduction of over **82.9%** in less than 60 days. It is reasonable to expect that the site will exhibit some fluctuations for the next six months depending on moisture conditions though the levels of contamination will continue to reduce over time due with normal rain and cultural practices.

SA-1000 naturally binds the sodium molecule which eliminates the salt's ability to bind to soil particles especially clay which allows it to be safely leached and naturally filtered through the soil profile. Any salt residue that still exists in the growing profile has been detoxified so that it will not negatively affect new plants from establishing and be supported by healthy active soils. **SA-1000** safely regenerates soil affected by salts and promotes improved soil structure for healthy, productive use of the site.

The site inspection after the completion of treatments noted full germination of the applied seed and additional establishment of native grasses and weeds that had not previously been present. It was also noted that the site had additional foot traffic from the cattle since this was a pasture. The increased cattle traffic and resulting cow pies identified that new plants growing in the treated area were already being grazed by the cattle which better clarifies why a full stand of either ryegrass or cow peas never fully developed.

Both the Energy Company and landowner are very pleased with the cost effective and immediate results the treatment has provided.

Summary:

SA-1000 is a cost effective, natural solution for the management of salt in a variety of soil types. The above mentioned results are reasonable expectations on all projects though all site conditions must be considered to properly establish the best treatment solutions for each individual project. 3 Tier offers a suite of specialty remediation products which are designed to meet challenges of most contaminated sites.

The following information will be required by any 3 Tier Technical Representative to properly recommend a solution and determine the appropriate application strategy including product rates and methods of treatment:

- Type of contamination, levels of contamination, depth of contamination, how long has the site been contaminated, and how quickly does the remediation have to be completed.
- Soil type and makeup. 3 Tier recommends the soil testing regime established by Oklahoma State University for salt remediation projects.
- Regulatory standard that needs to be met if applicable
- Site accessibility for different treatment methods
- Time of year and related seasonal weather considerations
- Any previous treatments or processes done to the subject site.

For additional information, contact Bioxy Research at info@bioxyresearch.com or call 855-55-BIOXY.

Edwards Environmental Corporation, contact George Edwards at byogeorge@aol.com or call 405-850-1630.

Detoxifying Salt Contaminated Soils Using SA-1000 Oklahoma Subject Site #3

**George Edwards, Edwards Environmental Corporation
Daniel J Burdette, 3 Tier Technologies LLC**

Introduction:

Today's energy industry is dependent on the use of fracing technology for the safe and efficient exploration of high demand gas/oil. A substantial byproduct of the fracing industry is the generation of a high salt wastewater. The management and disposal of this water is a relatively safe and simple process though as with any large handling systems small spills, pipe ruptures, valve failures, and even normal site operations may lead to the inadvertent release of small quantities of this waters on the soils in or around the exploration sites.

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Objective:

3 Tier Technologies in association with Edwards Environmental Corporation, 3 Tier's distributor and technical product support in Oklahoma, identified several sites that had been impacted from frac water releases. It is common that the exploration sites are located in rural areas and that the previous land usage was for agricultural purposes. The various subject sites are agricultural sites and since the releases have exhibited loss of vegetation due to the excess sodium buildup in the relatively high clay soils. High salts will neutralize a soils ability to support vegetation of any kind though it can be safely regenerated and managed through the application of **SA-1000**. The objective of this research was to identify various sites that had been impacted by an inadvertent release of fracing wastewater and to regenerate the soils back to productive agricultural use.

Edwards Environmental Corporation identified the third subject site, a 1.35 acre tract of land which had a storage tank leak that impacted the attached land. Since the release, the site has had limited vegetation on it and it was the goal of the Energy Company and the land owner to correct the issues so that the land could be returned to a viable pasture and support various grasses for grazing.

Methods:

Edwards Environmental Corporation initiated the salt water remediation project on Subject Site #3, a 1.35 acre tract of land, on December 18, 2013.

1. Site Analysis:

It was determined that the principal impact of the soils was the top eight (8) inches. Initial soil samples were collected from a variety of locations within the non-vegetated area of the site. The soils collected were properly stored and delivered to Environmental Testing Inc. of Oklahoma City for analysis. The composite sample was tested using the OSU salt contamination site criteria

2. Site Preparation:

The subject site was well defined by the lack of any vegetation. The subject site is a marshy site that had lower salt and EC levels and was not cultivated prior to treatment due to moisture levels and fear the equipment may get stuck. Site was treated without cultivation. All work was completed by the Energy Companies contractor.

3. Treatment Process:

SA-1000 is a liquid product that is applied by mixing with additional water to drench the soils of the subject site. The subject area had approximately 1900 cubic yards of soil to be treated. The recommended application rate for this site was 8 ounces of **SA-1000** concentrate diluted in approximately 3.5 gallons of water. The site required 50 barrels of water (Approximately 2000 gallons of water). A 1000 gallon water truck was used to dilute and apply the treatment through a hose and fire nozzle. The entire site received a single drenching (two truckloads). The site received a 4" layer of hay after the application to increase moisture retention and provide organics to the site. The entire process was completed in one day.

4. Additional Sampling:

Approximately 4 months after the treatment was applied to the site, the site was sampled in fifteen different areas to make a single composite soil sample that was then delivered to Environmental Testing Inc. and tested using the same methods as previously described. The site is not scheduled for additional testing

Results:

The following is the specific Subject Site test data:

Test	Pre-Treat	120 Day	+/-
pH	8.16	8.23	+0.01%
Bicarbonate Alkalinity	170 mg/L	220 mg/L	+22.7%
Conductivity (EC)	1870 um/cm	1060 um/cm	-43.3%
Total Soluble Salts	1200 ppm	678 ppm	-43.5%
Calcium	67.6 mg/L	27.5 mg/L	-59.3%
Potassium	12.1 mg/L	14.0 mg/L	+13.5%
Magnesium	68.3 mg/L	38.5 mg/L	-43.6%
Sodium	382 mg/L	155 mg/L	-59.4%
Chlorides	425 mg/L	141 mg/L	-66.8%
Nitrate as N	2.00 mg/L	5.93 mg/L	+66.2%
Sulfate as SO4	64.4 mg/L	56.4 mg/L	-12.4%
Exchangeable Sodium %	9.38 %	5.09 %	-45.7%
Sodium Absorption Ratio	7.87 meq/L	4.49 meq/L	-42.9%

Note: Yellow highlighted percentages are discussed further in the next section of the report.

The Subject site demonstrated significant Total Soluble Salt reduction of nearly **44%**, Chloride reduction over **66%**, and Conductivity reduction of over **43%** over the 120 day period. These reductions are very good considering the time of year when the application were made which was the winter. Due to the lower than normal ambient temperatures this winter in Oklahoma, the soil movement and processes in the top 6 to 8 inches would have been very limited. The improvements are quite good considering the

weather patterns and it is reasonable to expect that the site will exhibit increased reductions over the next few months due to increased spring moisture conditions and warmer weather.

The reduction in both Exchangeable Sodium Percentage (ESP) (Over 45% reduction) and Sodium Absorption Ratio (SAR) (Over 42% reduction) represent that the treated area is out of the range of soils that exhibit salt stress and related issues. Though the salt content still exists the soil is performing at normal levels which allow for proper moisture infiltration and soil performance characteristics. This trial also identified the key importance of proper Calcium and Magnesium levels to achieve critical reduction in EC, ESP, and SAR. Future treatment programs will include a newly formulated calcium additive specifically designed for salt remediation projects as a side note, the increase of Nitrogen in the site is an expected by-product of our treatment and the natural impact our natural products have on organics and the conversion of those organics into available nutrients. 3 Tier salt remediation products provide critical value in re-establish proper soil structure and rapid repair of the soils so the land can be immediately used for pasture or cropping uses.

SA-1000 naturally binds the sodium molecule which eliminates the salt's ability to bind to soil particles especially clay which allows it to be safely leached and naturally filtered through the soil profile. Any salt residue that still exists in the growing profile has been detoxified so that it will not negatively affect new plants from establishing and be supported by healthy active soils. **SA-1000** safely regenerates soil affected by salts and promotes improved soil structure for healthy, productive use of the site.

Both the Energy Company and landowner are very pleased with the cost effective and immediate results the treatment has provided.

Summary:

SA-1000 is a cost effective, natural solution for the management of salt in a variety of soil types. The above mentioned results are reasonable expectations on projects with similar soil structures. 3 Tier recommends a thorough soil testing that includes soil makeup, Conductivity, Total Soluble Salts, Chlorides, Calcium, and Manganese, though all site conditions must be considered to properly establish the best treatment solutions for each individual project. 3 Tier offers a suite of specialty remediation products which are designed to meet challenges of most contaminated sites.

The following information will be required by any 3 Tier Technical Representatives to properly recommend a solution and determine the appropriate application strategy including product rates and methods of treatment:

- Type of contamination, levels of contamination, depth of contamination, how long has the site been contaminated, and how quickly does the remediation have to be completed.
- Soil type and makeup. 3 Tier recommends the soil testing regime established by Oklahoma State University for salt remediation projects.
- Regulatory standard that needs to be met if applicable
- Site accessibility for different treatment methods
- Time of year and related seasonal weather considerations
- Any previous treatments or processes done to the subject site.

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