Oil and Gas Industry Whitepaper
&
Water Treatment Whitepaper

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

H2O Restore As Novel Product To Improve Water Quality Of Simulated and Real-World Frac Water

Lauren A. Stainback, Dept. of A. Chem., Triad Forensics Laboratory, Nov 17, 2011

Drilling an oil or gas well requires, on average, between 60,000-500,000 gallons of fresh water. An estimated 5 million gallons of fresh water is used by oil and gas fracturing operations per well. (USDOE GWPC Report, 2009) Certain wells are operated as multi-stage fracs and consume greater volumes of fresh water per reservoir than the more traditional single-stage fracs. Regardless of type, the fresh water is typically mixed with 1.8% (v/v) of chemical additives before being injected into a well frac. Thus, the overwhelming component of all fracing fluids is fresh water.

Fluid additives are oil and gas recovery-enhancing chemicals that include acid corrosion inhibitors, biocides, breaker fluids, emulsifiers, fluid–loss additives, and friction reducers. Additive combinations of the injected material are tailored to the specific geological and operational situations encountered within each well. To maintain optimal well production, the composition of the injected fluid is modified throughout the operating lifetime of a well. Injected fluids dissolve organic and inorganic material encountered within the well bore and the producing reservoir. These materials comprise heavy metals, elemental salts, minerals, and carbonaceous molecules in their liquid and gaseous forms. Microbes are also washed into the injection fluid. They include but are not limited to acid producing and hydrocarbon degrading bacteria species. This so-called "contaminating" material alters the injected fluid's physical and chemical properties.

Much of the fluid is eventually pumped back to the surface and handled in a variety of ways. It may be released into the environment, stored, or processed for partial re-use. Often it is left within the geological formation after first being pumped out and mixed with a propping agent to protect the well or preserve the geological formation. A USEPA environmental study (Palmer et al, 1991a) predicted a total recovery of injection

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

fluid to be between 68 and 82 percent. Risk assessment studies are ongoing and many are focused on the fate of the unrecovered 18 to 32 percent of the injection fluid. The injection fluid additives and contaminants may or may not pose known health hazards, or their associated health risks are long-term effects and are not readily apparent.

As fracing and drilling operations expand, government agencies are conducting field and laboratory studies to assess their impact on natural resources and risks posed to human health. Many US fracing operators have been asked to share water quality and consumption data with the USEPA. Key areas for risk assessment include: monitoring the consumption, lifetime, and fate of fresh water used for each well; reporting the nature and quantity of additives used in frac operations; the fate and lifetime of additives; waste stream identification, waste handling, waste treatment and disposal. Therefore, studies relating to frac fluid re-use or recycling and associated technological advances for frac wastewater treatment are integral for growth and expansion of fracing and drilling industries.

A finite volume of fresh water is available to support these operations. As fresh water volumes decline, costs for oil and gas production operations as well as wastewater disposal are on the rise. To defray these costs and comply with regulatory guidelines, site operators must develop or increase on-site water re-use and waste water treatment options. Fresh and flow-back water qualities in addition to injection fluid composition are critical factors when choosing an effective water treatment product. A well's unique geological conditions coupled with dynamic engineering and re-engineering of injection fluids presents unique problems for site operators. A promising broad-spectrum solution is a product developed by 3 Tier Technologies and aptly named H2O Restore. H2O Restore was specifically formulated for the treatment of wastewater and storage tanks.

Independent laboratory testing was conducted over a five-day period, using both synthetic and real world frac water matrices, to evaluate the H2O Restore product (see Table 1). A critical component of experimental design involved eliminating as many

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

unknown variables as possible. To demonstrate that analyte reductions were due to the H2O Restore product, a frac water matrix of known analytical composition was prepared and tested along with a real-word sample. The real-world sample was procured from a fracing operation in Pennsylvania. Synthetic frac water was developed by method of Hayes (Hayes et al 2009). This method of matrix preparation was developed for the USEPA as a suitable alternative to water from actual well samples. Both real-world and simulated water treatment with H2O Restore delivered reductions in all analytes studied (see Tables 1-2, and Attachments A-B).

The overall testing process involved five samples, set up in triplicate, with sub-samples taken and analyzed every 24 hours over a five-day test period. Experimental set-up and treatment was performed in the following manner for the synthetic frac water: *A control designated Sample C, consisting of 1 liter simulated frac water, remained untreated for a total of five days, and was sub-sampled at 0, 24, 48, 72, 96, and 120 hours. Sample RD102-A consisted of one liter of synthetic frac water having 2750ul of 1:20 (v/v) H2O Restore product to synthetic frac water added at 0, 24, 48, 72, 96, and 120 hours respectively and also having 2750ul taken as sub-samples and analyzed prior to each addition of diluted product. Sample RD102B consisted of 5250ul 1:10 (v/v) H2O Restore product to synthetic frac water added at 0, 24, 48, 72, 96, and 120 hours respectively and also having 5250ul taken as sub-samples and analyzed prior to each addition of diluted product.*

Experimental set-up and treatment was performed in the following manner for the real-world frac water: *A control designated Sample C, consisting of 1 liter frac water, remained untreated for a total of five days, and was sub-sampled at 0, 24, 48, 72, 96, and 120 hours. Sample RD102 consisted of one liter of frac water having 2750ul of 1:20 (v/v) H2O Restore product to frac water added at 0, 24, 48, 72, 96, and 120 hours respectively and also having 2750ul taken as sub-samples and analyzed prior to each addition of diluted product. All dilutions were prepared fresh daily by vortex mixing the*

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

respective solutions for 30 seconds and then allowing the mixtures to stand for ten minutes before adding to the one-liter frac water solution.

A definite improvement in frac water quality was observed for samples treated with H2O Restore when compared with an untreated sample over the same 5-day test period. Reductions for all metal analytes were observed as early as Day 1 in the synthetic frac water, see Attachment A. ICP-MS testing for all metal analytes was performed by EPA Method 200.7 (available upon request). Because ICP-MS testing does not show the valence for metal ions, further experimentation was conducted using ion chromatography for chromium metal. This yielded interesting results by showing that as H2O Restore reduced total Chromium, it reduced Chromium(VI) to a greater extent than Chromium(III) (internal study data not provided). Chromium(III) is less toxic than Chromium(VI) and is the most abundant form of elemental Chromium. Further examples of metal valence reductions were observed but are unreported as they fall outside the scope of this study. However, this should be investigated further as it shows great promise for utilizing H2O Restore for hazardous and solid waste treatment.

It is clear that H2O Restore is not merely precipitating metals out of solution. Rather than precipitation, which increases solutions' total suspended solids, H2O Restore acts as a sequestering agent, enveloping and holding harmful metal ions in a stable and soluble complex. By acting as a chelating agent, H2O Restore detoxifies poisonous metal agents by converting them to their chemically inert form. Therefore metals chelated by H2O Restore are converted to a biochemically inert form, at least from a toxicological standpoint. Naturally derived metal complexes are bound in some form of a chelate ring by humic acid or a protein. Virtually all biochemicals exhibit metal cation dissolution capabilities. Many affect solution pH to precipitate metal complexes. However, these metal salts are problematic in that they form scale deposits and are reactive. In an industry application, scale is a significant problem for machinery equipped with moving parts. Thus, by utilizing a treatment such as H2O Restore, scale formation is avoided

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

altogether. Both real-world and simulated water treatment with H2O Restore delivered reductions in all analytes studied. It was further noted that water treated by H2O Restore had significantly less visual turbidity within the water column (see photographs, Attachment D). This is an added benefit for flow-back water recycling because contaminants such as TSS and metal salts can be pumped from holding tanks without centrifugation when tanks are treated with H2O Restore. Because fresh water availability and water quality have significant impact on this industry, implementation of on-site treatments will greatly enhance frac water recycling. The benefits of using the H2O Restore product include rapid water column clearing, reduced total suspended solids, scale minimization and inhibition, as well as reductions in metal and mineral salts. Moreover, H2O Restore is a water treatment product that requires no additional equipment or modification to fracing process prior to implementation. Therefore H2O Restore shows significant competitive advantages over alternative innovations for the treatment of fracing injection fluids, fracing flow-back water, and waste water remediation.

Post Report Additions:

The retained trial samples were resampled and these results have been added to the appropriate Attachments. The purpose of the re-testing was to determine the additional performance the product may have after treatment. Total percentage of reductions have also been added to the spreadsheets.

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

Table 1: Water Quality in Simulated Frac Water Matrix Pre-and-Post Treatment Using Unique H2O Restore Product

Product Treatment Applied	Sample ID	Treatment Time Elapsed (hours)	Temperature (F)	pH	Conductivity (uS/cm)	Total Suspended Solids (mg/L calculated)
Matrix Blank-No Product	Sample C	0	71	8.4	>300,000	160000.0
Matrix Blank-No Product	Sample C	24	71	8.6	>300,000	159020.0
Matrix Blank-No Product	Sample C	48	71	7.9	>300,000	159879.0
Matrix Blank-No Product	Sample C	72	71	7.9	>300,000	159985.0
Matrix Blank-No Product	Sample C	96	71	7.9	>300,000	160000.0
Matrix Blank-No Product	Sample C	120	71	7.9	>300,000	159989.0
H2O Restore	Sample RD102-A	0	71	7.1	280000	158000.0
H2O Restore	Sample RD102-A	24	71	6.3	140000	130000.0
H2O Restore	Sample RD102-A	48	71	6.3	80000	124000.0
H2O Restore	Sample RD102-A	72	71	6.3	54000	123500.0
H2O Restore	Sample RD102-A	96	71	6.3	42000	123000.0
H2O Restore	Sample RD102-A	120	71	6.3	40000	123000.0
H2O Restore	Sample RD102-B	0	71	7.1	280000	158000.0
H2O Restore	Sample RD102-B	24	71	6.3	200000	132000.0
H2O Restore	Sample RD102-B	48	71	6.3	100000	128000.0
H2O Restore	Sample RD102-B	72	71	6.3	92000	126000.0
H2O Restore	Sample RD102-B	96	71	6.3	64000	124500.0
H2O Restore	Sample RD102-B	120	71	6.3	63000	124500.0

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

Table 2: Water Quality in Real-World Pennsylvania Frac Water Matrix Pre-and-Post Treatment Using Unique H2O Restore Product

Product Treatment Applied	Sample ID	Treatment Time Elapsed (hours)	Temperature (F)	pH	Conductivity (uS/cm)	Total Suspended Solids (mg/L calculated)
Matrix Blank-No Product	Sample C	0	71	7.9	280000.0	2800.0
Matrix Blank-No Product	Sample C	24	71	7.9	280000.0	2800.0
Matrix Blank-No Product	Sample C	48	71	7.9	280000.0	2800.0
Matrix Blank-No Product	Sample C	72	71	7.9	280000.0	2800.0
Matrix Blank-No Product	Sample C	96	71	7.9	280000.0	2800.0
Matrix Blank-No Product	Sample C	120	71	7.9	280000.0	2800.0
H2O Restore	Sample RD102-A	0	71	7.9	280000.0	2800.0
H2O Restore	Sample RD102-A	24	71	7.4	140000	600.0
H2O Restore	Sample RD102-A	48	71	7.4	60000	500.0
H2O Restore	Sample RD102-A	72	71	7.2	26000	430.0
H2O Restore	Sample RD102-A	96	71	7.2	12000	430.0
H2O Restore	Sample RD102-A	120	71	7.2	2000	410.0

Triad Forensics
Independent Service Laboratory
200 Northgate Park Dr. Ste. 200
Winston-Salem, North Carolina 27106
Tel 336-722-8963 Fax 336-722-8969
Info@TriadForensicsLab.com
www.TriadForensicsLab.com

References

Hayes, T, 2009. *Sampling and Analysis of Water Streams Associated with the Development of the Marcellus Shale Gas, Final Report*, prepared for Marcellus Shale Coalition, Gas Technology Institute, Des Plaines, IL, December 31.

USGS, 2010. *USGS Produced Water Database*, Internal Access Only

Attachment A - Synthetic Frac Water Data

Date	Product Treatment Applied	Treatment Time Elapsed (hours)	Temperature (F)	pH	EC (mS/cm)	TSS (Calculated mg/L from 10 mL sample)	Aluminum, Al (ppm)	Arsenic, As (ppm)	Barium, Ba 2+ (ppm)	Beryllium, Be (ppm)	Bismuth, Bi (ppm)	Cadmium, Cd (ppm)	Calcium, Ca 2+ (as CaCO3) (ppm)	Chloride, Cl (ppm) by adding fractional subsamples	Chromium, Cr (ppm)	Cobalt, Co (ppm)	Copper, Cu (ppm)	Indium, In (ppm)
10/26/11	Matrix Blank-No Product	0	71	8	>300,000	160000.0	99.7	99.8	98.8	99.9	96.0	100.0	96900.0	35250.0	100.1	99.9	100.7	100.0
10/27/2011	Matrix Blank-No Product	24	71	9	>300,000	159020.0	100.0	99.8	98.0	99.7	97.3	100.5	97000.0	35443.0	100.1	99.8	99.8	99.8
10/28/2011	Matrix Blank-No Product	48	71	8	>300,000	159879.0	99.8	99.8	97.6	99.7	97.4	102.0	97010.0	35450.0	100.1	99.9	99.8	100.0
10/29/2011	Matrix Blank-No Product	72	71	8	>300,000	159985.0	99.7	99.7	98.3	99.7	96.5	101.3	96980.0	35447.0	99.9	99.9	99.9	100.0
10/30/2011	Matrix Blank-No Product	96	71	8	>300,000	160000.0	100.1	99.8	97.9	99.7	96.3	100.4	96990.0	35460.0	99.9	99.9	99.8	99.9
10/31/2011	Matrix Blank-No Product	120	71	8	>300,000	159989.0	99.9	99.8	97.9	99.7	96.7	100.2	97000.0	35458.0	98.4	99.9	100.0	100.0
10/26/11	H2O Restore 10 to 1 dilution 350PPM Addition	0	71	7.1	280000	158000.0	99.7	99.8	98.8	99.9	96.0	100.0	96900.0	35240.0	100.1	99.9	100.7	100.0
10/27/2011	H2O Restore 10 to 1 dilution 350PPM Addition	24	71	6.3	140000	130000.0	82.9	84.0	86.2	87.0	88.0	95.0	82300.0	26530.0	80.3	84.0	86.9	91.0
10/28/2011	H2O Restore 10 to 1 dilution 350PPM Addition	48	71	6.3	80000	124000.0	79.6	83.7	85.0	87.0	85.0	93.2	74115.0	23850.0	78.4	79.8	79.4	87.8
10/29/2011	H2O Restore 10 to 1 dilution 350PPM Addition	72	71	6.3	54000	123500.0	79.1	82.9	84.1	84.9	85.0	92.1	60600.0	20410.0	78.4	78.5	78.6	84.0
10/30/2011	H2O Restore 10 to 1 dilution 350PPM Addition	96	71	6.3	42000	123000.0	79.1	82.9	84.0	84.5	84.0	91.4	57480.0	17310.0	78.2	78.5	78.4	80.6
10/31/2011	H2O Restore 10 to 1 dilution 350PPM Addition	120	71	6.3	40000	123000.0	79.1	82.9	83.9	84.5	84.0	91.4	56990.0	17300.0	78.2	78.4	78.4	80.2
11/29/2011	No Product Addition Retain re-tested	816	71	6.7	40000	61700.0	74.0	80..0	81.1	82.1	83.0	90.6	43500.0	14700.0	77.0	76.0	78.0	79.1
	Percentage of Change				-87.7%	-60.9%	-25.7%	-19.8%	-17.9%	-17.8%	-13.5%	-9.4%	-55.1%	-58.3%	-23.1%	-23.9%	-22.5%	-20.9%
10/26/11	H2O Restore 20 to 1 dilution 350PPM Addition	0	71	7.1	280000	158000.0	99.7	99.7	99.8	98.8	99.9	96.0	96900.0	35240.0	100.1	99.9	100.7	100.0
10/27/2011	H2O Restore 20 to 1 dilution 350PPM Addition	24	71	6.3	200000	132000.0	92.4	83.9	84.0	86.2	87.0	88.0	82300.0	33610.0	84.0	84.1	91.9	96.0
10/28/2011	H2O Restore 20 to 1 dilution 350PPM Addition	48	71	6.3	100000	128000.0	89.0	83.9	83.7	85.0	87.0	85.0	71600.0	30270.0	81.3	82.9	87.5	91.2
10/29/2011	H2O Restore 20 to 1 dilution 350PPM Addition	72	71	6.3	92000	126000.0	86.2	83.5	82.9	84.1	84.9	85.0	65600.0	27995.0	81.1	81.3	82.1	88.4
10/30/2011	H2O Restore 20 to 1 dilution 350PPM Addition	96	71	6.3	64000	124500.0	84.7	83.2	82.9	84.0	84.5	84.0	60700.0	26310.0	80.9	80.9	79.7	86.7
10/31/2011	H2O Restore 20 to 1 dilution 350PPM Addition	120	71	6.3	63000	124500.0	82.3	83.2	82.9	83.9	84.5	84.0	60010.0	26305.0	80.8	80.9	79.8	85.0
11/29/2011	No Product Addition Retain re-tested	816	71	6.5	63000	62900.0	82.3	83.2	82.0	86.4	84.4	83.0	54000.0	21000.0	79.0	79.0	78.0	84.6
	Percentage of Change				-77.5%	-60.2%	-17.5%	-16.5%	-17.8%	-12.6%	-15.5%	-13.5%	-44.3%	-40.4%	-21.1%	-20.9%	-22.5%	-15.4%

Attachment A - Synthetic Frac Water Data

Date	Product Treatment Applied	Treatment Time Elapsed (hours)	Iron, Fe 2+ (ppm)	Lead,Pb (PPM)	Magnesium, Mg 2+ (ppm)	Manganese, Mn (ppm)	Mercury, Hg (ppm)	Nickel, Ni (ppm)	Potassium, K+ (ppm)	Selenium, Se (ppm)	Silicon, Si (as (NH4)2SiF6) (ppm)	Silver, Ag (ppm)	Sodium, (as ratio: Na/NaCl) (ppm)	Strontium, Sr 2+ (ppm)	Thallium, Ti (ppm)	Vanadium, V (ppm)	Zinc, Zn (ppm)
10/26/11	Matrix Blank-No Product	0	102.0	100.0	100.3	99.0	96.4	100.1	104.0	94.0	99.8	99.7	22760.0	103.0	100.3	92.9	99.8
10/27/2011	Matrix Blank-No Product	24	103.0	98.7	101.0	99.3	96.4	99.8	103.2	93.7	97.6	100.1	23000.0	102.7	100.0	93.7	96.4
10/28/2011	Matrix Blank-No Product	48	102.7	100.0	99.3	99.3	96.9	99.6	103.0	94.1	97.5	98.7	22899.0	104.0	99.6	93.0	96.8
10/29/2011	Matrix Blank-No Product	72	102.0	99.4	101.2	99.4	97.0	100.0	103.8	93.6	98.0	99.8	22908.0	103.0	99.9	92.4	99.3
10/30/2011	Matrix Blank-No Product	96	100.0	99.2	99.3	99.6	96.5	99.7	103.5	93.4	99.0	99.3	22979.0	103.5	99.3	92.3	98.9
10/31/2011	Matrix Blank-No Product	120	100.1	99.6	98.7	99.5	96.4	98.9	102.8	93.1	99.1	98.6	22994.0	102.9	98.6	92.6	98.0
10/26/11	H2O Restore 10 to 1 dilution 350PPM Addition	0	102.0	100.0	100.3	99.0	96.4	100.1	104.0	94.0	99.8	99.7	22760.0	103.0	100.3	92.9	99.8
10/27/2011	H2O Restore 10 to 1 dilution 350PPM Addition	24	80.4	79.6	88.0	90.5	87.4	87.6	87.4	86.4	78.5	96.3	18010.0	87.8	90.6	80.3	87.2
10/28/2011	H2O Restore 10 to 1 dilution 350PPM Addition	48	79.1	79.2	84.6	87.6	79.2	85.5	86.2	81.0	74.0	90.1	14990.0	83.0	88.4	71.1	74.9
10/29/2011	H2O Restore 10 to 1 dilution 350PPM Addition	72	78.5	78.7	80.1	78.3	76.3	84.2	85.9	81.2	74.0	90.1	11270.0	81.1	88.2	68.9	68.5
10/30/2011	H2O Restore 10 to 1 dilution 350PPM Addition	96	78.2	78.6	78.2	74.6	74.1	84.2	85.9	81.2	73.9	90.1	10530.0	81.1	86.6	65.4	66.3
10/31/2011	H2O Restore 10 to 1 dilution 350PPM Addition	120	78.6	78.5	74.0	74.2	74.0	84.2	85.6	81.0	73.9	90.0	10470.0	81.1	86.5	65.2	66.0
11/29/2011	No Product Addition Retain re-tested	816	78.2	78.0	73.5	73.9	74.0	83.9	85.5	80.0	73.4	87.9	7840.0	80.0	83.7	64.0	58.9
	Percentage of Change		-23.3%	-22.0%	-26.7%	-25.3%	-23.2%	-16.2%	-17.8%	-14.8%	-26.5%	-11.8%	-65.6%	-22.3%	-16.5%	-31.1%	-41.0%
10/26/11	H2O Restore 20 to 1 dilution 350PPM Addition	0	102.0	100.0	100.3	99.0	96.4	100.1	104.0	94.0	99.8	99.7	22760.0	103.0	100.3	92.9	99.8
10/27/2011	H2O Restore 20 to 1 dilution 350PPM Addition	24	85.8	90.9	92.0	92.6	92.0	94.1	94.9	88.8	85.0	97.0	20010.0	91.6	90.4	84.2	87.0
10/28/2011	H2O Restore 20 to 1 dilution 350PPM Addition	48	82.6	87.3	89.6	89.5	88.8	89.6	89.6	85.0	80.1	96.9	18730.0	89.9	88.2	81.0	77.6
10/29/2011	H2O Restore 20 to 1 dilution 350PPM Addition	72	81.2	84.1	87.0	86.7	84.1	87.5	88.1	83.5	78.4	95.8	17470.0	88.1	86.5	79.1	71.9
10/30/2011	H2O Restore 20 to 1 dilution 350PPM Addition	96	79.3	82.0	84.0	84.6	81.6	86.1	87.3	83.3	76.9	95.6	15200.0	87.4	84.0	75.6	68.2
10/31/2011	H2O Restore 20 to 1 dilution 350PPM Addition	120	79.3	82.0	83.6	82.0	80.9	86.0	87.3	83.3	76.6	95.6	15200.0	87.1	84.0	75.0	68.0
11/29/2011	No Product Addition Retain re-tested	816	79.3	82.0	83.4	82.0	80.9	85.7	87.0	83.0	76.5	94.0	11600.0	85.6	83.8	74.5	67.7
	Percentage of Change		-22.2%	-18%	-16.8%	-17.2%	-16.1%	-14.4%	-16.3%	-11.7%	-12.3%	-5.7%	-49.0%	-16.9%	-16.5%	-19.8%	-32.2%

Attachment B- Real World Frac Water Data

Date	Product Treatment Applied	Treatment Time Elapsed (hours)	Temperature (F)	pH	EC (mS/cm)	TSS (Calculated mg/L from 10 mL sample)	Aluminum, Al (ppm)	Arsenic, As (ppm)	Barium, Ba 2+ (ppm)	Beryllium, Be (ppm)	Bismuth, Bi (ppm)	Cadmium, Cd (ppm)	Calcium, Ca 2+ (as CaCO3) (ppm)	Chloride, Cl (ppm) by adding fractional subsamples	Chromium, Cr (ppm)	Cobalt, Co (ppm)	Copper, Cu (ppm)	Indium, In (ppm)
10/26/11	Matrix Blank-No Product	0	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	14000.0	35250.0	2.0	<DL	<DL	<DL
10/27/2011	Matrix Blank-No Product	24	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	14000.0	35443.0	2.0	<DL	<DL	<DL
10/28/2011	Matrix Blank-No Product	48	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	14000.0	35450.0	2.0	<DL	<DL	<DL
10/29/2011	Matrix Blank-No Product	72	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	14000.0	35447.0	2.0	<DL	<DL	<DL
10/30/2011	Matrix Blank-No Product	96	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	14000.0	35460.0	2.0	<DL	<DL	<DL
10/31/2011	Matrix Blank-No Product	120	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	14000.0	35458.0	2.0	<DL	<DL	<DL
10/26/11	H2O Restore 10 to 1 dilution 350PPM Addition	0	71	7.9	280000	2800.0	6.0	0.1	2700.0	<DL	<DL	0.2	140000.0	72000.0	2.0	<DL	<DL	<DL
10/27/2011	H2O Restore 10 to 1 dilution 350PPM Addition	24	71	7.4	140000	600.0	5.7	0.1	2585.3	<DL	<DL	0.2	130900.0	67500.0	1.9	<DL	<DL	<DL
10/28/2011	H2O Restore 10 to 1 dilution 350PPM Addition	48	71	7.4	60000	500.0	5.5	0.1	2475.4	<DL	<DL	0.2	122391.5	63281.3	1.7	<DL	<DL	<DL
10/29/2011	H2O Restore 10 to 1 dilution 350PPM Addition	72	71	7.2	26000	430.0	5.3	0.1	2370.2	<DL	<DL	0.2	114436.1	59236.2	1.6	<DL	<DL	<DL
10/30/2011	H2O Restore No ProductAddition	96	71	7.2	12000	430.0	5.0	0.1	2269.4	<DL	<DL	0.2	106997.7	55618.3	1.5	<DL	<DL	<DL
10/31/2011	H2O Restore No ProductAddition	120	71	7.2	2000	410.0	5.0	0.1	2269.4	<DL	<DL	0.2	106997.7	55618.3	1.5	<DL	<DL	<DL
11/29/2011	No Product Addition Retain re-tested	816	71	7.4	2000	174.0	0.3	<DL	2235.0	<DL	<DL	<DL	80077.4	29601.0	0.7	<DL	<DL	<DL
	Percentage of Change				-99.3%	-93.8%	-95%	-100%	-17.2%	0%	0%	-100%	-42.8%	-58.9%	-65%	0%	0%	0%

Attachment B- Real World Frac Water Data

Date	Product Treatment Applied	Treatment Time Elapsed (hours)	Iron, Fe 2+ (ppm)	Lead,Pb (PPM)	Magnesium, Mg 2+ (ppm)	Manganese, Mn (ppm)	Mercury, Hg (ppm)	Nickel, Ni (ppm)	Potassium, K+ (ppm)	Selenium, Se (ppm)	Silicon, Si (as (NH4)2SiF6) (ppm)	Silver, Ag (ppm)	Sodium, (as ratio: Na/NaCl) (ppm)	Strontium, Sr 2+ (ppm)	Thallium, Ti (ppm)	Vanadium, V (ppm)	Zinc, Zn (ppm)
10/26/11	Matrix Blank-No Product	0	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/27/2011	Matrix Blank-No Product	24	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/28/2011	Matrix Blank-No Product	48	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/29/2011	Matrix Blank-No Product	72	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/30/2011	Matrix Blank-No Product	96	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/31/2011	Matrix Blank-No Product	120	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/26/11	H2O Restore 10 to 1 dilution 350PPM Addition	0	0.3	0.1	0.1	60.0	0.1	2.0	14.0	1.2	18.0	0.2	49000.0	1020.0	<DL	<DL	6.0
10/27/2011	H2O Restore 10 to 1 dilution 350PPM Addition	24	0.3	0.1	<DL	56.0	0.1	1.9	13.2	1.1	16.8	0.2	45937.5	953.7	<DL	<DL	5.6
10/28/2011	H2O Restore 10 to 1 dilution 350PPM Addition	48	0.3	0.1	<DL	52.2	0.1	1.9	12.4	1.0	15.7	0.2	43066.4	891.7	<DL	<DL	5.2
10/29/2011	H2O Restore 10 to 1 dilution 350PPM Addition	72	0.2	0.1	<DL	48.7	0.1	1.6	11.6	1.0	14.7	0.2	40374.8	833.7	<DL	<DL	4.9
10/30/2011	H2O Restore 10 to 1 dilution 350PPM Addition	96	0.2	0.1	<DL	45.4	0.1	1.5	10.9	0.9	13.8	0.1	37815.3	779.6	<DL	<DL	4.6
10/31/2011	H2O Restore 10 to 1 dilution 350PPM Addition	120	0.2	0.1	<DL	45.4	0.1	1.5	10.9	0.9	13.8	0.1	37815.3	779.6	<DL	<DL	4.6
11/29/2011	No Product Addition Retain re-tested	816	<DL	<DL	<DL	28.0	<DL	0.3	9.7	<DL	11.0	<DL	37815.3	779.6	<DL	<DL	3.0
	Percentage of Change		-100%	-100%	-100%	-53.3%	-100%	-85%	-30.7%	-100%	38.9%	-100%	-22.8%	-23.6%	0%	0%	-50%

Attachment D

< Real-World Frac Water
Before Treatment

Real-World Frac Water After
5 Days of Treatment with
1:20 Dilution H2O Restore >

< Simulated Frac Water
Sample
Before Treatment

Simulated Frac Water
Sample
After 5 Days of Treatment
with 1:20 Dilution H2O
Restore >

< Real-World Frac Water After
24 Hours of Treatment with
1:10 Dilution H2O Restore

Real-World Frac Water After 24
Hours of Treatment with 1:10
Dilution H2O Restore >

< Real-World Frac Water After
24 Hours of Treatment with
1:20 Dilution H2O Restore

Real-World Frac Water After 48
Hours of Treatment with 1:20
Dilution H2O Restore >

Real-World Frac Water After 48
Hours of Treatment with 1:20
Dilution H2O Restore >>

Executive Summary: H2O Restore Product Trials

Trial Purpose:

Hydraulic fracturing, often called fracking, fracing or hydrofracking, is the process of initiating and subsequently propagating a fracture in a rock layer, by means of a pressurized fluid, in order to release petroleum, natural gas, coal seam gas, or other substances for extraction. The fracturing, known colloquially as a frack job (or frac job), is done from a wellbore drilled into reservoir rock formations. The energy from the injection of a highly pressurized fluid, such as water, creates new channels in the rock which can increase the extraction rates and ultimate recovery of fossil fuels.

The fluid injected into the rock is typically slurry of water, proppants, and chemical additives. Additionally, gels, foams, and compressed gases, including nitrogen, carbon dioxide and air can be injected. The composition of injected fluid is changed during the operation of a well over time, that is initially acid is used to increase permeability, then proppants are used with a gradual increase in their size and/or density, and at the end the well is flushed with water under pressure. Injected fluid is to some degree recovered and stored in pits or tanks. Although the concentrations of the chemical additives are very low, the recovered fluid may be harmful due in part to high levels of sodium chloride, various heavy metals, a variety of suspended solids, and hydrocarbons picked up from the formation. The recovered fluid is often processed so that part of it can be reused in another fracking operation, part released into the environment after treatment, and some left in the geologic formation.

The purpose of this trial is to trace the development and validate the performance of 3 Tier's **H2O Restore**, an advanced technology for the treatment of this resulting wastewater into a safer waste product for re-use or disposal. With the dramatic increase in gas exploration both domestically and around the world, the remaining fluids have far exceeded anyone's expectations and since the foundation of this process is water, a highly sensitive and limited natural resource, developing safe treatment processes that increase the options for this wastewater are in high demand for the industry.

Trial Structure:

3 Tier structured the product research to ensure that the principal issues facing the industry have been addressed and that the information generated will identify the various performance characteristics of the product for industry use. Principal challenges are high sodium, electrical conductivity (EC), total suspended solids (TSS), metals, toxicity, and hydrocarbon residuals.

In an effort to achieve an independent evaluation and fully understand our products performance on these issues, 3 Tier contracted Triad Forensic Labs in Winston Salem North Carolina to be an independent testing agency to conduct a variety of product performance trials. Triad Labs has many years of testing experience and direct experience testing various frac waters from around the world. Their experience has been invaluable in this process.

This multi-phase process was structured to first evaluate current production products using a lab created frac water. The key to using the lab created water was to determine product performance in their pure form without any production chemical additives. After this initial evaluation phase, 3 Tier reviewed the results and determined that a hybrid formulation was required to achieve maximum performance.

The second phase evaluated the newly created H2O Restore in the original lab created frac water. Two rates were used to identify performance variations. The third phase required a real world frac wastewater sample which was acquired from an active energy company from Pennsylvania. A sample was sent from one of the companies many holding ponds. The key to this process was to now determine if any of the common fracing additives altered the performance characteristics of H2O Restore.

The final phase of this process required the treatment of a full size production storage pond. The key to the part of the process was to identify any application issues and to ensure that that product would perform the same as it did in the small lab scale testing. The process also verified that the product would not require any special equipment or application methods.

Phase 1: Triad labs, using their vast knowledge of the industry, created a synthetic version of the wastewater that contained high levels of contaminates without any of the fracking fluid solutions. The purpose of this step was to determine the performance of the products without the added variable of the actual fracking fluids. The lab solutions contained the following:

Chloride: 35,450 PPM
Electrical Conductivity (EC): <300,000
Total Suspended Solids (TSS): 160,000 PPM
23 Heavy Metals: Range was between 96 to 105 PPM
No Hydrocarbons in the test sample.

The trial was set up using two of 3 Tier's current products, Soil Rx, used for remediation of hydrocarbons, and H2O Rx, our salt and bi-carbonate treatment product. Soil Rx was applied at three different rates and the H2O Rx was applied at a single rate. The trial had a control sample and the four various applied treatments. Treatments were made on day 1, 2, 3, 4, all 24 hours apart. Samples were pulled before each application and after five days.

The initial findings provided valuable insight into the products ability to work on harsh materials. It was found the Soil Rx at the highest dosing rate and the H20 Rx performed similarly with the following average results.

The following are the average contaminant reductions for both products:
Chloride: From 35,450 to 22,980 or an average reduction of **35.1%**
Total Suspended Solids (TSS): From 160,000 to 129,970 or an average reduction of **18.8%**
23 Heavy Metals: Average reduction for all metals was **20.3%**

It must also be noted that there is no product out there that makes chlorides or metals disappear. However, the initial testing identified that a hybrid product could be created that would take the best portions of each product and create a new product to improve performance and that product is H2O Restore

Phase 2: Phase 1 provided the direction for the creation of H2O Restore which encompassed the best portions of two products into a new hybrid to be marketed as H2O Restore. The initial testing procedures were used to test the new product in the lab created frac water and compare the performance. For this trial, the best performing rate was used from the initial trial and a second rate, twice the original rate, was used.

The following are the results after five days (See Formal Triad Report for all results):
Chloride: From 35,450 to 17.300 or a reduction of **51%**
Electrical Conductivity (EC): From 280,000 to 40,000 or a reduction of **86%**
Total Suspended Solids (TSS): From 158,000 to 123,000 or a reduction of **22%**
23 Heavy Metals: Average reduction for metals was **22.5%**

Phase 3: Phase 2 of the process provided sufficient evidence that our technology provided a foundation for further testing. Working with an industry partner from Pennsylvania, we sourced a sample of real frack wastewater from a production pond. This material had the following contaminate makeup.

The real world wastewater sample contained the following:
Chloride: 72,000 PPM
Electrical Conductivity (EC): <300,000
Total Suspended Solids (TSS): 2800 PPM
22 Heavy Metals: Range was between 0.01 to 2700 PPM
Hydrocarbons were not measured in this sample.

This trial was setup using best performing rate from the previous study applied in the same method as in the first study.

The following are the average contaminant reductions (See Formal Triad Report for all results):
Chloride: From 72,000 to 55,618 or an average reduction of **24.3%**
Electrical Conductivity (EC): From <300,000 to 2000 or a reduction of **99.3%**
Total Suspended Solids (TSS): From 2800 to 1400 or an average reduction of **50%**
23 Heavy Metals: Average reduction for all metals was **32.6%****

****Additional testing has been conducted for the toxicity of these components. We have initial findings that the toxicity of the remaining chloride and metals has been significantly reduced and the United States EPA has requested a meeting to further discuss our findings on chloride and metals toxicity. Additional testing is being conducted specific to this issue and the results will be released upon completion.**

Phase 2 & 3 Addendum: All treated samples from Phase 2 & 3 were retained and re-sampled 34 days after initial treatments to see what effect static holding times have on the performance. It was noted in all trials that the performance seemed to be dose responsive, meaning that every time an application of product was applied, an incremental reduction was received. After the final treatment, the test samples seemed to level off at the last measured result though it was determined after the retain samples were tested that additional holding time did improve the Total Chloride levels, TSS, and reductions of various metals. The following is the summary including the 34 day results for all samples.

Synthetic Frack Water through 34 Days – Original Application Rate – H2O Restore (See Attached Report for all results):
Chloride: Start = 35,240 Day 5 = 26,305 Day 34 = 21,000 or a reduction of **40.4%**
Electrical Conductivity (EC): Start = 280,000 Day 5 = 63,000 Day 34 = 63,000 or a reduction of **77.5%**
Total Suspended Solids (TSS): Start = 158,000PPM Day 5 = 124,500 Day 34 = 62,900 or a reduction of **60.2%**
23 Heavy Metals: Average reduction for metals was **12% to 31%**

Synthetic Frack Water through 34 Days – Double Application Rate – H2O Restore (See Attached Report for all results):
Chloride: Start = 35,240 Day 5 = 17,300 Day 34 = 14,700 or a reduction of **58.3%**
Electrical Conductivity (EC): Start = 280,000 Day 5 = 40,000 Day 34 = 40,000 or a reduction of **87.7%**
Total Suspended Solids (TSS): Start = 158,000PPM Day 5 = 123,000 Day 34 = 61,700 or a reduction of **60.9%**
23 Heavy Metals: Average reduction for metals was **14% to 41%**

Real World Frack Water through 34 Days – Original Application Rate – H2O Restore (See Attached Report for all results):
Chloride: Start = 72,000 Day 5 = 55,618 Day 34 = 29,601 or a reduction of **58.9%**
Electrical Conductivity (EC): Start = 280,000 Day 5 = 2000 Day 34 = 2000 or a reduction of **99.3%**
Total Suspended Solids (TSS): Start = 2800 Day 5 = 1400 Day 34 = 174 or a reduction of **93.8%**
23 Heavy Metals: Average reduction for metals was **22% to 100%**

Phase 4: After discussions with our industry partner, we were approved to treat a 4.5 million gallon pond. This pond is a representative production holding pond and is being used to refine the application methodology and ensure that the product performs as well when applied to a large scale scenario.

A&M Environmental, 3 Tier's environmental contracting partner, was commissioned to do the applications to the pond and completed the applications last month. The ponds were treated with two applications on consecutive days using a 10 to 1 dilution of H2O Restore applied at a rate 350 PPM per application. For the purposes of this trial, the product was mixed in a 275 gallon tote and evenly sprayed across the surface of the water. Several totes of diluted product were required per application and each tote was evenly applied across each calculated section of the pond.

Currently, only initial data is available from the customer and a release for the information is being negotiated and should be available within the next week. The following is the first available data of the initial pond evaluation and raw data after the first treatment only.

Initial Pond analysis:
Chloride: 2260 mg/L
Total Suspended Solids (TSS): 8290 mg/L
Heavy Metals: Arsenic 14.7 ug/L, Barium 6880 ug/L, Chromium 25.6 ug/L, Lead 32.4 ug/L

First raw data collected on Day 2, 24 hours after initial treatment:
Chloride: 1820 mg/L
Total Suspended Solids (TSS): Not analyzed on this sample
Heavy Metals: Arsenic ND ug/L, Barium 2190 ug/L, Chromium ND ug/L, Lead ND ug/L
ND = Non Detect

Additional pond sampling 3 months after initial treatment:
Chloride: 1820 mg/L
Total Suspended Solids (TSS): 11.0 mg/L
Heavy Metals: Arsenic ND ug/L, Barium 1830 ug/L, Chromium 6.3 ug/L, Lead ND ug/L
ND = Non Detect

After just 24 hours, initial water tests show a 20% reduction in chloride, a 100% reduction in Arsenic, Chromium and Lead with a 68% reduction in Barium. The client opted not to test for TSS on the advice of the lab. The lab advised that if metals dropped than TSS would respectively reduce. TSS will be included all additional test results and the report will be updated and re-distributed.

The pond was sampled after 3 months and these results showed no change in the initial 20% reduction in chlorides, TSS was reduced by 99.8%, and Barium was reduced further to a total reduction 73.4%. Chromium showed a low level and all other metals remained Non-Detect including Mercury, Arsenic, Lead, Selenium and Silver.

Executive Summary:

3 Tier Technologies has built our reputation on responding to industry challenges with cost effective, natural solutions that have been fully tested and validated for performance. From the creation of the first activated humic acid product nearly 20 years ago which is the foundation for all our products today by our Chief Scientist, Alexander Shulgin, which was used for the treatment of contaminated soils around the Chernobyl Nuclear Plant disaster (See Crada Study for complete details), 3 Tier continues to be the leader in the development of industry solutions using natural, safe, chemical free products to meet today's growing challenges.

After hurricanes Rita and Katrina devastated southern Louisiana, 3 Tier was first to respond with a treatment for the high sodium levels left after the weeks of flood waters receded. Our response got farmers back to planting and proved that salt could be managed and soils recovered after heavy salt contamination with levels exceeding 4500 PPM (See Louisiana Hurricane Trial Report). Today, our humic is the only product used in the National Task Force coastal restoration plan to protect the tender seedlings from the harsh salt environments of the Louisiana coastlines.

In 2009, 3 Tier created the next generation in hydrocarbon remediation products just prior to the BP oil disaster in the Gulf of Mexico. Approved by the United States Environmental Protection Agency for National Contingency Plan for disaster cleanups, Soil Rx has hit the market worldwide providing a new natural approach to the in-situ and ex-situ cleanup of hydrocarbons around the world (See BP Report {Soil Rx is Product J in the report}, NCP Approval Letter and DEG Report).

Today our focus has shifted to the treatment of frac wastewater since water is a limited natural resource and the volumes of water used around the world continue to grow in gas exploration. 3 Tier has seized the opportunity to utilize the extensive experience is salt and metal management to develop a solution that should provide the industry the ability to re-use from one-third to one-half of the production wastewater back into the drilling process or to be safely used as irrigation water or safe disposal. The balance of the wastewater will be reduced to a consolidated solution with significantly reduced toxicity levels that will protect our underground water tables and disposal personal.

3 Tier will continue to develop our technologies and create solutions for industry partners to enable them to aggressively seek and generate safer and cleaner fuel alternatives while addressing production issues that may offset the value of the alternative fuels in the eyes of the public. Our scientific team continues to address requests from many industries and will continue to work with partners around the world to ensure that our products are of the highest quality, made from natural chemical free ingredients, and that we are able to implement into operational systems without added cost or additional equipment or processes.

This summary has been prepared by Daniel J Burdette, President and Lead Product Development Specialist for 3 Tier Technologies. Daniel can be contacted at dburdette@3tiertech.com or by phone at 877-226-7498. Additional updates will be provided as new information becomes available.

3 Tier Technologies LLC
250 National Place, Suite 142, Longwood FL 32750
www.3tiertech.com Toll Free: 877-226-7498