

ST. CROIX



OPERATING, INC.

## INJECTION WATER vs. INJECTION ZONE FLUID COMPATIBILITY

### Summary of Fluid Compatibility

The Longknife #3 well will be drilled with the intention of completions in the J Sand. The attached J Sand Water analysis for the State 2-16 is representative of the water quality from the J Sand in the area. As observed in the analysis, the J Sand water is less contaminated than the Lyons injection zone water when observing Chlorides, Sulfates, and TDS. Since there are limited Lyons completions in the county and no producing Lyons wells, the local sample data for the Lyons is several years old and predates the 909J sampling list or requirement, no new Lyons penetrations have been swab tested for water in the area.

The fluids injected into the Longknife #3 SWD injection well will come from the Longknife #2 oil well to be drilled on the same lease as the Longknife #3 SWD. The drilling fluids injected will consist of the fresh water used for drilling, sourced from industrial water wells and/or the State 2-16 J Sand well, if using recycled produced water. Injected drilling fluids come from the centrifuge on the drilling rig after de-watering the drilling mud at completion of drilling. There will be trace amounts of bentonite in the water. The water will be transferred from the closed loop fluid system using trucks to the tanks at the lease. Workover wastes would consist of produced fluids from the J Sand or Lyons on the same Buckhorn lease shown in the produced water analysis from the State 2-16 and Christianson 22-12A, below.

The used fresh water from drilling and an undersaturated brine from the J Sand, will be injected into the Lyons formation which contains a similar brine with higher salt and TDS content. Both brines and fresh water will coalesce since they are of similar chemistry and neither are fully saturated.

There are no representative Lyons producing wells in the area to obtain a sample from to run 909J analysis, so the attached sample is the best record we have locally. After the Longknife #3 is drilled, further sampling of the injection zone can be conducted and 909J panel could be run at that time.

After completion of the Longknife #2, production emulsion will flow through subterranean flowlines to the production facility. Flowlines will be 3" SDR 7 HDPE. At the production facility, the flowline will tie into a heater treater where the water and oil will separate. There is no gas in the J Sand in this region so no gas will be separated from the produced fluids. The heavy gravity

dead-oil from the J sand will flow through subterranean dump lines to crude oil storage tanks, and the produced water will flow through subterranean dump lines to produced water storage tanks and or skim tanks. From the produced water storage tanks, the produced water will then travel through subterranean process piping and through a filter and injection pump and then through another subterranean flowline to the Buckhorn #2 Injection well. In this area it is typically a very simple setup due to the limited fluid volume, rates and pressures expected from the production well.

# Injection Zone Water Analysis – Nearby Lyons Analog Well Christianson 22-12A



## BJ SERVICES Rocky Mountain Region Laboratory Water Analysis Report

LYONS  
FORMATION WTR

Project # S06-01-04

CO666

### Customer/Well Information

Company:	Delta Petroleum	Date:	6/1/2004
Well Name:	Christianson 22-12A	Prepared for:	Andy Peterson
Location:	12-3S-50W	Submitted by:	
State:	Washington County, Wyoming	Prepared by:	Lacy Emerson
Formation:	Lyons	Water Type:	Submitted Sample
Depth:	4810-4885 ft		

### Background Information

Reason for Testing: Submitted sample

Completion type:

Well History:

Special Considerations: Swab Sample 5/13/04

### Sample Characteristics

Sample Temp:	66 (°F)	Viscosity:	1 cp
pH:	7.20	Color:	Clear
Specific Gravity:	1.005	Odor:	hydrocarbon
S.G. (Corrected):	1.006 @ 60 °F	Turbidity:	none
Resistivity (Calc):	1.46 Ω-m	Filtrates:	None

### Sample Composition

#### CATIONS

	mg/l	me/l	ppm
Sodium (calc.)	1054	45.9	1049
Calcium	265	13.2	263
Magnesium	34	2.8	34
Barium	0	0.0	0
Potassium	0	0.0	0
Iron	2.80	0.1	2.79

#### ANIONS

Chloride	720	20.3	716
Sulfate	1875	39.0	1866
Hydroxide	0	0.0	0
Carbonate	< 1	---	---
Bicarbonate	171	2.8	170

#### SUMMARY

Total Dissolved Solids(calc.)	4122		4101
Total Hardness as CaCO3	801	16.0	797

### Scaling Tendencies

CaCO3 Factor	45203.93	Calcium Carbonate Scale Probability →	REMOTE
CaSO4 Factor	496237.5	Calcium Sulfate Scale Probability →	REMOTE

### Comments

# Injection Water Analysis – Nearby J Sand Analog Well State 2-16



## Division of Environmental Testing

2115 N Scranton St Suite 3040A  
Aurora, CO 80045  
800-440-5184

## FINAL RESULTS REPORT

Report Date : 7/25/2024

Report Time : 16:02

Project Manager: Ryan Dornbos

Project Name: State 909J

Project Number: N/A

Sample ID	Customer ID	Collected	Dilution	Result	Units	RL	Method Ref.
Analyte Name		Analysis Start					Recovery
<b>AA09708-1</b> State Pit SCO		Collected : 07/03/2024 12:51					
Anions - Bromide		07/05/2024 15:27	5.00	2.026	mg/L	0.1	EPA 300.0
Anions - Chloride		07/05/2024 15:27	500.00	419.035	mg/L	0.2	EPA 300.0
Anions - Fluoride		07/05/2024 15:27	5.00	10.282	mg/L	0.1	EPA 300.0
Anions - Nitrate		07/05/2024 15:27	5.00	Not Detected	mg/L	0.1	EPA 300.0
Anions - Nitrite		07/05/2024 15:27	5.00	<0.5000 - RL1	mg/L	0.5	EPA 300.0
Anions - Sulfate		07/05/2024 15:27	5.00	2.949	mg/L	0.2	EPA 300.0
Bicarbonate Alkalinity		07/09/2024 14:52		1243.06	mg/L		SM 2320B
Carbonate Alkalinity		07/09/2024 14:53		387.45	mg/L		SM 2320B
Conductivity		07/10/2024 09:35		4750	µS/cm	20	EPA 9050A & 120.1
Nitrate as Nitrogen		07/10/2024 10:58		Not Detected			
Nitrate, Anions		07/10/2024 10:58	5.00	Not Detected			
Nitrite as Nitrogen		07/10/2024 10:58		<0.153			
Nitrite, Anions		07/10/2024 10:58	5.00	<0.500			
pH, Water Temperature		07/05/2024 13:41		20.2	°C		
pH, Water		07/05/2024 13:41		9.29 - H1	S.U.	0.01	EPA9040C, EPA150.1
Sum of Nitrate and Nitrite as Nitrogen		07/10/2024 10:58		<0.153			
Total Alkalinity		07/09/2024 14:50		1630.51	mg/L		SM 2320B
Total Dissolved Solids		07/09/2024 10:51		2960	mg/L	10.00	SM2540C, EPA160.1
Total Suspended Solids		07/09/2024 11:34		141	mg/L	4.00	SM2540D, EPA160.2
<b>AA09708-2</b> State Pit SCO		Collected : 07/03/2024 12:51					
Total Metals, Aqueous - Barium		07/12/2024 10:44	2.00	158.401	µg/L	0.283	EPA3010A&3005A
Total Metals, Aqueous - Boron		07/12/2024 10:44	10.00	3847.085	µg/L	10.000	EPA3010A&3005A
Total Metals, Aqueous - Calcium		07/12/2024 10:44	100.00	27736.707	µg/L	20.000	EPA3010A&3005A
Total Metals, Aqueous - Iron		07/12/2024 10:44	10.00	7995.668	µg/L	10.000	EPA3010A&3005A
Total Metals, Aqueous - Magnesium		07/12/2024 10:44	100.00	6453.184	µg/L	20.000	EPA3010A&3005A
Total Metals, Aqueous - Manganese		07/12/2024 10:44	2.00	278.514	µg/L	0.500	EPA3010A&3005A
Total Metals, Aqueous - Phosphorous		07/12/2024 10:44	2.00	465.451	µg/L	10.000	EPA3010A&3005A
Total Metals, Aqueous - Potassium		07/12/2024 10:44	100.00	8747.280	µg/L	25.000	EPA3010A&3005A
Total Metals, Aqueous - Selenium		07/12/2024 10:44	2.00	2.008	µg/L	0.985	EPA3010A&3005A
Total Metals, Aqueous - Sodium		07/12/2024 10:44	10,000.00	1616889.996	µg/L	20.000	EPA3010A&3005A
Total Metals, Aqueous - Strontium		07/12/2024 10:44	2.00	101.314	µg/L	0.250	EPA3010A&3005A
<b>AA09708-3</b> State Pit SCO		Collected : 07/03/2024 12:51					
DRO/ORO, Aqueous - DRO		07/19/2024 10:13		Not Detected	mg/L	0.613	4 8015D, TCEQ Method TX1
DRO/ORO, Aqueous - ORO		07/19/2024 10:13		Not Detected	mg/L	12.264	4 8015D, TCEQ Method TX1
Gasoline Range Organics, Aqueous		07/11/2024 09:36	2.00	968.54	µg/L	225.80	EPA 8260
Volatile Organic Compounds - Benzene		07/12/2024 00:00	2.00	12.92	µg/L	0.72	EPA 8260d
Volatile Organic Compounds - Ethylbenzene		07/12/2024 00:00	2.00	Not Detected	µg/L	0.78	EPA 8260d
Volatile Organic Compounds - m&p-Xylene		07/12/2024 00:00	2.00	Not Detected	µg/L	1.81	EPA 8260d
Volatile Organic Compounds - o-Xylene		07/12/2024 00:00	2.00	Not Detected	µg/L	0.99	EPA 8260d
Volatile Organic Compounds - Toluene		07/12/2024 00:00	2.00	3.29	µg/L	0.70	EPA 8260d
Volatile Organic Compounds - Xylenes, total		07/12/2024 00:00	2.00	Not Detected	µg/L	2.80	EPA 8260d
<b>AA09708-4</b> State Pit SCO		Collected : 07/03/2024 12:51					
Radium-226		07/25/2024 06:24		1.37 - I	pCi/L	1.00	EPA 903.1
Radium-228		07/25/2024 06:24		4.10 - I	pCi/L	3.00	EPA 904.0

Report #2325 Not previously reported

The results listed pertain only to the samples submitted to Elevation Diagnostics, Division of Environmental Testing as per the Chain of Custody attached. This report may only be duplicated in full.

## Detailed Water Analysis Discussion

Analyte Comparison Table			
Test Patameter	Lyons	State 2-16	Units
Temp	66	68.36	deg F
pH	7.2	9.29	pH units
SG	1.005	-	Unitless
SG Corrected	1.06	-	Unitless
Resistivity	1.46	0.05	Ohmm
Viscosity	1	-	cp
Color	Clear	Clear	-
Odor	hydrocarbon	swampy	-
Cations			
Sodium	1054	1617	mg/L
Calcium	265	28	mg/L
Magnesium	34	6	mg/L
Barium	0	0	mg/L
Potassium	0	9	mg/L
Iron	2.8	8.0	mg/L
Anions			
Chlorides	720	419	mg/L
Sulfate	1875	3	mg/L
Hydroxide	0	-	
Carbonate	<1	387	mg/L
Bicarbonate	171	1243	mg/L
TDS	4122	2960	mg/L
Total Hardness	801	95.8	calc

The above table summarizes the comparable results from the previous listed tests. The J Sand water has a higher pH, sodium, potassium, iron, carbonate and bicarbonate result. The Lyons has higher calcium, magnesium, chlorides, sulfate, TDS and Hardness. Both fluids are undersaturated brines that are 10x to 80x higher than the range of TDS that is accepted for clean drinking water. High salinity and TDS will disqualify this water for use industrially or for agriculture in the region without extreme water treatment measure that are unavailable and uneconomic in the region for the uses and volumes that would be required.

Using TDS as a general qualifying measure of the contamination as it is in rule 802.a. the Lyons has a 25% higher TDS as compared to the J Sand water, and is above the minimum 3,000 mg/L limit required for an aquifer exemption. The TDS measured and provided in this report shows the J Sand water is less contaminated that the Lyons water.