ANTIDEGRADATION REVIEW: APPLICATION
UTAH DIVISION OF WATER QUALITY

Revised, May 2010

Introduction

In accordance with Utah Administrative Code (UAC R317-2-3) an antidegradation review (ADR) is a permit requirement for any project that will increase the level of pollutants in waters of the state. The rule outlines requirements for both Level I and Level II ADR reviews as well as public comment procedures. This application is intended to assist the applicant and Division of Water Quality (DWQ) staff in complying with the rule but is not a substitute for the complete rule in R317-2-3.5. Additional details can be found in the *Utah Antidegradation Implementation Guidance* and relevant sections of the guidance are cited on this application form. For additional clarification on the antidegradation application process and procedures, please contact Chris Bittner or Jeff Ostermiller.

ADRs should be among the first steps of an application for a UPDES permit because the review helps establish project design expectations. ADRs are also required for any project taking place with a stream channel and for applications to fill wetlands as part of the 404 permitting process. In some cases, ADRs are relatively straightforward, literally taking minutes to complete. However, depending on the nature of the project and the characteristic of the receiving water these reviews can sometimes be quite involved. Whenever possible, the Division of Water Quality (DWQ) recommends that the process be initiated at least one year prior to whenever a final approved permit is required to avoid unnecessary delays in permit issuance.

This antidegradation application must be completed and approved by DWQ before any UPDES permit can be issued. DWQ will determine if the project will impair beneficial uses (Level I ADR) using information provided by the applicant. The applicant is responsible for conducting the Level II ADR, if necessary. For the permit to be approved, the Phase II ADR must document that all feasible efforts have been taken to minimize pollution for social or economically beneficial projects resulting in any increase in pollution to waters of the state.

Note that Parts A, B, and D are required for all permits, whereas Parts C and D are only required for Level II ADRs. Once the application is complete, it should be signed, dated, and submitted to the DWQ staff member who is responsible for the UPDES permit or 401 Certification.

Antidegradation Review Application

Part A: Applicant Information

Name of Facility: WestWater Farms Produced Water Treatment Facility

Date: May 11, 2012

Applicant: WWF & ER-PWD Joint Venture, LLC

Facility Owner: WWF & ER-PWD Joint Venture, LLC

Facility Location: 100 West Highway 6
Westwater, Utah 84515

Application or Plans Prepared By: Stewart Environmental Consultants, LLC

Project Name: WestWater Farms Produced Water Treatment Facility

Receiving Water: Coal Draw (Outfalls 001 and 003) and Bitter Creek (Outfall 002)

What Are the Designated Uses of the Receiving Water (R317-2-6)?
Outfall 001 Coal Draw: 1C, 2A, 3B, 4
Outfall 002 Bitter Creek: 2B, 3C, 4
Outfall 003 Coal Draw: 1C, 2A, 3B, 4

Category of Receiving Water (Category 1, 2, or 3 from R317-2-3.2, -3.3, and -3.4):
Outfall 001 Coal Draw: 3
Outfall 002 Bitter Creek: 3
Outfall 003 Coal Draw: 3

UPDES Permit Number (if appropriate): N/A

Effluent Flow Reviewed: 450 gpm

<u>What is the application for? (check all that apply)</u>

☒ An application for a UPDES permit for a new facility or project.

☐ An expansion or modification of an existing wastewater treatment works that will result in an increase in the mass or concentration of a pollutant discharged to waters of the state.

☐ A permit renewal requiring limits for a pollutant not covered by the previous permit.

☐ An expansion or modification of an existing wastewater treatment works that will result in an increase in volume discharged over the volume used to obtain previous permit limits.

☐ A proposed UPDES permit renewal with no changes in facility operations.

Part B. Is a Level II ADR required?

This section of the application is intended to help applicants determine if a Level II ADR is required for specific permitted activities. However, the Executive Secretary may require a Level II ADR for an activity that would otherwise be exempt if extenuating circumstances suggest that a more extensive review of alternatives is needed to protect water quality.

B1. Are water quality impacts of the proposed project temporary and limited (Section 3.3.4)? Proposed projects that will have temporary and limited effects on water quality can be exempted from a Level II ADR.

☐ **Yes** Identify the reasons used to justify this determination from Part B1.1 and proceed to Part G. No Level II ADR is required.

☒ **No** (Proceed to Part B2 of the Application)

B1. 1 Complete this question only if the applicant is requesting a Level II review exclusion for temporary and limited projects (see R317-2-3.5(b)(3) and R317-2-3.5(b)(4)). For projects requesting a temporary and limited exclusion please indicate the factor(s) used to justify this determination (check all that apply and provide details as appropriate) (Section 3.3.4 of Implementation Guidance):

☐ The length of time during which water quality will be lowered is limited. How long?

☐ Water quality impacts are related exclusively to sediment or turbidity and fish spawning will not be impaired.

☐ There is little potential for long-term residual or short-term (acute) negative influences to existing uses.

B2. Are pollutant concentrations in the effluent different than the receiving waters? For most pollutants, pollutants that have concentrations in the effluent higher than the ambient concentrations at critical conditions in the receiving water (Section 3.3.3 of Implementation Guidance) require an antidegradation review? For a few pollutants such as pH or dissolved oxygen, an antidegradation review is required if the effluent concentrations are less than the ambient concentrations in the receiving water.

☒ **Yes** A Level II ADR is required (Proceed to Part C).

Permit Limits and Estimated Effluent Concentration

See Exhibit 1, WestWater Farms PWTF Parameters of Concern.

☐ **No** No Level II ADR is required and there is no need to proceed further with application questions.

Part C. Is the degradation from the project socially and economically necessary to accommodate important economic or social development in the area in which the waters are located? *The applicant must provide as much detail as necessary for DWQ to concur that the project is socially and economically necessary when answering the questions in this section. The social and economic importance of publicly owned treatment works (POTWs) are typically considered self-evident and do not require detailed explanation. More information is available in Section 6.2 of the Implementation Guidance.*

C1. Optional Independent Report. Questions C2 through C6 are provided for the convenience of applicants. However, in some cases it may be easier to address the factors captured by these questions in a separate report. As noted above, the social and economic importance of publicly owned treatment works are considered self evident and a detailed explanation is not typically required. Applicants that prefer a separate report should record the report name here and proceed to Part D of the application.

Report Name:

C2. Describe the social and economic benefits that would be realized through the proposed project, including the number and nature of jobs created and anticipated tax revenues.

The Facility will create approximately ten local technical jobs. These jobs will be facility operators and their compensation is expected to be $15-20 per hour.

Grand County will benefit from this project with a boost to the local economy. The County will profit approximately $0.10/barrel of treated produced water.

☐ The facility is a POTW and is necessary for economic and social growth of the serviced community.

C3. Describe any environmental benefits to be realized through implementation of the proposed project.

The closed treatment approach used at the Facility prevents harmful impacts to the environment. It protects air quality, soil, and nearby water sources. All volatile organic compound emissions will be captured and scrubbed to reduce emissions to the atmosphere.

The treated water from the Facility will meet or exceed regulatory standards, including the discharge standards for river basins, agricultural irrigation standards, and injection standards. This project will also create and contribute to the local non-tributary irrigation water to be beneficially used.

The location of this facility will reduce truck traffic from driving farther to reach current produced water disposal locations.

Hazardous contaminants are neutralized into non-hazardous materials for reuse and/or disposal.

C4. Describe any social and economic losses that may result from the project, including impacts to recreation or commercial development.

There are no social or economic losses anticipated in relation to the Facility.

C5. Summarize any supporting information from the affected communities on preserving assimilative capacity to support future growth and development.

The treatment process used at the WWF PWTF will result in valuable end products. The treated produced water can be used for irrigation, augmentation, or industrial purposes. These uses currently burden the already-depleted fresh water supply in the area. The treated water also provides a new water resource in a rapidly intensifying water supply crisis. The treatment process will also produce additional reclaimed crude oil that would have been primarily lost to vitalization into the atmosphere.

C6. Please describe any structures or equipment associated with the project that will be placed within or adjacent to the receiving water.

There are no structures or equipment associated with the project that will be placed within or adjacent to the receiving waters. The three proposed discharge locations for this project are located a distance from the facility and will require piping from the Facility to each outfall. Outfall 001 (Coal Draw) is approximately 1/5 mile from the Facility, Outfall 002 (Bitter Creek) is approximately 3/8 mile from the Facility, and Outfall 003 (Coal Draw) is approximately 1/2 mile from the Facility. The discharge points are located in generally dry portions of the streambeds that only experience running water during precipitation events.

Part D. Identify and rank (from increasing to decreasing potential threat to designated uses) the parameters of concern. *Parameters of concern are parameters in the effluent at concentrations greater than ambient concentrations in the receiving water. The applicant is responsible for identifying parameter concentrations in the effluent and DWQ will provide parameter concentrations for the receiving water. More information is available in Section 3.3.3 of the Implementation Guidance. Proceed to Part E.*

Ranked Parameters of Concern:

1. **Boron**: Effluent concentration is approximately 2 times above the limit.
2. **pH**: Effluent level is equal to the maximum range of the pH limit.
3. **pH**: Effluent level is within 60 percent of minimum range of the pH limit.
4. **Summer Temperature**: Effluent temperature is within 60 percent of the limit.

Part E. Alternative Analysis Requirements of a Level II Antidegradation Review. *Level II ADRs require the applicant to determine whether there are feasible less-degrading alternatives to proposed project. More information is available in Section 5.5 and 5.6 of the Implementation Guidance.*

E1. My permit is being renewed without any changes to flow or concentrations. I have considered alternative treatment and discharge options including changes to operations and maintenance and compared these to our current processes. I have not identified any economically feasible treatment or discharge alternatives that were not previously considered.

☐ Yes Proceed to Part F

☒ No or Does Not Apply Proceed to E2

E2. Please attach, as an appendix to this application, a report that describes the following factors for all alternative treatment options (see 1) a technical description of the treatment process, including construction costs and continued operation and maintenance expenses, 2) the mass and concentration of discharge constituents, and 3) a description of the reliability of the system, including the frequency where recurring operation and maintenance may lead to temporary increases in discharged pollutants. Most of this information is typically available from a Facility Plan, if available.

Report Name: Antidegradation Review – Part E Report Alternative Treatment Requirements

E3. Were any of the following alternatives feasible (check all that apply):

☐ Pollutant Trading

☐ Land Application

☒ Water Recycling/Reuse

☐ Connection to Other Facilities

☐ Total Containment

☐ Seasonal or Controlled Discharge

☐ Improved O&M of Existing Systems

☐ New Construction

☐ Upgrade to Existing Facility

It is anticipated that the treated water will be stored at the site in an open pond for reuse. The permitting process for a dam to create the impoundment has not been started at this point. Some treated water will be stored in the tanks currently installed for reuse.

E4. From the applicant's perspective, what is the preferred or current treatment option?

Treatment and recycling

E5. Is the preferred option also the least polluting alternative?

☒ Yes

☐ No

If no, what is the least polluting alternative?

If no, provide a summary of the justification for not using the least polluting alternative and if appropriate, provide a more detailed justification as an attachment. Name of attachment:

Part F. Optional Information

F1. Does the applicant want to conduct optional public reviews? More information is available in Section 3.7.1 of the Implementation Guidance

☐ **No**

☒ **Yes**

F2. Does the project include an optional mitigation plan?

☒ **No** Proceed to Part G
☐ **Yes** Proceed to Part F2.1

Report Name:

F2.1 Does the mitigation plan apply to specific project alternatives?

☐ **No**
☐ **Yes**

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature: [signature] **Title:** Technical Consultant to ER-PWD JV

Name (type or print): David R. Stewart, PhD, PE **Date:** May 11, 2012

ANTIDEGRADATION REVIEW: APPLICATION Exhibit 1
WestWater Farms PWTF Parameters of Concern

Parameter	Permit Limit Maximum Concentration	Estimated Effluent Concentration	Source of Data Code	Notes
Class 1C Waters				
Physical				
pH Minimum	6.5	6.5 SU	1	
pH Maximum	9	9.0 SU	1	
Bacteriological				
E. coli Mean	206 (#/100mL)	<100 (#/100mL)	1	30-day Geometric Mean
E. coli Max	668 (#/100 mL)	<300 (#/100mL)	1	
Dissolved Metals				
Antimony	5.6 µg/L	0.6 µg/L	4	
Arsenic	0.01 mg/L	0.0025 mg/L	1,4	
Barium	1.0 mg/L	0.5 mg/L	1	
Beryllium	<0.004 mg/L	0.0005 mg/L	4	
Cadmium	0.01 mg/L	0.0015 mg/L	1,4	
Chromium	0.05 mg/L	0.0025 mg/L	1,4	
Lead	0.015 mg/L	0.01 mg/L	1,4	
Mercury	0.002 mg/L	0.0001 mg/L	1,4	
Selenium	0.05 mg/L	0.0025 mg/L	1,4	
Silver	0.05 mg/L	0.05 mg/L	4	
Inorganics				
Bromate	0.01 mg/L	0.001 mg/L	4	
Chlorite	<1.0 mg/L	<0.5 mg/L	4	
Fluoride	1.4 mg/L	0.5 mg/L	1	
Nitrates	10 mg/L	5 mg/L	1	
Organics				
2,4-D	70 µg/L	7 µg/L	4	
2,4,5-TP	10 µg/L	1 µg/L	4	
Methoxychlor	40 µg/L	4 µg/L	4	
Radiological				
Gross Alpha	15pCi/L	1.5 pCi/L	4	
Gross Beta	4 mrem/yr	0.4 mrem/yr	4	
Radium 226 & 228	5 pCi/L	0.5 pCi/L	4	Combined
Strontium 90	8 pCi/L	0.8 pCi/L	4	
Tritium	20,000 pCi/L	10,000 pCi/L	4	
Uranium	30 pCi/L	3 pCi/L	4	
Class 2A Waters				
Physical				
pH Minimum	6.5	6.5 SU	1	
pH Maximum	9	9.0 SU	1	
Bacteriological				
E. coli Mean	126 (#/100mL)	<100 (#/100mL)	1	30-day Geometric Mean
E. coli Max	409 (#/100 mL)	<300 (#/100mL)	1	

ANTIDEGRADATION REVIEW: APPLICATION Exhibit 1
WestWater Farms PWTF Parameters of Concern

Parameter	Permit Limit Maximum Concentration	Estimated Effluent Concentration	Source of Data Code	Notes
Class 3B Waters				
Physical				
Temperature	27 ˚C	27 ˚C	1,4	
pH Minimum	6.5	6.5 SU	1	
pH Maximum	9	9.0 SU	1	
Dissolved Oxygen	5.5 mg/L	5.5 mg/L	4	30-day Average
Dissolved Oxygen	6.0 mg/L	6.0 mg/L	4	7-day Average
Dissolved Oxygen	5.0 mg/L	5.0 mg/L	4	1-day Average
Inorganics				
Total Ammonia (TNH3) @ pH 7.0 & Temp. 21.1	3.9 mg/L	2.0 mg/L	1,4	as N 30-day Average
Total Ammonia (TNH3) @ pH 9.0 & Temp. 26.7	1.3 mg/L	1.0 mg/L	1,4	as N 1-hour Average
Total Residual Chlorine (TRC)	0.011 mg/L	0.001 mg/L	1	4-day Average
Total Residual Chlorine (TRC)	0.019 mg/L	0.002 mg/L	1	1-hour Average
Dissolved Metals				Based upon a hardness of 100 CaCO3
Aluminum	87 µg/L	25 µg/L	1,4	4-day Average
Aluminum	750 µg/L	75 µg/L	1,4	1-hour Average
Arsenic	150 µg/L	2.5 µg/L	1,4	4-day Average
Arsenic	340 µg/L	35 µg/L	1,4	1-hour Average
Cadmium	0.2 µg/L	0.2 µg/L	1,4	4-day Average
Cadmium	2.0 µg/L	0.2 µg/L	1,4	1-hour Average
ChromiumVI	11.0 µg/L	2.5 µg/L	1,4	4-day Average
ChromiumVI	16.0 µg/L	3.0 µg/L	1,4	1-hour Average
Chromium III	74.1 µg/L	2.5 µg/L	1,4	4-day Average
Chromium III	569.8 µg/L	57 µg/L	1,4	1-hour Average
Copper	9.0 µg/L	2.5 µg/L	1,4	4-day Average
Copper	13.4 µg/L	3 µg/L	1,4	1-hour Average
Cyanide	5.2 µg/L	0.5 µg/L	1,4	4-day Average
Cyanide	22.0 µg/L	2.5 µg/L	1,4	1-hour Average
Iron	1,000.0 µg/L	100 µg/L	4	1-hour Average
Lead	2.5 µg/L	2.5 µg/L	1,4	4-day Average
Lead	64.6 µg/L	6.5 µg/L	1,4	1-hour Average
Mercury	0.012 µg/L	0.01 µg/L	1,4	4-day Average
Mercury	2.4 µg/L	0.03 µg/L	1,4	1-hour Average
Nickel	52.0 µg/L	2.5 µg/L	1,4	4-day Average
Nickel	468.2 µg/L	47 µg/L	1,4	1-hour Average

ANTIDEGRADATION REVIEW: APPLICATION Exhibit 1
WestWater Farms PWTF Parameters of Concern

Parameter	Permit Limit Maximum Concentration	Estimated Effluent Concentration	Source of Data Code	Notes
Selenium	4.6 µg/L	2.5 µg/L	1,4	4-day Average
Selenium	18.4 µg/L	3 µg/L	1,4	1-hour Average
Silver	3.2 µg/L	1.5 µg/L	4	1-hour Average
Zinc	118.1 µg/L	2.5 µg/L	1,4	4-day Average
Zinc	117.2 µg/L	2.5 µg/L	1,4	1-hour Average
Organics (Pesticides)				
Aldrin	1.50 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Chlordane	0.0043 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Chlordane	1.20 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
DDT, DDE	0.001 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
DDT, DDE	0.55 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Diazinon	0.17 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Diazinon	0.17 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Dieldrin	0.0056 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Dieldrin	0.240 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Endosulfan, a & b	0.056 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Endosulfan, a & b	0.110 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Endrin	0.036 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Endrin	0.086 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Heptachlor & H, epoxide	0.038 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Heptachlor & H, epoxide	0.260 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Lindane	0.08 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Lindane	1.0 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Methoxychlor	0.030 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)

ANTIDEGRADATION REVIEW: APPLICATION Exhibit 1
WestWater Farms PWTF Parameters of Concern

Parameter	Permit Limit Maximum Concentration	Estimated Effluent Concentration	Source of Data Code	Notes
Mirex	0.001 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Nonylphenol	6.6 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Nonylphenol	28.0 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Parathion	0.0130 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Parathion	0.066 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
PCB's	0.014 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Pentachlorophenol	15.0 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Pentachlorophenol	19.0 µg/L	0.0 µg/L	4	Acute Standard (1-hour Average)
Toxephene	0.0002 µg/L	0.0 µg/L	4	Chronic Standard (4-day Average)
Toxephene	0.730 µg/L	0.0 µg/L		Acute Standard (1-hour Average)
Class 4 Waters				
Total Dissolved Solids	1,200 mg/L	100 mg/L	1	
Arsenic	0.1 mg/L	0.0025 mg/L	1,4	
Boron	0.75 mg/L	0.25 mg/L	1,4	
Cadmium	0.01 mg/L	0.0015 mg/L	1,4	
Chromium	0.1 mg/L	0.0025 mg/L	1,4	
Copper	0.2 mg/L	0.0025 mg/L	1,4	
Lead	0.1 mg/L	0.01 mg/L	1,4	
Selenium	0.05 mg/L	0.0025 mg/L	1,4	
Gross Alpha	15 pCi/L	1.5 pCi/L	4	

Antidegradation Review – Part E Report
Alternative Treatment Requirements

of the

WestWater Farms Produced Water Treatment Facility
100 West Highway 6, Westwater, Utah

Prepared by:

Stewart Environmental Consultants, LLC
Consulting Engineers and Scientists
Fort Collins, Colorado

July 2011

Table of Contents

1.0 INTRODUCTION

WestWater Farms, LLC is proposing to construct a produced water treatment plant called WestWater Farms Produced Water Treatment Facility (Facility) to be located near the intersection of West State Highway 6 and Interstate 70 in Westwater, Utah. The Facility will receive and treat production water from oil and gas wells in Utah and Colorado.

During the planning and design of this facility, the overall goal was for the Facility to be able to provide for the recycling of produced water back to the energy companies or to be used as augmentation water for agricultural or municipal uses. For this to be possible, the produced water must be treated to the highest standards while still remaining economical. To reclaim the water and petroleum components as well as reduce any impact to the soils or potential local groundwater, and limit wildlife exposure, disposal of the produced water by evaporation ponds was not considered for this project.

2.0 TREATMENT PROCESS

Section 2.1 Pilot Study contains a discussion of how and why each treatment process was chosen. Sections 2.2–2.4 contain more detailed technical descriptions of each process.

WestWater Farms is using the best pollution control technology that is consistent with the highest standard currently used within Grand County. The Facility is utilizing the most advanced system for the treatment of produced water. The treatment system follows the best pollution control technology by designing a totally closed system from unloading to injection or treatment.

2.1 Pilot Study

A pilot system, run from July 26 to September 3, was used to obtain information about produced water in the project area and determine if the projected process flow scheme would be appropriate for a full-scale treatment system in Westwater. Each step of the treatment process is important to the system as a whole, as each process proved to aid or improve downstream processes. Each process and its relevant chemistry are discussed in this section; complete analytical results provided as full laboratory reports are available in the Report of a Limited Onsite Pilot Study of Oil Field Produced Water dated December 1, 2010 that was included in the Surface Water Discharge Application.

Aeration was used to reduce VOC concentrations and to aid in oxidation reactions. Oxidation reactions were not directly measured, but VOC reduction generally ranged from 15 to 75 percent, depending on the individual compound, with an average reduction of approximately 70 percent.

A walnut shell filter (WSF) was used to reduce free oil, grease, and other insoluble hydrocarbons. Due to the low concentrations of oil and grease in both the raw water and WSF effluent, analytical data is inconclusive. However, onsite observations and good ceramic microfiltration (CMF) operation indicate that the WSF was successful in reducing insoluble hydrocarbons. This is typical of other pilot programs and full-scale installations. The CMF was used to reduce metals concentrations and to remove suspended solids. Suspended solids reduction ranged from 90 to 95 percent and metals reduction ranged from 50 to 99 percent for metals whose solubility is affected by pH. The CMF will also reduce the Silt Density Index (SDI) prior to the reverse osmosis system.

Granular activated carbon (GAC) was used to reduce the concentration of soluble, nonpolar, organic compounds. Total organic carbon (TOC) removal ranged from 30 to 85 percent, averaging near 50 percent. It is important to note that the GAC used during the pilot testing was not optimized for the flow rates used; an engineered system in a full-sized plant should provide much better TOC reduction.

Ion exchange (IX) was used to reduce the concentration of divalent cations, including calcium, magnesium, barium, and strontium. Divalent cation reductions ranged from 72 to 99.8 percent, depending on the individual cation.

Reverse osmosis (RO) was used to reduce the concentration of any remaining contaminants, especially total dissolved solids (TDS), sodium, and boron. TDS reduction averaged 99.7 percent, sodium reduction averaged 99.6 percent, and boron reduction averaged 92 percent.

This pilot testing program verified that the proposed process flows for this facility will be able to meet the stated objectives of treating the produced water economically.

2.2 Selected Treatment Process Overview

The full-scale treatment process was designed based on the data collected from the pilot study discussed in Section 2.1.

Produced water from oil operations will be delivered to the Facility via tanker trucks. The water will be offloaded at one of the unloading bays and treated for injection or discharge. The treatment process includes the following processes and procedures:

- pumping from the delivery trucks
- grit and sand separation
- oil separation
- oil condensate management
- aeration
- walnut shell filtration
- chemical reaction
- treatment by electrocoagulation
- filtration through ceramic microfilter membranes, granular activated carbon, and reverse osmosis

The treated water can be sent to sale tanks during various steps in the process that will produce water suitable for reuse in oil and gas production processes, for injection into the permitted well, or discharge to a permit discharge point.

2.3 Operator Schedule and Production Rates

The Facility will receive produced water from oil and gas operations and treat it to meet the requirements of oil and gas well operators for reuse in oil and gas production processes, the requirements of the applicable discharge permit, or the requirements of the Underground Injection Control (UIC) permit for re-injection. The net water and contaminants will be disposed of according to guidelines determined by the United States Environmental Protection Agency (EPA) and the State of Utah via further treatment or in an onsite injection well.

The onsite injection well will be operated under a UIC permit issued by the State of Utah. The Facility will unload tanker trucks at a rate of approximately 15,000 barrels per day. Water and contaminants may be injected at a maximum rate of approximately 6,500 barrels per day; the balance of the water will either be transported off site for reuse in oil and gas production or discharged to a permit discharge point.

2.4 Process Summaries

The remainder of Section 2 describes the detailed treatment process that was selected as a result of the pilot study discussed in Section 2.1.

2.4.1 Existing Electrical Power Generation

The Facility is located at a site with limited electrical service. The only available electrical power is a 200-ampere 220-volt AC single-phase service. There is currently no natural gas service located at the Facility. The Facility will operate using two diesel-powered generators and one diesel-powered standby generator until either a natural gas supply can be pipelined to the Facility or the electrical service can be upgraded. The Facility will use the available power as much as possible and will use a 230 kW and a 300 kW generator to supply primary power to the operations portion of the Facility. A 100 kW generator is available as standby supply.

2.4.2 Existing Unloading Stations

The unloading process requires the truck driver to connect a flexible transfer hose to the transport truck tank outlet. The operator floods the unloading line, which allows the transfer pump at the assigned station to start. The pump has an explosion-proof motor and transfers the oil production water from the truck, past a flow meter, through a sand and grit centrifugal separator, and into the buffer tank. The Facility has six unloading stations and does not have an open pit or trench unloading station. An emulsion breaker may be added to the water in the pipeline to the buffer tank to aid in removal of emulsified oils in the water.

2.4.3 Existing Grit Tank

A sand centrifugal filter is located between the truck unloading stations and the buffer tank. This filter is periodically backwashed to a grit tank. The grit tank is partitioned to allow the grit and sand to settle in the grit chamber of the grit tank and the water flows into the liquid chamber of the grit tank. The grit tank also receives any water that is spilled on the concrete unloading pan and any water used to wash down these spills. The water level is monitored with level switches and transferred to the buffer tank via an explosion-proof sump pump in the liquid chamber.

A blower continuously draws air through the grit tank to keep the atmosphere in the headspace of the grit tank below the lower explosive limit (LEL). The air is filtered through a bed of granular activated carbon (GAC) prior to being discharged to the atmosphere. The exhaust from the GAC is monitored by a volatile organic compound (VOC) sensor and transmitter. The GAC is periodically replaced as indicated by the VOC monitor; spent carbon media is sealed and returned to the supplier for regeneration and/or disposal.

2.4.4 Existing Oil Separation

The unloaded water is transferred into the buffer tank. A Megator skimmer with an external pump skims free oils from the surface of the water inside the tank. The tank's maximum capacity is 200,000 gallons and waters received will have a retention time in the tank that ranges from 440 to 1,000 minutes. Free oils are pumped out of the tank by the skimmer pump and into a condensate separation system. The buffer tank is lined and free vapors or fumes are removed from the tank using two blowers and activated carbon adsorption units (similar to the blower and GAC setup described in Section 2.4.3). The headspace of the buffer tank is monitored for LEL, and the exhaust from the GAC units is monitored for VOCs in a manner similar to the description in Section 2.4.3.

2.4.5 Existing Oil Condensate Management and Overflow Tank

The oil and water collected by the Megator skimmer in the buffer tank are transferred by pump to the condensate separation and storage tanks. There are three condensate tanks and one overflow tank. The water that is separated is returned to the buffer tank to be further processed for reuse, injection, or discharge. Oil is removed from the condensate tanks by oil recovery trucks that transport the oil to a local refinery for processing and sale. The overflow tank is a 12,000-gallon tank that would receive water from the buffer tank in the event it should overflow. Water in this tank will be returned to the buffer tank as soon as capacity allows. The headspaces of all three condensate tanks are vented to GAC scrubbing media in a manner similar to the GAC and VOC description in Section 2.4.3.

2.4.6 Aeration Tank

Water will flow by gravity from the buffer tank to the aeration tank. The aeration tank will have a maximum capacity of approximately 34,000 gallons and the water will have a residence time of approximately 60 minutes. An aeration blower will introduce air into the bottom of the tank through a diffuser at approximately 450 standard cubic feet per minute (scfm). The main purpose of the aeration tank is to separate VOCs from the water into the headspace of the tank. A separate vapor blower will draw air through the headspace of the tank and into GAC scrubbing media, in a manner similar to the GAC and VOC description in Section 2.4.3.

2.4.7 Walnut Shell Filter

Water from the aeration tank will be pumped into a walnut shell filter (WSF). Bleach will be added to the feed water to reduce biofouling in the WSF. The WSF is a downflow filter that uses crushed American black walnut shells as the filter media. The purpose of this filter is to remove suspended solids and insoluble hydrocarbons. This is a closed filter system that will vent only during backwash cycles. The filtrate water will be discharged to the electrocoagulation (EC) reaction tank for further processing; at this point, the vast majority of volatile organic compounds have been removed from the water.

Backwash cycles will be performed based on pressure differential, total time of operation between backwash cycles, or as manually initiated by the operator. During the backwash cycle, the media is stirred and the flow direction of the feed water is reversed to flush built-up particulates and petroleum products from the filter to a backwash holding tank. Water in the backwash holding tank will be processed through a bag filter and the filtrate water will then be sent to the sludge holding tank. The backwash holding tank will be vented to the aeration tank carbon adsorption units.

2.4.8 Electrocoagulation

Sodium hydroxide will be added to the pipeline carrying water from the WSF to the EC reaction tank. The EC reaction tank provides approximately 20 minutes of reaction time for pH adjustment prior to the EC system.

Pretreated water will be pumped from the EC reaction tank into the EC system. The EC system is an electrochemical process that will treat the water by passing an electric current through electrodes submersed in the water. The EC process works through a combination of chemical coagulation and coprecipitation, oxidation, deemulsification, electron flooding, ionization, electrolysis, hydrolysis, and/or disinfection. Electrolysis of the water may produce oxygen and hydrogen gas, which will be vented outside the building using a powered fan system.

The EC effluent will drain to the EC transfer tank. A spray bar will apply a fine spray of clean water to minimize or eliminate foaming in the EC transfer tank. The water will then be pumped to the ceramic microfilter (CMF) reaction tank.

2.4.9 Ceramic Microfiltration

Sodium hydroxide, sodium hypochlorite, and/or flocculant may be added to the pipeline carrying water from the EC transfer tank to the CMF reaction tank as necessary. The CMF reaction tank provides approximately 30 minutes of reaction time prior to the CMF system. The CMF reaction tank will utilize a mixer in the tank to minimize or eliminate solids settling.

Pretreated water will be pumped from the CMF reaction tank into the CMF feed system. The CMF feed system will pump water into the CMF system. The CMF system will filter the water through ceramic microfilter membranes to remove any precipitated and/or suspended solids. The filtrate will be pumped to the GAC transfer tank.

The solids removed by the CMF will be transferred to a solids settling tank; the supernatant from the solids settling tank will be recycled back through the treatment process, and the solids will be transferred to a filter press for dewatering. Dewatered solids will be disposed of in accordance with applicable regulations, and recovered water will be recycled back through the water treatment process.

The CMF will be periodically cleaned using a clean-in-place (CIP) system that will circulate a cleaning solution through the CMF membranes. The cleaning solution may be a caustic solution consisting of dilute sodium hypochlorite and/or sodium hydroxide, or the cleaning solution may be an acidic solution consisting of dilute hydrochloric acid. The CIP system will have interlock controls so that sodium hypochlorite cannot be added to an acidic solution. The spent cleaning solution will be sent to a CIP neutralization (CIPN) system where the pH will be neutralized, and the neutralized solution will be recycled back through the water treatment process.

2.4.10 Granular Activated Carbon Filters

Filtrate water from the CMF will pass to the GAC transfer tank. The water will be pumped through GAC filters to remove any remaining dissolved organic compounds. The discharge from this process will be sent to the reverse osmosis (RO) feed tank. The carbon filters will have two columns. The Facility expects to operate with one column online and with one column in reserve to be used when a column must be taken offline to change its media.

Spent carbon will be returned to the supplier for regeneration and/or disposal of the media. The carbon media can be periodically backwashed to remove any built-up solids or biofilm. The backwash frequency will be based on pressure differential. The backwash water will be pumped to the WSF backwash tank.

2.4.11 Reverse Osmosis

Sodium hydroxide or hydrochloric acid may be added to the pipeline carrying water from the GAC to the RO feed tank. The RO feed tank provides approximately 20 minutes of reaction time for pH adjustment prior to the RO system. Antiscalant and/or sodium thiosulfate may be added to the pipeline carrying water from the RO feed tank to the RO system.

Pretreated water will pumped from the RO feed tank into the RO system. The RO system will filter water through membranes that will remove the majority of dissolved salts and any other dissolved contaminants. RO filtrate will be pumped to the RO permeate tank. In the RO permeate tank, the pH can be adjusted as necessary, and the resulting water can be used as clean, nonpotable water for the Facility, sent to holding tanks to be transported off site for reuse in oil and gas production, or can be discharged to a permit discharge point in accordance with all applicable permits or regulations. The dissolved contaminants removed by the RO will be disposed of via the existing injection well in accordance with all applicable permits and regulations.

The RO system will be periodically cleaned using a clean-in-place (CIP) system that will circulate a cleaning solution through the RO membranes. The cleaning solution may be a weakly basic solution consisting of a specialty RO cleaning product, or the cleaning solution may be a weakly acidic solution consisting of dilute citric acid. The spent cleaning solution will be disposed of via the existing injection well in accordance with all applicable permits and regulations.

2.4.12 Existing Injection Buffering Tank and Injection Process

Any water to be disposed of via injection will be held in the injection buffering tank. The water is transferred by pump to an onsite injection well where the water will be pumped at pressures up to 360 pounds per square inch (psi) for injection at a depth of 1,342 feet below grade. A biocide, barium sequestering agent, and corrosion inhibitor are added to the water to prevent various issues in the injection well.

2.5 Construction, Operation, and Maintenance Expenses

The engineer's estimate of probable cost to construct the Facility, including materials and installation, is estimated at $6,157,766. A breakdown of this cost is presented below in Table 1.

Table 1: Estimated Construction Costs

Item	Materials	Installation
Site improvements	$0	$10,000
Yard piping	$40,000	$35,000
Process tank area	$139,750	$57,800
Building process area	$2,940,695	$281,500
Building chemical area	$129,000	$37,500
Treatment building	$405,600	$99,400
Sales tank area	$45,000	$22,500
Building drain pump station	$19,500	$18,500
Electrical	$442,800	$295,200
Instrumentation	$127,200	$84,800
Subtotal 1	$4,289,545	$942,200
Contractor OH&P (7% of subtotal 1)	$300,269	$65,954
Subtotal 2	$4,589,814	$1,008,154
Contingency (10% of subtotal 2)	$458,982	$100,816
Probable Construction Cost	**$5,048,796**	**$1,108,970**

The engineer's estimate of operation and maintenance costs to treat the produced water at the Facility are $1.0577/barrel ($0.0229/gallon). A breakdown of this estimate is presented in Table 2.

Table 2: Estimated Operation and Maintenance Costs

Process	Cost
WSF	Costs figured into total annual electrical consumption
CMF	Costs figured into total annual electrical consumption
GAC	$0.0144/bbl
EC	$0.19/bbl
RO	$0.0376/bbl
Brine disposal by injection	$0.1009/bbl
Labor	$1,300,240/year
Chemicals	$0.0985
Laboratory Testing	$0.0065
Contingency	$460,274
TOTAL	**$1.0577/bbl**

3.0 DISCHARGE CONSTITUENTS

This section presents the expected mass and concentration of constituents for discharge as listed in Section V Effluent Characteristics of the Surface Water Discharge Application submitted on December 10, 2010. Table 3 presents the estimated daily maximum and average discharge pollutants. The source of this information is the WestWater Produced Water Pilot Study dated December 1, 2010 (included in the WestWater Farms Produced Water Treatment Facility Surface Water Discharge Application).

Table 3: Discharge Constituents

Discharge Constituent	Maximum Daily Value	Average Daily Value
Total suspended solids	10 ppm	2 ppm
Flow	450 gpm	380 gpm
Ammonia, as N	1.4 ppm	1.4 ppm
Temperature (winter)	50 deg F	45 deg F
Temperature (summer)	80 deg F	70 deg F
pH	9	7
Selenium, total	0.02 ppm	0.02 ppm
Iron, total	0.158 ppm	0.158 ppm
Magnesium, total	6.12 ppm	6.12 ppm
Boron, total	1.48 ppm	1.48 ppm
Oil and grease	0.00 ppm	0.00 ppm
Lead, total	0.02 ppm	0.02 ppm
Nickel, total	0.0254 ppm	0.0254 ppm
Cadmium, total	0.003 ppm	0.003 ppm
Mercury, total	0.0002 ppm	0.0002 ppm

4.0 SYSTEM RELIABILITY

This section contains a description of the reliability of the treatment system.

If necessary, the Facility is capable of shutting down for maintenance; because of this, an increase in pollutants above the expected levels stated in the Surface Water Discharge Application would never be discharged to the surface waters. If necessary, the produced waters containing the increased pollutants would be returned to the head of the Facility to be fully treated and ensure the levels were below the expected levels stated in the Surface Water Discharge Application.

To improve the reliability and availability of the Facility, redundancy was implemented throughout the treatment system. The carbon filters will be set up in two trains, each having one column. The Facility expects to operate one column, with one column in reserve to be used when a column must be taken offline to change the media. The aeration GAC system also implements redundancy with two GAC units. The following pumps are duplicated in the design of the system to decrease the probability of system failure:

- Aeration transfer pump
- EC transfer pump
- CMF feed pump
- CMF process pump
- GAC transfer pump