STEWART ENVIRONMENTAL CONSULTANTS, LLC
ENGINEERING FOR LIFE

ACEC MEMBER

July 8, 2016

Mr. Kent Brown
Town Administrator – Town of Milliken
1101 Broad Street
Milliken, CO 80543

Subject: Proposal and Contract for Pilot Testing Program for the Milliken RO Plant Efficiency Project

Dear Mr. Brown:

Stewart Environmental Consultants, LLC is pleased to provide this proposal to perform a pilot plant test for Town of Milliken RO facility. The objective of the treatment process is to increase the recovery of the groundwater from the existing treatment facility. Currently, the existing facility is able to recover 55% to 65% of the incoming water. The proposed facility will have a recovery of 98% of the incoming water based on current estimates. This will be verified in the pilot test. In addition, the current facility has an issue with discharge of selenium into the Little Thompson River. This pilot test will verify that the facility will be converted to a Zero Liquid Discharge facility, thereby eliminating the need for the discharge permit.

These tests will help us determine proper configuration of the plant for optimum treatability of the water, serving as design criteria for an onsite system. The final configuration will reflect the validated process configuration and efficiency, also refining the CAPEX and OPEX of the system to +/-10%. This validation data will be compiled into a final report for the purpose of final design and funding of the project.

1.0 PRELIMINARY DATA

Stewart Environmental review facility data representative of the Milliken raw water. The data indicate that the influent water to the RO facility is near 1,000 mg/l of total dissolved solids. The amount of cations and anions are not unusual for the groundwater in the area. We have performed technical models of this water with our proprietary technology and have shown the ability to reach the recoveries mentioned above. As part of this pilot test, we will obtain valid samples from the influent and run bench studies to determine proper dosing ratios of the chemistries involved. We will also provide this as a progress report and discuss the results with the staff.

2.0 PILOT VALIDATION OBJECTIVES

The objectives of the pilot validation are:

1. Validate the influent solids, dissolved metals and bacteria characteristics of the influent water.
2. Recovery efficiencies using Stewart Environmental proprietary membranes for this type of water and the treatment of the brine stream utilizing ceramic microfiltration (CMF) patented technology (these membranes are approved by the Colorado Department of Public Health and Environment for drinking water)
3. Collect sufficient data to determine the optimal unit processes to provide the desired treatment of the water
4. Validate scaled cost assumptions per influent and end-use requirement

5. Collect data for design engineering and scale-up of a full-size treatment process

3.0 PROCESS DESCRIPTION

The Town of Milliken currently uses a 1 stage RO system. Our first task will be to optimize this first stage to obtain higher recoveries (near 90% of the influent flow). This will be through membrane modification, additional pretreatment to the RO system and likely slightly higher pressure systems.

The next step will be to provide for the treatment of the resulting brine from the first stage. This will be accomplished utilizing the CMF system and an Interstage Precipitation Reactor (IPR). The Brine water is then directed into the IPR reaction tank where pH is adjusted and the water is chemically prepared for the IPR. Water is then directed to the IPR, tuned for scale forming compounds precipitation. Water then flows to the CMF reaction tank system, where it is both pH adjusted to precipitate remaining dissolved metals (if required) out of solution and mixed with a flocculent to coagulate suspended solids before flowing into the CMF feed tank skid. This skid contains a feed tank and pumps that supply the process stream to the CMF skid and also provides re-circulation of the process water to keep the solids and precipitates in suspension. The patented CMF skid, which is the keystone of the CMF Treatment System, includes multiple CMF elements in single or multiple stainless steel modules, depending on the desired flow rate. During filtration, the process stream passes through the CMF elements. After filtration by the CMF skid, the effluent is directed to discharge (injection pump). Separated material is directed to a filter press to reduce the mass prior to disposal hauling.

The permeate from the CMF will be sent to a second stage high pressure RO system. The brine from the second stage RO system will be concentrated to the solubility point of the salts and will either be disposed of as a non-hazardous waste at a landfill or potentially sold to the energy market as a by-product of this process.

3.1 Pilot Design and Execution

Stewart Environmental will work with the Town to treat a representative sample of approximately 10,000 gallons at the Milliken facility. As an alternative, this can be performed at the Fort Collins pilot facility. This is to be determined with the staff. The pilot will be automated and capable of running 24 hours a day with minimal supervision. The pilot plan will determine the hours of operation to simulate the actual working conditions of the facility. We will provide engineers to oversee the operation of the pilot plant, perform clean-in-place (CIP) operations, and collect samples for laboratory testing. The pilot test will run for a one to two month period.

Based on bench testing results, we will develop a process train to include an appropriate series of unit processes to treat your water.

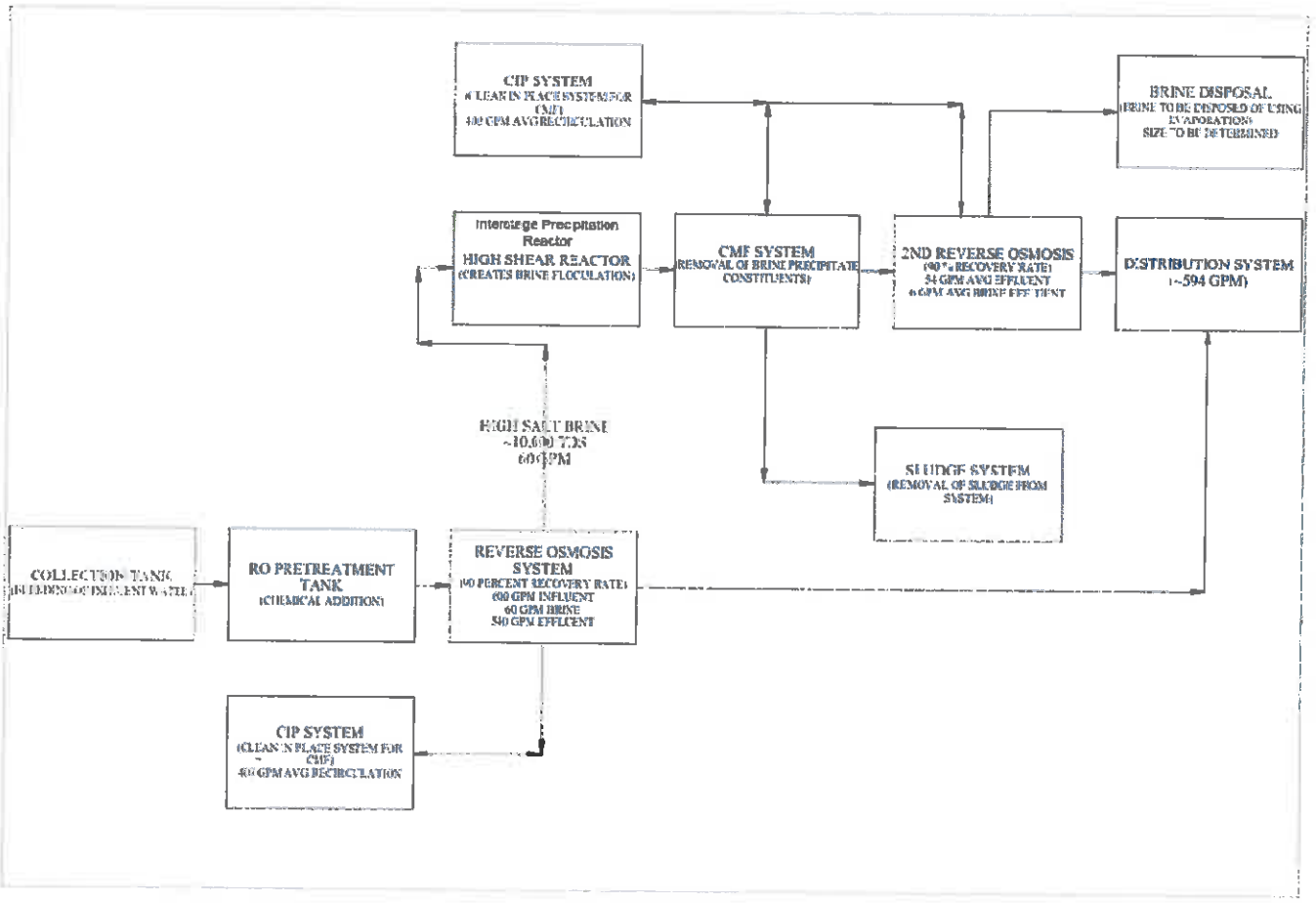
The study is designed for a flow rate of 10 gallons per minute (gpm) for the first stage RO, 1.5 gpm for the CMF and IRP and 10 gpm for the second stage RO system. The second stage RO system will be run as a batch system due to the limitations of the CMF and IRP systems. The list of processes for the produced water treatment are listed below as shown on the attached Figure 1 PFD.

Primary Pilot Processes:

1. 200 Mesh bag filter
2. 1 micron cartridge filter

3. First Stage RO system
4. Interstage Precipitation Reactor
5. CMF Pretreatment system
6. CMF Filtration system
7. Second Stage RO system
8. Brine concentration system

The pilot plant is shown in the attached diagram with explanation of the flows (this PFD provides for 99% recovery):



3.2 Evaluation of CMF Operating Parameters

Based on the water quality data and bench testing results, chemical pre-treatment parameters will be established and used for the initial operation of the pilot plant. The chemical pre-treatment will take place in a neutralization tank where pH may be adjusted and chemicals, such as polymers and/or metal grabbers, may be added to maintain flux through the CMF Membranes. During the pilot testing, the CMF process will operate until the trans-membrane pressure increases to more than 25 pounds per square inch (psi), at which point a chemical CIP will be initiated. During the CIP process, acids, caustics, and bleach will be used in varying concentrations to determine the sequence that will most rapidly return the trans-membrane operating pressure to normal operating levels.

Based on these tests, the optimal chemical pre-treatment and CIP process will be established for the current water conditions. This data will be included in the final report for final system design and projection of operation costs. During the pilot process, water samples will be collected and analyzed to determine the final outlet characteristics of the filtrate.

Data from the pilot will be modeled to a full-scale production facility of 864,000 gallons per day (600 gpm) processing capacity. The economic models will be derived to address CAPEX and OPEX characteristics meeting the criteria for brine reduction and increase in the recovery of the influent water.

4.0 SAMPLING AND LAB ANALYSES

We will collect water samples from the following phases in the process:

- Raw Water
- Post Stage 1 RO
- Post IPR
- Post-CMF
- Post Stage 2 RO
- Brine concentrate
- Sludge Analysis

A detailed list of proposed laboratory analyses can be provided upon request. During the pilot, changes and anomalies may require special testing and sampling; therefore, the proposed analyses may be altered during the pilot as situations arise. If adequate data are available, some samples may be excluded. All laboratory data will be included in the final pilot report.

5.0 DELIVERABLES

After all pilot water samples have been analyzed, a detailed pilot report will be provided. The report will include a description of the pilot system used, evaluation of pilot operational data, an evaluation of the laboratory analyses of water samples, and a set of design parameters for a process plant to process the produced water.

Stewart will also provide a success matrix for this project. The success matrix will be agreed to by all parties and is part of the contract.

6.0 SCHEDULE

The proposed schedule is for Stewart Environmental to treat a representative 10,000 gallons from the Towns wells in February 2016. Commencement of the validation is dependent upon availability of specialty rental equipment necessary to run the pilot. At this point, there are no issues anticipated with this schedule. A Final Report of the pilot study will be provided to the Town within three to four weeks after end of pilot deployment.

A preliminary schedule for this project is below and will be included as part of the overall contract. These dates can be modified depending on the results of the overall project:

Milliken Pilot Plant Testing Schedule - Preliminary

7.0 COMPENSATION FOR PILOT STUDY

Based on the scope of services provided in this proposal, the fee for this project is $200,000, with this total due upon agreement to proceed or as agreed to by Stewart and the Town.

If you have any questions concerning this information, please contact us.

Sincerely,

STEWART ENVIRONMENTAL CONSULTANTS, LLC

David R. Stewart, PhD, PE
President

Appendix A

Featured Projects

Long-Term Client Discussion

Stewart Environmental Consultants has been providing ceramic membrane based water filtration processes to the industrial sector for more than 20 years. The company was an early adopter of ceramics and has found their durability to be unmatched relative to the universe of options for treating challenging and variable waters. In testament to the durability and applicability to industrial waters, we have provided a short list of notable clients for which we provided the appropriate ceramic membrane solution and who continually praise the robustness of the process. In the industrial sector, robust processes equate to bottom line savings. Following is a list of clients for your reference.

STEWART CMF, LLC

Process Wastewater Filtration System
Western Digital, Fremont, California

Client: Western Digital

Contact: Mr. Wellington Wong, PE
Facilities Manager
510-557-7552

Location: Fremont, California

Year: 2008-2009

iption: Stewart CMF, LLC provided a 400 gallon-per-minute (gpm) patented ceramic micro-filtration (CMF) system for the treatment of the wastewater from production sources at the Western Digital facility in Fremont, California. The value of this system was such that our customer considerably decreased heavy metals discharge to the publicly owned treatment works (POTW), proportionally decreasing municipal fees as well as overall operations and maintenance (O&M) costs of the Western Digital wastewater facility. Economic efficiencies of ceramic membrane durability, as well as overall reduction in operational expenses, versus traditional polymeric processes continue to prove out.

- **Key Elements**

- Laboratory Analysis
- Pilot Test
- Strict Discharge Requirement
- Heavy Metals Removal
- Startup and Commissioning
- Training

- **Size**

- 400 gpm

STEWART CMF, LLC

Process Wastewater Filtration System
Alcoa Fastening Systems, Fullerton, California

Client: Alcoa Fastening Systems.

Contact: Mr. Tuan Ngo
Operations Manager
714-278-8795

Location: Fullerton, California

Year: 2008-2009

Description: Stewart CMF, LLC provided a 75-gallon-per-minute (gpm) average flow Ceramic Microfiltration (CMF) Treatment System to Alcoa Fasteners, Inc. for the treatment of metals finishing fluids at their Fullerton, California location. Wastewater filtration for regulatory compliance and water reuse were key components of the design criteria. The equipment included tanks, associated controls and instruments, and one 75–gallon-per-minute (gpm) patented CMF skid.

- **Key Elements**
  - Laboratory Analysis
  - Pilot Test
  - Strict Discharge Requirement
  - Heavy Metals Removal
  - Startup and Commissioning
  - Training
- **Size**
  - 75 gpm

STEWART CMF, LLC

Acid Mine Drainage Water Treatment

ASARCO, Inc. - Upper Blackfoot Mine Complex, Montana

Client: ASARCO, Inc.

Contact: Mr. Robert Roll
Site Response Section
Montana Department of Environmental Quality
Phone: 406-841-5025

Location: Montana

Year: 2008

ption: Stewart CMF, LLC provided a 130 gallon-per-minute (gpm) patented Ceramic Microfiltration (CMF) Treatment System for wastewater treatment at the Upper Blackfoot Mine Complex (UBMC), currently owned by ASARCO, Inc. The 130-gpm system is a skid-mounted unit, used for treating all of the acid mine drainage flows at UBMC. The EPA has recognized this plant as an example of industry best-practice due to its efficiency and effectiveness of operation, and the design engineer, Stewart Environmental, has been recognized nationally for this and similar designs. This project was performed as a component of a complete wastewater treatment solution, through a design-build arrangement with Camp Dresser & McKee.

- **Key Elements**

- Laboratory Analysis
- Pilot Test
- Strict Discharge Requirement
- Heavy Metals Removal Plant
- Startup and Commissioning
- Training

- **Size**

- 130 gpm

STEWART CMF, LLC

Process Wastewater Filtration System
Advanced Surface Technologies, Arvada, Colorado

Client: Advanced Surface Technologies (AST)

Contact: Mr. Jack Davis, CEO
303-432-8500

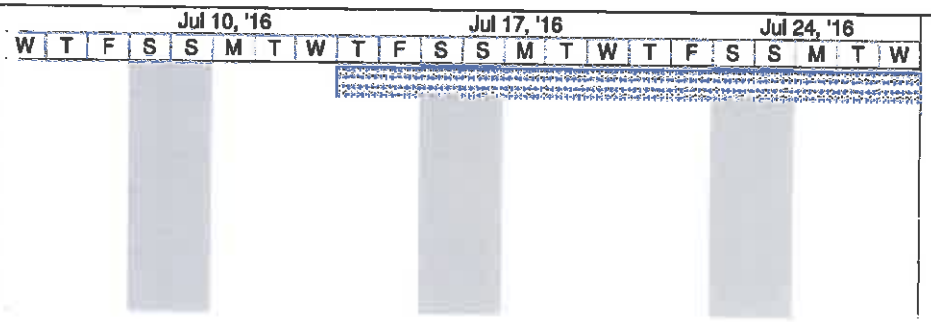
Location: Arvada, Colorado

Year: 1999

Description: AST has been a client for over 16 years. The company is in the business of metals plating, primarily chromium and nickel. The company ultimately discharges process water to the publicly owned treatment works (POTW). With their standard metals removal process, they were unable to meet pretreatment discharge standards and were faced with potential fines for violation. A ceramic based process was designed and implemented by Stewart allowing for the facility to continually meet discharge standards in every month after installation. The core process has been operational in one of the harshest industrial applications with basic standard maintenance for over 16 years, providing testimony to the durability of both the system and of ceramic membranes. Additionally, AST indicates the system requires low labor interaction, as well as low chemical and power consumption.

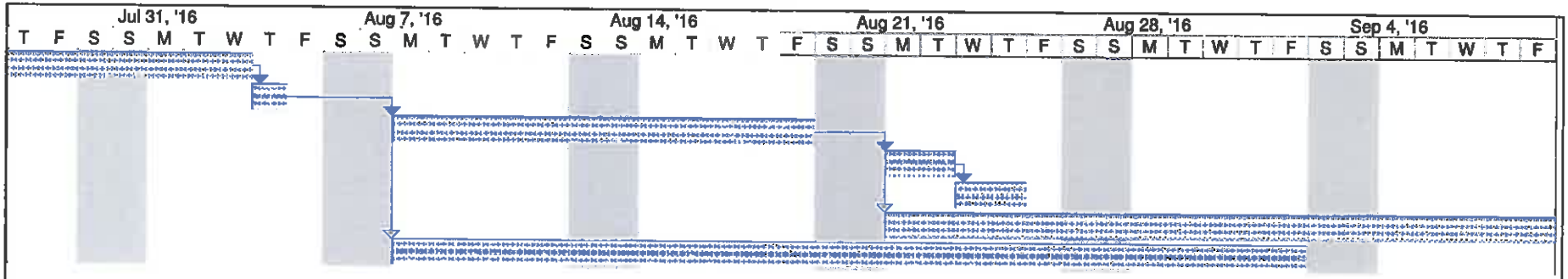
- **Key Elements**
  - Laboratory Analysis
  - Pilot Test
  - Strict Discharge Requirement
  - Heavy Metals Removal
  - Startup and Commissioning
  - Training
- **Size**
  - 50gpm

ID	Task Name	Duration	Start	Finish
1	Pilot Preparation	15 days	Thu 7/14/16	Wed 8/3/16
2	Mobilization and Setup	1 day	Thu 8/4/16	Thu 8/4/16
3	Pilot Operation	10 days	Mon 8/8/16	Fri 8/19/16
4	Demobilization and Teardown	2 days	Mon 8/22/16	Tue 8/23/16
5	Pilot Decontamination	2 days	Wed 8/24/16	Thu 8/25/16
6	Pilot Report	15 days	Mon 8/22/16	Fri 9/9/16
7	Laboratory Analysis	20 days	Mon 8/8/16	Fri 9/2/16



Project: Milliken Pilot Schedule
Date: Wed 7/6/16

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline



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Selected Treatment Main Unit Processes	Reverse Osmosis Unit with Brine Treatment for added capacity utilizing IPR, CMF and RO Technology
Water Recovery	98 percent +/- 2% with TDS level similar to CWCWD and City of Greeley
Brine Disposal	Concentration to dry salt for disposal or alternative such as Ten Pound Brine by-product or Disposal as a non-hazardous liquid waste
Economics	$4,200,000 Capital Cost +/- $400,000 $2.70 per 1,000 gallons +/1 $0.30 per 1,000 gallons
Operation	Two Operators needed for Sludge Press Operation when needed (OSHA)
	Complex System, Trained Operator Needed - Class B Operator for Drinking Water
	Control by PLC for a significant portion of the day
Environmental	Meets EPA and CDPHE regulations for Safe Drinking Water Parameters for MCL's and MCLG's

* All claims in Success Matrix are within (+/-)30%

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