



## **Sludge Dewatering Polymer Trials (2021)**

## Invitation to Bid

The following are the estimated deadlines for polymer manufacturer selection:

- Distribution of Solicitation Notice: June 13, 2021
- Manufacturer deadline to submit Notification of Interest: July 8, 2021
- On-site bench-scale jar test polymer product(s): July 6, 2021 – July 23, 2021
- On-site full-scale Performance Testing: August 2, 2021 – August 27, 2021
- Manufacturer deadline to submit formal bids: September 9, 2021

## Polymer Testing Protocol

Polymer equipment suppliers and/or polymer manufacturers will be invited by the City of Bozeman, Montana to participate in prequalification polymer trials. Dewatering trials will be conducted at the Bozeman Water Reclamation Facility (WRF). Prequalification trials shall consist of (i) bench-scale jar tests and (ii) full-scale performance tests. Based on the results of the trials, manufacturers whose polymer has met the performance criteria for this facility will be asked to submit separate sealed bids presenting their cost to supply the polymer equipment and/or polymer(s) for the facility. Bids from manufactures for polymers that have not undergone the full-scale performance tests will not be accepted or reviewed.

The City of Bozeman WRF has a location dedicated for blending and feed of polymer from chemical totes. The polymer feed equipment is a Fluid Dynamics Model #N0203-F110231, modified to now use a Blue-White Flex-Pro A2F24-MGG peristaltic emulsion pumping unit. This trial will include performance testing of the polymers dewatering a mix of anaerobically digested primary and secondary biosolids (sludges) for one (1) Huber ROTAMAT Screw Press RoS 3.2 dewatering unit with Flocculation Reactor. The results of these tests will enable vendors to be eligible to bid for supply of polymer suitable for the Huber Screw Press for one (1) year with the option of two (2) additional years upon mutual agreement of the City of Bozeman and the selected vendor.

## Initial Manufacturer Qualification

Manufacturers interested in participating in the Polymer Trials must submit, at a minimum, the following items in a Notification of Interest:

1. The manufacturer must be able to provide a minimum of twelve (12) totes (~270 gal, ~2,300 lbs) of the selected polymer to be delivered within 30 days of date of order. Upon request, supplier must include freeze protection for shipping during colder time periods to ensure polymer quality.
2. The manufacturer must provide current listing of ISO certifications such as 9001 and 14001 and other relative certifications such as designation from the American Chemistry Council as a Responsible Care® industry to demonstrate its dedication to quality control and environmental stewardship.
3. The performance testing shall be conducted under the direction of a designated Technical Representative (TR) provided by the manufacturer at no cost to the City of Bozeman. Manufacturer shall list the name, address and contact information for the designated TR. Upon award of contract, the designated TR must be responsible to quickly address the needs of the

City of Bozeman regarding polymer supply and quality, and provide polymer use technical assistance.

4. Manufacturers shall include a list of a minimum of three (3) municipal wastewater customers, with current contact information, that are currently using or have used the proposed polymer product(s) within the last three (3) years. This information will be provided to the City of Bozeman and its representative using the form provided in **Exhibit 1**.
5. Qualified manufacturers while on plant sites with polymers shall maintain product information for all polymers that will be considered for the full-scale tests. At a minimum, product information shall include polymer name, product number, current material safety data sheet (MSDS) and product specification indicating the % active polymer content.

Notification of Interest package must be received by the City of Bozeman, Montana by the following representative:

Tom Radcliffe  
City of Bozeman Water Reclamation Facility (WRF)  
2245 Springhill Rd., Bozeman, MT 59718  
Phone: (406) 582-2928  
Email: [tradcliffe@bozeman.net](mailto:tradcliffe@bozeman.net)

Based on results of the review of the information provided with the Notification of Interest, manufacturers that meet the qualifying criteria will be selected to participate in the polymer equipment and polymer trials program as outlined in the schedule in the Polymer Testing Protocol section.

### **Polymer Specifications**

The polymer equipment and polymer to be tested and bid shall be suitable as a conditioner for screw press dewatering of anaerobically digested (mixed) primary and secondary sludge biosolids from the Bozeman WRF. Polymers to be tested shall be high molecular weight cationic or anionic emulsion type (cationic expected) compatible with the City's existing polymer mixing and feed equipment noted above. The polymer may be used for thickening of waste activated sludge via a rotary screen thickener.

Polymer must maintain at least ninety percent (90%) effective strength for a minimum of six (6) months after delivery when stored in a covered, heated, and ventilated area (60°F to 80°F).

### **Polymer Testing Protocol**

The prequalification polymer testing consists of (i) bench-scale jar testing and (ii) full-scale performance testing. To prepare for the polymer testing, site visits by manufacturers to the WRF facilities are by appointment only coordinated through the key facility representative. Key operator contacts will be provided upon selection to participate. Unauthorized/unscheduled facility visits at any time by the manufacturer or its representatives are grounds for removal from the polymer trials program.

- **Bench-scale Testing**

Manufacturers will bench-scale test their polymer product(s) to determine which product provides the best potential thickening. Bench-scale testing will be conducted by appointment only by the manufacturers TR. All testing will take place at the Water Reclamation Facility (WRF) Laboratory located at 2245 Springhill Rd., Bozeman, MT. Representative samples of anaerobically digested sludge for dewatering testing will be provided and delivered by the WRF operations staff. All manufacturers who are selected to participate will be given an appointment to perform tests to screen their polymers. The appointment will be arranged at a date/time mutually agreeable upon with the WRF staff and the TRs. TRs may begin jar or other tests at 8:00 AM and shall complete all work by 3:00 PM, on the same day. Manufactures and TRs are responsible for any lab and testing equipment they feel necessary to conduct their tests beyond or in addition to the supplies and equipment available for use at the WRF.

- **Full-scale Performance Testing**

Full-scale testing will be performed by WRF operations staff with technical input from the TRs. A meeting will be held individually with each manufacturer before initiation of the full-scale testing to review the goals, conditions, testing protocol and responsibilities for the testing. The full-scale testing program will be conducted at WRF Solids & Dewatering Building and Laboratory, scheduled from July 26, 2021 – August 20, 2021. A detailed full-scale testing schedule will be developed to coordinate plant operations, TR availability, polymer supply, etc.

Prior to and during testing, the polymer supplier shall ensure that equipment to be used in the test at the plant will not adversely affect test results. The TR is responsible for verifying that test conditions and equipment are acceptable.

All pumps, tanks, mixers, etc. required for full-scale testing, in addition to what is available with WRF's existing blending and feed equipment, shall be provided and set up by the polymer supplier. Each TR will be responsible for performing any preliminary tests needed to determine initial polymer dosage required to minimize the effect on subsequent operations and to insure that an adequate supply of polymer is provided for the duration of testing. Polymer supply for up to 24 hours (two 8 to 10 hr days) will be allowed for each polymer proposed. The specific test duration (within the limits outlined above) and polymer quantities will be determined by the polymer supplier. The polymer for performance testing must be delivered to the respective facility at no cost to the City of Bozeman. Polymer shall be delivered to the plant a minimum of 24-hours prior to the scheduled testing date.

A daily trial schedule will be established prior to the testing date. On the day of the testing, each TR will be given an ample amount of time to make adjustments regarding polymer makeup and feed conditions (polymer mix conc., initial feed rates, etc.) before the official trial period begins. TRs will be allowed to sample the feed sludge at a single representative point of the process as designated by the Treatment Plant Superintendent or Operations Supervisor.

**The following conditions will apply to the full-scale performance test:**

1. Full-scale testing will be allowed by appointment only.
2. A meeting will be held individually with each manufacturer before initiation of full-scale testing to review the goals, conditions, testing protocol and responsibilities for the testing.
3. A maximum of two (2) people from the polymer manufacturer will be allowed on-site during the test.
4. A minimum of eight (8) hours, and a maximum of (10) hours per day of testing. Under no circumstances shall tests be continued past 5:00 PM.
5. Dosing will be tested at 26 GPM screw press feed flow (2019-2020 AVG) and 33 GPM (2019-2020 MAX). For 26 GPM, a minimum of three (3) polymer doses will be required. For 33 GPM, a single (1) polymer dose meeting the performance criteria will be required.
6. Required doses will be run as close as possible to:
  - a. 26 GPM: Lowest possible dosage (lbs AP/dry ton) to achieve performance goals, second dose at 2-4 (lbs AP/dry ton) increase, and a final dose at 4-6 (lbs AP/dry ton) increase.
  - b. 33 GPM: Lowest possible dosage (lbs AP/dry ton) to achieve performance goals.
  - c. Each of the defined doses will be run twice for a combined minimum of eight (8) samples. Operating parameters may be changed while testing the same polymer dose as described in Condition 8. Any remaining time can be used to retest doses or expand dose testing to increase efficiency.
7. Average of the three (3) best acceptable samples at 26 GPM will be used for evaluation. Each dose range must have a sample meet the performance criteria. Failure to meet the performance criteria at 33 GPM will be taken into consideration and may result in disqualification.
8. Operating parameters including polymer carrier/mixing water, screw press floc tank feed mixing valve, screw press floc tank mixing speed and screw press speed are available for adjustment at the TRs request.
9. Plant personnel will collect and composite samples. Samples will be collected prior to wash cycle initiation for timing purposes and consistency among manufacturers.
  - a. Samples collected and analyzed will include screw press cake solids and screw press supernatant (screwnate) via moisture balance and total solids (TS) respectively.
  - b. The first sample shall be collected ~60 minutes after dewatering device startup.
  - c. Thereafter, samples shall be collected every ~60 minutes.
  - d. Changes to polymer dose and/or other parameters are to be adjusted following sample collection and ran continuously for ~60 minutes.
10. Plant personnel will analyze samples. Split samples may be analyzed by a state of Montana certified laboratory, at the manufacturer's request and expense.

11. The manufacturer, at their own expense, shall remove and lawfully dispose of all unused product and containers at the conclusion of testing. At the City’s request, the manufacturer shall turn over any remaining unused blended polymer to the City at no cost.

In the event of equipment breakdown or malfunction, the City of Bozeman may elect (at their discretion) to reschedule a full-scale performance test. In this event, rescheduled date(s) shall be mutually agreed upon by the City of Bozeman and the manufacturer(s).

The City of Bozeman reserves the right to terminate testing immediately at their discretion if they determine that a polymer product does not meet the performance requirements or that the polymer being utilized is detrimental to equipment operation or performance.

The manufacturer shall monitor the testing to verify that all polymers and other related variables are within normal operating parameters. The TR should communicate any concerns to the Treatment Plant Superintendent or individual designated by the manager to supervise the test no later than two (2) days after completion of testing. TRs cannot directly request operators to make process changes other than indicated herein. Polymers that require the equipment to be run outside normal operating variables will be removed from consideration.

Upon completion of the full-scale trials, a copy of the performance data for the particular polymer supplied by and tested for a manufacturer will be supplied to that manufacturer’s TR for use in developing bid documents.

**Expected Dewatering Performance:** (minimum criteria)

Parameter	Value	Units
Dry Tons per Year	1,460	Bone Dry Standard Ton/Year
Tons per Day	4.0 (output)	Bone Dry Standard Ton/Day
Gallons per Day	37,000-48,000 (at 2.5% TS inlet)	GPD
Feed Gallons per Minute	26 & 33 (at 2.5% TS inlet)	GPM
Average Inlet Consistency Percent Total Solids	1.5-3%	% TS
Minimum Outlet Consistency Percent Total Solids	17%	% TS
Operating Days per Year	365	Days
Operating Days per Week	7	Days
Operating Hours per Day	24	Hours

### **Polymer Performance Evaluation Criteria**

The following equations provide evaluation criteria that will be used during the trials and with full-scale performance test data and submitted bids to identify the most cost effective product:

#### **Polymer Feed Rate, $P_{FR}$ , (GPH)**

\*Pump setting for each sample will be plotted on pre-test pump calibration graph/trend.

#### **Screw Press Loading, $S_L$ , (dry ton/hr)**

$$S_L = (S_{FR} \times 60 \text{ min/hr} \times D_{TS} \times 8.34 \text{ lbs/gal}) / 2000 \text{ (ton/lbs)}$$

Where:

$S_{FR}$  = Screw Press Feed Rate (GPM)

\*Trial testing operating setpoint

$D_{TS}$  = DIG #3 (Digester #3) Total Solids (%)

\*Sample tested in lab

#### **Pounds Active Polymer, $P_L$ , (lbs AP/dry ton)**

$$P_L = (P_{FR} \times P_D \times P_A) / S_L$$

Where:

$P_{FR}$  = Polymer Feed Rate (GPH)

\*Pump calibration

$P_D$  = Polymer Density (lbs/gal)

\*Manufacturer data

$P_A$  = Active Polymer (%)

\*Manufacturer data

$S_L$  = Screw Press Loading (dry ton/hr)

\*Trial testing data

#### **Solids Recovery, $R$ (%)**

$$R = [C_{TS} \times (D_{TS} - S_{TS})] / [D_{TS} \times (C_{TS} - S_{TS})] \times 100$$

Where:

$C_{TS}$  = Screw Press Cake Total Solids (%)

\*Trial sample tested in lab

$D_{TS}$  = DIG #3 Total Solids (%)

\*Trial sample tested in lab

$S_{TS}$  = Screwnate Total Solids (%)

\*Trial sample tested in lab

#### **Polymer Cost, $P_C$ , (\$/dry ton)**

$$P_C = (P_{FR} \times P_{\$}) / S_L$$

Where:

$P_{FR}$  = Polymer Feed Rate (GPH)

\*Pump calibration

$P_{\$}$  = Polymer Cost (\$/gal)

\*Manufacturer data

$S_L$  = Screw Press Loading (dry ton/hr)

\*Trial testing data

**Polymer Cost,  $P_{CR}$ , (\$/dry ton) \*Recovery Factored**

$$P_{CR} = P_C / R$$

Where:

$P_C$  = Polymer Cost (\$/dry ton)

\*Trial testing data

$R$  = Solids Recovery (%)

\*Trial testing data

**Polymer Cost,  $P_{CD}$ , (\$/day) \*Recovery Factored**

*(Estimate polymer cost/day assuming 4 dry ton)*

$$P_{CD} = P_{CR} \times 4 \text{ dry ton/day}$$

Where:

$P_{CR}$  = Polymer Cost (\$/dry ton)

\*Trial testing data



### Example Polymer Performance Calculation per Qualified Polymer

$P_{\$}$ = Polymer Cost (\$/gal)	\$8.50/gal	*Manufacturer data
$P_D$ = Polymer Density (lbs/gal)	8.50 lbs/gal	*Manufacturer data
$P_A$ = Active Polymer (%)	40%	*Manufacturer data
$S_{FR}$ = Screw Press Feed Rate (GPM)	26 GPM	*Trial testing operating setpoint
$D_{TS}$ = DIG #3 Total Solids (%)	2.50 %	*Sample tested in lab
$C_{TS}$ = Screw Press Cake Total Solids (%)	18.00%	*Trial sample tested in lab
$S_{TS}$ = Screwnate Total Solids (%)	0.30%	*Trial sample tested in lab
$P_{FR}$ = Polymer Feed Rate (GPH)	1.50 GPH	*Pump calibration

#### **Screw Press Loading, $S_L$ , (dry ton/hr)**

$$S_L = (S_{FR} \times 60 \text{ min/hr} \times D_{TS} \times 8.34 \text{ lbs/gal}) / 2000 \text{ (ton/lbs)}$$

$$S_L = (26 \text{ GPM} \times 60 \text{ min/hr} \times 2.50 \% \times 8.34 \text{ lbs/gal}) / 2000 \text{ (ton/lbs)} = 0.163 \text{ dry tons/hr}$$

#### **Pounds Active Polymer, $P_L$ , (lbs AP/dry ton)**

$$P_L = (P_{FR} \times P_D \times P_A) / S_L$$

$$P_L = (1.50 \text{ GPH} \times 8.50 \text{ lbs/gal} \times 40\%) / 0.163 \text{ dry tons/hr} = 31 \text{ lbs AP/dry ton}$$

#### **Solids Recovery, $R$ (%)**

$$R = [C_{TS} \times (D_{TS} - S_{TS})] / [D_{TS} \times (C_{TS} - S_{TS})] \times 100$$

$$R = [18.00\% \times (2.50 \% - 0.30\%)] / [2.50 \% \times (18.00\% - 0.30\%)] \times 100 = 89\%$$

#### **Polymer Cost, $P_C$ , (\$/dry ton)**

$$P_C = (P_{FR} \times P_{\$}) / S_L$$

$$P_C = (1.50 \text{ GPH} \times \$8.50/\text{gal}) / 0.163 \text{ dry tons/hr} = \$78.40/\text{dry ton}$$

#### **Polymer Cost, $P_{CR}$ , (\$/dry ton) \*Recovery Factored**

$$P_{CR} = P_C / R$$

$$P_{CR} = \$78.40/\text{dry ton} / 89\% = \$87.60/\text{dry ton}$$

#### **Polymer Cost, $P_{CD}$ , (\$/day) \*Recovery Factored (Estimate polymer cost/day assuming 4 dry ton)**

$$P_{CD} = P_{CR} \times 4 \text{ dry ton/day}$$

$$P_{CD} = \$87.60/\text{dry ton} \times 4 \text{ dry ton/day} = \$350.42/\text{day}$$

**Exhibit 1**

**References**

(Must be completed by manufacturer and included with Notification of Interest)

City of Bozeman  
Water Reclamation Facility (WRF)

2021 – Polymer Trials

Vendors shall provide references on this form. References must be of organizations having similar facilities as City of Bozeman Water Reclamation Facility (WRF).

Manufacturer: \_\_\_\_\_

1. Name or Utility: \_\_\_\_\_
- a. Contact: \_\_\_\_\_
  - b. Title: \_\_\_\_\_
  - c. Mailing Address: \_\_\_\_\_
  - d. Phone: \_\_\_\_\_
  - e. Email: \_\_\_\_\_

2. Name or Utility: \_\_\_\_\_
- a. Contact: \_\_\_\_\_
  - b. Title: \_\_\_\_\_
  - c. Mailing Address: \_\_\_\_\_
  - d. Phone: \_\_\_\_\_
  - e. Email: \_\_\_\_\_

3. Name or Utility: \_\_\_\_\_
- a. Contact: \_\_\_\_\_
  - b. Title: \_\_\_\_\_
  - c. Mailing Address: \_\_\_\_\_
  - d. Phone: \_\_\_\_\_
  - e. Email: \_\_\_\_\_