

December 16, 2022

Stefan Higgins
Assistant City Engineer
City of Blaine
10801 Town Square Drive NE
Blaine, MN 55449

Re: Water Treatment Plant 1 - Underdrain Design and Iron/Manganese Filter Pilot

Dear Mr. Higgins:

Barr Engineering (Barr) is pleased to present the City of Blaine (City) with a proposal to provide underdrain design and pilot testing to facilitate future upgrades to filters for Water Treatment Plants 1-3 (WTP 1-3). The work scope will be completed by testing filter modifications and new media at Filter 2 at Water Treatment Plant 1 (WTP 1). This project has been recommended in the draft Wholistic Review memo prepared by Barr. Originally envisioned to take place at WTP 3, the work has been expedited and moved to WTP 1 due to the recent failure of the filter underdrain in Filter 2. This project will include the following tasks described in greater detail later in this proposal:

- Design a repair for the broken underdrain piping. It is anticipated that this design (or a variation) will be replicated at other WTPs as their filters are rehabilitated.
- Perform pilot and full-scale testing to evaluate and recommend modifications to resolve backwash and long-term reliability issues experienced at WTP 1, 2, and 3.
- Aid during procurement and installation of air stripper media.

Barr performed a backwash reclaim study in December 2021 at WTP 1 and WTP 3 and it became apparent that there are inconsistencies with the existing filters including: filter vessel size, loading rate, backwash rate, backwash supply, control valve functionality, filter underdrain distribution piping, and filter backwash collection piping. The recent media change in the filters from Electromedia by Filtronics to pyrolusite resulted in an increase in backwash rates due to the denser pyrolusite filter media. That in turn has affected other plant system operations.

In addition, in November 2022, media loss was discovered in Filter 2 at WTP1. The plant was taken offline and media was removed from the filter. After media removal, it was discovered that the underdrain piping was broken in multiple places. Because the media has been removed from this filter, it is a good candidate for underdrain redesign and full-scale pilot testing of alternative media to determine the achievable capacity and operational improvements that a wholistic media changeout and underdrain redesign could provide at WTP 1, 2, and 3.

WTP 1 Underdrain Design and Iron/Manganese Filter Pilot Scope of Work

Task 1: Filter Underdrain Redesign

In the past 2 years, multiple filter underdrains at WTP 1-3 have been failing with little advance warning, resulting in significant disruptions to water quality and a reduction in available capacity in the City's distribution system. Due to these recent failures, Barr was planning to pilot test modifications to the underdrains in one filter at WTP 3 (along with new media) as part of a pilot test recommended in the draft Wholistic Review memo. However, a failure in the fall of 2022 of the Filter 2 underdrain at WTP 1 has made repairs on this filter an urgent priority. The pilot testing originally planned for WTP 3 will be moved to WTP 1.

Objective: Repair backwash underdrains and improve operation including lengthening useful life.

Description: The underdrain design will consider materials of construction, size, and configuration to provide flexibility to adapt to future filter media and/or piping modifications. The following tasks are proposed to be completed as part of the evaluation and design. Barr understands that this is a time-critical task.

- Perform analysis on existing media to determine the grain size and percentage of pyrolusite/sand to help understand the current operation better.
- Laser scan interior and exterior of filter vessel following media removal and concrete (if applicable).
- Perform hydraulic modeling on existing system and proposed system alternatives to aid in appropriately designing the size and configuration of the underdrain system.
- Coordinate with filter and media vendors.
- Perform calculations based on industry-standards.

Following these tasks Barr will design a replacement underdrain to be installed in Filter 2 by a contractor hired by the City. Due to the time-sensitivity and the emergency-repair nature of this underdrain installation, the work is not anticipated to be publicly bid.

Deliverables:

- 60% and 100% design drawings and technical specifications.

Assumptions:

- Blaine will provide existing information/shop drawings for the current iron and manganese removal filters in WTP 1, 2, and 3 and overall process piping.
- The filter underdrain design will not require modification of the filter shell (e.g., no modification to the ASME vessel designation). If filter shell modifications are required, a scope, schedule, and budget modification may be requested.
- Hydraulic modeling is anticipated to take 24 staff hours.

- The City will procure quotes for the underdrain repairs and/or self-perform repairs. It is assumed that public bidding is not required.

Task 2: WTP 1 Pilot and Full-Scale Testing

Objective: Determine the appropriate design basis for future modifications to WTP 1, 2, and 3 filters. The design basis will be determined through pilot and full-scale testing of filter media alternatives at WTP 1.

Based on the wholistic review performed in 2022, Barr understands the City will accept reduced treatment plant design capacities at WTP 1 and WTP 3. This will allow consideration of different filter media (and the subsequent loading capabilities and backwash requirements). The preliminary assumption is that WTP 1 and WTP 3 can have a capacity reduction by as much as 50%. Using this assumption, it is more likely that the existing filters can be reused.

Description: This task is to evaluate filter and/or media modifications to provide the background information needed for a wholistic filter upgrade at WTP 1, 2, and 3. Barr will accomplish this by performing hydraulic analyses and pilot testing to develop options to improve the performance and reliability of the filtration systems. Evaluation will be performed in such a way as to allow filter use at an MDH-approved flow rate during the pilot testing. Specific tasks include:

- Determine viable options for modifying the plant to operate as expected and within generally accepted filtration parameters. Options for modifications will include:
 - Infrastructure modifications to allow filtration (and backwashing) with pyrolusite (it is likely that this option will not be considered in detail due to extensive piping and valve modifications required)
 - Filter media change-out to a different (lower density) manganese and iron removal filtration media (GreensandPlus™ or similar)
 - Filter loading rates selected to maximize production within generally accepted filtration media parameters.
- Prepare pilot test work plan and operate parallel pilot tests (0.5 to 3 gpm) using columns of filter media to estimate:
 - Loading rate (assume 3-5 loading rates for each media)
 - Manganese and iron removal effectiveness
 - Filter run time between backwashes
 - Backwash requirements
 - Oxidant requirements

It is anticipated that the pilot test will operate for 3 weeks. Barr staff will be onsite for 40 hours/week during pilot testing. The pilot test will consist of up to three columns of various media. Each column will be operated through four cycle runs for a period sufficient to achieve breakthrough of iron or manganese. It is anticipated that 6 field tests will be performed per column run and a total of 6 lab samples will be collected throughout the pilot testing.

- Prepare full-scale test plan and design modifications of WTP 1 Filter 2 based on pilot test results to further evaluate one media and various loading and backwash rates. It is anticipated that the full-scale test will operate for 6 weeks. Barr staff will be onsite for 16 hours/week during the full-scale testing. Barr will collect weekly lab samples for the duration of the pilot test.

- Prepare pilot and full-scale test report and propose future upgrades for WTP 1, 2, and 3 based on:
 - Allowable loading rate and filter area
 - Available filter area
 - WTP capacity
 - Backwash requirements
 - Media type
 - Reuse of existing infrastructure (pipes, valves, pressure vessels, backwash tanks)
 - New infrastructure requirements

Deliverables:

- Pilot test work plan
- Pilot test results report
- Full-scale test work plan
- Full-scale test results report
- Design basis report for WTP 1, 2 and 3

Assumptions:

- The pilot testing will be performed at WTP1 and will be performed by Barr staff.
 - 3 week pilot test
 - 40 hrs/week Barr staff assistance to operate the pilot
 - 72 field tests for iron and manganese
 - 6 laboratory samples for iron and manganese.
- A \$5,000 equipment allowance is included within this proposal for pilot equipment rental. Barr will procure pilot equipment.
- The full-scale test will be performed at WTP1 on Filter 2.
- The City will rent or otherwise provide the recommended chemical feed equipment to facilitate the full-scale if existing feed equipment is not able to be used.
- City staff will operate the filters during full-scale testing.
 - 6-week full-scale test
 - 16 hrs/week Barr staff assistance
 - 6 laboratory samples for iron and manganese
- Underdrain repairs are completed by March 31, 2023
- Full-scale media is installed and ready to operate by April 21, 2023
- Other process or aesthetic upgrades are not included within this scope of work.
- Filter 2 at WTP 1 will be usable to produce water at MDH-approved flow rates (3 gpm/sf) if needed during the pilot testing.

Task 3 (Optional): WTP 1 Air Stripper Media Replacement

Objective: This purpose of this (optional) task is to aid Blaine in replacing the existing air stripper media.

Description: The media has reached the end of its useful life and is due for replacement. Barr will provide technical specifications for the air stripper media for Blaine to procure new media, as well as a proposed removal and installation protocol and sequence of operations. Barr will also provide onsite observation and office assistance during media installation. The benefit to the City for Barr to assist with this task is coordination with the pilot testing and filter repairs at WTP 1.

Deliverables:

- 60% and 100% technical specification(s)

Assumptions:

- Blaine will provide existing information on the current air stripper and media system if needed.
- The City will procure quotes for the air stripper replacement media and installation and/or self-perform installation. No public bidding is required.
- 8 hours/week of office assistance and onsite during a 6-week installation period.

Project Team

The project will be led by principal-in-charge Brian LeMon and project manager Julie Macejkovic. Bryan Oakley, Becca Vermace, Ben Israel, and Sorel Nelson will provide technical support for the underdrain redesign; the pilot and full-scale testing; and air stripper media replacement.

Schedule

The proposed project schedule is shown below.

phase/task	duration	est. completion date
notice to proceed		January 4, 2023
task 1: underdrain redesign and install		
Laser scan and modeling		January 23, 2023
Underdrain design documents	3 weeks	February 13, 2023
City receives quotes for underdrain replacement		February 28, 2023
Begin underdrain replacement		March 13, 2023
Complete underdrain replacement		March 31, 2023
task 2: pilot and full-scale testing		

phase/task	duration	est. completion date	
Pilot testing work plan	2 weeks	January 27, 2023	
Pilot preparation and testing	6 weeks	March 10, 2023	
Full-scale work plan	3 weeks	March 31, 2023	
Media installation and full-scale test prep		April 21, 2023	
Operate full-scale test	6 weeks	April 24 – June 2, 2023	
Pilot- and full-scale test report and design basis for future upgrades	2 weeks	June 16, 2023	
task 3 (optional): WTP 1 media replacement assistance			
	procurement documents	6 weeks	February 10, 2023
	installation assistance (office and onsite observation)	6 weeks	TBD

Budget

We request modification of the currently approved design budget to incorporate the work amendments described above.

Task	Estimated Budget
Task 1 – Underdrain Redesign	\$28,000
Task 2 – WTP1 Bench and Pilot testing	\$72,000
Subtotal (Tasks 1 and 2)	\$100,000
Task 3 (Optional) – WTP 1 Air Stripper Medial Replacement	\$16,000
Total (Tasks 1, 2, and 3)	\$116,000

If you have any questions regarding the additional scope items, please don't hesitate to call me for further clarification. If the terms of this proposal are acceptable, please sign the document in the appropriate places located below and return a copy to us for our records. The work is performed according to the terms of our master services agreement. Thank you for your continued work with Barr.

Sincerely,



Brian K. LeMon
Vice President, Sr. Civil Engineer

Accepted this ___ day of _____, 2023

CITY OF BLAINE

By _____ Michelle A. Wolfe

Its _____ CITY MANAGER

By _____ Tim Sanders

Its _____ MAYOR