JORDAN VALLEY WATER CONSERVANCY DISTRICT

REQUEST FOR STATEMENTS OF QUALIFICATIONS TO PROVIDE PROFESSIONAL ENGINEERING SERVICES FOR THE

JVWTP FILTER AND CHEMICAL FEED UPGRADES

Project #4289

January 2023

Summary

Jordan Valley Water Conservancy District (JVWCD or District) invites you to submit a Statement of Qualifications (SOQ) as defined in this request. SOQs shall be submitted in a sealed envelope to JVWCD's project manager, David McLean, P.E., at 8215 S. 1300 W., West Jordan, UT 84088, or via email to ellisad@jvwcd.org, **and received no later than 4:00 p.m. on February 15, 2023 for consideration.**

Introduction

The District was created under the Water Conservancy Act as a political subdivision of the State of Utah. The District was organized as a regional water supply agency to develop a water supply for rapidly growing areas outside of the Salt Lake City service area. JVWCD currently serves as a wholesale supplier to 17 member agencies and also operates a retail distribution system in several parts of Salt Lake County. In 2020, the District delivered approximately 120,000 acre-feet of municipal and industrial water to its wholesale and retail customers. JVWCD currently operates the Jordan Valley Water Treatment Plant as is primary treatment facility.

Project Background

In order to support growing peak day demands and enable treatment of the new Utah Lake Replacement (ULS supply), the District is pursuing an expansion of the JVWTP from its current 180 MGD capacity to a future capacity of 255 MGD net (assume 5% internal recycle requires pre-treatment and filtration capacity of 268 MGD gross). We have organized the various elements of the expansion into multiple projects, some of which are combined with other equipment replacement or seismic upgrade projects.

Project Description

The District desires to expand its JVWTP from 180 MGD to 255 MGD. These improvements will be made in four phases. This request is for Engineering Scope 3:

Engineering Scope 1	Basins 3-6 chain & flight, seismic, and plates for full 180 MGD pre-treatment capacity	Engineering design contract awarded to Brown and Caldwell Engineers on July 14, 2021.
Engineering Scope 2	Basins 1-2 demolition, seismic, building, plates for 255 MGD pre-treatment capacity.	Engineering design contract awarded to Hazen and Sawyer Engineers on September 14, 2022.
Engineering Scope 3	**Replace filter media for Filters 1-16. Upgrade chemical feed systems for 255 MGD capacity.**	**This Request**
Engineering Scope 4	Raw and finished water piping improvements for 255 MGD treatment capacity including expansion of the raw water pond, additional raw water piping, and construction of additional finished water reservoir(s).	Future engineering project

Note: JVWTP capacity will be limited to approximately 220 MGD until the completion of Engineering Scope 4.

This project will design required improvements for upgrades to the filters and chemical feed systems to support 255 MGD capacity. Other improvements will include pre-design evaluation of Ozone, and evaluation of alternatives for backwash tank redundancy.

Budget

The estimated budget for this project is approximately $40 million – $60 million. Engineering fees are expected to range from $5,000,000 - $6,500,000.

Proposed Engineering Services Scope

Pre-design Phase:
Generate a Basis of Design Report (BODR) and 30% drawing set to guide design of JVWTP improvements that achieve the project objectives described above. Provide support with the Utah Division of Drinking Water for concurrence with the filter re-rating approval. The BODR and 30% set should incorporate results from the following analyses.

1. Evaluate filter hydraulics. Evaluate the hydraulics at 220 MGD and 268 MGD assuming an upstream water elevation at 4746.22 (NAV88) as measured at the

existing hole core at the south filter access bay (north point similar to be provided by this project).

2. Evaluate options for improving filter flow split:
    a) Retain side influent split weir and extend the channels to improve momentum affects for basins 15 and 16 (with possible downstream side interconnect to mitigate momentum effects)
    b) Provide individual filter rate-of-flow control
    c) Other alternative(s) as determined by the selected consultant

3. Evaluate each of the existing chemical feed systems for operation at 268 MGD, including.
    a) Chlorine Dioxide
    b) Poly-aluminum Chloride
    c) Powdered Activated Carbon
    d) Cationic Polymer
    e) Filter-aid Polymer
    f) Gaseous Chlorine

    The evaluation should include analysis of equipment condition, capacity, chemical storage capacity/availability. Provide recommendations for improvements needed for a 20–30 year extended lifespan.

4. Evaluate feasibility and alternatives for the following additional improvements to the chemical feed systems for operation at 268 MGD.
    i. pH control system – a recent water quality study identified the treated water from the JVWTP as potentially corrosive. In addition, the JVWTP raw water pH has been declining in recent years. The District desires to add a pH adjustment chemical or other stabilization chemical which would help mitigate this corrosivity issue. Options that should be evaluated include:
        - Caustic
        - Soda ash
        - Phosphoric stabilizer
        - Other as appropriate

    b) Chlorination system location and type –
        i. It is the District's preference to continue the use of gaseous chlorine if this can be done in a safe and economical manner within state and national requirements. However, an evaluation of the following

chlorine feed system alternatives shall be performed to determine if gaseous chlorine offers the most advantageous benefit/cost ratio.
    0. Gaseous chlorine (similar to existing)
    1. On-site generation
    2. Sodium hypochlorite

ii. Evaluate the following location alternatives:
    0. Keep existing location in the “high-rise” building
    1. New stand-alone building south of the existing Chlorine Dioxide building
    2. New stand-alone building west of the emergency generator at the plant
    3. New shared pH Control/Chlorine building
    4. Other alternative as determined by the selected consultant

c) Flocculation Aid –
d) evaluate how the existing non-ionic filter aid chemical system could be upgraded to provide flocculation aid in addition to filter aid.

5. Air Scour Blowers – Evaluate the existing 250 hp blowers for operation with the deeper filter media and recommend blower improvements if they are deficient. Also, evaluate benefits against the cost of relocating the blowers to reduced sound impacts on the occupied portions of the building (if needed after the current acoustical improvements are completed).

6. Backwash Tank Redundancy – Evaluate and make a recommendation from the following alternatives to provide the desired redundancy.
    a) New 1 MG steel reservoir in parallel with existing including independent valving
    b) New 0.5 MG gallon steel reservoir in parallel to existing
    c) Other alternative(s) as determined by the selected consultant

7. In-Plant Corrosion Control – Several JVWTP pipes were design as unlined pipes with corrosion allowances rather lined pipes (i.e. raw water piping for filters 1-6). Evaluate the condition of these pipes and feasibility of using an epoxy lining to extend piping life.

8. Ozone – evaluate the potential use of ozone chemical treatment for influent TOC treatment, taste and odor control, and treatment of emerging contaminants to meet future water quality targets. Evaluate how the use of Ozone might affect the District’s primary disinfectant, chemical use, and solids storage (from reduced PAC usage). Options to consider might include pre-ozone injected at the screening building or intermediate ozonation.

9. Solids Handling Pumps – Confirm the ability of the solids handling pumps to operate and provide redundancy at the 220 MGD interim plant production capacity. If improvements are needed, recommend improvements for 13 MGD of solids recycle (268 MGD gross – 255 MGD net).

Design Phase:

Prepare plans and specifications to ultimately bid and construct the project per the findings of the pre-design effort. Provide design submittals at 60% and 90% for District staff review and comment. Incorporate District comments to provide a final set of bid documents. Include the following tasks:

1. Coordinate amendments to the design scope, if required, from findings of the preliminary design phase. Design of a future Ozone system, if recommended, would be included in a future design contract. Other chemical feed improvements most likely will be included in this design contract.

2. Prepare construction specifications and drawings for construction of the Project.

   A. Prepare mechanical, civil, structural, electrical, and instrumentation drawings for the improvements.

   B. Prepare plan, profile, and detail drawings, technical specifications, and bid schedule(s) for the pipeline. Drawings shall be 11x17 with a scale not to exceed 1" = 80'.

   C. Attend and conduct design workshops with JVWCD at Preliminary Design, 60%, 90%, and 100% completion.

   D. Provide an estimate of probable construction costs at the 60% and 100% submittal stage.

   E. The Senior Reviewer shall attend at least two (2) design review meetings with JVWCD in person.

   F. Review and become familiar with JVWCD's bidding documents, General Conditions and Supplemental General Conditions.

   G. Provide drawings and technical specifications to JVWCD for incorporation into the bidding documents. JVWCD will prepare the bidding documents using its standard Division 0 documents, General Conditions, and Supplemental General Conditions.

H. Meet with JVWCD personnel and Utah Division of Drinking Water (DDW) staff at the 90% design stage to verify compliance of the design with applicable water regulations. Respond as needed to comments from DDW staff and submit final drawings and specifications for plan approval.

I. Provide assistance during the bidding period including conducting a pre-bid side visit, responding to bidders' questions, issuing Addenda, as required, etc.

J. Assist in the bid opening, review the bids, and recommend an award of contract (within three working days).

K. Prepare a conformed set of drawings and specifications which will incorporate all addenda material into a conformed drawing set for use during construction.

Note: The National Geodetic Vertical Datum of 1929 (NGVD29) used in the original 1971 drawings was updated to North American Vertical Datum of 1988 (NAVD88). All drawings produced shall reference the NAVD88 datum.

Note: Seismic design criteria shall match these existing design criteria used for seismic upgrades at the plant (chemical building, filter building, basins 3-6):

Seismic Loads:

Code:	IBC 2018 & ASCE 7-16
Risk Category:	IV
0.2 Sec. Mapped Spectral Response, S_S:	0.835 g
1.0 Sec. Mapped Spectral Response, S_1:	0.271 g
Site Class:	C
0.2 Sec. Design Spectral Response, S_{DS}:	0.593 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.276 g
Importance Factor (I_e):	1.5
Component Importance Factor (I_p):	1.0, except I_p=1.5 for components identified in Section 13.1.3 of ASCE 7
Seismic Design Category	D

Notes:

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *Check individual members for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.*
3. *Consider hydrodynamic forces on submerged equipment per code as applicable*

3. Construction Management Phase:

   A. Following an award of construction contract, fulfill the duties and responsibilities of the ENGINEER as defined in JVWCD's construction contract documents.

   B. Administer the construction contract:

      1) Conduct pre-construction meeting.

      2) Review and recommend contractor submittals to JVWCD.

      3) Review and recommend contractor progress payments to JVWCD.

      4) Review contractor's claims.

      5) Recommend change orders, if any, to JVWCD.

      6) Conduct project close-out at completion of the work.

      7) Conduct a comprehensive inspection with the contractor and JVWCD at substantial completion, final completion, and just prior to warranty expiration. Prepare and deliver to JVWCD a written list of observed deficiencies.

   C. Perform field services:

      1) Coordinate all materials testing services to be completed by an independent testing firm.

      2) Designate a representative to attend weekly progress meetings which are conducted by the Contractor, and document content of progress meetings with minutes.

      3) Maintain a photograph history of the project and submit periodic photos to JVWCD during construction.

      4) The Engineer shall commit a Project Representative to provide on-site inspection of construction activities to verify compliance with the drawings and specifications for an estimated 52 weeks of full-time inspection and 52 weeks of part-time inspection.

   D. Documentation and Project Close-out

      1) Prepare final record drawings using the contractor's record drawings. Record drawings should be prepared according to JVWCD's Guidelines for Engineering Services (Attachment B).

2) Prepare a photographic history at the end of the project according to JVWCD's Guidelines for Engineering Services.

3) Prepare an Operation and Maintenance manual according to JVWCD's Guidelines for Engineering Services.

Sample Preliminary Schedule

Award of Engineering Contract:	March 2023
Contract Preparation:	30 calendar days
Preliminary Design Phase:	120 calendar days
Design Phase:	
60% Design:	60 calendar days
90% Design:	60 calendar days
100% Design:	60 calendar days
Schedule hold awaiting BRIC grant funding re-application (if necessary)	
Bidding through NTP:	60 calendar days
Construction Phase: (24 months)	720 calendar days
Commissioning	30 calendar days
Approximate date ready for service	May 2026
Warranty Inspection:	11 months after final completion

Engineers may revise this schedule as necessary to match their work plan.

Statement of Qualification Evaluation

SOQs shall not exceed eight (8) pages in length (excluding resumes, sample drawings, appendices and references). Provide one digital copy of the SOQ. Proposers may provide four (4) bound hard-copies for ease of use by the evaluation committee if desired

The SOQ should include the following information:

Note: additional information should be provided to establish the unique qualifications of your firm to provide the requested services):

- Qualifications: Identify the key members of the team listed by name including role and availability to the project in the format of a Project Team Chart. Indicate the education, experience, expertise, and location of each team member (it is acceptable to provide this in resume format in the appendix). Sample drawing(s) from applicable previous projects may be included in the appendix. Include evidence demonstrating compliance with the Minimum Qualifications section of this Request for SOQ.

- Work Plan: Include a detailed work plan which addresses the scope of the work and identifies key issues. A final agreed upon work plan will be incorporated into Schedule A of the Agreement. Include a project schedule of the key tasks and note the availability of project team members with respect to current workload and project start and completion dates.

  Include with the work plan a table showing the number of hours planned for the key positions for each major work task. Include subtotals of all labor hours for the preliminary design, design, and construction management phase. This information will be used to evaluate the work plan and the level of effort in each phase by the team and the key team members. **Do not include any billing rate or cost information in this work plan table**. *Include hours and costs for each item of the pre-design scope. If after review of the pre-design report, some line items (and costs) may be removed from design (i.e. pre-ozone) by negotiation and amendment prior to the beginning of the design phase of the project.*

- Past Performance: Provide information about past completed projects which satisfy the Minimum Qualifications requirements. Information about additional completed projects which the Proposer feels would be relevant may also be submitted. The past project performance information shall include:
  1. Brief description of project and scope of services performed,
  2. Name of owner,
  3. Owner contact information (direct phone number preferred),
  4. Role which proposed Project Team member(s) fulfilled on past project,
  5. Original engineering fee amount,
  6. Final engineering fee amount,
  7. Original construction or equipment purchase contract amount,
  8. Final construction or equipment purchase contract amount,
  9. Completion date established in the original construction or equipment purchase contract and actual final completion date.

  Incomplete projects (on-going work) may be used but may result in a lower grade for this section in the evaluation phase.

Professional Consulting Services Agreement

Comment on the acceptability of the enclosed Professional Consulting Services Agreement (Agreement) (Attachment A) with attached Schedule B-Requirements for Engineering Services (Attachment B). Any suggested changes to the Agreement must be identified with the proposal (as an attachment), although JVWCD reserves the right to reject any suggestions. No changes will be considered after the proposal due date.

Selection Method

Selection of a consultant will be done in accordance with the State of Utah's Procurement Code for Design Professional Services (Utah Code Title 63G, Chapter 6a, Part 15).

Minimum Qualifications

Engineering firms are required to meet the following minimum experience requirements to be considered responsive to this request for statements of qualifications (rSOQ)

- **The Project Manager** shall have successfully functioned as a Project Manager or in significant role on at least:
    - Three similar projects at municipal water treatment facilities

- **The Project Engineer** shall have successfully functioned as a Project Engineer or in significant role on at least:
    - Two similar projects at municipal water treatment facilities

- **The Process Engineer** shall have functioned in this role for at least:
    - Three similar projects at municipal water facilities

- **The Project Representative** shall have shall have functioned in this role for at least:
    - Three similar construction projects

- **The Senior Review Engineer(s)** shall have successfully functioned as a Senior Review engineer, Project Manager or Project Engineer on at least:
    - Five similar projects at municipal water treatment facilities

- The Project Manager, and Project Engineer(s) shall be licensed as Professional Engineers in Utah. The Senior Engineer shall also be licensed as a Professional Engineer.

- The project team and proposed work plan are responsive to the needs of the project and include all the disciplines required by the request for SOQ.

Evaluation Criteria

The following evaluation criteria are proposed (firms exceeding the minimum qualification will be scored higher in the evaluation process).

Evaluation Criteria	**Grade**	**Weight**	**Maximum Points**
1. Demonstrated Qualifications to meet the scope of work:			
a. Firm Resources that satisfy the defined minimum qualifications. Demonstrated availability of firm resources to the project team.	0-5	2	10
b. Project Manager and key team members with the education, expertise, and experience necessary as required for the project.	0-5	4	20
c. Availability of Project Manager and key team members to the project. Current workload with the District may be considered.	0-5	3	15
2. Responsiveness of Work Plan:			
a. Clearly written work plan responding to the requirements of this request which indicates an understanding of the key issues and deliverables required for this project. Higher scores may be given to SOQs which show familiarity with District facilities related to this project or which note suggested revisions to the scope of work which would lead to an enhanced outcome.	0-5	4	20
b. Project schedule which identifies completion dates for key milestones and a final completion date.	0-5	1	5
3. Past Performance:			
a. Positive verified past references for the Proposing Firm indicating successful past performance on similar projects, including projects for JVWCD.	0-5	3	15
b. Positive verified past references for the Project Manager and other key team members indicating successful past performance on similar projects, including projects for JVWCD.	0-5	3	15
Total:			100

Each criterion will be graded by an appointed evaluation committee. Grades will be awarded on a scale of 0-5 with 5 being the highest grade. The grades will be multiplied by the appropriate weight factor to determine the total score. SOQs shall have a level of effort appropriately matching the requirements, including efforts by key positions. SOQs falling short of an appropriate overall effort and/or effort by key positions may be considered non-responsive. JVWCD reserves the right to reject all SOQs.

Fee Proposal Instructions

A fee proposal will be requested from the firm receiving the highest score—the fee proposal will be due three (3) days after it is requested by JVWCD. If JVWCD's procurement officer is unable to agree to a satisfactory contract with the highest scoring design professional, at a price the procurement officer determines to be fair and reasonable to the procurement unit, the procurement officer shall formally terminate discussions with that design professional, and undertake discussions with the second highest scoring, qualified design professional. For additional information, see Utah Code Title 63G, Chapter 6a, Part 15, Section 1505.

The fee proposal shall be provided in a spreadsheet format similar to the sample fee proposal template in Attachment C. If the required information is not present, the fee proposal may be considered non-responsive. The hourly billing rate for each position, number of hours per task by position, and any fees for reimbursable expenses and overhead factors shall be clearly indicated. Proposed hourly billing rate increases, if applicable for multi-year projects, should likewise be clearly indicated.

The total proposed fee for the preliminary design and design phases of the project will be considered a maximum not-to-exceed fee amount. The fees submitted for the construction management phase shall be subject to increase/decrease based upon the actual level of effort needed during construction. It has been JVWCD's experience that more detailed designs result in fewer change orders and issues during construction and thus fewer construction management hours.

Upon execution of the Agreement by both parties, the Engineer will receive authorization to proceed with only those services identified in the Agreement. The Engineer must receive prior written authorization before performing any services outside the scope and fee amount identified in the Agreement.

For purposes of preparing the fee proposal make the following assumptions:

1. Design Contingency Budget

    a. Increase by 10% the number of hours to be spent on the Pre-design and Design Phases for the purpose of establishing a Design Contingency. The increase shall be proportional for each position.

b. This 10% increase shall be included as a separate task and released only with written authorization of the District's Engineering Department Manager in accordance with Schedule B – Requirements for Engineering Services.

2. Construction Phase Level of Effort

a. See Scope of Work-Construction Management Phase. Please provide comments on the adequacy of the estimated inspection hours and suggest any modifications.

CONFIDENTIALITY: All information, documents, records and paperwork, including but not limited to SOQs, bids, exhibits, or brochures (collectively, the "Paperwork") submitted to the District shall not be regarded by the District as proprietary, secret, or submitted in confidence, except as otherwise provided in a writing signed by the District. Please do not mark your Paperwork with legends such as "confidential," or "proprietary," or "not to be disclosed to third parties." The District is a Utah local district and is subject to the provisions of the Utah Government Records and Management Act ("GRAMA," Utah Code Ann. (1953) §§63-2-101 et seq.). Paperwork submitted to the District may be subject to disclosure to third parties under the District's interpretation of the provisions of GRAMA.

Questions or Suggestions

Proposers may ask questions or make suggestions to JVWCD on any element of this Request for SOQs. Questions or suggestions should be submitted to JVWCD's Project Manager, David McLean, PE, at 801-680-6334 or dmclean@jvwcd.org

ATTACHMENT A

PROFESSIONAL CONSULTING SERVICES AGREEMENT
(please provide comments)

PROFESSIONAL CONSULTING SERVICES AGREEMENT
FOR _____
(PROJECT NO. _____)

This Agreement is made as of _____, _____ ("Effective Date"), by and between the Jordan Valley Water Conservancy District, a water conservancy district organized under the laws of the State of Utah ("District"), and _____ a Utah corporation OPTIONAL WORDING: [a Utah _____/ a (State) _____ _____ authorized to do business and doing business in the State of Utah] ("Engineer").

RECITALS:

A. The District desires to obtain professional engineering services relating to the _____;

B. Engineer represents it has the necessary expertise and experience to perform the services requested by the District and that it is properly qualified and licensed in the State of Utah for this work; and,

C. Engineer has submitted a proposal outlining its proposed scope of activities for performance and completion of the services, and the Engineer is willing to perform the services requested by the District, consistent with the terms of this Agreement.

TERMS:

The parties agree as follows:

ARTICLE I
DEFINITIONS

1.1 Unless the context requires otherwise, the terms defined in this Article shall for all purposes of this Agreement and all schedules, have the following meanings:

1.1.1 Agreement: This Professional Consulting Services Agreement, including attachments.

1.1.2 Contract: The agreement between the District and the Contractor for the provision of labor, materials and equipment for the construction of the Project.

1.1.3 Contract Documents: All documents relating to construction of the Project, issued by or through the Engineer, on behalf of the District to

the Contractor, or by the District, including the Notice Inviting Bids, Instructions to Bidders, Bid, Information Required of Bidder, Bid Bond, Agreement Performance Bond, Payment Bond, General Conditions, Supplemental General Conditions, drawings, specifications, all addenda and change orders executed pursuant to the Contract.

1.1.4 Contractor: The party contracting with the District for the provision of labor, materials and equipment for the construction and quality control of the Project.

1.1.5 Contract Time: The projected date for substantial completion of the Contract.

1.1.6 Engineer's Fee: The Engineer's compensation for performing Services.

1.1.7 Phase: A logically separate aspect of the Engineer's Services on the Project which occurs in sequence or concurrently with other such aspects to allow for the orderly progress and management of the Engineer's Services for the Project.

1.1.8 Project: The Project is described on attached Schedule A.

1.1.9 Project Manager: The individual identified in Schedule D who will administer the performance of the Engineer's Services under this Agreement.

1.1.10 Project Representative: The individual identified in Schedule D who will provide observation and inspection of the construction of the Project. The Project Representative is the sole authorized representative of the District in all on-site relations with the Contractor, except as other properly authorized agents are designated by the Engineer and approved by the District.

1.1.11 Reimbursable Expenses: Non-salary expenditures made by the Engineer, its employees or its sub-consultants when performing services for the Project. Reimbursable Expenses include:

1.1.11.1 Reasonable expenses of transportation, subsistence and lodging when traveling in connection with the performance of services for the Project.

1.1.11.2 Reasonable expenses of long distance or toll telephone calls, telegrams, messenger service, field office expenses, and fees paid for securing approval of authorities having jurisdiction over the Project.

1.1.11.3 Reasonable expenses of all reproduction, postage and handling of drawings, specifications, reports or other Project-related instruments of service of the Engineer.

1.1.11.4 Reasonable expense of computer time as described on attached Schedule E.

1.1.11.5 Other reasonable reimbursable expenses to which the parties subsequently agree.

1.1.12 Hourly Billing Rate: The hourly fee which the Engineer charges for the time expended on the Project. The hourly billing rate shall be considered full compensation for time expended on the Project. Specific hourly billing rates for the Project are identified in Schedule E.

1.1.13 Services or Engineer's Services: The Engineer's duties and responsibilities to the District for professional consulting services as set forth in Article II.

1.1.14 Sub-Consultant: Any registered professional engineer, architect or other specialist engaged by the Engineer in connection with the Project.

1.1.15 Task: An independent and defined service or collection of services to be performed by the Engineer during a Phase(s) of the Project(s), such service or services being more particularly set forth in Schedule A.

1.2 Except where the context otherwise requires, words imparting the singular number shall include the plural and vice versa.

ARTICLE II
ENGINEER'S SERVICES

2.1 Basic Services: The Engineer shall provide the following Services on the Project, as more described and set out in Schedule A.

2.1.1 Pre-design Phase: Complete applicable investigations, evaluations, analyses, surveys, and reports.

2.1.2 Design Phase: Complete all necessary drawings and technical specifications for bidding the construction of the Project.

2.1.3 Construction Phase:

2.1.3.1 The Engineer shall assist the District during bidding and contract execution, administer the Contract, provide field observation and inspection of the Project, and provide management and reporting during the construction phase of the Project.

2.1.3.2 The Engineer shall designate the individuals named in Article IV as Project Manager and Project Representative to be the representatives of the District in its relations with the Contractor, subject to the requirements and limitations set out in the Contract Documents and this Agreement. Other personnel of the Engineer shall be designated as needed to administer the Contract, as further set forth in Section 2.2 and this Agreement.

2.1.3.3 The Engineer shall provide Project representation at the site, as described in Schedule A, in order to provide experienced inspection and observation of the quality and progress of the Contract construction work to verify it complies with the requirements of the Contract Documents, and to advise the District of defects and deficiencies. The Engineer shall direct its efforts toward verifying that the means, methods, techniques or procedures that are specified in the Contract Documents are faithfully observed and followed by the Contractor during construction of the Project, and, except as hereafter provided, that the completed Project conforms to the Contract Documents. The Engineer shall not be responsible for any means, methods, techniques, or procedures of construction selected by the Contractor not specified in the Contract Documents, or for safety precautions and programs incident to the work of Contractor.

2.1.3.4 The Engineer shall have the following powers and is hereby directed to exercise them as in its professional judgment are required to accomplish the above tasks, objectives and responsibilities:

Examine, review and investigate all material, equipment, work and workmanship for compliance with the Contract Documents, including the examination and investigation of plant, mill and shop facilities; require that work done in the absence of observation and examination be removed and replaced under the proper

observation and examination; make such examination and tests, as in its professional judgment are required, to verify that the work is being accomplished in accordance with the Contract Documents; reject work which does not meet the specifications of the Contract Documents and require the Contractor remove and replace such work according to the Contract Documents.

2.1.3.5 If disputes between the Contractor and the District arise, and/or if the Contractor shall file a claim or protest against the District during construction of the Project, the Engineer shall investigate and analyze all such disputes, claims and protests, and attempt to resolve them to the mutual satisfaction of the parties, and failing such resolution, recommend a course of action for the District.

2.1.3.6 The Engineer's recommendation of any payment requested in an application for payment by the Contractor will constitute a representation by the Engineer to the District, based on the Engineer's on-site observations of the Contractor's work in progress as an experienced and qualified design professional and on the Engineer's review of the application for payment and the accompanying data and schedules, that the work has progressed to the point indicated, that to the best of the Engineer's knowledge, information and belief the performance and quality of the work is in accordance with the Contract Documents (subject to an evaluation of the work by the Engineer as a functioning Project upon Substantial Completion as defined in the Contract Documents, to the results of any subsequent tests called for in the Contract Documents, and to any qualifications stated in the recommendation), and that the Contractor is entitled to payment of the amount recommended. However, by recommending any such payment, the Engineer will not thereby be deemed to have represented that the Engineer acted or performed to a standard of care higher than that required of the Engineer under this Agreement and the Contract.

2.2 Guidelines for Basic Services: The Engineer shall perform the Services in conformance with the District's Guidelines for Engineering Services, as set forth in Schedule B, and in conformance with such other guidelines imposed by the District during the progress of the Services, so long as such guidelines are in conformance with standard professional consulting services.

2.3 Additional Services: The District and the Engineer recognize and agree that services not set forth in Schedule A are not covered by the Engineer's Fee and are considered to be additional services. No additional services may be provided by the Engineer, and no compensation shall be paid therefore by the District, except upon written confirmation by the District as an amendment to this Agreement.

Upon request by the District, the following additional services shall be provided by the Engineer:

2.3.1 Perform work resulting from changes in design criteria made in writing at the direction of the District, after acceptance of the criteria by the Engineer;

2.3.2 Prepare applications and supporting documents for government review or action, other than those which may be specified in Schedule A;

2.3.3 Provide additional services required as a result of delinquency or insolvency of one or more of the Contractors; or as a result of damage to the Project caused by fire, flood, earthquake, or other acts of God, wherein damage was not a direct or indirect result of Engineer's negligence or within Engineer's control;

2.3.4 Provide additional services required as a result of strikes, walkouts, or other acts of trade or labor unions;

2.3.5 Provide expert witness testimony or litigation support at depositions, trials, court appearances, and other similar judicial proceedings and cooperate in formulating and responding to interrogatories and other similar discovery methods; and,

2.3.6 Perform any other item of work not specifically mentioned above, and requested by the District in writing.

ARTICLE III
TIME TO COMPLETE

The Engineer's Services, as defined in Article II, shall be completed within the timeframe set forth in Schedule C. Notwithstanding any term or provision of this Agreement to the contrary, all of the Services shall be completed within ___ calendar days after the Effective Date of this Agreement.

ARTICLE IV
ENGINEER'S PERSONNEL

The key personnel identified in Schedule D shall perform the Engineer's Services in the assigned capacities, as shown. Any substitution of key personnel and/or changes in assignments from those shown must be approved by the District in writing before such substitution or change may be made by the Engineer.

ARTICLE V
DISTRICT-FURNISHED SERVICES

5.1 Information: Upon the Engineer's request, the District shall provide to the Engineer or make available for review all information and data contained in record drawings, record documents and other records routinely kept by the District pertaining to the design, construction or operation of its facilities. The District does not warrant the accuracy or completeness of such data and information originating from entities or persons other than the District.

5.2 Review of Documents: The District shall review and consider all sketches, drawings, reports, studies, model results, specifications, bids, proposals, contracts, and other documents submitted by the Engineer relative to Engineer's Services. Whenever prompt action is necessary, the District shall within a reasonable time inform the Engineer of its decision regarding the same so as to not unduly delay the Engineer in its performance according to the schedule set forth in this Agreement.

5.3 Engineer Access: The District shall, at its expense, arrange and make provision for the Engineer's entry and access to such property (public and/or private) as may be necessary to enable the Engineer to perform the Services.

5.4 District Representative: The District shall designate in writing an individual who shall be authorized by the District to act as the District's Representative. The Representative shall have authority to receive reports from the Engineer and give instructions to the Engineer.

OPTIONAL 5.4 District Representative: The District hereby designates and authorizes _____ to act as the District's Representative. The Representative shall have authority to receive reports from the Engineer and give instructions to the Engineer.

5.5 Notifications of Defects: The District shall give written notice to the Engineer whenever the District or its Representative becomes aware of any defect or deficiency in the Engineer's Services.

5.6 Construction Right-of-Way: Where, based upon the Engineer's design work, rights-of-way are required for construction, the District will, at its expense, obtain such rights-of-way, including appraisals and title searches, utilizing descriptions and maps provided by the Engineer.

5.7 Consultation with District: Employees of the District shall be available for consultation with the Engineer at all reasonable times.

5.8 Permit Fees: The District shall pay any required permit fees, charges for plan checking, and any other fees charged by any public agency having jurisdiction over any part of the Project, if such charges are made.

5.9 Legal Opinions: The District shall, at its expense, furnish legal opinions on laws and the interpretation thereof which may affect the Project, if such opinions are judged by the District to be necessary.

ARTICLE VI
COMPENSATION

6.1 Basic Services: The District shall pay to the Engineer as compensation for Services attributable to the Project, the hourly billing rates as set forth in Schedule E multiplied by the number of hours expended on the Project, together with reimbursable expenses attributable to the Project multiplied by ___.

6.1.1 Pre-design and Design Phases: In no event shall the total compensation due the Engineer for the Pre-design and Design Phases, including reimbursable expenses, exceed _____ and ___/100 Dollars ($_____).

6.1.2 Construction Phase: The budget authorized for the Engineer's Services and for reimbursable expenses in the Construction Phase is _____ and ___/100 Dollars ($_____). As work in this Phase reaches seventy-five percent (75%) of the authorized budget set forth in Schedule E, the Engineer shall notify the District, and the Engineer and the District shall thereafter mutually review the extent of work already accomplished, the extent of work remaining to be completed and the past and projected expenses related thereto. At that time, the scope of Services and corresponding compensation for Services for the Construction Phase may be adjusted by the District.

6.2 Additional Services: In the event this Agreement is amended to provide for additional services by the Engineer, the Engineer's compensation for additional services shall be the hourly billing rate multiplied by the hours expended for additional services, and reimbursable expenses attributable to the additional services multiplied by ___.

A summary showing estimated cost data for each additional service requested shall be submitted to the District for approval prior to commencement of work on that additional service. The District shall not be obligated to reimburse the Engineer for costs incurred in excess of the estimated cost set forth in that summary, and the Engineer shall not be obligated to continue work or to incur costs in excess of the estimated cost until the District notifies the Engineer in writing that the estimated cost therefore has been increased. Additional sets of Contract Documents and reduced scale drawings shall be charged at actual cost of printing and mailing.

6.3 Format for Invoices: Invoices for the Engineer's Services and expenses shall be reviewed and signed by the Engineer's Project Manager before being sent to the District. Each invoice shall include the following information:

a. Project Name.

b. Time period of Services (beginning of month to end of month).

c. Current invoice charges, separated into Pre-design, Design and Construction Phases, with the following breakdown:

(i) Charges for Services, further described by:

(1) Employee name.

(2) Hours worked.

(3) Rate charged.

(ii) Reimbursable Expenses:

(1) Description.

(2) Cost.

d. Account summary, including:

(i) Total amount authorized for the Pre-design and Design Phases under this Agreement.

(ii) Total invoiced to date for the Pre-design and Design Phases.

(iii) Total amount authorized for the Construction Phase under this agreement.

(iv) Total invoiced to date for the Construction Phase.

6.4 Progress Payments: The Engineer's invoices for Services performed and for reimbursable expenses shall be delivered to the District after the end of the first calendar month following the Effective Date of this Agreement, and monthly thereafter so long as the Engineer's Services shall continue. The compensation requested on any such invoice shall be itemized to show hourly billing rate multiplied by time charged to the Project and reimbursable expenses which actually were incurred in the month identified in the invoice.

6.5 Payment of Invoice: The amount shown on each invoice for the Engineer's Fee and expenses shall be due and payable by the District after its review and acceptance of the Services itemized in the invoice. The Engineer may levy a simple interest charge of eight percent (8%) per annum on invoice amounts accepted for payment by the District and not paid within forty-five (45) days of the date of delivery of the invoice. Late payments made by the District shall be credited first to accrued interest and then to principal.

6.6 Suspension; Termination: In the event the District fails to submit payment on an invoice within sixty (60) days of the date of delivery to the District of such invoice, the Engineer may, at its discretion and upon ten (10) days written notice to the District, suspend its services or terminate this Agreement.

ARTICLE VII
SPECIAL TERMS AND CONDITIONS

7.1 Documents: All completed original reproducible tracings, survey notes, plans, specifications, reports, engineering calculations, and other original documents prepared by the Engineer in the performance of the Engineer's Services shall be the property of the District, and the Engineer shall, upon the request of the District, deliver such documents to the District. The Engineer may retain and use copies of the documents. The District agrees to hold harmless, indemnify and defend the Engineer against all third party damages, claims, expenses and losses arising out of any reuse by the District of the plans, specifications and documents if the District does not obtain the written authorization of the Engineer for their reuse.

7.2 Governmental Immunity: Except for the District’s obligations of indemnification as set forth in paragraph 7.1, nothing in this Agreement shall adversely affect any immunity from suit, or any right, privilege, claim or defense, which the District or its employees, officers and trustees may assert under state or federal law, including but not limited to the Utah Governmental Immunity Act, Utah Code Ann. (1953)

§§ 63-30-1 et seq. (the “Act”). All claims against the District or its employees, officers and trustees are subject to the provisions of the Act, which Act controls all procedures and limitations in connection with any claim of liability.

7.3 Conflict of Interest: The Engineer shall not establish or otherwise continue any conflict of interest created by virtue of this Agreement, prohibited under state or local laws.

7.4 Termination Prior to Completion: This Agreement may be terminated at any time by the District prior to completion of the Engineer's Services upon written notice to the Engineer. Upon receipt of such notice, the Engineer shall immediately stop any further work in progress, and in such event, the Engineer shall be entitled to payment for all of its Services performed by the Engineer and accepted by the District, to the date of cancellation, and for all work required to organize and deliver to the District the materials developed in the course of the Engineer's Services. Payment shall be due to the Engineer within forty-five (45) days after delivery of such materials and receipt of a verified and itemized invoice therefore.

7.5 Construction Estimates: Estimates of contract time, construction costs and quantities prepared by the Engineer or its employees represent their best professional judgment as design professionals and are supplied for the general guidance of the District. The Engineer does not guarantee the accuracy of such estimates as the Engineer has no control over the cost of labor and material, competitive bidding, or market or other conditions.

7.6 Indemnity and Insurance: The Engineer shall indemnify, defend and hold the District harmless from any claims under the Workers’ Compensation Act, and from any claims, demands, suits, causes of action, costs, fees, judgments, liability for bodily injury and death, and damages to property, real or personal, to the extent caused by or resulting from breach of contract, negligence, recklessness or intentional misconduct by the Engineer or by the negligence of the Engineer’s subconsultants, in the performance of the Engineer's Services under this Agreement. During the course of this Agreement, and for a period of four (4) years following Substantial Completion of the Engineer’s Services under this Agreement, the Engineer shall maintain both professional errors and omissions liability insurance and general commercial liability insurance providing coverage for all liability arising out of the performance of Services in connection with the Project and this Agreement. The liability insurance required shall include "prior acts" coverage for all services rendered for the Project and shall be written with a limit of liability of $500,000.00 per claim and a Project aggregate of $1,000,000.00.

7.7 Interpretation: Except as otherwise noted, releases from liability, indemnification against liability, limitations on liability, assumptions of liability and limitations on remedies which may be expressed in this Agreement, shall apply to all possible claims and/or causes of action, including but not limited to those arising under common law, equity, statute, contract, tort or otherwise.

ARTICLE VIII
GENERAL TERMS AND CONDITIONS

8.1 Standards of Performance: The Engineer shall perform its Services in a manner consistent with the professional skill and care ordinarily provided by other design professionals with the same or similar professional license, providing the same or similar design professional service in the same or similar locality at the same or similar time under the same or similar circumstances.

8.2 Force Majeure: Neither party shall hold the other responsible for damages or delays in performance caused by acts of God, strikes, lockouts, accidents, acts of any governmental entity having jurisdiction over the parties and/or the subject matter of this Agreement (other than those governmental entities named as parties or beneficiaries to this Agreement), or other events beyond the reasonable control of the other or the other's employees and agents. In the event either party claims that performance of its obligation is prevented or delayed by such cause, that party shall promptly notify the other party of that fact and the circumstances preventing or delaying performance.

8.3 Assignment: Neither the District nor the Engineer shall delegate and/or assign their respective duties and/or rights under this Agreement without the prior written consent of the other. The Engineer may subcontract, however, portions of the Services as it deems necessary to efficiently accomplish the Basic Services. Nothing in this paragraph shall release the Engineer from full compliance with the terms and conditions of Article IV.

8.4 Severability; Waiver: In the event a court, governmental agency or regulatory agency with proper jurisdiction determines that any provision of this Agreement is unlawful, that provision shall terminate. If a provision is terminated, but the parties can legally, commercially and practicably continue to perform this Agreement without the terminated provision, the remainder of this Agreement shall continue in effect. One or more waivers by either party of any provision, term, condition or covenant shall not be construed by the other party as a waiver of any subsequent breach of the same by the other party.

8.5 Governing Law: This Agreement shall be governed by, construed and enforced according to the laws of the State of Utah.

8.6 Merger; Amendments: This Agreement and the Contract Documents, including all amendments, represents the entire and integrated agreement between the District and the Engineer, and supersedes all prior negotiations, representations or agreements, whether written or oral, regarding the subject matter contained in this Agreement. The Agreement may be amended only by written instrument executed by all parties.

8.7 Attorney's Fees: In the event of a default or breach of this Agreement, the defaulting party agrees to pay all costs incurred by the non-defaulting party in enforcing this Agreement or in obtaining damages, including reasonable attorney's fees, whether incurred through legal proceedings or otherwise.

8.8 Notice: Any formal notice required to be given under this Agreement shall be deemed given when hand-delivered or when sent by registered or certified mail, return receipt requested, to the parties at their respective addresses stated below or to any other address after notice of such change of address has been given to the parties.

8.9 Third Party Beneficiaries: Nothing contained in this Agreement shall create a contractual relationship with a cause of action in favor of a third party against either the District or the Engineer. The Engineer's Services under this Agreement are being performed solely for the District's benefit, and no other entity shall have any claim against the Engineer because of this Agreement or the performance or non-performance of Services hereunder. The District agrees to use reasonable efforts to include a provision in all contracts with other contractors and other entities involved in the Project to carry out the intent of this paragraph.

"District":	"Engineer":
Jordan Valley Water Conservancy District 8215 South 1300 West West Jordan, Utah 84088	_____ _____ _____
By: _____ Barton A. Forsyth Its General Manager/CEO	By: _____ [Name] Its _____

ATTACHMENT B

SCHEDULE B - GUIDELINES FOR ENGINEERING SERVICES

SCHEDULE B
REQUIREMENTS FOR ENGINEERING SERVICES

1. CONTINGENCY FUNDS

A. Design Contingency funds shall not be utilized without prior authorization by the District. The use of Design Contingency funds shall be authorized in writing by District management on a task by task basis.

2. PRE-DESIGN/DESIGN PHASE

B. DRAWINGS

1.1 Computer-Aided Drafting (CAD) shall be used to prepare construction drawings. The drawings shall be delivered to the District in electronic form (AutoCAD 2016 or more recent) and hard copy on 11 x 17 paper.

1.2 Document Format:

a. Electronic documents shall be prepared in the following versions:

i. Spreadsheets in Excel version 2013

ii. Word processing in Word version 2013

iii. Presentations in PowerPoint version 2013

1.3 The cover sheet shall not include approval signatures from the District, although names of District officers may be printed.

1.4 The drawings shall be submitted to the District for its review and comment in accordance with paragraph E of this schedule, “Review of Contract Documents.”

1.5 All drawings shall show the District’s assigned Project number in the lower, right hand corner of the sheet.

2.1 Bidding and Contractual Documents: The Engineer shall provide Project-specific information to the District for completion of the District's standard bidding and contractual documents identified below. The Engineer shall provide the bid schedule to the District in hard copy and electronic format (Microsoft Word). The District shall print the documents. The following paper colors and format shall be used by the District when printing these documents:

2.1.1	Title Page	Single, Sided, White
2.1.2	Table of Contents	Double-Sided, Yellow
2.1.3	Notice Inviting Bids	Double-Sided, White
2.1.4	Instructions of Bidders	Double-Sided, White
2.1.5	Bid	Single-Sided, Blue
2.1.6	Bid Bond	Single-Sided, Blue
2.1.1	Information Required of Bidder	Single-Sided, Blue
2.1.2	Agreement	Double-Sided, White
2.1.3	Performance Bond	Single-Sided, White
2.1.4	Payment Bond	Single-Sided, White
2.1.5	Notice of Award	Single-Sided, White
2.1.6	Notice to Proceed	Single-Sided, White
2.1.7	Payment Application	Single-Sided, White
2.1.8	Change Order	Single-Sided, White
2.1.9	Contractor's Certificate of Substantial Completion	Single-Sided, Purple
2.1.10	Contractor's Certificate of Final Completion	Single-Sided, Purple
2.1.11	Consent of Surety for Final Payment	Single-Sided, Purple
2.1.12	Affidavit of Payment	Single-Sided, Purple

2.2 General and Supplemental Conditions: The District will provide General and Supplemental General Conditions; to be printed on green and yellow paper, respectively.

2.3 Technical Specifications:

2.3.1 The Engineer shall prepare technical specifications in electronic form (Microsoft Word). The technical specifications shall be delivered to the District prior to the bidding in electronic form and single-sided on 8 ½ x 11 white paper.

2.3.2 The draft sets of technical specifications shall be submitted to the District for its review and comment in accordance with paragraph E of this Schedule.

2.3.3 The technical specifications shall include, but not be limited to, the following General "Divisions."

2.3.3.1 General Requirements of the Work.

2.3.3.2 Contract Submittals – Include Submittal procedures requirements for equipment shop-drawings, record drawings, and submission of technical O&M manuals, spare parts lists, etc., prior to final payment.

2.3.3.3 Quality Control, Inspection, Testing.

2.3.3.4 Protection and Restoration of Existing Facilities.

2.3.3.5 Equipment Testing and Startup – Include requirements for testing, startup, certification of installation, and training of District personnel by manufacturer's representative for complex equipment.

2.3.3.6 Project Closeout Procedures and Requirements – These procedures and requirements must match the requirements, in the District's General Conditions.

2.3.3.7 Measurement and Payment – This should be explained in a separate section, or in each work item section of the technical specification.

2.3.3.8 Field Staking and Surveying – Include defining whether the Engineer or Contractor shall be responsible for field surveying and staking.

2.4 Addenda: If addenda are to be issued, each addendum will be prepared by the Engineer. The addendum will be approved, signed, and delivered by the District.

C. DOCUMENT BINDING REQUIREMENTS

3.1 With the exception of 11x17 drawings, all documents produced by the Engineer shall be bound in a three ring binder. This shall include pre-design reports, final reports, operation and maintenance manuals, etc. Drawings may be comb-bound during bidding and construction. As-constructed drawings shall be (1) comb-bound and (2) folded and included in three ring bound operation and maintenance manuals.

D. DESIGN REQUIREMENTS

4.1 All engineering designs shall include the following elements.

4.1.1 Adequate seismic bracing/anchorage of piping and equipment.

4.1.2 Provision of flexibility for differential settlement where buried piping and/or electrical conduit penetrates concrete vaults or basements.

4.1.3 All other standard engineering design issues shall be addressed.

E. REVIEW OF DRAWINGS AND TECHNICAL SPECIFICATIONS

5.1 The Engineer shall prepare one electronic set (PDF) and one photo copy ready paper set of drawings and technical specifications for review by the District.

5.1.1 Review documents shall be provided at the following minimum progress landmarks: ten percent (10%), thirty percent (30%), fifty percent (50%), ninety percent (90%) and one hundred percent (100%). If specified in the Scope of Work (Exhibit A) more landmarks may be required. A two-week minimum review period shall be allowed for review of the drawings and technical specifications at each progress landmark. At each progress landmark the Engineer shall

meet with the District for two to four hours to receive its comments and direction.

5.1.2 The Engineer shall return to the District, with each subsequent specification to be reviewed, all documents reviewed by the District during the previous submittal.

F. RIGHT-OF-WAY DESCRIPTIONS

Unless otherwise specified by the District, the Engineer will prepare legal descriptions for right-of-way to be acquired by the District from ownership plats and deeds, rather than by the actual survey. The District will prepare easement and other documents, utilizing legal descriptions prepared by the Engineer. Legal descriptions shall be in a metes and bounds format acceptable to the local County Recorder, which may record the document(s).

3. CONSTRUCTION SERVICES PHASE

A. PROJECT PERSONNEL

1.1 Engineer: The Engineer shall represent and perform Engineering Services for the District within the scope of authority delegated to it by the District as described in this Schedule B.

1.2 The Engineer will appoint, subject to the District's approval, the following personnel:

1.2.1 Project Manager: The individual designated by the Engineer and approved by the District to oversee and manage the administration of the Contract. The Project Manager shall supervise the Project Representative; alternatively, the Project Representative may also serve as the Project Manager as provided in Article IV of the Agreement.

1.2.2 Project Representative: The individual of the Engineer's firm appointed as Project Representative will be the Engineer's chief representative in all construction site relations with the Contractor and will have all authority and responsibility as set forth in the District's General Conditions of the Contract.

1.2.3 Other Personnel: The Project Manager may assign, and will supervise, such portions of contract administration

duties as he deems necessary, such as reviewing submittals, performing design changes, and substituting for the Project Representative on the construction site during brief absences of the appointed Project Representative. During brief absences of the assigned Project Representative the Project Manager will first send written notice to the Contractor and will notify the District.

B. CONTRACT EXECUTION ASSISTANCE

2.1 The District will issue the Notice of Award and Notice to Proceed to the Contractor.

2.2 Following Contract execution by the District, fully executed Contracts will be distributed by the District as follows:

District	One (1) Set
Contractor:	One (1) Set
Engineer:	One (1) Set

These three (3) sets will be bound in three-ring binders.

C. PRE-CONSTRUCTION CONFERENCE

3.1 The Project Manager and Project Representative shall familiarize themselves with the District's General Conditions of the Contract.

3.2 The Project Manager will prepare a Pre-Construction Conference agenda, and conduct such a conference with the Contractor and applicable third parties at the District's office or on-site. The Project Representative and District Representative shall be present. The agenda should cover the key points of the Contract Documents, including the General Conditions of the Contract, as well as other Project administration matters.

D. SUBMITTAL/SUBSTITUTIONS

4.1 The Project Manager shall review, process, and recommend approval/disapproval of Contractor submittals and substitution requests. Copies of each Contractor submittal and substitution request shall be sent to the District, together with the Project Manager's recommend action.

The District will direct the Engineer to approve/disapprove each submittal and substitution request.

E. INSPECTION/TESTING

5.1 The Project Representative will make all on-site inspections, with the general frequency and duration as directed by the District.

5.2 The Project Representative is authorized to order such tests as he deems necessary for proper administration and inspection of the Project, however, with respect to any such test to be performed by independent firms presently contracting directly with the District, the firm so contracting will be designated by the District to perform the tests. Reports of all test results, or test summaries, shall be submitted to the District by the Project Representative.

5.3 The Project Representative shall keep a daily written log of construction activities at the site during each visit. Copies of the daily log shall be sent to the District on a monthly basis.

5.4 The Project Representative's daily log shall include a comment of whether or not any event or circumstance has developed in the Contract or Project, which in the Project Representative's professional judgment may lead to a claim or protest from the Contractor. The Project Representative shall notify the District immediately of such an event or circumstance, receipt of a written claim or protest, or his becoming aware of events which may lead to such a claim, from the Contractor.

5.5 The Project Representative shall send to the District copies of notes from telephone calls or meetings with the Contractor that, in the opinion of the Project Manager, are significant.

5.6 The Project Representative shall take digital photographs of the construction in progress during each phase of the work. The Project Manager shall prepare a photographic history of the work as described in paragraph 10.3. The format of the digital photographs shall be in accordance with paragraph 10.3. Photographs shall be submitted periodically to the District during the construction phase of the work.

F. CHANGES IN THE WORK

6.1 Field Order: The Project Representative is authorized to, and shall issue all field orders in writing, as described in Article 1.14 of the General Conditions of the Contract. The Project Representative shall submit a copy of each field order to the District.

6.2 Change Orders: The Project Representative and Project Manager are not authorized to approve Change Orders. Change orders may be initiated by the District, by recommendation from the Project

Manager, or by claim of changed conditions by the Contractor. Change orders will be initially reviewed by the Project Manager, then forwarded with a recommendation to the District. The District shall consider if the recommendation is consistent with the Contract Documents, and if acceptable, the District will prepare the change order form for approval by the authorized District staff.

6.3 Emergencies: The District acknowledges that in emergencies immediately affecting the safety or protection of persons or property affected by the construction activities, the Contractor, without special instruction or authorization from the Project Representative or the District, is obligated to act to prevent threatened damage, injury or loss. The Contractor shall give the Project Representative prompt written notice of any significant changes in the Contract construction or deviations from the Contract Documents caused thereby.

G. PROGRESS MEETINGS

7.1 The Project Representative and/or the Project Manager shall attend progress meetings conducted by the Contractor, and shall document the content of the meetings with minutes. Progress meetings will be scheduled at a location and frequency suitable to the project needs. A District Representative will normally attend these meetings.

H. PROGRESS PAYMENTS

8.1 The Project Representative shall receive applications for payment from the Contractor, review and recommend the applications by signature. The Project Representative's signature recommending a progress payment shall constitute the verification of the representations required by the Agreement and the Contract.

8.2 The Project Manager will review the applications, approve them by signature, and submit them to the District within five business days of receipt from the Contractor.

8.3 Each application for payment shall contain the Contractor's certification and signature substantially in conformance with the following:

CONTRACTOR'S CERTIFICATION

The undersigned Contractor certifies that: (1) all previous progress payments received from Owner on account of Work done under the

Contract referred to herein have been applied to discharge in full all obligations of Contractor incurred in connection with Work covered by prior Applications for Payment numbered 1 though ____ inclusive; and (2) title to all materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all liens, claims, security interests and encumbrances (except such as covered by bond acceptable to Owner).

_____

Contractor (Name of Sole Ownership, Corporation or Partnership)

_____

Signature of Authorized Representative

_____ _____

Title Date

8.4 In accordance with State Law, the District will retain 5% of progress payments until the final payment and final completion of the Project.

4. PROJECT CLOSEOUT

1.1 The Project Manager shall be responsible to see that closeout procedures and documents, as specified in the District's General Conditions, are carefully observed. The following standard District forms, or similar forms of the Engineer acceptable to the District, will be used.

1.1.1 Contractor's Certificate of Substantial Completion

1.1.2 Engineer's Notice of Substantial Completion

1.1.3 Contractor's Certificate of Final Completion

1.1.4 Engineer's Notice of Final Completion

1.1.5 Consent of Surety for Final Payment

1.1.6 Affidavit of Payment (from Contractor)

1.2 The Project Manager will submit original copies of the Contractor's Certificates of Substantial and Final Completion to the District.

1.3 The Project Manager shall prepare and sign the Engineer's Certificate of Substantial Completion, a copy of which is attached.

1.4 The Project Manager will prepare, sign and submit the Engineer's Notice of Final Completion, together with the Final Payment application and all submittals required from the Contractor, when he is satisfied the work is complete. A copy of the Engineer's Notice of Completion is attached. The District's acceptance, as Owner, of the Notice of Final Completion will be evidenced by its making final payment.

5. OPERATION AND MAINTENANCE MANUAL

1.1 The Project Manager shall prepare an Operation and Maintenance Manual ("O&M Manual") for the Project. The O&M Manual shall be completed within seven (7) calendar days of Substantial Completion of the work. The intent for the O&M Manual is to be a reference for unfamiliar users of the Project facilities to become familiar with the operation of the facilities, receive direction on how and when to maintain the facilities, and be able to locate technical support reference when necessary.

The District wishes to have the O&M Manual in electronic format as much as possible. Although certain formats of electronic documents are defined in this Agreement, the District recognizes that technology will change and improve over time and encourages the Project Manager to look for creative ways of providing O&M Manuals in electronic versions as much as possible. For example, the Project Manager could require the Contractor to submit O&M Manual information in HTML, PDF or another universal standard electronic format that could be easily accessed by the District in the future.

The format of the O&M Manual shall be as follows:

<u>Volume I (By Engineer)</u>:

Section 1: Description of Facilities, Typical Operating Conditions, Standard Operating Procedures
Section 2: Description of Proper Maintenance Activities
Section 3: List of Equipment and Suppliers
Section 4: Contract Documents and Specifications
Section 5: Record Drawings (see 10.2)
Section 6: Project Photo Log (see 10.3)
Section 7: Other Pertinent Documents
Section 8: Compact Disc

Volume II (By Contractor):

Section 7: Shop Drawings
Section 8: Manufacturer's Literature and Operations & Maintenance Manuals

All the information in Volume I shall be in an electronic format as well as in paper format.

Unless specifically identified in the request for proposal, the Project Manager shall supply four (4) copies of the O&M Manual complete with electronic versions of information contained in the O&M Manual and one (1) additional copy of the electronic information.

1.2 The Project Manager will revise the original drawings to reflect record conditions, from the Contractor's marked-up record drawings and the Project Representative's inspection notes, sign and stamp them as follows:

JVWCD RECORD DRAWINGS:

Revisions drawn by _____ Date: _____

This record drawing has been prepared to reflect conditions as actually constructed, from records compiled during construction by the Contractor and the Engineer.

_____ _____
Project Manager Date

The record drawings are not intended to show in detail the exact location of minor/latent detail of construction. Instead, they are intended to represent as-built conditions in as much detail as practical and available, and to document substantial changes from the original design. The District recognizes that much of the information required to prepare the record drawings is compiled by the Contractor or others during construction, and therefore holds the Engineer harmless from any errors or omissions which may be incorporated into the drawings as a result.

The record drawings will be delivered to the District following Project completion. The record drawings shall be submitted in electronic ((a) AutoCAD 2016 or more recent and (b) PDF format) and (c) paper (11x17) format.

1.3 The Project Manager shall submit the complete photo history of the Project compiled during construction. The photo history shall be in electronic and paper formats. Both versions shall contain all photographs in chronological order with a date and caption below each photo.

The electronic version shall contain 4” x 6” photos in a JPEG format with a resolution of 150 dots per inch (DPI) or higher. If compressed the compression must be a high quality compression.

The paper version shall contain thumbnail-size photographs with no more than twelve (12) photos per 8-1/2” x 11” page.

ENGINEER'S NOTICE OF SUBSTANTIAL COMPLETION

OWNER ENGINEER

TO: Jordan Valley Water
Conservancy District
8215 South 1300 West
P. O. Box 70
West Jordan, UT 84088-0070

PROJECT NAME: _____

Date of Notice to Proceed: _____ Contract Time: _____
Calendar Days _____

In response to Contractor's Certificate of Substantial Completion dated: _____

This Certification of Substantial Completion applies to all work under the Contract Documents or to the following specified parts thereof:

The work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor and Engineer, and that work is hereby declared to be substantially complete in accordance with the Contract Documents on:

Date of Substantial Completion: _____, 20___.

A list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in it does not alter the responsibility of the Contractor to complete all the work in accordance with the Contract Documents. In accordance with the General Conditions, the items in the list shall be completed or corrected by the Contractor within 45 days of the above date of Substantial Completion.

Marked-up record drawings and operation and Maintenance technical information has been received from the Contractor.

The recommended responsibilities between the Owner and the Contractor for security, operation, safety, maintenance, heat, utilities and insurance, if any, shall be as follows:

Owner: _____
_____
_____

Contractor: _____
_____

ENGINEER'S NOTICE OF SUBSTANTIAL COMPLETION (Continued)

The following documents are attached to and made a part of this Certificate:

_____

_____

Execution of this Certificate by the Engineer extends the Contractor's release of claims against the Owner to the date of execution hereof, in accordance with Article 14.08 of the General Conditions, except for written claims filed prior to date of execution, of which the following, if any, are known to the Engineer:

_____

_____

Executed by the Engineer on _____, 20___.

_____	_____
Project Representative	Signature
_____	_____
Project Manager	Signature

The Contractor hereby acknowledges receiving this Certificate of Substantial Completion.

_____

Contractor (Name of Sole Ownership, Corporation or Partnership)

_____

Signature of Authorized Representative

_____	_____
Title	Date

(Engineer shall submit to the Owner a copy with the Contractor's signature following the Contractor's receipt.)

JORDAN VALLEY WATER CONSERVANCY DISTRICT

ENGINEER'S NOTICE OF FINAL COMPLETION

OWNER ENGINEER

TO: Jordan Valley Water
Conservancy District
8215 South 1300 West
West Jordan, UT 84088

PROJECT NAME: _____

Date of Notice to Proceed: _____

In response to Contractor's Certificate of Final Completion dated: _____

On the basis of our observation of the work during construction and final inspection, and on our review of the Contractor's application for final payment and accompanying documentation, we are satisfied that the Contractor has fulfilled all his obligations under the Contract Documents requisite to final payment.

The following remaining minor deficiencies in the work are recommended to be exempt from final payment, in accordance with Article 14.09 of the General Conditions of the Contract. Recommended completion time limits, extended warranty requirements, and the value of these exempt deficiencies are listed below:

DEFICIENCY	COMPLETION TIME	VALUE

The Contractor's application for final payment together with the following contractor submittals, which comprise all final submittal requirements under the Contract Documents, are submitted herewith:

1. Affidavit of Payment from the Contractor.

2. Consent of Surety for final payment.

The date of our satisfactory final inspection was _____, 20___. This date marks the beginning of the one-year Maintenance and Guarantee period, in accordance with Article 13.01(B) of the General Conditions of the Contract.

Acceptance of final payment by the Contractor shall be a release of claims against the Owner in accordance with Article 14.12 of the General Conditions of the Contract. Acceptance of this Notice of Completion by the Owner makes the Contractor's release effective on the date of execution hereof by the Engineer, excepting written claims filed by the Contractor prior to said date of execution of which the following are known to the Engineer:

_____

_____

Is the Engineer aware of any unresolved liens against the Contractor from suppliers or subcontractors?

☐ Yes ☐ No

Unresolved Liens (If Applicable):

_____

_____

_____

Executed by the Engineer on _____, 20___.

_____	_____
Project Representative	Signature
_____	_____
Project Manager	Signature

ATTACHMENT C

SAMPLE FEE PROPOSAL

(consultant may submit in their standard format)

Project Name
Fee Proposal Template Example

Client: Jordan Valley Water Conservancy District ***Firm Name:***

Date:

Tasks	Project Manager (Name)	Project Engineer (Name)	Project Rep. (Name)				Total Hours	Cost By Task
Team Member	$_____/hr	$_____/hr	$_____hr	$_____/hr	$_____/hr	$_____/hr		
Pre-Design								
1.								
2.								
							Subtotal:	
Design								
1.								
2.								
							Subtotal:	
Total Hours by Team Member								
							TOTAL LABOR COST	$
Direct Charges:								
							TOTAL DIRECT CHARGES	$
							TOTAL DESIGN FEE	$
Construction Management								
	1.							
	2.							
Total Hours by Team Member								
							TOTAL LABOR COST	$
Direct Charges:								
							TOTAL DIRECT CHARGES	
							TOTAL CONSTRUCTION MANAGEMENT FEE	
Optional Tasks								
1.								
2.								
Total Hours by Team Member								
Direct Charges								
							TOTAL LABOR COST	
							TOTAL DIRECT CHARGES	
							TOTAL OPTIONAL TASKS FEE	

_____
Principal's Name

_____
Principal's Signature

_____
Date

APPENDIX A

Carollo Engineers Increased Filtration Rate Pilot Testing Report
December 2022

Jordan Valley Water Conservancy District
Jordan Valley Water Treatment Plant

INCREASED FILTRATION RATE PILOT TESTING REPORT

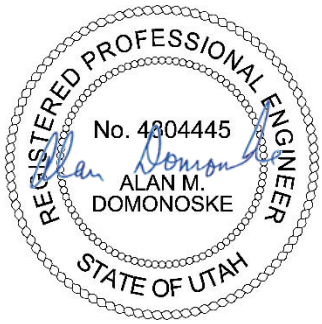
FINAL | December 2022

carollo

Jordan Valley Water Conservancy District
Jordan Valley Water Treatment Plant

INCREASED FILTRATION RATE PILOT TESTING REPORT

FINAL | December 2022



Contents

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Abbreviations

Carollo	Carollo Engineers, Inc.
DDW	Division of Drinking Water
floc	flocculant
floc/sed	flocculation/sedimentation
ft	feet
gal/sf	gallons per square foot
gpm/sf	gallons per minute per square foot
hrs	hours
in	inches
JVWCD	Jordan Valley Water Conservancy District
JVWTP	Jordan Valley Water Treatment Plant
L/d	media depth and bed depth or length over media size or diameter
mg/l	milligrams per liter
mgd	million gallons per day
mm	millimeter
NTU	nephelometric turbidity unit
PACl	polyaluminium chloride
PEC	cationic polymer
PLC	programmable logic controller
SCADA	supervisory control and data acquisition
sf	square foot
UFRV	unit filter run volume

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Section 1

INTRODUCTION

The purpose of this report is to present the results for filter loading rate pilot testing above 6 gallons per minute per square foot (gpm/sf) at the Jordan Valley Water Treatment Plant (JVWTP). The goal of the pilot testing was to obtain sufficient data to support filter rerating approval from the Utah Division of Drinking Water (DDW) for a filtration rate of at least 8.8 gpm/sf. This filtration rate would allow the JVWTP capacity to be expanded from 180 million gallons per day (mgd) capacity through the plant to a future 255 mgd production capacity without constructing additional filters.

1.1 Background

The Jordan Valley Water Conservancy District (JVWCD) is working to increase capacity of the JVWTP from 180 to 255 mgd by 2025 to address growth within the service area. JVWCD has performed various preliminary studies of the pretreatment and filtration systems to explore alternatives to achieve the desired capacity. In 2016, Carollo Engineers, Inc. (Carollo) completed a capacity and site optimization study. The study evaluated various means of achieving the desired 75 mgd increase in plant capacity and included a preliminary investigation into the feasibility of increasing the filtration rate.

Concurrent with the recent piloting effort, Carollo evaluated the existing filter depths and hydraulics to confirm the feasibility of rerating the existing filters. The evaluation found that the filter launders could be raised to accommodate a deeper more robust filter media which would allow the plant to achieve the targeted expansion. With pilot test results to support a deeper, more-robust media design, DDW could approve upgrades to the filters to achieve the 255 mgd target.

The existing filters utilize filter inlet weirs and level control to regulate flow through the filters. Each filter contains two cells, each with an area of 704 square feet (sf), for a total filter area of 1,408 sf per filter. During normal filtration and backwash, both cells operate as a single filter. The filters are equipped with filter-to-waste facilities.

Filters 1 through 6 were constructed with the original JVWTP construction in 1971. Filters 7 through 16 were constructed with the expansion to 180 mgd in 1985. The filter area, media depth, and basic operation of both filter groups are identical though the configuration does have some unique differences.

This report presents the filter testing that was completed to support approval for a filtration rate of at least 8.8 gpm/sf to deliver 255 mgd with one filter out of service for backwashes and a 5 percent internal recycle. Since this filtration rate exceeds the pre-approved maximum rate (6.0 gpm/sf) set forth by the DDW in R309-525-15 for dual media, rapid gravity filters, pilot testing was required to demonstrate that water treatment goals can still be met. The 8.8 and 10.0 gpm/sf filtration rates demonstrated within this report, are similar to other high-rate filter facilities approved within Utah and around the country.

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Section 2

PILOT MATERIALS AND METHODS

2.1 Piloting Overview

The current 180 mgd plant capacity for this facility has historically been defined by gross flow through the plant processes, which includes an approximate 5 percent internal recycle of clarified residual stream that reduces treated water deliveries to the distribution system to approximately 171 mgd. If JVWCD decides to expand the plant to deliver 255 mgd treated water to the distribution system, the plant processes will have to operate at 268 mgd with the assumed 5 percent internal recycle. Therefore, for this pilot study, filtration rates of 8.8 gpm/sf were tested to correspond to 268 mgd filtration capacity with one filter out of service. In addition, pilot-scale testing was conducted at filtration rates as high as 10.0 gpm/sf to demonstrate the performance of the proposed media design.

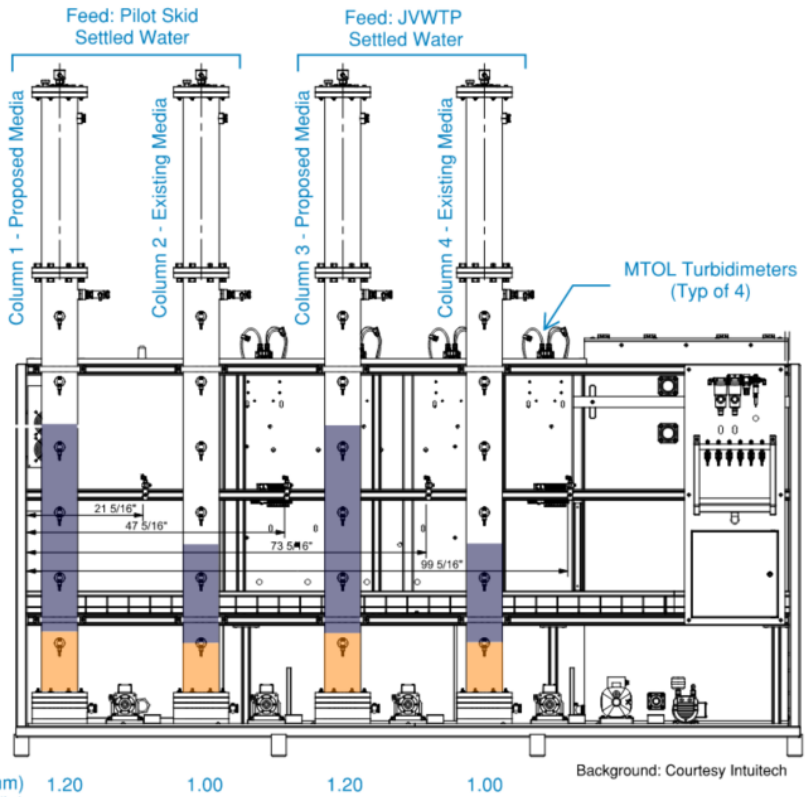
The pilot unit consisted of a pretreatment skid (flocculation/sedimentation [floc/sed]) and filtration skid (four pilot filter columns as shown in Figure 1). The pretreatment skid utilized JVWTP's raw water that had been pre-oxidized with chlorine dioxide. The pretreatment floc/sed skid could be operated with various chemical dosages and pretreatment settings without affecting the full-scale pretreatment or filters. The filtration skid utilized both settled water from the pretreatment skid and the JVWTP's settled water downstream of filter aid addition. This allowed different pretreatment strategies to be directly compared to the full-scale plant pretreatment. All water from the pilot skid was discharged to the plant drain.

Figure 1 Pilot Skid for Filtration Rate Testing at JVWTP

Two media configurations were utilized in the four pilot filter columns, as shown in Figure 2. Two pilot columns were loaded with existing media pulled from the plant filters. They consisted of 20 inches (in) of 1.0 millimeters (mm) anthracite over 10 in of 0.5 mm sand. This provided a total media depth of 30 in and bed depth (length) over media size (diameter) (L/d) ratio of 1,020. The L/d ratio - a unitless design parameter that can be correlated to filter performance - is equal to the depth of the media in mm divided by the effective diameter of the media grains in mm. Historically filter media designs were based upon an L/d of 1,000 to produce acceptable filter water quality. However, with increased filtration rate and low filtered water quality goals, new high-rate filters are now designed with an L/d between 1,200 and 1,600. The existing media does not meet the L/d target that modern filter designers prefer.

The other two pilot columns were loaded with 42 in of 1.2 mm anthracite over 12 in of 0.6 mm sand. This provided a total media depth of 54 in and L/d ratio of 1,380. The higher L/d ratio is desirable as the filter will have improved filtration robustness with respect to water quality, which is especially important at higher filtration rates. This filter media represents the proposed

media and was expected to have robust turbidity removal performance, good solids storage capacity, and reduced headloss during full-scale operation. With four pilot columns and two media designs, each media type was paired with the pilot pretreatment skid (Filter 1 and 2) or plant settled water (Filter 3 and 4) for comparison testing.



Anthracite Size (mm)	1.20	1.00	1.20	1.00
Anthracite Depth (in)	42	20	42	20
Sand Size (mm)	0.62	0.50	0.62	0.50
Sand Depth (in)	12	10	12	10
Total Depth (in)	54	30	54	30
L/d	1,380	1,020	1,380	1,020

Figure 2 Pilot Skid Configuration for Filtration Rate Testing at JVWTP

Pilot testing was conducted from October 2021 to August 2022 using a pilot skid manufactured by Intuitech in Salt Lake City, Utah. Initial startup began October 2021 and ran until November 2021. The full-scale plant was shut down for maintenance and repairs between November 2021 and January 2022. The pilot plant was also shut down during this period (raw and settled water could not be provided to the pilot plant) and was not restarted until February 2022. From February until mid-April 2022 several challenges were experienced during piloting. Chlorine dioxide feed system was not operational for the raw water until end of March 2022, which led to excess growth and filter clogging in the pretreatment skid and pilot filters. In addition, several feed pumps on the pilot skid failed, so no reliable data could be collected from March through mid-April 2022. Once issues were resolved, testing resumed May 2022 and continued through August 2022 to capture the worst-case conditions under which the filters would be operated at their highest rates full scale. The purpose of the testing was to

demonstrate the recommended media design meets the filter effluent quality goal for turbidity of 0.1 nephelometric turbidity unit (NTU) or less and an operational goal of unit filter run volumes (UFRV) of 7,500 gallons per square foot (gal/sf) or more. The UFRV is the volume of water produced by a square foot of media during a filter run and represents overall filter efficiency. At an UFRV of 7,500 gal/sf and typical backwash water usage, the efficiency of the filter is greater than 95 percent.

2.2 Materials and Methods

As previously described, two filter columns were supplied with settled water from the plant (Filters 3 and 4) and two columns were supplied with settled water from the pilot pretreatment skid (Filters 1 and 2). This allowed the effect of different pretreatment chemical strategies to be tested.

2.2.1 Pilot Testing

Each filter column on the pilot skid was approximately 10 feet (ft) tall and was equipped with a dedicated feed pump, flowmeter, pressure transducer for monitoring headloss, and effluent turbidity meter. Each column also included valves for control of influent, effluent, air scour, and backwash waste. The feed pumps were set to maintain a constant flow rate by means of logic between the effluent flowmeter and variable speed-controlled drives.

During pilot testing, the normal filter run was assumed to begin once the effluent turbidity dropped below 0.1 NTU following a backwash and was assumed to end once the effluent turbidity exceeded 0.1 NTU. However, each pilot filter run was continued until filter effluent turbidity exceeded 0.2 NTU (unless triggered by headloss) to identify potential filter run lengths that could be extended in full-scale operations by an attentive operator using small changes to pretreatment chemistry. Pilot testing has the inherent challenge in that a full-time operator is not constantly present to tune the chemistry for optimum filter performance operation.

The pressure transducer on each filter was used to measure the cleanbed headloss and to track the increase of headloss over a filter run as solids accumulated. The pilot filter run lengths were dictated by turbidity as described above, or total pilot column headloss exceeding 8 ft. During initial startup, headloss was set to 9 ft to match the current headloss available in the plant at the future 255 mgd but was lowered to 8 ft to prevent overpressure alarms during backwashing.

The pilot columns automatically backwashed at the termination of a filter run by the pilot control system. Backwash included air scour and reverse flushing. The backwash procedure consisted of air scour, combined air scour and low-rate wash, and a final high-rate wash to flush dislodged solids from the bed. There was a backwash tank on the pilot skid that stored filter effluent for backwash supply, and there was a pump on the skid that was used for backwashing. Backwashing could only be done for one filter column at a time.

2.2.1.1 Water Quality Collection

Water quality data for the plant settled water was measured and recorded by existing plant control system. Settled water turbidity from the pilot pretreatment skid was recorded by the pilot control system. Turbidity for each pilot column was also recorded by the pilot control system. Pilot and plant supervisory control and data acquisition (SCADA) recorded filter performance.

The pilot was operated by plant operations staff and data analysis was performed by Carollo. Data collected during the pilot testing was as follows:

- Settled water quality and upstream pretreatment conditions, configurations, and chemical dosages (recorded on SCADA).
- Filter column flow rates (recorded on SCADA).
- Filter column headloss (recorded on SCADA).
- Filter column effluent turbidity (recorded on SCADA).
- Filter column run time (recorded on SCADA).

2.2.1.2 Experimental Design

Filtration rates from 8.8 gpm/sf to 10 gpm/sf were tested during the piloting and compared to the existing media. Filter rate testing followed Table 1. The pilot testing protocol is included in Appendix A.

Table 1 Filter Rate Testing Protocol

Testing No.	Existing Media Loading Rate (gpm/sf)	Proposed Media Loading Rate (gpm/sf)
1	6.0	8.8
2	6.0	10.0
3	8.8	8.8

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Section 3

PILOTING RESULTS

The results from pilot testing are described in the following sections. Each test, as outlined in Table 1, and each filter was separated for comparisons. In addition, the benefit of floc aid and filter aid were evaluated and discussed.

3.1 Test No. 1 - Existing Media at 6 gpm/sf and Proposed Media at 8.8 gpm/sf

From June 8, 2022, through June 28, 2022, the filters with existing media were tested at 6 gpm/sf while the filters with proposed media were tested at 8.8 gpm/sf. This was done to evaluate how the proposed media would perform at the rate expected for 255 mgd plant flow in comparison to existing conditions (i.e., media and rate).

A comparison between the two media types is discussed in the following subsections for the filters being fed from the pilot pretreatment skid and the full-scale settled water.

3.1.1 Pilot Pretreatment Skid Settled Water Performance

Between June 15, 2022, and June 17, 2022, the pilot pretreatment skid was fed with a flocculant (floc) aid dose of 0.15 milligrams per liter (mg/L), a cationic polymer (PEC) dose of 1.2 mg/L, and a polyaluminium chloride (PACl) dose of 8 mg/L. These doses were consistent with those at the full-scale, except that the full-scale plant does not feed floc aid. A discussion on the benefit of floc aid is presented later in Section 3.4 - Chemical Dose Comparison. The influent turbidity (raw water, post chlorine dioxide addition) and settled water turbidity are shown in Figure 3. This water fed Filter 1 (proposed media) and Filter 2 (existing media). The data covers the same period for the pilot filter runs presented in this section.

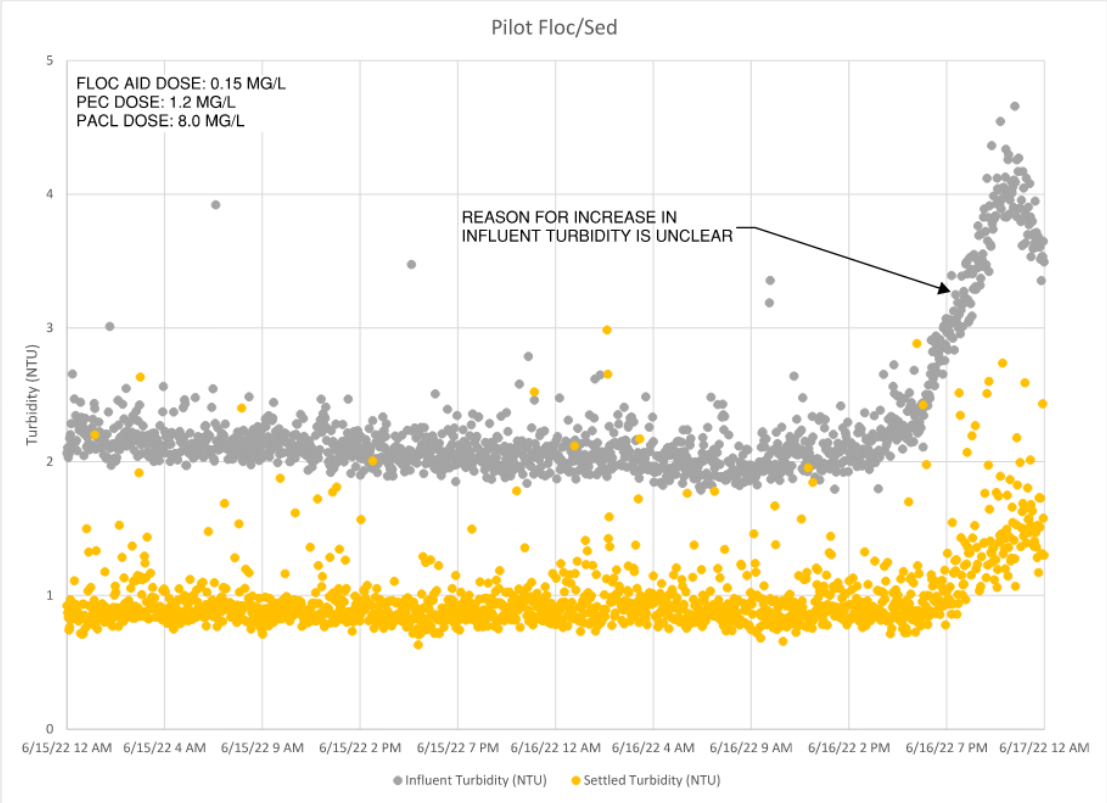

Figure 3 Test No. 1 - Pilot Floc/Sed Turbidity

As shown in Figure 3 settled water turbidity stayed at or below 1 NTU for most of the testing period. The reason for the increase of influent turbidity on approximately June 17th is unknown but was consistent with the full-scale data (see Figure 6.).

The performance of Filter 1 (proposed media) and Filter 2 (existing media) during this period is shown in Figure 4, Figure 5, and Table 2. Three consistent filter runs are presented between approximately June 15, 2022, and June 17, 2022. Filter aid was not added during this period. A discussion on the benefit of filter aid is presented later in Section 3.4 - Chemical Dose Comparison. The filter graphs show 5 different parameters: UFRV (divided by 1,000 so it could be shown on the same plot), filtration rate, headloss, and turbidity (shown on a secondary axis). UFRVs were calculated manually by estimating where turbidity was consistently above 0.1 NTU, unless triggered by headloss.

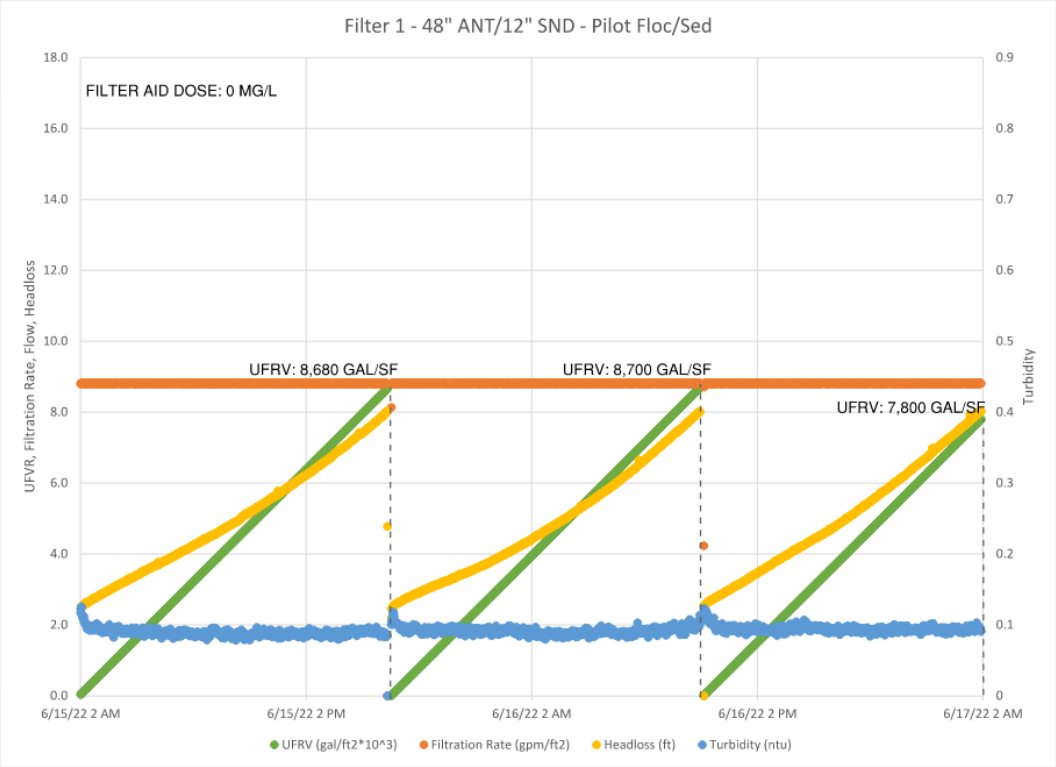

Figure 4 Test No. 1 - Filter 1 Performance (Proposed Deep Media at 8.8 gpm/sf)

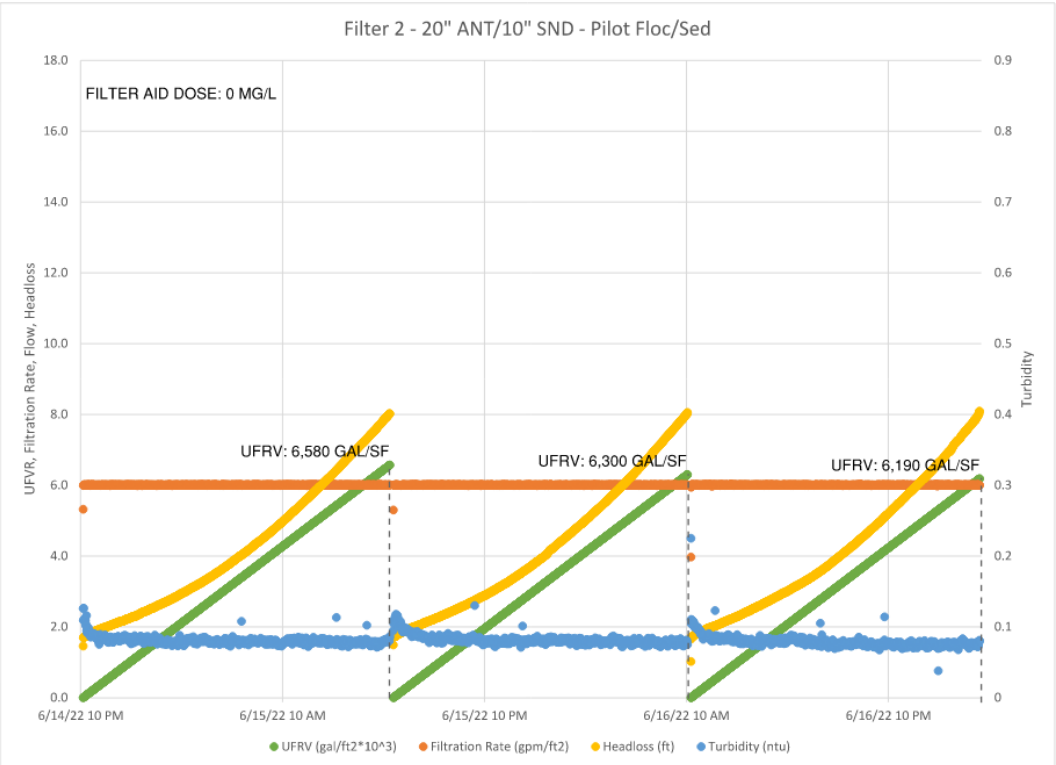

Figure 5 Test No. 1 - Filter 2 Performance (Existing Media at 6.0 gpm/sf)

Table 2 Test No. 1 - Filter Performance Summary Using Pilot Pretreatment

Parameter	Filter 1 (Run 1)	Filter 1 (Run 2)	Filter 1 (Run 3)	Filter 2 (Run 1)	Filter 2 (Run 2)	Filter 2 (Run 3)	**Filter 1 Average**	**Filter 2 Average**	**Perc. Diff.**
Filters									
Media Design	Proposed, Deep Bed			Existing			**Comparison**		
Filtration Rate (gpm/sf)	8.8	8.8	8.8	6.0	6.0	6.0	**8.8**	**6.0**	**32%**
Run Time (hrs)	16.4	16.4	14.8	18.2	17.5	17.2	**15.9**	**17.6**	**-11%**
UFRV (gal/sf)	8,674	8,690	7,803	6,575	6,304	6,187	**8,389**	**6,355**	**24%**
Cleanbed Headloss (ft)	2.5	2.5	2.5	1.7	1.7	1.7	**2.5**	**1.7**	**32%**
Final Headloss (ft)	8.0	8.0	8.0	8.0	8.1	8.1	**8.0**	**8.1**	**-0.4%**
Final Turbidity (NTU)	0.08	0.10	0.09	0.09	0.08	0.08	**0.09**	**0.08**	**12%**
Avg. Turbidity (NTU)	0.09	0.09	0.09	0.08	0.08	0.08	**0.09**	**0.08**	**14%**
Filter Aid Dose (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**	**0.0%**
Pretreatment									
Settled Water Turbidity (NTU)	1.0	1.0	1.5	1.0	1.0	1.5	**1.1**	**1.1**	**0.0%**
Floc Aid Dose (mg/L)	0.15	0.15	0.15	0.15	0.15	0.15	**0.15**	**0.15**	**0.0%**
PEC Dose (mg/L)	1.2	1.2	1.2	1.2	1.2	1.2	**1.2**	**1.2**	**0.0%**
PACl Dose (mg/L)	8.0	8.0	8.0	8.0	8.0	8.0	**8.0**	**8.0**	**0.0%**

Notes:
(1) Abbreviations: hrs = hours.

As shown in Figure 4 and Figure 5 and Table 2, Filter 1 (proposed media) outperformed Filter 2 (existing media) by approximately 24 percent in terms of UVRVs. UFRVs for Filter 1 were above 7,500 gal/sf, which represents an efficient filter. Although Filter 2 did not have UFRVs above 7,500 gal/sf, it still had UFRVs above 5,000 gal/sf. UFRVs below 5,000 gal/sf would represent an inefficient filter.

For all filter runs, backwashes were triggered by headloss. Cleanbed headloss (headloss at the start of a filter run) was higher for Filter 1 (2.5 ft) compared to Filter 2 (1.7 ft). This was expected since Filter 1 was running at a much higher filtration rate and has deeper media. Average turbidity throughout all filter runs was approximately equivalent between the two medias (approximately 0.09 NTU for Filter 1 and 0.08 for Filter 2). The elevated turbidity indicates the pilot floc/sed skid pretreatment chemicals were not optimized for the pilot filters. In full-scale operation the operations staff could better optimize pretreatment to achieve improved turbidity levels. However, turbidity never exceeded 0.1 NTU throughout the duration of the pilot filter runs. Note, it is common for full-scale filters to outperform pilot test results because continuous effort is dedicated to monitoring and optimizing pretreatment full-scale, which is not practical at pilot scale.

For this test condition, the proposed filter media produced equivalent water quality as the existing media, while operating at a much higher filtration rate and improved efficiency (higher UFRV).

3.1.2 Full-Scale Settled Water Performance

Between June 13, 2022, and June 17, 2022, the full-scale floc/sed was fed with a floc aid dose of 0 mg/L, a PEC dose of 1.2 mg/L, and a PACl dose of 6.3 mg/L. These doses were similar to those at the pilot pretreatment skid, except floc aid was not dosed. The influent turbidity (raw water, post chlorine dioxide addition) and settled water turbidity are shown in Figure 6. This water fed Filter 3 (proposed media) and Filter 4 (existing media). The data covers the same period for the two pilot filters runs presented in this section.

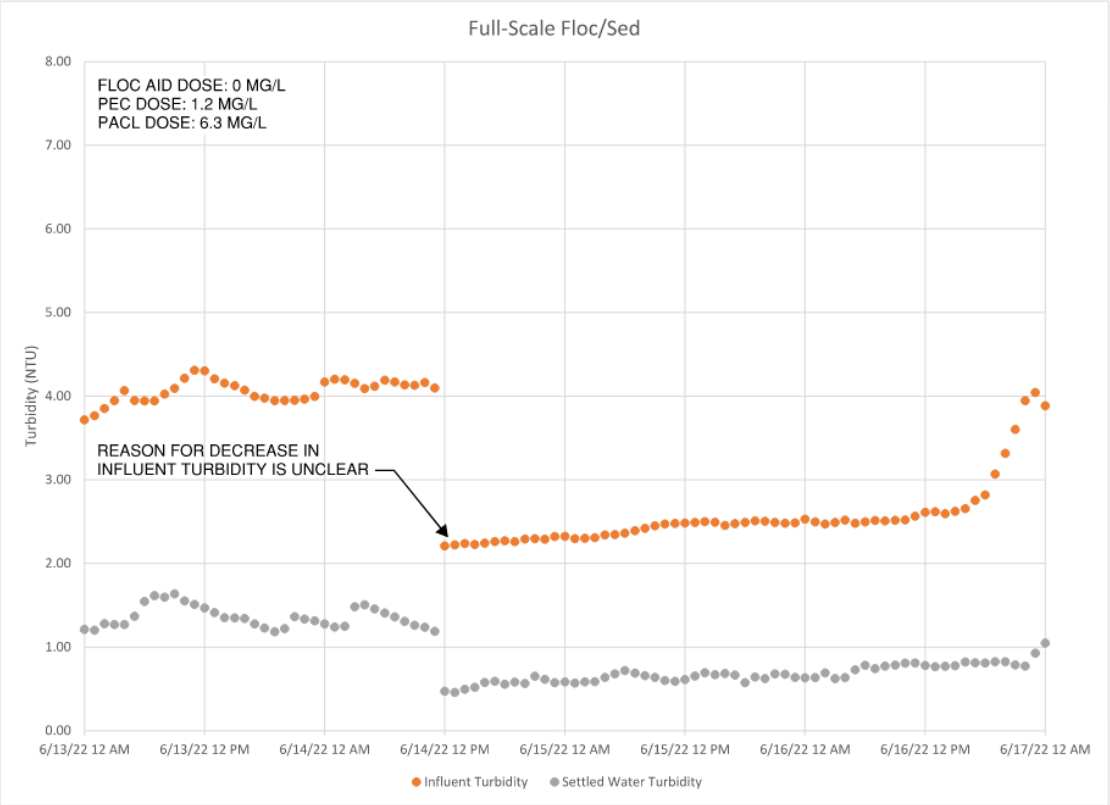

Figure 6 Test No. 1 - Full-Scale Floc/Sed Turbidity

As shown in Figure 6, full-scale settled water turbidity hovered between 1.1 and 1.8 NTU until June 14th, where it then dropped below 1 NTU. The reason for the drop in influent turbidity at that time is unclear. Note, that near the end of June 16th there was an increase in influent turbidity, which was consistent with the pilot pretreatment skid data previously presented.

The performance of Filter 3 and Filter 4 during this period is shown in Figure 7, Figure 8, and Table 3. Two consistent filter runs are presented between approximately June 13, 2022, and June 17, 2022. A filter aid dose of 0.03 mg/L, which was added at the full-scale plant, was dosed during this period. The pilot had the ability to add additional filter aid, but no more was added during this testing period.

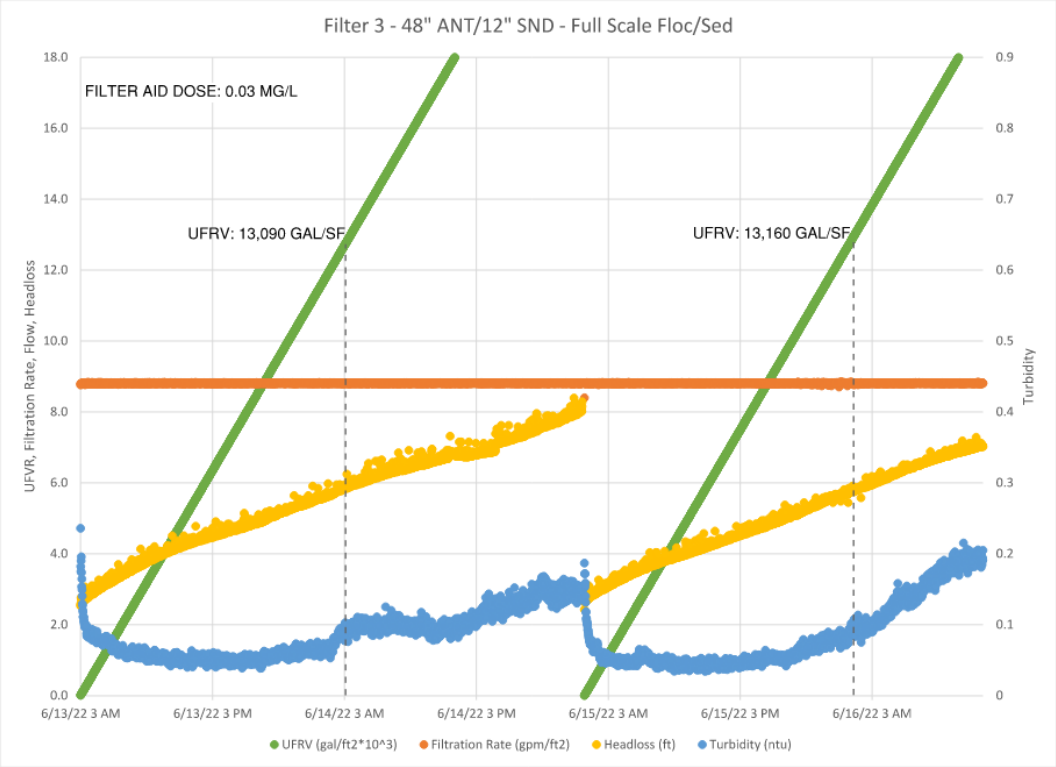

Figure 7 Test No. 1 - Filter 3 Performance (Proposed Deep Media at 8.8 gpm/sf)

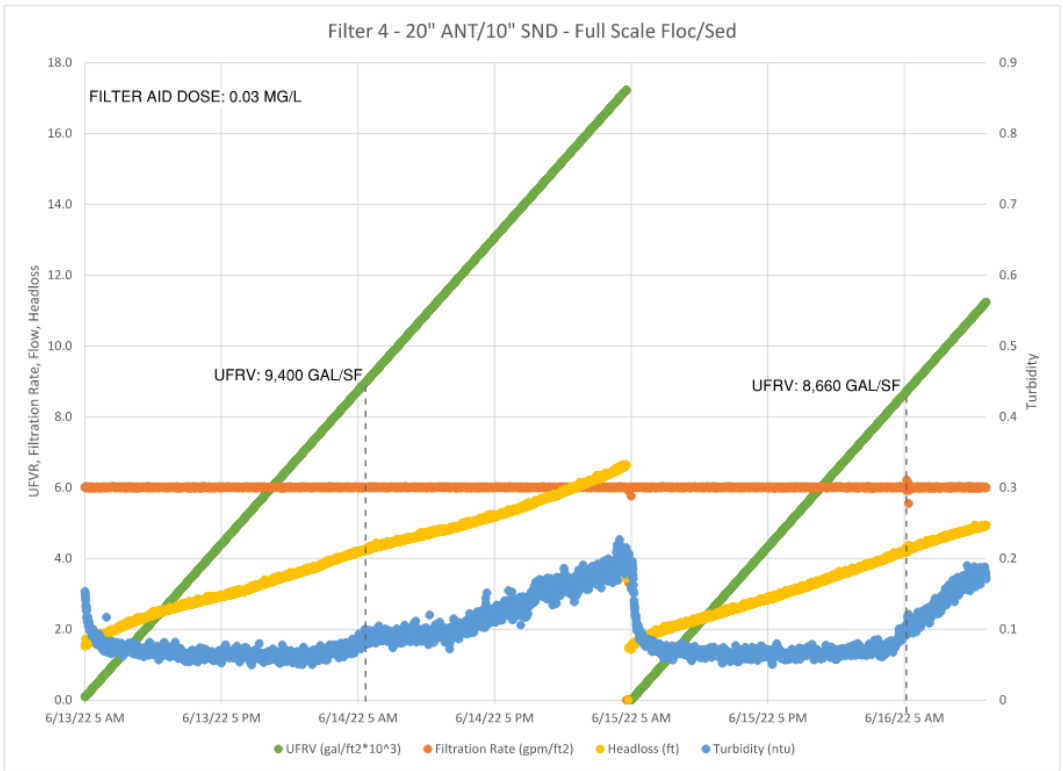

Figure 8 Test No. 1 - Filter 4 Performance (Existing Media at 6.0 gpm/sf)

Table 3 Test No. 1 - Filter Performance Summary Using Full-Scale Pretreatment

Parameter	Filter 3 (Run 1)	Filter 3 (Run 2)	Filter 4 (Run 1)	Filter 4 (Run 2)	**Filter 3 Average**	**Filter 4 Average**	**Perc. Diff.**
Filters							
Media Design	Proposed, Deep Bed		Existing		**Comparison**		
Filtration Rate (gpm/sf)	8.8	8.8	6.0	6.0	**8.8**	**6.0**	**32%**
Run Time (hrs)	24.8	24.9	26.1	24.0	**24.8**	**25.0**	**-0.9%**
UFRV (gal/sf)	13,085	13,158	9,396	8,655	**13,122**	**9,026**	**31%**
Cleanbed Headloss (ft)	2.5	2.6	1.5	1.5	**2.6**	**1.5**	**43%**
Final Headloss (ft)	5.9	5.8	4.3	4.2	**5.9**	**4.3**	**28%**
Final Turbidity (NTU)	0.10	0.10	0.10	0.10	**0.10**	**0.10**	**-0.9%**
Avg. Turbidity (NTU)	0.06	0.06	0.07	0.07	**0.06**	**0.07**	**-19%**
Filter Aid Dose(1) (mg/L)	0.03	0.03	0.03	0.03	**0.0**	**0.0**	**0.0%**
Pretreatment							
Settled Water Turbidity (NTU)	1.4	0.6	1.4	0.7	**1.0**	**1.0**	**-0.9%**
Floc Aid Dose (mg/L)	0.0	0.0	0.0	0.0	**0.0**	**0.0**	**0.0%**
PEC Dose (mg/L)	1.3	1.2	1.3	1.2	**1.2**	**1.2**	**0.4%**
PACl Dose (mg/L)	6.3	6.3	6.3	6.3	**6.3**	**6.3**	**0.0%**

Notes:
(1) Filter aid dose was fed at full scale and then diverted to the pilot units.

As shown in Figure 7, Figure 8 and Table 3, Filter 3 (proposed media) outperformed Filter 4 (existing media) by approximately 31 percent in terms of UVRVs. UFRVs for Filters 3 and 4 far exceeded the 7,500 gal/sf goal with the proposed media reaching UFRVs of over 13,000.

Similar to Filters 1 and 2, cleanbed headloss was higher for Filter 3 (2.5 ft) compared to Filter 4 (1.5 ft), due to the higher filtration rate and deeper media design. Average filter water turbidity for both filters was approximately equivalent and remained between 0.06 and 0.07 NTU. Final headloss of Filter 3 was also higher (5.8 ft) compared to Filter 4 (4.2 ft), which was also expected for the same reason for the higher cleanbed headloss and due to the extended UFRV.

For this test condition, the proposed filter media produced equivalent water quality as the existing media, while operating at a much higher filtration rate and improved efficiency (higher UFRV).

Compared to Filter 1 and 2, the full-scale pretreated water resulted in longer filter runs. This is not uncommon in pilot testing since operation staff are dedicated to the performance of the full-scale plant. Whereas pilot plant pretreatment does not receive the same operator attention to optimizing the pretreatment chemicals for optimal filtration.

3.2 Test No. 2 - Existing Media at 6 gpm/sf and Proposed Media at 10 gpm/sf

From June 28, 2022 through July 27, 2022 the filters with existing media were tested at 6 gpm/sf while the filters with proposed media were tested at 10 gpm/sf.

This high-rate testing was performed to demonstrate 8.8 gpm/sf is not the maximum filtration rate possible with the proposed media. Carollo and others have designed and permitted numerous facilities with filtration rates of 10 gpm/sf or even higher. Obtaining DDW approval to operate the filters up to 10 gpm/sf (when rerating the plant to 255 mgd) provides flexibility on the number of filters that can be taken offline for concurrent maintenance, etc.

A comparison between the pilot performance of the proposed and existing media design is discussed in the following subsections for the filters being fed from the pilot pretreatment skid and the full-scale settled water.

3.2.1 Pilot Pretreatment Skid Settled Water Performance

Between July 8, 2022 and July 12, 2022 the pilot pretreatment skid was fed with a floc aid dose of 0.15 mg/L, a PEC dose of 1.2 mg/L, and a PACl dose of 8 mg/L. These doses were consistent with those at the full-scale, except floc aid was not used full-scale. The influent turbidity and settled water turbidity are shown in Figure 9. This water fed Filter 1 (proposed media) and Filter 2 (existing media). The data covers the same period for the three pilot filter runs presented in this section.

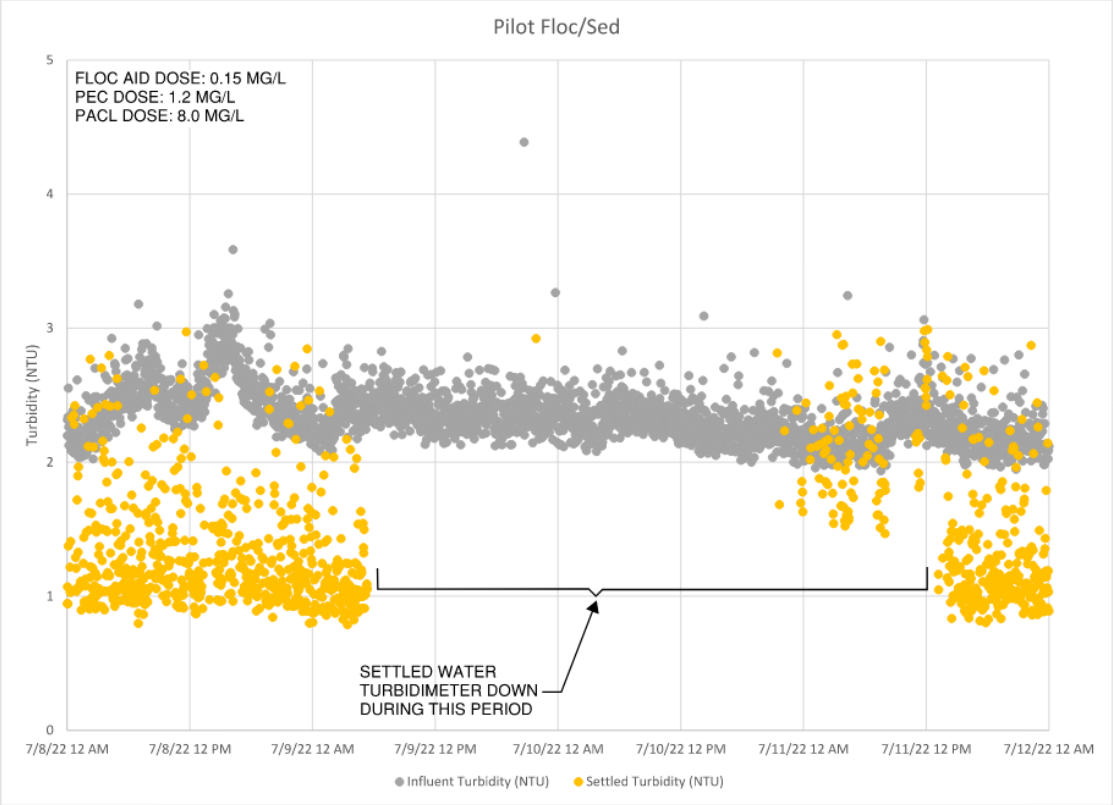

Figure 9 Test No. 2 - Pilot Floc/Sed Turbidity

As shown in Figure 9, settled water turbidity stayed at or below 1 NTU until about July 9th. From that point until July 11th, the turbidimeter was unresponsive. Note, there was a lot of noise in the turbidimeter readings during this testing period. Once the turbidimeter tubing was cleaned (data not shown) the noise was significantly reduced to the lower values shown in the plots. However, despite the noise, overall trends can still be observed in the data.

The performance of Filter 1 (proposed media) and Filter 2 (existing media) during this period is shown in Figure 10, Figure 11, and Table 4. Three consistent filter runs are presented between approximately July 9, 2022, and July 11, 2022. Filter aid dose of 0.02 mg/L was added during this period to Filter 1 and 2.

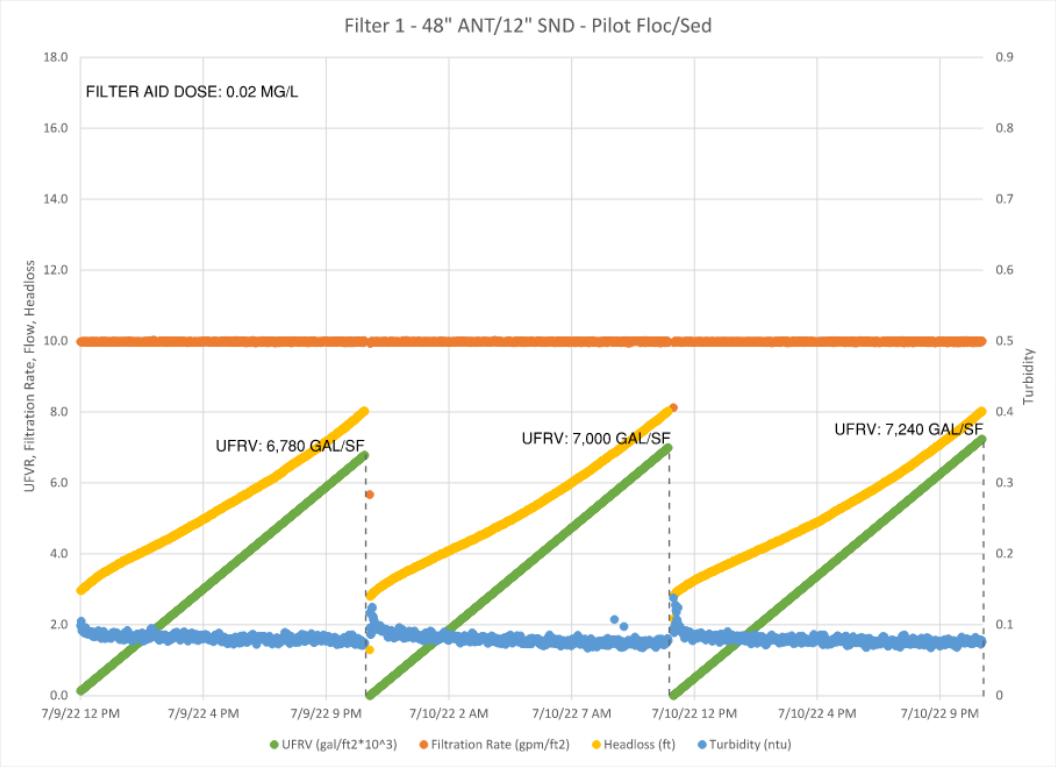

Figure 10 Test No. 2 - Filter 1 Performance (Proposed Deep Media at 10 gpm/sf)

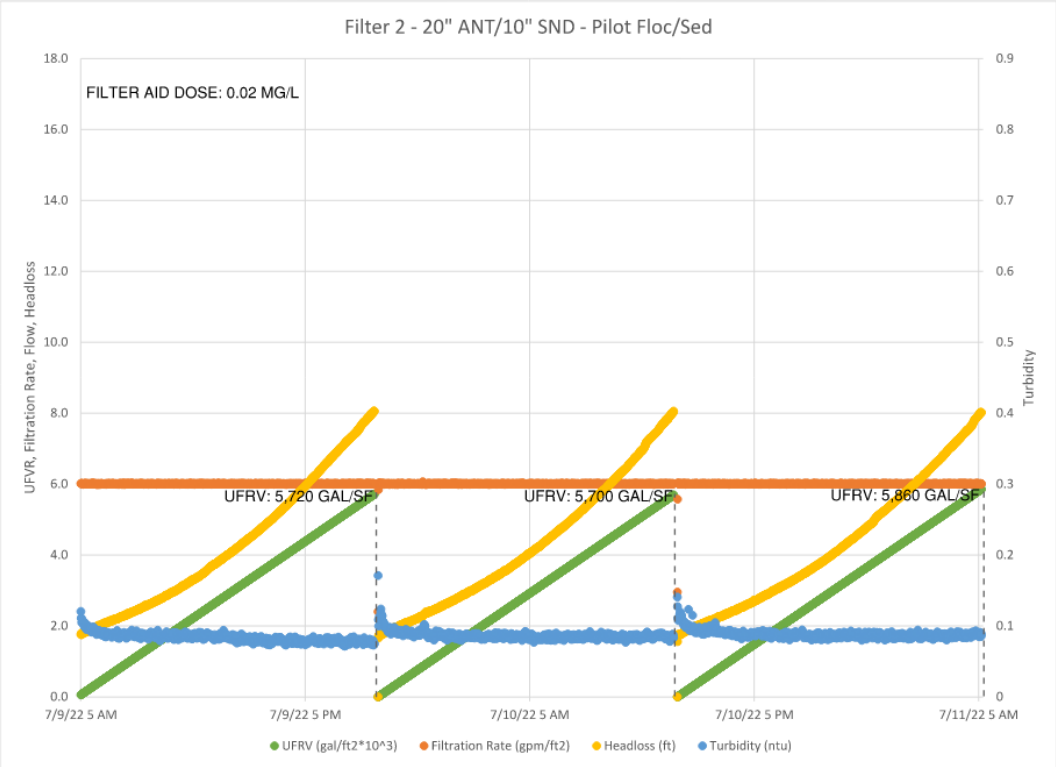

Figure 11 Test No. 2 - Filter 2 Performance (Existing Media at 6 gpm/sf)

Table 4 Test No. 2 - Filter Performance Summary Using Pilot Pretreatment

Parameter	Filter 1 (Run 1)	Filter 1 (Run 2)	Filter 1 (Run 3)	Filter 2 (Run 1)	Filter 2 (Run 2)	Filter 2 (Run 3)	**Filter 1 Average**	**Filter 2 Average**	**Perc. Diff.**
Filters									
Media Design	Proposed, Deep Bed			Existing			**Comparison**		
Filtration Rate (gpm/sf)	10.0	10.0	10.0	6.0	6.0	6.0	**10.0**	**6.0**	**40%**
Run Time (hrs)	11.3	11.7	12.1	15.9	15.8	16.3	**11.7**	**16.0**	**-37%**
UFRV (gal/sf)	6,784	6,995	7,236	5,717	5,695	5,861	**7,005**	**5,758**	**18%**
Cleanbed Headloss (ft)	2.8	2.8	2.8	1.7	1.7	1.8	**2.8**	**1.7**	**40%**
Final Headloss (ft)	8.0	8.0	8.0	8.1	8.0	8.0	**8.0**	**8.0**	**-0.1%**
Final Turbidity (NTU)	0.07	0.08	0.08	0.08	0.09	0.09	**0.08**	**0.08**	**-8.2%**
Avg. Turbidity (NTU)	0.08	0.08	0.08	0.08	0.09	0.09	**0.08**	**0.09**	**-7.4%**
Filter Aid Dose (mg/L)	0.02	0.02	0.02	0.02	0.02	0.02	**0.02**	**0.02**	**0.0%**
Pretreatment									
Settled Water Turbidity[(1)] (NTU)	1.2[(1)]	1.2[(1)]	1.2[(1)]	1.2[(1)]	1.2[(1)]	1.2[(1)]	**1.2**	**1.2**	**0.0%**
Floc Aid Dose (mg/L)	0.15	0.15	0.15	0.15	0.15	0.15	**0.15**	**0.15**	**0.0%**
PEC Dose (mg/L)	1.3	1.3	1.3	1.3	1.3	1.3	**1.2**	**1.2**	**0.0%**
PACl Dose (mg/L)	8.0	8.0	8.0	8.0	8.0	8.0	**8.0**	**8.0**	**0.0%**

Notes:
(1) Represents average settled water turbidity data available between July 8, 2022, and July 12, 2022, since the turbidimeter was down during a large portion of testing.

As shown in Figure 10, Figure 11 and Table 4, Filter 1 (proposed media) outperformed Filter 2 (existing media) by approximately 18 percent in terms of UVRVs. UFRVs for Filter 1 were slightly below 7,500 gal/sf. Filter 2 had UFRVs slightly above 5,000 gal/sf, which was about 1,000 gal/sf lower than Test No. 1 at 6 gpm/sf. This difference is likely due to higher settled water turbidity that was fed during this period.

For all filter runs, backwashes were triggered by headloss. Cleanbed headloss was higher for Filter 1 (2.8 ft) compared to Filter 2 (1.7 ft), as expected, and previously discussed. Filter 1 cleanbed headloss was also higher than Test No. 1 (2.8 ft compared to 2.5 ft), because of the higher filtration rate. Average turbidity throughout all filter runs was comparable between the proposed media and existing media designs (between 0.08 and 0.09 NTU), which was consistent with Test No. 1. Turbidity never exceeded 0.1 NTU throughout the duration of these filter runs.

For this test condition, the proposed filter media produced equivalent water quality as the existing media, while operating at a substantially higher filtration rate (10 gpm/sf vs 6 gpm/sf). Even under these substantial loading rate differences, the proposed media design also yielded improved efficiency (higher UFRV) compared to the existing media.

3.2.2 Full-Scale Settled Water Performance

Between July 8, 2022 and July 12, 2022 the full-scale floc/sed was fed with a floc aid dose of 0 mg/L, a PEC dose of 1.2 mg/L, and a PACl dose of 7.0 mg/L. These doses were similar to those at the pilot pretreatment skid, except floc aid was not used full scale. The influent turbidity and settled water turbidity are shown in Figure 12. This water fed Filter 3 (proposed media) and Filter 4 (existing media). The data covers the same period for the three pilot filters runs presented in this section.

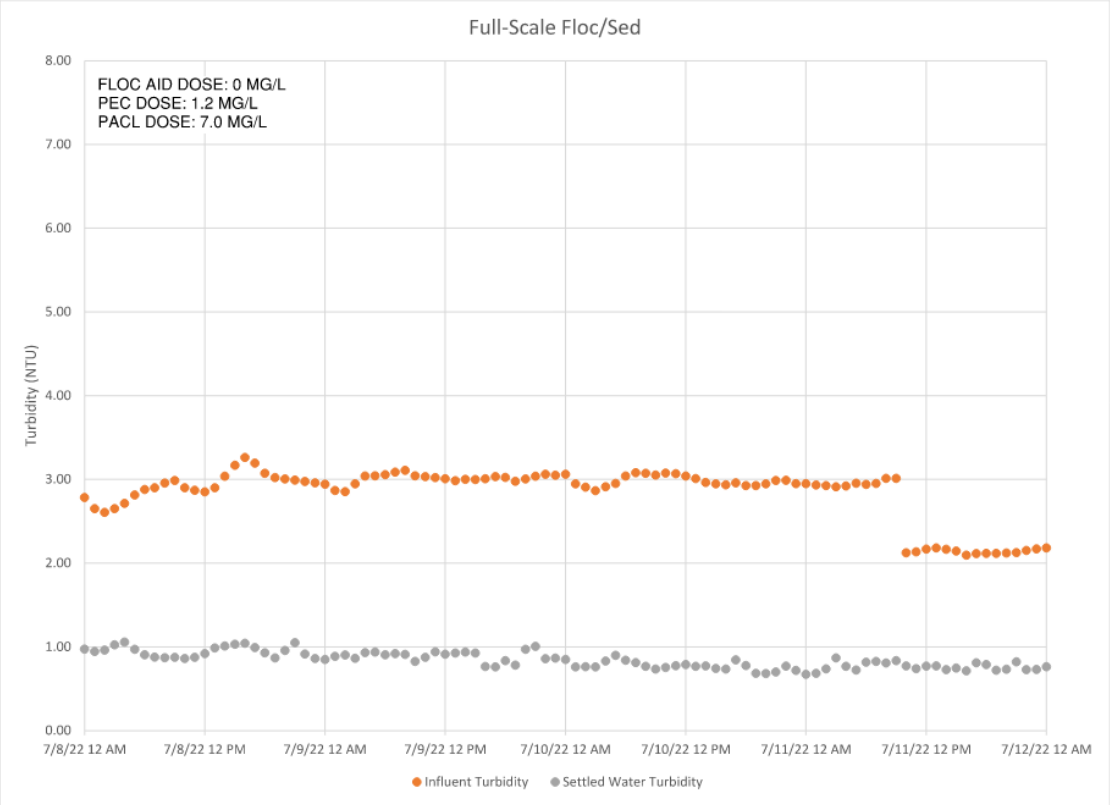

Figure 12 Test No. 2 - Full-Scale Floc/Sed Turbidity

As shown in Figure 12, settled water turbidity was around 1 NTU until July 10th, where it slowly dropped to approximately 0.8 NTU. The reason for the drop in influent turbidity on July 11th is unclear.

The performance of Filter 3 and Filter 4 during this period is shown in Figure 13, Figure 14, and Table 5. Three consistent filter runs are presented between approximately July 8, 2022, and July 12, 2022. A filter aid dose of 0.03 mg/L, which was added at the full-scale plant, was dosed during this period.

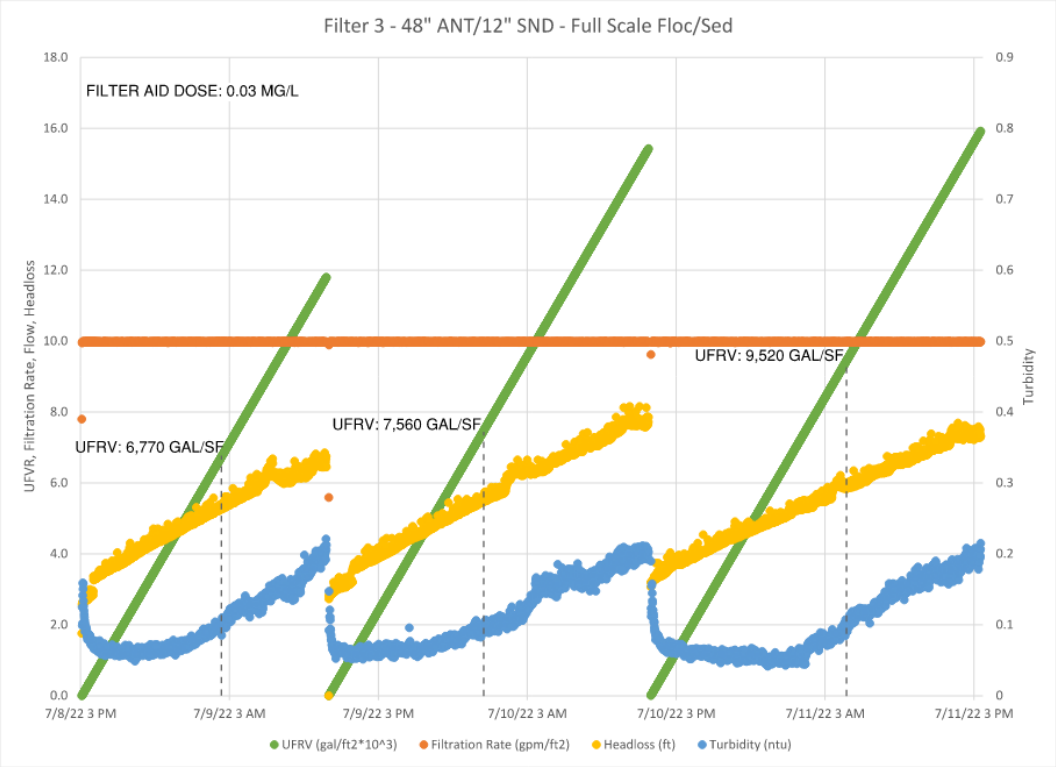

Figure 13 Test No. 2 - Filter 3 Performance (Proposed Deep Media at 10 gpm/sf)

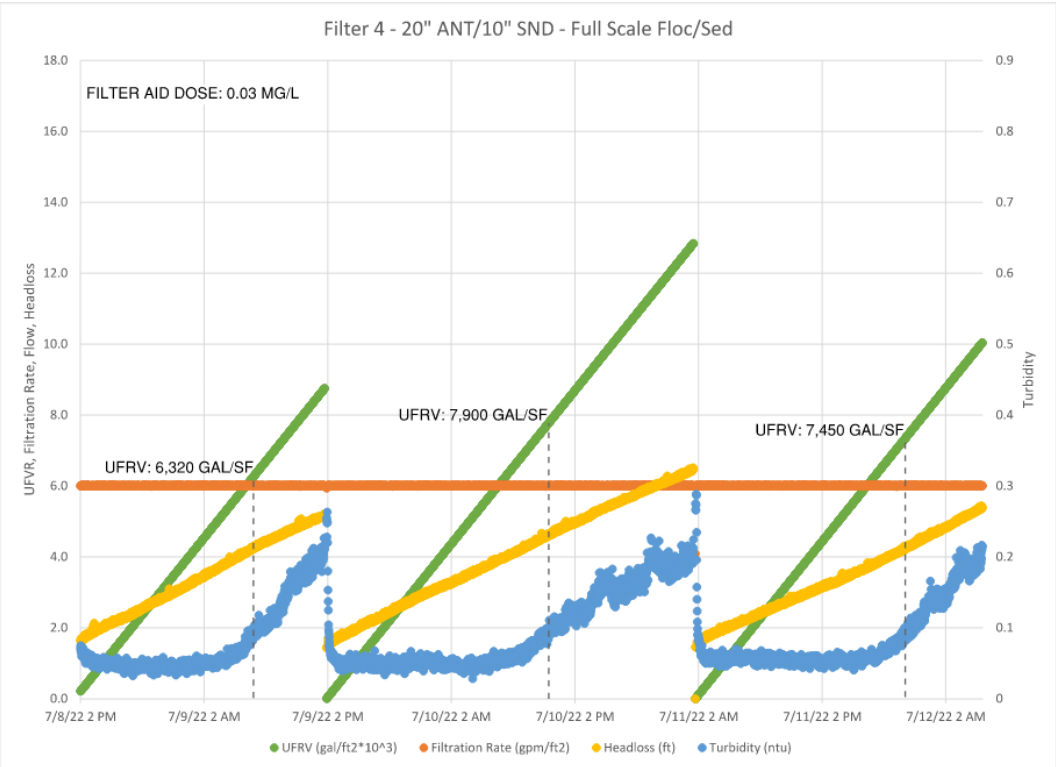

Figure 14 Test No. 2 - Filter 4 Performance (Existing Media at 6 gpm/sf)

Table 5 Test No. 2 - Filter Performance Summary Using Full-Scale Pretreatment

Parameter	Filter 3 (Run 1)	Filter 3 (Run 2)	Filter 3 (Run 3)	Filter 4 (Run 1)	Filter 4 (Run 2)	Filter 4 (Run 3)	**Filter 3 Average**	**Filter 4 Average**	**Perc. Diff.**
Filters									
Media Design	Proposed, Deep Bed			Existing			**Comparison**		
Filtration Rate (gpm/sf)	10.0	10.0	10.0	6.0	6.0	6.0	**10.0**	**6.0**	**40%**
Run Time (hrs)	11.3	12.6	15.9	17.5	21.9	20.7	**13.3**	**20.0**	**-51%**
UFRV (gal/sf)	6,771	7,557	9,515	6,317	7,896	7,450	**7,948**	**7,221**	**9.1%**
Cleanbed Headloss (ft)	2.6	2.7	3.2	1.5	1.5	1.5	**2.8**	**1.5**	**48%**
Final Headloss (ft)	5.3	5.5	5.9	4.3	4.7	4.3	**5.6**	**4.4**	**20%**
Final Turbidity (NTU)	0.11	0.10	0.10	0.10	0.10	0.11	**0.10**	**0.10**	**0.8%**
Avg. Turbidity (NTU)	0.07	0.07	0.06	0.05	0.06	0.06	**0.07**	**0.06**	**19%**
Filter Aid Dose[(1)] (mg/L)	0.03	0.03	0.03	0.03	0.03	0.03	**0.03**	**0.03**	**0.0%**
Pretreatment									
Settled Water Turbidity (NTU)	0.9	0.9	0.7	0.9	0.8	0.8	**0.9**	**0.8**	**0.8%**
Floc Aid Dose (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**	**0.0%**
PEC Dose (mg/L)	1.20	1.20	1.20	1.2	1.2	1.2	**1.2**	**1.2**	**0.0%**
PACl Dose (mg/L)	7.0	7.0	7.0	7.0	7.0	7.0	**7.0**	**7.0**	**0.0%**

Notes:
(1) Filter aid dose was fed at full scale and then diverted to the pilot units.

As shown in Figure 13, Figure 14 and Table 5, Filter 3 (proposed media) outperformed Filter 4 (existing media) by approximately 9 percent in terms of UVRVs. UFRVs for Filter 1 averaged slightly above 7,500 gal/sf. Filter 4 averaged UFRVs slightly below 7,500 gal/sf. This contrasts the test condition using pilot floc/sed feed water, which had shorter filter runs and smaller UFRVs. As previously explained, the reason for the longer filter runs for the pilot filters being fed with full-scale settled water is likely due to increased operator attention to fine tuning full-scale plant chemical dosages.

Similar to Filters 1 and 2, cleanbed headloss was higher for Filter 3 (2.8 ft) compared to Filter 4 (1.5 ft), as expected. Average turbidity between the proposed and existing media was equivalent and remained between 0.06 and 0.07 NTU. Final headloss of Filter 3 was also higher (5.6 ft) compared to Filter 4 (4.4 ft), as expected.

For this test condition, the proposed filter media produced equivalent water quality as the existing media, while operating at a substantially higher filtration rate (10 gpm/sf vs 6 gpm/sf). Even under these substantial loading rate differences, the proposed media design also yielded improved efficiency (higher UFRV) compared to the existing media.

3.3 Test No. 3 - Existing Media at 8.8 gpm/sf and Proposed Media at 8.8 gpm/sf

From July 27, 2022 until August 2, 2022 both filters (existing and proposed media) were tested at 8.8 gpm/. This was done to make a direct comparison of the two media designs at equal filtration rate.

A comparison between the two media types is discussed in the following subsections for the filters being fed from the pilot pretreatment skid and the full-scale settled water.

3.3.1 Pilot Pretreatment Skid Settled Water Performance

Between July 27, 2022, and August 1, 2022, the pilot pretreatment skid was fed with a floc aid dose of 0.15 mg/L, a PEC dose of 1.2 mg/L, and a PACl dose of 8 mg/L. These doses were consistent with those at the full-scale, except for floc aid was not used full scale. The influent turbidity and settled water turbidity are shown in Figure 15. This water fed Filter 1 (proposed media) and Filter 2 (existing media). The data covers the same period for the three pilot filters runs presented in this section.

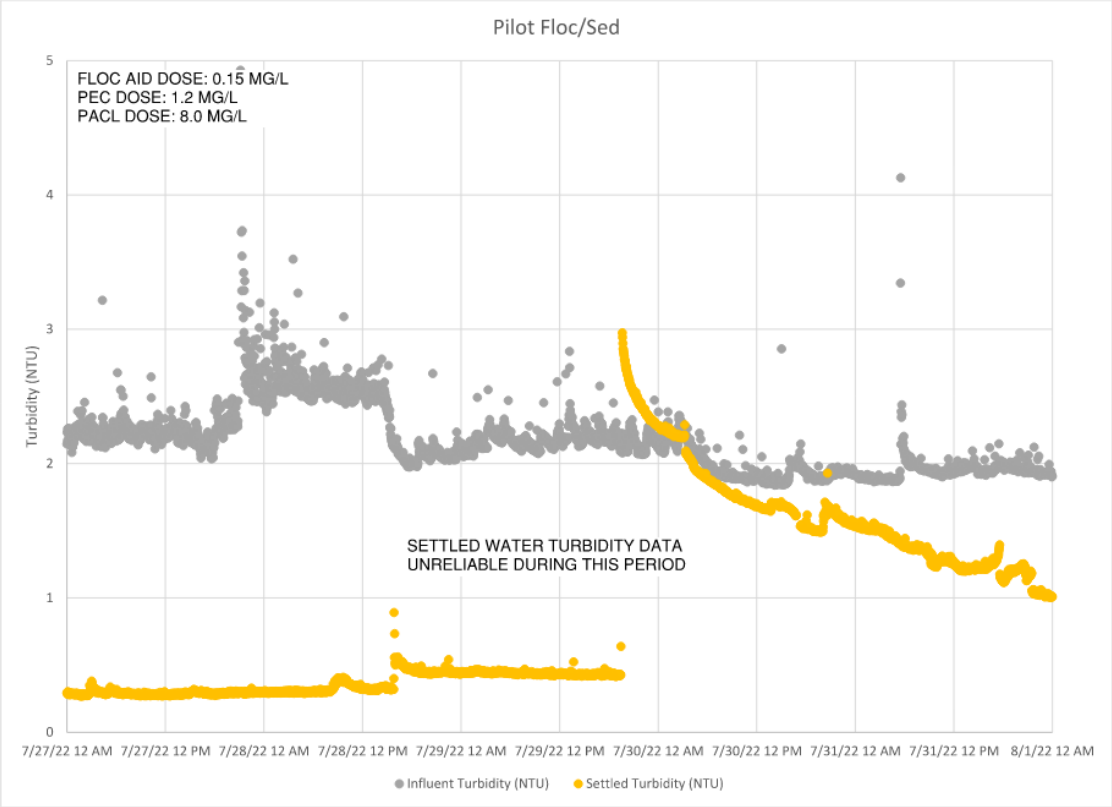

Figure 15 Test No. 3 - Pilot Floc/Sed Turbidity

As shown in Figure 15, settled water turbidity was between 0.4 and 0.5 NTU until July 30th and then it drastically increased and then decreased at an exponential rate. The initial data was after turbidimeter tubing was cleaned and the instruments were recalibrated. It's unclear what caused the large increase in turbidity and how reliable the settled water data was during this period.

The performance of Filter 1 (proposed media) and Filter 2 (existing media) during this period is shown in Figure 16, Figure 17, and Table 6. Three consistent filter runs are presented between approximately July 29, 2022, and July 30, 2022. Filter aid dose of 0.02 mg/L was added during this period.

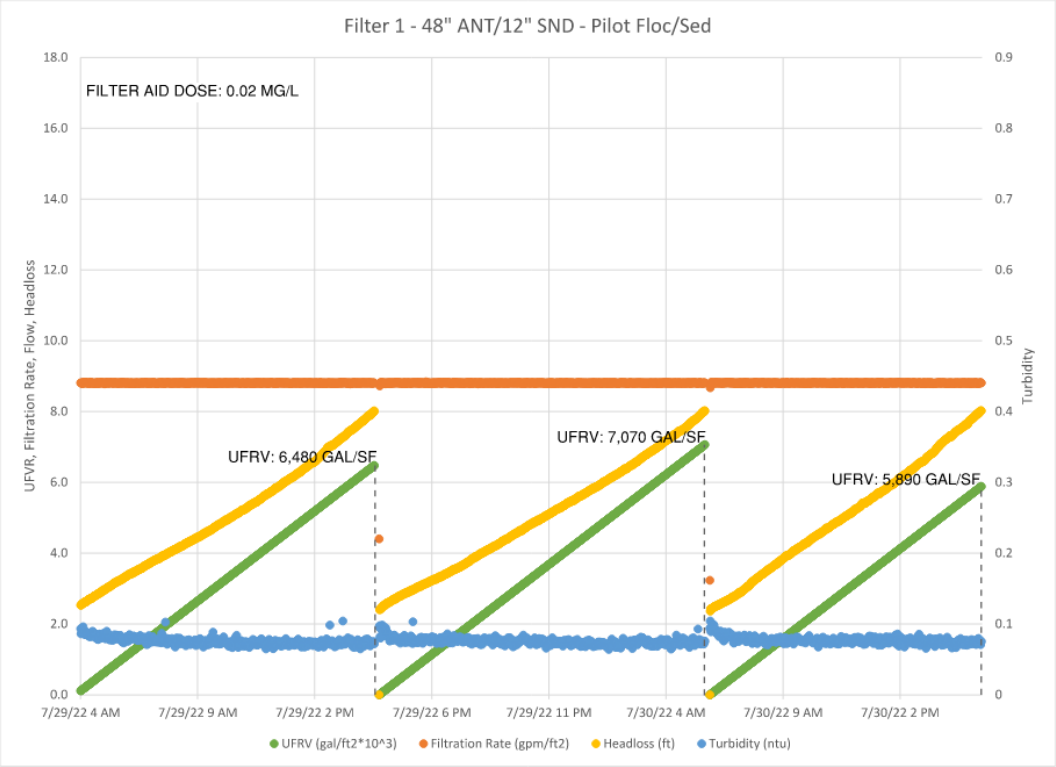

Figure 16 Test No. 3 - Filter 1 Performance (Proposed Deep Media at 8.8 gpm/sf)

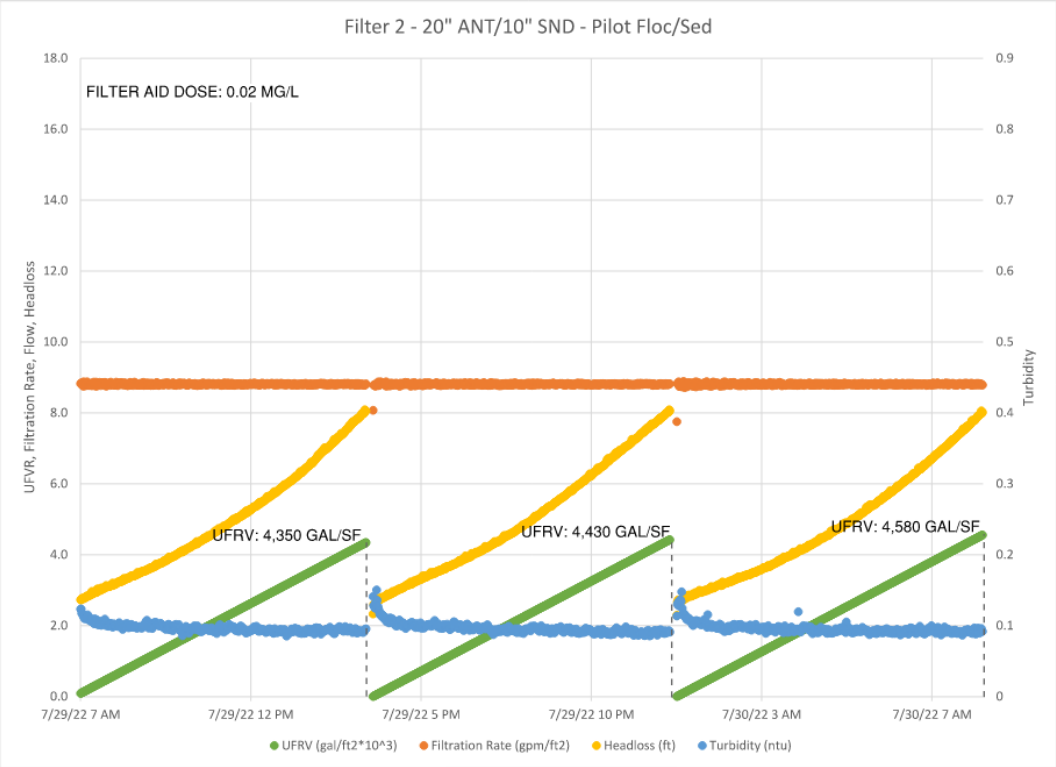

Figure 17 Test No. 3 - Filter 2 Performance (Existing Media at 8.8 gpm/sf)

Table 6 Test No. 3 - Filter Performance Summary Using Pilot Pretreatment

Parameter	Filter 1 (Run 1)	Filter 1 (Run 2)	Filter 1 (Run 3)	Filter 2 (Run 1)	Filter 2 (Run 2)	Filter 2 (Run 3)	**Filter 1 Average**	**Filter 2 Average**	**Perc. Diff.**
Filters									
Media Design	Proposed, Deep Bed			Existing			**Comparison**		
Filtration Rate (gpm/sf)	8.8	8.8	8.8	8.8	8.8	8.8	**8.8**	**8.8**	**-0.1%**
Run Time (hrs)	12.3	13.4	11.1	8.2	8.4	8.7	**12.2**	**8.4**	**31%**
UFRV (gal/sf)	6,480	7,065	5,887	4,345	4,426	4,576	**6,477**	**4,449**	**31%**
Cleanbed Headloss (ft)	2.5	2.4	2.4	2.6	2.6	2.7	**2.4**	**2.6**	**-7.8%**
Final Headloss (ft)	8.0	8.0	8.0	8.1	8.1	8.1	**8.0**	**8.1**	**-0.4%**
Final Turbidity (NTU)	0.07	0.08	0.08	0.10	0.09	0.09	**0.07**	**0.09**	**-24%**
Avg. Turbidity (NTU)	0.08	0.08	0.08	0.10	0.10	0.10	**0.08**	**0.10**	**-27%**
Filter Aid Dose (mg/L)	0.02	0.02	0.02	0.02	0.02	0.02	**0.02**	**0.02**	**0.0%**
Pretreatment									
Settled Water Turbidity (NTU)	0.4	1.1	1.7	0.4	0.4	1.9	**1.1**	**0.9**	**16%**
Floc Aid Dose (mg/L)	0.15	0.15	0.15	0.15	0.15	0.15	**0.15**	**0.15**	**0.0%**
PEC Dose (mg/L)	1.2	1.2	1.2	1.2	1.2	1.2	**1.2**	**1.2**	**0.0%**
PACl Dose (mg/L)	8.0	8.0	8.0	8.0	8.0	8.0	**8.0**	**8.0**	**0.0%**

As shown in Figure 16, Figure 17 and Table 6, Filter 1 (proposed media) outperformed Filter 2 (existing media) by approximately 31 percent in terms of UVRVs. UFRVs for Filter 1 were below 7,500 gal/sf. Filter 2 had UFRVs slightly below 5,000 gal/sf. Since the settled water turbidity was unreliable it is hard to determine why UFRVs for Filter 1 were so much lower than Test No. 1. However, in this case the proposed media clearly outperformed the existing media at the same 8.8 gpm/sf filtration rate.

For all filter runs, backwashes were triggered by headloss. Cleanbed headloss was similar for both Filter 1 (2.4 ft) and Filter 2 (2.6 ft), as expected. Filter 1 has significantly deeper media, but it is larger. Filter 2 has shallower media, but it is smaller. These effects can cancel each other out with respect to cleanbed headloss. Average turbidity throughout all filter runs was relatively equivalent (between 0.08 and 0.10 NTU), which was consistent with Test No. 1 and No. 2. Turbidity hovered around 0.1 NTU for the three filter runs for Filter 2, but never experienced breakthrough.

For this test condition, the feedwater quality was less than ideal but the proposed filter media produced equivalent or slightly better water quality as the existing media and operated at improved efficiency (higher UFRV) compared to the existing media.

3.3.2 Full-Scale Settled Water Performance

Between July 29, 2022, and August 1, 2022, the full-scale floc/sed was fed with a floc aid dose of 0 mg/L, a PEC dose of 1.2 mg/L, and a PACl dose of 6.5 mg/L. These doses were similar to those at the pilot pretreatment skid, except for floc aid. The influent turbidity and settled water turbidity are shown in Figure 18. This water fed Filter 3 (proposed media) and Filter 4 (existing media). The data covers the same period for the three pilot filters runs presented in this section.

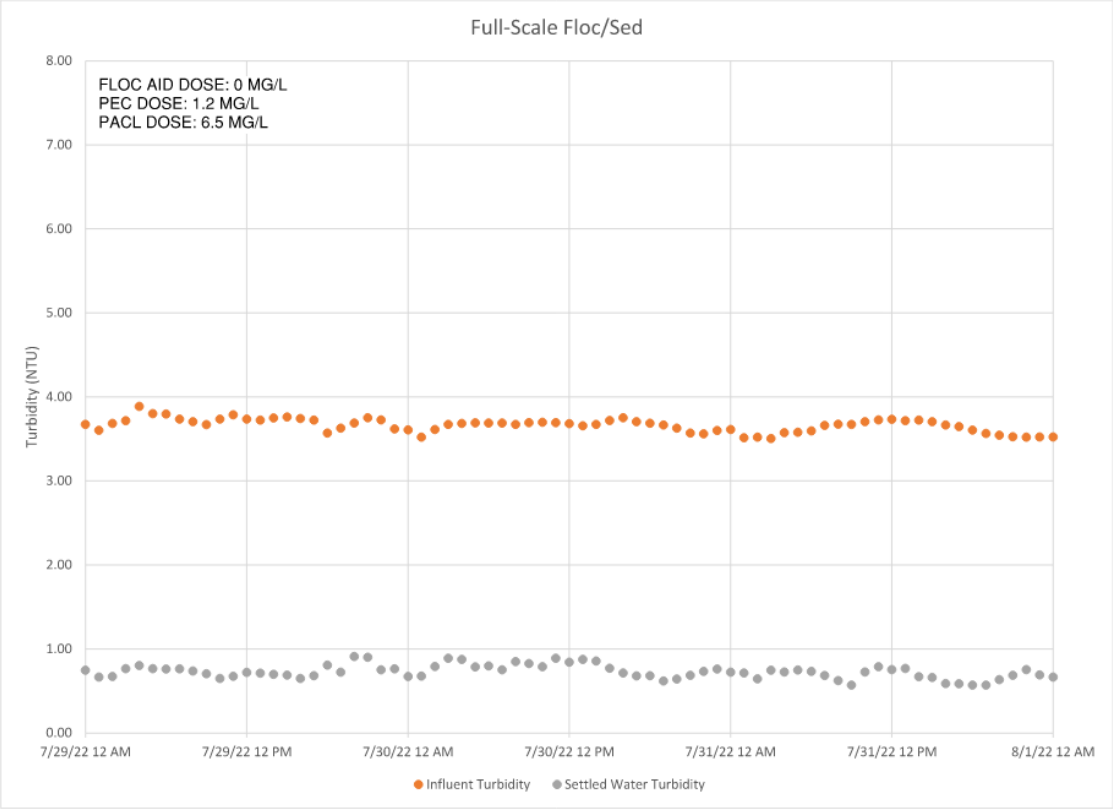

Figure 18 Test No. 3 - Full-Scale Floc/Sed Turbidity

As shown in Figure 12, settled water turbidity was just below 1 NTU for the entire testing period. No data anomaly was noted during this period.

The performance of Filter 3 and Filter 4 during this period is shown in Figure 19, Figure 20, and Table 7. Three consistent filter runs are presented between approximately July 29, 2022, and August 1, 2022. A total filter aid dose of 0.05 mg/L (0.03 mg/L at the full-scale plant and 0.02 mg/L at the pilot plant) was dosed during this period.

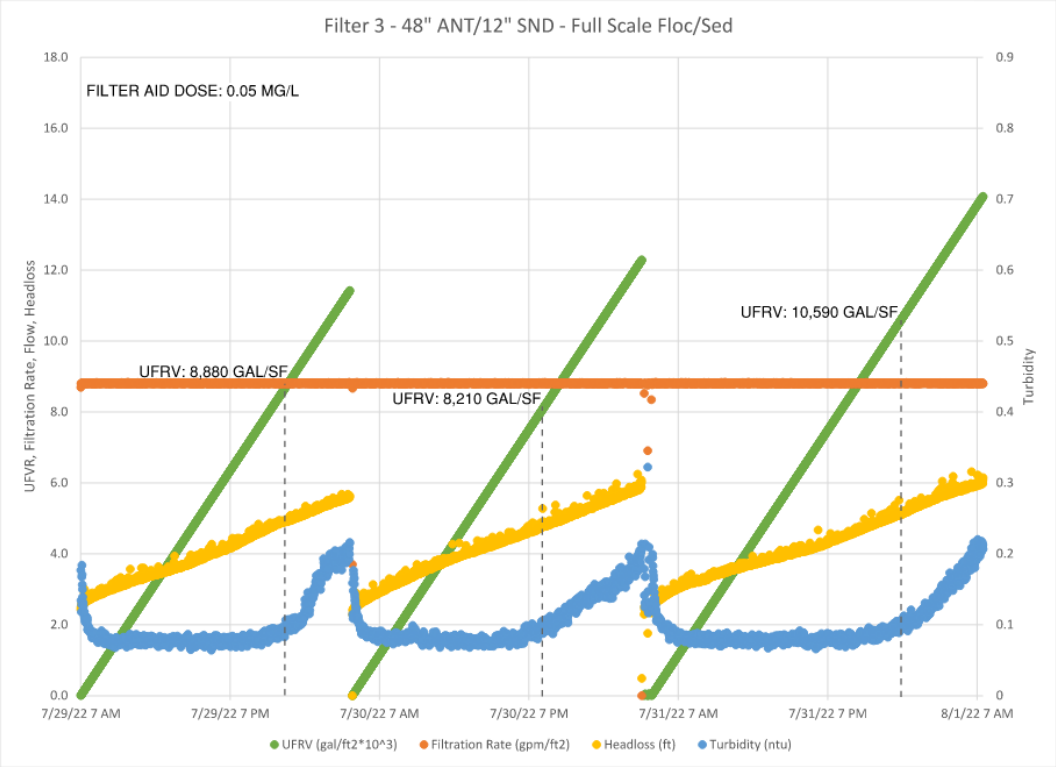

Figure 19 Test No. 3 - Filter 3 Performance (Proposed Deep Media at 8.8 gpm/sf)

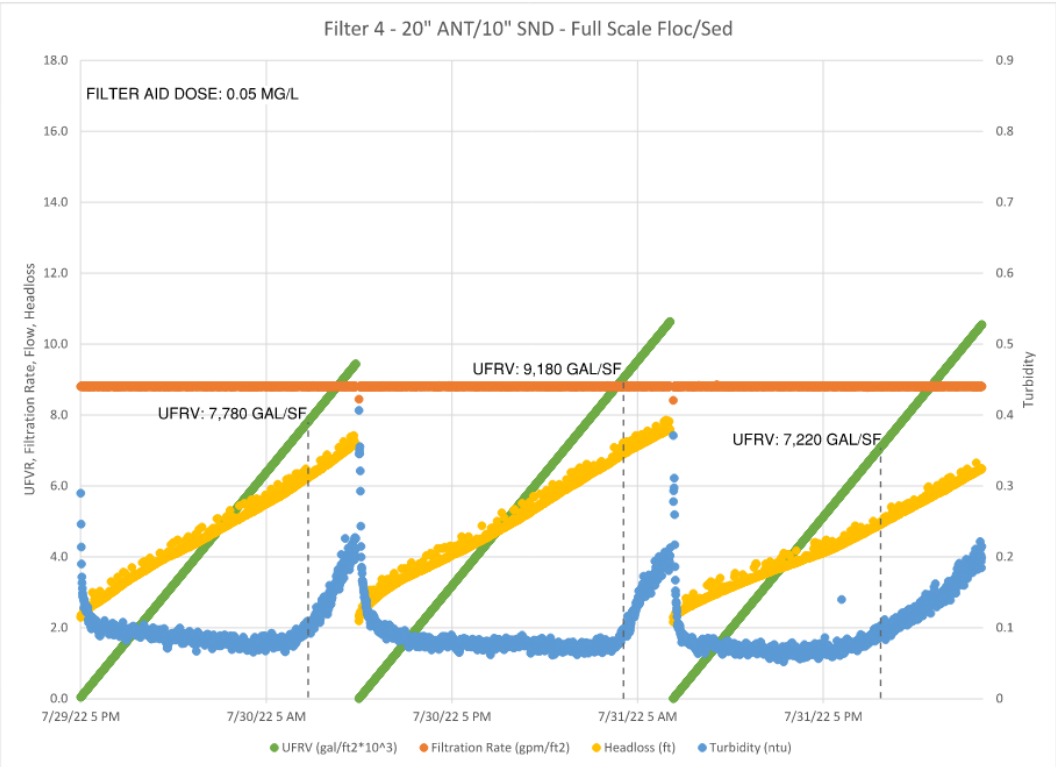

Figure 20 Test No. 3 - Filter 4 Performance (Existing Media at 8.8 gpm/sf)

Table 7 Test No. 3 - Filter Performance Summary Using Full-Scale Pretreatment

Parameter	Filter 3 (Run 1)	Filter 3 (Run 2)	Filter 3 (Run 3)	Filter 4 (Run 1)	Filter 4 (Run 2)	Filter 4 (Run 3)	**Filter 3 Average**	**Filter 4 Average**	**Perc. Diff.**
Filters									
Media Design	Proposed, Deep Bed			Existing			**Comparison**		
Filtration Rate (gpm/sf)	8.8	8.8	8.8	8.8	8.8	8.8	**8.8**	**8.8**	**0.0%**
Run Time (hrs)	16.8	15.5	20.0	14.7	17.4	13.7	**17.5**	**15.2**	**13%**
UFRV (gal/sf)	8,875	8,212	10,594	7,775	9,180	7,224	**9,227**	**8,060**	**13%**
Cleanbed Headloss (ft)	2.5	2.4	2.5	2.3	2.3	2.3	**2.5**	**2.3**	**6.3%**
Final Headloss (ft)	5.0	4.8	5.1	6.2	7.0	5.0	**5.0**	**6.1**	**-22%**
Final Turbidity (NTU)	0.10	0.10	0.10	0.10	0.10	0.10	**0.10**	**0.10**	**0.8%**
Avg. Turbidity (NTU)	0.08	0.08	0.08	0.09	0.08	0.07	**0.08**	**0.08**	**1.5%**
Filter Aid Dose(1) (mg/L)	0.05	0.05	0.05	0.05	0.05	0.05	**0.05**	**0.05**	**-0.2%**
Pretreatment									
Settled Water Turbidity (NTU)	0.7	0.8	0.7	0.8	0.7	0.7	**0.72**	**0.73**	**-0.8%**
Floc Aid Dose (mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	**0.0**	**0.0%**
PEC Dose (mg/L)	1.20	1.20	1.20	1.20	1.20	1.20	**1.2**	**1.2**	**0.0%**
PACl Dose (mg/L)	6.5	6.5	6.5	6.5	6.5	6.5	**6.5**	**6.5**	**0.0%**

Notes:
(1) Filter aid dose was fed at full scale and then diverted to the pilot units. The total dose shown reflects 0.03 mg/L fed at the full-scale plant and 0.02 fed at the pilot plant.

As shown in Figure 19, Figure 20 and Table 7, Filter 3 (proposed media) outperformed Filter 4 (existing media) by approximately 13 percent in terms of UVRVs. UFRVs for Filter 1 averaged slightly above 9,200 gal/sf. Filter 2 averaged UFRVs slightly below 8,000 gal/sf. This contrasts with the filter data using the pilot floc/sed feedwater, which had shorter filter runs and lower UFRVs due to the feedwater quality. However, the data is consistent in that the proposed media outperformed the existing media at the same filtration rate.

As shown with Filters 1 and 2, cleanbed headloss was similar for both Filter 3 (2.5 ft) and Filter 4 (2.3 ft), as expected. Average turbidity was equivalent for both media designs. Final headloss of Filter 3 was lower (5 ft) compared to Filter 4 (6 ft). This indicates that with optimized pretreatment, there was additional head available for the filter with the proposed media design. Therefore, if feedwater chemical treatment were optimized for the pilot, additional run time and UFRV would be achievable with the proposed media design.

For this test condition, the proposed filter media produced equivalent water quality as the existing media, while achieving a higher UFRV with more available filtration head to continue longer filter runs with optimized pretreatment.

3.4 Chemical Dose Comparison

For several periods during pilot testing both floc aid and filter aid dose were adjusted, either by adding more polymer, or removing it completely. Figure 21 and Figure 22 show a plot of the presence and absence of floc aid and filter aid during a filter run, respectively.

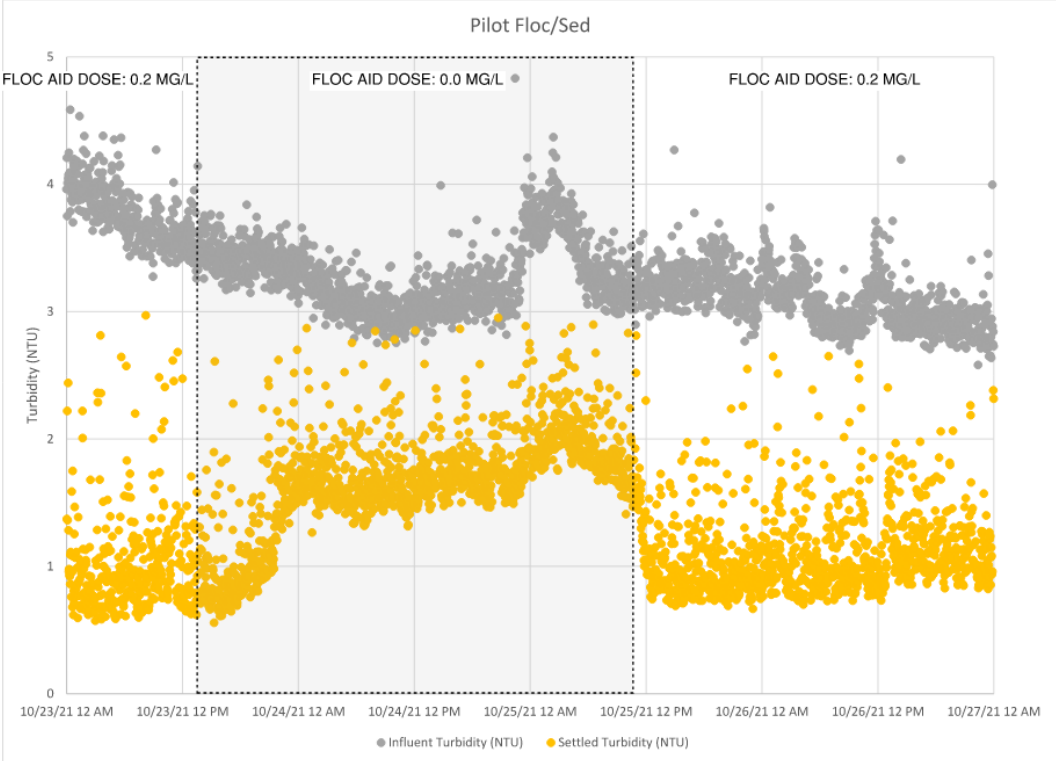

Figure 21 Floc Aid Comparison

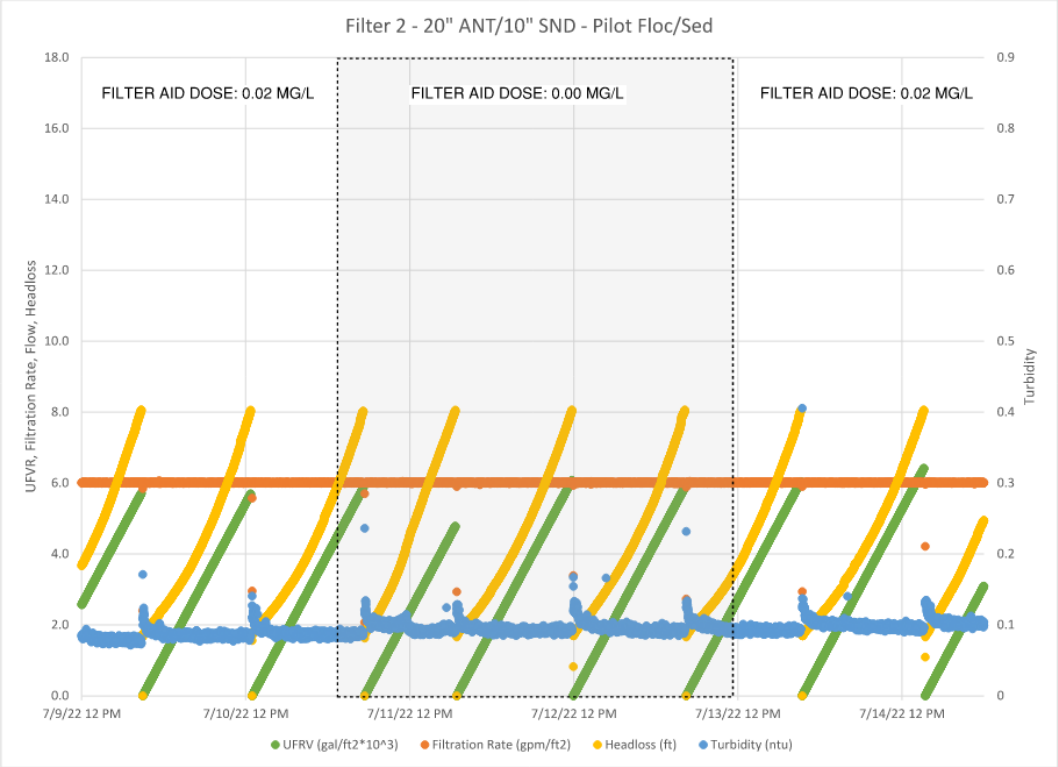

Figure 22 Filter Aid Comparison

As shown in Figure 21, the floc aid was effective at reducing settled water turbidity of the pilot floc/sed treatment unit. When removed, settled water turbidity increased, when added, settled water turbidity decreased. This was tested several times throughout piloting and the response was consistent. This would suggest that floc aid could be beneficial for the full-scale plant and should be considered.

Contrary to what is seen full-scale at the plant, the benefits of filter aid were not apparent during the pilot testing conducted, as shown in Figure 22. The addition or removal of filter aid did not have immediate effects on the filter runs. This was also tested several times, but the filtered turbidity or runtime did not show an affect during this pilot.

Note, that just because an effect was found during piloting it does not mean it will have the same effect at full-scale. Filter aid is available and often used full-scale to lengthen filter runs or optimize filtered water quality. This should be continued moving forward.

Section 4

SUMMARY AND CONCLUSIONS

The purpose of this report was to present the results for filter loading rate pilot testing. This testing was necessary to demonstrate the performance of proposed filter media needed for rerating the JVWCD filters. When paired with appropriate filter modification design documents, these pilot test results support a future request to DDW to rerate the JVWTP filters to at least 8.8 gpm/sf to support a plant production capacity of 255 mgd.

Three testing periods were conducted as a part of the piloting effort: (1) existing media at 6 gpm/sf filtration rate and proposed media at 8.8 gpm/sf; (2) existing media at 6 gpm/sf filtration rate and proposed media at 10 gpm/sf; and (3) existing media at 8.8 gpm/sf filtration rate and proposed media at 8.8 gpm/sf.

In all cases the proposed media achieved equivalent water quality as the existing media while operating at higher filtration rates. Additionally, under all test conditions, the proposed media outperformed the existing media in terms of production efficiency (UFRVs). For the proposed media, UFRVs were consistently above 7,500 gal/sf, with UFRVs as high as 13,000 gal/sf.

Differences were present between the pilot fed floc/sed and full-scale floc/sed water, the pilot filters receiving pilot pretreatment backwashed on headloss, whereas the pilot filters supplied with full-scale pretreatment had much lower headloss accumulation and backwashed on turbidity breakthrough. This indicates the pilot pretreatment was not optimized. As is common, the full-scale filters using the proposed media produced better water quality than the pilot filters.

Filter aid is already available at the plant and should continue to be utilized as a tool to optimize filter water quality. Floc aid should also be added to the full-scale plant as an optimization tool, as it was found beneficial for settled water turbidity.

The proposed media design (larger and deeper media) has clear benefits for upgrading and rerating the filters. Therefore, the proposed filter media and associated modifications (raising launders, etc.) are recommended to rerate the filters to 255 mgd. As such, design modification drawings should be submitted to DDW, alongside this pilot testing report, requesting the filters be rerated to 255 mgd. The pilot supports rerating the facility to 255 mgd using a filtration rate of 8.8 gpm/sf using the proposed media tested. However, to provide more operational flexibility for the number of filters that may be offline, JVWCD may request from DDW that filters be operated up to 10 gpm/sf. This is supported by the pilot data.

Concurrence should be requested for increased filtration rate from DDW prior to the District proceeding with detailed design for media replacement and launder modifications at its JVWTP.

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Appendix A

FILTER PILOT TESTING PROTOCOL

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PROJECT MEMORANDUM

Project Name:	Jordan Valley WTP Filter Piloting	**Date:**	11/01/2021
Client:	Jordan Valley Water Conservancy District	**Project Number:**	12305A.00
Prepared By:	Alan Domonoske, Patrick Carlson		
Subject:	Filtration Rate Pilot Testing Protocol		

The purpose of this memorandum is to provide a Pilot Test Protocol for filter loading rate testing above 6 gpm/sf at the Jordan Valley Water Treatment Plant (JVWTP). The goal of the pilot testing is to obtain sufficient data to support filter rerating approval from the Utah Division of Drinking Water (DDW) for a filtration rate of at least 8.4 gpm/sf. This filtration rate would allow the JVWTP capacity to be expanded from 180 to 255 million gallons per day (mgd) without constructing additional filters. This rate remains consistent with high filtration rates approved at other facilities in Utah.

Background

The Jordan Valley Water Conservancy District (JVWCD) is working to increase capacity of the JVWTP from 180 to 255 mgd by 2025 to address growth within the service area. JVWCD has performed various preliminary studies of the pretreatment and filtration systems to explore alternatives to achieve the desired capacity. In 2016, Carollo Engineers (Carollo) completed a capacity and site optimization study. The study evaluated various means of achieving the desired 75 mgd increase in plant capacity and included a preliminary investigation into the feasibility of increasing the filtration rate. With the current piloting effort, Carollo completed a more detailed study that has confirmed the feasibility of rerating the existing filters. This more detailed study concluded that the filter structures and plant hydraulics are such that by relocating the troughs to accommodate deeper, larger media, and with DDW filtration rate approval, the filter capacity can be increased.

This protocol outlines the filter testing that will be completed to obtain approval for a filtration rate of at least 8.4 gpm/sf to achieve 255 mgd with one filter out of service for backwash. Since this filtration rate exceeds the maximum rate (6.0 gpm/sf) set forth by the DDW in R309-525-15 for dual media, rapid gravity filters, pilot testing is required to demonstrate that water treatment goals can still be met. JVWCD owns the pilot equipment and will complete additional pilot testing beyond this protocol to obtain additional data to inform design and operational optimization.

The filters utilize an inlet weir and level controller to regulate flow through the filters. Each filter contains two cells, each with an area of 704 sf, for a total filter area of 1,408 sf per filter. During normal filtration and backwash, both cells operate as a single filter. The filters are equipped with filter-to-waste facilities. Filters 1 through 6 were constructed with the original WTP construction in 1971. Filters 7 through 16 were constructed with the expansion to 138 mgd in 1985. The filter area, media depth, and basic operation of both filter groups are identical though the configuration does have some unique differences.

Piloting Overview

The current 180 mgd plant capacity for this facility has historically been defined by gross flow

through the plant processes, which includes an approximate 5% internal recycle of clarified residual stream that reduces treated water deliveries to the distribution system. If JVWCD decides to expand the plant to deliver 255 mgd treated water to the system, the plant processes will have to operate at 268 mgd with the assumed 5% internal recycle. For this pilot study, filtration rates of 8.5 gpm/sf and 8.8 gpm/sf will be tested to correspond to 255 mgd and 268 mgd filtration capacity with one filter out of service. In addition, pilot scale testing will include filtration rates as high as 10.0 gpm/sf to understand the maximum capacity of the pilot filters.

The pilot unit consists of a pretreatment skid (flocculation and sedimentation) and filtration skid (four pilot filter columns as shown in Figure 1). The pretreatment skid utilizes JVWTP's raw water that has been preoxidized with chlorine dioxide and can be operated with various chemical dosages and pretreatment settings. The filtration skid can utilize settled water from the pretreatment skid or the JVWTPs settled water downstream of filter aid addition. This allows different pretreatment strategies to be directly compared to the full-scale plant. All water from the pilot skid is discharged to the plant drain.

Figure 1. Pilot skid for filtration rate testing at JVWTP.

Two media configurations are being utilized in the four pilot filter columns, as shown in Figure 2. Two pilot columns were loaded with existing media pulled from the plant filters. They consist of 20 inches of 1.0 mm anthracite over 10 inches of 0.5 mm sand. This provides a total media depth of 30 inches and L/d ratio of 1,020. The L/d ratio -- a unitless design parameter that can

be correlated to filter performance -- is equal to the depth of the media in mm divided by the effective diameter of the media grains in mm. Filter media generally produce acceptable water quality when the combined L/d ratio for sand and anthracite exceeds 1,200. The existing media does not meet this target. The other two pilot columns were loaded with 42 inches of 1.2 mm anthracite over 12 inches of 0.6 mm sand. This provides a total media depth of 54 inches and L/d ratio of 1,380. The higher L/d ratio can be correlated to higher filter performance. This filter media represents the preliminary recommended media and is expected to have robust turbidity removal performance, good solids storage capacity, and reduced headloss. With four pilot columns and two media designs, each media type can be paired with the pilot pretreatment skid or plant settled water for comparison testing.

The increased effective particle size for the recommended media reduces the headloss through the media at the higher filtration rates, and additional depth provides and 30% increase in the L/d ratio. The effective particle size for each layer was also checked for compatibility such that mixing of the two stratified layers is minimized during backwash. The deeper media also accommodates increased solids storage in the bed, before backwash, to create longer filter runs that improve the efficiency and performance of the filter.

The larger deeper media represents a high-rate filter media that has been successfully used at other similar Utah facilities with filtration rates at or above 8.5 gpm/sf. Because of the increased media depth, the launders must be raised to provide sufficient space for media expansion below the launders during backwash. Raising filter launders is a common filter retrofit to accommodate modern deeper media designs and the deep JVWTP filter boxes easily accommodate the higher troughs.

Although the current trough location could accommodate an additional 10-inches of media, the resulting 40-inch media depth is not recommended for testing at this time. This total media depth would require smaller media to meet the target L/d ratio of 1,200 and increased headloss through this smaller media would result in prohibitively short filter runs.

Pilot testing will be conducted for approximately six weeks and cover the different loading rates and pretreatment (plant and pilot settled water). Ideally, this pilot testing will be completed during late summer and early fall to capture the worst-case conditions under which the filters would be operated at high rates: high demand periods when filter clogging algal events in the raw water supply could occur. The purpose of the testing is to confirm the recommended media design meets the filter effluent quality goal for turbidity of 0.1 NTU or less and an operational goal of unit filter run volumes (UFRV) of 7,500 gal/sf or more. The UFRV is the volume of water produced by a square foot of media during a filter run and represents overall filter efficiency. At an UFRV of 7,500 gal/sf, the efficiency of the filter is approximately 98 percent.

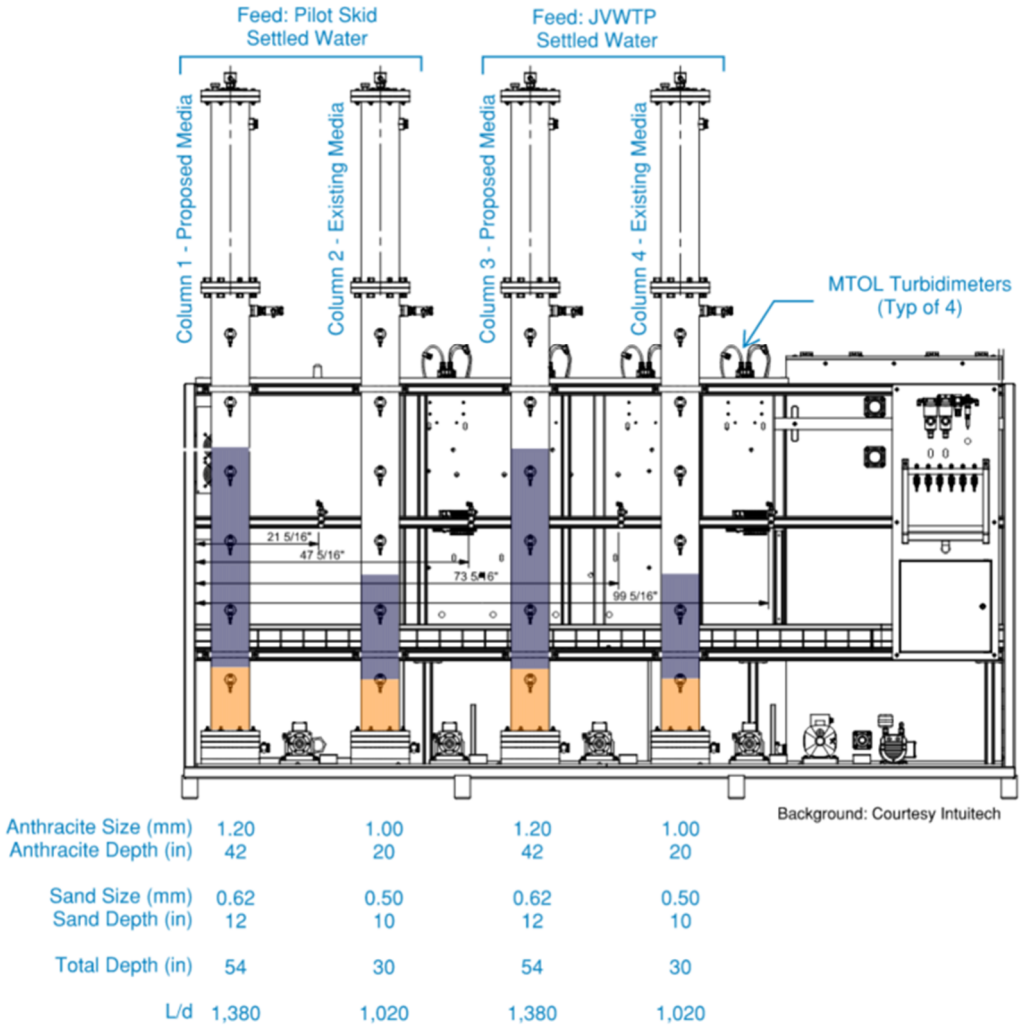

Figure 2. Pilot skid configuration for filtration rate testing at JVWTP.

Experimental Plans, Methods, and Materials

As previously described, two filter columns will be supplied with settled water from the plant and two columns will be supplied with settled water from the pilot pretreatment skid. This allows the effect of different pretreatment chemical strategies to be tested.

Water quality data for the plant settled water will be measured and recorded by existing plant control system. Settled water turbidity from the pilot pretreatment skid will be recorded by the pilot control system. Turbidity for each pilot column will also be recorded by the pilot control system. The pilot skid includes a PLC that will control filter operations and record filter performance.

Each filter column on the pilot skid is approximately 10 feet tall and is equipped with a dedicated feed pump, flowmeter, pressure transducer for monitoring headloss, and effluent turbidity meter (MTOL). Each column also includes valves for control of influent, effluent, air scour, and backwash waste. The feed pumps can be set to maintain a constant flow rate by means of logic between the effluent flowmeter and variable speed-controlled drives.

During this pilot testing, the normal filter run will be assumed to begin once the effluent turbidity drops below 0.1 NTU following a backwash and is assumed to end once the effluent turbidity exceeds 0.1 NTU. However, each filter run will continue until filter effluent turbidity exceeds 0.3 NTU to identify potential filter runs lengths that meet drinking water regulations.

The pressure transducer on each filter will be used to measure the clean bed headloss and to track the increase of headloss over a filter run as solids are accumulated. The pilot filter run lengths may be dictated by turbidity as described above, or total pilot column headloss exceeding 9 ft. This is the practical headloss limit available for the pilot and matches the current headloss available in the plant at the future 255 mgd.

The pilot columns will be automatically backwashed at the termination of a filter run by the pilot control system. Backwash includes air scour and reverse flushing. The backwash procedure consists of air scour, combined air scour and low-rate wash, and a final high-rate wash to flush dislodged solids from the bed. There is a backwash tank on the pilot skid that stores filter effluent for backwash supply, and there is pump on the skid that is used for backwashing. Backwashing is only done for one filter column at a time.

Filter effluent for each column will be analyzed for turbidity. Individual turbidimeters are located on the skid for each column. Turbidity for the effluent of each filter column will be recorded and compared between the test conditions and the settled water. Total flow through each filter will also be recorded for the calculation of UFRV.

Data collected during the pilot testing will be recorded using plant and pilot SCADA, and using operator tracking sheets. The pilot will be operated by plant operations staff and data analysis will be performed by Carollo. Data collected during the pilot testing will be as follows:

- Settled water quality and upstream pretreatment conditions, configurations, and chemical dosages - (Recorded on pilot and plant SCADA and operator tracking sheets)
- Filter column flow rates - (Recorded on pilot SCADA and Operator Tracking Sheet)
- Filter column clean bed headloss - (Recorded on pilot SCADA)
- Filter column headloss - (Recorded on pilot SCADA)
- Filter column effluent turbidity - (Recorded on pilot SCADA)
- Filter column run time - (Recorded on pilot SCADA)

Filtration rates from 8.4 gpm/sf to 10 gpm/sf will be tested during the piloting.

Testing Protocol

1. The following instruments will be calibrated prior to testing.
   A. Turbidity analyzers for plant and pilot settled water.
   B. Pilot skid instruments:
      1) Pressure transducers.
      2) Turbidimeters.
   C. Verify that trending is available and working properly from the SCADA system.
   D. Verify that the time reported by SCADA is consistent with test participant watches and control room clock.

2. Place filter media in columns as described in Figure 1. Wash and skim to required design depths in accordance with standard media washing protocol.

3. Prior to testing pilot runs at higher filtration rates, establish normal plant flows and pretreatment operations that can be held constant for the duration of the individual filter tests.
   A. Chemical feed and conventional pretreatment operations should be stable, constant, and optimized.
   B. Allow for a minimum of three complete filter runs per filtration rate tested for each pretreatment condition. Filtration rate testing should consist of the following:
      1) Existing media at 6.0 gpm/sf and proposed media at 8.5 gpm/sf and 8.8 gpm/sf.
         a) The purpose of this testing is to compare existing media at its rated capacity to proposed new media at its proposed rated capacity
      2) Existing media at 6.0 gpm/sf and proposed media at 10.0 gpm/sf.
         a) The purpose of this testing is to compare existing media at its rated capacity to proposed new media beyond its proposed rated capacity
      3) Existing media at 8.8 gpm/sf and proposed media at 8.8 gpm/sf.
         a) The purpose of this testing is to compare existing media with proposed new media at the proposed rated capacity. This demonstrates the benefit of the new media.
      4) Existing media at 8.8 gpm/sf and proposed media at 10.0 gpm/sf.
         a) The purpose of this testing is to compare existing media at the proposed new rate with proposed new media at even higher rates. This demonstrates the benefit of the new media.

4. Data will be downloaded by operations staff on weekly/bi-weekly basis and sent to engineer for review prior to weekly/biweekly calls.

5. Upon completion of pilot testing, Carollo will prepare pilot summary report for DDW review and pilot acceptance.

6. Review meeting will be held with DDW.