

# **City of O'Fallon – Department of Public Works**

## **Request for Qualifications**

**RFQ Number 25-028**



## **2025 Water & Sewer Projects Projects 25-101 – 25-103**

**March 7, 2025**

**REQUEST FOR QUALIFICATIONS**  
**FOR**  
**ENGINEERING SERVICES**

In compliance with Missouri Revised Statutes, the City of O'Fallon is seeking qualifications for professional engineering services related to the preparation of construction plans, specifications, bidding documents and other related items for general engineering services for various water and sewer projects for the City of O'Fallon.

A more detailed description of the projects is contained in Attachment "A" of this Request for Qualifications. The projects are anticipated to start in April 2025.

**SUBMITTAL**

Please submit four (4) paper copies and one (1) pdf on a Flash Drive detailing your firm's qualifications marked, "2025 Water & Sewer Projects" to the following:

City of O'Fallon  
Attn: Christine Grabin, Purchasing Agent  
100 North Main Street  
O'Fallon, MO 63366

**LIMIT EACH SUBMITTAL TO NO MORE THAN 10 PAGES FOR COMPANY BACKGROUND INFORMATION AND 5 PAGES FOR EACH SEPARATE PROJECT.** (For example, if a firm were to submit on 3 of the projects, that firm could have 10 pages for company background, 5 pages for each project, with a total page count of no more than 25 pages.) The following items are NOT included in the page limit: front and back covers, cover letter (1 page maximum), section dividers, table of contents, affidavit of compliance and E-Verify. The pages are to be printed, single-sided. Qualifications are due no later than 12:00 PM (local time) on Tuesday, March 18, 2025.

**QUALIFICATIONS**

Qualifications are not limited to, but should include the following:

1. The specialized experience and technical competence of the firm with respect to the type of services required includes, but is not limited to:
  - a. A brief description of the firm
  - b. A list of key personnel involved in the work and any experience or expertise they have related to the type of work requested, and the role those key personnel will fulfill in the project.
  - c. The office location of each key personnel.
  - d. This summary should include the same specialized experience, technical competence and firm information for all associates or sub-consultants anticipated to be involved in providing services on the project on behalf of the firm.
  
2. The capacity and capability of the firm (or firms) to perform the work in question, including specialized services within the time limitations fixed for completion of the project including, but not limited to:
  - a. It is understood that some firms do not employ all necessary in-house professional disciplines to accomplish a given project. A description of any arrangements/joint venture made with any other firm should be included
  - b. Provision of a list of the firm's current projects, completion schedule, and percent complete

3. The past performance of the firm (or firms) with respect to such factors as control of costs, quality of work, and ability to meet schedules including, but not limited to:
  - a. A listing and description of similar projects that have been completed by the firm in the past five (5) years  
At minimum, a list of the last five (5) similar projects completed by your firm, design time as per the Agreement vs. actual design time, engineer's estimated cost of construction, low bid, final construction costs and owner contact information (address, phone number and contact person for the agency)
  - b. The estimated schedule for completion of the design requirements of this project
  - c. A brief discussion of the firm's project approach and scope. Highlight any practical design and creative processes utilized in solving project problems to provide quality control and reduce construction costs on past projects
  - d. A description of the firm's processes that affect and control the project schedule, such as coordination with outside agencies (utility companies, permitting agencies, etc.)
4. The firm's proximity to and familiarity with the area in which the project is located including, but not limited to:
  - a. The firm's sensitivity to citizen concerns and the need for sharing project information with the public and elected officials
  - b. The familiarity of the firm with the project, including a discussion explaining the benefit the City of O'Fallon would gain by selecting the firm with regard to both the firm's anticipated technical approach on this project and overall participation as a project team member.
5. The state statute requires firms to include an Affidavit of Compliance and a copy of the E-Verify MOU with the letter of interest for all firms submitting qualifications. A clean, legible, active copy of each should be included with the submittal.

### **SELECTION PROCESS**

Proposals received will be evaluated by a review committee comprised of the City's staff for adequacy of content for the items noted above. The competency of all firms (including applicable subcontracted firms) will be reviewed and ranked as a whole. The committee will rank the firms and select the firm or firms that they believe to be the best qualified and capable of performing the desired work. The City will then begin contract negotiations and a detailed determination of the scope of services with the highest ranked firm. If the City is unable to negotiate a satisfactory contract with the firm selected, negotiations with that firm shall be terminated and the City will begin negotiations with another qualified firm. The City does reserve the right to reject any or all responses, to request interviews for further information, or to cancel the project. A selection criteria form (worksheet) is included as Attachment "C" for your information. For additional details, consultants can request a copy of the City's full policy with regard to the consultant selection process.

It will be necessary to use the design services Agreement (a/k/a Engineering Services Contract, or ESC) included as Attachment "B" for this project.

The City reserves the right to apportion the requirements of this RFQ amongst multiple firms or one single firm if this is determined to be in the City's best interest.

**ANTICIPATED SCHEDULE**

Below is the tentative anticipated schedule of these projects. All dates are considered approximate.

March 7, 2025	RFQ's Issued
March 18, 2025	RFQ's Due by 12:00pm
March 18 - 25, 2025	Selection committee ranks design firms based on qualifications.
March 25, 2025 - April 8, 2025	Negotiate scope of work and price
April 1, 2025	Submittal of ESC to City Council for Approval
April 2025	Notice to Proceed

Any questions that may arise should be directed in writing to:

Christine Grabin, Purchasing Agent

100 North Main Street

O'Fallon, MO, 63366

Or via e-mail at [CGrabin@ofallonmo.gov](mailto:CGrabin@ofallonmo.gov)

## Attachment "A"

### SCOPE OF WORK

#### 25-101 – 25-103 Water and Sewer Projects

It should be noted below that these descriptions of the projects and the expectations of the firm are considered general at this time. The final scope of services will be detailed under Exhibit A, Part 1 of the ESC. However, this list provides a basic understanding of the expectations for the purpose of the RFQ.

#### **Background**

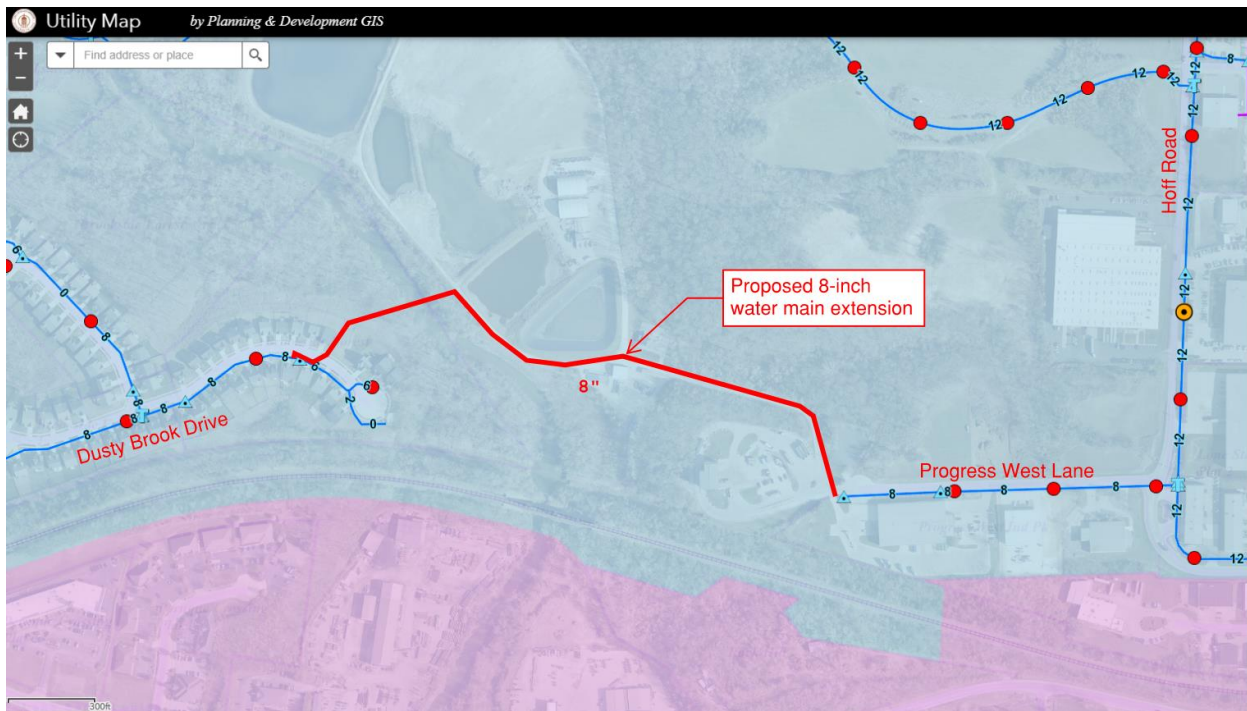
The City of O'Fallon (City) has completed Capital Improvement Plans (CIP) for the City's Water and Wastewater systems. A Water Treatment Plant Filter Evaluation and Pre-Oxidation Study has also been completed. The majority of these projects in this RFQ were identified in the CIP(s) and Study.

#### **25-101 – Water Treatment Plant Pre-Oxidation Improvements**

The existing Water Treatment Plant (WTP) aeration process is ineffective at generating the desired levels of dissolved oxygen within the water for oxidation of iron. Replacement of the aerator nozzles with cascade or induced draft aerators is recommended to improve effectiveness of the aeration process. The Filter Evaluation and Pre-Oxidation Study is included as Attachment "D" of this RFQ. The City is in need of recommendations for upgrades and specifications and plans for the improvements.

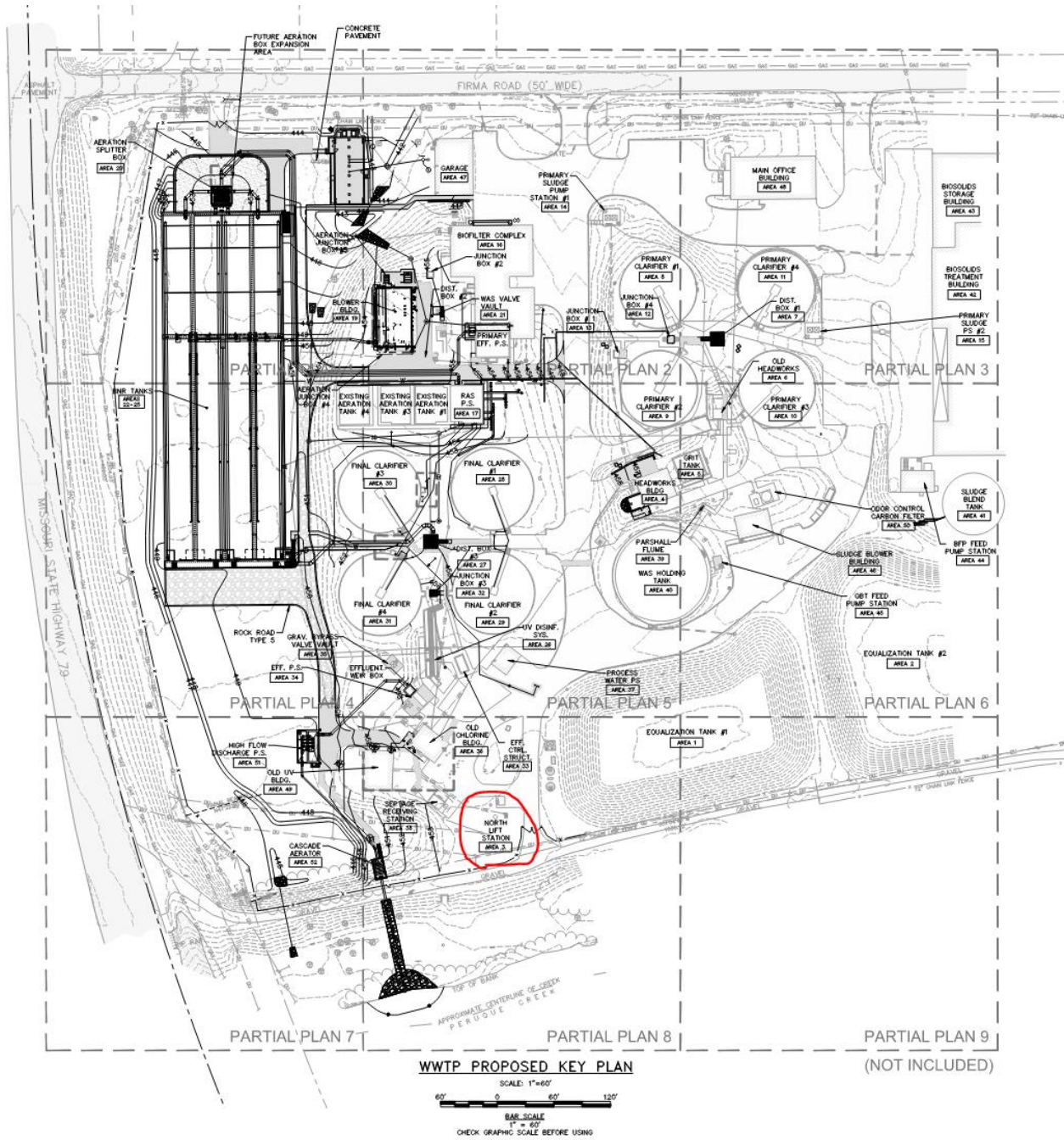
#### **25-102 – Brookside Forest Water Main Extension**

The City needs an engineer for the design and permitting of a new water main project that is planned. The project includes the extension of an existing 8-inch water main with approximately 2,060 feet of new PVC water main from Dusty Brook Drive to Progress West Lane.



## 25-103 – North Lift Station Upgrade

The existing North Lift Station is located on the southwest area of the wastewater treatment plant (WWTP) property and is one of four main lift stations in the City's sanitary sewer collection system. This lift station receives sanitary flow from in-town gravity sewers as well as return flow the WWTP equalization basins after high flow events and is critical to the operation of the collection system and the WWTP. The lift station has reached the end of its useful life and needs to be replaced. The City is in need of recommendations for upgrades and specifications and plans for the improvements.



## **Scope of Services**

These scopes of services are a generic overview of what is expected for projects needing design and construction. While this will apply to the larger projects, a slightly different scope will apply to smaller projects. A more defined Scope of Services will be developed during negotiation with the selected companies.

### **Phase 1 – Preliminary Study, Development of Plans and Specifications**

- Kickoff meeting
- Monthly Progress Meetings
- Review previous study and supporting material
- Review potential utility, gas lines, creek crossings, road crossings, wetlands, and any additional conflicts
- Finalize survey and soil investigation requirements
- Prepare a Preliminary Probable Construction Cost Opinion
- Coordinate survey, soil, wetlands, archeological, and COE issues with appropriate federal, state and local agencies including permitting.
- Coordinate utility, ditch, drainage, and road crossings with appropriate federal, state, and local agencies
- Geotechnical Investigation
- Final survey
- Preliminary plans and specifications
- 60% Plan and specification submittal review
- 90% Plan and specification submittal and review
- Submittal to review agencies
- Easement acquisition assistance and documentation
- Prepare Final Probable Construction Cost Opinion
- Final plans and specifications
- Provide City with two (2) copies of final plans and specifications
- 1 Meeting with Public Works Advisory Committee and 1 Meeting with City Council

### **Phase 2 – Bid Phase Proposed Scope (Final Contract Scope and Fees to be Determined Prior to Bidding)**

- Assist City in pre-bid conference
- Answer bidder's questions
- Assist in issuance of addendums as necessary
- Provide City with a Letter of Recommendation for bid award
- Provide City with Updated Probable Construction Cost Opinion

### **Phase 3 – Construction Related Services Phase Proposed Scope (Final Contract Scope and Fees to be Determined Prior to Bidding)**

- Assist City in Preconstruction Conference
- Conduct monthly construction progress meetings
- Respond to Request for Information documents
- Assist with Contract Change Orders as necessary
- Review shop drawings/submittals
- Perform Substantial Completion Inspection
- Perform Final Completion Inspection
- Provide construction inspection
- Provide record drawings
- Provide start-up assistance to City

## **Additional Services**

Additional services may be required depending upon the available records the City can provide. An estimate for additional services shall be provided. Consultant will refer to the City regarding the scope of services needed, and Consultant can contract with these firms to be sub-consultants.

## **Attachment "B"**

### **AGREEMENT FOR PROFESSIONAL SERVICES**

This Agreement, by and between the City of O'Fallon, a Missouri Municipal Corporation (OWNER), and \_\_\_\_\_,  
(Engineer)

#### **ARTICLE 1 ENGINEER'S SERVICES**

ENGINEER shall provide to OWNER professional services for \_\_\_\_\_, hereinafter referred to as "PROJECT". These services are identified and described in the Scope of Work (EXHIBIT A) attached to and made a part of this Agreement.

#### **ARTICLE 2 OWNER'S RESPONSIBILITIES**

##### **A. OWNER's Representative**

OWNER shall designate in writing a person to act as OWNER's Representative with respect to the services to be rendered under this Agreement. Such person shall have complete authority to transmit instructions, receive information, interpret and define OWNER's policies and make decisions with respect to ENGINEER's services for the PROJECT. OWNER may change its representative by submitting to the ENGINEER in writing.

##### **B. Information**

1. OWNER shall provide ENGINEER with general goals, objectives, and requirements for the PROJECT, including design objectives and constraints, space, capacity and performance requirements, flexibility, expandability, any budgetary limitations; and identify general design and construction standards which OWNER will require to be included in the Drawings and Specifications; and furnish copies of OWNER's standard forms, conditions, and related documents for ENGINEER to include in the Contract Documents, when applicable.
2. OWNER shall give prompt written notice to ENGINEER whenever OWNER observes or otherwise becomes aware of Hazardous Environmental Condition. OWNER shall give written notice to ENGINEER of any other development that affects the scope or time of performance of ENGINEER's services, or any defect or nonconformance in ENGINEER's services or in the work of any Contractor provided the OWNER becomes aware of the development, defect or nonconformance in services and recognizes that there are potential effects on the project.
3. If OWNER provides a budget for the PROJECT, it shall include contingencies for bidding, changes in the work during construction and other costs which are the responsibility of OWNER. OWNER shall, at the request of ENGINEER, provide a statement of funds available for the PROJECT and their source.
4. OWNER shall furnish to ENGINEER as required for performance of ENGINEER'S services (except to the extent provided otherwise in the Scope of Work), data prepared by or services of others, including; soil borings, probing and subsurface explorations, hydrographic surveys laboratory tests and inspections of samples, materials and equipment, appropriate professional interpretation of all of the foregoing; environmental assessment and impact statements; and other special data or consultation that is readily available to OWNER. The data provided is informational and ENGINEER may use the data in performing its services, provided, however, that ENGINEER shall review all such data, prior to using it, and notify the OWNER immediately if, in ENGINEER'S experience and judgment, any data does not appear to be consistent with actual conditions or appears to be otherwise incorrect.
5. OWNER shall provide such accounting, independent cost estimating and insurance counseling services as may be required for the PROJECT, such legal services as OWNER may require or ENGINEER may reasonably request with regard to legal issues pertaining to the PROJECT including any that may be raised by contractor(s), such auditing service as OWNER may require to ascertain how or for what purpose any contractor has used the moneys paid under the construction contract, and such inspection services as OWNER may require (except to the extent provided otherwise in the Scope of Work) to ascertain that contractor(s) are complying with any law, rule, regulation, ordinance, code or order applicable to their furnishing and performing the work.

6. OWNER shall advise ENGINEER of the identity and the scope of services of any independent consultants employed by OWNER to perform or furnish services in regard to the PROJECT, including but not limited to, cost estimating, PROJECT peer review, value engineering, and constructability review.
7. OWNER shall furnish to ENGINEER data as to OWNER's anticipated cost for services to be provided by others for OWNER so that ENGINEER may make necessary calculations to develop and periodically adjust ENGINEER's opinion of Probable Cost.
8. If OWNER designates a Construction Manager or an individual or entity other than, or in addition to, ENGINEER to represent OWNER at the site, define and set forth as an attachment to this Exhibit D the duties, responsibilities, and limitations of authority of such other party as well as the relation thereof to the duties, responsibilities and authority of the ENGINEER.
9. OWNER must establish and be present for the pre-bid conference, bid opening, pre-construction conferences, construction progress meetings, and other job related meetings, and substantial completion and final payment inspections.

**C. Access and Approvals**

1. OWNER shall arrange for access to and make all provisions for ENGINEER to enter upon public and private property as required for ENGINEER to perform its services under this Agreement. ENGINEER acknowledges that OWNER as a governmental entity must take certain steps to lawfully access private property; ENGINEER shall notify OWNER of the need to access private property which shall allow sufficient time for the OWNER to take those necessary steps. ENGINEER shall coordinate with OWNER with respect to access to public or private property.
2. OWNER shall assist the ENGINEER in the completion of all applicable forms and permits required by governmental authorities having jurisdiction over the PROJECT. OWNER shall provide all fees associated with the applications for forms and permits. OWNER will approve and execute all forms and permits prior to forwarding to governmental authorities.

**D. Coordination**

1. If OWNER designates a person to represent OWNER at the site other than ENGINEER, the duties, responsibilities and limitations of authority of such other person and the effect thereof on the duties and responsibilities of ENGINEER will be set forth in an "Exhibit D" that is to be identified, attached to and made a part of this Agreement before such services begin.
2. If more than one prime contract is to be awarded for construction, materials, equipment and services for the entire PROJECT, OWNER shall designate prior to the start of construction a person or organization to have authority and responsibility for coordinating the activities among the various prime contractors.

**E. Notice**

1. OWNER shall give reasonable written notice to ENGINEER whenever OWNER observes or otherwise becomes aware of any development that affects the scope or timing of ENGINEER's services, or any defect or nonconformance in the work of ENGINEER or any Contractor.
2. The ENGINEER is responsible for any of its work that violates sound engineering practices and policies, and/or the intent of the scope of the PROJECT.

**ARTICLE 3  
COMPENSATION AND PAYMENT**

**A. METHODS OF PAYMENT FOR SERVICES AND REIMBURSABLE EXPENSES**

1. OWNER will compensate ENGINEER for the performance of the services described in the Scope of Work (EXHIBIT A), part 1 in accordance with the Terms and Conditions of the attached EXHIBIT B.
2. OWNER shall compensate ENGINEER for the Additional Services performed or furnished under EXHIBIT A, Part 2, as set forth in EXHIBIT B.

- OWNER shall compensate ENGINEER for reimbursable expenses over and above the services provided for in paragraphs 3.A.1 and 3.A.2 incurred by ENGINEER and ENGINEER's consultants as set forth in EXHBIT C.

#### **B. OTHER PROVISIONS CONCERNING PAYMENTS**

- Preparation of Invoices – Invoices will be prepared in accordance with ENGINEER's standard invoicing practices and will be submitted to OWNER by ENGINEER unless otherwise agreed. The amount billed each invoice will be calculated and set forth in Exhibit B.
- Payment of Invoices – Invoices are due and payable within 30 days of receipt. If OWNER fails to make payment due ENGINEER for services and expenses within 90 days after receipt of ENGINEER's invoice therefore, the amounts due the ENGINEER will be increase at a rate of 1.0% per month (or maximum rate allowable by law, if less) from said ninetieth day. In addition, ENGINEER may, after giving seven days written notice to OWNER, suspend the services under this agreement until ENGINEER has been paid in full amounts due for services, expenses and other related charges. Payments will be credited first to interest and then to principal.
- Disputed Invoices – In the event of a disputed or contested invoice, only that portion so contested may be withheld from payment, and the undisputed portion will be paid. All Dispute resolution shall be handled in the process specified in Article 11 Paragraph F.

#### **4. PAYEMENTS DUE UPON TERMINATION**

- In the event of any termination under Paragraph 10.A & 10. B; ENGINEER will be entitled to invoice the OWNER and will be paid in accordance with Exhibit B for all services performed and furnished and all reimbursable expenses incurred through the effective date of termination.
  - In the event of termination by OWNER for convenience or by ENGINEER for cause, ENGINEER, in addition to invoicing for those items identified in paragraph 3.B.4.i, shall be entitled to invoice OWNER and shall be paid a reasonable amount for services and expenses directly attributable to termination, both before and after the effective date of termination, costs of terminating contracts with ENGINEER's sub consultants, and other related closeout costs, using methods and rates as set forth in EXHIBIT C.
- Records of ENGINEER's Costs – Records of ENGINEER's costs pertinent to ENGINEER's compensation under this agreement shall be kept in accordance with generally accepted accounting practices. To the extent necessary to verify ENGINEER's charges and upon OWNER's timely requests, copies of such records will be made available to OWNER at no cost.

### **ARTICLE 4 TIME FOR PERFORMANCE**

#### **A. COMMENCEMENT/COMPLETION**

ENGINEER shall commence the performance of the services for the PROJECT upon the date of this Agreement and complete the work in accordance with such schedule attached as part 3 of Exhibit A as may be mutually agreed to by the parties.

#### **B. SUSPENSION**

If OWNER fails to give prompt written authorization to proceed with any phase of the services after completion of the immediately preceding phase, or if the ENGINEER's services are delayed at no fault of ENGINEER, ENGINEER may, after giving seven days written notice to OWNER, suspend services under this agreement.

#### **C. LIQUIDATED DAMAGES**

Timely completion is an essential element of this contract. Final Plans shall be completed by the dates outlined in the schedule as set forth in Exhibit A Part 3. One hundred dollars per calendar day (**\$100 / calendar day**) will be deducted from any money due to ENGINEER for work not completed by the dates. The amount specified above is not a penalty but liquidated damages for loss to the City and the public.

**ARTICLE 5  
CHANGES IN THE WORK**

- A. CHANGES** - OWNER reserves the right, without impairing this Agreement, to order changes or alterations in the work to be performed hereunder by ENGINEER. If changes or alterations ordered affect the cost or progress of the work, adjustment shall be made in the time for performance of the work and compensation owing to ENGINEER, as the case may be. These said changes must be agreed upon by both parties prior to the work beginning, and a scope of work change must be executed.
- B. CONCEALED CONDITIONS** - Should concealed or unknown conditions be encountered in the performance of the work which present the risk of discharge, dispersal, release or escape of asbestos, any hazardous substance or any hazardous waste, ENGINEER shall promptly suspend its performance of the Work for the protection of the parties and their employees and notify OWNER of the conditions encountered. OWNER and ENGINEER shall promptly investigate the conditions and, if warranted, equitable and necessary adjustments shall be made in the terms and conditions of this Agreement. It is agreed, however, that ENGINEER shall have no duty to determine the existence of any hazardous substance or hazardous waste at the site of the work or to provide response action services even with equitable adjustments. The WORK shall be suspended until such time as the services of a qualified professional is acquired to assess the condition and make a recommendation for mitigation and or response. The ENGINEER will be compensated for the impact that the concealed condition has on its services rendered.

**ARTICLE 6  
STANDARD OF CARE**

- A.** ENGINEER represents that its services shall be performed with the skill and care which would be exercised by comparable qualified design professionals performing similar services at the time and place such services are performed. If the failure to meet these standards results in deficiencies in its services, ENGINEER shall furnish at its own cost and expense, the additional services, labor, materials and equipment necessary to correct such deficiencies. The City reserves the right to seek other remedies.
- B.** ENGINEER shall be responsible for the technical accuracy of its services and documents resulting therefrom, and OWNER shall not be responsible for discovering deficiencies therein. ENGINEER shall correct deficiencies without additional compensation regardless of the state of the project in which the error or omission is discovered.
- C.** ENGINEER shall perform or furnish professional engineering and related services in all phases of the PROJECT to which this agreement applies. ENGINEER shall serve as OWNER's prime professional for the PROJECT. ENGINEER may employ such consultant as ENGINEER deems necessary to assist in the performance or the furnishing of the services. ENGINEER shall not be required to employ any ENGINEER's Consultant unacceptable to ENGINEER. ENGINEER shall not employ any ENGINEER's sub consultants unacceptable to the OWNER.
- D.** ENGINEER and OWNER shall comply with acceptable Laws and Regulations and OWNER mandated standards. This agreement is based on these requirements as of its effective date. Changes to these requirements after the effective date of this agreement may be the basis for modifications to OWNER's responsibilities or to the ENGINEER's scope of services, times of performance, or compensation.
- E.** OWNER shall make decisions and carry out its other responsibilities in a timely manner and shall bear all costs incident thereto so as to not delay the services of ENGINEER. ENGINEER shall expedite the design as specified in this document.
- F.** Prior to the commencement of the Construction Phase, OWNER shall notify ENGINEER of any variation from the language indicated in the Exhibit E - "Notice of Acceptability of Work", or of any other notice or certification the ENGINEER will be requested to provide to OWNER or third parties in connection with the PROJECT. OWNER and ENGINEER shall reach an agreement on the terms of any such requested notice or certification, and OWNER shall authorize such additional services as are necessary to enable ENGINEER to provide the notices or certifications requested.
- G.** ENGINEER shall not be required to sign any documents, no matter who requested, that would result in the ENGINEER having to certify, guarantee, or warrant the existence of conditions whose existence the ENGINEER cannot ascertain. OWNER agrees not to make resolution of any dispute with the ENGINEER or payment of any amount due to the ENGINEER in any way contingent upon ENGINEER signing any such certification.

- H. During Construction Phase ENGINEER shall not supervise, direct or have control over Contractor's work nor shall ENGINEER have authority over or responsibility for the means, methods, techniques, sequences, or procedures of construction selected by Contractor, for safety precautions and programs incident to the Contractor's work in progress, nor for any failure of the Contractor to comply with Laws and Regulations applicable to the Contractor's furnishing and performing the Work.
- I. ENGINEER neither guarantees the performance of any Contractor nor assumes responsibility for any Contractor's failure to furnish and perform the Work in accordance with the Contract Documents.
- J. ENGINEER shall not be responsible for the acts or omissions of any Contractor(s), subcontractor, or supplier, or if any of the Contractor's agents or employees or any other persons (except ENGINEER's own employees or ENGINEER'S sub consultant, acting under the direction of the ENGINEER) at the site or otherwise furnishing or performing any of the Contractor's work; or if any decision made on interpretations or clarifications of the Contract Documents given by the OWNER without consultation and advice of ENGINEER.
- K. The General Conditions for any construction contract documents prepared hereunder are to be the "Standard General Conditions of the Construction Contract" as prepared by the Engineers Joint Contract Documents Committee (Document No. 1910-8, 1996 Edition) unless both parties mutually agree to use other General Conditions.

## **ARTICLE 7 INDEMNITY**

### **A. ENGINEER's Duty**

ENGINEER shall indemnify and hold harmless OWNER against all claims and suits by third parties for loss of or damage to property, or personal injury, including death, to persons, and from all judgments and recovered therefore, and from all expenses for defending such claim or suit, including court costs and attorney's fees, arising out of claims relating to the negligent acts, errors or omissions of ENGINEER in connection with ENGINEER'S performance of this Agreement. In no event shall ENGINEER have any duty to indemnify OWNER hereunder against claims arising as a result of OWNER'S sole negligence. ENGINEER'S indemnity obligation does not include any third party claims or suits arising out of errors or omissions in ENGINEER'S services due to ENGINEER being required, directly or indirectly by OWNER to take certain actions contrary to the recommendations of ENGINEER or which have the effect of eliminating safety related features in order to design within funding limitations or both. The parties acknowledge that ENGINEER shall be obligated to pay the OWNER'S costs of defense, including court costs and attorney's fees, in response to the claims covered by this section, but, ENGINEER shall not be required to provide such a defense. ENGINEER shall cooperate with the OWNER in defending all such claims described in this section and shall pay the costs of OWNER'S defense within 30 days following invoice therefor.

### **B. OWNER's Duty**

1. OWNER agrees to release, waive all rights of subrogation against, defend, indemnify and hold ENGINEER harmless from all claims, liabilities, demands, costs, expenses (including attorney's fees) and causes of action arising out of errors or omissions in ENGINEER's services due to ENGINEER being required, directly or indirectly, by OWNER to take certain actions contrary to the written recommendations of ENGINEER that notify the OWNER that the OWNER's direction will negatively impact service or safety of the project and is contrary to sound engineering practice or which have the effect of eliminating safety related features in order to design within funding limitations or both.

## **ARTICLE 8 LIMITATION OF LIABILITY**

OWNER agrees that in no event will ENGINEER be liable under this Agreement for any consequential, special, contingent or penal damages, including but not limited to loss of revenue, loss of profit, operating costs or business interruption losses, regardless of cause, including breach of contract, tort (including sole or concurrent negligence), strict liability or otherwise of ENGINEER, except to the extent of the compensation paid to ENGINEER.

## ARTICLE 9 INSURANCE

ENGINEER shall, unless otherwise approved in writing by Owner, obtain and maintain throughout the duration of this Agreement (or as otherwise specified) insurance written through a company duly authorized to conduct business in the State of Missouri and with a A.M. Best Rating of A-IX or higher and of the types and in the amounts described below.

- A.** Errors and Omissions Insurance (Professional Liability). Errors and omissions insurance with a limit of \$2,000,000 per claim/ \$2,000,000 aggregate. Such insurance shall cover all services provided by ENGINEER hereunder. In the event the ENGINEER also provides construction management services, such services shall be included in the coverage. Owner may on a project-by-project basis request the ENGINEER to provide a “project policy” with a five-year “extended reporting period” endorsement. Such requirement shall be by written amendment to the Agreement. All coverage shall be retroactive to the earlier of the date of this Agreement or the commencement of the ENGINEER’s services in relation to any Project authorized hereunder, covering personal injury, bodily injury and property damage.
- B.** Commercial General Liability (CGL) Insurance. Commercial general liability (“CGL”) in the amount of \$1,000,000 Each Occurrence, \$2,000,000 General Aggregate, \$2,000,000 Products/Completed Operations Aggregate, \$1,000,000 Personal Injury/Advertising Injury. The policy shall be endorsed so that the General Aggregate limit applies separately to each Project authorized hereunder.
1. CGL insurance shall cover liability arising from premises, operations, independent contractor, products-completed operations and personal injury and advertising liability and liability assumed under an insured contract (including the tort liability of another assumed in a business contract).
  2. Owner shall be included as an Additional Insured under the CGL, using an ISO Additional Insured Endorsement or equivalent. This insurance shall apply as primary insurance with respect to any other insurance or self-insurance programs afforded to, or maintained by, Owner.
  3. A Waiver of Subrogation in favor of the Owner shall be provided as an endorsement to the policy.
- C.** Business Auto Liability Insurance. Business auto liability and, if necessary, commercial umbrella insurance with a limit of \$1,000,000 each accident. Such insurance shall cover liability arising out of any auto (including owned, hired and non-owned autos). Owner shall be named as an additional insured and a waiver of subrogation in favor of the Owner shall be endorsed to the policy.
- D.** Workers Compensation Insurance. Workers' compensation and employer's liability insurance.
1. ENGINEER shall carry statutory Workers' Compensation Insurance as required by any applicable law or regulation. Employers Liability Insurance shall be in amounts of \$1,000,000 each accident for bodily injury, \$1,000,000 for bodily injury by disease and \$1,000,000 each employee for bodily injury by disease.
  2. A waiver of subrogation in favor of the Owner shall be endorsed to the policy.
- E.** Excess Umbrella Insurance. Excess umbrella liability insurance with a limit of \$1,000,000 per occurrence /\$1,000,000 aggregate, in excess of the above employer's liability, automobile liability and commercial general liability policies.
- F.** By requiring the insurance as set out herein, Owner does not represent that coverage and limits will necessarily be adequate to protect ENGINEER, and such coverage and limits shall not be deemed as a limitation on ENGINEER’s liability under the indemnities provided to Owner in this Agreement, or any other provision of the Contract Documents.
- G.** Prior to commencing the work, ENGINEER shall furnish Owner with a certificate(s) of evidence of insurance (ACORD Form 25 or equivalent), executed by a duly authorized representative of each insurer, showing compliance with the insurance requirements set forth above. Any endorsements confirming additional insured status, primary coverage and waivers of subrogation must accompany the insurance certificate(s).

1. All policies shall provide for thirty (30) days' written notice to Owner prior to the cancellation or material change of any insurance referred to therein. A copy of such endorsement must accompany the insurance certificate(s).
  2. Failure of Owner to demand such certificate or other evidence of full compliance with these insurance requirements or failure of Owner to identify a deficiency from evidence that is provided shall not be construed as a waiver of ENGINEER's obligation to maintain such insurance.
- H.** Owner shall have the right but not the obligation to prohibit ENGINEER from entering the Project site until such certificates or other evidence that insurance has been placed in complete compliance with these requirements is received and approved by Owner.
- I.** Failure to maintain the insurance required in this Section may result in termination of this Agreement at Owner's option. Owner may, but is not obligated to, obtain any insurance required hereunder and not maintained by the ENGINEER and charge the cost thereof to ENGINEER.
- J.** With respect to insurance maintained after final payment in compliance with a requirement above, an additional certificate(s) evidencing such coverage shall be promptly provided to Owner when requested.
- K.** ENGINEER shall provide certified copies of all insurance policies required above within ten (10) days of Owner's written request for said copies.
- L.** ENGINEER shall include the above requirements for types of insurance requirements in all of its subcontracts. Limit amounts for subcontractors may be less than those set forth above, upon written agreement of Owner. ENGINEER shall be responsible for collecting certificates of insurance and monitoring insurance coverage of its subcontractors to verify that the required coverage is maintained as required. All Subcontractors providing professional services shall be required to provide professional liability insurance.
- M.** Owner reserves the right to request ENGINEER to obtain additional insurance and limits on individual Projects authorized hereunder. ENGINEER shall endeavor to obtain such insurance as soon as possible after such request and advise Owner if the ENGINEER will be required to pay any additional premium. If so, the Owner shall pay such additional premium in excess of the premium for the above insurance. If ENGINEER cannot obtain such additional insurance, Owner may terminate this Agreement in full or in part upon notice to ENGINEER.

## **ARTICLE 10 TERMINATION**

### **A. Termination by OWNER**

1. In the event ENGINEER fails to comply with any provisions of this Agreement, or if the progress is unsatisfactory, OWNER may serve written notice hereof upon ENGINEER, and if ENGINEER neglects within a period of seven (7) days thereafter to commence its efforts to correct such failure, to the satisfaction of the OWNER, OWNER may terminate the Agreement upon written notice to ENGINEER. Upon such termination, ENGINEER shall cease its performance of this Agreement and shall deliver to OWNER all completed or partially completed satisfactory work and OWNER shall pay to ENGINEER the amount due for such satisfactory work.
2. OWNER also reserves the right to terminate this Agreement if it abandons or indefinitely postpones the PROJECT. Such termination shall be accomplished by written notice to that effect delivered to ENGINEER. Upon receipt of such notice, ENGINEER shall immediately cease work and deliver to OWNER all completed or partially completed work. Payment to ENGINEER shall be made for work performed up to receipt by ENGINEER of such termination notice, together with ENGINEER's costs for closing down its work, and ENGINEER shall have no claim for loss of anticipated profits or any additional compensation.

### **B. Termination by ENGINEER**

In the event OWNER fails to comply with any provisions of this Agreement, or if it fails to timely pay compensation due to ENGINEER, ENGINEER may serve written notice thereof upon OWNER, and if OWNER fails within a period of seven (7) days thereafter to correct such failure, ENGINEER may terminate this Agreement upon written notice to OWNER. Upon such

termination, ENGINEER shall cease its performance of this Agreement and when paid the amount due for such work, shall deliver to OWNER all completed or partially completed work for the PROJECT.

**C. Termination by OWNER for Convenience**

By OWNER effective upon the receipt of notice by ENGINEER.

The terminating party under paragraphs 10.A.1, 10.A.2, 10.B or 10.C may set the effective date of termination at a time up to 30 days later than otherwise provided to allow ENGINEER to demobilize personnel and equipment from the Site, to complete tasks whose value would otherwise be lost, to prepare notes as to the status of completed and uncompleted tasks, and to assemble Project materials in orderly files.

**ARTICLE 11  
GENERAL CONSIDERATIONS**

**A. Use of Documents**

All documents including Drawings, Specifications, and CADD discs prepared or furnished by ENGINEER pursuant to this Agreement shall become the property of the OWNER upon completion or termination of the Agreement. All documents shall be made available for use by the OWNER without restriction or limitation on its use. If the OWNER incorporates any portion of the work into a project or reuses any portion thereof, without written consent from the ENGINEER, then the owner does so at OWNER's sole risk and OWNER shall indemnify and hold harmless ENGINEER from all claims, damages, losses and expenses including attorneys' fees arising out of or resulting therefrom.

**B. Opinions of Cost**

Since ENGINEER has no control over the cost of labor, materials, equipment or services furnished by others, or over the Contractor(s)' methods of determining prices, or over competitive bidding or market conditions, ENGINEER's opinions of probable Total PROJECT Costs and Construction Costs provided for herein are to be made on the basis of ENGINEER's experience and qualifications and represent ENGINEER's best judgment as an experienced and qualified professional, familiar with the construction industry; but ENGINEER cannot and does not guarantee that proposals, bids or actual Total PROJECT or Construction Costs will not vary from opinions of probable cost prepared by ENGINEER. If, prior to the bidding or negotiating phase of the PROJECT, OWNER wishes greater assurance as to Total PROJECT or Construction Costs, OWNER will employ an independent cost estimator as provided in ARTICLE 2.

**C. Purchase Order Terms**

If OWNER issues a purchase order for the services provided by this Agreement according to OWNER's purchasing procedures, the terms and conditions printed on such purchase order and its supplements or amendments are superseded by this Agreement, and are not applicable to the work.

**D. Controlling Law**

This Agreement is to be governed by the Laws of the State of Missouri.

**E. Successors and Assigns**

1. OWNER and ENGINEER each is hereby bound and the partners, successors, executors, administrators and legal representative of OWNER and ENGINEER are hereby bound to the other party of this Agreement and to the partners, successors, executors, administrators and legal representatives (and said assigns) of such other party, in respect of all covenants, agreements and obligations of this Agreement.
2. Neither OWNER nor ENGINEER shall assign, sublet or transfer any rights under or interest in this Agreement without the written consent of the other, except to the extent that any assignment, subletting or transfer is mandated by law or the effect of this limitation may be restricted by law. Unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under this Agreement. Nothing contained in this paragraph shall prevent ENGINEER from employing such independent professional associates and consultants as ENGINEER may deem appropriate to assist in the performance of services hereunder.

3. Nothing under this Agreement shall be construed to give any rights or benefits in this Agreement to anyone other than OWNER and ENGINEER, and all duties and responsibilities undertaken pursuant to this Agreement will be for the sole and exclusive benefit of OWNER and ENGINEER and not for the benefit of any other party.
4. In the event the Agreement is terminated by the Engineer or the Owner, the Engineer will provide, at the owners request, all plans, tracing, maps, specifications, calculations, survey data, models, topo, design files, computer files, electronic data and files, notes, and all other documents related to the project. The status of these documents should reflect that with which the Engineer has requested payment for or has been paid for.

#### **F. Dispute Resolution**

1. *Notice:* Written notice stating the general nature of each Claim, dispute, or other matter shall be delivered by the claimant to OWNER promptly (but in no event later than 30 days) after the start of the event giving rise thereto. Notice of the amount or extent of the Claim, dispute, or other matter with supporting data shall be delivered to the OWNER within 60 days after the start of such event (unless OWNER allows additional time for claimant to submit additional or more accurate data in support of such Claim, dispute, or other matter).
2. OWNER's *Decision:* OWNER will render a formal decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any. OWNER's written decision on such Claim, dispute, or other matter will be final and binding upon ENGINEER unless:
  - A. an appeal from OWNER's decision is taken within the time limits and in accordance with the dispute resolution procedures set forth in Article 11.G; or
  - B. if no such dispute resolution procedures have been set forth in Article 11.G, a written notice of intention to appeal from OWNER's written decision is delivered by ENGINEER to OWNER within 30 days after the date of such decision, and a formal proceeding is instituted by the appealing party in a forum of competent jurisdiction within 60 days after the date of such decision or within 60 days after Substantial Completion, whichever is later (unless otherwise agreed in writing by OWNER), to exercise such rights or remedies as the appealing party may have with respect to such Claim, dispute, or other matter in accordance with applicable Laws and Regulations.
3. If OWNER does not render a formal decision in writing within the time stated in Article 11.F.2, a decision denying the Claim in its entirety shall be deemed to have been issued 31 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.
4. No Claim for an adjustment in Contract Price or Contract Times (or Milestones) will be valid if not submitted in accordance with this Article 11.F.

#### **G. Mediation**

1. All disputes between ENGINEER and OWNER shall be subject to non-binding mediation. Either party may demand mediation by serving a written notice stating the essential nature of the dispute. Mediation shall commence within sixty (60) days of receipt of notice. The mediator shall be appointed by agreement of the parties. Failing such agreement, the mediator shall be appointed by reference to a Circuit Judge serving in the County of Saint Charles, Missouri. No action or suit between the parties may commence unless:
  - a. The parties fail to hold a mediation within ninety (90) days after service of the written notice as required above;
  - b. A mediation occurred but did not resolve the dispute; or
  - c. A statute of limitation would elapse if suit was not filed.

#### **H. Alien Registration, Compliance and Enforcement**

1. Definitions - as used in this section, the following terms shall have the following meanings:
  - A. "Business entity", any person or group of persons performing or engaging in any activity, enterprise, profession, or occupation for gain, benefit, advantage, or livelihood. The term "business entity" shall include but not be limited to self-employed individuals, partnerships, corporations, contractors, and subcontractors. The term "business entity" shall include any business entity that possesses a business permit, license, or tax certificate issued by the state, any business entity that is exempt by law from obtaining such a business permit, and any business entity that is operating unlawfully without such a business permit. The term "business entity" shall not include a self-employed

individual with no employees or entities utilizing the services of direct sellers as defined in subdivision (17) of subsection 12 of section 288.034, RSMo;

- B. "Contractor", a person, employer, or business entity that enters into an agreement to perform any service or work or to provide a certain product in exchange for valuable consideration. This definition shall include but not be limited to a general contractor, subcontractor, independent contractor, contract employee, project manager, or a recruiting or staffing entity;
  - C. "Employee", any person performing work or service of any kind or character for hire within the state of Missouri;
  - D. "Employer", any person or entity employing any person for hire within the state of Missouri, including a public employer. Where there are two or more putative employers, any person or entity taking a business tax deduction for the employee in question shall be considered an employer of that person for purposes of this section;
  - E. "Employment", the act of employing or state of being employed, engaged, or hired to perform work or service of any kind or character within the state of Missouri;
  - F. "Federal work authorization program", any of the electronic verification of work authorization programs operated by the United States Department of Homeland Security or an equivalent federal work authorization program operated by the United States Department of Homeland Security to verify information of newly hired employees, under the Immigration Reform and Control Act of 1986 (IRCA), P.L.99-603;
  - G. "Knowingly", a person acts knowingly or with knowledge,
  - H. With respect to the person's conduct or to attendant circumstances when the person is aware of the nature of the person's conduct or that those circumstances exist; or
  - I. With respect to a result of the person's conduct when the person is aware that the person's conduct is practically certain to cause that result;
  - J. "Municipality", the City of O'Fallon, Missouri.
  - K. "Public employer", every department, agency, or instrumentality of the state of Missouri or any political subdivision of the state of Missouri;
  - L. "Unauthorized alien", an alien who does not have the legal right or authorization under federal law to work in the United States, as defined in 8 U.S.C. 1324a(h)(3);
  - M. "Work", any job, task, employment, labor, personal services, or any other activity for which compensation is provided, expected or due, including but not limited to all activities conducted by business entities.
2. Illegal Acts
- A. No business entity or employer may knowingly employ, hire for employment, or continue to employ an unauthorized alien to perform work within the municipality.
  - B. Accordingly, if the amount to be paid pursuant to this contract or grant exceeds five thousand dollars by the municipality the contracting or grant recipient business entity shall, as a condition of the award of contract or grant, by sworn affidavit and provision of documentation, affirm its enrollment and participation in a federal work authorization program with respect to the employees working in connection with the contracted services. Every such business entity shall also sign an affidavit affirming that it does not knowingly employ any person who is an unauthorized alien in connection with the contracted services. No such business entity or employer shall violate subsection 2A of this section.
  - C. The affidavit shall be approved as to form by the municipal attorney.

- D. An employer may enroll and participate in a federal work authorization program and shall verify the employment eligibility of every employee in the employer's hire whose employment commences after the employer enrolls in a federal work authorization program. The employer shall retain a copy of the dated verification report received from the federal government. Any business entity that participates in such program shall have an affirmative defense that such business entity has not violated subsection 2A of this section.
- E. A general contractor or subcontractor of any tier shall not be liable under subsection 2A of this section when such general contractor or subcontractor contracts with its direct subcontractor who violates subsection 2A of this section, if the contract binding the contractor and subcontractor affirmatively states that the direct subcontractor is not knowingly in violation of subsection 2A of this section and shall not henceforth be in such violation and the contractor or subcontractor receives a sworn affidavit under the penalty of perjury attesting to the fact that the direct subcontractor's employees are lawfully present in the United States.
- F. The determination of whether a worker is an unauthorized alien shall be made by the federal government. A determination of such status of an individual by the federal government shall create a rebuttable presumption as to that individual's status in any judicial proceedings brought under this section.
- G. Should the federal government discontinue or fail to authorize or implement any federal work authorization program, the municipality shall review this section for the purpose of determining whether this section is no longer applicable and should be repealed.

Accordingly, the parties have executed this Agreement in the prescribed form and manner, effective as of the day and year of the signature of the last party to execute the Agreement.

City of O' Fallon, Missouri, OWNER

BY: \_\_\_\_\_ DATE \_\_\_\_\_  
City Administrator

ATTEST:

\_\_\_\_\_  
City Clerk

\_\_\_\_\_, **ENGINEER**

BY: \_\_\_\_\_ Date \_\_\_\_\_

\_\_\_\_\_  
(Printed Name / Title)

ATTEST:

\_\_\_\_\_

\_\_\_\_\_  
(Printed Name / Title)



# Filter Evaluation and Pre-Oxidation Study



**City of O'Fallon, MO**

**O'Fallon Filter Evaluation and Pre-Oxidation Study  
Project No. 148570**

**FINAL  
September 2023**

# **Filter Evaluation and Pre-Oxidation Study**

prepared for

**City of O'Fallon, MO  
O'Fallon Filter Evaluation and Pre-Oxidation Study  
O'Fallon, MO**

**Project No. 148570**

**September 2023**

prepared by

**Burns & McDonnell Engineering Company, Inc.  
Kansas City, MO**

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## INDEX AND CERTIFICATION

**City of O'Fallon, MO  
Filter Evaluation and Pre-Oxidation Study  
Project No. 148570**

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### Certification

I hereby certify, as a Professional Engineer in the state of Missouri, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the City of O'Fallon, MO or others without specific verification or adaptation by the Engineer.



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Rachel Drain, P.E. (Missouri P.E. No. 2021025013 )

Date: September 21, 2023

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**LIST OF ABBREVIATIONS**

<b><u>Abbreviation</u></b>	<b><u>Term/Phrase/Name</u></b>
ACH	Aluminum Chlorohydrate
AWWA	American Water Works Association
BMcD	Burns & McDonnell
cfm	Cubic feet per minute
City	City of O'Fallon, MO
CRT	Concrete, Research, and Testing
DO	Dissolved Oxygen
EQ	Equalization
Fe	Iron
Fe <sup>+2</sup>	Ferrous Iron
Fe <sup>+3</sup>	Ferric Iron
ft	Feet
fps	Feet per second
gal	Gallons
gpm	Gallons per Minute
MCL	Maximum Contaminant Level
MDNR	Missouri Department of Natural Resources
mg/L	Milligrams per Liter
MGD	Million Gallons per Day
Mn	Manganese
NTU	Nephelometric Turbidity Units

<b><u>Abbreviation</u></b>	<b><u>Term/Phrase/Name</u></b>
OPC	Opinion of Probable Cost
PACl	Polyaluminum Chloride
PFD	Process Flow Diagram
RO	Reverse Osmosis
sf	Square Feet
SMCL	Secondary Maximum Contaminant Level
TOC	Total Organic Carbon
UC	Uniformity Coefficient
UFRV	Unit Filter Run Volume
UV	Ultraviolet
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

## 1.0 EXECUTIVE SUMMARY

The City of O'Fallon, MO operates a Water Treatment Plant (WTP) with alluvial wells as its water source. The incoming water contains high levels of iron, manganese, and hardness, which are removed through various treatment processes within the WTP. Although the WTP meets regulatory requirements for water quality, City Staff and previous studies have identified needs for optimization and improvements throughout the WTP, particularly related to oxidation and removal of iron and manganese, corrosion from the use of chlorine as a pre-oxidant, and the condition and performance of filtration.

This study reviewed the effectiveness of the pre-oxidation, aeration, settling, and filter processes to remove iron and manganese from the treated water. Filter health and performance was also evaluated, as were options for handling of the solids removed within the water treatment processes. The major findings from these evaluations are as follows:

1. The existing aeration process is ineffective at generating the desired levels of dissolved oxygen within the water for oxidation of iron. Replacement of the aerator nozzles with cascade or induced draft aerators is recommended to improve effectiveness of the aeration process.
2. Existing use of chlorine for oxidation of manganese is inefficient, leading to large chlorine doses, significant chlorine residual in the filters, and corrosion of critical equipment and building components from chlorine off-gassing. Contact time within the plant is limited; however, addition of baffling within the aeration and detention basins will not significantly improve oxidation of manganese. The use of permanganate to supplement chlorine and aeration, is recommended to provide a good balance of chemical costs, effective oxidation, and reduction of corrosion. This will require installation of a new storage and feed system for permanganate.
3. The existing flocculator units do not have adequate mixing or contact time to support use of a coagulant. Jar testing results support continued use of existing polymer type and dose range. Increasing cleaning frequency of the plate settlers should be considered to help mitigate solids carryover.
4. Filter underdrains have been compromised and filter rehabilitation is recommended (and currently in progress at the time of writing this report).
5. Current filter backwashing procedures do not result in clean media. Opening/closing time of the backwash supply control valve(s) should be reviewed and the duration of the high flow step of the backwash procedure should be extended. These measures will allow for better solids removal.
6. Several alternatives are available for residuals handling at the WTP; however, many are likely to be high cost and increase operational complexity at the WTP. The existing Equalization (EQ) Basin can be utilized as a gravity thickener with some operational modifications and additional

pumps to allow separate streams of solids and decant water to be transferred for disposal at the wastewater treatment plant (WWTP). These modifications are recommended to reduce the impact that the WTP residuals appear to be having on the WWTP UV disinfection system.

The evaluations conducted and results obtained are described in the sections within this report. A summary of operational and capital recommendations, along with their associated opinions of probable costs, are provided in Section 8.0.

## 2.0 INTRODUCTION

The City of O’Fallon, MO operates a Water Treatment Plant (WTP) with alluvial wells as its water source. The incoming water contains high levels of iron, manganese, and hardness, which are removed through various treatment processes within the WTP. Although the WTP meets regulatory requirements for water quality, City Staff and previous studies have identified needs for optimization and improvements throughout the WTP, particularly related to oxidation and removal of iron and manganese, corrosion from the use of chlorine as a pre-oxidant, and the condition and performance of filtration.

### 2.1 Scope

The scope of this evaluation includes the following major items:

- Analysis of historical filter data and performance;
- Physical inspection of filters;
- Evaluation of filter backwash procedure and its effectiveness;
- Analysis of historical iron and manganese removal throughout the plant;
- Review of the existing aeration system;
- Review of alternative oxidants and injection locations;
- Performance of jar testing to evaluate chemical additions to improve oxidation and particle removal; and
- Evaluation of alternatives for residuals disposal.

### 2.2 Existing Water Treatment Plant Facilities

The City of O’Fallon owns, operates, and maintains their WTP and distribution system. The raw water supply consists of groundwater from five (5) alluvial wells. The WTP has a rated capacity of 6 MGD and utilizes pre-oxidation with free chlorine, aeration and detention, flocculation, sedimentation with plate settlers, dual media filtration, reverse osmosis (RO), chlorine for disinfection, and ammonia addition to form monochloramine prior to the distribution system. Half of the water treated with flocculation and filtration is subsequently processed in a sidestream RO process. A process flow diagram (PFD) of the WTP is provided in Appendix A.

The groundwater is classified as high hardness and alkalinity, low total organic carbon (TOC), with high iron and manganese. The high levels of dissolved iron and manganese require pre-oxidation prior to physical removal processes. A high dose of sodium hypochlorite, generally ranging between 8 and 15 mg/L, is currently added to the raw water for pre-oxidation. After less than a minute of contact time, the

groundwater flows to the aeration basin where nozzles spray the water into the air to increase the air-water ratio and transfer dissolved oxygen into solution. The aeration basin is a rectangular concrete basin with a single baffle. The aeration nozzles are located on two feed pipes that span the length of the basin. The design is to operate both aeration pipes simultaneously but plant staff report that spray patterns are better with all flow directed through a single pipe, so this is the normal mode of operation. The plant also limits the level in the basins to 14 feet to keep the water level below the aeration nozzles for maximum spray action. A picture of the aeration basin and detention basin is included as Figure 2-1 below with a single aerator in operation.



**Figure 2-1: Aeration and Detention Basin**

Downstream of the aeration basin, the aerated water flows through the detention basin which is located adjacent to the aeration basin. The detention basin does not have any baffling to prevent short circuiting. Low lift pumps are submerged at the effluent end of the detention basin to pump water to the plate settler units that provide flocculation and settling via parallel plates. There are four plate settler units (Figure 2-2) that operate in parallel during normal operation. Each plate settler unit is designed for 1493 gpm (2.1 MGD). The plate settler units remove settleable solids from the water and send them to the equalization basin via automatic blowdown valves.



**Figure 2-2: Plate Settler Units**

From the plate settlers, the water flows by gravity to the filters. The WTP utilizes five conventional gravity filters. Each filter was designed for a capacity of 1500 GPM (2.1 MGD); however, operations staff indicate they can't be operated at these flows due to the high solids loading. Filters 1-4 have been in operation since 2003 and Filter 5 was constructed in 2010. Filter 1 was rehabilitated in 2012, followed by rehabilitation of Filters 2, 3 and 4 in 2014. At the time of writing this report, efforts are in progress to rehabilitate all five filters due to underdrain failures that occurred in Filters 2 and 5 within the time of this study.

The WTP is designed to send 50 percent of the gravity filter effluent through reverse osmosis (RO) for hardness removal. This flow is pumped by low-lift pumps into cartridge filters, and then high-pressure feed pumps send it through the RO membrane skids. The RO permeate is aerated and then re-combined with the remaining half of the gravity filter effluent. The combined stream is dosed with additional

sodium hypochlorite to achieve a target finished water chlorine residual and then pumped into finished water reservoir tanks. Finally, ammonia is added in the high service pump suction header and four high service pumps are used to send the treated water to the distribution system.

### 2.3 Current WTP Challenges

The WTP has a variety of challenges, including the following related to this study:

- The high dose of chlorine to the raw water has caused corrosion in the raw water piping.
- The maintained chlorine residual through the filters leads to chlorine off-gassing and has caused corrosion throughout the Filter Building. This includes corrosion on the steel filter tanks, structural elements of the metal building, stainless steel vessels of the cartridge filters, and portions of the RO skids.
- Visible corrosion is present on the exterior of the filter tanks and past modifications have indicated on-going flexing and corrosion of the bottoms of the tanks.
- Significant amounts of iron and manganese pass through the plate settlers and are still present in the filter influent, resulting in high loading on the filter media.
- The residual stream from the WTP is primarily a combination of plate settler blowdown and filter backwash waste. These streams are sent to an equalization basin and then pumped to the O'Fallon Wastewater Treatment Plant (WWTP). The high quantity of iron and manganese particles in this waste stream has been identified as a contributing factor to poor performance of the WWTP's ultraviolet (UV) disinfection system.
- Although not known at the beginning of this study, during the study underdrains in Filters 2 and 5 failed and significant accumulation of filter media was discovered in the Low Lift Pump Station and Cartridge Filters. Additionally, several valves on the filters were identified as not seating fully, leaking, and aged.

The City obtained the services of Burns & McDonnell (BMcD) to perform an evaluation of the existing filters and pre-oxidation system. This report documents the results of the process evaluation, recommended improvements, and conceptual designs.

## 2.4 Iron and Manganese Oxidation

Iron (Fe) and manganese (Mn) are naturally occurring minerals and are found in groundwater supplies throughout the United States. Many treatment facilities remove soluble iron and manganese to minimize the potential for complaints from customers related to water discoloration. Both minerals have EPA secondary maximum contaminant levels (SMCL) based on taste and discoloration. Iron, which has a SMCL of 0.3 mg/L, has a metallic taste, red or rusty color, and will cause reddish to orange staining. Manganese, which has a SMCL of 0.05 mg/L, has a bitter taste, can have a pink, purple, or dark color, and can cause dark brown or black stains. Water industry experience has shown that water quality complaints occur when levels are at or slightly above the SMCL. Furthermore, for the O'Fallon WTP, iron and manganese can cause fouling of RO membranes and must be removed prior to the RO system.

Both iron and manganese can be present in the soluble or oxidized form as water is pumped from the raw water wells. If the water appears clear, but turns red or cloudy upon exposure to air, the majority of the iron is dissolved and present in the Fe+2 (ferrous) oxidation state. When oxidized to Fe+3 (ferric), the water will turn cloudy and/or shades of red due to non-soluble iron particles. Naturally occurring manganese in the soluble form is in the Mn+2 oxidation state. When oxidized to Mn+4, the precipitate manganese dioxide (MnO<sub>2</sub>) will form, causing a brown to black color. It is important to note that both metals in the oxidized form will exist as particulates which can be removed by precipitation, sedimentation, and filtration. In general, iron is more readily oxidized than manganese using aeration and chemical oxidation. Manganese requires double the oxidant dosing, has slower oxidation kinetics, and can be difficult to completely oxidize with chlorine. While aeration can be very effective for iron oxidation, it does very little for manganese oxidation.

A summary of iron oxidation reactions and manganese reactions are included in Table 2-1 and Table 2-2, which show the oxidant amount, pH, and reaction time needed to completely oxidize iron or manganese. Overall, the time required to oxidize manganese is greater than the time to oxidize iron.

**Table 2-1: Summary of Iron Oxidation Reactions**

Oxidant	Oxidant needed to oxidize 1 mg of Fe <sup>2+</sup> (mg)	pH	Reaction Time
Oxygen	0.14	>7.5	15 min
Chlorine	0.64	>8	15-30 min
Potassium Permanganate	0.94	>5.5	<20 sec
Ozone	0.43		Instantaneous
Chlorine Dioxide	1.2	>5.5	10 sec

Source: AWWA Iron and Manganese Removal Handbook 2015

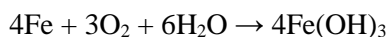
**Table 2-2: Summary of Manganese Oxidation Reactions**

Oxidant	Oxidant needed to oxidize 1 mg of Mn <sup>2+</sup> (mg)	pH	Reaction Time
Oxygen	0.29	>9	>1 hr
Chlorine	1.3	>8	2-3 hr
Potassium Permanganate	1.92	>5.5	<20 sec
Ozone	0.88		10-30 sec
Chlorine Dioxide	2.5	>5.5	10 sec

Source: AWWA Iron and Manganese Removal Handbook 2015

## 2.5 Aeration and Oxidants

In aeration, oxygen reacts with iron in the raw water to produce insoluble ferric hydroxide Fe(OH)<sub>3</sub> particles via the following reaction.



This translates to a need for 0.14 mg/L of oxygen for every 1 mg/L of iron to be oxidized. Variables that impact the effectiveness of aeration include dissolved oxygen (DO), pH, temperature, and reaction time. The amount of DO in water at 100 percent saturation is 9 mg/L at 20°C and increases approximately 1 mg/L for each 5°C temperature decrease. Increasing DO will increase iron oxidation from aeration. After the aeration saturates the raw water with DO, additional air will result in diminishing returns for iron oxidation. Similarly, the aeration process requires adequate reaction time to be effective. If the hydraulic loading is too high or DO is too low, the aeration process performance will be reduced.

Chlorine is also used to oxidize iron and manganese. When chlorine is added to water, it will react with organics, ammonia, nitrogen compounds, iron (Fe<sup>+2</sup>), and manganese (Mn<sup>+2</sup>). While free chlorine is effective for oxidation of iron, it requires higher doses and contact time for manganese oxidation because the reaction kinetics are slow, typically requiring two to three hours of contact time. A study by Knocke et al. (1990) showed that Mn<sup>+2</sup> oxidation with chlorine was more effective at higher pH (9.0 compared to 7.0), higher temperatures (25°C compared to 14°C), and required a chlorine dose higher than the stoichiometric requirements for dissolved Mn. As a result, a stronger oxidant, such as potassium permanganate, is typically used to oxidize manganese from Mn<sup>+2</sup> to Mn<sup>+4</sup>.

### 3.0 OPERATING DATA

#### 3.1 Raw and Finished Water Quality

The City provided daily average raw and finished water quality data from January 1<sup>st</sup>, 2021 through July 11<sup>th</sup>, 2022 as a basis for this study. The raw water quality data is summarized in Table 3-1 and the finished water quality is presented in Table 3-2.

**Table 3-1: Raw Water Quality Summary**

	Unit	Min	5 <sup>th</sup> Percentile	Average	95 <sup>th</sup> Percentile	Max
pH		6.75	6.97	7.07	7.18	7.25
Temperature	°F	53.9	56.1	59.3	62.8	66.4
Hardness	mg/L	184	202	220	236	252
Total Alkalinity	mg/L	186	206	221	236	262
Conductivity	mS/cm	292	395	448	557	584
Silica	ppm	10.8	19.8	25.4	30.2	36.5
Fluoride	ppm	0.00	0.10	0.19	0.29	1.53
Iron	ppm	4.00	5.21	8.02	10.9	13.1
Manganese	ppm	0.08	0.57	0.72	0.89	1.60

**Table 3-2: Finished Water Quality Summary**

	Unit	Min	5 <sup>th</sup> Percentile	Average	95 <sup>th</sup> Percentile	Max	MCL / [SMCL]
pH		7.54	7.66	7.80	7.97	8.20	[6.5-8.5]
Temperature	F	51.8	57.4	59.9	62.6	63.5	-
Turbidity	NTU	0.05	0.10	0.12	0.18	0.56	0.3
Hardness	mg/L	84	90	119	176	224	-
Total Alkalinity	mg/L	91	100	130	187	239	-
Conductivity	mS/cm	154	213	289	394	513	-
TDS	mS/cm	130	151	205	287	340	500
Free Chlorine	mg/L	0.01	0.07	0.12	0.22	0.94	-
Total Chlorine	mg/L	1.57	2.10	2.43	2.68	2.87	4
Iron	mg/L	0.001	0.004	0.02	0.05	0.50	[0.3]
Manganese	mg/L	0.004	0.01	0.02	0.04	0.22	[0.05]
Fluoride	mg/L	0.01	0.01	0.10	0.21	0.54	[2.0]
Ammonia	mg/L	0.04	0.26	0.42	0.57	1.55	-

The raw water pH ranges between 6.75 and 7.25 with an average value of 7.10. The temperature is within the typical range for alluvial wells in this area. The raw water has high hardness and alkalinity with average values of 220 mg/L and 220 mg/L, respectively. Finished water hardness varies and is highly dependent on the influent hardness, whether or not RO is in operation, and what percent of the stream is treated by RO. There is not a secondary maximum contaminant level (SMCL) for hardness, however very hard water can result in residential complaints due to calcium carbonate precipitation and scale build-up. Operational adjustments could be made to increase/decrease the RO stream to target a more consistent effluent hardness; however, that is not the current mode of operation. Some fluoride is present in the raw water and the finished water level is under the maximum contaminant level (MCL); however, fluoride in the finished water is below industry recommended values for dental protection. The raw water has high levels of iron and manganese, with average values of 8 and 0.7 mg/L, respectively. The WTP treatment process is currently able to reduce these values to acceptable levels in the finished water, but can struggle with maintaining low values. Overall, the effluent water quality meets the applicable MCLs and SMCLs for water quality parameters evaluated in this study.

### 3.2 Current Oxidation and Removal Through Unit Processes

#### 3.2.1 Dissolved Oxygen Profile through Plant

Dissolved oxygen (DO) was measured at different locations throughout the WTP utilizing a portable DO probe on March 7, 2023. The measured values are shown in Table 3-3. This data shows that desirable levels of DO for iron oxidation (i.e. greater than 9.0 mg/L) are not reached until the filters. The increase in DO from raw water to the aeration basin is due to the current aeration nozzles, and the increase between the plate settlers and filters is most likely due to the vortexing and air entrainment occurring at the plate settler outlet.

**Table 3-3: Dissolved Oxygen Levels in the WTP**

Location	Measured DO (mg/L)
Raw Water	1.94
Aeration Basin	6.27
Detention Basin Effluent	6.39
Flocculation Chamber	6.33
Plate Settler	7.64
Filters	10.51

### 3.2.2 Chlorine Profile through Plant

Total and free chlorine were measured through the WTP by plant staff during February 2023. The measured values are shown in Table 3-4.

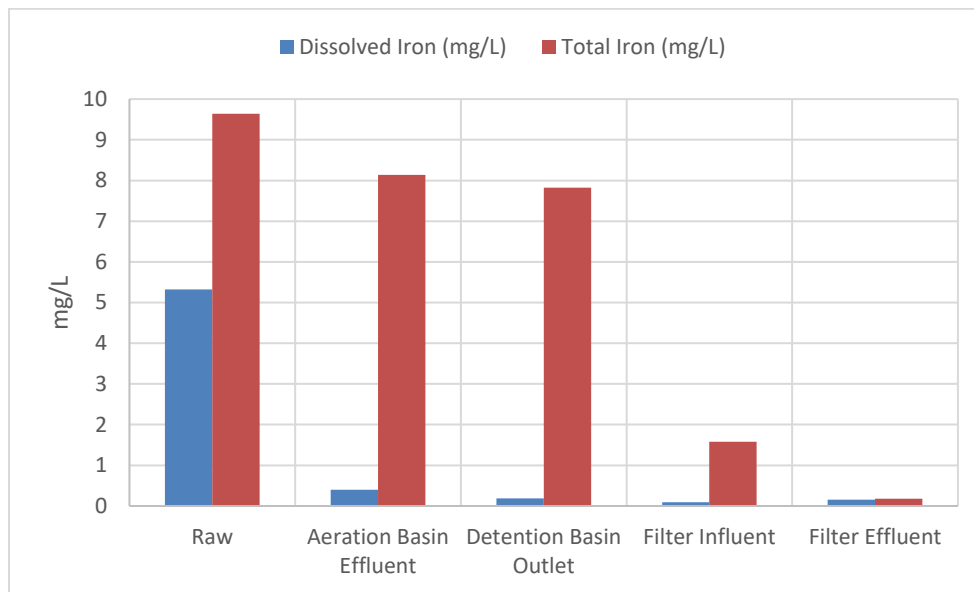
**Table 3-4: Chlorine Measurements in the WTP**

Sample Location	Date	Total Chlorine (mg/L)	Free Chlorine (mg/L)	pH
Plant Influent (Raw Water)	2/21/2023	-	-	6.87
	2/22/2023	-	-	6.81
	2/23/2023	-	-	6.85
	2/27/2023	-	-	6.77
	Average	-	-	6.83
Aeration Basin Inlet (post-aerators)	2/21/2023	3.29	2.73	6.99
	2/22/2023	4.22	3.22	7.02
	2/23/2023	2.88	2.28	7.01
	2/27/2023	1.88	1.53	6.94
	Average	3.07	2.44	6.99
Detention Basin Outlet (Grab from Basin at Low Lift Pump)	2/21/2023	4.43	3.69	7.04
	2/22/2023	4.61	3.82	7.02
	2/23/2023	2.87	2.29	7.03
	2/27/2023	1.67	1.21	6.94
	Average	3.40	2.75	7.01
Filter Influent (Sample Location at All Filters Influent Control Valve)	2/21/2023	3.12	2.66	7.14
	2/22/2023	4.49	3.76	7.04
	2/23/2023	2.71	2.33	7.12
	2/27/2023	1.54	1.25	7
	Average	2.97	2.50	7.08
Filter Effluent (Grab from Low Service Pit)	2/21/2023	1.47	0.21	7.06
	2/22/2023	3.88	3.37	7.08
	2/23/2023	2.36	1.9	7.07
	2/27/2023	1.21	0.86	7
	Average	2.23	1.59	7.05

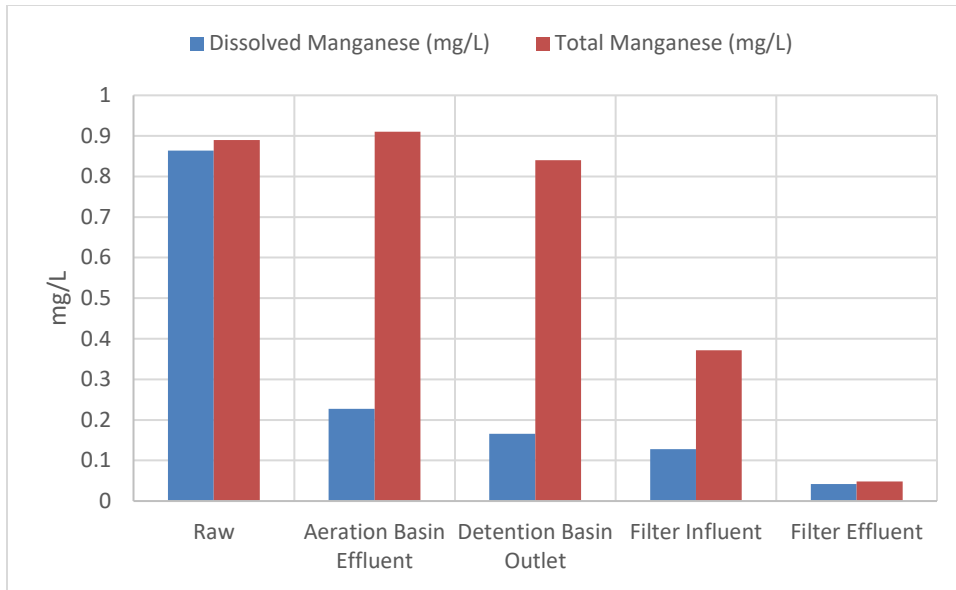
### 3.2.3 Existing Treatment for Iron and Manganese

During this study, WTP profile data was collected for iron and manganese that includes total and dissolved species at different locations through the WTP during both September 2022 and February 2023.

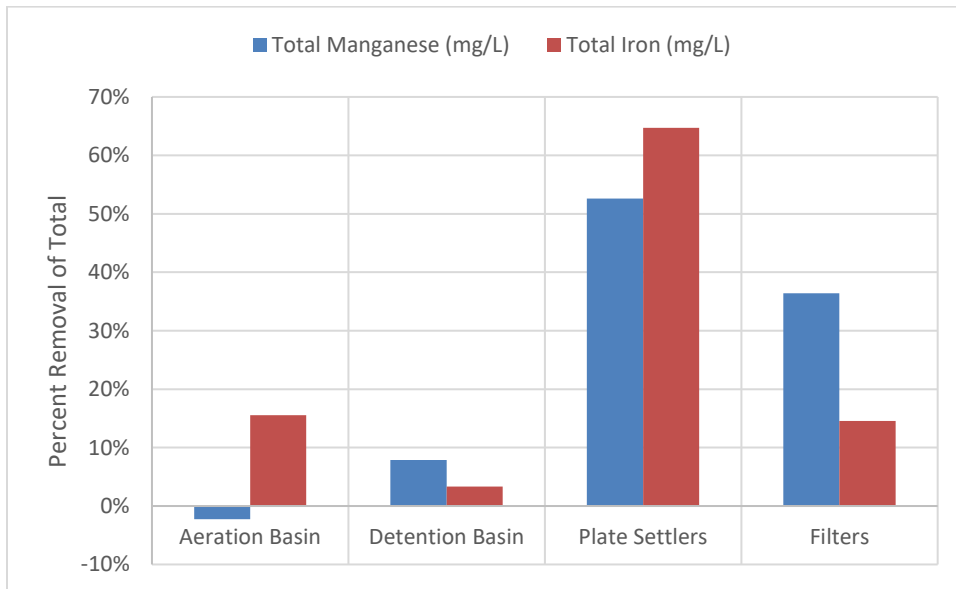
Figure 3-1, Figure 3-2 and Figure 3-3 depict the dissolved and total iron and manganese concentrations throughout the WTP in September, as well as overall percent removal in the structures. Figure 3-4 and Figure 3-5 depict the dissolved and total iron and manganese concentrations throughout the WTP in February. Total iron and manganese values include both dissolved and particulate (or oxidized) species. The difference between total and dissolved concentrations shows the suspended fraction that exist as  $\text{Fe}^{+3}$  and  $\text{Mn}^{+4}$ . A decrease in dissolved metals through a treatment process indicates that metal is being oxidized and is no longer in a dissolved form. A decrease in total metals indicates a physical removal of the particulate fraction.



**Figure 3-1: Dissolved and Total Iron Through the WTP (September 2022)**



**Figure 3-2: Dissolved and Total Manganese Through the WTP (September 2022)**



**Figure 3-3: Total Iron and Manganese Removal Through the WTP**

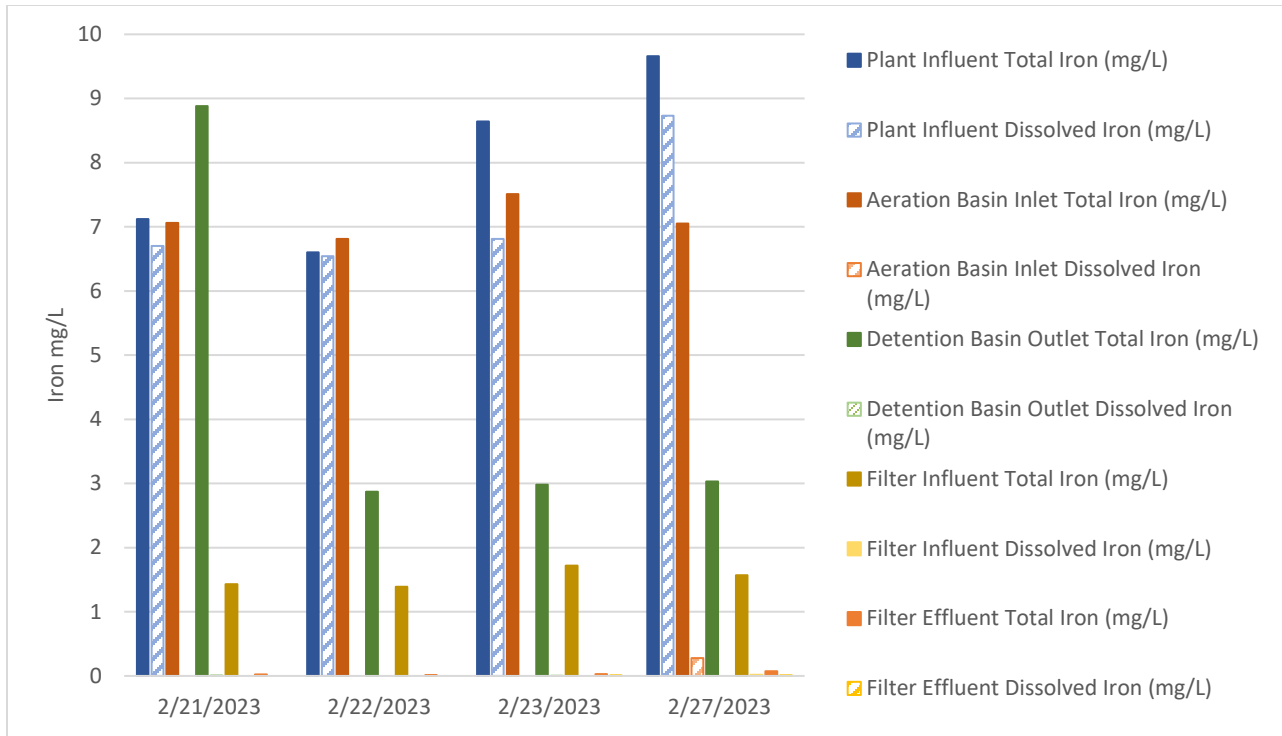


Figure 3-4: Total and Dissolved Iron through the WTP (February 2023)

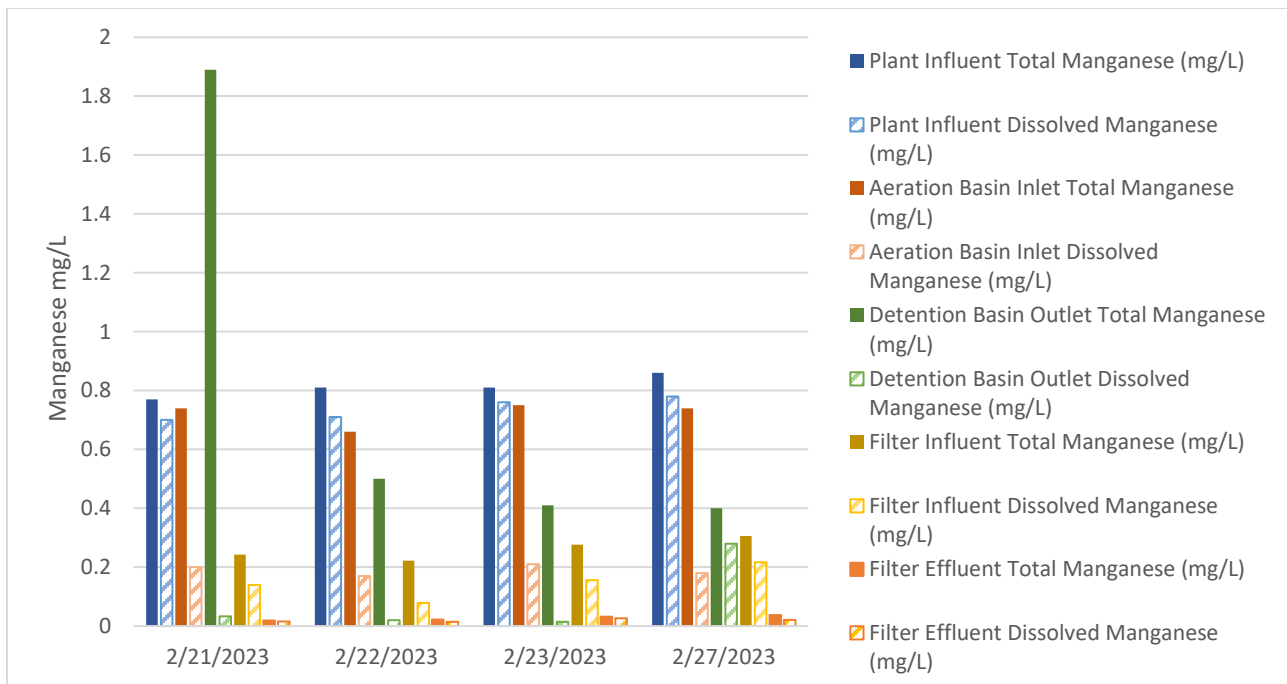


Figure 3-5: Total and Dissolved Manganese through the WTP (February 2023)

Figures 3-1 and 3-4 show that the majority of the dissolved iron is oxidized by the time water leaves the aeration basin. Particulate iron is removed in the detention basin, plate settlers, and filters. The February 2023 data indicates that more iron removal is occurring within the detention basin and filters than in the plate settlers, while the September 2022 data indicates the majority of removal occurred within the plate settlers. For both data sets, there is still a moderate amount of particulate iron present in the filter influent, which increases solids loading on the filters.

Figure 3-2 and 3-5 shows a significant reduction (~75 percent) of dissolved manganese occurs from the raw water to the aeration basin influent due to the initial chlorine addition, with another smaller reduction occurring in the detention basin. This is made possible by the very high chlorine dose added to the raw water, which is well in excess of stoichiometric doses. However, the remaining 25 percent of manganese is not readily oxidized and continues through the detention basin, and plate settlers despite the high chlorine residual. Within the gravity filters, the manganese is oxidized via a “greensand effect” such that the filter effluent dissolved manganese is generally below the SMCL of 0.05 mg/L for total manganese. This “greensand effect” is facilitated by the formation of manganese dioxide coating on the filter media (as discussed more in Section 6.5.4) and requires the continued presence of chlorine residual within the filter media.

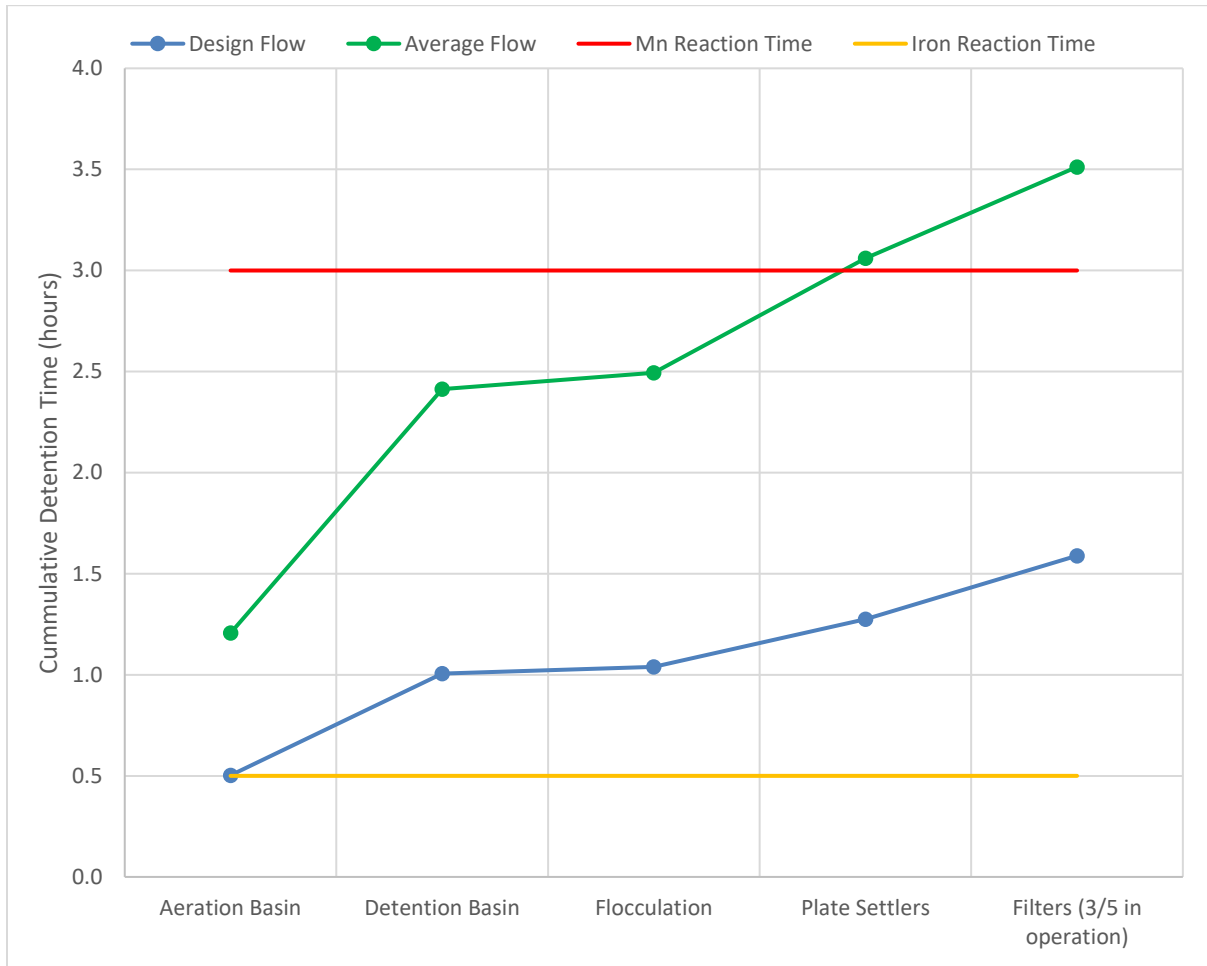
It is desirable for both iron and manganese to be fully oxidized prior to the plate settlers, as they are designed to remove particulate iron and manganese, and removal here reduces solids loading on the filters.

### 3.3 Treatment Process Detention Time

Detention time throughout the treatment process is critical for adequate oxidation of iron and manganese. In general, the oxidation kinetics for iron are faster than manganese. Chlorine takes more time to oxidize the iron and manganese compared to permanganate. According to the AWWA handbook on iron and manganese, the reaction time for chlorine to oxidize iron and manganese is 30 minutes and 3 hours (180 minutes) respectively at appropriate doses.

Figure 3-6 shows the cumulative detention time for each process in the WTP. This figure can be used to identify at which point in the treatment process sufficient detention time has been provided to achieve adequate iron and manganese oxidation with chlorine. Ideally, this point occurs prior to the plate settler units so that the oxidized particles can be removed from the water via the plate settlers. The detention time from the point of chlorine injection through flocculation is less than the 3 hours required for full

oxidation of manganese, but does provide more than the 30 minutes required for iron oxidation. This is true at both the average flow of 2.5 MGD and the design flow of 6 MGD.



**Figure 3-6: Cumulative Detention Time by Process**

## 4.0 JAR TESTING

### 4.1 Round 1 Jar Testing

Jar testing was conducted September 26-28, 2022 at the O'Fallon WTP to evaluate use of alternate coagulants and polymers to improve particle removal in the plate settlers, as well as observe the effectiveness of permanganate for pre-oxidation. Table 4-1 provides a summary of the nine jar tests performed and the specific goals of each test.

**Table 4-1: Jar Testing Plan**

Test Number	Water Source	Goals of Test
1	Aerated Water (post detention basin)	Set baseline to provide comparison of tests to plant performance, and observe performance of Magnafloc E38 at various doses
2	Aerated Water (post detention basin)	Observe performance of Alum at various doses
3	Aerated Water (post detention basin)	Observe performance of Ferric, PACL, and ACH at various doses
4	Aerated Water (post detention basin)	Screen various polymers for performance without a coagulant
5	Aerated Water (post detention basin)	Observe performance of top performing coagulants (ACH and PACL) and polymers (Magnafloc E38, 9212 and 9214) used together
6	Aerated Water (post detention basin)	Observe performance of a top performing polymer (Polymer 9212) at various doses without a coagulant
7	Raw Water (no chemicals)	Observe performance of permanganate for oxidation followed by Magnafloc E38
8	Raw Water (no chemicals)	Repeat of Test 7 with a longer reaction time for permanganate
9	Raw Water (no chemicals)	Compare oxidation by permanganate and chlorine followed by use of Magnafloc E38 and 9212

Mixing and settling conditions in the jar testing were selected to represent conditions within the WTP. Mixing energy and HRT in the flocculation chamber was calculated based on average plant flow, even flow split between four operating units, and the maximum flocculation mixer speed and HP. As a result of these calculations, all jar tests utilized mixing of the coagulant/polymers at a G-value of 275 sec<sup>-1</sup> (mixer set at 170 rpm) for 4 minutes. This was followed by 20 minutes of settling time prior to sample collection. For Tests 7-9, contact time with gentle continuous mixing was provided first for the pre-oxidation step, followed by the dosing of coagulant/polymer, 4 minutes of mixing and 20 minutes of settling.

#### 4.1.1.1 Coagulation Jar Testing Results

Results from Jar Test 1 are shown in Figure 4-1 and 4-2. Magnafloc E38 was dosed from 0 to 0.7 mg/L. Removal of turbidity, total iron, and total manganese generally increased as the chemical dose increased up to 0.4 mg/L, and then performance decreased. Doses of 0.2 mg/L and higher resulted in settled turbidities of less than 2.0 NTU. As such, this test indicates that the current dose of 0.3 mg/L is sufficient and additional chemical will not improve performance in the plate settler units.

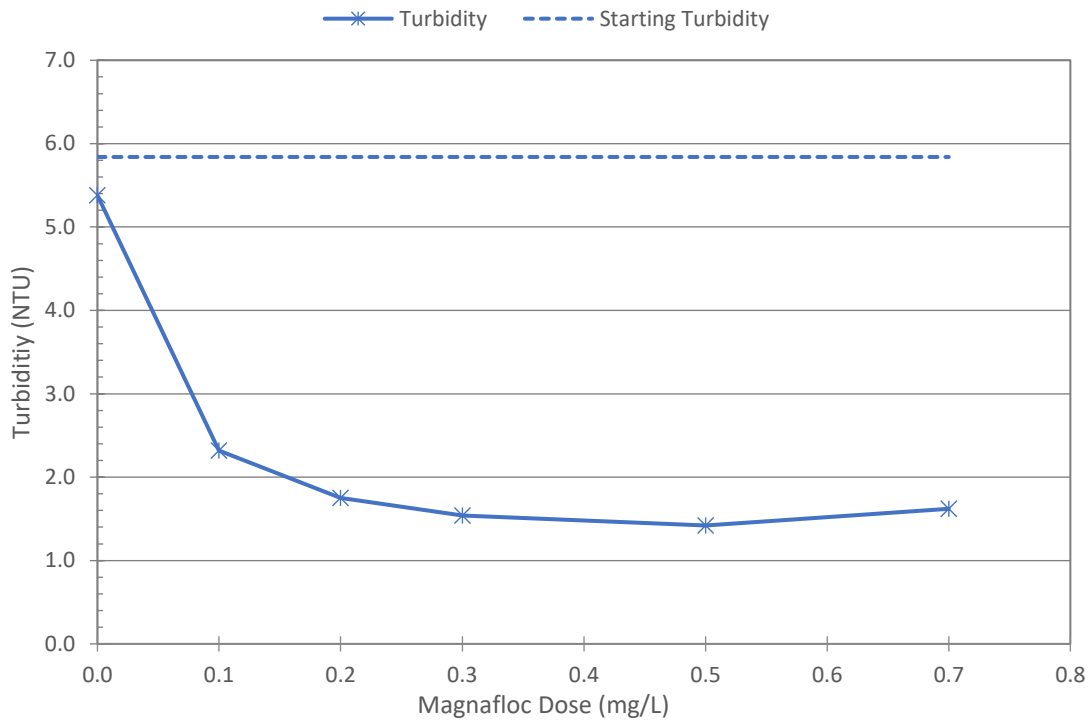
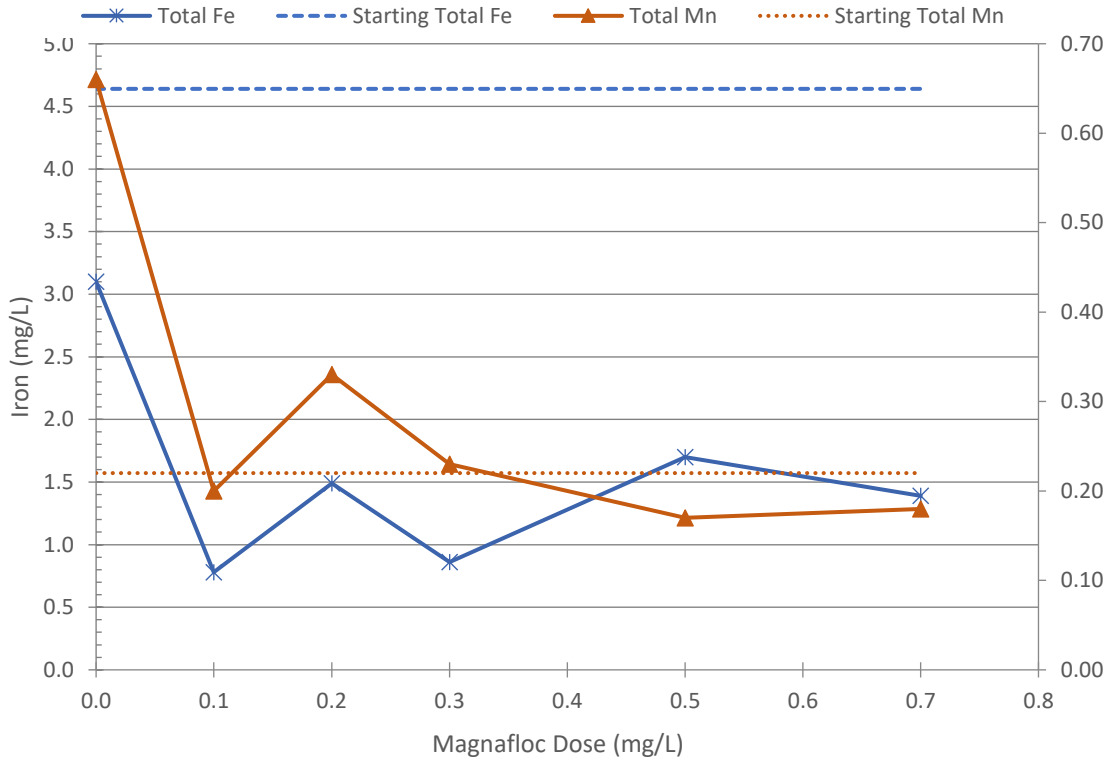
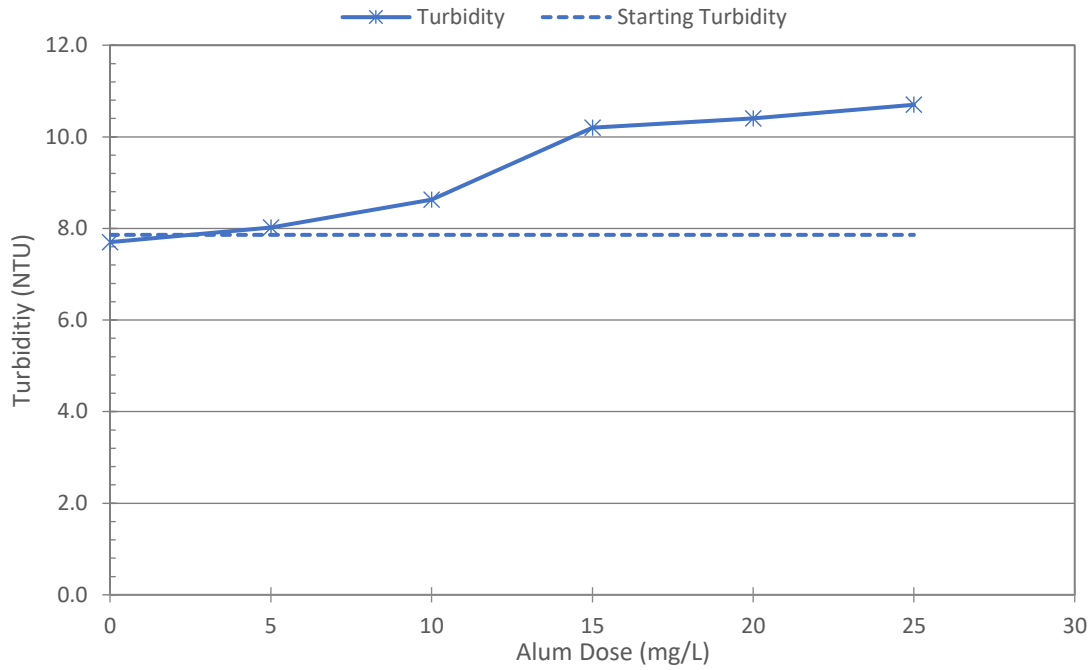


Figure 4-1: Jar Test 1 – Turbidity vs. Magnafloc Dose

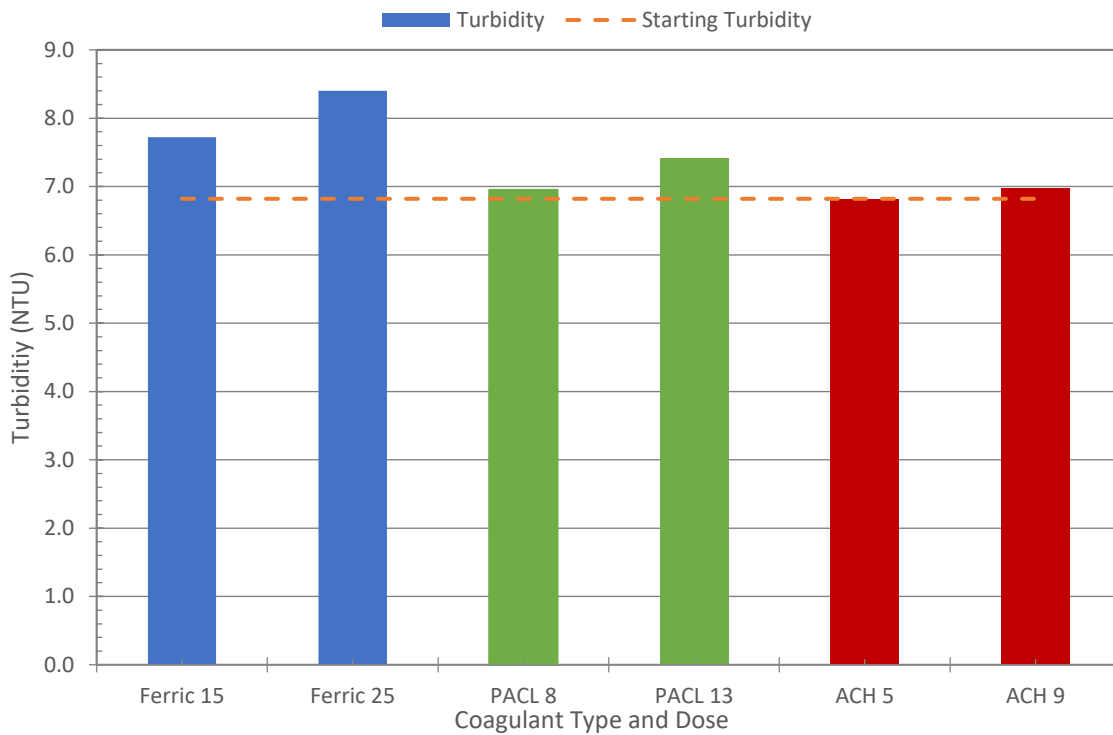


**Figure 4-2: Jar Test 1 – Iron vs. Magnafloc Dose**

Results from Jar Tests 2 and 3 indicated that the existing mixing conditions within the WTP are insufficient to support beneficial use of a coagulant. Comparison of the existing mixing energy of 275 sec<sup>-1</sup> to typically recommended values of >500 sec<sup>-1</sup> for coagulant dispersion, plus the lack of subsequent tapered flocculation mixing and time, also support this conclusion. Visual observation during the jar testing showed that floc formation was poor – with floc being very small and not settling well. Settled water turbidity measurements for various doses of all four coagulants tested – Alum, Ferric, PACL, and ACH – exceeded 6.8 NTU and were equal to or greater than the starting raw water turbidity, as shown in Figures 4-3 and 4-4.



**Figure 4-3: Jar Test 2 - Turbidity vs. Alum Dose**

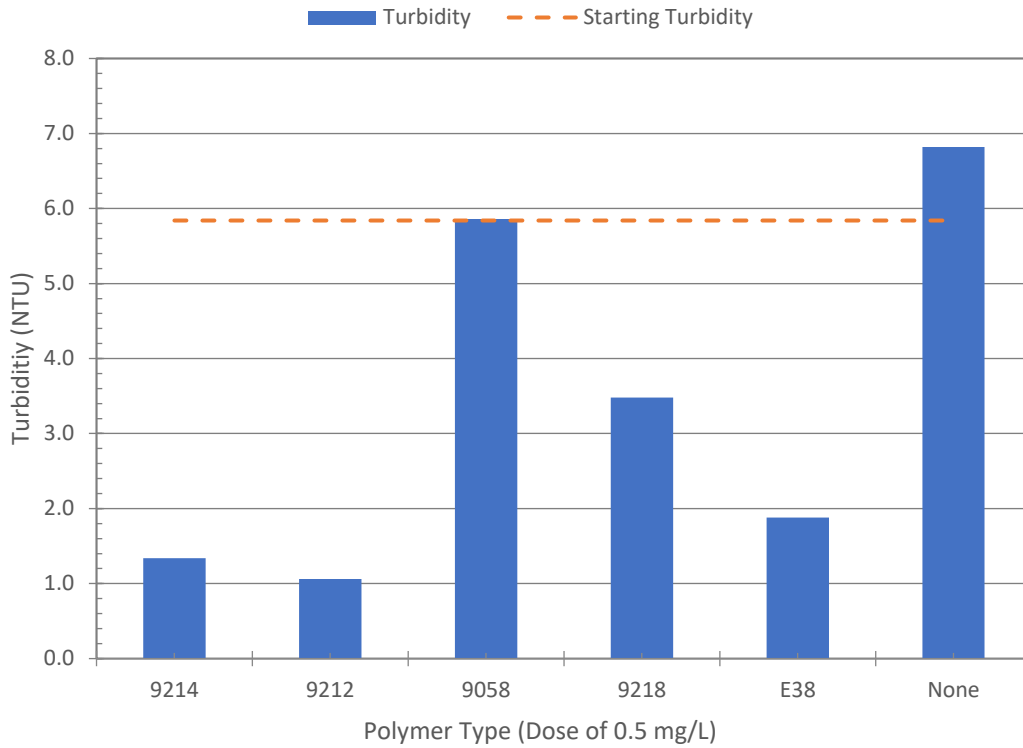


**Figure 4-4: Jar Test 3 - Turbidity vs. Coagulant Dose**

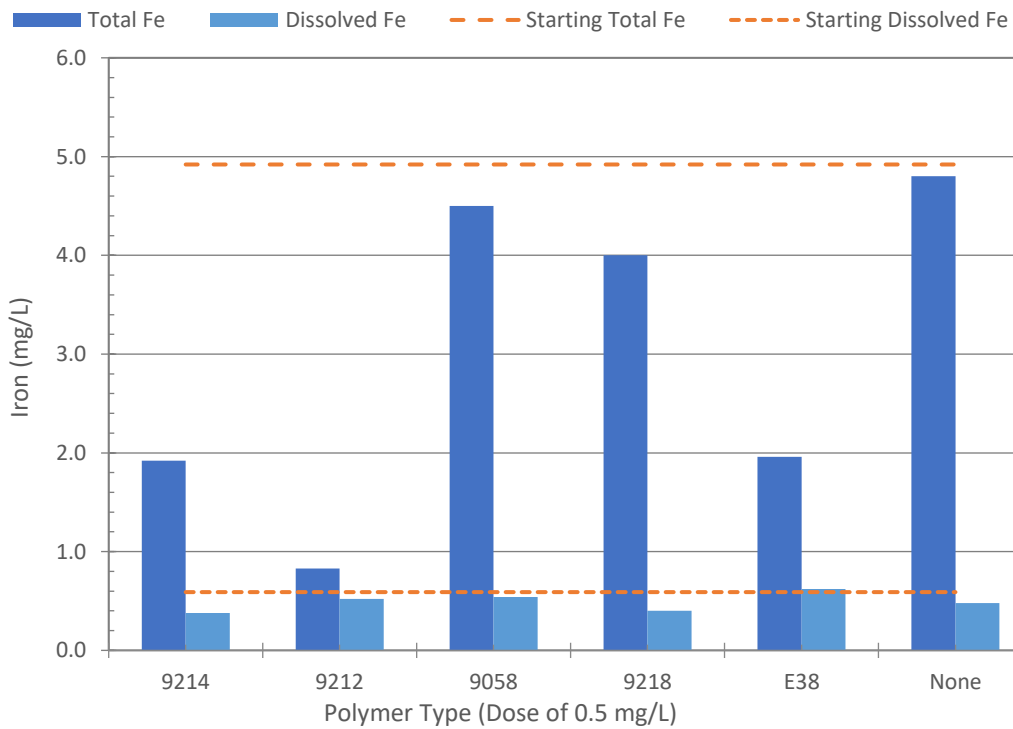
In Jar Test 4, five polymers were dosed at 0.5 mg/L to different jars. The characteristics of each polymer are listed in Table 4-2. All polymers showed some decrease in turbidity, iron, and manganese compared to the jar without polymer; with two polymers performing worse than the existing Magnafloc E38 and two performing better. The 9212 polymer performed the best with a settled water turbidity measurement of 1.06 NTU, compared to 1.34 NTU with the 9214 polymer and 1.88 NTU with the Magnafloc E38. Data from this test is displayed in Figure 4-5 through Figure 4-9. The results from this test indicate that some benefit could potentially be achieved by switching to the 9212 or 9214 products.

**Table 4-2: Jar Testing Polymer Properties (from Fife Water Services, Inc.)**

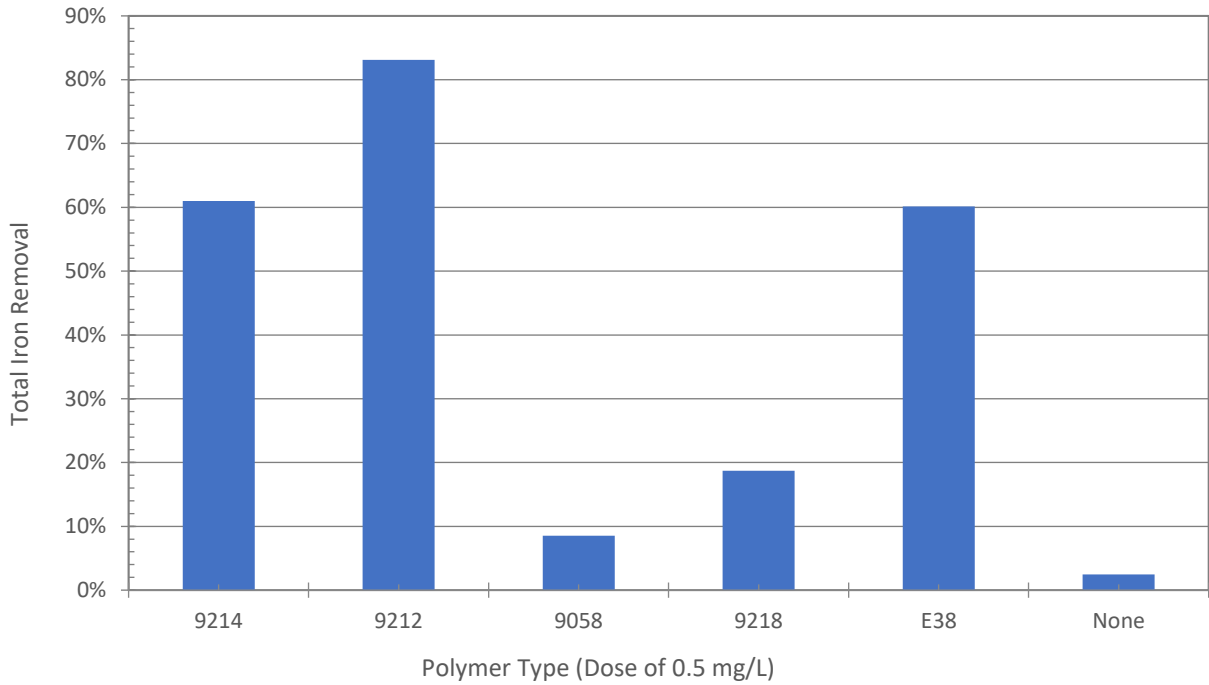
<b>Polymer Type</b>	<b>Molecular Weight</b>	<b>Type and Degree of Charge</b>	<b>Chemical Form</b>
9214G	Very High	Anionic, Low-Med	Emulsion
9212G	Very High	Anionic, Low	Emulsion
9058	(Not Available)	Cationic	Emulsion
9218G	Very High	Anionic, High	Emulsion
Magnafloc E38	Very High	Anionic, High	Emulsion



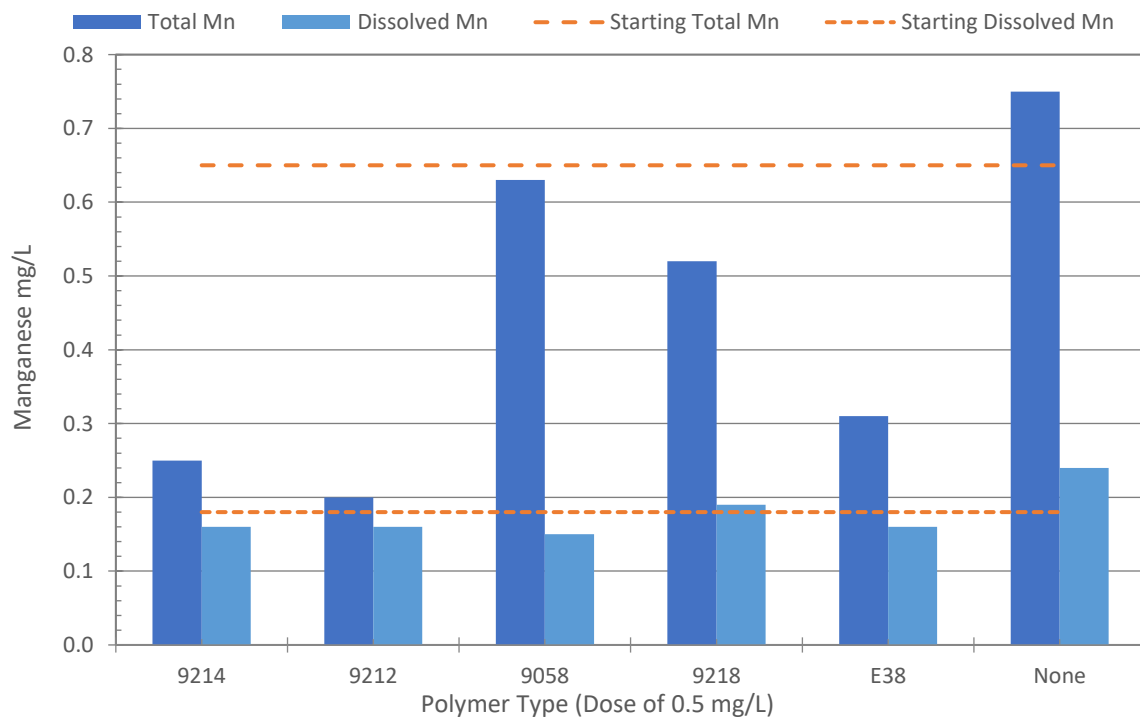
**Figure 4-5: Jar Test 4 - Turbidity vs. Polymer Type**



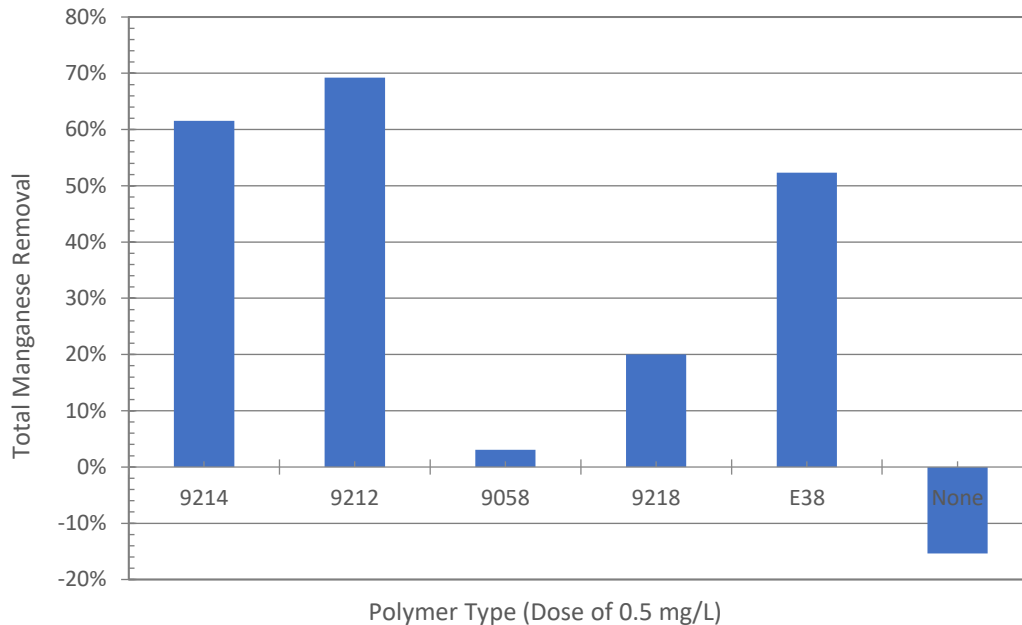
**Figure 4-6: Jar Test 4 - Iron vs. Polymer Type**



**Figure 4-7: Jar Test 4 - Iron Removal vs. Polymer Type**

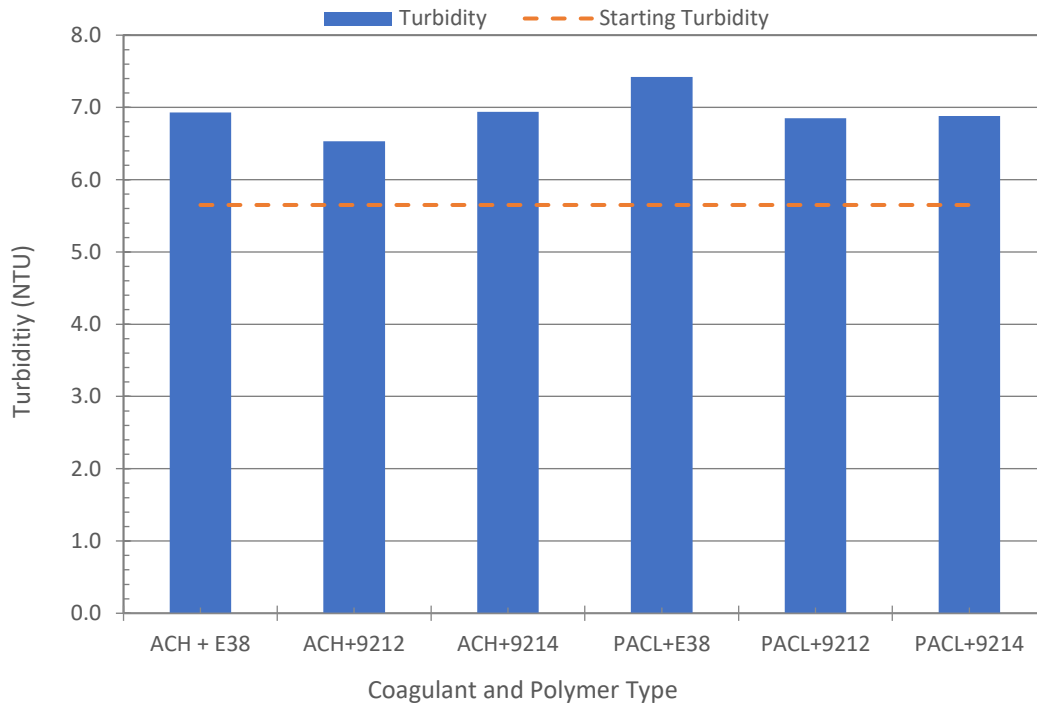


**Figure 4-8: Jar Test 4 – Manganese vs Polymer Type**



**Figure 4-9: Jar Test 4 - Manganese Removal vs. Polymer Type**

Jar Test 5 was conducted to explore the benefit of using both a coagulant and a polymer together for treatment. ACH was dosed at 9.0 mg/L, PACl was dosed at 13.0 mg/L, and each polymer was dosed at 0.3 mg/L. Similar to Jar Tests 2 and 3, poor floc formation and settling was observed, with all combinations resulting in higher settled water turbidity than the starting turbidity and no measurement lower than 6.5 NTU, as shown in Figure 4-10. This test further indicates the lack of adequate mixing conditions to support use of a coagulant.

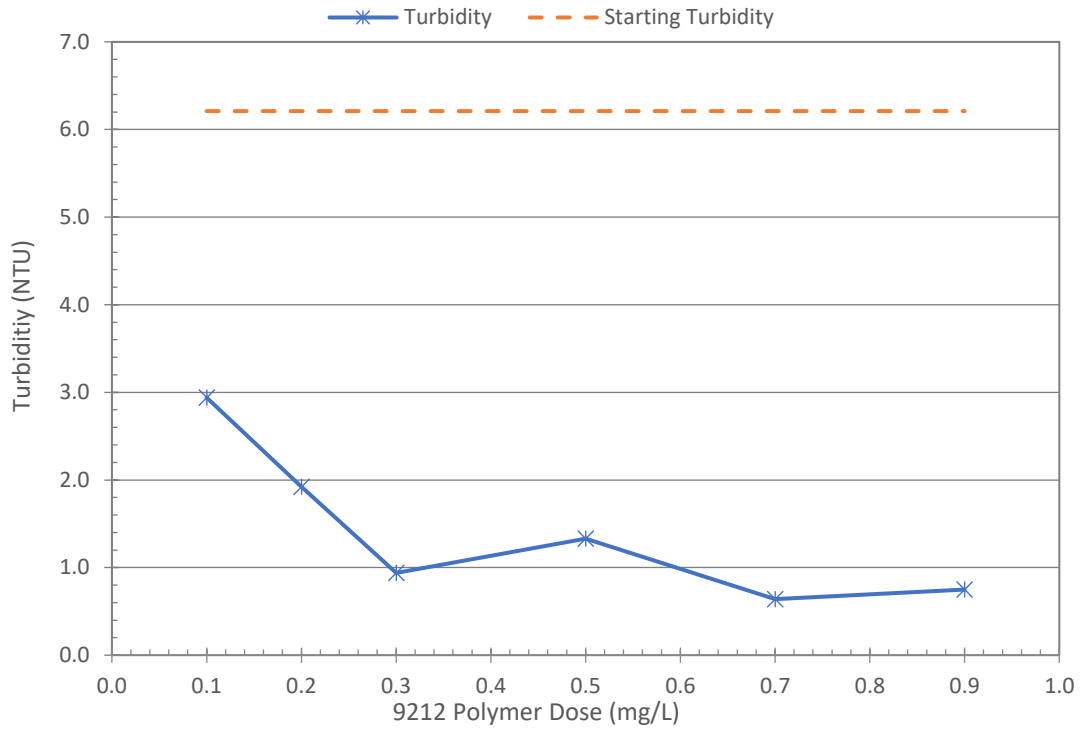


**Figure 4-10: Jar Test 5 - Turbidity vs. Coagulant and Polymer Type**

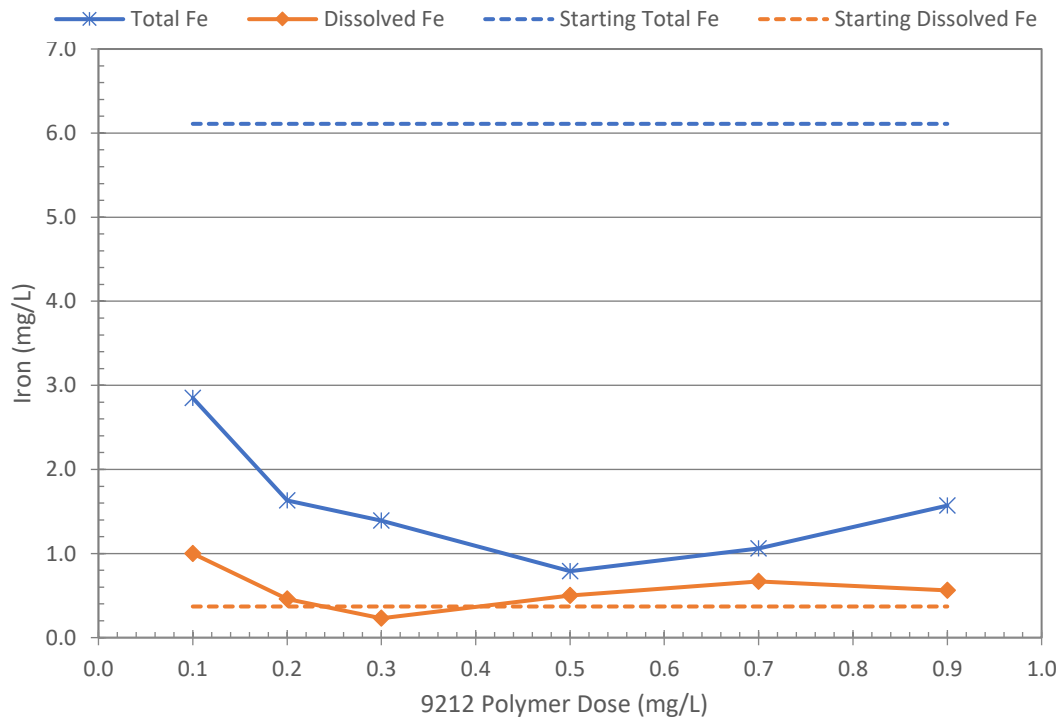
Based on the results of Jar Test 4, various doses of the 9212 polymer were tested in Jar Test 6. Doses ranged from 0.1 to 0.9 mg/L. Turbidity and total manganese generally decreased as chemical dose increased, while total iron removal was best at a dose of 0.5 mg/L. A dose of 0.2 mg/L resulted in settled turbidity less than 2.0 NTU and doses greater than 0.5 mg/L were required to achieve turbidity less than 1.0 NTU. Data from this test is displayed in Figure 4-11 through Figure 4-13. Relative pricing for each of the polymers utilized in the jar testing per MG is addressed in Table 4-3.

**Table 4-3: Chemical Dosing Price per Million Gallons**

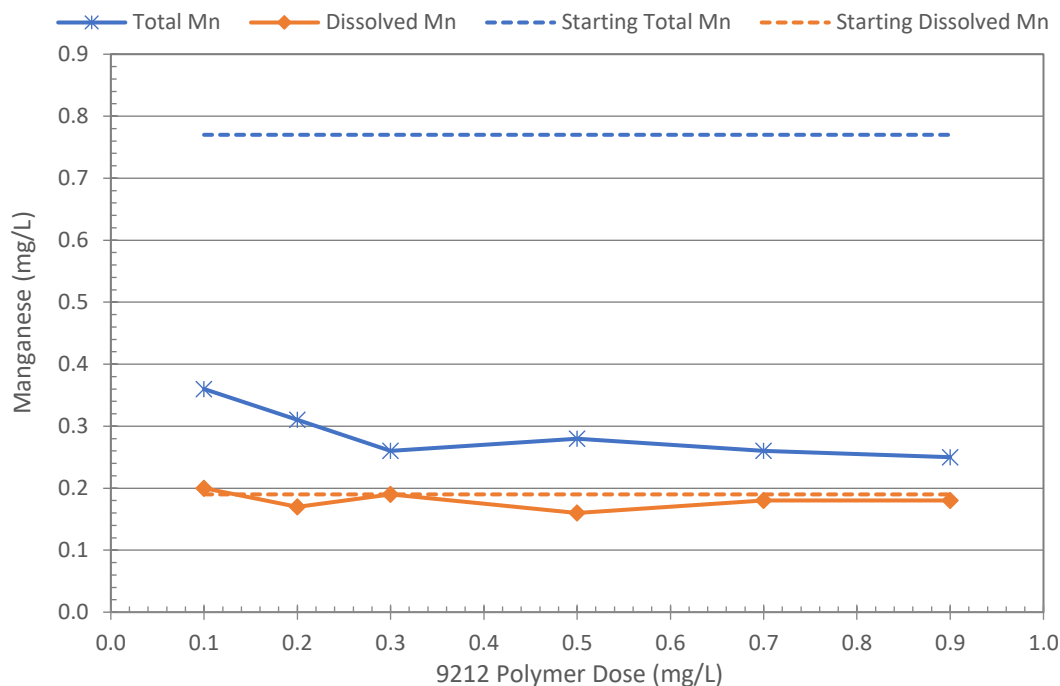
Polymer	Type	Polymer Dose (mg/L)	Average Dose (lb/MG)	Price \$/lb	Polymer \$/MG
E38	Flocculant	0.3	2.5	2.05	5.13
		0.5	4.2		8.55
FM-9212	Flocculant	0.3	2.5	2.45	6.13
		0.5	4.2		10.22
FM-9214	Flocculant	0.3	2.5	2.44	6.10
		0.5	4.2		10.17



**Figure 4-11: Jar Test 6 – Turbidity vs. 9212 Polymer Dose**



**Figure 4-12: Jar Test 6 – Iron vs. 9212 Polymer Dose**



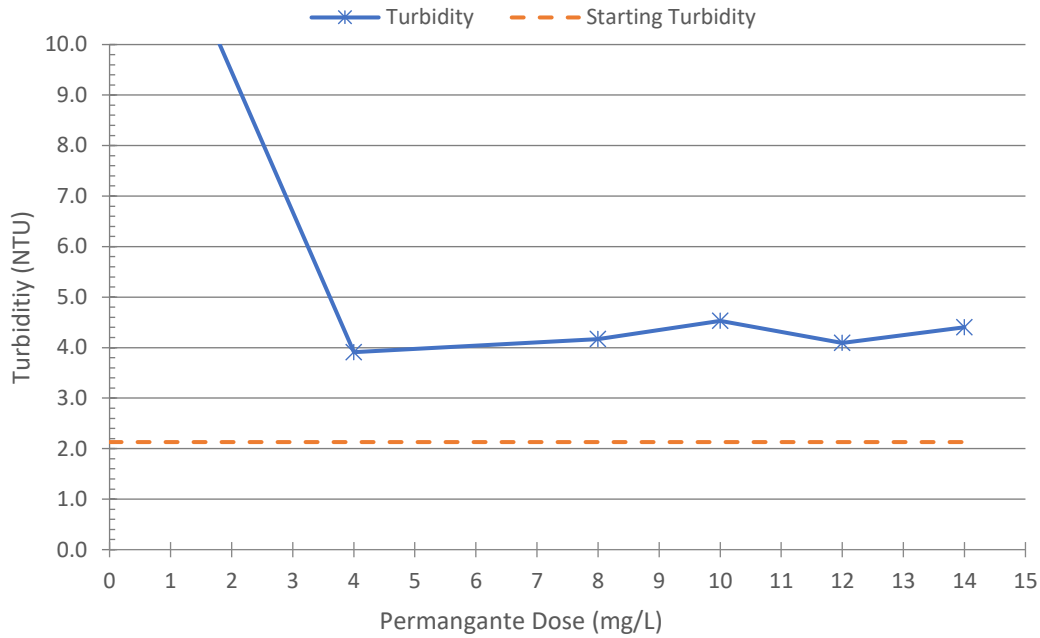
**Figure 4-13: Jar Test 6 – Manganese vs. 9212 Polymer Dose**

#### 4.1.1.2 Oxidation Jar Testing Results

Where Jar Tests 1-6 were focused on evaluation of chemical addition to improve particle removal in the primary treatment processes, Jar Tests 7-9 were focused on evaluating the potential to use permanganate for pre-oxidation. In Jar Test 7, each jar was dosed with a different amount of permanganate (ranging from 0 to 14 mg/L) and gently mixed for 10 minutes of contact time. Then 0.3 mg/L of Magnafloc E38 was dosed under the same mixing conditions and settling time used for the previous jar tests. After settling, a portion of the collected samples were filtered to measure dissolved iron and manganese. Even after filtering, Jars 4, 5 and 6 had a visible pink coloration.

Turbidity measurements after settling are shown in Figure 4-14. Jar 1, which had no permanganate, had a very high turbidity, while the remaining jars had similar turbidity values ranging from 3.9 to 4.5 NTU, indicating no major impact of permanganate dose on settleability. However, floc did visually appear smaller than floc observed in previous testing and in the WTP. The calculated stoichiometric dose of permanganate required to oxidize the iron and manganese in the water was 5.67 mg/L. Figure 4-15 and Figure 4-16 show that the best oxidation of iron and manganese was achieved with a permanganate dose of 8-10 mg/L, indicating either a very high demand from other compounds in the water or an error with the permanganate stock solution used for testing. Overdosing of permanganate will result in increased

amounts of dissolved manganese, which is seen in Figure 4-16, but the data also showed dissolved iron increasing again. This result was unexpected, along with the fact that the iron did not appear to fully oxidize, indicating either errors in the measurements or a resistive portion that may be complexed with organics or other material.



**Figure 4-14: Jar Test 7 – Turbidity vs. Permanganate Dose**

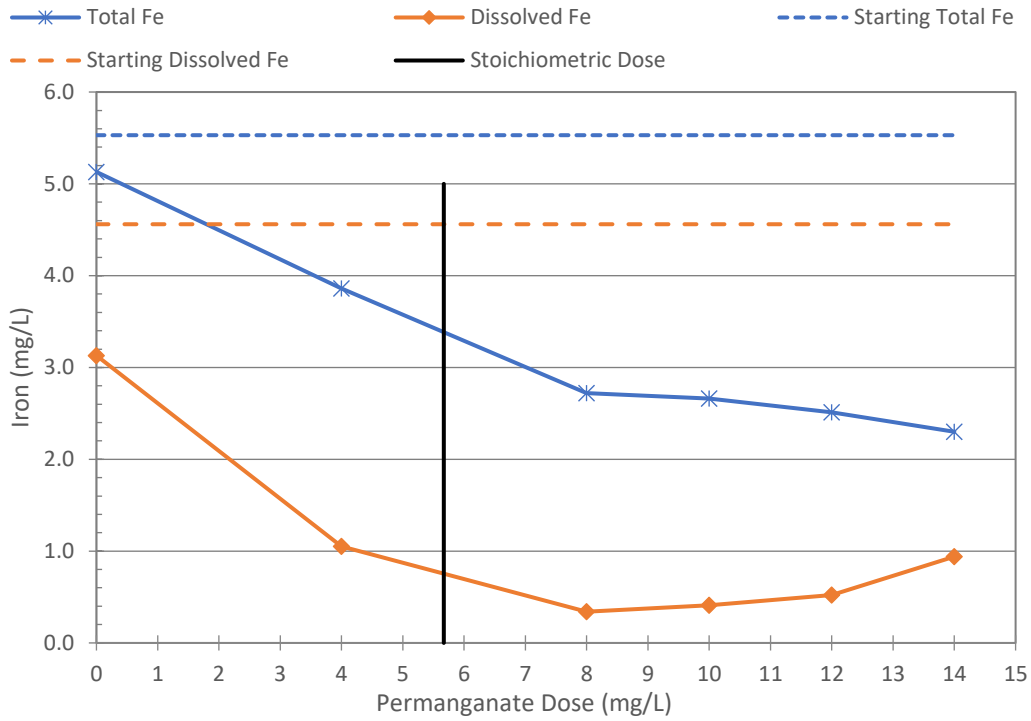


Figure 4-15: Jar Test 7 – Iron vs. Permanganate Dose

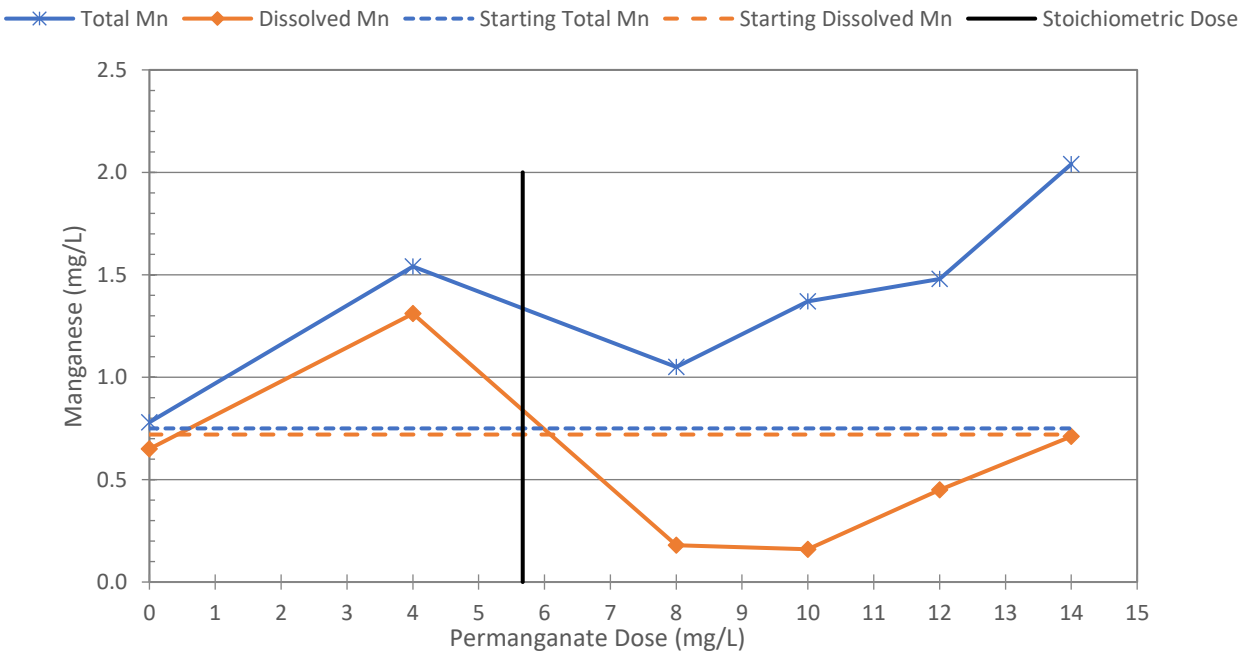


Figure 4-16: Jar Test 7 – Manganese vs. Permanganate Dose

Jar Test 8 was conducted to build on Jar Test 7, by narrowing in on the permanganate dosing range and increasing permanganate reaction time to 20 minutes to observe impact on iron oxidation. Visual appearance of floc material and observed values and trends for turbidity, iron, and manganese, were similar to those seen in Jar Test 7. The amount of iron oxidation achieved at 10 mg/L dose of permanganate appears to be slightly better than in Jar Test 7, but dissolved iron was still measured, as seen in Figure 4-17. Thus, the data is inconclusive on whether or not the additional reaction time improved overall iron oxidation and if there is in fact a portion of the iron that is resistive to oxidation. Manganese measurements are shown in Figure 4-18 and indicate that full manganese oxidation occurred between 9 and 10 mg/L of permanganate dose.

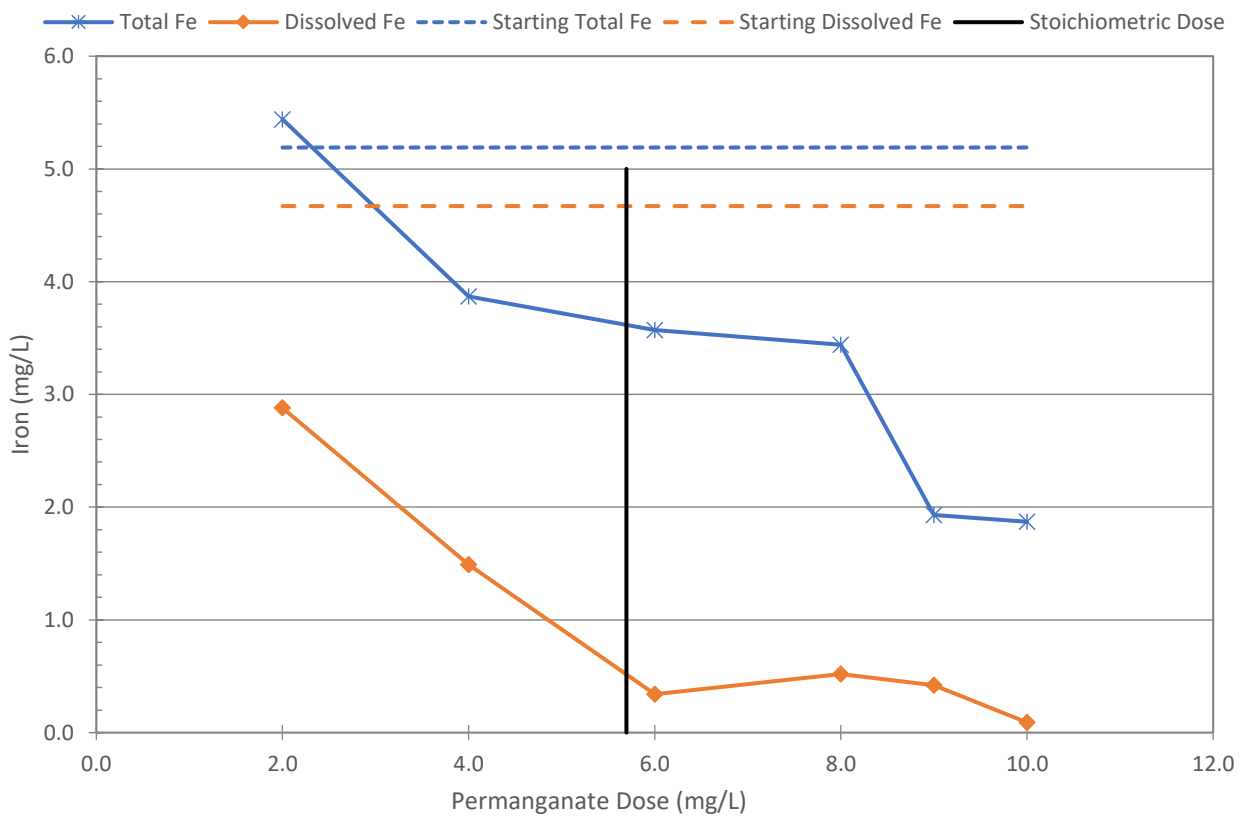
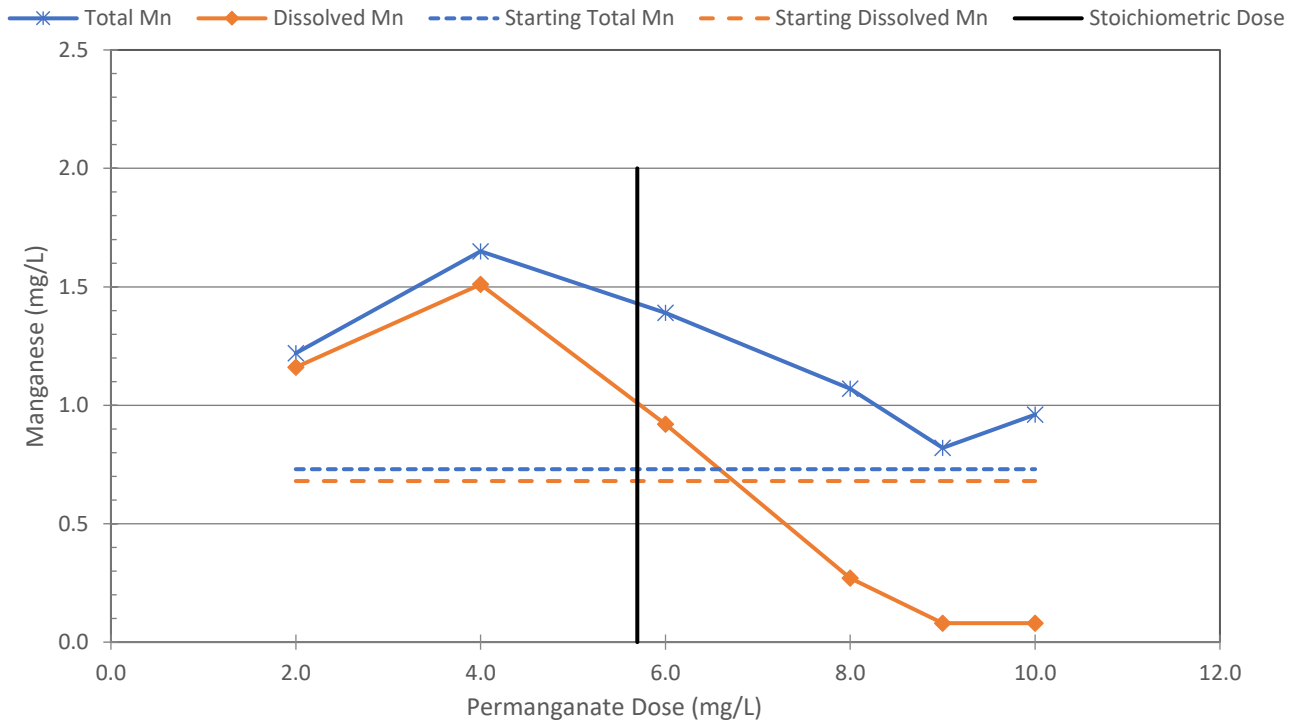


Figure 4-17: Jar Test 8 – Iron vs. Permanganate Dose



**Figure 4-18: Jar Test 8 – Manganese vs. Permanganate Dose**

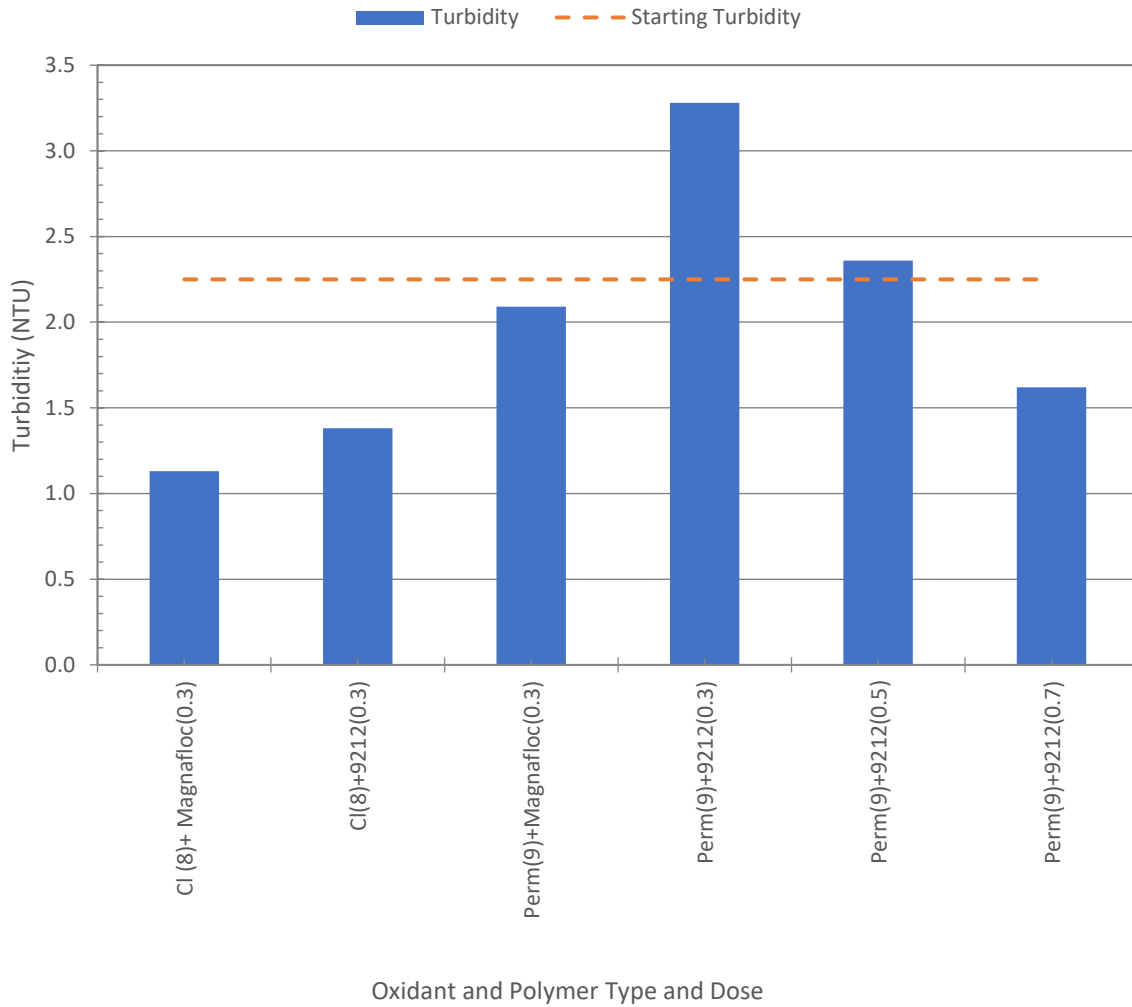
Finally, Jar Test 9 was conducted to observe comparative performance between chlorine and permanganate for pre-oxidation. During this test, 8 mg/L of chlorine was dosed to Jars 1 and 2 and 9 mg/L of permanganate was dosed to Jars 3, 4, 5 and 6. The stoichiometric doses required based on raw water iron and manganese levels were 4.3 mg/L of chlorine and 6.3 mg/L permanganate; thus the applied doses were respectively 187 percent and 143 percent of stoichiometric requirements. A reaction time of 60 minutes was provided, followed by dosing of polymer, with the same mixing and settling parameters as all other tests.

One primary goal was to determine if the observed difference in the visual appearance of floc material between Jar Tests 1-6 and Jar Tests 7-8 was due to use of permanganate rather than chlorine. Floc appearance was similar in this test across all jars and similar to the appearance of floc in Jar Test 7-8; thus this visual difference does not seem to be a result of the permanganate and is likely a function of something different in the jar tests vs the WTP or in the aging of the polymer used. Resulting turbidities after settling are shown in Figure 4-19. This data indicates slightly better performance in the jars dosed with chlorine compared to the jars dosed with permanganate. Due to the difference in dose above stoichiometric value, this is not a direct comparison and requires further review prior to conclusion that chlorine produces a more settleable floc.

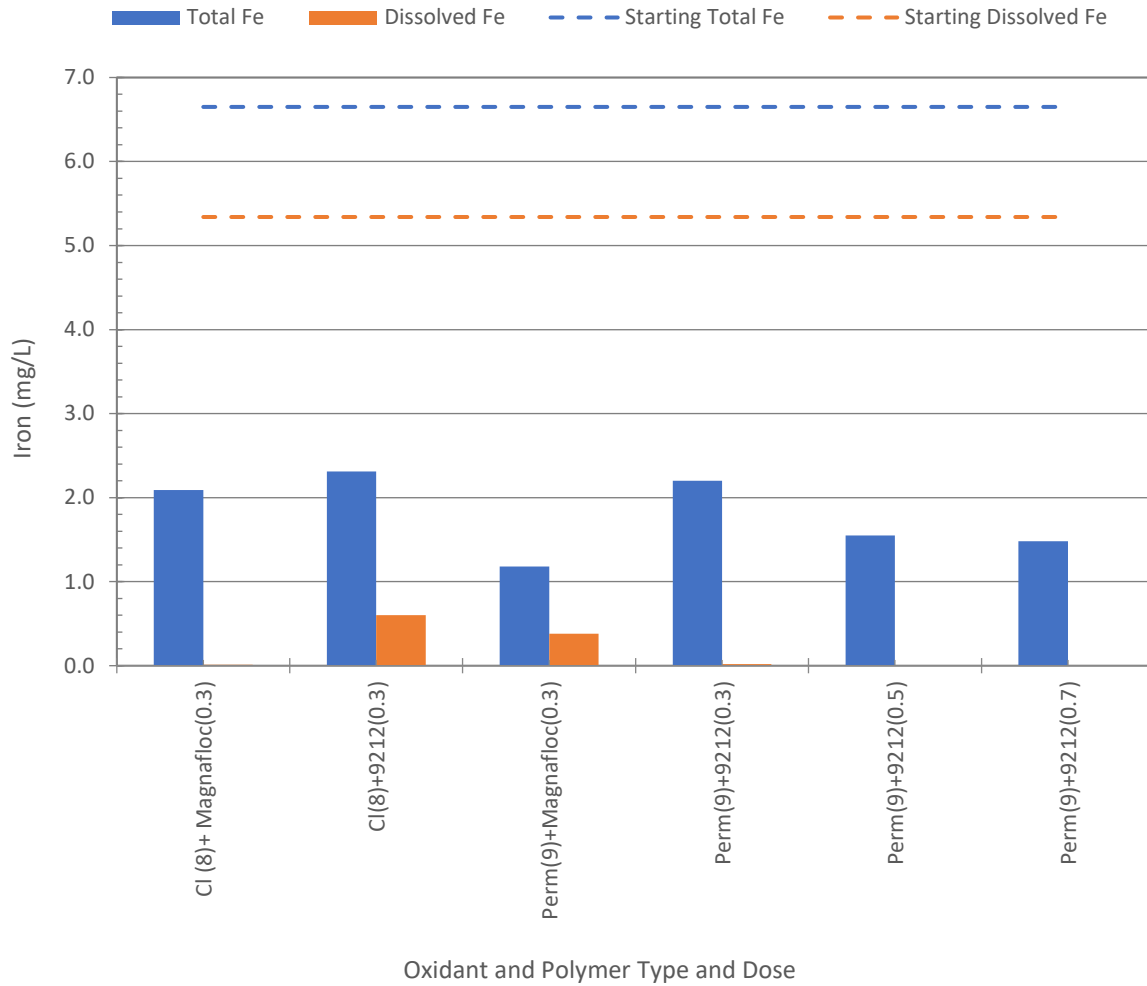
Figure 4-20 shows the total and dissolved iron measurements from the settled samples. This data indicates that complete oxidation of iron was achieved in four of the six jars, with one chlorine jar and one permanganate jar still showing residual dissolved iron. These values also indicate that permanganate achieved slightly better iron oxidation than chlorine, but when considered along with the turbidity results they are inconclusive.

Figure 4-21 shows the total and dissolved manganese measurements from the settled samples. Trace amounts of dissolved manganese were present in all jars and total manganese was higher in the jars dosed with permanganate. Due to the influence of overdosing permanganate, this data is inconclusive.

Further testing was recommended to determine if permanganate would provide adequate benefit to warrant use as an alternative or supplemental oxidant to chlorine.



**Figure 4-19: Jar Test 9 - Settled Turbidity for Different Oxidants and Polymers**



**Figure 4-20: Jar Test 9 - Iron Measurements with Different Oxidants and Polymers**

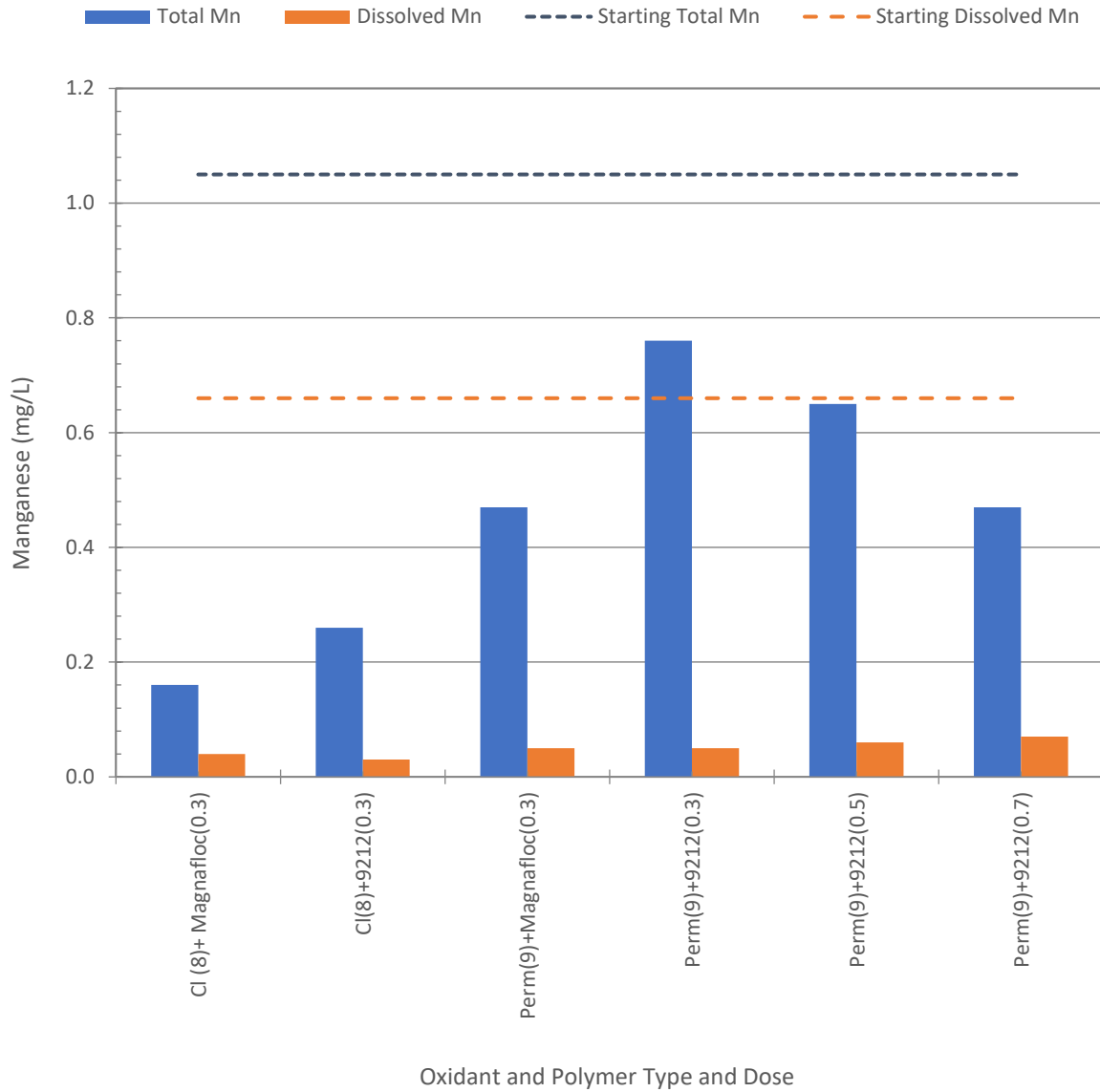


Figure 4-21: Jar Test 9 - Manganese Levels with Different Oxidants and Polymers

## 4.2 Round 2 Jar Testing

Due to the inconclusive nature of the Round 1 oxidation jar testing, additional bench-scale testing was conducted on March 6-8, 2023, at the O’Fallon WTP. This testing focused on use of aeration, chlorine, and potassium permanganate for the oxidation of dissolved iron and manganese.

Testing started with investigative tests to determine impact of DO levels and assess chlorine demand within the raw water. These tests were followed by several rounds of jar tests. Table 4-4 provides a summary of the jar tests performed and the specific goals of each test.

**Table 4-4: Oxidation Jar Testing Plan**

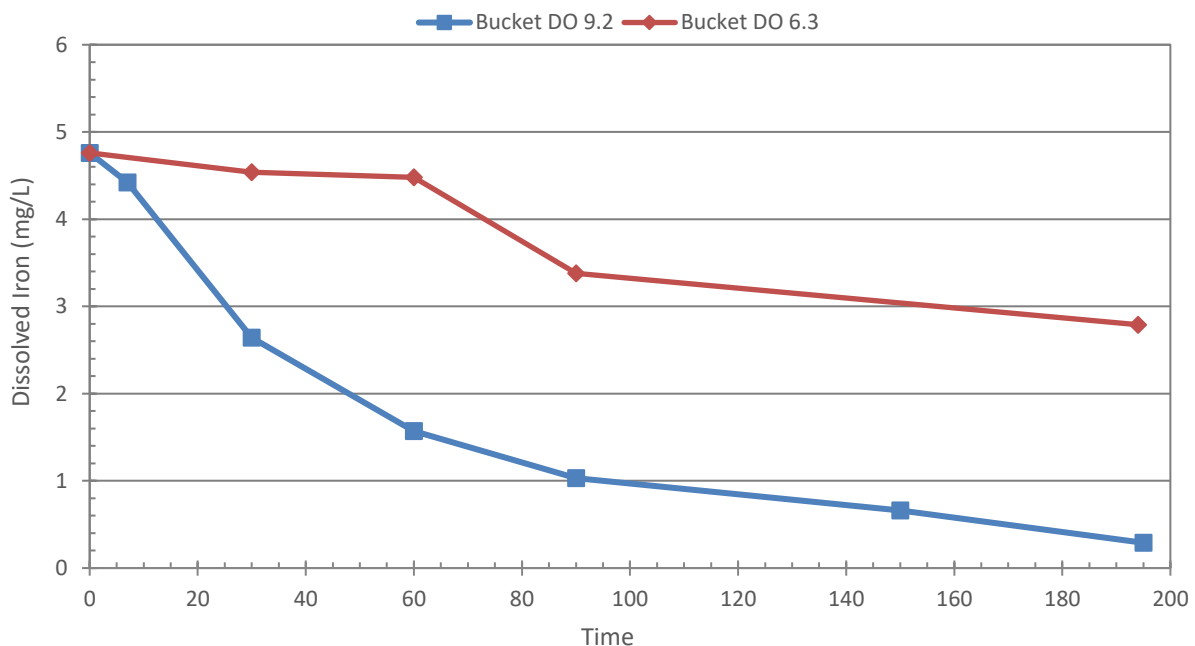
Test Number	Water Source	Goals of Test
1	Raw Water, No Aeration	Measure dissolved Fe and Mn oxidation with chlorine. Vary chlorine dose and track the impact of contact time.
2	Raw Water, No Aeration	Measure dissolved Fe and Mn oxidation with KMnO <sub>4</sub> . Vary KMnO <sub>4</sub> dose and track the impact of contact time.
3	Lab Aerated Raw Water	Measure dissolved Mn oxidation with chlorine after aeration. Vary chlorine dose and track the impact of contact time.
4	Lab Aerated Raw Water	Measure dissolved Mn oxidation with KMnO <sub>4</sub> after aeration. Vary KMnO <sub>4</sub> dose and track the impact of contact time.
5	Lab Aerated Raw Water	Measure dissolved Mn oxidation with KMnO <sub>4</sub> after aeration and 3 mg/L chlorine dose. Vary KMnO <sub>4</sub> dose.
6	Lab Aerated Raw Water	Measure total Fe and Mn with aeration, 3 mg/L Cl, 1.3 mg/L of KMnO <sub>4</sub> , and E38 polymer. Vary E38 polymer dose.

For jar testing, stock solutions of sodium hypochlorite and potassium permanganate were made in the lab and tested to confirm concentrations. Mixing energy in the jars was set at 80 RPM to provide moderate mixing energy for pre-oxidation testing. Dosing was staggered between beakers to allow time to sample and filter through 0.45 µm filters to provide total (unfiltered) and dissolved (filtered) results for iron and manganese.

### 4.2.1.1 Dissolved Oxygen Test

Dissolved oxygen (DO) was measured in the WTP to be approximately 2.5 mg/L before aeration and 6.6 mg/L after aeration. Raw water was collected before aeration and used for bench-scale testing by aerating the water in the lab via transferring between 5-gallon buckets. One bucket of sample raw water was poured between buckets to increase the DO from 2.5 mg/L to 6.3 mg/L. A second bucket was mixed similarly until the DO reached 9.2 mg/L. Iron in both buckets was then measured over time to observe the impact of DO and contact time on dissolved iron; the results are shown in Figure 4-22. Dissolved iron

decreased from 4.8 mg/L starting concentration to 3.4 mg/L after 90 minutes of contact time in the bucket with 6.3 mg/L DO. After 195 minutes, dissolved iron was approximately 2.8 mg/L (2.0 mg/L decrease). The oxidation kinetics of dissolved iron was much higher in the second bucket with DO of 9.2 mg/L, with dissolved iron values of 1.0 and 0.29 after 90 and 195 minutes, respectively. This test shows that the existing aeration basin is ineffective and a more optimized aeration basin designed to raise the DO higher could improve oxidation of iron in the aeration and detention basins. However, even with improved aeration, under higher plant flow rates and elevated iron concentrations, aeration alone is unlikely to fully oxidize iron within the existing basins.



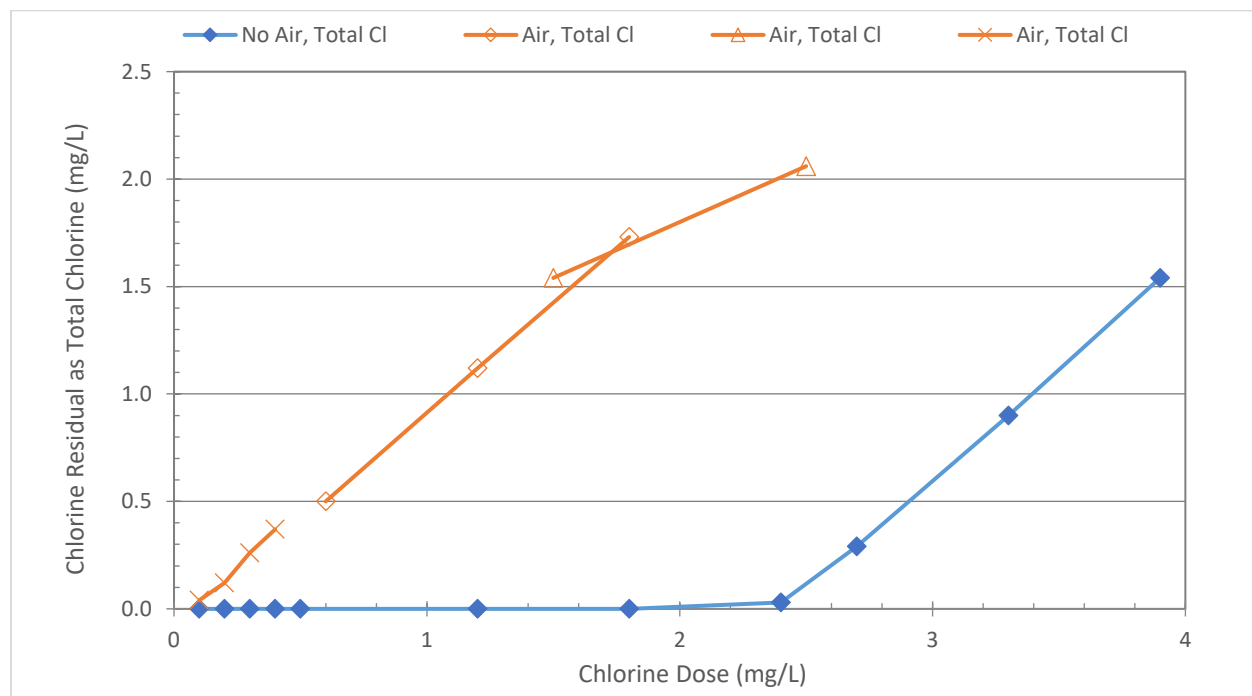
**Figure 4-22: Oxidation of Dissolved Iron with Dissolved Oxygen**

#### 4.2.1.2 Chlorine Demand Test

When chlorine is added to distilled water, the chlorine demand is 0 mg/L, thus the chlorine residual will equal the chlorine dose. For surface and ground water supplies, chlorine will react with organics, ammonia, nitrogen compounds, iron, manganese, and other compounds, resulting in some chlorine demand. Chlorine demand is defined by the chlorine dose required to achieve a 0.1 mg/L chlorine residual. Bench-scale testing was conducted to calculate the chlorine demand by adding free chlorine to raw water samples with and without aeration. Chlorine residual from each dose was graphed to determine the impact of aeration on chlorine demand and categorize how much demand is attributed to various compounds within the water.

A sample of raw water that was not aerated was dosed with 0.1 to 3.9 mg/L of chlorine. Total chlorine is graphically depicted by the blue line in Figure 4-23. The total chlorine demand was estimated to be approximately 2.5 mg/L for raw water without aeration. This demand includes the demand imparted by all compounds present within the water.

Chlorine testing was then conducted with raw water that was manually aerated and allowed to sit for a period of time. All of the dissolved iron was oxidized prior to chlorine addition thus eliminating that portion of the chlorine demand. Chlorine was dosed at 0.6, 1.2, and 1.8 mg/L, resulting in a total chlorine residual of 0.5, 1.1, and 1.7 mg/L. This test was repeated at lower (0.1 to 0.4 mg/L) and higher chlorine doses (1.5 and 2.5 mg/L). Total chlorine was measured and is graphically depicted using orange symbols in Figure 4-23. The total chlorine demand for the sample was estimated to be approximately 0.1 mg/L, which is indicative of the demand created by all other compounds in the water excluding iron. These data indicate that chlorine should be added after aeration. This would allow a portion of the dissolved iron to be oxidized by dissolved oxygen and reduce the chlorine dose required to achieve a total chlorine residual.



**Figure 4-23: Chlorine Demand Testing with and without Aeration**

#### 4.2.1.3 Oxidation Jar Testing Results

During Jar Test 1, chlorine was added to raw water that was not aerated. Total and dissolved manganese in the raw water were measured as 0.82 and 0.74 mg/L, respectively. Total and dissolved iron were 5.3

and 4.7 mg/L, respectively. Chlorine dose added to the jars varied between 0 and 10 mg/L. Samples were collected at 15, 30, and 90 minute intervals and filtered to measure the impact of chlorine dose and contact time on the oxidation of dissolved iron and manganese. Results from Jar Test 1 are shown in Figure 4-24 and Figure 4-25.

As shown in Figure 4-24, values from the beaker with chlorine dose of 0 mg/L indicates that some of the iron was oxidized from dissolved oxygen imparted by the continual mixing in the jars. Dissolved iron decreased from 4.7 mg/L to 3.4 mg/L after 90 minutes without chlorine (1.3 mg/L reduction). When 2 mg/L of chlorine was added, dissolved iron decreased to 2.3 mg/L after 15 minutes, 1.6 mg/L after 60 minutes, and 1.2 mg/L after 90 minutes. The stoichiometric chlorine dose to oxidize the 4.7 mg/L of iron was 3.0 mg/L. As a result, increasing the chlorine dose to 4 mg/L or higher oxidized all of the dissolved iron to non-detect for each contact time.

The results for the oxidation of dissolved manganese with chlorine are shown in Figure 4-25. The stoichiometric chlorine dose to oxidize the 4.7 mg/L of iron and 0.78 mg/L of manganese was 4.0 mg/L. The results show that a chlorine dose of 4 mg/L resulted in very little change in dissolved manganese (0.78 to 0.72 mg/L). Increasing the chlorine dose to 8 mg/L (twice the stoichiometric dose) decreased the dissolved manganese to half the original value (0.36 mg/L). At 10 mg/L, the dissolved manganese was decreased to 0.30 mg/L after 15 minutes and 0.22 mg/L after 90 minutes. This data shows that high levels of chlorine (well above the stoichiometric dose are required to oxidize dissolved manganese). Furthermore, the amount of benefit seen between 15 and 90 minutes of contact time is fractional compared to the total amount of removal desired. The results from Figure 4-24 and Figure 4-25 show that iron is oxidized first, resulting in a decrease in dissolved iron with no change in dissolved manganese at a chlorine dose of 2 mg/L. It is not until 4 mg/L, when dissolved iron is non-detect, that the oxidation of dissolved manganese is significant.

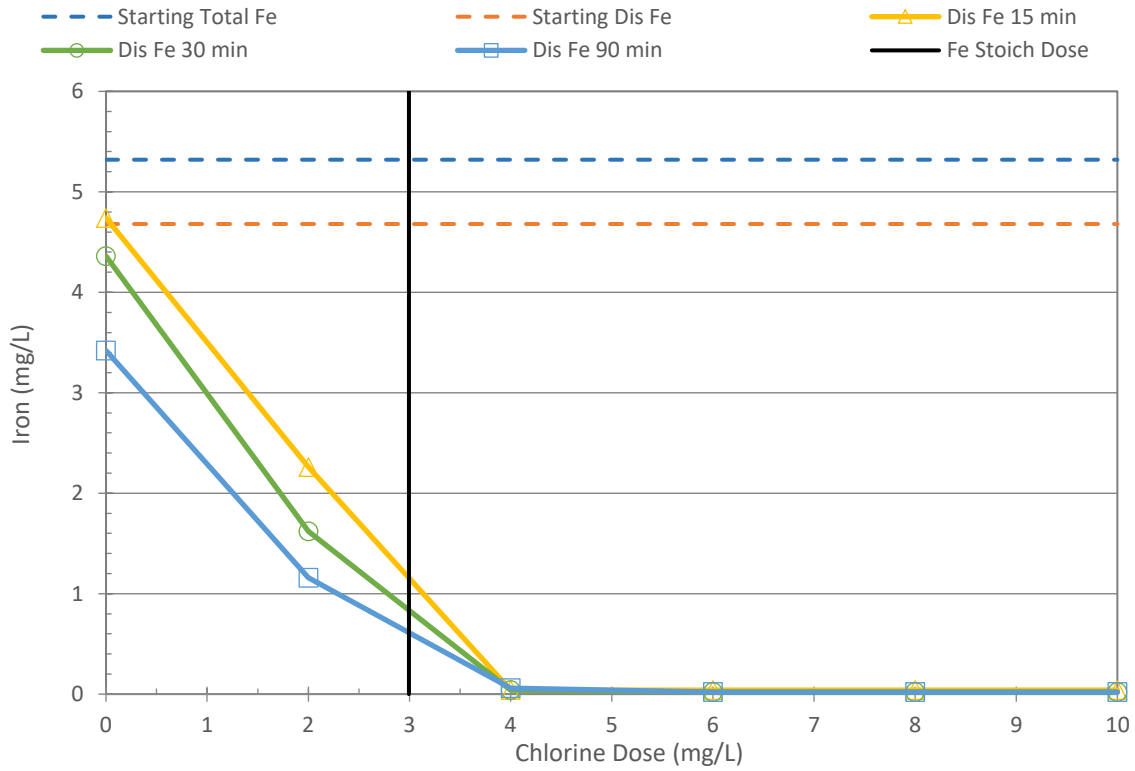
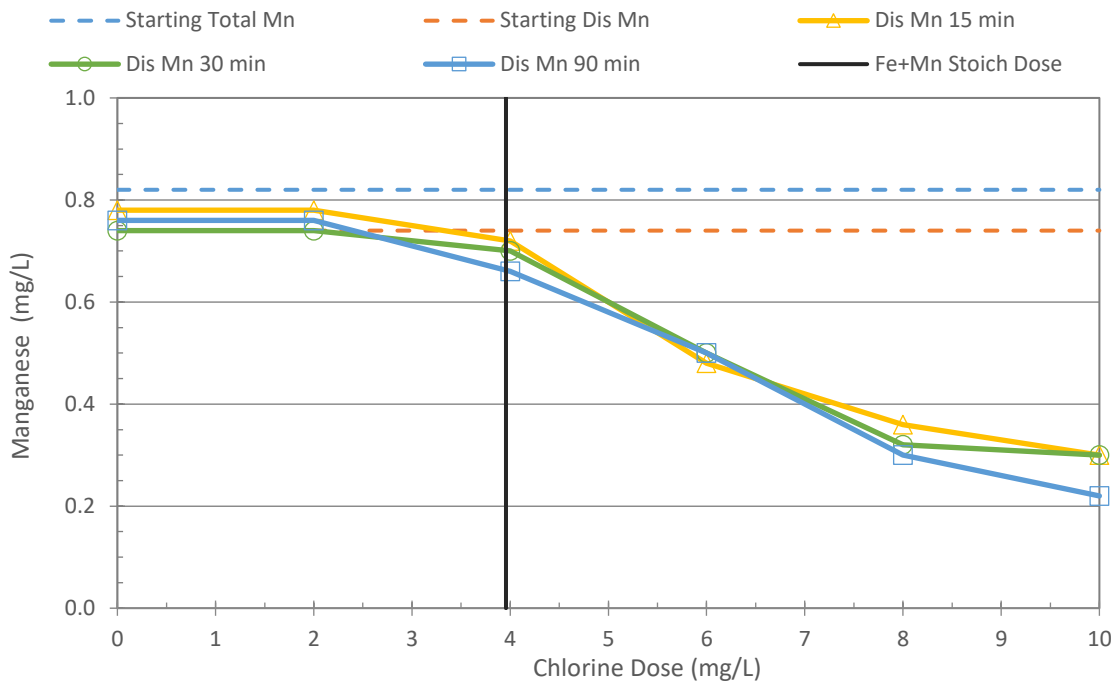


Figure 4-24: Oxidation of Iron with Chlorine Dose (without Aeration)



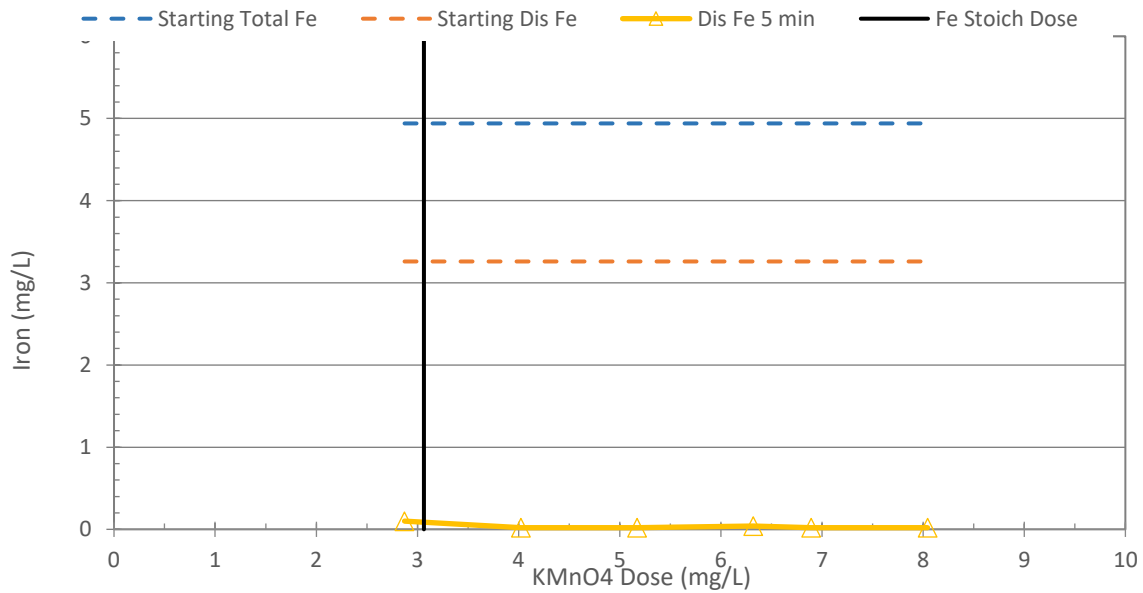
**Figure 4-25: Oxidation of Manganese with Chlorine Dose (without Aeration)**

During Jar Test 2, potassium permanganate was added to raw water that was not aerated. Total and dissolved manganese in the raw water were 0.86 and 0.84 mg/L, respectively. Total and dissolved iron were 4.9 and 3.3 mg/L, respectively. Permanganate dose to the jars varied between 2.9 and 8.0 mg/L. Samples were collected after 5 minutes and filtered to measure the impact of permanganate dose and contact time on the oxidation of iron and manganese. Results from Jar Test 2 are shown in Figure 4-26 and 4-27.

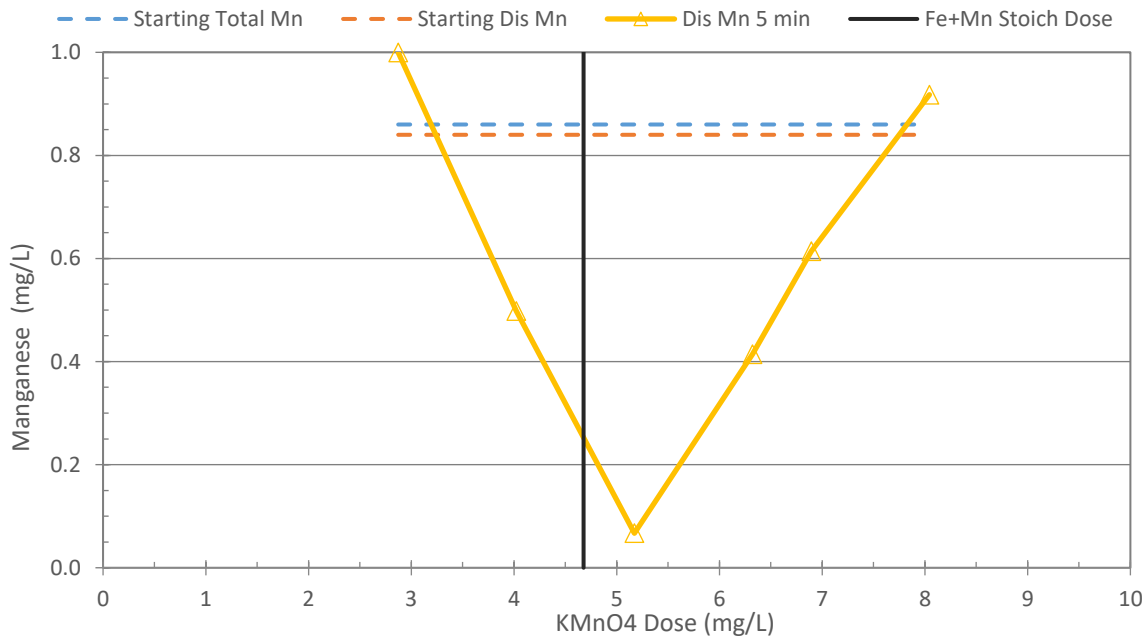
As shown in Figure 4-26, permanganate was very effective at oxidizing dissolved iron. The stoichiometric permanganate dose to oxidize the iron was 3.1 mg/L. A permanganate dose of 2.9 mg/L resulted in 0.10 mg/L of iron after 5 min of contact time. Doses greater than 2.9 mg/L resulted in non-detect iron.

The results for the oxidation of dissolved manganese with permanganate are shown in Figure 4-27. The stoichiometric permanganate dose to oxidize the dissolved iron and manganese was 4.7 mg/L. The results show that a permanganate dose of 4 mg/L decreased the dissolved iron to zero and dissolved manganese from 0.84 to 0.50 mg/L. Increasing the permanganate dose to 5.2 mg/L resulted in a dissolved manganese of 0.07 mg/L. This value is on the right side of the stoichiometric line, indicating that all of the original dissolved manganese was oxidized, and this amount is the extra permanganate residual in solution.

Increasing the permanganate dose beyond this amount increased the dissolved manganese due to the excess permanganate residual in solution.



**Figure 4-26: Oxidation of Iron with Permanganate Dose (without Aeration)**

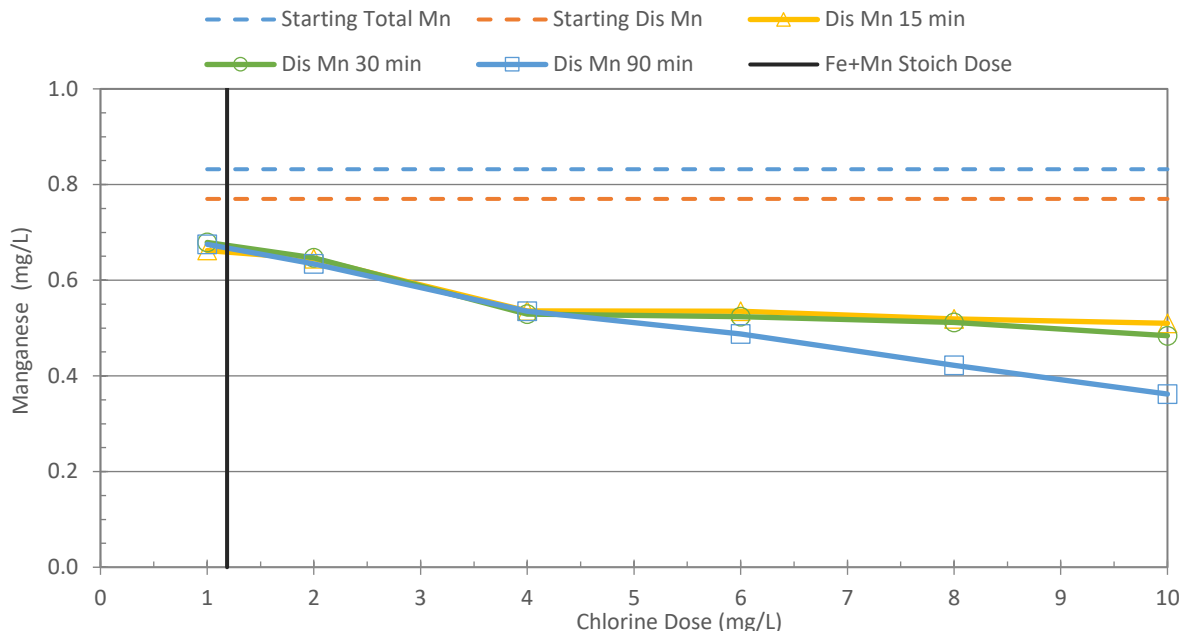


**Figure 4-27: Oxidation of Manganese with Permanganate Dose (without Aeration)**

During Jar Test 3, chlorine was added to raw water that was aerated in the lab using 5-gallon buckets. Dissolved oxygen was increased to 9.2 mg/L and then the water was allowed to sit for three hours prior to the jar test. Dissolved iron decreased during this time from 4.8 to 0.29 mg/L. Total and dissolved manganese were 0.83 and 0.77 mg/L, respectively at the beginning of the test. Chlorine was dosed to the jars varied between 1 and 10 mg/L. Samples were collected at 15, 30, and 90 minute intervals and filtered to measure the impact of chlorine dose and contact time on the oxidation of dissolved iron and manganese.

The stoichiometric dose to oxidize the 0.29 mg/L of dissolved iron was 0.19 mg/L chlorine. As a result, the lowest chlorine dose of 1 mg/L was able to oxidize the dissolved iron to non-detect after 15 minutes.

The results for the oxidation of dissolved manganese with chlorine are shown in Figure 4-28. The stoichiometric dose to oxidize the 0.29 mg/L of dissolved iron and 0.77 mg/L of dissolved manganese was 1.2 mg/L chlorine. The results show that a chlorine dose of 4 mg/L decreased the dissolved manganese to 0.54 mg/L for each contact time of 15, 30, and 90 minutes. At 10 mg/L chlorine dose, the dissolved manganese was decreased to 0.51 mg/L after 15 minutes and 0.36 mg/L after 90 minutes. This data shows that high levels of chlorine (well above the stoichiometric dose) for long contact times are required to oxidize dissolved manganese. Similar to Jar Test 1, the increased benefit between 15 and 90 minutes of contact time is fractional.

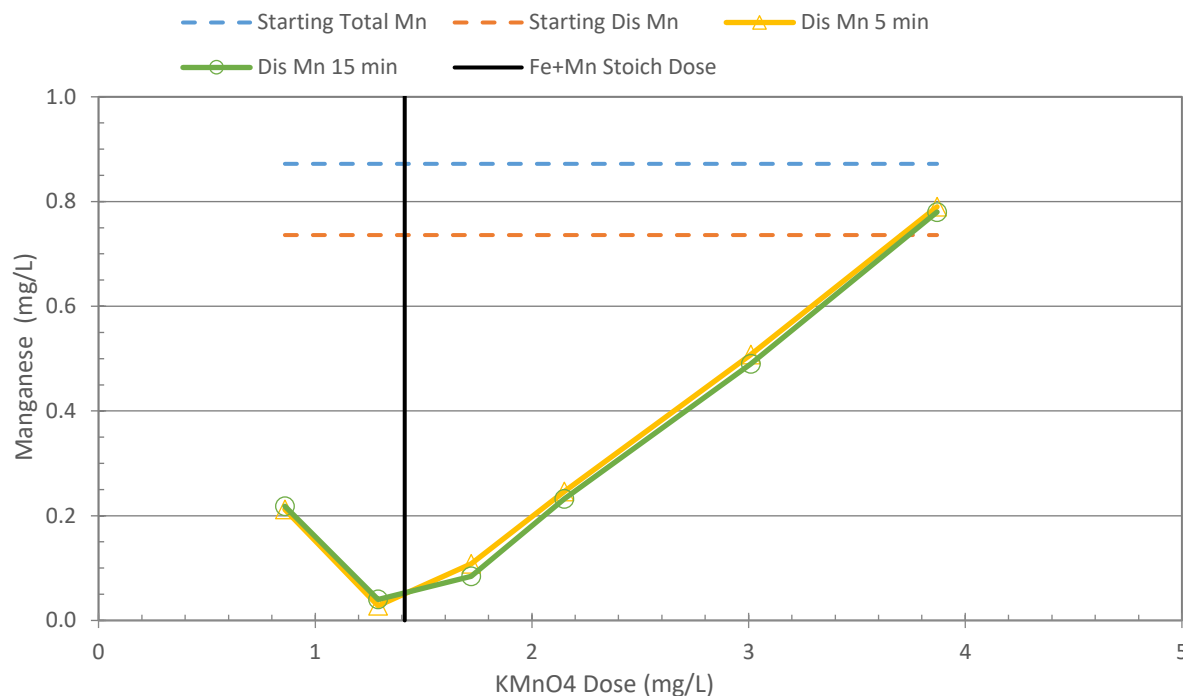


**Figure 4-28: Oxidation of Manganese with Chlorine Dose (after Aeration)**

During Jar Test 4, permanganate was added to raw water that was aerated in the lab using 5-gallon buckets. Dissolved oxygen was increased to 8.8 mg/L and allowed to sit for a few hours. Dissolved iron decreased during this time from 4.8 to 0.22 mg/L. Total and dissolved manganese were 0.87 and 0.74 mg/L, respectively at the start of the test. Permanganate doses to the jars varied between 0.86 and 3.9 mg/L. Samples were collected at 5 and 15 minute intervals and filtered to measure the impact of permanganate dose and contact time on the oxidation of dissolved iron and manganese.

The stoichiometric dose to oxidize the 0.22 mg/L of dissolved iron was 0.14 mg/L permanganate. As a result, all of the iron was oxidized at each permanganate dose.

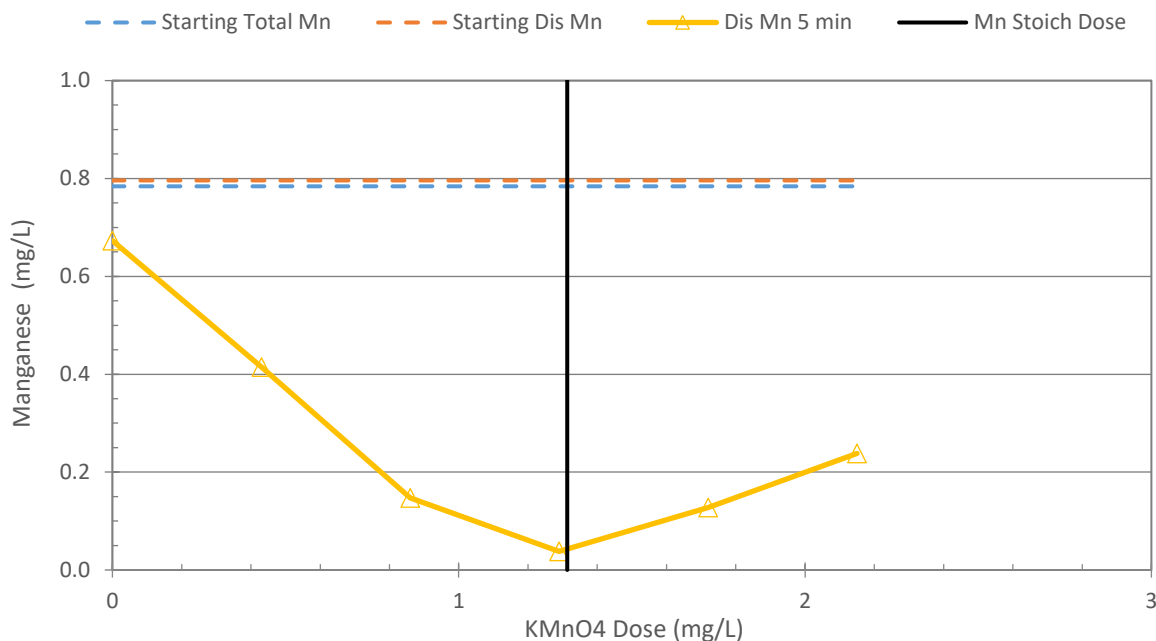
The results for the oxidation of dissolved manganese with permanganate are shown in Figure 4-29. The stoichiometric dose to oxidize the 0.74 mg/L of dissolved manganese was 1.4 mg/L permanganate. The results show that a permanganate dose of 1.3 mg/L decreased the dissolved manganese to 0.03 mg/L for both contact times (5 and 15 minutes). Higher doses of permanganate resulted in higher levels of dissolved manganese due to the excess permanganate residual in solution. The results from this test show that permanganate is very effective in oxidizing dissolved permanganate within 5 minutes and additional contact time provides no benefit.



**Figure 4-29: Oxidation of Manganese with Permanganate Dose (after Aeration)**

During Jar Test 5, dissolved manganese was measured after aeration, chlorine, and varying permanganate doses. The raw water dissolved iron and manganese before aeration were 5.0 and 0.80 mg/L, respectively. The raw water was aerated to increase the DO from 1.5 to 9.5 mg/L and allowed to sit 6 minutes, which then decreased the dissolved iron to 4.6 mg/L. The stoichiometric dose to oxidize the 4.6 mg/L of dissolved iron was 2.9 mg/L chlorine. As a result, a chlorine dose of 3 mg/L was added to each jar. A contact time of 15 minutes was provided to allow the chlorine to oxidize the dissolved iron, resulting in a dissolved iron of non-detect and dissolved manganese of 0.68 mg/L. Permanganate was then dosed at varying amounts between 0 and 2.2 mg/L to each jar to oxidize the dissolved manganese.

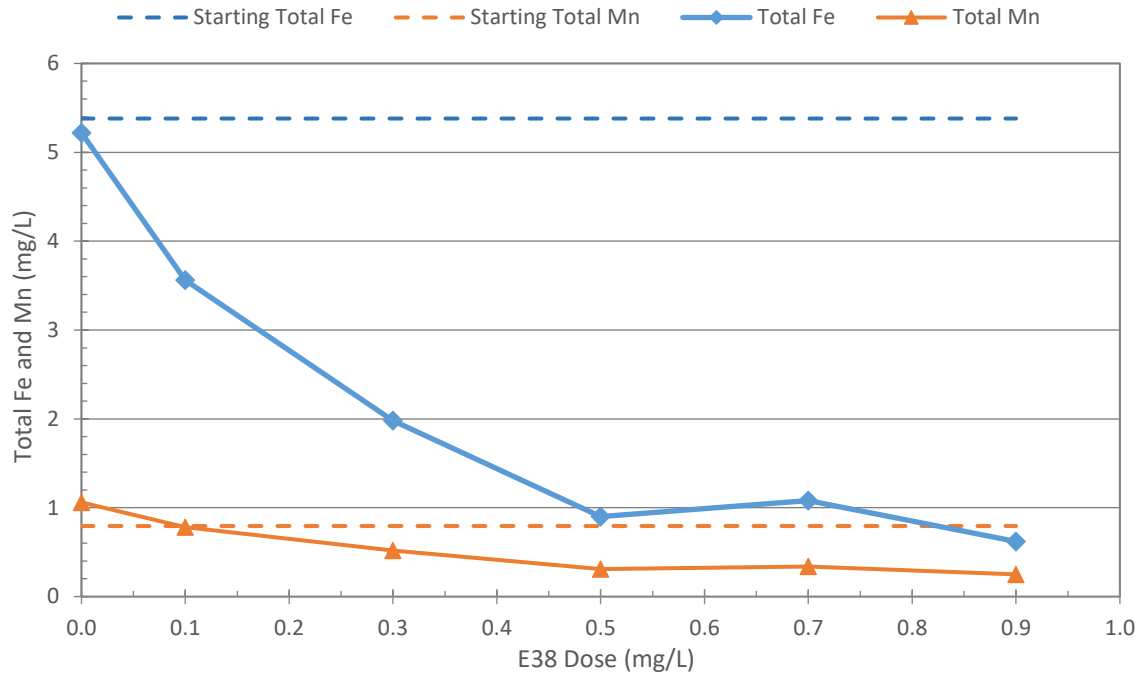
The results for the oxidation of dissolved manganese with permanganate are shown in Figure 4-30. The stoichiometric dose to oxidize the 0.68 mg/L of dissolved manganese was 1.3 mg/L permanganate. As shown in Figure 4-30, a permanganate dose of 1.3 mg/L decreased the dissolved manganese from 0.68 to 0.04 mg/L. Higher doses of permanganate resulted in higher levels of dissolved manganese due to the excess permanganate residual in solution. The results from this test show that a combination of aeration, chlorine (3 mg/L) and permanganate (1.3 mg/L) were very effective in oxidizing the iron and manganese to below the secondary limits.



**Figure 4-30: Oxidation of Manganese with Permanganate Dose (after Aeration and Chlorine)**

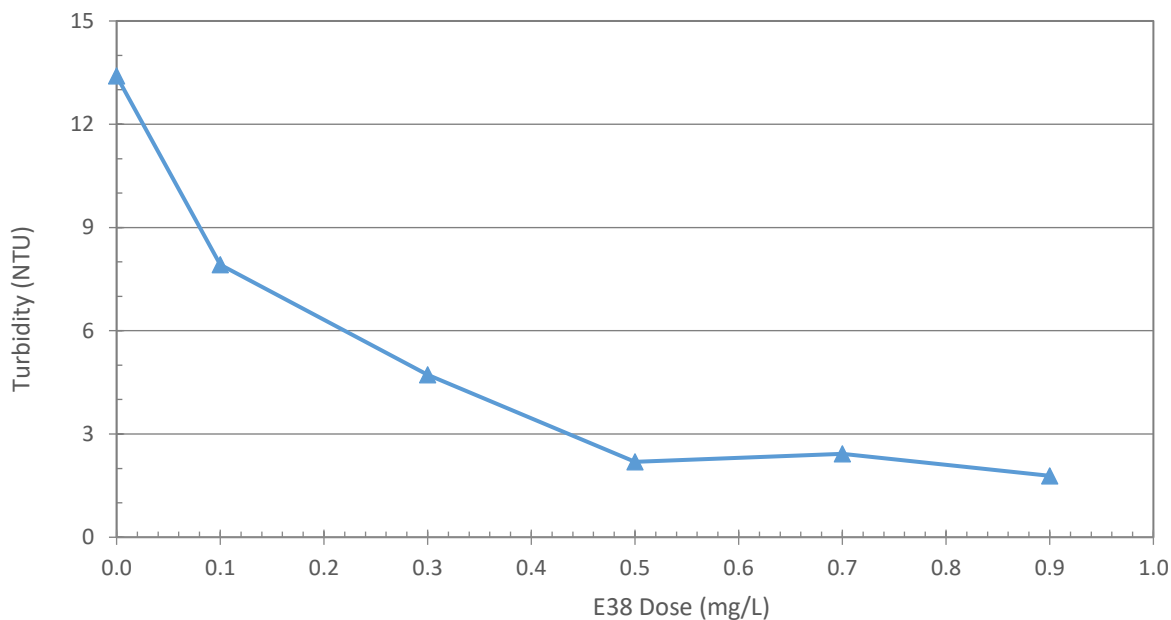
During Jar Test 6, total iron and manganese were measured after aeration, chlorine dose (3 mg/L), permanganate dose (1.3 mg/L), and varying E38 polymer doses. Total and dissolved manganese on the raw water were 0.80 and 0.79 mg/L, respectively. Total and dissolved iron were 5.7 and 4.7 mg/L, respectively. Similar to Jar Test 5, the raw water was aerated to increase the DO from 2.5 to 9.4 mg/L and allowed to sit 6 minutes. A chlorine dose of 3 mg/L was added followed by a contact time of 15 minutes to oxidize the dissolved iron. Permanganate was dosed at 1.3 mg/L to oxidize the dissolved manganese. The dissolved iron and manganese were 4.4 and 0.80 mg/L after aeration, 0.06 and 0.68 mg/L after chlorine dose, and 0.03 and 0.03 mg/L after permanganate dose, respectively. Polymer E38 was dosed between 0 and 0.9 mg/L followed by the standardized bench scale testing mixing energy and contact time (4 minutes at mixer speed of 170 rpm with G-value of 275). A settling time of 40 minutes was provided for iron, manganese, and turbidity to settle.

The results for total iron and manganese after aeration, pre-oxidation, and jar testing with varying E38 polymer are shown in Figure 4-31. Total iron and manganese were 0.90 and 0.31 mg/L, respectively, at E38 polymer dose of 0.5 mg/L. Diminishing returns were observed at higher doses. Total iron and manganese were 0.62 and 0.25, respectively, at E38 polymer dose of 0.9 mg/L.



**Figure 4-31: Total Iron and Manganese with Pre-oxidation and Varying E38 Dose**

The turbidity results for raw water after aeration, pre-oxidation, and jar testing with varying E38 polymer are shown in Figure 4-32. Turbidity values decreased from 13.4 to 2.2 NTU at E38 polymer dose of 0.5 mg/L. Diminishing returns were observed at higher doses, with turbidity of 1.8 NTU at E38 polymer dose of 0.9 mg/L. These values indicate slightly higher doses should be used than was observed with the previous E38 jar testing; this is likely due to the presence of more particles as a result of more complete oxidation of iron and manganese.



**Figure 4-32: Turbidity Reduction with Pre-oxidation and Varying E38 Dose**

### 4.3 Jar Testing Conclusions

The results from the aeration and pre-oxidation testing show that aeration and chlorine can be used in combination to oxidize dissolved iron. An increase in aeration to add more DO from 6.5 to 9.0 mg/L would improve the oxidation across a range of contact times. This improved use of oxygen will reduce the amount of chlorine and/or permanganate consumed in oxidation of dissolved iron.

Using more efficient aeration, combined with chlorine and permanganate, could provide the O'Fallon WTP with the benefits of faster reaction times and lower overall chemical dosing requirements. For example, average raw water containing 7 mg/L of dissolved iron and 1 mg/L of dissolved manganese, would require a stoichiometric chlorine dose of 6 mg/L, plus additional chlorine to force the manganese oxidation reactions. Using potassium permanganate alone would require a dose of 8.5 mg/L. Having new aeration system able to achieve a DO of 9.0 is anticipated provide approximately 80 percent reduction in dissolved iron, resulting in a chlorine dose of 1.1 mg/L to oxidize the remaining 1.8 mg/L of dissolved iron, and a potassium permanganate dose of 1.9 mg/L to oxidize the manganese. This would allow iron and manganese to be fully oxidized and removed prior to filtration. Under these conditions, the chlorine residual level in the filters could be lowered, reducing off-gassing and corrosion within the filter building.

## 5.0 PRE-OXIDATION EVALUATION

### 5.1 Aeration and Oxidation

#### 5.1.1 Current Aeration and Oxidation Configuration

The WTP currently oxidizes using aeration and chemical oxidation with chlorine (sodium hypochlorite). The chlorine is injected upstream of the aeration basin. The original plant design was to inject downstream of the detention basin, however there was not enough detention time to oxidize the iron and manganese before the plate settlers and filters. The aeration basin, as was shown in Figure 2-1, utilizes a simple nozzle design to mix water with air and the efficiency of oxygen transfer is limited. The detention time in the aeration basin and detention basin is 30 minutes each at the plant design flow of 6 MGD.

#### 5.1.2 Challenges and Limitations

The detention basin has no baffles to promote plug-flow. The aeration and detention basins have adequate capacity; however, without baffles, the flow can short circuit, resulting in a low effective contact time or  $T_{10}$ .  $T_{10}$  is defined as the point at which 10 percent of the water has exited the basin. In ideal plug-flow mixing, detention time equals  $T_{10}$ . The aeration basin  $T_{10}$  is 9 minutes compared to the detention time of 30 minutes. The detention basin  $T_{10}$  is only 3 minutes compared to the 30-minute detention time.

The aeration equipment is limited in the air-to-water ratio it is able to achieve and this can be further impacted by variation in plant flow. As discussed in Section 3.2.1 of this report, the existing aeration equipment cannot produce desired levels of DO in the aerated water.

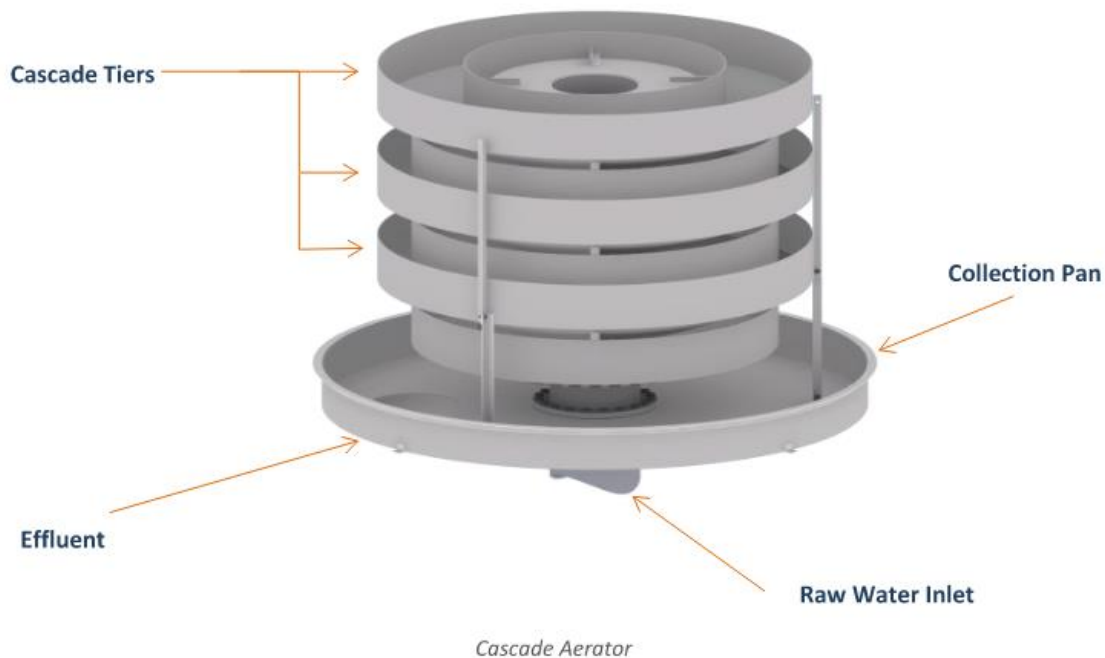
Some of the hypochlorite is likely lost to the air by injecting hypochlorite upstream of the aeration basin.

#### 5.1.3 Alternative Aeration Equipment

The current aeration basin can be replaced with more traditional aeration equipment such as a cascade aerator or induced draft aerator. Both systems can be designed to maximize the air/water interface to allow for increased transfer of oxygen and higher DO in the aerated effluent, which would increase the amount of iron oxidation achievable via the aeration basin. Vendor-provided information and quotes for new aeration equipment are included in Appendix B.

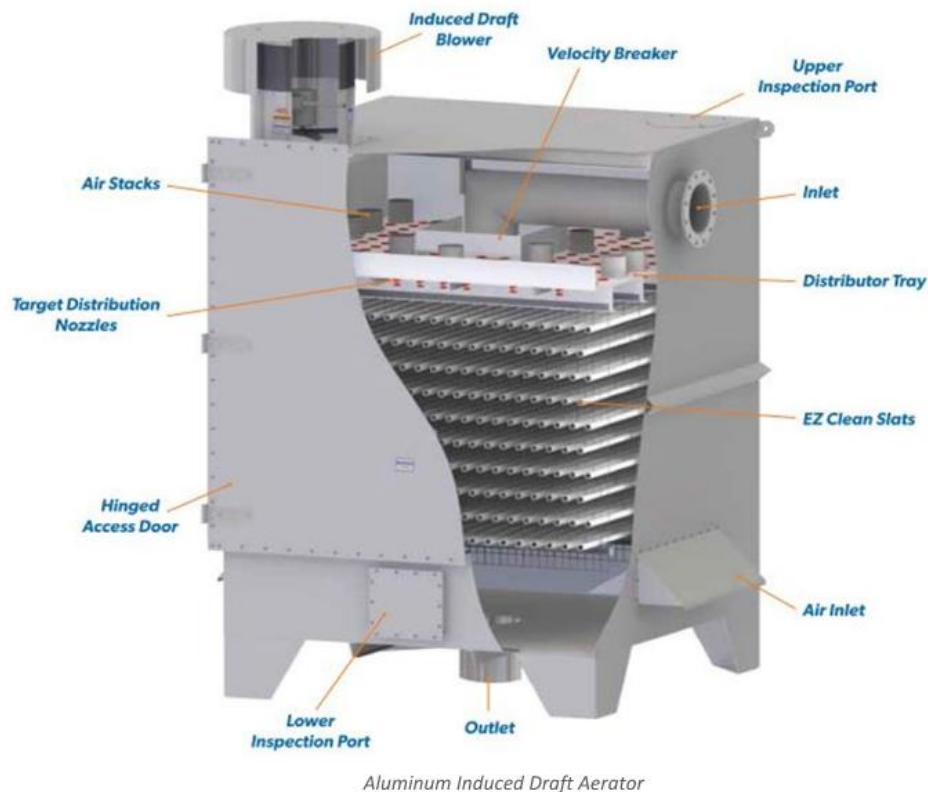
A cascade aerator (Figure 5-1) utilizes gravity, natural air draft and available head to send water down the equipment, forcing contact between air and water. There are no moving parts, nor electrical demand for the cascade aerator. The head requirement is the height of the column, which would need to be placed above the existing water surface in the aeration basin, but below the head limit of the well pumps.

Cascade aerators have minimal maintenance due to their simplistic design. As the cascade aerator depends on the natural draft of air in the environment, it is not possible to accurately predict the air-to-water ratio. It will vary based on windspeed. However, as seen in the jar testing and as discussed with equipment suppliers, this type of aeration will result in higher DO than the existing aeration nozzles.



**Figure 5-1: Cascade Aerator (Image courtesy of WesTech)**

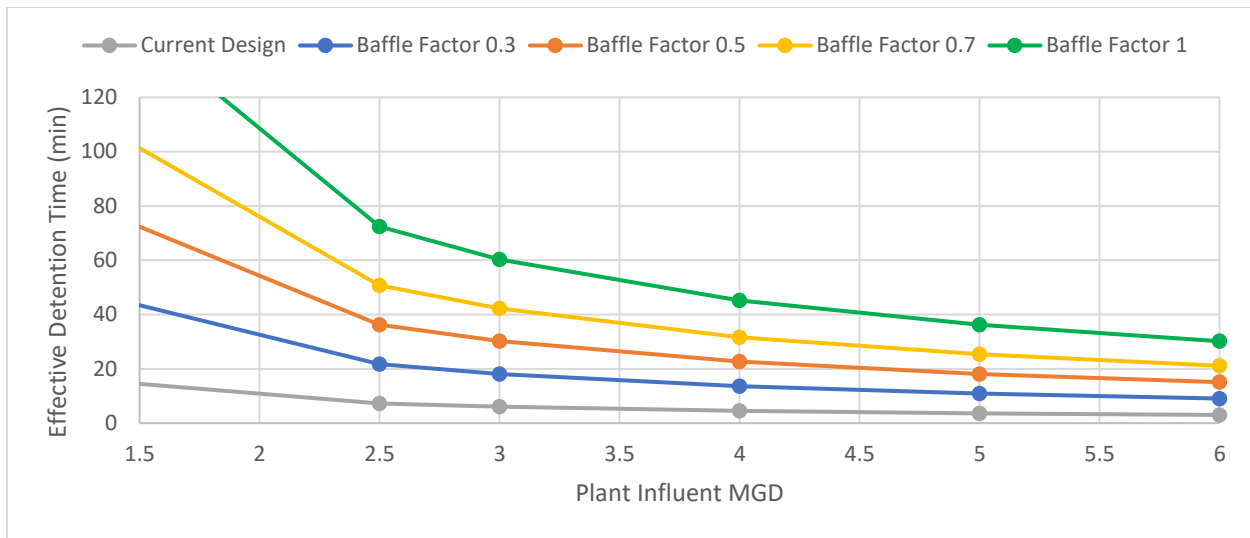
An induced draft aerator shown in Figure 5-2 uses a blower to induce an air flow that is counter current to the liquid flow from gravity. As the inlet liquid falls down through the aerator, air is being blown up through the equipment creating counter-current contact between the air and water for oxidation. While this equipment requires electrical power and a higher degree of maintenance, it also provides more precise design and control of the air-to-water ratio. The air-to-water ratio for the preliminary design from WesTech is 3.6:1 (cfm:gpm).



**Figure 5-2: Induced Draft Aerator (Image courtesy of WesTech)**

#### 5.1.4 Detention and Aeration Basin Modifications

Although the volume of the aeration and detention basins are adequate to provide 30 minutes of detention time each at design flow, the lack of baffles within the basins allow for short circuiting and dead spots. This means the actual effective detention time, or  $T_{10}$ , defined as the point at which 10 percent of the water has exited the basin, is lower. The effective detention time is based on a baffle factor that ranges from 0.1 to 1.0, with 1.0 being perfect plug flow and 0.1 being unbaffled. Currently, the aeration basin and detention basin are considered to have baffle factors of 0.3 and 0.1, respectively. To increase the overall effective detention time ( $T_{10}$ ), baffles can be installed within the basins. Adding baffles will increase plug flow characteristics and use of the whole basin volume, thereby reducing the potential for water to short circuit and leave the basins early. By keeping more of the water in the basin longer, the effective contact time increases to get closer to the calculated detention time. This provides more uniform and longer contact with the chlorine and oxygen in the water to promote oxidation of iron and manganese. Figure 5-3 details how the effective detention time within the detention basin increases with increasing baffle factor and changes based on flow into the plant for the detention basin.



**Figure 5-3: Effective Detention Time with Detention Basin Modifications**

If the detention basin was modified to have perfect plug flow (baffle factor of 1), the effective detention time would increase from 3 minutes to 30 minutes in the detention basin for the design rate of 6 MGD. A more realistic modification would be installation of serpentine weirs within the basin to increase the baffle factor to 0.7 and the effective detention time to 21 minutes. This modification at the average plant flowrate of 2.5 MGD would increase effective detention time from 7 minutes to 50 minutes.

The aeration basin could be similarly modified if the aeration equipment were replaced. A preliminary layout of the aeration basin modifications with both the cascade and induced draft aerators are included in Appendix C. Currently the aeration pipes limit any additional baffling in the aeration baffle.

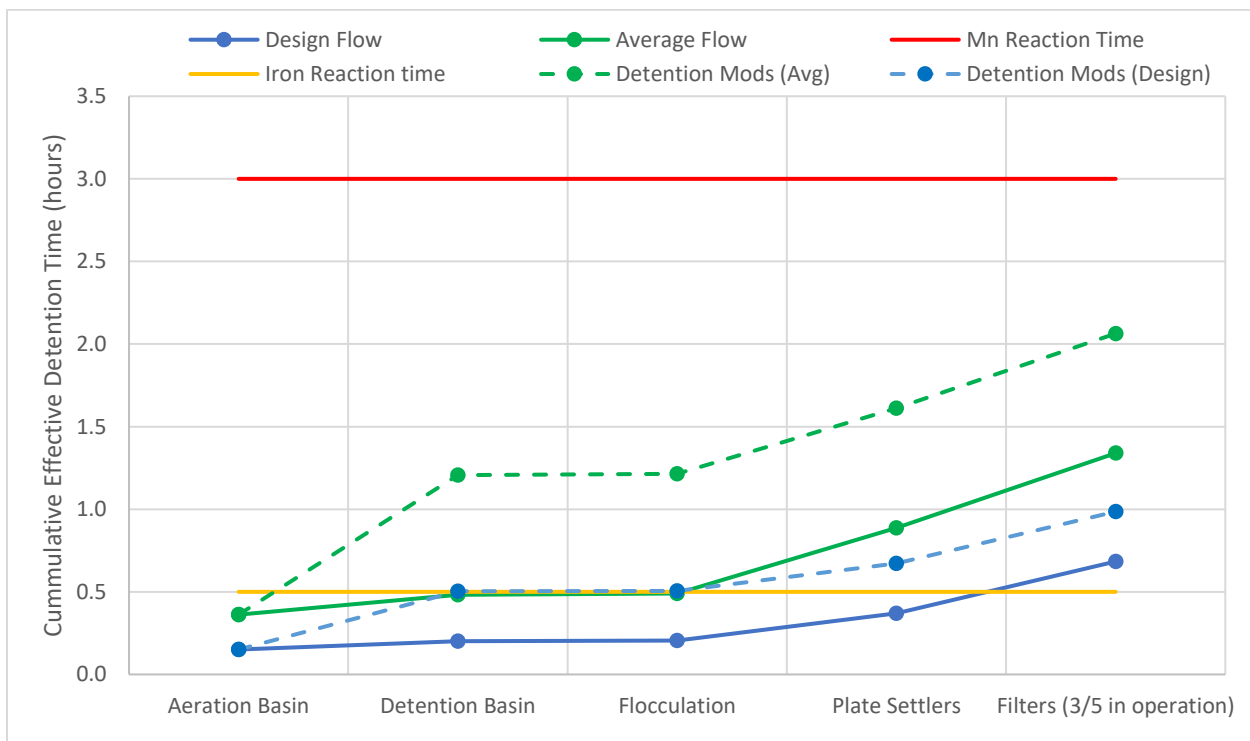
### 5.1.5 Effective Detention Time

A summary of iron oxidation reactions and manganese reactions was discussed in Section 2.4, which shows the time required to oxidize manganese is greater than the time to oxidize iron. Effective ( $T_{10}$ ) detention time is shown in Table 5-1. These values are well below the 3 hours required for chlorine to oxidize manganese.

**Table 5-1: Effective Detention Time ( $T_{10}$ ) in Minutes**

Unit Process	Existing Baffle Factor	Effective Detention Time at Average Flow	Effective Detention Time at Design Flow
Aeration Basin	0.3	21.7	9.0
Detention Basin	0.1	7.2	3.0
Rapid Mix	0.1	0.5	0.2
Settlers	0.7	23.8	9.9
Filters (3 Avg./5 Design)	1.0	27.2	11.3
TOTAL	---	80.4	33.5

Figure 5-4 depicts the effective detention time in the design and average flow throughout the plant, with the current configurations, and with detention modifications (i.e. improved baffling). This approach looks good theoretically and has been suggested for implementation in past studies; however, the benefit to be realized is likely to be low based on the results from jar testing which showed minimal additional oxidation from increased contact times (see Section 4.1.2.). As such, baffling is not a recommended capital improvement at this point.



**Figure 5-4: Effective Detention Time with Modifications**

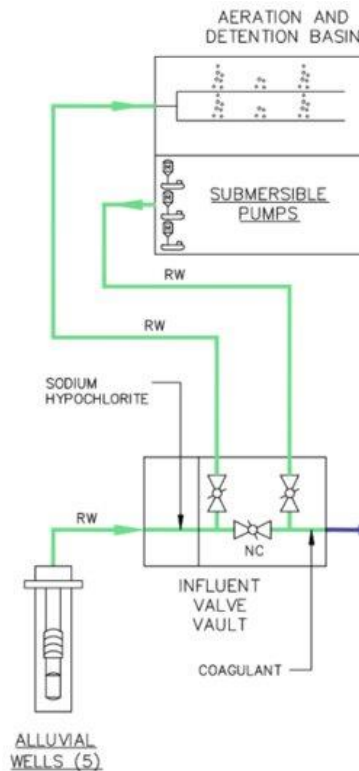
## 5.1.6 Alternative Oxidants and Dosing Locations

### 5.1.6.1 Chlorine Injection Point

As shown in Figure 5-5, the chlorine injection feed location is currently upstream of the aerators and aeration basin. Injection of the chlorine in this location has a couple of drawbacks.

1. It does not allow for dissolved oxygen from aeration to be used first to oxidize iron prior to chlorine oxidation. The air is a less expensive oxidant than the chlorine, and if utilized first, could reduce the amount of chlorine needed to oxidize the iron (assuming manganese is oxidized later with permanganate as discussed in later sections of this report).
2. This injection location may also cause some chlorine to be lost into the atmosphere via volatilization within the aeration spray.
3. The high chlorine dose has generated a lot of corrosion in the pipeline near the injection point and within the injection vault.

The WTP reports a chlorine dose at this location of approximately 8 to 15 mg/L. Based on stoichiometric calculations, the maximum chlorine demand for iron and manganese in the raw water is approximately 9 mg/L (assumes maximum iron and manganese concentrations of 11.8 and 0.95 mg/L, respectively). The additional chlorine usage above the stoichiometric requirement is due to other chlorine demands in the raw water, loss during aeration, excess dosing needed to achieve manganese oxidation, and WTP operational targets for maintaining chlorine residuals in the filters. This system could see benefits in reduction of chlorine usage by moving the chlorine injection point downstream of the aerators. This configuration would reduce potential for chlorine loss in aeration and allow the dissolved oxygen from aeration to oxidize a portion of the dissolved iron prior to chlorine addition.



**Figure 5-5: Existing Chlorine Injection Point Upstream of Aeration Basin**

### 5.1.7 Addition of Permanganate

As shown in jar testing, permanganate is very effective at oxidizing the dissolved manganese completely and within a very short contact time. Permanganate could be injected at some point within the aeration basin, after air and chlorine have been given some time to react with the dissolved iron.

Preliminary sizing for a permanganate system is included in Appendix C. This system would include storage in totes, a day tank, and chemical feed pumps. It is anticipated that the system could be located within one of the existing chemical feed rooms that is currently unused, such as the fluoride room. A preliminary layout of the permanganate system is also included in Appendix C.

Permanganate can damage membranes and overdosing of permanganate can lead to high dissolved manganese content in the finished water. As such, careful dosing is required. Use of online analyzers to measure raw water manganese and permanganate residual downstream of dosing is recommended with installation of a permanganate feed system at the O'Fallon WTP.

### 5.1.8 Impact on Corrosion

Implementation of a different pre-oxidation approach is anticipated to affect corrosion in the following ways:

1. Movement of chlorine feed downstream of aeration will reduce exposure of raw water piping to high chlorine concentrations.
2. Use of permanganate will lower the total amount of chlorine required.
3. Use of permanganate and achievement of full oxidation within the aeration and detention basins, will eliminate the need for the filters to operate as greensand filters. In this case, chlorine residual within the filters can be lowered, reducing exposure of the filter tanks to corrosion and reducing off-gassing of chlorine vapors within the filter building.

## 5.2 Iron and Manganese Removal

Once the iron and manganese are oxidized, the resulting particulates present in the water stream must be removed via physical processes. The plate settler units and media filters provide removal of these particles at the O'Fallon WTP.

### 5.2.1 Current Plate Settler Configuration

The plate settler units consist of a flocculation tank with top-mounted mixer. The flocculation tank is 2100 gallons and the mixer is 1 HP with a VFD to allow for variation of mixing speed. Each unit has 132 parallel plates for settling of solids, with a total effective area of 3028 ft<sup>2</sup>. Based on MDNR design guidelines, the allowable hydraulic loading rate for plate settlers is 0.5 gpm/ft<sup>2</sup> based on 80 percent of the project horizontal plate area (i.e. effective area). Thus, the plate settlers can handle up to 2.2 MGD and be withing acceptable hydraulic loading conditions.

Settled solids are then sent to the equalization basin on-site via an automatic blowdown valve. Each settler has a blowdown valve programmed to open for 60 seconds after 0.1 MGD has flowed through the settler.

### 5.2.2 Challenges and Limitations

The single mixer in the flocculation tank at the head of the plate settler units does not allow for separate mixing energies for rapid mix and flocculation, just one speed to achieve both.

The small flocculation volume only provides a short time for flocculation, 2 to 5 minutes at design and average flows, respectively.

The covers on the top of the units provide protection from infiltration of leaves but limit access to plates to perform regular cleaning.

### **5.2.3 Alternative Operations**

#### **5.2.3.1 Plate Settler Blowdown**

There are two available options for the blowdown mode to be triggered: flow or time between blowdowns. The blowdown trigger mode is currently set based on flow. If solids continue to leave in the plate settler effluent, this blowdown frequency may need to be increased to mitigate solids build-up within the hopper. Performance of the plate separators should be checked after the blowdown cycle by opening up the lowest tap on the plate separator. Blowdown discharge should be mainly orange colored water and if it is thick, the blowdown frequency should be increased.

#### **5.2.3.2 Plate Settler Cleaning**

According to the plate settler maintenance manual, cleaning of plate settlers can be performed by dropping the water level, allowing the solids to slide off of the plates. If further cleaning is required, a water hose with tap water pressure (should not exceed 40 psi) can be used to wash the solids down. The use of high-pressure washing should not be performed because of possible damage to the plates.

Cleaning systems and recommendations by vendors were evaluated, but most just include a periodic cleaning of the plates and consistent visual inspection. Parkson recommends cleaning the plates at least once a year using low water pressure (40 to 60 psi) with some type of spray wand/lance to clean the bottom of the plates.

## 6.0 FILTER EVALUATION

### 6.1 Background Information

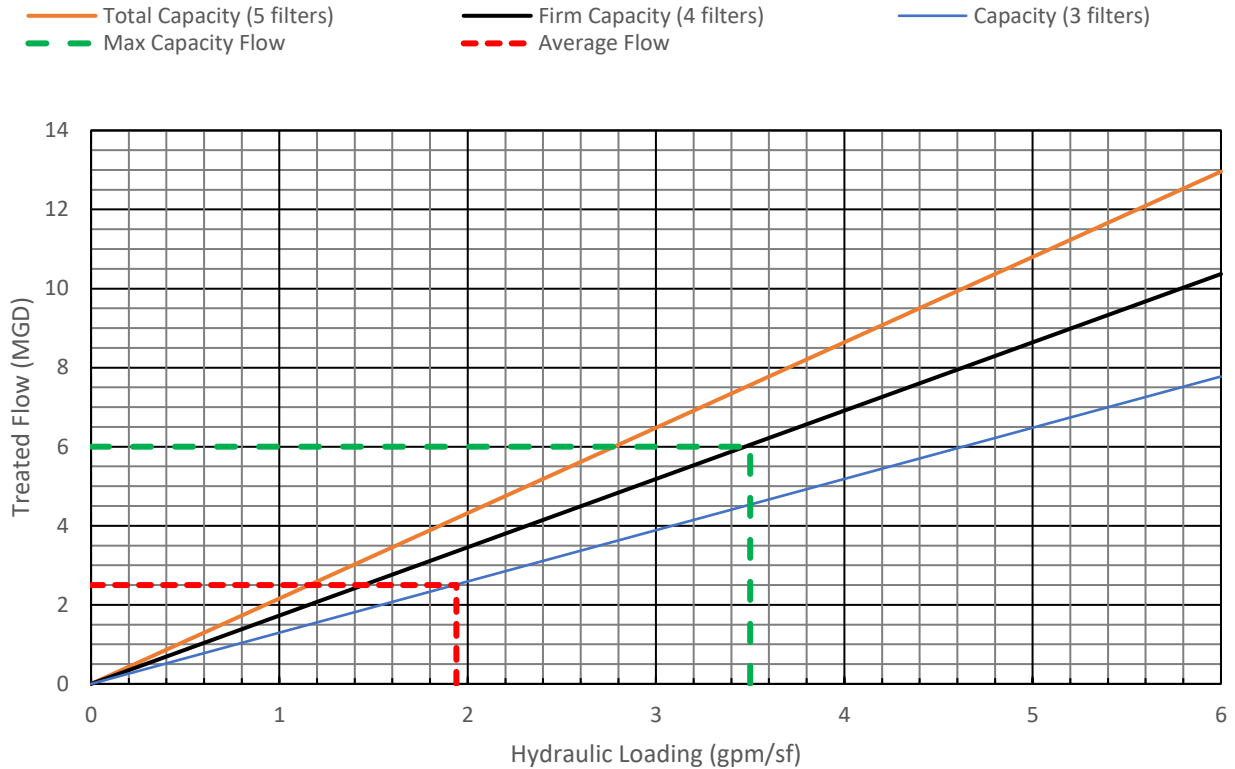
### 6.2 Filter Configuration

Each of the five filters has a surface area of 300 square feet (nominally 30 ft by 10 ft each). Each filter contains two painted metal troughs to convey backwash wastewater and three air scour pipe grids under the media. The filter underdrain is a Roberts Infinity with porous plate type underdrain.

Historical records indicate that the filters contain dual media with 15 inches of sand, (3 inches of course sand and 12 inches of silica sand), and 18 inches of anthracite. Backwash is supplied by finished water tanks by gravity, or through a wash water pump if necessary. Backwash waste is sent to an equalization basin and pumped to the neighboring WWTP.

### 6.3 Filter Capacity

Treatment capacity of a filtration system is based on the allowable hydraulic loading rate and the total surface area of the filters. Hydraulic loading rate is defined as the total applied flow (in gallons per minute) to each square foot of filter surface area. The most recently published Missouri Department of Natural Resources (MDNR) Minimum Design Standards for Missouri Community Water Systems (12/10/13) specifies a maximum design hydraulic loading rate of 2 gpm/sf and higher rates can be achieved with approval. The 2018 Edition of the Recommended Standards for Water Works (Ten State Standards) recommends a hydraulic loading rate between 2 and 4 gpm/sf. The graph in Figure 6-1 shows the WTP flow resulting from various applied hydraulic loading rates for firm and total capacity. The WTP capacity of 6 million gallons per day (MGD) requires a hydraulic loading rate of 2.8 gpm/sf when all filters are in service, and 3.5 gpm/sf when one filter is out of service (firm capacity).



**Figure 6-1: Filter Hydraulic Loading**

### 6.3.1 Filter Media Design

The O'Fallon WTP utilizes a dual media system with two filtration layers consisting of anthracite and sand. Records indicate that the filters have 15 inches of sand (3 inches of coarse and 12 of silica sand) and 18 inches of anthracite. The combination of sand and anthracite media is ideal because of the differences in size and specific gravity between the materials. Anthracite media, with lower density and larger particle size, will stratify on top following backwash, while the heavier and smaller sand will settle to the bottom.

This filter media arrangement allows larger particles to be removed in the top layer of the media bed with smaller particles being retained deeper in the media. The anthracite layer provides most of the solids storage capacity due to larger pore volume but is not able to remove finer material. The sand layer typically removes particles down to 25 microns but does not have the same solids storing capacity as anthracite.

Higher filtrate quality is obtained with the use of sand due to its small size; however, the sand lacks solids storage capacity and generates higher head loss. Filter run times can be increased by providing more

anthracite media that has fewer restrictions and less head loss. The anthracite allows more particles to be trapped within the media bed, further contributing to longer filter runs. The need for a high-quality filter effluent with higher solids storage capacity led to the development of the dual media filter using sand and anthracite.

### 6.3.2 Historical Filter Performance

Four performance indicators that are typically used in evaluating filter performance include turbidity removal, the length of the filter run, the unit filter run volume, and the ratio of backwash water used to the volume of water filtered. Ultimately, what is most critical to proper treatment is the turbidity removal performance of the filtration process since this is the basis for most regulatory and performance standards.

### 6.3.3 Turbidity Removal

The average turbidity of the water leaving the filters during sampling 2/12/2022 to 3/3/2022 was 0.15 NTU and consistently shows a 90% reduction in turbidity. Figure 6-2 below shows that the effluent turbidity from the WTP meets the regulatory requirement of less than 0.3 NTU.

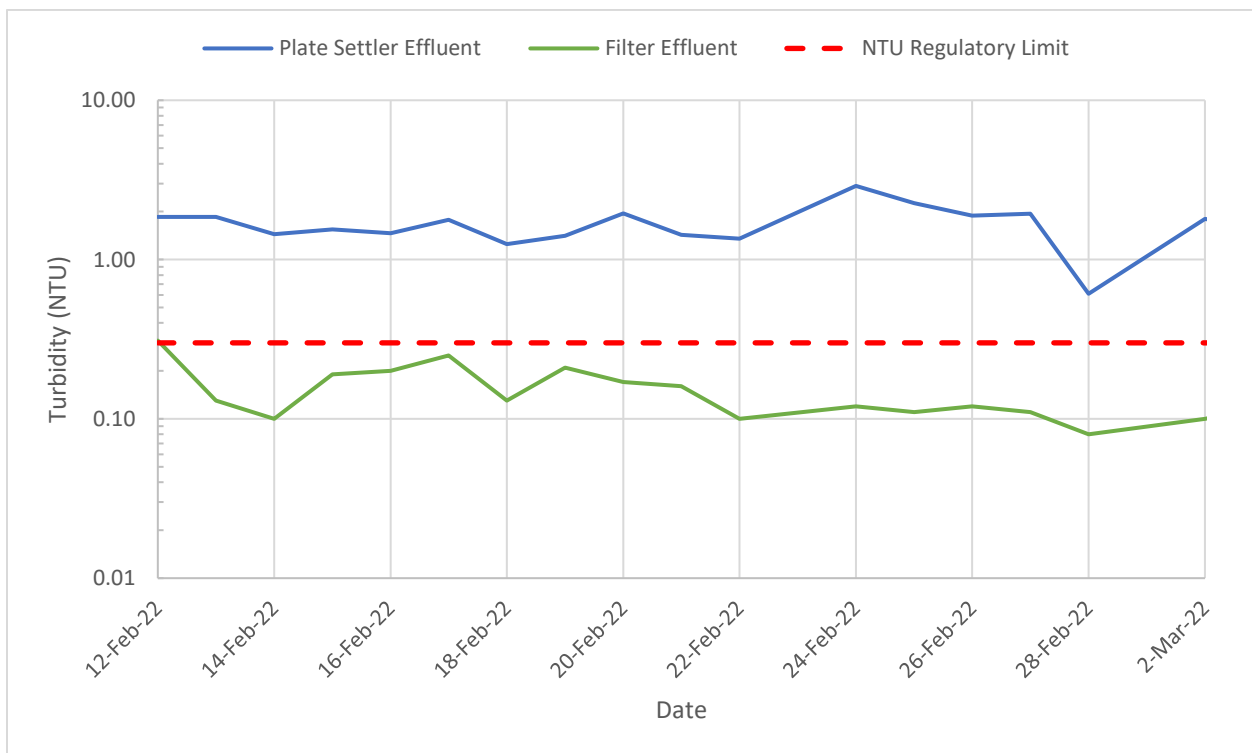


Figure 6-2: Plate Settler and Filter Effluent Turbidity

### 6.3.4 Filter Run Time

Filter run time refers to the amount of time a filter is in operation before it is backwashed. Filter run times can be terminated based on a number of operating parameters, including:

- Filter effluent turbidity;
- Headloss;
- Pre-determined maximum filter run time; and
- Operational convenience.

The primary trigger for terminating a filter run and initiating a backwash varies for each WTP. Many treatment facilities will use filter effluent turbidity or a predetermined run time to initiate backwash. A WTP with a tendency to form mud or lime balls will often use filter run time or headloss as the backwash trigger in order to prevent media fouling and solids accumulation. WTP staff indicated that filter run times are terminated based predominantly on run time of 48 hours or on a headloss of 6 ft as a secondary criterion.

Table 6-1 indicates the average run times before backwash and the average volume of water filtered before backwash that occurred during the month of June 2022. Filter 2 indicates slightly lower run times and volume of water prior to backwash than Filters 1, 3, and 4.

**Table 6-1: Filter Run Times and Flow**

	<b>Filter 1</b>	<b>Filter 2</b>	<b>Filter 3</b>	<b>Filter 4</b>
<b>Avg Run Time (Hrs)</b>	36	33	36	35
<b>Avg Flow (MGD)</b>	0.80	0.80	0.84	0.81
<b>Avg Volume before Backwash (MG)</b>	1.2	1.1	1.3	1.2

### 6.3.5 Unit Filter Run Volume

Comparison of the unit filter run volume (UFRV) accounts for various filter loading rates that are not recognized in the use of run times alone. To determine the UFRV, the filter loading rate and filter run length are multiplied together.

$$UFRV \left( \frac{gal}{sqft} \right) = \text{filtration rate} \left( \frac{gpm}{sqft} \right) \times \text{filter run time (hr)} \times 60 \left( \frac{min}{hr} \right)$$

The criteria in Table 6-2 can generally be used to evaluate UFRV values:

**Table 6-2: UFRV Performance Criteria**

<b>UFRV (gal/sf)</b>	<b>Performance</b>
Less than 6,000	Poor
8,000 – 10,000	Fair
Greater than 10,000	Good

WTP staff collected data for filter run time, loss of head, and total gallons filtered for Filters 1, 2, 3, and 4 over the month of June 2022. The average UFRV was calculated for each filter using the equation above. The filtration rate and UFRV for each filter can be seen in Table 6-3 and in Figure 6-3. Most of these values are significantly below the “Poor” performance rating for filtering, indicating need for improvement.

**Table 6-3: Average UFRV Values and Filtration Rates**

	<b>Filter 1</b>	<b>Filter 2</b>	<b>Filter 3</b>	<b>Filter 4</b>
<b>Filtration Rate (gpm/sf)</b>	1.84	1.82	1.94	1.87
<b>UFRV (gal/sf)</b>	3,984	3,597	4,217	3,912

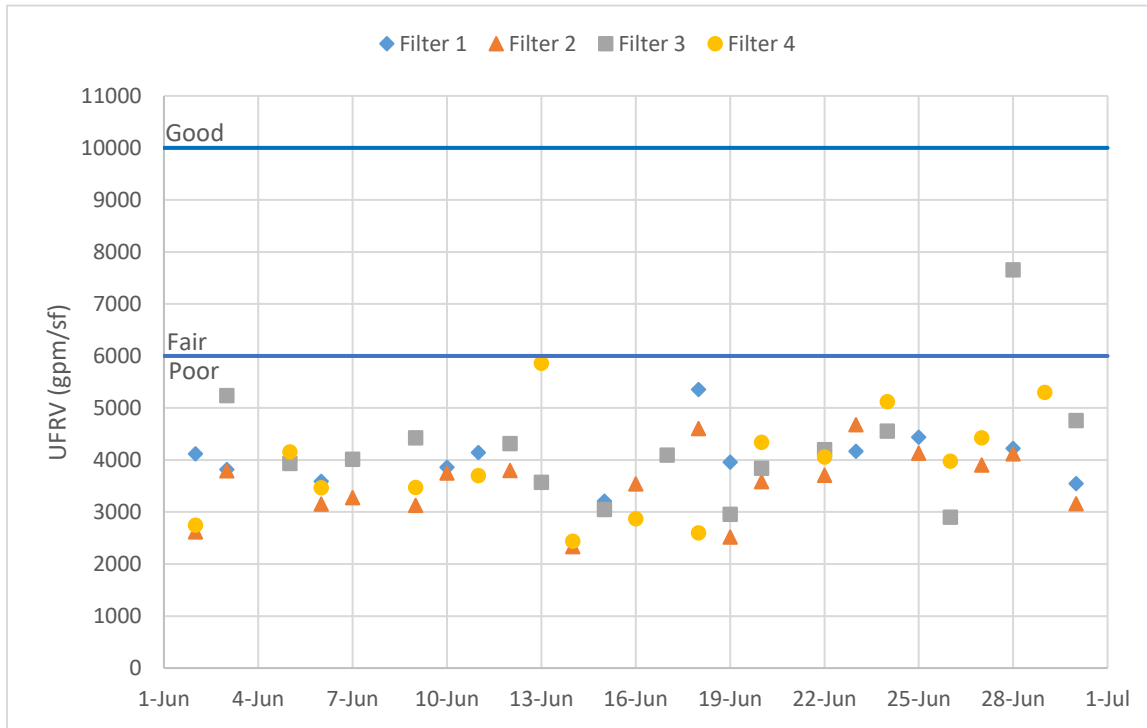


Figure 6-3: UFRV for Filters in June 2022

## 6.4 Physical Inspection

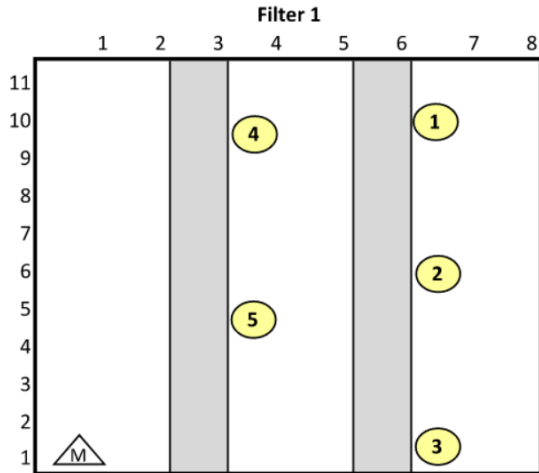
Physical inspection of the filters and media is an important component of filter evaluations. Precipitates or other substances in the media can indicate problems in processes upstream of the filters which may be preventing the filters from operating efficiently. Also, physical inconsistencies such as pitting or mounding of media in the filter can signal problems with the underdrain and help operators detect problems without removing all media from the filter to perform an inspection. Physical observations of the filter box, wash water troughs, and other components can also be used as a preventative measure to prevent leaking or failure of the filter by identifying potential issues before they develop into major problems.

Visual assessment of the filter media surface and filter components was performed concurrently with collection of media samples. Any accumulation of solids, media mounding or other problematic physical elements on the surface of the filter have been noted below. Physical conditions of filter walls and wash water troughs are also noted.

A visual assessment of the filter media surface showed slanted media as well as significant mounding and cratering in Filters 2 and 5. Both the troughs and the interiors of the walls were in good condition across all 5 filters. There was some corrosion and bending of the air scour piping above the water level, as well as solids accumulation on the surface of the media.

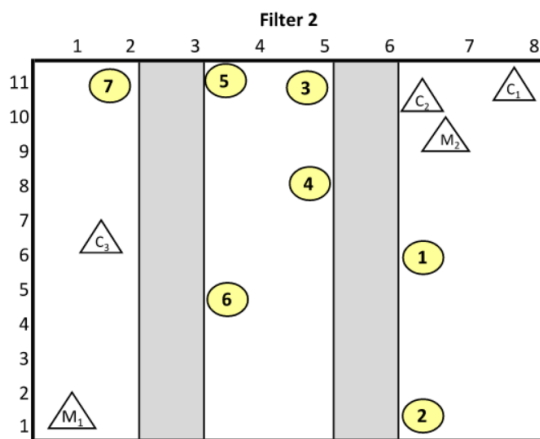
### 6.4.1 Media Surface

Observations of the media surface noted mounding and craters on Filters 1, 2, and 5. Inspection of Filter 4 showed a fairly even level of media throughout. Filters 2 and 5 presented the most decline to the media with a significant level of mounding, craters, and slanted surfaces. A significant amount of manganese accumulation was present along the walls in Filters 1 and 4. Figures 6-4, 6-5, 6-6 and 6-7 are a visual representation of the conditions of Filters 1, 2, 4, and 5. Figures 6-8 and 6-9 show photos of the cratering and mounding in Filters 2 and 5.



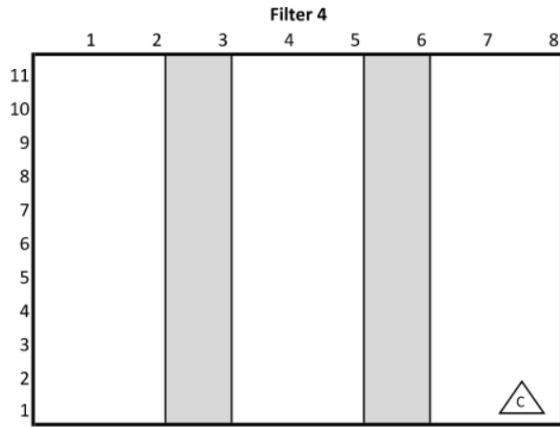
Note	X	Y	Distance to Media from Top of Trough (in)
Mound (M1)	1	1	
1	7	10	44.375
2	7	6	44.625
3	7	1	44.75
4	4	10	45.75
5	4	5	44.75

Figure 6-4: Filter 1 Surface Condition Map



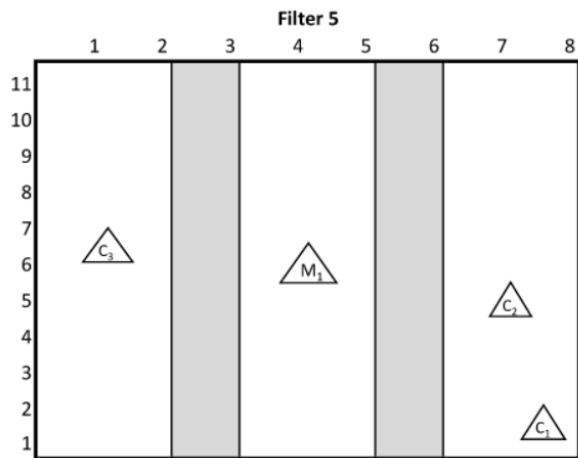
Note	X	Y	Distance to Media from Top of Trough (in)
Mound (M1)	1	1	
M2	7	10	
Crater (C1)	8	11	
C2	7	10	
C3	7	10	57
1	7	6	46.5
2	7	1	47.25
3	5	11	44.5
4	5	8	47.75
5	4	11	49
6	4	5	49.75
7	2	11	50.25

Figure 6-5: Filter 2 Surface Condition Map



Note	X	Y	Distance to Media from Top of Trough (in)
Crater (C)	8	1	44

Figure 6-6: Filter 4 Surface Condition Map



Note	X	Y	Distance to Media from Top of Trough (in)
Crater (C1)	8	1	44
C2	7	5	
C3	1	6	
Mound (M1)	4	6	

Figure 6-7: Filter 5 Surface Condition



**Figure 6-8: Filter 2 – Crater in Media Near Wall**



**Figure 6-9: Filter 5 – Crater in Media in Corner**

## 6.4.2 Filter Components

The existing filter tanks exhibit visible surface rusting and reduction of cross section in several locations both inside and outside of the tanks (Figure 6-10). The exterior coatings on all five tanks have exceeded their useful life. The interior overflow weir exhibits the most significant corrosion and delamination on the interior of the tanks, and the bottom tank shell exterior flange has the most severe corrosion on the exterior of the tanks as shown in Figure 6-11 and Figure 6-12, respectively. The City extracted several coupons of the exterior tank base flange at Filters 2 and 5 as well as the interior steel tank floor in Filter 2 in December 2022. The coupons taken from the interior of the tank showed no visible section loss. However, the coupons at the bottom exterior flange exhibited some visible section loss (~1/16”), but negligible section loss closer to the tank wall as shown in Figure 6-12.

Several of the filters are also leaking as noted by the pooling water adjacent to them. This can be seen in Figure 6-10.



**Figure 6-10: Elevation of Filter 2**



**Figure 6-11: Corrosion at Filter 3 Overflow Weir**



**Figure 6-12: Filter 5 Bottom Flange Coupon**

There are numerous piping and conduits clamped to the existing tanks. Some mounting struts are of FRP construction with stainless steel fasteners, while others are coated carbon steel as shown in Figure 6-13. The latter typically showed significant corrosion.

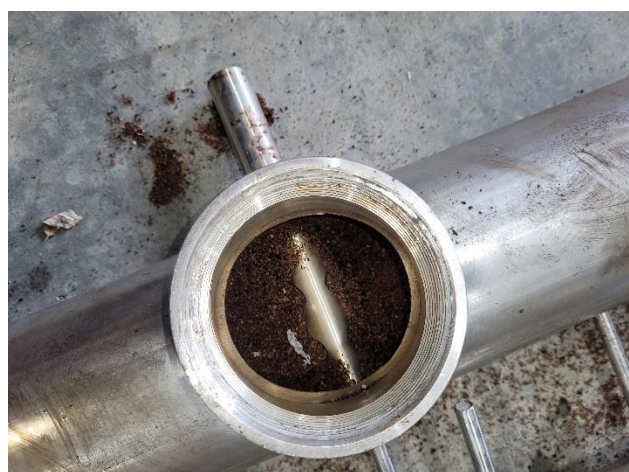


**Figure 6-13: Mounting Strut**

In November 2022, Filter 2 experienced a significant underdrain failure in which underdrain anchors broke away from the tank bottom plate during a backwash cycle as shown in Figure 6-14. The City removed the existing media, underdrains and grout. The underdrains and air scour piping were full of media in most locations as seen in Figure 6-15. Grout samples were sent to Concrete, Research, and Testing (CRT), who performed a petrographic examination of the grout. The report indicated significant chemical attack of the cement paste due to the concentration of magnesium in the water. The degradation of the grout occurred at exposed surfaces as well as cracks within the grout. CRT's report is included in Appendix D.



**Figure 6-14: Failure of Underdrain Anchors in Filter 2**



**Figure 6-15: Media in Filter 2 Underdrain and Air Piping**

At this time, all Filters are being rehabilitated with new tank coatings and a new center concrete flume with stainless steel underdrains with integral air scour.

### 6.4.3 Air Scour Piping

The O'Fallon WTP uses the Aeries air scour grid system which was installed in 2014. In all five filters, the current 6-inch air scour header is located above the surface of the media. The air scour rate is currently between 1.3 and 2.2 scfm/sf, which is low for this application, as it is designed for 2.5 scfm/sf. As part of the ongoing filter rehabilitation, the new underdrains will include air scour distribution integral with the underdrain laterals. New air scour piping will be routed from the main header to each filter.

## 6.5 Media Inspection

Inspection and analysis of the filter media was performed to determine media sizing, media characteristics, and layer stratification. These items impact the filter's ability to remove and store particles during filtration, as well as the required flow rate for effective backwash. Media layers were inspected by physically entering the filter and taking media samples from various locations in the center area of the filter. Other areas of the filter were excavated to inspect each layer and determine the level of mixing between media layers. During this inspection, a coating, likely manganese dioxide was present on the media on all of the filters.

### 6.5.1 Media Layer Depth

Measured depths for the filter media layers in various filters are shown in Table 6-4.

**Table 6-4: Depth of Media Layers (in)**

	<b>Average Media Depth (in)</b>	<b>Design Depth (in)</b>	<b>Standard Deviation (in)</b>
<b>Filter 1</b>	34.40	33	0.53
<b>Filter 2</b>	30.25	33	3.73
<b>Filter 4</b>	35.25	33	--

### 6.5.2 Gradation Analysis

The size characteristics of the filter media can be compared using several numerical values derived from a mechanical sieve gradation analysis and media distribution curves. The two most commonly used characteristics are the effective size and the uniformity coefficient (UC) of the media. The effective size of the filter media is defined as the size opening that will pass 10 percent (by weight) of a representative sample of the filter material and is commonly referred to as  $d_{10}$ . The UC is the ratio calculated as the size opening that will pass 60 percent of a representative sample of the filter material divided by the size opening that will pass 10 percent of the same sample (i.e.  $d_{60}/d_{10}$ ). As a material becomes more uniform in size, the uniformity coefficient will approach a value of one.

**Table 6-5: Existing Media Gradation Characteristics**

Anthracite	Filter	Filter	MDNR	Ten State Standards
	4	5		
Effective Size (d <sub>10</sub> )	0.89	0.85	0.6-0.8	0.8-1.2
Uniformity Coefficient	1.43	1.56	≤ 1.7	≤ 1.7
Sand	Filter	Filter	MDNR	Ten State Standards
	4	5		
Effective Size (d <sub>10</sub> )	0.62	0.57	0.4-0.55	0.45-0.55
Uniformity Coefficient	1.3	1.51	≤ 1.65	≤ 1.65

Review of Table 6-5 shows the effective size for anthracite and sand are slightly outside of MDNR standards. The anthracite is in compliance with Ten State Standards, but the sand is slightly larger than recommended.

The full gradation analysis from STRATA for the filters is provided in Appendix E. The shape of the curves are indicative of the grading of the media from each filter. Uniform layers are represented by nearly vertical lines, while well-graded media have an S-shaped curve that extends across many sieve screens. Numerically, uniform layers have a uniformity coefficient near 1.0; the amount of grading increases proportionately as the uniformity coefficients increase from 1.0. Review of the gradation curves reveals a fairly uniform distribution of media within both the sand and anthracite layers.

### 6.5.3 Media Layer Stratification

The difference in size and specific gravity between the anthracite and sand causes stratification of the two layers. Anthracite media has lower density and larger particle size, while sand is heavier and smaller. This allows the sand to settle more quickly after being fluidized and suspended during backwash. The anthracite, which settles more slowly, will settle on top of the sand. When sized incorrectly, the sand and anthracite will settle at similar speeds, leading to intermixing of the layers. The intermixing of media reduces the effectiveness of the filter, robbing a portion of the anthracite layer of its storage capacity and the sand layer of its fine particle removal capabilities. This zone is also more susceptible to the formation of mud balls and precipitates.

A key indicator of the likelihood of layer intermixing can be found by calculating the ratio of  $d_{90}$  of the upper layer with the  $d_{10}$  of the lower layer. For anthracite and sand, studies have shown that a ratio less

than 2.5 produces a sharp interface between the two layers<sup>1</sup>. A value of 2.9 corresponds to moderate levels of intermixing, while a value greater than 3.1 produces a significant amount of mixing. The calculated ratio of anthracite  $d_{90}$  over sand  $d_{10}$  in the filters sampled at the WTP is shown in Table 6-6. These data indicate low levels of intermixing in filters, which matches with observations made within the filters, excluding those areas with mounding and cratering.

**Table 6-6: Media Stratification**

	Filter	Filter
	4	5
Anthracite $D_{90}$ (mm)	1.27	1.41
Sand $D_{10}$ (mm)	0.62	0.57
$D_{90}/D_{10}$	2.05	2.47

#### 6.5.4 “Greensand” Effect

Greensand filters consist of a filter media that has a special coating of manganese dioxide, which can oxidize iron and manganese in water upon contact with the filter media. The filters in the plant are currently the second most effective spot for oxidizing the manganese, and this is due to the “greensand effect” that is occurring in the media. The dark coating on the anthracite is a buildup of manganese dioxide coating and is a catalyst to helping oxidize manganese in the filters.

### 6.6 Backwash Evaluation

#### 6.6.1 Current Backwash Procedures

Backwashing procedures include air scour and high-rate water backwash. The current backwash cycle includes the following steps:

- Air Scour for 180 seconds at a rate between approximately 1.3 and 2.2 cfm/sf;
- Initiate low wash rate at 2.20 MGD (5 gpm/sf) for 70 seconds;
- Air scour runs until wash water supply valve is confirmed open or the filter water level is 2.0 ft;
- Initiate high wash rate at 7.80 MGD (18 gpm/sf) for 400 seconds;
- Return to low wash rate at 2.20 MGD (5 gpm/sf) for 90 seconds; and
- Close valve drain.

<sup>1</sup> Cleasby and Woods. Intermixing of Dual Media and Multi-Media Granular Filters. JAWWA 67(4):197-203 (1975).

This procedure is consistently followed for all filters, during all seasons of the year and requires the use of approximately 40,000 gallons of water per backwash cycle.

### 6.6.2 Floc Retention Profiles

Traditional rapid rate, dual media gravity filters are designed to allow particles to penetrate deep into the media to achieve high water quality during an extended period without a tremendous buildup of headloss. The condition of the filter layers can be evaluated before and after backwashing with a floc retention profile. The floc retention profile consists of sampling the filter media for turbidity at varying depths to graphically portray turbidity measured (as an indication of floc or solids retention) relative to media depth. Performing this analysis before and after backwashing will reveal the effectiveness of the filter media and backwash cycle by determining where the floc is being captured in the media and how effective the backwash is in removing the captured floc from the filter bed.

According to Kawamura (2000) and granular media filtration studies, a floc retention profile for an ideal filter before backwash develops a “curved” distribution of solids through the filter media. The curvature of solids accumulation that develops will maintain its shape and will slowly move downward through the filter with increasing filter run time. As filtration continues, the curved distribution will reach the bottom of the filter media in which case turbidity breakthrough occurs, thus creating the need for backwashing. A proper backwash will then remove the solids that have accumulated and create a fairly constant distribution of low amounts of solids throughout the filter media.

The following criteria from AWWA<sup>2</sup> are used to evaluate a filter floc retention profile after backwash:

- A floc retention value of 30 to 60 NTU through the filter following a backwash typically represents a clean filter media, which can produce acceptable effluent turbidity and provide adequate storage of solids within the media. Operating an exceptionally clean filter (< 20 NTU) following startup may necessitate an extended period of filter to waste before the turbidity spike falls below the 0.3 NTU limit unless additional steps to induce a more rapid maturation occur (i.e. filter aid polymer).
- A floc retention value of 60 to 120 NTU through the filter following backwash represents a slightly dirty, less than ideal filter bed. Such a filter will be effective in removing turbidity in the absence of a filter aid during the beginning of the filter run.

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<sup>2</sup> AWWA, *Filter Evaluation Procedures for Granular Media*, Chapter 17(2003)

- A floc retention value greater than 120 NTU before or after backwash represents a dirty filter. If 120 NTU is present after backwash, modifications should be made to the backwash cycle to improve the cleanliness of the filter media.
- A floc retention value greater than 300 NTU represents dirty filter media. A value greater than 300 NTU in the deeper portions of the filter bed, before or after backwash, indicates solids in the filter media and an increased likelihood of mud balls or lime balls.

Media samples were taken from filters before and after backwash. These samples were then rinsed and the rinse water was tested for turbidity. Turbidity from the samples is typically measured and plotted to create turbidity profiles throughout the depth of each media bed. Then, these turbidity profiles are compared with AWWA's turbidity criteria for filters to indicate how dirty the filter media has become. However, due to the large amounts of iron and manganese present throughout the media bed in the O'Fallon WTP filters, turbidity tests were indeterminate. Turbidity meters measure turbidity by measuring the amount of light scattered by suspended particles. Because the particulate concentration was so high, an accurate turbidity measurement could not be obtained.

Photos taken during turbidity testing in Filter 1 are displayed in Figure 6-16 and show that the rinse water contained very high amounts of particulate iron and manganese. The top row of cups is before backwash and the bottom row is after backwash. Cups, from left to right, represent samples collected from media depths of 0-2 inches, 2-5 inches, 5-10 inches, 10-15 inches, 15-20 inches, 20-25 inches, and 25-30 inches. Observation of the rinse water showed very little difference between samples collected before backwash and those collected after backwash. This indicates that the current backwashing procedures are not sufficient to remove particles from the media. The inability of the backwash to remove the particles can cause buildup and full cleaning is never achieved. This will reduce the solids storage capacity of the media which decreases the space available for removal during the next filtration cycle. This will lead to higher head loss through the filter and more frequent backwashing.



**Figure 6-16: Floc Retention in Filter Media Before and After Backwash**

### 6.6.3 Flow Meter Calibration

WTP operators rely on flow meters and flow controllers to indicate what flow rates are being introduced into the filter during backwash. Poor calibration of these devices can result in inaccurate control and can lead to problems with unintentionally low or high flows. If flows are higher than control readings, media loss or gravel upset may occur; if flows are lower than control readings, cleaning will be inadequate. Error values of 5 to 10 percent are generally acceptable, but when the error is greater than 10 percent, recalibration of the flow meter should be performed. Rise rate tests were performed for low and high rate backwash flows and compared to backwash flows reported on SCADA. This data is shown in Figures 6-17 and 6-18. Table 6-7 shows the percent difference between the flow meter ranges from 7 to 12%, and recalibration is recommended.

**Table 6-7: Calculated Filter vs. SCADA Backwash Flow Rates**

	<b>Low Rate Backwash (MGD)</b>	<b>High Rate Backwash (MGD)</b>
Average Calculated Flowrate	1.23	5.51
Average SCADA Flowrate	1.31	6.17
Percent Difference	7%	12%

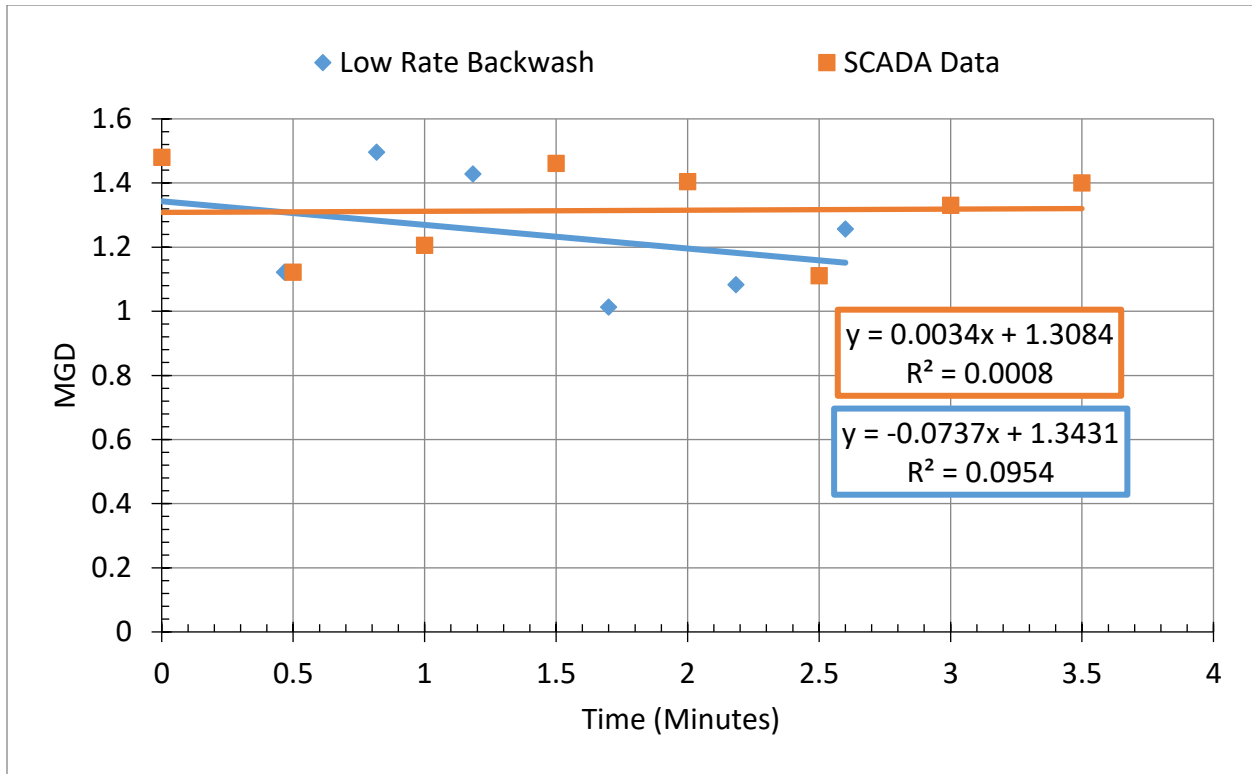
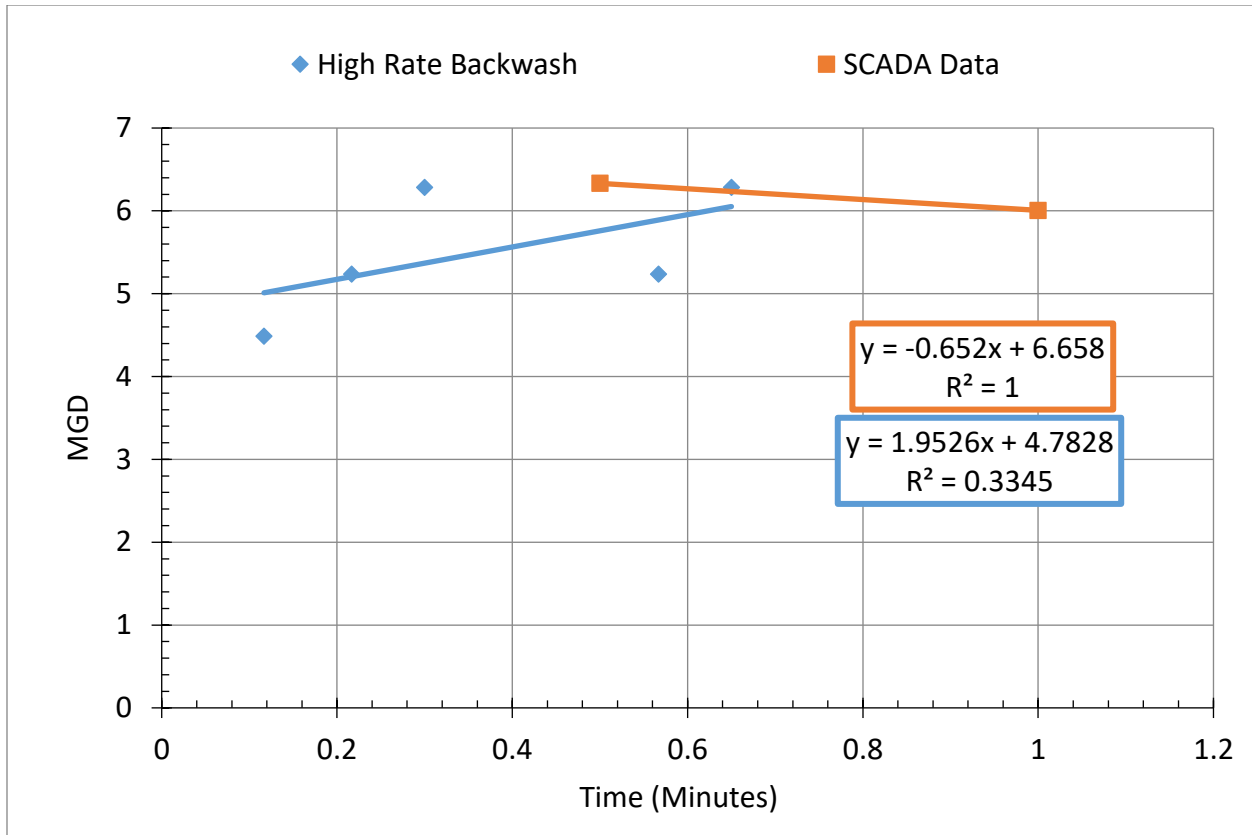


Figure 6-17: Low-Rate Backwash Data vs. SCADA Data



**Figure 6-18: High-Rate Rise Backwash Data vs. SCADA**

The SCADA trend for flow during backwash is shown in Figure 6-18. Review of this trend shows that it takes a significant amount of time to ramp up to and down from the high rate flow set point. As such the actual time when the filter is washed at the high rate is very minimal. This step should be extended and the opening time of the control valve modified to allow the filters to be washed at the high rate for at least 5 minutes, or as required to improve cleaning of the media.

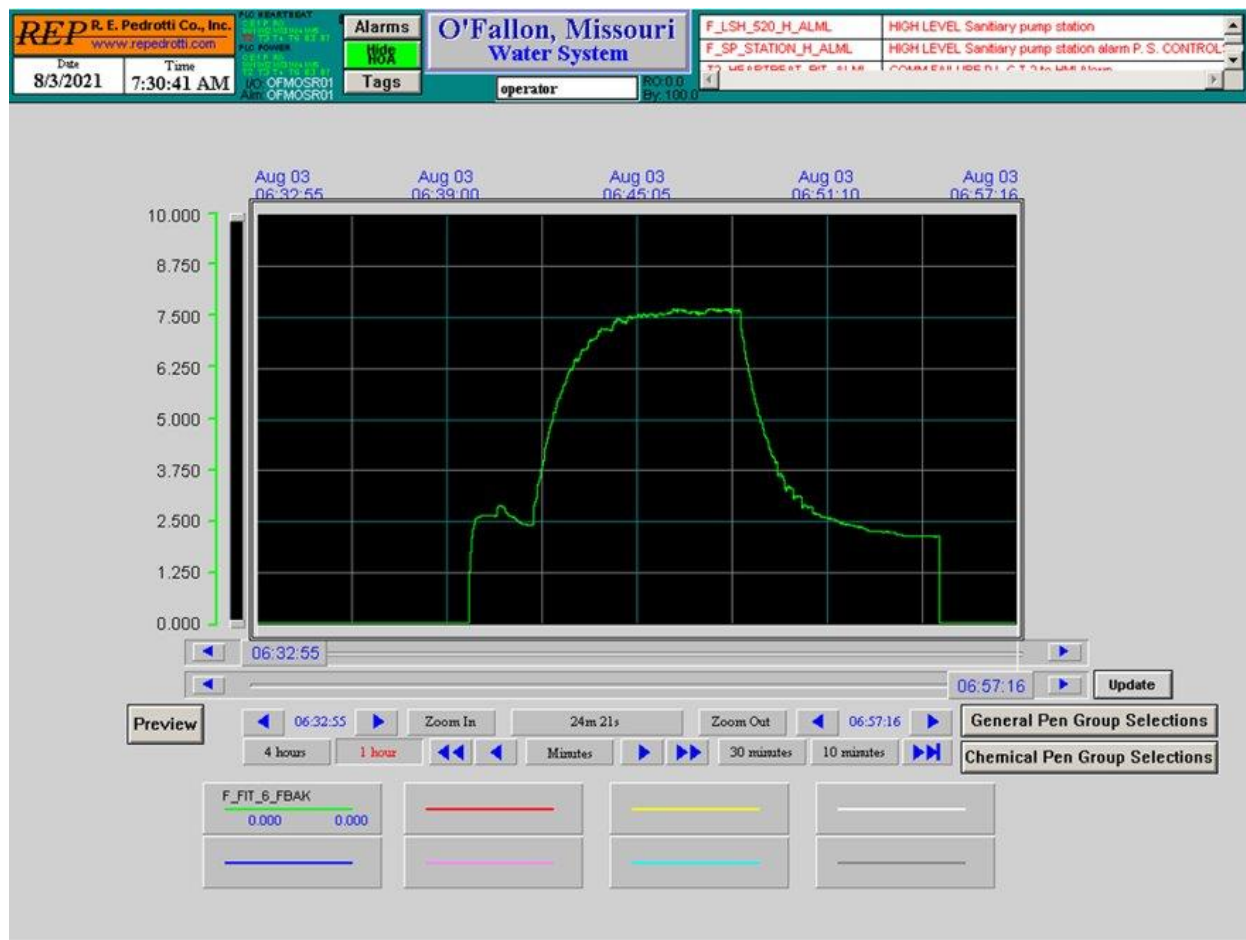


Figure 6-19: SCADA Backwash Flow Rate Data

### 6.6.4 Backwash Flow Rate

The recommended backwash rates for various filter media types are dependent on media size and specific gravity, as shown in Figure 6-19. Higher flow rates are required with increasing specific gravity and particle size. Designing the anthracite and sand sizes for similar flow rates allows both media layers to be cleaned equally at a given backwash flow rate. If the media layers are not properly sized, one layer will not be cleaned adequately or the other may be lost in the backwash cycle. The American Water Works Association (AWWA) recommends a backwash rate of 15 to 20  $\text{gpm}/\text{ft}^2$  for proper media cleaning; however, this number should be further evaluated using media characteristic information and backwash water temperature.

Figure 6-20 below depicts actual and recommended backwash flowrates for the sand and anthracite in Filters 4 and 5. The red line at 18  $\text{gpm}/\text{ft}^2$  is the current high rate backwash being used at the O'Fallon WTP. As shown in Figure 6-20, according to the media design, a rate of 18  $\text{gpm}/\text{ft}^2$  is required; however,

the actual size of the existing media requires backwash flows of up to 20 gpm/ft<sup>2</sup> to achieve fluidization. During observation of the filter backwash at 18 gpm/ft<sup>2</sup>, it was noted that the backwash troughs were nearly full with no free water surface drop over the edges of the troughs. As such, raising the backwash flow rate is likely to result in flooded backwash troughs and caution should be exercised if pursuing this further.

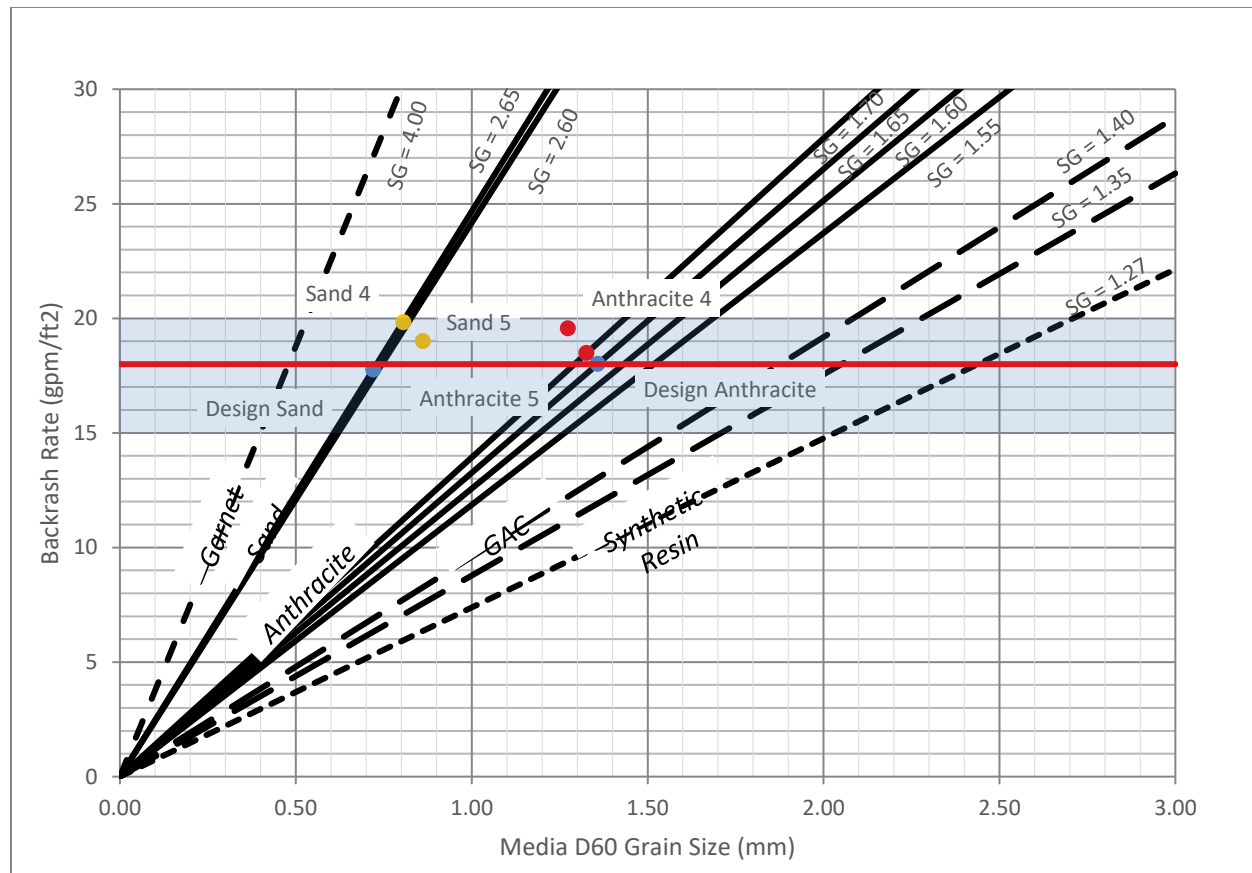


Figure 6-20: Recommended Backwash Rates for Media Types and Sizes

### 6.6.5 Media Bed Expansion

Bed expansion refers to the degree to which the fluidizable media (anthracite and filter sand) expands during backwash. Bed expansion is a direct indication of the efficiency of the backwash system to fluidize and clean the media. The degree of expansion is controlled by many factors, including the media size, gradation, grain shape, and the density of the filter medium, as well as the viscosity and density of the water. At different times of the year, the bed expansion at a set backwash flow rate will vary because of the effect of temperature on the density and viscosity of the water. For this reason, different backwash flow rates should be targeted in summer and winter. Backwash rates are typically designed to provide a filter bed expansion of 30 to 40 percent to provide sufficient particle collision and hydraulic scouring

turbulence. Expansion of up to 50 percent is allowable, as long as there is sufficient room between the top of media and the wash water troughs to allow for this expansion without incurring media loss.

Bed expansion was measured in Filter 1 during a normal backwash cycle to reach 8 inches, or 34 percent expansion. This is within the target range, indicating that the current high flow rate is sufficient for proper bed expansion.

**Table 6-8: Media Expansion**

<b>Filter</b>	<b>Observed Fluidization (in)</b>	<b>Observed Fluidization (% of bed)</b>
Filter 1	8	34%

### 6.6.6 Duration of Backwash Cycle

Time duration of the backwash flow is another important factor in the effectiveness and efficiency of a backwash cycle; however, time duration is secondary to achieving proper fluidization. If fluidization is not achieved, running the backwash for a long time will not produce good cleaning. Often, backwashes are run too long, past the point of diminished returns, resulting in inefficient use of water and power. A turbidity level of 10 NTU in the backwash water is recommended as a stopping point for backwash duration for two primary reasons. First, additional backwashing beyond this point will provide substantial diminishing returns for backwash water utilized. The second reason is that backwashing past this point might result in a filter that is too clean, assuming the backwash cycle is effective. A filter that is too clean is often referred to as poorly ripened. In order for a filter to be well ripened, or able to properly trap and retain particles, a small amount of particulate material must already be present within the media. A poorly ripened filter is one that has been cleaned to a point where particles within the media measure less than 30 NTU, reducing the filter's ability to trap and retain particles from the water.

The photo in Figure 6-21 shows the backwash water collected from Filter 1 at time intervals within the backwash cycle of 20 seconds, 40 seconds, 60 seconds, 2 minutes, 3 minutes, 4 minutes, 5 minutes, 6 minutes and 7 minutes (from left to right). Turbidity measurements from these samples, and similar samples from other filters, are shown in Figure 6-22. Samples within the first minute had a turbidity reading too high to register. The graph of these turbidity measurements indicates that the cutoff target of 10 NTU is achieved within the first 4 minutes of the backwash cycle. However, based on the review of SCADA flow rate trends and the amount of solids remaining within the media after backwash (see Sections 6.6.2 and 6.6.3), shortening of the backwash cycle is not recommended.



Figure 6-21: Turbidity in Filter Backwash Water for Filter 1

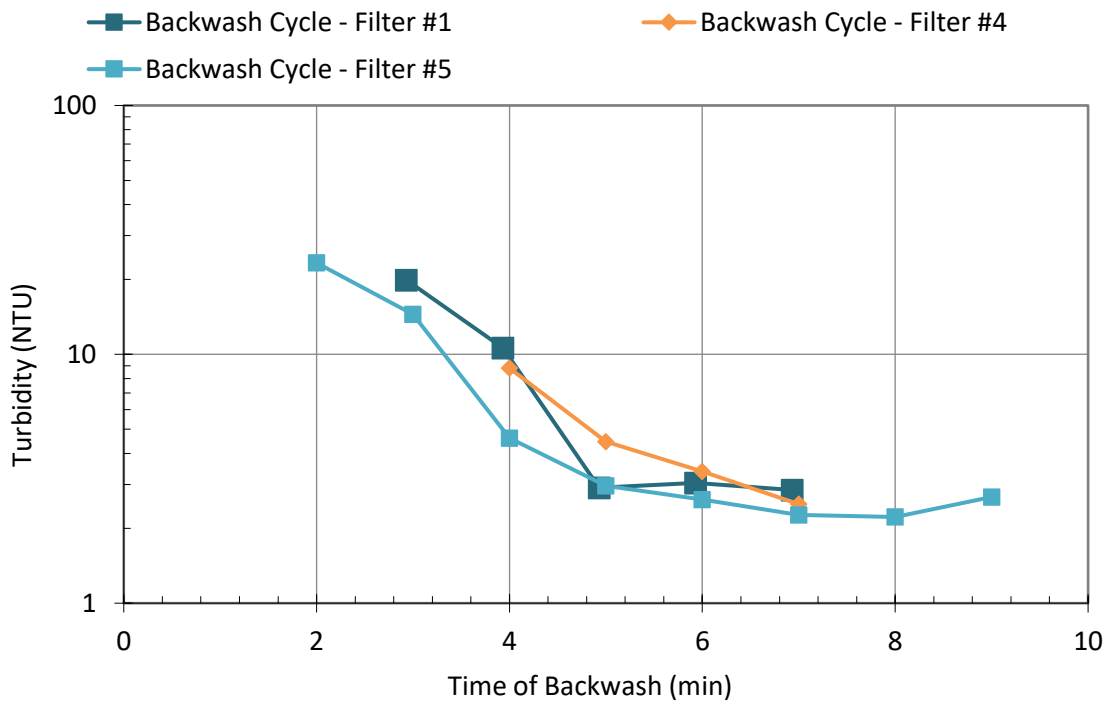


Figure 6-22: Turbidity in Filter 1, 4, and 5 Backwash Cycles

## 7.0 RESIDUALS HANDLING

### 7.1 Characterization of Waste Streams

The residual stream at the O'Fallon WTP consists of a combination of residuals from the plate settlers and backwash from the filters. This stream flows into an equalization (EQ) basin to settle out. This stream is high in iron and manganese content. The maximum flow rate into the EQ basin is 0.6 MGD if the plant was running at a full capacity of 6 MGD. Table 7-1 shown below summarizes the iron and manganese content in the residual streams based on historical plant flows. A key note from this table is that regardless of the residuals handling method utilized, a few hundred pounds of dry solids will be generated each day and required disposal.

**Table 7-1: Residual Streams Flows and Concentrations**

	Plant Flow Rate	Waste Flow (from Plate Settlers and Filter Backwash)	Solids Concentration	Iron Solids		Manganese Solids	
				mg/L	lb/d (dry)	mg/L	lb/d (dry)
	MGD	MGD	%				
Historical Average Plant Flow	2.6	0.13	0.02	300	330	15	16
Historical 95 <sup>th</sup> Percentile Plant Flow	3.2	0.27	0.02	220	490	11	25
Historical Max Plant Flow	3.3	0.47	0.01	130	500	9	34
Plant Design Capacity (6 MGD)	6.0	0.60	0.02	200	1000	12	60

### 7.2 Current Residuals Handling Methods

The current residuals handling system consists of an EQ basin (approximately 75,000 gallons) where the residuals from the plate settlers and the filter backwash combine before being sent to the head of the wastewater treatment plant (WWTP). Some sanitary streams and waste from the RO system clean-in-place also discharge to this EQ basin. The EQ basin is a below grade structure that contains two submersible pumps designed to pump based on water level in the EQ basin. The basin also has an overflow outlet that discharges at grade into a drainage swale.

Discharge of this stream containing high levels of iron and manganese to the WWTP has been shown to be problematic for the WWTP's UV disinfection system, reducing UVT of the water and limiting the

effectiveness of the UV system. Thus, various residual handling alternatives are considered herein to reduce these negative impacts.

### **7.3 Alternatives for Residuals Handling**

Various mechanical and non-mechanical technologies are available for management of WTP residuals. This section provides an overview of the options reviewed for implementation at the O'Fallon WTP. Vendor provided equipment information and quotes are included in Appendix F.

#### **7.3.1 Mechanical Dewatering**

Mechanical dewatering methods can generally obtain a higher degree of dewatering in significantly less time than gravity and evaporative methods by utilizing specialized equipment that exert some form of pressure. Mechanical dewatering methods require a higher degree of operator interaction; however, flexibility regarding capacity and operational run times can be engineered into the system. Residuals fed into a mechanical dewatering device should be homogenized or uniform; therefore, upstream equipment such as holding tanks, mixers, and transfer pumps are usually required.

##### **7.3.1.1 Filter Press**

A filter press (example unit shown in Figure 7-1) utilizes high-pressure filtration to separate liquids and solids as the residuals are pumped into the press. As the slurry is pumped into the machine, the solids build up on a filter cloth, forming filter "cake" and can be disposed of separate of the filtered liquid.

For the O'Fallon WTP, two presses would be required, one filling while the other one is dewatering, and three filtration cycles per day would be needed to capture the solids generated in this process. The filter press would need to be emptied by operations staff following each filtration cycle. If redundancy for the system is required, a third unit would need to be installed.

Each filter press is anticipated to cost approximately \$50,000 and the equipment would require construction of a new residuals handling building (~800 square feet), yard piping and electrical power. Filter presses generally work better with higher percent solids, but the press would be able to dewater the 200 mg/L stream from the EQ Basin directly with no additional up-stream concentrator required.



**Figure 7-1: Filter Press by M.W. Watermark**

### **7.3.1.2 Centrifuge**

A decanter centrifuge uses high speed rotation of a cylindrical bowl to separate liquids from solids and leaves the “cake” separate from the liquid to be disposed of. Cake solids concentrations can vary considerably from one facility to another based on the feed water quality and type of residuals. The sludge is pushed by augers into discharge ports to be disposed of. Figure 7-2 shows a decanter centrifuge manufactured by Centrisys. One or two units can be utilized depending on the dry solids loading rate of the plant; one is currently planned, but a second could be added if redundancy is desired.

Maintenance requirements are moderate. Operators would need to occasionally observe the centrate and adjust the polymer accordingly, but the system stays optimized regularly with little operator attention.

Each centrifuge and its associated instrumentation/controls is anticipated to cost approximately \$900,000 and the equipment would require construction of a new residuals handling building (~600 square feet for a single centrifuge), yard piping and electrical power. Influent solids concentrations of 1.5 percent are required to the influent of the centrifuge. This would require installation of an upstream thickener or other infrastructure to achieve this concentration, as the EQ basin would not be sufficient. This makes this option cost prohibitive for the O’Fallon WTP compared to other available options.

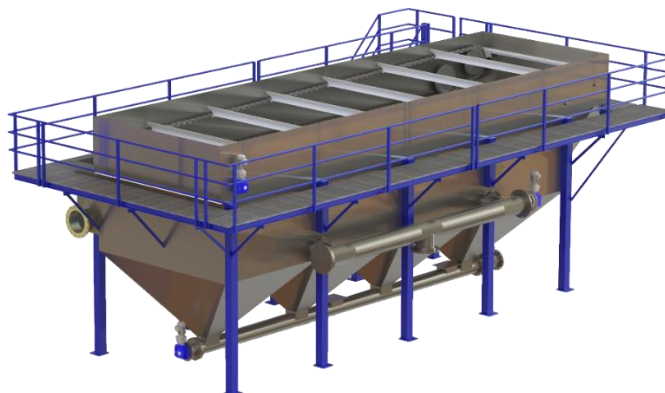


**Figure 7-2: Decanter Centrifuge by Centrisys**

### **7.3.1.3 Suspended Air Flotation System**

The suspended air flotation system depicted in Figure 7-3 uses micro air bubbles that attach to suspended solids and float them to the water's surface for removal. The sludge is removed by a skimming system to a desludging trough. A flotation cell and a froth generator are included in the skid-mounted system. This system by Heron can be located outside during operation and still remains efficient at higher water temperatures. A single unit would have sufficient capacity, and if redundancy is required, a second unit could be added.

The system equipment is anticipated to cost approximately \$320,000 and the equipment would require construction of additional solids pumps, yard piping and electrical power. The required influent solids concentration to the system is 1.5 percent. This would require installation of an upstream thickener or other infrastructure to achieve this concentration, as the EQ basin would not be sufficient. This makes this option cost prohibitive for the O'Fallon WTP compared to other available options.



**Figure 7-3: Suspended Air Flotation System by Heron Innovators**

## 7.3.2 Non-Mechanical Dewatering Methods

### 7.3.2.1 Drying Beds

Sand drying beds include a permeable sand layer at the bottom of the bed that allows clear liquid to percolate through to a gravel and underdrain collection system below. Concrete drying beds operate similarly; however, the residuals are dewatered over approximately 3-4 months' time and mechanically removed by a skid steer or other piece of equipment. Drying beds utilize evaporation as the primary method of dewatering; however, decanting from the free water surface can be achieved with telescoping valves or another method. Typically, drying beds are constructed with a minimum of three chambers such that once full, a chamber can be isolated and left to dry for several months until the desired level of dewatering is achieved. Constructing drying beds at the WTP would require a large portion of real estate and additional equipment and regular maintenance operation for scraping, stockpiling, and disposing of solids. Due to these requirements, this is not anticipated to be a desirable option.

### 7.3.3 Thickening and Sending to WWTP Solids Handling

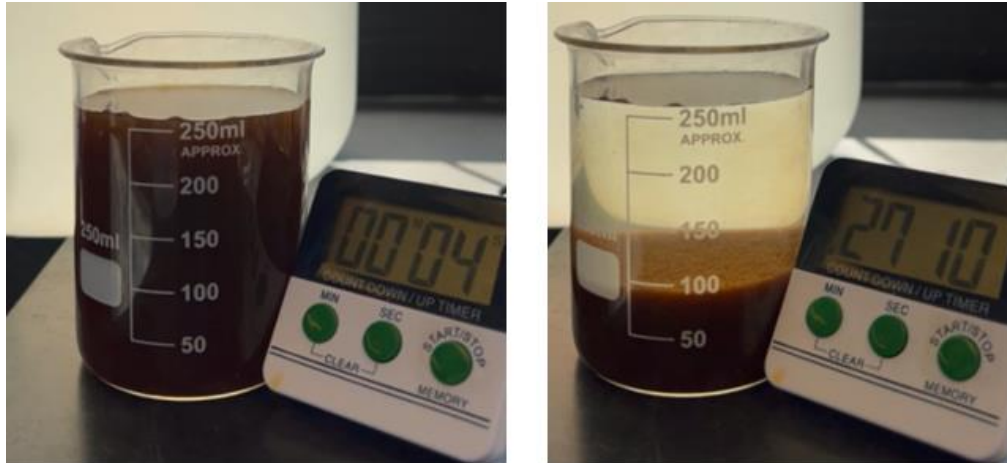
The existing equalization (EQ) basin is a below grade circular basin with submersible pumps located at the bottom of the tank. The EQ Basin has 4 influents into the basin including: a 6-inch sanitary drain, 24-inch filter wash water drain, 6-inch plate settler blowdown residual stream, and a 10-inch R.O reject overflow stream. Under current operation, the submersible pumps re-mix the contents of the basin when in operation and do not allow for any decanting of clear water.

During on-site field testing, water was collected from the EQ basin and observed to verify that settling of the solids in this basin can occur within a short period of time. Figure 7-4 depicts settling, at jar scale, over an approximate 30-minute time span in the EQ basin. This indicates that the EQ basin could be used as a gravity thickener if a few modifications were made, including the following:

1. Coordinate and adjust timing of pumping cycles and influent waste flows to allow time periods of no flow. These no flow periods must be of sufficient time duration to allow settling of solids to occur.
2. Install a new floating decant structure and decant pumps to pull clear water off the top of the tank. This stream could be sent to the head of the O'Fallon WWTP through the existing pipeline, or potentially recycled to the head of the WTP. A preliminary schematic for this is shown in Appendix C.

3. Install a new pipeline from the EQ Basin to the solids handling process at the O’Fallon WWTP. Settled solids would be pumped via the existing pumps.

This approach would remove a large portion of the settled iron and manganese solids from the WWTP process, reducing impact to the UV disinfection system. Furthermore, this approach would minimize the volume added to the solids processing system by separating out the decant flow prior to sending solids to the WWTP. Further evaluation and development of design for this approach is recommended.



**Figure 7-4: Equalization Basin Settling Test**

Based on the observations seen in the settling test depicted in Figure 7-4, the anticipated volumes and solids concentrations from the EQ basin when the basin is full are depicted in Table 7-2 below.

**Table 7-2: Projected Volumes and Concentrations from EQ Basin**

Operation	Stream Description	Volume (gallons)	Solids Concentration (%)
Current	Combined (To Head of WWTP)	75,000	0.02
Proposed	Decant (To Head of WTP or WWTP)	45,000	0.002
	Settled Solids (To Solids Handling at WWTP)	30,000	0.05

---

## **8.0 RECOMMENDATIONS AND OPINIONS OF PROBABLE CONSTRUCTION COSTS**

Based on the evaluations conducted within this study, a number of improvements are recommended for the O'Fallon WTP. These improvements are listed here and grouped according to categorization as operational improvements or capital improvements.

Burns & McDonnell developed an order-of-magnitude opinion of probable construction cost (OPCC) for each recommendation. Cost opinions are based on preliminary manufacturer pricing and data, current labor rates, industry averages for material costs, historical craft production rates and self-perform construction experience related to building the types of process and trade work detailed in the report. The order-of-magnitude cost opinions are based primarily on our experience and judgment as a professional consultant and contractor combined with information from similar WTP construction projects, vendors, and published sources. Since Burns & McDonnell has no control over weather, cost, availability of labor, availability of material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, economic conditions, government regulations and laws (including the interpretation thereof), competitive bidding or market conditions, and other factors affecting such opinions or projections, Burns & McDonnell does not guarantee the actual rates, costs, etc. will not vary from the opinions and projections developed herein.

### **8.1 Operational Improvements**

The recommendations in this category require little to no capital investment to implement and are summarized in Table 8-1.

**Table 8-1: Operational Improvements Cost and Benefit Analysis**

<b>Rec. Number</b>	<b>Description</b>	<b>Additional Design Required?</b>	<b>OPCC</b>	<b>Operational Cost Impact</b>	<b>Benefit</b>
1.1	Extend high-rate backwash time for better filter media cleaning and particle removal.	No	\$0	Cost of additional backwash water	Remove particles from filter more efficiently, extend filter run times
1.2	Perform regular visual inspections of filters. This should include observation of filter media surface prior to each backwash and annual checks of media depth and condition.	No	\$0	\$0	Proactively identify decline in filter condition and address issues early
1.3	Conduct full-scale testing of permanganate dosing at the head of the detention basin	Yes – will also require MDNR approval	Cost of temporary pumps, piping, containment, and instrumentation	Cost of permanganate equipment and chemical	Test out permanganate prior to implementing full-scale system. Reduce chlorine demand, improve speed and efficiency of manganese oxidation.
1.4	Following implementation of the new pre-oxidation approach in Section 8.2, work to slowly reduce chlorine residual in filters	Yes – requires coordination of disinfection CT with MDNR	\$0	Reduce chlorine costs	Reduce corrosion in Filter Building

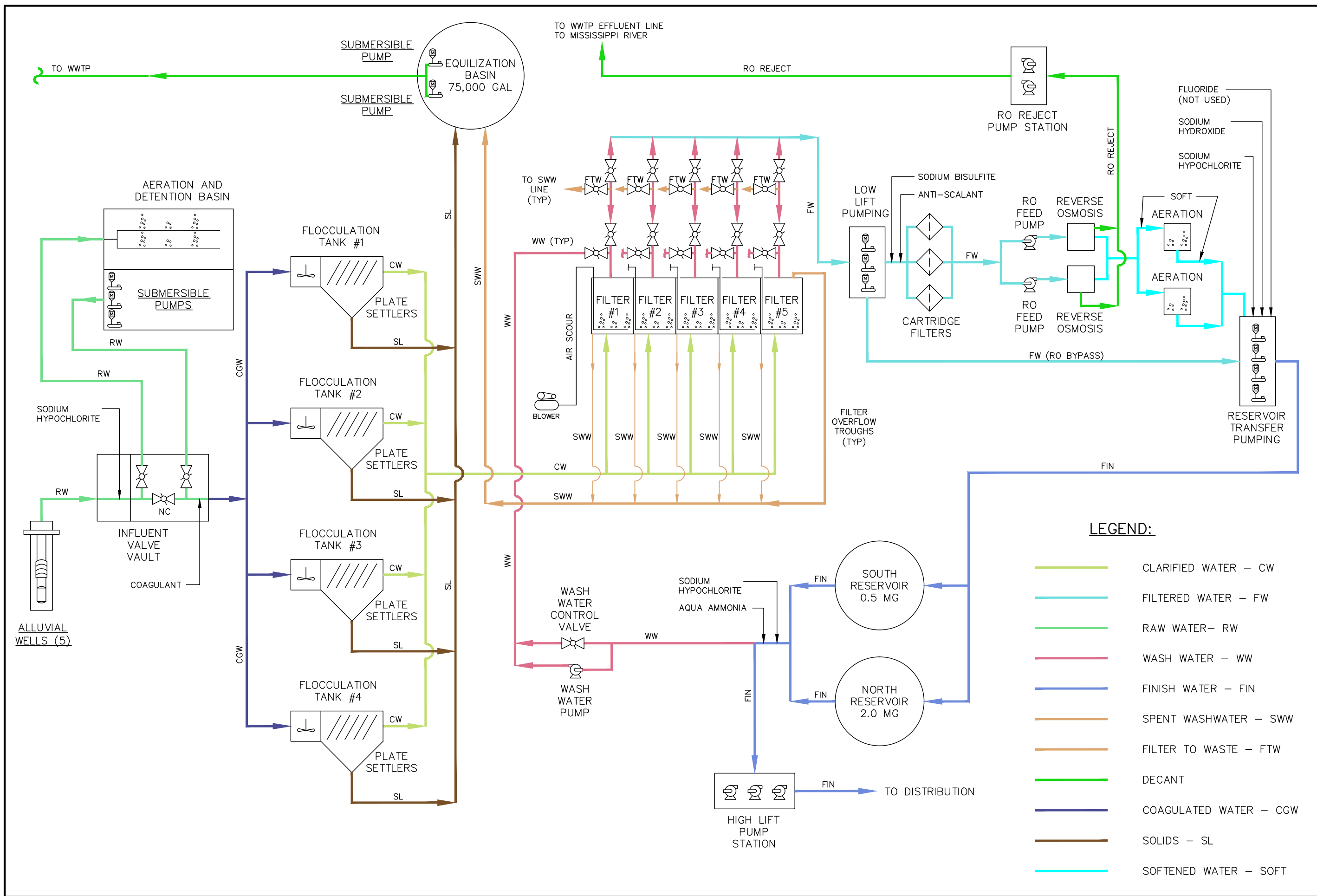
## 8.2 Capital Improvements

The recommendations in this category require capital investment to implement. Appendix G includes a breakdown of the Opinion of Probable Construction Costs (OPCC) for each recommended capital improvement.

**Table 8-2: Capital Improvements Cost and Benefit Analysis**

<b>Rec. Number</b>	<b>Description</b>	<b>Additional Design Required?</b>	<b>OPCC</b>	<b>Operational Cost Impact</b>	<b>Benefit</b>
2.1	Rehabilitate all five filters, including new concrete filter floors, stainless steel underdrains, media and coatings. (Project in construction at time of writing this report.)	Yes (Design complete at time of writing this report)	\$3,650,000	Negligible	Restore capacity and extend life of existing filters
2.2	Modify pre-oxidation approach by installing new aeration equipment, moving chlorine injection downstream of aeration, and installing a new permanganate storage and feed system.  (See Appendix C for preliminary layout.)	Yes	\$2,200,00	\$400,000 per year for permanganate chemical. Additional power cost for aeration equipment and permanganate equipment.	Reduce chlorine usage, improve speed and efficiency of manganese oxidation. Reduce corrosion in Filter building to protect equipment and building components.
2.3	Modify EQ basin with new pumps and decant weir to allow for settling of solids and separate disposal of solids and decant streams.  (See Appendix C for preliminary layout.)	Yes	\$1,630,000	Cost of additional pump power.	Minimize iron and manganese sent to WWTP and improve performance of UV system. Allow for recycle of decant water.

**APPENDIX A – PROCESS FLOW DIAGRAM**



- LEGEND:**
- CLARIFIED WATER – CW
  - FILTERED WATER – FW
  - RAW WATER – RW
  - WASH WATER – WW
  - FINISH WATER – FIN
  - SPENT WASHWATER – SWW
  - FILTER TO WASTE – FTW
  - DECANT
  - COAGULATED WATER – CGW
  - SOLIDS – SL
  - SOFTENED WATER – SOFT

**WATER TREATMENT PROCESS SCHEMATIC**

O'FALLON, MO  
WATER TREATMENT PLANT  
O'FALLON, MO

CAPITAL IMPROVEMENT PLAN

DESIGNED BY: KMC  
CHECKED BY: RHH  
DRAWN BY: JDE  
22880700-FIG 4-4.DWG

JOB NO: 228807  
DATE: JAN. 2016  
SCALE: N.T.S.

FIGURE 4-3

1520 S. Fifth Street, Suite 306  
St. Charles, Missouri 63303  
800.675.2756 | www.woodardcurran.com

**WOODARD & CURRAN**  
COMMITMENT & INTEGRITY DRIVE RESULTS

**APPENDIX B – ALTERNATIVE AERATION VENDOR EQUIPMENT**



# O'Fallon WTP

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## Missouri

### Representative

Brian Amsler  
Ray Lindsey Company  
St Louis, Missouri  
(816) 388-7440  
bamsler@raylindsey.com

### Contact

Don Tyson  
dtyson@westech-inc.com  
  
Kyra Meyer  
kmeyer@westech-inc.com



Proposal Number: 2230407  
Monday, September 26, 2022



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# Technical Proposal

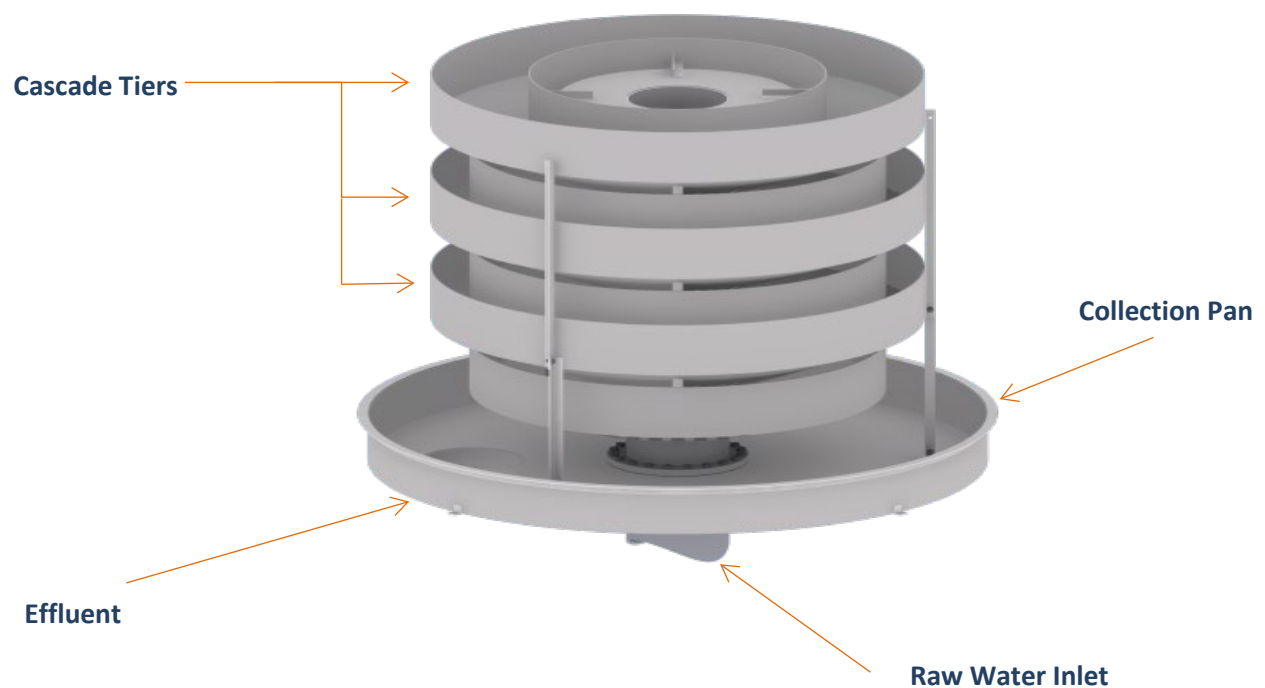
## Item A – Cascade Aerator, Model AWN111

Design Criteria	
Application	Iron Oxidation
Design Flow	4,167 gpm (6 MGD)
Number of Units	1
Unit Size	9 ft 6 in Diameter x 9 ft 6 in High

### Features and Benefits

The natural air draft sweeps by the exposed water surface and increases the oxygen content in the water as it flows down through the unit. Dissolved solids such as iron are transformed to their oxidized states, enabling them to be removed by downstream equipment. In addition, some unwanted dissolved gases (e.g., carbon dioxide, hydrogen sulfide, VOC) are removed to meet chemical requirements, stabilize pH, or eliminate objectionable tastes and odors.

- Corrosion resistant aluminum or stainless steel construction eliminates painting or galvanizing necessary for carbon steel units.
- Light weight eases installation.
- Cost effective method of aerating.
- No moving parts – minimal maintenance.



Cascade Aerator

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### Cascade Aerator Scope of Supply

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Dimension	Inlet	Materials of Construction
9 ft 6 in Diameter x 9 ft 6 in High	24 in	Type 3000 series aluminum

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### Collection Pan Scope of Supply

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Dimension	Inlet	Materials of Construction
11 ft 6 in Square x 12 in High	24 in	Type 3000 series aluminum

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#### Note

Due to the aluminum (or stainless steel) alloy used, exposed surfaces may have a dull or uneven appearance, and water staining is possible.

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### Weights

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Estimated Shipping Weight/Total	2,700 lbs
Estimated Shipping Weight/Heaviest Piece	2,200 lbs
Estimated Operating Weight	10,800 lbs

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**Note: Any item not listed above to be furnished by others.**

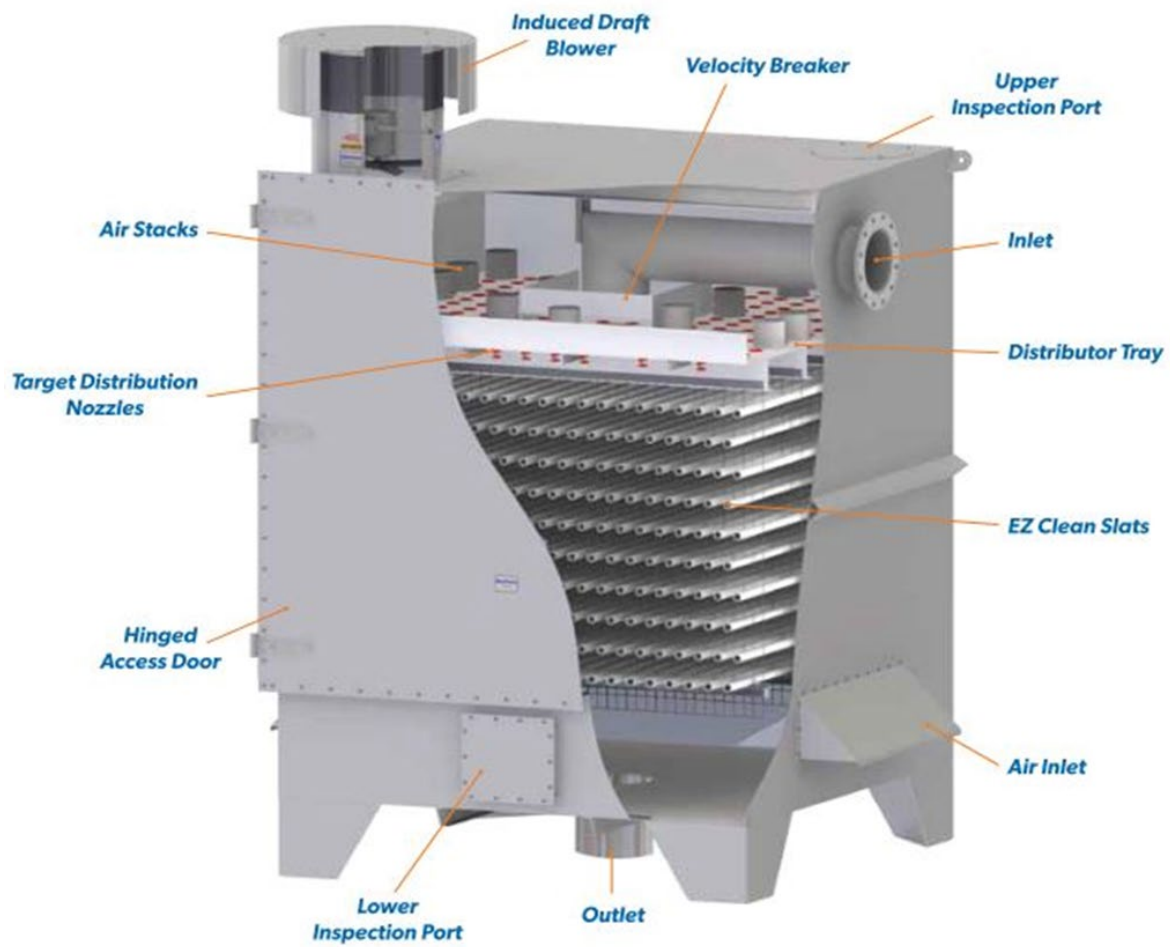
## Item B – Two (2) Aluminum Induced Draft Aerators (AIDA™), Model AWI21I

Design Criteria	
Application	Iron Oxidation
Design Flow	4,167 gpm (6 MGD)
Flow per Unit	2,084 gpm
Number of Units	2
Unit Size	120 in Square x 120 in Shell Height
Loading Rate	20.84 gpm/ft <sup>2</sup>
Blower Capacity	7,500 cfm @ 3/8 in SP (Total/Unit)
Air to Water Ratio	3.6:1 (cfm:gpm)

### Features and Benefits

A counter-current flow of air, supplied by an induced draft type blower, continuously sweeps through the aerator oxidizing the ferrous iron and carrying away released gases that may be present. Dissolved solids such as iron are transformed to their oxidized states, enabling them to be removed by downstream equipment. In addition, unwanted dissolved gases (e.g., carbon dioxide) are removed to reduce chemical requirements, stabilize pH, or eliminate objectionable tastes and odors.

- Aluminum construction eliminates painting, and corrosion-resistant internals simplify maintenance.
- Multiple internal media configurations optimize treatment performance.
- Factory assembly minimizes installation costs and prevents field errors.
- Gravity inlet tray ensures uniform water distribution and air collection across internals, and eliminates troublesome spray distribution nozzles. It also minimizes inlet pressure requirements and reduces long-term pumping costs compared to spray aerators.
- General Filter target nozzles equipped with a bell mouthed entrance to minimize clogging and provide even water droplet distribution in the aeration section are located in the distribution tray
- Top-mounted induction blower minimizes footprint.



*Aluminum Induced Draft Aerator*

### Aluminum Induced Draft Aerator Shell Scope of Supply

Quantity	Dimension	Notes
2	120 in Square x 120 in High	Materials of construction are Type 3000 series aluminum plates with Type 6061 aluminum structural members, Shipped complete with the following features
Feature	Notes	
Shell sides and bottom plate	1/4 in thick	
Shell top plate	3/16 in thick	
Lifting lugs	Included	
Nameplate assembly	Included	
Support legs	Includes predrilled anchor holes (Anchor bolts are not by WesTech.)	
Air intake	Included	
Media access	Hinged and bolted side	
Water distributor	Distribution tray complete with velocity breaker box and air stacks	
Target nozzles	Included	
Media	Round PVC slats on 6 in vertical centers	
Media support	Type 304 stainless steel support grids	
Lower inspection port	13 in x 15 in placed below the internals	
Upper inspection port	18 in diameter placed in the cover	
Inlet connection	14 in flanged top side	
Outlet connection	18 in plain end bottom	
Air exhaust connection	Includes moisture separator in the cover	

### Induced Draft Blower Scope of Supply

Quantity	Volume	Pressure	Model	Motor
4	3,750 scfm each	3/8 in SP	ID-244L	1/2 hp, 460V, 60 Hz, 3 ph, TENV
Feature	Notes			
Housing	Aluminum with stainless steel trim and rain hood			
Exhaust screen	Aluminum and stainless steel			
Hardware	Type 18-8 stainless steel, includes hardware for mounting			

### Fabrications Scope of Supply

Feature	Quantity	Notes
Air Inlet Hoods	4	Aluminum construction, with hood mounting bolts and screened air intake with quick release screen

#### Notes:

- Due to the aluminum (or stainless steel) alloy used, exposed surfaces may have a dull or uneven appearance, and water staining is possible.
- It is recommended that a delay timer be used to keep the blower running for at least 10 minutes after the pump stops. This is to dry the unit out to prevent icing of the outlet screens in colder climates.

- It is recommended that the installing contractor provide an appropriate coating or product barrier for aluminum surfaces in contact with concrete or mortar to prevent corrosion.
- Aerator influent flanged connection is not designed to support the weight of the influent piping. Alternate means of influent pipe support should be provided.

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### Weights

Estimated Shipping Weight/Heaviest Piece	4,200 lbs
Estimated Operating Weight/Vessel	14,500 lbs

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### WesTech Trips to the Site

Total Trips	Total Days	Includes
1	1	Installation inspection, startup, instruction of plant personnel, and training

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**Note: Any item not listed above to be furnished by others.**

# Clarifications and Exceptions

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## General Clarifications

**Terms & Conditions:** This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

**Escalation:** If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-party index, and in both cases without any additional profit or margin being added.

**USA Tariffs and Current Trade Laws:** All prices are based on current USA and North America tariffs and trade laws/agreements at time of bid. Any changes in costs due to USA Tariffs and trade laws/agreements will be passed through to the purchaser at cost.

The Infrastructure Investment and Jobs Act of 2021 (IIJA) includes potentially significant changes to historical “Buy American” or “American Iron and Steel” (AIS) requirements for federally funded projects, including water-related infrastructure projects as administered by the Environmental Protection Agency (EPA). The IIJA was signed into law on Nov 15, 2021. However the EPA has yet to issue additional information and guidance clarifying the application and interpretation of these changes. Although WesTech makes every effort to source the steel for our equipment and products domestically, not everything is reasonably or commercially available to meet all project specific constraints. Consequently, any proposal or offer for sale by WesTech, including any resulting equipment order, does not guarantee compliance with the Buy American provisions of the Infrastructure Investment and Jobs Act of 2021 at this time.

## Cascade Aerator Clarifications

- Availability of equipment components specified may dictate substitutions of equal quality at the discretion of WesTech.
- All hardware is crated and shipped to the jobsite for assembly by the contractor.
- No field service or startup has been included in this proposal due to the simplicity of the equipment. If field service is desired, it can be added for an additional cost.

## Items not furnished by WesTech

- Unloading of equipment from delivering carrier, protected storage of equipment, installation, supervision of installation
- All underground and interconnecting piping, pipe supports, wall inserts or sleeves, Dresser or flexible couplings, hangers, air release piping and valves, sampling lines and sinks, field work of piping (i.e., drilling and tapping for instrumentation) and flow meters
- Walkways, handrails, stairways and ladders

- All chemical feeders, feed lines, start-up chemicals, chemicals, labor and procedures for the disinfection of equipment, laboratory test equipment
- Structural design, supply and installation of concrete tanks and pads, rebar, anchors, concrete, grout and sealant
- Motor control center, motor starters, disconnects, electrical wiring and conduit, telemetering equipment, supports for controls and any pumps
- Any equipment and service not listed in this proposal

### **Aluminum Induced Draft Aerator Comments and Clarifications**

- Availability of equipment components specified may dictate substitutions of equal quality at the discretion of WesTech.
- All hardware is crated and shipped to the jobsite for assembly by the contractor.

### **Items Not Furnished by WesTech**

- Unloading of equipment from delivering carrier, protected storage of equipment, installation, supervision of installation
- All underground and interconnecting piping, pipe supports, wall inserts or sleeves, Dresser or flexible couplings, hangers, air release piping and valves, sampling lines and sinks, field work of piping (i.e., drilling and tapping for instrumentation) and flow meters
- Walkways, handrails, stairways and ladders, air ducts and roof flashing
- All chemical feeders, feed lines, start-up chemicals, chemicals, labor and procedures for the disinfection of equipment, laboratory test equipment
- Structural design, supply and installation of concrete pads, tanks. foundations, rebar, anchors, concrete, grout and sealant
- Motor control center, motor starters, disconnects, electrical wiring and conduit, telemetering equipment and supports for controls
- Any equipment and service not listed in this proposal

### **Exceptions**

Not applicable

# Commercial Proposal

Proposal Name: O'Fallon WTP  
 Proposal Number: 2230407  
 Monday, September 26, 2022

## 1. Bidder's Contact Information

Company Name	WesTech Engineering, LLC
Primary Contact Name	Don Tyson
Phone	(801) 265-1000
Email	dtyson@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

## 2. Budget Pricing

Currency: USD

### Scope of Supply

A	Cascade Aerator, Model AWN11I	\$105,000
B	(2) Aluminum Induced Draft Aerators (AIDA™), Model AWI21I	\$260,000
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are valid for a period not to exceed 30 days from date of proposal.

### Additional Field Service

Daily Rate (Applicable Only to Field Service Not Included in Scope)	\$1,200
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Pricing does not include field service unless noted in scope of supply, but is available at the daily rate plus expenses. The greater of a two week notice or visa procurement time is required prior to departure date. Our field service policy can be provided upon request for more details.

## 3. Payment Terms

Purchase Order Acceptance and Contract Execution	10%
Submittals Provided by WesTech	15%
Release for Fabrication	35%
Notification of Ready to Ship	40%

All payments are net 30 days. Partial shipments are allowed. An approved Letter of Credit is required if Incoterms CIF, CFR, DAP, CIP, or CPT are applicable. Payment is required in full for all other Incoterms prior to international shipment. Other terms per WesTech proforma invoice. Please note that the advising bank must be named as: Wells Fargo Bank, International Department, 9000 Flair Drive, 3rd Floor, El Monte, California 91731, USA.

## 4. Schedule

Submittals, after Purchase Order Acceptance and Contract Execution	6 to 8 weeks
Ready to Ship, after Receipt of Final Submittal Approval	18 to 20 weeks
<b>Estimated Weeks to Ready to Ship</b>	<b>24 to 28 weeks*</b>

\*Customer submittal approval is typically required to proceed with equipment fabrication and is not accounted for in the schedule above. Project schedule will be extended to account for time associated with receipt of customer submittal approval.

## 5. Freight

Domestic	FOB Shipping Point - Full Freight Allowed to Jobsite (FSP-FFA)	
<b>From</b>	<b>Final Destination</b>	<b>Number of Trucks or Containers</b>
WesTech Shops	O'Fallon, MO	TBD

# One-Year Warranty

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WesTech is meeting a global need for clean water through technology treatment solutions. We are proud that the equipment and systems we design, build, maintain, and operate are making the world a better place and creating a more sustainable environment for future generations.

Equipment manufactured or sold by WesTech Engineering, LLC, once paid for in full, is backed by the following warranty:

Subject to the terms below, WesTech warrants all new equipment manufactured or sold by WesTech Engineering, LLC to be unencumbered and free from defects in material and workmanship, and WesTech will replace or repair, F.O.B. its factories or other location it chooses, any part or parts returned to WesTech which WesTech's examination and analysis determine have failed within the warranty period because of defects in material and workmanship. The warranty period is either, one calendar year immediately following start-up, or eighteen (18) months from when WesTech sent its ready-to-ship notification to the purchaser, whichever expires sooner. All repair or replacement parts qualifying under this warranty shall be free of charge. Purchaser will provide timely written notice to WesTech of any defects it believes should be repaired or replaced under this warranty. WesTech will reject as untimely any warranty defect claim that purchaser submits more than thirty (30) days after the possible warranty defect first occurred. Unless specifically stated otherwise, this warranty does not cover normal wear or consumables. This warranty is not transferable.

This warranty shall be void and shall not apply where the equipment or any part thereof

- a) has been dismantled, modified, repaired or connected to other equipment, outside of a WesTech factory, or without WesTech's written approval, or
- b) has not been installed in complete adherence to all WesTech's or parts manufacturer's requirements, recommendations, and procedures, or
- c) has been subject to misuse, abuse, neglect, or accident, or has not at all times been operated and maintained in strict compliance with all of WesTech's requirements and recommendations therefor, including, but not limited to, the relevant WesTech Operations & Maintenance Manual and any other of WesTech's specified guidelines & procedures, or
- d) has been subject to force majeure events; use of chemicals not approved in writing by WesTech; electrical surges; overloading; significant power, water or feed supply fluctuations; or non-compliance with agreed feedwater or chemical volumes, specifications or procedures.

In any case where a part or component of equipment under this warranty is or may be faulty and the component or part is also covered under the warranty of a third party then the purchaser shall provide reasonable assistance to first pursue a claim under the third party warranty before making a claim under this warranty from WesTech. WesTech Engineering, LLC gives no warranty with respect to parts, accessories, or components purchased other than through WesTech. The warranties which apply to such items are those offered by the respective manufacturers.

This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.

# Terms & Conditions

Terms and Conditions appearing in any order based on this proposal which are inconsistent herewith shall not be binding on WesTech Engineering, LLC. The sale and purchase of equipment described herein shall be governed exclusively by the foregoing proposal and the following provisions:

**1. SPECIFICATIONS:** WesTech Engineering, LLC is furnishing its standard equipment as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Owner's plans, specifications, or addenda as there may be deviations. The equipment will, however, meet the general intention of the mechanical specifications of these documents.

**2. ITEMS INCLUDED:** This proposal includes only the equipment specified herein and does not include erection, installation, accessories, nor associated materials such as controls, piping, etc., unless specifically listed.

**3. PARTIES TO CONTRACT:** WesTech Engineering, LLC is not a party to or bound by the terms of any contract between WesTech Engineering, LLC's customer and any other party. WesTech Engineering, LLC's undertakings are limited to those defined in the contract between WesTech Engineering, LLC and its direct customers.

**4. PRICE AND DELIVERY:** All selling prices quoted are subject to change without notice after 30 days from the date of this proposal unless specified otherwise. Unless otherwise stated, all prices are F.O.B. WesTech Engineering, LLC or its supplier's shipping points. All claims for damage, delay or shortage arising from such equipment shall be made by Purchaser directly against the carrier. When shipments are quoted F.O.B. job site or other designation, Purchaser shall inspect the equipment shipped, notifying WesTech Engineering, LLC of any damage or shortage within forty-eight hours of receipt, and failure to so notify WesTech Engineering, LLC shall constitute acceptance by Purchaser, relieving WesTech Engineering, LLC of any liability for shipping damages or shortages.

**5. PAYMENTS:** All invoices are net 30 days. Delinquencies are subject to a 1.5 percent service charge per month or the maximum permitted by law, whichever is less on all past due accounts. Pro rata payments are due as shipments are made. If shipments are delayed by the Purchaser, invoices shall be sent on the date when WesTech Engineering, LLC is prepared to make shipment and payment shall become due under standard invoicing terms. If the work to be performed hereunder is delayed by the Purchaser, payments shall be based on the purchase price and percentage of completion. Products held for the Purchaser shall be at the risk and expense of the Purchaser. Unless specifically stated otherwise, prices quoted are for equipment only. These terms are independent of and not contingent upon the time and manner in which the Purchaser receives payment from the owner.

**6. PAYMENT TERMS:** Credit is subject to acceptance by WesTech Engineering, LLC's Credit Department. If the financial condition of the Purchaser at any time is such as to give WesTech Engineering, LLC, in its judgment, doubt concerning the Purchaser's ability to pay, WesTech Engineering, LLC may require full or partial payment in advance or may suspend any further deliveries or continuance of the work to be performed by the WesTech Engineering, LLC until such payment has been received.

**7. ESCALATION:** If between the proposal date and actual procurement and through no fault of the Seller, the relevant cost of labor, material, freight, tariffs, and other Seller costs combined relating to the contract, increase by greater than 2.5% of the overall contract price, then the contract price shall be subject to escalation and increased. Such increase shall be verified by documentation and the amount of contract price escalation shall be calculated as either the actual increased cost to the Seller or, if agreed by the Parties, the equivalent increase of a relevant industry recognized third-

party index, and in both cases without any additional profit or margin being added.

**8. APPROVAL:** If approval of equipment submittals by Purchaser or others is required, a condition precedent to WesTech Engineering, LLC supplying any equipment shall be such complete approval.

**9. INSTALLATION SUPERVISION:** Prices quoted for equipment do not include installation supervision. WesTech Engineering, LLC recommends and will, upon request, make available, at WesTech Engineering, LLC's then current rate, an experienced installation supervisor to act as the Purchaser's employee and agent to supervise installation of the equipment. Purchaser shall at its sole expense furnish all necessary labor equipment, and materials needed for installation.

Responsibility for proper operation of equipment, if not installed by WesTech Engineering, LLC or installed in accordance with WesTech Engineering, LLC's instructions, and inspected and accepted in writing by WesTech Engineering, LLC, rests entirely with Purchaser; and any work performed by WesTech Engineering, LLC personnel in making adjustment or changes must be paid for at WesTech Engineering, LLC's then current per diem rates plus living and traveling expenses.

WesTech Engineering, LLC will supply the safety devices described in this proposal or shown in WesTech Engineering, LLC's drawings furnished as part of this order but excepting these, WesTech Engineering, LLC shall not be required to supply or install any safety devices whether required by law or otherwise. The Purchaser hereby agrees to indemnify and hold harmless WesTech Engineering, LLC from any claims or losses arising due to alleged or actual insufficiency or inadequacy of the safety devices offered or supplied hereunder, whether specified by WesTech Engineering, LLC or Purchaser, and from any damage resulting from the use of the equipment supplied hereunder.

**10. ACCEPTANCE OF PRODUCTS:** Products will be deemed accepted without any claim by Purchaser unless written notice of non-acceptance is received by WesTech Engineering, LLC within 30 days of delivery if shipped F.O.B. point of shipment, or 48 hours of delivery if shipped F.O.B. point of destination. Such written notice shall not be considered received by WesTech Engineering, LLC unless it is accompanied by all freight bills for said shipment, with Purchaser's notations as to damages, shortages and conditions of equipment, containers, and seals. Non-accepted products are subject to the return policy stated below.

**11. TAXES:** Any federal, state, or local sales, use or other taxes applicable to this transaction, unless specifically included in the price, shall be for Purchaser's account.

**12. TITLE:** The equipment specified herein, and any replacements or substitutes therefore shall, regardless of the manner in which affixed to or used in connection with realty, remain the sole and personal property of WesTech Engineering, LLC until the full purchase price has been paid. Purchaser agrees to do all things necessary to protect and maintain WesTech Engineering, LLC's title and interest in and to such equipment; and upon Purchaser's default, WesTech Engineering, LLC may retain as liquidated damages any and all partial payments made and shall be free to enter the premises where such equipment is located and remove the same as its property without prejudice to any further claims on account of damages or loss which WesTech Engineering, LLC may suffer from any cause.

**13. INSURANCE:** From date of shipment until the invoice is paid in full, Purchaser agrees to provide and maintain at its expense, but for WesTech Engineering, LLC's benefit, adequate insurance including, but not limited

to, builders risk insurance on the equipment against any loss of any nature whatsoever.

**14. SHIPMENTS:** Any shipment of delivery dates recited represent WesTech Engineering, LLC's best estimate but no liability, direct or indirect, is assumed by WesTech Engineering, LLC for failure to ship or deliver on such dates.

WesTech Engineering, LLC shall have the right to make partial shipments; and invoices covering the same shall be due and payable by Purchaser in accordance with the payment terms thereof. If Purchaser defaults in any payment when due hereunder, WesTech Engineering, LLC may, without incurring any liability therefore to Purchaser or Purchaser's customers, declare all payments immediately due and payable with maximum legal interest thereon from due date of said payment, and at its option, stop all further work and shipments until all past due payments have been made, and/or require that any further deliveries be paid for prior to shipment.

If Purchaser requests postponements of shipments, the purchase price shall be due and payable upon notice from WesTech Engineering, LLC that the equipment is ready for shipment; and thereafter any storage or other charge WesTech Engineering, LLC incurs on account of the equipment shall be for the Purchaser's account.

If delivery is specified at a point other than WesTech Engineering, LLC or its supplier's shipping points, and delivery is postponed or prevented by strike, accident, embargo, or other cause beyond WesTech Engineering, LLC's reasonable control and occurring at a location other than WesTech Engineering, LLC or its supplier's shipping points, WesTech Engineering, LLC assumes no liability in delivery delay. If Purchaser refuses such delivery, WesTech Engineering, LLC may store the equipment at Purchaser's expense. For all purposes of this agreement such tender of delivery or storage shall constitute delivery.

**15. WARRANTY:** WesTech Engineering LLC warrants equipment it supplies only in accordance with the attached WesTech Warranty. This warranty is expressly given by WesTech and accepted by purchaser in lieu of all other warranties whether written, oral, express, implied, statutory or otherwise, including without limitation, warranties of merchantability and fitness for particular purpose. WesTech neither accepts nor authorizes any other person to assume for it any other liability with respect to its equipment. WesTech shall not be liable for normal wear and tear, corrosion, or any contingent, incidental, or consequential damage or expense due to partial or complete inoperability of its equipment for any reason whatsoever. The purchaser's exclusive and only remedy for breach of this warranty shall be the repair and or replacement of the defective part or parts within a reasonable time of WesTech's accepting the validity of a warranty claim made by the purchaser.

**16. PATENTS:** WesTech Engineering, LLC agrees that it will, at its own expense, defend all suits or proceedings instituted against Purchaser and pay any award of damages assessed against it in such suits or proceedings, so far as the same are based on any claim that the said equipment or any part thereof constitutes an infringement of any apparatus patent of the United States issued at the date of this Agreement, provided WesTech Engineering, LLC is given prompt notice in writing of the institution or threatened institution of any suit or proceeding and is given full control of the defense, settlement, or compromise of any such action; and Purchaser agrees to give WesTech Engineering, LLC needed information, assistance, and authority to enable WesTech Engineering, LLC so to do. In the event said equipment is held or conceded to infringe such a patent, WesTech Engineering, LLC shall have the right at its sole option and expense to a) modify the equipment to be non-infringing, b) obtain for Purchaser the license to continue using said equipment, or c) accept return of the equipment and refund to the Purchaser the purchase price thereof less a reasonable charge for the use thereof. WesTech Engineering, LLC will reimburse Purchaser for actual out-of-pocket expenses, exclusive of legal fees, incurred in preparing such information and rendering such assistance

at WesTech Engineering, LLC's request. The foregoing states the entire liability of WesTech Engineering, LLC, with respect to patent infringement; and except as otherwise agreed to in writing, WesTech Engineering, LLC assumes no responsibility for process patent infringement.

**17. SURFACE PREPARATION AND PAINTING:** If furnished, shop primer paint is intended to serve only as minimal protective finish. WesTech Engineering, LLC will not be responsible for the condition of primed or finish painted surfaces after equipment leaves its shops. Purchasers are invited to inspect paint in shops for proper preparation and application prior to shipment. WesTech Engineering, LLC assumes no responsibility for field surface preparation or touch-up of shipping damage to paint. Painting of fasteners and other touch-up to painted surfaces will be by Purchaser's painting contractor after mechanism installation.

Motors, gear motors, and other components not manufactured by WesTech Engineering, LLC will be painted with that manufacturer's standard paint system. It is WesTech Engineering, LLC's intention to ship major steel components as soon as fabricated, often before drive, motors, and other manufactured components. Unless Purchaser can ensure that shop primed steel shall be field painted within thirty (30) days after arrival at the job site, WesTech Engineering, LLC encourages the Purchaser to order these components without primer.

WesTech Engineering, LLC's prices are based on paints and surface preparations as outlined in the main body of this proposal. In the event that an alternate paint system is selected, WesTech Engineering, LLC requests that Purchaser's order advise of the paint selection. WesTech Engineering, LLC will then either adjust the price as may be necessary to comply or ship the material unpainted if compliance is not possible due to application problems or environmental controls.

**18. CANCELLATION, SUSPENSION, OR DELAY:** After acceptance by WesTech Engineering, LLC, this proposal, or Purchaser's order based on this proposal, shall be a firm agreement and is not subject to cancellation, suspension, or delay except upon payment by Purchaser of appropriate charges which shall include all costs incurred by WesTech Engineering, LLC to date of cancellation, suspension, or delay plus a reasonable profit. Additionally, all charges related to storage and/or resumption of work, at WesTech Engineering, LLC's plant or elsewhere, shall be for Purchaser's sole account; and all risks incidental to storage shall be assumed by Purchaser.

**19. FORCE MAJEURE:** Neither party hereto shall be liable to the other for default or delay in delivery caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, act of government, pandemic, delay of carriers, failure of normal sources of supply, complete or partial shutdown of plant by reason of inability to attain sufficient raw materials or power, and/or other similar contingency beyond the reasonable control of the respective parties. The time for delivery specified herein shall be extended during the continuance of such conditions, or any other cause beyond such party's reasonable control. Escalation resulting from a Force Majeure event shall be equitably adjusted per the escalation policy stated above.

**20. RETURN OF PRODUCTS:** No products may be returned to WesTech Engineering, LLC without WesTech Engineering, LLC's prior written permission. Said permission may be withheld by WesTech Engineering, LLC at its sole discretion.

**21. BACKCHARGES:** WesTech Engineering LLC will not approve or accept backcharges for labor, materials, or other costs incurred by Purchaser or others in modification, adjustment, service, or repair of WesTech Engineering LLC furnished materials unless such back charge has been authorized in advance in writing by a WesTech Engineering LLC purchase order, or work requisition signed by WesTech Engineering LLC.

**22. INDEMNIFICATION:** Purchaser agrees to indemnify WesTech Engineering, LLC from all costs incurred, including but not limited to court costs and reasonable attorney fees, from enforcing any provisions of this contract, including but not limited to breach of contract or costs incurred in collecting monies owed on this contract.

**23. ENTIRE AGREEMENT:** This proposal expresses the entire agreement between the parties hereto superseding any prior understandings and is not subject to modification except by a writing signed by an authorized officer of each party.

**24. MOTORS AND MOTOR DRIVES:** In order to avoid shipment delays of WesTech Engineering, LLC equipment, the motor drives may be sent directly to the job site for installation by the equipment installer. Minor fit-up may be required.

**25. EXTENDED STORAGE:** Extended storage instructions will be part of information provided to shipment. If equipment installation and start-up is delayed more than 30 days, the provisions of the storage instructions must be followed to keep WARRANTY in force.

**26. LIABILITY:** Professional liability insurance, including but not limited to, errors and omissions insurance, is not included. In any event, liability for errors and omissions shall be limited to the lesser of \$100,000 USD or the value of the particular piece of equipment (not the value of the entire order) supplied by WesTech Engineering LLC against which a claim is sought.

**27. ARBITRATION NEGOTIATION:** Any controversy or claim arising out of or relating to the performance of any contract resulting from this proposal or

contract issued, or the breach thereof, shall be settled by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association, and judgment upon the award rendered by the arbitrator(s) may be entered to any court having jurisdiction.

ACCEPTED BY PURCHASER

Customer Name: \_\_\_\_\_

Customer Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contact Name: \_\_\_\_\_

Contact Phone: \_\_\_\_\_

Contact Email: \_\_\_\_\_

Signature: \_\_\_\_\_

Printed Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

# Supplemental Information

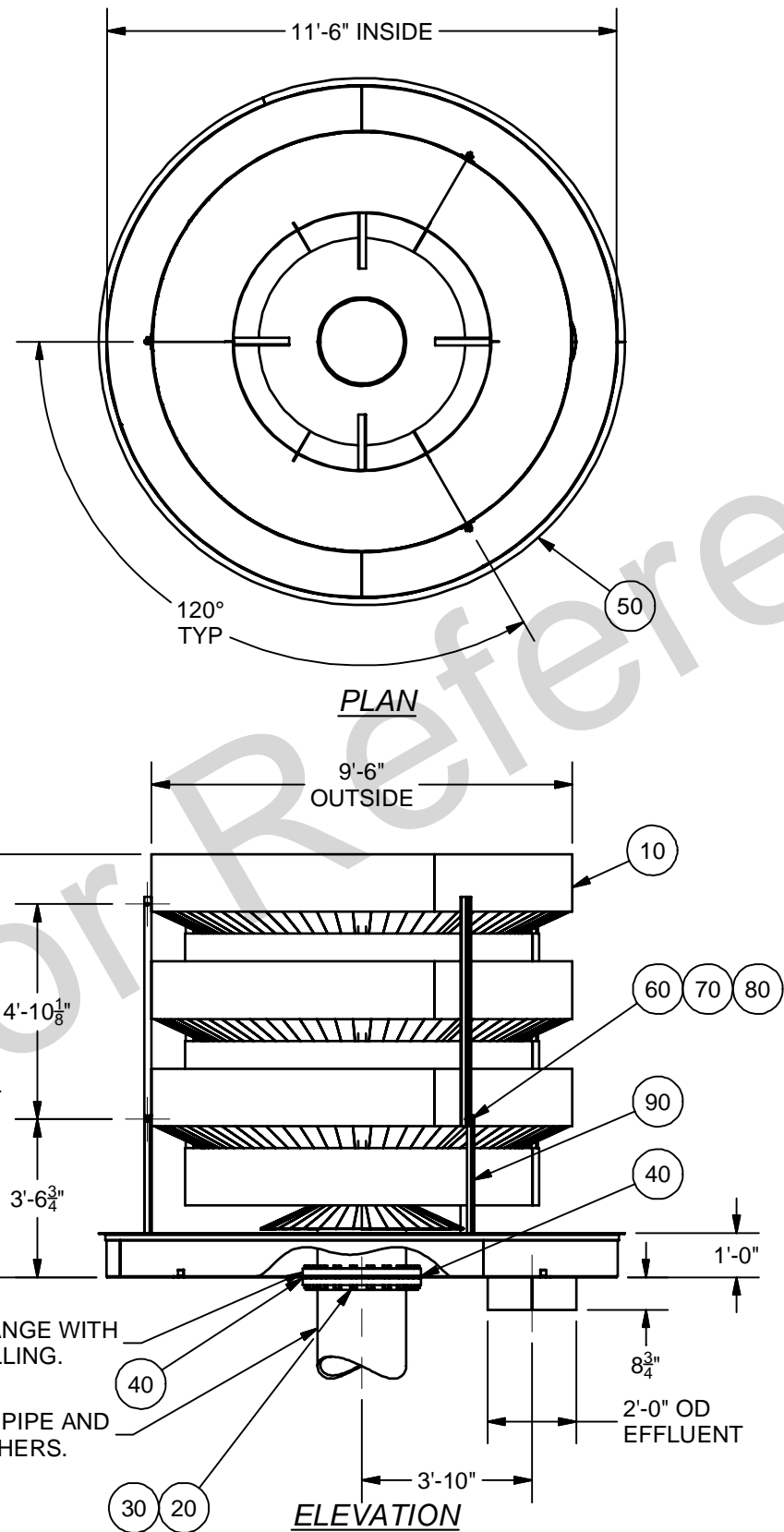
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Drawings  
Brochure

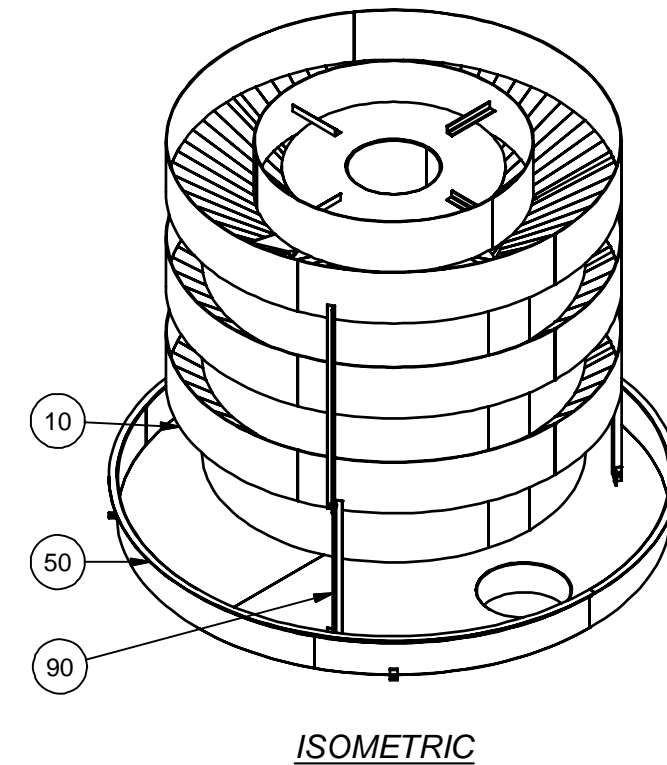
STD: BORDER-1101-11X17B

INTL REF:

= 1" AT PLOT SCALE



BILL OF MATERIAL						
POS	UNIT QTY	ITEM CODE	DESCRIPTION	MATERIAL	LENGTH, IN	TOTAL WT, LB
10	1	W3T155583	FAB AERATOR CASCADE 114 X 114			2116.0
20	20	W2T77504	BOLT,HEX;1.25 IN DIA;5.75 IN LG;SS;UNC	STN STL, 18-8		11.9
30	20	W2T87439	NUT;HEX;1.25 IN DIA;UNC;SS304;7 TPI;GR 5	STN STL, 18-8		0.0
40	2	W2T77273	GSKT,SEAL;FLG FF;24 IN;0.125 IN THK	Neoprene		0.1
50	1	W3T155285	FAB PAN CLCT 138 DIA X 12 H 24 PIPE AL			536.1
60	6	W2T84539	BOLT,HEX;0.5 IN DIA;1.5 IN LG;304SS;UNC	STN STL, 18-8		0.8
70	6	W2T84531	NUT;HEX-FIN;0.5 IN DIA;UNC;SS304	STN STL, 18-8		0.2
80	12	W2T295609	WASHER;FLAT;0.5 IN;1.25 OD;18-8SS	STN STL, 18-8		0.5
90	3	W3T155225	FAB ANGLE COL PAN SUPT 6061 42.5 IN			11.7



24" PLATE FLANGE WITH 150# ASA DRILLING.

24" MOUNTING PIPE AND FLANGE BY OTHERS.

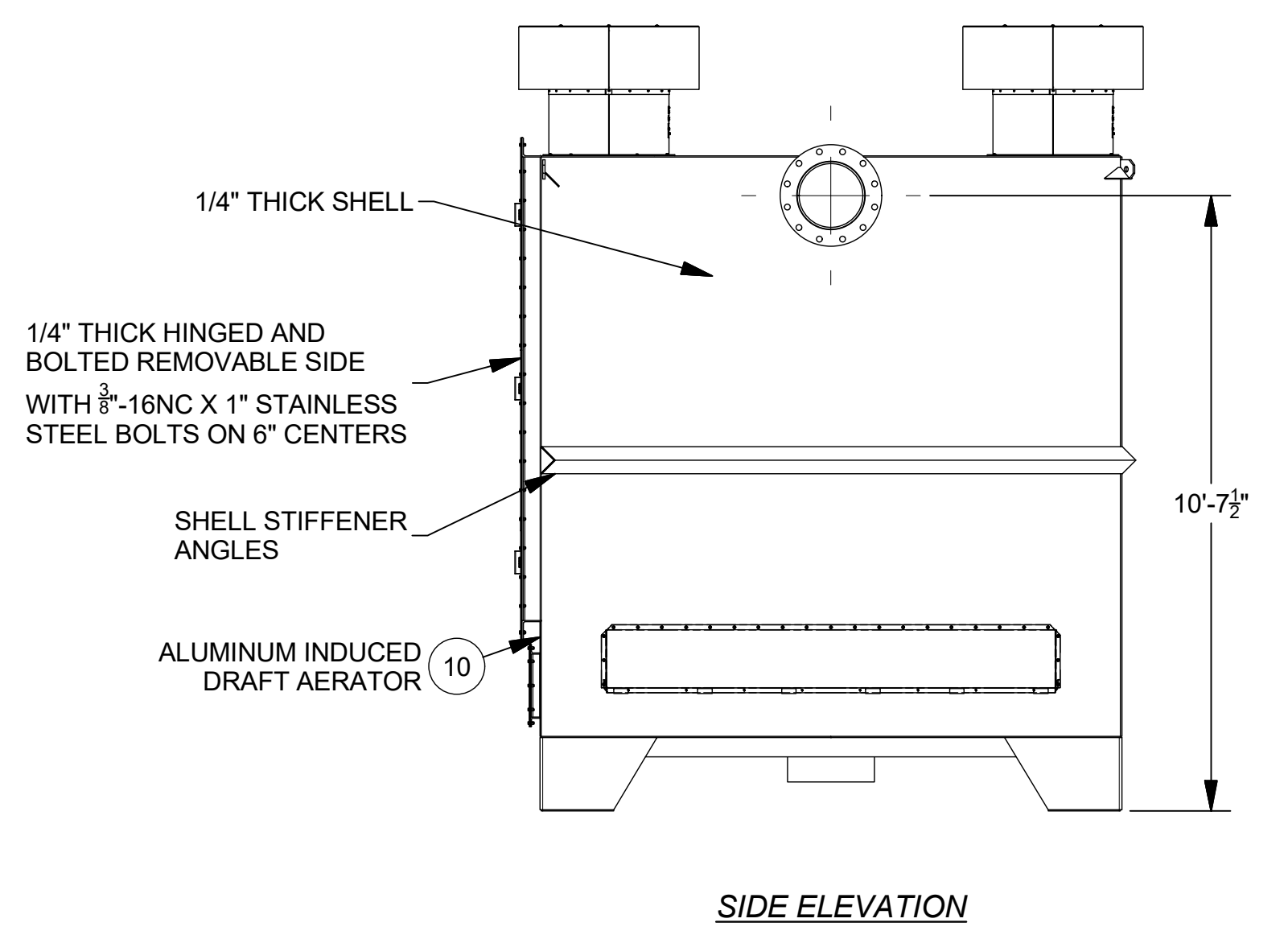
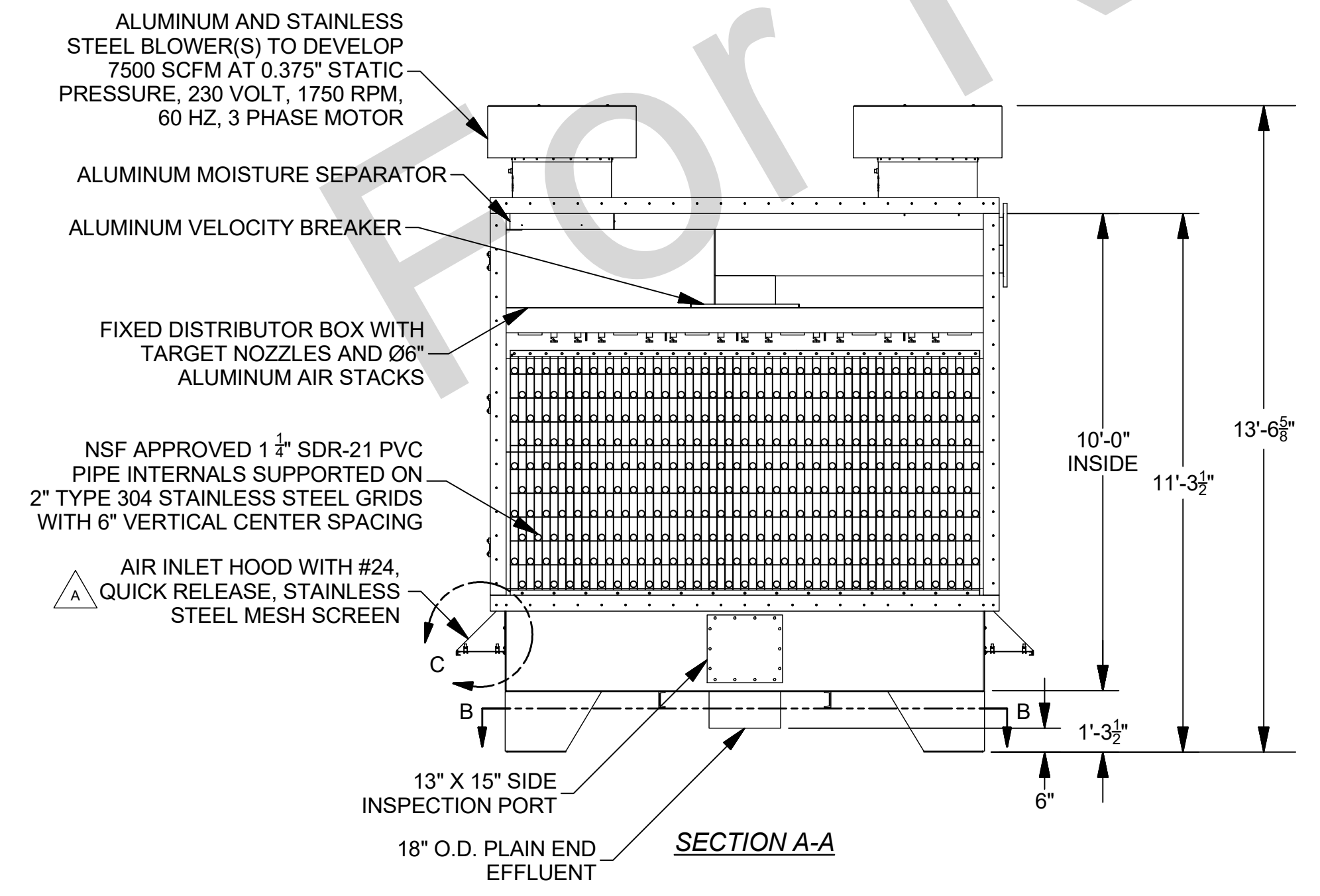
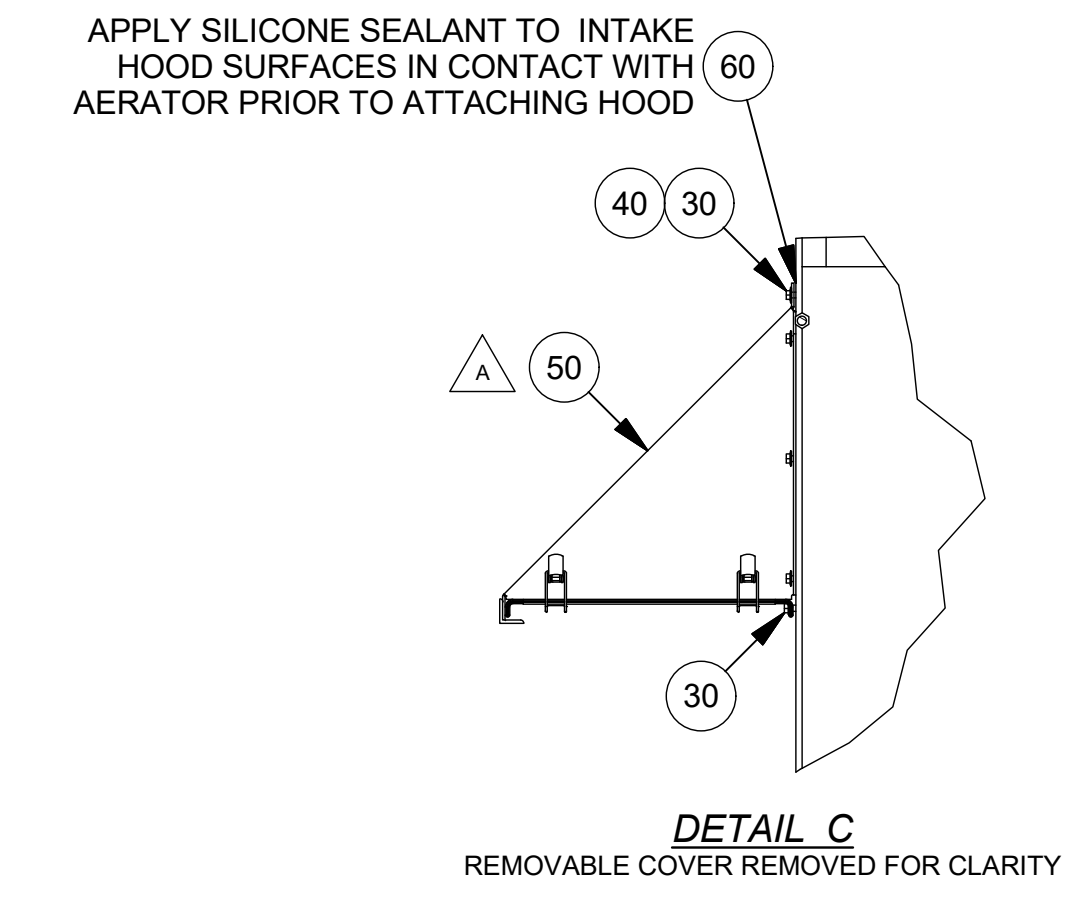
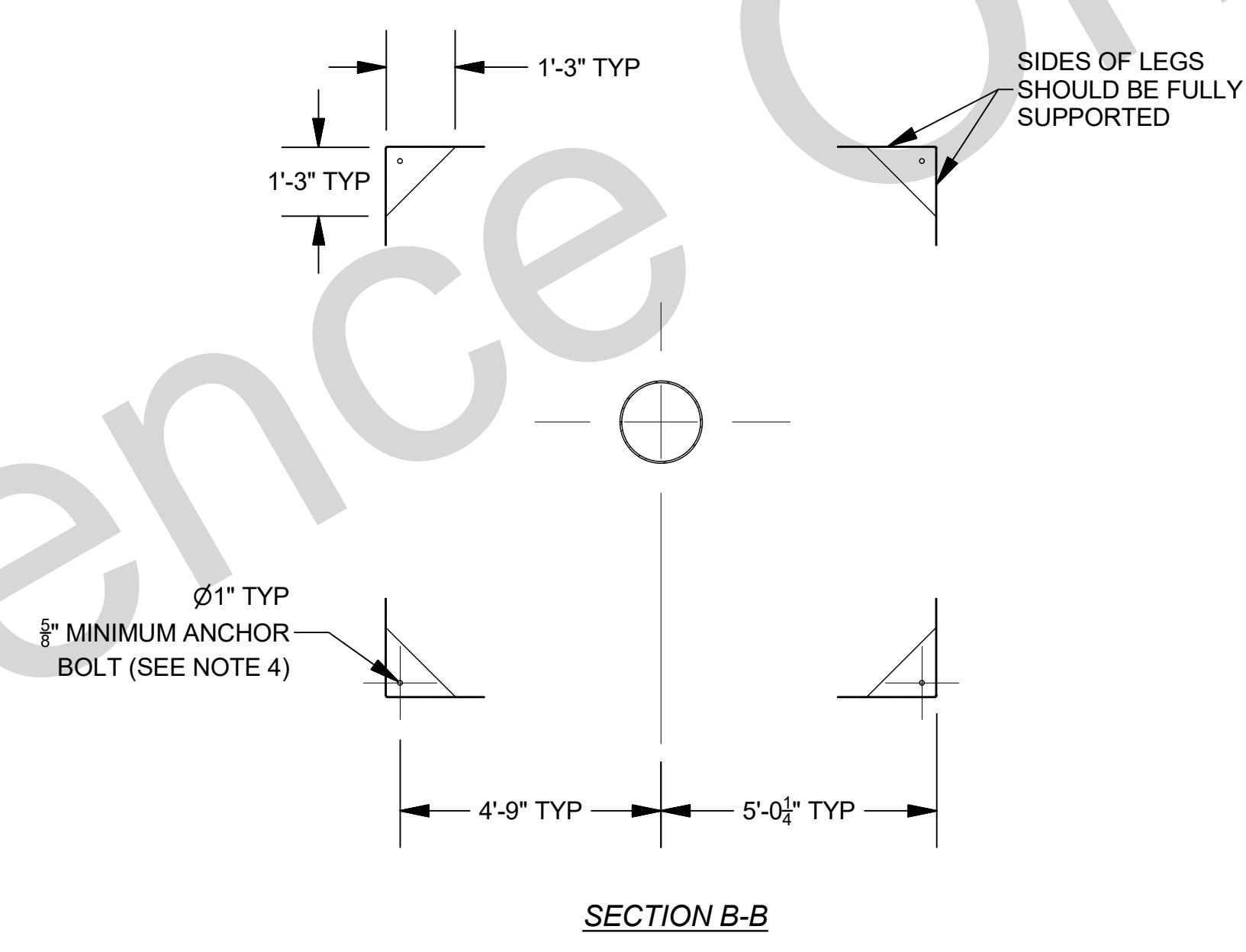
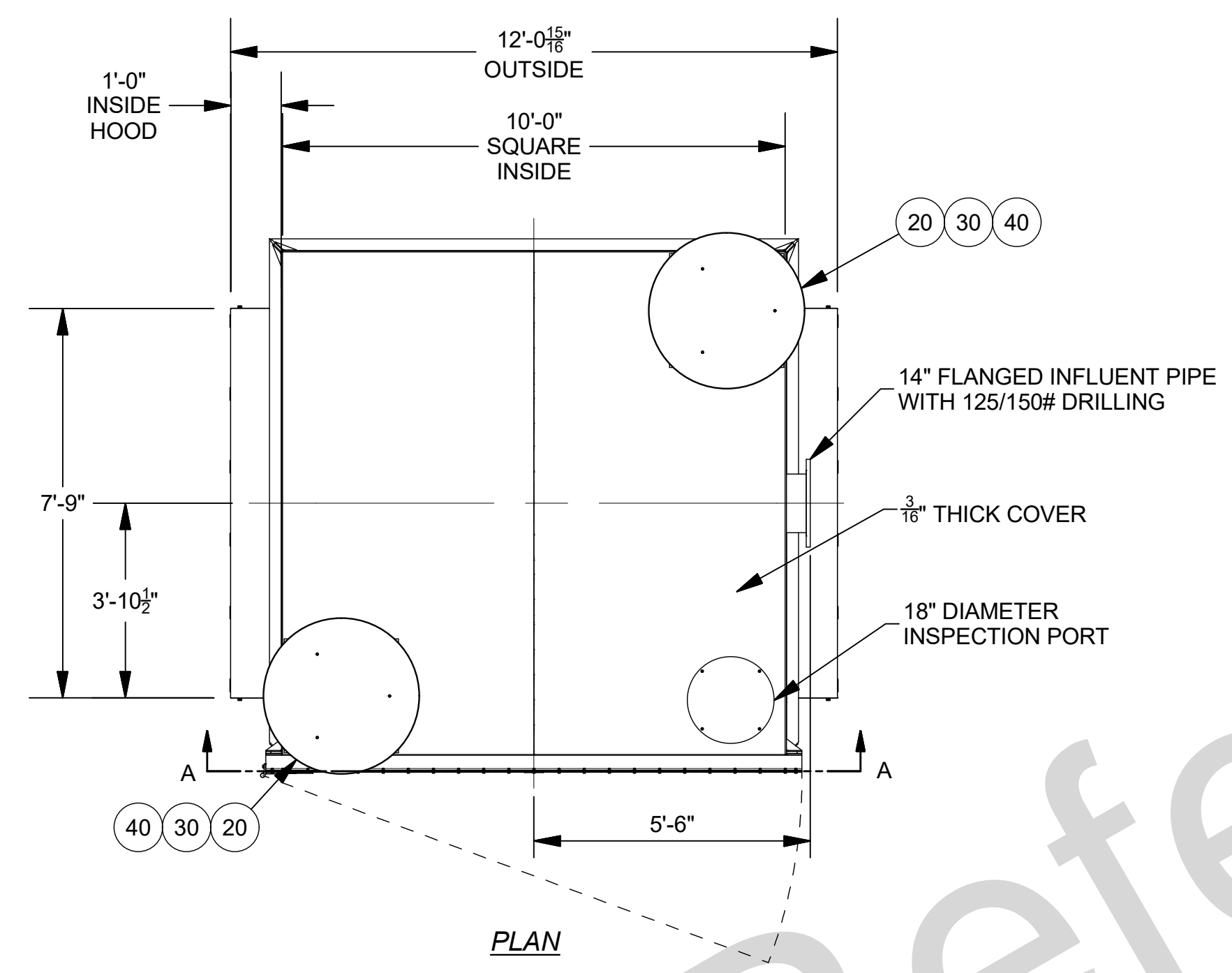
**ADDITIONAL NOTES:**

- 1.) ALL PLATE IS 1/4" TYPE 3003 ALUMINUM UNLESS OTHERWISE NOTED.
- 2.) ALL ANGLE IS 2" X 2" X 1/4" TYPE 6061 ALUMINUM UNLESS OTHERWISE NOTED.
- 3.) HOLES ARE PROVIDED FOR ATTACHMENT TO GUY WIRES WHEN AERATOR IS LOCATED OUTSIDE OR IS SUSCEPTIBLE TO DAMAGING FORCES. GUY WIRES AND HARDWARE ARE RECOMMENDED BUT NOT PROVIDED.
- 4.) MOUNTING FASTENERS ARE PROVIDED IN THE QUANTITIES SHOWN ON THE BILL OF MATERIAL.

<p>COMPANY CONFIDENTIAL THIS DRAWING IS PROPERTY OF WESTECH ENGINEERING, INC. AND IS TRANSMITTED IN CONFIDENCE. NEITHER RECEIPT NOR POSSESSION CONFERS OR TRANSFERS ANY RIGHTS TO REPRODUCE, USE, OR DISCLOSE, IN WHOLE OR IN PART, DATA CONTAINED HEREIN FOR ANY PURPOSE, WITHOUT THE WRITTEN PERMISSION OF WESTECH ENGINEERING, INC.</p>							DESIGNER CB	DATE 12/2/2010	TITLE NATURAL AERATION ALUMINUM CASCADE AERATOR 114IN DIA X 114IN TALL, WITH 138IN DIA COLLECTOR PAN			
							CHECKER RLJ	DATE 1/28/2011	CLIENT			
							ENGINEER SCJ	DATE 12/2/2010				
							MANAGER	DATE				
							FILE:					
							SCALE: 1/4" = 1'-0"					
0	RELEASE FOR FABRICATION	12/2/2010	CB	RLJ	SCJ		PROJECT 900216	CODE W3T155615	DRAWING 9002164073	SHEET 1 OF 1	REV 0	
REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN	<p><b>WestTech</b> MICROFLOC/General Filter Products Ames, IA 515-268-8400</p>					

BILL OF MATERIAL					
PIECE	UNIT QTY	PART NO	DESCRIPTION	MATERIAL	TOTAL WT, LB
10	1	1-17408	AERATOR ASSEMBLY, INDUCED DRAFT, 120 SQ, 120 HIGH, SF, 0.900, PE		4180.1
20	2	1-9240	BLOWER, ID-244L, 230V, 3PH, 60HZ, 0.5HP, W/RAINHOOD, CW		231.4
30	74	2-8996	BOLT, TAP, 0.25-20UNC x 1	304	1.5
40	58	2-9028	WSHR, BOND SEALING, 0.25	18-8	0.2
50	2	1-11981	HOOD, INTAKE ID, SCREENED, BOLTED, 12 x 93		53.2
60	4	2-16476	ADHESIVE, SEALANT, 12.9FL OZ CARTRIDGE, BLUE	SILICONE	3.0

APPROX. OPERATING WEIGHT: 14250 LB



- NOTES:**
- AERATOR IS SHIPPED FULLY ASSEMBLED EXCEPT FOR SOME AIR HANDLING EQUIPMENT. REFER TO BILL OF MATERIAL FOR IDENTIFICATION OF FIELD ASSEMBLED ITEMS.
  - ALL AERATOR PLATE IS TO BE 3003 ALUMINUM. STRUCTURALS TO BE 6061 ALUMINUM.
  - THE AERATOR SHALL BE WELDED INSIDE AND OUTSIDE WITH FILLET WELDS EQUAL TO THE THICKNESS OF THE PLATES. ALL MAIN HOUSING SEAM WELDS SHALL BE DYE PENETRANT CHECKED AT THE FACTORY BEFORE SHIPMENT TO ENSURE THEY ARE WATERTIGHT.
  - THE MAXIMUM ANCHOR BOLT DIAMETER IS 7/8". THE MINIMUM WASHER DIAMETER IS 2" FOR ALL ANCHOR SIZES. ANCHORAGE IS BY OTHERS.
  - FLANGE BOLT HOLE PATTERN IS TO STRADDLE UNIT CENTERLINE.
  - AERATOR INLET AND EFFLUENT PIPE STUBS ARE NOT DESIGNED TO SUPPORT INLET AND EFFLUENT PIPING. ADDITIONAL PIPE SUPPORTS SHOULD BE USED BUT WILL BE SUPPLIED BY OTHERS.
  - INFLUENT AND EFFLUENT PIPE MOUNTING HARDWARE AND GASKETS ARE PROVIDED BY OTHERS.
  - IF INSTALLATION INSTRUCTIONS ARE NOT CLEARLY UNDERSTOOD, CONSULT WESTECH FOR ADDITIONAL INFORMATION BEFORE COMMENCING ERECTION.
  - IMPROPER STORAGE, HANDLING, INSTALLATION, OR FIELD MODIFICATIONS OF EQUIPMENT MAY RESULT IN DAMAGE AND LOSS OF WARRANTY PROTECTION.
  - THE BLOWER MOTOR MUST BE WIRED CORRECTLY TO THE VOLTAGE LISTED ON THE UNIT.
  - REMOVE THE DRAIN PLUG ON THE BLOWER CONDENSATION DRAIN BEFORE START UP.

BACKCHARGES FOR FIELDWORK OF ANY KIND ARE NOT ACCEPTABLE WITHOUT PRIOR WRITTEN AUTHORIZATION BY WESTECH ENGINEERING, INC.

**WestTech**

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TITLE **AIDA, 120 SQ, 120, SF 6 VC, 0.900, PE, 2500 GPM 7500 SCFM**

DESIGNER	CHECKER	APPROVER	DATE
MO96	SH40	JA20	2015-05-27

DOCUMENT NUMBER		SHEET	REV
1-18323		1 OF 1	A

REV	REVISION DESCRIPTION	ECN	DESIGNER	APPROVER	DATE
A	UPDATED TO QUICK RELEASE SCREEN DESIGN	3274	RE59	RE59	2019-09-26

REFERENCE DOCUMENTS



General Filter

# Aerators

Aeration and Gas Stripping

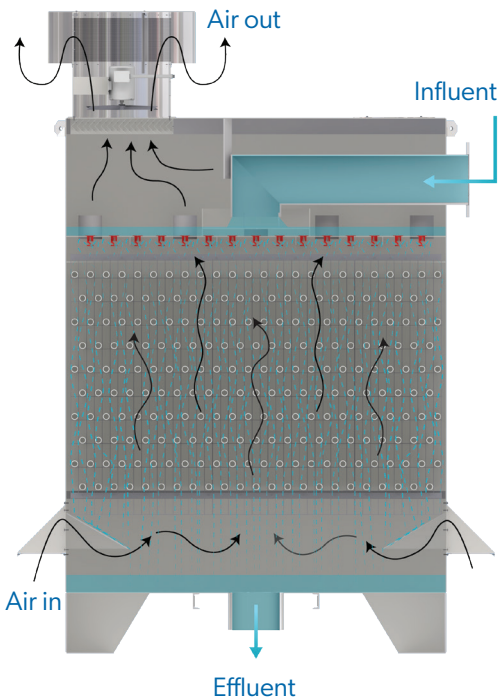


**WESTECH<sup>®</sup>**

# Aeration Experts

General Filter products and processes have treated water supplies since 1935. Now part of the WesTech product line, General Filter continues to be a leader in the design and manufacture of many of today's proven treatment technologies. With over 1,000 installations, aeration technologies are prominent among those many innovations.

WesTech provides all types of aerator systems – from pressure aerators and cascade aerators to positive draft designs. Our aeration manufacturing material has evolved from redwood to steel to fiberglass and finally aluminum. The General Filter maintenance-free aluminum designs that are offered today incorporate all of the advancements that have been made since initial product development.



**Induced Draft Aerator  
Process Flow Diagram**

**Positive Draft Aeration** is an effective, inexpensive, and low-maintenance method of improving finished water quality for a large number of applications. Dissolved solids such as iron and manganese are transformed to their oxidized states, enabling them to be removed by downstream clarification and filtration equipment. In addition, the aeration process can remove objectionable taste and odors and reduce the chemical requirements of lime softening.

Positive Draft Aerator systems introduce air and efficiently disperse water in a countercurrent flow to ensure the most effective contact. WesTech aerators contain many features of operation and construction not available in competitive models. The primary advantage General Filter Positive Draft Aerators offer is a unique gravity distributor tray that is specifically designed for each application. Because it is gravity fed, not pressurized, there is significant operational cost savings for the water plant over the life of the system. In addition, custom-designed trays allow for efficient and consistent operation over a wide range of flows. Neither of these advantages can be realized using a pressurized spray header distribution method.

# Positive Draft Aeration

## Induced Draft Aerators

Induced Draft Aerators are most often used for the oxidation of iron from groundwater sources, enabling the oxidized iron to be removed by downstream clarification and filtration equipment. The aerator can also remove some unwanted dissolved gasses like CO<sub>2</sub>, stabilizing the pH of the water and reducing the chemical requirements for lime softening and post reverse osmosis filtration.

Induced Draft Aerators utilize an axial flow blower mounted on the top of the unit to pull air into screened air inlet hoods located on the lower side of the aerator housing. This blower creates a negative pressure in the top portion of the aerator housing above the distributor box by drawing the air out of the unit.



## Forced Draft Aerators

Forced Draft Aerators are best applied to high gas removal needs such as methane, hydrogen sulfide, CO<sub>2</sub>, and disinfection byproduct (DBP). Gas removal is accomplished by water cascading over internal tray slats or random packed loose filled media. Forced Draft Aerators utilize a non-overloading, belt-driven blower located near the lower side of the aerator housing.

### Aluminum Induced and Forced Draft Aerator Selection

#### Induced Draft Aerator Applications

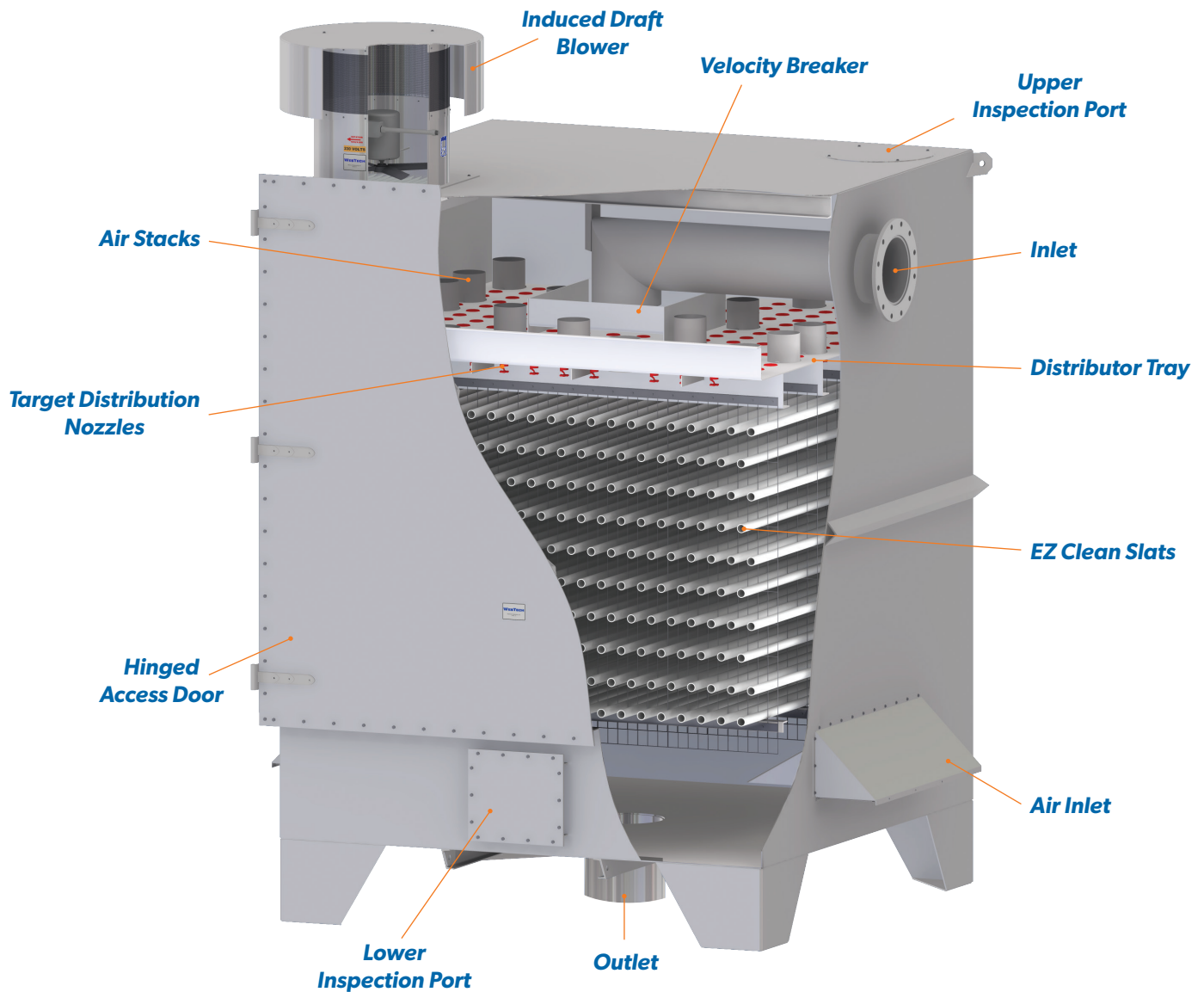
- Iron Oxidation
- CO<sub>2</sub> Reduction
- Radon Reduction
- THM Reduction

#### Forced Draft Aerator Applications

- VOC Stripping
- Hydrogen Sulfide Reduction
- CO<sub>2</sub> Reduction
- Radon Reduction
- THM Reduction

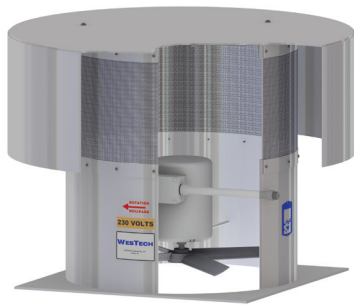
UNIT CAPACITY GPM	UNIT SIZE X 10' HIGH	BLOWER CAPACITY (SCFM)	INLET WATER CONN. SIZE	EFF. WATER CONN. SIZE
65 – 100	24" x 24"	300	3"	4"
105 – 155	30" x 30"	469	4"	4"
160 – 225	36" x 36"	675	4"	6"
230 – 305	42" x 42"	919	6"	6"
310 – 400	48" x 48"	1,200	6"	8"
405 – 505	54" x 54"	1,519	6"	8"
510 – 625	60" x 60"	1,875	8"	8"
630 – 755	66" x 66"	2,269	8"	10"
760 – 900	72" x 72"	2,700	8"	10"
905 – 1,055	78" x 78"	3,169	10"	12"
1,060 – 1,225	84" x 84"	3,675	10"	12"
1,230 – 1,600	96" x 96"	4,800	12"	14"
1,605 – 2,025	108" x 108"	6,075	12"	16"
2,030 – 2,500	120" x 120"	7,500	14"	18"
2,505 – 3,025	132" x 132"	9,075	16"	20"
3,030 – 3,600	144" x 144"	10,800	16"	24"

# Induced Draft Aerator



## Aerator Housing

The corrosion-resistant, all-aluminum housing provides a chamber for the countercurrent flow of water and air. Standard housings are available for capacities ranging from 65 to 3,600 gpm. Larger custom sizes are also available. A hinged and bolted removable side is furnished for internal access. All aerators have a media inspection port. Inlet and exhaust air ducts are screened and baffled to prevent water loss and debris entrance. The moisture separator at the top of the aerator unit provides multiple changes in air direction for minimal moisture carryover.



## Aerator Materials

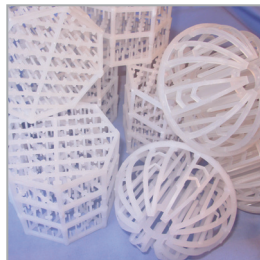
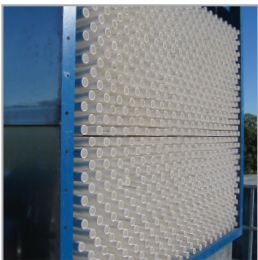
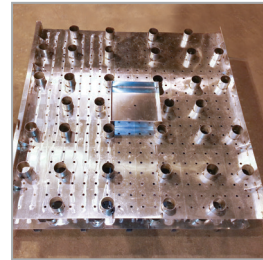
Component	Standard	Common Options
Housing	Aluminum	Stainless Steel
Distributor Tray	Aluminum	Stainless Steel
Media	PVC Slats	Loose Fill
Blower	Induced Draft, Permanently Sealed	Forced Draft, Explosion-Proof
Design Shape	Square	Round or Rectangular

## Blower Motor

An induced draft blower of exceptional quality eliminates the need to access the only moving mechanical part of an aerator. It is designed to run maintenance-free for long, reliable service. The blower housing is aluminum for corrosion resistance. The blades are cast aluminum and balanced for smooth operation. The motor includes sealed bearings and a motor shaft that is made of wear-resistant stainless steel. No other aerator blower is as dependable, durable, or maintenance-free.

## Distributor Tray and Nozzles

The distributor tray assures that dispersed water reaches every corner of the aerator evenly. The aluminum construction results in corrosion-resistance and long life. Integral target distribution nozzles provide even water droplet distribution in the aeration zone. The low headloss distributor tray reduces pumping costs and decreases the head requirement of the system.

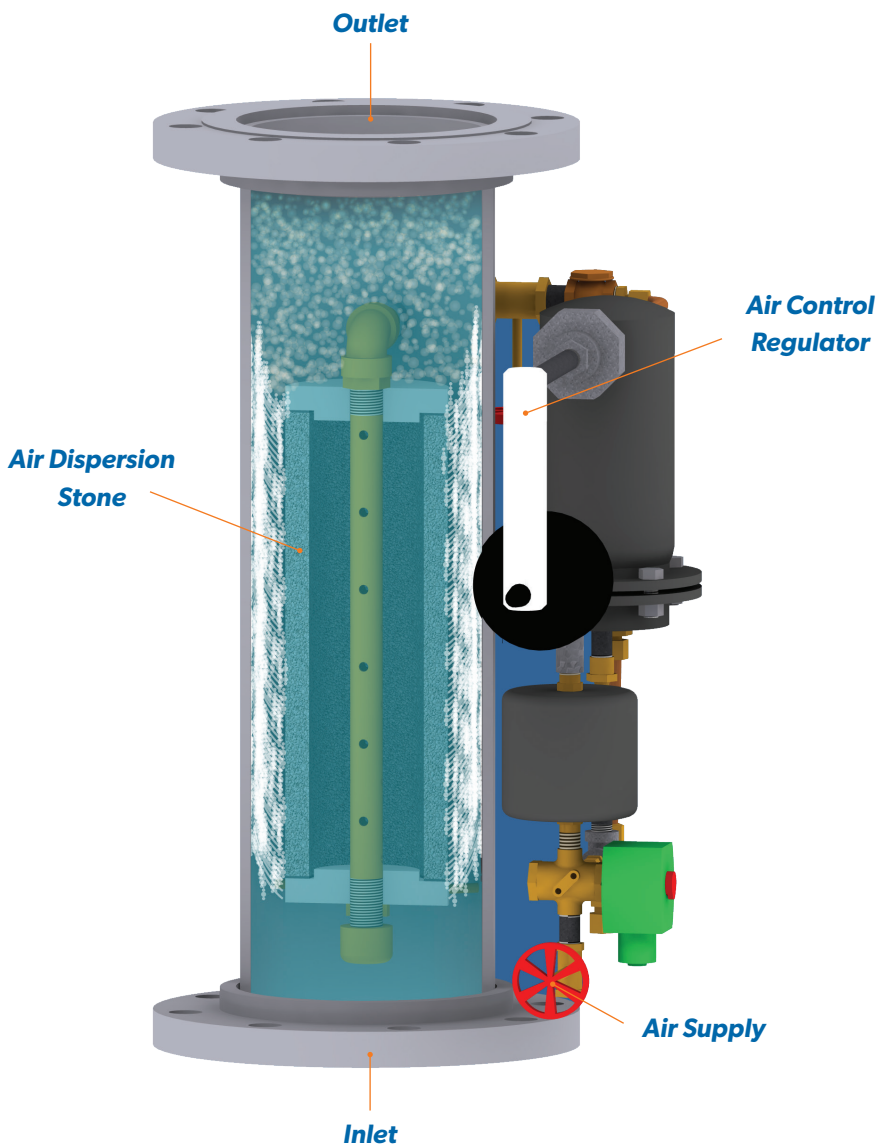


## EZ Clean Slats or Loose Fill

EZ Clean Slats continually break up water into droplets for better mass transfer. They can be individually removed for periodic cleaning, unlike mesh or red-wood trays which require replacement. These efficient, round PVC slats are designed to handle high loadings. Loose fill internals are available for high gas removal efficiency.

# ATOMERATOR™ Pressure Aeration

ATOMERATOR Pressure Aerators force finely diffused air into a stream of moving water under pressure in a manner that ensures intimate contact between the air and all particles dispersed in the water. They are ideal for oxidation of iron which can then be removed by filtration in a pressure filter system. The ATOMERATOR unit eliminates the need for a chemical oxidant. ATOMERATOR Pressure Aerators effectively treat groundwater for iron removal within the proper design criteria. Pilot treatment units are available for onsite process verification.



## Features

- A means of pressure aeration for iron oxidation
- Treatment of 40 to 1,000 gpm per unit
- Completely enclosed treatment unit
- Single pump operation

## Cascade Aerator

Cascade Aerators work by natural air draft. Water flows from the top of the unit, splashing off of the cascading trays, exposing water droplets to air naturally flowing past the unit. Cascade Aerators have no moving parts, require no electricity, and are maintenance-free.

Cascade Aerators are best applied for oxidation of iron by addition of oxygen followed by detention and filtration. They are Ideal for iron concentrations above 10 ppm as the open structure eliminates fouling due to iron precipitation. They can also be applied to increase dissolved oxygen at the end of wastewater plants.



## AERALATER® Packaged Iron and Manganese Removal

The AERALATER self-contained treatment plant combines aeration, detention, and filtration in a single unitized package to minimize the footprint of the water treatment system. It provides economical and dependable performance in treating groundwater supplies containing iron, manganese, carbon dioxide, hydrogen sulfide, radon, VOC, arsenic, taste, and odor.

## Pilot Plant

Several pilot plants are available to test different water sources. A pilot plant can easily and economically fine-tune the aerator design. Useful for evaluating aerator performance factors for special applications, it may also be used to verify the conclusions of a predictive model. It can also be combined with other pilot processes to simulate a full treatment system.





General Filter

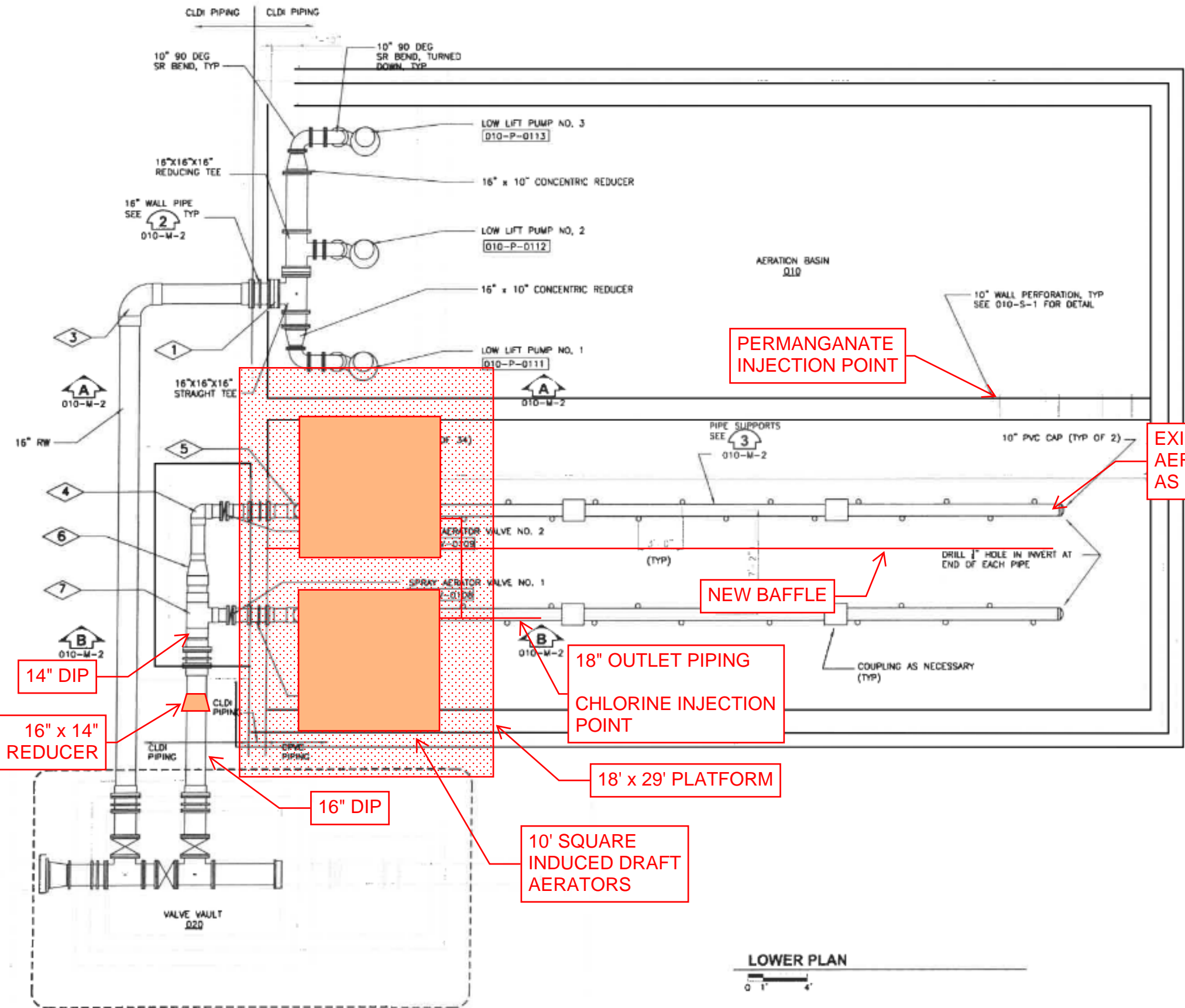


Represented by:

**WESTECH**® Tel: 801.265.1000  
westech-inc.com  
info@westech-inc.com  
Salt Lake City, Utah, USA

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**APPENDIX C – PRELIMINARY LAYOUT FOR WTP MODIFICATIONS**



PERMANGANATE INJECTION POINT

EXISTING SPRAY AERATOR TO UTILIZE AS BYPASS

NEW BAFFLE

14" DIP

16" x 14" REDUCER

16" DIP

18" OUTLET PIPING  
CHLORINE INJECTION POINT

18' x 29' PLATFORM

10' SQUARE INDUCED DRAFT AERATORS

LOWER PLAN

0 1' 4'

FOR REMOVAL AND DETAILS SEE DRAWING NO. 020-SM-1

	<p>INDUCED DRAFT AERATOR PRELIMINARY LAYOUT</p>
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# PERMANGANATE FEED SYSTEM SIZING

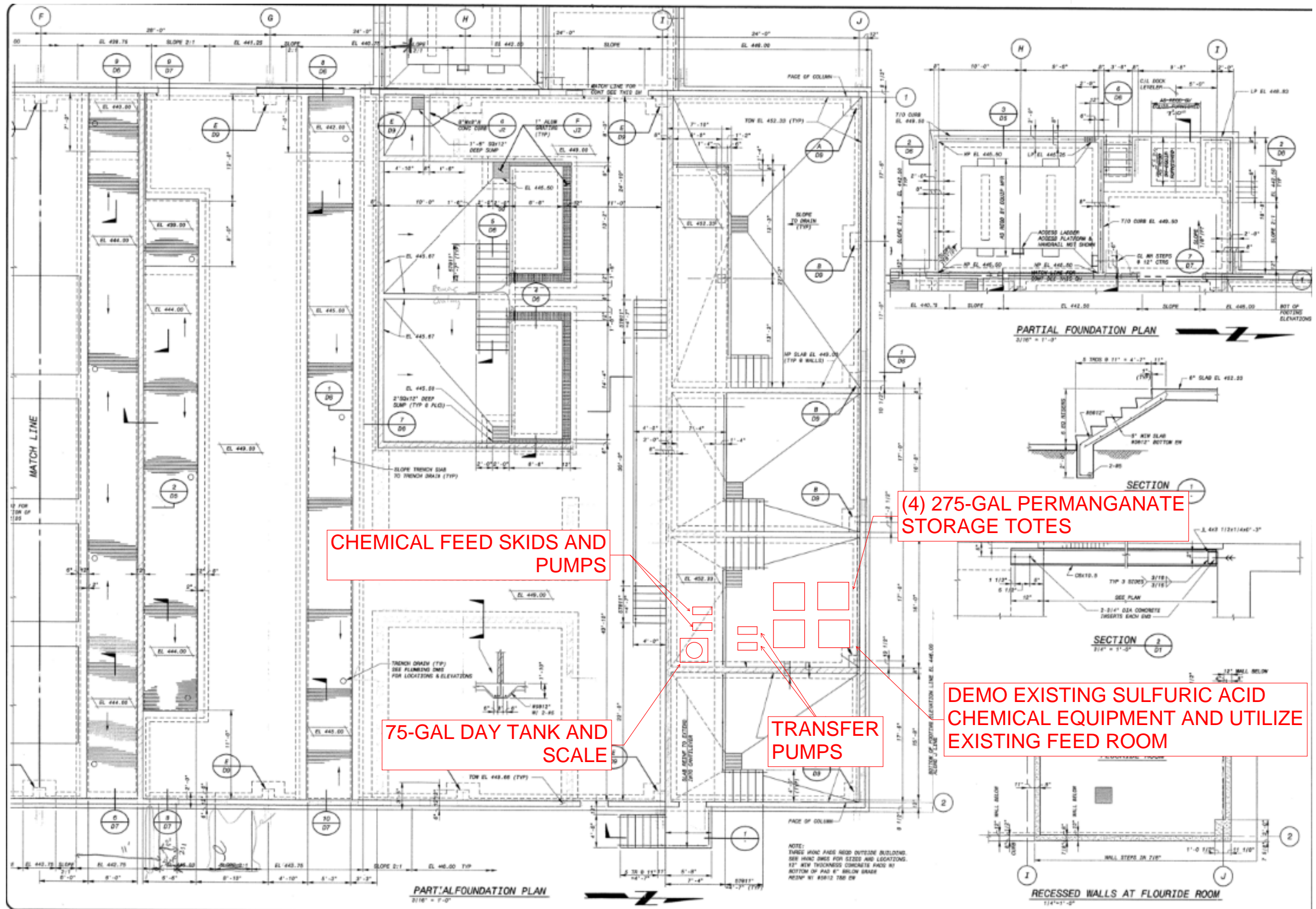


Client: City of O'Fallon, MO  
 Project: WTP Pre-Oxidation and Filter Evaluation  
 Project No.: 110690  
 Calculation: Permanganate Feed System

Permanganate Feed System			
Parameter	Units	Total Plant	Total Plant
General Information			
Chemical	---	Sodium Permanganate	Sodium Permanganate
Solution Concentration	%wt	20.0	40.0
Specific Gravity	---	1.16	1.38
Solution Density	lb/gal	9.7	11.5
Maximum Design Flow	MGD	6.0	6.0
Average Design Flow	MGD	3.0	3.0
Minimum Design Flow	MGD	2.0	2.0
Maximum Design Chemical Dose	mg/L	9.93	9.93
Average Design Chemical Dose	mg/L	1.38	1.38
Minimum Design Chemical Dose	mg/L	1.04	1.04
Maximum Solution Dose <sup>2</sup>	gpd	257	108
	lb/d soln	2,484	1,242
	lb/d chem	497	497
Average Solution Dose <sup>1</sup>	gpd	18	8
	lb/d soln	173	86
	lb/d chem	35	35
Minimum Solution Dose <sup>3</sup>	gpd	9	4
	lb/d soln	86	43
	lb/d chem	17.3	17.3
Storage Design Dose <sup>4</sup>	gpd	36	15
	lb/d soln	346	173
	lb/d chem	69	69
Storage			
30-day Storage Volume <sup>5</sup>	gal	1,073	451
	lb solution	10,376	5,188
	lb chem	2,075	2,075
10-day Storage Volume <sup>5</sup>	gal	358	150
	lb solution	3,459	1,729
	lb chem	692	692
Storage Type	---	Tote	Tote
Volume per Storage Container	lb	275	275
Number of Storage Containers	---	4	2
Total Storage Volume	lb	1,073	451
Containment Type	---	Sump	Sump
24-hour Storage Volume	gal	36	15
30-hour Storage Volume	gal	45	19
Volume per Solution Tank	gal	75	75
Number of Solution Tanks	gal	1	1
Total Solution Tank Volume	gal	75	75

**Notes:**

- 1 Calculated using the average chemical dose and average daily flow.
- 2 Calculated using the maximum chemical dose and maximum flow.
- 3 Calculated using the minimum chemical dose and minimum flow.
- 4 Calculated using the average chemical dose and maximum flow.
- 5 Calculated based on the Storage Design Dose.



CHEMICAL FEED SKIDS AND PUMPS

75-GAL DAY TANK AND SCALE

TRANSFER PUMPS

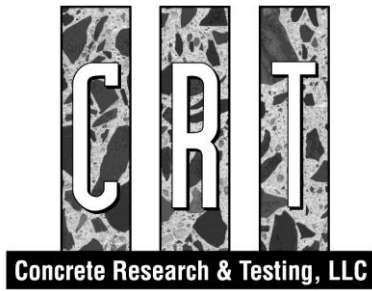
(4) 275-GAL PERMANGANATE STORAGE TOTES

DEMO EXISTING SULFURIC ACID CHEMICAL EQUIPMENT AND UTILIZE EXISTING FEED ROOM

	<p>PERMANGANATE SYSTEM PRELIMINARY LAYOUT</p>
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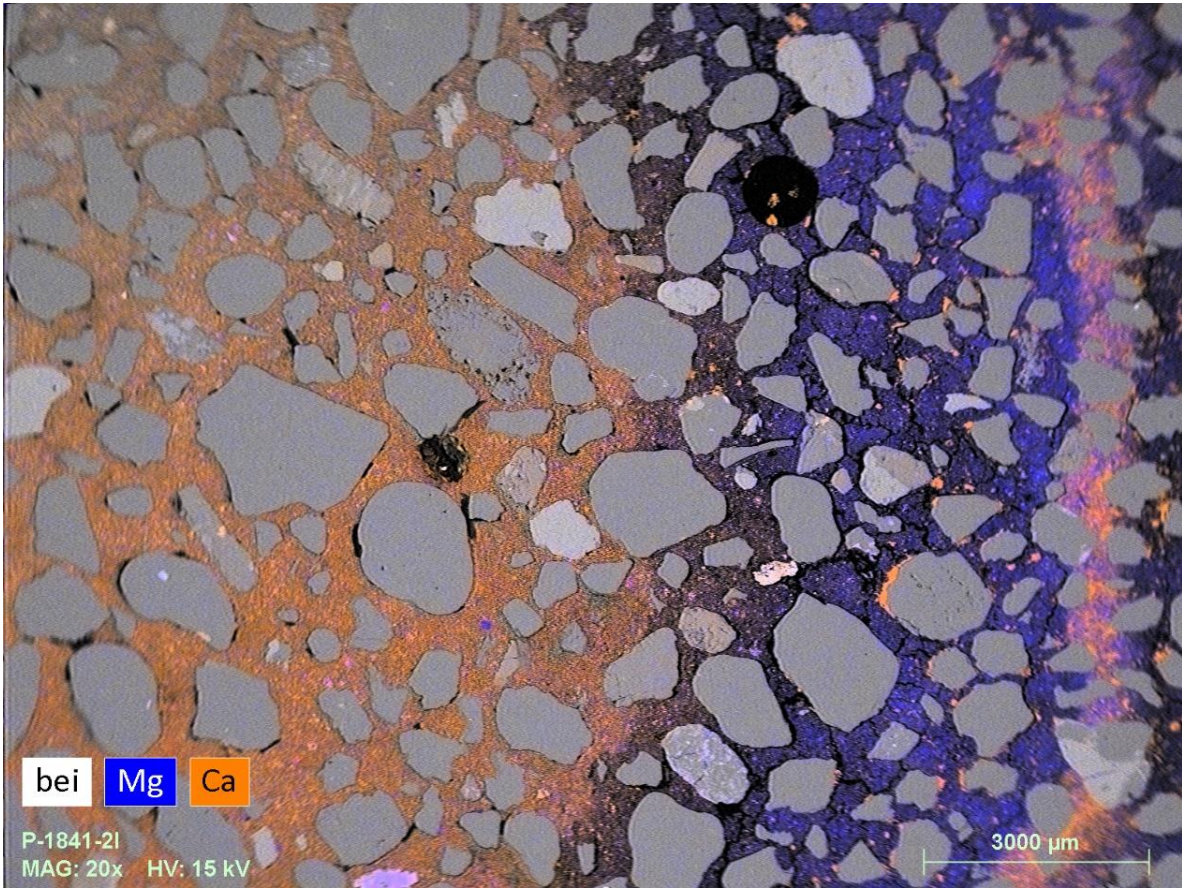
## **APPENDIX D – CONCRETE AND RESEARCH TESTING**



**CRT Report No. P-1841**

**Petrographic Examination of a Grout Sample Removed  
Water Treatment Plant Filter #2 in O'Fallon, Missouri**

**February 9, 2023**



**Prepared for: City of O'Fallon, Missouri  
Client Project No. 22-110**

## **INTRODUCTION**

One grout sample was received from Jason Dennis with the City of O'Fallon, Missouri, on January 4, 2023. The sample was removed from filter #2 at the O'Fallon Water Treatment Plant located at 321 Firma Road in O'Fallon. The grout was placed ca. 2015 to 2016.

The filters consist of 300 ft<sup>3</sup> stainless steel tanks with fiber-reinforced polymer underdrains. A diagram of the filter is shown in Figure 1 of the Appendix, and site photographs of Filter #2 are shown in Figure 2. The diagram and photos were provided by the City of O'Fallon.

The grout is present in horizontal placements below the underdrains and as vertical placements between the individual underdrain components. In November of 2022, failure in the form of heaving underdrains was observed. The received sample represents grout from a vertical placement.

Concrete Research & Testing (CRT) was requested by the City of O'Fallon to perform a petrographic examination on the grout to characterize the quality and condition of the grout and to determine the cause of the grout failure.

## **SAMPLE DESCRIPTION**

The sample has dimensions of 3.6 to 4.0 in. by 2.0 to 2.9 in. by 0.6 in. thick. The large surfaces of the sample are the formed side surfaces. These surfaces are partially deteriorated. The sides of the sample are fractured surfaces. The sample exhibits a full-depth crack oriented perpendicular to the formed surfaces. Photographs of the sample in the as-received condition are shown in Figure 3.

## **EXAMINATION AND TEST METHODS**

A preliminary stereomicroscopic examination was performed on the sample. Epoxy was applied to portions of the sample to protect and preserve features of the near-surface mortar during the specimen preparation.

The sample was prepared for petrographic examination. Two parallel saw-cuts were made to obtain a ~0.5 in.-thick section from the center of the sample. The saw-cut section was then prepared for microscopic examination by lapping on a steel wheel with progressively-finer diamond and silicon carbide abrasives.

The depth of carbonation was measured on the sample following the exposure of a freshly saw-cut surface to phenolphthalein solution.

The lapped surface of the section was examined under a stereomicroscope having a magnification range of 3.5X to 220X. Visual and microscopic examinations were also performed on fresh fractured surfaces of the sample. The examinations were performed following the relevant guidelines outlined in ASTM C856, “Standard Practice for Petrographic Examination of Hardened Grout.”

The water-cement ratio (w/c) of the grout was estimated based on observations and qualitative assessments of the cement paste, including hardness, textural features, color, abundance of residual cement particles and rate of water absorption. The hardness is determined by probing the cement paste with a sharpened metal tool.

A polished section of the grout and secondary deposits from within the crack were prepared for chemical analysis. The prepared samples were carbon coated and examined using a Scanning Electron Microscope (SEM) with Energy Dispersive X-Ray Spectroscopy (EDS) capability. The EDS analyzer provides a semi-quantitative elemental chemical analysis of the material examined. The elemental data are converted to oxides by assuming stoichiometric cation/oxygen ratios. The SEM/EDS analyses were performed following the relevant guidelines of ASTM C1723 “Standard Guide for Examination of Hardened Concrete Using Scanning Electron Microscopy.”

## **EXAMINATION AND TEST RESULTS**

Photographs of the lapped surfaces of the section prepared from the sample are presented in Figure 4.

**Aggregate** – The grout contains a natural sand fine aggregate with a maximum particle size of 1.4 mm. The sand is comprised primarily of quartz particles. The sand also contains small amounts of feldspar, chert, and limonite particles; minor amounts of igneous/metamorphic rock, magnetite, and pyroxene/amphibole particles; and trace amounts of coal particles.

The sand is judged to be good quality and is uniformly distributed throughout the examined sample.

**Cement Paste** – The cement paste of the examined grout consists of well-hydrated portland cement. The cement paste in the examined grout is judged to be good quality with a water-cement ratio (w/c) estimated to be in the range of 0.48 to 0.53.

**Air Voids/Consolidation** – The grout represented by the examined sample is non air-entrained and well consolidated with an estimated total air void content of less than 1 percent.

**Chemical Attack** – The near-surface cement paste in the grout exhibits evidence of severe chemical attack. The cement paste exhibiting chemical attack is very weak and highly absorptive. The affected cement paste extends to depths of 4 to 5 mm at the fractured ends of the sample (see Figure 5). The chemical attack has affected only portions of the formed surfaces. Where present the chemical attack extends to depths of 0.5 to 2.0 mm (see Figure 5).

SEM/EDS analyses were performed on a polished sample of the unaffected and attacked cement paste. Representative SEM/EDS analyses of the cement paste are shown in Figure 6 and Figure 7. The weakened cement paste near the fractured surface is depleted in calcium and enriched in magnesium relative to the unaffected, sound cement paste in the middle of the sample. Elemental mapping images illustrating the depleted calcium and enriched magnesium are shown in Figure 8.

**Cracking** – A full depth crack extends between the two formed surfaces in the sample. The crack has a uniform width of 0.2 mm and contains white, crystalline secondary deposits. Photomicrographs of the crack in the as-received sample are shown in Figure 9.

**Secondary Deposits** – White, crystalline secondary deposits are present within the full depth crack (see Figure 9). The deposits were identified as ettringite by SEM/EDS analysis. The data from the analysis are presented in Figure 10.

**Carbonation** – Carbonation testing was performed on a freshly saw-cut surface of the sample (see Figure 4). The cement paste at the deteriorated side surfaces is fully carbonated to depths of 3 to 5 mm and lightly carbonated to depths of 9 to 10 mm. Minor areas at one of the large formed surfaces exhibits shallow carbonation to a maximum depth of 1.5 mm. The other large formed surface is fully carbonated to typical depths of 3 mm or less and lightly carbonated to depths of up to 5.5 mm.

## **SUMMARY AND CONCLUSIONS**

A petrographic examination was performed on a grout sample removed from Filter #2 at the Water Treatment Plant located in O'Fallon, Missouri. The examination was performed to characterize the quality and condition of the grout and to determine the cause of the material failure.

### **General Quality of the As-Placed Grout**

The grout contains a natural sand fine aggregate that is uniformly distributed throughout the examined sample and is judged to be good quality.

The cement paste of the examined sample is judged to be good quality with an estimated water-cement ratio in the range of 0.48 to 0.53.

The grout is well consolidated and is judged to be non-air entrained with an estimated total air void content of less than 1 percent.

### **Condition of the Grout**

The edges of the grout sample exhibit severe deterioration which is worse at the fractured end surfaces relative to the formed surfaces (see Figure 5).

### **Cause of the Grout Deterioration**

The deterioration of the grout is related to the chemical attack of the cement paste. The chemical attack has caused a very significant weakening of the affected cement paste.

The SEM/EDS analyses on the affected and unaffected cement paste show that the chemical attack is related to exposure to magnesium within the tank water (see Figure 6 through Figure 8). It appears

that water is penetrating into the grout through vertical cracks within the grout. In some areas the water is also penetrating between the filters and the formed surfaces of the grout.

### **Magnesium Attack**

It is well known that magnesium-based solutions can cause chemical attack of portland cement concrete. When portland cement undergoes hydration, the major reaction product is calcium silicate hydrate. Calcium silicate hydrate is the primary compound in the cement paste responsible for the strength of portland cement concrete. The cement paste in concrete exposed to magnesium-based solutions undergoes decalcification during which magnesium reacts with the calcium silicate hydrate to form magnesium silicate hydrate. The formation of magnesium silicate hydrate in place of calcium silicate hydrate significantly weakens the affected cement paste.

### **Recommendations**

Assuming the water chemistry of the tank does not change, it is recommended that the portland cement grout be replaced with a sanded polymer grout product or a chemical resistant cementitious grout product.



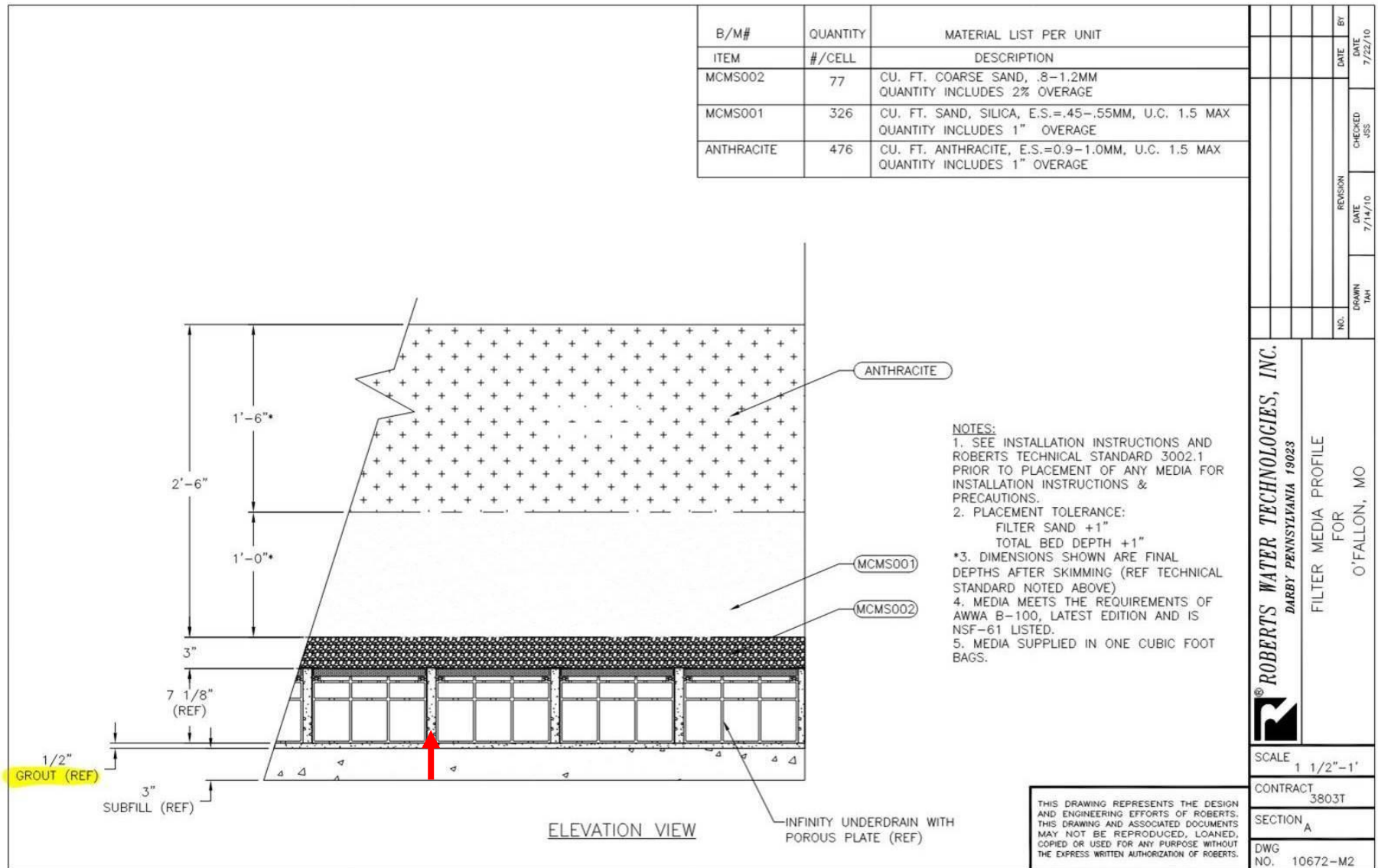
Trisha Piercey, Petrographer  
Grout Research & Testing, LLC



Nick Scaglione, President & Petrographer  
Grout Research & Testing, LLC

- *All samples will be discarded 1 month after the report issue date unless otherwise requested.*

# APPENDIX



**Figure 1. Diagram showing the layout Filter #2. The diagram was provided by The City of O’Fallon. The red arrow shows an example of the vertical grout placement.**

# APPENDIX



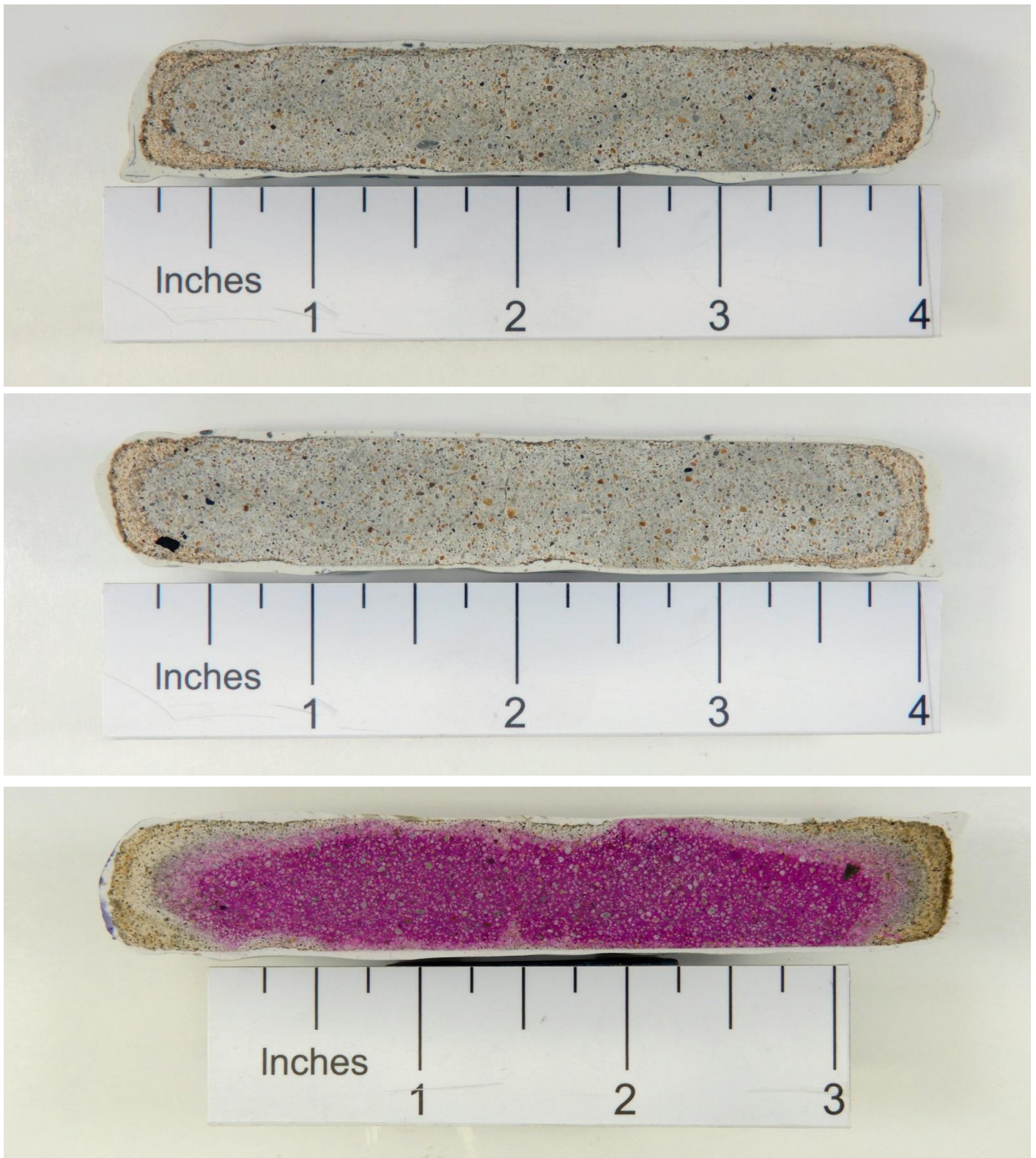
**Figure 2. Site photograph showing the interior of Filter #2. The photo was provided by The City of O'Fallon. Pieces of failed grout material can be seen in the photo.**

# APPENDIX



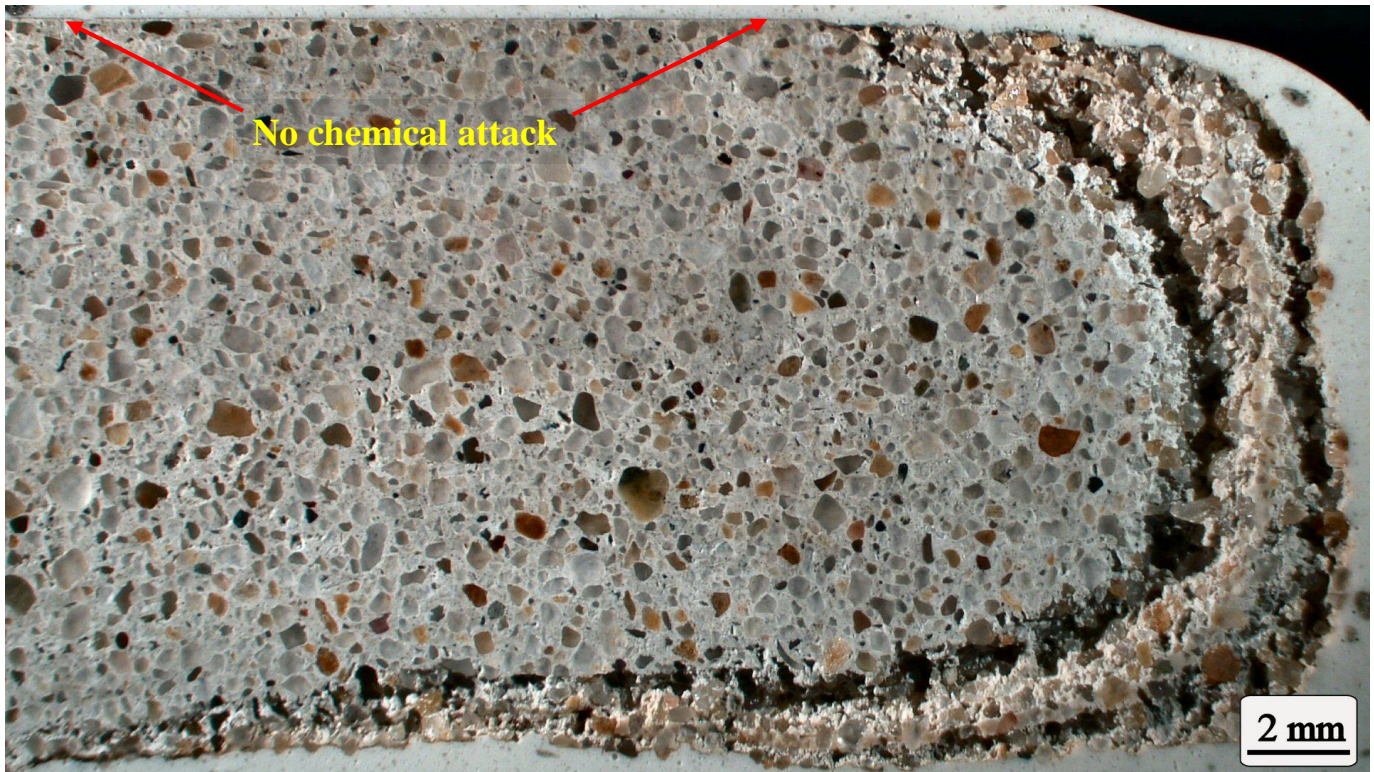
**Figure 3. Photographs showing the grout sample in the as-received condition.**

# APPENDIX



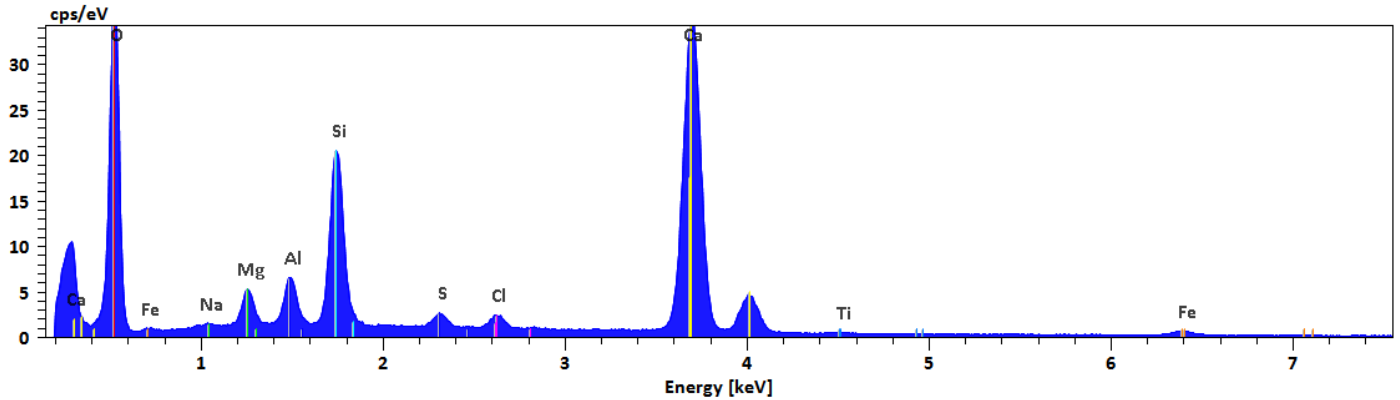
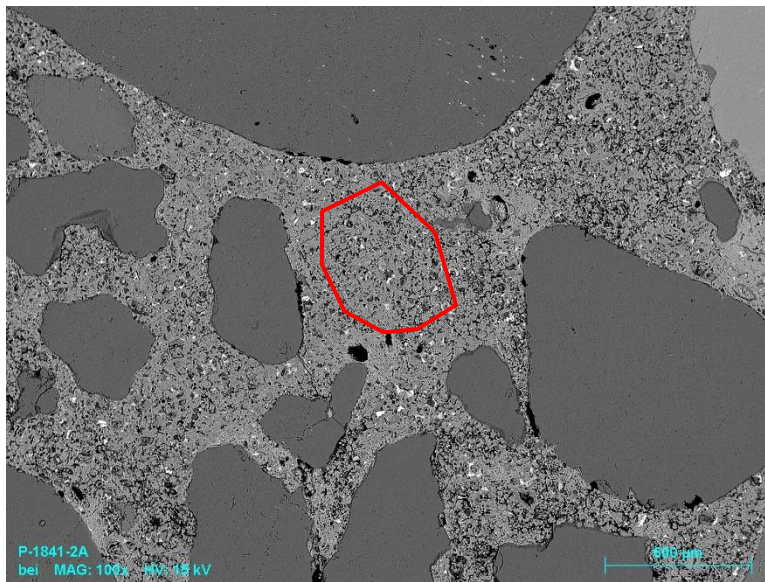
**Figure 4.** Photographs showing the lapped surfaces of the section prepared from the sample (upper photos) and a saw cut surface following the application of phenolphthalein solution (lower photo). The areas not colored pink are carbonated.

# APPENDIX



**Figure 5.** Cross-section photomicrographs of the grout showing the chemically attacked cement paste near the edges of the sample. Portions of the cement paste were lost during specimen preparation due to the weak nature of the material. Portions of the formed surface do not exhibit chemical attack.

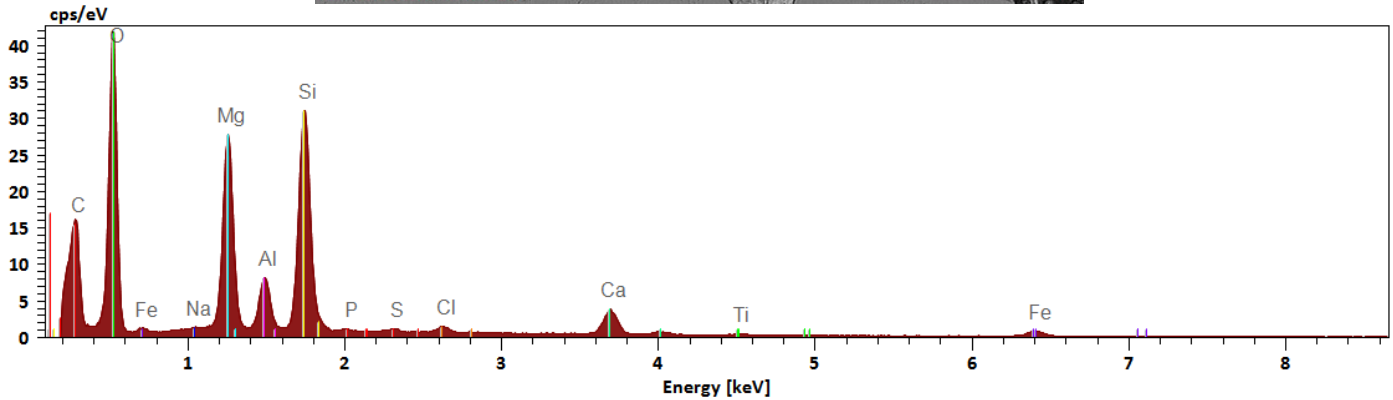
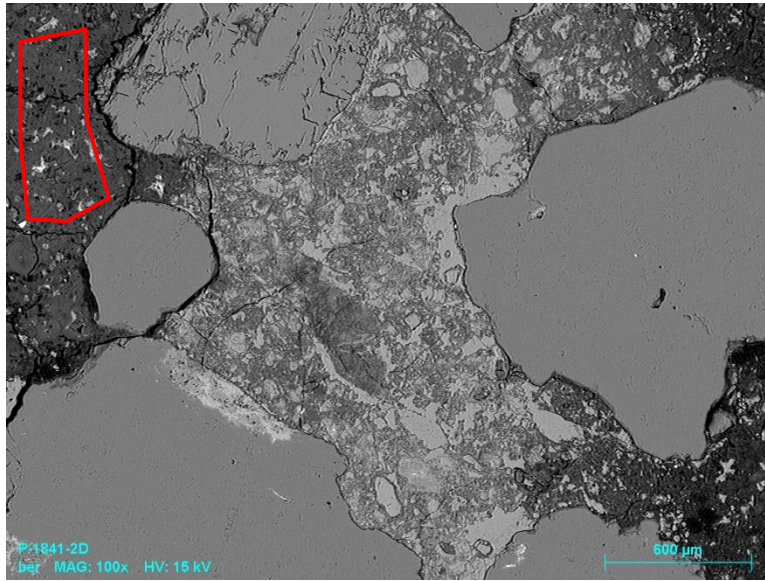
# APPENDIX



Element	Weight, %	Compound	Compound Weight, %
Ca	43.70	CaO	<b>61.15</b>
Si	10.66	SiO <sub>2</sub>	22.81
Al	2.69	Al <sub>2</sub> O <sub>3</sub>	5.08
Mg	2.08	MgO	<b>3.45</b>
Fe	2.24	Fe <sub>2</sub> O <sub>3</sub>	3.20
S	0.96	SO <sub>3</sub>	2.36
Ti	0.25	TiO <sub>2</sub>	0.42
Na	0.31	Na <sub>2</sub> O	0.42
Cl	1.08	Cl <sup>-</sup>	1.08
O	36.03	—	—
<b>Total</b>	<b>100.00</b>		<b>100.00</b>

**Figure 6. Representative SEM/EDS analysis of the unaffected cement paste in the grout. The analysis confirmed the material to be hydrated portland cement. The polygon in the upper backscatter-electron image represents the area analyzed. Note the calcium oxide and magnesium oxide contents (shown in bold type).**

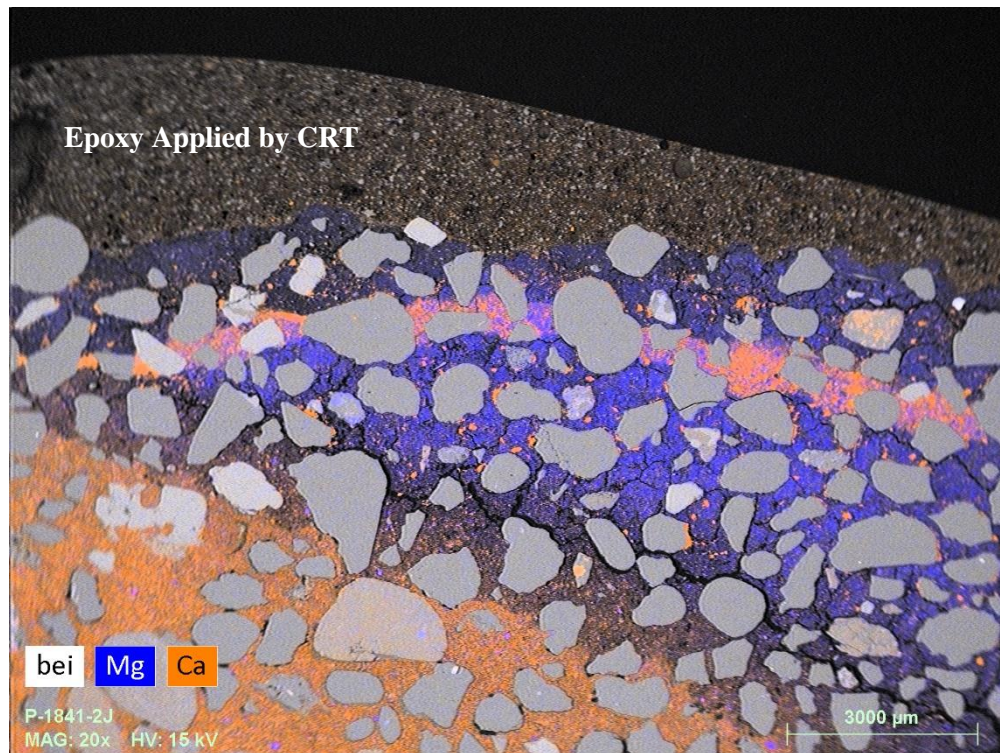
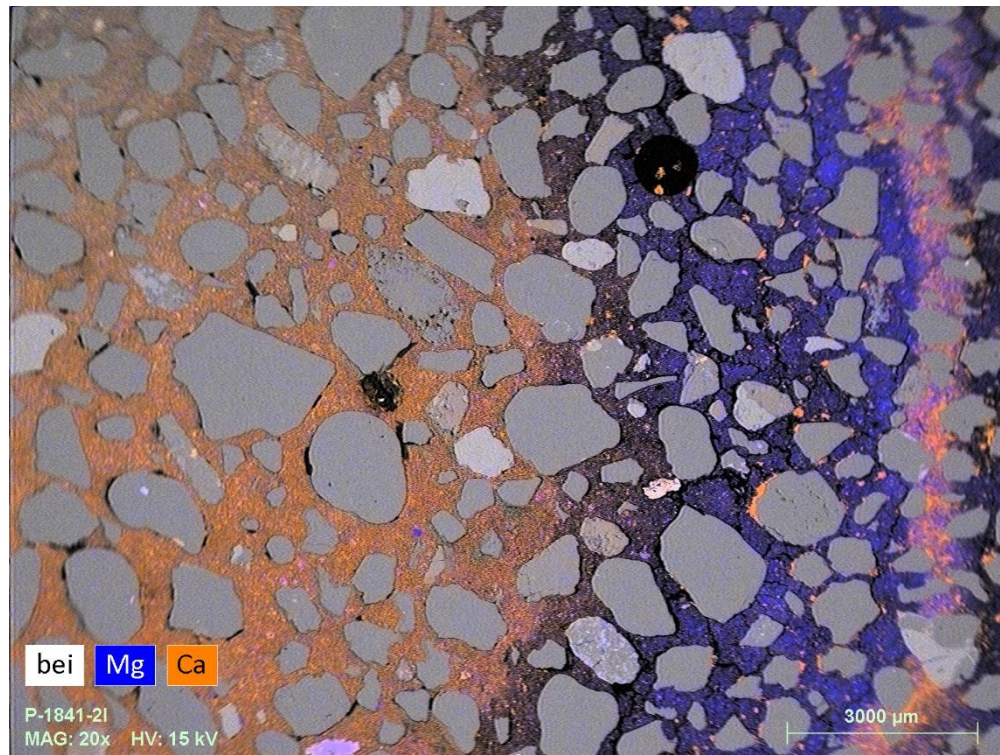
# APPENDIX



Element	Weight, %	Compound	Compound Weight, %
Ca	5.08	CaO	<b>7.10</b>
Si	22.13	SiO <sub>2</sub>	47.35
Al	5.16	Al <sub>2</sub> O <sub>3</sub>	9.75
Mg	16.68	MgO	<b>27.66</b>
Fe	3.92	Fe <sub>2</sub> O <sub>3</sub>	5.61
S	0.18	SO <sub>3</sub>	0.45
Ti	0.37	TiO <sub>2</sub>	0.62
Na	0.46	Na <sub>2</sub> O	0.62
P	0.13	P <sub>2</sub> O <sub>5</sub>	0.30
Cl	0.54	Cl <sup>-</sup>	0.54
O	43.35	—	—
<b>Total</b>	<b>100.00</b>		<b>100.00</b>

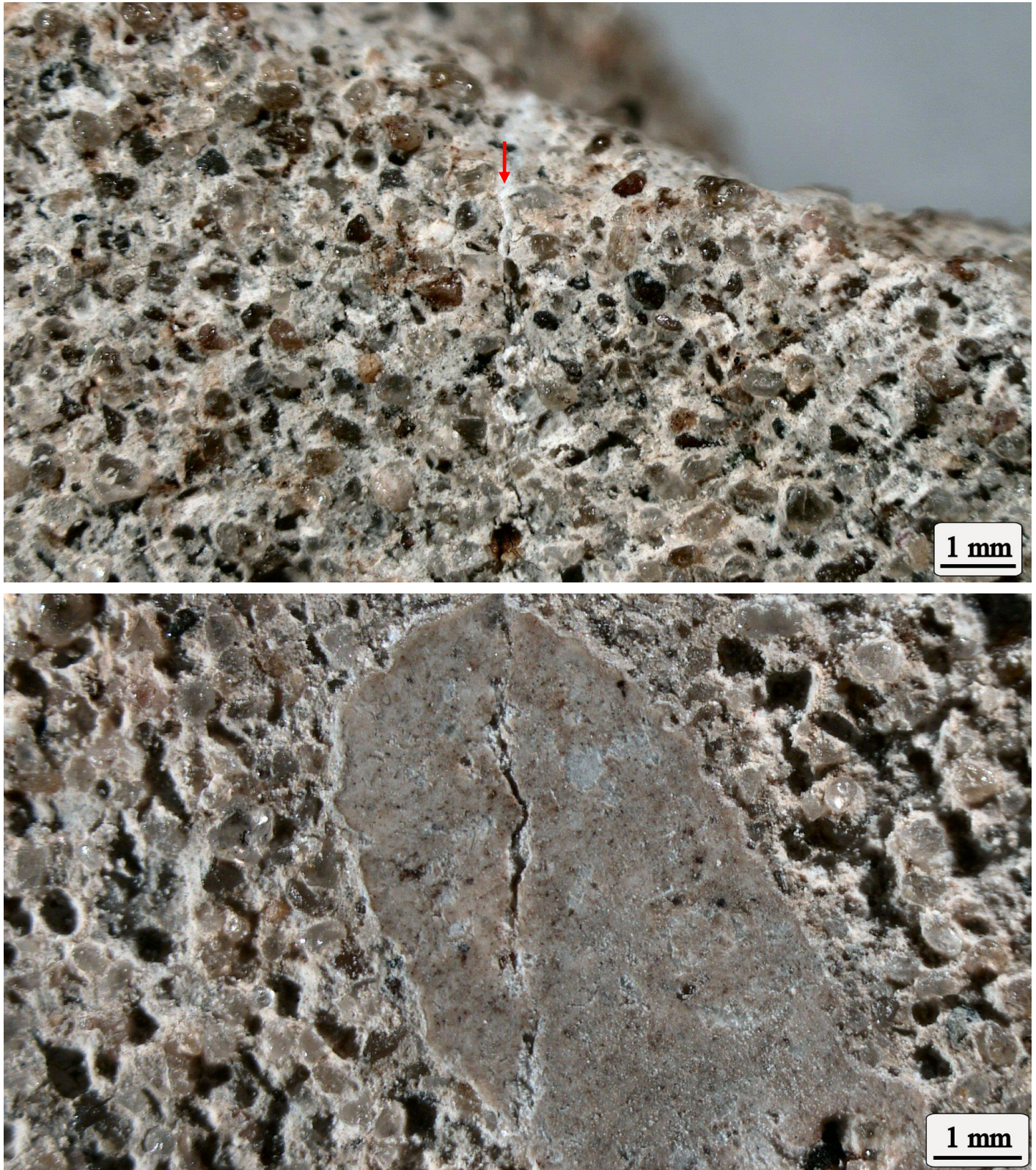
**Figure 7. Representative SEM/EDS analysis of the chemically attacked cement paste in the grout. The polygon in the upper backscatter-electron image represents the area analyzed. Note the significantly decreased calcium oxide content and the significantly increased magnesium oxide content relative to the unaffected cement paste shown in Figure 6.**

# APPENDIX



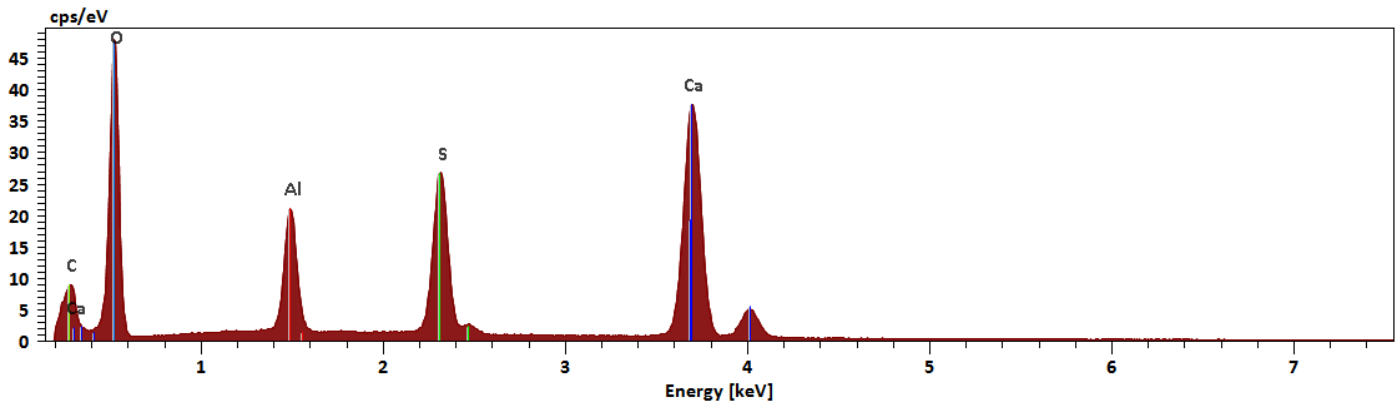
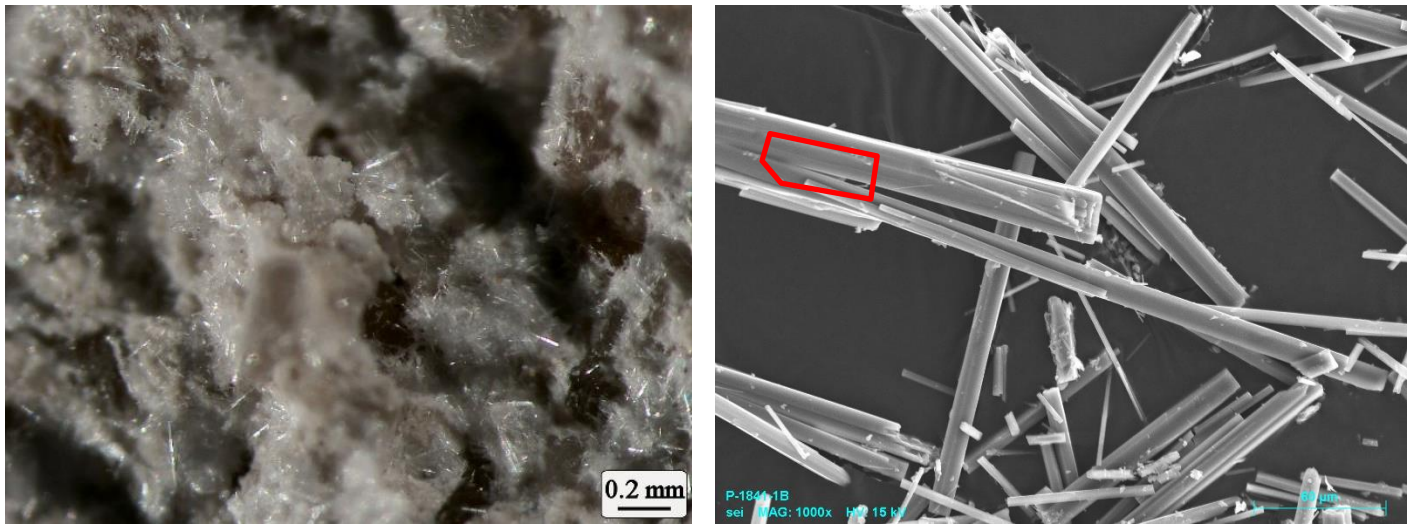
**Figure 8.** False-color, composite images of the cement paste, which is deteriorated at the right edge (upper photo) and top-right (lower photo) in the images. Color was assigned to represent the concentration of the chemical constituents: calcium is orange, and magnesium is blue. The deteriorated cement paste is depleted in calcium and enriched in magnesium relative to the sound paste in the center of the sample.

# APPENDIX



**Figure 9.** Cross-section photomicrographs showing the full-depth crack in the grout sample. The red arrow in the upper photo highlights the secondary deposits in the crack; the deposits consist of ettringite (see Figure 9).

# APPENDIX



Element	Weight, %	Compound	Compound Weight, %
Ca	37.29	CaO	52.18
Al	8.22	Al <sub>2</sub> O <sub>3</sub>	15.52
S	12.93	SO <sub>3</sub>	32.30
O	41.56	—	—
<b>Total</b>	<b>100.00</b>		<b>100.00</b>

**Figure 10. Representative SEM/EDS analysis of the crystalline secondary deposits removed from the full depth crack in the grout (see Figure 9). The analysis confirmed the material to be ettringite. The upper left photomicrograph shows the deposits in situ. The polygon in the upper-right secondary electron image represents the area analyzed.**

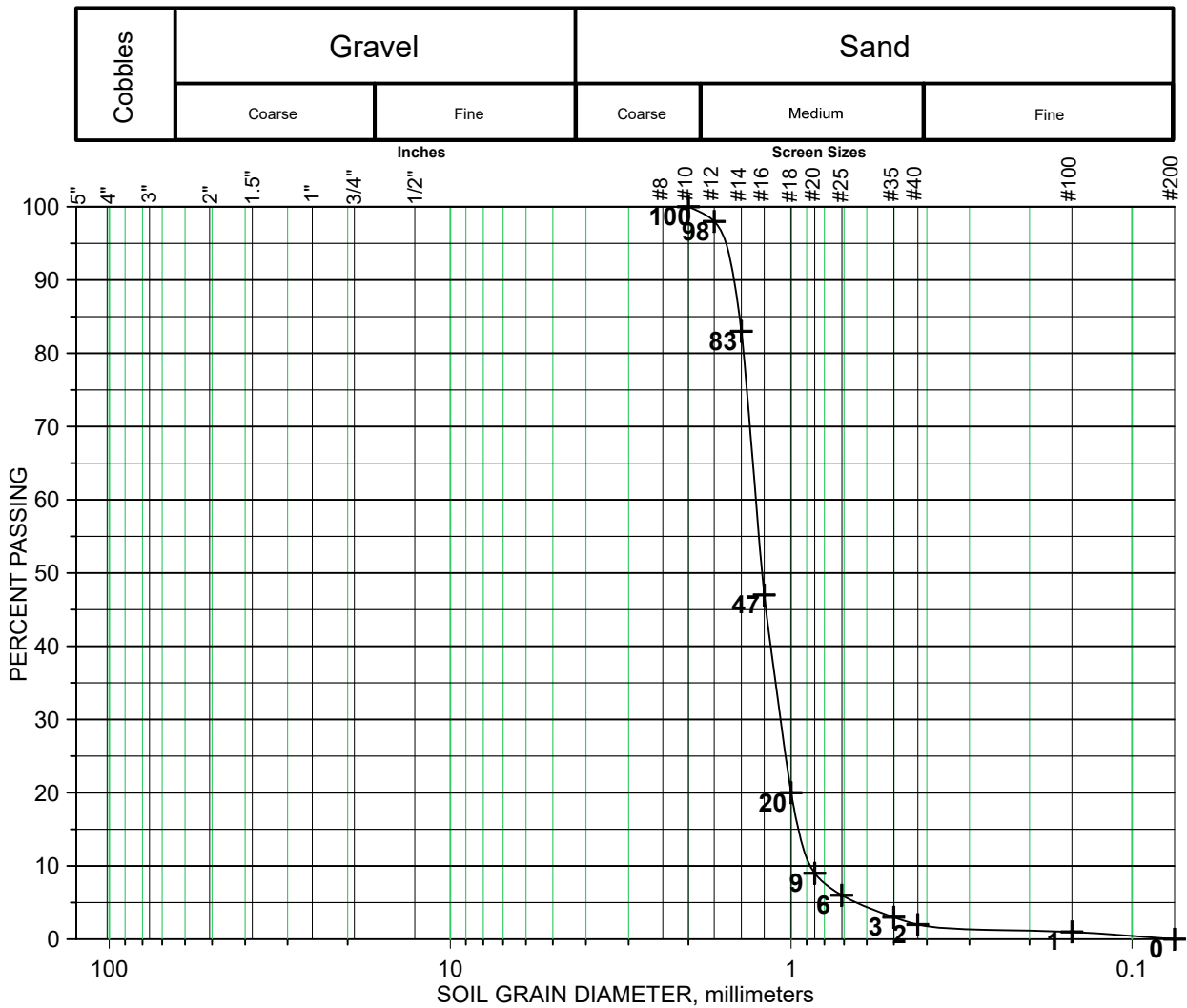
**APPENDIX E – STRATA DATA**

# GRADATION ANALYSIS

## ASTM D 6913

Project: 2022-2025 Misc. Lab Testing  
 Client Project: O'Fallon WTP  
 Project Number: BO22188A  
 Client: Burns & McDonnell  
 Sample Number: BL221347  
 Sample Location: Filter #4  
 Sample Classification: Anthracite  
 Apparent Specific Gravity: 1.811  
 Date tested: 10/10/22 By: K. Gray

$D_{10} = 0.89 \text{ mm}$   
 $D_{60} = 1.27 \text{ mm}$   
 $C_U (D_{60}/D_{10}) = 1.43$



Reviewed by: *Keith Wildman*  
 Keith Wildman  
 Laboratory Services Coordinator

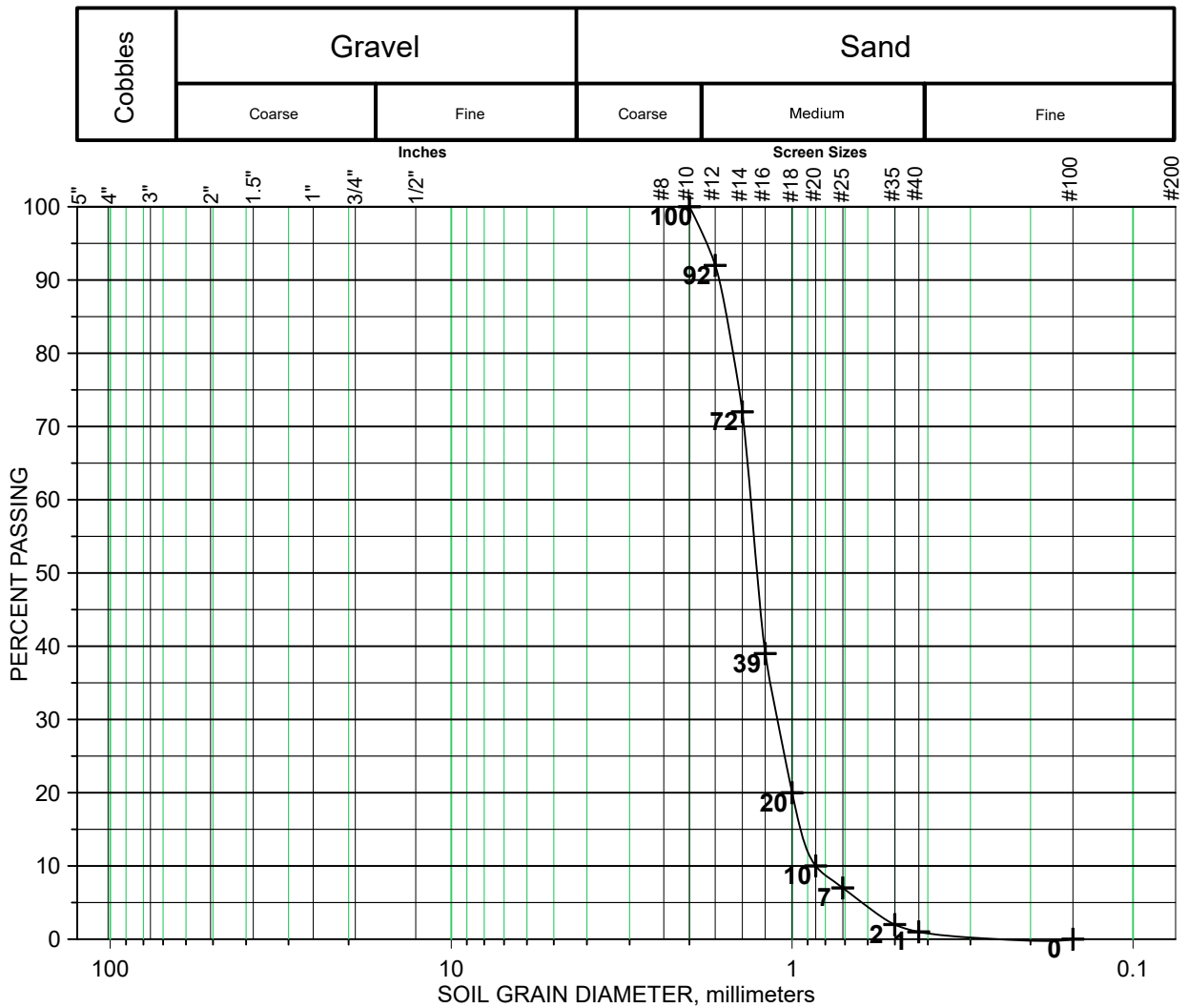


# GRADATION ANALYSIS

## ASTM D 6913

Project: 2022-2025 Misc. Lab Testing  
 Client Project: O'Fallon WTP  
 Project Number: BO22188A  
 Client: Burns & McDonnell  
 Sample Number: BL221346  
 Sample Location: Filter #5  
 Sample Classification: Anthracite  
 Apparent Specific Gravity: 1.701  
 Date tested: 10/10/22 By: K. Gray

$D_{10} = 0.85 \text{ mm}$   
 $D_{60} = 1.33 \text{ mm}$   
 $C_U (D_{60}/D_{10}) = 1.56$



Reviewed by: *Keith Wildman*  
 Keith Wildman  
 Laboratory Services Coordinator

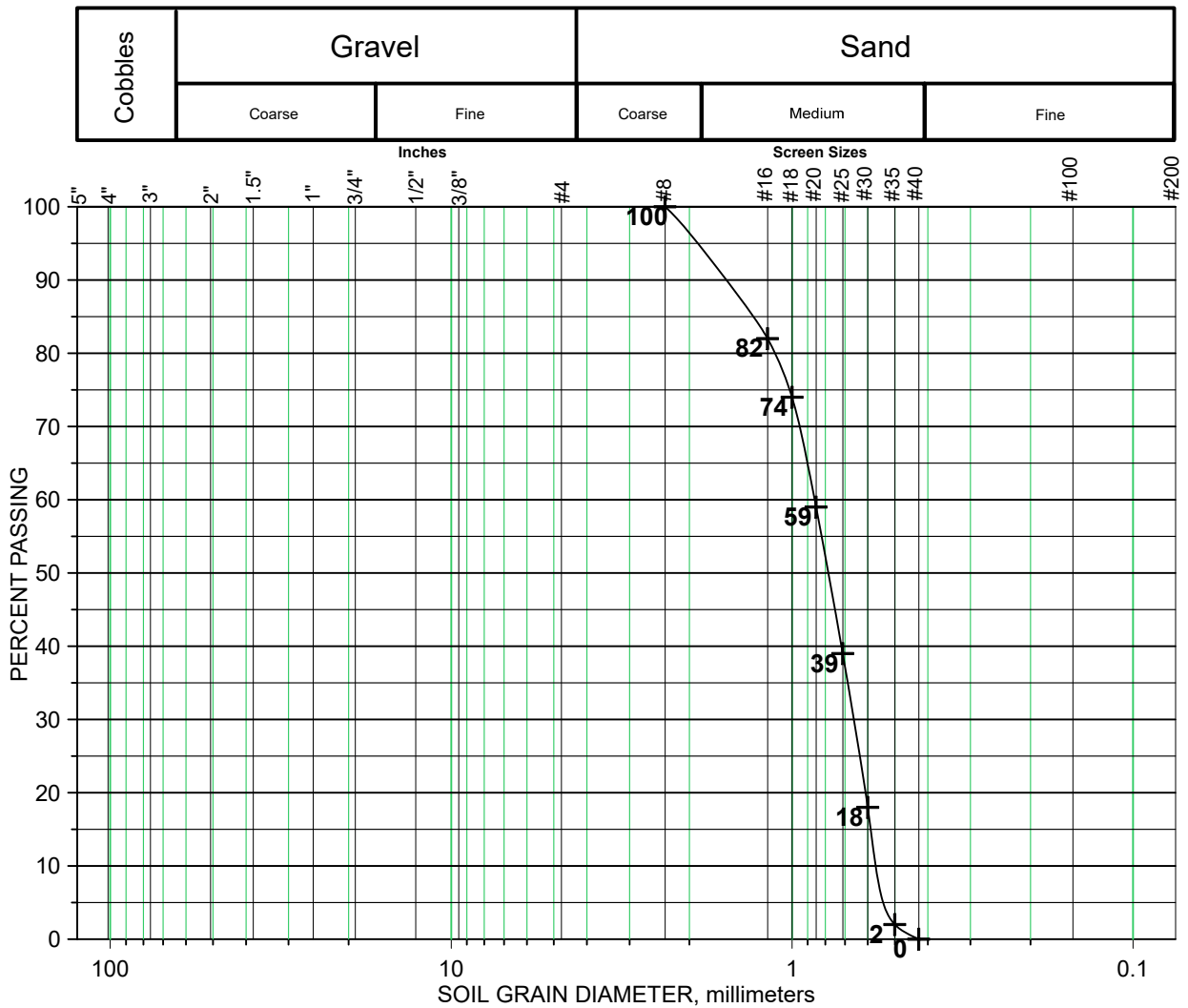


# GRADATION ANALYSIS

## ASTM D 6913

Project: 2022-2025 Misc. Lab Testing  
 Client Project: O'Fallon WTP  
 Project Number: BO22188A  
 Client: Burns & McDonnell  
 Sample Number: BL221348  
 Sample Location: Filter #5  
 Sample Classification: Sand  
 Apparent Specific Gravity: 2.397  
 Date tested: 10/10/22 By: K. Gray

$D_{10} = 0.57 \text{ mm}$   
 $D_{60} = 0.86 \text{ mm}$   
 $C_U (D_{60}/D_{10}) = 1.51$



Reviewed by: *Keith Wildman*  
 Keith Wildman  
 Laboratory Services Coordinator

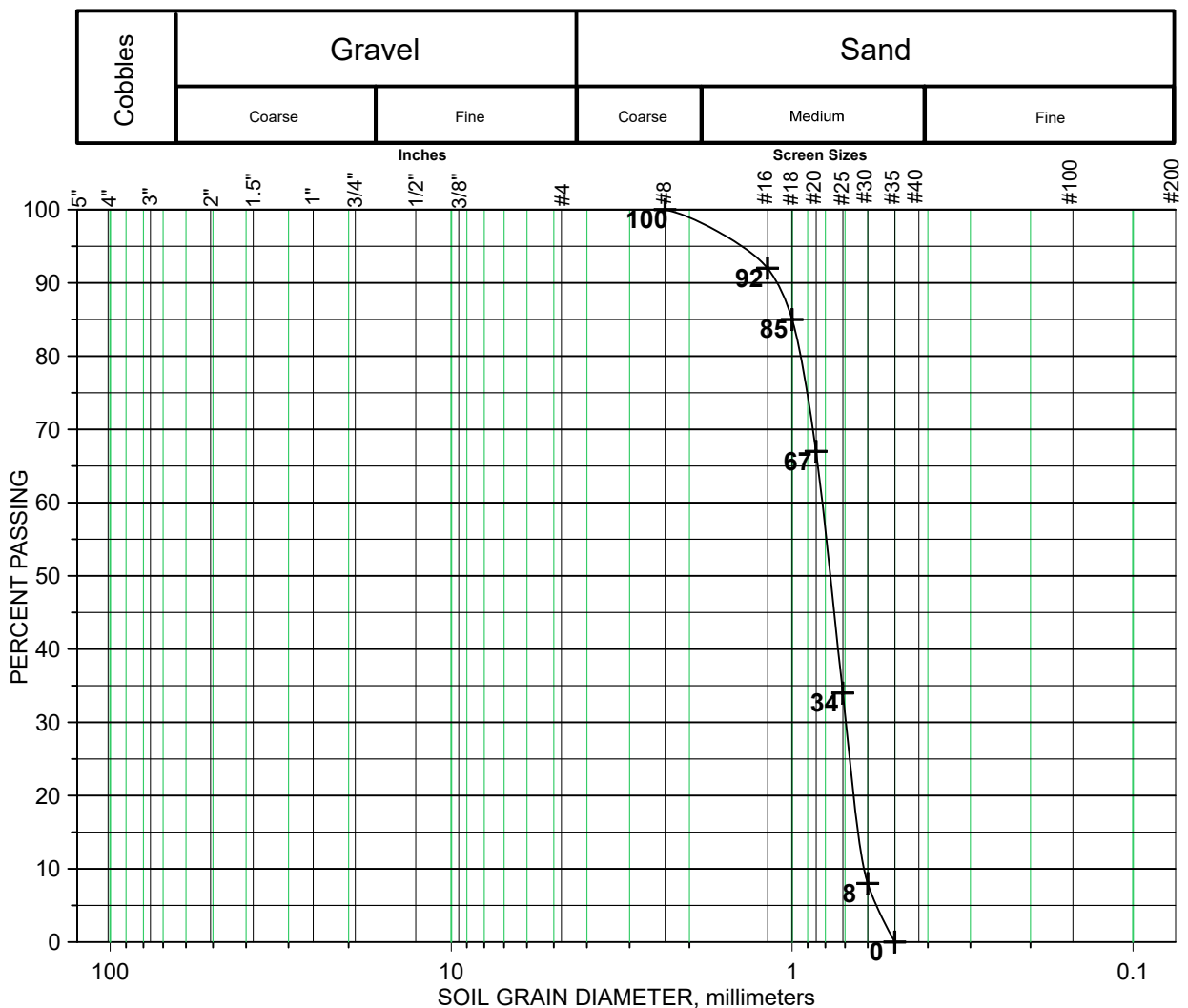


# GRADATION ANALYSIS

## ASTM D 6913

Project: 2022-2025 Misc. Lab Testing  
 Client Project: O'Fallon WTP  
 Project Number: BO22188A  
 Client: Burns & McDonnell  
 Sample Number: BL221349  
 Sample Location: Filter #4  
 Sample Classification: Sand  
 Apparent Specific Gravity: 2.643  
 Date tested: 10/10/22 By: K. Gray

$D_{10} = 0.62 \text{ mm}$   
 $D_{60} = 0.805 \text{ mm}$   
 $C_U (D_{60}/D_{10}) = 1.30$



Reviewed by: *Keith Wildman*  
 Keith Wildman  
 Laboratory Services Coordinator



**APPENDIX F – RESIDUALS HANDLING VENDOR EQUIPMENT**



## Proposal

**Number:** 100422-06R0  
**To:** Ressler And Associates Inc  
Po Box 4018  
Ballwin, MO 63022-4018  
US- United States

**Date:** 04-October-2022  
**Attn:** Jim Hopkins  
**Tel:** 314-409-4975  
**E-Mail:** [jhopkins@resslerassociates.com](mailto:jhopkins@resslerassociates.com)

**Proposal Valid Through:** 03-November-2022

**M.W. Watermark, LLC is pleased to provide this quotation for the following:**

### SCOPE OF SUPPLY:

#### One (1) M.W. WATERMARK FILTER PRESS MODEL FP800G32L-38/48-20/25ASX

##### Basis of Design

Application: Iron sludge  
Temperature: Between 45°F and 110°F  
Installation Location: Indoors  
Power Supply: None, unless control option selected.  
Feed Pressure: Up to 100 psi



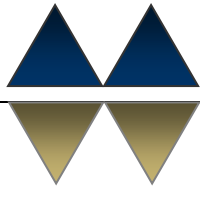
Options shown may not be included in the quoted price.

##### Equipment Description

Plate size: 800 x 800 mm plates.  
Cake Thickness: 32 mm chambers.  
Press Capacity: 20 cu. ft. expandable to 25 cu. ft.  
Filtration Area: 405 sq. ft. expandable to 511 sq. ft.  
Chamber Quantity: 38 expandable to 48 (approx.)  
Overall Dimensions: 195"L x 55"W x 65"H (approx.) with 26" under-plate clearance. "A" dimension = 112"  
Empty Weight: 5,220 pounds  
Hydraulics: Air-operated hydraulics, automatic closure, enclosed in the leg of the filter press.  
Filter Plates: Polypropylene, gasketed (EPDM), recessed chamber.  
Filter Cloths: Installed polypropylene mono/multi-filament. Application could determine other styles.  
Filter Press Frame: Sidebar design, ASTM A36 carbon steel construction with 304SS side rail caps.  
Coating: Blasted to SSPC-SP6. UV-resistant aliphatic acrylic polyurethane. Color: RAL-5017 Traffic Blue

##### Features Included

Manifold Design: Air Blow/ Even Fill - Fully assembled with manual valves to provide even chamber filling and air blowdown. Includes air regulator.  
Manifold Material: PVC / EPDM, Schedule 80  
Plate Shifter: Semi-automatic plate shifter, pneumatically-operated, with air regulator and recoil hose.  
Expandable Capacity: Allows for future expansion of the filter press plate stack to 25 ft<sup>3</sup> without revision to foundation or hydraulics.



# M.W. WATERMARK, L.L.C.

4660 136th Avenue Holland, MI 49424

Ph 616.399.8850

Fax 616.399.8860

[www.mwwatermark.com](http://www.mwwatermark.com)

## SCOPE OF ENGINEERING:

- Approval Drawings: Electronic (if requested by Purchaser).
- IO&M Manuals: One hard copy and one electronic copy sent with unit.
- Additional hard copy manuals are available for \$75 USD each at time of order.

## TERMS AND CONDITIONS:

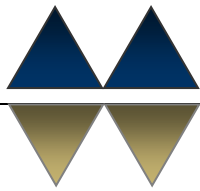
- M.W. Watermark, LLC's Standard Conditions of Sale, as attached, shall apply.

## PURCHASER/OWNER RESPONSIBILITY:

- Filter press feed pump, unless pump selected.
- Mechanical and electrical installation labor.
- Civil work including supply of anchor bolts.
- Unloading, uncrating, installation or installation supervision.
- Installation may require purchaser-supplied forklift or crane/hoist.
- Platforms, gratings or railings unless stated otherwise.
- Interconnecting piping or wiring.
- Compressed air supply.
- Valves, fittings, appurtenances not specifically listed.
- All taxes, fees, lien waivers, bonds, permits or licenses, unless expressly stated.
- Room ventilation, air conditioning, or lighting
- Compatibility of equipment materials of construction with process environment.
- Any other auxiliary equipment or service not detailed above.

## CLARIFICATIONS AND EXCEPTIONS:

No.	Section	Part	Description
1.	General	-	Items (such as bolts, fittings, etc.) not specifically listed in this proposal are selected based on MWW standard practice.
2.	General	-	Component performance ratings stated in this proposal are nominal. Actual performance may vary.
3.	General	-	Accuracy and/or precision of equipment as installed may vary based on installation and site conditions.
4.	General	-	Unless stated in the Scope of Supply, design to meet specific seismic requirements is not included.
5.	General	-	UL listing is included only if stated in the Scope of Supply.



# M.W. WATERMARK, L.L.C.

4660 136th Avenue Holland, MI 49424

Ph 616.399.8850

Fax 616.399.8860

[www.mwwatermark.com](http://www.mwwatermark.com)

## COMMERCIAL OFFERING:

**Payment Terms:** 50% Down Payment Due Upon Order, 50% Due Upon Notice of Readiness for Shipment  
**Freight Terms:** Ex-Works - Holland, MI  
**Freight to Job Site:** Not Included  
**Taxes:** Not Included  
**Submittal:** 1 to 2 weeks after receipt of written order and final specifications, if applicable.  
**Shipment:** 8 to 10 weeks after shop drawing approval, to be confirmed upon order acceptance. Please advise if expedited delivery required.  
**Startup & Training:** Not Included  
**Warranty:** As described in MWW Standard Conditions of Sale  
**Net OEM Price:** **\$50,050 USD**

## OPTIONAL EQUIPMENT:

1	Cake Hopper:	Two forkliftable, self-dumping filter cake discharge hoppers on casters to assist with filter cake disposal.	\$4,640
2	AOD Feed Pump:	2" Air-operated diaphragm feed pump installed on filter press-mounted shelf included. Polypropylene/Santoprene wetted materials.	\$4,050
3	Control Panel:	Automatic Feed Pump Control System controls the air-operated diaphragm feed pump (optional item or supplied by others). 120VAC/1Φ/60Hz/2A (std.)	\$5,080
4	CGR Tool Kit:	Tools for maintaining cloths and gaskets on CGR filter plates.	\$450
5	Startup Assistance:	MW Watermark field representative for startup assistance, one trip and two days on site.	\$5,250

All prices in U.S. Dollars

Please return one signed copy of this quotation, or your purchase order, to M.W. Watermark, LLC at the address below.

Refer to this quotation, date, and related correspondence.

**Issued By:** **M.W. WATERMARK, LLC**  
4660 136<sup>th</sup> Avenue, Holland, MI 49424

**Signed:** *Jose E. Calvillo*  
**Name:** Jose E. Calvillo  
**Title:** Sales Engineer  
**E-Mail:** jcalvillo@mwwatermark.com



**It's Official! M.W. Watermark is the World's Greatest!**

**Click here** to watch M.W. Watermark featured on the television series, "World's Greatest!"



## Standard Conditions of Sale

**I. GENERAL:** All references to M.W. Watermark, LLC (or any derivative thereof) shall mean M.W. Watermark, LLC Corporation and all references to Buyer herein shall mean the customer named in a purchase order, quotation or proposal. All quotations from M.W. Watermark, LLC shall be considered solicitations of offers. All purchase orders placed by Buyer shall be considered offers, which can only be accepted upon written notice thereof from M.W. Watermark, LLC. Buyer shall either sign M.W. Watermark, LLC's quotation, or in the alternative, issue a purchase order containing necessary information, such as site name, price schedule, type and quantity of product, requested delivery date and delivery instructions. Notwithstanding any terms or conditions that may be included in Buyer's purchase order form or other communications, M.W. Watermark, LLC's acceptance is conditional upon Buyer's assent to the terms and conditions set forth herein. It is agreed that sales are made only on the terms and conditions herein and any other terms or conditions shall not become a part of the agreement unless expressly agreed to in writing by M.W. Watermark, LLC. M.W. Watermark, LLC's failure to object to any terms or conditions contained in Buyer's purchase order or other communication shall not be deemed to be acceptance of such terms or conditions. The terms and conditions set forth herein shall be deemed incorporated (as though set forth in full) into any agreement entered into between M.W. Watermark, LLC and Buyer unless otherwise noted in writing. M.W. Watermark, LLC reserves the right, without any increase in price, to modify the design and specifications of M.W. Watermark, LLC products, provided that the modification does not adversely affect the original performance specifications as specified by M.W. Watermark, LLC or as requested by Buyer. Shipments, deliveries and performance of work shall at all times be subject to the approval of M.W. Watermark, LLC's Credit Department. M.W. Watermark, LLC may at any time decline to make any shipment or delivery or perform any work except upon receipt of payment or security or upon terms and conditions satisfactory to M.W. Watermark, LLC.

**II. PRICES, TERMS OF PAYMENT & TAXES:** (a) **PRICES:** Unless expressly stated to be firm for a definite period, offers are subject to change without notice, and in all cases are subject to withdrawal at any time before acknowledgment by Buyer. Under no condition will a quotation from M.W. Watermark, LLC remain in effect for longer than sixty (60) days unless otherwise agreed to in writing by M.W. Watermark, LLC. If a price is stated in the quotation, it is based upon shipment of the quantities and quality requested by Buyer and on the basis of M.W. Watermark, LLC's internal delivery schedule at the time of preparation of said quotation. (b) **TERMS OF PAYMENT:** Unless otherwise stated in a quotation, payments against invoices shall be due and payable thirty (30) days from the date of shipment, regardless of the date upon which Buyer receives the invoice from M.W. Watermark, LLC. If in M.W. Watermark, LLC's opinion, Buyer's financial condition does not justify continuation of production or shipment on the terms of payment specified, M.W. Watermark, LLC may, upon written notice to Buyer, cancel or suspend any outstanding order or part thereof, unless Buyer shall promptly pay for all goods delivered or shall make advance payments to M.W. Watermark, LLC as it, at its option, shall determine. If Buyer delays shipment for any reason, date of readiness for shipment shall be deemed to be the date of shipment for payment purposes. If Buyer delays manufacture for any reason, a payment shall be made based on purchase price and percentage of completion, with the balance payable in accordance with the terms as stated. If payments are not made in conformance with the terms stated herein, the contract price shall, without prejudice to M.W. Watermark, LLC's right to immediate payment, be increased by 1½% per month on the unpaid balance, not to exceed the maximum amount permitted by law. If at any time in M.W. Watermark, LLC's judgment Buyer may be or may become unable or unwilling to meet the terms specified herein, M.W. Watermark, LLC may require satisfactory assurance or full or partial payment as a condition to commencing, or continuing manufacture, or in advance of shipment. (c) **TAXES:** Except for the amount, if any, of tax stated in a M.W. Watermark, LLC quotation, the prices set forth therein are exclusive of any amount for federal, state, local, excise, sales, use, property, in-country, import, VAT or similar taxes or duties. Such prices also exclude permit, license, customs and similar fees levied upon shipment of M.W. Watermark, LLC products.

**III. SHIPMENT:** The anticipated shipment date set forth in the quotation is approximate and subject to change. Notwithstanding other limitations set forth by M.W. Watermark, LLC, M.W. Watermark, LLC shall not be liable for any delays in shipment which are caused by events beyond the control of M.W. Watermark, LLC including, but not limited to, delays caused by inaccurate or incomplete data furnished by Buyer, changes or revisions in the work to be performed, tardy approval of shop drawings by Buyer, acts of Buyer or Buyer's agent, accidents, strikes, inability to obtain labor or materials, or delay in transportation. M.W. Watermark, LLC shall have the right to extend the anticipated shipment date for up to ten (10) calendar days, for any reason, provided M.W. Watermark, LLC shall give Buyer written notice of such delay at least seven (7) days prior to the scheduled shipping date. Equipment or parts will be crated for domestic truck shipment at M.W. Watermark, LLC's expense; however, M.W. Watermark, LLC assumes no responsibility for loss of, or damage to the equipment after delivery to the carrier, who shall be deemed to be acting as agent for Buyer, and the equipment shall thereafter be at the Buyer's sole risk. It is M.W. Watermark, LLC's policy to ship its equipment "Bill Collect," and the motor freight company will mail their invoice(s) directly to Buyer's billing address, unless otherwise agreed in writing. If shipment of the products is delayed upon request of Buyer, or as a result of any conduct of Buyer or Buyer's agents, M.W. Watermark, LLC shall not be liable for damage to the products occurring during storage. Buyer shall reimburse M.W. Watermark, LLC upon demand by M.W. Watermark, LLC for any costs incurred by M.W. Watermark, LLC in connection with said storage, including steps taken to protect the products from the elements. Any delay in shipment requested or caused by Buyer or its agents will not affect the terms of payment as provided herein. Buyer shall be responsible for the payment of any additional cost of shipping occasioned by the delay.

**IV. TITLE & RISK OF LOSS:** M.W. Watermark, LLC's prices are F.O.B. Factory unless otherwise explicitly noted in the quotation and are exclusive of taxes, shipping and insurance. Title to all goods and risk of loss, deterioration or damage shall pass to Buyer upon tender to the carrier; except that a security interest in the products or any replacement shall remain in M.W. Watermark, LLC's name, regardless of mode of attachment to realty or other property, until the full purchase price has been fully paid in cash. Buyer agrees to do all acts necessary to perfect and maintain said security interest, and to protect M.W. Watermark, LLC's interest by adequately insuring the products against loss or damage from any external cause with M.W. Watermark, LLC named as insured or co-insured. Any claim by Buyer against M.W. Watermark, LLC for shortage or damage occurring prior to delivery must be made in writing within ten (10) calendar days after receipt of shipment and accompanied by an original transportation bill signed by the carrier noting that carrier received goods from M.W. Watermark, LLC in the condition claimed. M.W. Watermark, LLC shall have the right to ship all goods at one time or in portions, within the time for shipping provided in such order, unless specifically requested in writing by the Buyer that these shipments be made in total. Any shipments returned to M.W. Watermark, LLC as a result of Buyer's unexcused delay or failure to accept delivery will require Buyer to pay all additional costs incurred by M.W. Watermark, LLC. Additionally, once Buyer has been notified that its order is available for shipment, if Buyer requests that the products not be shipped until a later date, the products will be stored at the Buyer's risk and expense until permission to ship to the jobsite is given by Buyer.

**V. ERECTION:** Unless otherwise agreed in writing, products are assembled, installed and/or erected by and at the full expense of Buyer.



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**VI. CANCELLATION & BREACH:** Buyer agrees that M.W. Watermark, LLC products are specially manufactured goods that are not suitable for sale to others in the ordinary course of business. Therefore, purchase orders placed with M.W. Watermark, LLC cannot be canceled without recourse, nor shipments of goods made up, or in process, be deferred beyond the original shipment dates specified, except with M.W. Watermark, LLC's written consent and upon terms which shall indemnify M.W. Watermark, LLC against all loss. In the event of cancellation or the substantial breach of the agreement between Buyer and M.W. Watermark, LLC, including without limitation, failing to make payment when due, Buyer agrees that M.W. Watermark, LLC will suffer serious and substantial damage which will be difficult, if not impossible, to measure, both at the time of entering the agreement and as of the time of such cancellation or breach. Therefore, the parties agree that upon such cancellation or breach, the Buyer shall pay to M.W. Watermark, LLC the sums set forth below which M.W. Watermark, LLC and Buyer do hereby agree shall constitute agreed and liquidated damages in such event:

- a. If cancellation or breach shall occur after the acceptance of the purchase order but prior to mailing of general arrangement drawings by M.W. Watermark, LLC to Buyer, liquidated damages shall be 10% of the selling price.
- b. If cancellation or breach shall occur within thirty (30) days from the mailing of general arrangement drawings by M.W. Watermark, LLC to Buyer, the liquidated damages shall be 30% of the selling price.
- c. If the cancellation or breach occurs after thirty (30) days from the mailing of general arrangement drawings by M.W. Watermark, LLC to Buyer, but prior to notification that the order is ready for shipment, the liquidated damages shall be the total of 30% of the selling price plus the expenses incurred, cost of material, and reasonable value of the work expended to fill the respective order by M.W. Watermark, LLC's engineers and other employees, agents and representatives after the mailing of general arrangement drawings by M.W. Watermark, LLC to Buyer. All sums will be determined at the sole reasonable discretion of M.W. Watermark, LLC provided, however, that the total liquidated damages under this provision shall not exceed the total selling price.
- d. If cancellation or breach shall occur after M.W. Watermark, LLC has notified Buyer that the order is ready for shipment, then the liquidated damages shall be the total selling price.

**VII. DRAWINGS & SPECIFICATIONS:** In the event that drawings are sent to Buyer for approval after an order is placed, the drawings must be returned marked "Approved" or "Approved As Noted" within twenty (20) working days after receipt unless otherwise noted. In the event that Buyer's written comments are not given within the twenty (20) day period, M.W. Watermark, LLC shall deem the items approved.

**VIII. CORRECTIVE WORK & "BACK CHARGES":** In no event shall any work be done, or services or material be purchased or expense otherwise incurred by the Buyer for the account of M.W. Watermark, LLC until after full and complete particulars (including an estimate of material cost) have been submitted in writing and approved in writing by M.W. Watermark, LLC. M.W. Watermark, LLC must be given the opportunity to discuss and research alternative methods to lower the costs involved in such corrective work. Unless agreed-upon in writing by M.W. Watermark, LLC, M.W. Watermark, LLC will not be liable for labor costs, overhead, administrative costs, interest or any other consequential or indirect costs Buyer incurs. Returned items will not be accepted unless M.W. Watermark, LLC has previously agreed to such return in writing and supplied written return-shipment instructions to Buyer.

**IX. SELECTION OF MATERIALS:** Because all M.W. Watermark, LLC products are specially manufactured products, the material make-up of many of M.W. Watermark, LLC's products varies from project to project. The determination of the materials' suitability and adaptability (including without limitation, paints and/or coatings) to the specific needs of the Buyer is solely the Buyer's choice and responsibility.

**X. CONFIDENTIAL INFORMATION & IMPROVEMENTS:** The design, construction, application and operation of M.W. Watermark, LLC's products and services embody proprietary and confidential information; therefore, Buyer will maintain this information in strict confidence, will not disclose it to others and will only use this information in connection with the use of the products or to facilitate the provision of services sold by M.W. Watermark, LLC. Buyer will not copy or reproduce any written or printed materials or drawings furnished to Buyer by M.W. Watermark, LLC. Buyer agrees to immediately return all confidential material to M.W. Watermark, LLC if requested in writing by M.W. Watermark, LLC. Buyer will not copy the products or make any design drawings of the products and will not permit others to copy or make any design drawings of the products. M.W. Watermark, LLC shall have a royalty-free license to make, use and sell, any changes or improvements in the products invented or suggested by Buyer or its employees. Buyer acknowledges that a remedy at law for any breach or attempted breach of this Section will result in a harm to M.W. Watermark, LLC for which monetary damages alone will not be adequate. Buyer covenants and agrees that neither it nor any of its affiliates will oppose any demand for specific performance and injunctive and other equitable relief in case of any such breach or attempted breach. Notwithstanding anything to the contrary herein, M.W. Watermark, LLC may seek enforcement of any breach of this Section without the necessity of complying with the provisions regarding resolution of disputes herein.

**XI. FIELD SERVICE:** Field Service included in the quotation will only be scheduled upon written request and may be subject to credit approval. Should the Buyer have outstanding balances due M.W. Watermark, LLC, no startup / field service will be scheduled until such payments are received by M.W. Watermark, LLC. The Buyer assumes all responsibility for the readiness of the system when it requests startup service. Should M.W. Watermark, LLC's Field Service Engineer arrive at the jobsite and determine that the system cannot be started up within a reasonable time, M.W. Watermark, LLC shall have the option to bring the Field Service Engineer home and bill the Buyer for time, travel and living expenses. Additional field service is available from M.W. Watermark, LLC at the prevailing per-diem rate at the time of the request for service plus all travel and living expenses, portal-to-portal. A purchase order or change order will be required prior to scheduling this additional service.

**XII. LIMITATION OF LIABILITY:** Unless expressly agreed to in writing by M.W. Watermark, LLC, all damages not direct and actual in nature, including without limitation, consequential, incidental, exemplary and punitive damages, shall be expressly prohibited damages. Such prohibited damages include, but are not limited to, lost rent or revenue; rental payments; costs (increased or not) of administration or supervision; costs or delays suffered by others unable to commence work or provide services as previously scheduled for which a party to this contract may be liable; increased costs of borrowing funds devoted to the project (including interest); delays in selling all or part of the project upon completion; damages caused by reason of Force Majeure or acts of God (with the broadest statutory or court of law definition possible); termination of agreements to lease or buy all or part of the project, whether or not suffered before completion of services or work; forfeited bonds, deposits, or other monetary costs or penalties due to delay of the project; interest for any reason assessed to Buyer; increased taxes (federal, state, local, or international) due to delay or recharacterization of the project; lost tax credits or deductions due to delay; impairment of security; attorney and other legal fees for any reason assessed to Buyer, loss of use of the Equipment or any associated Equipment, costs of substitute Equipment, facilities or services, down time costs, claims of customers of Buyer for such



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other damages; or any other indirect loss arising from the conduct of the parties. M.W. Watermark, LLC only agrees to responsibility for damages from proven negligent and willful acts of its direct employees only.

**XIII. APPLICABLE LAWS & GOVERNING LAW:** To the best of M.W. Watermark, LLC's knowledge, M.W. Watermark, LLC products comply with most laws, regulations and industrial practices; however, M.W. Watermark, LLC does not accept responsibility for any state, city or other local law not specifically brought to M.W. Watermark, LLC's attention. For OSHA compliance, (1) M.W. Watermark, LLC is only liable for those OSHA standards, which are in effect as of the date of the quotation, and to the extent they are applicable to the performance by M.W. Watermark, LLC. (2) M.W. Watermark, LLC is only responsible for the physical characteristics of the product(s) and not for the circumstances of the use of the product(s). (3) M.W. Watermark, LLC's liability through any noncompliance to OSHA shall be limited to the cost of modifying the product(s) or replacing the non-complying product(s) or component(s) after receipt of prompt written notice of noncompliance. The rights and obligations of Buyer and M.W. Watermark, LLC shall be governed by and interpreted in accordance with the substantive laws of the state of Michigan including the uniform commercial code of Michigan, excluding conflicts of law and choice of law principles.

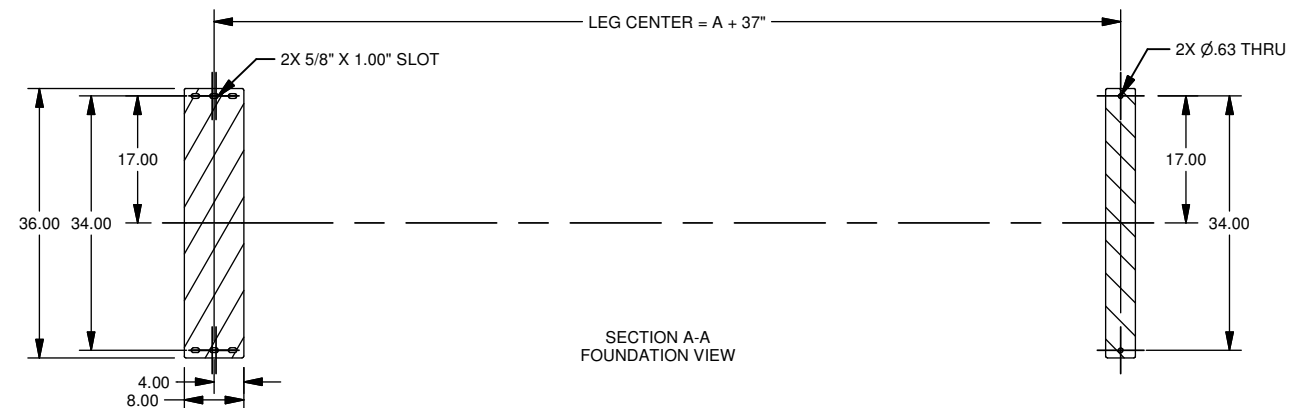
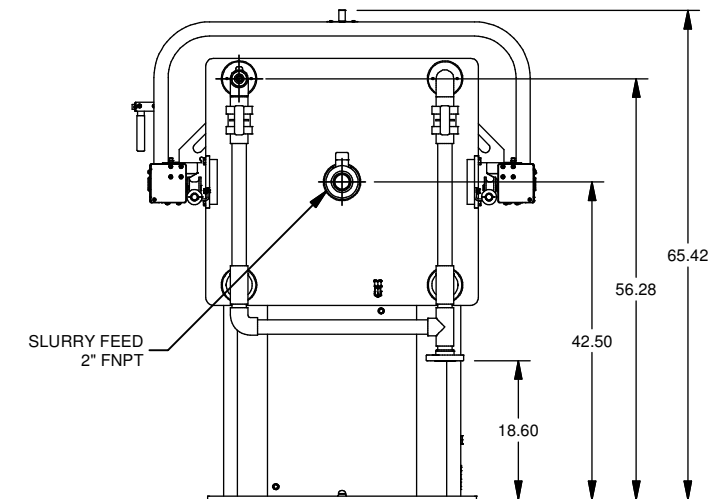
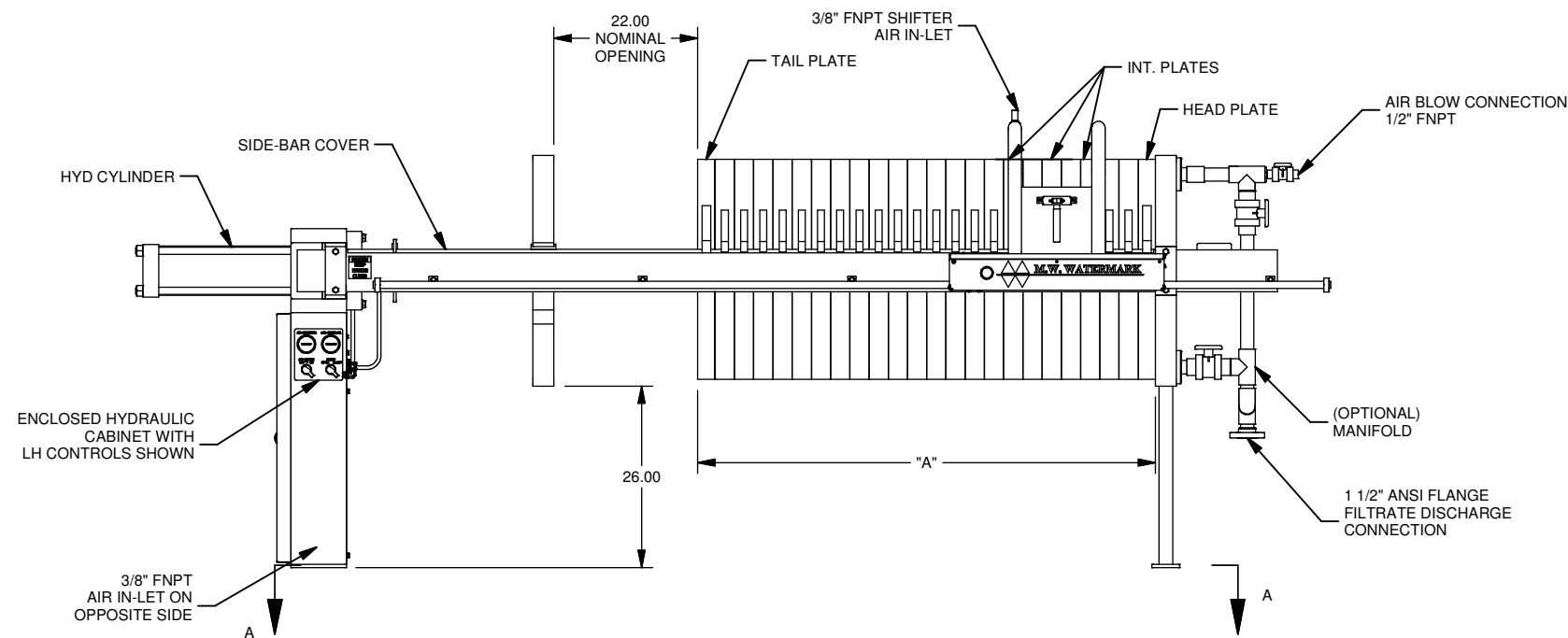
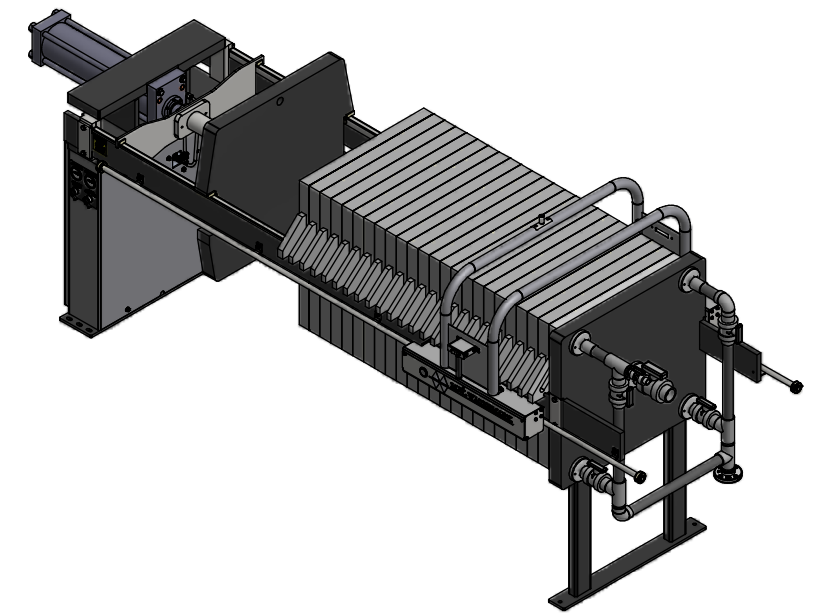
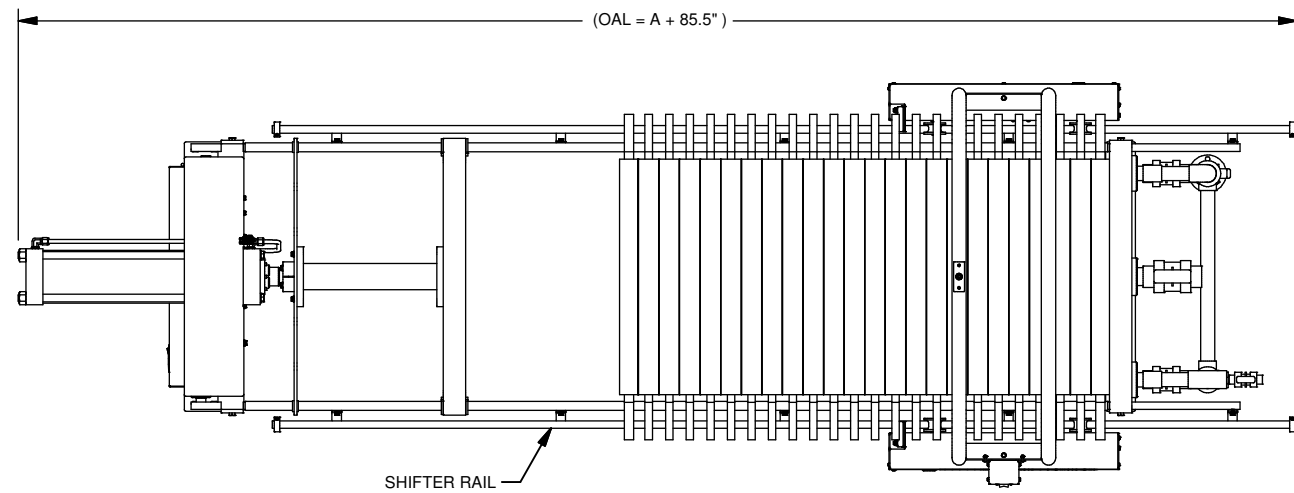
**XIV. DISPUTE RESOLUTION:** Any issue, claim or dispute ("Action") that may arise out of or in connection with the project referenced in the quotation and which Buyer and M.W. Watermark, LLC are not able to resolve by good faith negotiations, shall be submitted to mediation. Both parties shall choose a mediator and said mediator will decide the forum most convenient for both parties. Both parties agree to reasonably attempt to resolve all Actions via this medium. If mediation shall fail, the Action shall be submitted to binding arbitration administered by the American Arbitration Association under its Construction Industry Arbitration Rules and Mediation Procedures (Including Procedures for Large, Complex Construction Disputes), and judgment on the award rendered by the arbitrator(s) may be entered in a court having jurisdiction thereof. The parties agree to use mediation then arbitration to resolve such Action in lieu of litigation. In the event that an Action is brought, the prevailing party shall be entitled to be reimbursed for, and/or have judgment entered with respect to, all of its costs and expenses, including reasonable attorney's fees' and legal expenses.

**XV. PATENTS:** M.W. Watermark, LLC shall indemnify Buyer against any judgment for damages and costs which may be rendered against Buyer in a suit brought on account of the alleged infringement of any United States patent by any product supplied by M.W. Watermark, LLC, unless (a) the alleged infringement occurs as a result of any alteration or modification to the product or the use of the product in combination with the products or services of any party other than M.W. Watermark, LLC, or (b) the product was made in accordance with materials, designs or specifications furnished or designated by Buyer, in which case Buyer shall indemnify M.W. Watermark, LLC against any judgment for damages and costs which may be rendered against M.W. Watermark, LLC in any suit brought on account of the alleged infringement of any United States patent by such product or by such materials, designs or specifications; provided that prompt written notice be given to the party from whom indemnity is sought of the bringing of the suit and an opportunity be given to such party to settle or defend it as that party may see fit and that every reasonable assistance in settling or defending it shall be rendered. M.W. Watermark, LLC shall in no event be liable to Buyer for special, indirect, incidental or consequential damages arising out of allegation of patent infringement.

**XVI. MECHANICAL WARRANTY:** All Equipment sold pursuant to this quotation are warranted to be free from defective material and workmanship, under normal use and service, for a period of twelve (12) months from date of shipment to Buyer's jobsite ("Warranty Period"). In the event that defects develop during the Warranty Period, under normal and proper use, M.W. Watermark, LLC is to be notified promptly in writing, and upon receipt of its written consent, the products are to be returned promptly to M.W. Watermark, LLC, F.O.B. M.W. Watermark, LLC's factory. If M.W. Watermark, LLC's inspection indicates defective material or workmanship, the parts will, at M.W. Watermark, LLC's option, either be repaired or replaced without charge. In the case of components purchased by M.W. Watermark, LLC and incorporated in the Equipment, M.W. Watermark, LLC's Mechanical Warranty is limited to the component manufacturer's warranty. In addition to any other limitation or disclaimer with respect to this Mechanical Warranty, M.W. Watermark, LLC shall have no liability with respect to any of the following: failure of the products, or damages to them, due to Buyer's negligence or willful misconduct, abuse or improper storage, installation, application or maintenance (as specified in M.W. Watermark, LLC's O&M manuals); any products that have been altered or repaired in any way without M.W. Watermark, LLC's prior written consent; any products damaged while in transit or otherwise by accident; decomposition of products by chemical action, erosion or corrosion or wear to products caused by abrasive materials. Service calls during the Warranty Period, when requested by Buyer and where no evidence of defective material or workmanship is found, will be at Buyer's expense. M.W. Watermark, LLC shall not be held liable for any further cost, expense, or labor to replace Equipment or replaceable parts. All indirect damages are hereby limited pursuant to the Limitation of Liability clause herein and shall continue for the duration of the Warranty Period.

THE FOREGOING MECHANICAL WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER GUARANTEES AND WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, WHETHER WRITTEN, ORAL OR STATUTORY, WHICH ARE EXCLUDED TO THE FULLEST EXTENT PERMISSIBLE BY LAW. ALL WARRANTIES AND OBLIGATIONS OF M.W. WATERMARK, LLC SHALL TERMINATE IF BUYER FAILS TO PERFORM ITS OBLIGATIONS UNDER THIS OR ANY OTHER AGREEMENT BETWEEN THE PARTIES OR IF BUYER FAILS TO PAY ANY CHARGES DUE M.W. WATERMARK, LLC.

**XVII. MISCELLANEOUS:** The parties agree that the foregoing constitutes the entire agreement between Buyer and M.W. Watermark, LLC and that there are no other agreements, terms or conditions, expressed or implied, unless otherwise agreed to in writing. This document may not be modified or superseded other than by an instrument in writing signed by both Buyer and M.W. Watermark, LLC. This document shall be binding upon and inure to the benefit of Buyer and M.W. Watermark, LLC and their heirs, assignees, legal representatives and the project Owner for the project referenced in the quotation. The invalidity or non-enforceability of any particular provision of this document shall not affect the other provisions hereof, and this document shall be construed in all respects as if such invalid or unenforceable provisions were omitted.



**DRAWING FOR REFERENCE ONLY**

THIRD ANGLE PROJECTION  
  
 ALL WELD SYMBOL SIZES ARE MINIMUM REQUIRED.  
 DIMENSIONS IN [mm] ARE MILLIMETERS.  
 DO NOT SCALE DRAWING.  
 DRAWN PER ASME Y14.5-2009

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AND TOLERANCES TO BE AS FOLLOWS.

FABRICATION	MACHINE
.XX ± .06	.XX ± .03
[X ± 2]	.XXX ± .005
< ± 2"	[X ± 1]
	[X ± .1]
	< ± 1"

REV	DESCRIPTION	DATE	BY	ECN	REV	DESCRIPTION	DATE	BY	ECN
1	UPDATED TO STYLE 55 CYLINDER	11/14/13	DAM						

COMPANY CONFIDENTIAL  
 THIS DOCUMENT AND ALL INFORMATION CONTAINED HEREIN ARE THE PROPERTY OF M.W. WATERMARK AND/OR ITS AFFILIATES. THE DESIGN CONCEPTS AND INFORMATION CONTAINED HEREIN ARE PROPRIETARY TO M.W. WATERMARK AND ARE SUBMITTED IN CONFIDENCE. THEY ARE NOT TRANSFERABLE AND MUST BE USED ONLY FOR THE PURPOSE FOR WHICH THE DOCUMENT IS EXPRESSLY LOANED. THEY MUST NOT BE DISCLOSED, REPRODUCED, LOANED OR USED IN ANY OTHER MANNER WITHOUT THE EXPRESS WRITTEN CONSENT OF M.W. WATERMARK. IN NO EVENT SHALL THEY BE USED IN ANY MANNER DETRIMENTAL TO THE INTEREST OF M.W. WATERMARK. ALL PATENT RIGHTS ARE RESERVED. UPON THE DEMAND OF M.W. WATERMARK, THIS DOCUMENT, ALONG WITH ALL COPIES AND EXTRACTS, AND ALL RELATED NOTES AND ANALYSES, MUST BE RETURNED TO M.W. WATERMARK OR DESTROYED, AS INSTRUCTED BY M.W. WATERMARK. ACCEPTANCE OF THE DELIVERY OF THIS DOCUMENT CONSTITUTES AGREEMENT TO THESE TERMS AND CONDITIONS.

DWG BY	DATE	TITLE
TMZ	4/29/2013	DRAWING SPECIFICATIONS FOR FP800-AS
CKD BY	DATE	CLIENT
FILE:	40007938.idw	
SALES ORDER NUM:		
SCALE:	NONE	

**M.W. WATERMARK LLC**  
[www.mwwatermark.com](http://www.mwwatermark.com)

SERIAL NUMBER	DRAWING NUMBER	SHEET	REV
	40007938	1 OF 1	1

**NUMBER:** 11872 Rev 1

**DATE:** 10/18/22

**TO:** O'Fallon Wastewater Treatment Plant  
100 Firma Rd.  
O'Fallon, Missouri 63366  
Ph : (636) 272-4601

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Budget Proposal  
O'Fallon WTP  
O'Fallon, Missouri  
CS30-4 2PH



**Centrisys Contact**

Cory Melancon  
Regional Sales Manager  
9586 58<sup>th</sup> Place  
Kenosha, WI 53144  
Ph: (262) 654-6006  
Direct: (713) 419-0390  
Email: cory.melancon@centrisys.us

**Centrisys Representative**

Trent Ropp  
Ray Lindsey Company  
17221 Bel Ray Place  
Belton, MO 64012  
Email: tropp@raylindsey.com  
Ph: (816) 839-6076  
Direct: (816) 332-1972

Centrisys is pleased to provide this budget quotation for the following:

**ITEM 1. ONE (1) DECANTER CENTRIFUGE UNIT, MODEL CS30-4 2PH COMPLETE WITH AUTOMATIC HYDRAULIC BACKDRIVE**

**1.A Basis of Design – Sludge Feed Characteristics**

Industry Type:	Municipal Wastewater
Application:	Plate Settlers and Filter Backwash
Number of units:	One (1)
Design Feed Flow rate/Unit:	416 gpm (excluding polymer flow)
Dry Solids loading:	3,127 lbs/hr
Feed Concentration:	1.5%
Operation time:	24 hrs/day; 7 days/week

**1.B Centrifuge specification**

Model:	CS30-4 2PH
Inside bowl diameter (in):	30
Bowl length (in):	117
Bowl length to diameter ratio:	4:1
Beach angle (deg):	15
Maximum Bowl speed (RPM):	2650
Type of lubrication:	Air/Oil
Main Motor HP:	200
Back Drive Motor HP:	60

**1.C Equipment description**

- (1) Each unit will be provided based on the attached drawing CS30-4 2P Centrifuge GA.pdf  
Centrifugally Casted Duplex SS Solid bowl
  - (i) Scroll conveyor with Duplex SS Scroll shaft; 316SS flights
  - (ii) 304 SS lower and upper casing
  - (iii) Solid and liquid flexible connectors
  - (iv) Dewatered Sludge and Centrate Chutes/Hoppers
  - (v) Powder coated carbon steel base/frame
  - (vi) Vibration isolators
  - (vii) Spare parts/tools
  - (viii) Control Panel (water cooled)
    - A. 304SS NEMA 4X Enclosure for each centrifuge
    - B. Main circuit breaker
    - C. VFD for main drive motor
    - D. Allen Bradley PLC (compact logix), valve amplifier and motor starter for automatic hydraulic back drive system
    - E. Ethernet communication and historical trending of key parameters
    - F. 10" Allen-Bradley panel view touch screen
  - (ix) Instrumentation
    - A. One (1) vibration sensor per unit
    - B. One (1) main bearing temperature sensor, type PT100 on each bearing
    - C. One (1) each Bowl/Scroll speed sensor/unit
    - D. One (1) Hydraulic oil level/temp, hydraulic pressure sensor/unit
  - (x) Automatic Air/Oil Lubrication System
    - A. One (1) low oil level sensor per unit
  - (xi) One (1) trip and 5 days or 40 hours (whichever occurs first) of startup assistance

**BUDGET PRICE:**

All of the above for ..... **\$888,400** USD  
F.O.B. Job Site, freight included, taxes excluded.

**PAYMENT TERMS:**

30% with order; 60% upon shipment; 10% after startup not to exceed 90 days after shipment.

Lead Time: 60 weeks following receipt of the Approval drawings

**BUYER/OWNER RESPONSIBILITY:**

- Stand
- Feed pump
- Polymer system
- Flow meter
- Cake conveyor
- Anchor bolts.
- Building and building plans (Centrisys provides only the layout drawings without any responsibility of updating any plans or building)
- Building modifications
- Structural and Civil engineering labor
- Lubricants
- All utilities that are required for operation
- Unloading, uncrating, installation, and installation supervision. Installation will, at minimum, require a forklift and possibly a crane/hoist.
- Readiness of the Equipment before requesting start-up service. Non-readiness may incur additional charges.
- Compatibility of Equipment materials of construction with process environment.
- Piping connections, platforms, gratings, and railings unless stated otherwise.
- Any other auxiliary equipment or service not detailed above.

Issued by

Ethan Banks  
Applications Engineer

Date:10/18/22





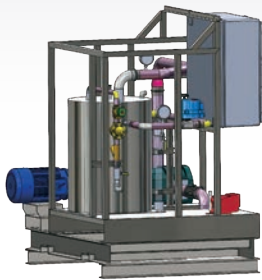
**HERON INNOVATORS**  
*The Clear Advantage*

**FLOTATION  
WITHOUT  
DISSOLVED AIR**

# **SAFE<sup>®</sup>**

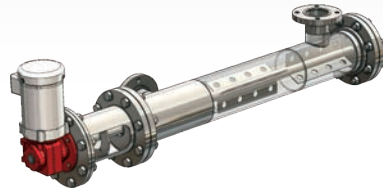
**Water & Wastewater Treatment**

# SAF® Systems



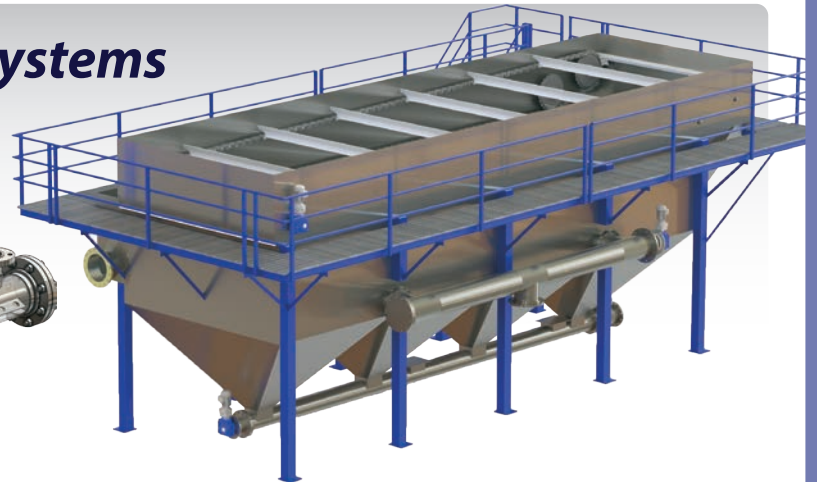
## SAF® Generator

The SAF® Generator produces microbubble froth independently of the process stream. These bubbles resist coalescing for significantly higher surface area and lifespan. Due to surface tension advantage and electrostatic affinity, the microbubbles attract, attach, and encapsulate the particles.



## ClearMixer

SAF® microbubble froth is injected and stirred into the influent stream prior to entering the flotation cell. Most of the microbubble to particle reaction takes place in this mixer.



## ClearFloater

SAF® systems do not require any additional air/gas to be injected into the flotation cell.

Hydraulic and solids loading capacities are increased with SAF® due to rapid rise rates and a very robust float. Less surface area is needed for a smaller physical footprint.

Heron offers stainless steel flotation cells for applications up to 11 MGD (42,000 M<sup>3</sup>/D).

## Skid Mounted Systems

Up to 4 MGD

Heron Innovators offers custom designed systems that are plumbed, wired, and tested with the flotation and ancillary equipment all on one single skid. This plug-and-play design minimizes installation time and costs normally associated with field integration of pumps, pH control, chemical feed, and other associated equipment.

◆ Commissioning and start-up are a matter of hours instead of days.

## SAF® Conversions



Traditional flotation systems are easily converted to SAF® with the addition of a SAF® Generator and ClearMixer.

- ◆ Improve separation for cleaner effluent
- ◆ Increase hydraulic flow capacity
- ◆ Increase solids loading capacity
- ◆ Produce dryer skimmed float
- ◆ Reduce chemical costs
- ◆ Reduce maintenance
- ◆ Reduce energy costs

# Suspended Air® Flotation (SAF®)

Serving Municipal and Industrial Clients



## Flotation without dissolved air?

SAF® Generators produce a microbubble froth at atmospheric pressure that is more than 40% air (or gas). In other words, dissolving air or gas is not part of the mechanism behind SAF®. Performance is not limited by changing conditions (e.g. temperature, pressure, gas solubility, etc.) and the physics that constrain other flotation methods. Reliability is greatly improved. As Heron customers say, "It just always works."

- ▶ Primary Treatment
- ▶ Secondary Bio-Solids Removal & Thickening
- ▶ Oil/Water Separation
- ▶ Surface Water Treatment



Easily handles the removal of algae.

*Heron Innovators, Inc.*  
**(916) 408-6601**

*info@heroninnovators.com*  
*www.heroninnovators.com*

# SAF<sup>®</sup> Specifications

HORSEPOWER

SAF <sup>®</sup> System	Flow Capacity					Float Area		Skid Size		Skid w/o pumps	Feed Pump	Solids Pump
	GPM	MGD	LPS	M <sup>3</sup> /D	BPD	FT <sup>2</sup>	M <sup>2</sup>	FT	M			
CF25 / F8	50	0.072	3	273	1,714	5	1.5	6 x 12	2 x 4	2	1	1
CF50 / F8	125	0.180	8	681	4,286	10	3	8 x 18	2 x 5	2.5	2	2
CF125 / F25	350	0.504	22	1,908	12,000	17.5	5	8 x 22	2 x 7	3	10	2
CF250 / F50	700	1.008	44	3,816	24,000	35	11	10 x 28	3 x 9	5	15	3
CF500 / F100	1,400	2.016	88	7,631	48,000	72	22	12 x 35	4 x 11	8	20	3
CF1000 / F200	2,800	4.032	177	15,263	96,000	144	44	12 x 35	4 x 11	18	40	3
CF2000 / F400	6,000	8.640	379	32,706	205,714	304	93	(Not Skid-Mounted)		-	80	5
CF3000 / F400	8,000	11.52	505	43,608	274,285	400	122	(Not Skid-Mounted)		-	100	7.5



**HERON INNOVATORS**  
*The Clear Advantage*  
 1025 Nichols Drive, Rocklin, CA 95765

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## Heron Innovators Suspended Air® Flotation System Pricing

Line	SAF® Flotation System	Price
<i>ClearFloater (304L SS), ClearMixer, Skimmer, L-Catwalk, Ladder, Basic Controls w/VFDs</i>		
1	Heron Model CF250 Flotation Cell	Quantity x 1
<i>SAF® Froth Generation System</i>		
2	Heron Model F25 Froth Generator	Quantity x 1
<b>Total Flotation System Purchase Price (USD)</b>		<b>\$262,545</b>

Ancillary Equipment		
<i>Heron System Integration</i>		
3	Components To Be Field Integrated by Others	
<i>Influent Feed System</i>		
4	External Feed Pump (not supplied) / External Control	
<i>Flow Measurement</i>		
5	External Flow Meter (not supplied) / External Control	
<i>Flocculation Tubes</i>		
6	6"x 100' Sched 80 PVC, Plug-Flow Serpentine, 304SS Stand, 3-way Polymer Manifold	
<i>Skimmed Solids Pump</i>		
7	Not Included	
<i>pH Measurement and Adjustment</i>		
8	Not Included	
<i>Acid/Caustic Double-Lined Safety Working Tanks</i>		
9	Not Included	
<i>Coagulant Supply</i>		
10	Not Included	
<i>Polymer Supply</i>		
11	Not Included	
<i>Automated Flush System for Shutdown</i>		
12	Not Included	
<i>Control Panel</i>		
13	NEMA 4X Control Panel, Relay Logic/VFDs (included)	
<b>Ancillary Equipment Purchase Price</b>		<b>\$48,760</b>
		Quantity x 1
<b>Total Ancillary Equipment Purchase Price</b>		<b>\$48,760</b>

<b>Grand Total System Price (USD)</b>		<b>\$311,305</b>
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**APPENDIX G – OPINION OF PROBABLE CONSTRUCTION COSTS**

**Recommendation 2.1 - Filter Rehabilitation**

<b>Item</b>	<b>Unit</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Cost</b>
<b>Filters 2 and 5 Rehab</b>	LS	1		\$ 470,000
<b>Filters 1-5 Underdrains and Media (Roberts)</b>	LS	1		\$ 654,000
<b>Filters 1, 3, and 4 Rehab</b>	LS	1		\$ 920,000
<b>Filters 1-5 Valves and Actuators</b>				
Valves (20")	EA	6	\$ 13,000	\$ 81,000
Valves (12"-14")	EA	15	\$ 9,000	\$ 135,000
Actuators	EA	10	\$ 16,000	\$ 160,000
Backwash Supply Pressure Control	LS	1	\$ 45,000	\$ 45,000
Installing Level Sensors	LS	5	\$ 1,500	\$ 8,000
<b>Flow Meters</b>				
Filter Flow Meters	EA	5	\$ 17,000	\$ 38,000
Backwash Flow Meter	EA	1	\$ 28,000	\$ 12,000
Piping Modifications	EA	6	\$ 8,000	\$ 48,000
<b>Electrical and Controls</b>				
Electrical Supply and Installation	EA	1	\$ 94,000	\$ 135,000
LangeTech Contract (Instruments, SCADA, VCP/PLCs)	LS	1	\$ 320,000	\$ 320,000
<i>Subtotal</i>				\$ 3,026,000
Engineering				\$ 237,000
Contingency @ 15%				\$ 381,000
<b>Total</b>				<b>\$ 3,650,000</b>

**Recommendation 2.2 - Modification of Pre-Oxidation System**

<b>Item</b>	<b>Unit</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Cost</b>
<b>Aeration System</b>				
Induced Draft Aerator	LS	2	\$ 156,000	\$ 320,000
Concrete Work	CY	20	\$ 2,500	\$ 50,000
FRP Baffle Wall	EA	1	\$ 96,000	\$ 100,000
14" DIP Inlet piping	LF	100	\$ 420	\$ 50,000
14" DIP Fittings/Elbows	EA	5	\$ 10,000	\$ 50,000
14" Valves	EA	2	\$ 10,000	\$ 20,000
18" DIP Outlet piping	LF	40	\$ 540	\$ 30,000
18" DIP Fittings/Elbows	EA	2	\$ 10,000	\$ 20,000
Site Work/Demo	LS	1	\$ 20,000	\$ 20,000
Platform/Grating	LS	1	\$ 120,000	\$ 120,000
Electrical/Instrumentation/Controls @ 20% of Equipment	LS	1	\$ 70,000	\$ 70,000
<b>Permanganate Tote System and Movement of Chlorine Injection</b>				
Containment Pallets	EA	2	2000	\$ 10,000
Feed Pumps (duplex skid)	LS	1	\$ 26,000	\$ 30,000
Piping and Valves	LS	1	\$ 52,000	\$ 60,000
Injection Diffusers and Supports	EA	1	\$ 16,000	\$ 20,000
Site Work	LS	1	\$ 20,000	\$ 20,000
HVAC and Plumbing Modifications (assuming minimal)	LS	1	\$ 20,000	\$ 20,000
Analyzers	LS	1	\$ 60,000	\$ 60,000
Electrical/Instrumentation/Controls @ 20%	LS	1	\$ 44,000	\$ 50,000
<b>Subtotal</b>				
				\$ 1,120,000
Contingency @ 30%				\$ 340,000
<b>Subtotal</b>				
				\$ 1,460,000
Contractor GC/I/P/etc @ 30%				\$ 440,000
Engineering @20%				\$ 300,000
<b>Total</b>				<b>\$ 2,200,000</b>

# Cost Analysis

	Influent Total Fe	Influent Total Mn	Aeration Reduction		Chlorine Dose (mg/l, 100% strength)	Permanganate Dose (mg/L, 100% strength)	Chemical Cost							
			Fe	Mn			Chlorine (avg dose) lb/MG	Chlorine \$/gal	Chlorine (avg dose) \$/MG	Perm. (avg dose) lb/MG	Perm. \$/liquid lb	Perm. (avg dose) \$/MG	Yearly Cost (Assuming avg flow of 2.5 MGD)	
														Total \$/MG
Scenario 1 - Existing Air, Chlorine	8.02	0.72	0.3	0	5.88		49		\$ 760	0	\$ -	\$ 760	\$ 694,000	
Scenario 2 - Existing Air, Permanganate	8.02	0.72	0.3	0		8.64	0		\$ -	72	\$ 5,008	\$ 5,008	\$ 4,569,000	
Scenario 3 - New Air, Permanganate	8.02	0.72	3.2	0		5.91	0		\$ -	49	\$ 3,427	\$ 3,427	\$ 3,128,000	
Scenario 4 - New Air, Chlorine, Permanganate	8.02	0.72	3.2	0	3.08	1.38	26	\$ 2.14	\$ 399	12	\$ 2.16	\$ 801	\$ 1,200	\$ 1,095,000
Scenario 5a - NO Air, Permanganate	8.02	0.72	0	0		8.92	0		\$ -	74	\$ 5,171	\$ 5,171	\$ 4,719,000	
Scenario 5b - NO Air, Chlorine, Permanganate	8.02	0.72	0	0	5.13	1.38	43		\$ 664	12	\$ 801	\$ 1,465	\$ 1,337,000	
Scenario 5c - Existing Air, Chlorine, Permanganate	8.02	0.72	0.3	0	4.94	1.38	41		\$ 639	12	\$ 801	\$ 1,440	\$ 1,314,000	

- Chemical costs will go up with use of permanganate
- Difference in Scenarios 4 and 5c, results in ~5 year payback for new aeration equipment (~\$1.1M)

## Notes

Assuming 90 % of total iron is dissolved

Assuming 95 % of total manganese is dissolved

Existing Air: DO = 6.3 mg/L with 0.30 mg/L Fe oxidation (from bench testing)

New Air: DO = 9.0 mg/L with 3.2 mg/L Fe oxidation (from bench testing)

Scenario #4: Air for some Fe, Chlorine for remaining Fe, KMnO4 for Mn

Scenario #5: No Air for Comparison

Chlorine cost per O'Fallon's new cost in June 2023

Permanganate cost per Fife budgetary info for totes, Nov 2022

**Recommendation 2.3 - Modification of EQ Basin**

<b>Item</b>	<b>Unit</b>	<b>Quantity</b>	<b>Unit Cost</b>	<b>Cost</b>
Decant Pump Station	LS	1	\$ 196,000	\$ 200,000
6" DI Piping (to WWTP)	LF	2000	\$ 180	\$ 360,000
6" Valves	EA	4	\$ 10,000	\$ 40,000
Site Work	LS	1	\$ 30,000	\$ 30,000
Concrete Work	LS	1	\$ 20,000	\$ 20,000
Temporary Bypass	LS	1	\$ 10,000	\$ 10,000
Rerouting of Sanitary Piping	LS	1	\$ 20,000	\$ 20,000
Level Instrumentation	LS	1	\$ 10,000	\$ 10,000
Electrical/Instrumentation/Controls @ 20%	LS	1	\$ 140,000	\$ 140,000
<i>Subtotal</i>				\$ 830,000
Contingency @ 30%				\$ 250,000
<i>Subtotal</i>				\$ 1,080,000
Contractor GC/I/P/etc @ 30%				\$ 330,000
Engineering @20%				\$ 220,000
<b>Total</b>				<b>\$ 1,630,000</b>



CREATE AMAZING.

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