

BEFORE THE
WASHINGTON UTILITIES & TRANSPORTATION COMMISSION

UW-240151

CASCADIA WATER, LLC

September 26, 2024

Direct Exhibit of Culley J. Lehman

**SUMMARY OF PILOT TESTING, ESTATES WATER SYSTEM,
NORTH AND SOUTH WELLS**

Exh. CJL-5



DATE: August 24, 2021

TO: Jeff Tasoff, P. E.
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FROM: Cullen J. Wilder, P.E.¹

SUBJECT: Summary of Pilot Testing, Estates Water System, North and South Wells

On August 9, 2021, we pilot tested the North and South Wells belonging to the Estates Water System. The purpose of the pilot test was to determine the efficacy of the ATEC system in removing manganese from the water produced by either of these wells and to identify the optimal ATEC filtration equipment for treatment that will reliably remove this contaminant to less than its Secondary Maximum Contamination Level (SMCL) set by the USEPA of 0.05 mg/L.

The treatment system is to have a capacity of either of the two wells at 200 gpm.

The pilot filter system is designed to simulate actual operation of an ATEC filter system on a small scale in terms of retention, media depth, flow per cubic foot of media, flow per square foot of media (loading rate) and so forth. During the pilot testing the pilot trailer's field lab was used to determine chlorine, iron, manganese, hydrogen sulfide (H₂S) and ammonia concentrations in the raw and finished water.

Excellent pilot test results were attained for each of these wells. Based on these results, an ATEC filter system comprised of (5) 30-inch filters with 60-inch sidewalls filled with 42-inches of AS-741M (pyrolusite) media is recommended. The system would be delivered on one skid, with piping, manifolds, valves, underdrain and underdrain support factory installed. Preliminary plans for the recommended system are given in this report.

The remainder of the report discusses the pilot testing and the recommended system. This report is meant to summarize and document the results of the pilot testing and the basis for the recommended systems. This pilot test report should be helpful in preparing a technical report given in WAC 246-290-110 but is not meant to satisfy the requirements in this section.

General Description of the ATEC Iron, Manganese and Arsenic Removal Process

ATEC Systems uses pyrolusite based media for its high-rate arsenic, iron, and manganese removal systems. The iron is oxidized to its insoluble state and filtered while the manganese is adsorbed on the surface of the media where it is secured and oxidized in place. Chlorine is injected immediately upstream of the filters. The chlorine is used to oxidize the iron and to maintain the filter bed in an oxidized state, not to oxidize and precipitate the manganese as is the case with most other treatment systems.

¹ Registered in WA and CA

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In this pilot test, chlorine was introduced to the influent ahead of four 6-inch diameter filter columns with 60-inch filter sidewalls. The filters are manifolded together at the inlet and outlet and filled with AS 741 M Filter Media. The pilot test characteristics are given in the Appendix.

Pilot testing results for the wells are tabulated in Tables 1 and 2 and shown graphically in Figures 1, 2, and 3 of this report.

Pilot Test Results

A total of 12 samples were taken on a half-hourly basis until the end of the test. Other than the first sample taken at the start, the North Well was found to have manganese much lower than the SMCL. Therefore, at 11:30 the testing of the North Well was ended and the testing continued at the South Well.

The sizing of the treatment systems is based on the testing the South Well, 9 samples numbers 3 through 11.

The average loading rate of the South Well was 8.82 gpm/sf.

Raw water manganese concentrations of the water of the South Well were consistent averaging 0.079 mg/L, a little more than 50 % above the SMCL of 0.050 mg/L.

In three tests ammonia ranged from 0.05 mg/L to 0.08 mg/L, averaging 0.067 mg/L. The USEPA has no standard for ammonia, but its presence can often be the cause of taste and odor complaints.

Chlorine dosage varied little, averaging 2.45 mg/L. Treated water chlorine concentration averaged 1.54 mg/L. The average chlorine demand was 0.91 mg/L.

Manganese removal was excellent. Finish water manganese concentrations of samples 3 – 11 were below the detection limit.

Ammonia concentrations in the finish water were below the detection limit.

Recommended System

At the treatment objective of 200 gpm capacity, the recommended system of (5) 30-inch diameter filters would have a loading rate of 8.16 gpm/sf during production and 10.2 gpm/sf during the 25 minutes of backwash when one filter was out of service.

Summary

Based on ATEC's experience with previous systems with similar water, we recommend that backwash should be set initially at 24 hours. The system should be observed for 6 to 8 weeks to determine whether this interval should be adjusted.

Preliminary drawings for this system are included in this report.

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Summary of the Recommended Filter System

<u>Parameter</u>	<u>Value</u>
Production Rate	200 gpm
Loading Rate	8.16 gpm/sf
Backwash Rate	28 gpm/sf
Backwash Flow	137 gpm
Backwash Duration	5-minutes per filter
Backwash Frequency	24 hours of production
Backwash Amount	3,425 gallons
Production Between Backwash Cycles	288,000 gallons
Backwash as a Percentage of Production	1.2 %

Please contact me if you have any questions or need further information.

Yours truly,



Cullen J. Wilder, P.E. (CA, WA)
Vice President
ATEC Systems Associates, Inc.
916-742-5542 (direct)

Table 1
Summary of Pilot Study Test Conditions
Estates Water System, North and South Wells
August 9, 2021

<u>Date</u>	<u>Sample Number</u>	<u>Time</u>	<u>Meter Reading (Gallons)</u>	<u>Average Flow (gpm)</u>	<u>Loading Rate (gpm/ft²)</u>	<u>Loading Rate (gpm/ft³)</u>	<u>Media Contact Time (Minutes)</u>	<u>Cl₂ Dose (mg/L)</u>	<u>KMnO₄ as Mn (mg/L)</u>	<u>Temp °C</u>
Noth Well	8/9 Start	10:00	-	4.53	5.77	1.65	4.54	2.56	0.810	13.0
	1	10:30	175.3	5.84	7.44	2.13	3.52	1.98	0.875	13.0
	2	11:00	314.5	4.64	5.91	1.69	4.43	3.64	2.996	13.0
South Well	3	12:00	447.8	6.86	8.73	2.50	3.00	2.46	0.749	11.5
	4	12:30	668.8	7.37	9.38	2.68	2.79	2.29	0.470	11.8
	5	13:00	892.4	7.45	9.49	2.71	2.76	2.26	0.504	11.8
	6	13:30	1,089.1	6.56	8.35	2.39	3.14	2.57	0.863	11.6
	7	14:00	1,278.1	6.30	8.02	2.29	3.26	2.68	1.158	11.8
	8	14:30	1,511.1	7.77	9.89	2.83	2.65	2.17	0.852	11.6
	9	15:00	1,709.2	6.60	8.41	2.40	3.11	2.56	0.925	11.8
	10	15:30	1,903.9	6.49	8.26	2.36	3.17	2.60	1.370	11.7
	11	16:00	2,112.6	6.96	8.86	2.53	2.96	2.43	1.175	11.9
Total or Average			2,112.60	6.45	8.21	2.35	3.28	2.52	1.062	12.0

NA, indicates Not Applicable for this test

Not Dosed, (ND) indicating the period of the test

Not Tested, (NT) indicating no value entered because there was no sample to test

Media contact time = Empty bed contact time

200 gpm each (North and South Wells, 85 psi

Used 42" AS-741 media

Sodium Hypochlorite titrated @ 7592.4

BW start of the test

Used Booster pump

Air in supply water of North Well

Only able to get 5.5 gpm from North well deadhead and using booster pump

Due to the Fe/Mn results of the North Well, moved to South well after 11:30 run

Backwashed air from filter columns

Able to get better flow from South Well

Operator states they can occasionaly smell H₂S

Backwashed end of test

Table 2
Summary of Pilot Test Results
Estates Water System, North and South Wells
August 9, 2021

Sample Number	Source Water							Product Water								
	pH (Units)	Fe (mg/L)	Mn (mg/L)	H ₂ S (mg/L)	Ammonia (mg/L)	Silica (mg/L)	PSI	pH (Units)	Cl ₂ (F) (mg/L)	Cl ₂ (T) (mg/L)	Fe (mg/L)	Mn (mg/L)	H ₂ S (mg/L)	Ammonia (mg/L)	Silica (mg/L)	PSI
Start	7.00	0.02	0.029				19	7.00	1.63	1.75	-	0.013				14
1	7.00	0.01	0.009				19	7.00	1.07	1.11	-	-				14
2	7.00	0.02	0.018				19	7.00	0.51	0.64	-	0.003				14
3	7.00	0.04	0.072	-		6.60	12	7.00	1.19	1.71	-	-	-		6.60	6
4	7.00	0.05	0.079		0.080		12	7.00	1.12	1.82	0.01	-		-		6
5	7.00	0.06	0.064		0.070	9.70	12	7.00	1.27	1.76	-	-		-	9.78	6
6	7.00	0.06	0.077		0.050		12	7.00	1.19	1.71	-	-		-		6
7	7.00	0.05	0.091				12	6.90	1.12	1.52	-	-				6
8	7.00	0.05	0.078				12	6.90	1.05	1.32	-	-				6
9	7.00	0.04	0.071				12	7.00	0.99	1.63	-	-				6
10	7.00	0.05	0.093				11	6.90	0.99	1.23	-	-				5
11	7.00	0.04	0.081				11	7.00	0.81	1.25	-	-				5
Total or Average	7.00	0.04	0.064	-	0.067	8.15	14	6.98	1.08	1.45	0.00	0.001	-	-	8.19	8
Average as Percent of MCL		13.6%	127.0%								0.30%	2.91%				
Average Removal Rate											97.8%	97.71%				

Non Detect, indicating the absence of a metal or chemical at or above the method detection limit is shown as "-" and calculated in the total or average as zero.

Figure 1
Pilot Test Results
Chlorine Dosage and Free Residual Concentrations
Estates Water System, North and South Wells
August 9, 2021

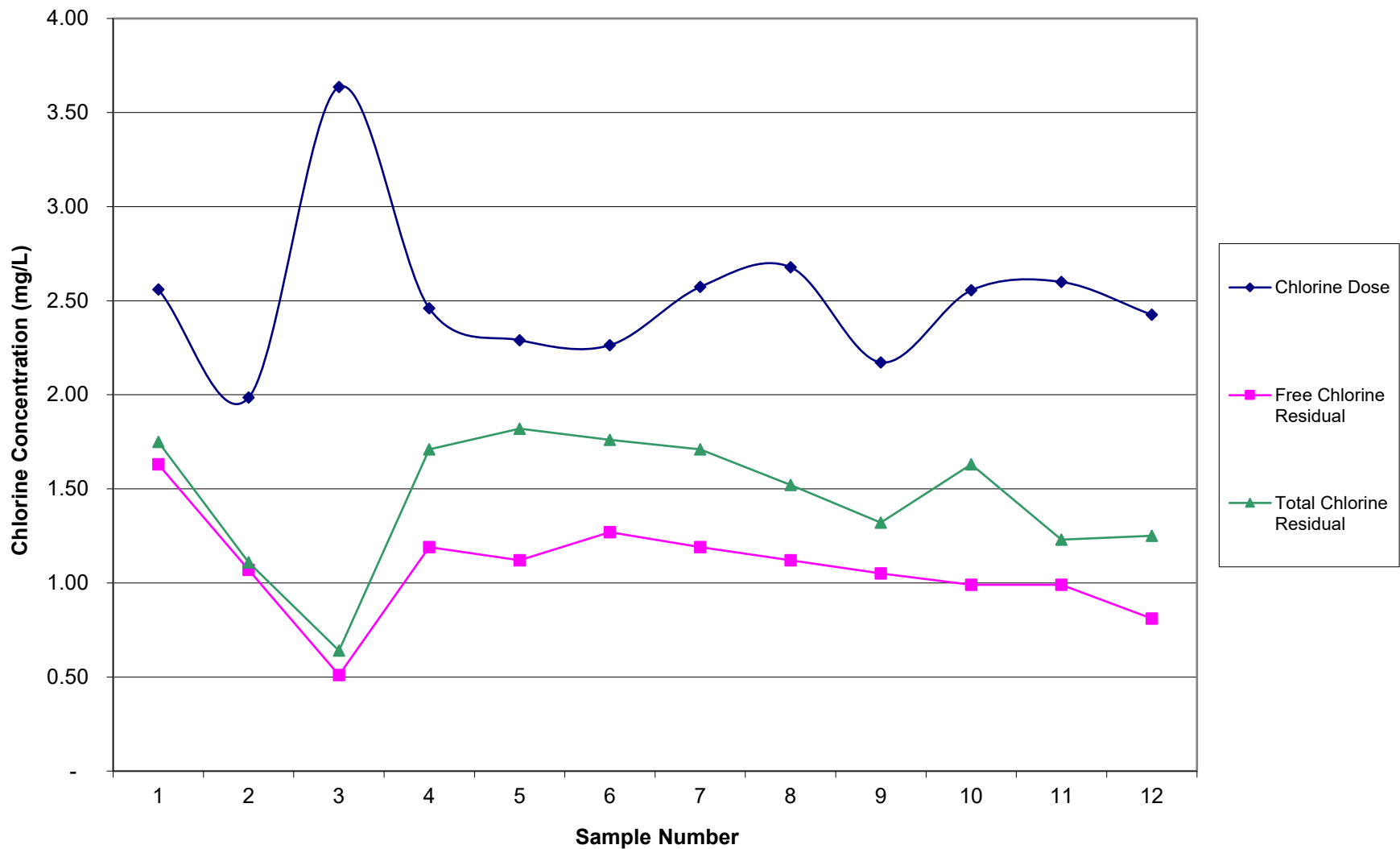


Figure 2
Pilot Test Results
Manganese Removal Using AS-741M Filter Media
Estates Water System, North and South Wells
August 9, 2021

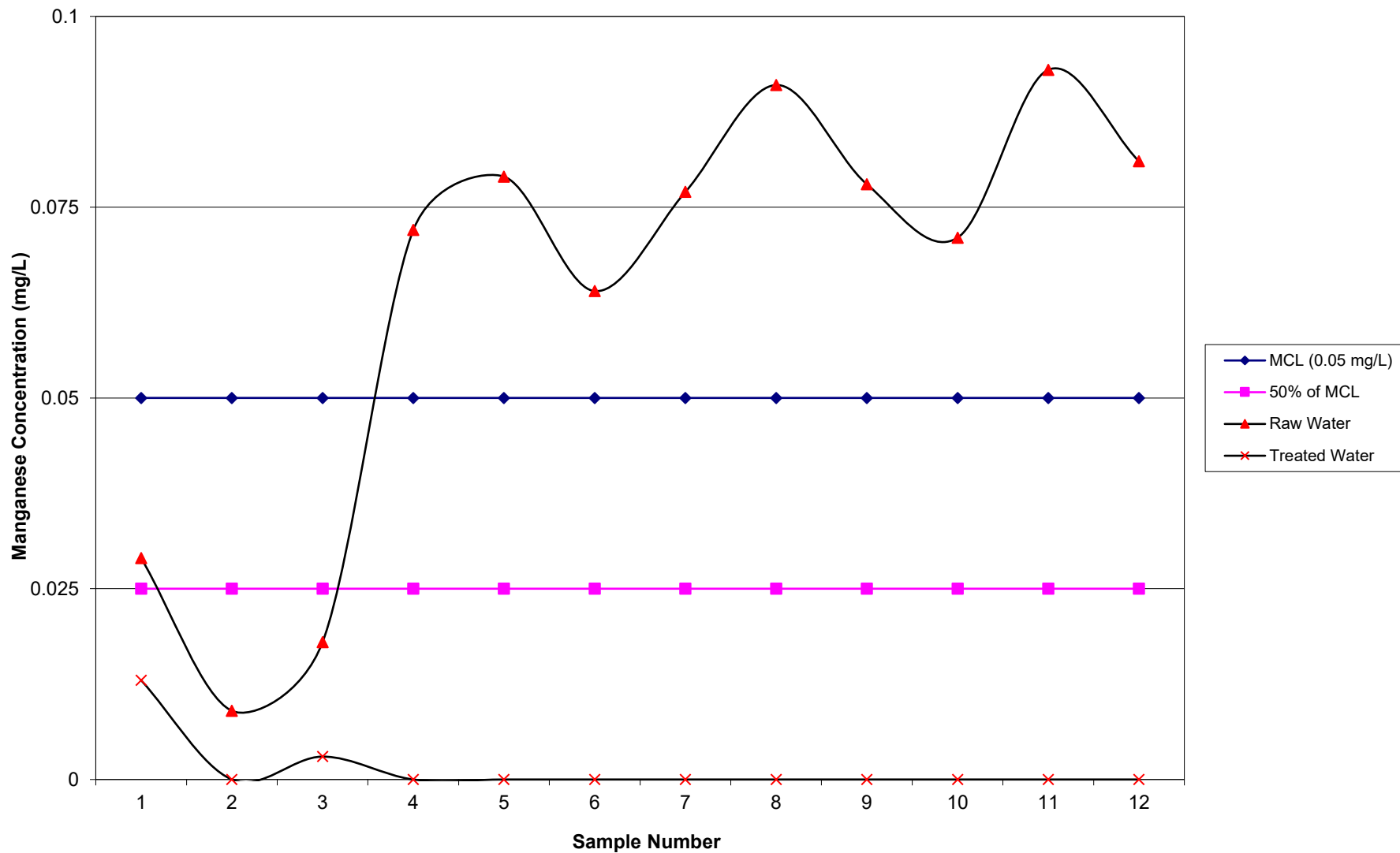
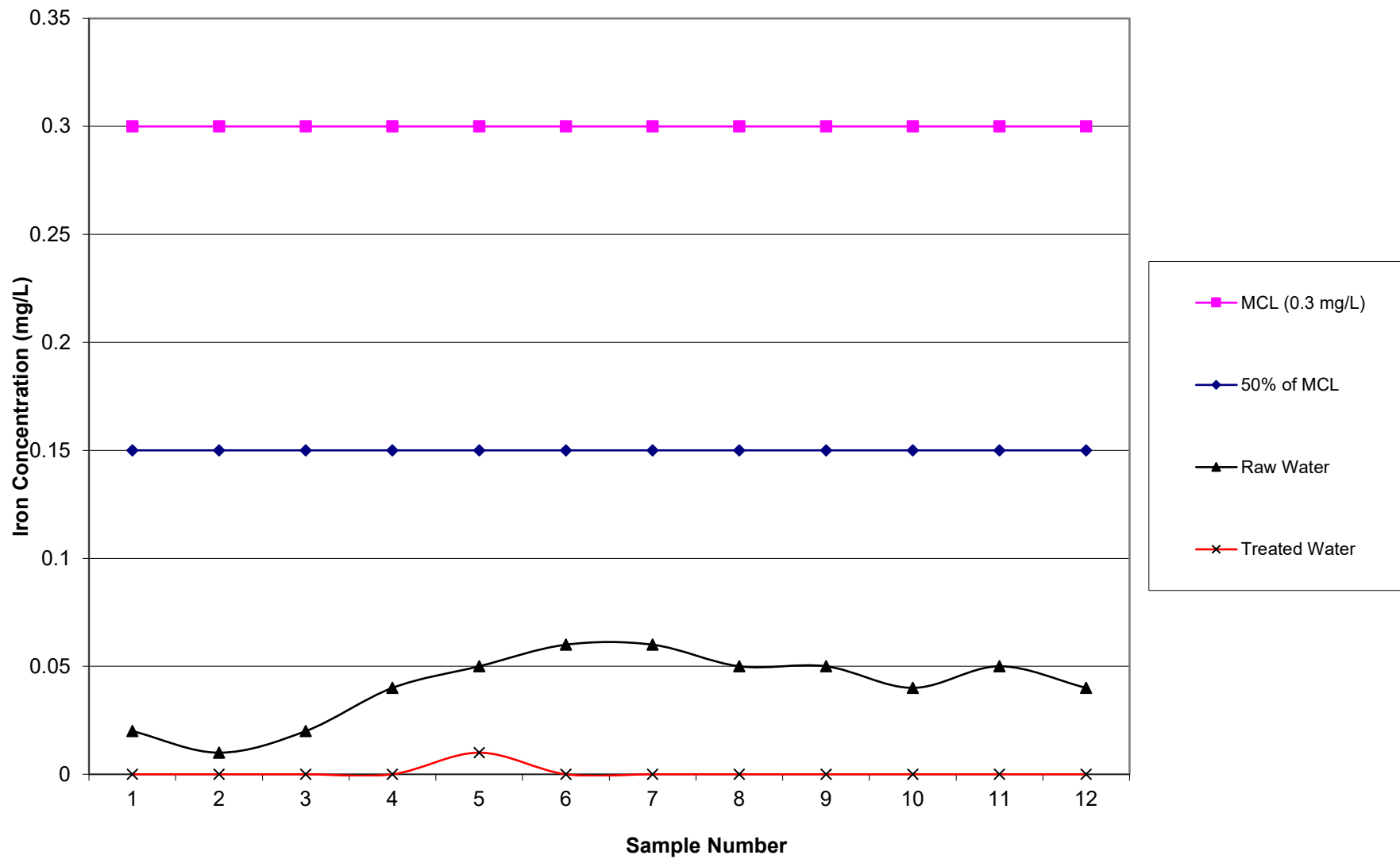
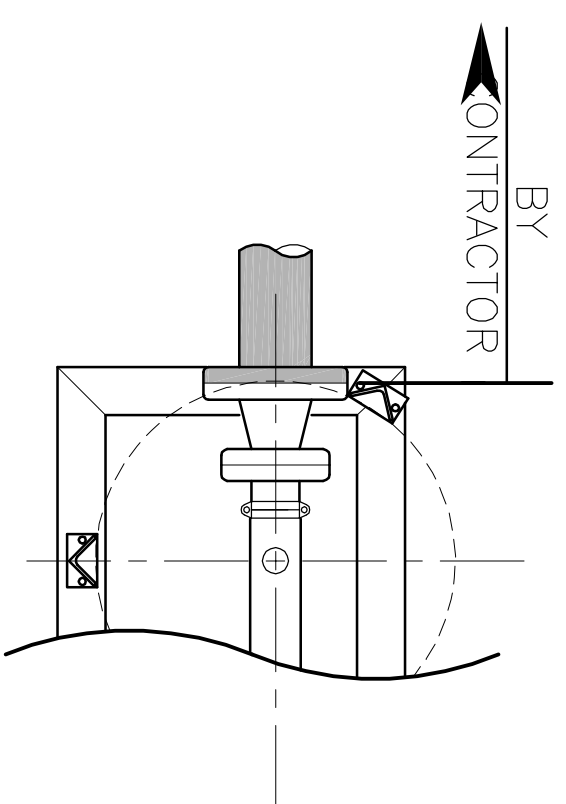
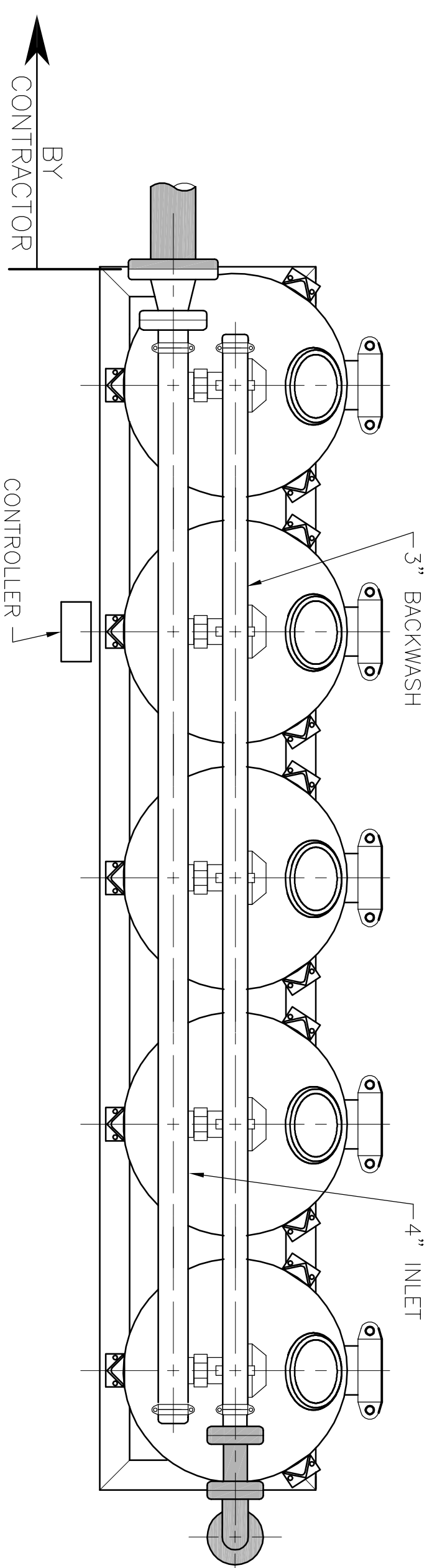


Figure 3
Pilot Test Results
Iron Removal Using ATEC AS-741M Filter Media
Estates Water System, North and South Wells
August 9, 2021

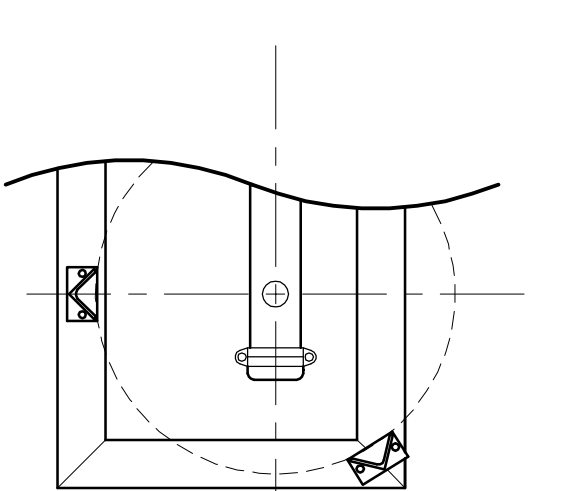




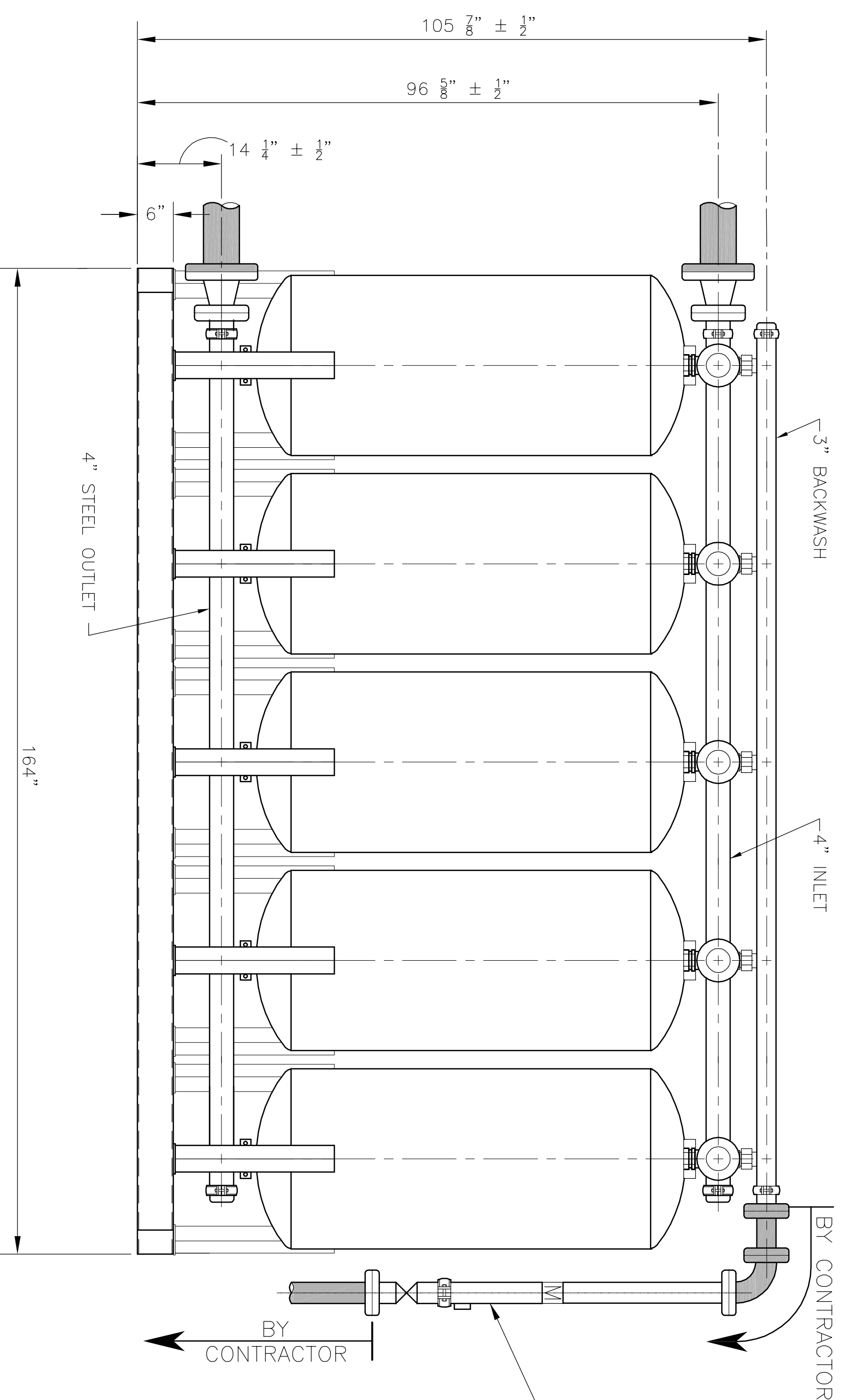
LEFT SIDE, FILTERS REMOVED



PLAN VIEW

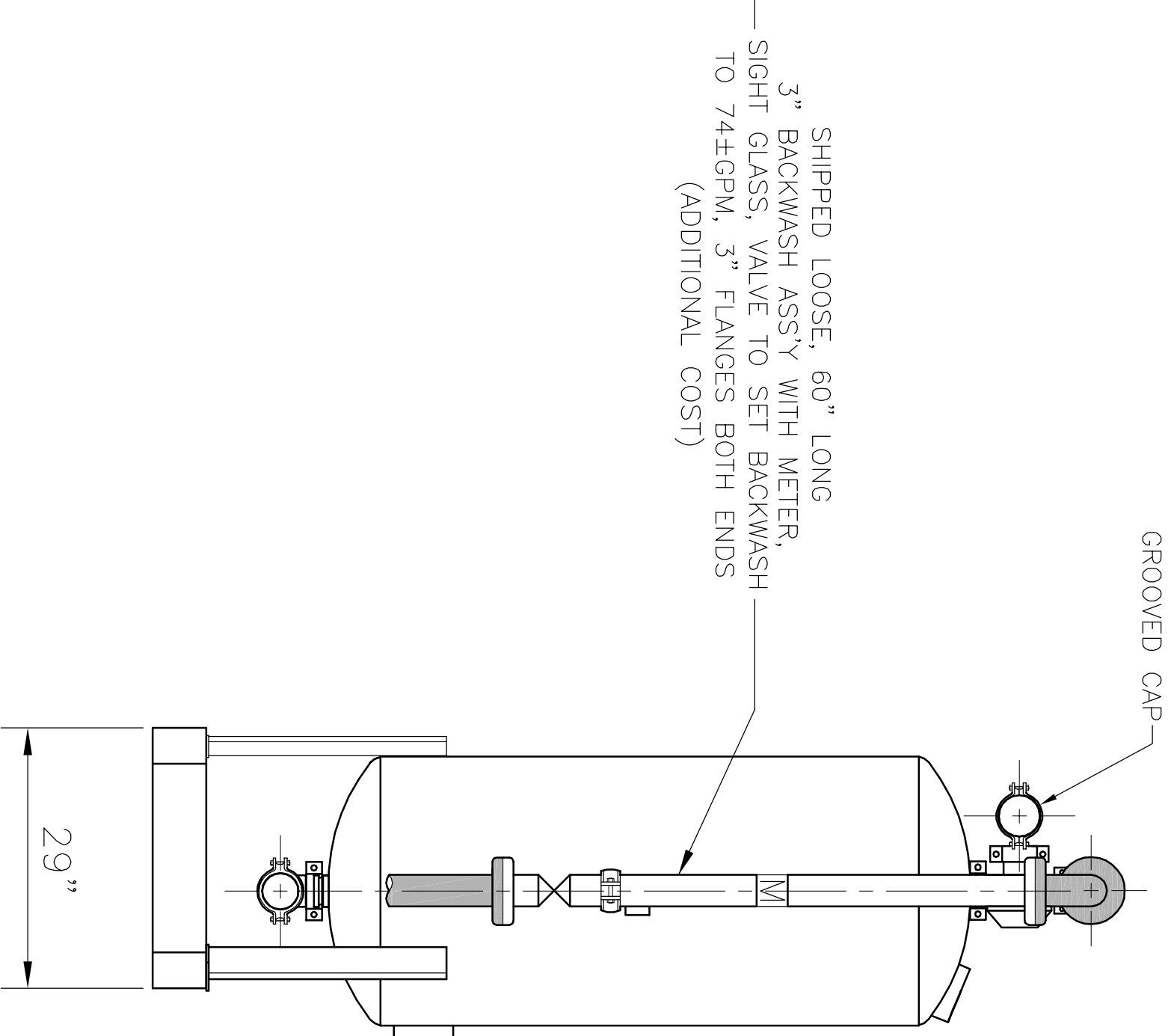


RIGHT SIDE, FILTERS REMOVED



LEFT ELEVATION

FRONT ELEVATION



RIGHT ELEVATION

NOTE: A 60" LONG, 3-INCH BACKWASH FLANGED BACKWASH ASSEMBLY WITH REGULATING VALVE, METER AND SIGHT GLASS CAN BE SHIPPED LOOSE TO REGULATE BACKWASH TO 137 GPM, (EXTRA COST ITEM).

ATEC
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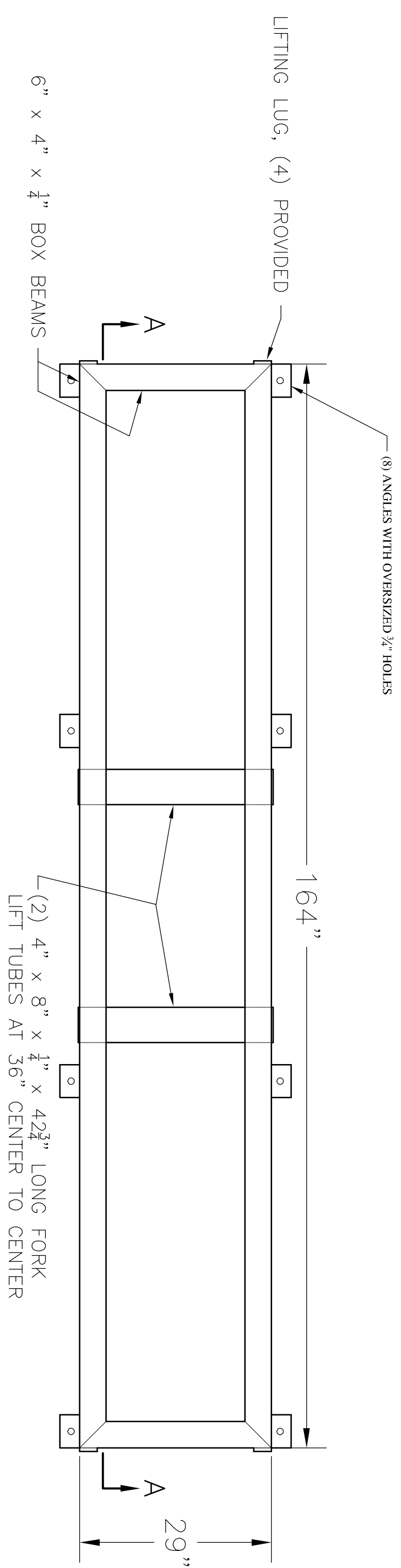
DESIGN BY:	
DRAWN BY:	
CHECKED BY:	
APRD BY:	
NO.	DATE
BY	APVD

SCALE IN FEET
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1" = 1'-0"
SCALEABLE IN 11x17 - 1/2" = 1'-0"

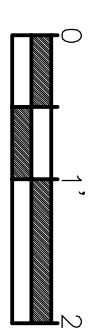
IRON AND MANGANESE TREATMENT
ESTATES WATER SYSTEM
NORTH AND SOUTH WELLS

FILTER DETAILS

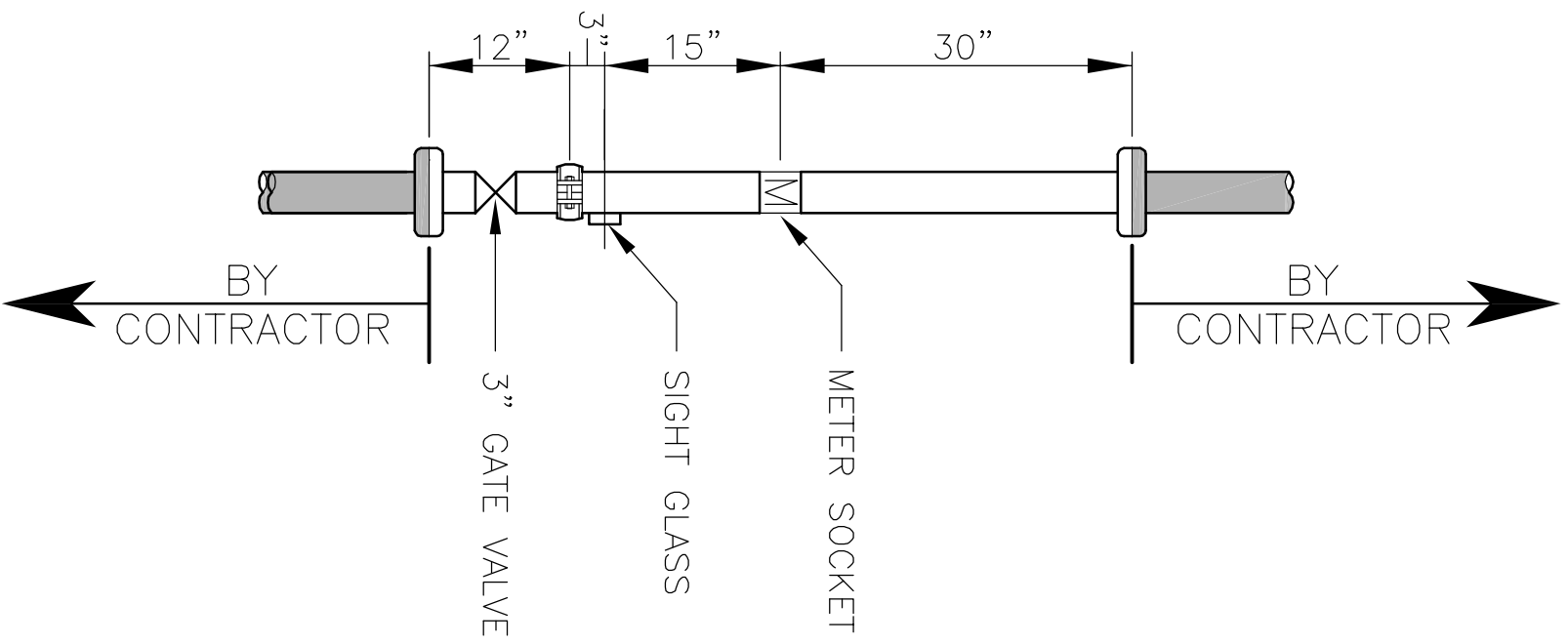
SHEET NO.	1 of 1
DWG. NO.	
DATE:	8/20/2021
FILE:	Estates Water System N & S



SKID PLAN
(5 FILTER)



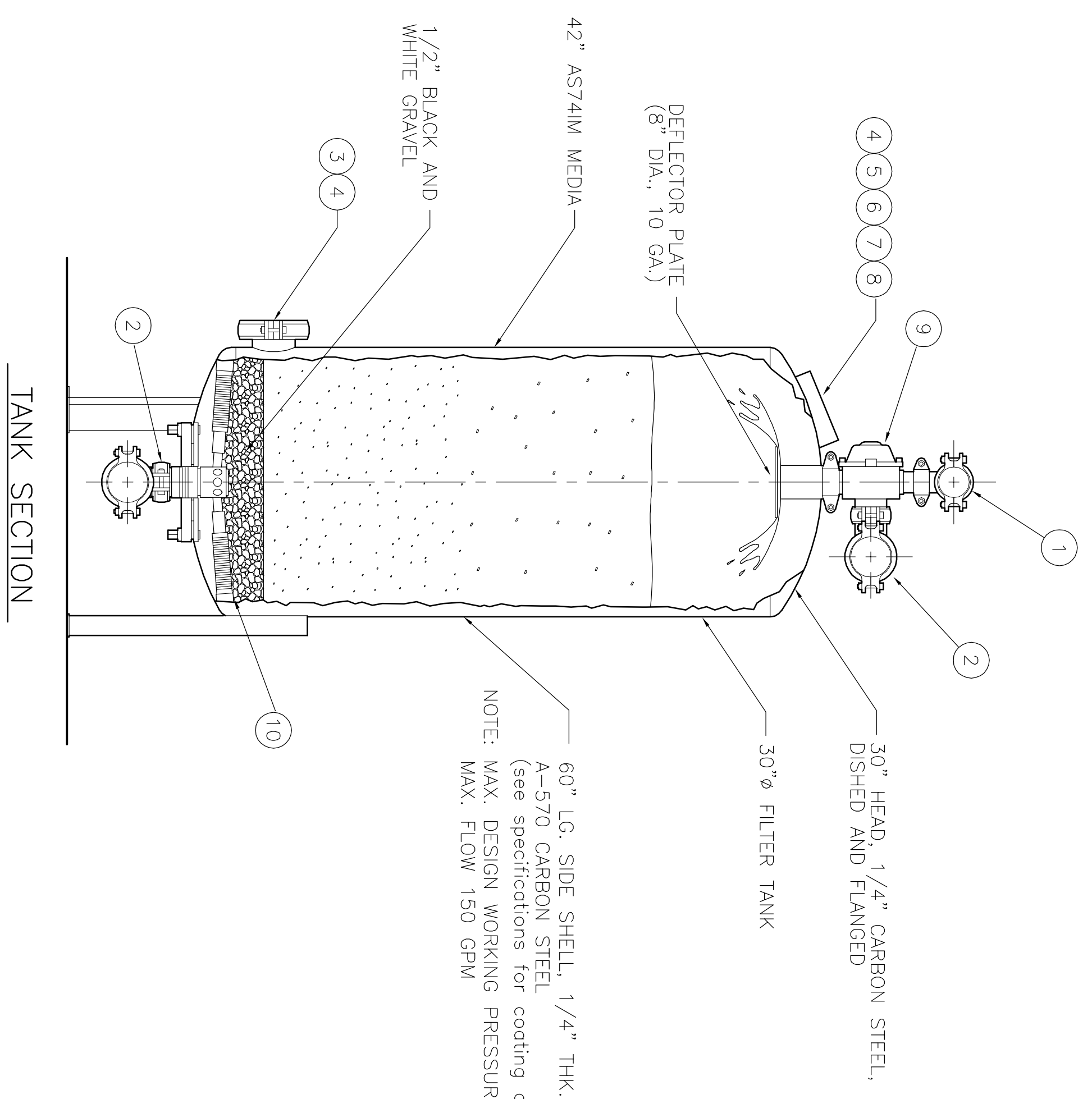
NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1" = 1'-0"
SCALEABLE IN 11x17 - 1/2" = 1'-0"



BACKWASH ASSEMBLY
(SHIPPED LOOSE)
(ADDITIONAL COST)

NOTE:

DIMENSIONS GIVEN ARE FOR THE CONTRACTOR'S INFORMATION, BUT WILL VARY BECAUSE OF NORMAL FABRICATION TOLERANCES. CONTRACTOR SHALL CONNECT EXTERIOR PIPING TO FIT THE ATEC UNIT AS SHIPPED.

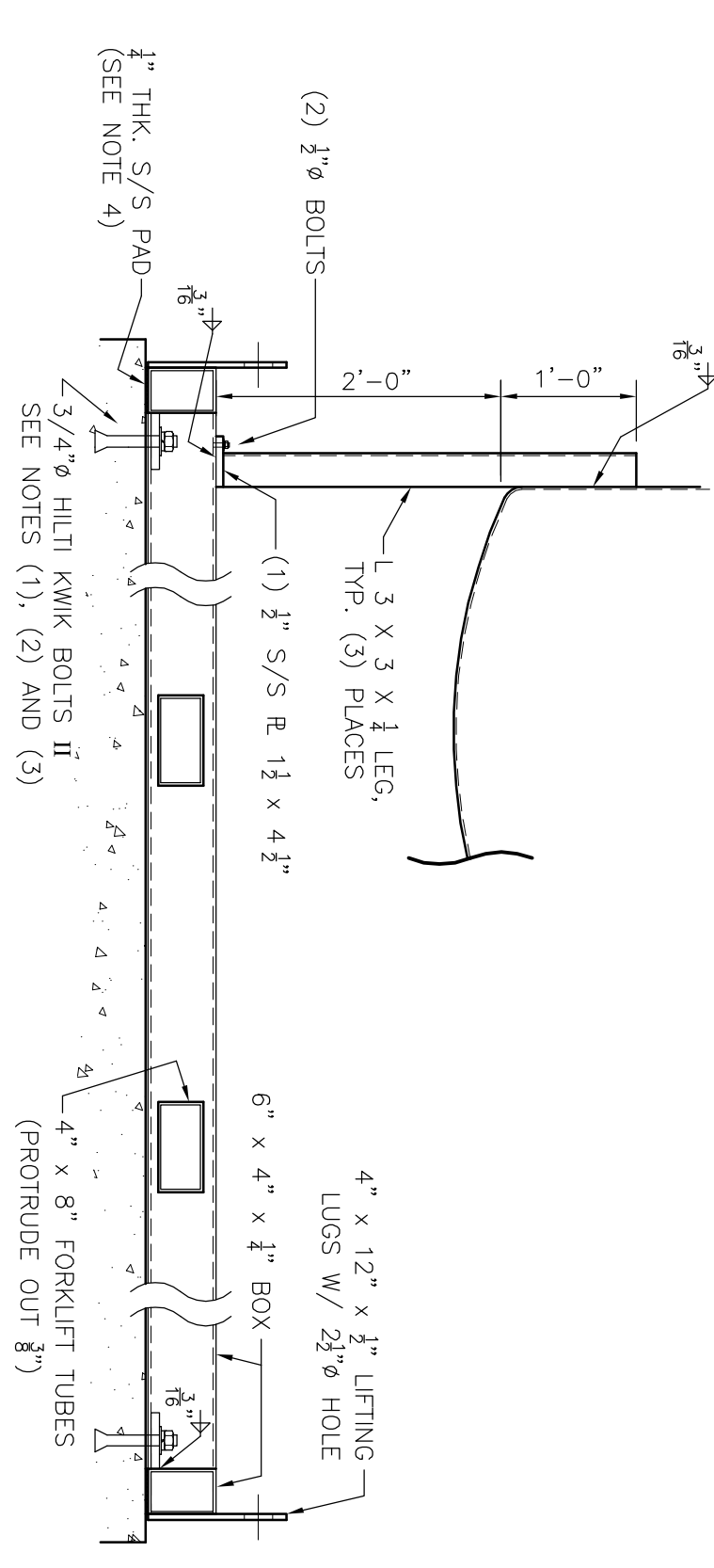


TANK SECTION

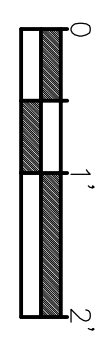
NOTE: MAX. DESIGN WORKING PRESSURE 150 PSI
MAX. FLOW 150 GPM

BILL OF MATERIAL		
ITEM	QTY	PART NO. DESCRIPTION
1	1	PFS-CPJ03 3" GROOVED COUPLING, CAST IRON W/ BOLTS & GASKET
2	3	PFS-CPJ04 4" GROOVED COUPLING, CAST IRON W/ BOLTS & GASKET
3	1	PFS-CAPO8 8" GROOVED END CAP
4	1	PFS-CPJ08 8" GROOVED COUPLING, CAST IRON W/ BOLTS & NUTS
5	1	PFS-HHP11 11"x15" HAND HOLE PLATE
6	1	PFS-HHR11 11"x15" HAND HOLE GASKET
7	1	PFS-HHOS11 11"x15" HAND HOLE BOLT SET
8	1	PFS-HHOR11 11"x15" HAND HOLE HOLD DOWN GRAB
9	1	UA SS48 3"x3"x3" SERIES 350 BERHAD BACKWASH VALVE
10	1	V-BF-4 UNDER-DRAIN ASSEMBLY 31BL. SS W/ SOH 80 PVC CAP COMPLETE

NOTE: QUANTITIES FOR ONE (1) TANK



SECTION A-A
SCALE 1" = 1'-0"



NOTE: CHECK SCALE
SCALEABLE IN 22x34 - 1" = 1'-0"
SCALEABLE IN 11x17 - 1/2" = 1'-0"

- NOTES:
- (1) DESIGNER SHALL DETERMINE NO. AND DEPTH OF ANCHOR BOLTS TO SUIT LOCAL CODE REQUIREMENTS. FOUR BOLTS ARE REQUIRED AS A MINIMUM AT EXTERIOR GUSSETS.
 - (2) ANCHOR BOLT HOLES ARE TO BE DRILLED INTO CONCRETE FOUNDATION THROUGH OVERSIZED DRILL HOLES IN GUSSETS IN SKID ASSEMBLY BY INSTALLATION CONTRACTOR.
 - (3) 1/4" THICK S/S PADS ARE PROVIDED UNDER SKIDS FOR CLEARANCE BETWEEN SKIDS AND CONCRETE FOUNDATION. SIX PADS ARE PROVIDED FOR 2 & 3 FILTER SKIDS, EIGHT PADS FOR 3-14 FILTER SKIDS

FILTER TANKS AND MANIFOLDS ON THIS SHEET SUPPLIED BY ATEC SYSTEMS:

THE CONTRACTOR WILL BE RESPONSIBLE FOR:
 1. UNLOADING THE UNITS AND PLACING THEM IN THE CORRECT INSTALLED LOCATION.
 2. ATTACH MANIFOLDS CONNECTING THE TWO BANKS OF FILTERS.
 3. LOADING THE TWO TYPE OF MEDIA INTO THE FILTER.
 4. CONNECTING POWER SUPPLY TO FILTER BACKWASH PLC (120 VAC, SWITCHED CIRCUIT).

ATEC
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DESIGN BY:	
DRAWN BY:	
CHECKED BY:	
APRD BY:	

NO.	DATE	BY	APVD

IRON AND MANGANESE TREATMENT
ESTATES WATER SYSTEM
NORTH AND SOUTH WELLS

FILTER DETAILS

SHEET NO. 2 of 1
DWG. NO.
DATE: 8/20/2021
FILE: Estates Water System N & S

APPENDIX



Table 1

**Physical Characteristics of Pilot Filter Set and Media
ATEC Iron and Manganese Removal System**

Pilot Filters¹

Sidewall Height (inches)	48 to 60
Overall Height (inches)	62 to 74
Diameter (inches)	6
Filter Surface Area (each) (ft. ²)	0.1964
Total Filter Surface Area (ft ²)	0.7854
Underdrain	Stainless Steel Wedgewire, 0.01" slots
Media Support	¾" minus crushed granite, 4"
Source Water Connections	¾" Standard Hose
Recommended Minimum/Maximum Working Pressure	20/90 psi

Filter Media²

Depth in Filters (inches)	36 to 48
Volume in Filters (ft ³)	2.36 to 3.15
Approximate Weight in Filters (lbs.)	285
Weight (lbs./ft ³)	120.5
Physical Size (mm)	0.32 –to-0.85

Maximum Removal Capacity

Iron Removal (mg/L)	10
Manganese Removal (mg/L)	10
Hydrogen Sulfide Removal (mg/L)	5
Non-Adsorptive Removal (microns)	>20

Chemical Dosing Equipment³

Stenner Peristaltic Solution Metering Pumps (up to 17.0 gpd @ 100 psi)
LMI Solution Metering Pumps (various capacities)

Other Equipment

Chlorine Analyzer, Hach CL 17 or ProMinent D2C
Flow Meters, Sea Metrics, Inc., FT-420
Data Logger, Endress + Hauser, Mini-Logger
Automatic Samplers, ISCO, Inc.

^{1/} The pilot filter plant consists of four, 6" filter columns connected by common manifolds for influent, effluent and backwash water. Each filter is controlled by a three-way ball valve. The system is set up to closely mimic a full-scale filter system in terms of media depth, application rates in terms of both area (gpm/ft² of filter area) and volume (gpm/ft³ of media), and backwash characteristics to the extent possible. Source water is metered using a totalizing flow meter. Pressure is measured on the influent and effluent manifold to determine headloss. Chemical injection points are located as close to the filter as possible to simulate actual operation. In cases where extended contact time is desired before the source water enters the filters, a pipe section of pre-determined volume is placed between the chemical injection points and the filters to provide accurate contact time measurement. Sidewall height is variable to a maximum of 60" without modification, allowing a maximum media bed depth of 48".

- ^{2/} AS-721M and AS-741M Filter Media, 0.85 to 2.36mm and 0.42mm to 0.85mm, respectively, are both granular manganese dioxide media, derived from naturally occurring pyrolusite, and are certified to ANSI/NSF Standard 61.
- ^{3/} Solution metering pumps are available for the injection of up to three chemicals, if needed. Normally, the only chemical injected is chlorine. And in the case of arsenic, ferric chloride. There are, however, provisions for special circumstances, such as pH adjustment for corrosion control or the treatment of water at fish hatcheries that do not permit chlorine.

Table 2 Analytical Equipment

The following analytical equipment is normally carried on our pilot trailers.

Spectrophotometer, Model DR/2800, Hach Co., Loveland, CO
Digital Titrator, Hach Co., Loveland, CO
pH Meter, Model 266, Orion Co., Boston, MA
Stir Plate, Hach Co., Loveland, CO
0.45-Micron Filter, Nalgene

Glassware—beakers, flasks, columns, sample cells, 10 and 25 ml

Although not normally carried in each trailer, a turbidity meter is available.

Reagents for the following field tests:

Spectrophotometer

Free Chlorine, DPD, Method 8021 and 10059 (300 tests)
Total Chlorine, DPD, Method 8167 or 10060 (300 tests)

Iron, FerroZine Method, Method 8147 (500 tests)
Iron, Total, FerroVer Method, Method 8008 (300 tests)

Manganese, Low Range, PAN Method, Method 8149 (500 tests)

Nitrogen, Ammonia, Salicylate Method, Method 8155 (100 tests)

Sulfide, Methylene Blue Method, Method 8131 (100 tests)

Silica, Molybdate Method, Method 8282 (100 tests)

Digital Titrator

Alkalinity, Phenolphthalein and Total Method, Method 8203 (100 tests)
Hardness, Phenolphthalein and Total Method, Method 8203 (100 tests)
Total Chlorine, Iodometric Method, Method 8209 (100 tests)

Field tests not listed above may be available. Please note that we send all tests for arsenic and other contaminants that require digestion or distillation to a commercial laboratory.

Figure 1

ATEC Iron and Manganese Removal Pilot Plant



The exterior of ATEC Systems' pilot trailer is shown above. The source and product water connections are shown entering and exiting the trailer. Inside dimensions are 14' x 6' x 6½'.



The front one-half of the trailer is shown above. The instrument foreground on the wall is an in-line chlorine analyzer. The smaller boxes on the wall above the light are electronic flow meters used to monitor cumulative as well as instantaneous flow for each treatment train in the pilot plant.



Picture above shows the interior of the pilot plant trailer from the rear. The sample outlets and the analytical equipment are on the desk in the front of the trailer.



The picture on the left shows one set of filters. Source water enters through the hose inlet in the wall, passes through a flow meter, past a chlorine injection point, through an in-line static mixer, into the inlet manifold, down through the filter media. Product water is discharged through the wall. The pail holding the sodium hypochlorite solution can be seen to the right of the filter vessels and the in-line chlorine analyzer is on the wall above the NaOCl container. The sample ports and analytical equipment is forward of the chlorine analyzer. A second container of Ferric Chloride solution and feed pump is provided for pilot testing for arsenic removal.

Table 3
SUMMARY OF SITE AND INITIAL DATA REQUIREMENTS

1. Power, 115 VAC for injection equipment and lighting
2. Source water, minimum 10 gpm @ 30 psig (ATEC will supply pump if necessary).
3. Disposal of water and backwash effluent¹

Data Needed from Utility

1. Comprehensive Water System Plan (relevant sections)
2. Inorganic test results (most recent)

¹ Any necessary permits are the responsibility of the client

