CITY COUNCIL WORKSHOP
CITY OF BAY CITY

Tuesday, December 06, 2022 at 4:30 PM
COUNCIL CHAMBERS | 1901 5th Street

COUNCIL MEMBERS

Mayor: Robert K Nelson
Mayor Pro Tem: Jim Folse
Council Members: Floyce Brown, Bradley Westmoreland, Becca Sitz, Blayne Finlay

Vision Statement

Through a united and collaborative effort, we seek to grow the City of Bay City with a diverse culture that is proud to call Bay City home. We envision a thriving family-centered community where citizens are involved in the future development of our city. We desire our citizens to work, play, worship and shop in the community in which we live. Visitors are welcomed and encouraged to enjoy the friendly environment and amenities the citizens and business owners have created together.

AGENDA

THE FOLLOWING ITEM WILL BE ADDRESSED AT THIS OR ANY OTHER MEETING OF THE CITY COUNCIL UPON THE REQUEST OF THE MAYOR, ANY MEMBER(S) OF COUNCIL AND/OR THE CITY ATTORNEY:

ANNOUNCEMENT BY THE MAYOR THAT COUNCIL WILL RETIRE INTO CLOSED SESSION FOR CONSULTATION WITH CITY ATTORNEY ON MATTERS IN WHICH THE DUTY OF THE ATTORNEY TO THE CITY COUNCIL UNDER THE TEXAS DISCIPLINARY RULES OF PROFESSIONAL CONDUCT OF THE STATE BAR OF TEXAS CLEARLY CONFLICTS WITH THE OPEN MEETINGS ACT (TITLE 5, CHAPTER 551, SECTION 551.071(2) OF THE TEXAS GOVERNMENT CODE).

CALL TO ORDER

CERTIFICATION OF QUORUM

PUBLIC COMMENTS

REGULAR ITEMS FOR DISCUSSION, CONSIDERATION AND / OR APPROVAL

1. **Discuss plan for Public Works to have drainage reviewed prior to project being submitted to Drainage District #1.**

2. **Presentation and discussion regarding arsenic.** Jeremy Gaston, Garver Engineering

3. **Discuss an update on the Wastewater Treatment Plant Project.** Dan Olson, Garver Engineering

ADJOURNMENT

CERTIFICATION OF POSTING

This is to certify that the above notice of a City Council Workshop Meeting was posted on the front window of the City Hall of the City of Bay City, Texas on **Friday, December 2, 2022 before 5:00 pm**. Any questions concerning the above items, please contact the Mayor and City Manager's office at (979) 245-2137.

Summary of Findings Memorandum

City of Bay City
Arsenic Removal Evaluation

Prepared by:

12141 Wickchester Lane, Suite 200
Houston, TX 77079

November 2022

Engineer's Certification

We hereby certify that this Summary of Findings Memorandum for the Arsenic Removal Project was prepared by Garver under our direct supervision for the City of Bay City.

DRAFT ONLY

Jeremy Gaston, PE
State of Texas PE License #127302

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1.0 Project Background

The City of Bay City operates five Water Treatment Plants (WTP) consisting of six groundwater wells serving the city's population. The largest well at the Bay City 6th Street & Avenue I WTP was found to have high levels of arsenic which exceeded the maximum contaminant level (MCL) set by the Texas Commission on Environmental Quality (TCEQ). Compliance with the arsenic Rule requires maintenance of arsenic levels below the MCL at all entry points to the distribution system on a running annual average basis. Arsenic levels can be controlled by blending source waters prior to the entry point, implementing arsenic removal processes at individual wells, or in a centralized treatment facility.

The Bay City 6th Street & Avenue I Well is currently not in production due to the arsenic MCL exceedance. During the previous arsenic exceedance, the City implemented a blending plan to blend water from the water plants prior to the entry point to the distribution system. Generally, blending is a preferred alternative to arsenic removal treatment. However, blending was not found to be effective during this latest violation due to the generally elevated arsenic concentrations occurring at other facilities (while still below the MCL), resulting in higher arsenic concentrations overall in the distribution system water.

Garver contracted with Bay City to perform an arsenic removal study in order to bring their largest well back in operation. Garver was scoped to investigate blending optimization from multiple well sites and several treatment technologies at individual well sites and a centralized treatment facility to reduce the arsenic levels to below the MCL.

2.0 Evaluation of Existing Water Plants

2.1 6th Street and Avenue I

The existing 6th Street & Avenue I WTP consists of one well and vertical turbine pump, chemical building, a 1 MG ground storage tank, booster pump station, and a backup generator (Figure 1). The well production capacity is 1,320 gpm (1.9 mgd). The chemical building stores polyphosphate, chlorine gas cylinders, and fluoride. The chlorine gas cylinders in the chemical building provide an average feed rate of 40 lb/day. There are three pumps in the booster pump station building: with a capacity of 500 gpm, 1,000 gpm, and 1,500 gpm respectively. Appendix A contains record drawings of the 6th Street and Avenue I WTP from the City.

As shown on Figure 1, the 6th Street & Avenue I WTP has limited space for new treatment units or equipment. Subsequently, tree removal and/or fence relocation may be necessary or additional land or easement may be necessary.

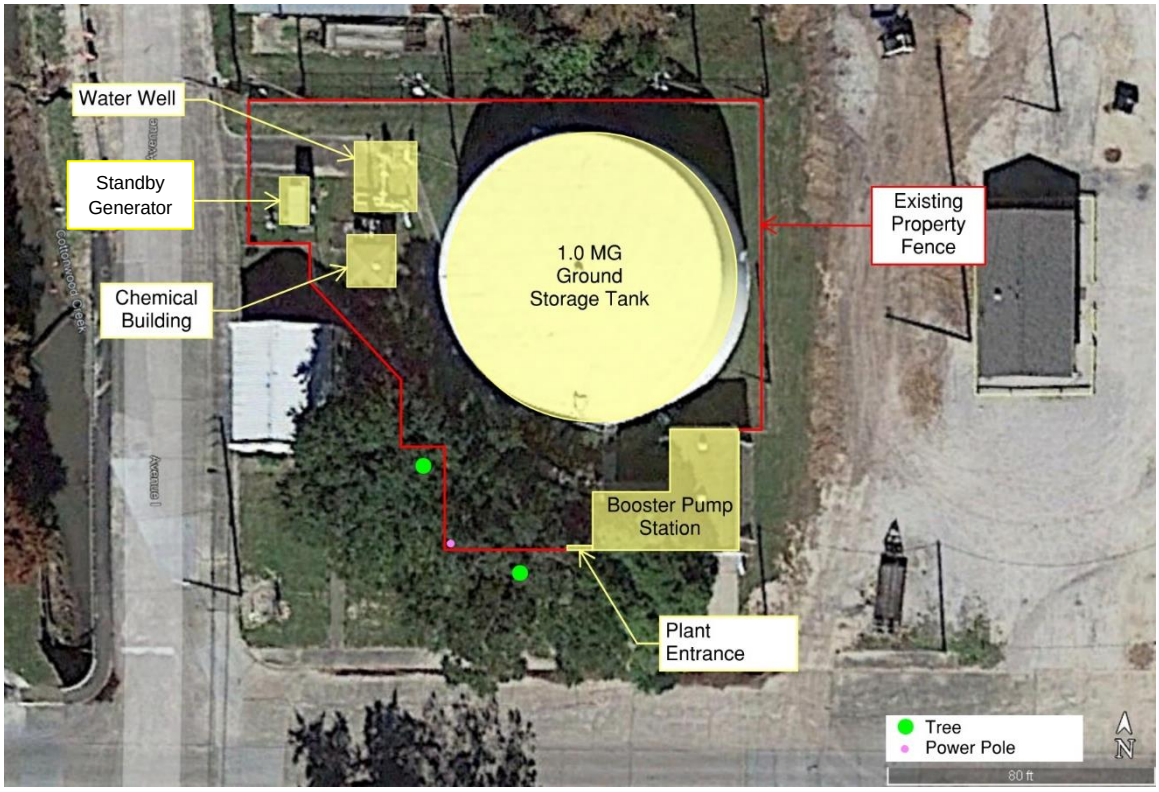


Figure 1: Bay City 6th St and Ave I WTP Existing Site Layout

2.2 6th Street and Katy Avenue

The existing 6th St and Katy Avenue WTP consists of one well and vertical turbine pump, chemical building, and a 450,000 gallon elevated storage tank (Figure 2). The well production capacity is 1,050 gpm (1.5 MGD). The well pumps directly into the distribution system and the elevated storage tank is filled from the distribution system. The 6th Street & Avenue I WTP and 6th St and Katy Avenue WTP are 0.9 miles apart from each other in downtown Bay City. As shown on Figure 2, it appears that anticipated individual treatment systems can fit appropriately on this site with adequate room for maintenance and future servicing.

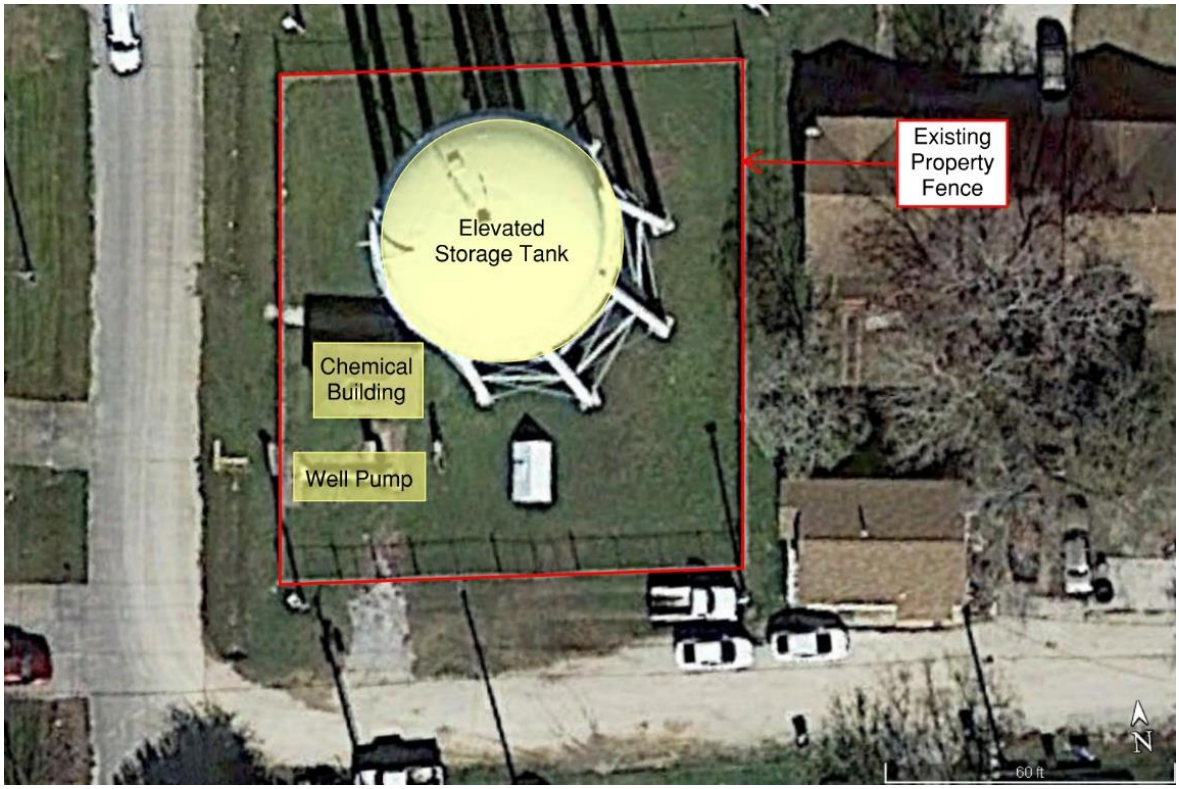


Figure 2: Bay City 6th St and Katy Ave WTP Existing Site Layout

3.0 Additional Water Quality Sampling

Additional water quality testing was performed to characterize water quality parameters for these wells. This information was also provided to the vendors to allow them to suggest potential treatment system type and size. Water quality parameters analyzed included Arsenic III, Arsenic V, Phosphate, Vanadium, Silica, Alkalinity, and the pH from the Bay City 6th Street & Avenue I well. The water quality testing was performed by Eurofins South Central LLC located in Stafford, TX.

On August 11, 2022, 80 gallons of raw unchlorinated well water was collected from the Bay City 6th Street & Avenue I well for additional water quality testing using Rapid Small Scale Column Tests (RSSCTs). Five gallons of the raw well water was allocated for additional water quality testing while the remaining 75 gallons of the raw well water was allocated for the RSSCTs and used used for testing treatment performance..

Arsenic speciation test was performed using Hydride-Generation Cryo-Trapping Gas Chromatography-Atomic Absorption Spectrometry (GC-AAS) based on the United States Environmental Protection Agency (USEPA) Method 1632 to quantify Arsenic III, Arsenic V, and Inorganic Arsenic. Vanadium and Silica

concentrations were measured using Inductively Coupled Plasma (ICP) using USEPA Method 6010D. The test methods used are recommended in the USEPA publication: Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, also known as SW-846. The Phosphates as Total Phosphorus was quantified using Colorimetry based on USEPA Methods 365.1, 365.2, and 365.3. Alkalinity was measured using titration based on Standard Methods (SM) for the Examination of Water and Wastewater 2320B.

The summarized results of the additional water quality sampling are shown in Table 1. The results were sent to manufacturers of various arsenic treatment technologies to select appropriate treatment technology and preliminary design and budgetary proposals. Complete water quality sampling testing procedures and results are provided in Appendix B.

Table 1: Water Quality Data

Analyte	Results	Unit
Arsenite, As(III)	1.15	ug/L
Arsenate, As(V)	9.55	ug/L
Inorganic Arsenic	10.7	ug/L
Vanadium	Non-Detectable	
SiO_2	17.3	mg/L
Phosphates as Total Phosphorus	Non-Detectable	
pH	8.28	
Temperature	17.9	Degrees C
Alkalinity	213	mg/L

4.0 Water Quality Modeling (Blending Optimization)

Blending prior to entry points (EPs) to the distribution system can be used to bring arsenic levels below the Maximum Contaminant Level (MCL, 0.01 mg/L). Challenges to implementing blending or centralized treatment include the need to convey sufficient volumes of water with low arsenic levels to existing well sites or new treatment facilities for blending.

Blending targeted at one constituent can result in negative impacts to other water quality parameters and chemical stability of the water. Water quality modeling is used to assess the feasibility and water quality impacts of blending.

Garver used a spreadsheet-based blending model to determine if blending strategies could reliably produce finished water with arsenic levels below the MCL. The model was used to identify optimized blends of water from the wells at 4th Street & Avenue B (EP001) and Grace Street & Moore Avenue (EP005) wells, which have arsenic levels below the MCL, with water from the 6th Street & Katy (EP003),

Mockingbird Lane (EP002), and 6th Street & Avenue I (EP004) wells, which have arsenic levels approaching or above the MCL.

4.1 Blending Model Inputs

Inputs to the model include the rated capacities for the EPs, which are available on TCEQ's Safe Drinking Water Information System (SDWIS) website and summarized in Table 2. Historical average day and maximum day demands for the overall system were given as 1,645 gpm and 2,268 gpm, respectively.

Table 2: Entry Point Capacities

Entry Point Number	Entry Point Location	Rated Flow (GPM)
EP001	4th Street & Avenue B	1,360
EP002	Mockingbird Lane	1,010
EP003	6th Street & Katy	1,050
EP004	6th Street & Avenue I	1,250
EP005	Grace Street & Moore Avenue	1,300

Water quality data was collected from each EP as part of regulatory compliance monitoring, and data from 2019 through 2022 was used in this analysis. Generally, only one measurement was available per water quality parameter. Where multiple measurements were available for arsenic, the maximum value was used. The average was used for other parameters. City staff collected and provided one pH measurement per entry point in 2022. Measured and calculated water quality parameters are summarized in Table 3 with their MCLs or Texas Secondary Constituent Levels (SCLs).

Table 3: Entry Point Water Quality Data from 2019 to 2022

Parameter	EP001	EP002	EP003	EP004	EP005	MCL/*SMCL*	Units
Arsenic	0.005	0.008	0.009	0.013	0.005	0.01	mg/L
Calcium	30	18	16	14	21	--	mg/L
Chloride	40	72	67	47	106	*300*	mg/L
Iron	0.08	0.05	0.04	0.03	0.05	*0.3*	mg/L
Magnesium	12.2	7.9	6.6	5.5	8.6	--	mg/L
Manganese	0.02	0.01	0.01	0.00	0.00	*0.05*	mg/L
Sulfate	15	14	14	14	13	*300*	mg/L
Total Alkalinity	278	251	251	246	282	--	mg/L as $CaCO_3$
Total Hardness	123	79	67	57	84	--	mg/L as $CaCO_3$
Total Dissolved Solids (TDS)	325	377	372	330	440	*1000*	mg/L
pH	7.8	8.0	7.9	7.8	7.9	≥ *7.0*	S.U.

These data were used as inputs to the Rothberg, Tamburini, and Winsor (RTW) model available from the American Waterworks Association (AWWA), which was used to calculate calcium carbonate stability indices including the Langelier Saturation Index (LSI), Ryznar Index (RI), Aggressiveness Index (AI), and calcium carbonate precipitation potential (CCPP) for each water. Additionally, the chloride to sulfate mass ratio (CSMR), which is related to the potential for galvanic corrosion and lead release, was calculated for each well. Results are summarized in Table 4. Based on TCEQ's classification system (Table 5), the water from each entry point would be classified as non-corrosive to slightly corrosive.

Table 4: Chemical Stability Indices for Entry Points

Parameter	EP001	EP002	EP003	EP004	EP005	Units
CSMR*	2.7	5.1	4.8	3.4	8.2	--
LSI	0.3	0.3	0.1	-0.1	0.3	--
RI	7.1	7.5	7.7	7.9	7.4	--
AI	12.1	12.1	11.9	11.7	12.1	--
CCPP	12.7	6.1	2.6	-1.3	7.8	mg/L as $CaCO_3$

*CSMR - Chloride to Sulfate Mass Ratio
LSI - Langelier Saturation Index
RI - Ryznar Index
AI - Aggressiveness Index
CCPP - Calcium Carbonate Precipitation Potential

Table 5: TCEQ Classification System

Index	Description	Classifications
Langelier Index (LSI)*	Indicator for the degree of calcium carbonate saturation in a water. Calculated using measured pH, alkalinity, calcium concentration, total dissolved solids, and water temperature. This index is not directly related to the corrosivity of a water as it relates to lead and copper, but it is an indicator of the likelihood for calcium carbonate scales to form or be dissolved. A low LSI could indicate the potential for dissolution of the cement in asbestos-cement piping. LSI can also be used to indicate a maximum pH for corrosion control that would not promote excessive calcium carbonate scaling.	Per TCEQ: • LSI ≥ -0.25: Noncorrosive • LSI < -0.25: Slightly corrosive • LSI < -1.0: Corrosive
Ryznar Index (RI)*	Alternative to LSI for calculating calcium carbonate scaling potential. Calculated using measured pH, alkalinity, calcium concentration, total dissolved solids, and water temperature. This index is not directly related to the corrosivity of a water. Like LSI, RI can also be used to indicate a maximum pH for corrosion control that would not promote excessive scaling.	Per TCEQ: • RI <7.0: Noncorrosive • 7.0 ≤ RI ≤ 8.5 Slightly corrosive • RI > 8.5: Corrosive

Calcium Carbonate Precipitation Potential (CCPP)*	Calcium carbonate stability index that predicts whether a water is undersaturated or supersaturated with calcium carbonate as well as the quantity (mg/L) of calcium carbonate that would theoretically precipitate from or have to be dissolved into the water to reach equilibrium. This index is not directly related to the corrosivity of a water but can be used to indicate a maximum pH for corrosion control that would not promote excessive scaling.	Per TCEQ: • CCPP > 0: Noncorrosive • -3.0 < CCPP < 0: Slightly corrosive • CCPP < -3.0: Corrosive
Aggressiveness Index (AI)*	Simplified version of LSI that is intended to determine if asbestos-cement piping would be appropriate for a given system.	Per TCEQ • AI > 12: Noncorrosive • 10 ≤ AI ≤ 12: Slightly corrosive • AI < 10: Corrosive
Chloride:Sulfate Mass Ratio (CSMR) *	Indicator for potential lead release, particularly lead release due to galvanic corrosion. CSMR is calculated as the ratio of chloride to sulfate in milligrams per liter.	Per TCEQ: • CSMR < 0.2: Non-corrosive • 0.2 < CSMR < 0.5: Slightly Corrosive • CSMR > 0.5 & Total Alkalinity > 50 mg/L-$CaCO_3$: Slightly Corrosive • CSMR > 0.5 & Total Alkalinity < 50 mg/L-$CaCO_3$: Corrosive
*Parameter required by TCEQ for corrosivity engineering reports. Classification range terminology is per TCEQ guidance.		

4.2 Blend Development

Arsenic has exceeded the MCL at 6th Street and Avenue I and has reached 90% of the MCL at 6th Street and Katy Avenue, but it has remained below 80% of the MCL at the remaining entry points. EP001 and EP005 water can be used to bring blended water arsenic levels below the MCL, but given that EP002 has approached 80% of the MCL in the past, it has not been particularly beneficial for blending.

Blends were developed for multiple scenarios and evaluated based on:

- Blended water arsenic levels, with minimization of arsenic levels desired, but arsenic levels up to 80% of the MCL considered acceptable.
- Utilization of water sources.
- Optimization of overall water quality based on MCLs, SMCLs, and chemical stability indices.

Two-well, three-well, four-well, and five-well blends were developed using EP water quality data. Table 6 shows blends that use all available water from each contributing well site based on the rated capacities of

the existing entry points. Blends 2a and 2c produce blended water with the lowest arsenic levels and would provide sufficient flow to serve the system during historical maximum day demand conditions, but these blends could not be produced at the same time. Rather, Blend 2d or EP005 and EP002 could serve the system at the same time as Blend 2a, and Blend 2b or EP001 and EP002 could serve the system at the same time as Blend 2c.

If three-well blends were used, the system could also receive water directly from EP002, as well as EP005 in the case of Blend 3a or EP001 in the case of Blend 3b. A significant portion of the system would receive water with arsenic at 80-90% of the MCL with the 3-well blends. Four- and five-well blends would be expected to produce water with arsenic at 80% of its MCL.

Table 6: Arsenic Levels for Blends Assuming Maximum Production at Entry Points' Rated Capacities

Blend	EP001 (%)	EP002 (%)	EP003 (%)	EP004 (%)	EP005 (%)	Blended Flow (gpm)	Arsenic (mg/L)
2a: EP001 & EP003	56	--	44	--	--	2,410	0.007
2b: EP001 & EP004	52	--	--	48	--	2,610	0.009
2c: EP005 & EP003	--	--	45	--	55	2,350	0.007
2d: EP005 & EP004	--	--	--	49	51	2,550	0.009
3a: EP001, EP003, & EP004	37	--	29	34	--	3,660	0.009
3b: EP003, EP004, & EP005	--	--	29	35	36	3,600	0.009
4: EP001, EP003, EP004, & EP005	27	--	21	25	26	4,960	0.008
5: EP001, EP002, EP003, EP004, & EP005	23	17	18	21	22	5,970	0.008

The blends could be further optimized to bring arsenic levels to 70% of the MCL (e.g., to 0.007 mg/L As) using only a portion of the water available from each existing EP, as shown in Table 7.

Table 7: Optimized Blends with 0.007 mg/L Arsenic

Blend	EP001 (%)	EP002 (%)	EP003 (%)	EP004 (%)	EP005 (%)	Blended Flow (gpm)	% of Available Flow
$2a_O$: EP001 & EP003	56	--	44	--	--	2,410	100
$2b_O$: EP001 & EP004	70	--	--	30	--	1,943	74
$2c_O$: EP005 & EP003	--	--	45	--	55	2,350	100

2d$_O$: EP005 & EP004	--	--	--	33	67	1,940	76
3a$_O$: EP001, EP003, & EP004	63	--	18	19	--	2,159	59
3b$_O$: EP003, EP004, & EP005	--	--	21	19	60	2,167	60
4$_O$: EP001, EP003, EP004, & EP005	31	--	21	18	30	4,333	87
5$_O$: EP001, EP002, EP003, EP004, & EP005	27	19	13	13	28	4,643	78

Of the blends evaluated, use of Blends 2a$_O$ + 2d$_O$, Blend 4$_O$, or Blend 5$_O$ provide the ability to produce the most water with arsenic levels of 0.007 mg/L. Based on water quality parameters measured at the individual EPs (shown in Table 3), no MCLs or SCLs aside from arsenic are exceeded by any EP. However, there is some variation in CSMR and calcium carbonate stability indices, so these values were calculated for blends 2a$_O$, 2d$_O$, 4$_O$, and 5$_O$ at 20°C. RTW Model inputs and blending results are shown in Table 8. All blends would be considered noncorrosive or slightly corrosive based on TCEQ's classification system. Blend 2d$_O$ is somewhat less desirable than other blends due to its higher TDS and CSMR. The spreadsheet used to calculate the optimized blending is located in Appendix C.

Table 8: Chemical Stability Indices for Optimized Blends

Parameter	2a$_O$	2d$_O$	4$_O$	5$_O$
pH	7.8	7.9	7.9	7.9
Alkalinity	266	270	266	266
TDS	345	404	369	374
Calcium	60	46	53	53
LSI	0.2	0.2	0.3	0.3
RI	7.4	7.5	7.4	7.4
AI	12.0	12.0	12.1	12.1
CCPP	7.1	5.3	7.4	7.4
CSMR	3.6	6.5	4.8	4.9

4.3 Blending Recommendations

If blending is the selected alternative for arsenic management in the Bay City System, blending infrastructure could be installed in phases, starting with that required for Blend 2a$_O$. Infrastructure for Blend 4$_O$ could be installed to allow the City to utilize water from existing 6th Street & Avenue I (EP004), and infrastructure for Blend 5 could be installed if arsenic levels approach the MCL at Mockingbird Lane (EP002).

4.4 Treatment Evaluation/Findings

Garver used the blending model to determine the degree of treatment that would be required at 6th Street & Katy (EP003) and 6th Street & Avenue I (EP004) to bring arsenic levels to 70% of the MCL without blending with water from other EPs. It was assumed that treatment would consist of adsorption using iron oxide media and treated water would be blended with untreated water. Based on the results of Rapid Small-Scale Column Tests (RSSCTs), treated water arsenic would be at or below 0.001 mg/L, and there would be no impact on pH. Untreated water from each site would have the same water quality as shown in Table 3.

Based on the aforementioned assumptions to meet 70% of the maximum contaminant level, the following treatment findings are presented (Table 9):

EP003 (6th Street and Katy Avenue) → Minimum 31% of the water requires treatment

EP004 (6th Street and Avenue I) → Minimum 50% of the water requires treatment

Table 9: Summary of Blended Treated and Untreated Water for 6th St & Avenue I and 6th St & Katy Avenue

EP	Percent Treated	Percent Untreated	Blended Water As (mg/L)
EP003	31%	69%	0.00652
EP004	50%	50%	0.00675

5.0 Alternatives Evaluation

Garver was scoped to analyze three permanent arsenic treatment system alternatives comprising:

1. Adsorption
2. Ion exchange
3. Reverse osmosis.

The treatment alternatives were evaluated for location at individual water treatment plant sites. Based on discussion with several vendors, Garver assessed that coagulation-assisted microfiltration could also be a treatment consideration for the affected water plant sites. Consequently, Garver added coagulation-assisted microfiltration as a fourth arsenic treatment system alternative. **The full vendor proposals for each arsenic treatment alternative are included in Appendix D.**

5.1 Adsorption

Garver studied adsorption as a viable arsenic removal treatment system utilizing iron oxide adsorptive media. A typical adsorption vessel system would include two carbon steel pressure vessels on a skid, with each vessel handling half of the required treatment flow. A proposed adsorption system plan layout is shown on Figure 3. Garver solicited proposals for installing individual adsorption treatment systems at the 6th St & Avenue I WTP and one at the 6th St & Katy Avenue WTP. The projected design and operating criteria for an adsorption vessel with iron oxide based media for each WTP site are provided in Table 10.

The system will be designed such that each adsorption vessel can handle half of the proposed treatment flow. During media replacement, this would allow the treatment unit to remain online and still provide half capacity. It should be noted that the adsorptive media is typically proprietary which may cause difficulty sourcing the same media if it becomes discontinued in the future.

Table 10: Projected Design and Operating Criteria for Adsorption System at Each WTP Site

Design/Operating Criteria	6th Street & Avenue I	6th Street & Katy Avenue
Proposed Treatment Flow Rates (gpm)	660	330
Head Loss (psi)	3 (clean bed) 10 (initiate BW)	3 (clean bed) 10 (initiate BW)
Media Life Est. (months)	21	18
Media Replacement Duration (hrs)	4	4
Backwash Frequency (days)	45	45
Backwash Flow Rates (gpm)	455	215
Backwash Duration (min)	15	15
Backwash Volume (gal)	6,825 (each) 13,650 (total)	3,225 (each) 6,450 (total)

The adsorption media system will require backwashing approximately every 45 days to remove particulates and redistribute the bed material. The backwash source can be raw water or treated water. Backwash waste stream will have no arsenic and can be discharged to sewer.

As shown on Figures 4 and 5, while it appears an adsorption vessel treatment system will fit on the 6th Street and Avenue I site, access will likely be constrained to perform routine operations and maintenance, and in particular to remove and replace media. The proposed adsorption system for the 6th Street and Katy Avenue site is smaller than at Avenue I and there is more available land area. As shown on Figure 6, it appears that an adsorption vessel treatment system can fit appropriately on the 6th Street and Katy Avenue site with adequate room for maintenance and future servicing.

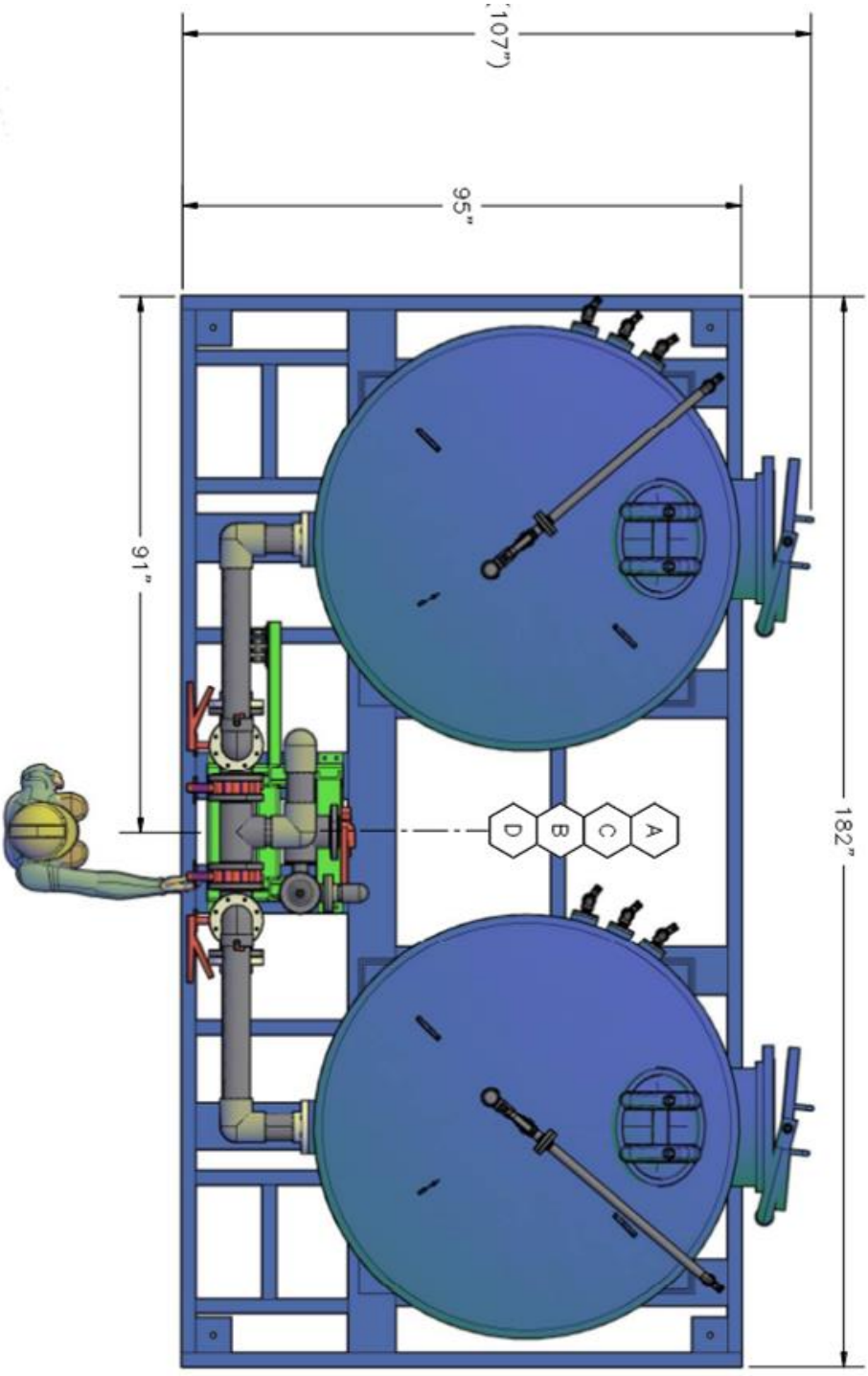


Figure 3: Plan View of Proposed Iron Adsorption Media System

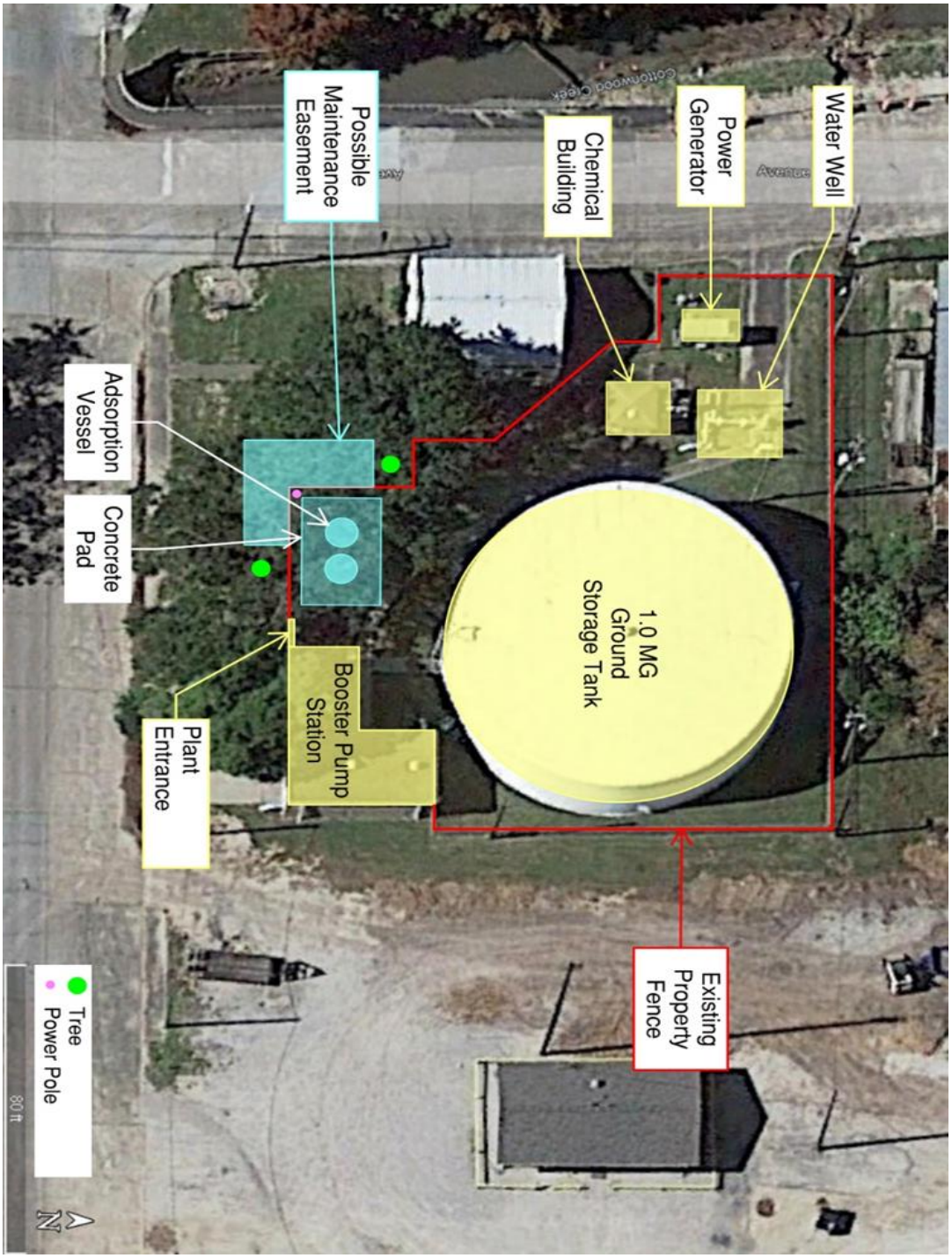


Figure 4: 6th Street and Avenue I WTP Proposed Adsorption Treatment System Site Layout Alternative 1

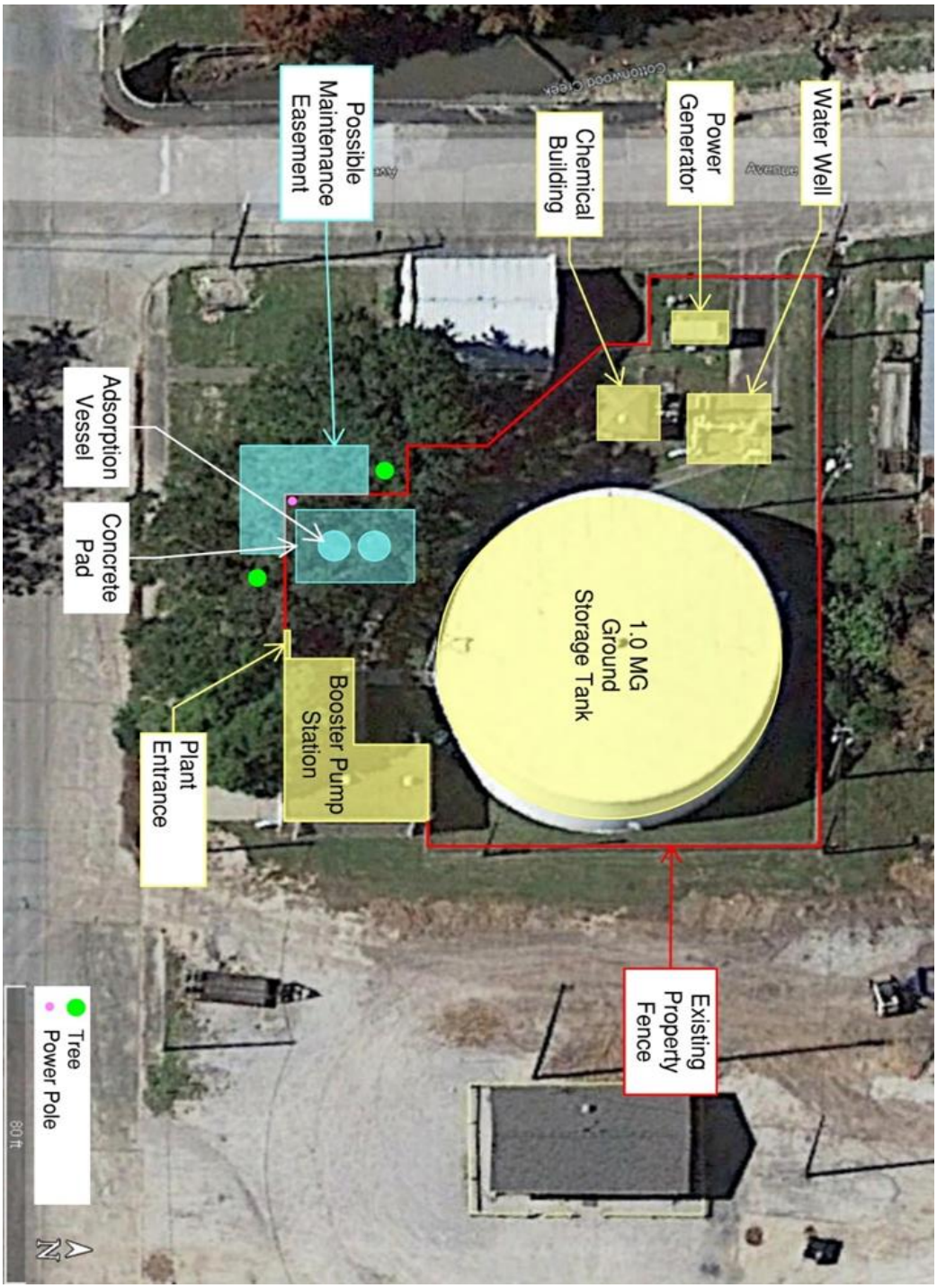


Figure 5: 6th Street and Avenue I WTP
Proposed Adsorption Treatment System Site Layout Alternative 2

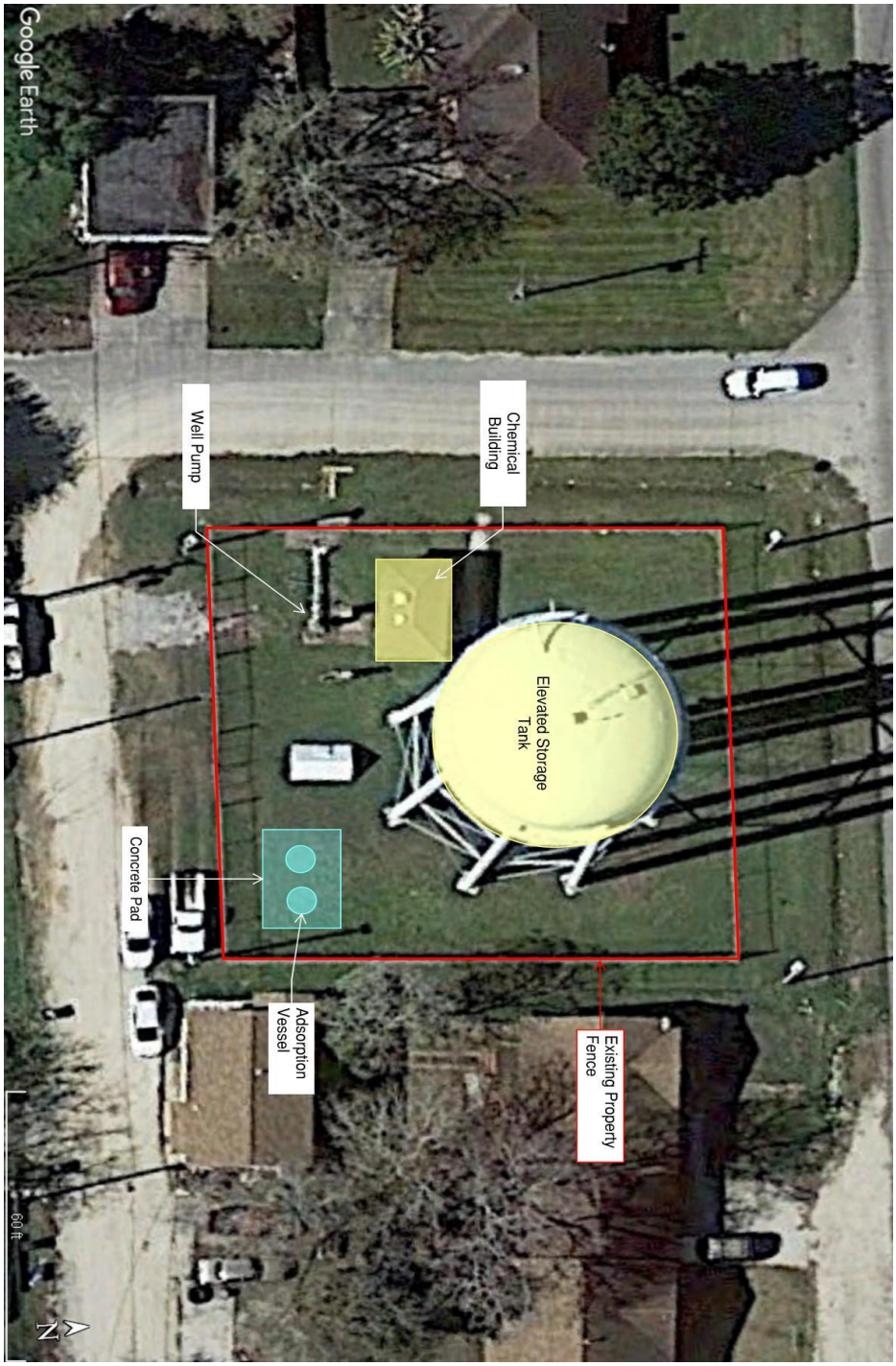


Figure 6 : 6th Street & Katy Ave. WTP
Proposed Adsorption Treatment System Layout

5.1.1 Rapid Small Scale Column Test

Garver contracted Arizona State University (ASU) to perform Rapid Small Scale Column Tests (RSSCTs) on the raw groundwater samples to assess arsenic removal using two types of iron adsorption media: Bayoxide E33 and Dry Granular Ferric Hydroxide (GFH). The purpose of the RSSCTs was to project arsenic breakthrough for both types of iron adsorption media and determine if there was any notable advantage to one media over the other.

ASU conducted one RSSCT run for each type of media. The raw well water samples were chlorinated by ASU staff with liquid chlorine at a dose of 2 mg/L. ASU performed the RSSCTs at ambient pH after samples were filtered and acidified to 2% trace-metal grade nitric acid. During the RSSCTs, ASU collected effluent samples and analyzed them for arsenic at various points along the breakthrough curve.

The results of the RSSCT concluded that there was negligible difference in the arsenic breakthrough curves between the Bayoxide E33 and Dry GFH media columns. This suggests the capacity, lifetime, and media replacement frequency (based upon arsenic removal under the conditions tested) would be nearly identical.

As shown in Figure 7 7, both adsorbents achieved between 10,000 to 14,000 bed volumes treated before exceeding the 1 ug/L detection limit for arsenic. Approximately 80% of arsenic breakthrough (target value) occurred around 100,000 bed volumes treated. The full results of the Rapid Small Scale Column Tests performed by Arizona State University is provided in Appendix E.

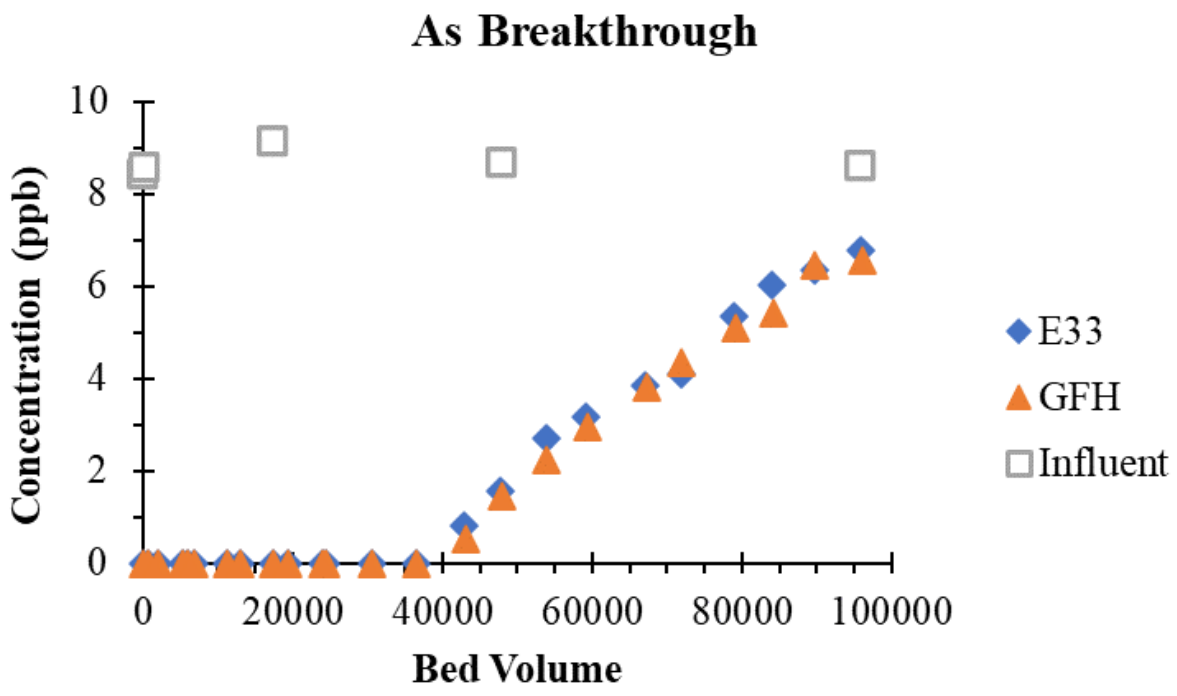


Figure 7: Arsenic Breakthrough Curve using Bayoxide E33 and Dry GFH

5.2 Ion Exchange

Garver evaluated ion exchange as a viable arsenic removal treatment. Ion exchange systems typically are used in the form of columns that can contain a variety of resins. During a service cycle, a flow stream is directed into the ion exchange column where it reacts with the resin. Ion exchange resin is used as a physical medium to facilitate ion exchange reactions. Over the course of one or more service cycles, an ion exchange resin will become exhausted, meaning that it can no longer facilitate ion exchange reactions. Regeneration is a process where functional groups are restored to the spent resin matrix. This is accomplished through the application of a chemical regenerant solution.

A proposed ion exchange system for the Bay City water plants would include two carbon steel pressure vessels on a skid, with each vessel handling half of the required treatment flow. Figure 8 depicts a schematic of a proposed ion exchange system. The proposed resin media is FerrIX A33E, a highly porous hybrid anion resin infused with iron oxide, which will need to be regenerated every five to six months. While ion exchange systems are easy to install and connect to existing infrastructure, a key disadvantage is having to utilize a recommended brine solution to regenerate the resin on-site, which is an added cost and generates saline waste which needs to be discharged to a nearby sewer. Additionally, the location of the ion exchange system within the water plant needs careful consideration so the resins

do not get exposed to oxidants which can result in irreversible damage to the resins. Ion exchange resins are also prone to organic fouling.

As provided in Table 12, since Ion Exchange is notably more expensive than adsorption and has saline waste considerations along with the complexity of on-site resin regeneration and capacity for silica interference, it is not a recommended alternative.

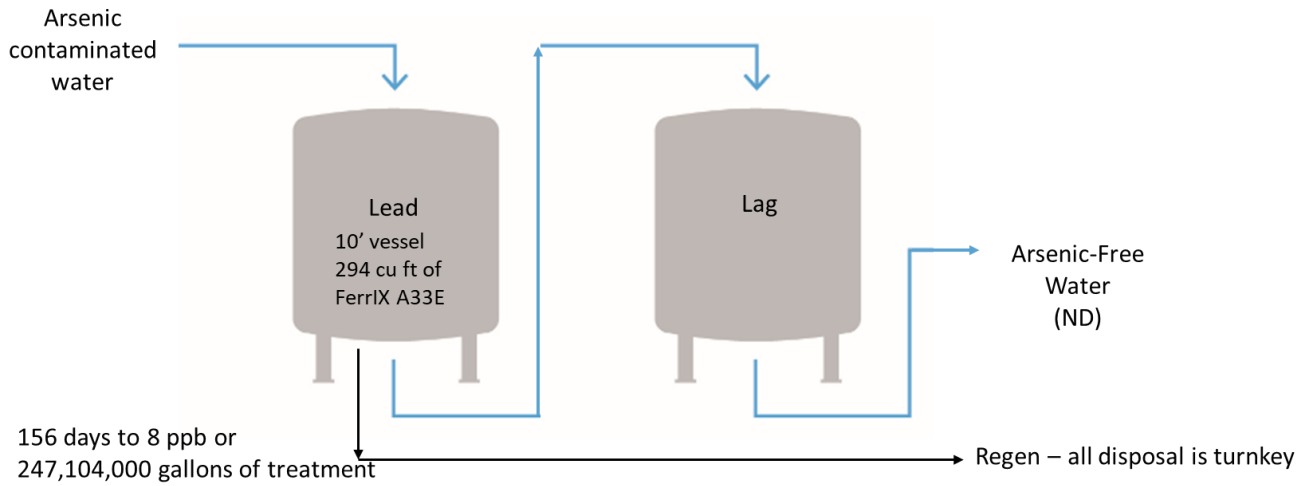


Figure 8: Schematic of Proposed Ion Exchange System

5.3 Reverse Osmosis

Garver considered Reverse Osmosis (RO) as an arsenic treatment alternative because RO is shown to be effective at removing arsenic besides other constituents from water, including organic carbon, salts, dissolved minerals, and color. shows the general configuration of a reverse osmosis system which consists of membranes, pressure vessels, cleaning in place (CIP) skid, acid-dosing skids, and a flushing system.

Based on discussion with several vendors for the Bay City water plant sites, RO will produce high amounts of wasted water from the reject stream, projected at 40% of the RO feed water. This consistent reject stream or brine will need to be properly disposed of likely to sewer.

Given that Bay City does not need to invest capital to treat the affected well sites to very low arsenic levels to reach MCL compliance (or have other treatment objectives), and considering the high energy costs and high waste volumes projected for this given application, the use of reverse osmosis technology does not seem warranted for this particular application.

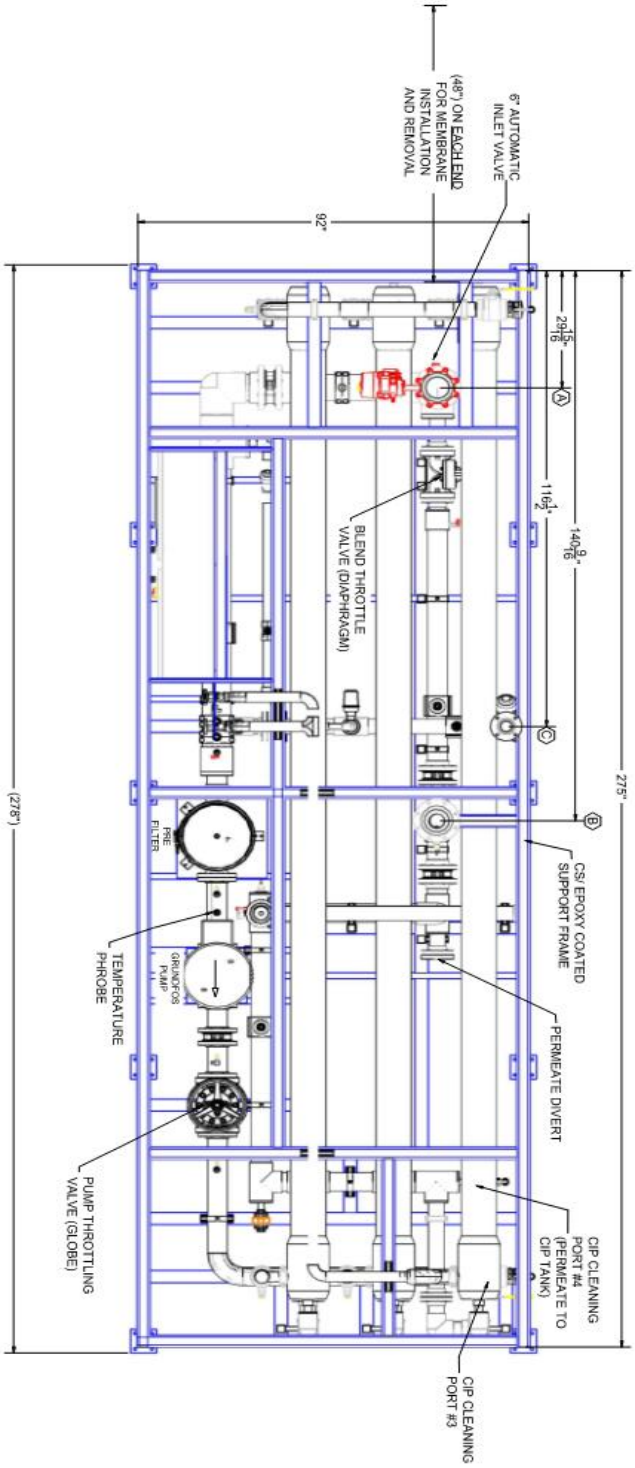


Figure 8: Plan View Proposed Reverse Osmosis System

5.4 Coagulation/Microfiltration

Garver considered Coagulation-Enhanced Microfiltration as an additional treatment alternative due to recommendations from several vendors after presenting additional water quality data. A coagulation-enhanced microfiltration system consists of a feed tank, a reverse filtration tank, feed pumps, membrane modules, a cleaning in place (CIP) system, a neutralization system, and chemical storage (Figure 8).

A coagulant such as Ferric Chloride and a pH adjuster such as citric acid are added to the water followed by direct microfiltration without flocculation. Microfiltration uses a filter membrane that must be backwashed frequently, projected at 1-2 times each week. The coagulation/microfiltration process produces backwash water as a liquid waste. The backwash water waste may be disposed by discharging to a nearby sewer. Since chemicals such as coagulants, pH adjustment, and caustic will need to be added to the system, notable additional chemical storage will be needed onsite. This is cumbersome for the 6th Street and Avenue I WTP given the site is constrained in terms of available land. Based on the vendor proposals, the coagulation-microfiltration system had the highest capital cost.

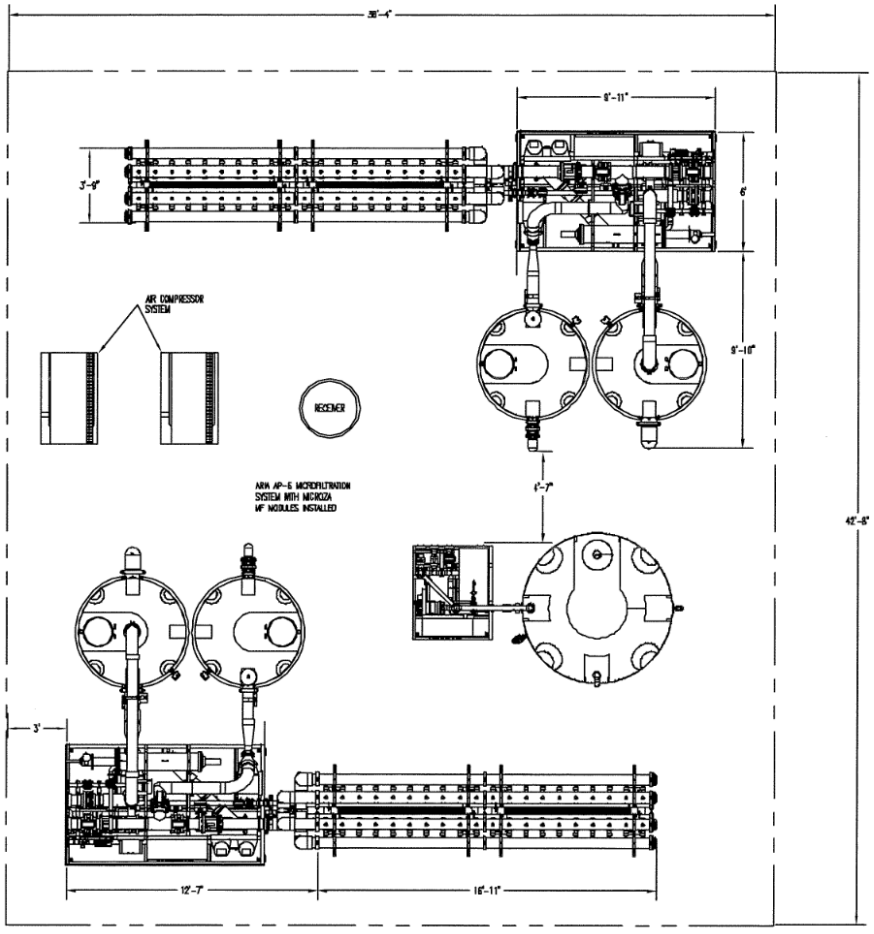


Figure 8: Plan View of Proposed Microfiltration System

5.5 Summary of Alternatives

Garver evaluated four arsenic treatment alternatives based on the scope and subsequent vendor engagement. Table 11 summarizes the advantages and disadvantages of each arsenic treatment alternative.

Table 11: Advantages and Disadvantages of Arsenic Treatment Alternatives

Treatment Alternative	Advantage	Disadvantage
Adsorption	• Lowest capital cost • Easy installation and media replacement • Convenient disposal of media waste to municipal landfill	• Monthly backwash required • Proprietary media
Ion Exchange	• Backwash not required • Media is reusable • Easy installation • Smallest footprint	• Silica interference • Prone to fouling • Brine solution required • Onerous on-site regeneration
Reverse Osmosis	• Backwash not required • Membrane is regenerable • Automatic flushing	• High waste volume • Complex operations • Brine disposal
Coagulation/Microfiltration	• Many applications nationwide and in Texas • Coagulation direct injection to piping	• Weekly backwash required • Highest capital cost • Additional chemical storage and cost • Largest footprint

Garver received proposals from multiple vendors for four different treatment technologies all using the same treatment criteria. We subsequently prepared a high-level capital cost estimation of each treatment alternative based on vendor, site/civil work, process piping, structural, and electrical costs and found that Adsorption (using granular iron oxide media) would be the least expensive capital cost alternative. Coagulation enhanced microfiltration was estimated to be the most expensive treatment alternative considered. Table 12 provides a capital cost summary for each of the arsenic treatment alternatives.

Table 12: Summary of Estimated Capital Costs of Arsenic Treatment Alternatives

Treatment Alternative	6th St and Ave I	6th St and Katy Ave
Adsorption	$ 2,550,000	$ 1,980,000
Ion Exchange	$ 3,610,000	$ 2,610,000
Reverse Osmosis	$ 4,260,000	$ 3,110,000
Coagulation-Microfiltration	$ 4,790,000	$ 3,560,000

5.6 Centralized Treatment System

One treatment alternative was to consider implementation of a centralized treatment system if treatment at individual sites was not deemed an optimal long-term solution. Garver considered two options for a centralized treatment system in order to treat the inflows from multiple well sites. One alternative was consideration for a new overall centralized treatment system which will have inflows from all five existing facilities [Reference Table 2] and anticipated to be located at a new parcel of land without existing facilities which would be somewhat equidistant to all WTP sites. The other option was to construct a combined treatment system which will treat combined inflows from 6th Street & Avenue I WTP and 6th Street & Katy Avenue WTP at the existing 6th Street & Avenue I WTP site, taking advantage of existing facilities.

5.6.1 Overall Centralized Treatment System

The overall centralized treatment system would include flow from all five sites and ideally would be at a neutral location which is equidistant to all the well sites because the existing WTP sites are not only size constrained, but do not have the capacity to store and handle the combined flows of all the WTPs. Garver did not identify an exact city-owned property for the site of the centralized treatment system. However, for preliminary cost estimating and comparison purposes, the site location was assumed to be somewhat equidistant to all existing WTP sites for the purposes of estimating distribution system modification costs.

An overall centralized treatment system creates known, tangible challenges to the City to construct. A new overall centralized treatment facility would necessitate extensive distribution system piping modifications with disruption of City streets, traffic flow, and pedestrian access. Additionally, a new centralized treatment system would expectedly involve construction of new larger facilities (with existing reliable facilities that are already useful to the City) and also likely warrant modifications of standard operating procedures.

Conversely, a centralized treatment system could bring advantages should water quality notably degrade at the other City wells besides 6th Street and Avenue I and 6th Street and Katy Ave. However, with additional storage and pumping facilities for an overall centralized treatment system, the anticipated construction cost of a new overall centralized treatment facility is projected to be six times the cost of the combined individual treatment systems located at 6th Street and Avenue I and 6th Street and Katy Ave., this is provided in Table 13. Additionally, as a result of the modeling performed and treatment recommendations provide in Section 4.4, only modest amounts of water need to be treated at the impacted well sites. The individual treatment systems also offer flexibility to modify and treat higher flows to meet MCL requirements if the raw water quality changes over time; acknowledging that increasing treated flows would shorten the media life.

Given the estimated capital construction cost of an individual treatment system, this allows the City to install a similar individual treatment system at each of other well sites before ever encroaching the projected cost of a centralized treatment system; with notably less public and operational impacts.

Treatment at individual well sites do seem a viable and economic alternative for Bay City and can be deemed as an optimal long-term solution. Consequently, the consideration of an overall centralized treatment system to accommodate flow from all five sites does not seem warranted for Bay City given the aforementioned findings and is not being considered further as a justifiable alternative for design.

5.6.2 Combined Treatment System (6th St & Avenue I and 6th St & Katy Avenue)

Another treatment option considered was a combined treatment facility located at 6th Street & Avenue WTP to treat inflows from 6th Street & Avenue I WTP and 6th Street and Katy Avenue WTP. The 6th Street and Avenue I WTP site was considered even though it is more spatially constrained than the 6th Street and Katy Avenue WTP site because the well pump at 6th Street and Katy Avenue pumps directly into the distribution system without the use of booster pumps. Additionally, the ground storage tank at 6th Street & Avenue I has a large enough volume to store the combined treated flows before being pumped into the distribution system by the existing booster pump station.

The combined treatment system cost was **based on a proposal received for an iron adsorption media vessel,** the least expensive alternative. The combined treatment system at 6th Street & Avenue I would allow for the utilization of the existing facilities onsite with marginal operating impacts. As shown in Table 13, the combined treatment system cost is $350,000 more than the individual treatment systems at each site. However, with the larger combined system, the media life would be expected to be about two months longer and the City would only have to maintain and operate one system in lieu of two. Notwithstanding, for cost comparison purposes, we assumed the City would need to install a new dedicated water line from 6th Street and Katy Ave. to the 6th Street and Avenue I location.

5.7 Estimated Capital Construction Cost Comparison

Garver considered costs from vendors, site and civil work, backwashing piping, process piping and valves, electrical, instrumentation and controls, and concrete to estimate the capital construction costs of **iron adsorption media vessels** at individual well sites and at the centralized treatment system locations (described in Sections 5.6.1, 5.6.2). A comparison of the estimated capital construction costs between the treatment alternatives are shown in .

Table 13: Estimated Capital Cost Comparison of Individual Treatment Units and Centralized Treatment Systems

Adsorption System	6th St & Avenue I	6th St & Katy	Combined (Katy & Ave I)	Overall Centralized
Cost	$ 2,550,000	$ 1,980,000	$ 4,940,000	$ 14,400,000

Note: Table 13 Capital Construction Costs do not include cost for additional land or easement if deemed necessary

6.0 Recommendation

Garver evaluated four permanent arsenic removal systems for the 6th Street and Ave I and 6th St and Katy Ave Water Treatment Plants. The existing conditions and operations were assessed to determine alternatives to reduce arsenic levels to below the MCL and maintain TCEQ compliance.

Based on the capital cost, treatment reliability, technology footprint, operations and maintenance complexity, operations and maintenance cost, and requisite city staff engagement, **we recommend the City of Bay City implement Alternative No.1: Iron Adsorption Media Vessel at each well site**. This alternative will require a slab on grade system containing two carbon steel vessels and adsorptive media at each water plant site.

Garver assessed the need of adding an in-line booster pump at both treatment plant sites. For **6th Street and Avenue I,** given the treatment system maximum head loss of 10 psi, and the known differential between the well pump and ground storage tank, the addition of a new booster pump station is not anticipated and is not included in the capital construction cost. At the **6th Street and Katy Ave** site, the well pumps directly into the distribution system. With a similar treatment system head loss of 10 psi, this operational impact may need to be discussed further with the City. At this time we have not included an inline booster pump in the capital cost estimate for 6th Street and Katy Ave.

Based on the blending optimization model, only 50% of the water from the 6th St & Avenue I WTP will need to be treated and only 31% of the water from the 6th St & Katy Avenue WTP will need to be treated to reach 70% of the MCL and maintain compliance with TCEQ. Additionally, the amount of treated water can be easily and readily changed should raw water quality change in the future.

Garver considered two vendors for the installation of an adsorptive system, AdEdge (Chart Industries) and Applied Process Equipment. AdEdge provided a more competitive proposal with a smaller footprint. Our treatment team also has experience with multiple successful installations by AdEdge that exhibit operational reliability. Subsequently, herein, **we recommend the City of Bay City implement Iron Adsorption Media Vessels by AdEdge at each plant site**, **6th Street & Avenue I and 6th Street & Katy Avenue**.

We would note that since the combined treatment system capital cost estimate is less than 10% more than the mutual individual treatment units, this may be an option to the recommended alternative that we can explore more closely during Detailed Design should the City have interest.

Appendix A:
Record Drawings

N. I. C.

GENERAL NOTES

1. Contractor Shall Protect All Trees Designated, By Constructing A Barrier Around Each Tree Trunk.
2. Existing Pool Filter And Associated Piping Above Ground And Underground Shall Be Removed And Salvaged As Directed By Bay City Officials.
3. Contractor Shall Field Verify The Location Of Any Existing Abandoned Underground Piping That May Interfere With Construction Of New Facilities.

NOTE:

DEMOLITION OF EXISTING STRUCTURES AND FILL OF EXISTING SWIMMING POOL PER THIS SHEET WILL HAVE BEEN ACCOMPLISHED BY THE CITY OF BAY CITY PRIOR TO THIS CONTRACT.
THIS SHEET IS INCLUDED HEREIN FOR CONTRACTOR'S REFERENCE ONLY.

N. I. C.

LEGEND

- +49.67 Existing Spot Elevations
- Large Shade Trees To Be Protected As Per Note #1
- Concrete To be demolished & removed (may be used as fill in area indicated) To a min depth of 18" below grade or to Elev. indicated
- Interior of Existing Swimming Pool To Be Filled With Compacted Select Sandy Clay & Finished Grade Elev 5190, After Breaking Up " Bottom of Pool " To Allow Ground Water Drainage.
- Interior of Existing Swimming Pool To Be Filled With Rubble and Debris, above Elevation 4700, as shown on Sht 3 of 3

CITY OF BAY CITY, TEXAS

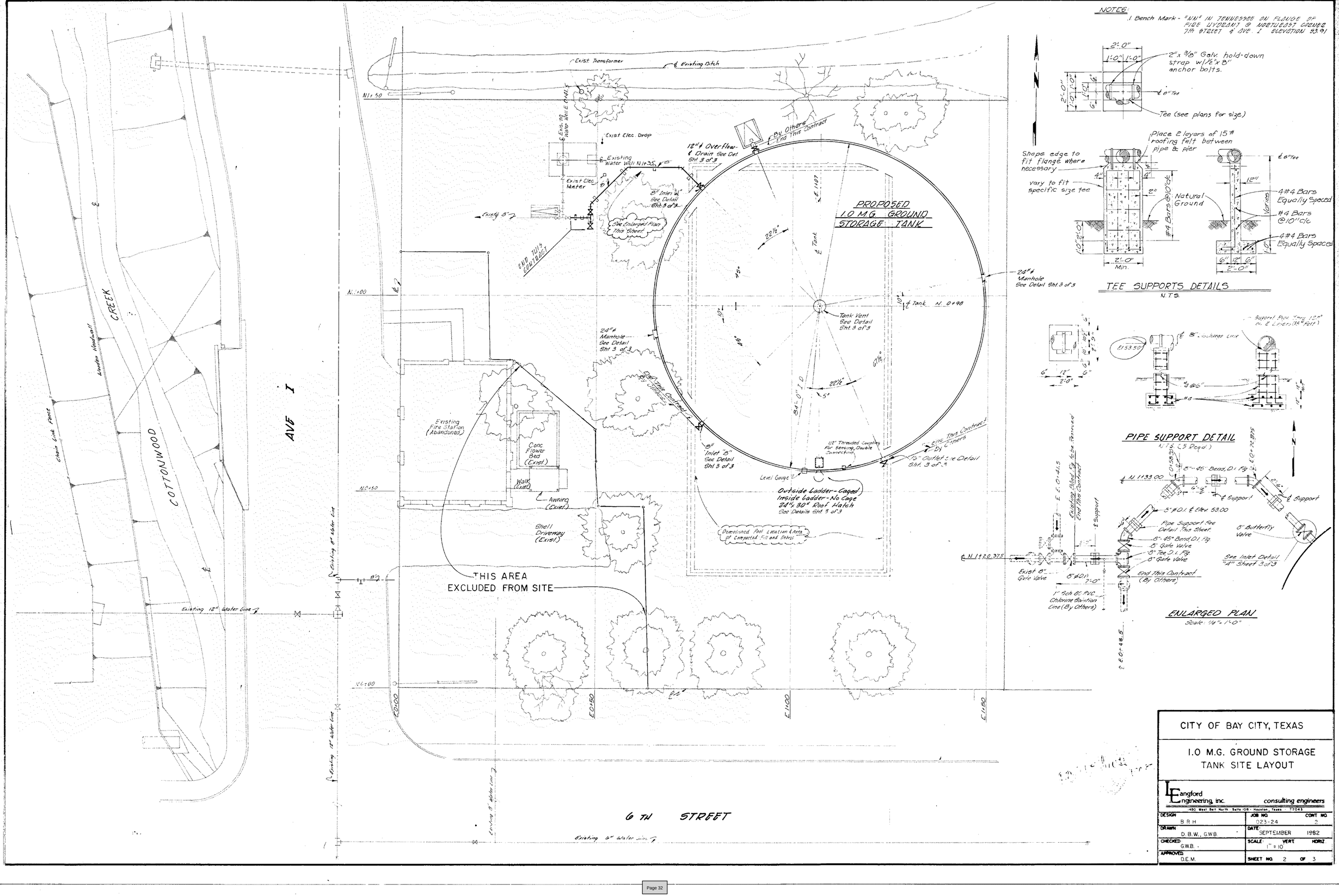
DEMOLITION PLAN

Langford Engineering, inc. consulting engineers
450 West Bath North Suite 108 - Houston, Texas - 77063

DESIGN B.R.H.	JOB NO 023-24	CONT NO 2
DRAWN C.W. & D.W.	DATE SEPTEMBER	1982
CHECKED G.W.B.	SCALE VERT	HORIZ 1" = 10'
APPROVED D.E.M.	SHEET NO. 1	OF 3

NOTES:

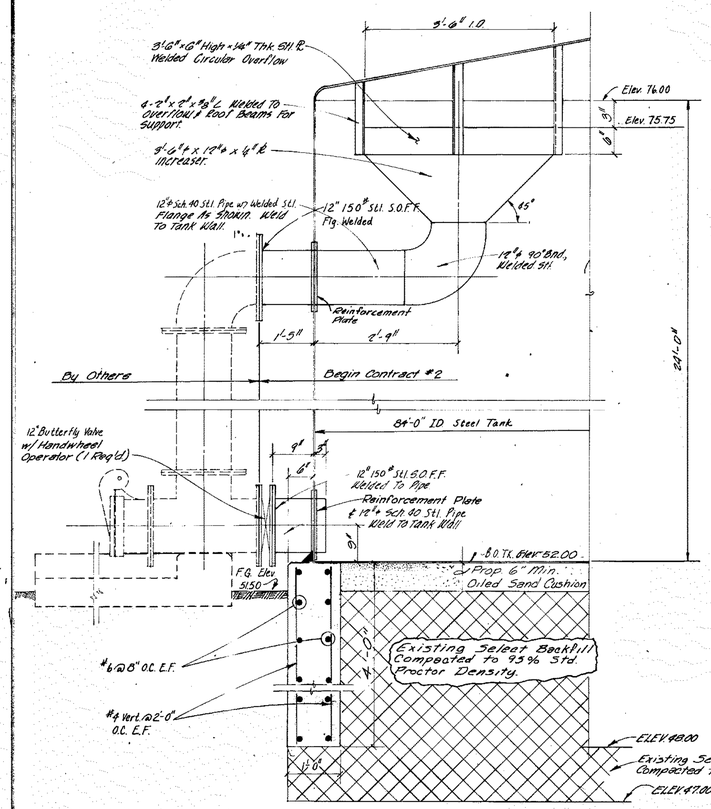
1. Bench Mark - "UU" IN TENNESSEE ON FLANGE OF FIRE HYDRANT @ NORTHEAST CORNER 7th STREET & AVE. I ELEVATION 93.91



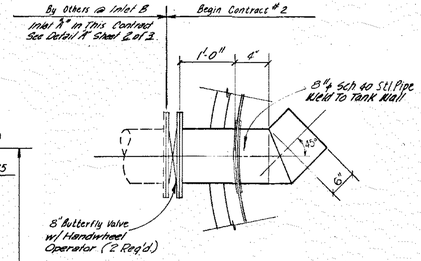
TEE SUPPORTS DETAILS
N.T.S.

ENLARGED PLAN
Scale: 1/4" = 1'-0"

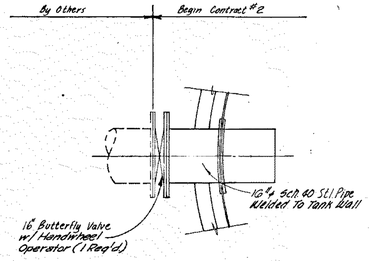
CITY OF BAY CITY, TEXAS	
I.0 M.G. GROUND STORAGE TANK SITE LAYOUT	
LEangford Engineering, Inc. consulting engineers 450 West Bell North Suite 108 - Houston, Texas 77043	
DESIGN B.R.H.	JOB NO. 023-24
DRAWN D.B.W., G.W.B.	DATE SEPTEMBER 1982
CHECKED G.W.B.	SCALE 1" = 10' VERT. HORIZ
APPROVED D.E.M.	SHEET NO. 2 OF 3



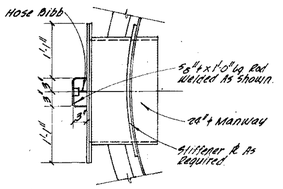
TANK DRAIN DETAIL
N.T.S.



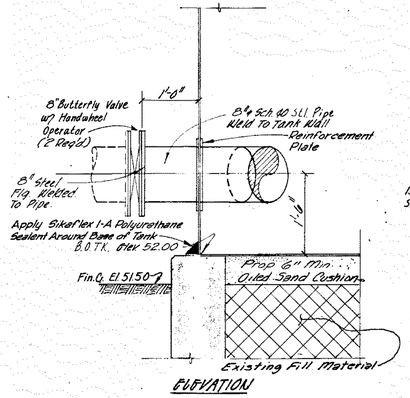
PLAN VIEW



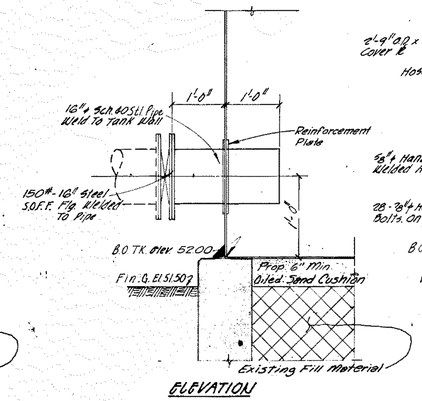
PLAN VIEW



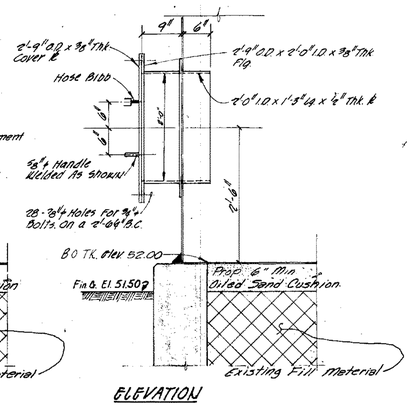
PLAN VIEW



ELEVATION



ELEVATION

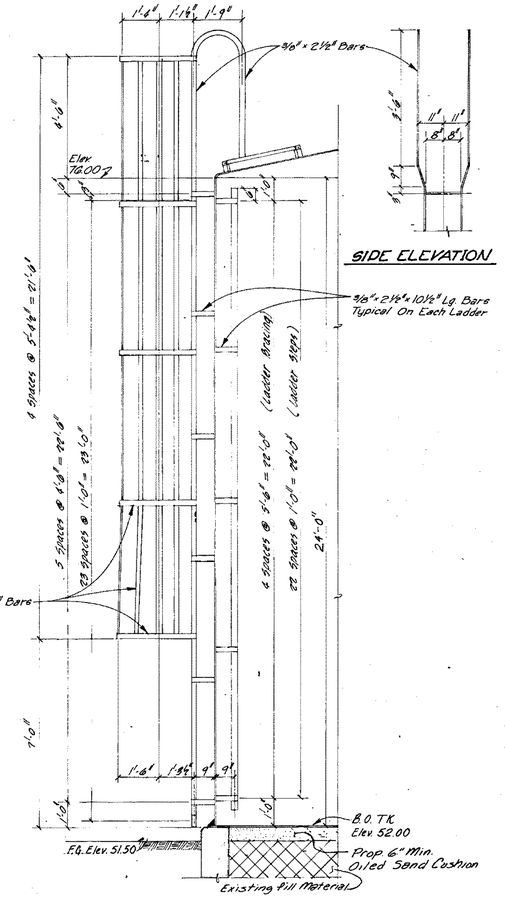


ELEVATION

TANK INLET "A" & "B" DETAILS
(See Sheet 2 of 3 For Inlet Location and Designation)
N.T.S. (2 Req'd)

TANK OUTLET DETAILS
N.T.S.

MANHOLE DETAILS
(2 Required) See Sheet 2 of 3 For Location.
N.T.S.

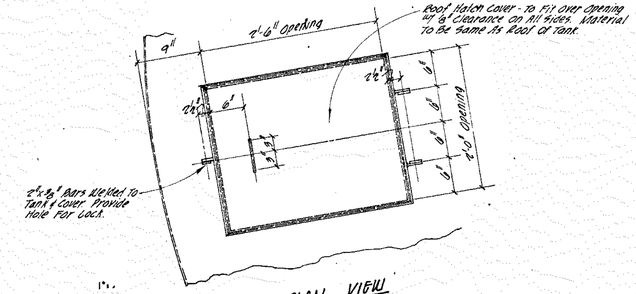


SIDE ELEVATION

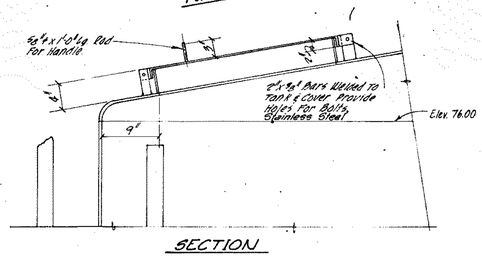
3/16" x 2½" x 10½" Lg. Bars Typical On Each Ladder

¼" x 2½" Bars Typical

ELEVATION

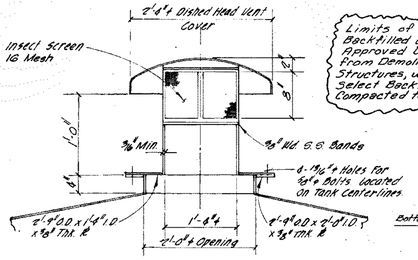


PLAN VIEW



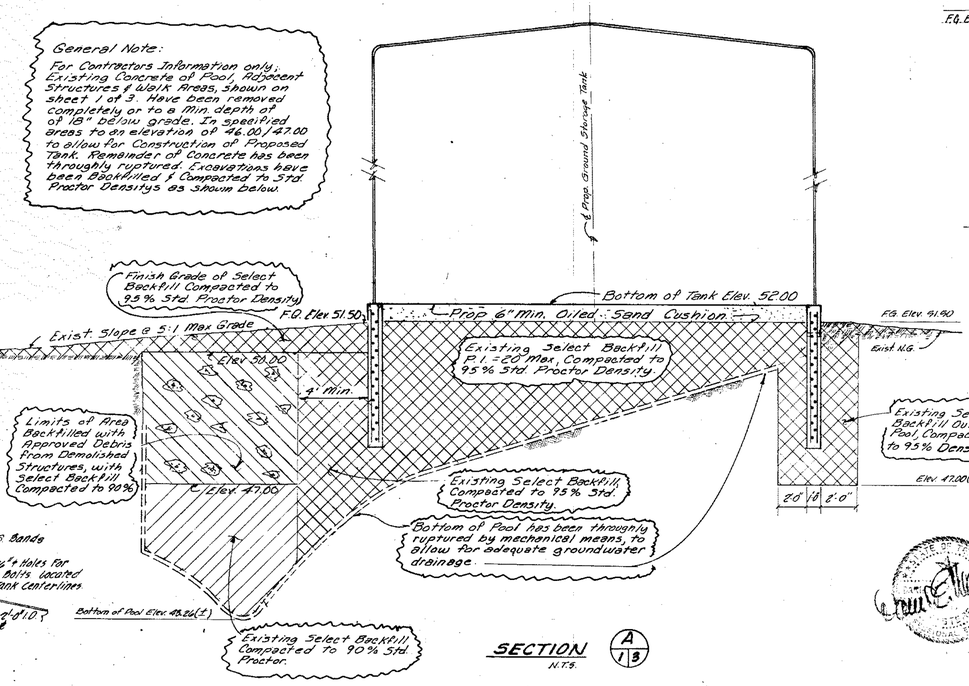
SECTION

ACCESS HATCH DETAILS
Scale: ½" = 1'-0"

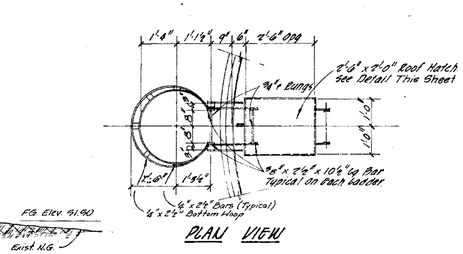


TANK VENT DETAIL
N.T.S.

General Note:
For Contractors Information only; Existing Concrete of Pool, Adjacent Structures & Walk Areas, shown on sheet 1 of 3 Have been removed completely or to a Min. depth of of 18" below grade. In specified areas to an elevation of 46.00 / 47.00 to allow for Construction of Proposed Tank. Remainder of Concrete has been throughly ruptured. Excavation have been Backfilled & Compacted to Std. Proctor Densitys as shown below.



SECTION
N.T.S.
A
1 | 3



PLAN VIEW

ACCESS LADDER DETAILS
N.T.S.

CITY OF BAY CITY, TEXAS

I.O.M.G GROUND STORAGE TANK
MISCELLANEOUS DETAILS

Langford Engineering, Inc. — consulting engineers
14811 West Bellfort North Suite 105 Houston, Texas 77043

DESIGN: B.R.H.	JOB NO. 023-24	CONT. NO. 2
DRAWN: G.W.B., P.J.S.	DATE: SEPTEMBER 1982	
CHECKED: G.W.B.	SCALE: VERT. AS SHOWN	HORIZ.
APPROVED: D.E.M.	SHEET NO. 3 OF 3	

CITY OF BAY CITY, TEXAS

CONSTRUCTION OF 1.0 M.G. GROUND STORAGE TANK

JOB NO. 023-24 CONTRACT NO. 2

INDEX OF DRAWINGS

SHT. NO.	SHEET TITLE
023-24*2	COVER SHEET
1 of 3	DEMOLITION PLAN
2 of 3	1.0 M.G. GROUND STORAGE TANK SITE LAYOUT
3 of 3	1.0 M.G. GROUND STORAGE TANK MISCELLANEOUS DETAILS

MAYOR

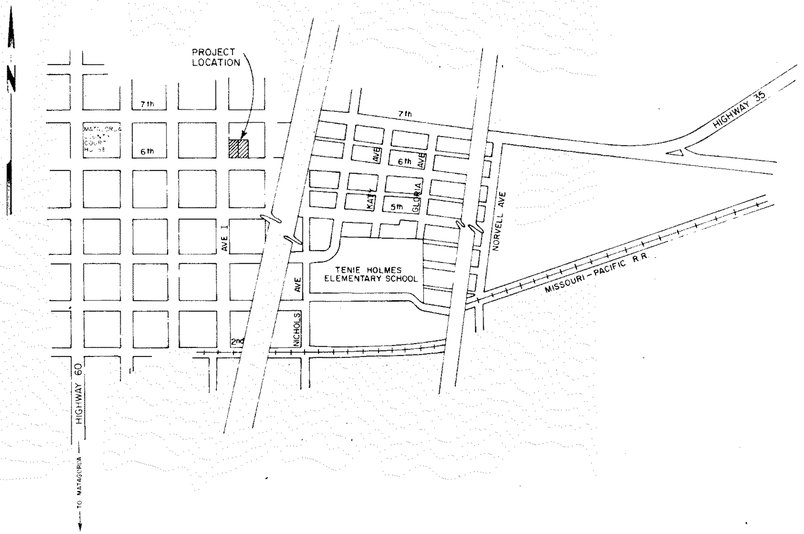
Glen White

CITY COUNCIL

C. B. Keener
Frank Henderson
Georgia Herreth
Pasqual Martinez
Meyer Denn

DIRECTOR OF UTILITIES

Clark Young



LANGFORD ENGINEERING INC.
CONSULTING ENGINEERS
1450 West Belt Drive North · Suite 108
Houston, Texas · 77043
Sept., 1982

IN ACCORDANCE WITH THE AGREEMENT DATED 12/10/82 1982, BETWEEN THE CITY OF BAY CITY, TEXAS, OWNER, AND TANK BUILDERS, INC. CONTRACTOR, FOR CONSTRUCTION OF 1.0 M.G. GROUND STORAGE TANK, JOB NO. 023-24, CONTRACT NO. 2, THE CONTRACT DRAWINGS LISTED IN THE DRAWING INDEX AND BOUND HEREWITH ARE CERTIFIED AND IDENTIFIED AS PART OF THE AGREEMENT.

TANK BUILDERS, INC.
CONTRACTOR

BY: Bruce Kromer

TITLE: BRUCE KROMER, VICE-PRES.

DATE: 12/10/82

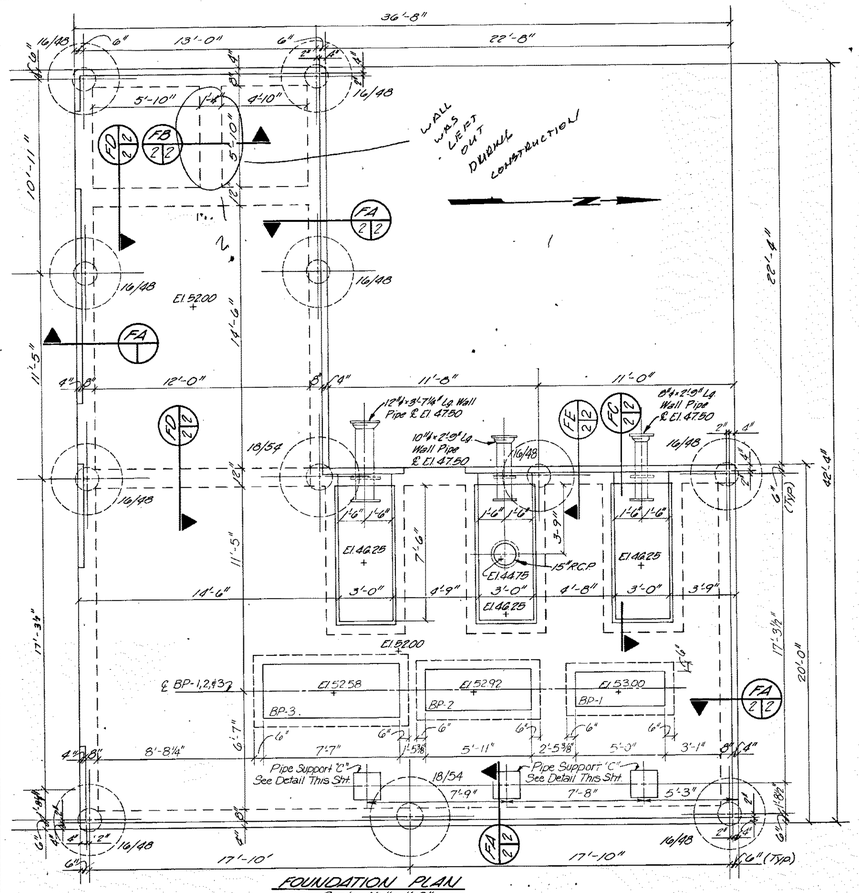
CITY OF BAY CITY
OWNER

BY: Glen White

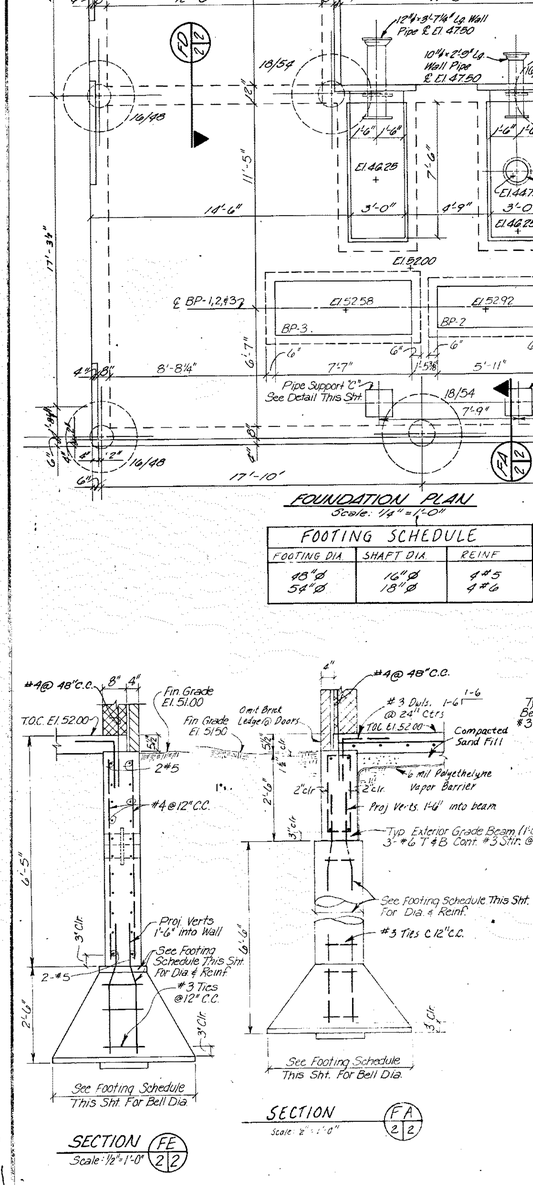
TITLE: Mayor

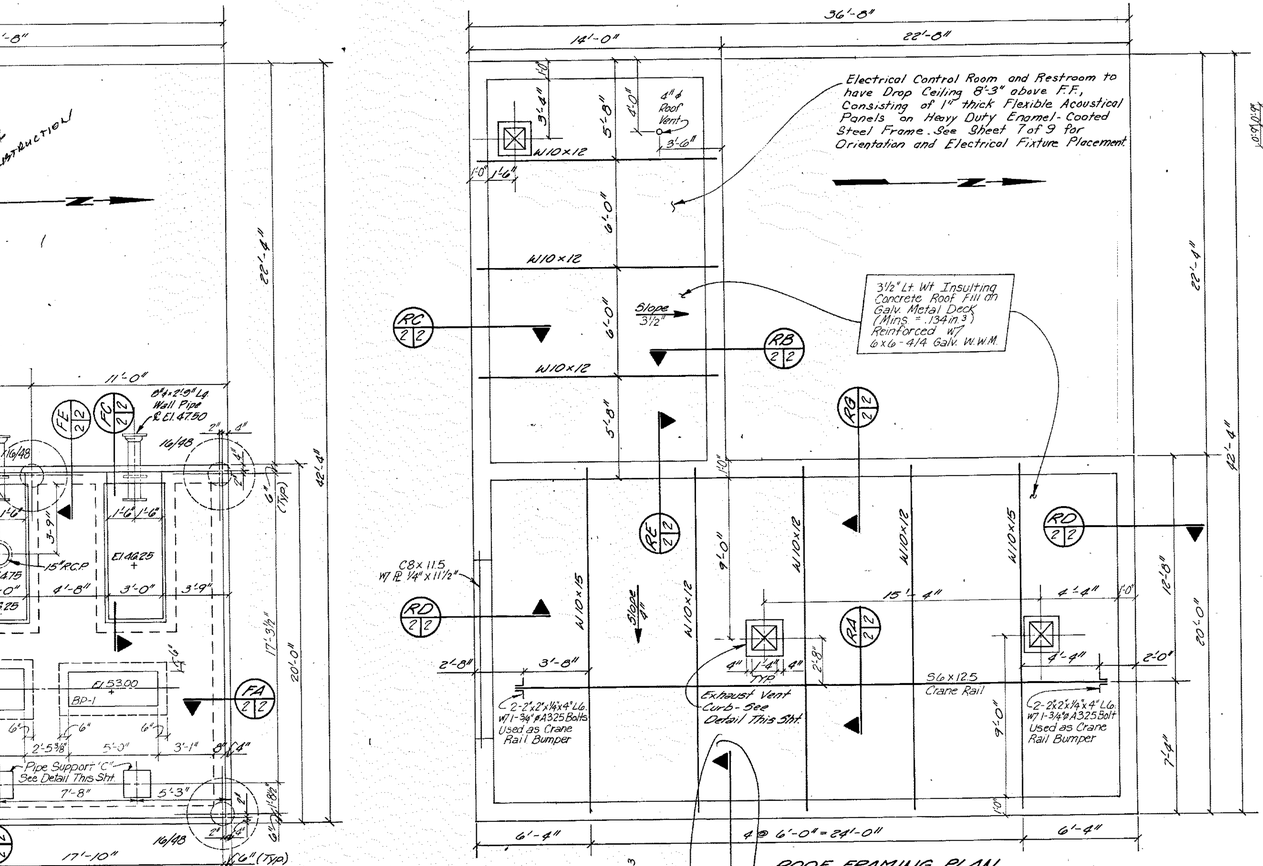
DATE: 12-10-82

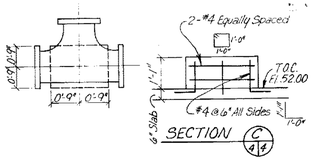

NOTES:
1. Remove as soon as practicable, accumulated Rubbish and Open Block for public use. Where Section of Concrete pavement has been removed and it is desirable not to replace the pavement the same day, the Contractor will be required to provide, install, and maintain Steel plating suitable to carry Public Traffic Safely over the opened area. Include the cost of Steel plating and all work required in other items of the project.
2. All excess excavation and unsatisfactory and/or waste material, including vegetation, roots concrete, and debris shall be disposed of by the Contractor as approved by the City of Bay City. Include haul in other items of the project.
3. BENCH MARK - "NN" in Tennessee on flange of fire hydrant @ Northeast corner 7th Street & Avenue I. Elevation 53.91.
4. Field Verify Location And Type of Material Prior To Connecting The New 4" Sanitary Sewer To The Existing 6" Sanitary Line. The Connection Will Require The Installation of 1-6"x6"x4" Wye, M.J., D.I. And 1-4"-45° Bend M.J., D.I. With Associated Adapters To Connect The Wye Into The Existing 6" Line.
EXISTING 1.0 M.G. GROUND STORAGE TANK
BOOSTER PUMP STATION
CREEK
COTTONWOOD
AVE. I
6 TH STREET
Existing Water Plant Site
Existing Fire Station (Abandoned)
Shell Driveway
This Area Excluded from Project Site
GENERATOR PAD
500 GAL. FUEL TANK
Existing 12" Water Line
Existing 6" Water Line
Existing 8" Water Line
Prop. 12" PVC Water Line. See Sheet 8 of 9 for Stationing and Profile of Water Line.
Limits of 12" D.I. Water Line
Prop. 12" T.S. & Valve w/ Box
Prop. 12" Gate Valve & Box
See Note #1 This Sht. for Excavation in Street.
Approximate Location of Old Abandoned Well. Verify Location Before Installing New 12" Water Line
Approx. 16 L.F. 4" M.J. D.I. Pipe w/ Associated Required Adapters
See Note #4 This Sheet
Remove Exist. 6" San. Swr. & Install Approx. 16 L.F.-6" M.J. D.I. Pipe w/ Associated Required Adapters.
SECTION A/1 N.T.S.
6" Reinf. Conc. Apron
6" Reinf. Conc. Pavement (Typ.)
#3 Bars @ 24" c.c. Lap 30 Bar Diameters
Recompacted Subgrade To 95% Standard Proctor Density
Diminish Curb To Zero At End Of Conc. Apron
TYPICAL SIDEWALK X-SECTION N.T.S.
Width Varies, See Plan This Sheet
Fin. Grade 51.40
6x6, 6/6 Wire Mesh
ENLARGED PLAN Scale 3/8" = 1'-0"
℄ 10" Elev. 47.50
CITY OF BAY CITY, TEXAS
BOOSTER PUMP STATION AND YARD PIPING SITE LAYOUT
Langford Engineering, Inc. consulting engineers
DESIGN B.R.H.
DRAWN G.W.B.
CHECKED D.E.M.
APPROVED D.E.M.
JOB NO. 023-24
CONT NO. 3
DATE: SEPTEMBER 1982
SCALE 1" = 10'
SHEET NO. 1 OF 9



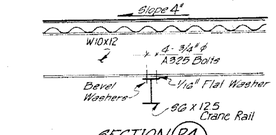
FOOTING SCHEDULE		
FOOTING DIA	SHAFT DIA	REINF
48"ø 54"ø	16"ø 18"ø	4 #5 4 #6

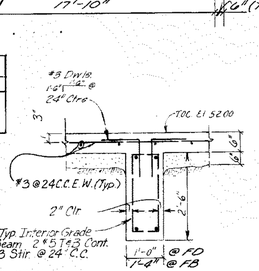


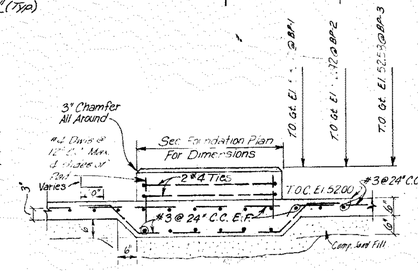


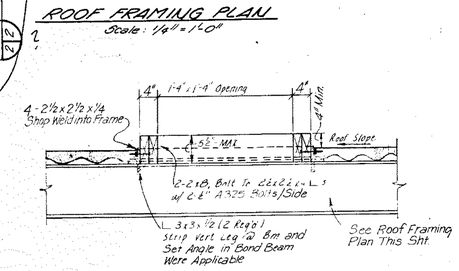


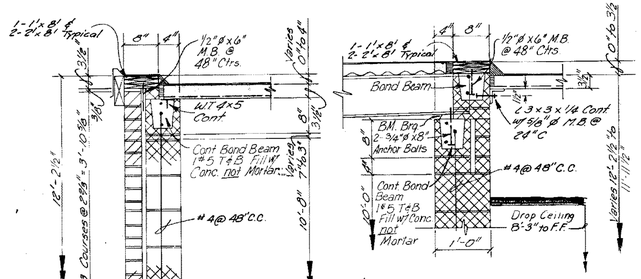
PIPE SUPPORT "C"
N.T.S.

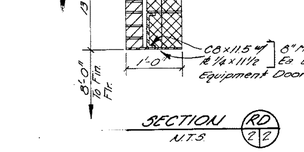


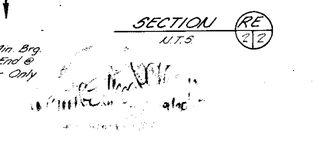


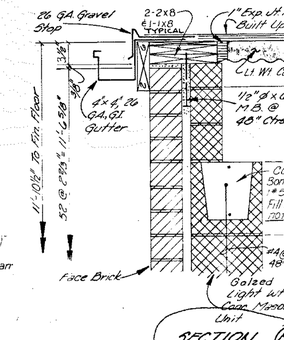




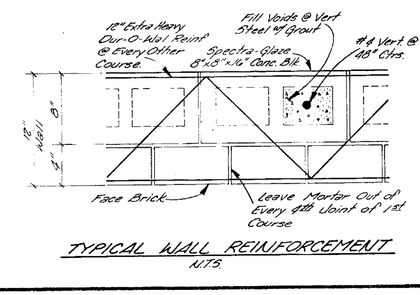








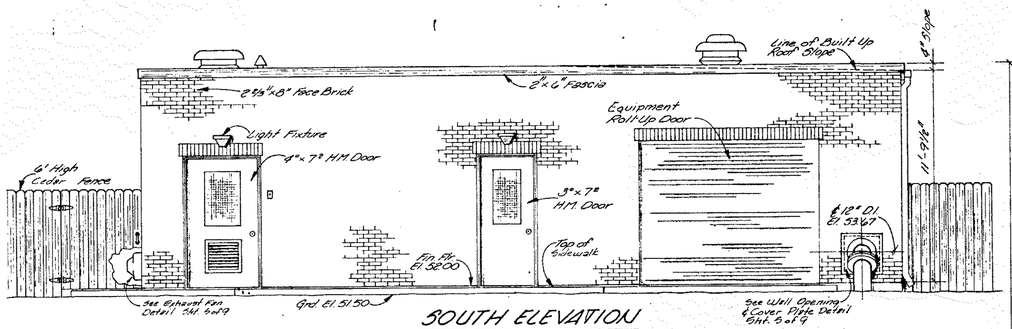
NOTE: Exterior Wall of Suction Line Well is Continuous For 23'-8"



GENERAL NOTES

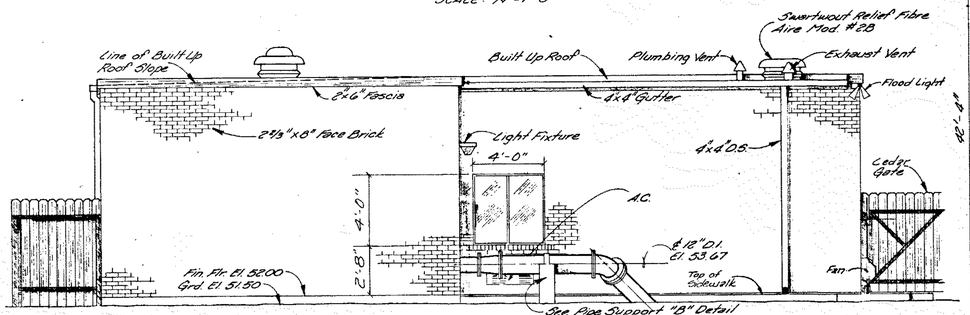
1. All construction joints, all corners, sumps and openings to be formed and/or have additional reinforcing as per sheet titled "STANDARD CONCRETE DETAILS" unless otherwise noted.
2. Floors to receive steel trowel finish with light brooming.
3. All Reinforcing to be Lapped 30 Bar Diameter.
4. Fill Under Booster Pump Building Slab with Sand. Excavate to 6" Below Natural Grade and Replace Material With Compacted Sand. Use Sand Free From Clay and Foreign Matter which has a Plasticity Index Of Four or Less Compact To at least 95% Standard Proctor Density At Optimum Moisture Water Using Roller or Vibrator Equipment.
5. Dimensions @ Pump Pads are for Steel Drip Rim Base. Cast Iron Base Dimension may vary from Dimensions Shown on Plan, Verify With Pump Station Plans.
6. Omit Brick Ledge @ All Door Openings.

CITY OF BAY CITY, TEXAS		
BOOSTER PUMP STATION STRUCTURAL FOUNDATION PLAN & STRUCTURAL ROOF PLAN & DETAILS		
Langford Engineering Inc. consulting engineers 455 West Bay Area Blvd. Suite 208 • Webster, Texas 77598		
DESIGN J.D.R.	JOB NO. 023-24	CONT. NO. 3
DRAWN D.B.W.	DATE SEPTEMBER 1982	
CHECKED D.E.M.	SCALE VERT AS SHOWN	HORIZ
APPROVED D.E.M.	SHEET NO. 2 OF 9	



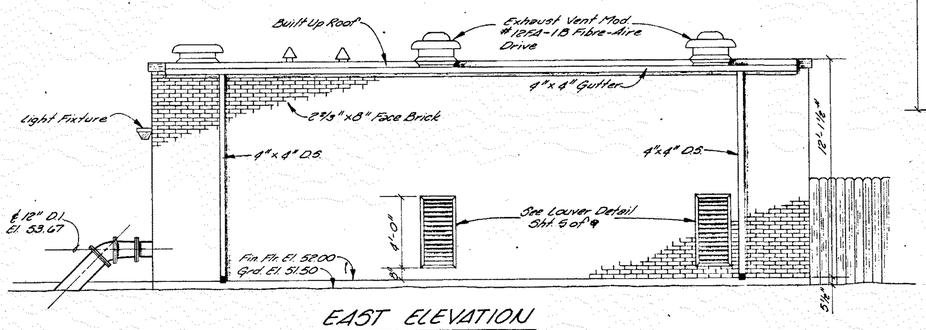
SOUTH ELEVATION

SCALE: 1/4"=1'-0"



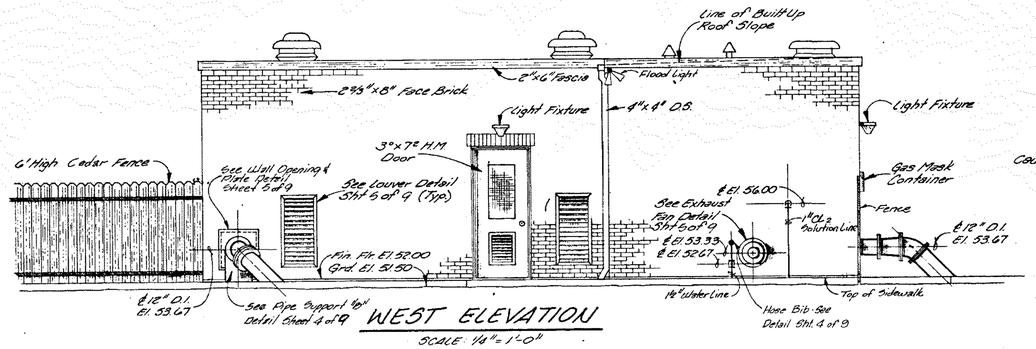
NORTH ELEVATION

SCALE: 1/4"=1'-0"



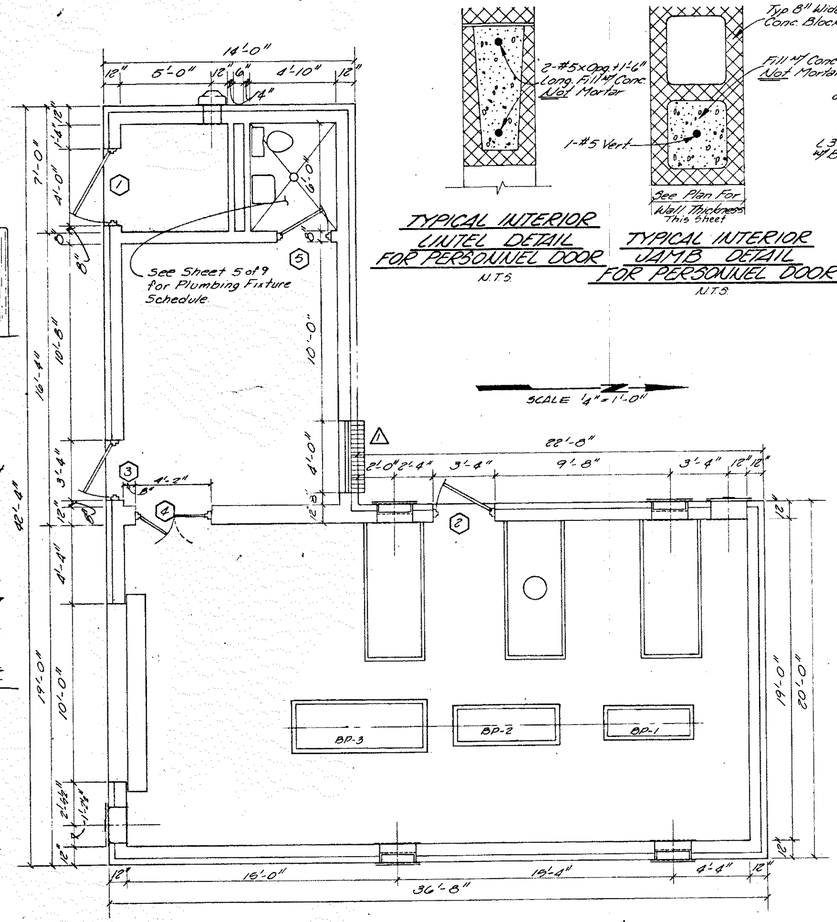
EAST ELEVATION

SCALE: 1/4"=1'-0"



WEST ELEVATION

SCALE: 1/4"=1'-0"



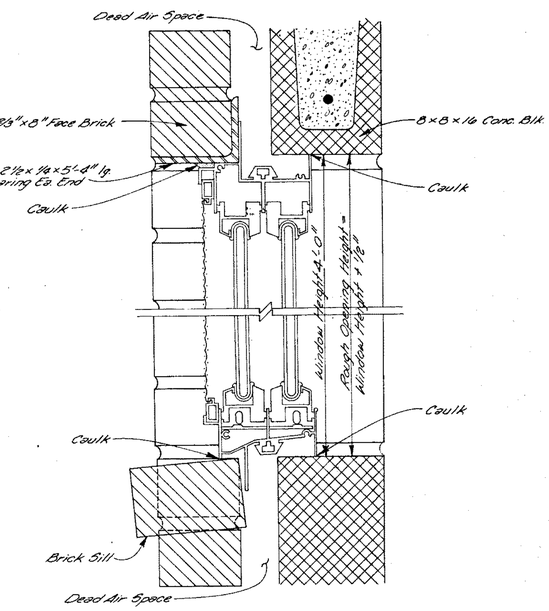
SCALE 1/4"=1'-0"

TYPICAL INTERIOR LINTEL DETAIL FOR PERSONNEL DOOR

N.T.S.

TYPICAL INTERIOR JAMB DETAIL FOR PERSONNEL DOOR

N.T.S.



TYPICAL EXTERIOR WINDOW DETAIL

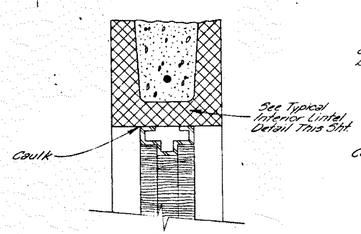
N.T.S.

DOOR SCHEDULE

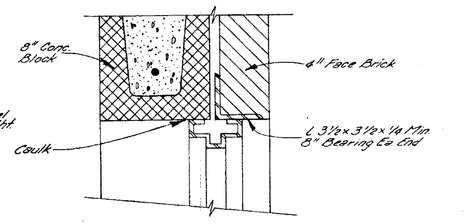
SYMBOL	SIZE	DESCRIPTION
1	3'0"x7'0"	Republic Steel Door, Series DM120, Type GLI, 5 3/4" Steel Frame, Cylindrical Lock & Std. Hardware, 1 Req'd, or Pioneer or Approved Equal. ¼" Aluminum Threshold
2	3'0"x7'0"	Republic Steel Door, Series DM120, Type GLI, 5 3/4" Steel Frame, Cylindrical Lock & Std. Hardware, 1 Req'd, or Pioneer or Approved Equal. ¼" Aluminum Threshold
3	3'0"x7'0"	Republic Steel Door, Series DM120, Type 9, 5 3/4" Steel Frame, Cylindrical Lock & Std. Hardware, 1 Req'd or Pioneer, Approved Equal.
4	4'0"x8'0" 7-10	Republic Steel Door, Series DM120, Type 6, Double Swing Right Hand Active, 5 3/4" Steel Frame, Std. Hardware, & ¼" Aluminum Threshold, 1 Req'd or Pioneer or Approved Eq.
5	24"x8'0" 7-10	Republic Steel Door, Series DM120, Type F, 5 3/4" Steel Frame, Std. Lock & Hardware ¼" Aluminum Threshold, 1 Req'd or Pioneer or Approved Equal.

WINDOW SCHEDULE

SYMBOL	SIZE	DESCRIPTION
A	4'-0" 4'-0"	Alcoa Aluminum Window, Series 300 insulating sliding Window, w/ Screen or Alenco Series 700 or Approved Eq.



HEAD



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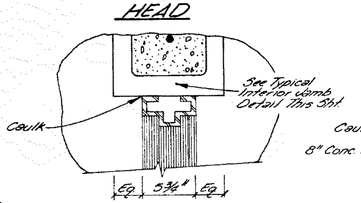
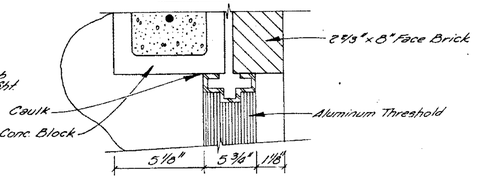
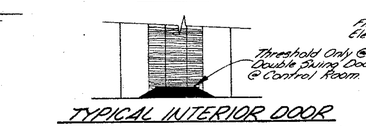


JAMB

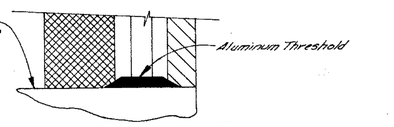


JAMB



TYPICAL INTERIOR DOOR DETAIL

N.T.S.



EXTERIOR DOOR DETAIL

N.T.S.

EQUIPMENT DOOR NOTES

1. Furnish & Install (1) KRINEAR Mod. FPD-20 or APTON Type ATM or Approved Equal.
2. Door curtain shall be composed of interlocking slats (Hot Dip Galv.) w/ a phosphate coating for paint adhesion. Both ends of alternate slats shall be provided w/ end-locking. Also every 6th slat shall withstand a windload of 20 lbs/sq ft.
3. Doors shall come complete w/:
   A. Brackets - Fabricated from min 3/16" thk. steel plates and shall be fastened to supporting wall angle by not less than 2-⅞" Ø Bolts.
   B. Hood - shall be 24 ga (Hot Dip Galv.) sheet metal.
   C. Guides - Fabricated of min 3/16" thk. heavy steel angles continuous from floor to top of brackets.
4. Doors shall be operated by an electric operator. Motor shall be ½ h.p., 115 v, 1 Ø complete w/ worm gear reducer & an emergency hand chain hoist, and a 24 volt control station, "Open-Close-Stop." The "Close" control button shall be of the constant-pressure type. (Motor to be wall mounted).
5. All ferrous surfaces and steel parts shall recieve one factory applied coat of rust inhibitive metal primer.
6. The equipment doors shall cover a 10'-0" Wide x 8'-0" High Opening

CITY OF BAY CITY, TEXAS.

BOOSTER PUMP STATION
ARCHITECTURAL PLAN
ELEVATIONS AND DETAILS

Langford Engineering, inc. consulting engineers
1450 West Bell North • Suite 108 • Houston, Texas • 77043

DESIGN: B.R.H.	JOB NO. 023-24	CONT. NO. 03
DRAWN: N.D.	DATE: SEPTEMBER 1982	
CHECKED: D.E.M.	SCALE: VERT. AS SHOWN	HORIZ.
APPROVED: D.E.M.	SHEET NO. 3 OF 9	

FITTING & VALVE SCHEDULE

Item No.	Description	No. Req'd
1	16" X 16" Tee, D.I., M.J.	1
2	16" X 10" Tee, D.I., M.J.	1
3	16" X 8" Tee, D.I., M.J.	1
4	16" X 12" Conc. Red., D.I., Large End M.J.	1
5	16" X 10" Conc. Red. D.I., Small End M.J.	1
6	12" x 12" Tee, D.I., Flg'd	1
7	12" x 10" Conc. Red., D.I., Flg'd	4
8	McDONNELL FST-V Flow Stretcher	5
10	12"-45° Bend, D.I., Flg'd.	7
11	12" X 8" Tee, D.I., Flg'd.	2
12		
13	12" X 10" Eccent. Red., D.I., Flg'd	1
14	12" X 3'-7" lg Wall Pipe, D.I., M.J., Flg'd.	1
15	12" Dresser Flange Adapter Style 127	1
16	10"-45° Bend, D.I., Flg'd.	2

CONTINUED

17	10" X 8" Eccent. Red., D.I., Flg'd.	1
18	10" X 6" Conc. Red., D.I., Flg'd.	1
19	10" Dresser Flange Adapter Style 127	3
20	10" X 2'-9" lg Wall Pipe, D.I., M.J. Flg'd.	1
22	8"-45° Bend, D.I., Flg'd.	2
23	8" X 6" Eccent. Red., D.I., Flg'd.	1
24	8" X 6" Conc. Red., D.I., Flg'd.	1
25	8" X 4" Conc. Red., D.I., Flg'd.	1
26	8" X 2'-9" lg Wall Pipe, D.I., M.J., Flg'd.	1
27	8" Dresser Flange Adapter, Style 127	1
A	10" W-5500DR Rockwell Turbo-meter And 10" Strainer	2
B	12" Butterfly Valve	1
C	10" Butterfly Valve	2
D	8" Butterfly Valve	6
E	10" Check Valve	1
F	8" Check Valve	2

HOSE BIB DETAIL
N.T.S.

PIPE SUPPORT "B"
N.T.S.

SUPPORT BRACKET DETAIL
N.T.S.

GAUGE DETAIL
N.T.S.

ELECTRICAL CONTROL ROOM

BOOSTER PUMP ROOM

MECHANICAL PLAN
scale: 3/8" = 1'

SECTION
scale: 3/8" = 1'

PIPE SUPPORT "A"
N.T.S.

GRATING FRAME DETAILS
N.T.S.

GENERAL NOTES

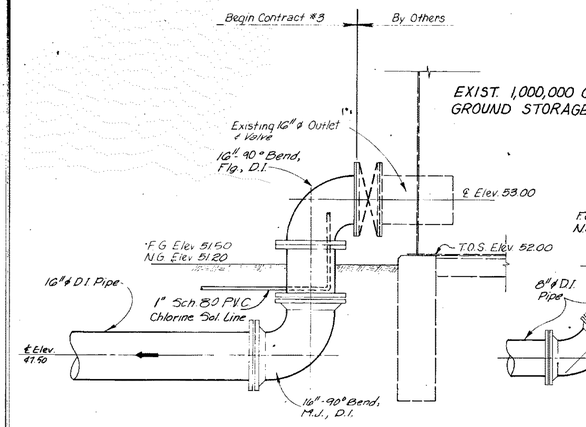
1. SUMP PUMP - Furnish & Install (1) "ITT/FLYGT" Model # 3102 Pump, 60 hz, 1Ø, 115 V, 1750 rpm, ½ hp, 1½" Discharge Piping.
2. Dimensions @ Booster Pump Bases & Concrete Base Pad Are For Steel Drip Rim Base Cast Iron Base Dimensions May Vary From Ones Shown On Plan. Refer To Approved Manufacturers Shop Drawings For Verification (Contractor Shall Weld Pump Suction & Discharge Center-line Locations As Shown On Plans.
3. ¾" ϕ Drip Rim Base Drain Line Outlet Location & Routing To Piping Pit May Vary W/ C.I. Base
4. GRATING - Furnish & Install "IKG" Fiberglass Grating Type "CG" - 1½" x 15" x ⅜" s/s, Furnish Each Pit w/ (2) 3'-0" Wid x 3'-9" Lg Sections For Easy Removal, Cut Openings For Pipe As Necessary (Cut Edges Shall Be Finished Smooth).
5. WELL - Furnish & Install (1) "AURORA 80 XT" Low Head Pump Type - Catalog # 909300 (2) Ton Capacity w/ Chain Container # 909394).

CITY OF BAY CITY, TEXAS

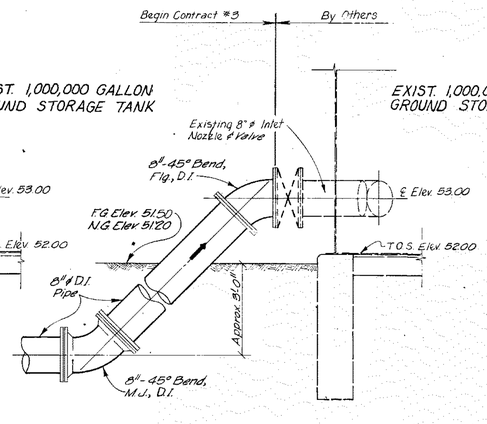
BOOSTER PUMP STATION
MECHANICAL, PLAN, SECTION AND DETAILS

Langford Engineering, Inc. consulting engineers
1450 West Bell North - Suite 108 - Houston, Texas - 77043

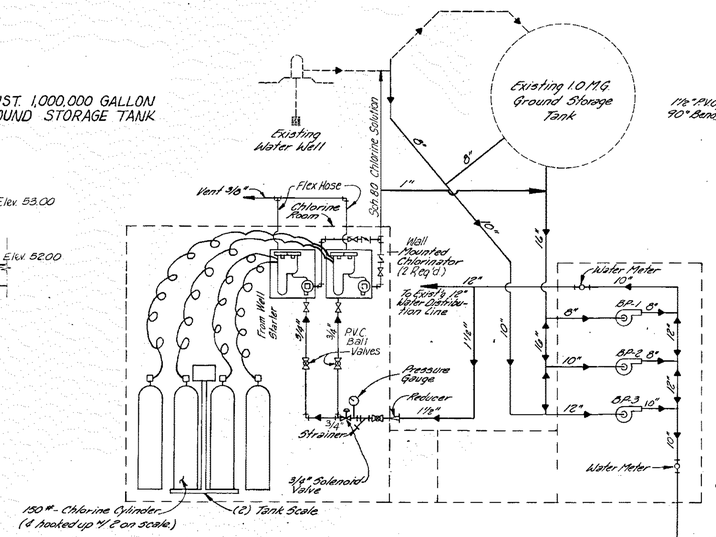
DESIGN: BRH	JOB NO. 023-24	CONT NO. 03	
DRAWN: BRH	DATE: SEPTEMBER 1982		
CHECKED: DEM	SCALE: AS SHOWN	VERT.	HORIZ.
APPROVED: DEM	SHEET NO. 4 OF 9		



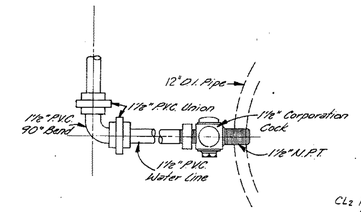
OUTLET DETAIL
N.T.S.



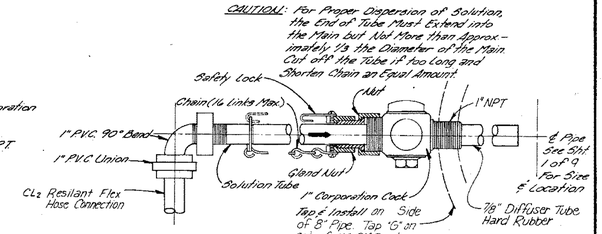
INLET "B" DETAIL
N.T.S.



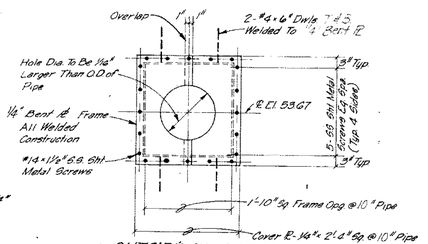
CHLORINATION SCHEMATIC
N.T.S.



WATER SUPPLY TAP DETAIL
N.T.S.

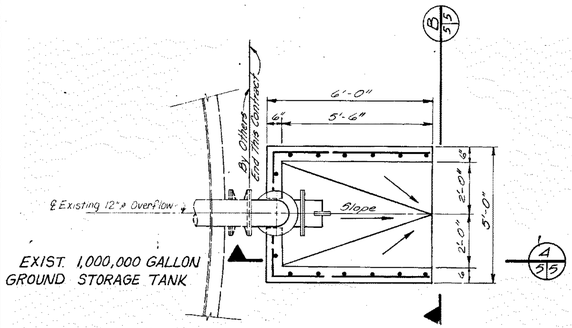


CHLORINE INJECTION DETAIL
N.T.S.

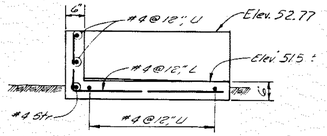


EXHAUST FAN DETAIL
N.T.S.

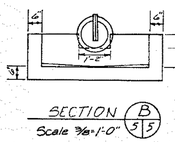
WALL OPENING & COVER PLATE DETAIL
N.T.S.



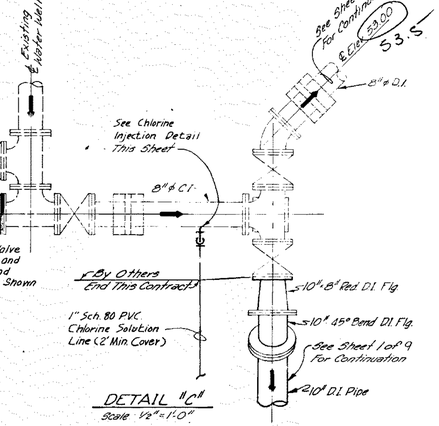
TANK DRAIN - PLAN
Scale: 3/8" = 1'-0"



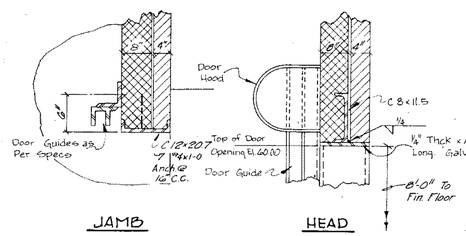
SECTION (A 5/5)
Scale: 3/8" = 1'-0"



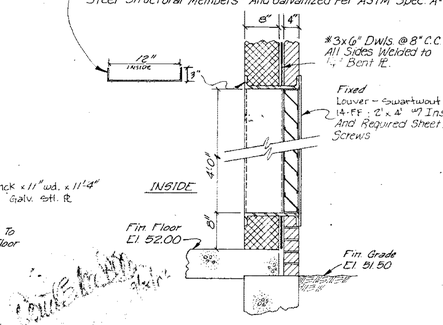
SECTION (B 5/5)
Scale 3/4" = 1'-0"



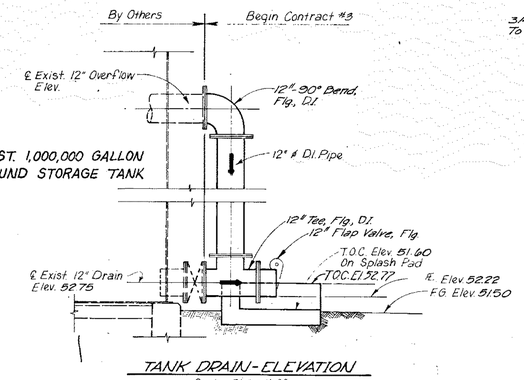
DETAIL "C"
Scale: 1/2" = 1'-0"



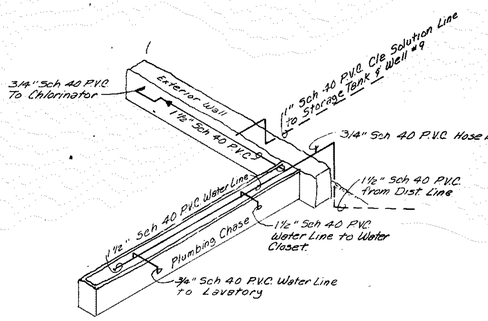
EQUIPMENT DOOR DETAIL
Scale: 1" = 1'-0"



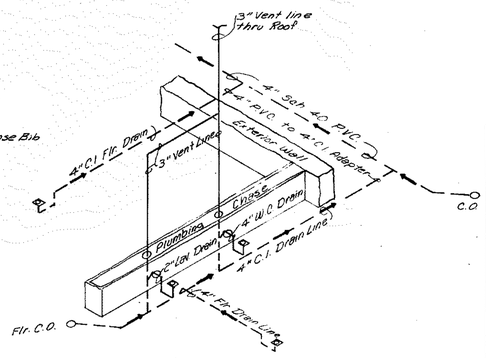
TYPICAL LOUVER DETAIL
Scale: 3/4" = 1'-0"



TANK DRAIN - ELEVATION
Scale: 3/8" = 1'-0"



WATER FEED SYSTEM DIAGRAM FOR CONTROL BLDG.
N.T.S.



DRAIN AND RISER DIAGRAM FOR CONTROL BLDG.
N.T.S.

PLUMBING FIXTURE SCHEDULE

SYMBOL	DESCRIPTION	
	WATER CLOSET	American Standard No. 2502.011, "Glenco" Toilet Siphon Jet, Viterous China, with Church No. 5320.072 Moltex heavy duty Plastic, Elongated bowl, open front, Flush Valve Sloan Royal No. 112 Y.V. or as Manufactured by Briggs or Approved equal.
	LAVATORY	American Standard "Comrade" Wall Hung, 20" x 18" Viterous China, with concealed arm hangers, No. 2103.729 Trim 1 1/4" Pop-up Drain, 1 1/4" Tail piece No. 4420.030 wid, cast brass, C.P., "P" trap with cleanout No. 2306.017, supplies & stop or as Manufactured by Briggs or other Approved equal.
	FLOOR DRAIN	Zurn Type Z-470, Cast Iron, with Nickel Bronze Strainer, Drum Trap, & Backwater Valve, or as Manufactured by Wade or other Approved equal.

PLUMBING SPECIFICATIONS:
1. Provide 4 oz. lead flashing at all plumbing Vents. turn flashing down into vent 2" min.
2. Test Sanitary Line & Vent piping by plugging all openings & filling the system the height of all vents. Inspect all joints, repair all leaks found & retest until piping is demonstrated to be free of leaks.

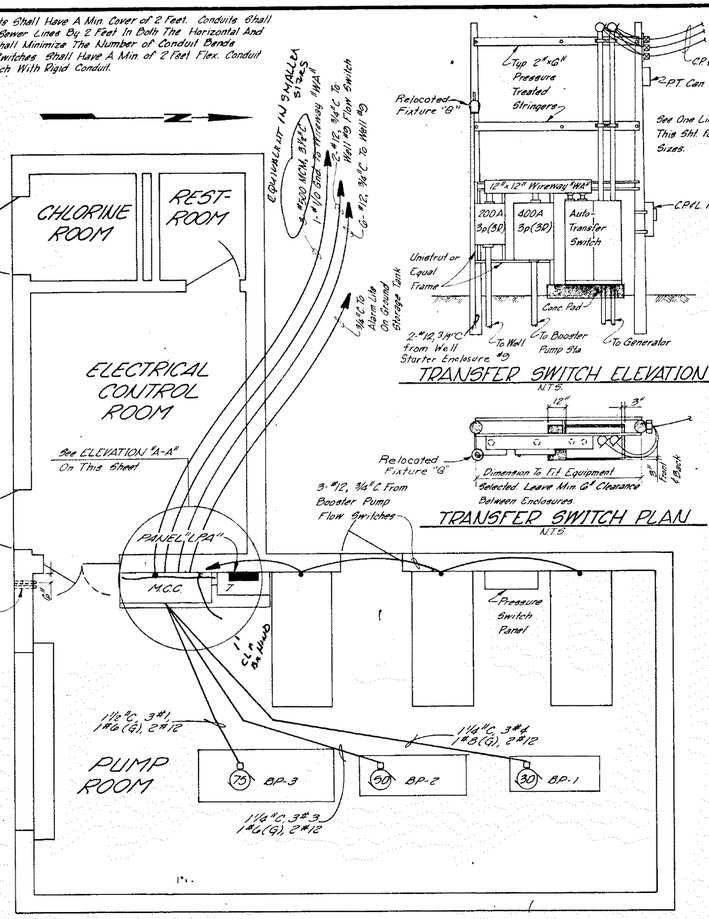
CITY OF BAY CITY, TEXAS

MISCELLANEOUS DETAILS

Langford Engineering, inc. consulting engineers
450 West Bay North Suite 28 Houston, Texas 77343

DESIGN G.W.B.	JOB NO 023-24	CONT NO 3
DRAWN G.W.B.	DATE SEPTEMBER 1982	
CHECKED D.E.M.	SCALE VERT AS SHOWN	HORIZ
APPROVED D.E.M.	SHEET NO. 5 OF 9	

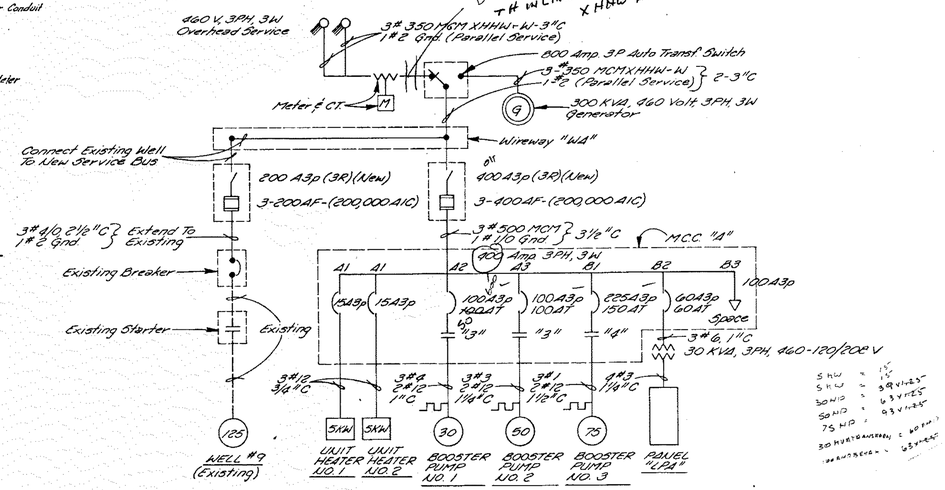
NOTE: All Electrical Conduits Shall Have A Min. Cover of 2 Feet. Conduits Shall Clear All Water And Sewer Lines By 2 Feet In Both The Horizontal And Vertical. Contractor Shall Minimize The Number of Conduit Bends Required. All Flow Switches Shall Have A Min of 2 Feet Flex. Conduit Connecting Flow Switch With Rigid Conduit.



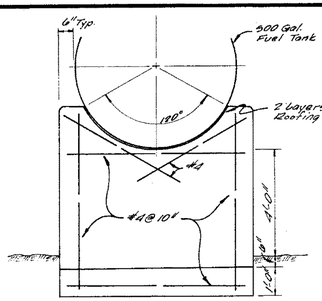
POWER PLAN
SCALE: 1/4" = 1'0"

TRANSFER SWITCH ELEVATION
N.T.S.

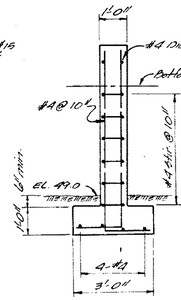
TRANSFER SWITCH PLAN
N.T.S.

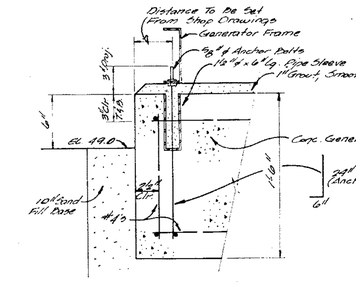


ONE LINE DIAGRAM
N.T.S.

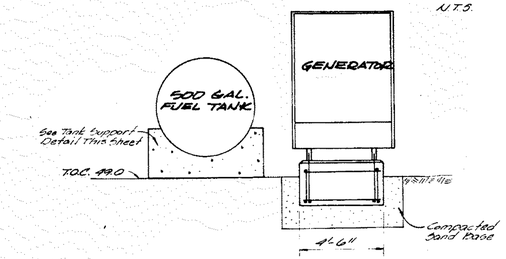


TANK SUPPORT
N.T.S.

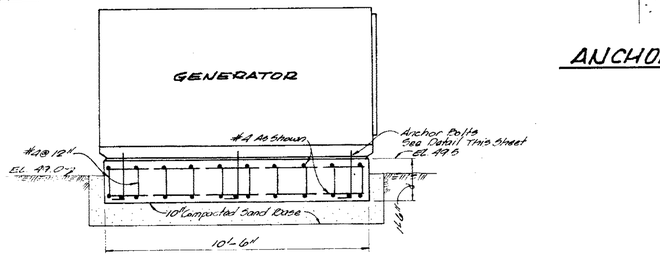




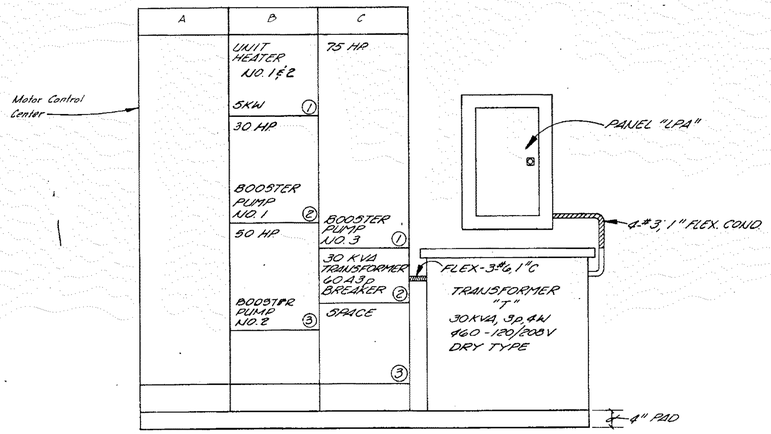
ANCHOR BOLT DETAIL
N.T.S.



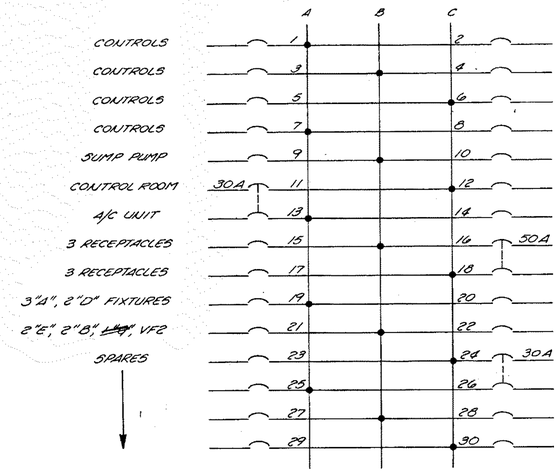
GENERATOR SET - EAST ELEVATION



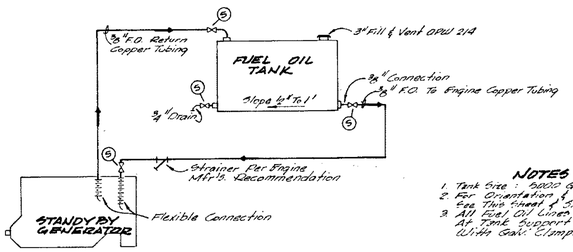
GENERATOR SET - SOUTH ELEVATION



ELEVATION "A-A"
SCALE: 3/4" = 1'0"

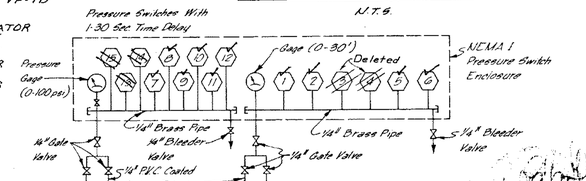


PANEL "LPA"
All Breakers 20 Amps, Unless Noted
3 PH, 4W - 100 Ampere M.lo.
Surface Mount 120/208 Volts



NOTES
1. Tank Size: 5000 Gal.
2. For Orientation & Details See This Sheet & Sheet 1 of 9
3. All Fuel Oil Lines To Be Supported At Tank Support & Engine Foundation With Galv. Clamps.

AUX. ENGINE SUPPLY SCHEMATIC - TYPICAL
N.T.S.



SCHEMATIC DIAGRAM
HIGH AND LOW PRESSURE SWITCHES

CITY OF BAY CITY, TEXAS

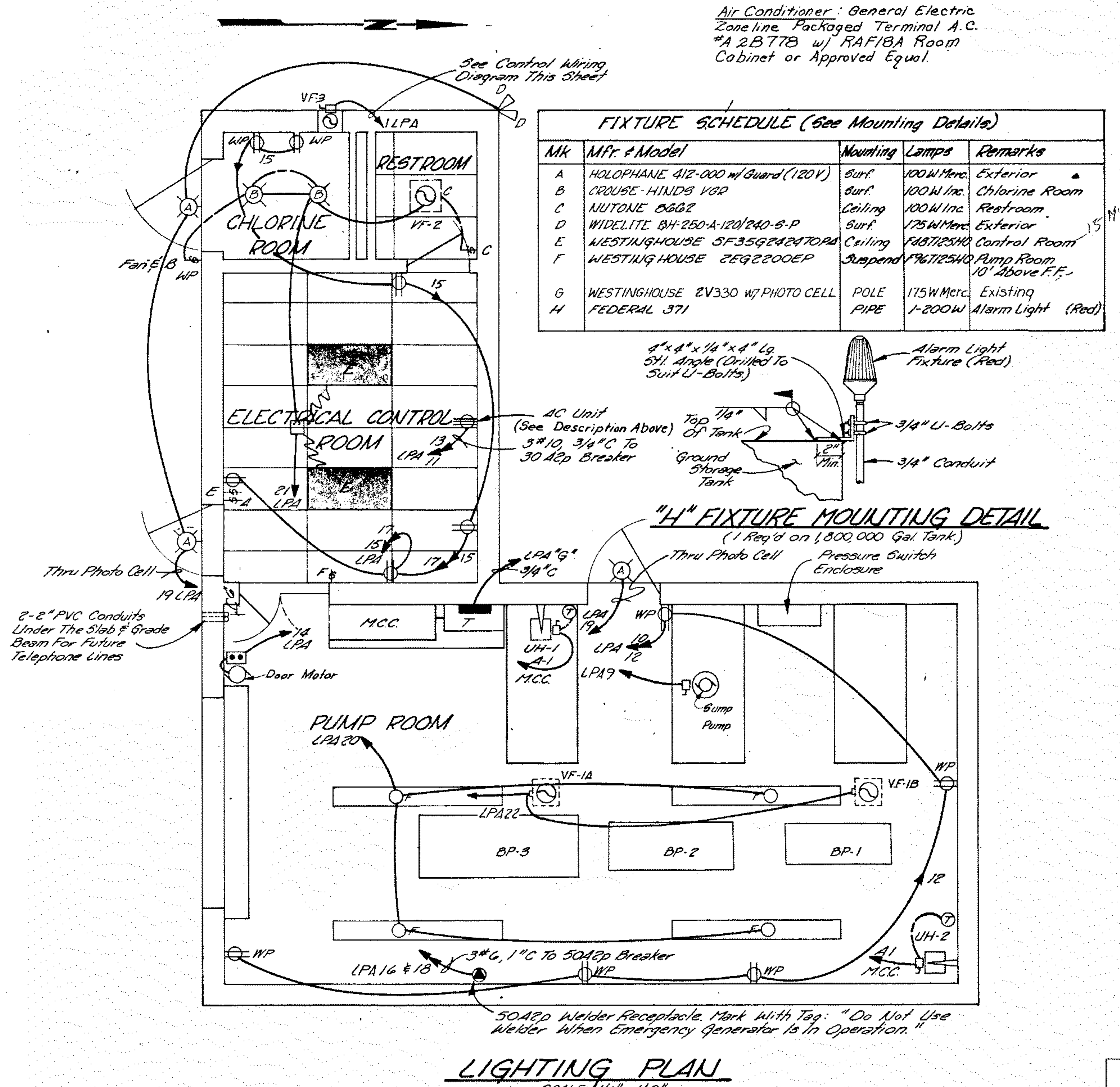
ELECTRICAL PLAN, DIAGRAMS AND DETAILS

Langford Engineering, Inc. consulting engineers
1450 West Bait North - Suite 108 - Houston, Texas - 77043

DESIGN	D.E.M.	JOB NO. 023.24	CONT NO. 03
DRAWN	N.J.D.	DATE	SEPTEMBER 1982
CHECKED	G.D.W.	SCALE: VERT.	HORIZ AS SHOWN
APPROVED	G.D.W.	SHEET NO. 6	OF 9

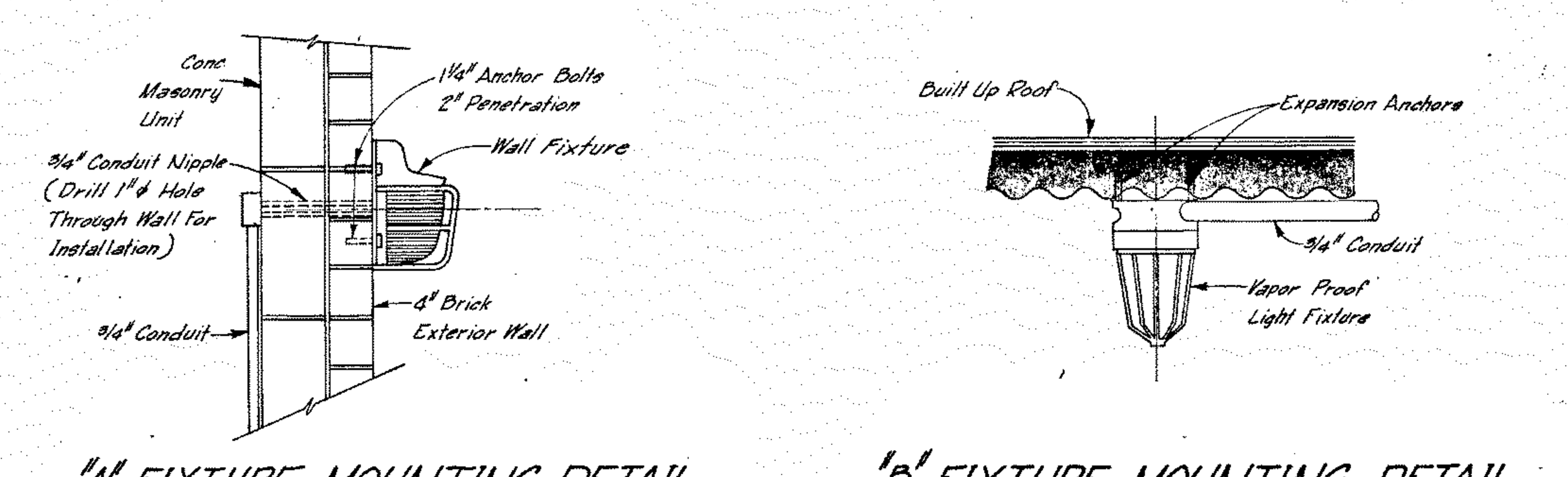
Air Conditioner: General Electric Zoneline Packaged Terminal A.C. #A2B778 w/ RAF18A Room Cabinet or Approved Equal.

FIXTURE SCHEDULE (See Mounting Details)				
Mk	Mfr. & Model	Mounting	Lamps	Remarks
A	HOLOPHANE 412-000 w/ Guard (120V)	Surf.	100W Merc.	Exterior
B	CROUSE-HINDS VGR	Surf.	100W Inc.	Chlorine Room
C	NUTONE 8662	Ceiling	100W Inc.	Restroom
D	WIDELITE BH-250-A-120/240-S-P	Surf.	175W Merc.	Exterior
E	WESTINGHOUSE SF35G24247OPA	Ceiling	F48T12SHO	Control Room
F	WESTINGHOUSE ZEG2200EP	Suspend	F96T12SHO	Pump Room 10' Above F.F.
G	WESTINGHOUSE 2V330 w/ PHOTO CELL	POLE	175W Merc.	Existing
H	FEDERAL 371	PIPE	1-200W	Alarm Light (Red)



LIGHTING PLAN

SCALE: 1/4" = 1'0"



"A" FIXTURE MOUNTING DETAIL

3 Required

"B" FIXTURE MOUNTING DETAIL

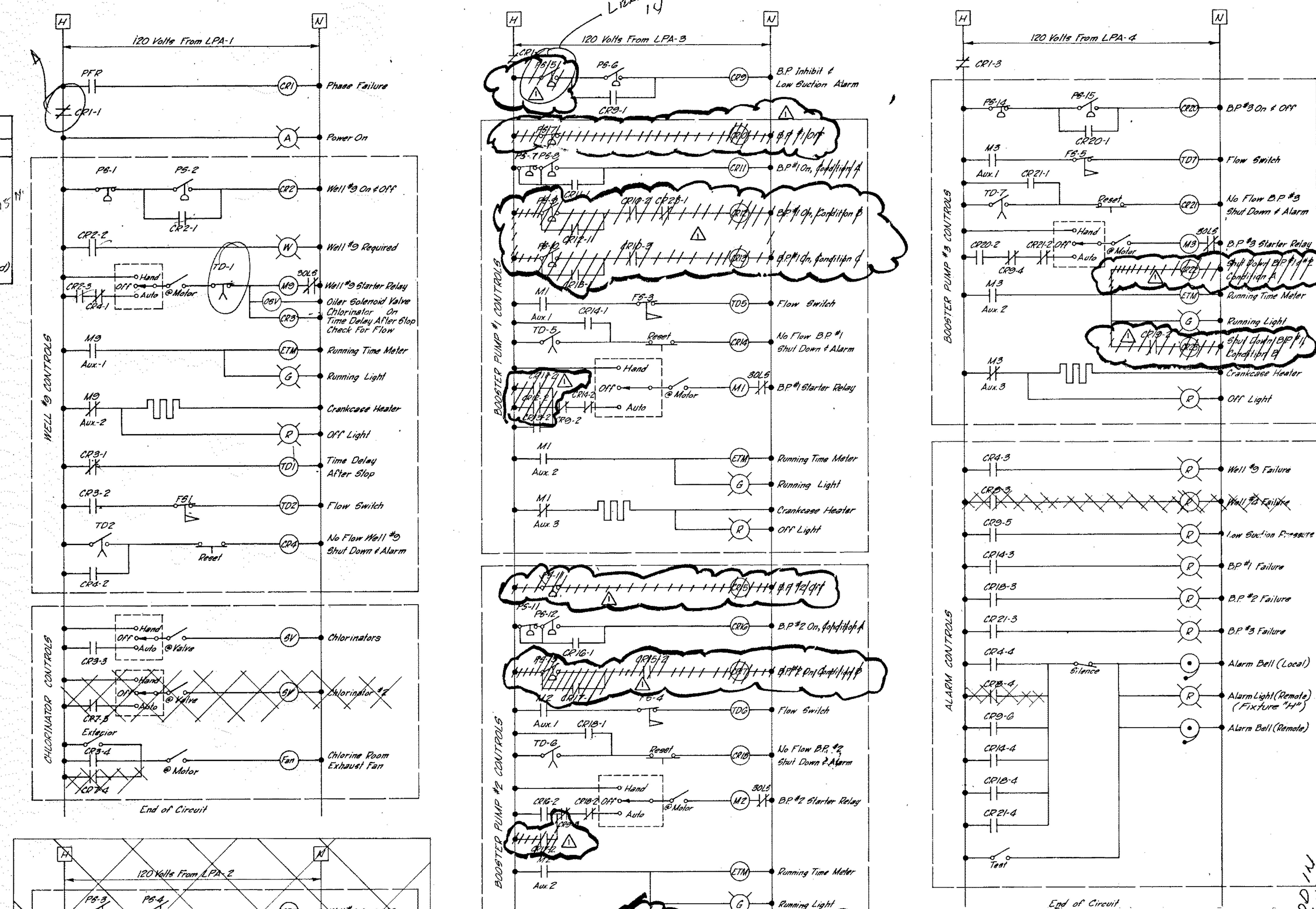
2 Required

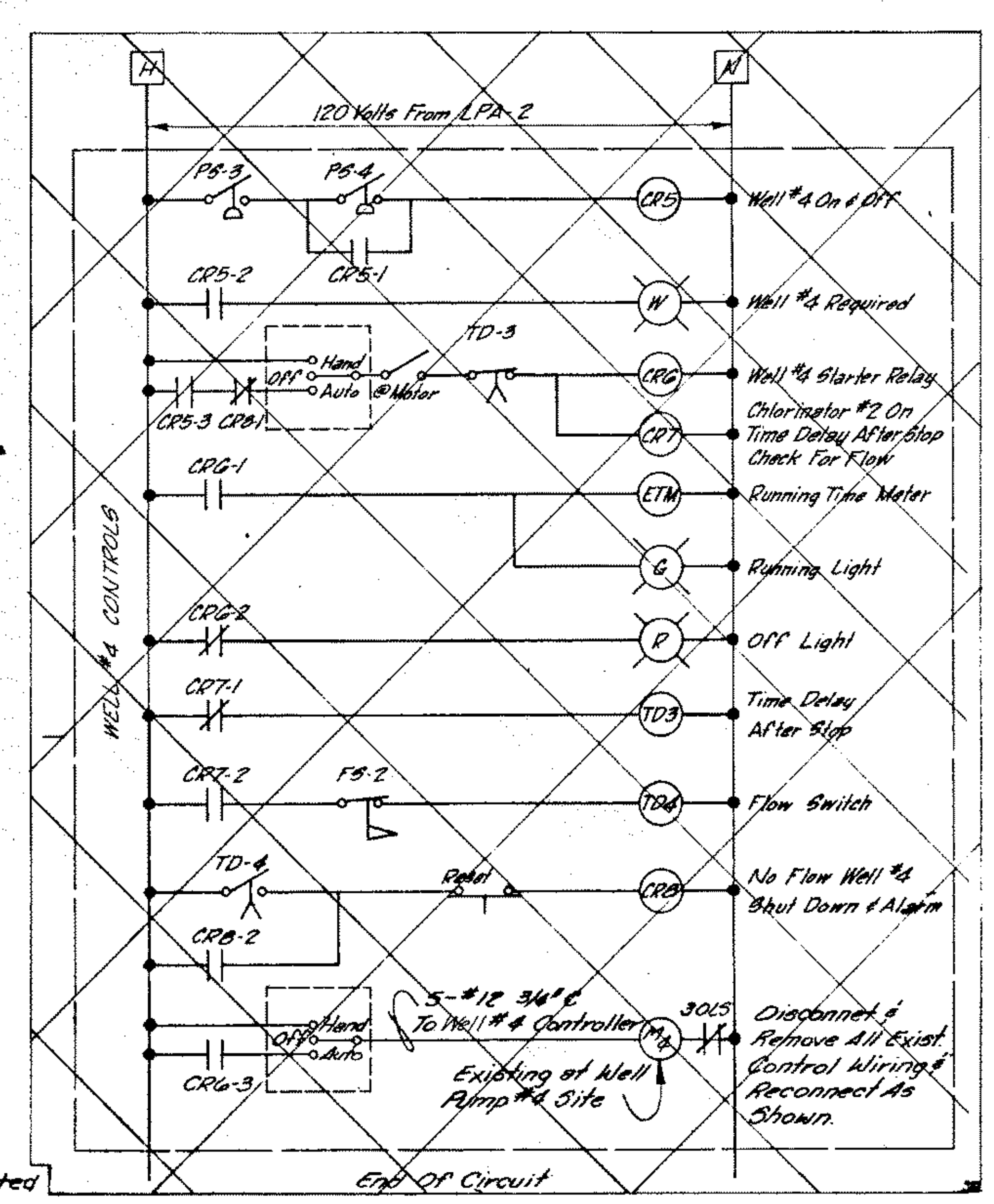
LEGEND

- Crankcase Heater
- PS-2 Pressure Switch Normally Open or Closed As Indicated
- FS-4 Flow Indicating Switch Normally Opened or Closed As Indicated
- TD-3 Time Delay Relay Switch Normally Opened or Closed As Indicated
- CR Control Relay
- TD Time Delay Relay Coil
- A Amber - Power On
- W White - Required
- G Green - Run
- R Red - Fail
- ETM Elapsed Time Meter
- Normally Open Contact
- Normally Closed Contact
- Hand - Off - Auto Selector Switch
- Alarm Bell
- M Booster Pump Motor
- SV Solenoid Valve
- Motor - No. Indicates Size
- M4 Motor Starter - Holding Coil Number 4 Indicates Well Pump Number

Flow Switch* Number	Pipe Diameter	Min Flow In GPM
FS-1	8"	125
~~FS-2~~	~~8"~~	~~125~~ — Deleted
FS-3	8"	125
FS-4	10"	270
FS-5	12"	515

*Flow Switches to Be Mcdonnell Series FS7-V or Equal





Time Delay Relay Settings (all timers reset on de-energization)					
	Energized Relay Effect On Switch				
Switch	Before Timing	During Timing	After Timing	Delay Range	Function
TD-1	Closed	Open	Closed	1-30 Min.	Refuse immed. restart of Well #9
TD-2	Open	Open	Closed*	1-60 Sec.	Shutdown Well #9 if no flow
~~TD-3~~	~~Closed~~	~~Open~~	~~Closed~~	~~1-30 Min.~~	~~Refuse immed. restart of Well #4~~ Deleted
~~TD-4~~	~~Open~~	~~Open~~	~~Closed*~~	~~1-60 Sec.~~	~~Shutdown Well #4 if no flow~~ Deleted
TD-5	Open	Open	Closed*	1-60 Sec.	Shutdown BP #1 if no flow
TD-6	Open	Open	Closed*	1-60 Sec.	Shutdown BP #2 if no flow
TD-7	Open	Open	Closed*	1-60 Sec.	Shutdown BP #3 if no flow
Others**	Open	Open	Closed	1-60 Sec.	Delay action of

* Circuit held until manually reset.
** Relays associated with each of the 15 pressure switches.

Pressure Switch Settings			
Switch	Open	Close	Function
PS-1	24'		Stop Well #9
PS-2		21'	Start Well #9
~~PS-3~~	~~24'~~		~~Stop Well #4~~ Deleted
~~PS-4~~		~~23'~~	~~Start Well #4~~ Deleted
~~PS-5~~		~~7'~~	~~uninhibit booster pumps above 7'~~
PS-6		5'	Lock out booster pumps at 5'
PS-7	67 psi		Stop B.P. #1
PS-8		61 psi	Start B.P. #1 ~~- Condition A~~
~~PS-9~~		~~56 psi~~	~~Condition B~~
~~PS-10~~		~~50 psi~~	~~Condition C~~
PS-11	63 psi		Stop B.P. #2
PS-12		57 psi	Start B.P. #2 ~~- Condition A~~
~~PS-13~~		~~62 psi~~	~~Start B.P. #2 - Condition B~~
PS-14	60 psi		Stop B.P. #3
PS-15		54 psi	Start B.P. #3

ADD IN WITH SHOP DRAWING

PS-9 PS-10 PS-11 PS-12

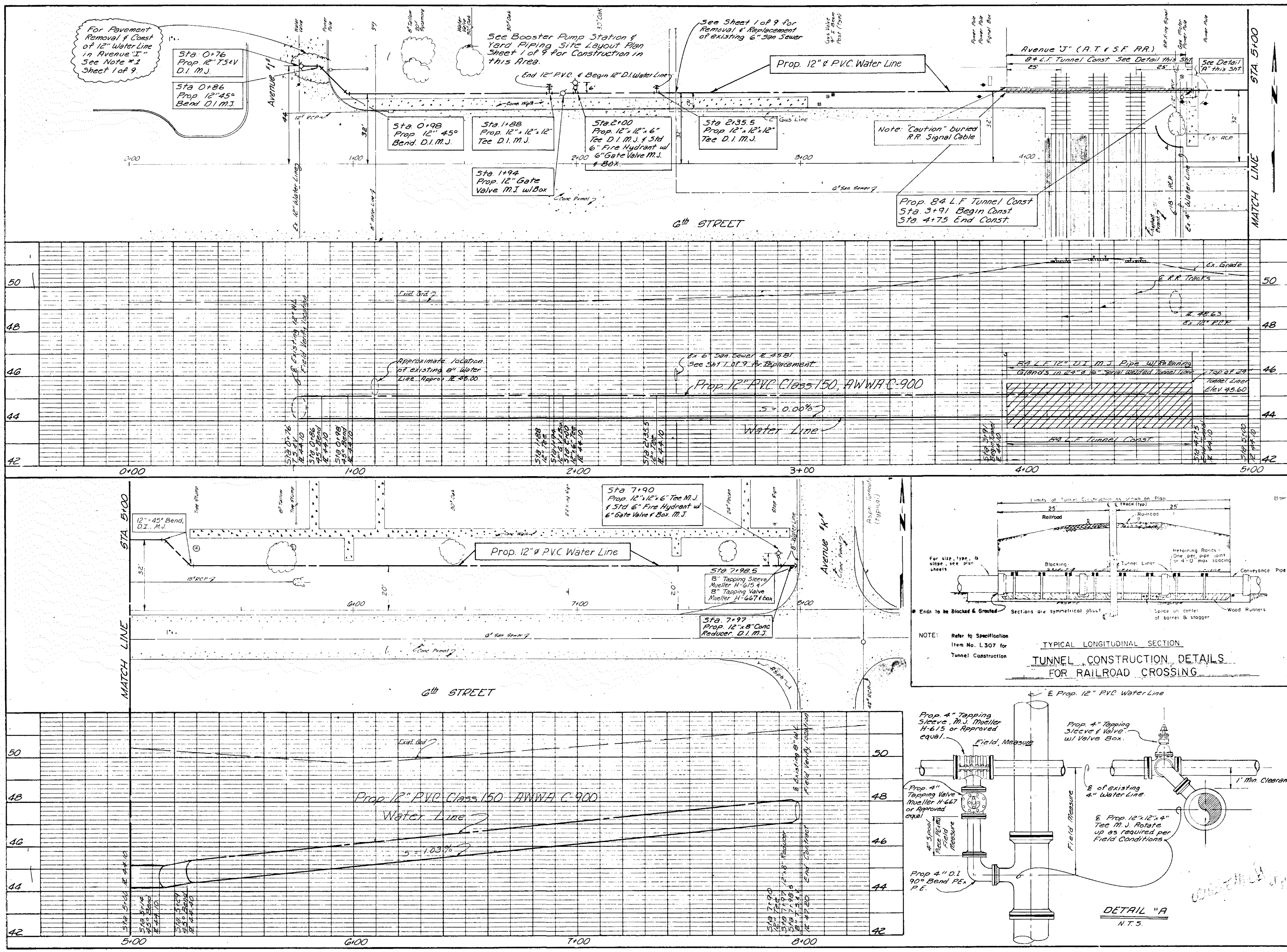
NO.	DESCRIPTION OF REVISION	DATE	BY
1	SIMPLIFY CONTROL SYSTEM BY DELETING PS-5, PS-9, PS-10 and PS-13 and CHANGING SETTINGS ON PS-8, PS-11, PS-12 and PS-14.	1/21/83	G.J.M.

CITY OF BAY CITY, TEXAS

ELECTRICAL PLAN, DIAGRAMS AND DETAILS

Langford Engineering, inc. consulting engineers
1450 West Belt North · Suite 108 · Houston, Texas · 77043

DESIGN: D.E.M.	JOB NO. 023-24	CONT. NO. 03	
DRAWN: G.W.B.	DATE: SEPTEMBER 1982		
CHECKED: G.D.W.	SCALE: AS SHOWN	VERT	HORIZ.
APPROVED: G.D.W.	SHEET NO. 7 OF 9		



CONSTRUCTION NOTES

1. Bench mark-"NN" in "Tennessee" on flange of fire hydrant at North East corner of 7th street and Ave. I. Elevation 53.91.

2. Proposed 12" water line:

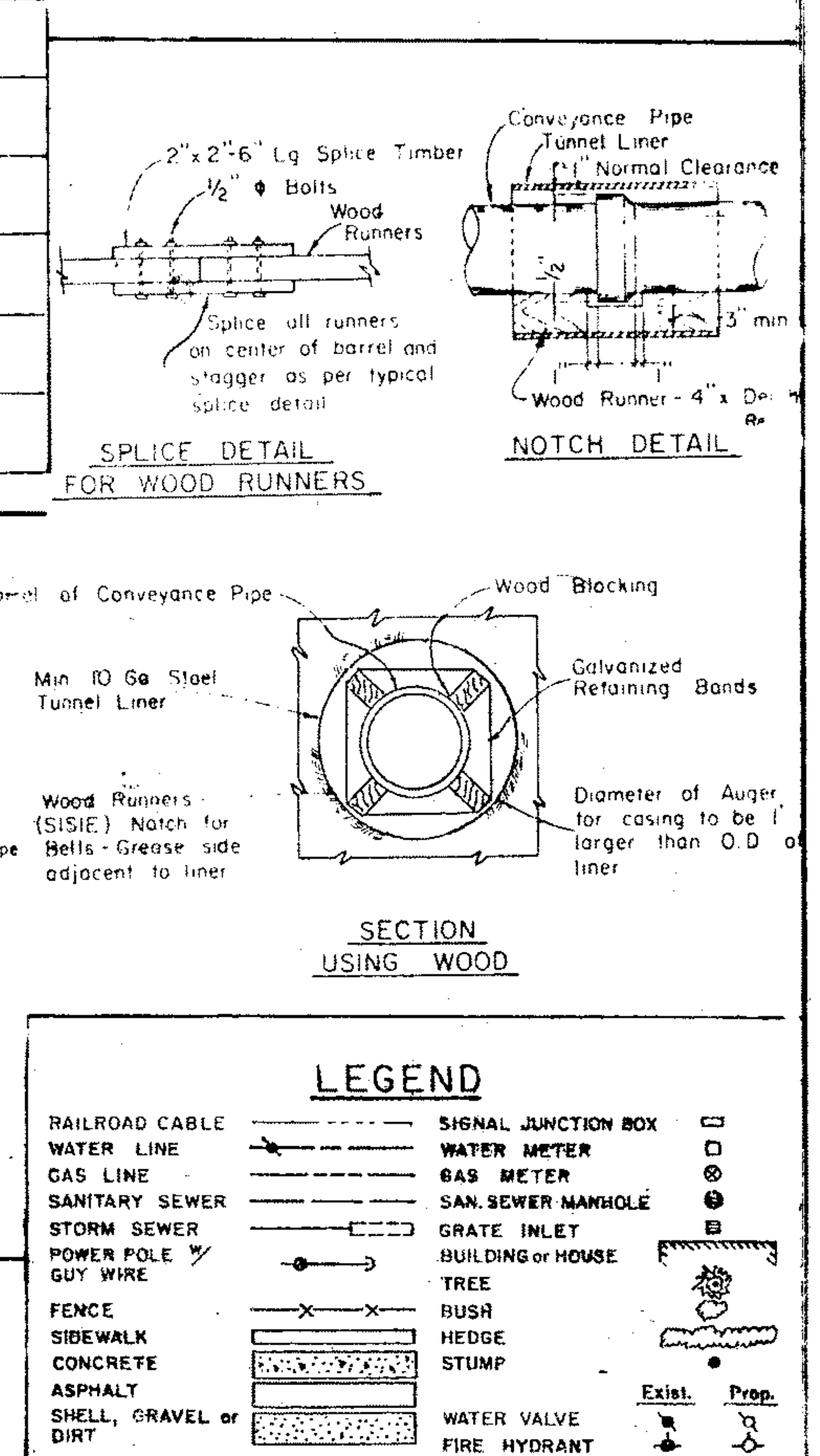
The alignment and location of the proposed 12" water line and it's connections, hyd's, tie-ins etc. were determined from surveys excavation probing and from said information supplied by owner.. Since exact locations and sizes of said utilities may be in doubt (due to a lack of records and inability to determine exactly on the ground), the owner reserves the right to make changes in line and location (due to unforseeable obstructions) without additional compensation to contractor.

3. Connection into existing 8" water line system and tie in to existing 4" water line:

Contractor shall not commence until the proposed 12" water line is installed, pressure tested, chlorinated and an acceptable sample has been approved by the Texas Department of Health.

4. List of known utilities and owners representative:

City of Bay City-Dir. of Utilities-
Mr. C. Young-245-2322
City of Bay City-Water/Sewer Supt.-
Mr. Brinkman-245-9183
Bay City Gas Co.-Supervisor-
Mr. J. Deleon, Jr.-245-2327
Southwestern Bell Tel. Co. Supervisor-
Mr. Bruno-245-5703
Central Power and Light Co.-
245-8371
A.T. and S.F. Railroad-

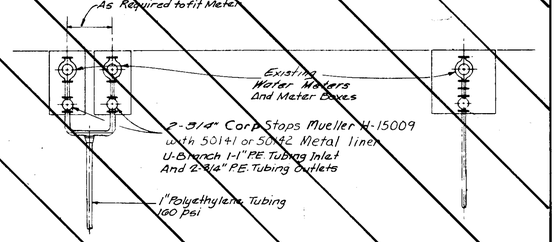


CITY OF BAY CITY, TEXAS

12" WATERLINE
6th STREET FROM AVE. I
TO AVE. K

Langford Engineering, inc. consulting engineers

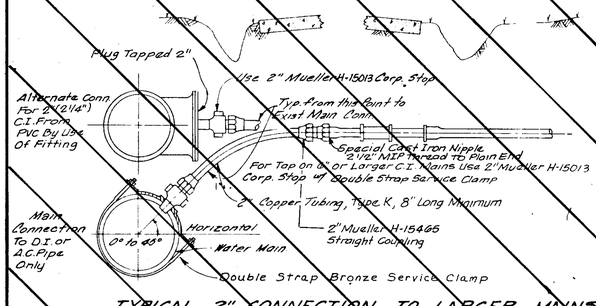
DESIGN	JOB NO. 023-24 — CONT. NO. 3
DRAWN L W B	DATE SEPTEMBER 1982
CHECKED G. J. M.	SCALE VERT. 1" = 2'-0" HORIZ. 1" = 20'
APPROVED D. E. M.	SHEET NO. 8 OF 9



DOUBLE SERVICE — SINGLE SERVICE

TYPICAL SERVICE RECONNECTIONS

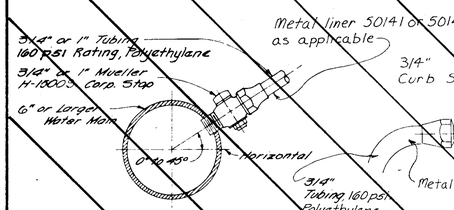
N.T.S.



TYPICAL 2" CONNECTION TO LARGER MAINS

DETAIL "D"

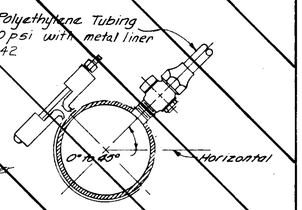
N.T.S.



TAP DETAIL

DETAIL "A"

N.T.S.



CURB STOP DETAIL

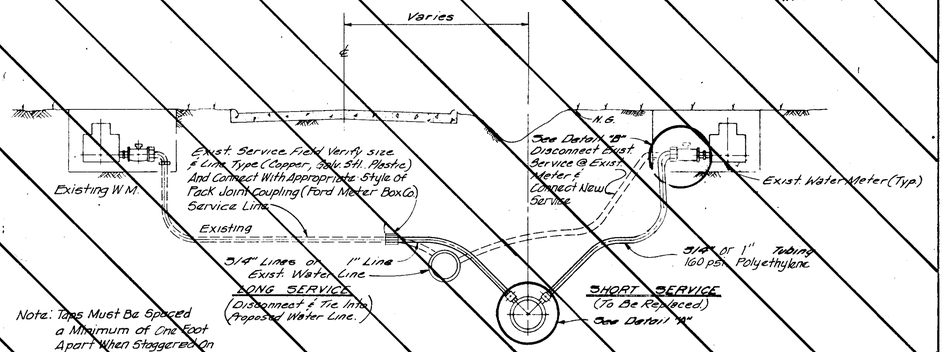
DETAIL "B"

N.T.S.

1" Connection To 2" or 2 1/4" C.I. Pipe For Suppling Existing C.I. Pipe From Proposed 6" PVC Pipe.

DETAIL "C"

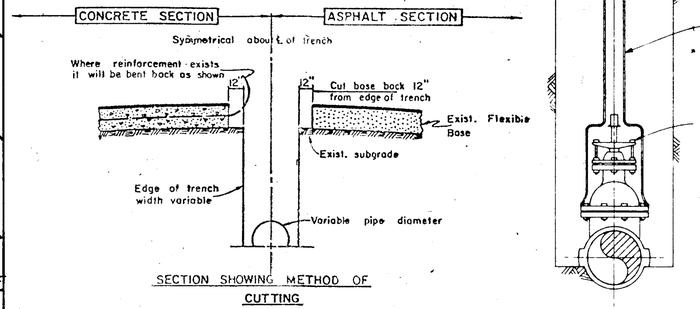
N.T.S.



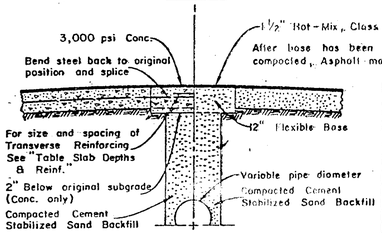
Note: Taps Must Be Spaced a Minimum of One Foot Apart When Staggered On Opposite Sides Of The Water Main And Must Be Spaced a Minimum Of Two Foot Apart When On Same Side of Water Main

RESIDENTIAL SERVICE RECONNECTION

N.T.S.



SECTION SHOWING METHOD OF CUTTING

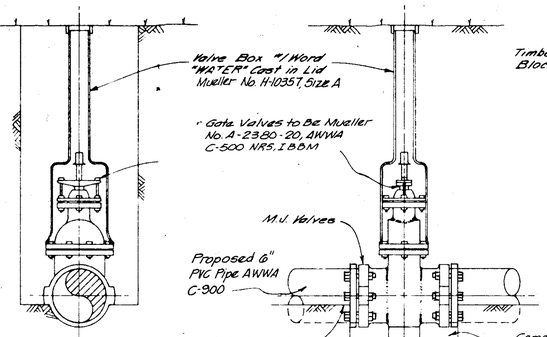


SECTION SHOWING METHOD OF REPAIR

CUTTING AND REPAIRING CONCRETE AND ASPHALT PAVEMENT DETAIL

Table of Slab Depths & Reinf.

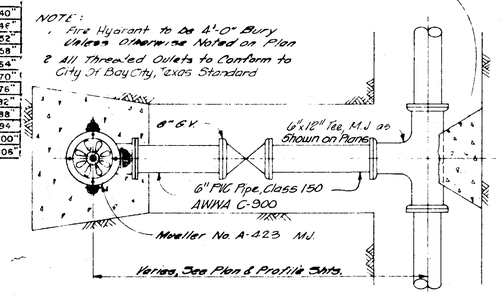
Min. Depth of Slab	Width of Trench	Size of Bar	Spacing	Length of Bar
8"	18"	4	9"	40"
8"	24"	4	8"	42"
8"	30"	4	7"	52"
8"	36"	4	6"	58"
10"	42"	4	8 1/2"	64"
10"	48"	4	7 1/2"	70"
10"	54"	4	7"	76"
10"	60"	4	6 1/2"	82"
10"	66"	5	9"	88"
10"	72"	6	8 1/2"	94"
10"	78"	6	8"	100"
10"	84"	6	7 1/2"	106"



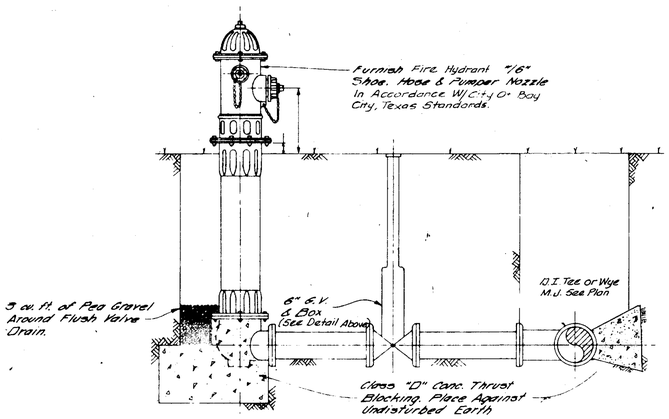
FRONT ELEVATION — SIDE ELEVATION

GATE VALVE INSTALLATION DETAIL

N.T.S.



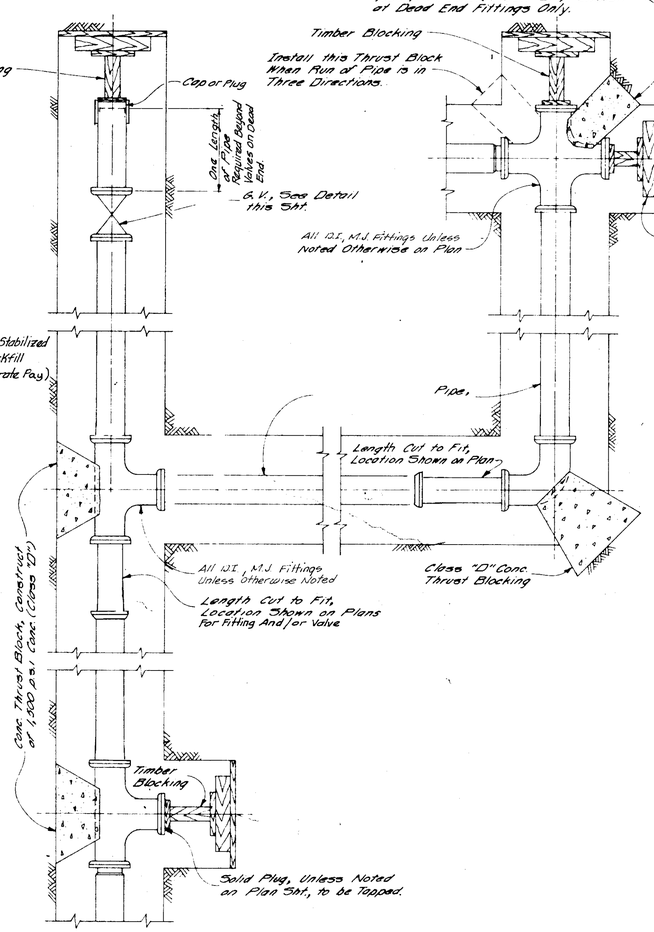
PLAN



ELEVATION

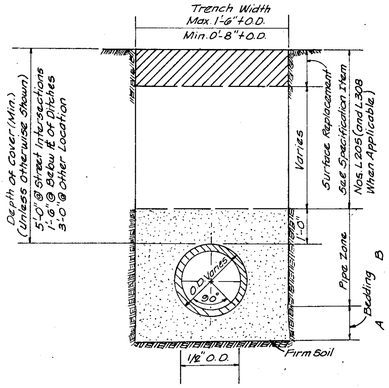
STANDARD FIRE HYDRANT DETAILS

N.T.S.



FITTING ASSEMBLY & THRUST BLOCK DETAILS

N.T.S.



A. Bank-Sand Bedding (Min. 6" Depth). If Unstable Soil Exists At Grade Use Shell or Aggregate Bedding In lieu Of Bank Sand Bedding. No Separate Payment For Bedding.

B. Bank-Sand Backfill In Pipe Zone. No Separate Payment for Bank-Sand Backfill.

TYPICAL DITCH AND BACKFILL

NTS

CITY OF BAY CITY, TEXAS

STANDARD CONSTRUCTION DETAILS

Langford Engineering, Inc. consulting engineers
9821 Katy Freey, Houston, Texas — 1722 Market St. Baytown, Texas

DESIGN L.W.B.	JOB NO. 023 24	CONT NO. 3
DRAWN N.J.D.	DATE SEPTEMBER 1982	
CHECKED G.J.M.	SCALE N.T.S.	
APPROVED	SHEET NO. 9 OF 9	

CITY OF BAY CITY, TEXAS

CONSTRUCTION OF
WATER PUMP STATION
AT AVE I & SIXTH STREET

JOB NO. 023-24 CONTRACT NO. 3

INDEX OF DRAWINGS

IN ACCORDANCE WITH THE AGREEMENT DATED 12/13/82 1982, BETWEEN THE CITY OF BAY CITY, TEXAS, OWNER, AND MERCER CONSTRUCTION COMPANY, CONTRACTOR, FOR CONSTRUCTION OF WATER PUMP STATION AT AVENUE I AND SIXTH STREET, JOB NO. 023-24, CONTRACT NO. 3, THE CONTRACT DRAWINGS LISTED IN THE DRAWING INDEX AND BOUND HEREWITH ARE CERTIFIED AND IDENTIFIED AS PART OF THE AGREEMENT.

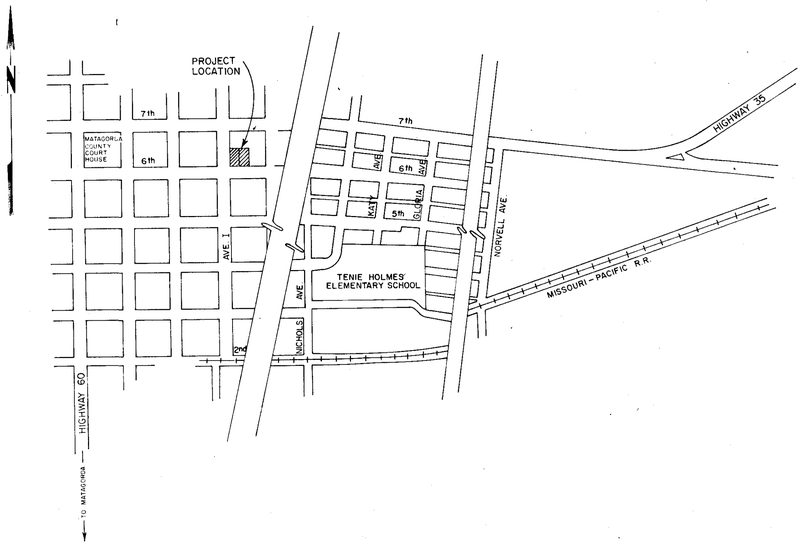
MERCER CONSTRUCTION CO.
CONTRACTOR
BY: W.N. Mercer
TITLE: Pres
DATE: 12/13/82

CITY OF BAY CITY
OWNER
BY: Glen White
TITLE: Mayor
DATE: 12-13-82

MAYOR
Glen White

CITY COUNCIL
C.B. Keener
Frank Henderson
Georgia Herreth
Pasqual Martinez
Meyer Denn

DIRECTOR OF UTILITIES
Clark Young

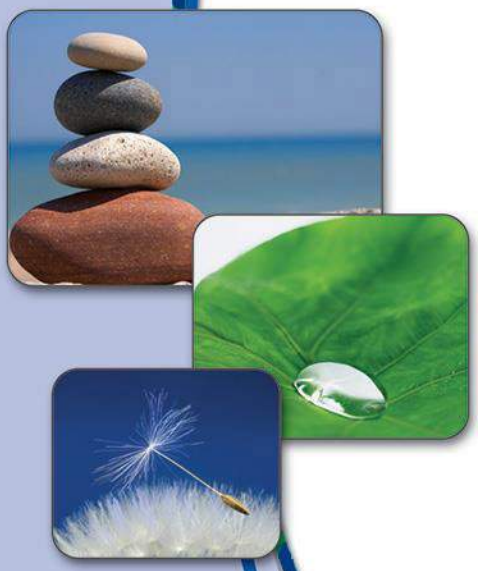


LANGFORD ENGINEERING INC.
CONSULTING ENGINEERS
1450 West Belt Drive North · Suite 108
Houston, Texas · 77043

Sept., 1982

Appendix B:
Additional Water Quality Sampling

eurofins | Environment Testing America



ANALYTICAL REPORT

Eurofins Houston
4145 Greenbriar Dr
Stafford, TX 77477
Tel: (281)240-4200

Laboratory Job ID: 860-32031-1
Client Project/Site: Bay City Raw Water Wells

For:
Garver LLC
12141 Wickchester Lane
Suite 200
Houston, Texas 77079

Attn: Sabin K Jacob

Authorized for release by:
9/9/2022 5:51:08 PM

Travis Richter, Project Manager
(281)794-7216
Travis.Richter@et.eurofinsus.com

Table of Contents

Definitions/Glossary

Client: Garver LLC
Job ID: 860-92051-1
Project/Site: Bay City Raw Water Wells

Qualifiers

Metals

Qualifier	Qualifier Description
U	Indicates the analyte was analyzed for but not detected.

General Chemistry

Qualifier	Qualifier Description
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
U	Indicates the analyte was analyzed for but not detected.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Case Narrative

Client: Garver LLC
Project/Site: Bay City Raw Water Wells

Job ID: 860-32031-1

Job ID: 860-32031-1

Laboratory: Eurofins Houston

Narrative

Job Narrative
860-32031-1

Comments
No additional comments.

Receipt
The sample was received on 8/24/2022 1:00 PM. Unless otherwise noted below, the sample arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 4.2º C.

Receipt Exceptions

The Chain-of-Custody (COC) was incomplete as received and/or improperly completed. COC is totally empty, no information at all.

Metals
Method 1632 As III: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for analytical batch 580-402991 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Detection Summary

Client: Garver LLC
Project/Site: Bay City Raw Water Wells

Job ID: 860-32031-1

Client Sample ID: Sample1 — Lab Sample ID: 860-32031-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenite	1.15		0.500	0.255	ug/L	10		1632 As III	Total/NA
Arsenate	9.55		1.00	0.690	ug/L	1		1632 As V	Total/NA
Inorganic Arsenic	10.7		1.00	0.690	ug/L	20		1632	Total/NA
SiO2	17.3		1.07	0.446	mg/L	1		6010D	Total/NA
pH	8.28	HF			SU	1		9040C	Total/NA
Temperature	17.9	HF			Degrees C	1		9040C	Total/NA
Corrosivity	8.28	HF			SU	1		9040C	Total/NA
Alkalinity	213		4.00	4.00	mg/L	1		SM 2320B	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample Results

Client: Garver LLC
Job ID: 860-32031-1
Project/Site: Bay City Raw Water Wells

Client Sample ID: Sample1
Lab Sample ID: 860-32031-1

Date Collected: 08/24/22 00:00
Matrix: Water

Date Received: 08/24/22 13:00

Method: 1632 As III - Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenite	**1.15**		0.500	0.255	ug/L			09/02/22 19:00	10

Method: 1632 As V - Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenate	**9.55**		1.00	0.690	ug/L			09/06/22 12:58	1

Method: 1632 - Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Inorganic Arsenic	**10.7**		1.00	0.690	ug/L			09/08/22 13:19	20

Method: 6010D - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Vanadium	<0.00518	U	0.0200	0.00518	mg/L		08/31/22 09:30	08/31/22 17:39	1
SiO2	**17.3**		1.07	0.446	mg/L		08/31/22 09:30	08/31/22 17:39	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Phosphate as P	<0.00959	U	0.0200	0.00959	mg/L		09/02/22 17:21	09/03/22 12:58	1
pH	**8.28**	**HF**			SU			09/01/22 13:44	1
Temperature	**17.9**	**HF**			Degrees C			09/01/22 13:44	1
Corrosivity	**8.28**	**HF**			SU			09/01/22 13:44	1
Alkalinity	**213**		4.00	4.00	mg/L			08/27/22 15:27	1

QC Sample Results

Client: Garver LLC
Project/Site: Bay City Raw Water Wells

Job ID: 860-32031-1

Method: 1632 - Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS

Lab Sample ID: MB 580-403385/10
Matrix: Water
Analysis Batch: 403385

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Inorganic Arsenic	<0.345	U	0.500	0.345	ug/L			09/08/22 12:43	10

Lab Sample ID: LCS 580-403385/11
Matrix: Water
Analysis Batch: 403385

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Inorganic Arsenic	2.47	2.747		ug/L		111	50 - 150

Lab Sample ID: LCSD 580-403385/12
Matrix: Water
Analysis Batch: 403385

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Inorganic Arsenic	2.47	2.578		ug/L		104	50 - 150	6	35

Lab Sample ID: 860-32031-1 MS
Matrix: Water
Analysis Batch: 403385

Client Sample ID: Sample1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Inorganic Arsenic	10.7		4.95	15.07		ug/L		89	50 - 150

Lab Sample ID: 860-32031-1 MSD
Matrix: Water
Analysis Batch: 403385

Client Sample ID: Sample1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Inorganic Arsenic	10.7		4.95	16.12		ug/L		110	50 - 150	7	35

Method: 1632 As III - Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS

Lab Sample ID: MB 580-402991/41
Matrix: Water
Analysis Batch: 402991

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenite	<0.0255	U	0.0500	0.0255	ug/L			09/02/22 18:40	1

Lab Sample ID: MB 580-402991/9
Matrix: Water
Analysis Batch: 402991

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Arsenite	<0.255	U	0.500	0.255	ug/L			09/02/22 14:26	10

QC Sample Results

Client: Garver LLC
Project/Site: Bay City Raw Water Wells

Job ID: 860-92031-1

Method: 1632 As III - Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS (Continued)

Lab Sample ID: LCS 580-402991/10
Matrix: Water
Analysis Batch: 402991

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Arsenite	2.50	1.685		ug/L		67	30 - 170

Lab Sample ID: LCSD 580-402991/11
Matrix: Water
Analysis Batch: 402991

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Arsenite	2.50	2.232		ug/L		89	30 - 170	28	35

Method: 6010D - Metals (ICP)

Lab Sample ID: MB 860-67310/1-A
Matrix: Water
Analysis Batch: 67553

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 67310

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Vanadium	<0.00518	U	0.0200	0.00518	mg/L		08/31/22 09:30	08/31/22 16:51	1
SiO2	<0.446	U	1.07	0.446	mg/L		08/31/22 09:30	08/31/22 16:51	1

Lab Sample ID: LCS 860-67310/2-A
Matrix: Water
Analysis Batch: 67553

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 67310

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Silicon	10.0	10.40		mg/L		104	80 - 120
Vanadium	1.00	1.030		mg/L		103	80 - 120

Lab Sample ID: LCSD 860-67310/3-A
Matrix: Water
Analysis Batch: 67553

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 67310

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Silicon	10.0	10.30		mg/L		103	80 - 120	1	20
Vanadium	1.00	1.030		mg/L		103	80 - 120	0	20

Method: 365.1 - Phosphorus, Total

Lab Sample ID: MB 860-67785/4-A
Matrix: Water
Analysis Batch: 67832

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 67785

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Phosphate as P	<0.00959	U	0.0200	0.00959	mg/L		09/02/22 17:21	09/03/22 12:52	1

QC Sample Results

Client: Garver LLC
Job ID: 860-92031-1
Project/Site: Bay City Raw Water Wells

Method: 365.1 - Phosphorus, Total (Continued)

Lab Sample ID: LCS 860-67785/5-A
Matrix: Water
Analysis Batch: 67832

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 67785

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Total Phosphate as P			0.250	0.2565		mg/L		103	90 - 110		

Lab Sample ID: LCSD 860-67785/6-A
Matrix: Water
Analysis Batch: 67832

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 67785

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Total Phosphate as P			0.250	0.2548		mg/L		102	90 - 110	1	20

Method: 9040C - pH

Lab Sample ID: 860-32031-1 DU
Matrix: Water
Analysis Batch: 67561

Client Sample ID: Sample1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
pH	8.28	HF		8.310		SU				0.4	20
Temperature	17.9	HF		17.80		Degrees C				0.6	20
Corrosivity	8.28	HF		8.310		SU				0.4	

Method: SM 2320B - Alkalinity

Lab Sample ID: MB 860-66975/4
Matrix: Water
Analysis Batch: 66975

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	<4.00	U	4.00	4.00	mg/L			08/27/22 13:24	1

Lab Sample ID: LCS 860-66975/5
Matrix: Water
Analysis Batch: 66975

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits		
Alkalinity			250	249.5		mg/L		100	85 - 115		

Lab Sample ID: LCSD 860-66975/6
Matrix: Water
Analysis Batch: 66975

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Alkalinity			250	253.6		mg/L		101	85 - 115	2	20

QC Association Summary

Client: Garver LLC
Project/Site: Bay City Raw Water Wells

Job ID: 860-32031-1

Metals

Prep Batch: 67310

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	3010A	
MB 860-67310/1-A	Method Blank	Total/NA	Water	3010A	
LCS 860-67310/2-A	Lab Control Sample	Total/NA	Water	3010A	
LCSD 860-67310/3-A	Lab Control Sample Dup	Total/NA	Water	3010A	

Analysis Batch: 67553

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	6010D	67310
MB 860-67310/1-A	Method Blank	Total/NA	Water	6010D	67310
LCS 860-67310/2-A	Lab Control Sample	Total/NA	Water	6010D	67310
LCSD 860-67310/3-A	Lab Control Sample Dup	Total/NA	Water	6010D	67310

Analysis Batch: 402991

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	1632 As III	
MB 580-402991/41	Method Blank	Total/NA	Water	1632 As III	
MB 580-402991/9	Method Blank	Total/NA	Water	1632 As III	
LCS 580-402991/10	Lab Control Sample	Total/NA	Water	1632 As III	
LCSD 580-402991/11	Lab Control Sample Dup	Total/NA	Water	1632 As III	

Analysis Batch: 403027

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	1632 As V	

Analysis Batch: 403385

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	1632	
MB 580-403385/10	Method Blank	Total/NA	Water	1632	
LCS 580-403385/11	Lab Control Sample	Total/NA	Water	1632	
LCSD 580-403385/12	Lab Control Sample Dup	Total/NA	Water	1632	
860-32031-1 MS	Sample1	Total/NA	Water	1632	
860-32031-1 MSD	Sample1	Total/NA	Water	1632	

General Chemistry

Analysis Batch: 66975

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	SM 2320B	
MB 860-66975/4	Method Blank	Total/NA	Water	SM 2320B	
LCS 860-66975/5	Lab Control Sample	Total/NA	Water	SM 2320B	
LCSD 860-66975/6	Lab Control Sample Dup	Total/NA	Water	SM 2320B	

Analysis Batch: 67561

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	9040C	
860-32031-1 DU	Sample1	Total/NA	Water	9040C	

Prep Batch: 67785

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	365.2/365.3/365	
MB 860-67785/4-A	Method Blank	Total/NA	Water	365.2/365.3/365	

QC Association Summary

Client: Garver LLC
Project/Site: Bay City Raw Water Wells

Job ID: 860-32031-1

General Chemistry (Continued)

Prep Batch: 67785 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 860-67785/5-A	Lab Control Sample	Total/NA	Water	365.2/365.3/365	
LCSD 860-67785/6-A	Lab Control Sample Dup	Total/NA	Water	365.2/365.3/365	

Analysis Batch: 67832

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
860-32031-1	Sample1	Total/NA	Water	365.1	67785
MB 860-67785/4-A	Method Blank	Total/NA	Water	365.1	67785
LCS 860-67785/5-A	Lab Control Sample	Total/NA	Water	365.1	67785
LCSD 860-67785/6-A	Lab Control Sample Dup	Total/NA	Water	365.1	67785

Lab Chronicle

Client: Garver LLC
Job ID: 860-32031-1
Project/Site: Bay City Raw Water Wells

Client Sample ID: Sample1
Lab Sample ID: 860-32031-1
Date Collected: 08/24/22 00:00
Matrix: Water
Date Received: 08/24/22 13:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	1632		20			403385	09/08/22 13:19	D1C	EET SEA
Total/NA	Analysis	1632 As III		10			402991	09/02/22 19:00	D1C	EET SEA
Total/NA	Analysis	1632 As V		1			403027	09/06/22 12:58	AJR	EET SEA
Total/NA	Prep	3010A			50 mL	50 mL	67310	08/31/22 09:30	MD	EET HOU
Total/NA	Analysis	6010D		1			67553	08/31/22 17:39	DP	EET HOU
Total/NA	Prep	365.2/365.3/365			10 mL	10 mL	67785	09/02/22 17:21	ALL	EET HOU
Total/NA	Analysis	365.1		1			67832	09/03/22 12:58	ALL	EET HOU
Total/NA	Analysis	9040C		1			67561	09/01/22 13:44	TL	EET HOU
Total/NA	Analysis	SM 2320B		1			66975	08/27/22 15:27	TL	EET HOU

Laboratory References:

EET HOU = Eurofins Houston, 4145 Greenbriar Dr, Stafford, TX 77477, TEL (281)240-4200

EET SEA = Eurofins Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Accreditation/Certification Summary

Client: Garver LLC
Job ID: 880-92031-1
Project/Site: Bay City Raw Water Wells

Laboratory: Eurofins Houston

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date
Texas	NELAP	T104704215-22-47	06-30-23

The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.

Analysis Method	Prep Method	Matrix	Analyte
6010D	3010A	Water	SiO2
9040C		Water	Corrosivity
9040C		Water	Temperature

Laboratory: Eurofins Seattle

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-004	02-19-25
ANAB	Dept. of Defense ELAP	L2236	01-19-25
ANAB	Dept. of Energy	L2236	01-19-25
ANAB	ISO/IEC 17025	L2236	01-19-25
Arkansas DEQ	State	8801526	05-23-23
California	State	2954	07-07-22 *
Florida	NELAP	E87575	06-30-23
Louisiana	NELAP	03073	06-30-23
Maine	State	WA01273	05-02-24
Montana (UST)	State	NA	04-14-27
New Jersey	NELAP	WA014	06-30-23
New York	NELAP	11662	04-01-23
Oregon	NELAP	4167	07-08-23
US Fish & Wildlife	US Federal Programs	A20571	06-30-23
USDA	US Federal Programs	P330-20-00031	02-10-23
Washington	State	C788	07-13-23
Wisconsin	State	399133460	08-31-22 *

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Client: Garver LLC
Job ID: 880-52031-1
Project/Site: Bay City Raw Water Wells

Method	Method Description	Protocol	Laboratory
1632	Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS	EPA	EET SEA
1632 As III	Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS	EPA	EET SEA
1632 As V	Arsenic Speciation by Hydride- Generation Cryo-Trapping GC-AAS	EPA	EET SEA
6010D	Metals (ICP)	SW846	EET HOU
365.1	Phosphorus, Total	EPA	EET HOU
9040C	pH	SW846	EET HOU
SM 2320B	Alkalinity	SM	EET HOU
3010A	Preparation, Total Metals	SW846	EET HOU
365.2/365.3/365	Phosphorus, Total	MCAWW	EET HOU

Protocol References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

EET HOU = Eurofins Houston, 4145 Greenbriar Dr, Stafford, TX 77477, TEL (281)240-4200

EET SEA = Eurofins Seattle, 5755 8th Street East, Tacoma, WA 98424, TEL (253)922-2310

Sample Summary

Client: Garver LLC
Job ID: 860-32031-1
Project/Site: Bay City Raw Water Wells

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
860-32031-1	Sample1	Water	08/24/22 00:00	08/24/22 13:00

Eurofins Houston
4147 Greenbriar Dr
Stafford TX 77477
Phone (281) 240-4200

Chain of Custody Record

eurofins | Environment Testing America

Client Information	Sampler	Lab PM: Richter Travis W	Carrier Tracking No(s):	COC No: 860-11857-4135.1
Client Contact: Sabin Jacob	Phone:	E-Mail: Travis.Richter@et.eurofinsus.com	State of Origin:	Page: Page 1 of 1
Company: Garver	PWSID:			Job #:
Address: 12141 Wickchester Lane Suite 200	Due Date Requested:			
City: Houston	TAT Requested (days):			
State, Zip: TX, 77079	Compliance Project: Δ Yes Δ No			
Phone: 713-491-8333(Tel)	PO #: Purchase Order Requested			
Email: SKJacob@GarverUSA.com	WO #:			
Project Name: Bay City Raw Water Wells	Project #: 86003663			
Site:	SSOW#:			

Analysis Requested

Preservation Codes:

A	HCL	M	Hexane
B	NaOH	N	None
C	Zn Acetate	O	AsNaO2
D	Nitric Acid	P	Na2O4S
E	NaHSO4	Q	Na2SO3
F	MeOH	R	Na2S2O3
G	Amchlor	S	H2SO4
H	Ascorbic Acid	T	TSP Dodecahydrate
I	Ice	U	Acetone
J	DI Water	V	MCAA
K	EDTA	W	pH 4-5
L	EDA	Y	Trizma
		Z	other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	[redacted]	365.1 Total Phosphorus as P	6010D Sl and V by ICP	2320B, 9040C	1632, 1632_As_III	Total Number of containers	Special Instructions/Note:
			Preservation Code:				S	D	N	A		
				Water								
				Water								
				Water								
				Water								
				Water								
				Water								
				Water								
				Water								

860-32031 Chain of Custody

Temp: 3.0 IR ID HOU-344
C/F +1.2
Corrected Temp: 4.2

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*

Deliverable Requested: I II III IV Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
			[signature]	8/24/22 1300	Ex
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.	Cooler Temperature(s) °C and Other Remarks:

Ver 01/16/2019

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9/9/2022

ITEM #2.

Eurofins Houston
4145 Greenbriar Dr
Stafford, TX 77477
Phone: 281-240-4200

Chain of Custody Record

eurofins Environment Testing America

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Richter, Travis W	Carrier Tracking No(s):	COC No: 860-16260.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: Travis.Richter@et.eurofinsus.com	State of Origin: Texas	Page: Page 1 of 1
Company: Eurofins Environment Testing Northwest,		Accreditations Required (See note): NELAP - Texas		Job #: 860-32031-1
Address: 5755 8th Street East, ,	Due Date Requested: 8/31/2022			Preservation Codes:
City: Tacoma	TAT Requested (days):			A - HCL; B - NaOH; C - Zn Acetate; D - Nitric Acid; E - NaHSO4; F - MeOH; G - Amchlor; H - Ascorbic Acid; I - Ice; J - DI Water; K - EDTA; L - EDA; M - Hexane; N - None; O - AsNaO2; P - Na2O4S; Q - Na2SO3; R - Na2S2O3; S - H2SO4; T - TSP Dodecahydrate; U - Acetone; V - MCAA; W - pH 4-5; Y - Trizma; Z - other (specify); Other:
State, Zip: WA, 98424				
Phone: 253-922-2310(Tel)	PO #:			
Email:	WO #:			
Project Name: Bay City Raw Water Wells	Project #: 86003663			
Site:	SSOW#:			

Analysis Requested

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	1632/ Inorganic Arsenic in Water	1632_As_III/ Arsenite in Water	1632_As_V_Calc/ Arsenic Speciation in Water	Total Number of containers	Special Instructions/Note:
			Preservation Code:		X	X				X	
Sample1 (860-32031-1)	8/24/22	Central		Water			X	X	X	2	

Note: Since laboratory accreditations are subject to change, Eurofins Environment Testing South Central, LLC places the ownership of method, analyte & accreditation compliance upon out subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins Environment Testing South Central, LLC laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins Environment Testing South Central, LLC attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins Environment Testing South Central, LLC.

Possible Hazard Identification	Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
Unconfirmed	☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months
Deliverable Requested: I, II, III, IV, Other (specify) Primary Deliverable Rank: 2	Special Instructions/QC Requirements: 7777 6734 9351

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:
Relinquished by:	Date/Time: 8/25/22 1900	Company: Ex	Received by:	Date/Time: 8/26/22 0930	Company: ETS
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: ☐ Yes ☐ No	Custody Seal No.: NA	Cooler Temperature(s) °C and Other Remarks: 0.5 D.J 2 -0.1

Login Sample Receipt Checklist

Client: Garver LLC

Job Number: 860-32031-1

Login Number: 32031
List Number: 1
Creator: Palmar, Pedro

List Source: Eurofins Houston

Question	Answer	Comment
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	False	No information at all.
COC is filled out with all pertinent information.	False	No information at all.
Is the Field Sampler's name present on COC?	False	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	False	No date or time on COC or sample containers
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	N/A	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	

Login Sample Receipt Checklist

Client: Garver LLC

Job Number: 860-32031-1

Login Number: 32031
List Number: 2
Creator: Miller, Darren R

List Source: Eurofins Seattle
List Creation: 08/26/22 12:30 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	N/A	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Appendix C:

Water Quality Modeling (Blending Optimization) Calculations

Water Quality Data from Drinking Water Watch and City Staff

Parameter	EP001	EP003	EP002	EP004	EP005	Column1	MCL/SMCL	Units
Arsenic	0.0053	0.0090	0.0077	0.0125	0.005		0.01	mg/L
Calcium	30.3	16.2	18.4	13.7	20.8		--	mg/L
Chloride	40	67	72	47	106		300	mg/L
Fluoride	0.37	0.47	0.38	0.42	0.61		2	mg/L
Iron	0.075	0.044	0.047	0.028	0.053		0.3	mg/L
Magnesium	12.2	6.55	7.92	5.53	8.57		--	mg/L
Manganese	0.017	0.0087	0.011	0.0081	0.0118		0.05	mg/L
Selenium	0.003	0.0051	0.0066	0.0034	0.003		0.05	mg/L
Sodium	71.7	107	107	98.2	140.5		--	mg/L
Sulfate	15	14	14	14	13		300	mg/L
Total Alkalinity	278	251	251	246	282		--	mg/L as $CaCO_3$
Total Hardness	123	67.4	78.6	57	84.4		--	mg/L as $CaCO_3$
Total Dissolved Solids	325	372	377	330	440		1000	mg/L
CSMR	2.7	4.8	5.1	3.4	8.2			
pH	7.8	7.9	8	7.8	7.9		≥ 7.0	S.U.
DI C	571	512	509	506	575		--	mg/L as $CaCO_3$

Capacity and Flow Data from Drinking Water Watch

Entry Point	Rated Flow (GPM)
EP001	1360
EP003	1050
EP002	1010
EP004	1250
EP005	1300

Condition	MGD	GPM	With 25% Safety Factor
Max Day Demand	3.266	2268	2835
Average Day	2.369	1645	2056

Blend Types

Type	Description	Max Flow (gpm)
1	Single Well (no blending)	
2a	Two Wells - EP001 + EP003	2410
2b	Two Wells - EP001 + EP004	2610
2c	Two Wells - EP005 + EP003	2350
2d	Two Wells - EP005 + EP004	2550
3a	Three Wells - EP001 + EP003 + EP004	3660
3b	Three Wells - EP003 + EP004 + EP005	3600
3c	Three Wells - EP005 + EP003 + EP002	3360
3d	Three Wells - EP005 + EP002 + EP004	3560
4	Four Wells - EP001 + EP003 + EP004 + EP005	4960
5	Five Wells - All Entry Points	5970

Blending calculations for conservative parameters are provided in the table below. Blends are filtered based on the "Used" column (far right).

Blends

Blend Type	Blend	EP001	EP003	EP002	EP004	EP005	Check	Arsenic	Calcium
2a	16	56%	44%	0%	0%	0%	100%	0.007	24
2b	38	70%	0%	0%	30%	0%	100%	0.007	25
2c	54	0%	45%	0%	0%	55%	100%	0.007	19
2d	68	0%	0%	0%	33%	67%	100%	0.007	18
3a	89	63%	18%	0%	19%	0%	100%	0.007	25
3b	109	0%	21%	0%	19%	60%	100%	0.007	18
4	141	31%	21%	0%	18%	30%	100%	0.007	21
5	159	27%	13%	19%	13%	28%	100%	0.007	21

Blend Type2	Chloride	Fluoride	Iron	Magnesium	Manganese	Selenium	Sodium	Sulfate
2a	52	0.4	0.061	10	0.013	0.004	87	15
2b	42	0.4	0.061	10	0.014	0.003	80	15
2c	89	0.5	0.049	8	0.010	0.004	126	13
2d	87	0.5	0.045	8	0.011	0.003	127	13
3a	46	0.4	0.060	10	0.014	0.003	83	15
3b	87	0.5	0.046	8	0.010	0.004	125	13
4	67	0.5	0.053	9	0.012	0.003	104	14
5	69	0.5	0.053	9	0.012	0.004	106	14

Blend Type3	Total Alkalinity	Total Hardness	Dissolved Inorganic Carbon	Total Dissolved Solids	CSMR
2a	266	99	545	345	3.6
2b	268	103	552	327	2.9
2c	268	77	547	410	6.6
2d	270	75	552	404	6.5
3a	267	100	548	334	3.2
3b	269	76	549	405	6.5
4	266	87	545	369	4.8
5	266	88	544	374	4.9

Blend Type4	EP001 Flow	EP003 Flow	EP002 Flow	EP004 Flow	EP005 Flow	Total Blended Flow	Total Flow	Used
2a	1360	1050	0	0	0	2410	4720	Y
2b	1360	0	0	583	0	1943	4253	Y
2c	0	1050	0	0	1300	2350	4720	Y
2d	0	0	0	640	1300	1940	4310	Y
3a	1360	389	0	410	0	2159	4469	Y
3b	0	455	0	412	1300	2167	4537	Y
4	1322	910	0	780	1300	4333	5382	Y
5	1254	604	882	604	1300	4643	4877	Y

Source Water Quality Data

Parameter	EP001	EP003	EP002	EP004	EP005	MCL/SMCL	Units	
Arsenic	0.0053	0.009	0.0077	0.0125	0.005	0.01	mg/L	
Calcium	30.3	16.2	18.4	13.7	20.8	--	mg/L	
Chloride	40	67	72	47	106	300	mg/L	
Fluoride	0.37	0.47	0.38	0.42	0.61	2	mg/L	
Iron	0.075	0.044	0.047	0.028	0.053	0.3	mg/L	
Magnesium	12.2	6.55	7.92	5.53	8.57	--	mg/L	
Manganese	0.017	0.0087	0.011	0.0081	0.0118	0.05	mg/L	
Selenium	0.003	0.0051	0.0066	0.0034	0.003	0.05	mg/L	
Sodium	71.7	107	107	98.2	140.5	--	mg/L	
Sulfate	15	14	14	14	13	300	mg/L	
Total Alkalinity	278	251	251	246	282	--	mg/L as CaCO3	
Total Hardnes	123	67.4	78.6	57	84.4	--	mg/L as CaCO3	
Total Dissolve	325	372	377	330	440	1000	mg/L	
CSMR	2.7	4.8	5.1	3.4	8.2	0		0
pH	7.8	7.9	8	7.8	7.9	≥ 7.0	S.U.	
DI C	571	512	509	506	575	--	mg/L as CaCO3	

Treatment Needed to Achieve 0.007 mg/L As

EP	Percent Treated	Percent Untreated	Blended Water As (m
EP003	31%	69%	0.00652
EP004	50%	50%	0.00675

Equilibrium Calculations

Chemical Species	Start			
H2O	1	mM		
[H+]	1.13243E-08	mM	7.945989	3.16228E-09
[OH-]		mM		
[CO32-]		mM		
[Na+]	0	mM		
Kw	1E-14	mM		
Ka1	5.01187E-07	mM		
Ka2	5.01187E-11	mM		

Used solver to perform iterations to adjust [H+] so that the Alk = column matches the formula column

Equil
[OH-] = Kw/[H+]
[H2CO3*]=[H+][HCO3-]/Ka1
[CO32-]=Ka2[HCO3-]/[H+]

α0	[H+]2/([H+]2+[H+]Ka1+Ka1Ka2])
α1	[H+]Ka1/([H+]2+[H+]Ka1+Ka1Ka2])
α2	Ka1Ka2/([H+]2+[H+]Ka1+Ka1Ka2])

MB
Ct = [H2CO3*]+[HCO3-]+[CO32-]

α0	0.022
α1	0.974
α2	0.004

CB
[H+]+[Na+]=[OH-]+[HCO3-]+2[CO32-]

PC
[H+]=[OH-]+[HCO3-]+2[CO32-]

Get species in terms of [H+]
[OH-] 8.83057E-07

Solve for [H+]
0 8.71733E-07

pH 7.945988661

Iteration for [H+]

Blend	Alk =	(α1+2α2)CT + [OH-]-[H+]
2a	5.32	5.36
2b	5.25	5.30
2b	5.37	5.42
2c	5.36	5.37
2d	5.40	5.42
2d	5.29	5.32
3a	5.34	5.38
3a	5.19	5.22
3b	5.37	5.39
3b	5.21	5.23
3c	5.26	5.26
4	5.33	5.36
4	5.31	5.34
5	5.33	5.35
5	5.26	5.28

Results recorded here

Results from RTW Model recorded here

Calcium (mg/L)	Blend Type	Blend	Total Alkalinity (mg/L as $CaCO_3$)	Dissolved Inorganic Carbon (mg/L as $CaCO_3$)	Total Alkalinity meq/L	DIC (mM)	pH	Calcium (mg/L as $CaCO_3$)	Dissolved Solids (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	LSI	RI	AI	CCPP (mg/L as $CaCO_3$)
24	2a	16	266	545	5.32	5.45	7.8	60	345	52	15	0.34	7.2	12.1	10.3
22	2b	34	263	540	5.25	5.40	7.8	56	327	43	15	0.18	7.4	12.0	5.7
25	2b	38	268	552	5.37	5.52	7.8	63	327	42	15	0.25	7.3	12.0	8.3
19	2c	54	268	547	5.36	5.47	7.9	47	410	89	13	0.32	7.4	12.1	8.2
18	2d	68	270	552	5.40	5.52	7.9	46	404	87	13	0.20	7.5	12.0	5.3
17	2d	82	264	541	5.29	5.41	7.9	43	386	77	13	0.17	7.6	12.0	4.2
25	3a	89	267	548	5.34	5.48	7.8	62	334	46	15	0.44	7.1	12.2	12.4
21	3a	102	259	532	5.19	5.32	7.8	51	340	50	14	0.25	7.4	12.0	7.0
18	3b	109	269	549	5.37	5.49	7.9	46	405	87	13	0.21	7.5	12.0	5.6
17	3b	114	260	533	5.21	5.33	7.9	42	382	74	14	0.17	7.6	12.0	4.2
19	3c	128	263	535	5.26	5.35	7.9	47	400	84	14	#REF!	#REF!	#REF!	#REF!
21	4	141	266	545	5.33	5.45	7.9	53	369	67	14	0.27	7.4	12.1	7.7
21	4	154	265	543	5.31	5.43	7.9	52	366	65	14	0.26	7.4	12.0	7.2
21	5	159	266	544	5.33	5.44	7.9	53	374	69	14	0.26	7.4	12.1	7.3
20	5	162	263	537	5.26	5.37	7.9	51	368	66	14	0.23	7.4	12.0	6.4

RTW Model
4th Street & Avenue B (EP001)

The RTW Model Ver. 4.0 ID: **EP001**

STEP 1: Enter initial water characteristics.

Measured TDS	325	mg/L
Measured temperature	20	deg C
Measured pH	7.8	
Measured alk, as CaCO3	278	mg/L
Measured Ca, as CaCO3	75.75	mg/L
Measured Cl	40	mg/L
Measured SO4	15	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	278	mg/L	> 40 mg/L	Interim pH	7.80		6.8-9.3
Interim Ca, as CaCO3	76	mg/L	> 40 mg/L	Precipitation potential	12.69	mg/L	4-10 mg/L
Alk/(Cl+SO4)	5.1		> 5.0	Langelier index	0.34		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	293	mg/L
Initial Ca sat, as CaCO3	35	mg/L
Initial DIC, as CaCO3	571	mg/L

Theoretical interim water characteristics

Interim acidity	293	mg/L
Interim Ca sat, as CaCO3	35	mg/L
Ryznar index	7.12	
Interim DIC, as CaCO3	571	mg/L
Aggressiveness Index	12.12	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	265	mg/L
Final Ca	63	mg/L
Final acidity	293	mg/L
Final pH	7.56	
Final DIC, as CaCO3	559	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.58E-08	1.58E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.71E-03	5.71E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.52E-03	5.52E-03													
[CO3-]	2.1E-05	2.1E-05	-40493.37	14	-0.34	7.46	75.75	278.00	5.71E-03	1.76E-04	2.10E-05	5.52E-03	5.11E-07	1.58E-08	7.8000
[H2CO3*	0.000176	1.76E-04	-4052.13	13	0.52	7.79	40.26	242.51	5.36E-03	5.15E-04	5.52E-06	4.84E-03	1.53E-07	5.29E-08	7.2769
[Ca++]s	3.47E-04	3.47E-04	-405.94	12	9.79	####	0.00	171.73	4.65E-03	1.22E-03	1.18E-06	3.43E-03	4.59E-08	1.76E-07	6.7538
pHs alk		7.46	-22.32	11	10.61	####	0.00	87.13	3.81E-03	2.06E-03	1.79E-07	1.74E-03	1.38E-08	5.88E-07	6.2308
			120.14	10	11.56	####	0.00	32.88	3.26E-03	2.60E-03	2.03E-08	6.60E-04	4.13E-09	1.96E-06	5.7077
			248.29	9	12.57	####	0.00	10.40	3.04E-03	2.82E-03	1.98E-09	2.15E-04	1.24E-09	6.54E-06	5.1846
			285.67	8	13.60	####	0.00	2.20	2.96E-03	2.89E-03	1.82E-10	6.58E-05	3.71E-10	2.18E-05	4.6615
			389.50	7	14.65	####	0.00	-2.65	2.91E-03	2.89E-03	1.64E-11	1.97E-05	1.11E-10	7.27E-05	4.1385
			1397.84	6	15.71	####	0.00	-11.83	2.82E-03	2.81E-03	1.43E-12	5.76E-06	3.34E-11	2.42E-04	3.6154
			11496.10	5	16.80	####	0.00	-40.35	2.53E-03	2.53E-03	1.16E-13	1.55E-06	1.00E-11	8.09E-04	3.0923
			114272.73	4	18.05	####	0.00	-134.80	1.59E-03	1.59E-03	6.54E-15	2.92E-07	3.00E-12	2.70E-03	2.5692
			1321474.57	3	#####	####	0.00	-293.46	1.81E-96	1.81E-96	6.71E-109	1.00E-100	9.01E-13	8.99E-03	2.0462
			31337047.74	2	#####	####	0.00	-293.46	6.04E-96	6.04E-96	2.01E-109	1.00E-100	2.70E-13	3.00E-02	1.5231
			2125848253.25	1	#####	####	0.00	-293.46	2.01E-95	2.01E-95	6.03E-110	1.00E-100	8.10E-14	1.00E-01	1.0000
			285.67	8	-0.34	7.46	75.75	278.00	5.71E-03	1.76E-04	2.10E-05	5.52E-03	5.11E-07	1.58E-08	7.8000
			289.26	7.9	-0.20	7.50	71.06	273.31	5.67E-03	2.18E-04	1.64E-05	5.43E-03	4.06E-07	2.00E-08	7.7000
			293.46	7.8	-0.06	7.54	65.56	267.81	5.61E-03	2.70E-04	1.28E-05	5.33E-03	3.22E-07	2.51E-08	7.6000
			298.50	7.7	0.09	7.59	59.07	261.32	5.55E-03	3.32E-04	9.93E-06	5.21E-03	2.56E-07	3.16E-08	7.5000
			304.63	7.6	0.27	7.67	51.44	253.69	5.47E-03	4.06E-04	7.67E-06	5.06E-03	2.03E-07	3.98E-08	7.4000
			312.19	7.5	0.46	7.76	42.52	244.77	5.38E-03	4.93E-04	5.88E-06	4.88E-03	1.62E-07	5.01E-08	7.3000
			321.58	7.4	0.70	7.90	32.20	234.45	5.28E-03	5.95E-04	4.48E-06	4.68E-03	1.28E-07	6.31E-08	7.2000
			333.30	7.3	1.02	8.12	20.42	222.67	5.16E-03	7.11E-04	3.38E-06	4.45E-03	1.02E-07	7.94E-08	7.1000
			347.98	7.2	1.60	8.60	7.20	209.45	5.03E-03	8.43E-04	2.52E-06	4.18E-03	8.10E-08	1.00E-07	7.0000
			366.38	7.1	9.59	####	0.00	194.91	4.88E-03	9.87E-04	1.87E-06	3.89E-03	6.43E-08	1.26E-07	6.9000
			389.50	7	9.73	####	0.00	179.25	4.73E-03	1.14E-03	1.36E-06	3.58E-03	5.11E-08	1.58E-07	6.8000
			293.46	7.8	-0.06	7.54	65.56	267.81	5.61E-03	2.70E-04	1.28E-05	5.33E-03	3.22E-07	2.51E-08	7.6000
			293.92	7.79	-0.05	7.54	64.96	267.21	5.61E-03	2.75E-04	1.25E-05	5.32E-03	3.15E-07	2.57E-08	7.5900
			294.39	7.78	-0.03	7.55	64.34	266.59	5.60E-03	2.81E-04	1.22E-05	5.31E-03	3.08E-07	2.63E-08	7.5800
			294.87	7.77	-0.02	7.55	63.72	265.97	5.59E-03	2.87E-04	1.19E-05	5.30E-03	3.01E-07	2.69E-08	7.5700
			295.36	7.76	0.00	7.56	63.09	265.34	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.75E-08	7.5600
			295.86	7.75	0.01	7.56	62.45	264.70	5.58E-03	2.99E-04	1.13E-05	5.27E-03	2.87E-07	2.82E-08	7.5500
			296.37	7.74	0.03	7.57	61.79	264.04	5.58E-03	3.05E-04	1.10E-05	5.26E-03	2.81E-07	2.88E-08	7.5400
			296.88	7.73	0.05	7.58	61.13	263.38	5.57E-03	3.12E-04	1.07E-05	5.25E-03	2.74E-07	2.95E-08	7.5300
			297.41	7.72	0.06	7.58	60.45	262.70	5.56E-03	3.18E-04	1.05E-05	5.23E-03	2.68E-07	3.02E-08	7.5200
			297.95	7.71	0.08	7.59	59.77	262.02	5.55E-03	3.25E-04	1.02E-05	5.22E-03	2.62E-07	3.09E-08	7.5100
			298.50	7.7	0.09	7.59	59.07	261.32	5.55E-03	3.32E-04	9.93E-06	5.21E-03	2.56E-07	3.16E-08	7.5000
					0.00	7.56	63.09	265.34	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.75E-08	7.5600
					0.00	7.56	63.03	265.28	5.59E-03	2.94E-04	1.15E-05	5.28E-03	2.93E-07	2.76E-08	7.5590
					0.00	7.56	62.96	265.21	5.59E-03	2.94E-04	1.15E-05	5.28E-03	2.93E-07	2.77E-08	7.5580
					0.00	7.56	62.90	265.15	5.59E-03	2.95E-04	1.15E-05	5.28E-03	2.92E-07	2.77E-08	7.5570
					0.01	7.56	62.83	265.08	5.59E-03	2.95E-04	1.15E-05	5.28E-03	2.91E-07	2.78E-08	7.5560
					0.01	7.56	62.77	265.02	5.58E-03	2.96E-04	1.14E-05	5.28E-03	2.91E-07	2.79E-08	7.5550
					0.01	7.56	62.71	264.96	5.58E-03	2.97E-04	1.14E-05	5.28E-03	2.90E-07	2.79E-08	7.5540
					0.01	7.56	62.64	264.89	5.58E-03	2.97E-04	1.14E-05	5.27E-03	2.89E-07	2.80E-08	7.5530
					0.01	7.56	62.58	264.83	5.58E-03	2.98E-04	1.13E-05	5.27E-03	2.89E-07	2.81E-08	7.5520
					0.01	7.56	62.51	264.76	5.58E-03	2.99E-04	1.13E-05	5.27E-03	2.88E-07	2.81E-08	7.5510
					0.01	7.56	62.45	264.70	5.58E-03	2.99E-04	1.13E-05	5.27E-03	2.87E-07	2.82E-08	7.5500
					0.00	7.56	63.09	265.34	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.75E-08	7.5600
					0.00	7.56	63.08	265.33	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.75E-08	7.5599
					0.00	7.56	63.08	265.33	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5598
					0.00	7.56	63.07	265.32	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5597
					0.00	7.56	63.06	265.31	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5596
					0.00	7.56	63.06	265.31	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5595
					0.00	7.56	63.05	265.30	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5594
					0.00	7.56	63.04	265.29	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5593
					0.00	7.56	63.04	265.29	5.59E-03	2.94E-04	1.16E-05	5.28E-03	2.93E-07	2.76E-08	7.5592
					0.00	7.56	63.03	265.28	5.59E-03	2.94E-04	1.15E-05	5.28E-03	2.93E-07	2.76E-08	7.5591
					0.00	7.56	63.03	265.28	5.59E-03	2.94E-04	1.15E-05	5.28E-03	2.93E-07	2.76E-08	7.5590
					0.00	7.56	63.06	265.31	5.59E-03	2.93E-04	1.16E-05	5.28E-03	2.94E-07	2.76E-08	7.5596

Tk	293
I	0.008125
E	80.094785
A	0.5062483
f(I)	0.0826856
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.9132255
fd	0.6955241
K1p	4.97E-07
K2p	6.03E-11
Kwp	8.10E-15
Ksp	7.29E-09

	Forms of CaCO3 and their solubility product constants			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Mockingbird Lane (EP002)

The RTW Model Ver. 4.0 ID: **EP002**

STEP 1: Enter initial water characteristics.

Measured TDS	377	mg/L
Measured temperature	20	deg C
Measured pH	8	
Measured alk, as CaCO3	251	mg/L
Measured Ca, as CaCO3	45	mg/L
Measured Cl	72	mg/L
Measured SO4	14	mg/L

For CT and TTHM functions enter current:

Treated water pH	8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	251	mg/L	> 40 mg/L	Interim pH	8.00		6.8-9.3
Interim Ca, as CaCO3	45	mg/L	> 40 mg/L	Precipitation potential	6.06	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.9		> 5.0	Langelier index	0.26		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	258	mg/L
Initial Ca sat, as CaCO3	25	mg/L
Initial DIC, as CaCO3	509	mg/L

Theoretical interim water characteristics

Interim acidity	258	mg/L
Interim Ca sat, as CaCO3	25	mg/L
Ryznar index	7.48	
Interim DIC, as CaCO3	509	mg/L
Aggressiveness Index	12.05	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	245	mg/L
Final Ca	39	mg/L
Final acidity	258	mg/L
Final pH	7.82	
Final DIC, as CaCO3	503	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.00E-08	1.00E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.09E-03	5.09E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	4.96E-03	4.96E-03													
[CO3-]	3.1E-05	3.1E-05	-40971.47	14	-0.26	7.74	45.00	251.00	5.09E-03	9.87E-05	3.06E-05	4.96E-03	8.19E-07	1.00E-08	8.0000
[H2CO3	9.9E-05	9.87E-05	-4099.93	13	0.64	8.11	21.39	227.39	4.85E-03	3.12E-04	8.10E-06	4.53E-03	2.37E-07	3.46E-08	7.4615
[Ca++]s	2.50E-04	2.50E-04	-410.96	12	9.63	####	0.00	174.88	4.33E-03	8.30E-04	1.81E-06	3.49E-03	6.86E-08	1.19E-07	6.9231
pHs alk		7.74	-25.24	11	10.42	####	0.00	97.55	3.55E-03	1.60E-03	2.92E-07	1.95E-03	1.99E-08	4.12E-07	6.3846
			106.39	10	11.36	####	0.00	38.54	2.96E-03	2.19E-03	3.35E-08	7.72E-04	5.75E-09	1.43E-06	5.8462
			223.51	9	12.39	####	0.00	12.25	2.70E-03	2.45E-03	3.14E-09	2.50E-04	1.66E-09	4.92E-06	5.3077
			257.72	8	13.45	####	0.00	2.89	2.61E-03	2.53E-03	2.71E-10	7.48E-05	4.82E-10	1.70E-05	4.7692
			350.49	7	14.53	####	0.00	-1.85	2.56E-03	2.54E-03	2.28E-11	2.17E-05	1.39E-10	5.88E-05	4.2308
			1250.30	6	15.61	####	0.00	-9.85	2.48E-03	2.47E-03	1.86E-12	6.12E-06	4.03E-11	2.03E-04	3.6923
			10263.40	5	16.74	####	0.00	-35.01	2.23E-03	2.23E-03	1.40E-13	1.59E-06	1.17E-11	7.02E-04	3.1538
			102167.47	4	18.03	####	0.00	-121.21	1.37E-03	1.36E-03	7.21E-15	2.83E-07	3.38E-12	2.42E-03	2.6154
			1198549.56	3	#####	####	0.00	-257.72	1.67E-96	1.67E-96	7.37E-109	1.00E-100	9.78E-13	8.38E-03	2.0769
			29896507.52	2	#####	####	0.00	-257.72	5.76E-96	5.76E-96	2.13E-109	1.00E-100	2.83E-13	2.89E-02	1.5385
			2090289794.96	1	#####	####	0.00	-257.72	1.99E-95	1.99E-95	6.18E-110	1.00E-100	8.19E-14	1.00E-01	1.0000
			257.72	8	-0.26	7.74	45.00	251.00	5.09E-03	9.87E-05	3.06E-05	4.96E-03	8.19E-07	1.00E-08	8.0000
			260.95	7.9	-0.12	7.78	41.90	247.90	5.06E-03	1.23E-04	2.41E-05	4.91E-03	6.51E-07	1.26E-08	7.9000
			264.72	7.8	0.02	7.82	38.37	244.37	5.02E-03	1.53E-04	1.89E-05	4.85E-03	5.17E-07	1.58E-08	7.8000
			269.23	7.7	0.18	7.88	34.28	240.28	4.98E-03	1.90E-04	1.48E-05	4.78E-03	4.11E-07	2.00E-08	7.7000
			274.71	7.6	0.35	7.95	29.48	235.48	4.93E-03	2.34E-04	1.15E-05	4.69E-03	3.26E-07	2.51E-08	7.6000
			281.47	7.5	0.55	8.05	23.82	229.82	4.88E-03	2.88E-04	8.94E-06	4.58E-03	2.59E-07	3.16E-08	7.5000
			289.86	7.4	0.81	8.21	17.17	223.17	4.81E-03	3.53E-04	6.90E-06	4.45E-03	2.06E-07	3.98E-08	7.4000
			300.32	7.3	1.19	8.49	9.40	215.40	4.73E-03	4.29E-04	5.30E-06	4.30E-03	1.63E-07	5.01E-08	7.3000
			313.42	7.2	2.68	9.88	0.40	206.40	4.64E-03	5.17E-04	4.03E-06	4.12E-03	1.30E-07	6.31E-08	7.2000
			329.85	7.1	9.40	####	0.00	196.12	4.54E-03	6.19E-04	3.05E-06	3.92E-03	1.03E-07	7.94E-08	7.1000
			350.49	7	9.53	####	0.00	184.57	4.42E-03	7.34E-04	2.28E-06	3.69E-03	8.19E-08	1.00E-07	7.0000
			257.72	8	-0.12	7.78	41.90	247.90	5.06E-03	1.23E-04	2.41E-05	4.91E-03	6.51E-07	1.26E-08	7.9000
			258.03	7.99	-0.11	7.78	41.56	247.56	5.05E-03	1.26E-04	2.35E-05	4.90E-03	6.36E-07	1.29E-08	7.8900
			258.34	7.98	-0.09	7.79	41.23	247.23	5.05E-03	1.29E-04	2.30E-05	4.90E-03	6.22E-07	1.32E-08	7.8800
			258.65	7.97	-0.08	7.79	40.89	246.89	5.05E-03	1.31E-04	2.24E-05	4.89E-03	6.07E-07	1.35E-08	7.8700
			258.96	7.96	-0.06	7.80	40.54	246.54	5.04E-03	1.34E-04	2.19E-05	4.89E-03	5.94E-07	1.38E-08	7.8600
			259.28	7.95	-0.05	7.80	40.19	246.19	5.04E-03	1.37E-04	2.13E-05	4.88E-03	5.80E-07	1.41E-08	7.8500
			259.61	7.94	-0.04	7.80	39.84	245.84	5.04E-03	1.40E-04	2.08E-05	4.87E-03	5.67E-07	1.45E-08	7.8400
			259.94	7.93	-0.02	7.81	39.48	245.48	5.03E-03	1.43E-04	2.03E-05	4.87E-03	5.54E-07	1.48E-08	7.8300
			260.27	7.92	-0.01	7.81	39.11	245.11	5.03E-03	1.46E-04	1.98E-05	4.86E-03	5.41E-07	1.51E-08	7.8200
			260.61	7.91	0.01	7.82	38.74	244.74	5.02E-03	1.50E-04	1.94E-05	4.86E-03	5.29E-07	1.55E-08	7.8100
			260.95	7.9	0.02	7.82	38.37	244.37	5.02E-03	1.53E-04	1.89E-05	4.85E-03	5.17E-07	1.58E-08	7.8000
					-0.01	7.81	39.11	245.11	5.03E-03	1.46E-04	1.98E-05	4.86E-03	5.41E-07	1.51E-08	7.8200
					-0.01	7.81	39.08	245.08	5.03E-03	1.47E-04	1.98E-05	4.86E-03	5.40E-07	1.52E-08	7.8190
					0.00	7.81	39.04	245.04	5.03E-03	1.47E-04	1.97E-05	4.86E-03	5.39E-07	1.52E-08	7.8180
					0.00	7.81	39.00	245.00	5.03E-03	1.47E-04	1.97E-05	4.86E-03	5.38E-07	1.52E-08	7.8170
					0.00	7.82	38.97	244.97	5.03E-03	1.48E-04	1.97E-05	4.86E-03	5.36E-07	1.53E-08	7.8160
					0.00	7.82	38.93	244.93	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.35E-07	1.53E-08	7.8150
					0.00	7.82	38.89	244.89	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.34E-07	1.53E-08	7.8140
					0.00	7.82	38.86	244.86	5.03E-03	1.49E-04	1.95E-05	4.86E-03	5.33E-07	1.54E-08	7.8130
					0.00	7.82	38.82	244.82	5.03E-03	1.49E-04	1.95E-05	4.86E-03	5.31E-07	1.54E-08	7.8120
					0.01	7.82	38.78	244.78	5.03E-03	1.49E-04	1.94E-05	4.86E-03	5.30E-07	1.55E-08	7.8110
					0.01	7.82	38.74	244.74	5.02E-03	1.50E-04	1.94E-05	4.86E-03	5.29E-07	1.55E-08	7.8100
					0.00	7.82	38.97	244.97	5.03E-03	1.48E-04	1.97E-05	4.86E-03	5.36E-07	1.53E-08	7.8160
					0.00	7.82	38.96	244.96	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8159
					0.00	7.82	38.96	244.96	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8158
					0.00	7.82	38.96	244.96	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8157
					0.00	7.82	38.95	244.95	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8156
					0.00	7.82	38.95	244.95	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8155
					0.00	7.82	38.94	244.94	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8154
					0.00	7.82	38.94	244.94	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8153
					0.00	7.82	38.94	244.94	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.35E-07	1.53E-08	7.8152
					0.00	7.82	38.93	244.93	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.35E-07	1.53E-08	7.8151
					0.00	7.82	38.93	244.93	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.35E-07	1.53E-08	7.8150
					0.00	7.82	38.94	244.94	5.03E-03	1.48E-04	1.96E-05	4.86E-03	5.36E-07	1.53E-08	7.8154

Tk	293
I	0.00943
E	80.0948
A	0.50625
f(I)	0.08849
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90788
fd	0.67938
K1p	5.02E-07
K2p	6.18E-11
Kwp	8.19E-15
Ksp	7.64E-09

	Forms of CaCO3 and their solubility product constants			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
6th Street & Katy (EP003)

The RTW Model Ver. 4.0 ID: **EP003**

STEP 1: Enter initial water characteristics.

Measured TDS	372	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	251	mg/L
Measured Ca, as CaCO3	40	mg/L
Measured Cl	67	mg/L
Measured SO4	14	mg/L

For CT and TTHM functions enter current:

Treated water pH	8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	251	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	40	mg/L	> 40 mg/L	Precipitation potential	2.60	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.1		> 5.0	Langelier index	0.11		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	261	mg/L
Initial Ca sat, as CaCO3	31	mg/L
Initial DIC, as CaCO3	512	mg/L

Theoretical interim water characteristics

Interim acidity	261	mg/L
Interim Ca sat, as CaCO3	31	mg/L
Ryznar index	7.68	
Interim DIC, as CaCO3	512	mg/L
Aggressiveness Index	11.90	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	248	mg/L
Final Ca	37	mg/L
Final acidity	261	mg/L
Final pH	7.83	
Final DIC, as CaCO3	509	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim														
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final	
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH	
[DIC]	5.12E-03	5.12E-03					mg CaCO3/L	mg CaCO3/L								
[HCO3-]	4.97E-03	4.97E-03														
[CO3-]	2.43E-05	2.43E-05	-40927.29	14	-0.11	7.79	40.00	251.00	5.12E-03	1.25E-04	2.43E-05	4.97E-03	6.50E-07	1.26E-08	7.9000	
[H2CO3*	0.000125	1.25E-04	-4095.51	13	0.97	8.34	12.65	223.65	4.85E-03	3.80E-04	6.43E-06	4.46E-03	1.92E-07	4.27E-08	7.3692	
[Ca++]s	3.13E-04	3.13E-04	-410.51	12	9.73	####	0.00	165.51	4.26E-03	9.56E-04	1.41E-06	3.31E-03	5.64E-08	1.45E-07	6.8385	
pHs alk		7.79	-25.16	11	10.54	####	0.00	88.09	3.49E-03	1.73E-03	2.21E-07	1.76E-03	1.66E-08	4.92E-07	6.3077	
			106.53	10	11.48	####	0.00	33.98	2.95E-03	2.27E-03	2.51E-08	6.81E-04	4.90E-09	1.67E-06	5.7769	
			223.57	9	12.50	####	0.00	10.76	2.72E-03	2.50E-03	2.40E-09	2.21E-04	1.44E-09	5.67E-06	5.2462	
			257.74	8	13.55	####	0.00	2.38	2.63E-03	2.57E-03	2.14E-10	6.69E-05	4.25E-10	1.93E-05	4.7154	
			350.59	7	14.61	####	0.00	-2.28	2.59E-03	2.57E-03	1.86E-11	1.97E-05	1.25E-10	6.54E-05	4.1846	
			1251.38	6	15.69	####	0.00	-10.81	2.50E-03	2.50E-03	1.57E-12	5.65E-06	3.69E-11	2.22E-04	3.6538	
			10274.21	5	16.80	####	0.00	-37.59	2.23E-03	2.23E-03	1.22E-13	1.49E-06	1.09E-11	7.53E-04	3.1231	
			102277.51	4	18.08	####	0.00	-127.83	1.33E-03	1.33E-03	6.30E-15	2.61E-07	3.20E-12	2.56E-03	2.5923	
			1199843.38	3	#####	####	0.00	-260.97	1.73E-96	1.73E-96	7.10E-109	1.00E-100	9.43E-13	8.68E-03	2.0615	
			29928788.38	2	#####	####	0.00	-260.97	5.87E-96	5.87E-96	2.09E-109	1.00E-100	2.78E-13	2.95E-02	1.5308	
			2092546875.73	1	#####	####	0.00	-260.97	1.99E-95	1.99E-95	6.16E-110	1.00E-100	8.18E-14	1.00E-01	1.0000	
			257.74	8	-0.11	7.79	40.00	251.00	5.12E-03	1.25E-04	2.43E-05	4.97E-03	6.50E-07	1.26E-08	7.9000	
			260.97	7.9	0.04	7.84	36.43	247.43	5.08E-03	1.55E-04	1.91E-05	4.91E-03	5.16E-07	1.58E-08	7.8000	
			264.74	7.8	0.20	7.90	32.28	243.28	5.04E-03	1.92E-04	1.49E-05	4.84E-03	4.10E-07	2.00E-08	7.7000	
			269.25	7.7	0.38	7.98	27.42	238.42	4.99E-03	2.37E-04	1.16E-05	4.74E-03	3.26E-07	2.51E-08	7.6000	
			274.74	7.6	0.59	8.09	21.69	232.69	4.94E-03	2.92E-04	9.04E-06	4.64E-03	2.59E-07	3.16E-08	7.5000	
			281.51	7.5	0.86	8.26	14.95	225.95	4.87E-03	3.57E-04	6.98E-06	4.50E-03	2.06E-07	3.98E-08	7.4000	
			289.90	7.4	1.30	8.60	7.07	218.07	4.79E-03	4.34E-04	5.35E-06	4.35E-03	1.63E-07	5.01E-08	7.3000	
			300.38	7.3	9.27	####	0.00	208.95	4.70E-03	5.24E-04	4.07E-06	4.17E-03	1.30E-07	6.31E-08	7.2000	
			313.49	7.2	9.39	####	0.00	198.53	4.60E-03	6.27E-04	3.08E-06	3.96E-03	1.03E-07	7.94E-08	7.1000	
			329.94	7.1	9.52	####	0.00	186.84	4.48E-03	7.44E-04	2.30E-06	3.73E-03	8.18E-08	1.00E-07	7.0000	
			350.59	7	9.65	####	0.00	173.95	4.35E-03	8.72E-04	1.70E-06	3.48E-03	6.50E-08	1.26E-07	6.9000	
			260.97	7.9	-0.11	7.79	40.00	251.00	5.12E-03	1.25E-04	2.43E-05	4.97E-03	6.50E-07	1.26E-08	7.9000	
			261.32	7.89	-0.09	7.80	39.66	250.66	5.12E-03	1.27E-04	2.38E-05	4.97E-03	6.35E-07	1.29E-08	7.8900	
			261.68	7.88	-0.08	7.80	39.32	250.32	5.11E-03	1.30E-04	2.32E-05	4.96E-03	6.21E-07	1.32E-08	7.8800	
			262.04	7.87	-0.06	7.81	38.98	249.98	5.11E-03	1.33E-04	2.26E-05	4.95E-03	6.07E-07	1.35E-08	7.8700	
			262.40	7.86	-0.05	7.81	38.63	249.63	5.11E-03	1.36E-04	2.21E-05	4.95E-03	5.93E-07	1.38E-08	7.8600	
			262.78	7.85	-0.04	7.81	38.28	249.28	5.10E-03	1.39E-04	2.16E-05	4.94E-03	5.79E-07	1.41E-08	7.8500	
			263.16	7.84	-0.02	7.82	37.92	248.92	5.10E-03	1.42E-04	2.10E-05	4.94E-03	5.66E-07	1.45E-08	7.8400	
			263.54	7.83	-0.01	7.82	37.55	248.55	5.10E-03	1.45E-04	2.05E-05	4.93E-03	5.53E-07	1.48E-08	7.8300	
			263.94	7.82	0.01	7.83	37.18	248.18	5.09E-03	1.48E-04	2.01E-05	4.92E-03	5.41E-07	1.51E-08	7.8200	
			264.33	7.81	0.02	7.83	36.81	247.81	5.09E-03	1.52E-04	1.96E-05	4.92E-03	5.28E-07	1.55E-08	7.8100	
			264.74	7.8	0.04	7.84	36.43	247.43	5.08E-03	1.55E-04	1.91E-05	4.91E-03	5.16E-07	1.58E-08	7.8000	
					-0.01	7.82	37.55	248.55	5.10E-03	1.45E-04	2.05E-05	4.93E-03	5.53E-07	1.48E-08	7.8300	
					0.00	7.82	37.51	248.51	5.09E-03	1.46E-04	2.05E-05	4.93E-03	5.52E-07	1.48E-08	7.8290	
					0.00	7.82	37.48	248.48	5.09E-03	1.46E-04	2.04E-05	4.93E-03	5.51E-07	1.49E-08	7.8280	
					0.00	7.83	37.44	248.44	5.09E-03	1.46E-04	2.04E-05	4.93E-03	5.50E-07	1.49E-08	7.8270	
					0.00	7.83	37.40	248.40	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8260	
					0.00	7.83	37.37	248.37	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.47E-07	1.50E-08	7.8250	
					0.00	7.83	37.33	248.33	5.09E-03	1.47E-04	2.02E-05	4.93E-03	5.46E-07	1.50E-08	7.8240	
					0.00	7.83	37.29	248.29	5.09E-03	1.48E-04	2.02E-05	4.92E-03	5.45E-07	1.50E-08	7.8230	
					0.01	7.83	37.26	248.26	5.09E-03	1.48E-04	2.01E-05	4.92E-03	5.43E-07	1.51E-08	7.8220	
					0.01	7.83	37.22	248.22	5.09E-03	1.48E-04	2.01E-05	4.92E-03	5.42E-07	1.51E-08	7.8210	
					0.01	7.83	37.18	248.18	5.09E-03	1.48E-04	2.01E-05	4.92E-03	5.41E-07	1.51E-08	7.8200	
					0.00	7.83	37.40	248.40	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8260	
					0.00	7.83	37.40	248.40	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8259	
					0.00	7.83	37.40	248.40	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8258	
					0.00	7.83	37.39	248.39	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8257	
					0.00	7.83	37.39	248.39	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8256	
					0.00	7.83	37.39	248.39	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8255	
					0.00	7.83	37.38	248.38	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8254	
					0.00	7.83	37.38	248.38	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.47E-07	1.50E-08	7.8253	
					0.00	7.83	37.37	248.37	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.47E-07	1.50E-08	7.8252	
					0.00	7.83	37.37	248.37	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.47E-07	1.50E-08	7.8251	
					0.00	7.83	37.37	248.37	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.47E-07	1.50E-08	7.8250	
					0.00	7.83	37.40	248.40	5.09E-03	1.47E-04	2.03E-05	4.93E-03	5.48E-07	1.49E-08	7.8260	

Tk	293
I	0.0093
E	80.094785
A	0.5062483
f(I)	0.0879545
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.9083709
fd	0.6808521
K1p	5.02E-07
K2p	6.16E-11
Kwp	8.18E-15
Ksp	7.61E-09

	Forms of CaCO3 and their solubility product constants			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	**14**	Enter 14 or 18
Ferric sulfate	**9**	Enter 9,5,3 or 0
Ferric Chloride	**0**	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
6th Street & Avenue I (EP004)

The RTW Model Ver. 4.0 ID: **EP004**

STEP 1: Enter initial water characteristics.

Measured TDS	330	mg/L
Measured temperature	20	deg C
Measured pH	7.8	
Measured alk, as CaCO3	246	mg/L
Measured Ca, as CaCO3	35	mg/L
Measured Cl	47	mg/L
Measured SO4	14	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	246	mg/L	> 40 mg/L	Interim pH	7.80		6.8-9.3
Interim Ca, as CaCO3	35	mg/L	> 40 mg/L	Precipitation potential	-1.25	mg/L	4-10 mg/L
Alk/(Cl+SO4)	4.0		> 5.0	Langelier index	-0.05		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	260	mg/L
Initial Ca sat, as CaCO3	39	mg/L
Initial DIC, as CaCO3	506	mg/L

Theoretical interim water characteristics

Interim acidity	260	mg/L
Interim Ca sat, as CaCO3	39	mg/L
Ryznar index	7.89	
Interim DIC, as CaCO3	506	mg/L
Aggressiveness Index	11.74	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	N/A	mg/L
Final Ca	N/A	mg/L
Final acidity	N/A	mg/L
Final pH	N/A	
Final DIC, as CaCO3	N/A	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.58E-08	1.58E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.06E-03	5.06E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	4.88E-03	4.88E-03													
[CO3-]	1.9E-05	1.9E-05	-40541.24	14	-15.52	-1.52	493614471.84	493614682.84	4.94E+03	1.64E-08	4.94E+03	8.16E-01	8.11E-01	1.00E-14	14.0000
[H2CO3	0.00016	1.56E-04	-4056.94	13	-13.63	-0.10	55612358.05	55612569.05	5.56E+02	1.66E-08	5.56E+02	2.76E-01	2.70E-01	3.00E-14	13.5231
[Ca++]s	3.93E-04	3.93E-04	-406.69	12	-11.75	1.30	6423673.18	6423884.18	6.42E+01	1.72E-08	6.41E+01	9.54E-02	9.02E-02	8.99E-14	13.0462
pHs alk		7.85	-24.85	11	-9.93	2.64	794085.03	794296.03	7.95E+00	1.91E-08	7.91E+00	3.53E-02	3.01E-02	2.70E-13	12.5692
			105.48	10	-8.25	3.84	114917.06	115128.06	1.15E+00	2.48E-08	1.14E+00	1.52E-02	1.00E-02	8.09E-13	12.0923
			219.57	9	-6.80	4.82	21681.29	21892.29	2.22E-01	4.16E-08	2.13E-01	8.54E-03	3.34E-03	2.42E-12	11.6154
			252.76	8	-5.59	5.55	5408.35	5619.35	5.88E-02	9.22E-08	5.25E-02	6.31E-03	1.12E-03	7.27E-12	11.1385
			344.55	7	-4.54	6.13	1629.70	1840.70	2.10E-02	2.44E-07	1.54E-02	5.56E-03	3.72E-04	2.18E-11	10.6615
			1235.80	6	-3.57	6.62	552.83	763.83	1.02E-02	6.99E-07	4.92E-03	5.32E-03	1.24E-04	6.54E-11	10.1846
			10163.52	5	-2.67	7.03	213.97	424.97	6.85E-03	2.06E-06	1.61E-03	5.23E-03	4.14E-05	1.96E-10	9.7077
			101232.62	4	-1.88	7.36	102.87	313.87	5.74E-03	6.14E-06	5.35E-04	5.19E-03	1.38E-05	5.88E-10	9.2308
			1191147.35	3	-1.20	7.56	64.99	275.99	5.36E-03	1.83E-05	1.77E-04	5.16E-03	4.60E-06	1.76E-09	8.7538
			30012661.70	2	-0.59	7.68	49.22	260.22	5.20E-03	5.41E-05	5.82E-05	5.09E-03	1.53E-06	5.29E-09	8.2769
			2110464515.14	1	0.05	7.85	35.00	246.00	5.06E-03	1.56E-04	1.86E-05	4.88E-03	5.12E-07	1.58E-08	7.8000
			252.76	8	-0.59	7.68	49.22	260.22	5.20E-03	5.41E-05	5.82E-05	5.09E-03	1.53E-06	5.29E-09	8.2769
			255.93	7.9	-0.47	7.71	46.60	257.60	5.17E-03	6.77E-05	4.60E-05	5.06E-03	1.22E-06	6.65E-09	8.1769
			259.65	7.8	-0.34	7.74	43.91	254.91	5.15E-03	8.47E-05	3.63E-05	5.02E-03	9.68E-07	8.38E-09	8.0769
			264.10	7.7	-0.20	7.77	41.02	252.02	5.12E-03	1.06E-04	2.86E-05	4.98E-03	7.69E-07	1.05E-08	7.9769
			269.53	7.6	-0.06	7.81	37.79	248.79	5.08E-03	1.32E-04	2.25E-05	4.93E-03	6.11E-07	1.33E-08	7.8769
			276.21	7.5	0.09	7.86	34.10	245.10	5.05E-03	1.64E-04	1.76E-05	4.87E-03	4.85E-07	1.67E-08	7.7769
			284.52	7.4	0.25	7.93	29.80	240.80	5.00E-03	2.03E-04	1.38E-05	4.79E-03	3.85E-07	2.10E-08	7.6769
			294.88	7.3	0.44	8.02	24.74	235.74	4.95E-03	2.50E-04	1.07E-05	4.69E-03	3.06E-07	2.65E-08	7.5769
			307.85	7.2	0.67	8.15	18.79	229.79	4.89E-03	3.07E-04	8.31E-06	4.58E-03	2.43E-07	3.33E-08	7.4769
			324.11	7.1	0.99	8.36	11.79	222.79	4.82E-03	3.75E-04	6.40E-06	4.44E-03	1.93E-07	4.20E-08	7.3769
			344.55	7	1.62	8.89	3.62	214.62	4.74E-03	4.55E-04	4.90E-06	4.28E-03	1.53E-07	5.29E-08	7.2769
			259.65	7.8	-0.06	7.81	37.79	248.79	5.08E-03	1.32E-04	2.25E-05	4.93E-03	6.11E-07	1.33E-08	7.8769
			260.06	7.79	-0.05	7.82	37.45	248.45	5.08E-03	1.35E-04	2.19E-05	4.92E-03	5.97E-07	1.36E-08	7.8669
			260.48	7.78	-0.03	7.82	37.09	248.09	5.08E-03	1.38E-04	2.14E-05	4.92E-03	5.83E-07	1.39E-08	7.8569
			260.90	7.77	-0.02	7.83	36.74	247.74	5.07E-03	1.41E-04	2.09E-05	4.91E-03	5.70E-07	1.42E-08	7.8469
			261.33	7.76	-0.01	7.83	36.38	247.38	5.07E-03	1.44E-04	2.04E-05	4.91E-03	5.57E-07	1.46E-08	7.8369
			261.77	7.75	0.01	7.84	36.01	247.01	5.07E-03	1.47E-04	1.99E-05	4.90E-03	5.44E-07	1.49E-08	7.8269
			262.22	7.74	0.02	7.84	35.64	246.64	5.06E-03	1.50E-04	1.94E-05	4.89E-03	5.32E-07	1.52E-08	7.8169
			262.68	7.73	0.04	7.85	35.26	246.26	5.06E-03	1.53E-04	1.89E-05	4.89E-03	5.20E-07	1.56E-08	7.8069
			263.14	7.72	0.06	7.85	34.88	245.88	5.06E-03	1.57E-04	1.85E-05	4.88E-03	5.08E-07	1.60E-08	7.7969
			263.62	7.71	0.07	7.86	34.49	245.49	5.05E-03	1.60E-04	1.80E-05	4.87E-03	4.96E-07	1.63E-08	7.7869
			264.10	7.7	0.09	7.86	34.10	245.10	5.05E-03	1.64E-04	1.76E-05	4.87E-03	4.85E-07	1.67E-08	7.7769
					-0.01	7.83	36.38	247.38	5.07E-03	1.44E-04	2.04E-05	4.91E-03	5.57E-07	1.46E-08	7.8369
					0.00	7.83	36.34	247.34	5.07E-03	1.44E-04	2.03E-05	4.91E-03	5.56E-07	1.46E-08	7.8359
					0.00	7.83	36.31	247.31	5.07E-03	1.44E-04	2.03E-05	4.90E-03	5.54E-07	1.46E-08	7.8349
					0.00	7.83	36.27	247.27	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.53E-07	1.47E-08	7.8339
					0.00	7.83	36.23	247.23	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8329
					0.00	7.83	36.20	247.20	5.07E-03	1.45E-04	2.01E-05	4.90E-03	5.51E-07	1.47E-08	7.8319
					0.00	7.83	36.16	247.16	5.07E-03	1.46E-04	2.01E-05	4.90E-03	5.49E-07	1.48E-08	7.8309
					0.01	7.84	36.12	247.12	5.07E-03	1.46E-04	2.00E-05	4.90E-03	5.48E-07	1.48E-08	7.8299
					0.01	7.84	36.09	247.09	5.07E-03	1.46E-04	2.00E-05	4.90E-03	5.47E-07	1.48E-08	7.8289
					0.01	7.84	36.05	247.05	5.07E-03	1.47E-04	1.99E-05	4.90E-03	5.46E-07	1.49E-08	7.8279
					0.01	7.84	36.01	247.01	5.07E-03	1.47E-04	1.99E-05	4.90E-03	5.44E-07	1.49E-08	7.8269
					0.00	7.83	36.27	247.27	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.53E-07	1.47E-08	7.8339
					0.00	7.83	36.27	247.27	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.53E-07	1.47E-08	7.8338
					0.00	7.83	36.26	247.26	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.53E-07	1.47E-08	7.8337
					0.00	7.83	36.26	247.26	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.53E-07	1.47E-08	7.8336
					0.00	7.83	36.25	247.25	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.53E-07	1.47E-08	7.8335
					0.00	7.83	36.25	247.25	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8334
					0.00	7.83	36.25	247.25	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8333
					0.00	7.83	36.24	247.24	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8332
					0.00	7.83	36.24	247.24	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8331
					0.00	7.83	36.24	247.24	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8330
					0.00	7.83	36.23	247.23	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8329
					0.00	7.83	36.25	247.25	5.07E-03	1.45E-04	2.02E-05	4.90E-03	5.52E-07	1.47E-08	7.8334

Tk	293
I	0.00825
E	80.0948
A	0.50625
f(I)	0.08327
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.91269
fd	0.69388
K1p	4.97E-07
K2p	6.05E-11
Kwp	8.11E-15
Ksp	7.33E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Grace Street & Moore Avenue (EP005)

The RTW Model Ver. 4.0 ID: **EP005**

STEP 1: Enter initial water characteristics.

Measured TDS	440	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	282	mg/L
Measured Ca, as CaCO3	52.5	mg/L
Measured Cl	106	mg/L
Measured SO4	13	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical).
Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	282	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	53	mg/L	> 40 mg/L	Precipitation potential	7.77	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.4		> 5.0	Langelier index	0.27		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	293	mg/L
Initial Ca sat, as CaCO3	29	mg/L
Initial DIC, as CaCO3	575	mg/L

Theoretical interim water characteristics

Interim acidity	293	mg/L
Interim Ca sat, as CaCO3	29	mg/L
Ryznar index	7.36	
Interim DIC, as CaCO3	575	mg/L
Aggressiveness Index	12.07	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	274	mg/L
Final Ca	45	mg/L
Final acidity	293	mg/L
Final pH	7.72	
Final DIC, as CaCO3	567	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.75E-03	5.75E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.58E-03	5.58E-03													
[CO3-]	2.81E-05	2.81E-05	-41500.15	14	-0.26	7.64	52.50	282.00	5.75E-03	1.38E-04	2.81E-05	5.58E-03	6.59E-07	1.26E-08	7.9000
[H2CO3*	0.000138	1.38E-04	-4152.74	13	0.69	8.06	22.07	251.57	5.45E-03	4.21E-04	7.44E-06	5.02E-03	1.94E-07	4.27E-08	7.3692
[Ca++]s	2.86E-04	2.86E-04	-416.01	12	9.69	####	0.00	186.73	4.80E-03	1.06E-03	1.63E-06	3.73E-03	5.72E-08	1.45E-07	6.8385
pHs alk		7.63	-23.91	11	10.50	####	0.00	99.80	3.93E-03	1.93E-03	2.57E-07	2.00E-03	1.69E-08	4.92E-07	6.3077
			118.43	10	11.44	####	0.00	38.61	3.32E-03	2.54E-03	2.93E-08	7.74E-04	4.97E-09	1.67E-06	5.7769
			250.47	9	12.46	####	0.00	12.28	3.05E-03	2.80E-03	2.81E-09	2.51E-04	1.46E-09	5.67E-06	5.2462
			289.33	8	13.51	####	0.00	2.84	2.96E-03	2.88E-03	2.51E-10	7.61E-05	4.31E-10	1.93E-05	4.7154
			392.33	7	14.57	####	0.00	-2.15	2.91E-03	2.89E-03	2.18E-11	2.25E-05	1.27E-10	6.54E-05	4.1846
			1390.38	6	15.64	####	0.00	-10.77	2.82E-03	2.82E-03	1.84E-12	6.46E-06	3.74E-11	2.22E-04	3.6538
			11385.12	5	16.74	####	0.00	-37.57	2.55E-03	2.55E-03	1.45E-13	1.72E-06	1.10E-11	7.53E-04	3.1231
			113083.07	4	17.99	####	0.00	-127.82	1.65E-03	1.65E-03	8.15E-15	3.29E-07	3.25E-12	2.56E-03	2.5923
			1305144.28	3	#####	####	0.00	-292.94	1.71E-96	1.71E-96	7.30E-109	1.00E-100	9.56E-13	8.68E-03	2.0615
			30733939.27	2	#####	####	0.00	-292.94	5.79E-96	5.79E-96	2.15E-109	1.00E-100	2.82E-13	2.95E-02	1.5308
			2075840174.18	1	#####	####	0.00	-292.94	1.97E-95	1.97E-95	6.34E-110	1.00E-100	8.30E-14	1.00E-01	1.0000
			289.33	8	-0.26	7.64	52.50	282.00	5.75E-03	1.38E-04	2.81E-05	5.58E-03	6.59E-07	1.26E-08	7.9000
			292.94	7.9	-0.12	7.68	48.51	278.01	5.71E-03	1.72E-04	2.21E-05	5.52E-03	5.24E-07	1.58E-08	7.8000
			297.14	7.8	0.03	7.73	43.90	273.40	5.66E-03	2.13E-04	1.73E-05	5.43E-03	4.16E-07	2.00E-08	7.7000
			302.15	7.7	0.19	7.79	38.49	267.99	5.61E-03	2.63E-04	1.35E-05	5.33E-03	3.30E-07	2.51E-08	7.6000
			308.25	7.6	0.38	7.88	32.12	261.62	5.55E-03	3.24E-04	1.04E-05	5.21E-03	2.62E-07	3.16E-08	7.5000
			315.76	7.5	0.61	8.01	24.63	254.13	5.47E-03	3.96E-04	8.07E-06	5.07E-03	2.08E-07	3.98E-08	7.4000
			325.07	7.4	0.91	8.21	15.86	245.36	5.38E-03	4.82E-04	6.19E-06	4.89E-03	1.66E-07	5.01E-08	7.3000
			336.68	7.3	1.48	8.68	5.71	235.21	5.28E-03	5.82E-04	4.72E-06	4.69E-03	1.32E-07	6.31E-08	7.2000
			351.21	7.2	9.35	####	0.00	223.60	5.17E-03	6.97E-04	3.56E-06	4.46E-03	1.04E-07	7.94E-08	7.1000
			369.44	7.1	9.48	####	0.00	210.56	5.03E-03	8.26E-04	2.67E-06	4.21E-03	8.30E-08	1.00E-07	7.0000
			392.33	7	9.61	####	0.00	196.17	4.89E-03	9.70E-04	1.97E-06	3.92E-03	6.59E-08	1.26E-07	6.9000
			292.94	7.9	-0.12	7.68	48.51	278.01	5.71E-03	1.72E-04	2.21E-05	5.52E-03	5.24E-07	1.58E-08	7.8000
			293.33	7.89	-0.11	7.68	48.08	277.58	5.71E-03	1.76E-04	2.15E-05	5.51E-03	5.12E-07	1.62E-08	7.7900
			293.72	7.88	-0.09	7.69	47.65	277.15	5.70E-03	1.79E-04	2.10E-05	5.50E-03	5.00E-07	1.66E-08	7.7800
			294.12	7.87	-0.08	7.69	47.20	276.70	5.70E-03	1.83E-04	2.05E-05	5.49E-03	4.89E-07	1.70E-08	7.7700
			294.53	7.86	-0.07	7.69	46.75	276.25	5.69E-03	1.87E-04	2.00E-05	5.48E-03	4.78E-07	1.74E-08	7.7600
			294.95	7.85	-0.05	7.70	46.30	275.80	5.69E-03	1.91E-04	1.95E-05	5.48E-03	4.67E-07	1.78E-08	7.7500
			295.37	7.84	-0.04	7.70	45.83	275.33	5.68E-03	1.96E-04	1.90E-05	5.47E-03	4.56E-07	1.82E-08	7.7400
			295.80	7.83	-0.02	7.71	45.36	274.86	5.68E-03	2.00E-04	1.86E-05	5.46E-03	4.46E-07	1.86E-08	7.7300
			296.24	7.82	-0.01	7.71	44.88	274.38	5.67E-03	2.04E-04	1.81E-05	5.45E-03	4.36E-07	1.91E-08	7.7200
			296.68	7.81	0.01	7.72	44.39	273.89	5.67E-03	2.09E-04	1.77E-05	5.44E-03	4.26E-07	1.95E-08	7.7100
			297.14	7.8	0.03	7.73	43.90	273.40	5.66E-03	2.13E-04	1.73E-05	5.43E-03	4.16E-07	2.00E-08	7.7000
					-0.01	7.71	44.88	274.38	5.67E-03	2.04E-04	1.81E-05	5.45E-03	4.36E-07	1.91E-08	7.7200
					0.00	7.72	44.83	274.33	5.67E-03	2.05E-04	1.81E-05	5.45E-03	4.35E-07	1.91E-08	7.7190
					0.00	7.72	44.78	274.28	5.67E-03	2.05E-04	1.80E-05	5.45E-03	4.34E-07	1.91E-08	7.7180
					0.00	7.72	44.74	274.24	5.67E-03	2.05E-04	1.80E-05	5.45E-03	4.33E-07	1.92E-08	7.7170
					0.00	7.72	44.69	274.19	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7160
					0.00	7.72	44.64	274.14	5.67E-03	2.06E-04	1.79E-05	5.45E-03	4.31E-07	1.93E-08	7.7150
					0.00	7.72	44.59	274.09	5.67E-03	2.07E-04	1.79E-05	5.45E-03	4.30E-07	1.93E-08	7.7140
					0.01	7.72	44.54	274.04	5.67E-03	2.07E-04	1.78E-05	5.44E-03	4.29E-07	1.94E-08	7.7130
					0.01	7.72	44.49	273.99	5.67E-03	2.08E-04	1.78E-05	5.44E-03	4.28E-07	1.94E-08	7.7120
					0.01	7.72	44.44	273.94	5.67E-03	2.08E-04	1.77E-05	5.44E-03	4.27E-07	1.95E-08	7.7110
					0.01	7.72	44.39	273.89	5.67E-03	2.09E-04	1.77E-05	5.44E-03	4.26E-07	1.95E-08	7.7100
					0.00	7.72	44.74	274.24	5.67E-03	2.05E-04	1.80E-05	5.45E-03	4.33E-07	1.92E-08	7.7170
					0.00	7.72	44.73	274.23	5.67E-03	2.05E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7169
					0.00	7.72	44.73	274.23	5.67E-03	2.05E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7168
					0.00	7.72	44.72	274.22	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7167
					0.00	7.72	44.72	274.22	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7166
					0.00	7.72	44.71	274.21	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7165
					0.00	7.72	44.71	274.21	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7164
					0.00	7.72	44.70	274.20	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7163
					0.00	7.72	44.70	274.20	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7162
					0.00	7.72	44.69	274.19	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7161
					0.00	7.72	44.69	274.19	5.67E-03	2.06E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7160
					0.00	7.72	44.73	274.23	5.67E-03	2.05E-04	1.80E-05	5.45E-03	4.32E-07	1.92E-08	7.7168

Tk	293
I	0.011
E	80.0948
A	0.50625
f(I)	0.09493
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90208
fd	0.66218
K1p	5.09E-07
K2p	6.34E-11
Kwp	8.30E-15
Ksp	8.04E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 2a: EP001 & EP003

The RTW Model Ver. 4.0 ID: **Blend 2a**

STEP 1: Enter initial water characteristics.

Measured TDS	347	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	266.49	mg/L
Measured Ca, as CaCO3	63.072	mg/L
Measured Cl	53.637	mg/L
Measured SO4	14.574	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	266	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	63	mg/L	> 40 mg/L	Precipitation potential	10.33	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.9		> 5.0	Langelier index	0.34		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	277	mg/L
Initial Ca sat, as CaCO3	29	mg/L
Initial DIC, as CaCO3	544	mg/L

Theoretical interim water characteristics

Interim acidity	277	mg/L
Interim Ca sat, as CaCO3	29	mg/L
Ryznar index	7.22	
Interim DIC, as CaCO3	544	mg/L
Aggressiveness Index	12.13	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	256	mg/L
Final Ca	53	mg/L
Final acidity	277	mg/L
Final pH	7.66	
Final DIC, as CaCO3	533	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.44E-03	5.44E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.28E-03	5.28E-03													
[CO3-]	2.56E-05	2.56E-05	-40700.83	14	-0.34	7.56	63.07	266.49	5.44E-03	1.33E-04	2.56E-05	5.28E-03	6.47E-07	1.26E-08	7.9000
[H2CO3*	0.000133	1.33E-04	-4072.87	13	0.51	7.88	33.93	237.35	5.15E-03	4.05E-04	6.75E-06	4.73E-03	1.90E-07	4.27E-08	7.3692
[Ca++]s	2.91E-04	2.91E-04	-408.12	12	9.70	####	0.00	175.43	4.53E-03	1.02E-03	1.47E-06	3.51E-03	5.61E-08	1.45E-07	6.8385
pHs alk		7.56	-23.58	11	10.51	####	0.00	93.22	3.70E-03	1.84E-03	2.31E-07	1.86E-03	1.65E-08	4.92E-07	6.3077
			114.23	10	11.45	####	0.00	35.92	3.13E-03	2.41E-03	2.63E-08	7.20E-04	4.87E-09	1.67E-06	5.7769
			237.71	9	12.47	####	0.00	11.38	2.89E-03	2.65E-03	2.51E-09	2.33E-04	1.43E-09	5.67E-06	5.2462
			273.75	8	13.52	####	0.00	2.57	2.80E-03	2.73E-03	2.24E-10	7.07E-05	4.23E-10	1.93E-05	4.7154
			372.83	7	14.58	####	0.00	-2.23	2.75E-03	2.73E-03	1.94E-11	2.08E-05	1.25E-10	6.54E-05	4.1846
			1334.52	6	15.66	####	0.00	-10.80	2.66E-03	2.66E-03	1.64E-12	5.98E-06	3.67E-11	2.22E-04	3.6538
			10966.33	5	16.76	####	0.00	-37.58	2.40E-03	2.39E-03	1.28E-13	1.59E-06	1.08E-11	7.53E-04	3.1231
			109069.32	4	18.03	####	0.00	-127.82	1.49E-03	1.49E-03	6.95E-15	2.92E-07	3.18E-12	2.56E-03	2.5923
			1268619.97	3	#####	####	0.00	-277.19	1.74E-96	1.74E-96	7.02E-109	1.00E-100	9.38E-13	8.68E-03	2.0615
			30716205.21	2	#####	####	0.00	-277.19	5.90E-96	5.90E-96	2.07E-109	1.00E-100	2.76E-13	2.95E-02	1.5308
			2110399931.85	1	#####	####	0.00	-277.19	2.00E-95	2.00E-95	6.10E-110	1.00E-100	8.14E-14	1.00E-01	1.0000
			273.75	8	-0.34	7.56	63.07	266.49	5.44E-03	1.33E-04	2.56E-05	5.28E-03	6.47E-07	1.26E-08	7.9000
			277.19	7.9	-0.20	7.60	59.27	262.69	5.40E-03	1.66E-04	2.01E-05	5.21E-03	5.14E-07	1.58E-08	7.8000
			281.20	7.8	-0.06	7.64	54.85	258.27	5.35E-03	2.05E-04	1.57E-05	5.13E-03	4.08E-07	2.00E-08	7.7000
			286.01	7.7	0.09	7.69	49.67	253.09	5.30E-03	2.54E-04	1.22E-05	5.04E-03	3.24E-07	2.51E-08	7.6000
			291.87	7.6	0.26	7.76	43.56	246.98	5.24E-03	3.12E-04	9.49E-06	4.92E-03	2.57E-07	3.16E-08	7.5000
			299.09	7.5	0.45	7.85	36.38	239.80	5.17E-03	3.81E-04	7.32E-06	4.78E-03	2.04E-07	3.98E-08	7.4000
			308.05	7.4	0.68	7.98	27.98	231.40	5.09E-03	4.64E-04	5.62E-06	4.62E-03	1.62E-07	5.01E-08	7.3000
			319.23	7.3	0.98	8.18	18.26	221.68	4.99E-03	5.59E-04	4.28E-06	4.43E-03	1.29E-07	6.31E-08	7.2000
			333.22	7.2	1.51	8.61	7.16	210.59	4.88E-03	6.69E-04	3.23E-06	4.21E-03	1.02E-07	7.94E-08	7.1000
			350.78	7.1	9.49	####	0.00	198.13	4.75E-03	7.93E-04	2.41E-06	3.96E-03	8.14E-08	1.00E-07	7.0000
			372.83	7	9.62	####	0.00	184.42	4.62E-03	9.29E-04	1.78E-06	3.68E-03	6.47E-08	1.26E-07	6.9000
			277.19	7.9	-0.06	7.64	54.85	258.27	5.35E-03	2.05E-04	1.57E-05	5.13E-03	4.08E-07	2.00E-08	7.7000
			277.56	7.89	-0.05	7.64	54.37	257.79	5.35E-03	2.10E-04	1.53E-05	5.12E-03	3.99E-07	2.04E-08	7.6900
			277.94	7.88	-0.03	7.65	53.88	257.30	5.34E-03	2.14E-04	1.49E-05	5.12E-03	3.90E-07	2.09E-08	7.6800
			278.32	7.87	-0.02	7.65	53.38	256.81	5.34E-03	2.19E-04	1.46E-05	5.11E-03	3.81E-07	2.14E-08	7.6700
			278.71	7.86	0.00	7.66	52.88	256.30	5.33E-03	2.23E-04	1.42E-05	5.10E-03	3.72E-07	2.19E-08	7.6600
			279.11	7.85	0.01	7.66	52.36	255.79	5.33E-03	2.28E-04	1.39E-05	5.09E-03	3.64E-07	2.24E-08	7.6500
			279.51	7.84	0.03	7.67	51.84	255.26	5.32E-03	2.33E-04	1.35E-05	5.08E-03	3.55E-07	2.29E-08	7.6400
			279.93	7.83	0.04	7.67	51.31	254.73	5.32E-03	2.38E-04	1.32E-05	5.07E-03	3.47E-07	2.34E-08	7.6300
			280.34	7.82	0.06	7.68	50.77	254.20	5.31E-03	2.43E-04	1.29E-05	5.06E-03	3.39E-07	2.40E-08	7.6200
			280.77	7.81	0.07	7.68	50.22	253.65	5.31E-03	2.48E-04	1.25E-05	5.05E-03	3.32E-07	2.45E-08	7.6100
			281.20	7.8	0.09	7.69	49.67	253.09	5.30E-03	2.54E-04	1.22E-05	5.04E-03	3.24E-07	2.51E-08	7.6000
					0.00	7.66	52.88	256.30	5.33E-03	2.23E-04	1.42E-05	5.10E-03	3.72E-07	2.19E-08	7.6600
					0.00	7.66	52.83	256.25	5.33E-03	2.24E-04	1.42E-05	5.10E-03	3.71E-07	2.19E-08	7.6590
					0.00	7.66	52.78	256.20	5.33E-03	2.24E-04	1.41E-05	5.10E-03	3.70E-07	2.20E-08	7.6580
					0.00	7.66	52.72	256.15	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.69E-07	2.20E-08	7.6570
					0.00	7.66	52.67	256.10	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.69E-07	2.21E-08	7.6560
					0.00	7.66	52.62	256.04	5.33E-03	2.26E-04	1.40E-05	5.09E-03	3.68E-07	2.21E-08	7.6550
					0.01	7.66	52.57	255.99	5.33E-03	2.26E-04	1.40E-05	5.09E-03	3.67E-07	2.22E-08	7.6540
					0.01	7.66	52.52	255.94	5.33E-03	2.27E-04	1.40E-05	5.09E-03	3.66E-07	2.22E-08	7.6530
					0.01	7.66	52.47	255.89	5.33E-03	2.27E-04	1.39E-05	5.09E-03	3.65E-07	2.23E-08	7.6520
					0.01	7.66	52.42	255.84	5.33E-03	2.28E-04	1.39E-05	5.09E-03	3.64E-07	2.23E-08	7.6510
					0.01	7.66	52.36	255.79	5.33E-03	2.28E-04	1.39E-05	5.09E-03	3.64E-07	2.24E-08	7.6500
					0.00	7.66	52.78	256.20	5.33E-03	2.24E-04	1.41E-05	5.10E-03	3.70E-07	2.20E-08	7.6580
					0.00	7.66	52.77	256.19	5.33E-03	2.24E-04	1.41E-05	5.10E-03	3.70E-07	2.20E-08	7.6579
					0.00	7.66	52.77	256.19	5.33E-03	2.24E-04	1.41E-05	5.10E-03	3.70E-07	2.20E-08	7.6578
					0.00	7.66	52.76	256.18	5.33E-03	2.25E-04	1.41E-05	5.10E-03	3.70E-07	2.20E-08	7.6577
					0.00	7.66	52.76	256.18	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6576
					0.00	7.66	52.75	256.17	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6575
					0.00	7.66	52.75	256.17	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6574
					0.00	7.66	52.74	256.16	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6573
					0.00	7.66	52.74	256.16	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6572
					0.00	7.66	52.73	256.15	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6571
					0.00	7.66	52.72	256.15	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.69E-07	2.20E-08	7.6570
					0.00	7.66	52.75	256.17	5.33E-03	2.25E-04	1.41E-05	5.09E-03	3.70E-07	2.20E-08	7.6574

Tk	293
I	0.008675
E	80.094785
A	0.5062483
f(I)	0.0852038
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.9108948
fd	0.6884507
K1p	4.99E-07
K2p	6.10E-11
Kwp	8.14E-15
Ksp	7.44E-09

	Forms of CaCO3 and their solubility product constants			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	**14**	Enter 14 or 18
Ferric sulfate	**9**	Enter 9,5,3 or 0
Ferric Chloride	**0**	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 2b (1): EP001 & EP004

The RTW Model Ver. 4.0 ID: **Blend 2b (1)**

STEP 1: Enter initial water characteristics.

Measured TDS	327.4	mg/L
Measured temperature	20	deg C
Measured pH	7.8	
Measured alk, as CaCO3	262.64	mg/L
Measured Ca, as CaCO3	55.83	mg/L
Measured Cl	43.36	mg/L
Measured SO4	14.52	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	263	mg/L	> 40 mg/L	Interim pH	7.80		6.8-9.3
Interim Ca, as CaCO3	56	mg/L	> 40 mg/L	Precipitation potential	5.69	mg/L	4-10 mg/L
Alk/(Cl+SO4)	4.5		> 5.0	Langelier index	0.18		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	277	mg/L
Initial Ca sat, as CaCO3	37	mg/L
Initial DIC, as CaCO3	540	mg/L

Theoretical interim water characteristics

Interim acidity	277	mg/L
Interim Ca sat, as CaCO3	37	mg/L
Ryznar index	7.43	
Interim DIC, as CaCO3	540	mg/L
Aggressiveness Index	11.97	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	257	mg/L
Final Ca	50	mg/L
Final acidity	277	mg/L
Final pH	7.67	
Final DIC, as CaCO3	534	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.58E-08	1.58E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.40E-03	5.40E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.21E-03	5.21E-03													
[CO3-]	1.99E-05	1.99E-05	-40516.40	14	-0.18	7.62	55.83	262.64	5.40E-03	1.66E-04	1.99E-05	5.21E-03	5.11E-07	1.58E-08	7.8000
[H2CO3*	0.000166	1.66E-04	-4054.44	13	0.80	8.07	22.32	229.13	5.06E-03	4.86E-04	5.23E-06	4.57E-03	1.53E-07	5.29E-08	7.2769
[Ca++]s	3.68E-04	3.68E-04	-406.30	12	9.82	####	0.00	162.27	4.40E-03	1.15E-03	1.11E-06	3.24E-03	4.60E-08	1.76E-07	6.7538
pHs alk		7.62	-23.53	11	10.64	####	0.00	82.34	3.60E-03	1.95E-03	1.69E-07	1.65E-03	1.38E-08	5.88E-07	6.2308
			113.10	10	11.58	####	0.00	31.07	3.08E-03	2.46E-03	1.92E-08	6.23E-04	4.13E-09	1.96E-06	5.7077
			234.50	9	12.59	####	0.00	9.81	2.87E-03	2.67E-03	1.87E-09	2.03E-04	1.24E-09	6.54E-06	5.1846
			269.87	8	13.63	####	0.00	2.02	2.79E-03	2.73E-03	1.72E-10	6.22E-05	3.72E-10	2.18E-05	4.6615
			367.92	7	14.67	####	0.00	-2.70	2.75E-03	2.73E-03	1.55E-11	1.86E-05	1.11E-10	7.27E-05	4.1385
			1320.02	6	15.73	####	0.00	-11.85	2.65E-03	2.65E-03	1.35E-12	5.43E-06	3.34E-11	2.42E-04	3.6154
			10856.06	5	16.83	####	0.00	-40.35	2.37E-03	2.37E-03	1.09E-13	1.45E-06	1.00E-11	8.09E-04	3.0923
			108009.50	4	18.09	####	0.00	-134.80	1.42E-03	1.42E-03	5.88E-15	2.62E-07	3.01E-12	2.70E-03	2.5692
			1258877.41	3	#####	####	0.00	-277.23	1.81E-96	1.81E-96	6.72E-109	1.00E-100	9.01E-13	8.99E-03	2.0462
			30700911.04	2	#####	####	0.00	-277.23	6.04E-96	6.04E-96	2.01E-109	1.00E-100	2.70E-13	3.00E-02	1.5231
			2118456704.18	1	#####	####	0.00	-277.23	2.01E-95	2.01E-95	6.04E-110	1.00E-100	8.10E-14	1.00E-01	1.0000
			269.87	8	-0.18	7.62	55.83	262.64	5.40E-03	1.66E-04	1.99E-05	5.21E-03	5.11E-07	1.58E-08	7.8000
			273.26	7.9	-0.04	7.66	51.40	258.21	5.35E-03	2.06E-04	1.55E-05	5.13E-03	4.06E-07	2.00E-08	7.7000
			277.23	7.8	0.12	7.72	46.20	253.01	5.30E-03	2.55E-04	1.21E-05	5.04E-03	3.23E-07	2.51E-08	7.6000
			281.99	7.7	0.29	7.79	40.08	246.89	5.24E-03	3.13E-04	9.40E-06	4.92E-03	2.56E-07	3.16E-08	7.5000
			287.78	7.6	0.49	7.89	32.87	239.68	5.17E-03	3.83E-04	7.25E-06	4.78E-03	2.04E-07	3.98E-08	7.4000
			294.92	7.5	0.73	8.03	24.45	231.26	5.08E-03	4.65E-04	5.56E-06	4.61E-03	1.62E-07	5.01E-08	7.3000
			303.79	7.4	1.07	8.27	14.70	221.51	4.99E-03	5.62E-04	4.23E-06	4.42E-03	1.28E-07	6.31E-08	7.2000
			314.86	7.3	1.81	8.91	3.57	210.38	4.88E-03	6.72E-04	3.20E-06	4.20E-03	1.02E-07	7.94E-08	7.1000
			328.71	7.2	9.49	####	0.00	197.90	4.75E-03	7.96E-04	2.39E-06	3.95E-03	8.10E-08	1.00E-07	7.0000
			346.09	7.1	9.62	####	0.00	184.16	4.61E-03	9.32E-04	1.77E-06	3.68E-03	6.44E-08	1.26E-07	6.9000
			367.92	7	9.75	####	0.00	169.37	4.47E-03	1.08E-03	1.29E-06	3.38E-03	5.11E-08	1.58E-07	6.8000
			277.23	7.8	-0.04	7.66	51.40	258.21	5.35E-03	2.06E-04	1.55E-05	5.13E-03	4.06E-07	2.00E-08	7.7000
			277.67	7.79	-0.02	7.67	50.92	257.73	5.35E-03	2.11E-04	1.52E-05	5.12E-03	3.97E-07	2.04E-08	7.6900
			278.11	7.78	-0.01	7.67	50.43	257.24	5.34E-03	2.15E-04	1.48E-05	5.11E-03	3.88E-07	2.09E-08	7.6800
			278.56	7.77	0.01	7.68	49.93	256.74	5.34E-03	2.20E-04	1.44E-05	5.11E-03	3.79E-07	2.14E-08	7.6700
			279.03	7.76	0.02	7.68	49.42	256.23	5.33E-03	2.24E-04	1.41E-05	5.10E-03	3.70E-07	2.19E-08	7.6600
			279.50	7.75	0.04	7.69	48.91	255.72	5.33E-03	2.29E-04	1.37E-05	5.09E-03	3.62E-07	2.24E-08	7.6500
			279.98	7.74	0.05	7.69	48.38	255.19	5.32E-03	2.34E-04	1.34E-05	5.08E-03	3.54E-07	2.29E-08	7.6400
			280.46	7.73	0.07	7.70	47.85	254.66	5.32E-03	2.39E-04	1.31E-05	5.07E-03	3.46E-07	2.34E-08	7.6300
			280.96	7.72	0.08	7.70	47.31	254.12	5.31E-03	2.44E-04	1.27E-05	5.06E-03	3.38E-07	2.40E-08	7.6200
			281.47	7.71	0.10	7.71	46.76	253.57	5.31E-03	2.49E-04	1.24E-05	5.05E-03	3.30E-07	2.45E-08	7.6100
			281.99	7.7	0.12	7.72	46.20	253.01	5.30E-03	2.55E-04	1.21E-05	5.04E-03	3.23E-07	2.51E-08	7.6000
					-0.01	7.67	50.43	257.24	5.34E-03	2.15E-04	1.48E-05	5.11E-03	3.88E-07	2.09E-08	7.6800
					-0.01	7.67	50.38	257.19	5.34E-03	2.16E-04	1.48E-05	5.11E-03	3.87E-07	2.09E-08	7.6790
					-0.01	7.67	50.33	257.14	5.34E-03	2.16E-04	1.47E-05	5.11E-03	3.86E-07	2.10E-08	7.6780
					0.00	7.67	50.28	257.09	5.34E-03	2.16E-04	1.47E-05	5.11E-03	3.85E-07	2.10E-08	7.6770
					0.00	7.67	50.23	257.04	5.34E-03	2.17E-04	1.46E-05	5.11E-03	3.84E-07	2.11E-08	7.6760
					0.00	7.67	50.18	256.99	5.34E-03	2.17E-04	1.46E-05	5.11E-03	3.83E-07	2.11E-08	7.6750
					0.00	7.67	50.13	256.94	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.82E-07	2.12E-08	7.6740
					0.00	7.67	50.08	256.89	5.34E-03	2.18E-04	1.45E-05	5.11E-03	3.82E-07	2.12E-08	7.6730
					0.00	7.68	50.03	256.84	5.34E-03	2.19E-04	1.45E-05	5.11E-03	3.81E-07	2.13E-08	7.6720
					0.00	7.68	49.98	256.79	5.34E-03	2.19E-04	1.45E-05	5.11E-03	3.80E-07	2.13E-08	7.6710
					0.01	7.68	49.93	256.74	5.34E-03	2.20E-04	1.44E-05	5.11E-03	3.79E-07	2.14E-08	7.6700
					0.00	7.67	50.18	256.99	5.34E-03	2.17E-04	1.46E-05	5.11E-03	3.83E-07	2.11E-08	7.6750
					0.00	7.67	50.18	256.99	5.34E-03	2.17E-04	1.46E-05	5.11E-03	3.83E-07	2.11E-08	7.6749
					0.00	7.67	50.17	256.98	5.34E-03	2.17E-04	1.46E-05	5.11E-03	3.83E-07	2.11E-08	7.6748
					0.00	7.67	50.17	256.98	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.11E-08	7.6747
					0.00	7.67	50.16	256.97	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6746
					0.00	7.67	50.16	256.97	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6745
					0.00	7.67	50.15	256.96	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6744
					0.00	7.67	50.15	256.96	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6743
					0.00	7.67	50.14	256.95	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6742
					0.00	7.67	50.14	256.95	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6741
					0.00	7.67	50.13	256.94	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.82E-07	2.12E-08	7.6740
					0.00	7.67	50.14	256.95	5.34E-03	2.18E-04	1.46E-05	5.11E-03	3.83E-07	2.12E-08	7.6742

Tk	293
I	0.00819
E	80.0948
A	0.50625
f(I)	0.08297
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.91297
fd	0.69473
K1p	4.97E-07
K2p	6.04E-11
Kwp	8.10E-15
Ksp	7.31E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 2b (2): EP001 & EP004

The RTW Model Ver. 4.0 ID: **Blend 2b (2)**

STEP 1: Enter initial water characteristics.

Measured TDS	326.5	mg/L
Measured temperature	20	deg C
Measured pH	7.8	
Measured alk, as CaCO3	268.4	mg/L
Measured Ca, as CaCO3	63.3	mg/L
Measured Cl	42.1	mg/L
Measured SO4	14.7	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	268	mg/L	> 40 mg/L	Interim pH	7.80		6.8-9.3
Interim Ca, as CaCO3	63	mg/L	> 40 mg/L	Precipitation potential	8.26	mg/L	4-10 mg/L
Alk/(Cl+SO4)	4.7		> 5.0	Langelier index	0.25		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	283	mg/L
Initial Ca sat, as CaCO3	36	mg/L
Initial DIC, as CaCO3	552	mg/L

Theoretical interim water characteristics

Interim acidity	283	mg/L
Interim Ca sat, as CaCO3	36	mg/L
Ryznar index	7.30	
Interim DIC, as CaCO3	552	mg/L
Aggressiveness Index	12.03	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	260	mg/L
Final Ca	55	mg/L
Final acidity	283	mg/L
Final pH	7.63	
Final DIC, as CaCO3	543	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.58E-08	1.58E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.52E-03	5.52E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.33E-03	5.33E-03													
[CO3-]	2.03E-05	2.03E-05	-40507.78	14	-0.25	7.55	63.30	268.40	5.52E-03	1.70E-04	2.03E-05	5.33E-03	5.11E-07	1.58E-08	7.8000
[H2CO3*	0.00017	1.70E-04	-4053.57	13	0.67	7.95	29.05	234.15	5.17E-03	4.97E-04	5.34E-06	4.67E-03	1.53E-07	5.29E-08	7.2769
[Ca++]s	3.60E-04	3.60E-04	-406.17	12	9.81	####	0.00	165.82	4.49E-03	1.18E-03	1.14E-06	3.31E-03	4.60E-08	1.76E-07	6.7538
pHs alk		7.55	-23.08	11	10.63	####	0.00	84.13	3.67E-03	1.99E-03	1.73E-07	1.68E-03	1.38E-08	5.88E-07	6.2308
			115.74	10	11.57	####	0.00	31.75	3.15E-03	2.51E-03	1.96E-08	6.37E-04	4.13E-09	1.96E-06	5.7077
			239.67	9	12.58	####	0.00	10.03	2.93E-03	2.73E-03	1.91E-09	2.07E-04	1.24E-09	6.54E-06	5.1846
			275.79	8	13.62	####	0.00	2.09	2.85E-03	2.79E-03	1.76E-10	6.36E-05	3.72E-10	2.18E-05	4.6615
			376.01	7	14.66	####	0.00	-2.68	2.81E-03	2.79E-03	1.58E-11	1.90E-05	1.11E-10	7.27E-05	4.1385
			1349.20	6	15.72	####	0.00	-11.84	2.71E-03	2.71E-03	1.38E-12	5.55E-06	3.34E-11	2.42E-04	3.6154
			11095.99	5	16.82	####	0.00	-40.35	2.43E-03	2.43E-03	1.11E-13	1.49E-06	1.00E-11	8.09E-04	3.0923
			110357.35	4	18.08	####	0.00	-134.80	1.49E-03	1.48E-03	6.13E-15	2.74E-07	3.00E-12	2.70E-03	2.5692
			1282342.63	3	#####	####	0.00	-283.32	1.81E-96	1.81E-96	6.72E-109	1.00E-100	9.01E-13	8.99E-03	2.0462
			30939368.58	2	#####	####	0.00	-283.32	6.04E-96	6.04E-96	2.01E-109	1.00E-100	2.70E-13	3.00E-02	1.5231
			2121226936.30	1	#####	####	0.00	-283.32	2.01E-95	2.01E-95	6.04E-110	1.00E-100	8.10E-14	1.00E-01	1.0000
			275.79	8	-0.25	7.55	63.30	268.40	5.52E-03	1.70E-04	2.03E-05	5.33E-03	5.11E-07	1.58E-08	7.8000
			279.26	7.9	-0.11	7.59	58.77	263.87	5.47E-03	2.11E-04	1.59E-05	5.25E-03	4.06E-07	2.00E-08	7.7000
			283.32	7.8	0.04	7.64	53.46	258.56	5.42E-03	2.60E-04	1.24E-05	5.15E-03	3.23E-07	2.51E-08	7.6000
			288.18	7.7	0.21	7.71	47.20	252.30	5.36E-03	3.20E-04	9.60E-06	5.03E-03	2.56E-07	3.16E-08	7.5000
			294.10	7.6	0.39	7.79	39.83	244.93	5.28E-03	3.91E-04	7.41E-06	4.88E-03	2.03E-07	3.98E-08	7.4000
			301.40	7.5	0.61	7.91	31.22	236.32	5.20E-03	4.76E-04	5.68E-06	4.71E-03	1.62E-07	5.01E-08	7.3000
			310.46	7.4	0.90	8.10	21.26	226.36	5.10E-03	5.74E-04	4.32E-06	4.52E-03	1.28E-07	6.31E-08	7.2000
			321.77	7.3	1.35	8.45	9.89	214.99	4.98E-03	6.87E-04	3.26E-06	4.29E-03	1.02E-07	7.94E-08	7.1000
			335.93	7.2	9.48	####	0.00	202.23	4.86E-03	8.13E-04	2.44E-06	4.04E-03	8.10E-08	1.00E-07	7.0000
			353.70	7.1	9.61	####	0.00	188.19	4.72E-03	9.53E-04	1.80E-06	3.76E-03	6.43E-08	1.26E-07	6.9000
			376.01	7	9.74	####	0.00	173.08	4.56E-03	1.10E-03	1.32E-06	3.46E-03	5.11E-08	1.58E-07	6.8000
			283.32	7.8	-0.11	7.59	58.77	263.87	5.47E-03	2.11E-04	1.59E-05	5.25E-03	4.06E-07	2.00E-08	7.7000
			283.76	7.79	-0.09	7.60	58.28	263.38	5.47E-03	2.15E-04	1.55E-05	5.24E-03	3.97E-07	2.04E-08	7.6900
			284.22	7.78	-0.08	7.60	57.78	262.88	5.46E-03	2.20E-04	1.51E-05	5.23E-03	3.88E-07	2.09E-08	7.6800
			284.68	7.77	-0.06	7.61	57.27	262.37	5.46E-03	2.25E-04	1.47E-05	5.22E-03	3.79E-07	2.14E-08	7.6700
			285.15	7.76	-0.05	7.61	56.75	261.85	5.45E-03	2.29E-04	1.44E-05	5.21E-03	3.70E-07	2.19E-08	7.6600
			285.63	7.75	-0.03	7.62	56.23	261.33	5.45E-03	2.34E-04	1.40E-05	5.20E-03	3.62E-07	2.24E-08	7.6500
			286.12	7.74	-0.02	7.62	55.69	260.79	5.44E-03	2.39E-04	1.37E-05	5.19E-03	3.54E-07	2.29E-08	7.6400
			286.62	7.73	0.00	7.63	55.15	260.25	5.44E-03	2.44E-04	1.33E-05	5.18E-03	3.46E-07	2.34E-08	7.6300
			287.13	7.72	0.01	7.63	54.59	259.69	5.43E-03	2.50E-04	1.30E-05	5.17E-03	3.38E-07	2.40E-08	7.6200
			287.65	7.71	0.03	7.64	54.03	259.13	5.42E-03	2.55E-04	1.27E-05	5.16E-03	3.30E-07	2.45E-08	7.6100
			288.18	7.7	0.04	7.64	53.46	258.56	5.42E-03	2.60E-04	1.24E-05	5.15E-03	3.23E-07	2.51E-08	7.6000
					0.00	7.63	55.15	260.25	5.44E-03	2.44E-04	1.33E-05	5.18E-03	3.46E-07	2.34E-08	7.6300
					0.00	7.63	55.09	260.19	5.44E-03	2.45E-04	1.33E-05	5.18E-03	3.45E-07	2.35E-08	7.6290
					0.00	7.63	55.04	260.14	5.43E-03	2.45E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6280
					0.00	7.63	54.98	260.08	5.43E-03	2.46E-04	1.32E-05	5.17E-03	3.43E-07	2.36E-08	7.6270
					0.00	7.63	54.93	260.03	5.43E-03	2.46E-04	1.32E-05	5.17E-03	3.42E-07	2.37E-08	7.6260
					0.00	7.63	54.87	259.97	5.43E-03	2.47E-04	1.32E-05	5.17E-03	3.42E-07	2.37E-08	7.6250
					0.01	7.63	54.82	259.92	5.43E-03	2.47E-04	1.31E-05	5.17E-03	3.41E-07	2.38E-08	7.6240
					0.01	7.63	54.76	259.86	5.43E-03	2.48E-04	1.31E-05	5.17E-03	3.40E-07	2.38E-08	7.6230
					0.01	7.63	54.71	259.81	5.43E-03	2.49E-04	1.31E-05	5.17E-03	3.39E-07	2.39E-08	7.6220
					0.01	7.63	54.65	259.75	5.43E-03	2.49E-04	1.30E-05	5.17E-03	3.38E-07	2.39E-08	7.6210
					0.01	7.63	54.59	259.69	5.43E-03	2.50E-04	1.30E-05	5.17E-03	3.38E-07	2.40E-08	7.6200
					0.00	7.63	55.04	260.14	5.43E-03	2.45E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6280
					0.00	7.63	55.03	260.13	5.43E-03	2.45E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6279
					0.00	7.63	55.03	260.13	5.43E-03	2.45E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6278
					0.00	7.63	55.02	260.12	5.43E-03	2.46E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6277
					0.00	7.63	55.02	260.12	5.43E-03	2.46E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6276
					0.00	7.63	55.01	260.11	5.43E-03	2.46E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6275
					0.00	7.63	55.00	260.10	5.43E-03	2.46E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6274
					0.00	7.63	55.00	260.10	5.43E-03	2.46E-04	1.32E-05	5.18E-03	3.43E-07	2.36E-08	7.6273
					0.00	7.63	54.99	260.09	5.43E-03	2.46E-04	1.32E-05	5.18E-03	3.43E-07	2.36E-08	7.6272
					0.00	7.63	54.99	260.09	5.43E-03	2.46E-04	1.32E-05	5.17E-03	3.43E-07	2.36E-08	7.6271
					0.00	7.63	54.98	260.08	5.43E-03	2.46E-04	1.32E-05	5.17E-03	3.43E-07	2.36E-08	7.6270
					0.00	7.63	55.04	260.14	5.43E-03	2.45E-04	1.33E-05	5.18E-03	3.44E-07	2.36E-08	7.6280

Tk	293
I	0.00816
E	80.0948
A	0.50625
f(I)	0.08286
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.91306
fd	0.69503
K1p	4.97E-07
K2p	6.04E-11
Kwp	8.10E-15
Ksp	7.30E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 2c: EP005 & EP003

The RTW Model Ver. 4.0 ID: **Blend 2c**

STEP 1: Enter initial water characteristics.

Measured TDS	412.45	mg/L
Measured temperature	20	deg C
Measured pH	8	
Measured alk, as CaCO3	268.45	mg/L
Measured Ca, as CaCO3	49.377	mg/L
Measured Cl	91.134	mg/L
Measured SO4	13.437	mg/L

For CT and TTHM functions enter current:

Treated water pH	8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	268	mg/L	> 40 mg/L	Interim pH	8.00		6.8-9.3
Interim Ca, as CaCO3	49	mg/L	> 40 mg/L	Precipitation potential	8.24	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.6		> 5.0	Langelier index	0.32		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	276	mg/L
Initial Ca sat, as CaCO3	24	mg/L
Initial DIC, as CaCO3	544	mg/L

Theoretical interim water characteristics

Interim acidity	276	mg/L
Interim Ca sat, as CaCO3	24	mg/L
Ryznar index	7.35	
Interim DIC, as CaCO3	544	mg/L
Aggressiveness Index	12.12	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	260	mg/L
Final Ca	41	mg/L
Final acidity	276	mg/L
Final pH	7.77	
Final DIC, as CaCO3	536	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim														
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final	
{H+}	1.00E-08	1.00E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH	
[DIC]	5.44E-03	5.44E-03					mg CaCO3/L	mg CaCO3/L								
[HCO3-]	5.30E-03	5.30E-03														
[CO3-]	3.32E-05	3.32E-05	-41275.09	14	-0.32	7.68	49.38	268.45	5.44E-03	1.05E-04	3.32E-05	5.30E-03	8.25E-07	1.00E-08	8.0000	
[H2CO3*	0.000105	1.05E-04	-4130.26	13	0.57	8.03	24.25	243.32	5.19E-03	3.31E-04	8.80E-06	4.85E-03	2.39E-07	3.46E-08	7.4615	
[Ca++]s	2.37E-04	2.37E-04	-413.86	12	9.60	####	0.00	187.40	4.63E-03	8.83E-04	1.97E-06	3.74E-03	6.91E-08	1.19E-07	6.9231	
pHs alk		7.68	-24.49	11	10.39	####	0.00	104.77	3.80E-03	1.71E-03	3.18E-07	2.10E-03	2.00E-08	4.12E-07	6.3846	
			113.19	10	11.33	####	0.00	41.47	3.17E-03	2.34E-03	3.65E-08	8.31E-04	5.79E-09	1.43E-06	5.8462	
			238.70	9	12.36	####	0.00	13.21	2.89E-03	2.62E-03	3.43E-09	2.69E-04	1.68E-09	4.92E-06	5.3077	
			275.51	8	13.42	####	0.00	3.18	2.79E-03	2.71E-03	2.97E-10	8.05E-05	4.85E-10	1.70E-05	4.7692	
			374.05	7	14.50	####	0.00	-1.77	2.74E-03	2.71E-03	2.49E-11	2.34E-05	1.40E-10	5.88E-05	4.2308	
			1329.32	6	15.59	####	0.00	-9.82	2.66E-03	2.65E-03	2.04E-12	6.61E-06	4.06E-11	2.03E-04	3.6923	
			10896.54	5	16.71	####	0.00	-35.00	2.41E-03	2.40E-03	1.55E-13	1.73E-06	1.18E-11	7.02E-04	3.1538	
			108328.82	4	17.98	####	0.00	-121.21	1.54E-03	1.54E-03	8.33E-15	3.22E-07	3.40E-12	2.42E-03	2.6154	
			1258688.22	3	#####	####	0.00	-275.51	1.66E-96	1.66E-96	7.48E-109	1.00E-100	9.85E-13	8.38E-03	2.0769	
			30365949.08	2	#####	####	0.00	-275.51	5.72E-96	5.72E-96	2.17E-109	1.00E-100	2.85E-13	2.89E-02	1.5385	
			2081805242.65	1	#####	####	0.00	-275.51	1.98E-95	1.98E-95	6.27E-110	1.00E-100	8.25E-14	1.00E-01	1.0000	
			275.51	8	-0.32	7.68	49.38	268.45	5.44E-03	1.05E-04	3.32E-05	5.30E-03	8.25E-07	1.00E-08	8.0000	
			278.96	7.9	-0.18	7.72	46.07	265.14	5.41E-03	1.31E-04	2.61E-05	5.25E-03	6.56E-07	1.26E-08	7.9000	
			282.97	7.8	-0.04	7.76	42.31	261.38	5.37E-03	1.62E-04	2.05E-05	5.19E-03	5.21E-07	1.58E-08	7.8000	
			287.76	7.7	0.11	7.81	37.95	257.02	5.33E-03	2.01E-04	1.61E-05	5.11E-03	4.14E-07	2.00E-08	7.7000	
			293.59	7.6	0.28	7.88	32.85	251.92	5.27E-03	2.49E-04	1.25E-05	5.01E-03	3.29E-07	2.51E-08	7.6000	
			300.77	7.5	0.48	7.98	26.84	245.90	5.21E-03	3.06E-04	9.71E-06	4.90E-03	2.61E-07	3.16E-08	7.5000	
			309.68	7.4	0.73	8.13	19.76	238.83	5.14E-03	3.75E-04	7.50E-06	4.76E-03	2.07E-07	3.98E-08	7.4000	
			320.79	7.3	1.08	8.38	11.49	230.56	5.06E-03	4.55E-04	5.75E-06	4.60E-03	1.65E-07	5.01E-08	7.3000	
			334.70	7.2	1.97	9.17	1.91	220.98	4.96E-03	5.50E-04	4.38E-06	4.41E-03	1.31E-07	6.31E-08	7.2000	
			352.15	7.1	9.38	####	0.00	210.03	4.86E-03	6.58E-04	3.31E-06	4.19E-03	1.04E-07	7.94E-08	7.1000	
			374.05	7	9.50	####	0.00	197.73	4.73E-03	7.80E-04	2.48E-06	3.95E-03	8.25E-08	1.00E-07	7.0000	
			275.51	8	-0.04	7.76	42.31	261.38	5.37E-03	1.62E-04	2.05E-05	5.19E-03	5.21E-07	1.58E-08	7.8000	
			275.84	7.99	-0.03	7.76	41.90	260.97	5.36E-03	1.66E-04	2.00E-05	5.18E-03	5.09E-07	1.62E-08	7.7900	
			276.17	7.98	-0.01	7.77	41.49	260.56	5.36E-03	1.70E-04	1.95E-05	5.17E-03	4.97E-07	1.66E-08	7.7800	
			276.50	7.97	0.00	7.77	41.07	260.14	5.36E-03	1.73E-04	1.91E-05	5.16E-03	4.86E-07	1.70E-08	7.7700	
			276.83	7.96	0.02	7.78	40.65	259.72	5.35E-03	1.77E-04	1.86E-05	5.16E-03	4.75E-07	1.74E-08	7.7600	
			277.18	7.95	0.03	7.78	40.22	259.28	5.35E-03	1.81E-04	1.82E-05	5.15E-03	4.64E-07	1.78E-08	7.7500	
			277.52	7.94	0.05	7.79	39.78	258.85	5.34E-03	1.85E-04	1.77E-05	5.14E-03	4.54E-07	1.82E-08	7.7400	
			277.87	7.93	0.06	7.79	39.33	258.40	5.34E-03	1.89E-04	1.73E-05	5.13E-03	4.43E-07	1.86E-08	7.7300	
			278.23	7.92	0.08	7.80	38.88	257.95	5.33E-03	1.93E-04	1.69E-05	5.12E-03	4.33E-07	1.91E-08	7.7200	
			278.59	7.91	0.10	7.81	38.42	257.49	5.33E-03	1.97E-04	1.65E-05	5.12E-03	4.23E-07	1.95E-08	7.7100	
			278.96	7.9	0.11	7.81	37.95	257.02	5.33E-03	2.01E-04	1.61E-05	5.11E-03	4.14E-07	2.00E-08	7.7000	
					-0.01	7.77	41.49	260.56	5.36E-03	1.70E-04	1.95E-05	5.17E-03	4.97E-07	1.66E-08	7.7800	
					-0.01	7.77	41.45	260.52	5.36E-03	1.70E-04	1.95E-05	5.17E-03	4.96E-07	1.66E-08	7.7790	
					-0.01	7.77	41.41	260.48	5.36E-03	1.70E-04	1.94E-05	5.17E-03	4.95E-07	1.67E-08	7.7780	
					-0.01	7.77	41.37	260.43	5.36E-03	1.71E-04	1.94E-05	5.17E-03	4.94E-07	1.67E-08	7.7770	
					-0.01	7.77	41.32	260.39	5.36E-03	1.71E-04	1.93E-05	5.17E-03	4.93E-07	1.67E-08	7.7760	
					-0.01	7.77	41.28	260.35	5.36E-03	1.71E-04	1.93E-05	5.17E-03	4.92E-07	1.68E-08	7.7750	
					0.00	7.77	41.24	260.31	5.36E-03	1.72E-04	1.93E-05	5.17E-03	4.91E-07	1.68E-08	7.7740	
					0.00	7.77	41.20	260.27	5.36E-03	1.72E-04	1.92E-05	5.17E-03	4.89E-07	1.69E-08	7.7730	
					0.00	7.77	41.16	260.23	5.36E-03	1.73E-04	1.92E-05	5.17E-03	4.88E-07	1.69E-08	7.7720	
					0.00	7.77	41.11	260.18	5.36E-03	1.73E-04	1.91E-05	5.16E-03	4.87E-07	1.69E-08	7.7710	
					0.00	7.77	41.07	260.14	5.36E-03	1.73E-04	1.91E-05	5.16E-03	4.86E-07	1.70E-08	7.7700	
					0.00	7.77	41.16	260.23	5.36E-03	1.73E-04	1.92E-05	5.17E-03	4.88E-07	1.69E-08	7.7720	
					0.00	7.77	41.15	260.22	5.36E-03	1.73E-04	1.92E-05	5.17E-03	4.88E-07	1.69E-08	7.7719	
					0.00	7.77	41.15	260.22	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7718	
					0.00	7.77	41.14	260.21	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7717	
					0.00	7.77	41.14	260.21	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7716	
					0.00	7.77	41.14	260.20	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7715	
					0.00	7.77	41.13	260.20	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7714	
					0.00	7.77	41.13	260.20	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7713	
					0.00	7.77	41.12	260.19	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.87E-07	1.69E-08	7.7712	
					0.00	7.77	41.12	260.19	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.87E-07	1.69E-08	7.7711	
					0.00	7.77	41.11	260.18	5.36E-03	1.73E-04	1.91E-05	5.16E-03	4.87E-07	1.69E-08	7.7710	
					0.00	7.77	41.14	260.20	5.36E-03	1.73E-04	1.91E-05	5.17E-03	4.88E-07	1.69E-08	7.7715	

Tk	293
I	0.01031
E	80.0948
A	0.50625
f(I)	0.09218
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90454
fd	0.66942
K1p	5.06E-07
K2p	6.27E-11
Kwp	8.25E-15
Ksp	7.87E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 2d (1): EP005 & EP004

The RTW Model Ver. 4.0 ID: **Blend 2d (1)**

STEP 1: Enter initial water characteristics.

Measured TDS	403.7	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	270.12	mg/L
Measured Ca, as CaCO3	46.143	mg/L
Measured Cl	86.53	mg/L
Measured SO4	13.33	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	270	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	46	mg/L	> 40 mg/L	Precipitation potential	5.29	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.7		> 5.0	Langelier index	0.20		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	281	mg/L
Initial Ca sat, as CaCO3	29	mg/L
Initial DIC, as CaCO3	551	mg/L

Theoretical interim water characteristics

Interim acidity	281	mg/L
Interim Ca sat, as CaCO3	29	mg/L
Ryznar index	7.50	
Interim DIC, as CaCO3	551	mg/L
Aggressiveness Index	12.00	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	265	mg/L
Final Ca	41	mg/L
Final acidity	281	mg/L
Final pH	7.77	
Final DIC, as CaCO3	546	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.51E-03	5.51E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.35E-03	5.35E-03													
[CO3-]	2.65E-05	2.65E-05	-41201.64	14	-0.20	7.70	46.14	270.12	5.51E-03	1.33E-04	2.65E-05	5.35E-03	6.55E-07	1.26E-08	7.9000
[H2CO3*	0.000133	1.33E-04	-4122.91	13	0.82	8.19	16.85	240.83	5.22E-03	4.06E-04	7.02E-06	4.80E-03	1.93E-07	4.27E-08	7.3692
[Ca++]s	2.94E-04	2.94E-04	-413.11	12	9.71	####	0.00	178.48	4.59E-03	1.02E-03	1.54E-06	3.57E-03	5.68E-08	1.45E-07	6.8385
pHs alk		7.70	-24.23	11	10.51	####	0.00	95.18	3.76E-03	1.86E-03	2.42E-07	1.90E-03	1.67E-08	4.92E-07	6.3077
			114.18	10	11.45	####	0.00	36.77	3.17E-03	2.44E-03	2.75E-08	7.37E-04	4.93E-09	1.67E-06	5.7769
			240.29	9	12.47	####	0.00	11.67	2.92E-03	2.68E-03	2.63E-09	2.39E-04	1.45E-09	5.67E-06	5.2462
			277.26	8	13.52	####	0.00	2.66	2.83E-03	2.76E-03	2.35E-10	7.24E-05	4.28E-10	1.93E-05	4.7154
			376.58	7	14.58	####	0.00	-2.20	2.79E-03	2.76E-03	2.04E-11	2.14E-05	1.26E-10	6.54E-05	4.1846
			1339.51	6	15.66	####	0.00	-10.79	2.70E-03	2.69E-03	1.73E-12	6.13E-06	3.71E-11	2.22E-04	3.6538
			10983.43	5	16.76	####	0.00	-37.58	2.43E-03	2.43E-03	1.35E-13	1.63E-06	1.09E-11	7.53E-04	3.1231
			109185.84	4	18.02	####	0.00	-127.82	1.53E-03	1.53E-03	7.38E-15	3.02E-07	3.22E-12	2.56E-03	2.5923
			1267560.36	3	#####	####	0.00	-280.73	1.72E-96	1.72E-96	7.20E-109	1.00E-100	9.49E-13	8.68E-03	2.0615
			30486358.78	2	#####	####	0.00	-280.73	5.83E-96	5.83E-96	2.12E-109	1.00E-100	2.80E-13	2.95E-02	1.5308
			2086179662.62	1	#####	####	0.00	-280.73	1.98E-95	1.98E-95	6.25E-110	1.00E-100	8.24E-14	1.00E-01	1.0000
			277.26	8	-0.20	7.70	46.14	270.12	5.51E-03	1.33E-04	2.65E-05	5.35E-03	6.55E-07	1.26E-08	7.9000
			280.73	7.9	-0.05	7.75	42.31	266.29	5.47E-03	1.66E-04	2.08E-05	5.28E-03	5.20E-07	1.58E-08	7.8000
			284.77	7.8	0.10	7.80	37.87	261.85	5.43E-03	2.06E-04	1.63E-05	5.20E-03	4.13E-07	2.00E-08	7.7000
			289.60	7.7	0.28	7.88	32.66	256.64	5.37E-03	2.54E-04	1.27E-05	5.11E-03	3.28E-07	2.51E-08	7.6000
			295.48	7.6	0.48	7.98	26.53	250.50	5.31E-03	3.12E-04	9.86E-06	4.99E-03	2.61E-07	3.16E-08	7.5000
			302.71	7.5	0.73	8.13	19.31	243.29	5.24E-03	3.82E-04	7.61E-06	4.85E-03	2.07E-07	3.98E-08	7.4000
			311.69	7.4	1.09	8.39	10.87	234.85	5.16E-03	4.65E-04	5.84E-06	4.69E-03	1.64E-07	5.01E-08	7.3000
			322.89	7.3	2.20	9.40	1.10	225.08	5.06E-03	5.61E-04	4.45E-06	4.49E-03	1.31E-07	6.31E-08	7.2000
			336.91	7.2	9.37	####	0.00	213.91	4.95E-03	6.72E-04	3.36E-06	4.27E-03	1.04E-07	7.94E-08	7.1000
			354.49	7.1	9.49	####	0.00	201.37	4.82E-03	7.96E-04	2.51E-06	4.02E-03	8.24E-08	1.00E-07	7.0000
			376.58	7	9.62	####	0.00	187.54	4.68E-03	9.34E-04	1.86E-06	3.75E-03	6.55E-08	1.26E-07	6.9000
			280.73	7.9	-0.05	7.75	42.31	266.29	5.47E-03	1.66E-04	2.08E-05	5.28E-03	5.20E-07	1.58E-08	7.8000
			281.10	7.89	-0.04	7.75	41.90	265.87	5.47E-03	1.69E-04	2.03E-05	5.28E-03	5.08E-07	1.62E-08	7.7900
			281.48	7.88	-0.02	7.76	41.48	265.45	5.46E-03	1.73E-04	1.98E-05	5.27E-03	4.96E-07	1.66E-08	7.7800
			281.87	7.87	-0.01	7.76	41.05	265.03	5.46E-03	1.77E-04	1.94E-05	5.26E-03	4.85E-07	1.70E-08	7.7700
			282.26	7.86	0.01	7.77	40.62	264.59	5.45E-03	1.81E-04	1.89E-05	5.25E-03	4.74E-07	1.74E-08	7.7600
			282.66	7.85	0.02	7.77	40.18	264.15	5.45E-03	1.85E-04	1.84E-05	5.25E-03	4.63E-07	1.78E-08	7.7500
			283.07	7.84	0.04	7.78	39.73	263.71	5.44E-03	1.89E-04	1.80E-05	5.24E-03	4.53E-07	1.82E-08	7.7400
			283.48	7.83	0.05	7.78	39.27	263.25	5.44E-03	1.93E-04	1.75E-05	5.23E-03	4.42E-07	1.86E-08	7.7300
			283.91	7.82	0.07	7.79	38.81	262.79	5.44E-03	1.97E-04	1.71E-05	5.22E-03	4.32E-07	1.91E-08	7.7200
			284.33	7.81	0.09	7.80	38.35	262.32	5.43E-03	2.01E-04	1.67E-05	5.21E-03	4.23E-07	1.95E-08	7.7100
			284.77	7.8	0.10	7.80	37.87	261.85	5.43E-03	2.06E-04	1.63E-05	5.20E-03	4.13E-07	2.00E-08	7.7000
					-0.01	7.76	41.05	265.03	5.46E-03	1.77E-04	1.94E-05	5.26E-03	4.85E-07	1.70E-08	7.7700
					-0.01	7.76	41.01	264.98	5.46E-03	1.77E-04	1.93E-05	5.26E-03	4.84E-07	1.70E-08	7.7690
					0.00	7.76	40.96	264.94	5.46E-03	1.78E-04	1.93E-05	5.26E-03	4.83E-07	1.71E-08	7.7680
					0.00	7.76	40.92	264.90	5.46E-03	1.78E-04	1.92E-05	5.26E-03	4.82E-07	1.71E-08	7.7670
					0.00	7.76	40.88	264.85	5.46E-03	1.78E-04	1.92E-05	5.26E-03	4.81E-07	1.71E-08	7.7660
					0.00	7.77	40.83	264.81	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7650
					0.00	7.77	40.79	264.77	5.45E-03	1.79E-04	1.91E-05	5.26E-03	4.79E-07	1.72E-08	7.7640
					0.00	7.77	40.75	264.72	5.45E-03	1.80E-04	1.90E-05	5.26E-03	4.77E-07	1.73E-08	7.7630
					0.01	7.77	40.70	264.68	5.45E-03	1.80E-04	1.90E-05	5.26E-03	4.76E-07	1.73E-08	7.7620
					0.01	7.77	40.66	264.64	5.45E-03	1.80E-04	1.89E-05	5.25E-03	4.75E-07	1.73E-08	7.7610
					0.01	7.77	40.62	264.59	5.45E-03	1.81E-04	1.89E-05	5.25E-03	4.74E-07	1.74E-08	7.7600
					0.00	7.76	40.88	264.85	5.46E-03	1.78E-04	1.92E-05	5.26E-03	4.81E-07	1.71E-08	7.7660
					0.00	7.76	40.87	264.85	5.46E-03	1.78E-04	1.92E-05	5.26E-03	4.81E-07	1.71E-08	7.7659
					0.00	7.77	40.87	264.85	5.46E-03	1.78E-04	1.92E-05	5.26E-03	4.81E-07	1.71E-08	7.7658
					0.00	7.77	40.86	264.84	5.46E-03	1.78E-04	1.92E-05	5.26E-03	4.80E-07	1.72E-08	7.7657
					0.00	7.77	40.86	264.84	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7656
					0.00	7.77	40.85	264.83	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7655
					0.00	7.77	40.85	264.83	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7654
					0.00	7.77	40.85	264.82	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7653
					0.00	7.77	40.84	264.82	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7652
					0.00	7.77	40.84	264.82	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7651
					0.00	7.77	40.83	264.81	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7650
					0.00	7.77	40.85	264.83	5.46E-03	1.79E-04	1.91E-05	5.26E-03	4.80E-07	1.72E-08	7.7654

Tk	293
I	0.01009
E	80.0948
A	0.50625
f(I)	0.09129
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90534
fd	0.67181
K1p	5.05E-07
K2p	6.25E-11
Kwp	8.24E-15
Ksp	7.82E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 2d (2): EP005 & EP004

The RTW Model Ver. 4.0 ID: **Blend 2d (2)**

STEP 1: Enter initial water characteristics.

Measured TDS	386.08	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	264.35	mg/L
Measured Ca, as CaCO3	43.299	mg/L
Measured Cl	77.078	mg/L
Measured SO4	13.49	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	264	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	43	mg/L	> 40 mg/L	Precipitation potential	4.20	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.9		> 5.0	Langelier index	0.17		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	275	mg/L
Initial Ca sat, as CaCO3	30	mg/L
Initial DIC, as CaCO3	539	mg/L

Theoretical interim water characteristics

Interim acidity	275	mg/L
Interim Ca sat, as CaCO3	30	mg/L
Ryznar index	7.57	
Interim DIC, as CaCO3	539	mg/L
Aggressiveness Index	11.96	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	260	mg/L
Final Ca	39	mg/L
Final acidity	275	mg/L
Final pH	7.79	
Final DIC, as CaCO3	535	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.39E-03	5.39E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.23E-03	5.23E-03													
[CO3-]	2.58E-05	2.58E-05	-41050.81	14	-0.16	7.74	43.30	264.35	5.39E-03	1.31E-04	2.58E-05	5.23E-03	6.52E-07	1.26E-08	7.9000
[H2CO3*	0.000131	1.31E-04	-4107.85	13	0.89	8.26	14.56	235.61	5.10E-03	3.99E-04	6.82E-06	4.70E-03	1.92E-07	4.27E-08	7.3692
[Ca++]s	2.99E-04	2.99E-04	-411.64	12	9.71	####	0.00	174.47	4.49E-03	1.00E-03	1.49E-06	3.49E-03	5.66E-08	1.45E-07	6.8385
pHs alk		7.73	-24.39	11	10.52	####	0.00	92.95	3.68E-03	1.82E-03	2.34E-07	1.86E-03	1.67E-08	4.92E-07	6.3077
			112.11	10	11.46	####	0.00	35.88	3.11E-03	2.39E-03	2.67E-08	7.19E-04	4.91E-09	1.67E-06	5.7769
			235.34	9	12.48	####	0.00	11.38	2.86E-03	2.63E-03	2.55E-09	2.33E-04	1.45E-09	5.67E-06	5.2462
			271.41	8	13.53	####	0.00	2.57	2.77E-03	2.70E-03	2.28E-10	7.07E-05	4.26E-10	1.93E-05	4.7154
			368.93	7	14.59	####	0.00	-2.23	2.73E-03	2.70E-03	1.98E-11	2.08E-05	1.26E-10	6.54E-05	4.1846
			1314.77	6	15.66	####	0.00	-10.80	2.64E-03	2.63E-03	1.67E-12	5.98E-06	3.70E-11	2.22E-04	3.6538
			10787.91	5	16.77	####	0.00	-37.58	2.37E-03	2.37E-03	1.30E-13	1.58E-06	1.09E-11	7.53E-04	3.1231
			107289.01	4	18.04	####	0.00	-127.82	1.47E-03	1.47E-03	7.02E-15	2.89E-07	3.21E-12	2.56E-03	2.5923
			1249298.57	3	#####	####	0.00	-274.80	1.72E-96	1.72E-96	7.15E-109	1.00E-100	9.46E-13	8.68E-03	2.0615
			30369252.96	2	#####	####	0.00	-274.80	5.85E-96	5.85E-96	2.11E-109	1.00E-100	2.79E-13	2.95E-02	1.5308
			2091554671.41	1	#####	####	0.00	-274.80	1.99E-95	1.99E-95	6.20E-110	1.00E-100	8.21E-14	1.00E-01	1.0000
			271.41	8	-0.16	7.74	43.30	264.35	5.39E-03	1.31E-04	2.58E-05	5.23E-03	6.52E-07	1.26E-08	7.9000
			274.80	7.9	-0.02	7.78	39.54	260.60	5.35E-03	1.63E-04	2.02E-05	5.17E-03	5.18E-07	1.58E-08	7.8000
			278.77	7.8	0.14	7.84	35.18	256.24	5.31E-03	2.02E-04	1.58E-05	5.09E-03	4.11E-07	2.00E-08	7.7000
			283.51	7.7	0.32	7.92	30.07	251.13	5.26E-03	2.49E-04	1.23E-05	5.00E-03	3.27E-07	2.51E-08	7.6000
			289.27	7.6	0.52	8.02	24.06	245.11	5.20E-03	3.07E-04	9.58E-06	4.88E-03	2.60E-07	3.16E-08	7.5000
			296.38	7.5	0.79	8.19	16.97	238.03	5.13E-03	3.75E-04	7.39E-06	4.75E-03	2.06E-07	3.98E-08	7.4000
			305.20	7.4	1.19	8.49	8.69	229.75	5.05E-03	4.56E-04	5.67E-06	4.58E-03	1.64E-07	5.01E-08	7.3000
			316.20	7.3	9.25	####	0.00	220.16	4.95E-03	5.51E-04	4.32E-06	4.39E-03	1.30E-07	6.31E-08	7.2000
			329.97	7.2	9.37	####	0.00	209.21	4.84E-03	6.59E-04	3.26E-06	4.18E-03	1.03E-07	7.94E-08	7.1000
			347.23	7.1	9.50	####	0.00	196.91	4.72E-03	7.81E-04	2.44E-06	3.93E-03	8.21E-08	1.00E-07	7.0000
			368.93	7	9.63	####	0.00	183.36	4.58E-03	9.16E-04	1.80E-06	3.66E-03	6.52E-08	1.26E-07	6.9000
			274.80	7.9	-0.02	7.78	39.54	260.60	5.35E-03	1.63E-04	2.02E-05	5.17E-03	5.18E-07	1.58E-08	7.8000
			275.17	7.89	0.00	7.79	39.14	260.19	5.35E-03	1.66E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7900
			275.54	7.88	0.01	7.79	38.72	259.78	5.35E-03	1.70E-04	1.93E-05	5.16E-03	4.95E-07	1.66E-08	7.7800
			275.92	7.87	0.03	7.80	38.30	259.36	5.34E-03	1.74E-04	1.88E-05	5.15E-03	4.83E-07	1.70E-08	7.7700
			276.31	7.86	0.04	7.80	37.88	258.93	5.34E-03	1.77E-04	1.83E-05	5.14E-03	4.72E-07	1.74E-08	7.7600
			276.70	7.85	0.06	7.81	37.45	258.50	5.33E-03	1.81E-04	1.79E-05	5.13E-03	4.62E-07	1.78E-08	7.7500
			277.10	7.84	0.08	7.82	37.01	258.06	5.33E-03	1.85E-04	1.75E-05	5.13E-03	4.51E-07	1.82E-08	7.7400
			277.50	7.83	0.09	7.82	36.56	257.62	5.32E-03	1.89E-04	1.70E-05	5.12E-03	4.41E-07	1.86E-08	7.7300
			277.92	7.82	0.11	7.83	36.11	257.17	5.32E-03	1.93E-04	1.66E-05	5.11E-03	4.31E-07	1.91E-08	7.7200
			278.34	7.81	0.12	7.83	35.65	256.71	5.32E-03	1.98E-04	1.62E-05	5.10E-03	4.21E-07	1.95E-08	7.7100
			278.77	7.8	0.14	7.84	35.18	256.24	5.31E-03	2.02E-04	1.58E-05	5.09E-03	4.11E-07	2.00E-08	7.7000
					0.00	7.79	39.14	260.19	5.35E-03	1.66E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7900
					0.00	7.79	39.09	260.15	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.63E-08	7.7890
					0.00	7.79	39.05	260.11	5.35E-03	1.67E-04	1.96E-05	5.16E-03	5.04E-07	1.63E-08	7.7880
					0.00	7.79	39.01	260.07	5.35E-03	1.67E-04	1.96E-05	5.16E-03	5.03E-07	1.63E-08	7.7870
					0.00	7.79	38.97	260.02	5.35E-03	1.68E-04	1.96E-05	5.16E-03	5.02E-07	1.64E-08	7.7860
					0.01	7.79	38.93	259.98	5.35E-03	1.68E-04	1.95E-05	5.16E-03	5.00E-07	1.64E-08	7.7850
					0.01	7.79	38.89	259.94	5.35E-03	1.69E-04	1.95E-05	5.16E-03	4.99E-07	1.64E-08	7.7840
					0.01	7.79	38.85	259.90	5.35E-03	1.69E-04	1.94E-05	5.16E-03	4.98E-07	1.65E-08	7.7830
					0.01	7.79	38.81	259.86	5.35E-03	1.69E-04	1.94E-05	5.16E-03	4.97E-07	1.65E-08	7.7820
					0.01	7.79	38.76	259.82	5.35E-03	1.70E-04	1.93E-05	5.16E-03	4.96E-07	1.66E-08	7.7810
					0.01	7.79	38.72	259.78	5.35E-03	1.70E-04	1.93E-05	5.16E-03	4.95E-07	1.66E-08	7.7800
					0.00	7.79	39.14	260.19	5.35E-03	1.66E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7900
					0.00	7.79	39.13	260.18	5.35E-03	1.66E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7899
					0.00	7.79	39.13	260.18	5.35E-03	1.66E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7898
					0.00	7.79	39.12	260.18	5.35E-03	1.66E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7897
					0.00	7.79	39.12	260.17	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7896
					0.00	7.79	39.11	260.17	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.06E-07	1.62E-08	7.7895
					0.00	7.79	39.11	260.16	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.62E-08	7.7894
					0.00	7.79	39.11	260.16	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.62E-08	7.7893
					0.00	7.79	39.10	260.16	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.62E-08	7.7892
					0.00	7.79	39.10	260.15	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.63E-08	7.7891
					0.00	7.79	39.09	260.15	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.63E-08	7.7890
					0.00	7.79	39.10	260.15	5.35E-03	1.67E-04	1.97E-05	5.16E-03	5.05E-07	1.63E-08	7.7891

Tk	293
I	0.00965
E	80.0948
A	0.50625
f(I)	0.08946
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.907
fd	0.67676
K1p	5.03E-07
K2p	6.20E-11
Kwp	8.21E-15
Ksp	7.70E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 3a (1): EP001, EP003, & EP004

The RTW Model Ver. 4.0 ID: **Blend 3a (1)**

STEP 1: Enter initial water characteristics.

Measured TDS	335.31	mg/L
Measured temperature	20	deg C
Measured pH	8	
Measured alk, as CaCO3	267.06	mg/L
Measured Ca, as CaCO3	62.51	mg/L
Measured Cl	47.09	mg/L
Measured SO4	14.63	mg/L

For CT and TTHM functions enter current:

Treated water pH	8	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	267	mg/L	> 40 mg/L	Interim pH	8.00		6.8-9.3
Interim Ca, as CaCO3	63	mg/L	> 40 mg/L	Precipitation potential	12.41	mg/L	4-10 mg/L
Alk/(Cl+SO4)	4.3		> 5.0	Langelier index	0.44		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	274	mg/L
Initial Ca sat, as CaCO3	23	mg/L
Initial DIC, as CaCO3	541	mg/L

Theoretical interim water characteristics

Interim acidity	274	mg/L
Interim Ca sat, as CaCO3	23	mg/L
Ryznar index	7.12	
Interim DIC, as CaCO3	541	mg/L
Aggressiveness Index	12.22	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	255	mg/L
Final Ca	50	mg/L
Final acidity	274	mg/L
Final pH	7.68	
Final DIC, as CaCO3	529	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim														
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final	
{H+}	1.00E-08	1.00E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH	
[DIC]	5.41E-03	5.41E-03					mg CaCO3/L	mg CaCO3/L								
[HCO3-]	5.28E-03	5.28E-03														
[CO3-]	3.2E-05	3.2E-05	-40591.60	14	-0.43	7.57	62.51	267.06	5.41E-03	1.06E-04	3.20E-05	5.28E-03	8.12E-07	1.00E-08	8.0000	
[H2CO3*	0.000106	1.06E-04	-4061.95	13	0.37	7.83	37.25	241.80	5.16E-03	3.34E-04	8.46E-06	4.82E-03	2.35E-07	3.46E-08	7.4615	
[Ca++]s	2.30E-04	2.30E-04	-407.02	12	9.59	####	0.00	185.62	4.60E-03	8.89E-04	1.88E-06	3.71E-03	6.80E-08	1.19E-07	6.9231	
pHs alk		7.56	-23.34	11	10.38	####	0.00	103.26	3.78E-03	1.71E-03	3.04E-07	2.06E-03	1.97E-08	4.12E-07	6.3846	
			114.85	10	11.33	####	0.00	40.72	3.15E-03	2.34E-03	3.47E-08	8.16E-04	5.70E-09	1.43E-06	5.8462	
			238.36	9	12.36	####	0.00	12.94	2.87E-03	2.61E-03	3.25E-09	2.64E-04	1.65E-09	4.92E-06	5.3077	
			274.38	8	13.42	####	0.00	3.09	2.77E-03	2.70E-03	2.81E-10	7.89E-05	4.77E-10	1.70E-05	4.7692	
			373.91	7	14.49	####	0.00	-1.79	2.73E-03	2.70E-03	2.36E-11	2.29E-05	1.38E-10	5.88E-05	4.2308	
			1340.24	6	15.58	####	0.00	-9.83	2.65E-03	2.64E-03	1.93E-12	6.47E-06	4.00E-11	2.03E-04	3.6923	
			11018.45	5	16.70	####	0.00	-35.00	2.39E-03	2.39E-03	1.47E-13	1.70E-06	1.16E-11	7.02E-04	3.1538	
			109590.25	4	17.97	####	0.00	-121.21	1.53E-03	1.53E-03	7.86E-15	3.14E-07	3.35E-12	2.42E-03	2.6154	
			1274309.47	3	#####	####	0.00	-274.38	1.68E-96	1.68E-96	7.24E-109	1.00E-100	9.69E-13	8.38E-03	2.0769	
			30821628.39	2	#####	####	0.00	-274.38	5.81E-96	5.81E-96	2.10E-109	1.00E-100	2.80E-13	2.89E-02	1.5385	
			2116307481.24	1	#####	####	0.00	-274.38	2.01E-95	2.01E-95	6.06E-110	1.00E-100	8.12E-14	1.00E-01	1.0000	
			274.38	8	-0.43	7.57	62.51	267.06	5.41E-03	1.06E-04	3.20E-05	5.28E-03	8.12E-07	1.00E-08	8.0000	
			277.83	7.9	-0.31	7.59	59.20	263.75	5.38E-03	1.32E-04	2.52E-05	5.22E-03	6.45E-07	1.26E-08	7.9000	
			281.86	7.8	-0.17	7.63	55.43	259.98	5.34E-03	1.64E-04	1.97E-05	5.16E-03	5.12E-07	1.58E-08	7.8000	
			286.69	7.7	-0.03	7.67	51.05	255.60	5.30E-03	2.04E-04	1.54E-05	5.08E-03	4.07E-07	2.00E-08	7.7000	
			292.57	7.6	0.12	7.72	45.91	250.46	5.25E-03	2.52E-04	1.20E-05	4.98E-03	3.23E-07	2.51E-08	7.6000	
			299.82	7.5	0.30	7.80	39.85	244.40	5.19E-03	3.09E-04	9.34E-06	4.87E-03	2.57E-07	3.16E-08	7.5000	
			308.82	7.4	0.49	7.89	32.73	237.28	5.12E-03	3.78E-04	7.21E-06	4.73E-03	2.04E-07	3.98E-08	7.4000	
			320.05	7.3	0.74	8.04	24.40	228.95	5.03E-03	4.60E-04	5.53E-06	4.57E-03	1.62E-07	5.01E-08	7.3000	
			334.11	7.2	1.07	8.27	14.77	219.32	4.94E-03	5.55E-04	4.21E-06	4.38E-03	1.29E-07	6.31E-08	7.2000	
			351.76	7.1	1.79	8.89	3.77	208.32	4.83E-03	6.64E-04	3.18E-06	4.16E-03	1.02E-07	7.94E-08	7.1000	
			373.91	7	9.49	####	0.00	195.97	4.70E-03	7.86E-04	2.37E-06	3.91E-03	8.12E-08	1.00E-07	7.0000	
			274.38	8	-0.03	7.67	51.05	255.60	5.30E-03	2.04E-04	1.54E-05	5.08E-03	4.07E-07	2.00E-08	7.7000	
			274.70	7.99	-0.01	7.68	50.57	255.12	5.30E-03	2.08E-04	1.51E-05	5.07E-03	3.98E-07	2.04E-08	7.6900	
			275.03	7.98	0.00	7.68	50.09	254.64	5.29E-03	2.13E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6800	
			275.36	7.97	0.02	7.69	49.59	254.14	5.29E-03	2.17E-04	1.43E-05	5.05E-03	3.80E-07	2.14E-08	7.6700	
			275.70	7.96	0.03	7.69	49.09	253.64	5.28E-03	2.22E-04	1.40E-05	5.04E-03	3.71E-07	2.19E-08	7.6600	
			276.04	7.95	0.05	7.70	48.58	253.13	5.28E-03	2.26E-04	1.36E-05	5.04E-03	3.63E-07	2.24E-08	7.6500	
			276.39	7.94	0.06	7.70	48.07	252.62	5.27E-03	2.31E-04	1.33E-05	5.03E-03	3.54E-07	2.29E-08	7.6400	
			276.74	7.93	0.08	7.71	47.54	252.09	5.26E-03	2.36E-04	1.30E-05	5.02E-03	3.46E-07	2.34E-08	7.6300	
			277.10	7.92	0.09	7.71	47.00	251.55	5.26E-03	2.41E-04	1.27E-05	5.01E-03	3.38E-07	2.40E-08	7.6200	
			277.46	7.91	0.11	7.72	46.46	251.01	5.25E-03	2.46E-04	1.23E-05	5.00E-03	3.31E-07	2.45E-08	7.6100	
			277.83	7.9	0.12	7.72	45.91	250.46	5.25E-03	2.52E-04	1.20E-05	4.98E-03	3.23E-07	2.51E-08	7.6000	
					-0.01	7.68	50.57	255.12	5.30E-03	2.08E-04	1.51E-05	5.07E-03	3.98E-07	2.04E-08	7.6900	
					-0.01	7.68	50.52	255.07	5.29E-03	2.08E-04	1.50E-05	5.07E-03	3.97E-07	2.05E-08	7.6890	
					-0.01	7.68	50.47	255.02	5.29E-03	2.09E-04	1.50E-05	5.07E-03	3.96E-07	2.05E-08	7.6880	
					-0.01	7.68	50.43	254.98	5.29E-03	2.09E-04	1.50E-05	5.07E-03	3.95E-07	2.06E-08	7.6870	
					-0.01	7.68	50.38	254.93	5.29E-03	2.10E-04	1.49E-05	5.07E-03	3.94E-07	2.06E-08	7.6860	
					-0.01	7.68	50.33	254.88	5.29E-03	2.10E-04	1.49E-05	5.07E-03	3.93E-07	2.07E-08	7.6850	
					-0.01	7.68	50.28	254.83	5.29E-03	2.11E-04	1.48E-05	5.07E-03	3.92E-07	2.07E-08	7.6840	
					0.00	7.68	50.23	254.78	5.29E-03	2.11E-04	1.48E-05	5.07E-03	3.91E-07	2.07E-08	7.6830	
					0.00	7.68	50.18	254.73	5.29E-03	2.12E-04	1.48E-05	5.06E-03	3.90E-07	2.08E-08	7.6820	
					0.00	7.68	50.13	254.68	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.08E-08	7.6810	
					0.00	7.68	50.09	254.64	5.29E-03	2.13E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6800	
					0.00	7.68	50.13	254.68	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.08E-08	7.6810	
					0.00	7.68	50.13	254.68	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.08E-08	7.6809	
					0.00	7.68	50.12	254.67	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6808	
					0.00	7.68	50.12	254.67	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6807	
					0.00	7.68	50.11	254.66	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6806	
					0.00	7.68	50.11	254.66	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6805	
					0.00	7.68	50.11	254.66	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6804	
					0.00	7.68	50.10	254.65	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6803	
					0.00	7.68	50.10	254.65	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6802	
					0.00	7.68	50.09	254.64	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6801	
					0.00	7.68	50.09	254.64	5.29E-03	2.13E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6800	
					0.00	7.68	50.10	254.65	5.29E-03	2.12E-04	1.47E-05	5.06E-03	3.89E-07	2.09E-08	7.6802	

Tk	293
I	0.00838
E	80.0948
A	0.50625
f(I)	0.08388
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.91212
fd	0.69216
K1p	4.98E-07
K2p	6.06E-11
Kwp	8.12E-15
Ksp	7.36E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 3a (2): EP001, EP003, & EP004

The RTW Model Ver. 4.0 ID: **Blend 3a (2)**

STEP 1: Enter initial water characteristics.

Measured TDS	341.23	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	259.42	mg/L
Measured Ca, as CaCO3	53.119	mg/L
Measured Cl	51.345	mg/L
Measured SO4	14.376	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	259	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	53	mg/L	> 40 mg/L	Precipitation potential	7.02	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.9		> 5.0	Langelier index	0.25		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	270	mg/L
Initial Ca sat, as CaCO3	30	mg/L
Initial DIC, as CaCO3	529	mg/L

Theoretical interim water characteristics

Interim acidity	270	mg/L
Interim Ca sat, as CaCO3	30	mg/L
Ryznar index	7.39	
Interim DIC, as CaCO3	529	mg/L
Aggressiveness Index	12.04	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	252	mg/L
Final Ca	46	mg/L
Final acidity	270	mg/L
Final pH	7.72	
Final DIC, as CaCO3	522	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.29E-03	5.29E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.14E-03	5.14E-03													
[CO3-]	2.48E-05	2.48E-05	-40647.24	14	-0.25	7.65	53.12	259.42	5.29E-03	1.30E-04	2.48E-05	5.14E-03	6.46E-07	1.26E-08	7.9000
[H2CO3*	0.00013	1.30E-04	-4067.52	13	0.66	8.03	24.72	231.02	5.01E-03	3.95E-04	6.56E-06	4.61E-03	1.90E-07	4.27E-08	7.3692
[Ca++]s	2.98E-04	2.98E-04	-407.64	12	9.71	####	0.00	170.71	4.41E-03	9.93E-04	1.43E-06	3.41E-03	5.60E-08	1.45E-07	6.8385
pHs alk		7.65	-24.02	11	10.52	####	0.00	90.67	3.61E-03	1.79E-03	2.24E-07	1.81E-03	1.65E-08	4.92E-07	6.3077
			111.21	10	11.46	####	0.00	34.92	3.05E-03	2.35E-03	2.55E-08	7.00E-04	4.86E-09	1.67E-06	5.7769
			231.45	9	12.48	####	0.00	11.06	2.81E-03	2.58E-03	2.43E-09	2.27E-04	1.43E-09	5.67E-06	5.2462
			266.50	8	13.53	####	0.00	2.47	2.72E-03	2.65E-03	2.17E-10	6.87E-05	4.22E-10	1.93E-05	4.7154
			363.07	7	14.59	####	0.00	-2.26	2.68E-03	2.66E-03	1.88E-11	2.02E-05	1.24E-10	6.54E-05	4.1846
			1300.46	6	15.67	####	0.00	-10.80	2.59E-03	2.58E-03	1.59E-12	5.81E-06	3.66E-11	2.22E-04	3.6538
			10689.42	5	16.78	####	0.00	-37.58	2.32E-03	2.32E-03	1.24E-13	1.54E-06	1.08E-11	7.53E-04	3.1231
			106366.26	4	18.05	####	0.00	-127.82	1.42E-03	1.42E-03	6.58E-15	2.77E-07	3.18E-12	2.56E-03	2.5923
			1241890.81	3	#####	####	0.00	-269.85	1.74E-96	1.74E-96	7.01E-109	1.00E-100	9.37E-13	8.68E-03	2.0615
			30472756.54	2	#####	####	0.00	-269.85	5.91E-96	5.91E-96	2.06E-109	1.00E-100	2.76E-13	2.95E-02	1.5308
			2110343433.70	1	#####	####	0.00	-269.85	2.01E-95	2.01E-95	6.08E-110	1.00E-100	8.13E-14	1.00E-01	1.0000
			266.50	8	-0.25	7.65	53.12	259.42	5.29E-03	1.30E-04	2.48E-05	5.14E-03	6.46E-07	1.26E-08	7.9000
			269.85	7.9	-0.11	7.69	49.41	255.71	5.26E-03	1.61E-04	1.95E-05	5.07E-03	5.13E-07	1.58E-08	7.8000
			273.76	7.8	0.03	7.73	45.11	251.41	5.21E-03	2.00E-04	1.52E-05	5.00E-03	4.07E-07	2.00E-08	7.7000
			278.45	7.7	0.19	7.79	40.06	246.36	5.16E-03	2.47E-04	1.19E-05	4.90E-03	3.24E-07	2.51E-08	7.6000
			284.16	7.6	0.37	7.87	34.11	240.41	5.10E-03	3.04E-04	9.21E-06	4.79E-03	2.57E-07	3.16E-08	7.5000
			291.19	7.5	0.58	7.98	27.11	233.41	5.03E-03	3.72E-04	7.11E-06	4.65E-03	2.04E-07	3.98E-08	7.4000
			299.92	7.4	0.86	8.16	18.93	225.22	4.95E-03	4.52E-04	5.45E-06	4.49E-03	1.62E-07	5.01E-08	7.3000
			310.82	7.3	1.28	8.48	9.46	215.75	4.86E-03	5.45E-04	4.15E-06	4.31E-03	1.29E-07	6.31E-08	7.2000
			324.46	7.2	9.37	####	0.00	204.94	4.75E-03	6.52E-04	3.13E-06	4.09E-03	1.02E-07	7.94E-08	7.1000
			341.57	7.1	9.50	####	0.00	192.81	4.63E-03	7.73E-04	2.34E-06	3.85E-03	8.13E-08	1.00E-07	7.0000
			363.07	7	9.63	####	0.00	179.45	4.49E-03	9.06E-04	1.73E-06	3.59E-03	6.46E-08	1.26E-07	6.9000
			269.85	7.9	-0.11	7.69	49.41	255.71	5.26E-03	1.61E-04	1.95E-05	5.07E-03	5.13E-07	1.58E-08	7.8000
			270.21	7.89	-0.10	7.69	49.01	255.31	5.25E-03	1.65E-04	1.90E-05	5.07E-03	5.01E-07	1.62E-08	7.7900
			270.58	7.88	-0.09	7.69	48.60	254.90	5.25E-03	1.68E-04	1.85E-05	5.06E-03	4.90E-07	1.66E-08	7.7800
			270.96	7.87	-0.07	7.70	48.19	254.49	5.24E-03	1.72E-04	1.81E-05	5.05E-03	4.79E-07	1.70E-08	7.7700
			271.34	7.86	-0.06	7.70	47.77	254.07	5.24E-03	1.76E-04	1.77E-05	5.05E-03	4.68E-07	1.74E-08	7.7600
			271.72	7.85	-0.04	7.71	47.34	253.64	5.23E-03	1.80E-04	1.72E-05	5.04E-03	4.57E-07	1.78E-08	7.7500
			272.12	7.84	-0.03	7.71	46.91	253.21	5.23E-03	1.84E-04	1.68E-05	5.03E-03	4.47E-07	1.82E-08	7.7400
			272.52	7.83	-0.01	7.72	46.47	252.77	5.23E-03	1.88E-04	1.64E-05	5.02E-03	4.37E-07	1.86E-08	7.7300
			272.93	7.82	0.00	7.72	46.02	252.32	5.22E-03	1.92E-04	1.60E-05	5.01E-03	4.27E-07	1.91E-08	7.7200
			273.34	7.81	0.02	7.73	45.57	251.87	5.22E-03	1.96E-04	1.56E-05	5.01E-03	4.17E-07	1.95E-08	7.7100
			273.76	7.8	0.03	7.73	45.11	251.41	5.21E-03	2.00E-04	1.52E-05	5.00E-03	4.07E-07	2.00E-08	7.7000
					-0.01	7.72	46.47	252.77	5.23E-03	1.88E-04	1.64E-05	5.02E-03	4.37E-07	1.86E-08	7.7300
					-0.01	7.72	46.43	252.73	5.23E-03	1.88E-04	1.64E-05	5.02E-03	4.36E-07	1.87E-08	7.7290
					-0.01	7.72	46.38	252.68	5.23E-03	1.88E-04	1.63E-05	5.02E-03	4.35E-07	1.87E-08	7.7280
					-0.01	7.72	46.34	252.64	5.22E-03	1.89E-04	1.63E-05	5.02E-03	4.34E-07	1.87E-08	7.7270
					-0.01	7.72	46.29	252.59	5.22E-03	1.89E-04	1.62E-05	5.02E-03	4.33E-07	1.88E-08	7.7260
					-0.01	7.72	46.25	252.55	5.22E-03	1.90E-04	1.62E-05	5.02E-03	4.32E-07	1.88E-08	7.7250
					0.00	7.72	46.20	252.50	5.22E-03	1.90E-04	1.62E-05	5.02E-03	4.31E-07	1.89E-08	7.7240
					0.00	7.72	46.16	252.46	5.22E-03	1.90E-04	1.61E-05	5.02E-03	4.30E-07	1.89E-08	7.7230
					0.00	7.72	46.11	252.41	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.29E-07	1.90E-08	7.7220
					0.00	7.72	46.07	252.37	5.22E-03	1.91E-04	1.60E-05	5.01E-03	4.28E-07	1.90E-08	7.7210
					0.00	7.72	46.02	252.32	5.22E-03	1.92E-04	1.60E-05	5.01E-03	4.27E-07	1.91E-08	7.7200
					0.00	7.72	46.11	252.41	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.29E-07	1.90E-08	7.7220
					0.00	7.72	46.11	252.41	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7219
					0.00	7.72	46.11	252.40	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7218
					0.00	7.72	46.10	252.40	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7217
					0.00	7.72	46.10	252.39	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7216
					0.00	7.72	46.09	252.39	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7215
					0.00	7.72	46.09	252.39	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7214
					0.00	7.72	46.08	252.38	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7213
					0.00	7.72	46.08	252.38	5.22E-03	1.91E-04	1.60E-05	5.02E-03	4.28E-07	1.90E-08	7.7212
					0.00	7.72	46.07	252.37	5.22E-03	1.91E-04	1.60E-05	5.01E-03	4.28E-07	1.90E-08	7.7211
					0.00	7.72	46.07	252.37	5.22E-03	1.91E-04	1.60E-05	5.01E-03	4.28E-07	1.90E-08	7.7210
					0.00	7.72	46.10	252.39	5.22E-03	1.91E-04	1.61E-05	5.02E-03	4.28E-07	1.90E-08	7.7216

Tk	293
I	0.00853
E	80.0948
A	0.50625
f(I)	0.08455
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.9115
fd	0.69027
K1p	4.98E-07
K2p	6.08E-11
Kwp	8.13E-15
Ksp	7.40E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model
Blend 3b (1): EP003, EP004, & EP005

The RTW Model Ver. 4.0 ID: **Blend 3b (1)**

STEP 1: Enter initial water characteristics.

Measured TDS	405.87	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	268.65	mg/L
Measured Ca, as CaCO3	47.368	mg/L
Measured Cl	87.65	mg/L
Measured SO4	13.4	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	269	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	47	mg/L	> 40 mg/L	Precipitation potential	5.56	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.7		> 5.0	Langelier index	0.21		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	279	mg/L
Initial Ca sat, as CaCO3	30	mg/L
Initial DIC, as CaCO3	548	mg/L

Theoretical interim water characteristics

Interim acidity	279	mg/L
Interim Ca sat, as CaCO3	30	mg/L
Ryznar index	7.48	
Interim DIC, as CaCO3	548	mg/L
Aggressiveness Index	12.00	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	263	mg/L
Final Ca	42	mg/L
Final acidity	279	mg/L
Final pH	7.76	
Final DIC, as CaCO3	542	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim														
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final	
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH	
[DIC]	5.48E-03	5.48E-03					mg CaCO3/L	mg CaCO3/L								
[HCO3-]	5.32E-03	5.32E-03														
[CO3-]	2.64E-05	2.64E-05	-41219.93	14	-0.20	7.70	47.37	268.65	5.48E-03	1.32E-04	2.64E-05	5.32E-03	6.55E-07	1.26E-08	7.9000	
[H2CO3*	0.000132	1.32E-04	-4124.74	13	0.79	8.16	18.24	239.53	5.19E-03	4.04E-04	6.99E-06	4.78E-03	1.93E-07	4.27E-08	7.3692	
[Ca++]s	2.96E-04	2.96E-04	-413.31	12	9.71	####	0.00	177.53	4.57E-03	1.02E-03	1.53E-06	3.55E-03	5.68E-08	1.45E-07	6.8385	
pHs alk		7.69	-24.38	11	10.51	####	0.00	94.69	3.74E-03	1.84E-03	2.40E-07	1.89E-03	1.67E-08	4.92E-07	6.3077	
			113.46	10	11.46	####	0.00	36.58	3.16E-03	2.42E-03	2.74E-08	7.33E-04	4.93E-09	1.67E-06	5.7769	
			238.95	9	12.48	####	0.00	11.61	2.91E-03	2.67E-03	2.62E-09	2.38E-04	1.45E-09	5.67E-06	5.2462	
			275.75	8	13.52	####	0.00	2.64	2.82E-03	2.75E-03	2.34E-10	7.21E-05	4.28E-10	1.93E-05	4.7154	
			374.48	7	14.59	####	0.00	-2.21	2.77E-03	2.75E-03	2.03E-11	2.13E-05	1.26E-10	6.54E-05	4.1846	
			1331.75	6	15.66	####	0.00	-10.79	2.68E-03	2.68E-03	1.72E-12	6.10E-06	3.71E-11	2.22E-04	3.6538	
			10919.05	5	16.76	####	0.00	-37.58	2.42E-03	2.41E-03	1.35E-13	1.62E-06	1.09E-11	7.53E-04	3.1231	
			108554.38	4	18.03	####	0.00	-127.82	1.51E-03	1.51E-03	7.32E-15	2.99E-07	3.22E-12	2.56E-03	2.5923	
			1261179.97	3	#####	####	0.00	-279.19	1.72E-96	1.72E-96	7.20E-109	1.00E-100	9.50E-13	8.68E-03	2.0615	
			30414660.43	2	#####	####	0.00	-279.19	5.83E-96	5.83E-96	2.12E-109	1.00E-100	2.80E-13	2.95E-02	1.5308	
			2084671927.73	1	#####	####	0.00	-279.19	1.98E-95	1.98E-95	6.25E-110	1.00E-100	8.24E-14	1.00E-01	1.0000	
			275.75	8	-0.20	7.70	47.37	268.65	5.48E-03	1.32E-04	2.64E-05	5.32E-03	6.55E-07	1.26E-08	7.9000	
			279.19	7.9	-0.06	7.74	43.56	264.84	5.44E-03	1.65E-04	2.07E-05	5.25E-03	5.20E-07	1.58E-08	7.8000	
			283.21	7.8	0.09	7.79	39.14	260.42	5.40E-03	2.04E-04	1.62E-05	5.18E-03	4.13E-07	2.00E-08	7.7000	
			288.01	7.7	0.26	7.86	33.96	255.25	5.34E-03	2.52E-04	1.26E-05	5.08E-03	3.28E-07	2.51E-08	7.6000	
			293.86	7.6	0.46	7.96	27.86	249.15	5.28E-03	3.10E-04	9.81E-06	4.96E-03	2.61E-07	3.16E-08	7.5000	
			301.05	7.5	0.70	8.10	20.69	241.97	5.21E-03	3.80E-04	7.58E-06	4.82E-03	2.07E-07	3.98E-08	7.4000	
			309.98	7.4	1.04	8.34	12.30	233.58	5.13E-03	4.62E-04	5.81E-06	4.66E-03	1.64E-07	5.01E-08	7.3000	
			321.11	7.3	1.84	9.04	2.58	223.87	5.03E-03	5.58E-04	4.43E-06	4.47E-03	1.31E-07	6.31E-08	7.2000	
			335.05	7.2	9.37	####	0.00	212.76	4.92E-03	6.68E-04	3.34E-06	4.25E-03	1.04E-07	7.94E-08	7.1000	
			352.53	7.1	9.50	####	0.00	200.29	4.79E-03	7.92E-04	2.50E-06	4.00E-03	8.24E-08	1.00E-07	7.0000	
			374.48	7	9.63	####	0.00	186.54	4.66E-03	9.28E-04	1.85E-06	3.73E-03	6.55E-08	1.26E-07	6.9000	
			279.19	7.9	-0.06	7.74	43.56	264.84	5.44E-03	1.65E-04	2.07E-05	5.25E-03	5.20E-07	1.58E-08	7.8000	
			279.57	7.89	-0.05	7.74	43.15	264.43	5.44E-03	1.68E-04	2.02E-05	5.25E-03	5.08E-07	1.62E-08	7.7900	
			279.94	7.88	-0.03	7.75	42.73	264.01	5.43E-03	1.72E-04	1.97E-05	5.24E-03	4.97E-07	1.66E-08	7.7800	
			280.33	7.87	-0.02	7.75	42.30	263.59	5.43E-03	1.76E-04	1.93E-05	5.23E-03	4.85E-07	1.70E-08	7.7700	
			280.72	7.86	0.00	7.76	41.87	263.15	5.42E-03	1.80E-04	1.88E-05	5.23E-03	4.74E-07	1.74E-08	7.7600	
			281.12	7.85	0.01	7.76	41.43	262.72	5.42E-03	1.84E-04	1.83E-05	5.22E-03	4.64E-07	1.78E-08	7.7500	
			281.52	7.84	0.03	7.77	40.99	262.27	5.41E-03	1.88E-04	1.79E-05	5.21E-03	4.53E-07	1.82E-08	7.7400	
			281.93	7.83	0.04	7.77	40.54	261.82	5.41E-03	1.92E-04	1.75E-05	5.20E-03	4.43E-07	1.86E-08	7.7300	
			282.35	7.82	0.06	7.78	40.08	261.36	5.41E-03	1.96E-04	1.70E-05	5.19E-03	4.33E-07	1.91E-08	7.7200	
			282.78	7.81	0.08	7.79	39.61	260.90	5.40E-03	2.00E-04	1.66E-05	5.18E-03	4.23E-07	1.95E-08	7.7100	
			283.21	7.8	0.09	7.79	39.14	260.42	5.40E-03	2.04E-04	1.62E-05	5.18E-03	4.13E-07	2.00E-08	7.7000	
					0.00	7.76	41.87	263.15	5.42E-03	1.80E-04	1.88E-05	5.23E-03	4.74E-07	1.74E-08	7.7600	
					0.00	7.76	41.83	263.11	5.42E-03	1.80E-04	1.88E-05	5.22E-03	4.73E-07	1.74E-08	7.7590	
					0.00	7.76	41.79	263.07	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.72E-07	1.75E-08	7.7580	
					0.00	7.76	41.74	263.02	5.42E-03	1.81E-04	1.87E-05	5.22E-03	4.71E-07	1.75E-08	7.7570	
					0.00	7.76	41.70	262.98	5.42E-03	1.81E-04	1.86E-05	5.22E-03	4.70E-07	1.75E-08	7.7560	
					0.01	7.76	41.65	262.94	5.42E-03	1.82E-04	1.86E-05	5.22E-03	4.69E-07	1.76E-08	7.7550	
					0.01	7.76	41.61	262.89	5.42E-03	1.82E-04	1.85E-05	5.22E-03	4.68E-07	1.76E-08	7.7540	
					0.01	7.76	41.57	262.85	5.42E-03	1.82E-04	1.85E-05	5.22E-03	4.67E-07	1.77E-08	7.7530	
					0.01	7.76	41.52	262.81	5.42E-03	1.83E-04	1.84E-05	5.22E-03	4.66E-07	1.77E-08	7.7520	
					0.01	7.76	41.48	262.76	5.42E-03	1.83E-04	1.84E-05	5.22E-03	4.65E-07	1.77E-08	7.7510	
					0.01	7.76	41.43	262.72	5.42E-03	1.84E-04	1.83E-05	5.22E-03	4.64E-07	1.78E-08	7.7500	
					0.00	7.76	41.83	263.11	5.42E-03	1.80E-04	1.88E-05	5.22E-03	4.73E-07	1.74E-08	7.7590	
					0.00	7.76	41.82	263.11	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7589	
					0.00	7.76	41.82	263.10	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7588	
					0.00	7.76	41.82	263.10	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7587	
					0.00	7.76	41.81	263.09	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7586	
					0.00	7.76	41.81	263.09	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7585	
					0.00	7.76	41.80	263.09	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7584	
					0.00	7.76	41.80	263.08	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7583	
					0.00	7.76	41.79	263.08	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.72E-07	1.75E-08	7.7582	
					0.00	7.76	41.79	263.07	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.72E-07	1.75E-08	7.7581	
					0.00	7.76	41.79	263.07	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.72E-07	1.75E-08	7.7580	
					0.00	7.76	41.81	263.09	5.42E-03	1.80E-04	1.87E-05	5.22E-03	4.73E-07	1.74E-08	7.7585	

Tk	293
I	0.01015
E	80.0948
A	0.50625
f(I)	0.09151
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90514
fd	0.67122
K1p	5.05E-07
K2p	6.25E-11
Kwp	8.24E-15
Ksp	7.83E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model

Blend 4 (1): EP001, EP003, EP004, & EP005

The RTW Model Ver. 4.0 ID: **Blend 3b (2)**

STEP 1: Enter initial water characteristics.

Measured TDS	383.5	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	260.56	mg/L
Measured Ca, as CaCO3	44.065	mg/L
Measured Cl	75.638	mg/L
Measured SO4	13.635	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	261	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	44	mg/L	> 40 mg/L	Precipitation potential	4.23	mg/L	4-10 mg/L
Alk/(Cl+SO4)	2.9		> 5.0	Langelier index	0.17		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	271	mg/L
Initial Ca sat, as CaCO3	30	mg/L
Initial DIC, as CaCO3	531	mg/L

Theoretical interim water characteristics

Interim acidity	271	mg/L
Interim Ca sat, as CaCO3	30	mg/L
Ryznar index	7.57	
Interim DIC, as CaCO3	531	mg/L
Aggressiveness Index	11.96	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	256	mg/L
Final Ca	40	mg/L
Final acidity	271	mg/L
Final pH	7.79	
Final DIC, as CaCO3	527	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.31E-03	5.31E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.16E-03	5.16E-03													
[CO3-]	2.54E-05	2.54E-05	-41028.42	14	-0.16	7.74	44.07	260.56	5.31E-03	1.29E-04	2.54E-05	5.16E-03	6.52E-07	1.26E-08	7.9000
[H2CO3*	0.000129	1.29E-04	-4105.61	13	0.86	8.23	15.73	232.23	5.03E-03	3.93E-04	6.71E-06	4.63E-03	1.92E-07	4.27E-08	7.3692
[Ca++]s	3.03E-04	3.03E-04	-411.45	12	9.72	####	0.00	171.94	4.43E-03	9.91E-04	1.47E-06	3.44E-03	5.66E-08	1.45E-07	6.8385
pHs alk		7.73	-24.63	11	10.52	####	0.00	91.58	3.62E-03	1.79E-03	2.30E-07	1.83E-03	1.67E-08	4.92E-07	6.3077
			110.49	10	11.47	####	0.00	35.34	3.06E-03	2.35E-03	2.63E-08	7.08E-04	4.91E-09	1.67E-06	5.7769
			231.99	9	12.49	####	0.00	11.21	2.82E-03	2.59E-03	2.51E-09	2.30E-04	1.45E-09	5.67E-06	5.2462
			267.52	8	13.54	####	0.00	2.52	2.73E-03	2.66E-03	2.24E-10	6.96E-05	4.26E-10	1.93E-05	4.7154
			363.70	7	14.60	####	0.00	-2.24	2.69E-03	2.67E-03	1.94E-11	2.05E-05	1.26E-10	6.54E-05	4.1846
			1296.50	6	15.67	####	0.00	-10.80	2.60E-03	2.59E-03	1.64E-12	5.88E-06	3.70E-11	2.22E-04	3.6538
			10639.27	5	16.78	####	0.00	-37.58	2.33E-03	2.33E-03	1.28E-13	1.56E-06	1.09E-11	7.53E-04	3.1231
			105837.70	4	18.05	####	0.00	-127.82	1.43E-03	1.43E-03	6.82E-15	2.81E-07	3.21E-12	2.56E-03	2.5923
			1234917.15	3	#####	####	0.00	-270.87	1.73E-96	1.73E-96	7.14E-109	1.00E-100	9.45E-13	8.68E-03	2.0615
			30235232.10	2	#####	####	0.00	-270.87	5.86E-96	5.86E-96	2.10E-109	1.00E-100	2.79E-13	2.95E-02	1.5308
			2091190430.52	1	#####	####	0.00	-270.87	1.99E-95	1.99E-95	6.19E-110	1.00E-100	8.21E-14	1.00E-01	1.0000
			267.52	8	-0.16	7.74	44.07	260.56	5.31E-03	1.29E-04	2.54E-05	5.16E-03	6.52E-07	1.26E-08	7.9000
			270.87	7.9	-0.02	7.78	40.36	256.86	5.28E-03	1.61E-04	1.99E-05	5.10E-03	5.18E-07	1.58E-08	7.8000
			274.78	7.8	0.14	7.84	36.06	252.56	5.23E-03	1.99E-04	1.56E-05	5.02E-03	4.11E-07	2.00E-08	7.7000
			279.46	7.7	0.31	7.91	31.03	247.52	5.18E-03	2.46E-04	1.21E-05	4.93E-03	3.27E-07	2.51E-08	7.6000
			285.14	7.6	0.51	8.01	25.09	241.59	5.12E-03	3.02E-04	9.43E-06	4.81E-03	2.59E-07	3.16E-08	7.5000
			292.15	7.5	0.77	8.17	18.11	234.61	5.05E-03	3.70E-04	7.28E-06	4.68E-03	2.06E-07	3.98E-08	7.4000
			300.85	7.4	1.14	8.44	9.94	226.44	4.97E-03	4.50E-04	5.58E-06	4.52E-03	1.64E-07	5.01E-08	7.3000
			311.69	7.3	2.57	9.77	0.49	216.99	4.88E-03	5.43E-04	4.25E-06	4.33E-03	1.30E-07	6.31E-08	7.2000
			325.27	7.2	9.38	####	0.00	206.19	4.77E-03	6.50E-04	3.21E-06	4.12E-03	1.03E-07	7.94E-08	7.1000
			342.30	7.1	9.51	####	0.00	194.06	4.65E-03	7.70E-04	2.40E-06	3.88E-03	8.21E-08	1.00E-07	7.0000
			363.70	7	9.64	####	0.00	180.70	4.52E-03	9.03E-04	1.78E-06	3.61E-03	6.52E-08	1.26E-07	6.9000
			270.87	7.9	-0.02	7.78	40.36	256.86	5.28E-03	1.61E-04	1.99E-05	5.10E-03	5.18E-07	1.58E-08	7.8000
			271.24	7.89	0.00	7.79	39.96	256.46	5.27E-03	1.64E-04	1.94E-05	5.09E-03	5.06E-07	1.62E-08	7.7900
			271.60	7.88	0.01	7.79	39.55	256.05	5.27E-03	1.68E-04	1.90E-05	5.08E-03	4.94E-07	1.66E-08	7.7800
			271.98	7.87	0.03	7.80	39.14	255.64	5.27E-03	1.71E-04	1.85E-05	5.08E-03	4.83E-07	1.70E-08	7.7700
			272.36	7.86	0.04	7.80	38.72	255.22	5.26E-03	1.75E-04	1.81E-05	5.07E-03	4.72E-07	1.74E-08	7.7600
			272.74	7.85	0.06	7.81	38.30	254.79	5.26E-03	1.79E-04	1.76E-05	5.06E-03	4.61E-07	1.78E-08	7.7500
			273.14	7.84	0.07	7.81	37.86	254.36	5.25E-03	1.83E-04	1.72E-05	5.05E-03	4.51E-07	1.82E-08	7.7400
			273.54	7.83	0.09	7.82	37.42	253.92	5.25E-03	1.87E-04	1.68E-05	5.04E-03	4.41E-07	1.86E-08	7.7300
			273.95	7.82	0.10	7.82	36.98	253.48	5.24E-03	1.91E-04	1.64E-05	5.04E-03	4.31E-07	1.91E-08	7.7200
			274.36	7.81	0.12	7.83	36.52	253.02	5.24E-03	1.95E-04	1.60E-05	5.03E-03	4.21E-07	1.95E-08	7.7100
			274.78	7.8	0.14	7.84	36.06	252.56	5.23E-03	1.99E-04	1.56E-05	5.02E-03	4.11E-07	2.00E-08	7.7000
					0.00	7.79	39.96	256.46	5.27E-03	1.64E-04	1.94E-05	5.09E-03	5.06E-07	1.62E-08	7.7900
					0.00	7.79	39.92	256.42	5.27E-03	1.64E-04	1.94E-05	5.09E-03	5.05E-07	1.63E-08	7.7890
					0.00	7.79	39.88	256.38	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.04E-07	1.63E-08	7.7880
					0.00	7.79	39.84	256.34	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7870
					0.00	7.79	39.80	256.30	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.01E-07	1.64E-08	7.7860
					0.00	7.79	39.76	256.26	5.27E-03	1.66E-04	1.92E-05	5.09E-03	5.00E-07	1.64E-08	7.7850
					0.00	7.79	39.72	256.22	5.27E-03	1.66E-04	1.92E-05	5.09E-03	4.99E-07	1.64E-08	7.7840
					0.01	7.79	39.68	256.18	5.27E-03	1.67E-04	1.91E-05	5.08E-03	4.98E-07	1.65E-08	7.7830
					0.01	7.79	39.63	256.13	5.27E-03	1.67E-04	1.91E-05	5.08E-03	4.97E-07	1.65E-08	7.7820
					0.01	7.79	39.59	256.09	5.27E-03	1.67E-04	1.90E-05	5.08E-03	4.96E-07	1.66E-08	7.7810
					0.01	7.79	39.55	256.05	5.27E-03	1.68E-04	1.90E-05	5.08E-03	4.94E-07	1.66E-08	7.7800
					0.00	7.79	39.84	256.34	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7870
					0.00	7.79	39.83	256.33	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7869
					0.00	7.79	39.83	256.33	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7868
					0.00	7.79	39.83	256.33	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7867
					0.00	7.79	39.82	256.32	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7866
					0.00	7.79	39.82	256.32	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7865
					0.00	7.79	39.81	256.31	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.64E-08	7.7864
					0.00	7.79	39.81	256.31	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.64E-08	7.7863
					0.00	7.79	39.81	256.31	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.64E-08	7.7862
					0.00	7.79	39.80	256.30	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.01E-07	1.64E-08	7.7861
					0.00	7.79	39.80	256.30	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.01E-07	1.64E-08	7.7860
					0.00	7.79	39.83	256.33	5.27E-03	1.65E-04	1.93E-05	5.09E-03	5.02E-07	1.63E-08	7.7869

Tk	293
I	0.00959
E	80.0948
A	0.50625
f(I)	0.08918
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90725
fd	0.6775
K1p	5.03E-07
K2p	6.19E-11
Kwp	8.21E-15
Ksp	7.68E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model

Blend 4 (2): EP001, EP003, EP004, & EP005

The RTW Model Ver. 4.0 ID: **Blend 4 (1)**

STEP 1: Enter initial water characteristics.

Measured TDS	369.7	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	266.38	mg/L
Measured Ca, as CaCO3	54.529	mg/L
Measured Cl	67.58	mg/L
Measured SO4	13.935	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	266	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	55	mg/L	> 40 mg/L	Precipitation potential	7.73	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.3		> 5.0	Langelier index	0.27		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	277	mg/L
Initial Ca sat, as CaCO3	29	mg/L
Initial DIC, as CaCO3	543	mg/L

Theoretical interim water characteristics

Interim acidity	277	mg/L
Interim Ca sat, as CaCO3	29	mg/L
Ryznar index	7.36	
Interim DIC, as CaCO3	543	mg/L
Aggressiveness Index	12.06	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	259	mg/L
Final Ca	47	mg/L
Final acidity	277	mg/L
Final pH	7.71	
Final DIC, as CaCO3	536	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.43E-03	5.43E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.28E-03	5.28E-03													
[CO3-]	2.58E-05	2.58E-05	-40906.80	14	-0.27	7.63	54.53	266.38	5.43E-03	1.32E-04	2.58E-05	5.28E-03	6.50E-07	1.26E-08	7.9000
[H2CO3*	0.000132	1.32E-04	-4093.45	13	0.64	8.01	25.50	237.35	5.14E-03	4.03E-04	6.82E-06	4.73E-03	1.91E-07	4.27E-08	7.3692
[Ca++]s	2.94E-04	2.94E-04	-410.18	12	9.71	####	0.00	175.63	4.53E-03	1.01E-03	1.49E-06	3.51E-03	5.64E-08	1.45E-07	6.8385
pHs alk		7.63	-23.97	11	10.51	####	0.00	93.46	3.70E-03	1.83E-03	2.34E-07	1.87E-03	1.66E-08	4.92E-07	6.3077
			113.49	10	11.46	####	0.00	36.05	3.13E-03	2.41E-03	2.66E-08	7.23E-04	4.89E-09	1.67E-06	5.7769
			237.34	9	12.48	####	0.00	11.43	2.88E-03	2.65E-03	2.54E-09	2.34E-04	1.44E-09	5.67E-06	5.2462
			273.55	8	13.52	####	0.00	2.59	2.80E-03	2.72E-03	2.27E-10	7.10E-05	4.25E-10	1.93E-05	4.7154
			372.13	7	14.59	####	0.00	-2.22	2.75E-03	2.73E-03	1.97E-11	2.09E-05	1.25E-10	6.54E-05	4.1846
			1328.58	6	15.66	####	0.00	-10.79	2.66E-03	2.66E-03	1.67E-12	6.00E-06	3.69E-11	2.22E-04	3.6538
			10907.81	5	16.77	####	0.00	-37.58	2.39E-03	2.39E-03	1.30E-13	1.59E-06	1.09E-11	7.53E-04	3.1231
			108476.03	4	18.03	####	0.00	-127.82	1.49E-03	1.49E-03	7.05E-15	2.93E-07	3.20E-12	2.56E-03	2.5923
			1261780.05	3	#####	####	0.00	-276.98	1.73E-96	1.73E-96	7.10E-109	1.00E-100	9.43E-13	8.68E-03	2.0615
			30557000.64	2	#####	####	0.00	-276.98	5.87E-96	5.87E-96	2.09E-109	1.00E-100	2.78E-13	2.95E-02	1.5308
			2099727242.10	1	#####	####	0.00	-276.98	1.99E-95	1.99E-95	6.16E-110	1.00E-100	8.18E-14	1.00E-01	1.0000
			273.55	8	-0.27	7.63	54.53	266.38	5.43E-03	1.32E-04	2.58E-05	5.28E-03	6.50E-07	1.26E-08	7.9000
			276.98	7.9	-0.13	7.67	50.74	262.59	5.40E-03	1.65E-04	2.02E-05	5.21E-03	5.16E-07	1.58E-08	7.8000
			280.98	7.8	0.01	7.71	46.34	258.19	5.35E-03	2.04E-04	1.58E-05	5.13E-03	4.10E-07	2.00E-08	7.7000
			285.77	7.7	0.17	7.77	41.17	253.02	5.30E-03	2.52E-04	1.23E-05	5.04E-03	3.26E-07	2.51E-08	7.6000
			291.60	7.6	0.35	7.85	35.09	246.94	5.24E-03	3.10E-04	9.58E-06	4.92E-03	2.59E-07	3.16E-08	7.5000
			298.78	7.5	0.57	7.97	27.94	239.79	5.17E-03	3.79E-04	7.40E-06	4.78E-03	2.05E-07	3.98E-08	7.4000
			307.69	7.4	0.84	8.14	19.57	231.42	5.08E-03	4.61E-04	5.67E-06	4.62E-03	1.63E-07	5.01E-08	7.3000
			318.81	7.3	1.25	8.45	9.89	221.74	4.99E-03	5.57E-04	4.32E-06	4.43E-03	1.30E-07	6.31E-08	7.2000
			332.73	7.2	9.37	####	0.00	210.68	4.88E-03	6.66E-04	3.26E-06	4.21E-03	1.03E-07	7.94E-08	7.1000
			350.20	7.1	9.49	####	0.00	198.27	4.75E-03	7.90E-04	2.44E-06	3.96E-03	8.18E-08	1.00E-07	7.0000
			372.13	7	9.62	####	0.00	184.59	4.62E-03	9.26E-04	1.80E-06	3.69E-03	6.50E-08	1.26E-07	6.9000
			276.98	7.9	-0.13	7.67	50.74	262.59	5.40E-03	1.65E-04	2.02E-05	5.21E-03	5.16E-07	1.58E-08	7.8000
			277.35	7.89	-0.12	7.67	50.33	262.18	5.39E-03	1.68E-04	1.98E-05	5.20E-03	5.04E-07	1.62E-08	7.7900
			277.72	7.88	-0.10	7.68	49.91	261.76	5.39E-03	1.72E-04	1.93E-05	5.20E-03	4.93E-07	1.66E-08	7.7800
			278.11	7.87	-0.09	7.68	49.49	261.34	5.38E-03	1.76E-04	1.88E-05	5.19E-03	4.82E-07	1.70E-08	7.7700
			278.50	7.86	-0.07	7.69	49.06	260.91	5.38E-03	1.79E-04	1.84E-05	5.18E-03	4.71E-07	1.74E-08	7.7600
			278.89	7.85	-0.06	7.69	48.62	260.47	5.37E-03	1.83E-04	1.79E-05	5.17E-03	4.60E-07	1.78E-08	7.7500
			279.29	7.84	-0.04	7.70	48.18	260.03	5.37E-03	1.87E-04	1.75E-05	5.17E-03	4.50E-07	1.82E-08	7.7400
			279.70	7.83	-0.03	7.70	47.73	259.58	5.37E-03	1.91E-04	1.71E-05	5.16E-03	4.39E-07	1.86E-08	7.7300
			280.12	7.82	-0.02	7.70	47.27	259.12	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.29E-07	1.91E-08	7.7200
			280.55	7.81	0.00	7.71	46.81	258.66	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.20E-07	1.95E-08	7.7100
			280.98	7.8	0.01	7.71	46.34	258.19	5.35E-03	2.04E-04	1.58E-05	5.13E-03	4.10E-07	2.00E-08	7.7000
					0.00	7.71	46.81	258.66	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.20E-07	1.95E-08	7.7100
					0.00	7.71	46.76	258.61	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7090
					0.00	7.71	46.71	258.56	5.36E-03	2.01E-04	1.62E-05	5.14E-03	4.18E-07	1.96E-08	7.7080
					0.00	7.71	46.67	258.52	5.35E-03	2.01E-04	1.61E-05	5.14E-03	4.17E-07	1.96E-08	7.7070
					0.01	7.71	46.62	258.47	5.35E-03	2.02E-04	1.61E-05	5.14E-03	4.16E-07	1.97E-08	7.7060
					0.01	7.71	46.57	258.42	5.35E-03	2.02E-04	1.60E-05	5.14E-03	4.15E-07	1.97E-08	7.7050
					0.01	7.71	46.52	258.38	5.35E-03	2.02E-04	1.60E-05	5.14E-03	4.14E-07	1.98E-08	7.7040
					0.01	7.71	46.48	258.33	5.35E-03	2.03E-04	1.60E-05	5.13E-03	4.13E-07	1.98E-08	7.7030
					0.01	7.71	46.43	258.28	5.35E-03	2.03E-04	1.59E-05	5.13E-03	4.12E-07	1.99E-08	7.7020
					0.01	7.71	46.38	258.23	5.35E-03	2.04E-04	1.59E-05	5.13E-03	4.11E-07	1.99E-08	7.7010
					0.01	7.71	46.34	258.19	5.35E-03	2.04E-04	1.58E-05	5.13E-03	4.10E-07	2.00E-08	7.7000
					0.00	7.71	46.81	258.66	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.20E-07	1.95E-08	7.7100
					0.00	7.71	46.80	258.65	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7099
					0.00	7.71	46.80	258.65	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7098
					0.00	7.71	46.79	258.64	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7097
					0.00	7.71	46.79	258.64	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7096
					0.00	7.71	46.78	258.63	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7095
					0.00	7.71	46.78	258.63	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7094
					0.00	7.71	46.77	258.63	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7093
					0.00	7.71	46.77	258.62	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7092
					0.00	7.71	46.76	258.62	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7091
					0.00	7.71	46.76	258.61	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7090
					0.00	7.71	46.80	258.65	5.36E-03	2.00E-04	1.62E-05	5.14E-03	4.19E-07	1.95E-08	7.7099

Tk	293
I	0.00924
E	80.0948
A	0.50625
f(I)	0.08771
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.9086
fd	0.68153
K1p	5.02E-07
K2p	6.16E-11
Kwp	8.18E-15
Ksp	7.59E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model

Blend 5 (1): EP001, EP002, EP003, EP004, & EP005

The RTW Model Ver. 4.0 ID: **Blend 4 (2)**

STEP 1: Enter initial water characteristics.

Measured TDS	367.33	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	265.38	mg/L
Measured Ca, as CaCO3	52.824	mg/L
Measured Cl	65.787	mg/L
Measured SO4	14.012	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	265	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	53	mg/L	> 40 mg/L	Precipitation potential	7.18	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.3		> 5.0	Langelier index	0.26		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	276	mg/L
Initial Ca sat, as CaCO3	30	mg/L
Initial DIC, as CaCO3	541	mg/L

Theoretical interim water characteristics

Interim acidity	276	mg/L
Interim Ca sat, as CaCO3	30	mg/L
Ryznar index	7.39	
Interim DIC, as CaCO3	541	mg/L
Aggressiveness Index	12.05	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	258	mg/L
Final Ca	46	mg/L
Final acidity	276	mg/L
Final pH	7.72	
Final DIC, as CaCO3	534	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim														
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final	
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH	
[DIC]	5.41E-03	5.41E-03					mg CaCO3/L	mg CaCO3/L								
[HCO3-]	5.26E-03	5.26E-03														
[CO3-]	2.57E-05	2.57E-05	-40885.70	14	-0.25	7.65	52.82	265.38	5.41E-03	1.32E-04	2.57E-05	5.26E-03	6.49E-07	1.26E-08	7.9000	
[H2CO3*	0.000132	1.32E-04	-4091.34	13	0.67	8.04	23.89	236.45	5.12E-03	4.02E-04	6.79E-06	4.72E-03	1.91E-07	4.27E-08	7.3692	
[Ca++]s	2.95E-04	2.95E-04	-409.98	12	9.71	####	0.00	174.94	4.51E-03	1.01E-03	1.48E-06	3.50E-03	5.64E-08	1.45E-07	6.8385	
pHs alk		7.64	-24.01	11	10.51	####	0.00	93.09	3.69E-03	1.83E-03	2.33E-07	1.86E-03	1.66E-08	4.92E-07	6.3077	
			113.11	10	11.46	####	0.00	35.90	3.12E-03	2.40E-03	2.65E-08	7.20E-04	4.89E-09	1.67E-06	5.7769	
			236.48	9	12.48	####	0.00	11.38	2.87E-03	2.64E-03	2.53E-09	2.33E-04	1.44E-09	5.67E-06	5.2462	
			272.53	8	13.53	####	0.00	2.57	2.79E-03	2.71E-03	2.26E-10	7.07E-05	4.25E-10	1.93E-05	4.7154	
			370.79	7	14.59	####	0.00	-2.23	2.74E-03	2.72E-03	1.96E-11	2.08E-05	1.25E-10	6.54E-05	4.1846	
			1324.16	6	15.66	####	0.00	-10.80	2.65E-03	2.65E-03	1.66E-12	5.98E-06	3.68E-11	2.22E-04	3.6538	
			10872.58	5	16.77	####	0.00	-37.58	2.38E-03	2.38E-03	1.30E-13	1.59E-06	1.09E-11	7.53E-04	3.1231	
			108133.61	4	18.04	####	0.00	-127.82	1.48E-03	1.48E-03	6.99E-15	2.90E-07	3.20E-12	2.56E-03	2.5923	
			1258457.35	3	#####	####	0.00	-275.95	1.73E-96	1.73E-96	7.09E-109	1.00E-100	9.42E-13	8.68E-03	2.0615	
			30533039.56	2	#####	####	0.00	-275.95	5.88E-96	5.88E-96	2.09E-109	1.00E-100	2.78E-13	2.95E-02	1.5308	
			2100413340.75	1	#####	####	0.00	-275.95	1.99E-95	1.99E-95	6.15E-110	1.00E-100	8.18E-14	1.00E-01	1.0000	
			272.53	8	-0.25	7.65	52.82	265.38	5.41E-03	1.32E-04	2.57E-05	5.26E-03	6.49E-07	1.26E-08	7.9000	
			275.95	7.9	-0.12	7.68	49.04	261.60	5.38E-03	1.64E-04	2.02E-05	5.19E-03	5.16E-07	1.58E-08	7.8000	
			279.94	7.8	0.03	7.73	44.66	257.22	5.33E-03	2.03E-04	1.58E-05	5.11E-03	4.10E-07	2.00E-08	7.7000	
			284.71	7.7	0.19	7.79	39.51	252.07	5.28E-03	2.51E-04	1.23E-05	5.02E-03	3.26E-07	2.51E-08	7.6000	
			290.52	7.6	0.38	7.88	33.45	246.01	5.22E-03	3.09E-04	9.53E-06	4.90E-03	2.59E-07	3.16E-08	7.5000	
			297.68	7.5	0.59	7.99	26.32	238.88	5.15E-03	3.78E-04	7.36E-06	4.76E-03	2.05E-07	3.98E-08	7.4000	
			306.56	7.4	0.87	8.17	17.99	230.55	5.06E-03	4.60E-04	5.65E-06	4.60E-03	1.63E-07	5.01E-08	7.3000	
			317.65	7.3	1.33	8.53	8.34	220.90	4.97E-03	5.55E-04	4.30E-06	4.41E-03	1.30E-07	6.31E-08	7.2000	
			331.53	7.2	9.37	####	0.00	209.88	4.86E-03	6.64E-04	3.25E-06	4.19E-03	1.03E-07	7.94E-08	7.1000	
			348.93	7.1	9.49	####	0.00	197.50	4.73E-03	7.87E-04	2.43E-06	3.95E-03	8.18E-08	1.00E-07	7.0000	
			370.79	7	9.63	####	0.00	183.87	4.60E-03	9.23E-04	1.80E-06	3.67E-03	6.49E-08	1.26E-07	6.9000	
			275.95	7.9	-0.12	7.68	49.04	261.60	5.38E-03	1.64E-04	2.02E-05	5.19E-03	5.16E-07	1.58E-08	7.8000	
			276.32	7.89	-0.10	7.69	48.63	261.20	5.37E-03	1.68E-04	1.97E-05	5.18E-03	5.04E-07	1.62E-08	7.7900	
			276.69	7.88	-0.09	7.69	48.22	260.78	5.37E-03	1.71E-04	1.92E-05	5.18E-03	4.93E-07	1.66E-08	7.7800	
			277.08	7.87	-0.07	7.70	47.80	260.36	5.36E-03	1.75E-04	1.87E-05	5.17E-03	4.81E-07	1.70E-08	7.7700	
			277.46	7.86	-0.06	7.70	47.37	259.93	5.36E-03	1.79E-04	1.83E-05	5.16E-03	4.71E-07	1.74E-08	7.7600	
			277.86	7.85	-0.04	7.71	46.94	259.50	5.35E-03	1.83E-04	1.78E-05	5.15E-03	4.60E-07	1.78E-08	7.7500	
			278.26	7.84	-0.03	7.71	46.49	259.06	5.35E-03	1.87E-04	1.74E-05	5.15E-03	4.49E-07	1.82E-08	7.7400	
			278.67	7.83	-0.01	7.72	46.05	258.61	5.35E-03	1.91E-04	1.70E-05	5.14E-03	4.39E-07	1.86E-08	7.7300	
			279.08	7.82	0.00	7.72	45.59	258.15	5.34E-03	1.95E-04	1.66E-05	5.13E-03	4.29E-07	1.91E-08	7.7200	
			279.51	7.81	0.02	7.73	45.13	257.69	5.34E-03	1.99E-04	1.62E-05	5.12E-03	4.19E-07	1.95E-08	7.7100	
			279.94	7.8	0.03	7.73	44.66	257.22	5.33E-03	2.03E-04	1.58E-05	5.11E-03	4.10E-07	2.00E-08	7.7000	
					-0.01	7.72	46.05	258.61	5.35E-03	1.91E-04	1.70E-05	5.14E-03	4.39E-07	1.86E-08	7.7300	
					-0.01	7.72	46.00	258.56	5.35E-03	1.91E-04	1.69E-05	5.14E-03	4.38E-07	1.87E-08	7.7290	
					-0.01	7.72	45.96	258.52	5.34E-03	1.92E-04	1.69E-05	5.14E-03	4.37E-07	1.87E-08	7.7280	
					-0.01	7.72	45.91	258.47	5.34E-03	1.92E-04	1.68E-05	5.14E-03	4.36E-07	1.87E-08	7.7270	
					-0.01	7.72	45.87	258.43	5.34E-03	1.92E-04	1.68E-05	5.13E-03	4.35E-07	1.88E-08	7.7260	
					-0.01	7.72	45.82	258.38	5.34E-03	1.93E-04	1.68E-05	5.13E-03	4.34E-07	1.88E-08	7.7250	
					0.00	7.72	45.77	258.33	5.34E-03	1.93E-04	1.67E-05	5.13E-03	4.33E-07	1.89E-08	7.7240	
					0.00	7.72	45.73	258.29	5.34E-03	1.94E-04	1.67E-05	5.13E-03	4.32E-07	1.89E-08	7.7230	
					0.00	7.72	45.68	258.24	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7220	
					0.00	7.72	45.64	258.20	5.34E-03	1.95E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7210	
					0.00	7.72	45.59	258.15	5.34E-03	1.95E-04	1.66E-05	5.13E-03	4.29E-07	1.91E-08	7.7200	
					0.00	7.72	45.68	258.24	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7220	
					0.00	7.72	45.68	258.24	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7219	
					0.00	7.72	45.67	258.23	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7218	
					0.00	7.72	45.67	258.23	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7217	
					0.00	7.72	45.66	258.22	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7216	
					0.00	7.72	45.66	258.22	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.31E-07	1.90E-08	7.7215	
					0.00	7.72	45.66	258.22	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7214	
					0.00	7.72	45.65	258.21	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7213	
					0.00	7.72	45.65	258.21	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7212	
					0.00	7.72	45.64	258.20	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7211	
					0.00	7.72	45.64	258.20	5.34E-03	1.95E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7210	
					0.00	7.72	45.64	258.20	5.34E-03	1.94E-04	1.66E-05	5.13E-03	4.30E-07	1.90E-08	7.7211	

Tk	293
I	0.00918
E	80.0948
A	0.50625
f(I)	0.08745
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90883
fd	0.68224
K1p	5.01E-07
K2p	6.15E-11
Kwp	8.18E-15
Ksp	7.58E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

RTW Model

Blend 5 (2): EP001, EP002, EP003, EP004, & EP005

The RTW Model Ver. 4.0 ID: **Blend 5 (1)**

STEP 1: Enter initial water characteristics.

Measured TDS	373.54	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	266.32	mg/L
Measured Ca, as CaCO3	53.14	mg/L
Measured Cl	68.68	mg/L
Measured SO4	13.99	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	266	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	53	mg/L	> 40 mg/L	Precipitation potential	7.30	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.2		> 5.0	Langelier index	0.26		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	277	mg/L
Initial Ca sat, as CaCO3	29	mg/L
Initial DIC, as CaCO3	543	mg/L

Theoretical interim water characteristics

Interim acidity	277	mg/L
Interim Ca sat, as CaCO3	29	mg/L
Ryznar index	7.38	
Interim DIC, as CaCO3	543	mg/L
Aggressiveness Index	12.05	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	259	mg/L
Final Ca	46	mg/L
Final acidity	277	mg/L
Final pH	7.72	
Final DIC, as CaCO3	536	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim														
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final	
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH	
[DIC]	5.43E-03	5.43E-03					mg CaCO3/L	mg CaCO3/L								
[HCO3-]	5.27E-03	5.27E-03														
[CO3-]	2.58E-05	2.58E-05	-40940.93	14	-0.26	7.64	53.14	266.32	5.43E-03	1.32E-04	2.58E-05	5.27E-03	6.50E-07	1.26E-08	7.9000	
[H2CO3*	0.000132	1.32E-04	-4096.86	13	0.66	8.03	24.13	237.31	5.14E-03	4.03E-04	6.83E-06	4.73E-03	1.92E-07	4.27E-08	7.3692	
[Ca++]s	2.95E-04	2.95E-04	-410.53	12	9.71	####	0.00	175.63	4.53E-03	1.01E-03	1.49E-06	3.51E-03	5.64E-08	1.45E-07	6.8385	
pHs alk		7.64	-24.04	11	10.51	####	0.00	93.49	3.70E-03	1.83E-03	2.34E-07	1.87E-03	1.66E-08	4.92E-07	6.3077	
			113.35	10	11.46	####	0.00	36.06	3.13E-03	2.41E-03	2.67E-08	7.23E-04	4.90E-09	1.67E-06	5.7769	
			237.24	9	12.48	####	0.00	11.44	2.88E-03	2.65E-03	2.55E-09	2.34E-04	1.44E-09	5.67E-06	5.2462	
			273.47	8	13.53	####	0.00	2.59	2.79E-03	2.72E-03	2.27E-10	7.10E-05	4.25E-10	1.93E-05	4.7154	
			371.96	7	14.59	####	0.00	-2.22	2.75E-03	2.73E-03	1.98E-11	2.09E-05	1.25E-10	6.54E-05	4.1846	
			1327.39	6	15.66	####	0.00	-10.79	2.66E-03	2.66E-03	1.67E-12	6.01E-06	3.69E-11	2.22E-04	3.6538	
			10896.48	5	16.77	####	0.00	-37.58	2.39E-03	2.39E-03	1.31E-13	1.59E-06	1.09E-11	7.53E-04	3.1231	
			108361.84	4	18.03	####	0.00	-127.82	1.49E-03	1.49E-03	7.06E-15	2.93E-07	3.20E-12	2.56E-03	2.5923	
			1260489.02	3	#####	####	0.00	-276.90	1.73E-96	1.73E-96	7.11E-109	1.00E-100	9.43E-13	8.68E-03	2.0615	
			30529128.38	2	#####	####	0.00	-276.90	5.87E-96	5.87E-96	2.09E-109	1.00E-100	2.78E-13	2.95E-02	1.5308	
			2097952278.87	1	#####	####	0.00	-276.90	1.99E-95	1.99E-95	6.17E-110	1.00E-100	8.19E-14	1.00E-01	1.0000	
			273.47	8	-0.26	7.64	53.14	266.32	5.43E-03	1.32E-04	2.58E-05	5.27E-03	6.50E-07	1.26E-08	7.9000	
			276.90	7.9	-0.12	7.68	49.35	262.53	5.39E-03	1.64E-04	2.03E-05	5.21E-03	5.17E-07	1.58E-08	7.8000	
			280.90	7.8	0.03	7.73	44.95	258.13	5.35E-03	2.04E-04	1.59E-05	5.13E-03	4.10E-07	2.00E-08	7.7000	
			285.68	7.7	0.19	7.79	39.79	252.97	5.30E-03	2.52E-04	1.24E-05	5.03E-03	3.26E-07	2.51E-08	7.6000	
			291.51	7.6	0.37	7.87	33.72	246.90	5.24E-03	3.10E-04	9.59E-06	4.92E-03	2.59E-07	3.16E-08	7.5000	
			298.68	7.5	0.59	7.99	26.57	239.75	5.17E-03	3.79E-04	7.41E-06	4.78E-03	2.06E-07	3.98E-08	7.4000	
			307.59	7.4	0.87	8.17	18.21	231.39	5.08E-03	4.61E-04	5.68E-06	4.62E-03	1.63E-07	5.01E-08	7.3000	
			318.70	7.3	1.31	8.51	8.54	221.72	4.99E-03	5.56E-04	4.33E-06	4.43E-03	1.30E-07	6.31E-08	7.2000	
			332.60	7.2	9.37	####	0.00	210.67	4.88E-03	6.66E-04	3.27E-06	4.21E-03	1.03E-07	7.94E-08	7.1000	
			350.05	7.1	9.49	####	0.00	198.26	4.75E-03	7.89E-04	2.44E-06	3.96E-03	8.19E-08	1.00E-07	7.0000	
			371.96	7	9.62	####	0.00	184.59	4.61E-03	9.25E-04	1.81E-06	3.69E-03	6.50E-08	1.26E-07	6.9000	
			276.90	7.9	-0.12	7.68	49.35	262.53	5.39E-03	1.64E-04	2.03E-05	5.21E-03	5.17E-07	1.58E-08	7.8000	
			277.27	7.89	-0.10	7.69	48.94	262.12	5.39E-03	1.68E-04	1.98E-05	5.20E-03	5.05E-07	1.62E-08	7.7900	
			277.64	7.88	-0.09	7.69	48.52	261.70	5.39E-03	1.72E-04	1.93E-05	5.19E-03	4.93E-07	1.66E-08	7.7800	
			278.03	7.87	-0.08	7.69	48.10	261.28	5.38E-03	1.75E-04	1.88E-05	5.19E-03	4.82E-07	1.70E-08	7.7700	
			278.42	7.86	-0.06	7.70	47.67	260.85	5.38E-03	1.79E-04	1.84E-05	5.18E-03	4.71E-07	1.74E-08	7.7600	
			278.81	7.85	-0.05	7.70	47.24	260.42	5.37E-03	1.83E-04	1.79E-05	5.17E-03	4.60E-07	1.78E-08	7.7500	
			279.22	7.84	-0.03	7.71	46.79	259.97	5.37E-03	1.87E-04	1.75E-05	5.16E-03	4.50E-07	1.82E-08	7.7400	
			279.62	7.83	-0.02	7.71	46.34	259.52	5.36E-03	1.91E-04	1.71E-05	5.16E-03	4.40E-07	1.86E-08	7.7300	
			280.04	7.82	0.00	7.72	45.89	259.07	5.36E-03	1.95E-04	1.67E-05	5.15E-03	4.30E-07	1.91E-08	7.7200	
			280.46	7.81	0.01	7.72	45.42	258.60	5.36E-03	2.00E-04	1.63E-05	5.14E-03	4.20E-07	1.95E-08	7.7100	
			280.90	7.8	0.03	7.73	44.95	258.13	5.35E-03	2.04E-04	1.59E-05	5.13E-03	4.10E-07	2.00E-08	7.7000	
					0.00	7.72	45.89	259.07	5.36E-03	1.95E-04	1.67E-05	5.15E-03	4.30E-07	1.91E-08	7.7200	
					0.00	7.72	45.84	259.02	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.29E-07	1.91E-08	7.7190	
					0.00	7.72	45.80	258.98	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7180	
					0.00	7.72	45.75	258.93	5.36E-03	1.97E-04	1.65E-05	5.15E-03	4.27E-07	1.92E-08	7.7170	
					0.00	7.72	45.70	258.88	5.36E-03	1.97E-04	1.65E-05	5.14E-03	4.26E-07	1.92E-08	7.7160	
					0.01	7.72	45.66	258.84	5.36E-03	1.97E-04	1.65E-05	5.14E-03	4.25E-07	1.93E-08	7.7150	
					0.01	7.72	45.61	258.79	5.36E-03	1.98E-04	1.64E-05	5.14E-03	4.24E-07	1.93E-08	7.7140	
					0.01	7.72	45.56	258.74	5.36E-03	1.98E-04	1.64E-05	5.14E-03	4.23E-07	1.94E-08	7.7130	
					0.01	7.72	45.52	258.70	5.36E-03	1.99E-04	1.63E-05	5.14E-03	4.22E-07	1.94E-08	7.7120	
					0.01	7.72	45.47	258.65	5.36E-03	1.99E-04	1.63E-05	5.14E-03	4.21E-07	1.95E-08	7.7110	
					0.01	7.72	45.42	258.60	5.36E-03	2.00E-04	1.63E-05	5.14E-03	4.20E-07	1.95E-08	7.7100	
					0.00	7.72	45.84	259.02	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.29E-07	1.91E-08	7.7190	
					0.00	7.72	45.84	259.02	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.29E-07	1.91E-08	7.7189	
					0.00	7.72	45.83	259.01	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.29E-07	1.91E-08	7.7188	
					0.00	7.72	45.83	259.01	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7187	
					0.00	7.72	45.82	259.00	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7186	
					0.00	7.72	45.82	259.00	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7185	
					0.00	7.72	45.81	258.99	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7184	
					0.00	7.72	45.81	258.99	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7183	
					0.00	7.72	45.80	258.98	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7182	
					0.00	7.72	45.80	258.98	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7181	
					0.00	7.72	45.80	258.98	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.28E-07	1.91E-08	7.7180	
					0.00	7.72	45.84	259.02	5.36E-03	1.96E-04	1.66E-05	5.15E-03	4.29E-07	1.91E-08	7.7190	

Tk	293
I	0.00934
E	80.0948
A	0.50625
f(I)	0.08812
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90822
fd	0.6804
K1p	5.02E-07
K2p	6.17E-11
Kwp	8.19E-15
Ksp	7.62E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

The RTW Model Ver. 4.0 ID: **Blend 5 (2)**

STEP 1: Enter initial water characteristics.

Measured TDS	368.15	mg/L
Measured temperature	20	deg C
Measured pH	7.9	
Measured alk, as CaCO3	262.85	mg/L
Measured Ca, as CaCO3	50.656	mg/L
Measured Cl	66	mg/L
Measured SO4	14.01	mg/L

For CT and TTHM functions enter current:

Treated water pH	7.9	
Chlorine residual		mg/L
Chlorine or hypochlorite dose as chlorine equivalent		mg/L

STEP 2: Enter amount of each chemical to be added (expressed as 100% chemical). Press Ctrl+C to select chemicals for this list.

Alum *14H2O	0	mg/L
Carbon dioxide	0	mg/L
Caustic soda	0	mg/L
Chlorine gas	0	mg/L
Ferric chloride (anhydrous)	0	mg/L
Ferrous sulfate *7H2O	0	mg/L
Hydrochloric acid	0	mg/L
Hydrofluosilicic acid	0	mg/L
Lime (slaked)	0	mg/L
Sulfuric Acid	0	mg/L

STEP 3: Adjust at Step 2 until interim water characteristics meet your criteria.

Theoretical interim water characteristics			Desired	Theoretical interim water characteristics			Desired
Interim alkalinity	263	mg/L	> 40 mg/L	Interim pH	7.90		6.8-9.3
Interim Ca, as CaCO3	51	mg/L	> 40 mg/L	Precipitation potential	6.38	mg/L	4-10 mg/L
Alk/(Cl+SO4)	3.3		> 5.0	Langelier index	0.23		>0

Press PAGE DOWN for additional initial, interim and final water characteristics if desired.

Calculated initial water characteristics

Initial acidity	273	mg/L
Initial Ca sat, as CaCO3	30	mg/L
Initial DIC, as CaCO3	536	mg/L

Theoretical interim water characteristics

Interim acidity	273	mg/L
Interim Ca sat, as CaCO3	30	mg/L
Ryznar index	7.43	
Interim DIC, as CaCO3	536	mg/L
Aggressiveness Index	12.02	

Theoretical final water characteristics after CaCO3 precipitation

Final alkalinity	256	mg/L
Final Ca	44	mg/L
Final acidity	273	mg/L
Final pH	7.74	
Final DIC, as CaCO3	530	mg/L

Press PAGE UP to review measured initial water characteristics, chemical addition quantities and additional interim water characteristics.

CT and TTHM Results

Required chlorine residual to maintain current level of giardia inactivation	N/A	mg/L
Estimated maximum total trihalomethane concentration change from current level	N/A	%

	Initial	Interim													
			Interim	Interim	Delta	Final	Final	Final		Final	Final	Final	Final	Final	Final
{H+}	1.26E-08	1.26E-08	Acd, mg/l	pH	pH	pH	Ca	Alk	[DIC]	[H2CO3*]	[CO3--]	[HCO3-]	{OH-}	{H+}	pH
[DIC]	5.36E-03	5.36E-03					mg CaCO3/L	mg CaCO3/L							
[HCO3-]	5.21E-03	5.21E-03													
[CO3-]	2.54E-05	2.54E-05	-40893.04	14	-0.23	7.67	50.66	262.85	5.36E-03	1.31E-04	2.54E-05	5.21E-03	6.50E-07	1.26E-08	7.9000
[H2CO3*	0.000131	1.31E-04	-4092.08	13	0.71	8.08	22.00	234.20	5.08E-03	3.98E-04	6.73E-06	4.67E-03	1.91E-07	4.27E-08	7.3692
[Ca++]s	2.98E-04	2.98E-04	-410.07	12	9.71	####	0.00	173.28	4.47E-03	1.00E-03	1.47E-06	3.46E-03	5.64E-08	1.45E-07	6.8385
pHs alk		7.67	-24.21	11	10.52	####	0.00	92.21	3.66E-03	1.81E-03	2.30E-07	1.84E-03	1.66E-08	4.92E-07	6.3077
			111.95	10	11.46	####	0.00	35.56	3.09E-03	2.38E-03	2.62E-08	7.13E-04	4.89E-09	1.67E-06	5.7769
			234.21	9	12.48	####	0.00	11.27	2.85E-03	2.61E-03	2.51E-09	2.31E-04	1.44E-09	5.67E-06	5.2462
			269.93	8	13.53	####	0.00	2.54	2.76E-03	2.69E-03	2.24E-10	7.00E-05	4.25E-10	1.93E-05	4.7154
			367.24	7	14.59	####	0.00	-2.24	2.71E-03	2.69E-03	1.94E-11	2.06E-05	1.25E-10	6.54E-05	4.1846
			1311.35	6	15.66	####	0.00	-10.80	2.63E-03	2.62E-03	1.64E-12	5.92E-06	3.69E-11	2.22E-04	3.6538
			10767.24	5	16.77	####	0.00	-37.58	2.36E-03	2.36E-03	1.28E-13	1.57E-06	1.09E-11	7.53E-04	3.1231
			107102.72	4	18.04	####	0.00	-127.82	1.45E-03	1.45E-03	6.87E-15	2.85E-07	3.20E-12	2.56E-03	2.5923
			1248139.02	3	#####	####	0.00	-273.31	1.73E-96	1.73E-96	7.09E-109	1.00E-100	9.42E-13	8.68E-03	2.0615
			30426658.11	2	#####	####	0.00	-273.31	5.87E-96	5.87E-96	2.09E-109	1.00E-100	2.78E-13	2.95E-02	1.5308
			2099027456.52	1	#####	####	0.00	-273.31	1.99E-95	1.99E-95	6.15E-110	1.00E-100	8.18E-14	1.00E-01	1.0000
			269.93	8	-0.23	7.67	50.66	262.85	5.36E-03	1.31E-04	2.54E-05	5.21E-03	6.50E-07	1.26E-08	7.9000
			273.31	7.9	-0.09	7.71	46.91	259.11	5.32E-03	1.63E-04	2.00E-05	5.14E-03	5.16E-07	1.58E-08	7.8000
			277.26	7.8	0.06	7.76	42.57	254.77	5.28E-03	2.01E-04	1.56E-05	5.06E-03	4.10E-07	2.00E-08	7.7000
			281.99	7.7	0.22	7.82	37.47	249.67	5.23E-03	2.49E-04	1.22E-05	4.97E-03	3.26E-07	2.51E-08	7.6000
			287.75	7.6	0.41	7.91	31.47	243.67	5.17E-03	3.06E-04	9.45E-06	4.85E-03	2.59E-07	3.16E-08	7.5000
			294.83	7.5	0.63	8.03	24.41	236.61	5.10E-03	3.75E-04	7.29E-06	4.72E-03	2.05E-07	3.98E-08	7.4000
			303.63	7.4	0.92	8.22	16.15	228.35	5.02E-03	4.55E-04	5.59E-06	4.56E-03	1.63E-07	5.01E-08	7.3000
			314.61	7.3	1.43	8.63	6.60	218.80	4.92E-03	5.50E-04	4.26E-06	4.37E-03	1.30E-07	6.31E-08	7.2000
			328.35	7.2	9.37	####	0.00	207.88	4.81E-03	6.58E-04	3.22E-06	4.15E-03	1.03E-07	7.94E-08	7.1000
			345.59	7.1	9.50	####	0.00	195.63	4.69E-03	7.79E-04	2.40E-06	3.91E-03	8.18E-08	1.00E-07	7.0000
			367.24	7	9.63	####	0.00	182.13	4.55E-03	9.14E-04	1.78E-06	3.64E-03	6.50E-08	1.26E-07	6.9000
			273.31	7.9	-0.09	7.71	46.91	259.11	5.32E-03	1.63E-04	2.00E-05	5.14E-03	5.16E-07	1.58E-08	7.8000
			273.68	7.89	-0.08	7.71	46.51	258.71	5.32E-03	1.66E-04	1.95E-05	5.13E-03	5.04E-07	1.62E-08	7.7900
			274.05	7.88	-0.06	7.72	46.10	258.29	5.32E-03	1.70E-04	1.90E-05	5.13E-03	4.93E-07	1.66E-08	7.7800
			274.43	7.87	-0.05	7.72	45.68	257.88	5.31E-03	1.73E-04	1.86E-05	5.12E-03	4.82E-07	1.70E-08	7.7700
			274.82	7.86	-0.03	7.73	45.26	257.45	5.31E-03	1.77E-04	1.81E-05	5.11E-03	4.71E-07	1.74E-08	7.7600
			275.21	7.85	-0.02	7.73	44.83	257.02	5.30E-03	1.81E-04	1.77E-05	5.10E-03	4.60E-07	1.78E-08	7.7500
			275.60	7.84	0.00	7.74	44.39	256.59	5.30E-03	1.85E-04	1.72E-05	5.10E-03	4.49E-07	1.82E-08	7.7400
			276.01	7.83	0.01	7.74	43.94	256.14	5.29E-03	1.89E-04	1.68E-05	5.09E-03	4.39E-07	1.86E-08	7.7300
			276.42	7.82	0.03	7.75	43.49	255.69	5.29E-03	1.93E-04	1.64E-05	5.08E-03	4.29E-07	1.91E-08	7.7200
			276.84	7.81	0.04	7.75	43.03	255.23	5.29E-03	1.97E-04	1.60E-05	5.07E-03	4.19E-07	1.95E-08	7.7100
			277.26	7.8	0.06	7.76	42.57	254.77	5.28E-03	2.01E-04	1.56E-05	5.06E-03	4.10E-07	2.00E-08	7.7000
					0.00	7.74	44.39	256.59	5.30E-03	1.85E-04	1.72E-05	5.10E-03	4.49E-07	1.82E-08	7.7400
					0.00	7.74	44.34	256.54	5.30E-03	1.85E-04	1.72E-05	5.10E-03	4.48E-07	1.82E-08	7.7390
					0.00	7.74	44.30	256.50	5.30E-03	1.86E-04	1.72E-05	5.10E-03	4.47E-07	1.83E-08	7.7380
					0.00	7.74	44.26	256.45	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.46E-07	1.83E-08	7.7370
					0.00	7.74	44.21	256.41	5.30E-03	1.87E-04	1.71E-05	5.09E-03	4.45E-07	1.84E-08	7.7360
					0.00	7.74	44.17	256.36	5.30E-03	1.87E-04	1.70E-05	5.09E-03	4.44E-07	1.84E-08	7.7350
					0.01	7.74	44.12	256.32	5.30E-03	1.87E-04	1.70E-05	5.09E-03	4.43E-07	1.85E-08	7.7340
					0.01	7.74	44.08	256.28	5.30E-03	1.88E-04	1.69E-05	5.09E-03	4.42E-07	1.85E-08	7.7330
					0.01	7.74	44.03	256.23	5.30E-03	1.88E-04	1.69E-05	5.09E-03	4.41E-07	1.85E-08	7.7320
					0.01	7.74	43.99	256.19	5.30E-03	1.89E-04	1.69E-05	5.09E-03	4.40E-07	1.86E-08	7.7310
					0.01	7.74	43.94	256.14	5.29E-03	1.89E-04	1.68E-05	5.09E-03	4.39E-07	1.86E-08	7.7300
					0.00	7.74	44.30	256.50	5.30E-03	1.86E-04	1.72E-05	5.10E-03	4.47E-07	1.83E-08	7.7380
					0.00	7.74	44.30	256.49	5.30E-03	1.86E-04	1.71E-05	5.10E-03	4.47E-07	1.83E-08	7.7379
					0.00	7.74	44.29	256.49	5.30E-03	1.86E-04	1.71E-05	5.10E-03	4.47E-07	1.83E-08	7.7378
					0.00	7.74	44.29	256.48	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7377
					0.00	7.74	44.28	256.48	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7376
					0.00	7.74	44.28	256.48	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7375
					0.00	7.74	44.27	256.47	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7374
					0.00	7.74	44.27	256.47	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7373
					0.00	7.74	44.26	256.46	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7372
					0.00	7.74	44.26	256.46	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.46E-07	1.83E-08	7.7371
					0.00	7.74	44.26	256.45	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.46E-07	1.83E-08	7.7370
					0.00	7.74	44.28	256.48	5.30E-03	1.86E-04	1.71E-05	5.09E-03	4.47E-07	1.83E-08	7.7375

Tk	293
I	0.0092
E	80.0948
A	0.50625
f(I)	0.08754
K1	4.14E-07
K2	4.20E-11
Kw	6.75E-15
Ks	3.53E-09
fm	0.90875
fd	0.68199
K1p	5.01E-07
K2p	6.15E-11
Kwp	8.18E-15
Ksp	7.58E-09

	Forms of CaCO3 and their solubility product consta			
Form #	1	2	3	4
Preferred	Calcite	Aragonite	Vaterite	General
1	3.53E-09	4.95E-09	1.34E-08	5.41253E-09

Coagulant	no. of waters of hydrations	
Aluminum Sulfate	14	Enter 14 or 18
Ferric sulfate	9	Enter 9,5,3 or 0
Ferric Chloride	0	Enter 0 or 6

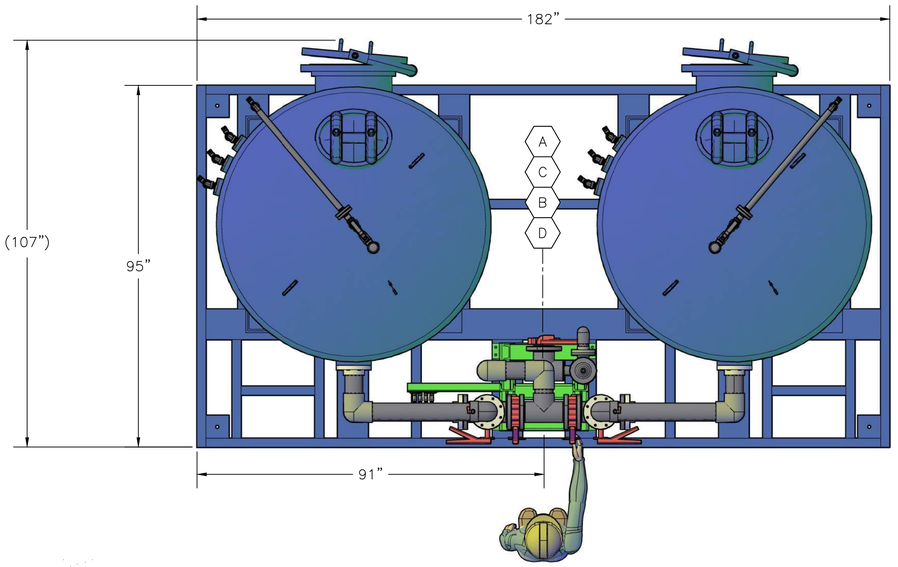
Chemicals Available for Use in RTW Model

Indicate with a Y those chemicals which you want to include in the input area.
Up to 10 may be used at one time. Press HOME to return to the main screen.

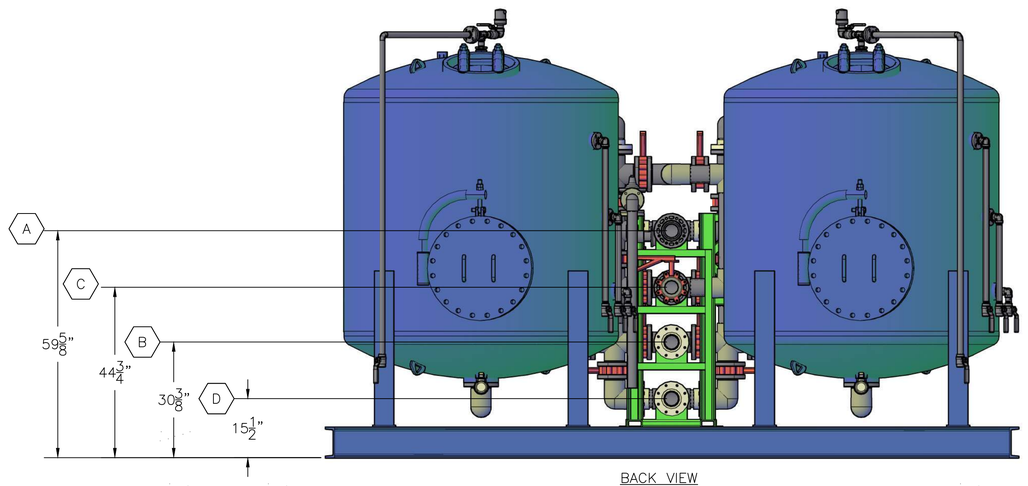
Y or N ?		Chemical Name	Alk	Acd	Ca	Cl	SO4
y		Alum *14H2O	-0.51	0.51	0	0	0.48
n		Alum 50% solution	-0.24	0.24	0	0	0.23
n		Aluminum Chloride	-1.12	1.12	0	0.8	0
n		Calcium carbonate	1	0	1	0	0
n		Calcium chloride	0	0	0.9	0.64	0
n		Calcium hypochlorite	0.7	-0.7	0.7	0	0
y		Carbon dioxide	0	2.28	0	0	0
y		Caustic soda	1.25	-1.25	0	0	0
y		Chlorine gas	-1.41	1.41	0	0.5	0
y		Ferric chloride (anhydrous)	-0.93	0.93	0	0.66	0
n		Ferric sulfate *9H2O	-0.53	0.53	0	0	0.51
y		Ferrous sulfate *7H2O	-0.36	0.36	0	0	0.36
y		Hydrochloric acid	-1.37	1.37	0	0.97	0
y		Hydrofluosilicic acid	-2.08	2.08	0	0	0
y		Lime (slaked)	1.35	-1.35	1.35	0	0
n		Phosphoric acid	-1.53	1.53	0	0	0
n		Potassium Hydroxide	0.89	-0.89	0	0	0
n		Quicklime	1.79	-1.79	1.79	0	0
n		Soda ash	0.94	0	0	0	0
n		Sodium bicarbonate	0.6	0.6	0	0	0
n		Sodium hypochlorite	0.67	-0.67	0	0	0
y		Sulfuric Acid	-1.02	1.02	0	0	0.98
n		Zinc Sulfate	-0.35	0.35	0	0	0.33
n		Magnesium hydroxide	1.71	-1.71	0	0	0
n		User Specified*					

* See User's Manual for information on user specified chemicals

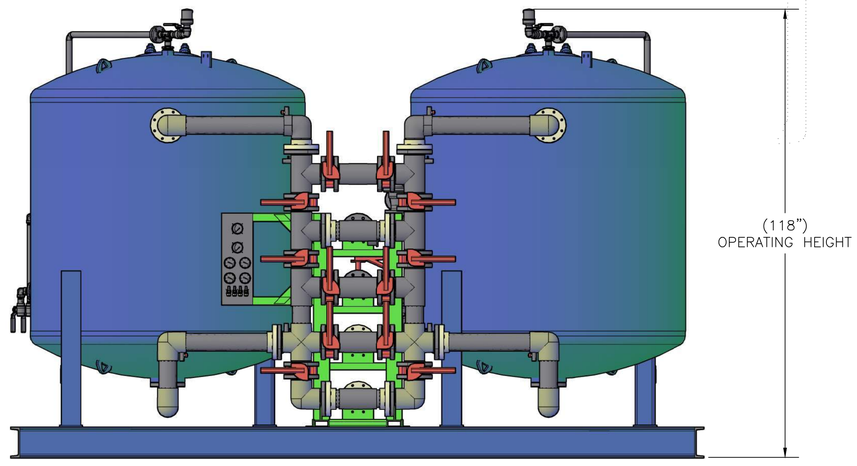
Appendix D:
Manufacturer Information



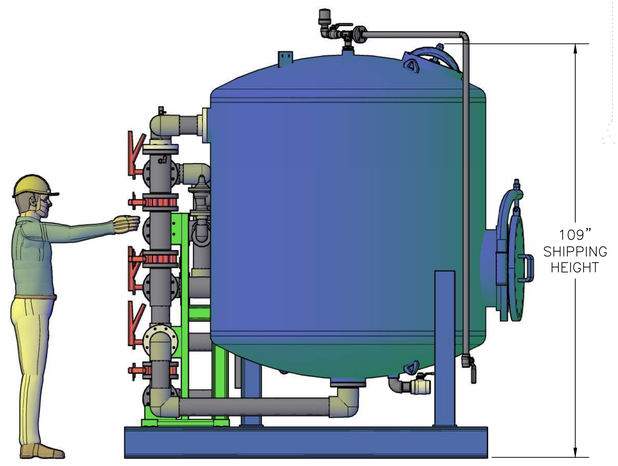
PLAN VIEW



BACK VIEW



FRONT VIEW



RIGHT SIDE VIEW

SALES DRAWING

AdEdge water technologies
2055 Boggs Road
Duluth, GA 30096
P. 678-835-0052 F. 678-835-0057
www. adedgetechnologies.com

TP.	SERVICE CONNECTIONS:	TYPE/MATERIAL:
A	SYSTEM RAW WATER INLET	4” 150# SCH80 PVC FLANGE
B	SYSTEM TREATED OUTLET	4” 150# SCH80 PVC FLANGE
C	SYSTEM BACKWASH OUTLET	4” BUTTERFLY VALVE FLANGE
D	AUX. BACKWASH INLET	4” 150# SCH80 PVC FLANGE

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:
–	–	–	–	–

DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD-0000	12/15/21	NTS

MODEL:
ADEDGE MODULAR
PFAS TREATMENT SYSTEM
APUPFx-7260CS-2-MVT-LL

COSTUMER:
TBD

TITLE:
SALES GENERAL ARRANGEMENT

DRAWING NUMBER:
M-001

SHEET:
3 OF 4

DIMENSIONAL NOTES:

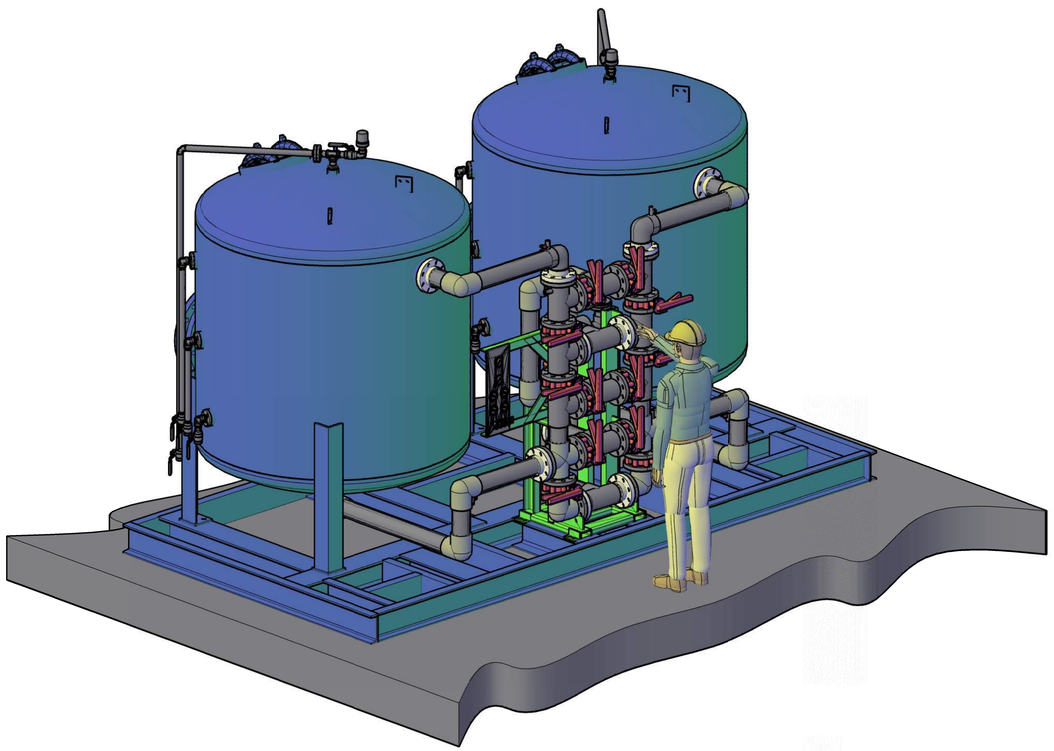
1. ALL DIMENSIONS ARE +/− 2".
2. DO NOT SCALE DRAWING. REFER TO ADEDGE ENGINEERING DEPT FOR ALL DIMENSIONS
3. (##): REFERENCE DIMENSION

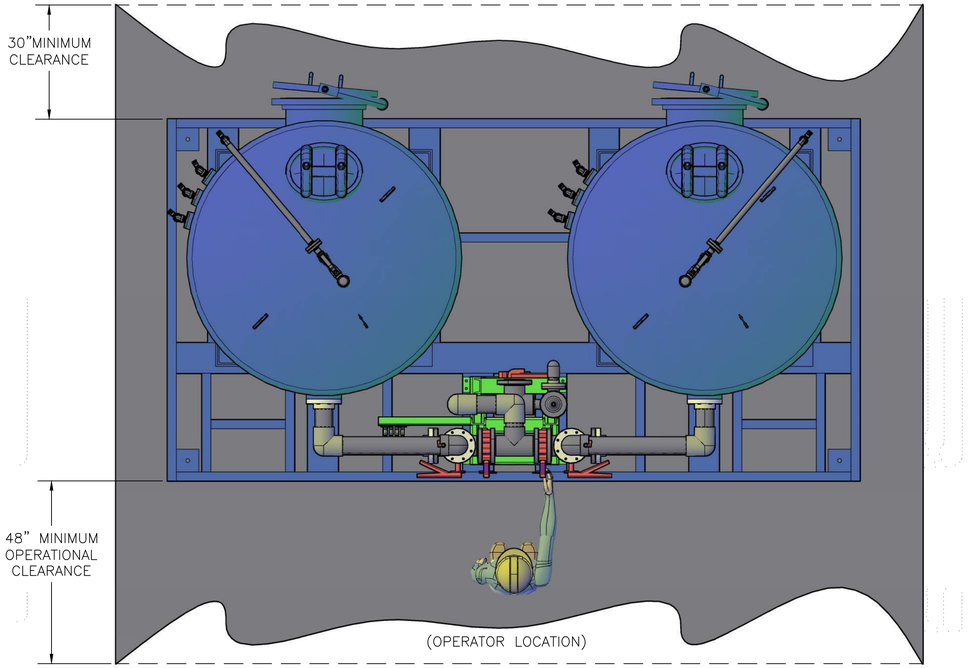
GENERAL SYSTEM SPECIFICATIONS:

1. SCH80 PVC INLET/OUTLET WITH FLANGED TIE POINTS
2. SCH80 PVC VALVE TREE PIPING
3. LUG−STYLE BUTTERFLY VALVES WITH MANUEL OPERATOR ON VALVE TREE
4. LUG−STYLE BUTTERFLY VALVE WITH MANUAL OPERATOR FOR BACKWASH OUTLET
5. 304SS HYDRAULIC PANEL WITH DP GAUGE FOR EACH VESSEL.
6. PRESSURE GAUGES AND SAMPLE VALVES ON EACH VESSEL'S INLET AND OUTLET

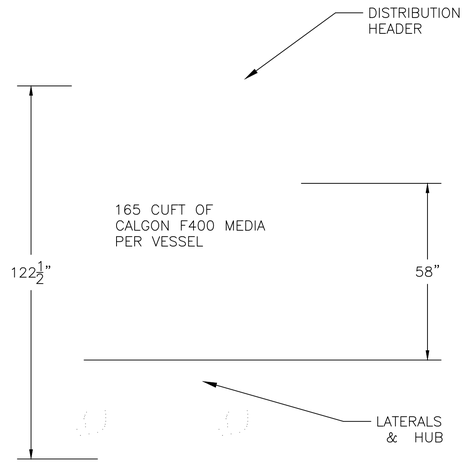
SYSTEM WEIGHT:

1. APPROXIMATE SHIPPING WEIGHT: 13,500 LBS





PLAN VIEW
FRONT AND BACK CLEARANCE



VESSEL INTERNAL VIEW

SALES DRAWING

AdEdge water technologies
2055 Boggs Road
Duluth, GA 30096
P. 678−835−0052 F. 678−835−0057
www. adedgetechnologies.com

TP.	SERVICE CONNECTIONS:	TYPE/MATERIAL:

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:
−	−	−	−	−

DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD−0000	12/15/21	NTS

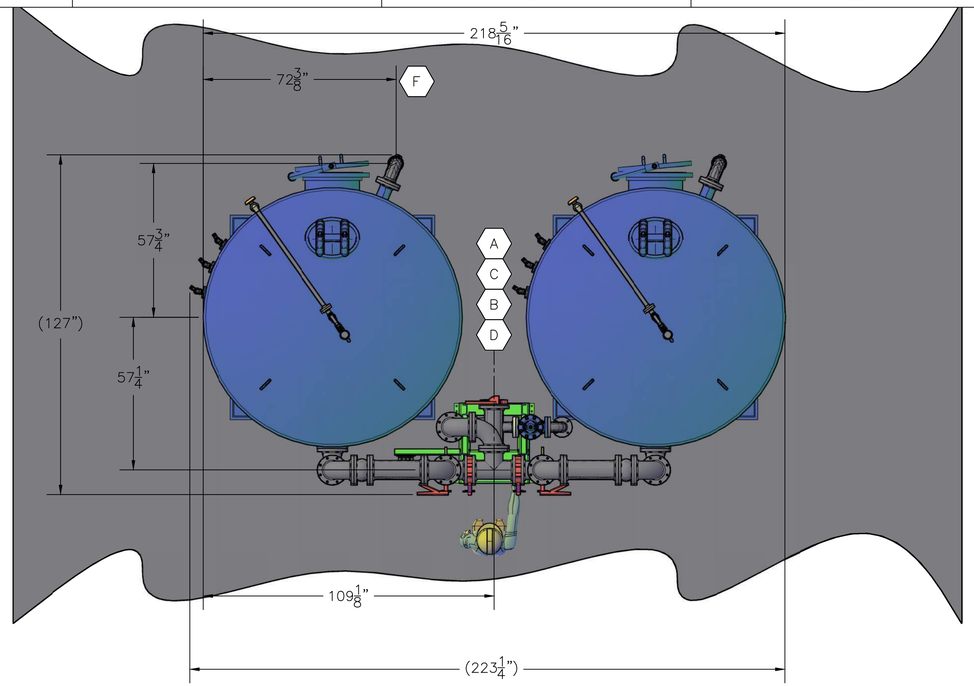
MODEL:
ADEDGE MODULAR
PFAS TREATMENT SYSTEM
APUPFx−7260CS−2−MVT−LL

COSTUMER:
TBD

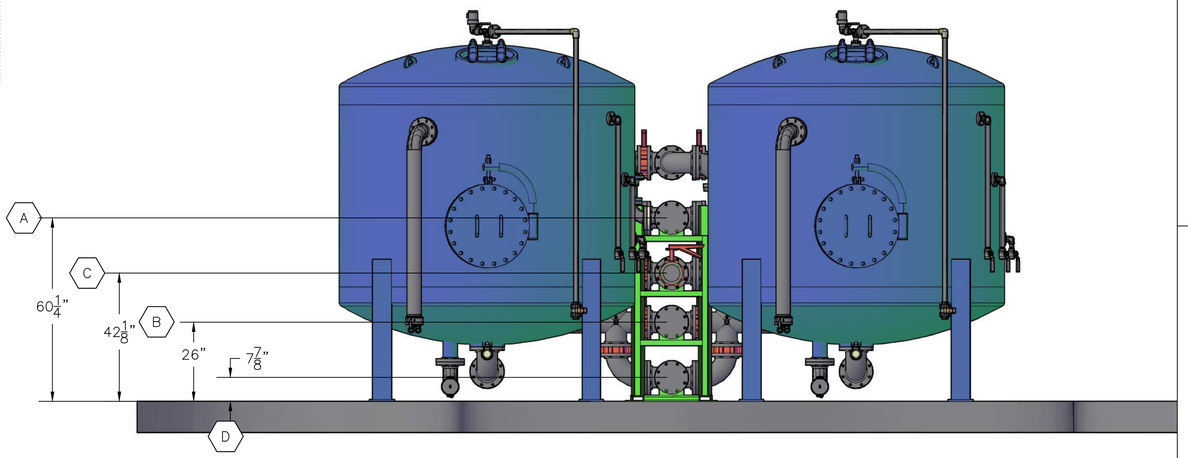
TITLE:
SALES GENERAL ARRANGEMENT

DRAWING NUMBER: M−002

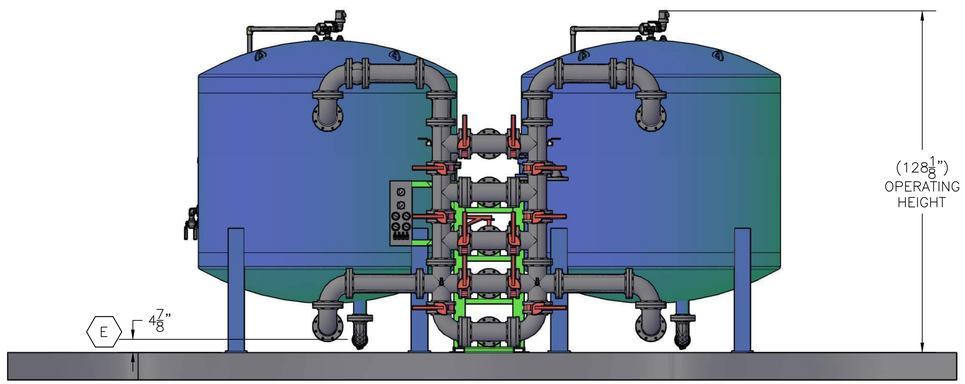
SHEET: 4 OF 4



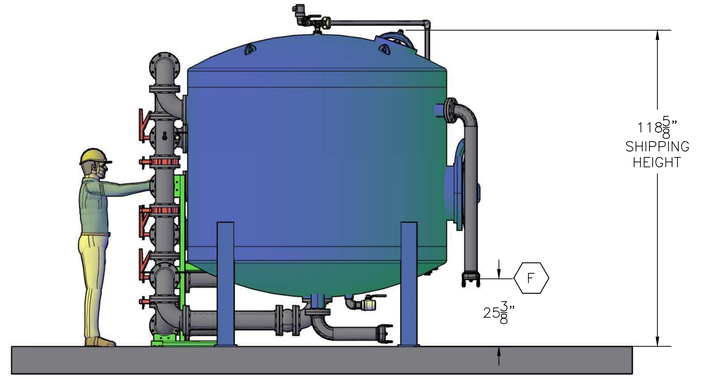
PLAN VIEW



BACK VIEW



FRONT VIEW



RIGHT SIDE VIEW

SALES DRAWING

AdEdge water technologies
2055 Boggs Road
Duluth, GA 30096
P. 678-835-0052 F. 678-835-0057
www. adedgetechnologies.com

TP.	SERVICE CONNECTIONS:	TYPE/MATERIAL:
A	SYSTEM RAW WATER INLET	6" 150# DI FLANGE
B	SYSTEM TREATED OUTLET	6" 150# DI FLANGE
C	SYSTEM BACKWASH OUTLET	6" BUTTERFLY VALVE
D	AUX. BACKWASH INLET	6" 150# DI FLANGE
E	SLUICING NOZZLE (DISCHARGE)	4" 316SS PLUG
F	SLUICING NOZZLE (FILL)	4" 316SS PLUG

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:
–	–	–	–	–

DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD-0000	12/15/21	NTS

MODEL:
ADEDGE MODULAR
PFAS TREATMENT SYSTEM
MODPFx-9660CS-2-MT-LL

COSTUMER:
TBD

TITLE:
SALES GENERAL ARRANGEMENT

DRAWING NUMBER:
M-001

SHEET:
3 OF 4

DIMENSIONAL NOTES:

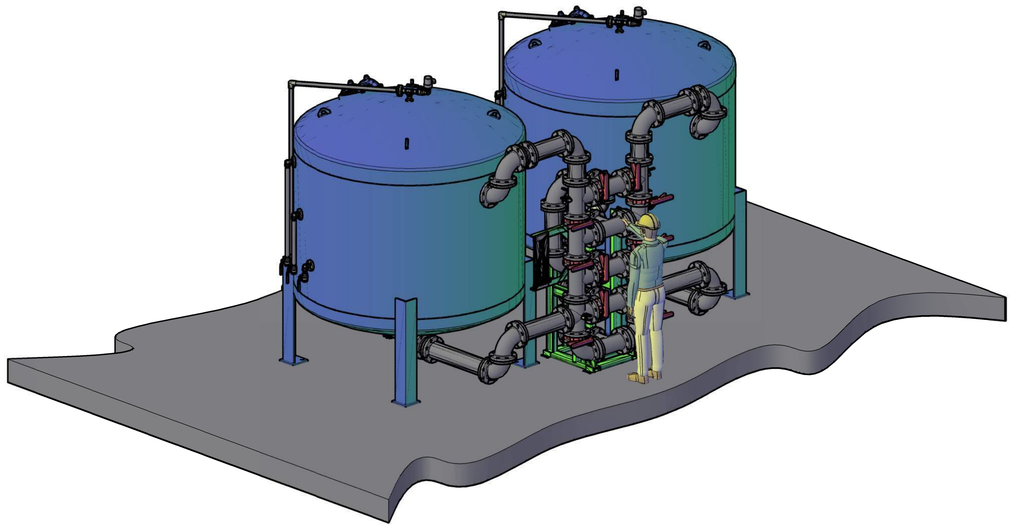
1. ALL DIMENSIONS ARE +/− 2".
2. DO NOT SCALE DRAWING. REFER TO ADEDGE ENGINEERING DEPT FOR ALL DIMENSIONS
3. (##): REFERENCE DIMENSION

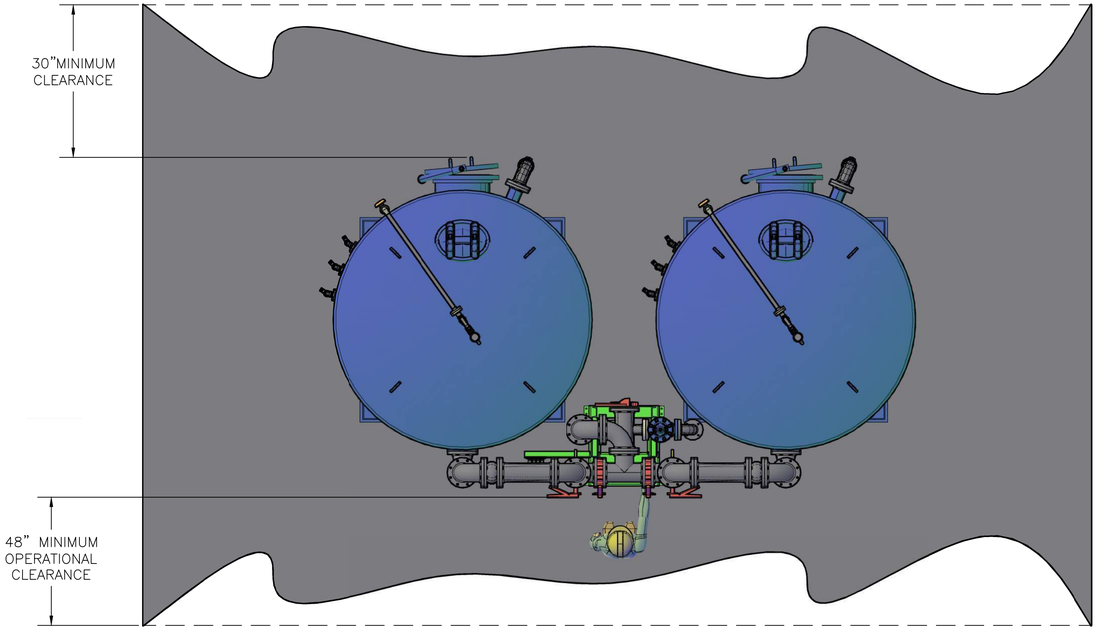
GENERAL SYSTEM SPECIFICATIONS:

1. DUCTILE IRON INLET/OUTLET WITH FLANGED TIE POINTS
2. DUCTILE IRON VALVE TREE PIPING
3. LUG−STYLE BUTTERFLY VALVES WITH MANUEL OPERATOR ON VALVE TREE
4. LUG−STYLE BUTTERFLY VALVE WITH MANUAL OPERATOR FOR BACKWASH OUTLET
5. 304SS HYDRAULIC PANEL WITH DP GAUGE FOR EACH VESSEL.
6. PRESSURE GAUGES AND SAMPLE VALVES ON EACH VESSEL'S INLET AND OUTLET

SYSTEM WEIGHT:

1. APPROXIMATE SHIPPING WEIGHT:





(OPERATOR LOCATION)

PLAN VIEW
FRONT AND BACK CLEARANCE

SALES DRAWING

AdEdge water technologies tm
2055 Boggs Road
Duluth, GA 30096
P. 678−835−0052 F. 678−835−0057
www. adedgetechnologies.com

TP.	SERVICE CONNECTIONS:	TYPE/MATERIAL:

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:
−	−	−	−	−

DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD−0000	12/15/21	NTS

MODEL:
ADEDGE MODULAR
PFAS TREATMENT SYSTEM
MODPFx−9660CS−2−MVT−LL

COSTUMER:
TBD

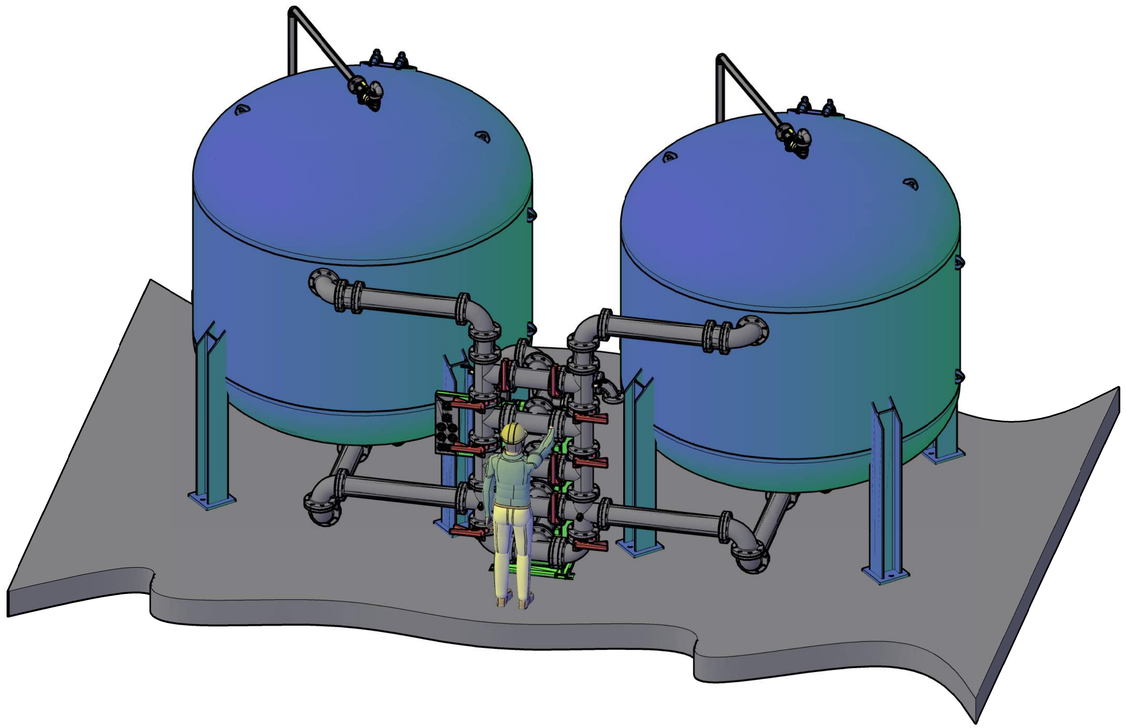
TITLE:
SALES GENERAL ARRANGEMENT

DRAWING NUMBER:
M−002

SHEET:
4 OF 4

MODPFx-12060CS-2-MVT-LL

ADEDGE TREATMENT SYSTEM



AdEdge water technologies tm
2055 Boggs Road
Duluth, GA 30096
P. 678-835-0052 F. 678-835-0057
www. adedgetechnologies.com

CONTRACTOR: ---

SHEET INDEX

DRAWING NO.	TITLE	SHEET NO.

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:

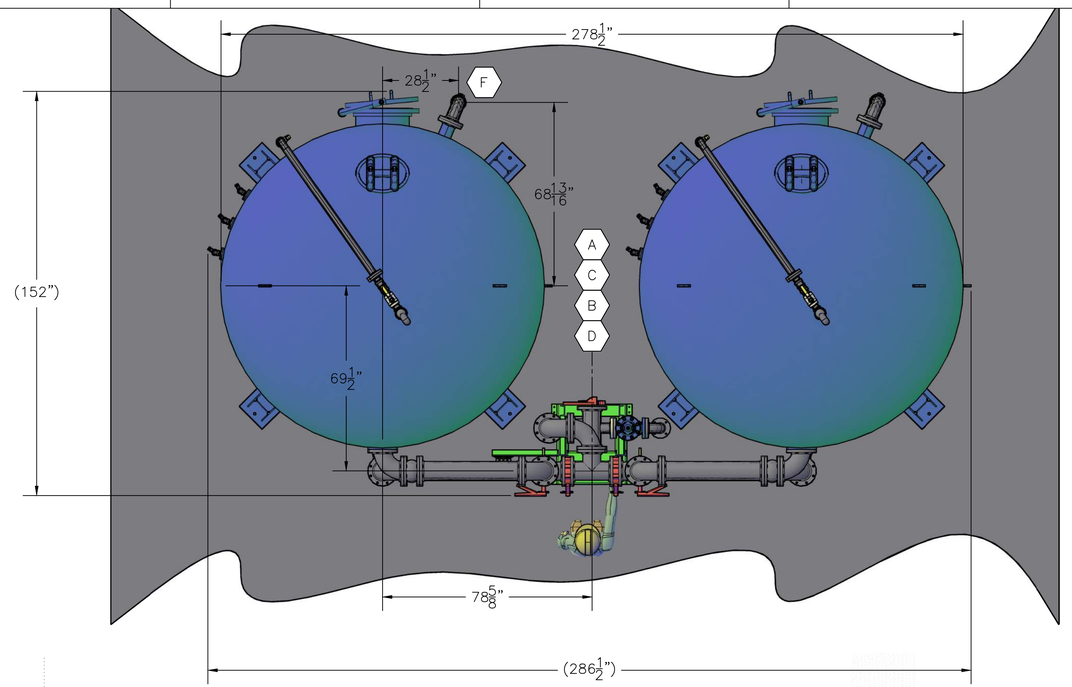
DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD-0000	12/15/21	NTS

MODEL: ADEDGE MODULAR PFAS TREATMENT SYSTEM MODPFx-12060CS-2-MVT-LL

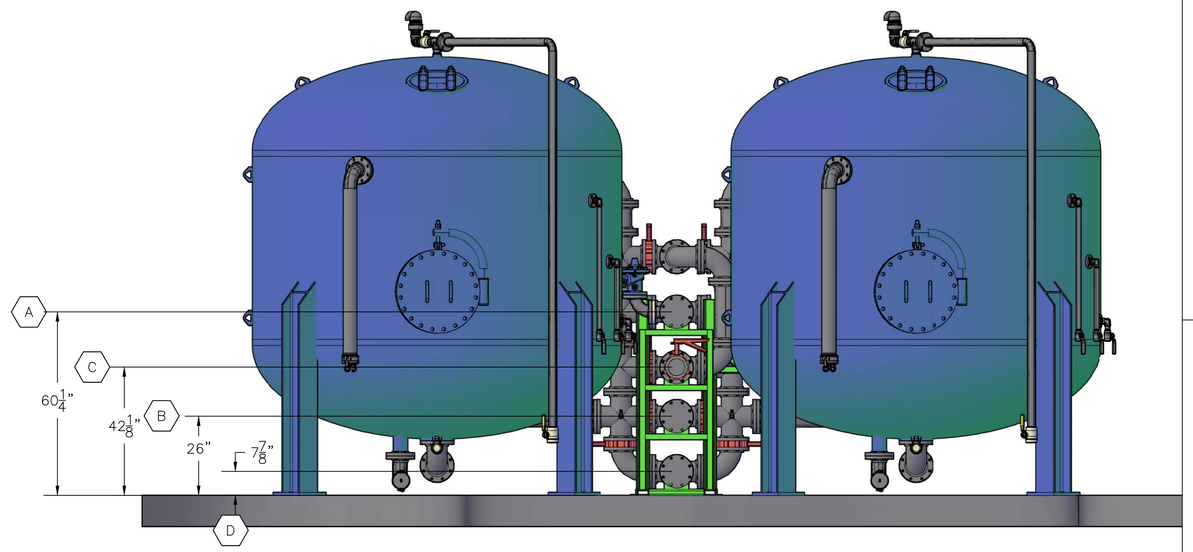
COSTUMER: TBD

TITLE: COVER

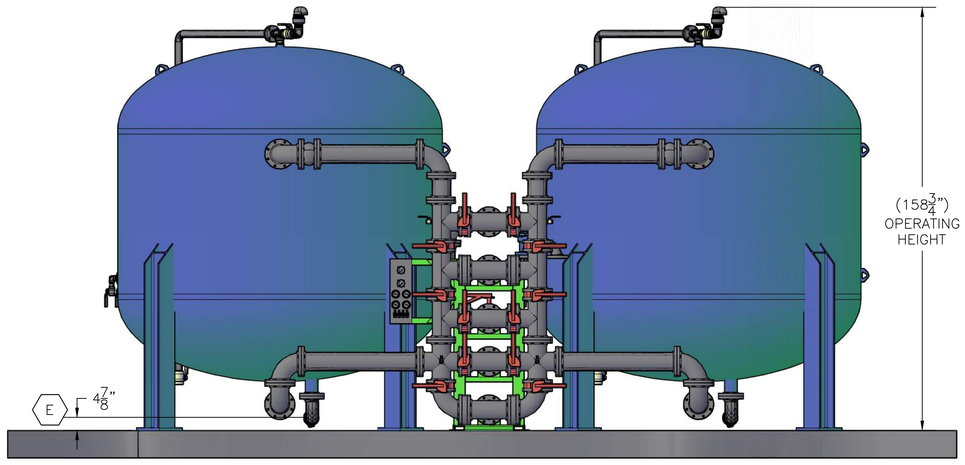
SALES DRAWING



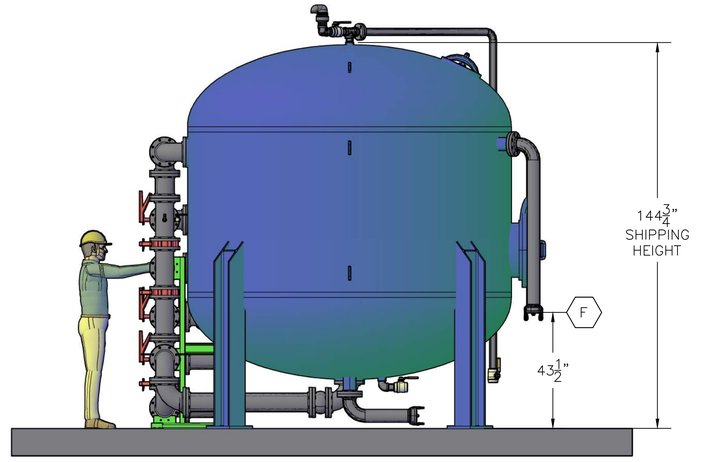
PLAN VIEW



BACK VIEW



FRONT VIEW



RIGHT SIDE VIEW

SALES DRAWING

AdEdge water technologies
2055 Boggs Road
Duluth, GA 30096
P. 678-835-0052 F. 678-835-0057
www. adedgetechnologies.com

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E	SLUICING NOZZLE (DISCHARGE)	4" 316SS PLUG
F	SLUICING NOZZLE (FILL)	4" 316SS PLUG

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:
–	–	–	–	–

DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD-0000	12/15/21	NTS

MODEL:
ADEDGE MODULAR
PFAS TREATMENT SYSTEM
MODPFx-12060CS-2-MVT-LL

COSTUMER:
TBD

TITLE:
SALES GENERAL ARRANGEMENT

DRAWING NUMBER:
M-001

SHEET:
3 OF 4

DIMENSIONAL NOTES:

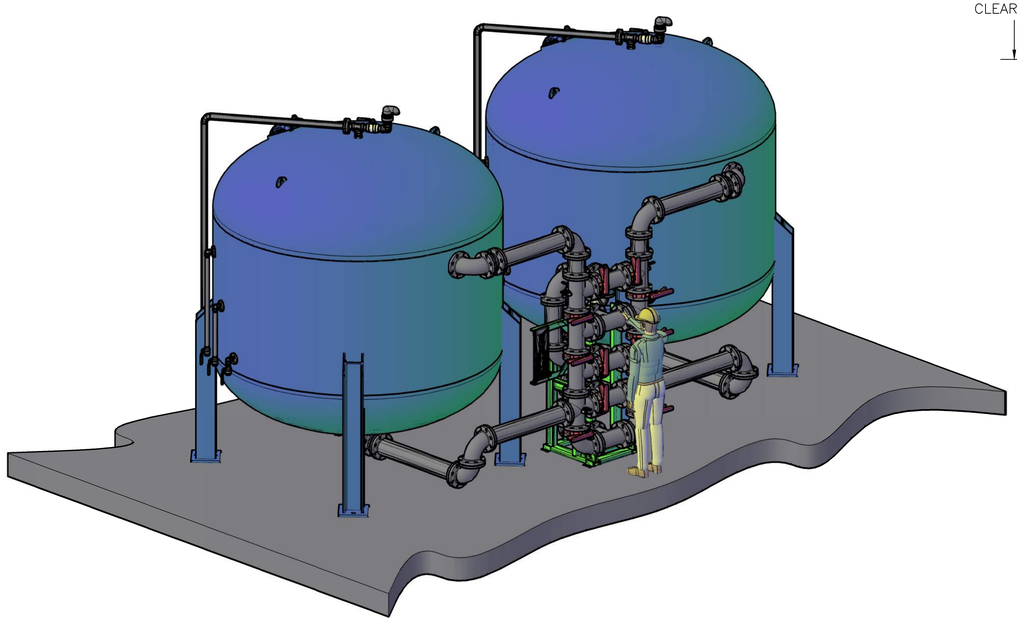
1. ALL DIMENSIONS ARE +/– 2".
2. DO NOT SCALE DRAWING. REFER TO ADEDGE ENGINEERING DEPT FOR ALL DIMENSIONS
3. (##): REFERENCE DIMENSION

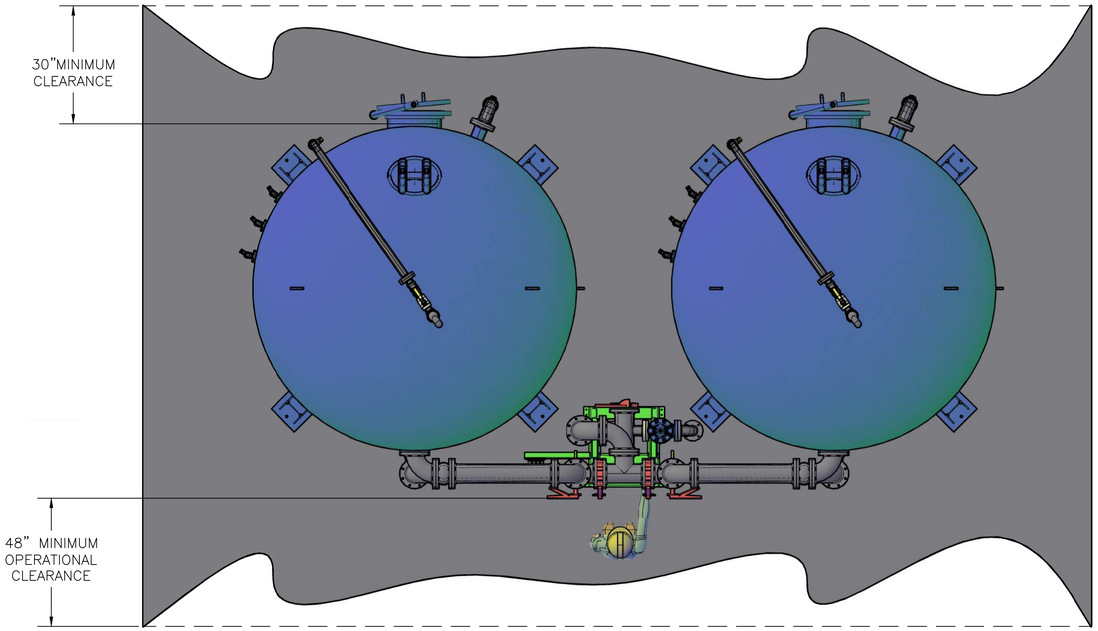
GENERAL SYSTEM SPECIFICATIONS:

1. DUCTILE IRON INLET/OUTLET WITH FLANGED TIE POINTS
2. DUCTILE IRON VALVE TREE PIPING
3. LUG–STYLE BUTTERFLY VALVES WITH MANUEL OPERATOR ON VALVE TREE
4. LUG–STYLE BUTTERFLY VALVE WITH MANUAL OPERATOR FOR BACKWASH OUTLET
5. 304SS HYDRAULIC PANEL WITH DP GAUGE FOR EACH VESSEL.
6. PRESSURE GAUGES AND SAMPLE VALVES ON EACH VESSEL'S INLET AND OUTLET

SYSTEM WEIGHT:

1. APPROXIMATE SHIPPING WEIGHT:





(OPERATOR LOCATION)

PLAN VIEW
FRONT AND BACK CLEARANCE

SALES DRAWING

AdEdge water technologies tm
2055 Boggs Road
Duluth, GA 30096
P. 678–835–0052 F. 678–835–0057
www. adedgetechnologies.com

TP.	SERVICE CONNECTIONS:	TYPE/MATERIAL:

REV. #	DATE:	BY:	APPROVED BY:	REVISION DESCRIPTION:
–	–	–	–	–

DRAWN BY:	CHECKED BY:	APPROVED BY:	PROJECT #:	DATE:	SCALE:
MC	CN	GG	TBD–0000	12/15/21	NTS

MODEL:
ADEDGE MODULAR
PFAS TREATMENT SYSTEM
MODPFx–12060CS–2–MVT–LL

COSTUMER:
TBD

TITLE:
SALES GENERAL ARRANGEMENT

DRAWING NUMBER:
M–002

SHEET:
4 OF 4

APPLIED PROCESS EQUIPMENT, INC. ATOMUS +F11

CUSTOMER NAME:	**Zahra Anwar**
SITE NAME:	**Bay City Well A**
DATE OF SAMPLE:	**9/26/2022**

Estimated Arsenic Removal Performance With pH Control, Bed Volumes, Is Between:

188,400 & 200,400

For those sites where pH adjustment is recommended (see commentary below), the performance estimated is based on the adjusted pH of 7.0-7.2

Estimated Arsenic Removal Performance Without pH Control, Bed Volumes, Is Between:

70,800 & 82,800

Arsenic Removal Performance Cannot Be Calculated Because The Following Data is Missing:

Parameter	Units	Minimum Optimal Value	Maximum Optimal Value	Value	Commentary
Arsenic	ppb	N.A	100	10.4	Value is within range, preformance estimate can be generated
Calcium	ppm	8	N.A	13.7	Total of Calcium and mangnesium is used in the Calcium Addition Calculation when hardness is less than the minimum optimal value & is used as a check to the hardness value.
Iron	ppb	0	300	28	Value less than MCL. No impact.
Magnesium	ppm	N.A	N.A	5.53	Total of Calcium and mangnesium is used in the Calcium Addition Calculation when hardness is less than the minimum optimal value & is used as a check to the hardness value.
Manganese	ppb	0	50	8.1	Value less than MCL. No impact.
Phosphorus	ppb	0	180	0	Phosphorus is a significant competing ion and its presence will negatively impact arsenic removal performance. However, the phosphorus is shown as zero so will not affect treatment..
Silica	ppm	0	35	17.3	Silica is a significant competing ion and its presence will negatively impact arsenic removal performance. However, the silica level is within normal range so the impact is minimal.
Vanadium	ppb	0	50	0	Vanadium is a significant competing ion and its presence will negatively impact arsenic removal performance. Vanadium is shown as zero so will not affect treatment.
Fluoride	ppm	0	1		Value less than MCL. No impact.
pH		5.5	9.5	8.28	pH is between 7.5 and 8.5. pH adjustment to 7.0 - 7.5 is highly recommended for optimum arsenic removal performance
T-Alkalinity	ppm as $CaCO_3$	N.A	N.A	246	Used for pH adjustment calculation.
Hardness	ppm as $CaCO_3$	21	300	88	Water contains enough calcium and magnesium to prevent silica gel formation.
Total Dissolved Solids	ppm	N.A	500	330	Value less than MCL. No impact.
Conductivity	S/cm	N.A	1000	592	Value used to check Total Dissolved Solids value.

Note: N.A. = Not Applicable Yellow = Indicates Parameter is out of Optimal Range

Note the following:

Water with pH greater than 9 may still require pH adjustment for optimum performance.

Economical treatment can still be achieved, if the ideal range for a parameter is exceeded. Particularly, for increased levels of phosphorus and vanadium compared to other adsorptive medias.

APPLIED PROCESS EQUIPMENT, INC.

WATER TREATMENT DIVISION

Date: November 3, 2022 **Quote No: WT22-11-1675**

TO: **Zahra Anwar** Garver Engineering 12141 Wickchester Lane Suite 200 Houston, TX 77079 **RE:** 700 GPM Arsenic Removal System – Bay City Well A	**Phone:** 713-482-4794 **Email:** ZBAnwar@GarverUSA.com
Pages: 2 **Est. Delivery:** 24 – 26 Weeks ARO **F.O.B.:** Scottsdale, AZ	**Delivery To:** TBD
Quoted By: Christy McDonnel	**Phone:** (480) 998-4097 **Fax:** (480) 951-8434 **Email:** christy@apewater.com

To place an order email to orders@apewater.com

QTY	Description	Unit Price	Amount
1	**Multiple Tank SKID with Backwash Plumbing and Control** *System includes:* • *(4) 72" OD x 60" Side Shell Vertical Media Tank* • *Internal coating is 3M Scothkote 134, NSF 61 Certified* • *Exterior Paint and Coating, Carboline Carboguard 60 and 134 HG Urethane* • *Max pressure of 100 PSI* • *Max Temperature 150 °F* • *6" Inlet and Outlet Flanged -Double RFSO 150# from Main Carbon Steel Manifold* • *Top and Side Shell Manways with Carbon Steel Hinge, 150 # Flanged, 12"x16" Elliptical* • *316 Stainless Steel, Hub and Lateral* • *AUTOMATION DETAIL: Automatic Butterfly Valve Allen Bradley MicroLogix 1400 with Nema 4 enclosure* • *System is fully assembled, plumbed, and wired with tanks bolted onto a structural steel skid* • *Installation and Operation & Maintenance Manuals Included*	$334,245	**$334,245.00**
265	**Cubic Feet of ATOMUS Z21 Media,** *to be filled in three of the four media vessels. Fourth vessel is for backwash water or filled with additional media and used for media changeover*	$525/cu ft	**$139,125.00**
	NOTE: Standard price for ATOMUS Z21 media is $625/ cu ft when purchasing a supersack which contains 30 cu ft. Given the size of the system, the price has been discounted to $525/cu ft. This price will be extended to replacement media.		

APPLIED PROCESS EQUIPMENT, INC.

WATER TREATMENT DIVISION

24	**Cubic Feet of Underbed Gravel,** *to be filled in three of the four media vessels. Fourth vessel is for backwash water or filled with additional media and used for media changeover*	$45/CUFT	**$1,080.00**
1	**40,000 Gallon HORIZONTAL Storage Tank for Water** Application: Aboveground Type: SINGLE WALL Material: MILD CARBON STEEL	$185,798.00	**$185,798.00**
1	**Backwash Pump w/Motor – 2000 GPM**	$5,500.00	**$5,500.00**
1	**WALCHEM pH Adjustment System Components ONLY** • *W120 pH Controller and sensor* • *0.6 GPH Metering Pump* • *275 Gallon Double-wall Tank* • *2" Static Mixer* • *Flow switch* *275 Gallons Hydrochloric Acid to be supplied by others.	$12,985	**$12,985.00**
	OPTIONAL EQUIPMENT (not included in total below)		
1	**Optional C02 pH adjustment system**	$25,169	
3	**Onsite Technician for Startup and Training**. $1900/ day + travel. Estimating 3 Days	$1900.00	
	Estimated Shipping & Handling:		***TBD***
	This Quote does not include applicable sales tax. Minimum order $50.00. Credit card charges will incur a surcharge of 3%.	***Total:***	***$678,733.00***

SUBMITTED BY: Christy McDonnel

APPLIED PROCESS EQUIPMENT, INC.

ACCEPTED BY: _____

Bay City Well A		
BULK MEDIA Caclulate Cost Per 1000 Gallons Treated Water		
USAGE GPD	633,600	
USAGE GPY	231,264,000	
Price per CUFT	525	ATOMUS Z21 Bulk Media
CUFT Needed	265	
Cost Per Change	$139,125.00	
	$139,125.00	Annual Cost (100% Treated Water)
	1	X # of media changes in 1 year
	$139,125.00	= cost per year
	$139,125.00	Cost per year
	231,264,000	Annual Blend Treated to 0PPB
	0.000601585	Cost per gallon
	0.000601585	Cost per gallon
	1000	X 1000 Gallons
	$0.60	Cost per 1000 Gallons Treated to 0 PPB

APPLIED PROCESS EQUIPMENT, INC.

WATER TREATMENT DIVISION

Date: November 3, 2022 **Quote No: WT22-09-1665**

TO: **Zahra Anwar** Garver Engineering 12141 Wickchester Lane Suite 200 Houston, TX 77079 **RE:** 700 GPM Arsenic Removal System – Bay City Well A	**Phone:** 713-482-4794 **Email:** ZBAnwar@GarverUSA.com
Pages: 2 **Est. Delivery:** 24 – 26 Weeks ARO **F.O.B.:** Scottsdale, AZ	**Delivery To:** TBD
Quoted By: Christy McDonnel	**Phone:** (480) 998-4097 **Fax:** (480) 951-8434 **Email:** christy@apewater.com

To place an order email to orders@apewater.com

QTY	Description	Unit Price	Amount
7	**100 GPM Applied Cartridge System SKID with ATOMUS F11 Arsenic Removal Cartridges System Includes:** • *(1) Skid with four stainless steel 25 GPM vessels (p/n ISO-100-SK)* • *(1) Totalizing Flow Meter, 2"* • *(4) Air/vacuum relief valves, Max working pressure of 100 psi, threaded, ¾ "NPT (DT-040-LP)* • *(1) EZ Lift Handle - Cartridge Extraction Tool* • *Required valves, ports, and gauges* • *One Installation & Maintenance manual* *NOTE: Replacement ATOMUS F11 Cartridges (p/n AT-042) priced at $981*	$92,500.00	**$647,500.00**
-7	**25% Multi Skid Discount**	-$23,125	**-$161,875.00**
	Subtotal		**$485,625.00**
2	**ACS SS Eight Bag Pre-Filter Bag Housing** Material: Stainless Steel 304 Inlet/Outlet size: 8" ANSI Flange Shell O-ring: EPDM Configuration: install 8pcs of size 2 filter bags	$25,280	**$50,560.00**
-2	**25% Multi Unit Discount**	-$6,320	**-12,640.00**
	Subtotal		**$37,920.00**

APPLIED PROCESS EQUIPMENT, INC.

WATER TREATMENT DIVISION

140	**ACS - ATOMUS F11 Arsenic Removal Cartridge** *NSF/ANSI 61, Use with ACS Systems*	$1,308.00	**$183,120.00**
-140	**25% Multi Pallet Discount**	-$327.00	**-$45,780.00**
	Subtotal		**$137,340.00**
1	**WALCHEM pH Adjustment System Components ONLY** • *W120 pH Controller and sensor* • *0.6 GPH Metering Pump* • *275 Gallon Double-wall Tank* • *2" Static Mixer* • *Flow switch* *275 Gallons Hydrochloric Acid to be supplied by others.	$12,985	**$12,985.00**
-1	**25% Multi Pallet Discount**	-$3,246.00	**-$3,246.00**
			$9,739.00
	OPTIONAL EQUIPMENT (not included in total below)		
1	***C02 pH adjustment system***	*$25,169*	
	Estimated Shipping & Handling:		***TBD***
	This Quote does not include applicable sales tax. Minimum order $50.00. Credit card charges will incur a surcharge of 3%.	***Total:***	***$670,624.00***

SUBMITTED BY: Christy McDonnel

APPLIED PROCESS EQUIPMENT, INC.

ACCEPTED BY: _____

APPLIED PROCESS EQUIPMENT, INC.

Bay City Well A

WATER Chemistry

As	10.4	**ppb**	
pH	8.28		
Ph	0	**ppb**	
Va	0	**ppb**	
Si	17.3	**ppm**	
Hardness	88	**ppm**	
Fe	28	**ppb**	
Mn	8.1	**ppb**	
Fl	4220	**ppb**	
Flowrate	700	**GPM**	
Number Cartridges	140		
Daily Usage	633600	**gallons**	Calculated from annual
Annual	231,264,000	**gallons**	

Treatment Summary

	ISOLUX	ISOLUX	ATOMUS F11	ATOMUS F11
Pretreatment for pH Adjustment	NO	YES	NO	YES
Bed Volumes Treated per Cartridge	69,000	157,000	82,800	200,400
Gallons treated per Cartridge	155,250	353,250	186,300	450,900
Total Gallons treated	21,735,000	49,455,000	26,082,000	63,126,000
Estimated media life (years)	0.09	0.21	0.11	0.27
Cartridge System	YES	YES	YES	YES
Backwash	NO	NO	NO	NO
Media Replacement Cost Summary				
Number of Cartridges Used	140	140	140	140
Price per Cartridge	$ 1,200	$ 1,200	$ 981	$ 981
Volume of Bulk Media Used (ft3)				
Price of Bulk Media per ft3				
Total Cost of One Media Replacement	$ 168,000	$ 168,000	$ 137,340	$ 137,340
Total Cost per year	$ 1,787,548	$ 785,610	$ 1,217,767	$ 503,149
		plus pH Chemicals		plus pH Chemicals

Bay City Well A

CARTRIDGE Caclulate Cost Per 1000 Gallons Treated Water

USAGE GPD	633,600	
USAGE GPY	231,264,000	
Price per Cartridge	981	ATOMUS F11
Numb Of Carts	140	
Cost Per Change	$137,340.00	
	$137,340.00	Annual Cost (100% Treated Water)
	4	X # of cart changes in 1 year
	$549,360.00	= cost per year
	$549,360.00	Cost per year
	231,264,000	Annual Blend Treated to 0 PPB
	0.002375467	Cost per gallon
	$0.00	Cost per gallon
	1000	X 1000 Gallons
	$2.38	Cost per 1000 Gallons Treated to 0 PPB

WATER TREATMENT SKID SYSTEMS

NSF 61 CERTIFIED SYSTEMS | SIMPLE TO OPERATE | NO BACKWASHING

50 & 100 GPM

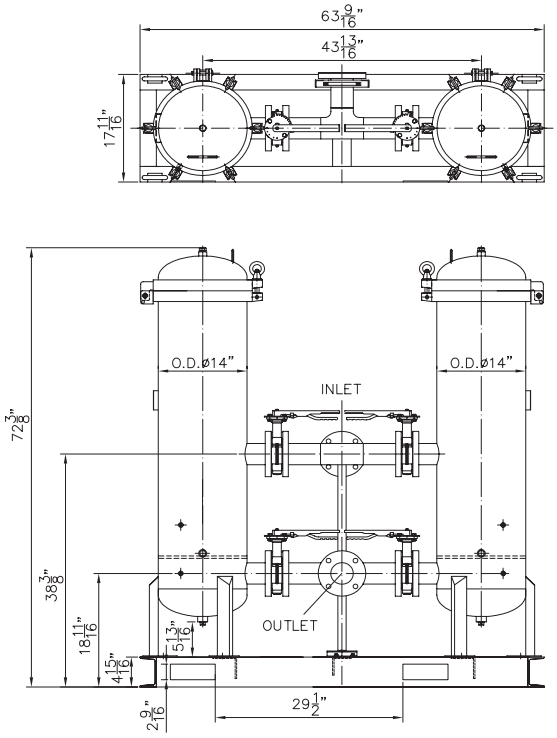
- **Stainless Steel Vessel Housings**
- **Prefilters**
- **Choice of Cartridges**

Applied CARTRIDGE SYSTEMS

APPLIED CARTRIDGE SYSTEMS 50 & 100 GPM SKIDS OFFER SMALL EM

NSF 61 CERTIFIED

50 GPM SKIDS



Model: ISO-50-SK

NSF 61 Certified System Packages

Applied Cartridge Systems skids were designed for quick, complication-free regulatory compliance. Each skid is a self-contained water treatment cartridge system with 304 stainless steel housings, prefilters and a choice of cartridges, all NSF 61 certified together as a single package.

No Backwashing! Easy To Maintain

Applied Cartridge Systems skids are exceptionally easy to operate. There's no need to backwash. No hazardous waste streams. No large media tanks, media pumping or disposal. Just periodic one-man cartridge replacement.

Maintenance downtime can be minimized or even eliminated. The multi-vessel skid configuration allows continuous operation during cartridge change-out.

Choice of Treatment Cartridges

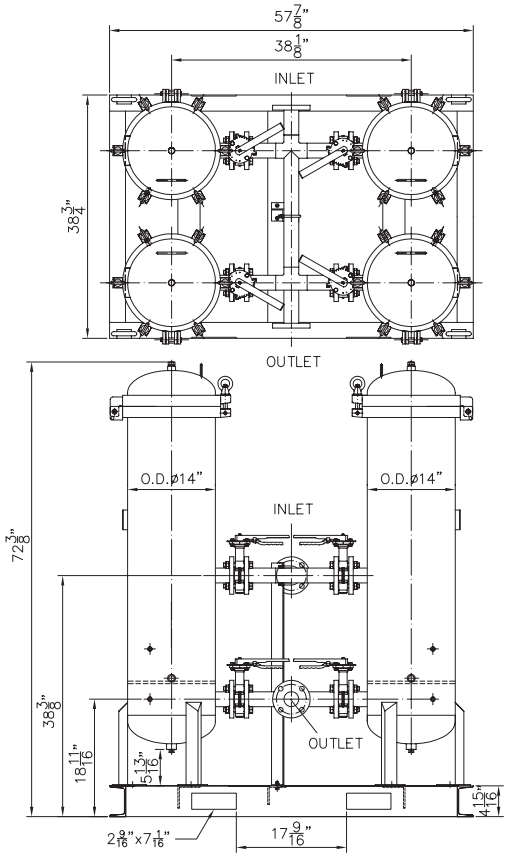
The growing family of ATOMUS® cartridges addresses a range of water treatment issues. All cartridges are designed exclusively for Applied Cartridge Systems.

Building on two Arsenic removal cartridges, ISOLUX® (also known as ATOMUS® 122), and the new ATOMUS® F11 cartridge, Applied Cartridge Systems has expanded the cartridge offering to include treatment for Phosphorus, Fluoride and coming soon, PFAS.

Every cartridge is fully sealed to prevent media contact. Cartridge housings, and the media they hold, are NSF 61 certified and landfill safe.*

NSF 61 CERTIFIED

100 GPM SKIDS



Model: ISO-100-SK

Fast, Drop-In Ready Installation

Skids typically don't require electrical service or sewer tie-in. With simple, inlet/outlet flange connections and optional pre-plumbed piping sub-assemblies, a cartridge skid system can be assembled and ready to hook-up to a water supply in less than a day.

Small Footprints

With Applied Cartridge System skids there is no need for large media storage tanks. 50 GPM skid footprints are 5' long by 1.5' deep, and the 100 GPM units are only 5' long by 3' deep.

Truly easy to operate and maintain. Simple one-person cartridge loading and replacement.

** USEPA TCLP tested as non-hazardous waste safe for landfill, but due to variances in influent water quality, users are urged to perform independent verification of the non-hazardous character of spent media cartridges. Additionally, some states may have disposal criteria different from Federal guidelines (TCLP)*

TWO STANDARD SIZES – STAINLESS STEEL CONSTRUCTION

	50-GPM Model: ISO-50-SK	**100-GPM** Model: ISO-100-SK
No. of Media Cartridges (Replaceable)	10 (Five per vessel)	20 (Five per vessel)
Number of Vessels per Skid	2	4
Vessel Construction	150 psi, 304 Stainless Steel	150 psi, 304 Stainless Steel
Cartridge Size	4.5" OD x 42" L	4.5" OD x 42" L
System Shipping Weight	675 lbs	1,200 lbs
Inlet/Outlet Connection	2", 150 lb ANSI Flange	3", 150 lb ANSI Flange
Footprint	64" L x 18" D x 75" H	58" L x 39" D x 75" H
Minimum Required Headroom (for cartridge removal)	120"	120"

Small System Water Treatment Simplified.

Applied Cartridge Systems 50 GPM and 100 GPM Skids offer a unique, exceptionally easy to operate cartridge technology that's head and shoulders above other water treatment systems.

Ideal for small to mid-size water treatment applications up to 500 GPM, Applied Cartridge Systems skids have been installed in community drinking water systems, rural water utilities, schools, hotels and resorts, RV parks, office complexes, subdivisions and multi-user wells all across North America.

NSF 61 CERTIFIED

5, 10, 15, 20, 25 GPM models

NSF 61 CERTIFIED SYSTEMS | SMALL FOOTPRINTS | SIMPLE OPERATION | NO BACKWASHING

NSF/ANSI/CAN 61 IAPMO R&T ®

ISO-05-SS, ISO-10-SS, ISO-15-SS, ISO-20-SS, ISO-25-SS, ISO-50-SK and ISO-100-SK have been certified by IAPMO R&T against standard NSF/ANSI/CAN 61 and 372 for material safety and lead free requirements. Not certified for contaminant reduction or structural integrity by IAPMOR&T.

Applied CARTRIDGE SYSTEMS

9332 North 95th Way
Scottsdale, AZ 85258
sales@appliedcartridgesystems.com 480-315-8430

ATOMUS® +Z21

Atomus Z21® Arsenic removal granules

ARSENIC REMOVAL MEDIA

ATOMUS Z21® Arsenic Removal Media, is a binary mixed metal adsorption media uniquely formulated to remove Arsenic from drinking water. With large, solid, high surface area granules, ATOMUS® Z21 media has demonstrated twice the arsenic loading capacity, longer life and shorter reaction time (EBT) than other arsenic removal medias.

Ideal for medium to high flow rate applications up to 2,000 gpm. ATOMUS® Z21 is NSF 61 certified and delivers unmatched performance than other arsenic adsorption media.

- Unparalleled non-leachable Arsenic bond
- Removes Arsenic III & V simultaneously
- NSF 61 certified for drinking water use
- Non-toxic – Media has passed USEPA TCLP and California wet tests*
- Imparts no odors, taste or color to water
- pH range greater than any other Arsenic adsorption media
- Least impacted by competing ions like Silica, Phosphorus or Vanadium

High-capacity tanks manufactured to specific application requirements

Media Specifications:

System Type:	Granular media in pressure vessels	Contaminant Removal:	Arsenic III & V, plus phosphate, chromium, selenium, fluoride
Media Type:	Patented Binary Metal adsorption media	Backwashing:	Monthly
Surface Area:	Greater than 200 m^2/g	pH range:	5.5 – 10.5
Bulk Density (weight):	48 lbs./Cubic ft.	pH Zero point-of-charge: (ZETA point)	12
Minimum Empty bed contact time (EBCT):	2.5 to 3 minutes	Media Disposal:	Landfill*
Surface Loading Rate:	7-9 gpm/ft^2	Pressure Drop:	Less than 10 psi
Particle Size:	10 x 65 mesh	Cost per Gallon Treated:	Low

NSF®

Certified to NSF/ANSI 61

** USEPA TCLP tested as non-hazardo[us] [l]andfill, but due to variances in influent water quality, users are urged to perform independent verification [of] [h]azardous character of spent media cartridges. Additionally, some states may have disposal criteria different f[rom] [g]uidelines (TCLP).*

ATOMUS® +Z21

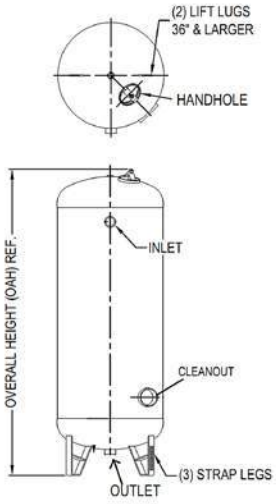
CARBON STEEL TREATMENT VESSELS

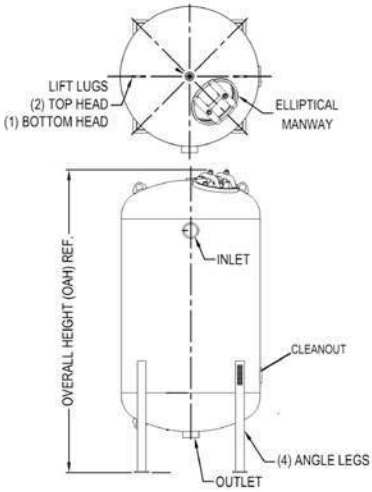
Designed for use with ATOMUS®Z21 Bulk Granular Adsorption Media

- NSF/ANSI 61 certified interior coating
- Carbon steel construction
- Coated finish in “Safety Blue” epoxy
- 100 PSIG working pressures
- 150 PSIG is available
- Seismically rated supports (optional)
- ASME Code available on request
- Custom sizes available

10 Standard vessel sizes from 20”–72” for a wide range of applications. Custom high-capacity tank sizes also available

All vessel sizes include precision stainless steel internal distributors





Standard Capacity Vessels

MODEL NO.	DIAMETER	HEIGHT (OVERALL)	VOLUME (GAL.)	MEDIA (CUBIC FT.)	INLET/OUTLET
2060LC	20”	76”	85	6	2” NPS*
2460LC	24”	78”	124	9	2” NPS
3060LC-3	30”	85”	205	14	3” NPT**
3672LC	36”	101”	350	20	3” NPT
4272LC	42”	103”	484	28	3” NPT

*(NPS) National Pipe Straight **(NPT) National Pipe Threaded

High-Capacity Vessels

MODEL NO.	DIAMETER	HEIGHT (OVERALL)	VOLUME (GAL.)	MEDIA (CUBIC FT.)	INLET/OUTLET
4872LC	48”	111”	660	36	4” NPT
5472LC	54”	113”	848	46	4” NPT
6072LC	60”	115”	1060	8	4” NPT
6672LC	66”	115”	1276	70	4” NPT
7272LC	72”	119”	1568	84	4” NPT

*(NPS) National Pipe Straight **(NPT) National Pipe Threaded

NSF Certified to NSF/ANSI 61

APPLIED PROCESS EQUIPMENT, INC. WATER TREATMENT

9332 North 95th Way
Suite B 106
Scottsdale, AZ 85258
480-998-4097
sales@apewater.com

Budgetary Proposal for a Pall ARIA™ Membrane Filtration System

City of Bay City, TX Arsenic Removal WTP

1/0/1900
Proposal #: OPP1876513 -0-B

Submitted to:

Zahra Anwar
Garver
713-482-4794
ZBAnwar@GarverUSA.com

Submitted by:

Rick Moro
Regional Sales Manager
516-924-2054
rick_moro@pall.com

PROPRIETARY & CONFIDENTIAL
INFORMATION NOTICE

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- to use this document and the information it contains exclusively for the above-stated purpose and to avoid use of the information for performance of the proposed work by recipient itself or any third party.

- to avoid publication or other disclosure of this document or the information it contains to any third party without the prior approval of Pall Corporation.

- to make only those copies needed for recipient's internal review, and

- to return this document and any copies thereof when they are no longer needed for the purpose for which furnished or upon the request of Pall Corporation.

Table of Contents

1 Pall Offering

1.1 Scope Summary

660-gpm Membrane Flitration System for Arsenic Removal

1.2 Pricing Summary

Item	Description	Sale Price (US)
1	Aria™ Membrane Filtration System (Details Per Section 2)	$2,000,000

1.3 Delivery Schedule

The schedule provided is Pall's standard and reflects typical project execution. If requested, we would be happy to review customer schedule requirements and adjust where possible to accommodate project specific needs.

	Milestone	Typical Schedule
1	Acknowledgement of Purchase Order	Typically 1 to 2 weeks after Receipt of Purchase Order
2	Submittals/Shop Drawings	Typically 4 weeks after Acknowledgement of Purchase Order
3	Commence Manufacturing1	Typically 2 weeks after Submittals/Shop Drawings submitted
4	Equipment Ready to Ship and Preliminary O&M Manual	Typically 22 -26 weeks after Commence Manufacturing
5	Installation Completed (by Others)	Variable
6	Commissioning Complete/Final Acceptance	Approximately 5 weeks after Installation Completed

Note 1: For standard equipment, manufacturing may commence order acknowledgement. The schedule above assumes standard equipment and standard submittals.

1.4 Terms and Conditions

All sales made by Pall are subject to the terms contained within this Section 1.4 and *Additional Terms and Conditions of Sale of Systems and Made to Order Goods – The Americas* (Available upon request).

Price Validity	This proposal is for discussion purposes only, does not constitute a binding agreement on either party, and remains subject to corporate approval by both parties. The information contained herein is deemed confidential and is not to be shared with any third party.
Shipping Terms	The price does not include shipping costs. Delivery shall be FCA Seller's Shipping Point, INCOTERMS® 2010.
Payment Terms	Payment of invoiced amounts due to Seller shall be paid Net 30 days and as further defined in *Additional Terms and Conditions of Sale Systems and Made to Order Goods – The Americas* .
Bonds	No bonds of any type are included with this proposal.
Taxes	No taxes are included in the pricing. Payment of all Taxes related to the Goods and Services proposed shall be the exclusive responsibility of the Buyer as further defined in *Additional Terms and Conditions of Sale Systems and Made to Order Goods – The Americas* .

2 Scope of Supply

2.1 Scope Summary Table

Item Description	By PALL	By OTHERS
(1) Master Control Panel with Allen Bradley Logix PLC, or equal	X	
Design and supply of systems prior to membrane filtration system.		X
Feed Tank Included as part of packaged system - Shipped Loose	X	
Feed Pump(s) and VFD(s) included as part of AP skid	X	
Feed Strainer included as part of AP Skid	X	
2 (1 + 1) AP6 Units, each factory assembled and tested unit including valves, instruments & I/O required for operation	X	
Each AP Unit will include a membrane module rack for on-site assembly and (30) hollow fiber membrane modules	X	
RF Tank Included as part of packaged system - Shipped Loose	X	
RF Pump(s) included as part of AP Skid	X	
(1) 2500 gallon CIP System factory assembled and tested prior to shipment with valves, instruments, pumps, tank, heater as needed for operation	X	
(1) 10500 gallon Neutralization System factory assembled per the P&ID and tested prior to shipment:	X	
(2) Air Compressors (1) Air Receiver	X	
Chemical Storage Equipment		X
Supply of any required chemicals		X
Design and supply of anchor bolts for Pall supplied Equipment		X
Receiving, unloading and safe storage of equipment until ready for installation		X
Installation of all equipment		X
Design and supply of interconnecting pipe, inclusive of pipe supports and flexible connectors		X
Motor Control Center (MCC)		X
All wiring, cabling, and tubing for power supply, signals, communications, and to connections on Pall supplied equipment		X
Design, supply, and installation of all civil infrastructure inclusive of buildings, fire and safety protection, HVAC, walkways, platforms, etc.		X
All Permits		X

2.3 Submittal Description

The project schedule is based on submittals/shop drawings provided in electronic format via a secure FTP site for information only. This allows work to proceed on the project without a document approval process.

Submittals/Shop Drawings
P&ID
General Arrangement Drawings for Pall-Supplied Equipment
Electrical Interconnect Drawing (Power One-Line, I/O Interconnection, and Network Layout)
Electrical Drawings for Pall-Supplied Panels
Mechanical Replacement Parts List
Electrical Replacement Parts List
Compressed Air System Information
Installation Manual
Cutsheets for Pall-Supplied Off-Skid Components
Installation & Startup Checklist
Final Submittal (provided at completion of commissioning)
Operation and Maintenance Manual
Software License Transfer Documentation

2.4 Services and Labor

Commissioning & Training time is estimated to be 4 man-weeks. Training activities occur during the commissioning process.

Commissioning

Each day shall be considered 8 hours on site. Commissioning will begin once the system is fully installed. A commissioning Checklist is prepared specifically for each project during project execution. Commissioning shall consist of the activities outlined in the project specific Commissioning Checklist. Commissioning activities include:

- Confirmation of network communications
- Confirmation that I/O is connected to the control system
- Confirmation of MF System functionality (components are functioning and control system sequences are functional)
- Startup and tuning of Pall controls

Operator Training

Operator training is estimated to take 1 to 3 days depending on system complexity. Training is provided on-site by a Pall Field Service Engineer. The estimated time assumes that all staff are trained at the same time. Training time will be split between a classroom presentation and hands-on training with the equipment.

3 Technical Summary

3.1 Process Summary

Source Description:

Bay City, Texas Water Plant Arsenic Removal project for arsenic removal for two groundwater wells and

Treatment processes prior to Membrane Filtration System:

Coagulation and pH adjustment of 1 ppm of Ferric Chloride per 10-20 ppb of Arsenic if optimiazed. The

Membrane System Feed Water Characteristics

Quality of the water entering the Pall Membrane Filtration System as summarized in table below forms the basis of design for this proposal. In the event that the feed water to the membrane filtration system is outside these parameters the system performance, cleaning protocol, operating parameters, and/or warranties may be affected.

Parameter	Units	Range
Turbidity	NTU	< 5
TOC	ppm	< 3
Hardness	ppm	50-350
Alkalinity	ppm	60-320
TSS	ppm	< 20
Fe	ppm	< 1.0
Mn	ppm	< 0.5

Notes:

1 – Assumed Water Quality is based on typical water quality for similar source waters. The design parameters may change after review of actual source water quality data.

3.2 Treated Water Objectives

The proposed membrane system is designed to achieve the following results given the feed fluid conditions described in Section 3.1 of this proposal and operation of the system in accordance with the operation and maintenance manual.

Net Filtrate Capacity of 0.95 MGD

Turbidity less than 0.10 NTU 95% of the time, below 0.20 NTU at all times.

The membrane system shall produce effluent with Silt Density Index (SDI) value of 2.5 or less in 95% of samples using ASTM 4189-95 and a Pall nylon test membrane.

3.3 Operational Parameters

Hollow Fiber Membrane System operational parameters at design flow		
Net Filtrate Capacity	0.950	MGD
Recovery	96.9%	%
Instantaneous Flux	70	GFD
FM (Backwash) Interval	42	Minutes
EFM Interval	3	Day(s)
CIP Interval	60	Days

3.4 Acceptance Criteria

The system shall be accepted by the end user upon completion of the following:

1) Completed system commissioning per section 2.4
2) Production of 1st useable effluent

O&M Cost Summary

All informations regarding waste, chemical usage and electricity are based on the following assumptions:

1. All racks (including redundant racks if any) are on line
2. EFM is triggered by volume and occurs less frequenctly at lower flux.
3. Chemical solutions are reused up to 1 times
4. Solution strength, chemical pricing and electricity pricing assumptions are proivded on the next page.
5. The values provided are estimated and do not account for fluid volumes associated with field piping or other plant specific conditions.

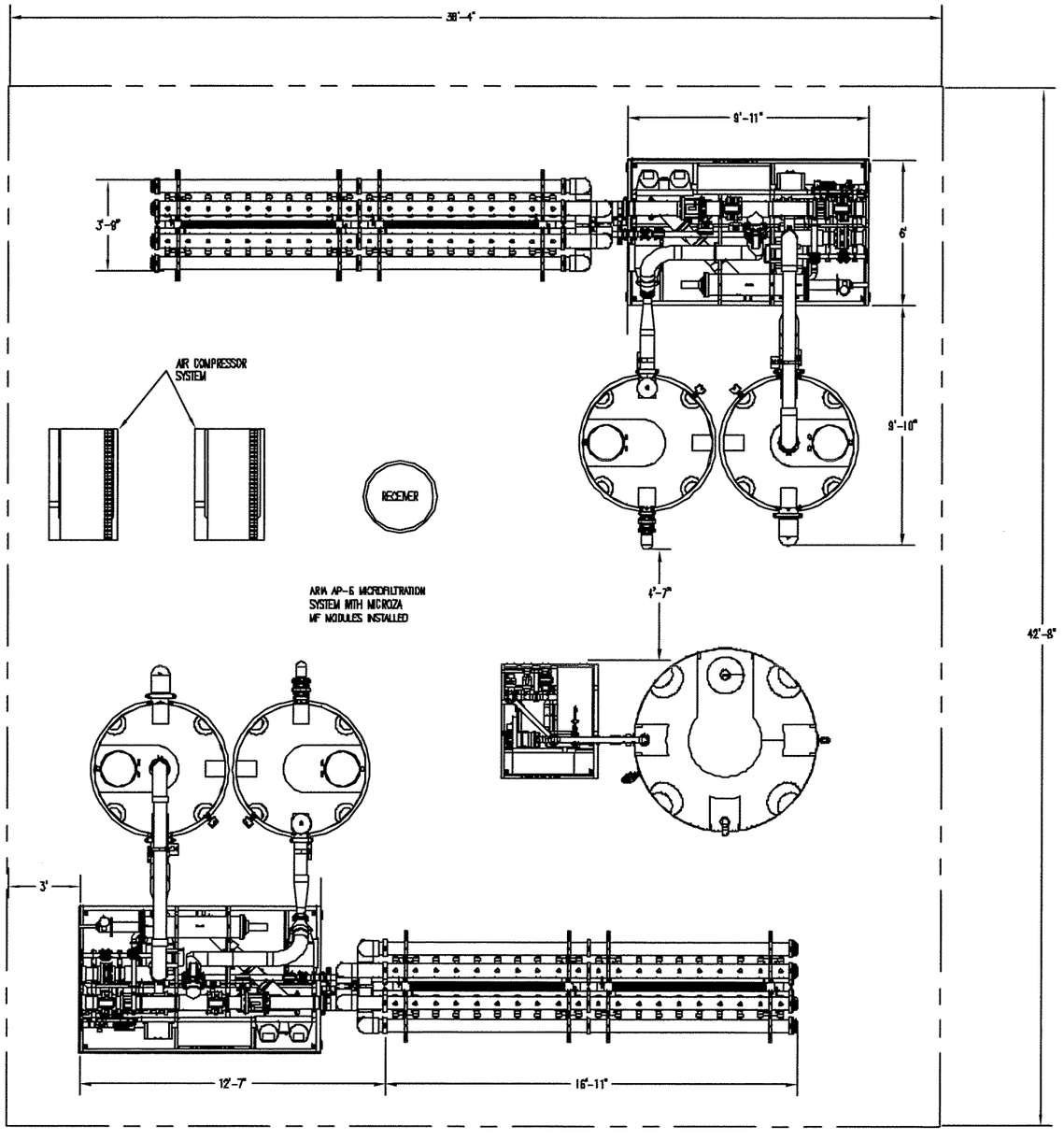
Waste Volumes			
	Frequency	**Waste per Event**	**Daily Waste (Gal)**
Flux Maintenance (Reverse Filtration)	Approximately 33 per rack each day	420	27,720

Chemical Cleaning Waste Volumes			
	Frequency	**Monthly Waste (Gal)**	**Annual Waste (MGal)**
Enhanced Flux Maintenance (EFM) & Clean in Place (CIP) Waste	EFM 6 day(s) CIP 60 days	40,620	0.49

Electrical Usage		
kWhr/month	**kWhr/yr**	**$USD/yr**
4,018	48,210	$4,821

Chemical Usage			
	Gal/year	**Gal/month**	**$USD/yr**
Chlorine: (Sodium Hypochlorite)	376	31	$526
Caustic (NaOH): (Sodium Hydroxide)	799	67	$1,438
Citric Acid:	818	68	$4,419
Sodium Bisulfite:	0	0	$0

O&M Cost Summary		
Energy and Chemical Cost Assumptions		
Electricity:	Cost Per KWH	$0.10
Chlorine:	Cost Per Gallon of Stock Solution	$1.40
(Sodium Hypochlorite)	Concentration of Stock Solution	12.5%
Caustic (NaOH):	Cost Per Gallon of Stock Solution	$1.80
(Sodium Hydroxide)	Concentration of Stock Solution	25.0%
Citric Acid:	Cost Per Gallon of Stock Solution	$5.40
	Concentration of Stock Solution	50.0%
Sodium Bisulfite:	Cost Per Gallon of Stock Solution	$2.45
	Concentration of Stock Solution	40.0%



PROJECT NUMBER 17338	NAME	DATE
DRAWN BY		
PROJECT ENGINEER		
CHECKED		
MANUFACTURING		
ENGINEERING MANAGER		
QUALITY CONTROL		
RELEASED BY		

COMPANY CONFIDENTIAL

---> DO NOT SCALE DRAWING <---

DIMENSION ARE IN: INCH ONLY

SPECIFICATIONS

DRAWING TITLE: PRELIMINARY LAYOUT (2) AP-6

TOLERANCE: .XXX ±, .XX ±, .X ±, .XX ±, ANGLE ±

FINISH ±

BREAK EDGES ✓ ALL OTHERS

Pall Corporation
PALL TRINITY MICRO
CORTLAND, NEW YORK

PART NUMBER

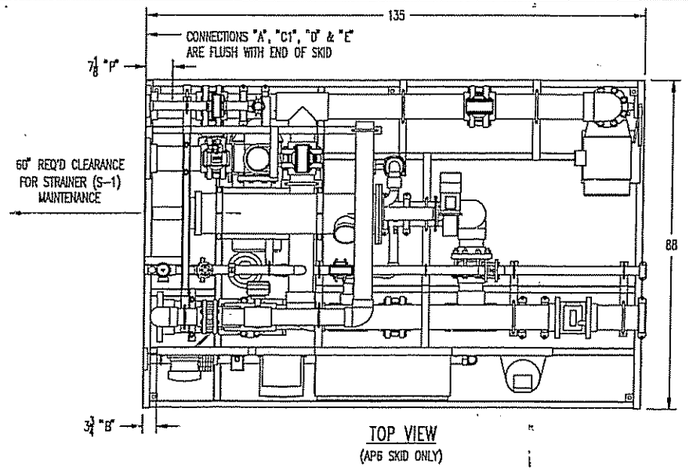
SCALE: 1:32

SIZE: D

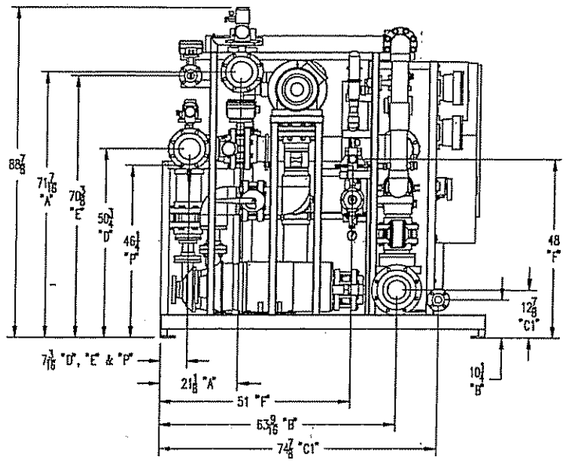
REVISION: *

SHEET 1 OF SHEET 1

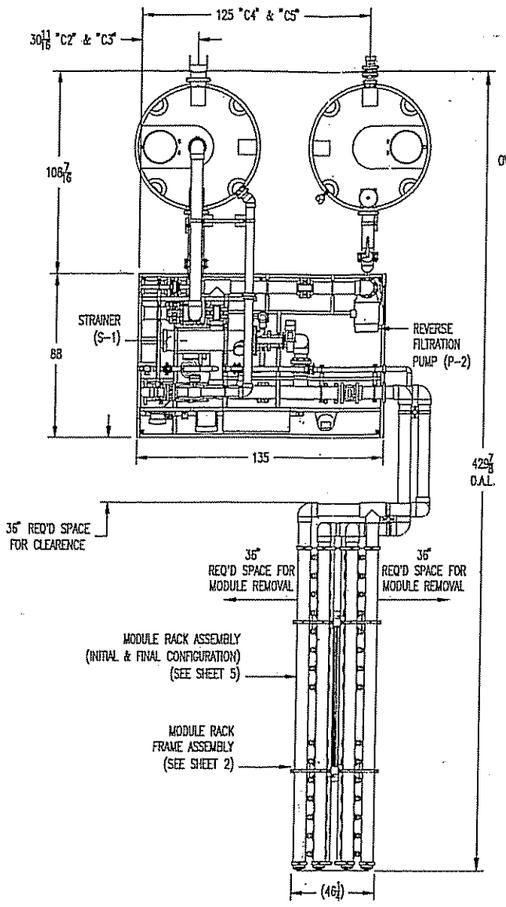
CAD FILE NAME: NONE



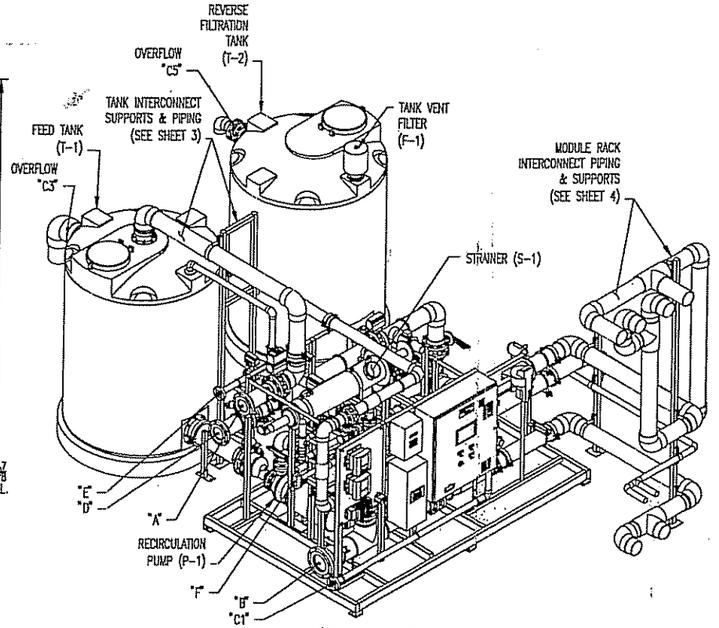
TOP VIEW
(AP6 SKID ONLY)



LEFT SIDE VIEW
(AP6 SKID ONLY)

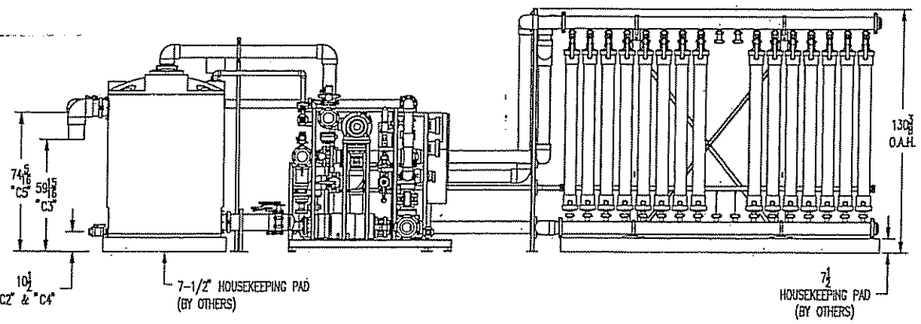


TOP VIEW

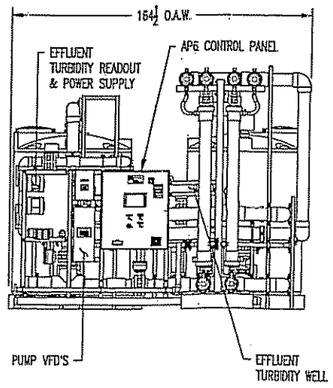


LEFT/FRONT ISOMETRIC VIEW
(REMOTE MODULE RACK REMOVED FOR CLARITY)

ARIA℠ AP6 SYSTEM WEIGHT				
	WEIGHT			
EQUIPMENT	DRY Lbs.	DRY Kgs.	WET Lbs.	WET Kgs.
SKID	3600	1633	4100	1860
INTERCONNECT	500	227	1900	862
MODULE RACK	3500	1587.5	9000	4082
TOTAL WEIGHT	8400	3810	34000	15422



LEFT SIDE VIEW



FRONT VIEW

P	PARTICLE COUNTER	1/2" FNPT	NOTE 9
F	COMPRESSED AIR SUPPLY	1-1/2" FNPT	NOTE 9
E	CIP MAKE UP WATER	2" FLG	NOTE 8 & 9
D	FILTRATE FORWARD	6" FLG	NOTE 8 & 9
C5	REVERSE FILTRATION TANK T-2 OVERFLOW	4"	NOTE 9
C4	REVERSE FILTRATION TANK T-2 DRAIN	2" SW	NOTE 9
C3	FEED TANK T-1 OVERFLOW	6"	NOTE 9
C2	FEED TANK T-1 DRAIN	2" SW	NOTE 9
C1	MISC. DRAIN	2" FLG	NOTE 8 & 9
B	CIP/RF/AS DRAIN	6" FLG	NOTE 8 & 9
A	FEED	6" FLG	NOTE 8 & 9
ITEM	DESCRIPTION	TYPE	

BATTERY LIMIT CONNECTIONS

DIMENSIONS PROVIDED WITHIN THIS DRAWING ARE FOR REFERENCE ONLY. BECAUSE OF FITTING SIZE VARIATIONS, PRIOR TO MAKING FINAL WELDS, PIPING SHALL BE DRY FIT UP TO FRAME TO ENSURE PROPER ALIGNMENT OF PIPING, FLANGES, BOLT HOLES, ETC.

NOTES:

1.) DO NOT STORE THE MODULES OR THEIR SHIPPING CONTAINERS OUTSIDE OR IN AN AREA WHERE THERE WILL BE EXPOSURE TO DIRECT SUNLIGHT, EXCESSIVE HEAT, OR COLD. PALL CORPORATION REQUIRES MEMBRANES BE STORED IN A CONTROLLED, SECURE ENVIRONMENT TO GUARANTEE MODULES ARE NOT DAMAGED DURING STORAGE
2.) DO NOT DROP OR EXPOSE THE MODULES OR THEIR SHIPPING CONTAINERS TO SHOCK OR IMPACT. THERE MAY BE DAMAGE TO THE MEMBRANE EVEN IF NO VISIBLE DAMAGE TO THE MODULE CASE IS EVIDENT.
3.) THE MODULE RACK ASSEMBLY, INTERCONNECT PIPING ASSEMBLY, AND TANKS WILL BE SHIPPED SEPARATELY FOR INSTALLATION IN THE FIELD.
4.) THIS DRAWING SHOWS (1) COMPLETE AP6 ASSEMBLY.
5.) THE DISKS ON ELASTOMER-SEATED BUTTERFLY VALVES MUST BE AT LEAST PARTIALLY OPEN WHEN TIGHTENING FLANGE BOLTS. FAILURE TO DO SO WILL CAUSE PREMATURE FAILURE, AND WILL VOID ALL WARRANTIES ON THE VALVE.
6.) REFER TO INSTALLATION INSTRUCTIONS FOR PIPING ASSEMBLY.
7.) THE CONTROL ENCLOSURE IS CONSTRUCTED OF CARBON STEEL, PAINTED BLUE AND RATED NEMA 4. THE USE OF ALL CONDUIT PENETRATION HUBS OF THE SAME ENVIRONMENTAL RATING AS THE ENCLOSURE IS REQUIRED.
DO NOT PENETRATE THE TOP OF THE ENCLOSURE.
8.) ALL FLANGES ARE BOLT CIRCLE/HOLE SIZE EQUIVALENT TO ANSI 150# RATED FLANGES.
9.) PIPING, CONNECTING TO PALL EQUIPMENT, MUST BE ADEQUATELY SUPPORTED TO PREVENT ANY NOZZLE LOADS ON THE EQUIPMENT.
DO NOT USE SKID CONNECTIONS TO SUPPORT PIPING.

TABLE OF CONTENTS

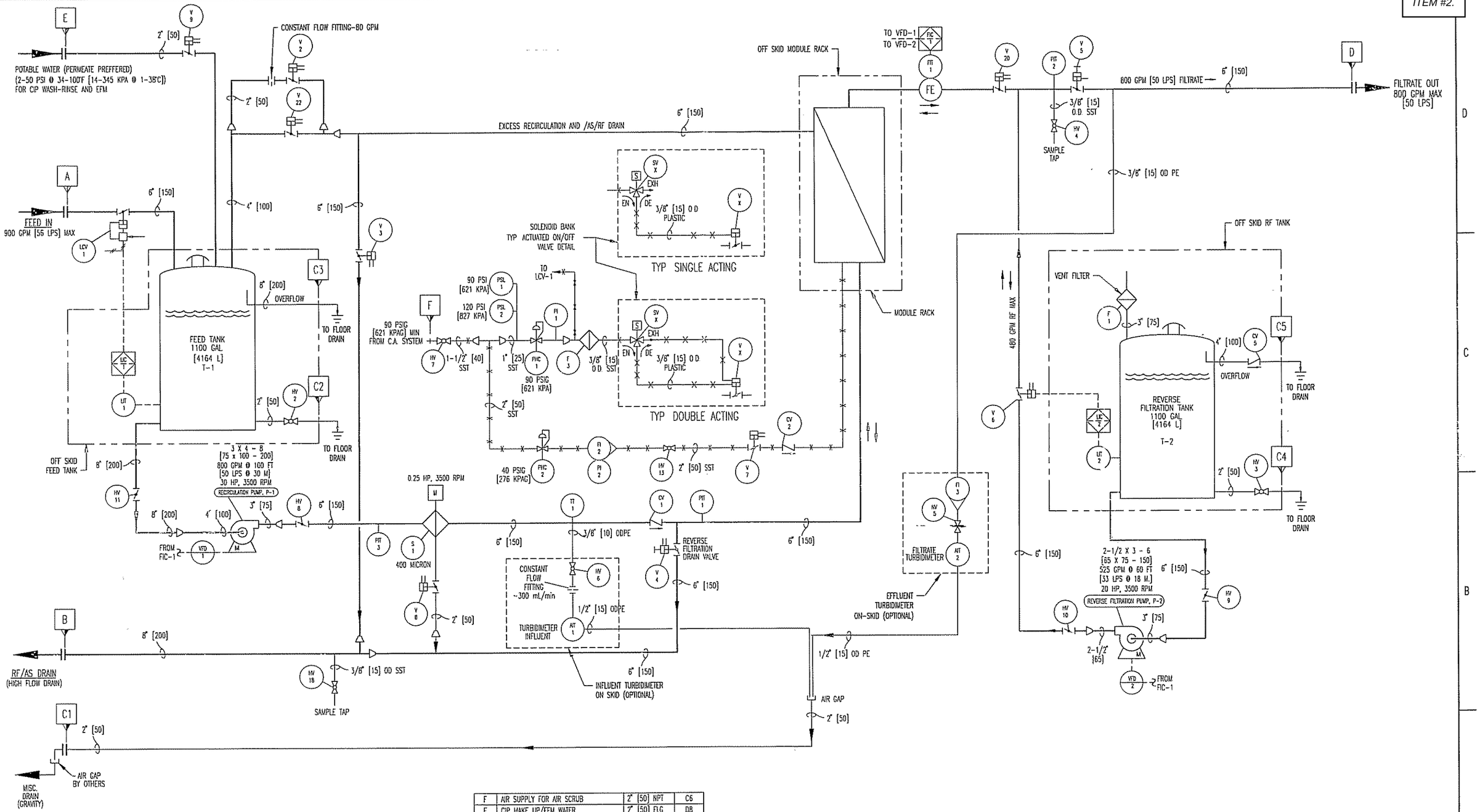
CODE IDENT. NO. 17233	NAME	DATE	---> DO NOT SCALE DRAWING <---
DRAWN BY	S. SMITH	05/27/2003	UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET
PROJECT ENGINEER	K. POOLE	05/27/2003	
ENGINEER	—	—	DIMENSIONS ARE IN: INCHES ONLY — TOLERANCE: .X ± .XX ±
ENGINEER	—	—	
ENGINEER	—	—	SURFACE FINISH √ (125) — .X ± FRACTION ± .XX ± ANGLE ±
CHECKER	D. CLARK	05/27/2003	

PALL Pall Corporation
PALL ADVANCED SEPARATIONS SYSTEMS CORTLAND, NEW YORK

DRAWING NUMBER 10000000283 | REVISION 00 | DWG SIZE D

DRAWING NAME: SYSTEM MF, 02.00013 Z5006

THIRD ANGLE PROJECTION | SCALE 1/40 | MATERIAL NUMBER 15413 | SHEET 1 OF 5



ITEM	DESCRIPTION	TYPE	ZONE
F	AIR SUPPLY FOR AIR SCRUB	2" [50] NPT	C6
E	CIP MAKE UP/EFM WATER	2" [50] FLG	D8
D	FILTRATE FORWARD	6" [150] FLG	D1
C5	MISC. DRAIN OVERFLOW (RF TANK)	4" [100] SW	C2
C3	MISC. DRAIN OVERFLOW (FEED TANK)	6" [150] SW	C7
C2/4	MISC. DRAIN (FEED & RF TANK)	2" [50] SW	B2/C7
C1	MISC. DRAIN (SKID)	2" [50] FLG	A8
B	CIP/RF/AS DRAIN	6" [200] FLG	B8
A	FEED	6" [150] FLG	C8

BATTERY LIMIT CONNECTIONS

LEGEND

(PALL) (PURCHASER) BATTERY LIMIT – PIPING AND TUBING

NOTES:
1. AIR SUPPLY: CLEAN, DRY, AND OIL FREE INSTRUMENT GRADE AIR @ 90 PSIG MIN. DELIVERY PRESSURE; 4 SCFM/MODULE ÷ 0.5 CFM FOR VALVES
2. ELECTRICAL SUPPLY: 460VAC
3. ALL FLOWS SHOWN ARE MAXIMUM
4. ALL PIPING IS SCHEDULE 40 PVC U O N

CODE IDENT. NO. 17238	NAME	DATE
DRAWN BY	S. SMITH	3/04/2004
PROJECT ENGINEER	M. POOLE	3/04/2004
ENGINEER	——	——
ENGINEER	——	——
ENGINEER	——	——
CHECKER	A. HEDDING	3/04/2004

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DIMENSIONS ARE IN: INCHES ONLY

TOLERANCE: X ± .XXX ±; FRACTIONS ± 1/8; ANGLE ± 2°

SURFACE FINISH √ [Ra/m]: ——

PALL Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

DRAWING NUMBER 10000001350 | REVISION 00 | DWG SIZE D

DRAWING NAME: SYSTEM,MF,AP6,2004,STOCK,R1,P&ID

THIRD ANGLE PROJECTION | SCALE: NONE | MATERIAL MANAGER | SHEET 2 OF 4

POTABLE WATER (PERMEATE PREFFERED)
(2-50 PSI @ 34-100°F [14-345 KPA @ 1-38°C])
FOR CIP WASH-RINSE AND EFM.
REFER TO SUPPLIED CIP CHARTS.
SEE NOTE 4 (SHEET 1)

2500 GAL HOT WATER TANK T-80

HOT WATER PUMP P-80
1-1/4" X 1-1/2" - 6
[30 X 40 - 150]
100 GPM @ 70 FT (MAX)
[6 LPS @ 21 M]
3 HP 3550 RPM

3 GPM @ 90 PSIG
[0.2 LPS @ 621 KPAG]
EFM PUMP P-81

EFM NaOCl INJECTION LINE
SUCTION LIFT 8 FT MAX

(PALL SUPPLIED)

TO CHN PANEL

TO OPTIONAL NEUTRALIZATION SYSTEM

(90-100°F)

TO AP SKID "A"

TO AP SKID "B"

FROM C.A. SYSTEM

SET @ 90 PSIG

SOLENOID BANK
TYP ACTUATED ON/OFF
VALVE DETAIL

TYP SINGLE ACTING

3 GPM @ 90 PSIG
[0.2 LPS @ 621 KPAG]
NaOCl TRANSFER PUMP P-90

6 GPM @ 90 PSIG
[0.4 LPS @ 621 KPAG]
CAUSTIC TRANSFER PUMP P-92

6 GPM @ 90 PSIG
[0.4 LPS @ 621 KPAG]
ACID TRANSFER PUMP P-91

55 GAL [208 L] DRUM NaOCl (12.5%) T-90 (BY OTHERS)

55 GAL [208 L] DRUM CAUSTIC (25%) T-92 (BY OTHERS)

55 GAL [208 L] DRUM ACID (50%) T-91 (BY OTHERS)

NOTES:
1 HOT WATER TANK TO BE SHIPPED LOOSE AND INSTALLED IN FIELD BY OTHERS.
2 ALL INSTRUMENTS AND OR EQUIPMENT TO BE CONNECTED TO CHN PANEL.

L4B/C	EFM INJECTION FROM CIP SKID (P-91, 92)	1/2" [15] TUBE	ODPE	B2,3/C5
L4A	EFM INJECTION FROM CIP SKID (P-90)	3/8" [10] TUBE	ODPE	B4, C5
L2A/B	CIP XFER SYSTEM MANIFOLD (TO AP SKIDS)	2" [50] FLG	PVC	C4
J1B	COMPRESSED AIR EFM SKID TO CIP SKID	1/2" [15] FNPT	ODPE	A4/B5
J1A	COMPRESSED AIR EFM	1/2" [15] FNPT	SST	B8
H5	NaOCl FOR EFM	3/8" [10] TUBE	PE	B5
H4	EFM SKID OUTLET (TO NEUTRALIZATION)	2" [50] FLG	PVC	C3
H3	HOT WATER TANK DRAIN	1" [25] FLG	PVC	C8
H2	HOT WATER TANK OVERFLOW DRAIN	2" [50] SW	PVC	D8
H1	EFM SKID INLET	2" [50] FLG	PVC	D5

BATTERY LIMIT TABLE

ITEM	DESCRIPTION	TYPE	MAT'L	ZONE

IMPORTANT: BEFORE ATTEMPTING TO OPERATE OR INSTALL THIS SYSTEM, IT IS ESSENTIAL TO READ AND UNDERSTAND THIS PRODUCT'S OPERATION AND MAINTENANCE MANUAL (SHIPPED UNDER SEPARATE COVER). FAILURE TO READ THE OPERATION AND MAINTENANCE MANUAL BEFORE ATTEMPTING TO OPERATE ANY PALL CORPORATION EQUIPMENT MAY RESULT IN SERIOUS PERSONAL INJURY AND/OR PRODUCT DAMAGE AND MAY VOID ANY AND/OR ALL WARRANTIES.

CODE IDENT. NO. 17238	NAME	DATE
DRAWN BY	S. SMITH	XX/MAR/2004
PROJECT ENGINEER	M. POOLE	XX/MAR/2004
ENGINEER	----	----
ENGINEER	----	----
ENGINEER	----	----
CHECKER	J. HOSKINS	XX/MAR/2004

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UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET
DIMENSIONS ARE IN: INCHES ONLY
TOLERANCE: X ± .XXX ± | FRACTIONS ± 1/8 | ANGLE ± 2°
SURFACE FINISH: µIN. ___ / µm ___

PALL Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

DRAWING NUMBER 10000001350 | REVISION 00 | DWG SIZE D

DRAWING NAME: SYSTEM,MF,AP6,2004,STOCK,R1,P&ID

THIRD ANGLE PROJECTION | SCALE NONE | MATERIAL NUMBER | SHEET 3 OF 4

VALVE SYMBOLS

- GATE VALVE OR MISCELLANEOUS
- GLOBE VALVE
- CHECK VALVE
- SPRING LOADED CHECK VALVE
- PLUG VALVE
- 3-WAY PLUG VALVE
- ROTARY/BALL VALVE
- BUTTERFLY VALVE (W/ PNEUMATIC ACTUATOR)
- BUTTERFLY VALVE (HAND)
- NEEDLE VALVE
- ANGLE VALVE
- CONTROL VALVE
- FLOAT VALVE
- AIR RELEASE VALVE
- BACKFLOW PREVENTER
- DIAPHRAGM VALVE
- SAFETY RELIEF VALVE
- 2 WAY SOLENOID VALVE
- 3 WAY SOLENOID VALVE (DE, EX)
- 4 WAY SOLENOID VALVE
- PNEUMATIC ACTUATOR CONTROL VALVE
- PRESSURE REDUCING VALVE (REGULATOR)
- POSITIONER & CYLINDER AIR TO CLOSE SINGLE ACTING (ATC)
- POSITIONER & CYLINDER AIR TO OPEN SINGLE ACTING (ATO)
- POSITIONER & CYLINDER AIR TO AIR DOUBLE ACTING (ATA)

TYPICAL SYMBOLS

- CONTAINMENT
- UNDEFINED SIGNAL
- PNEUMATIC SIGNAL
- COMPRESSED AIR PIPING
- ELECTRIC SIGNAL
- FIELD MOUNTED DEVICE
- PANEL FACE MOUNTED DEVICE
- INSIDE OF PANEL MOUNTED DEVICE
- DEVICE MOUNTED ON AUXILIARY PANEL FACE
- DEVICE MOUNTED INSIDE OF AUXILIARY PANEL
- PROGRAMMABLE LOGIC CONTROLLER IN MAIN PANEL
- PROGRAMMABLE LOGIC CONTROLLER IN AUXILIARY PANEL
- DISPLAY ON MAIN PANEL
- COMPUTER FUNCTION PRIMARY LOCATION
- COMPUTER FUNCTION AUXILIARY LOCATION
- MESSAGE DISPLAY ON CRT
- ELECTRIC OPERATOR (M)
- INTERLOCK (I)
- MAGNETIC FLOWMETER W/ INTEGRAL ELECTRONICS (M)
- VARIABLE AREA FLOWMETER
- GEAR/DISPLACEMENT FLOWMETER
- ACTUATOR, W/ TRAVEL STOPS
- ACTUATOR, AIR TO CLOSE (SINGLE ACTING) (A.T.C.)
- ACTUATOR, AIR TO OPEN (SINGLE ACTING) (A.T.O.)
- ACTUATOR, AIR TO CLOSE & AIR TO OPEN (DOUBLE ACTING) (A.T.A.)
- TWO (2) ITEMS IN ONE (1) DEVICE
- FLOW CONVERTER (ADD IDENTIFYING INFORMATION OUTSIDE BALLOON TO CLARIFY FUNCTION OF ITEM INSIDE BALLOON, EXT. I/P: CURRENT TO PNEUMATIC CONVERTER) (FY I/P)
- MANWAY

TYPICAL SYMBOLS

- DRAIN
- HUB DRAIN
- DIAPHRAGM SEAL
- BUTTERFLY VALVE WITH FIXED ORIFICE IN DISC
- SLIP JOINT/EXPANSION CONNECTION
- MANUAL VALVE OPERATOR
- (CUSTOMER) (PALL) CUSTOMER CONNECTION
- (CUSTOMER) (PALL) ELECTRICAL CONNECTION
- SPRAY BALL
- AIR VENT
- PILOT LIGHT (R)

COLOR CODE
R=RED
A=AMBER
G=GREEN
B=BLUE
W=WHITE

- SIGHT GLASS
- SWING ELBOW
- INSULATED EQUIPMENT
- STEAM OR ELECTRICAL TRACED WITH INSULATION
- ELECTRICAL HEAT TRACE
- ITEM OR EQUIPMENT NO.
- EDUCTOR (W/ GATE VALVE & FUNNEL)

TYPICAL SYMBOLS

- ANTIFOAM INLET
- 'Y' STRAINER
- STRAINER/FILTER
- CONSTANT FLOW FITTING
- FLEXIBLE CONNECTOR/ EXPANSION JOINT
- FLEXIBLE REDUCER
- REDUCER
- FLANGED CONNECTION
- AIR GAP
- CAPPED OR PLUGGED CONNECTION

PUMP SYMBOLS

- CENTRIFUGAL PUMP (M)
- ROTARY PUMP (M)
- (TUBING) PERISTALTIC PUMP (M)
- DOUBLE HEAD PERISTALTIC PUMP (M)
- MOTORIZED DIAPHRAGM PUMP (M)
- PNEUMATIC DIAPHRAGM PUMP
- METERING PUMP (M)
- VERTICAL PUMP
- SUBMERGED PUMP (M)

FLOW INSTRUMENTS

FC	FLOW CONTROLLER (BLIND)
FCV	FLOW CONTROL VALVE
FE	FLOW ELEMENT
FFC	FLOW RATIO CONTROLLER
FG	FLOW SIGHT GLASS
FI	FLOW INDICATOR
FIC	FLOW INDICATOR CONTROLLER
FIT	FLOW INDICATOR TRANSMITTER
FM	FLOW METER
FQ	FLOW TOTALIZER
FQC	FLOW TOTALIZER CONTROLLER
FR	FLOW RECORDER
FRC	FLOW RECORDER CONTROLLER
FSH	FLOW SWITCH HIGH
FSHH	FLOW SWITCH HIGH HIGH
FSL	FLOW SWITCH LOW
FSLL	FLOW SWITCH LOW LOW
FT	FLOW TRANSMITTER (BLIND)
FX	FLOW INTEGRATOR

PRESSURE INSTRUMENTS

DSPI	DIFFERENTIAL SET POINT INDICATOR
PC	PRESSURE CONTROLLER (BLIND)
PCV	PRESSURE CONTROL VALVE
PDC	PRESSURE DIFFERENTIAL CONTROLLER
PDH	DIFFERENTIAL PRESSURE HIGH
PDHH	DIFFERENTIAL PRESSURE HIGH HIGH
PDI	DIFFERENTIAL PRESSURE INDICATOR
PDS	DIFFERENTIAL PRESSURE SWITCH
PHC	PRESSURE HAND CONTROL (REGULATOR)
PI	PRESSURE INDICATOR
PIC	PRESSURE INDICATING CONTROLLER
PIS	PRESSURE INDICATING SWITCH
PIT	PRESSURE INDICATING TRANSMITTER
PLH	PRESSURE LIMIT HIGH
PR	PRESSURE RECORDER
PRC	PRESSURE RECORDER CONTROLLER
PSH	PRESSURE SWITCH HIGH
PSHH	PRESSURE SWITCH HIGH HIGH
PSL	PRESSURE SWITCH LOW
PSLL	PRESSURE SWITCH LOW LOW
PT	PRESSURE TRANSMITTER (BLIND)

LEVEL INSTRUMENTS

LC	LEVEL CONTROLLER (BLIND)
LCV	LEVEL CONTROL VALVE
LE	LEVEL ELEMENT
LG	LEVEL GAGE GLASS
LI	LEVEL INDICATOR
LIC	LEVEL INDICATOR CONTROLLER
LIT	LEVEL INDICATING TRANSMITTER
LR	LEVEL RECORDER
LRC	LEVEL RECORDING CONTROLLER
LSH	LEVEL SWITCH HIGH
LSHH	LEVEL SWITCH HIGH HIGH
LSL	LEVEL SWITCH LOW
LSLL	LEVEL SWITCH LOW LOW
LSM	LEVEL SWITCH MID
LT	LEVEL TRANSMITTER (BLIND)

TEMPERATURE INSTRUMENTS

TC	TEMPERATURE CONTROLLER (BLIND)
TCV	TEMPERATURE CONTROL VALVE
TE	TEMPERATURE ELEMENT
TI	TEMPERATURE INDICATOR
TIC	TEMPERATURE INDICATING CONTROLLER
TIT	TEMPERATURE INDICATING TRANSMITTER
TLH	TEMPERATURE LIMIT HIGH
TR	TEMPERATURE RECORDER
TRC	TEMPERATURE RECORDER CONTROLLER
TSH	TEMPERATURE SWITCH HIGH
TSHH	TEMPERATURE SWITCH HIGH HIGH
TSL	TEMPERATURE SWITCH LOW
TSLL	TEMPERATURE SWITCH LOW LOW
TT	TEMPERATURE TRANSMITTER

MISCELLANEOUS

AE	ANALYTICAL ELEMENT
AIT	ANALYTICAL INDICATING TRANSMITTER
A.S.	AIR SUPPLY
A.T.A.	AIR TO ACTIVATE
A.T.C.	AIR TO CLOSE
A.T.O.	AIR TO OPEN
CV	CHECK VALVE
DE	DE-ENERGIZE
DPI	DIFFERENTIAL PRESSURE INDICATOR
E	ENERGIZE
EX	EXHAUST
H	HEATER
HV	HAND VALVE (MANUAL)
I/P	CURRENT TO PNEUMATIC TRANSDUCER
LS	LIMIT SWITCH
M	MECHANICAL DEVICE/MISCELLANEOUS
N.C.	NORMALLY CLOSED
N.O.	NORMALLY OPEN
NV	NEEDLE VALVE
O/C/A	OPEN-CLOSE-AUTO
ORP	OXIDATION REDUCTION POTENTIAL
P	PUMP
P/A	PULSE TO ANALOG
P/I	PNEUMATIC TO CURRENT TRANSDUCER
PRD	PRESSURE RUPTURE DISK
PS	PUMP SPEED
REV.	REVERSING
SG	SIGHT GLASS
S.P.	SET POINT
SS	SELECTOR SWITCH
SV	SOLENOID VALVE
T	TANK
TS	TRAVEL STOP
TYP	TYPICAL
UA	MULTIVARIABLE ALARM
UON	UNLESS OTHERWISE NOTED
V	VALVE (ACTUATED)
VFC	VOLT FREE CONTACT
VFD	VARIABLE FREQUENCY DRIVE
Y	CONVERTER

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CODE IDENT. NO. 17238	NAME	DATE
DRAWN BY	S. SMITH	XMAR2004
PROJECT ENGINEER	M. POOLE	XMAR2004
ENGINEER	———	———
ENGINEER	———	———
ENGINEER	———	———
CHECKER	J. HEDRING	XMAR2004

---> DO NOT SCALE DRAWING <---

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET

DIMENSIONS ARE IN: INCHES ONLY
SURFACE FINISH: µIN. ___ (µm) ___
TOLERANCE: X ± .XXX ±; .X ± FRACTION ± 1/8; .XX ± ANGLE ± 2°

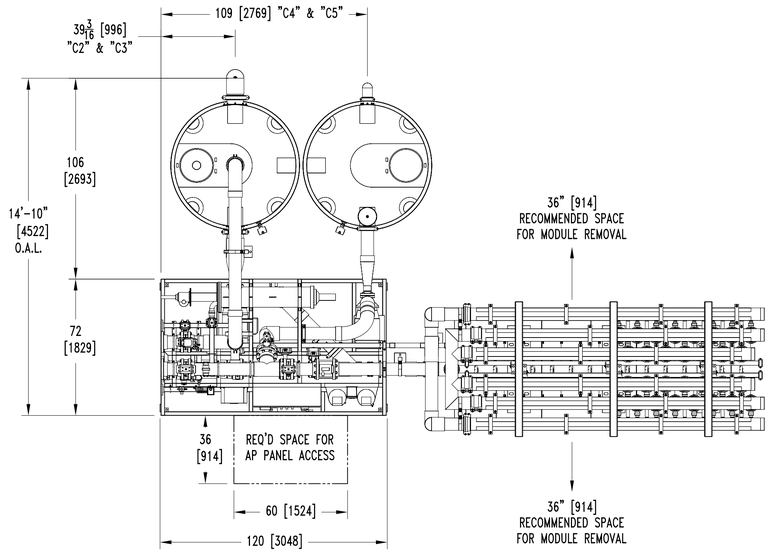
THIRD ANGLE PROJECTION

Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

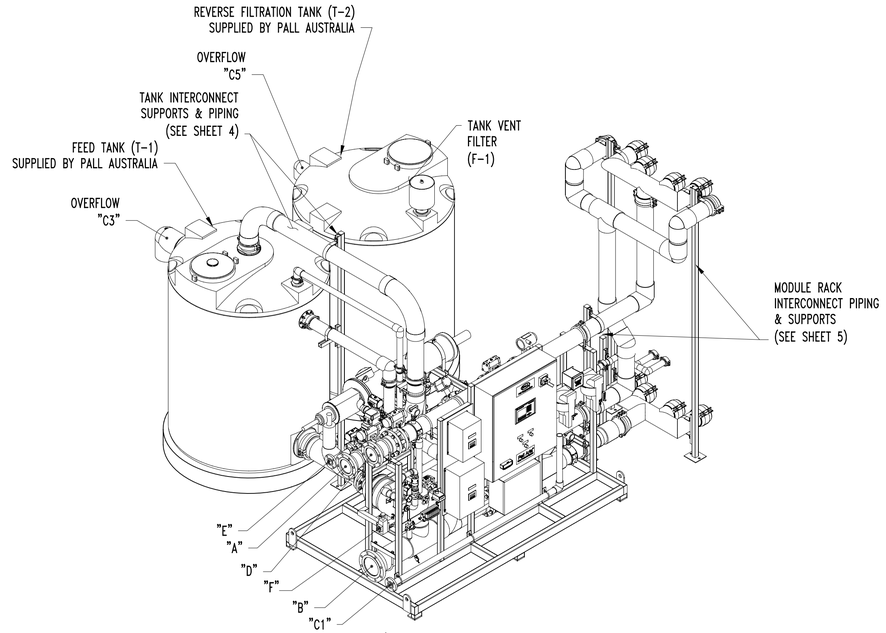
DRAWING NUMBER: 10000001350
REVISION: 00
DWG SIZE: D

DRAWING NAME: SYSTEM,MF,AP6,2004,STOCK,R1,P&ID

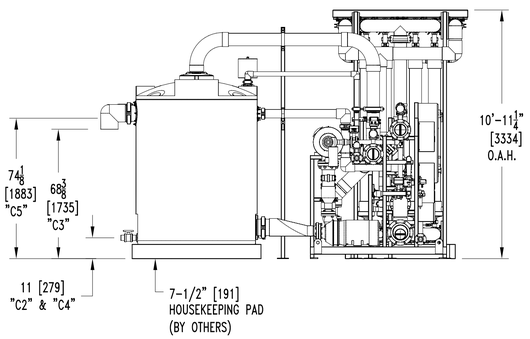
SCALE: NONE
MATERIAL NUMBER:
SHEET 4 OF 4



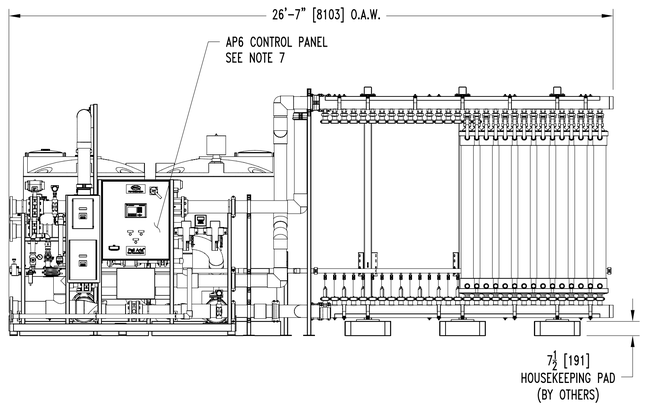
TOP VIEW



LEFT/FRONT ISOMETRIC VIEW
(REMOTE MODULE RACK REMOVED FOR CLARITY)



LEFT SIDE VIEW



FRONT VIEW

F	COMPRESSED AIR SUPPLY	1-1/2" [40] FNPT	NOTE 9
E	CIP MAKE UP WATER	2" [50] FLG	NOTE 8 & 9
D	FILTRATE FORWARD	6" [150] FLG	NOTE 8 & 9
C5	REVERSE FILTRATION TANK T-2 OVERFLOW	4" [100] SW	NOTE 9
C4	REVERSE FILTRATION TANK T-2 DRAIN	2" [50] SW	NOTE 9
C3	FEED TANK T-1 OVERFLOW	8" [200] SW	NOTE 9
C2	FEED TANK T-1 DRAIN	2" [50] SW	NOTE 9
C1	MISC. DRAIN	2" [50] FLG	NOTE 8 & 9
B	CIP/RF/AS DRAIN	8" [200] FLG	NOTE 8 & 9
A	FEED	6" [150] FLG	NOTE 8 & 9
ITEM	DESCRIPTION	TYPE	

BATTERY LIMIT CONNECTIONS

NOTES:

1.) DO NOT STORE THE MODULES OR THEIR SHIPPING CONTAINERS OUTSIDE OR IN AN AREA WHERE THERE WILL BE EXPOSURE TO DIRECT SUNLIGHT, EXCESSIVE HEAT, OR COLD. PALL CORPORATION REQUIRES MEMBRANES BE STORED IN A CONTROLLED, SECURE ENVIRONMENT TO GUARANTEE MODULES ARE NOT DAMAGED DURING STORAGE.
2.) DO NOT DROP OR EXPOSE THE MODULES OR THEIR SHIPPING CONTAINERS TO SHOCK OR IMPACT. THERE MAY BE DAMAGE TO THE MEMBRANE EVEN IF NO VISIBLE DAMAGE TO THE MODULE CASE IS EVIDENT.
3.) THE MODULE RACK ASSEMBLY, INTERCONNECT PIPING ASSEMBLY, AND TANKS WILL BE SHIPPED SEPARATELY FOR INSTALLATION IN THE FIELD.
4.) THIS DRAWING SHOWS (1) COMPLETE AP6 ASSEMBLY.
5.) THE DISKS ON ELASTOMER-SEATED BUTTERFLY VALVES MUST BE AT LEAST PARTIALLY OPEN WHEN TIGHTENING FLANGE BOLTS. FAILURE TO DO SO WILL CAUSE PREMATURE FAILURE, AND WILL VOID ALL WARRANTIES ON THE VALVE.
6.) REFER TO INSTALLATION INSTRUCTIONS FOR PIPING ASSEMBLY.
7.) THE CONTROL ENCLOSURE IS CONSTRUCTED OF CARBON STEEL, PAINTED BLUE AND RATED NEMA 4. THE USE OF ALL CONDUIT PENETRATION HUBS OF THE SAME ENVIRONMENTAL RATING AS THE ENCLOSURE IS REQUIRED. ***DO NOT PENETRATE THE TOP OF THE ENCLOSURE.***
8.) ALL FLANGES ARE BOLT CIRCLE/HOLE SIZE EQUIVALENT TO ANSI 150# RATED FLANGES.
9.) PIPING, CONNECTING TO PALL EQUIPMENT, MUST BE ADEQUATELY SUPPORTED TO PREVENT ANY NOZZLE LOADS ON THE EQUIPMENT. ***DO NOT USE SKID CONNECTIONS TO SUPPORT PIPING.***

AP6 SYSTEM WEIGHT				
	WEIGHT			
EQUIPMENT	DRY Lbs.	DRY Kgs.	WET Lbs.	WET Kgs.
SKID	3,600	1,633	4,100	1,860
INTERCONNECT	1,000	453	2,100	953
MODULE RACK	7,200	3,266	9,000	4,082
TANKS	800	363	19,000	8,618
TOTAL WEIGHT	12,600	5,715	34,200	15,513

DIMENSIONS PROVIDED WITHIN THIS DRAWING ARE FOR REFERENCE ONLY. BECAUSE OF FITTING SIZE VARIATIONS, PRIOR TO MAKING FINAL WELDS, PIPING SHALL BE DRY FIT UP TO FRAME TO ENSURE PROPER ALIGNMENT OF PIPING, FLANGES, BOLT HOLES, ETC.

TABLE OF CONTENTS

PALL ARIA™ AP-6 SYSTEM

IMPORTANT: BEFORE ATTEMPTING TO OPERATE OR INSTALL THIS SYSTEM, IT IS ESSENTIAL TO READ AND UNDERSTAND THIS PRODUCT'S OPERATION AND MAINTENANCE MANUAL (SHIPPED UNDER SEPARATE COVER). FAILURE TO READ THE OPERATION AND MAINTENANCE MANUAL BEFORE ATTEMPTING TO OPERATE ANY PALL CORPORATION EQUIPMENT MAY RESULT IN SERIOUS PERSONAL INJURY AND/OR PRODUCT DAMAGE, AND MAY VOID ANY AND/OR ALL WARRANTIES.

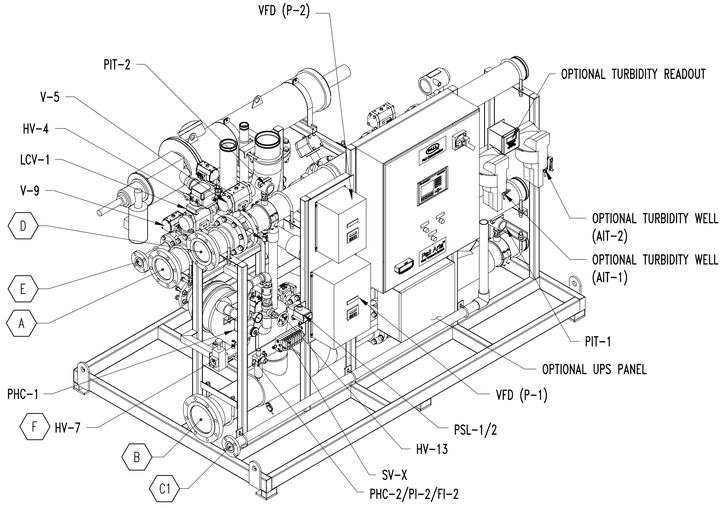
CODE IDENT. NO. 17238	NAME	DATE	--> DO NOT SCALE DRAWING <--
DRAWN BY	S. SMITH	08AUG2007	UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET
PROJECT ENGINEER	M. POOLE	21AUG2007	
ENGINEER	----	----	DIMENSIONS ARE IN: INCHES [mm] — TOLERANCE: X. ± .XXX ±
ENGINEER	----	----	SURFACE FINISH √ µIN: ___ [µm] ___ — .X ± .XX ± — FRACTION ± 1/8 — ANGLE ± 2°
ENGINEER	----	----	
CHECKER	J. HOSKINS	21AUG2007	

Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

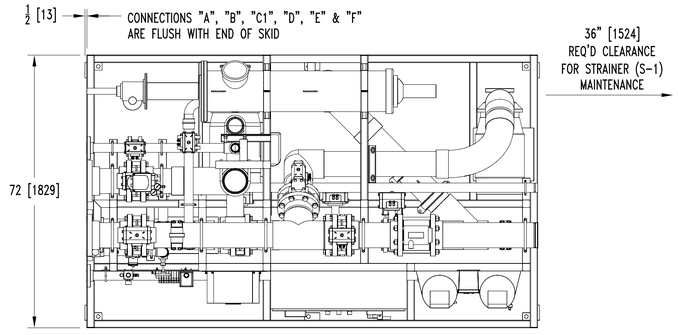
DRAWING NUMBER: 10000014584 | REVISION: 00 | DWG SIZE: D

DRAWING NAME: ASSY,FILTSKID,AP6,2008,R1,0DEG,QUAD,C

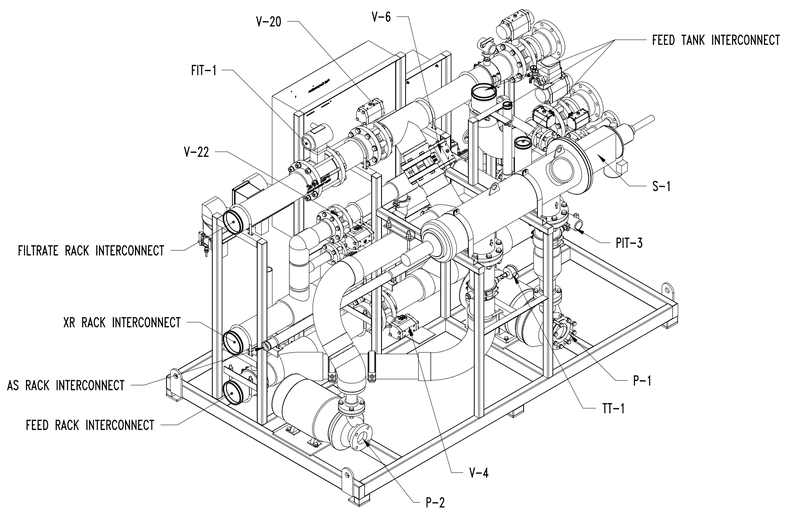
THIRD ANGLE PROJECTION | SCALE: 1/40 | MATERIAL NUMBER | SHEET 1 OF 5



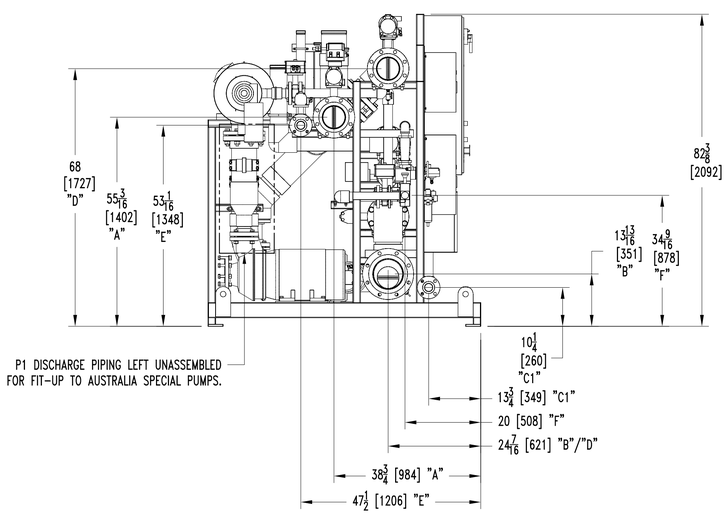
LEFT/FRONT ISOMETRIC VIEW



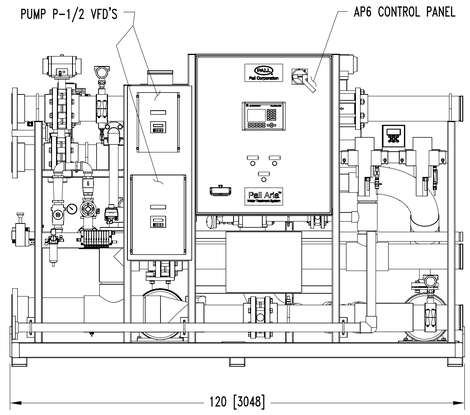
TOP VIEW
(AP6 SKID ONLY)



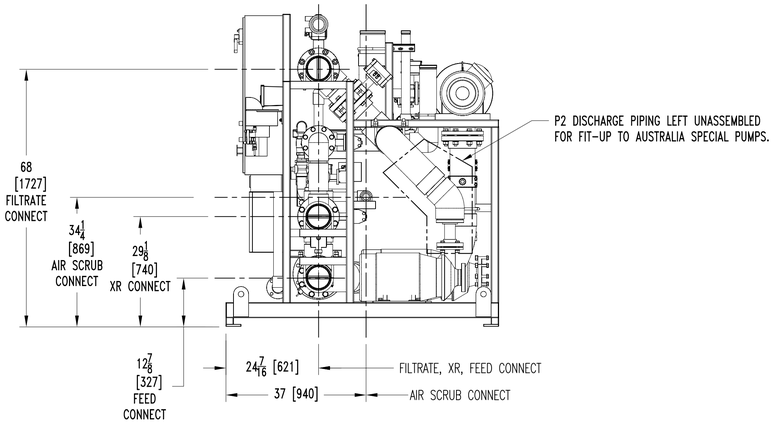
RIGHT/REAR ISOMETRIC VIEW



LEFT SIDE VIEW
(AP6 SKID ONLY)



FRONT VIEW
(AP6 SKID ONLY)



RIGHT SIDE VIEW
(AP SKID MODULE RACK INTERCONNECT)
SCALE: 1/16

PALL ARIA™ AP-6 SYSTEM

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DRAWN BY	S. SMITH	08AUG2007
PROJECT ENGINEER	M. POOLE	21AUG2007
ENGINEER	----	----
ENGINEER	----	----
ENGINEER	----	----
CHECKER	J. HOSKINS	21AUG2007

--> DO NOT SCALE DRAWING <--

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET

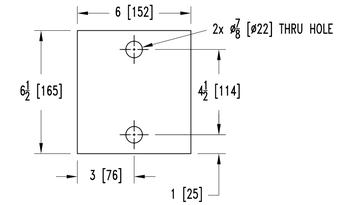
DIMENSIONS ARE IN: INCHES [mm]
SURFACE FINISH √ μIN: ___ {μm}: ___
TOLERANCE: X. ± .XXX ± | X ± FRACTION ± 1/8 | XX ± ANGLE ± 2°

Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

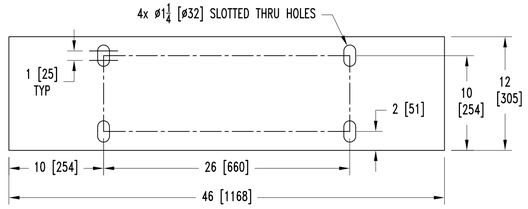
DRAWING NUMBER: 10000014584 | REVISION: 00 | DWG SIZE: D

DRAWING NAME: ASSY,FILTSKID,AP6,2008,R1,0DEG,QUAD,C

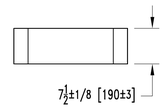
THIRD ANGLE PROJECTION | SCALE: 1/20 | MATERIAL NUMBER | SHEET 2 OF 5



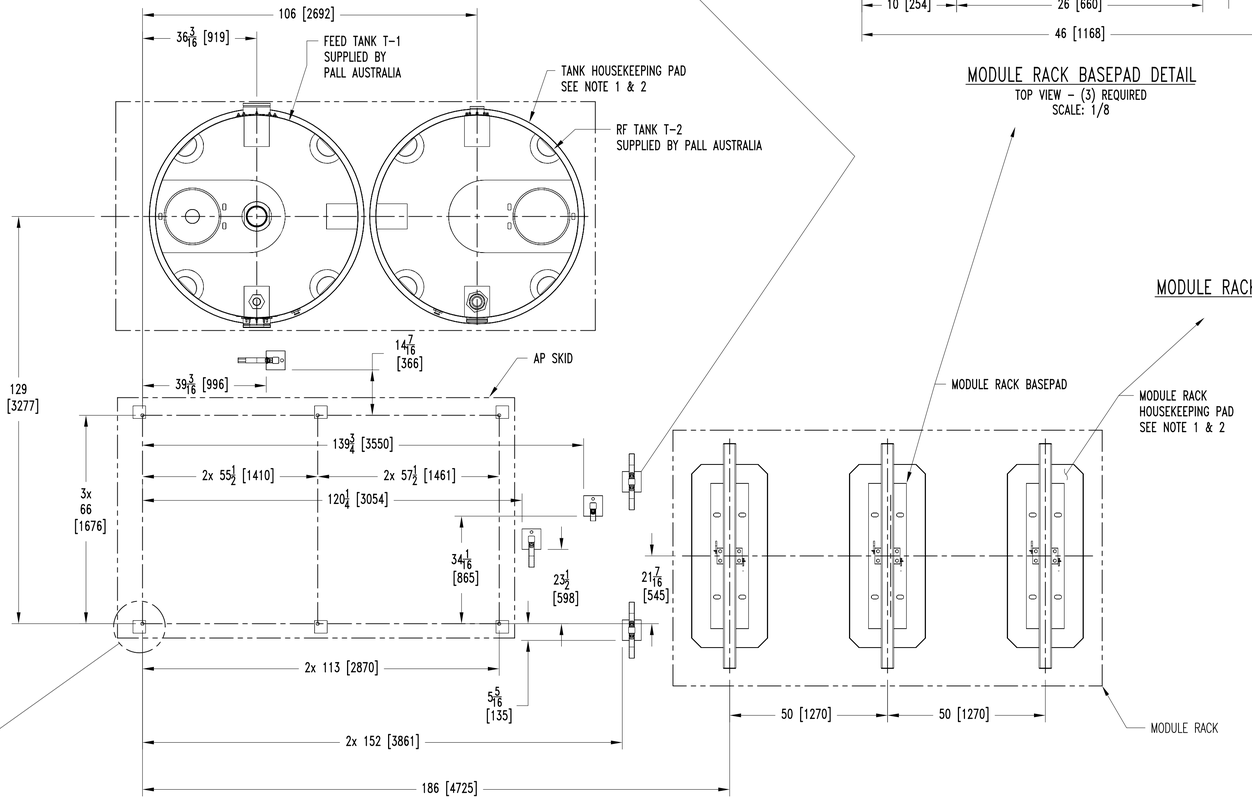
INTERCONNECT SUPPORT BASEPAD
(5) REQUIRED
SCALE: 1/4



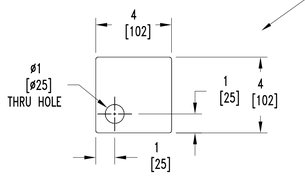
MODULE RACK BASEPAD DETAIL
TOP VIEW – (3) REQUIRED
SCALE: 1/8



MODULE RACK/TANK HOUSEKEEPING PAD DETAIL
(BY OTHERS)
SEE NOTE 1 & 2
SCALE: 1/16



BASEPAD FOOTPRINT LAYOUT
TOP VIEW
SEE NOTE 1
SCALE: 1/2"=1'



AP6 BASEPAD DETAIL
(6) REQUIRED
SCALE: 1/4

NOTES:

1.) THE TANKS T-1, T-2 AND THE MODULE RACK BASE PLATES ARE ELEVATED 7-1/2" HIGHER THAN THE AP6 BASE PLATES; THE EQUIPMENT MOUNTING PADS SHALL BE POURED TO ACCOMMODATE THIS DIFFERENCE. HOUSEKEEPING PAD TO BE SIZED, SUPPLIED AND INSTALLED BY OTHERS. HOUSEKEEPING PAD IS TO BE POURED LEVEL TO ACCOMMODATE MODULE RACK AND TANKS T-1 AND T-2.
2.) IT IS RECOMMENDED THAT THE MODULE RACK/TANK HOUSEKEEPING PADS EXTEND 6" ON ALL SIDES OF EQUIPMENT.
3.) ANCHOR BOLTS FOR SECURING MODULE RACK TO HOUSEKEEPING PAD TO BE SIZED, SUPPLIED AND INSTALLED BY OTHERS.
4.) AFTER LEVELING OF MODULE RACK, SHIM AND GROUT AS NECESSARY (BY OTHERS).
5.) THE MODULE RACK FRAME IS SHIPPED UNASSEMBLED.
6.) DO NOT ANCHOR MODULE RACK FRAME UNTIL ALL INTERCONNECT PIPING FROM AP6 SKID TO MODULE RACK IS INSTALLED.

PALL ARIA™ AP-6 SYSTEM

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DRAWN BY	S. SMITH	08AUG2007
PROJECT ENGINEER	M. POOLE	21AUG2007
ENGINEER	----	----
ENGINEER	----	----
ENGINEER	----	----
CHECKER	J. HOSKINS	21AUG2007

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TOLERANCE: X. ± XXX ±
SURFACE FINISH √ μIN: ___ [μm]: ___ .X ± FRACTION ± 1/8
.XX ± ANGLE ± 2'

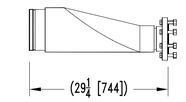
Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

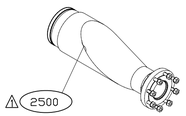
DRAWING NUMBER: 10000014584 | REVISION: 00 | DWG SIZE: D

DRAWING NAME: ASSY,FILTSKID,AP6,2008,R1,0DEG,QUAD,C

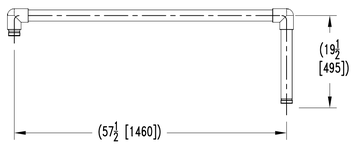
THIRD ANGLE PROJECTION | SCALE: 1/16 | MATERIAL NUMBER | SHEET 3 OF 5

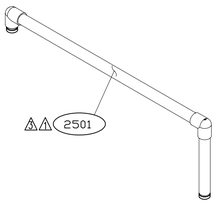
ITEM #2.



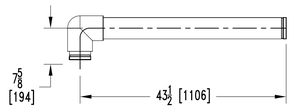


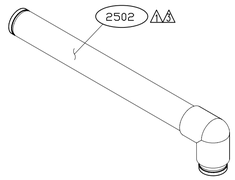
INTERCONNECT-TANK/P-1 (2500)
(FEED TANK TO ARIA AP6 FEED PUMP P-1)
(SEE NOTE 2 THIS SHEET)



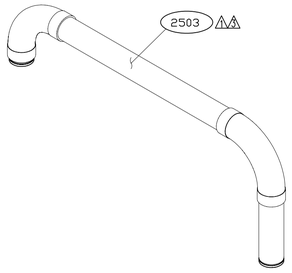


INTERCONNECT-TANK/POTABLE WATER (2501)
(FEED TANK TO ARIA AP6 CONNECTION "E")

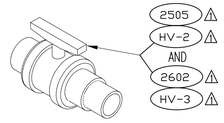




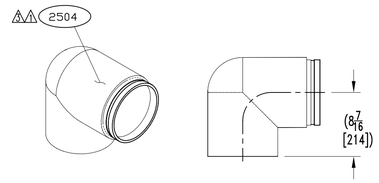
INTERCONNECT-TANK/AP SKID EXCESS RECIRC. (2502)
(FEED TANK TO AP6 EXCESS RECIRC. CONNECTION)



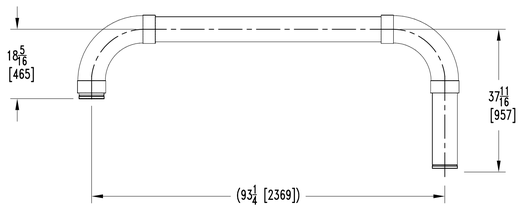
INTERCONNECT-TANK/FEED WATER (2503)
(FEED TANK TO ARIA AP6 CONNECTION "A")
SCALE: 1/20

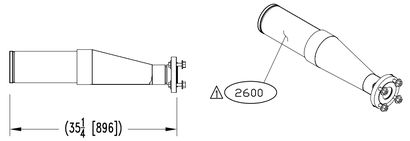


TANK T-1/T-2 DRAIN CONNECTION "C2" (2505) & "C4" (2602)
(RF TANK TO CUSTOMER DRAIN)
(SEE NOTE 3 THIS SHEET)

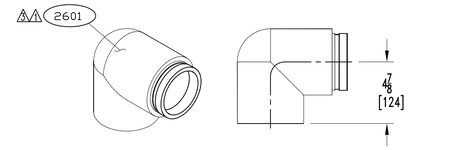


TANK T-1 OVERFLOW CONNECTION "C3" (2504)
(FEED TANK TO CUSTOMER DRAIN)
(SEE NOTE 3 THIS SHEET)

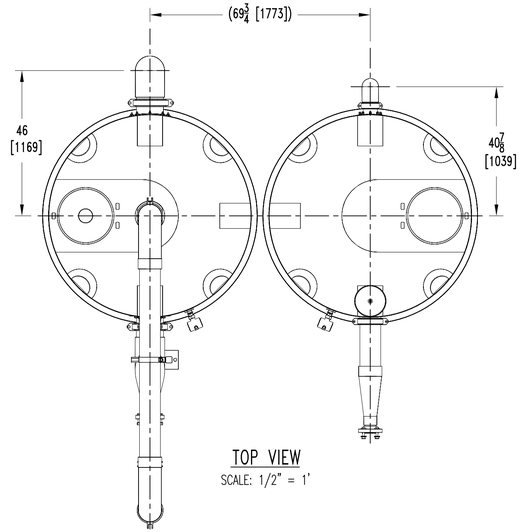




INTERCONNECT-TANK/P-2 (2600)
(FEED TANK TO ARIA AP6 FEED PUMP P-2)
(SEE NOTE 2 THIS SHEET)



"TANK T-2 OVERFLOW CONNECTION "C5" (2601)
(RF TANK TO CUSTOMER DRAIN)
(SEE NOTE 3 THIS SHEET)



TOP VIEW
SCALE: 1/2" = 1'

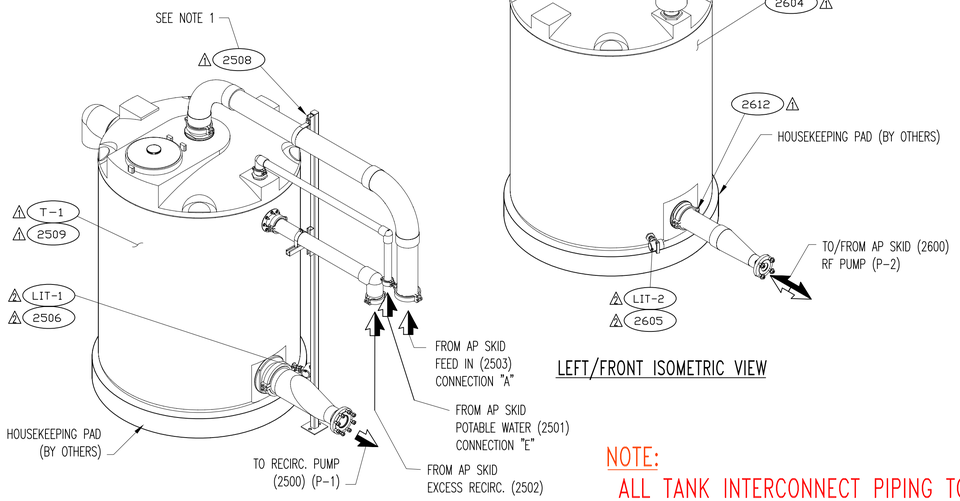
DIMENSIONS PROVIDED WITHIN THIS DRAWING ARE FOR REFERENCE ONLY.

NOTES:
1.) INTERCONNECT PIPING SUPPORTS TO BE LOCATED AS CLOSE TO TANK CONNECTION AS POSSIBLE. ADJUSTMENT OF SUPPORTS TO REMOVE NOZZLE LOAD FROM TANKS IS REQUIRED.
2.) INTERCONNECT PIPING ITEMS 2500 & 2600 ARE TO BE INSTALLED PRIOR TO ALL OTHER INTERCONNECT PIPE RUNS FROM AP SKID. TANK LOCATION TO BE ADJUSTED FOR FIT-UP.
3.) TANK OVERFLOW AND DRAIN PIPING TO BE SUPPORTED AT TANK CONNECTION (BY OTHERS).
4.) ANCHOR BOLTS FOR SECURING PIPE SUPPORTS TO BE SIZED, SUPPLIED AND INSTALLED BY OTHERS.
5.) ALL TANK INTERCONNECT PIPING TO BE SHIPPED LOOSE AND TO INCLUDE 6" ADDITIONAL LENGTH PER CUT FOR FIELD FIT-UP TO PALL AUSTRALIA SUPPLIED TANKS.

⚠1 LABEL PIPE OR EQUIPMENT FOR FIELD INSTALLATION, INSTRUMENTS TO BE PACKAGED AND LABELED ON OUTSIDE OF BOX. TEXT IS TO BE WRITTEN IN BLACK CHARACTERS ON A LAMINATED WHITE ADHESIVE LABEL, WITH A TEXT HEIGHT OF 3/16."

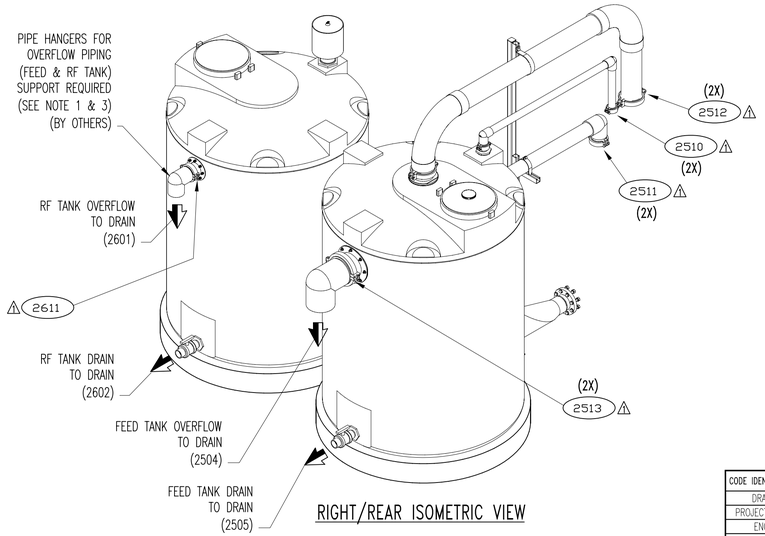
⚠2 PACKAGE AND LABEL PARTS ACCORDING TO ITEM NUMBER. PACKAGES WITH MULTIPLE PARTS WILL HAVE QUANTITY INDICATED.

⚠3 TAKE NOTE; MACHINE GROVE ON INTERCONNECT PIPING TO BE UTILIZED FOR CONNECTION TO TANKS AND SKID.



LEFT/FRONT ISOMETRIC VIEW

LEFT/FRONT ISOMETRIC VIEW



RIGHT/REAR ISOMETRIC VIEW

NOTE:
ALL TANK INTERCONNECT PIPING TO BE SHIPPED LOOSE AND TO INCLUDE 6" ADDITIONAL LENGTH PER CUT FOR FIELD FIT-UP TO PALL AUSTRALIA SUPPLIED TANKS.

ITEM	QTY	UNIT	SAP NO	DESCRIPTION
2612	1	EA	12782	CLAMP,6.0IN,GRV,7000,CS,GALV,18-8BLT
2611	1	EA	12780	CLAMP,4.0IN,GRV,7000,CS,GALV,18-8BLT
2605	1	EA	10731	PRESS TRANS,ROSEMOUNT,0-30PSI (LIT-2)
2604	1	EA	12660	TANK, 1100 GAL, HDPE (T-2)
2603	1	EA	14895	FILTER, TANK VENT, 3.00 IN MPT (F-1)
2602	1	EA	------	PIPE, ASSEMBLY, TANK T-2 DRAIN, PVC
2601	1	EA	------	PIPE, ASSEMBLY, TANK T-2 OVERFLOW, PVC
2600	1	EA	------	PIPE, ASSEMBLY, AP PUMP P-2 TO TANK T-2, SST
2513	2	EA	12784	CLAMP,8.0IN,GRV,7000,CS,GALV,18-8BLT
2512	2	EA	12782	CLAMP,6.0IN,GRV,7000,CS,GALV,18-8BLT
2511	2	EA	12780	CLAMP,4.0IN,GRV,7000,CS,GALV,18-8BLT
2510	2	EA	12776	CLAMP,2.0IN,GRV,7000,CS,GALV,18-8BLT
2509	1	EA	12660	TANK, 1100 GAL, HDPE (T-1)
2508	1	EA	------	PIPE SUPPORT, EXCESS RECIRC. INTC. TO T-1, CS
2506	1	EA	10731	PRESS TRANS,ROSEMOUNT,0-30PSI (LIT-1)
2505	1	EA	------	PIPE,ASSY,TANK T-1 DRAIN,PVC
2504	1	EA	------	PIPE,ASSY,TANK T-1 OVERFLOW,PVC
2503	1	EA	------	PIPE,ASSY,AP SKID CONN. "A" TO TANK T-1, PVC
2502	1	EA	------	PIPE,ASSY,AP SKID EXCESS RECIRC. TO TANK T-1, PVC
2501	1	EA	------	PIPE,ASSY,AP SKID CONNECTION "E" TO TANK T-1, PVC
2500	1	EA	------	PIPE,ASSY,AP PUMP P-1 TO TANK T-1, SST

PALL ARIA™ AP-6 SYSTEM

IMPORTANT: BEFORE ATTEMPTING TO OPERATE OR INSTALL THIS SYSTEM, IT IS ESSENTIAL TO READ AND UNDERSTAND THIS PRODUCT'S OPERATION AND MAINTENANCE MANUAL (SHIPPED UNDER SEPARATE COVER). FAILURE TO READ THE OPERATION AND MAINTENANCE MANUAL BEFORE ATTEMPTING TO OPERATE ANY PALL CORPORATION EQUIPMENT MAY RESULT IN SERIOUS PERSONAL INJURY AND/OR PRODUCT DAMAGE, AND MAY VOID ANY AND/OR ALL WARRANTIES.

CODE IDENT. NO. 17238	NAME	DATE
DRAWN BY	S. SMITH	08AUG2007
PROJECT ENGINEER	M. POOLE	21AUG2007
ENGINEER	----	----
ENGINEER	----	----
ENGINEER	----	----
CHECKER	J. HOSKINS	21AUG2007

--> DO NOT SCALE DRAWING <--

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET

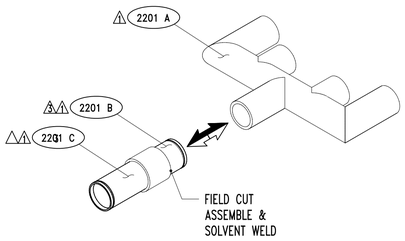
DIMENSIONS ARE IN: INCHES [mm]
SURFACE FINISH √ μIN: ___ [μm]: ___
TOLERANCE: X. ± XXX ± / X ± FRACTION ± 1/8 / XX ± ANGLE ± 2°

Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

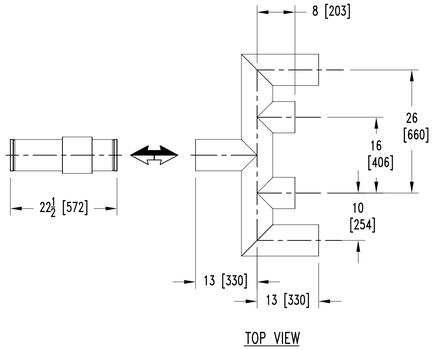
DRAWING NUMBER: 10000014584
REVISION: 00
DWG SIZE: D

DRAWING NAME: ASSY,FILTSKID,AP6,2008,R1,0DEG,QUAD,C

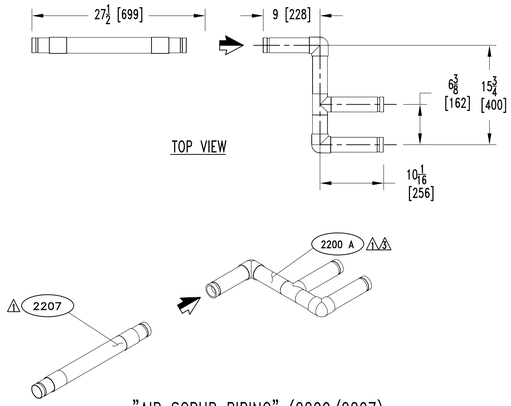
THIRD ANGLE PROJECTION
SCALE: 1/16
MATERIAL NUMBER
SHEET 4 OF 5



"FEED PIPING" (2201)
(AP SKID TO MODULE RACK)

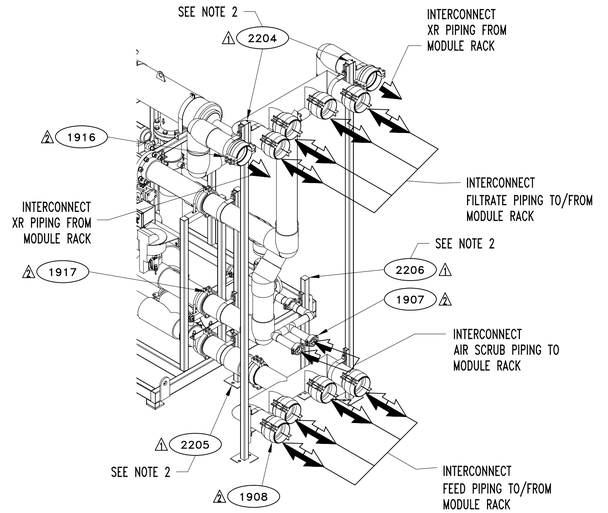


TOP VIEW



TOP VIEW

"AIR SCRUB PIPING" (2200/2207)
(AP SKID TO MODULE RACK)
(SEE NOTE 1 THIS SHEET)
SCALE: 1"=1'



LEFT/REAR ISOMETRIC VIEW

DIMENSIONS PROVIDED WITHIN THIS DRAWING ARE FOR REFERENCE ONLY.

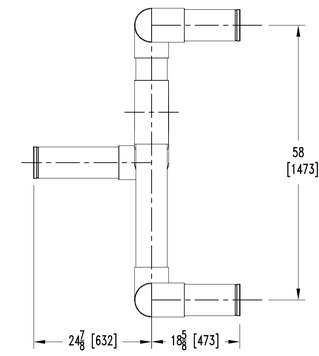
⚠1 LABEL PIPE OR EQUIPMENT FOR FIELD INSTALLATION, INSTRUMENTS TO BE PACKAGED AND LABELED ON OUTSIDE OF BOX. TEXT IS TO BE WRITTEN IN BLACK CHARACTERS ON A LAMINATED WHITE ADHESIVE LABEL, WITH A TEXT HEIGHT OF 3/16."

⚠2 PACKAGE AND LABEL PARTS ACCORDING TO ITEM NUMBER. PACKAGES WITH MULTIPLE PARTS WILL HAVE QUANTITY INDICATED.

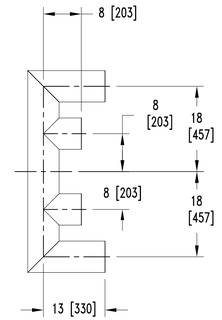
⚠3 TAKE NOTE; MACHINE GROVE ON INTERCONNECT PIPING TO BE UTILIZED FOR CONNECTION TO MODULE RACK AND SKID.

NOTES:

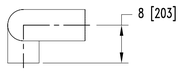
1.) INTERCONNECT PIPING ITEM 2200/2207 TO BE INSTALLED PRIOR TO ALL OTHER INTERCONNET PIPE RUNS FROM AP SKID TO MODULE RACK.
2.) INTERCONNECT PIPING SUPPORTS TO BE LOCATED AS CLOSE TO AP SKID/MODULE RACK CONNECTIONS AS POSSIBLE TO AVOID NOZZLE LOAD.



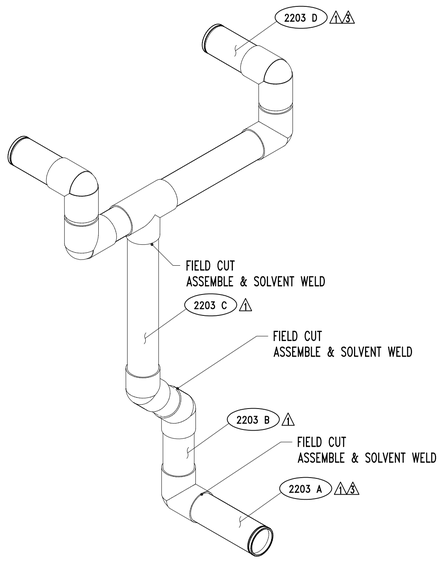
TOP VIEW



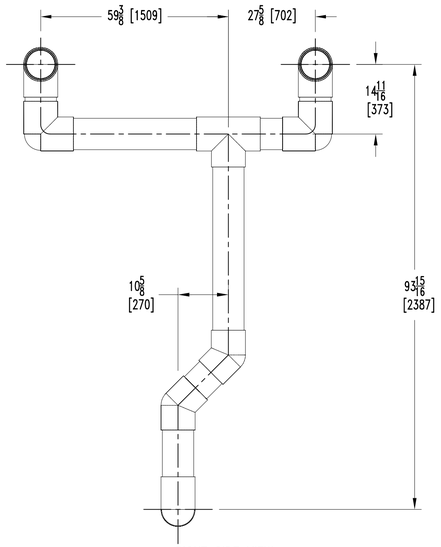
TOP VIEW



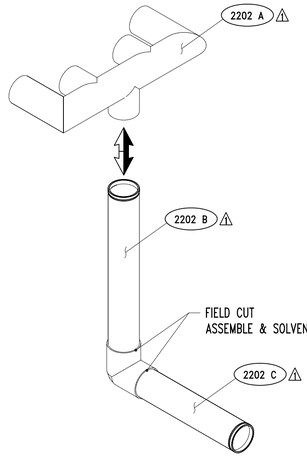
FRONT VIEW



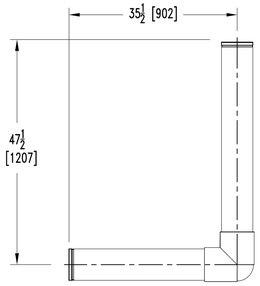
"XR PIPING" (2203)
(AP SKID TO MODULE RACK)



RIGHT SIDE VIEW



"FILTRATE PIPING" (2202)
(AP SKID TO MODULE RACK)



FRONT VIEW

ITEM	QTY	UNIT	SAP NO	DESCRIPTION
2207	1	EA	19039	ASSY,AIR,HOSE,FLEX,0DEG,AP6
2206	1	EA	------	PIPE SUPPORT, INTERCONNECT PIPE RUN SUPPORT, CS
2205	1	EA	------	PIPE SUPPORT, INTERCONNECT PIPE RUN SUPPORT, CS
2204	2	EA	------	PIPE SUPPORT, INTERCONNECT PIPE RUN SUPPORT, CS
2203	1	EA	------	PIPE,ASSY,XR,SKID TO MODULE RACK,PVC
2202	1	EA	------	PIPE,ASSY,FILT.,SKID TO MODULE RACK,PVC/HDPE
2201	1	EA	------	PIPE,ASSY,FEED,SKID TO MODULE RACK,PVC/HDPE
2200	1	EA	------	PIPE,ASSY,AS, SKID TO MODULE RACK,HDPE
1917	3	EA	12782	CLAMP,6.0IN,GRV,7000,CS,GALV,18-8BLT
1916	3	EA	28799	CLAMP,6.0IN,GRV,7307,CS,GALV,18-8BLT
1908	8	EA	30019	CLAMP,6.0IN,GRV,7305,CS,GALV,18-8BLT
1907	4	EA	12776	CLAMP,2.0IN,GRV,7000,CS,GALV,18-8BLT

CODE IDENT. NO. 17238	NAME	DATE
DRAWN BY	S. SMITH	08AUG2007
PROJECT ENGINEER	M. POOLE	21AUG2007
ENGINEER	----	----
ENGINEER	----	----
ENGINEER	----	----
CHECKER	J. HOSKINS	21AUG2007

--> DO NOT SCALE DRAWING <--

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING INFORMATION PERTAINS ONLY TO THIS SHEET

DIMENSIONS ARE IN: INCHES [mm]
SURFACE FINISH √ μIN: ___ {μm}: ___

TOLERANCE	
X. ±	XXX ±
.X ±	FRACTION ± 1/8
.XX ±	ANGLE ± 2°

Pall Corporation
Pall Advanced Separations Systems
Cortland, New York

DRAWING NUMBER 10000014584 | REVISION 00 | DWG SIZE D

DRAWING NAME: ASSY,FILTSKID,AP6,2008,R1,0DEG,QUAD,C

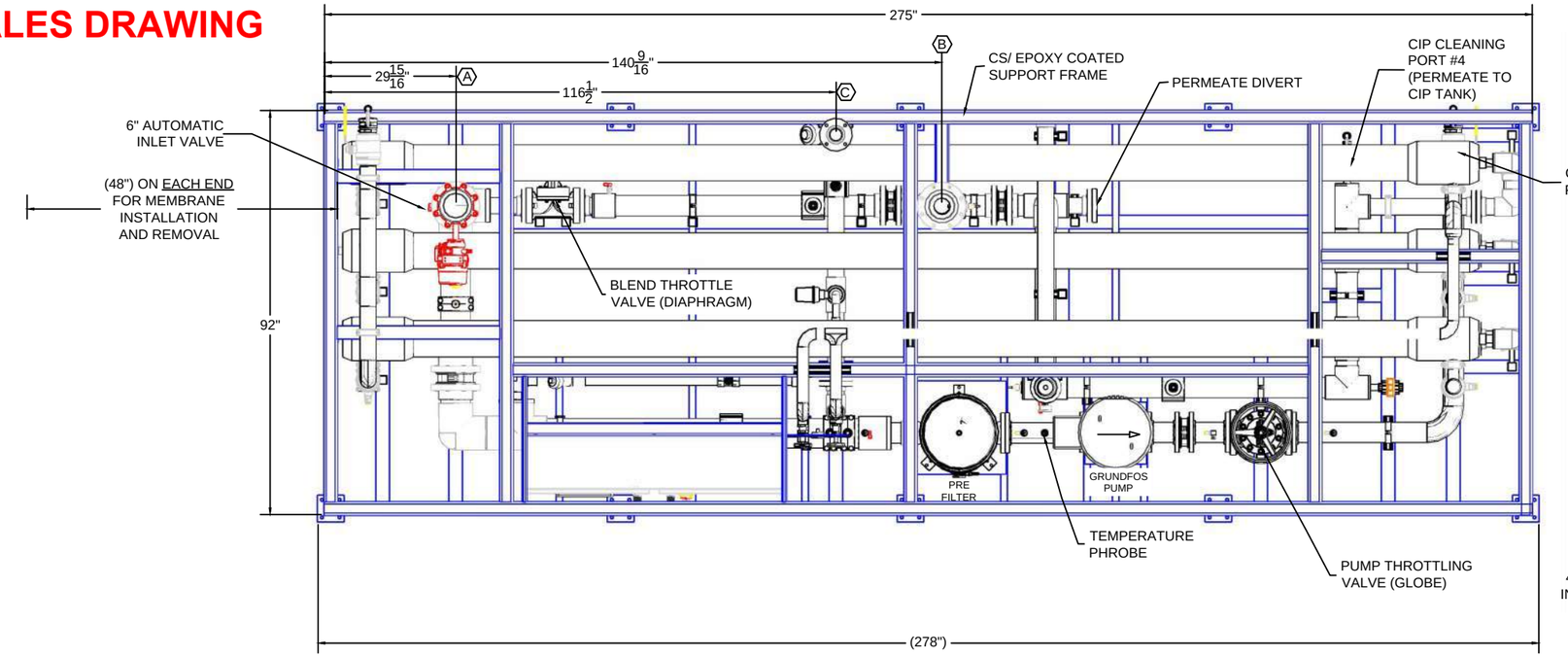
THIRD ANGLE PROJECTION | SCALE 1/16 | MATERIAL NUMBER | SHEET 5 OF 5

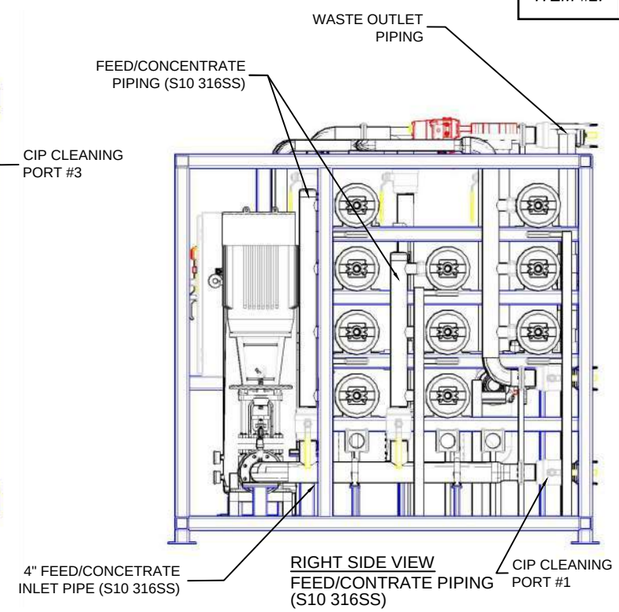
PALL ARIA™ AP-6 SYSTEM

IMPORTANT: BEFORE ATTEMPTING TO OPERATE OR INSTALL THIS SYSTEM, IT IS ESSENTIAL TO READ AND UNDERSTAND THIS PRODUCT'S OPERATION AND MAINTENANCE MANUAL (SHIPPED UNDER SEPARATE COVER). FAILURE TO READ THE OPERATION AND MAINTENANCE MANUAL BEFORE ATTEMPTING TO OPERATE ANY PALL CORPORATION EQUIPMENT MAY RESULT IN SERIOUS PERSONAL INJURY AND/OR PRODUCT DAMAGE, AND MAY VOID ANY AND/OR ALL WARRANTIES.

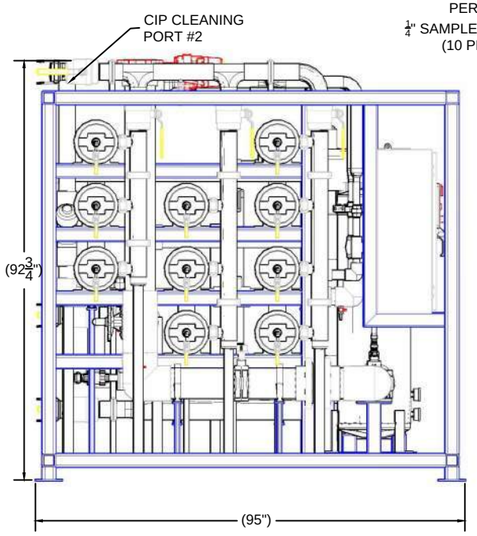
EXAMPLE SALES DRAWING

ITEM #2.

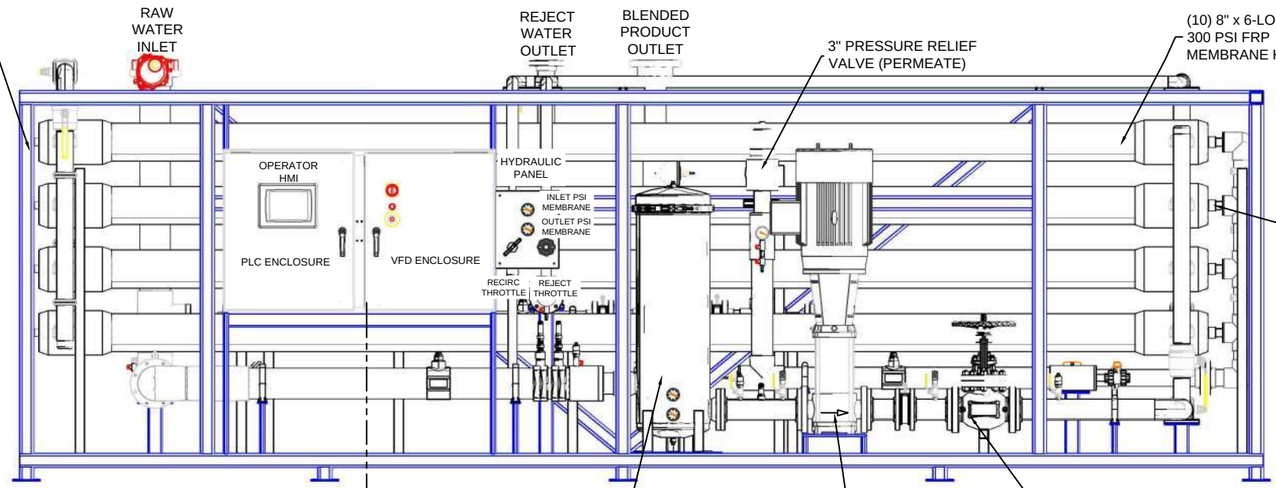


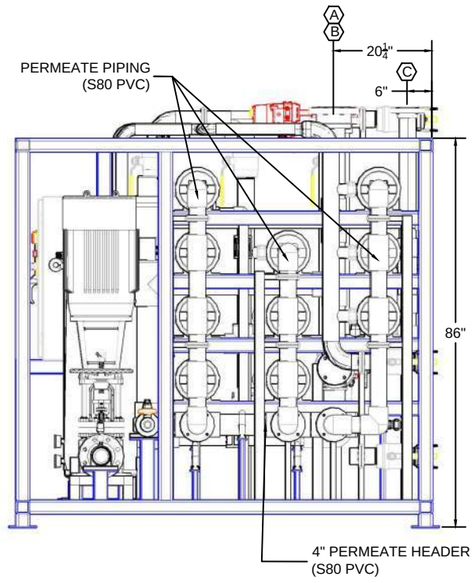


RIGHT SIDE VIEW
FEED/CONTRATE PIPING (S10 316SS)



LEFT SIDE VIEW





RIGHT SIDE VIEW
PERMEATE PIPING (S80 PVC)

DO NOT SCALE DRAWING REFER TO ADEDGE ENGINEERING DEPARTMENT FOR ALL DIMENSIONS.

REV #	DATE	REVISIONS

AdEdge water technologies
2055 Boggs Road
Duluth, GA 30096
P. 678-835-0052 F. 678-83
www.adedgetechnologies

TP	SERVICE CONNECTIONS	TYPE / MATERIAL
A/D	RAW WATER INLET	6" FLANGE, SCH 80 PVC
B/E	BLENDED PRODUCT OUTLET	6" FLANGE, SCH 80 PVC
C/F	REJECT WATER OUTLET	3" FLANGE, SCH 80 PVC

Title: GENERAL ARRANGEMENT DRAWING RO1 AND RO2

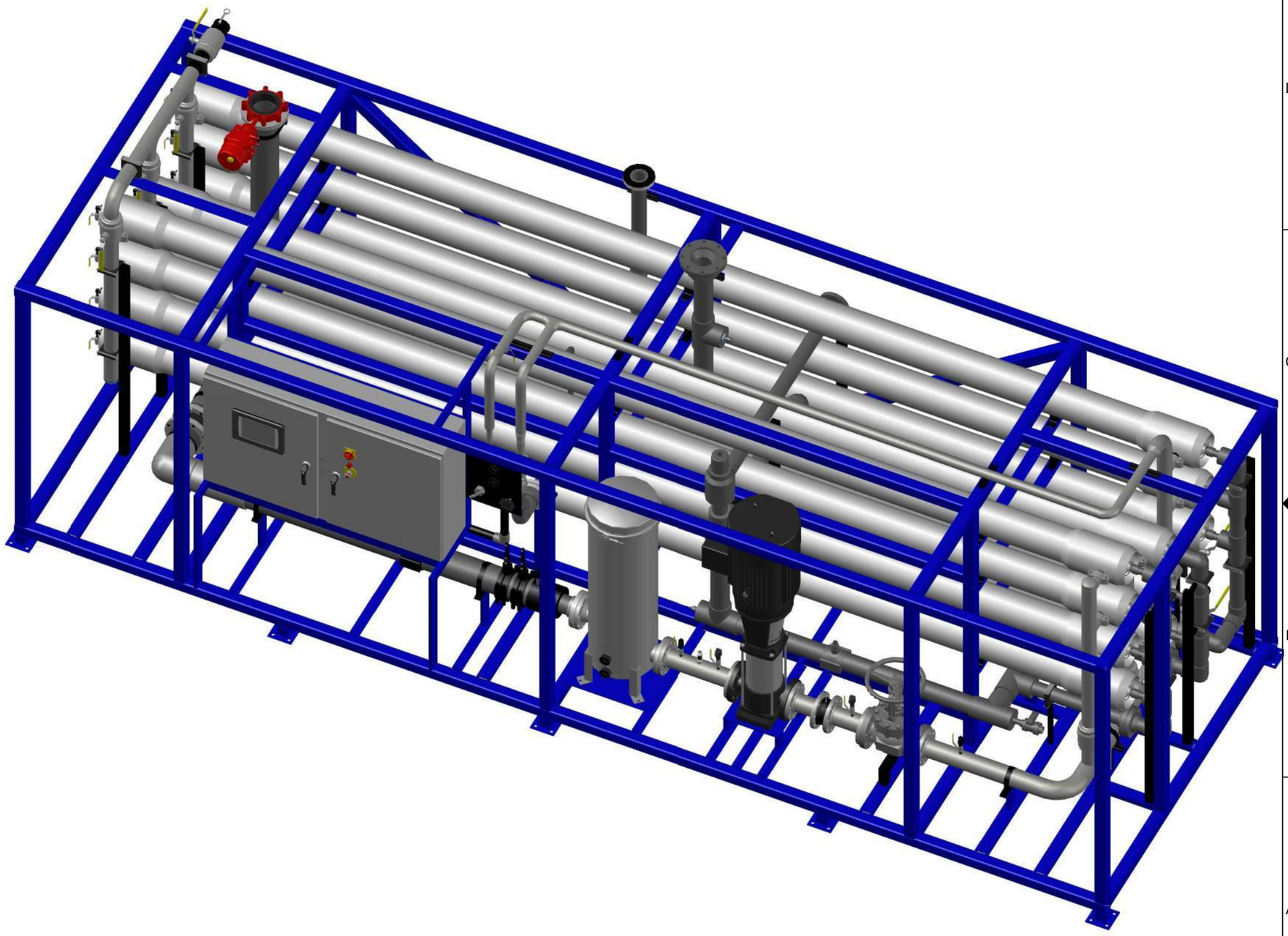
REVERSE OSMOSIS SYSTEM
MODEL: ADRO8-6L-10H (7 x 3 ARRAY)

Designed by	Checked by	Approved by	Project	Date	Scale
			FCPA-0616		

Customer: GENERAL ARRANGEMENT

Dwg. File	Rev. Date	Rev.No	Sheet
FCPA-0616.GA.01_A(1)			

EXAMPLE SALES DRAWING



DESIGN CRITERIA:

RAW WATER FLOW:	500 GPM
PUMP FLOW:	355 GPM
PERMEATE FLOW:	270 GPM
BYPASS HEADER FLOW:	170 GPM
REJECT FLOW:	85 GPM
RECIRCULATION:	25 GPM
REJECT FLOW TO DRAIN	60 GPM
BLENDED PRODUCT FLOW:	440 GPM
FEED PRESSURE TO 1st STAGE:	169 PSI
REJECT PRESSURE:	104 PSI
PERMEATE PRESSURE:	20 PSI

DO NOT SCALE DRAWING REFER TO ADEDGE ENGINEERING DEPARTMENT FOR ALL DIMENSIONS.

REV #	DATE	REVISIONS

AdEdge water technologies
2055 Boggs Road
Duluth, GA 30096
P. 678-835-0052 F. 678-835-0057
www.adedgetechnologies.com

TP	SERVICE CONNECTIONS	TYPE / MATERIAL
A/D	RAW WATER INLET	6" FLANGE, SCH 80 PVC
B/E	BLENDED PRODUCT OUTLET	6" FLANGE, SCH 80 PVC
C/F	REJECT WATER OUTLET	3" FLANGE, SCH 80 PVC

Title: GENERAL ARRANGEMENT DRAWING RO1 ADN RO2

REVERSE OSMOSIS SYSTEM
MODEL: ADRO8-6L-10H (7 x 3 ARRAY)

Designed by	Checked by	Approved by	Project	Date	Scale
			FCPA-0616		

Customer: GENERAL ARRANGEMENT

Dwg. File	Rev. Date	Rev.No	Sheet
FCPA-0616.GA.01_A(1)			

APPLIED PROCESS EQUIPMENT, INC.

WATER TREATMENT DIVISION

Date: November 11, 2022 **Quote No: WT22-11-1679**

TO: **Zahra Anwar** Garver Engineering 12141 Wickchester Lane Suite 200 Houston, TX 77079 **RE:** 700 GPM Arsenic Removal System – Bay City Well A	**Phone:** 713-482-4794 **Email:** ZBAnwar@GarverUSA.com
Pages: 2 **Est. Delivery:** 16 Weeks upon receipt of approved signed final drawings **F.O.B.:** Scottsdale, AZ	**Delivery To:** TBD
Quoted By: Christy McDonnel	**Phone:** (480) 998-4097 **Fax:** (480) 951-8434 **Email:** christy@apewater.com

To place an order email to orders@apewater.com

QTY	Description	Unit Price	Amount
1	**Multiple Tank SKID with Backwash Plumbing and Control** *System includes:* • *(10) 54" OD x 48" Side Shell Vertical Media Tank* • *Internal coating is 3M Scothkote 134, NSF 61 Certified* • *Max pressure of 100 PSI* • *Max Temperature 150 °F* • *10" Inlet and Outlet Flanged* • *316 Stainless Steel, Hub and Lateral* • *AUTOMATION DETAIL: Synergy NEMA 4X ; Solenoid 24 VAC; 454D Pneumatic Backwash Valves* • *System is fully assembled, plumbed, and wired with tanks bolted onto a structural steel skid* • *Installation and Operation & Maintenance Manuals Included*	$430,238.00	**$430,238.00**
476	**Cubic Feet of ATOMUS Z21 Media, 47.6 CUFT per Vessel**	$525/cu ft	**$249,900.00**
	NOTE: Standard price for ATOMUS Z21 media is $625/ cu ft when purchasing a supersack which contains 30 cu ft. Given the size of the system, the price has been discounted to $525/cu ft. This price will be extended to replacement media.		
100	**Cubic Feet of Underbed 2mm Sand/gravel, 10CUFT per vessel**	$45/CUFT	**$4,500.00**
1	**HORIZONTAL Storage Tank for Water** Application: Aboveground Type: SINGLE WALL Material: MILD CARBON STEEL		**TBD**

APPLIED PROCESS EQUIPMENT, INC.

WATER TREATMENT DIVISION

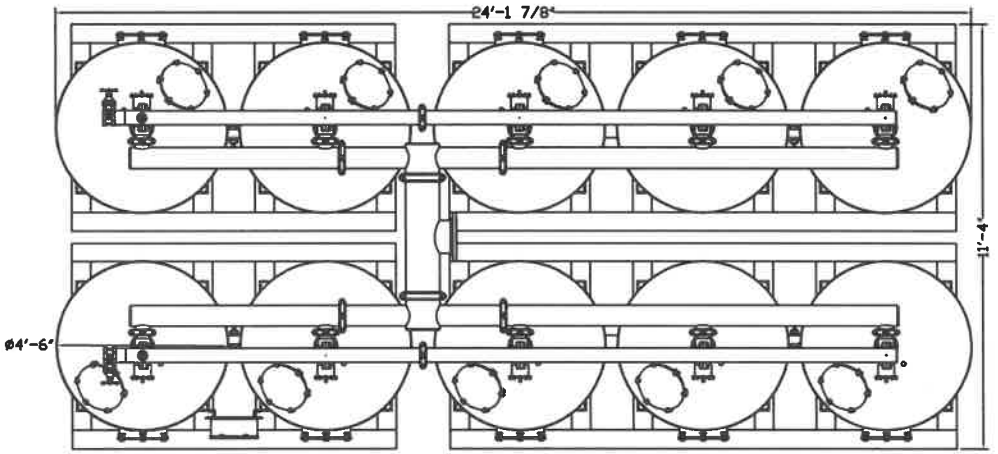
1	**Backwash Pump w/Motor**	$7,780.00	**$7,780.00**
1	**WALCHEM pH Adjustment System Components ONLY** • *W120 pH Controller and sensor* • *0.6 GPH Metering Pump* • *275 Gallon Double-wall Tank* • *2" Static Mixer* • *Flow switch* *275 Gallons Hydrochloric Acid to be supplied by others.	$17,985	**$17,985.00**
	OPTIONAL EQUIPMENT (not included in total below)		
1	**Optional C02 pH adjustment system**	$35,169	
3	**Onsite Technician for Startup and Training**. $1900/ day + travel. Estimating 3 Days	$1900.00	
	Estimated Shipping & Handling:		***TBD***
	This Quote does not include applicable sales tax. Minimum order $50.00. Credit card charges will incur a surcharge of 3%.	***Total:***	***$710,403.00***

SUBMITTED BY: *Christy McDonnel*

APPLIED PROCESS EQUIPMENT, INC.

ACCEPTED BY: _____

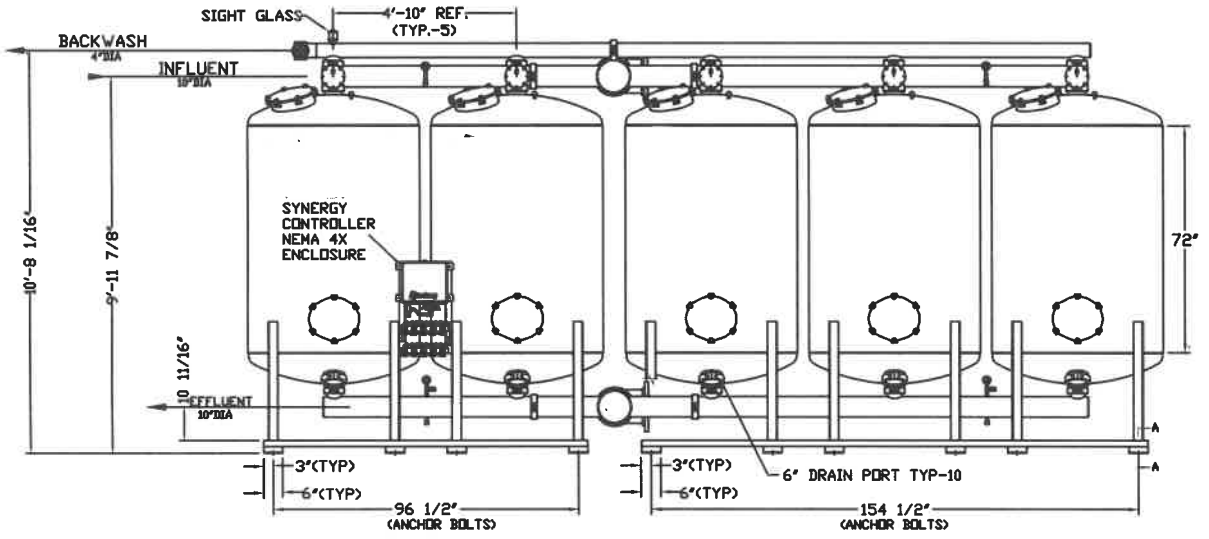
5472-10A

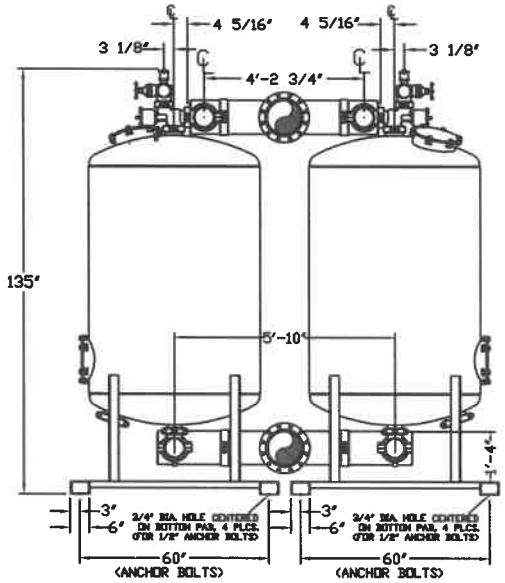


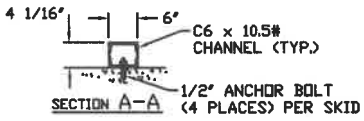
NOTES:
1. FLOW RATE DESIGN: 420 GPM.
   BACKWASH RATE: 10 GPM/FT^2.
2. MAXIMUM WORKING PRESSURE: 80 PSI.
3. ELECTRICAL REQUIREMENTS:
   CONTROLLER 120V;
   SOLENOIDS 24VAC; FACTORY WIRED
4. AIR SUPPLY REQUIRED: 2 CFM @ 70 PSIG (MIN.).
5. MEDIA REQUIREMENT PER TANK:
   A. 1/2"x3/4" CRUSHED ROCK: 9.5 CU. FT. .
   B. GRANULAR ACTIATED CARBON: 63.5 CU. FT. .
6. WEIGHTS: (APPROX.)

EQUIPMENT:	14,980 LBS (LESS MEDIA)
MEDIA:	28,016 LBS
OPERATION:	84,000 LBS

7. EXTERIOR PAINT COLOR: STANDARD BLUE, RAL 5010.







SYM	REVISIONS	BY	DATE	APP
B	REPLACE HEAD 104018954 w/104018955	STO	6-17	APP
C	CHANGE 4" DRAIN PORT TO 6"	STO	5-15	APP
B	UPDATED YARDNEY LOGO WELD TABS ON MANWAY RINGS	STO	1-13	APP
A	ADDED 4" DRAIN PORT	STO	8-12	APP

yardney WATER FILTRATION SYSTEMS RIVERSIDE, CALIFORNIA

APPROVALS DATE

GAC 5472-10A
FILTER SYSTEM

SIZE D | DRAWING NO. 9500547210 | REV D

SCALE NONE | SYSTEM\GAC | SHEET 1 OF 1

The Terms and Conditions of contained herein are the exclusive terms and conditions for the sale of products from Applied Process Equipment, Inc., an Arizona corporation ("APE") to you, its Customer. Customer agrees that the terms and conditions stated herein and, to the extent not stated herein but contained on any APE invoice, constitute the final, complete, exclusive expression of the agreement between APE and Customer. In the event that any Customer form, purchase order or any other document submitted by Customer contains terms and conditions in addition to or different from the terms and conditions herein or from any APE invoice, Customer agrees, by so submitting its purchase order or order form, by receiving an order acknowledgment or by accepting product produced by APE, that such new or additional terms are rejected and that the language of the APE terms and conditions control. Any and all new or additional terms contained on any Customer document (whether provided to APE prior or subsequent to the delivery of these Terms and Conditions) are hereby expressly and completely rejected. Acceptance of Customer's order for product from APE is expressly limited to these terms and conditions.

1. Orders become effective only when accepted and approved by APE. There shall be a minimum order amount of $1000.00 exclusive of freight. APE's acceptance is expressly made conditional on the Customer's assent to the terms and conditions contained herein and to the terms and conditions of any proposal issued by APE to the Customer, and APE agrees to furnish the product covered by the order only upon such terms and conditions. Any of the terms or provisions of the Customer's order which are inconsistent with the terms and provisions contained herein are not agreed to by APE and shall not be binding on APE and shall not be considered applicable to the sale or shipment of the products ordered.

2. Orders, shipments, and terms of payment are subject to the approval of APE's credit department. Invoices shall be rendered when the products are shipped. Terms of payment are net 30 days, unless otherwise agreed by APE. Any sums not paid within the specified net terms are subject to a service charge of 1.5% per month. No discount will be allowed to any Customer having an overdue balance. Any discounts previously granted to any Customer that fails to pay any APE invoice when due will be immediately forfeited and lost. Any discount forfeited or lost due to untimely payment of any invoice will be billed to Customer, which shall be immediately due and payable. Customer will pay all costs, collection agency commissions, expenses and all reasonable attorney fees incurred in the collection of any past due sums. By submitting an order or taking receipt of APE products, Customer consents to the exclusive jurisdiction of the state and federal courts located in the State of Arizona. Customer shall be deemed to have accepted the products shipped by APE within ten (10) days after delivery to Customer. After acceptance, Customer shall not be entitled to reject the products that are not in accordance with these terms and conditions. APE reserves the right to refrain from performing any work on any of Customer's orders should any of Customer's account(s) or jobs with APE be or become past due. Payments shall be made to APE at the address listed on the APE invoice.

3. All shipments are F.O.B. APE's plant or warehouse, unless otherwise agreed upon. Risk of loss of or damage to the goods shall pass to the Customer upon delivery by APE to the initial carrier, notwithstanding any right that the Customer may have to cancel or return goods. In the event APE is forced to delay delivery of goods to the initial carrier, due to any action or the Customer's request, risk of loss shall have passed upon the date APE would have otherwise delivered the goods to the initial carrier. Customer agrees to pay all reasonable storage and insurance charges specified by APE. In the event goods are returned pursuant to paragraph 5, risk of loss shall remain with Customer until the goods are delivered to the APE's plant and accepted by APE. Customer agrees to indemnify and hold APE harmless from any loss or damage to the goods or consequence thereof, sustained while the risk of such loss or damage remains upon Customer.

4. Delivery and shipment dates are estimated dates only. No allowance is made, nor shall APE be liable directly or indirectly for delays or non-performance due to delays of carriers or delays caused by labor difficulties, shortages, strikes, stoppages, fires accidents, failure or delay in obtaining materials or manufacturing facilities, acts of any government affecting APE in any way, bad weather, causes beyond APE's control, acts of God, or any other contingency that was not foreseen at the time when an order was submitted to APE. APE shall not be liable for any damages or penalties whatsoever, whether direct, indirect, special, consequential, or otherwise, resulting from APE's failure to perform or delay in performing. APE may decline to deliver, accept for cash, or stop goods, in transit, whenever for any reason doubt as to your financial responsibility develops or may arise.

5. Purchased products may be returned at Customer's request only upon the approval of APE. Products must be in re-sellable condition and in their original packaging. No cash refunds will be provided for returned products. APE will issue a credit memorandum for any authorized material return. Said credit memorandum will have no cash value and shall expire one (1) year after issuance. Authorized Returns not accompanied by a new order of greater or equal value shall be subject to a restocking fee of 25% of the original sale price.

6. APE will, to the extent permissible, pass through to you all available applicable original equipment manufacturer and additional warranties for any product sold. NO EMPLOYEE, REPRESENTATIVE OR DISTRIBUTOR IS AUTHORIZED TO CHANGE THE FOREGOING WARRANTIES IN ANY WAY OR GRANT ANY OTHER WARRANTY ON BEHALF OF APE. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES (INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE) AND NO REPRESENTATIONS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, ARE MADE BY APE IN CONNECTION WITH THE MANUFACTURE OR SALE OF ITS PRODUCTS. THE LIABILITY OF APE, WHETHER IN CONTRACT, TORT, UNDER ANY WARRANTY, OR OTHERWISE, SHALL NOT EXTEND BEYOND ITS OBLIGATION TO REPAIR OR REPLACE, AT ITS OPTION, ANY PRODUCT OR

PART FOUND BY APE TO BE DEFECTIVE IN MATERIAL OR WORKMANSHIP. APE SHALL NOT BE LIABLE FOR COST OF REMOVAL OR INSTALLATION AND/OR SHALL NOT BE RESPONSIBLE FOR ANY DIRECT, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE.

Whether based on any Warranty claim or otherwise, APE will not, in ANY event, be liable for any loss of profit, interruption of business or any other special, consequential or incidental damages suffered or sustained by Customer. APE's total maximum liability to Customer in respect of the manufacture and sale of products is limited to the Warranty stated herein and, if any claim by Customer is based on a theory other than the Warranties, then the damages are limited to the total monies received by APE from the Customer for the particular products described in Customer's order. The total maximum liability for scheduled orders that are drawn down against each month will be the monthly total of the effected order or the total value of the items effected whichever is the lesser.

7. Any assistance, suggestions, or technical advice given the Customer by APE or any agent thereof, concerning dimensions, handling, installation, testing, storage, use or placement in service of any product is an accommodation for which APE shall have no liability unless such liability expressly assumed by APE in writing and signed by an officer of the company.

8. No employee, agent, or representative of APE has the authority or power to add, waive, or amend these terms and conditions unless first authorized in writing by an officer of APE. Any transaction with Customer shall be construed under the laws of the State of Ohio. Waiver of APE of any breach shall not thereafter be deemed a waiver of a subsequent breach of the same of any other provision hereof.

9. **Use & Maintenance**

This Equipment is not for use with influent water which is (a) microbiologically unsafe, or (b) of unknown quality without adequate treatment and/or disinfection.

- You must maintain the Equipment according to manufacturer instructions using manufacturer-authorized service parts, including replacement of filters and other components as recommended in the site-specific maintenance instructions.
- If your water quality, water consumption, water pressure or flow rate change, or if maintenance of the Equipment is affected by external factors such as sand, sediment, or an inadequate water supply, different or additional Equipment may be required, and this Equipment should not be used if such quality, consumption, pressure, flow rate change or external factors are outside of specified ranges in the original project scope.
- You are responsible for all maintenance of and repairs to the Equipment arising from damage due to:
    - your misuse or negligence
    - theft
    - unreasonable wear and use (including without limitation repair or alteration by unauthorized persons and relocation from the original site of installation), or
    - any other event beyond APE's control.

ATOMUS® ARSENIC TREATMENT TECHNOLOGY

APPLICATION PARAMETERS

Empty Bed Contact Time (EBCT)	Typically 3–6 min
pH Range	5.5–9.5
Surface Loading Rate	Up to 7 gpm/ft² or 5 lps/m²
Backwash Rate	7–10 gpm/ft² or 5–7 lps/m²

IMPACT OF WATER QUALITY

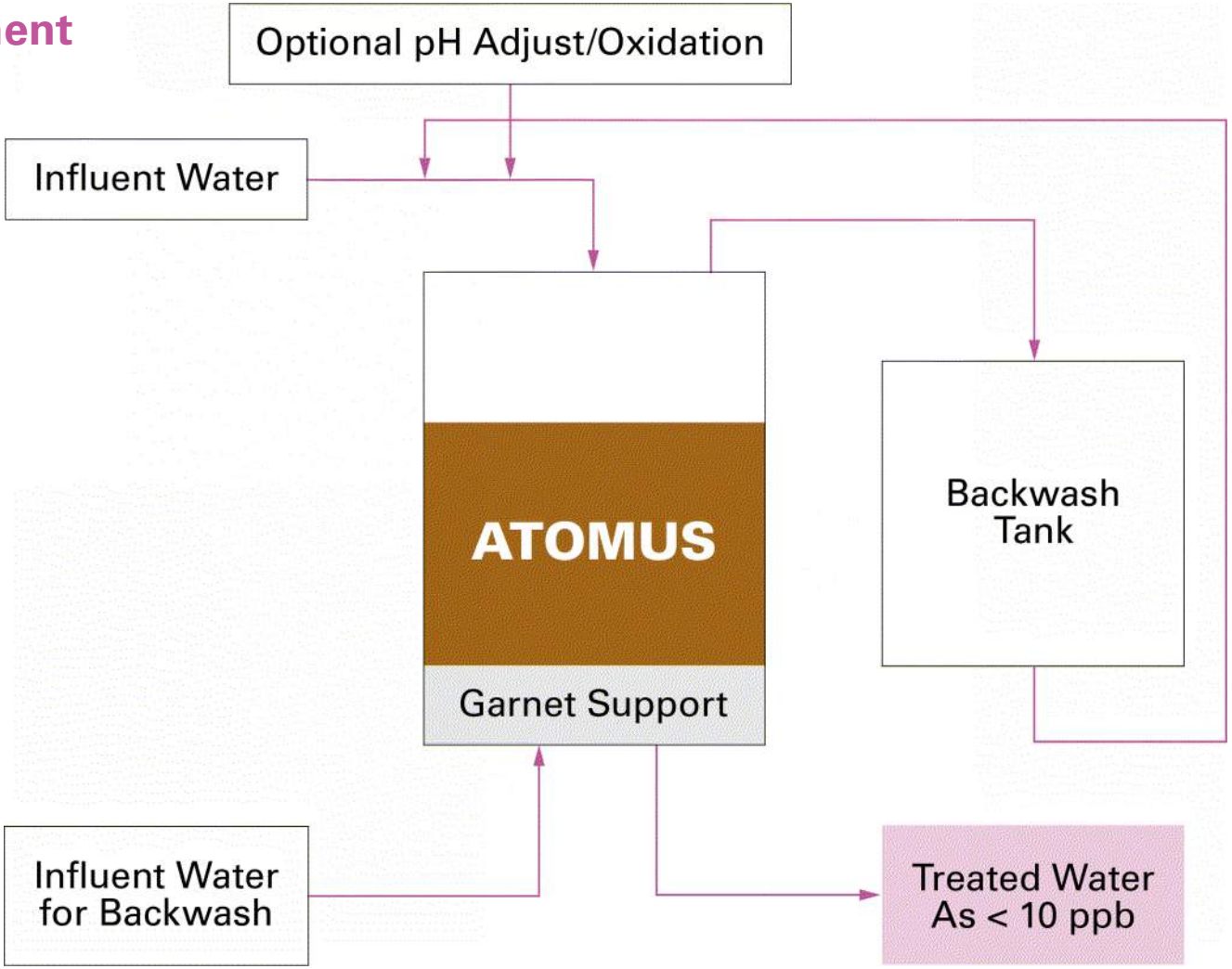
Water Quality Optimum Working Conditions for ATOMUS

pH	5.5–9.5
Total Arsenic	0.010–0.100 mg/L
Iron	< 0.3 mg/L
Manganese	< 0.05 mg/L
Phosphate	< 0.55 mg/L
Silica	< 35 mg/L
Sulfate	< 100 mg/L
Sulfides	< detect mg/L
Total Suspended Solids	< 5 mg/L
Vanadium	< 0.05 mg/L
Fluoride	< 1 mg/L
Turbidity	5 NTU
Hardness	< 300 mg/L

- Water with **pH > 9** may require pH adjustment for best performance.
- Economical treatment can still be achieved if ideal range is exceeded.
- Particularly for increased levels of silica and phosphate, ATOMUS will often provide the most economical treatment when compared to other adsorptive arsenic removal medias.

ATOMUS MEDIA DEPLOYMENT

Deployment



STATIC COLUMN – MEDIA BED

- **Support media:** Bottom layer of treatment bed
  - Any inert media will do (e.g., garnet or sand)
  - Support: 1/4″–1/8″ particle sizing; 6″–12″ of support is bed height
- **ATOMUS media:** Actual treatment bed
  - Height of media bed and support media should not be > 70% of vessel height to allow at least 30% freeboard for bed expansion during backwash process.

ATOMUS SYSTEM STARTUP STEPS I

General

- Verify that electrical, pneumatic and hydraulic connections have been properly made.
- A newly constructed or rebuilt system may have debris in the supply or suction lines, such as oil, grease and dirt. In order to protect the media and underdrain from debris, all lines should be flushed prior to the system start-up.

Sand (Garnet) System Loading

- Open the upper man way to view and load the media during the start-up.
- Put the system in back-flow mode and begin to slowly fill the tank according to specifications of the distribution plate manufacturer.
    - Check specifications of the distribution plate manufacturer. Water usually loaded about 25% of system rate during this operation.
- Fill the tank with water until the distribution plate/laterals are covered with about .5 meters of water. Fill gently so the distribution plate/laterals are not broken or shifted.
- Load the sand gently on the water-covered laterals and move bag around to get an even level.
    - *Note: You will likely need to use a tool to level the sand as much as possible for the best distribution.*
- After the sand has been loaded and leveled, begin loading the ATOMUS media.

ATOMUS SYSTEM STARTUP STEPS II

ATOMUS Media Loading

- Position the discharge spout of the bulk bag down inside the vessel through the top of the tank opening (about 0.5 meters from the surface of the media below) and untie the spout for ATOMUS media to discharge into the tank.
    - Move the bag around a bit to get a more even distribution in the tank.
    - Continue loading until the specified amount of media has been loaded.
        - *Note: Continue to move the discharge spout of the bag up to keep it 0.5 meters from the surface below to get good flow.*
- After the media has been loaded, clean the media and debris from the manway; seal surfaces and check seals to make sure they are clean.
- Close the manway.
- Continue to fill the vessel from the bottom (with water) to push out air trapped in the bed during filling. *(Cont.)*

ATOMUS SYSTEM STARTUP STEPS II *(CONT.)*

ATOMUS Media Loading

- Continue to leave the system in reverse flow at low flow rate until the tank is full and until air bubbles are no longer visible (this can be seen in the sight glass and in the tank vent).
- Put flow in normal backwash at backwash loading rate of 7–10 gpm/ft^2 to remove fines from transport. This backwash will take about 15–20 minutes. Water will resemble "light tea" in color when the backwash is complete (it does not need to be clear).
    - Check backwash water to make sure no "coarse" ATOMUS particles are in the water (coarse particles can be felt while rubbing fingers together under flowing water).
    - Water will initially be very dark brown due to fines (~70 mesh / < 0.2 mm).
        - *Note: If a screen is installed on the backwash line to ensure media is not "blown" from the vessel, check the pressure drop to make sure screen is not blinded with the fines that are being removed.*
    - If after 15–20 minutes backwash water is not a "light tea" color, run the process for longer.

ATOMUS SYSTEM STARTUP STEPS III

- After backwash, reverse flow to operational down flow, but still in closed loop for rinse and bed-repacking.
- Water should clear in 2–10 minutes (typically less than 5 minutes). Clear time varies based on how many fines were left in the bed.
- Check pressure drop across the vessel. It should be less than 10 psi (0.7 bar). More than 10 psi (0.7 bar) would indicate backwash was not adequate and should be repeated.
- When water clears, open valves and send water to the distribution system.
- Backwash process should be run periodically to prevent bed compaction and channeling, thus ensuring the system remains in good condition.
    - *Note: Backwash water can be recovered and fed back into the influent to the system at ratio not to exceed 10% after it has settled in the backwash tank.*

ATOMUS MEDIA CHANGEOVER

- Discharge ATOMUS media in tank by moving the bag around a bit to get a more even distribution in the tank.
- Continue to fill the vessel from the bottom (with water) to push out air trapped in the bed during filling.
- Put flow in normal backwash at a backwash loading rate of 7–10 gpm/ft² (5–7 lps/m²) to remove fines from transport—backwash might take 15–20 minutes.
- Water will resemble “light tea” in color when the backwash is complete (it does not need to be fully clear).
- Check backwash to make sure no “coarse” ATOMUS media is in the backwash tank (no actual media flushed out).
- Water might initially be dark brown due to fines (70 mesh / <0.2 mm).
    - *Note: If a screen is installed on the backwash line to ensure media is not “blown” from the vessel, check the pressure drop to make sure screen is not blinded with the fines that are being removed.*
- If after 15–20 minutes the backwash water is not “light tea”, please run the backwash little longer.
- After backwash, reverse flow to operational down flow, but still in closed loop for rinse and bed-repacking.
- Water should clear in 2–10 minutes (typically less than 5 minutes).
- Check pressure drop at vessel. It should be less than 10 psi (0.7 bar). More than 10 psi (0.7 bar) would indicate backwash was not enough.
- When water clears, open valves and send water to distribution system.
- Backwash should be run periodically to prevent [illegible]mpaction and channeling, thus ensuring the system remains in good condition.

QUESTIONS?

Applied Process Equipment, Inc. // 9332 N. 95th Way, Suite B106, Scottsdale, AZ 85258
// Phone: 480.998.4097 // sales@apewater.com // **Apewater.com**

APPLIED PROCESS EQUIPMENT, INC.

ATOMUS®

City of Bay City WTP
Arsenic Removal with Ion Exchange – Preliminary Proposal

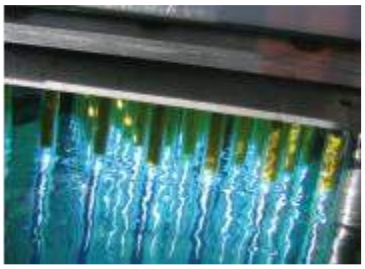
Vision Equipment

TEXAS • NEW MEXICO • OKLAHOMA

PRESENTED TO:

Zahra Anwar
Garver USA

Vision Equipment Contact:
Keisha Antoine, PhD, PE
PH: 832-356-3903



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- Headworks Fine Screening
- Indexed Tray De-Gritting
- Vortex De-Gritting
- Septage Receiving Stations
- In-Line Grinding
- Manhole Grinders
- Grit Classifiers
- Clarifiers
- Oxidation Ditch Systems
- Fine Bubble Aeration
- Course Bubble Aeration
- Lagoon Aeration
- Retractable Aeration
- Oxidation Ditch Conversions
- Biosolids Thickening
- Biosolids Dewatering
- PD Blowers
- Turbo Blowers
- Horizontal UV Disinfection
- SBR
- MBR
- Packaged WWTPs
- Sludge Holding Tank Aeration
- Digester Mixers
- Trickling Filters
- SS Mesh Filters
- Washer/Compactors

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AET - Hybrid Settlers for WTP and WWTP Applications
APG Neuros - Turbo Blowers and Aeration Systems
AquaTec, Inc. - Submersible Aeration Mixers (SAM)
C.E. Shepherd - Trickling Filter Media, Under Drains
CECO Environmental - Odor Control, Bioscrubbers, Carbon Systems
CleanTek - Roto-Sieve Fine Drum Screens
Duperon - FlexRake® Multi-Rake Headworks Screens, Storm Screens, Trash Rakes, Rag Removal Systems
Dynamic Water Control Gates - SS Slide, Flap, Weir Gates
Envirodyne Systems, Inc. - Indexed Tray De-gritting, Disk Aerators, Brush Aerators, Mixer Aeration, Clarifiers, DHV-Approved Surface Aerators, Thickeners, Anaerobic Digester Covers, Rotary Distributors, Sludge Baggers, Brush Type Weir Cleaners, Belt Filter Presses, Gravity Belt Thickeners
Franklin Miller - Twin Shafted Grinders, Septage Receiving Systems, Screenings Washer, Headworks Screening, In-Line Grinders, Bulk Water Fill Stations
Guardian Environmental - Chain and Flight Sludge Collectors
H20 Innovation - MBR, UF, IFAS Systems
Industrial Service Solutions - SBR, Extended Aeration, BNR
Invent Filtration Technologies - Tertiary SS Disk Filter
Ishigaki - Screw Press Dewatering, Sludge Thickening
Jaeger-Aeration - Least Cost Extended Aeration Designs, Disk, Strip and Tube Diffusers, SBR and BNR Biological Processes
KWS - Materials Handling Systems
Marmac Water - WTP Chemical Dosing and Metering Systems
Midwest Fabricators - FRP Weirs, Baffles, and Troughs
Mixing Systems, Inc. - Hydraulic Tank Mixing
Neotec UV - Ultraviolent Disinfection
Prime Solution - Rotary Press Dewatering
Scinor - Replacement UF Membrane Filters
United Blower, Inc. - PD, Multistage, Hybrid Blowers
Vapex Environmental - Vapor Phase Odor Control for Lift Stations and WWTPs, FOG Mitigation
WTP Equipment Corp. - Material Handling Shafted and Shaftless Screw Conveyors, Vertical Screw Conveyors, Screw Feeders, Hoppers, Blenders, Silos, Bins

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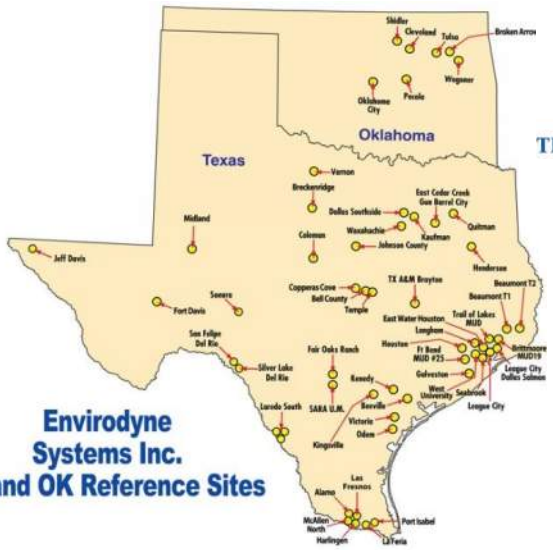
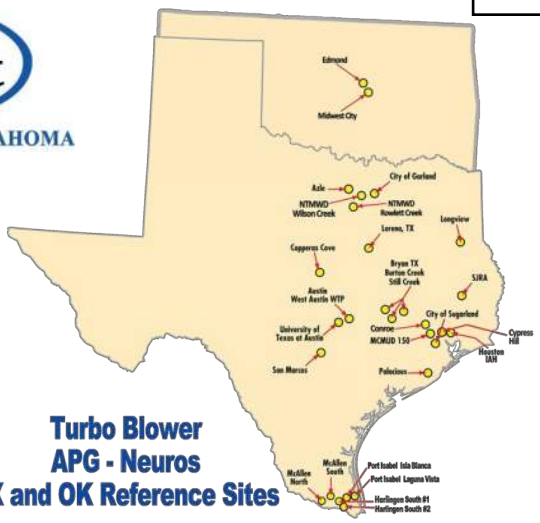
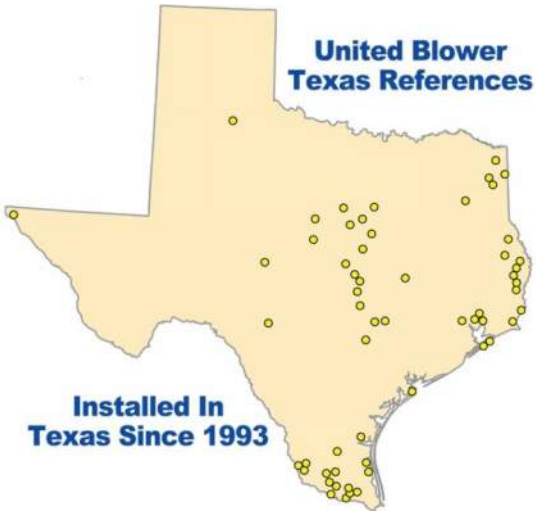


Envirodyne Systems Inc. TX and OK Reference Sites



Turbo Blower APG - Neuros TX and OK Reference Sites

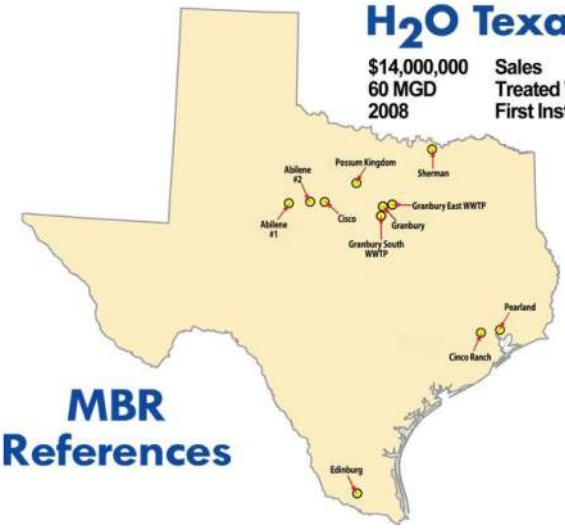
Texas Duperon Waste Water FlexRake References (2003 to Present)



United Blower Texas References

Installed In Texas Since 1993

Duperon Storm Water Screening References (2003 to Present)



H_2O Texas

$14,000,000 Sales
60 MGD Treated Water
2008 First Install

MBR References

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November 11, 2022

Zahra Anwar
12141 Wickchester Lane
Suite 640
Houston, TX 77079

Subject: Preliminary proposal for arsenic removal with ion exchange

Reference: City of Bay City WTP Arsenic Removal

Dear Zahra,

I trust this message finds you well. We thank you for your inquiry and updated inputs regarding requirements. Please find below H2O Innovation's recommendation for an ion exchange option for arsenic removal based on your inputs. We previously provided you with H2O's recommendation for iron adsorption in conjunction with chlorination and enhanced greensand media filtration and RO dated October 22nd and November 9th, 2022, respectively.

Feed properties:

- Feed Flow: 330gpm & 660 gpm
- Feed As Concentration: 0.01 mg/L
- Target As Concentration: <0.01 ug/L
- Empty Bed Contact Time (EBCT): 4 min

Item No	Equipment	Price
1	Well A - 1540 gpm TWO (2) 330 gpm trains	$1,005,000
2	Well B - 1160 gpm ONE (1) 330 gpm train	$675,000

Taxes are not included. Allowance(s) should be made to budget for future increases.

Each budgetary price includes the following:

- Configuration
  - 660gpm Six (6) FRP vessels in 5+1 configuration
  - 330gpm Three (3) FRP vessels in 2+1 configuration
- Arsenic removal filter media
- Piping, valves, instruments
- Frame(s)
- Automation and PLC
- Regeneration non included

Notes:

- Ex-Works (EXW) H2O Production Facility
- Excludes taxes, shipping, startup/commissioning, spares, installation
- H2O standard design and scope of supply
- H2O Standard Terms and Conditions

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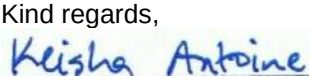
- Feedwater supplied by others

Please note this information is preliminary subject to engineering review. The final scopes will dictate the final and complete scope of supply of the vendor. The vendor-supplied scope of materials and services will be the sole basis for the final prices offered by Vision Equipment. If questions arise, please feel free to call my cell number at 832-356-3903. We remain at your service.

Thank you for your consideration.

Kind regards,



Keisha Antoine, PhD, PE
Vision Equipment – Houston

cc: Hershel Ezzell, P.E. – Vision Equipment – Houston

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City of Bay City WTP
Arsenic Removal with RO – Preliminary Proposal

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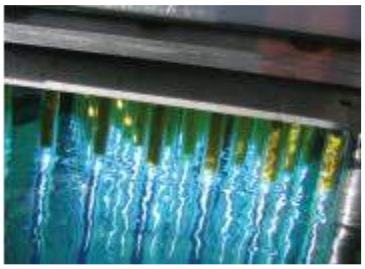

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- Septage Receiving Stations
- In-Line Grinding
- Manhole Grinders
- Grit Classifiers
- Clarifiers
- Oxidation Ditch Systems
- Fine Bubble Aeration
- Course Bubble Aeration
- Lagoon Aeration
- Retractable Aeration
- Oxidation Ditch Conversions
- Biosolids Thickening
- Biosolids Dewatering
- PD Blowers
- Turbo Blowers
- Horizontal UV Disinfection
- SBR
- MBR
- Packaged WWTPs
- Sludge Holding Tank Aeration
- Digester Mixers
- Trickling Filters
- SS Mesh Filters
- Washer/Compactors

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AET - Hybrid Settlers for WTP and WWTP Applications
APG Neuros - Turbo Blowers and Aeration Systems
AquaTec, Inc. - Submersible Aeration Mixers (SAM)
C.E. Shepherd - Trickling Filter Media, Under Drains
CECO Environmental - Odor Control, Bioscrubbers, Carbon Systems
CleanTek - Roto-Sieve Fine Drum Screens
Duperon - FlexRake® Multi-Rake Headworks Screens, Storm Screens, Trash Rakes, Rag Removal Systems
Dynamic Water Control Gates - SS Slide, Flap, Weir Gates
Envirodyne Systems, Inc. - Indexed Tray De-gritting, Disk Aerators, Brush Aerators, Mixer Aeration, Clarifiers, DHV-Approved Surface Aerators, Thickeners, Anaerobic Digester Covers, Rotary Distributors, Sludge Baggers, Brush Type Weir Cleaners, Belt Filter Presses, Gravity Belt Thickeners
Franklin Miller - Twin Shafted Grinders, Septage Receiving Systems, Screenings Washer, Headworks Screening, In-Line Grinders, Bulk Water Fill Stations
Guardian Environmental - Chain and Flight Sludge Collectors
H20 Innovation - MBR, UF, IFAS Systems
Industrial Service Solutions - SBR, Extended Aeration, BNR
Invent Filtration Technologies - Tertiary SS Disk Filter
Ishigaki - Screw Press Dewatering, Sludge Thickening
Jaeger-Aeration - Least Cost Extended Aeration Designs, Disk, Strip and Tube Diffusers, SBR and BNR Biological Processes
KWS - Materials Handling Systems
Marmac Water - WTP Chemical Dosing and Metering Systems
Midwest Fabricators - FRP Weirs, Baffles, and Troughs
Mixing Systems, Inc. - Hydraulic Tank Mixing
Neotec UV - Ultraviolent Disinfection
Prime Solution - Rotary Press Dewatering
Scinor - Replacement UF Membrane Filters
United Blower, Inc. - PD, Multistage, Hybrid Blowers
Vapex Environmental - Vapor Phase Odor Control for Lift Stations and WWTPs, FOG Mitigation
WTP Equipment Corp. - Material Handling Shafted and Shaftless Screw Conveyors, Vertical Screw Conveyors, Screw Feeders, Hoppers, Blenders, Silos, Bins

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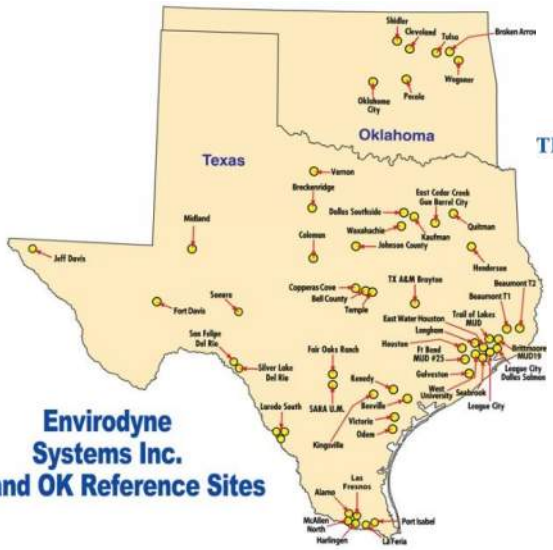
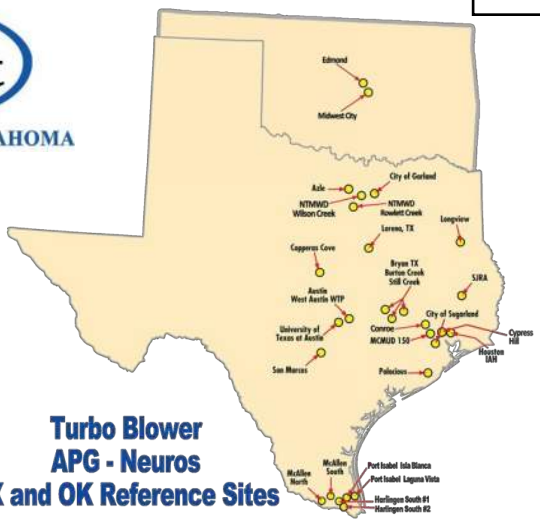
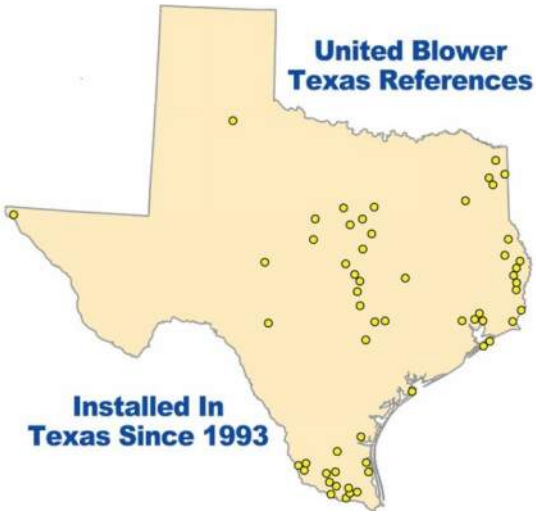


Envirodyne Systems Inc. TX and OK Reference Sites



Turbo Blower APG - Neuros TX and OK Reference Sites

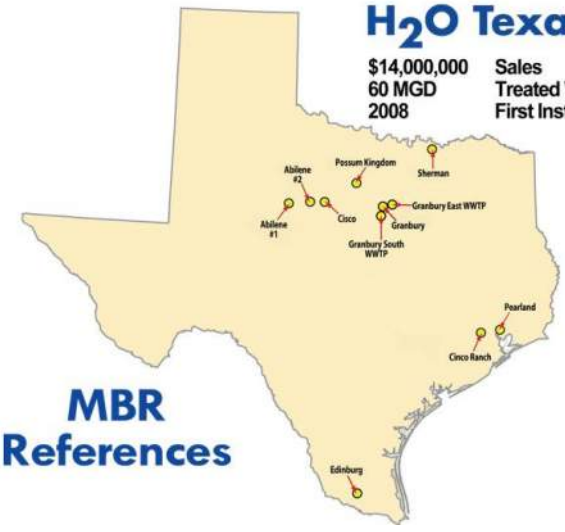
Texas Duperon Waste Water FlexRake References (2003 to Present)



United Blower Texas References

Installed In Texas Since 1993

Duperon Storm Water Screening References (2003 to Present)



H_2O Texas

$14,000,000 Sales
60 MGD Treated Water
2008 First Install

MBR References

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November 9, 2022

Zahra Anwar
12141 Wickchester Lane
Suite 640
Houston, TX 77079

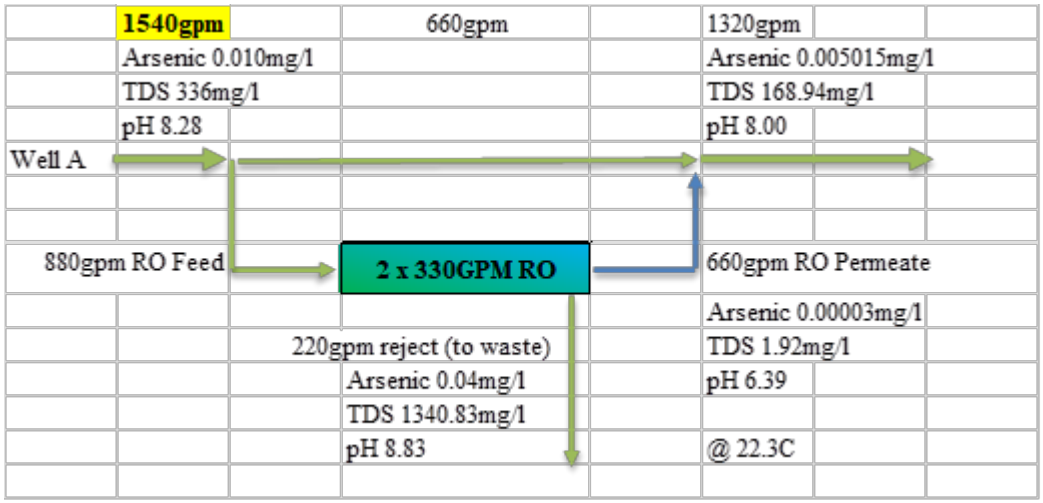
Subject: Preliminary proposal for arsenic removal with RO

Reference: City of Bay City WTP Arsenic Removal

Dear Zahra,

I trust this message finds you well. We thank you for your inquiry and updated inputs regarding requirements. Please find below H2O Innovation's recommendation for a reverse osmosis (RO) option for arsenic removal based on your inputs. We previously provided you with H2O's recommendation for iron adsorption in conjunction with chlorination and enhanced greensand media filtration dated October 22, 2022.

Well A



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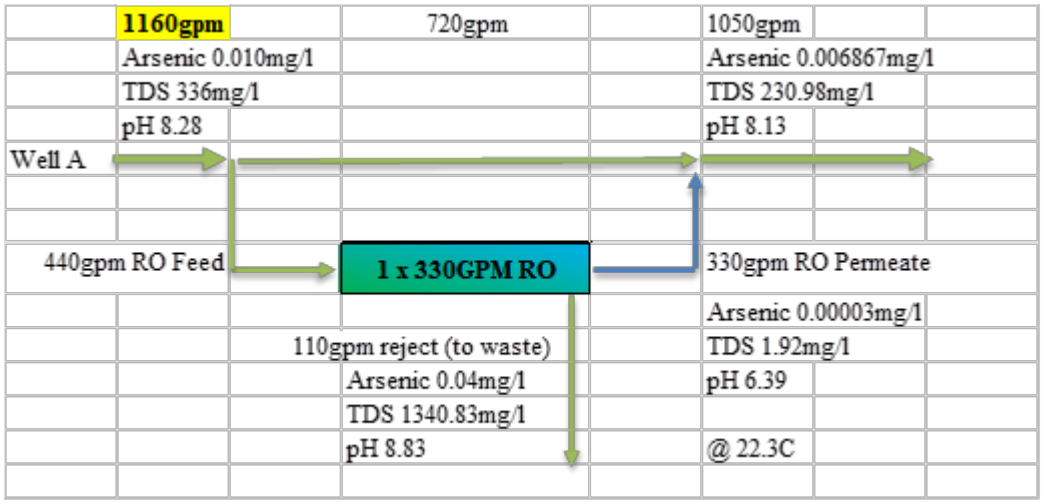
Well B



Item No	Equipment	Price
1	Well A - 1540 gpm TWO (2) 330 gpm RO trains	$980,000
2	Well B - 1160 gpm ONE (1) 330 gpm RO train	$645,000

Taxes are not included. Allowance(s) should be made to budget for future increases.

Each budgetary price includes the following:

- Membranes
- Pressure Vessels
- Cleaning in Place (CIP) Skid
- Duplex dosing sets
- Automatic CIP flush
- Instruments and Controls
    - Remote Input/Output w/ InteLogx
    - One Remote IO Panel to MCP (CompactLogx)
    - Variable frequency drives
    - Conductivity Probe - Train Feed
    - pH/ORP Probe - Train Feed
    - Pressure Transmitter/Gauge - Train Permeate
    - pH/ORP Probe - Train Permeate
    - Pressure Transmitter/Gauge - 1st Stage Permeate
    - Pressure Switch - 1st Stage Permeate
    - Flow Meter - 2nd Stage Permeate
    - Pressure Transmitter - 2nd Stage Feed
- Valving
    - Automated Concentrate Flow Control Valve

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- Limit Switches for Automatic Valves

Notes:

- Ex-Works (EXW) H2O Production Facility
- Excludes taxes, shipping, startup/commissioning, spares, installation
- Excludes chemicals/consumables
  - A PWT antiscalant projection is included for reference
  - Based on the provided data, barium sulfate and iron scaling are potential risks.
- H2O standard design and scope of supply
- H2O Standard Terms and Conditions
- Feedwater supplied by others

Please note this information is preliminary subject to engineering review. The final scopes will dictate the final and complete scope of supply of the vendor. The vendor-supplied scope of materials and services will be the sole basis for the final prices offered by Vision Equipment. If questions arise, please feel free to call my cell number at 832-356-3903. We remain at your service.

Thank you for your consideration.

Kind regards,

Keisha Antoine

Keisha Antoine, PhD, PE
Vision Equipment – Houston

cc: Hershel Ezzell, P.E. – Vision Equipment – Houston

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Permeate Blending

Project name	Bay City, Texas
Client Name	Garver
Calculated by	Michael Gisclair
HP pump flow	440.00 gpm
Feed pressure	228.0 psi
Feed temperature	22.3 °C
Feed Water pH	8.28
Chemical dose, mg/l	None
Pumping specific energy	2.74 kWh/kgal
Pass NDP	210.6 psi
Average flux	11.9 gfd

Permeate flow/train	330.00 gpm
Total plant product flow	1320.00 gpm
Number of trains	2.00
Raw water flow/train	770.00 gpm
Permeate recovery	75.00 %
Blended flow	660.00 gpm
Membrane age	5.0 years
Flux decline,per year	7.0 %
Fouling factor	0.70
SP increase, per year	7.0 %
Feed type	Brackish Well High-Fouling
Pretreatment	Conventional

Pass-Stage	Perm. Flow	Flow / Vessel Feed	Conc	Flux	DP	Flux Max	Beta	Stagewise Pressure Perm.	Boost	Exhaust	Conc	Perm. TDS	Membrane Type	Membrane Quantity	PV# x Elem #
	gpm	gpm	gpm	gfd	psi	gfd		psi	psi	psi	psi	mg/l			
1-1	237.1	44.0	20.3	12.2	13.6	12.7	1.05	0.0	0.0	0	214.3	1.4	CPA6-LD	70	10 x 7M
1-2	93.2	40.6	22.0	11.2	11.1	11.6	1.05	0.0	0.0	0	203.2	3.2	CPA6-LD	30	5 x 6M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Blended Water
Hardness, as CaCO3	56.91	56.91	0.007	123.4	228.1	28.46
Ca	13.70	13.70	0.002	29.7	54.9	6.85
Mg	5.53	5.53	0.001	12.0	22.2	2.77
Na	98.20	98.20	0.656	212.4	391.6	49.43
K	2.67	2.67	0.020	5.8	10.6	1.35
NH4	0.05	0.05	0.001	0.1	0.2	0.03
Ba	0.259	0.259	0.000	0.6	1.0	0.13
As+5	0.010	0.010	0.00003	0.022	0.04	0.01
Fe+2	0.028	0.028	0.000	0.1	0.1	0.01
Mn+2	0.008	0.008	0.000	0.0	0.0	0.00
CO3	0.01	0.01	0.000	0.0	0.1	0.00
HCO3	0.50	0.50	0.006	1.1	1.9	0.25
SO4	14.00	14.00	0.019	30.3	56.1	7.01
Cl	182.97	182.97	1.009	395.9	730.3	91.99
F	0.42	0.42	0.005	0.9	1.7	0.21
NO3	0.05	0.05	0.001	0.1	0.2	0.03
OH	0.03	0.03	0.000	0.1	0.1	0.01
SiO2	17.30	17.30	0.073	37.4	69.1	8.69
B	0.27	0.27	0.122	0.5	0.7	0.20
CO2	0.00	0.00	0.00	0.00	0.00	0.00
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TDS	**335.97**	**335.97**	**1.92**	**726.81**	**1340.83**	**168.94**
pH	**8.28**	**8.28**	**6.39**	**8.59**	**8.83**	**8.00**

Saturations	Raw Water	Feed Water	Permeate Water	Concentrate	Limits
CaSO4 / Ksp * 100, %	0	0	0	1	400
SrSO4 / Ksp * 100, %	0	0	0	0	1200
BaSO4 / Ksp * 100, %	305	305	0	1487	10000
SiO2 Saturation, %	12	12	0	37	140
CaF2 / Ksp * 100, %	0	0	0	17	50000
Ca3(PO4)2	0.0	0.0	0.0	0.0	2.4
CCPP, mg/l	0.08	0.08	-0.15	0.58	850
Langelier index	-2.57	-2.57	-10.05	-0.89	2.8
Ionic strength	0.01	0.01	0.00	0.03	
Osmotic pressure, psi	3.4	3.4	0.0	13.5	
TDS / Osmotic pressure, mg/l.psi	98.3	98.3	97.6	98.3	

Permeate Blending

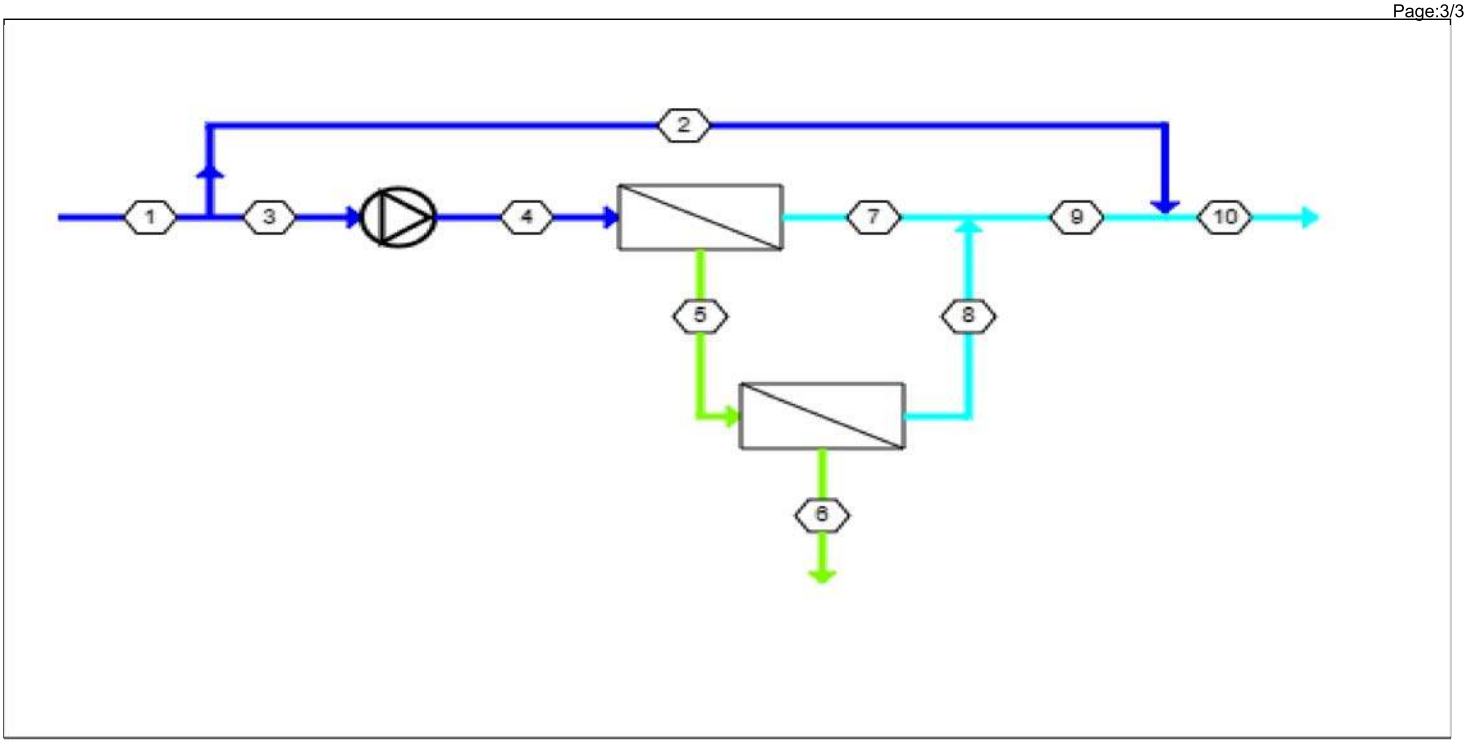
Project name	Bay City, Texas
Client Name	Garver
Calculated by	Michael Gisclair
HP pump flow	440.00 gpm
Feed pressure	228.0 psi
Feed temperature	22.3 °C
Feed Water pH	8.28
Chemical dose, mg/l	None
Pumping specific energy	2.74 kWh/kgal
Pass NDP	210.6 psi
Average flux	11.9 gfd

Permeate flow/train	330.00 gpm
Total plant product flow	1320.00 gpm
Number of trains	2.00
Raw water flow/train	770.00 gpm
Permeate recovery	75.00 %
Blended flow	660.00 gpm
Membrane age	5.0 years
Flux decline,per year	7.0 %
Fouling factor	0.70
SP increase, per year	7.0 %
Feed type	Brackish Well High-Fouling
Pretreatment	Conventional

Pass-Stage	Perm. Flow	Flow / Vessel Feed	Conc	Flux	DP	Flux Max	Beta	Stagewise Pressure Perm.	Boost	Exhaust	Conc	Perm. TDS	Membrane Type	Membrane Quantity	PV# x Elem #
	gpm	gpm	gpm	gfd	psi	gfd		psi	psi	psi	psi	mg/l			
1-1	237.1	44.0	20.3	12.2	13.6	12.7	1.05	0.0	0.0	0	214.3	1.4	CPA6-LD	70	10 x 7M
1-2	93.2	40.6	22.0	11.2	11.1	11.6	1.05	0.0	0.0	0	203.2	3.2	CPA6-LD	30	5 x 6M

Pass-Stage	membrane no.	Feed Pressure	Pressure Drop	Conc Osmotic pressure	NDP	Permeate Water Flow	Flux	Recovery	Beta	Permeate (Stagewise cumulative) TDS	Econd (@ 25.0 °C)	Ca	Na	Cl
		psi	psi	psi	psi	gpm	gfd	(%)		mg/l	µS/cm	mg/l	mg/l	mg/l
1-1	1	228.0	2.84	3.7	223.0	3.5	12.7	8.0	1.03	1.1	2.1	0.001	0.376	0.577
1-1	2	225.1	2.52	4.0	220.0	3.5	12.5	8.6	1.03	1.1	2.2	0.001	0.389	0.598
1-1	3	222.6	2.21	4.4	217.3	3.4	12.3	9.2	1.03	1.2	2.3	0.001	0.404	0.620
1-1	4	220.4	1.92	4.9	214.8	3.4	12.2	10.1	1.04	1.2	2.4	0.001	0.419	0.643
1-1	5	218.5	1.64	5.5	212.4	3.3	12.0	11.1	1.04	1.3	2.5	0.001	0.434	0.667
1-1	6	216.8	1.38	6.3	210.2	3.3	11.9	12.3	1.05	1.3	2.5	0.001	0.449	0.691
1-1	7	215.5	1.13	7.3	208.1	3.3	11.8	13.9	1.05	1.4	2.7	0.001	0.478	0.734
1-2	1	214.3	2.53	8.0	205.4	3.2	11.6	7.9	1.03	2.3	4.4	0.002	0.772	1.187
1-2	2	211.8	2.24	8.7	202.4	3.2	11.4	8.5	1.03	2.4	4.7	0.002	0.821	1.263
1-2	3	209.5	1.97	9.6	199.5	3.1	11.3	9.1	1.03	2.6	5.0	0.002	0.877	1.349
1-2	4	207.6	1.71	10.6	196.7	3.1	11.1	9.9	1.04	2.7	5.3	0.002	0.942	1.449
1-2	5	205.9	1.46	11.9	193.9	3.0	10.9	10.8	1.04	3.0	5.8	0.003	1.018	1.566
1-2	6	204.4	1.23	13.5	191.1	3.0	10.8	12.0	1.05	3.2	6.3	0.003	1.110	1.706

Permeate Blending



Stream No.	Flow (gpm)	Pressure (psi)	TDS (mg/l)	pH	Econd (µS/cm) (@ 25.0 °C)
1	770	0	336	8.28	711
2	330	0	336	8.28	711
3	440	0	336	8.28	711
4	440	228	336	8.28	711
5	203	214	727	8.59	1531
6	110	203	1341	8.83	2618
7	237	0	1.41	6.25	3.00
8	93.2	0	3.21	6.61	6.50
9	330	0	1.92	6.39	3.90
10	660	0	169	8.00	358

Permeate Blending

Project name	Bay City, Texas		1/3
Client Name	Garver		
Calculated by	Michael Gisclair		
HP pump flow	440.00 gpm	Permeate flow/train	330.00 gpm
Feed pressure	228.0 psi	Raw water flow/train	1160.00 gpm
Feed temperature	22.3 °C	Permeate recovery	75.00 %
Feed Water pH	8.28	Blended flow	1050.00 gpm
Chemical dose, mg/l	None	Membrane age	5.0 years
Pumping specific energy	2.74 kWh/kgal	Flux decline,per year	7.0 %
Pass NDP	210.6 psi	Fouling factor	0.70
Average flux	11.9 gfd	SP increase, per year	7.0 %
		Feed type	Brackish Well High-Fouling
		Pretreatment	Conventional

Pass-Stage	Perm. Flow	Flow / Vessel Feed	Conc	Flux	DP	Flux Max	Beta	Perm.	Stagewise Pressure Boost	Exhaust	Conc	Perm. TDS	Membrane Type	Membrane Quantity	PV# x Elem #
	gpm	gpm	gpm	gfd	psi	gfd		psi	psi	psi	psi	mg/l			
1-1	237.1	44.0	20.3	12.2	13.6	12.7	1.05	0.0	0.0	0	214.3	1.4	CPA6-LD	70	10 x 7M
1-2	93.2	40.6	22.0	11.2	11.1	11.6	1.05	0.0	0.0	0	203.2	3.2	CPA6-LD	30	5 x 6M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Blended Water
Hardness, as CaCO3	56.91	56.91	0.007	123.4	228.1	39.03
Ca	13.70	13.70	0.002	29.7	54.9	9.39
Mg	5.53	5.53	0.001	12.0	22.2	3.79
Na	98.20	98.20	0.656	212.4	391.6	67.54
K	2.67	2.67	0.020	5.8	10.6	1.84
NH4	0.05	0.05	0.001	0.1	0.2	0.03
Ba	0.259	0.259	0.000	0.6	1.0	0.18
As+5	0.010	0.010	0.00003	0.022	0.04	0.01
Fe+2	0.028	0.028	0.000	0.1	0.1	0.02
Mn+2	0.008	0.008	0.000	0.0	0.0	0.01
CO3	0.01	0.01	0.000	0.0	0.1	0.00
HCO3	0.50	0.50	0.006	1.1	1.9	0.35
SO4	14.00	14.00	0.019	30.3	56.1	9.61
Cl	182.97	182.97	1.009	395.9	730.3	125.78
F	0.42	0.42	0.005	0.9	1.7	0.29
NO3	0.05	0.05	0.001	0.1	0.2	0.03
OH	0.03	0.03	0.000	0.1	0.1	0.02
SiO2	17.30	17.30	0.073	37.4	69.1	11.89
B	0.27	0.27	0.122	0.5	0.7	0.22
CO2	0.00	0.00	0.00	0.00	0.00	0.00
NH3	0.00	0.00	0.00	0.00	0.00	0.00
TDS	**335.97**	**335.97**	**1.92**	**726.81**	**1340.83**	**230.98**
pH	**8.28**	**8.28**	**6.39**	**8.59**	**8.83**	**8.13**

Saturations	Raw Water	Feed Water	Permeate Water	Concentrate	Limits
CaSO4 / Ksp * 100, %	0	0	0	1	400
SrSO4 / Ksp * 100, %	0	0	0	0	1200
BaSO4 / Ksp * 100, %	305	305	0	1487	10000
SiO2 Saturation, %	12	12	0	37	140
CaF2 / Ksp * 100, %	0	0	0	17	50000
Ca3(PO4)2	0.0	0.0	0.0	0.0	2.4
CCPP, mg/l	0.08	0.08	-0.15	0.58	850
Langelier index	-2.57	-2.57	-10.05	-0.89	2.8
Ionic strength	0.01	0.01	0.00	0.03	
Osmotic pressure, psi	3.4	3.4	0.0	13.5	
TDS / Osmotic pressure, mg/l.psi	98.3	98.3	97.6	98.3	

Permeate Blending

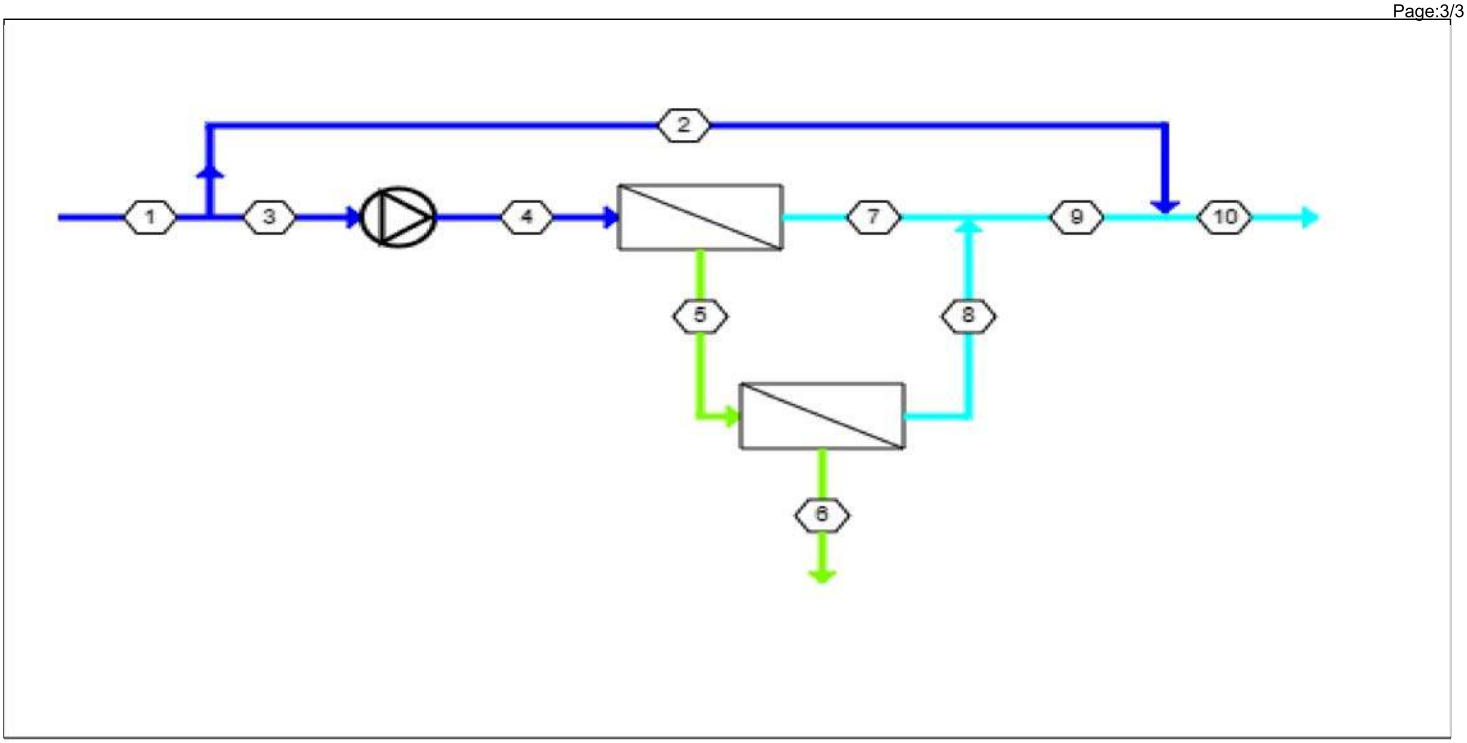
Project name	Bay City, Texas
Client Name	Garver
Calculated by	Michael Gisclair
HP pump flow	440.00 gpm
Feed pressure	228.0 psi
Feed temperature	22.3 °C
Feed Water pH	8.28
Chemical dose, mg/l	None
Pumping specific energy	2.74 kWh/kgal
Pass NDP	210.6 psi
Average flux	11.9 gfd

Permeate flow/train	330.00 gpm
Raw water flow/train	1160.00 gpm
Permeate recovery	75.00 %
Blended flow	1050.00 gpm
Membrane age	5.0 years
Flux decline,per year	7.0 %
Fouling factor	0.70
SP increase, per year	7.0 %
Feed type	Brackish Well High-Fouling
Pretreatment	Conventional

Pass-Stage	Perm. Flow	Flow / Vessel Feed	Flow / Vessel Conc	Flux	DP	Flux Max	Beta	Stagewise Pressure Perm.	Boost	Exhaust	Conc	Perm. TDS	Membrane Type	Membrane Quantity	PV# x Elem #
	gpm	gpm	gpm	gfd	psi	gfd		psi	psi	psi	psi	mg/l			
1-1	237.1	44.0	20.3	12.2	13.6	12.7	1.05	0.0	0.0	0	214.3	1.4	CPA6-LD	70	10 x 7M
1-2	93.2	40.6	22.0	11.2	11.1	11.6	1.05	0.0	0.0	0	203.2	3.2	CPA6-LD	30	5 x 6M

Pass-Stage	membrane no.	Feed Pressure	Pressure Drop	Conc Osmotic pressure	NDP	Permeate Water Flow	Flux	Recovery	Beta	Permeate (Stagewise cumulative) TDS	Econd (@ 25.0 °C)	Ca	Na	Cl
		psi	psi	psi	psi	gpm	gfd	(%)		mg/l	µS/cm	mg/l	mg/l	mg/l
1-1	1	228.0	2.84	3.7	223.0	3.5	12.7	8.0	1.03	1.1	2.1	0.001	0.376	0.577
1-1	2	225.1	2.52	4.0	220.0	3.5	12.5	8.6	1.03	1.1	2.2	0.001	0.389	0.598
1-1	3	222.6	2.21	4.4	217.3	3.4	12.3	9.2	1.03	1.2	2.3	0.001	0.404	0.620
1-1	4	220.4	1.92	4.9	214.8	3.4	12.2	10.1	1.04	1.2	2.4	0.001	0.419	0.643
1-1	5	218.5	1.64	5.5	212.4	3.3	12.0	11.1	1.04	1.3	2.5	0.001	0.434	0.667
1-1	6	216.8	1.38	6.3	210.2	3.3	11.9	12.3	1.05	1.3	2.5	0.001	0.449	0.691
1-1	7	215.5	1.13	7.3	208.1	3.3	11.8	13.9	1.05	1.4	2.7	0.001	0.478	0.734
1-2	1	214.3	2.53	8.0	205.4	3.2	11.6	7.9	1.03	2.3	4.4	0.002	0.772	1.187
1-2	2	211.8	2.24	8.7	202.4	3.2	11.4	8.5	1.03	2.4	4.7	0.002	0.821	1.263
1-2	3	209.5	1.97	9.6	199.5	3.1	11.3	9.1	1.03	2.6	5.0	0.002	0.877	1.349
1-2	4	207.6	1.71	10.6	196.7	3.1	11.1	9.9	1.04	2.7	5.3	0.002	0.942	1.449
1-2	5	205.9	1.46	11.9	193.9	3.0	10.9	10.8	1.04	3.0	5.8	0.003	1.018	1.566
1-2	6	204.4	1.23	13.5	191.1	3.0	10.8	12.0	1.05	3.2	6.3	0.003	1.110	1.706

Permeate Blending



Stream No.	Flow (gpm)	Pressure (psi)	TDS (mg/l)	pH	Econd (µS/cm) (@ 25.0 °C)
1	1160	0	336	8.28	711
2	720	0	336	8.28	711
3	440	0	336	8.28	711
4	440	228	336	8.28	711
5	203	214	727	8.59	1531
6	110	203	1341	8.83	2618
7	237	0	1.41	6.25	3.00
8	93.2	0	3.21	6.61	6.50
9	330	0	1.92	6.39	3.90
10	1050	0	231	8.13	489

ProDose XPRT Report v:3.1.0.2

Project Information

Client:	Garver	Print Date:	11/2/2022 9:05:25 PM
Project:	Bay City	Comments:	
Location:	Bay City, TX	Case Number:	1
Prepared By:	M Gisclair	Case Description:	

System Information

Feed Water Type:	Well Water	Flow Units:	Gal/min
Feed Water Flow:	440.0	Concentrate Flow:	110.0
Permeate Flow:	330.0	Recycle Flow:	0.0
System Recovery (%):	75.00%	RO Recovery:	75.00%
Feed Temperature:	22.3 Deg C	Membrane Rejection:	99.3%

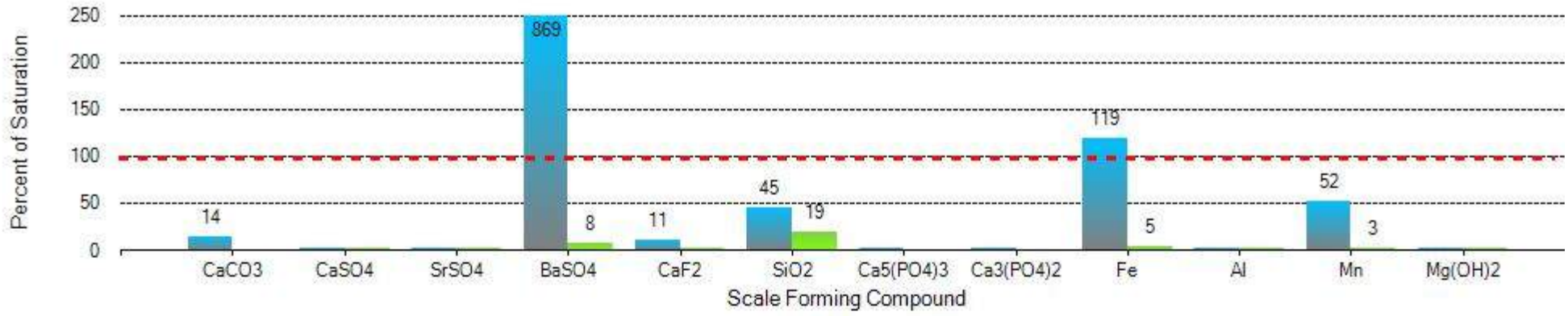
Product Selection

SpectraGuard 111

Antiscalant Dose Rate:	**0.25 mg/l Feed**	**0.98 mg/l in Concentrate**
Estimated Usage (100%):	**1.30 lbs/day**	**474.43 lbs/yr, 215.20 kg/yr**
Pretreatment:	**No acid/base dose**	
Estimated Usage (100%):	**0.00 kg/day**	

Concentrate Solubilities

- NO CHEM **- WITH PWT**



Saturation %	Raw Feed	Feed	Concentrate	With PWT	Saturation %	Raw Feed	Feed	Concentrate	With PWT
LSI	-2.2	-2.2	-0.6	-	**SiO2**	12.1	12.1	44.8	**19.5**
CCPP-ppm	-6	-6	-2	-	**Ca5(PO4)3-SI**	0.0	0.0	0.0	**0.0**
CaCO3	0	0	14	**0.0**	**Ca3(PO4)2-SI**	0.0	0.0	0.0	**0.0**
CaSO4	0.1	0.1	0.5	**0.1**	**Fe**	30.3	30.3	119.4	**4.6**
SrSO4	0.0	0.0	0.0	**0.0**	**Al**	0.0	0.0	0.0	**0.0**
BaSO4	93.3	93.3	868.8	**7.9**	**Mn**	19.0	19.0	51.5	**2.6**
CaF2	0.2	0.2	10.6	**0.0**	**Mg(OH)2**	0	0	0	**0**

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Water Analysis

Ions (mg/l)	Sys Feed	Pretreatment	Net Feed	Permeate	Concentrate
Ca	13.70	13.70	13.70	0.06	54.61
Mg	5.53	5.53	5.53	0.03	22.04
Na	104.77	104.77	104.77	1.45	414.72
K	2.67	2.67	2.67	0.04	10.57
NH4	0.05	0.05	0.05	0.00	0.19
Ba	0.26	0.26	0.26	0.00	1.03
Sr	0.00	0.00	0.00	0.00	0.00
Fe	0.03	0.03	0.03	0.00	0.12
Mn	0.01	0.01	0.01	0.00	0.04
Al	0.00	0.00	0.00	0.00	0.00
HCO3	0.50	0.50	0.50	0.03	1.83
Cl	182.97	182.97	182.97	2.54	724.27
SO4	14.00	14.00	14.00	0.06	55.81
F	0.42	0.42	0.42	0.01	1.66
NO3	0.05	0.05	0.05	0.00	0.20
PO4	0.00	0.00	0.00	0.00	0.00
SiO2	17.30	17.30	17.30	0.24	68.48
TDS	342	342	342	4	1,356
pH	8.28	8.28	8.28	7.11	8.89

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Appendix E:
Rapid Small-Scale Column Test

Rapid Small-Scale Column Tests: Arsenic Removal by E33 and GFH for Bay City, TX

Report Prepared by

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Chao Zheng, Assistant Professor

Emily Briese, PhD student

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National Science Foundation
Nanosystems Engineering Research Center for Nanotechnology Enabled Water Treatment

September 2022

Purpose of Tests

Using a rapid small-scale column test (RSSCT), ASU simulated a full-scale packed bed system of 2.5 min EBCT and a loading rate of 9.36 and 9.61 for E33 and GFH, respectively. Water was shipped to ASU from Bay City, TX. The duration of the test was 96,000 bed volumes to obtain the breakthrough curves of Arsenic species.

Methodology

RSSCT Methodology

RSSCT bench-scale testing is a method where dimensionless mathematical methods are used to scale down a full-scale packed-bed adsorption system based upon similitude between solute transport mechanisms. The advantages of RSSCTs are that breakthrough curves can be obtained in a fraction of the time and water that would be required for pilot tests. Theoretically, RSSCTs and full-scale systems would have identical breakthrough curves, but in reality, they differ based upon water quality, biological processes, and RSSCT scaling assumptions. In the development of scaling equations three conditions are required in order for similarity to be maintained (Crittenden et al. 1986; Crittenden et al. 1987; Crittenden et al. 1991). First, boundary conditions for the large-scale and small-scale process must occur at the same dimensionless coordinate values in the dimensionless differential equations. Second, dimensionless parameters in the dimensionless differential equations must be equal for the large-scale and small-scale process. Finally, no change in mechanism can occur when reducing the size of the process. RSSCTs can be designed using equations 1 and 2 (**Eq. 1**, **2**), if the effective surface diffusivity is independent of particle size, the system is identical between the full-scale and RSSCT columns (Table 1). If the surface diffusivities are not identical between the large-scale and RSSCT columns, perfect similarity cannot be guaranteed. However, if it is assumed that surface diffusivity is linearly proportional to the particle radius and that surface diffusion is the controlling mechanism, an RSSCT can be designed using equations 3 and 4 (**Eq. 3**, **4)** that would produce an RSSCT that would perform very similar to the full-scale adsorber. The Reynolds number is a dimensionless ratio of the inertial forces over the viscous forces in a fluid. The Schmidt number is a dimensionless ratio of the diffusion of momentum over the diffusion of mass. The product of the Reynolds number and the Schmidt number can be used to determine the minimum Reynolds for the RSSCT such that the effects of dispersion are not important. Dispersion is not important if the product of the Reynolds number and the Schmidt number is in the mechanical dispersion region from 200,000-200. a value of 1000 is used in all proposed work. The following equations were used:

$$\frac{EBCT_{SC}}{EBCT_{LC}} = \left[\frac{d_{p,SC}}{d_{p,LC}}\right] = \frac{t_{SC}}{t_{LC}} \ldots \textbf{Eq. 1}$$

$$\frac{V_{SC}}{V_{LC}} = \left[\frac{d_{p,SC}}{d_{p,LC}}\right] x \frac{Re_{SC} x\, Sc}{Re_{LC} x\, Sc} \ldots \textbf{Eq. 2}$$

$$Re = \frac{V x \rho_L x d_p}{\mu} \ldots \textbf{Eq. 3}$$

$$Sc = \frac{\mu}{D_L x \rho_L} \ldots \textbf{Eq. 4}$$

where the parameters are defined as follows: Empty bed contact time (EBCT), media diameter (dp), run duration (t), loading rate (V), effective surface diffusivity (D), Reynolds number (Re), Schmidt number (Sc), liquid density (ρL), viscosity (μ), and liquid diffusivity of arsenic (DL). Subscript "SC" indicates small column (i.e., RSSCT column) and "LC" indicates large column. Figure 1 shows a schematic of the RSSCT set-up.

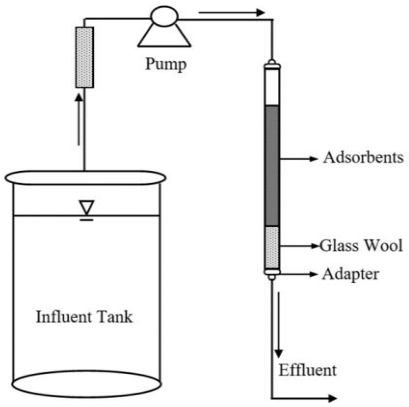

Figure 1: RSSCT configuration with pre-column glass wool filter.

RSSCT columns are 0.43 cm diameter tubes. Piston pumps (QG150) with stainless steel heads (Q2CSC) are used (Fluid Metering Inc. Syosset, NY). Glass wool packed into the bottom of the column supports the adsorbent. The sieved adsorbent (140x170 mesh) is added to the column using a funnel and ultra-pure water to flush the material down into the column. The precise amount of adsorbent media in the columns will be calculated based upon proportional diffusivity scaling approaches to a representative demonstration scale packed bed system (Badruzzaman 2002; Badruzzaman et al. 2004; Westerhoff et al. 2005). Columns are backwashed to remove fines, by operating the column in upflow mode (bed expansion of approximately 40%) with distilled water until the effluent water visually ran clear. The typical flow rate for backwashing the mini columns are in the 5-25 ml/min range and resulted in bed expansion of approximately 40%.

RSSCTs were set up to treat at least 75,000 bed volumes of water. The RSSCT simulate a full-scale system with an empty bed contact time (EBCT) of 2.5 min EBCT and a loading rate of 6 gpm/ft^2. The RSSCT used 140x170 mesh material and proportional diffusivity scaling parameters. The RSSCT column length was 3.75 cm and 3.85 cm for E33 and GFH. The columns were operated at a flowrate of 2.26 and 2.32 mL/min, respectively.

Material Preparation and Column Setup Methodology

Sample bottles and testing equipment were cleaned to ensure no organic or inorganic contamination, following techniques used by Badruzzaman, et al. 2004. Sample bottles and equipment were placed into a 0.1% Alconox solution overnight, triple-rinsed with deionized water, dried, placed into 10% nitric acid overnight, triple-rinsed with deionized water, and dried. Media preparation included grinding and sieving both sorbents (E33 and GFH) to an approximate crushed media diameter size of 0.096 mm. Sorbents were placed in a mortar with deionized water and grinded using a pestle. Grounded sorbents were then sieved through a sieve stack of 140x170 (No. 140 on top of No. 170), using deionized water. Sorbents collected on the No. 170 sieve were stored in centrifuged tubes, with the remaining volume filled with deionized water. This was done to ensure the sorbents stayed moist, avoiding oxidation.

The RSSCT setup followed the schematic shown in the Figure 1. The influent was first passed through a pre-filtration column using glass wool to avoid fouling and clogging within the sorbent column. Water is then passed through the pump and enters through the top of the sorbent column.

The sorbent column is positioned vertically, where sorbents are placed on top of glass wool. Glass wool was used to prevent sorbent leaching into the effluent.

Sample Collection and Analysis

Samples from 2 locations (influent and effluent from each RSSCT) were collected periodically for around 17 days. Samples were filtered and acidified 2% with trace-metal grade nitric acid (HNO_3). A detailed account of the obtained data and associated bed volumes is available in the Appendix (Table A2 and A3). Samples of approximately 45 mL were taken and immediately stored in the dark at a 4 ^oC. ASU conducted analysis on the samples for general water characteristics (pH and conductivity) and through induced coupled plasma-mass spectrometry (ICP-MS). The ICP-MS measured concentrations of species (V, Cr, Cu, Se, As, Si, U, and W) by atomizing any molecules to their atomistic constituents. RSSCT's were run to approximately 96,000 bed volumes.

RSSCT Results

The average influent conditions for the waters during each test are summarized below in **Table 1**.

Table 1: Summary of average influent concentrations. Note, BDL indicates below detection limit.

Parameter	Bay City, TX
Influent pH	8.5
Influent Total Alkalinity (mg/L $CaCO_3$)	260
Influent Conductivity (μS/cm)	605
Phosphate (ppm)	0.9
Sulfate (ppm)	14
As	8.7 ± 0.3
V	BDL
Cr	BDL
Cu	BDL
Cd	BDL
Se	BDL
U	BDL
W	BDL
Si (ppm)	8.6

E33 Bayoxide and Granular Ferric Hydroxide RSSCT Performance

A RSSCT was performed using the sorbent E33 Bayoxide, produced by AdEdge Media. This column was run to 95,820 bed volumes treated (BVT) and breakthrough of chemicals were monitored through the effluent. The fastest breakthrough (lowest adsorption) was observed for Si, followed by As.

A RSSCT was conducted using Granular Ferric Hydroxide (GFH). This column was run to 96,030 bed volumes treated (BVT) and breakthrough profiles were monitored through the effluent for both As and Si. Breakthrough profiles for both media, including influent As concentration, can be seen in **Figure 1**.

Figure 1 compares arsenic breakthrough curves for E33 and GHF. We conclude there is little difference in the arsenic breakthrough curves between the E33 and GFH column for arsenic. This means the capacity, lifetime and replacement frequency of the media based upon arsenic removal under the conditions tested would not differ. Both adsorbents achieved between 10,000 to 14,000 bed volumes treated before exceeding the 1 ug/L detection limit for arsenic. Approximately 80% arsenic breakthrough occurred around 100,000 bed volumes treated.

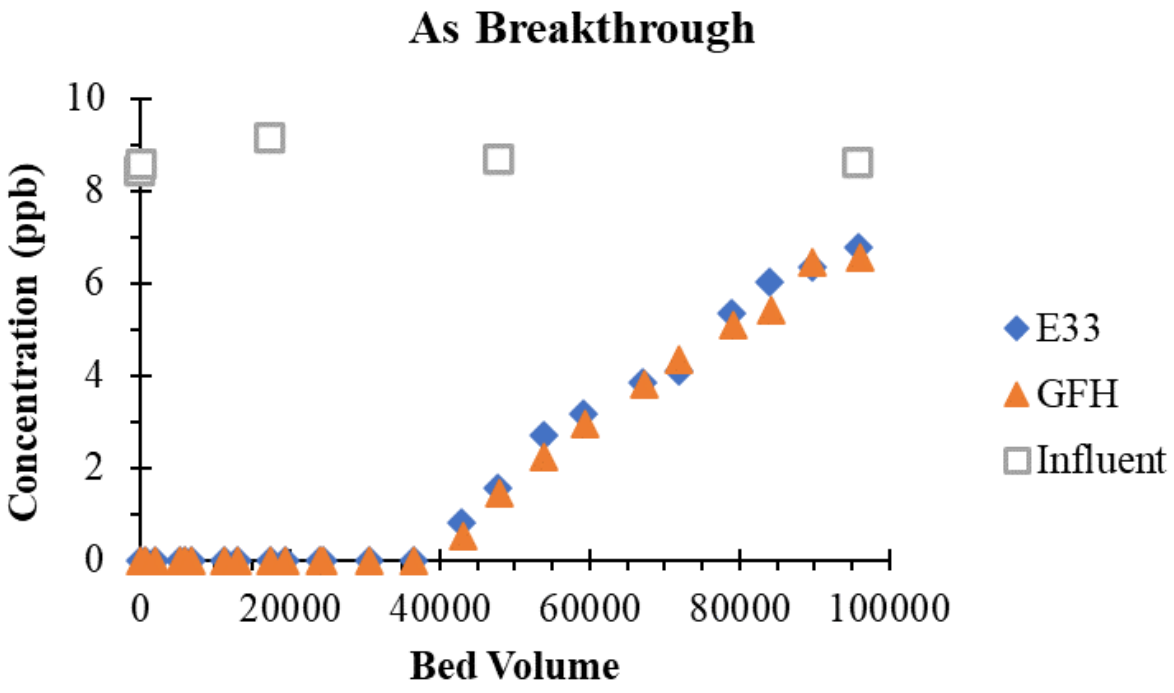

Figure 1: Arsenic Breakthrough curve for E33, up to 95,820 bed volumes treated.

Findings

- E33 and GHF. We conclude there is little difference in the arsenic breakthrough curves between the E33 and GFH column for arsenic. This means the capacity, lifetime and replacement frequency of the media based upon arsenic removal under the conditions tested would not differ. Both adsorbents achieved between 10,000 to 14,000 bed volumes treated before exceeding the 1 ug/L detection limit for arsenic. Approximately 80% arsenic breakthrough occurred around 100,000 bed volumes treated.

- E33 and GFH show similar performance for the breakthrough profiles of silica.

- The water had non-detectable concentrations of other metals (vanadate, tungstate, uranate) that are often considered competing species for arsenate removal. This is potentially one reason why both E33 and GFH media resulted in similar performance in removing arsenic.

- Other operational factors (e.g., pressure fluctuations, turbidity, backwashing, etc.) affected by on-site conditions may influence replacement frequency of arsenic adsorption media.

References

[1] M. Vahter, "Health effects of early life exposure to arsenic," *Basic Clin. Pharmacol. Toxicol.*, vol. 102, no. 2, pp. 204–211, 2008.

[2] K. M. Zierold, L. Knobeloch, and H. Anderson, "Prevalence of chronic diseases in adults exposed to arsenic-contaminated drinking water," *Am. J. Public Health*, vol. 94, no. 11, pp. 1936–1937, 2004.

[3] M. Badruzzaman, P. Westerhoff, and D. R. U. Knappe, "Intraparticle diffusion and adsorption of arsenate onto granular ferric hydroxide (GFH)," *Water Res.*, vol. 38, no. 18, pp. 4002–4012, 2004.

[4] P. K. Westerhoff, "RSSCT Training Protocol," 2015.

APPENDICES

Rapid Small-Scale Column Tests: Arsenic Removal by E33 and GFH for Bay City, TX

Report Prepared by

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National Science Foundation
Nanosystems Engineering Research Center for Nanotechnology Enabled Water Treatment

September 2022

Table A1: Metal Concentrations detected by ICP-MS for E33

	ICP-MS Bay City E33 (ppb)											
Sample ID	Date	Time	Bed Volume Treated	V	Cr	Cu	Cd	Se	As	Si (ppm)	U	W
1 E33	8/29/22	11:45 AM	125	BDL	2.1	BDL	BDL	BDL	0.0	2.5	BDL	BDL
2 E33		2:06 PM	713	BDL	2.1	BDL	BDL	BDL	0.0	6.7	BDL	BDL
3 E33		7:04 PM	1950	BDL	BDL	BDL	BDL	BDL	0.0	7.8	BDL	BDL
4 E33	8/30/22	8:43 AM	5350	BDL	BDL	BDL	BDL	BDL	0.0	8.1	BDL	BDL
5 E33		11:20 AM	6000	BDL	BDL	BDL	BDL	BDL	0.0	8.1	BDL	BDL
6 E33		2:56 PM	6900	BDL	BDL	BDL	BDL	BDL	0.0	8.0	BDL	BDL
7 E33	8/31/22	8:24 AM	11250	BDL	BDL	BDL	BDL	BDL	0.0	8.2	BDL	BDL
8 E33		3:25 PM	13000	BDL	BDL	BDL	BDL	BDL	0.0	8.2	BDL	BDL
9 E33	9/1/22	8:53 AM	17350	BDL	BDL	BDL	BDL	BDL	0.0	8.2	BDL	BDL
10 E33		4:43 PM	19300	BDL	BDL	BDL	BDL	BDL	0.0	8.3	BDL	BDL
11 E33	9/2/22	11:35 AM	24000	BDL	BDL	BDL	BDL	BDL	0.0	8.4	BDL	BDL
12 E33		1:23 PM	24450	BDL	BDL	BDL	BDL	BDL	0.0	8.3	BDL	BDL
13 E33	9/3/22	2:16 PM	30650	BDL	BDL	BDL	BDL	BDL	0.0	8.4	BDL	BDL
14 E33	9/4/22	1:33 PM	36450	BDL	BDL	BDL	BDL	BDL	0.0	8.3	BDL	BDL
15 E33	9/5/22	3:47 PM	42985	BDL	BDL	BDL	BDL	BDL	0.8	8.5	BDL	BDL
16 E33	9/6/22	10:55 AM	47750	BDL	BDL	BDL	BDL	BDL	1.6	8.6	BDL	BDL
17 E33	9/7/22	11:06 AM	53775	BDL	BDL	BDL	BDL	BDL	2.7	8.5	BDL	BDL
18 E33	9/8/22	8:43 AM	59160	BDL	BDL	BDL	BDL	BDL	3.2	8.5	BDL	BDL
19 E33	9/9/22	4:40 PM	67120	BDL	BDL	BDL	BDL	BDL	3.8	8.4	BDL	BDL
20 E33	9/10/22	11:24 AM	71790	BDL	BDL	BDL	BDL	BDL	4.1	8.5	BDL	BDL
21 E33	9/11/22	4:09 PM	78950	BDL	BDL	BDL	BDL	BDL	5.4	8.5	BDL	BDL
22 E33	9/12/22	12:25 PM	84000	BDL	BDL	BDL	BDL	BDL	6.0	8.7	BDL	BDL
23 E33	9/13/22	10:54 AM	89600	BDL	BDL	BDL	BDL	BDL	6.3	8.7	BDL	BDL
24 E33	9/14/22	11:52 AM	95820	BDL	BDL	BDL	BDL	BDL	6.8	8.7	BDL	BDL

Table A2: Metal Concentrations detected by ICP-MS for GFH

	ICP-MS Bay City GFH (ppb)											
Sample ID	Date	Time	Bed Volume Treated	V	Cr	Cu	Cd	Se	As	Si (ppm)	U	W
1 GFH	8/29/22	11:25 AM	125	BDL	BDL	BDL	BDL	BDL	0.0	4.6	BDL	BDL
2 GFH		1:46 PM	713	BDL	BDL	BDL	BDL	BDL	0.0	7.9	BDL	BDL
3 GFH		6:43 PM	1950	BDL	BDL	BDL	BDL	BDL	0.0	8.9	BDL	BDL
4 GFH	8/30/22	8:20 AM	5350	BDL	BDL	BDL	BDL	BDL	0.0	8.9	BDL	BDL
5 GFH		10:57 AM	6000	BDL	BDL	BDL	BDL	BDL	0.0	8.8	BDL	BDL
6 GFH		2:33 PM	6900	BDL	BDL	BDL	BDL	BDL	0.0	8.9	BDL	BDL
7 GFH	8/31/22	7:58 AM	11250	BDL	BDL	BDL	BDL	BDL	0.0	8.8	BDL	BDL
8 GFH		2:59 PM	13000	BDL	BDL	BDL	BDL	BDL	0.0	9.0	BDL	BDL
9 GFH	9/1/22	8:24 AM	17350	BDL	BDL	BDL	BDL	BDL	0.0	9.0	BDL	BDL
10 GFH		4:13 PM	19300	BDL	BDL	BDL	BDL	BDL	0.0	9.0	BDL	BDL
11 GFH	9/2/22	11:02 AM	24000	BDL	BDL	BDL	BDL	BDL	0.0	9.1	BDL	BDL
12 GFH		12:50 PM	24450	BDL	BDL	BDL	BDL	BDL	0.0	8.9	BDL	BDL
13 GFH	9/3/22	1:40 PM	30650	BDL	BDL	BDL	BDL	BDL	0.0	9.3	BDL	BDL
14 GFH	9/4/22	12:54 PM	36450	BDL	BDL	BDL	BDL	BDL	0.0	9.1	BDL	BDL
15 GFH	9/5/22	3:26 PM	43075	BDL	BDL	BDL	BDL	BDL	0.5	9.2	BDL	BDL
16 GFH	9/6/22	10:34 AM	47850	BDL	BDL	BDL	BDL	BDL	1.4	9.2	BDL	BDL
17 GFH	9/7/22	10:45 AM	53890	BDL	BDL	BDL	BDL	BDL	2.3	9.2	BDL	BDL
18 GFH	9/8/22	8:27 AM	59308	BDL	BDL	BDL	BDL	BDL	3.0	9.2	BDL	BDL
19 GFH	9/9/22	4:37 PM	67340	BDL	BDL	BDL	BDL	BDL	3.8	9.2	BDL	BDL
20 GFH	9/10/22	11:05 AM	71950	BDL	BDL	BDL	BDL	BDL	4.4	9.3	BDL	BDL
21 GFH	9/11/22	3:50 PM	79125	BDL	BDL	BDL	BDL	BDL	5.1	9.0	BDL	BDL
22 GFH	9/12/22	12:04 PM	84180	BDL	BDL	BDL	BDL	BDL	5.4	9.1	BDL	BDL
23 GFH	9/13/22	10:35 AM	89800	BDL	BDL	BDL	BDL	BDL	6.5	9.5	BDL	BDL
24 GFH	9/14/22	11:32 AM	96030	BDL	BDL	BDL	BDL	BDL	6.6	9.3	BDL	BDL

Arsenic Treatment Proposals

Mike O'Day – O'Day Drilling

- Local well driller with extensive knowledge of water wells and water quality
- Reviewed the drillers logs for each of our water wells, sampling results for arsenic and total dissolved solids (2005 to current)
- Explained that arsenic lies within zones within the aquifer – rather than treating it after it is pumped, recommend a strategy to minimize arsenic level within the well
- Proposal: downhole camera survey, cleaning and conduct water quality study to identify the zone where arsenic is located
- Once the zone is determined the well can be blocked to minimize the arsenic level in the groundwater pumped
- Mr. O'Day is consulting with his colleagues to gather information on what company could conduct the water quality study (9/14/2022)
- Not on EPA's list of best available technologies – would have to verify with TCEQ

Update as of 11/29/2022

- Texas Commission on Environmental Quality did respond to my inquiry regarding Mr. O'Day's proposal. The Plan and Technical Review Team advised they would consider the approach. However, it would require a plans and specification submittal which must be prepared and submitted by a licensed engineer before any work is started.
- Points to consider:
    - Finding an engineer to prepare plans may be difficult since this is an atypical approach and not considered a best available technology
    - There is a possibility TCEQ may not approve the plans once submitted
- Gathering quotes for pulling the well, downhole camera survey and cleaning.
- Searching for a company that would conduct the water quality study to determine arsenic zone within the aquifer.

Arsenic Treatment Proposals

David Burnett

- David Burnett – retired TAMU Engineer, wastewater treatment in oil/gas industry
- Greg Reymeke - Crusader Water Systems of Utah
- Keith McLeroy (College Station) - Retego Labs & Les Merrill
- Proposal: pilot water treatment using Crusader adsorbent technology
- Designed based on well configuration, water flow & quality data
- Mr. Burnett and Mr. Keith McLeroy would be local engineers assisting in monitoring and assessment of pilot
- Likely no cost for the proposal
- Will need to conduct a site visit – waiting for proposal and a confirmed date from Mr. Burnett to schedule the site visit
- This treatment is similar to Garver's proposal
- Will require TCEQ approval to ensure it meets approved treatment technologies

Update as of 11/29/2022

- No proposal received from Retego Labs/Crusader Water Systems of Utah
- Mr. Burnett recently recommended DeNora Water Services; office located in Sugarland. He has reached out to their office to arrange a meeting.
- In reviewing the information on their website, www.denora.com, their recommended treatment for arsenic is also adsorption.
    - Excerpts from their website:
        - The easiest way to remove arsenic is to use iron to adsorb it from the water. The iron is then removed and disposed of to a sanitary landfill.
        - If your groundwater already has iron present, by simply precipitating and filtering it out of the water, you can also remove the arsenic via co-precipitation/adsorption followed by filtration.