Public Utilities Department
City of Bossier City, Louisiana

Water System Improvement Plan

April 16, 2008

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Section 1
Project Definition, Purpose, and Scope

1.1 Project Definitions

Project Name:	City of Bossier City Water System Improvement Plan (SIP)
Name of System:	City of Bossier City, Louisiana Water System
PWSID Number:	1015004
Contact Name & Address:	Mr. Lorenz “Lo” Walker Mayor P. O. Box 5337 Bossier City, Louisiana 71171-5337 (318) 741-8504
System Classification:	Community
Supply Type:	Surface Water
Type of Ownership:	Public
Current Population Served:	58,496 (includes Benton but not Cypress Bayou)
Current Number of Service Connections:	20,648 (does not include Benton and Cypress Bayou)
Planning Period:	Through 2028

This Water System Improvement Plan was prepared by:

CDM
6120 Perkins Road, Suite 200
Baton Rouge, Louisiana 70808
Attention: Justin S. Haydel, P.E.
(225) 757-7200

1.2 Planning Area Description

The planning area is located in Bossier Parish and is generally extends five miles beyond the limits of Bossier City. It is bounded on the west by the Red River, on the north by Kingston-Deen Point Road, on the east by State Highway 157, and on the south by the Goathill Road, Pinehill Road, and Red Chute Bayou. The planning area encompasses all of the City of Bossier City as well as areas presently served by the city. The total planning area is approximately 180 square miles and is shown in Figure 1-1.

Insert Figure 1-1 – Planning Area

S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 1-1 03/13/08 12:25 simpsonkc

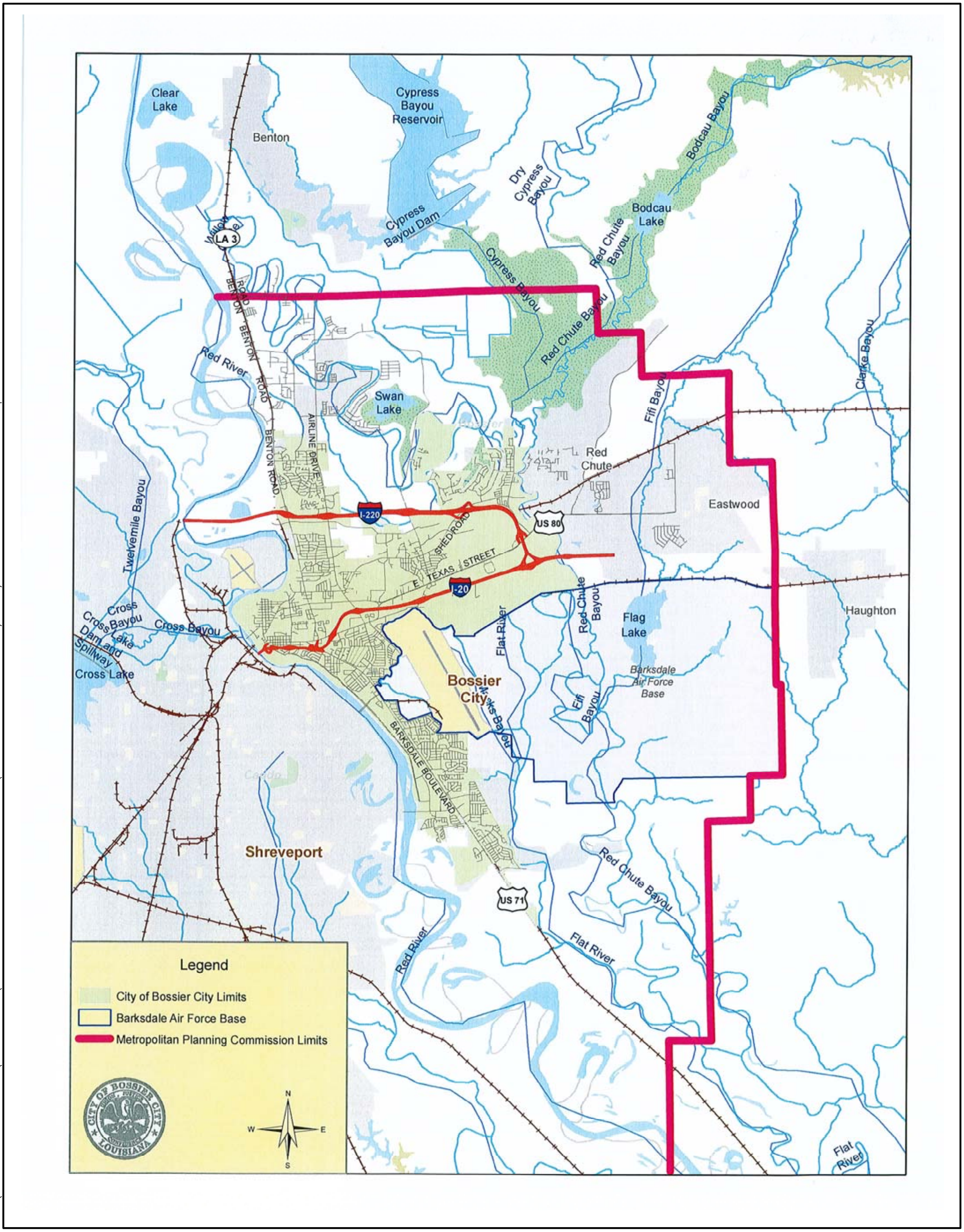

Figure No. 1-1
BOSSIER CITY
PLANNING AREA

CDM

1.3 Introduction and Background

The City of Bossier City has operated this water system for the benefit of its residents for over 50 years. Over that period of time the city has grown in population served and made improvements in raw water supply, treatment, storage, and distribution. Periodically, studies have been conducted in order to define the needs of this system to assure that adequate quantities of water are available and that quality of water is preserved. These studies have been used to define costs and funding methods for necessary improvements. The most recent study, *Hydraulic Analysis and Master Plan for the Bossier City Water System*, was conducted in 2002 which projected needs through the year 2025; it was supplemented in 2006 with a water treatment plant evaluation.

1.4 Relationship to Other Water Systems

Bossier City provides water to two wholesale users, Town of Benton and Cypress Bayou Water System. Bossier City meters each of their water use at a single point of entry and is not responsible for their distribution system or water quality downstream of metered points. The agreement with the Town of Benton was signed in June 1975. The agreement with Cypress-Black Bayou Recreation and Water Conservation District was signed in December 1969.

In January 2001, Bossier City signed an agreement with Sligo Water System to serve as a backup source of potable water for a period of 10 years.

1.5 Purpose and Scope

In effort to achieve eligibility for the SRF low interest loan program, CDM has been retained by the City of Bossier City to develop the System Improvement Plan (SIP). This SIP includes a detailed presentation of the existing water system and an evaluation of the proposed water treatment and distribution facilities and improvements required to meet the city's needs through the year 2028, including:

- Description of the Planning Area, including environmental considerations, permit requirements, and existing utilities;
- Evaluation of existing facilities and their current capacities;
- Analysis of treatment process improvements and/or expansion alternatives;
- Estimation of population to be served by the water treatment system and the water demand generated;
- Estimation of the probable construction cost of the recommended water management plan; and

- Identification of the required and recommended improvements for the construction and expansion programs, the estimated cost of the program alternatives, and the relative priority ranking of each recommended program element.

The SIP is organized as follows:

- Section 1: Project Definition, Purpose, and Scope
- Section 2: Existing Conditions and Deficiencies
- Section 3: Future Conditions
- Section 4: Evaluation of Alternatives
- Section 5: Selected Plan and Description
- Section 6: Arrangements for Implementation
- Section 7: Environmental Impacts

Section 2
Existing Conditions and Deficiencies

2.1 Ground Water Sources

Bossier City does not use ground water as a water supply source.

2.2 Surface Waters

2.2.1 Raw Water Source

Bossier City's water system has relied on the Red River for its supply since 1958. Two river intakes are built there; one pump station pumps to an off-line reservoir and the other station pumps directly to the water plant. A third raw water pump station draws water out of the reservoir and discharges it directly to the water plant. Figure 2-1 illustrates surface raw water sources along with other water system components.

The reservoir primarily functions as a pre-sedimentation basin. The reservoir also serves to protect Bossier's supply against accidental spills upstream on the Red River. River pumps can be turned off and a spill can be allowed to pass the river intakes while Bossier is still able to treat and supply drinking water to its citizens. The size of the reservoir is 600 million gallons (MG). The reservoir is large enough to provide an emergency supply to Bossier for approximately 30 days depending on time of year and the associated demand.

2.2.2 Raw Water Pumping

Photo 1 – Reservoir Pump Station

Under normal operating conditions, water from the reservoir is pumped approximately 3 miles to the WTP. The Reservoir Pump Station (see Photo 1) contains six pumps located on a concrete slab supported by concrete piles. All six pumps were installed as part of the 1996 expansion to the WTP. The pumps are electric motor driven. On-site generators are provided and are sufficient to run all pumps. Capacities shown in Table 2-1 are based on manufacturer pump curves. Firm capacity is calculated assuming that the largest pump is out of service. The existing monorail and hoist need to be replaced.

Table 2-1
Reservoir Pump Station

Pump Name	Constant or Variable Speed	Rated Capacity
Pump No. 1	Constant	5 MGD
Pump No. 2	Constant	5 MGD
Pump No. 3	Constant	5 MGD
Pump No. 4	Constant	11.5 MGD
Pump No. 5	Variable	11.5 MGD
Pump No. 6	Variable	11.5 MGD
	Total Rated Capacity (Firm)	**38 MGD**

FIGURE 2-1

Water Supply, Treatment, and EWST

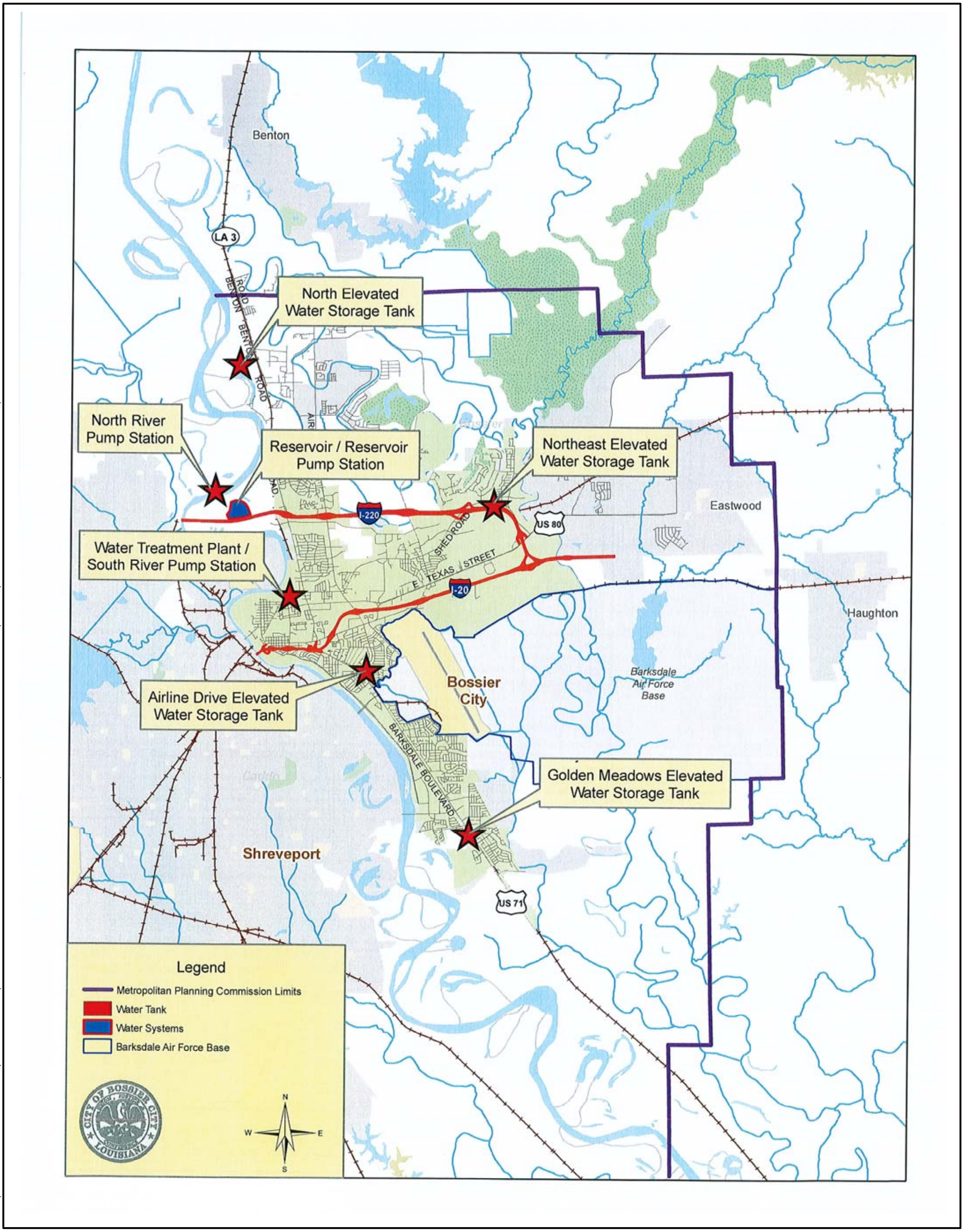

Figure No. 2-1
BOSSIER CITY
WATER SYSTEM

CDM

One 20-inch and one 30-inch pipelines transport raw water from the reservoir pump station to the water treatment plant. These pipes provide approximately 26 mgd of raw water to the WTP.

The reservoir was constructed in 1963 and has a capacity of approximately 600 million gallons (MG). According to city staff, an elevation survey was conducted in 2000 and showed little silt accumulation in the reservoir. The reservoir is located on private property and leased to the city for 100 years.

The North River Pump Station (Photo 2) directs flow from the Red River to the reservoir. There are two pumps located on a concrete slab supported by concrete piles. The pumps were installed in 1992 and are electric motor drive. An on-site generator is provided and is sufficient to run all pumps. The pumps are constant speed and are rated as shown in Table 2-2. Rated capacity is based on manufacturer pump curves. A single 36-inch pipe transports raw water pulled from the Red River to the reservoir. This pump station is not connected to the SCADA system.

Photo 2: North River Pump Station

A new monorail, hoist, and staircase are needed at the North River Pump Station to replace existing equipment in poor condition. Additional pipeline capacity is needed to transport water from the river to the reservoir.

Table 2-2
North River Pump Station

Pump Name	Constant or Variable Speed	Rated Capacity
Pump No. 1	Constant	24 MGD
Pump No. 2	Constant	24 MGD
	Total Rated Capacity (Firm)	**24 MGD**

The South River Pump Station (see Photo 3) can direct flow from the Red River to the reservoir or feed directly to the plant. This pump station was modified in 2002 to include a metal pump house and two new 10 MGD vertical turbine pumps. There are two pumps located in metal housing above a concrete slab supported by concrete piles. The pumps are electric motor drive. An on-site generator is provided and is sufficient to run all pumps. The pumps are constant speed and are rated as shown in Table 2-3. Rated capacity is based on manufacturer pump curves. A single 30-inch pipe transports raw water from the pump station to the WTP.

Photo 3: South River Pump Station

Table 2-3 South River Pump Station		
Pump Name	**Constant or Variable Speed**	**Rated Capacity**
Pump No. 4	Variable	10 MGD
Pump No. 5	Variable	10 MGD
	Total Rated Capacity (Firm)	**10 MGD**

Current piping arrangement allows the Reservoir and South River Pump Stations to run together. However, there is no bypass or pressure regulating valve in the raw water pumping system. Plant staff manually limits flow from the pump stations to prevent damage to pipelines caused by pressure differentials. A raw water blending structure is recommended to improve operational flexibility.

2.2.3 Red River Water Quality

Red River water chemistry is tested daily at the WTP. Table 2-4 includes raw water quality from the Red River and the reservoir. Appendix A contains several graphs showing water quality. The water quality of the Red River and reservoir changes seasonally with higher turbidities typically occurring in the spring.

Table 2-4
Historical Raw Water Quality Data
1998 to 2007

Parameter	Location	Average	Minimum	Maximum	Primary MCL	Secondary MCL
Turbidity, NTU	River	47	4	800	TT	n/a
	Reservoir	13	2	61		
Alkalinity, mg/L as $CaCO_3$	River	108	20	262	n/a	n/a
	Reservoir	107	54	214		
pH	River	7.8	6.3	9.0	n/a	6.5-8.5
	Reservoir	8.0	6.7	9.2		
Hardness, mg/L as $CaCO_3$	River	198	34	528	n/a	n/a
	Reservoir	194	40	376		
Chlorides, mg/L	River	132	28	665	n/a	250
	Reservoir	135	44	318		
Total Dissolved Solids, mg/L	River	365	17	1,061	n/a	500
	Reservoir	372	25	763		

1. n/a = Not Applicable
2. TT = Treatment Technique

2.3 Purchased Water Sources

Bossier City does not purchase water for its use.

2.4 Water Treatment

2.4.1 Water Treatment Methods and Equipment

The water treatment plant is located at 1401 Hamilton Road in Bossier City, Louisiana as shown in Figure 2-1. The WTP is a conventional surface water treatment facility that was originally constructed in 1958 with Plant 1 and two filters; an additional two filters were added in 1972. The plant was again expanded in 1996 to its current 25 mgd capacity. The portion of the WTP constructed in 1996 is identified as Plant 2. A major process change that was implemented during the 1996 expansion was the addition of ozone, which was added for primary disinfection and as a pre-oxidant for taste, odor, and color control. Figure 2-2 shows the existing process schematically.

The WTP's average daily flow during 2005-2007 was about 13 mgd. During the same time period, the minimum day recorded was 6.6 mgd (02/20/2006); the maximum day was roughly 24 mgd (07/18/2006).

The existing 25 mgd water plant consists of the following processes:

- Raw Water Ozone Contactors (two)
- Solids Contact Clarifiers (four)
- Pre-filter Ozone Contactors (two)
- Rapid Gravity Filters (twelve)
- Clearwells (three tanks with a total capacity of 4.7 MG)
- High Service Pump Stations (two)

The existing process units and equipment data is summarized in Table 2-5.

FIGURE 2-2, Existing WTP Schematic

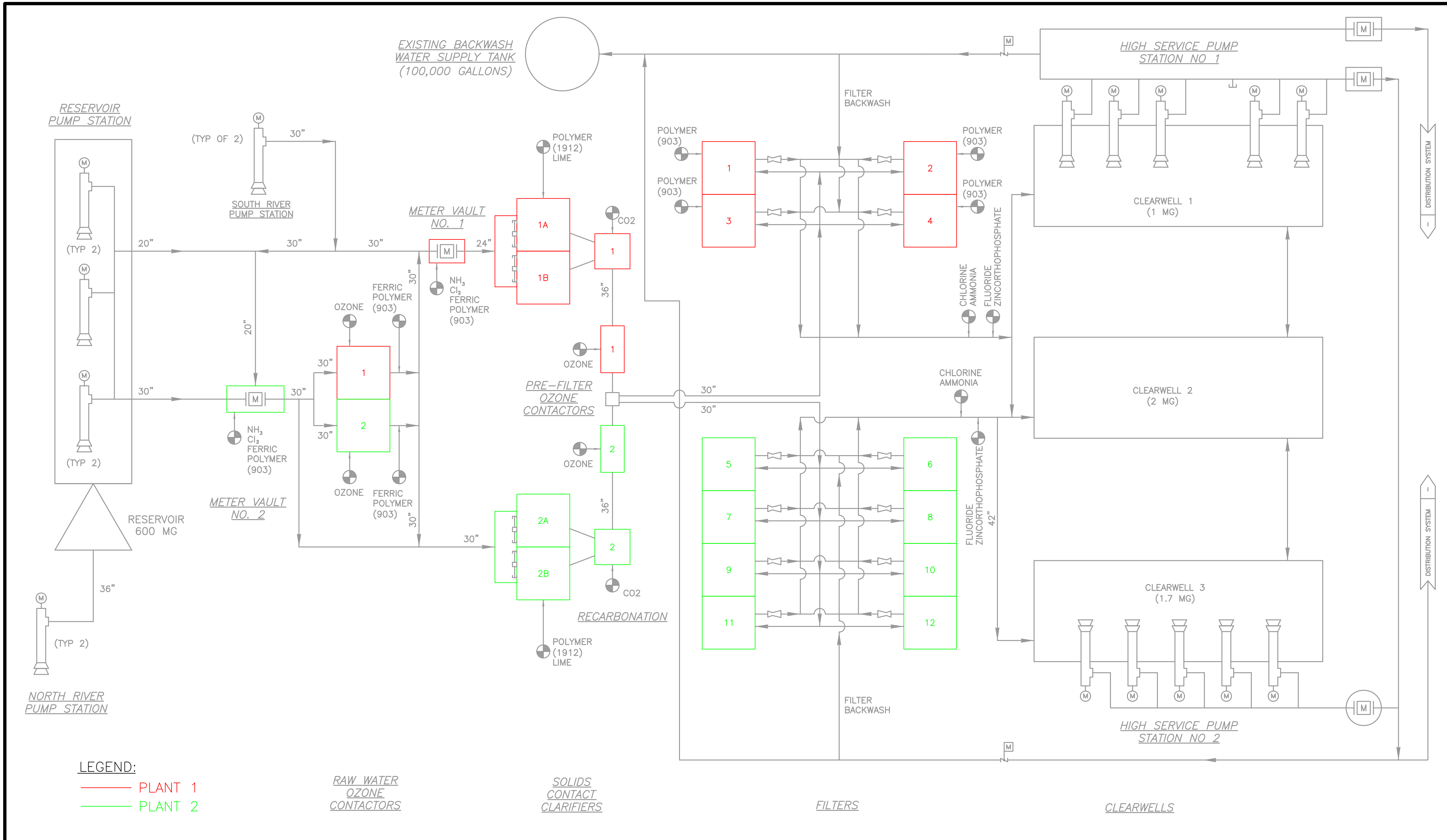

FIGURE 2-2
EXISTING PROCESS SCHEMATIC
BOSSIER CITY WTP

CDM

Table 2-5
Existing WTP Process Units and Equipment Data

Plant Component	Data	
WTP Rated Capacity		
Maximum Daily Treatment Capacity	25 mgd	
Raw Water Ozone Contactors / Primary Disinfection		
Number of units	2	
Size (length x width x side water depth), each	63 ft x 20 ft x 17.5 ft	
Tank Volume, total	330,000 gal	
Baffling Coefficient for Evaluation	0.6	
Applied Ozone Dosage	3 to 5 mg/L typical operating dose	
Solids Contact Clarifiers	Plant 1	Plant 2
Number of units	2	2
Size (length x width x side water depth), each	43 ft x 43 ft x 15.5 ft	56 ft x 56 ft x 16.5 ft
Capacity, each @ 25 mgd	4.7 mgd	7.9 mgd
Detention Time, each @ 25 mgd	66 min	71 min
Upflow rate @ 25 mgd	2.3 gpm/ft2	2.3 gpm/ft2
Recarbonation Boxes		
Number of units	1	1
Size (length x width x side water depth), each	12.5 ft x 12.5 ft x 12.5 ft	10 ft x 4 ft x 3.8 ft
Capacity, each	14,600 gal	1,700 gal
Detention time	2.2 min	0.15 min
Pre-Filter Ozone Contactors		
Number of units	2	2
Size (length x width x side water depth), each	27 ft x 12 ft x 19 ft	33 ft x 12 ft x 19 ft
Tank Volume, total	94,000 gallons	113,000 gallons
Baffling Coefficient for Evaluation	0.6	
Applied Ozone Dosage	1 to 2 mg/L typical operating dose	

Table 2-5 *continued*
Existing WTP Process Units and Equipment Data

Plant Component	Data	
Filters	Plant 1	Plant 2
Number of units	4	8
Type	dual-media	dual-media
Size (length x width), each	25 ft x 28 ft	32 ft x 25 ft
Capacity, each @ 25 mgd	1.9 mgd	2.2 mgd
Surface area	700 ft^2	800 ft^2
Surface loading rate (all filters in operation)	1.9 gpm/ ft^2	1.9 gpm/ ft^2
Surface loading rate (one filter out of service)	2.1 gpm/ ft^2	2.1 gpm/ ft^2
Washwater Supply Tank		
Number of Units	1	
Capacity, total	100,000 gal	
High-Service Pumps		
Number of units / ultimate	5 @ 200 Hp Clearwell No. 1	5 @ 200 Hp Clearwell No. 3
Design capacity	3,000 gpm @ 200 ft 17 mgd firm	3,000 gpm @ 200 ft 17 mgd firm
Type	vertical turbine	vertical turbine
Capacity, total	43 mgd	
Capacity, firm	39 mgd	
Clearwell Storage		
Clearwell 1	1 MG	
Clearwell 2	2 MG	
Clearwell 3	1.7 MG	
Ammonia Storage		
Number of units	1	
Type	steel pressure vessel	
Capacity, each	2,250 gals	

Table 2-5 *continued* Existing WTP Process Units and Equipment Data		
Plant Component	**Data**	
Ammoniators		
Number of units	2	2
Capacity, each	50 lb/day	150 lb/day
Chlorine Storage		
Number of units	11 maximum	
Type	1-ton containers	
Capacity, each	2,000 lbs	
Chlorinators		
Number of units	2	2
Ejector capacity, each	500 lb/day	500 lb/day
Liquid Oxygen (LOX) Storage		
Number of units	1	
Capacity, each	11,000 gallons	
Ozone		
Number of generators	2 (1 more to be installed in 2008)	
Capacity, each	1 @ 600 lbs/day and 1 @ 1,200 lbs/day	
Polymer Storage		
Number of units	1	
Type	bulk tank	
Capacity, total	5,300 gals	
Polymer Feed Pumps		
Number of units	5	
Max Feed Rate	3.7 gph	8.44 gph

Table 2-5 *continued*
Existing WTP Process Units and Equipment Data

Plant Component	Data	
Polymer Aid Storage		
Number of units	10-12	
Type	55 gallon drums	
Capacity, total	550 - 660 gals	
Polymer Aid Feed Pumps		
Number of units	2	
Max Feed Rate	3.7 gph	8.44 gph
Ferric Sulfate Storage		
Type	bulk tank	
Capacity, total	6,000 gals	
Ferric Sulfate Feed Pumps		
Number of units	2	
Max Feed Rate	83 lph	83 lph
Lime Storage		
Number of units	1	
Type	silo	
Capacity, total	72 tons	
Lime Slakers/Feeders		
Number of units	2	2
Type	slurry slakers/ volumetric feeders	slurry slakers/ volumetric feeders
Capacity, each	1,450 lbs/hr	1,450 lbs/hr
Slurry Transfer Pumps		
Number of units	2	2
Type	air diaphragm	air diaphragm

Table 2-5 *continued*
Existing WTP Process Units and Equipment Data

Plant Component	Data	
Fluoride Storage		
Number of units	1	
Type	bulk tank	
Capacity, total	5,500 gals	
Day tank	350 gal	
Fluoride Metering Pumps		
Number of units	2	
Max Feed Rates	2.1 gph	
Zinc Orthophosphate Storage		
Number of units	1	
Type	bulk tank	
Capacity, each	5,600 gal	
Day tank	350 gal	
Zinc Orthophosphate metering pumps		
Number of units	2	
Capacity, each	1.6 gph	1.6 gph
Carbon Dioxide Storage		
Number of units	1	
Type	bulk tank	
Capacity, total	26 tons	
Recarbonation Metering Pumps		
Number of units	2	

2.4.1.1 Influent Flow Metering

As raw water enters the WTP, flow is measured before the Raw Water Ozone Contactor. If the Raw Water Ozone Contactor is bypassed, this flow meter serves to monitor flow to Plant 2. A second flow meter is located on influent line to Plant 1.

Flow splitting is achieved by throttling valves on the downstream end of the raw water ozone contactors. These throttled valves regulate the flows directed to Plant 1 and Plant 2.

Expansion of the plant will mean construction of a new flow splitting structure to properly divide flows between the existing and new treatment facilities. A flow meter will be provided to monitor flow to the new plant; existing flow meters will remain in service.

2.4.1.2 Raw Water Ozone Contactors

Two Raw Water Ozone Contactors were added with the 1996 plant expansion. They were added primarily for taste and odor control, but also provide primary disinfection credit.

The above-grade structure is divided into two basins each equipped with three sections divided by under and over baffles to maximize contact time by minimizing short circuiting. The flow split is dependent on valve positions in the influent and effluent lines of each contactor.

Ozone is applied at three different locations within the ozone contactors with six sets of diffuser grids per contactor, two per section. Each contactor is 63 ft by 20 ft with a 17.5 ft side water depth providing a total volume of 330,000 gallons and a minimum detention time of 19 minutes at the maximum daily design flow of 25 mgd. The ozone dose typically applied is 3-5 mg/L.

Effluent from the Raw Water Ozone Contactors flows by gravity to the Solid Contact Clarifiers of Plant 1 and Plant 2. Coagulants, ferric sulfate (if needed), and primary polymer are added at the effluent of the ozone contactors. Flow combines into a single pipe at the end of the ozone contactors and coagulation chemicals are injected at this point. The bottom floor of the ozone contactor building contains polymer, ferric sulfate, and ammonia feed equipment. Typically, only polymer is injected into the ozone effluent.

The building above the contactors is divided into an operations area and ozone generation area. The operations section includes an entrance area, control room/motor control center, office, and restroom. The ozone area includes the ozone generation and delivery equipment. A discussion of the needs of the ozone system is provided in Section 4.1.8.9.

2.4.1.3 Solids Contact Clarification

Solid Contact Clarifiers (SCCs) are used for flocculation and clarification. Basic operational characteristics of the SCCs are discussed below.

The SCCs have separate flocculation and clarifying zones. In the flocculation zone, the particles are gently mixed to increase the rate of collisions without disrupting the formation of particle aggregates. The smaller discrete particles agglomerate into larger floc particles heavy enough to settle by gravity. Settled floc is large and durable enough to be removed during settling and filtration. In the clarifying zone, the treated water exits the basin as the particle aggregates are allowed to settle. The SCCs typically allow for good suspended solids removal in less space than conventional clarifiers.

Performance of SCCs depends on the:

- Surface loading rate, also known as the surface overflow rate;
- Uniform flow distribution into the settling zone;
- Minimization of flow short circuiting from hydraulic and density currents;
- Uniform withdrawal of clarified water; and
- Sludge withdrawal without disturbing settling efficiency.

The WTP utilizes four contact basins, two basins in Plant 1 and two basins in Plant 2, for clarification and softening. Each basin has tube settlers. Each Plant 1 solids contact clarifier has a maximum capacity of 4.7 mgd. Each Plant 2 SCC has a maximum capacity of 7.9 mgd. Both plant's SCCs have an upflow rate of approximately 2.3 gpm per square foot.

The SCCs are normally operated only to clarify the water. The primary coagulant used at the WTP is polymer with ferric added when necessary. Approximately two weeks per year the hardness of the raw water increases and the facility may add lime in the SCCs for softening and carbon dioxide in the downstream recarbonation boxes for pH adjustment. Historical data shows that softening at the Bossier WTP is performed typically less than two weeks per year.

The concrete contact basins are constructed entirely above ground. Orifices in launders collect the clarified water just below the surface. This product water from each plant's two SCCs is then combined in a common junction chamber where carbon dioxide is added if necessary. The water is then directed to the pre-filter ozone contactors.

Under most circumstances the SCCs units perform well with settled water turbidities below 2 NTU and often below 1 NTU. There are times when the units do not perform satisfactorily: during high hydraulic loading and during low raw water turbidities, those less than 10 NTU. During high flows and low turbidity (e.g., July or August), Bossier's units have difficulty achieving turbidity limits.

Table 2-6 compares Bossier WTP's SCCs to the maximum design criteria for clarifying units stated in the *Recommended Standards for Water Works*, commonly known as the *Ten State Standards*, 2003 edition, and the *Louisiana State Sanitary Code for Water Supplies*. The *Ten State Standards* includes minimum and maximum limits.

Table 2-6
Solids Contact Clarification Performance and Design Criteria

Criteria	Bossier City Current Results	Ten State Standards
Hydraulic Detention Time	1.1 hrs	2-4 hrs (min) [1]
Upflow Rate (at the slurry separation line)	2.3 gpm/ft^2	1.75 gpm/ft ^{2} (softeners) (max) 1.0 gpm/ft ^{2} (clarifiers) (max) 2.0 gpm/ft ^{2} (clarifiers with tube settlers)

1. Ten State Standards does not provide guidance on hydraulic detention time for clarifiers with tube or plate settlers.

At the current plant design flow of 25 mgd, an upflow rate of 2.3 gpm/ft^2 was calculated at the sludge separation line, which is approximately 4 ft below the collection orifices. The 2.3 gpm/ft ^{2} upflow rate of the SCCs is 15 percent higher than the maximum design criteria for clarifiers with tube settlers and may explain the degraded performance during peak-demand conditions.

The combined capacity of the four SCCs at the maximum allowable upflow rate of 2.0 gpm/ft^2 is roughly 22 mgd, which is about the maximum sustainable capacity observed during the 2006 peak production season.

Considering the physical limitation of the clarifiers with respect to upflow and the noticeable degradation in clarifier performance at flows higher than 22 mgd, which were seen during the 2006 peak-demand season, it is suggested that the SCC's total capacity be de-rated from 25 mgd to 20 mgd. Additional plant capacity should be accounted for in the new plant design to make up for this loss in capacity (i.e. the plant expansion necessary will be 25 mgd).

The existing system does not allow transfer of sludge between the SCCs. The tube settler supports need to be replaced due to damage. Some tubes need to be replaced due to damage and brittleness.

2.4.1.4 Recarbonation Boxes

The effluent from all of the Solid Contact Clarifiers flows into Recarbonation Boxes constructed adjacent to the clarifiers. Carbon dioxide is applied to the clarified water only when the WTP is operating in the lime softening mode. Hydraulic retention time in the boxes is 2.2 minutes and 0.15 minutes for Plant 1 and Plant 2, respectively.

The contact time provided is significantly less that the 20 minutes suggested in the *Ten State Standards*. This, however, has not hampered the plant's recarbonation system performance, which is likely due to more efficient recarbonation systems in use today while the standard reflects the efficiencies of older systems. The recarbonation chemical feed system needs to be replaced due to damage and age.

2.4.1.5 Pre-Filter Ozone Contactors

Pre-filter Ozone Contactors were constructed as part of the 1996 expansion. A total of two ozone contactors are installed between Plant 1 and Plant 2 filters. The flow is split between the two plants based on the relative volumes of the ozone contactors. Plant 1 contactors are 27 ft by 12 ft by 19 ft side water depth with an approximate volume of 46,000 gallons each. Plant 2 contactors are 33 feet long and contain approximately 56,000 gallons each.

The contactors are fed through 36-inch pipes from the Solids Contact Clarifiers to opposite sides of the ozone contactors. Flow is from the outside of the building to the inside filter influent gullet. Each unit has four diffuser grids and two over/under baffle walls. Plant 1 and Plant 2 flows are combined in the filter influent gullet, which feeds all filters.

The Pre-Filter Ozone Contactor is used for partial disinfection credit. Ozone residual at the end of the pre-filter contactors is continually measured. The ozone dosage typically applied is 1 to 2 mg/L. The ozone generation system located in the Ozone Building supplies both the raw water and pre-filter ozone contactors.

A discussion on needs of the ozone system is provided in Section 2.4.1.8.9. Modifications to the building ventilation system are needed.

2.4.1.6 Filtration

The following sections discuss the typical design elements of a rapid gravity filtration system. Twelve dual-media filters remove suspended solids from the settled water prior to introduction into the clearwells and then the City's distribution system. The twelve filters at the Bossier WTP were constructed in three stages:

- Filters 1 and 2 were constructed in 1958. In 1996, an air scour system was added and the media was replaced. Some damaged under drain modules were replaced in 1988.
- Filters 3 and 4 were constructed in 1972. In 1996, an air scour system was added and the media was replaced. Some damaged under drain modules were replaced in 1988.
- Filters 5 through 12 were constructed in 1996.

Filters 1 to 4 are 28 ft by 25 ft having a surface area of approximately 700 ft^2 per filter. Filters 5 to 12 are 32 ft by 25 ft and have a surface area of approximately 800 ft^2 per filter. The filters operate at 1.9 gpm/ft^2 when all filters are in operation and 2.1 gpm/ft^2 when one filter is out of service for backwashing. The filtration media consists of 14-1/2 inches of anthracite over 15 inches of sand overlaying 15 inches of support gravel. Two types of filter underdrain systems are used. Fre-Flow underdrain system is used in Filters 1-4. The Leopold Universal underdrain system was installed on Filters 5-12. The units are constructed entirely above grade in a concrete structure.

All filters have a constant rate flow control scheme during the filter run. The level in the filter is maintained at a set point. Flow through the filters is divided evenly between all in-service filters. Outlet rate-of-flow controllers adjust the flow from individual filters to account for increasing headloss across the filter and to keep the water level over the filters at the set point.

All filter inlet and outlet piping is contained in a common pipe gallery. Filtered water is collected in the underdrain system and conveyed through filtered water conduits under the pipe gallery floor and then into the clearwells.

The inlet and outlet water to and from the filters is sampled. Grab samples are taken from the filter inlet pipes, and continuous samples are taken from the filtered water outlet pipes at each filter. Review of water quality data showed that the dual-media filters have demonstrated an ability to provide filtered water turbidity consistently lower than 0.1 NTU, which is well below the current standard of 0.3 NTU.

Filter backwashing is manually controlled. Each of the filters is equipped with air scour and water backwash system and is backwashed using various combinations of air and water. Filters 5 through 12 were constructed with air scour piping, and Filters 1 through 4 were retrofitted with air scour piping as part of the 1996 expansion.

One elevated 100,000 gallon washwater storage tank supplies the washwater for filter backwashing. Water from the high service pump stations is used to fill the elevated washwater supply tank. Control valves, which are located near each high service station, are opened by the plant control system to fill the elevated tank after a backwash. Since the washwater volume in the elevated tank is limited, the distribution system augments the supply. Spent backwash water is collected in backwash lines and discharged to the Red River.

Ten State Standards requires air flow to be 3-5 SCFM/ ft^2 and variable backwash rate not to exceed 8 gpm/ft^2 for approximately 15 minutes. Current backwash operation includes 3 minutes of air followed by about 20 minutes of water. Existing Filters 1 through 4 have a surface area of 700 ft^2 and Filters 5 through 12 have a surface area of 800 ft^2. A Using 8 gpm/ft and their current backwash time of 20 minutes, approximately 128,000 gallons is required for each filter backwash.

Photo 3: Filter 4

The current backwash storage tank volume is 100,000 gallons. Providing only 15 minutes of backwash water at 8 gpm/ft^2 for the larger filters. When the water in the elevated tank is depleted, a valve is opened to continue to backwash with water from the high service system. Water is pumped from the clearwells by the high service pumps directly to the filters. This method of operation allows higher pressure during the later minutes of backwashing. No modifications to the existing backwash system are recommended.

Due to age of the Filters 1-4, replacement of the under drains, air scour system, media, and troughs is needed.

2.4.1.7 High Service Pumping

Two High Service Pump Stations pump finished water from the Clearwells to the distribution system. Each station includes five 200 hp vertical turbine constant-speed pumps which supply finished water to the distribution system and storage tanks. The vertical turbine pumps are mounted on the roofs of Clearwell 1 and 3. Each pump is rated at 3,000 gpm at 200 feet of head. Since all pumps are located in the same vicinity and pump to a common header before going into the distribution system, high service pumping capacity is evaluated together. The firm capacity of high service pumping is 39 mgd, assuming one pump is out of service.

Regarding pumping capacity, the *Ten State Standards* design guidance states that a pumping facility must:

- Have at least two pumps.
- Be capable of providing the maximum day demand with any pump out of service.
- Have capacity to supply the peak demand without dangerous overloading.

Currently, the pumping capacity fulfills the above three criteria with the peak capacity of 39 mgd. During average flow conditions, two or three high service pumps operate to maintain pressure in the distribution system. Pressure in the distribution system also is maintained through the use of four elevated water storage tanks that are discussed in Section 2.5. Typically, the high service pumps start filling the tanks during mid-morning when water demand decreases and again in mid-afternoon. Due to demand through the early evening, the tanks are completely filled overnight.

Photo 4: High Service Pump Station No. 1

There are three existing clearwells with a total storage capacity of 4.7 MG. Clearwell 1 has a capacity of 1 MG and was constructed in 1958. A crack in the ceiling was repaired in 2006. Clearwell 2 has a capacity of 2 MG and was constructed in 1972. Clearwell 2 was inspected in 2005 and no problems were discovered. Clearwell 3 has a capacity of 1.7 MG and was installed in 1996.

Clearwell 3 is the only baffled tank. There are three concrete baffle walls which prevent short circuiting of flow.

After a heavy rain, the administration building at the WTP occasionally experiences higher turbidity water than normal. An inspection of the clearwells will determine if this is caused by infiltration of groundwater.

2.4.1.8 Chemical Storage and Feed Systems

Ten chemicals are used at the plant in the production of potable water. Each is discussed below with respect to storage and feed capacity.

Table 2-7
Historical Chemical Use (2005-2007)

Chemical	Average (mg/L)	Maximum (mg/L)
Primary Polymer (903) [1]	6.67	15.98
Secondary Polymer (1912)	1.01	3.76
Ferric Sulfate	14.09	26.63
Ammonia	1.15	2.41
Chlorine	4.85	11.35
Lime [2]	-	-
Fluoride	0.63	0.93
Zinc Orthophosphate	2.92	5.23
Carbon Dioxide [2]	-	-

1. Historical data for polymer use at the filters is not available and not included above. Based on conversations with plant operators, when polymer is used at the filters, the dosage goal is 8 mg/L.
2. Historical use data is not available.

2.4.1.8.1 Primary Polymer (903)

The primary coagulant used by Bossier the majority of the year is polymer. Polymer is stored as a liquid in a 5,300 gallon tank. Typically, polymer is fed at the outlet of the raw water ozone contactor. If bypassing the ozone contactors, polymer can be fed directly into the raw water at the influent meter vaults.

Photo 5: Polymer Feed System at Ozone Building

The polymer feed equipment in the Ozone Building was installed in 1996. Control of the feed pump is through a local control panel (LCP), however the LCP cannot adjust the pump stroke.

During high turbidity periods, polymer also is fed at the filters. The dosing rate varies between 1 mg/L and 8 mg/L. At Filters 1-4, polymer is applied on the top of the filters. Polymer is injected into the influent header pipe of Filters 5-12. The polymer feed equipment to Filters 1-4 is installed in the filter gallery. The polymer feed equipment to Filters 5-12 is located in the pipe gallery. Neither system is connected to SCADA nor have local control panels.

2.4.1.8.2 Secondary Polymer (1912)

A second polymer is used at the Solid Contact Clarifiers to assist with coagulation. This polymer is stored in 50 gallon drums and dosed into the centerwell of each Solid Contact Clarifier. The typical dosage is 1 to 4 mg/L. The equipment was installed in 2000 and is not connected to the plant SCADA system nor does it have local control panels. Polymer 1912 is fed seasonally to improve clarifier performance. When used, dosing information is recorded by plant operators daily.

2.4.1.8.3 Ferric Sulfate

Ferric sulfate (ferric) is occasionally used as a coagulant. It is stored as a liquid in a 6,000 gallon tank onsite; however, because of the infrequency of use, ferric is often metered from tote containers. Ferric is typically used during low turbidity periods when the polymer aid is less effective.

The ferric feed equipment is located in the Ozone Building and was installed in 1996. Due to age of system, the feed equipment needs to be replaced.

2.4.1.8.4 Ammonia

Photo 6: Ammonia Storage Tank

Ammonia is used for production of chloramine, which is used as the residual disinfectant in the distribution system. It is stored as a liquid in a 2,250 gallon bulk storage tank. Gas is withdrawn from the pressurized tank and is metered using four ammoniators, two per plant. Gas rotameters are then used to measure gas flow to proportionally feed the application points at the outlet lines of the contact basins. Maximum feed rates for each plant are 100 lbs/day. The WTP typically feeds ammonia at a concentration between 1.5 mg/L and 2.5 mg/L. The ammonia storage tank is located outside. During weather changes, the pressure regulating valve must be adjusted in order to get adequate ammonia from the tank.

A vault around each of the filtered effluent lines contains dosing points for ammonia, chlorine, fluoride, and zinc orthophosphate. Access to the vault requires plant staff to be trained in confined space entry and use personal safety devices. The ammonia feed lines clog several times per year and require plant staff to enter the chemical feed vault to make repairs. An alternate dosing location that does not require confined space entry is needed. The feed equipment was replaced in 2006. However, rust on the equipment enclosures is present and there is a distinct ammonia smell in the room indicating possible minor leaks. The feed equipment and storage tank should be evaluated for replacement. Modifications to ammonia room in the ozone building should be made to prevent equipment from sweating. For security reasons, switching to liquid ammonium sulfate may be considered during design.

2.4.1.8.5 Chlorine

The available chlorine storage is currently 11 1-ton containers or 22,000 pounds. The storage area is located on a rack outside the administration building and adjacent to Plant 1 clarifiers. From the rack, two containers are manifolded together and the chlorine is fed as a gas to the chlorinators located on the ground floor of the treatment plant. Operating under vacuum, the chlorinators meter chlorine gas to a series of injectors. The injectors induce the vacuum and also mix chlorine gas with water to form a chlorine solution. Rotameters are used downstream of the injectors to proportionately feed the solution to the application points.

Photo 7: Chlorine Feed Equipment

The WTP feeds chlorine at a concentration between 5 to 11 mg/L after the filters. Due to the size of the distribution system, a residual of 3.5 mg/L is maintained in the clearwell.

The chlorine feed equipment was installed in 1996. The available chlorine storage is insufficient for the future maximum month condition. New chlorine storage and feed equipment in a single location will be utilized to meet the demands of the expanded plant.

2.4.1.8.6 Lime

Calcium oxide, or quicklime, is delivered in dry form by bulk trucks and off loaded pneumatically to a 72 ton silo. A transfer blower at the bottom of the silo conveys lime from the bulk silo located in the yard to smaller day bins located in the chemical feed room. From the day bins, quicklime is proportionally fed into slakers using dry chemical feeders. The slakers convert the calcium oxide to calcium hydroxide through a chemical reaction initiated by the addition of water. The lime is then pumped with diaphragm pumps to the SCCs for pH adjustment and softening.

As stated previously, at most lime is used only a few weeks of the year. However, it is one of the most labor intensive processes at the Bossier WTP. While lime itself is relatively inexpensive, it is difficult to handle and calcium carbonate accumulation on the equipment and piping can cause feed problems. The lime system, including storage, slaking and delivery, needs to be replaced. Also, based on how little the lime is placed in service, use of calcium hydroxide may be considered during design so that the plant does not have to slake lime.

2.4.1.8.7 Fluoride

The Bossier WTP adds liquid fluoride or hydrofluosilicic acid to the filtered water at an average dose of 0.6 mg/L. The existing tank capacity is 5,500 gallons.

The fluoride feed equipment was installed in 1996 and rehabilitated in 2006. There are currently a few problems with the flow meter, but otherwise the system works well. Additional feed equipment is needed for the plant expansion. As discussed under Section 2.4.1.8.4, the fluoride dosing point is located in the chemical vault and needs to be changed to prevent confined space entry by plant personnel.

2.4.1.8.8 Zinc Orthophosphate

Zinc orthophosphate is used as a sequestering agent to prevent corrosion of piping in the distribution system. At the Bossier WTP, zinc orthophosphate is stored as a liquid in a 5,600 gallon tank north of the filter building. The storage tank fills a 350 gallon day tank. The zinc orthophosphate is fed as a liquid with chemical metering pumps.

The existing feed equipment was installed in 2006 and is in good condition. Additional metering pumps will be required for feeding chemical at the new plant.

Photo 8: Zinc Orthophosphate Feed Equipment

2.4.1.8.9 Ozone

The Bossier City WTP utilizes ozone for primary disinfection. However, the ozonation process also provides secondary benefits including control of taste and odor and enhancement of the sedimentation process. The existing ozonation system includes the following major process equipment:

- Liquid Oxygen Storage (LOX) — one, 11,000 gallon vertical tank
- LOX Vaporization — one, 11,000 scfh ambient vaporizer
- Ozone Generation — one 800 ppd (8%) Generator No. 1 and one 1,500 ppd (10%) Generator No. 4
- Ozone Off-Gas Destruction — four 200 scfm thermal catalytic destruct units

Ozone is applied to the raw water as it enters the WTP and also to the settled water upstream of the filters. A total of six contact basins exist for ozone diffusion – two raw water contact basins and four pre-filter contact basins. Ozone is diffused via three diffuser grids within each of the raw water contactors and two diffuser grids within each of the pre-filter contactors. Each diffuser grid is composed of multiple ceramic disc diffusers.

As originally installed, the oxygen feed gas was supplied to the ozone generators by a vacuum pressure swing absorption (VPSA) oxygen generation system. Additionally, a liquid oxygen (LOX) storage and vaporization system was installed as a supplemental and redundant system in case of VPSA failure. In 2006, the VPSA system experienced a significant mechanical failure that would have required a substantial capital expenditure for repair. At that time, the decision was made to maintain operations using the supplemental LOX system and to decommission the VPSA system. The existing LOX system was originally designed as a short-term solution in the event of VPSA failure. As noted above, the system only consists of a single storage tank and vaporizer, and thus, requires expansion to ensure the ozone process will not be interrupted due to loss of oxygen supply.

The ozone generation process requires application of significant electrical power, which results in generation of excess heat that must be dissipated. Cooling for the existing generators and power supply units (PSUs) is accomplished using a 100-ton chilled water system. This system was designed as a stand-alone system with sufficient capacity for the original plant. This system provides sufficient capacity for the existing on-line generator and PSU combination, however, as stated above, there is no stand-by capacity. Consequently, if the chilled water system or a portion thereof would require maintenance, the supply of chilled water to the ozone generator and PSU would limit production capacity.

Performance and condition of the existing ozone diffusion systems are unknown. The Bossier WTP is the only drinking water source for Bossier City, and the inability to take ozone contact basins off-line for inspection without a significant interruption of treatment has limited diffusion system maintenance opportunities. This has likely resulted in a reduction of ozone transfer efficiency, and also, potentially increased the required ozone dose. Consequently, it is likely that repair or replacement of the ozone diffusion systems is needed. Upon examination and evaluation of the existing diffusion systems, it is likely that an alternative ozone application option, such as side-stream injection may be implemented.

The existing ozonation system was installed with gasket materials suitable for the original design condition of 8% maximum ozone in oxygen concentration. Even with operation at or below the design concentration, the oxidation capacity of the ozone gas has affected these materials. Additionally, with installation of newer generation equipment, the ozonation system will be operated at higher concentrations (8% to 12%) for which these materials are not suitable. Ozone system operation is currently limited due to the existing gasket materials; therefore, replacement of these sealing elements will be required.

The existing ozonation system instruments were installed in 1996. The combination of exposure to an ozone environment and evolution of technology requires that the existing instruments be evaluated and replaced as needed to ensure accurate process control and overall system safety.

2.4.1.8.10 Recarbonation

Carbon dioxide is used for recarbonation when the plant is lime softening. The recarbonation system was rehabilitated in 1996. A single 26-ton bulk tank is available for carbon dioxide storage. Two feed pumps are located in the chemical room next to the filter gallery. The recarbonation feed equipment needs to be replaced. It has not been operated since 2000.

2.4.1.9 Disinfection

The existing disinfection process for the Bossier WTP uses ozone as the primary disinfectant. Ozone is generated on-site and is applied at two locations in the process stream:

- Raw water ozone contactor
- Pre-filter ozone contactor

Ozone applied in the raw water contactor provides taste and odor control in addition to meeting a portion of the primary disinfection requirements. Currently, the ozone residual used to calculate the CT is measured at the effluent of the raw water contactor.

Ozone applied in the pre-filter contactor provides additional disinfection. There are two pre-filter contactors; one for Plant 1 and one for Plant 2. Currently, the ozone residual used to calculate the CT is measured at the effluent of the pre-filter contactor.

The current ozone disinfection process enables the Bossier WTP to comply with both the disinfection requirements and disinfection by-product limitations.

Chlorine and ammonia are applied to the filtered water to form chloramines as the secondary disinfectant. Chlorine and ammonia are fed in the filter water piping between the filters and the clearwells.

2.4.1.10 Process Waste Streams

Residuals generated at the Bossier WTP can be separated into distinct waste streams: waste backwash water, clarifier sludge blowdown or lime residuals blowdown, and process drainage. The 1996 upgrade was designed for the waste backwash water to flow to a gravity thickener. The underflow from the thickener was to be pumped to belt presses with the dewatered cake to be hauled off site and disposed. However, in 2006, the city received a permit to discharge all waste streams to the Red River. Therefore, the discharge to the Red River is used because it is more economical.

2.4.2 Electrical

The electrical service provider for the plant is Southwestern Electric Power Company (AEP). Four separate electrical services are installed:

- High Service Pump Station 1 is fed from AEP overhead line via an underground radial feed and a 2,000 kVA pad mounted transformer. Standby power is provided by a 1,130 kW diesel generator. This pump station is billed under AEP's Municipal Pumping Service (MPS) rate schedule.

- The ozone facility is served from the same overhead line as the High Service Pump Station 1, via an underground radial feed and a 1,500 kVA pad mounted transformer. Standby power is provided by a diesel generator. This service is billed under the Lighting and Power Service (LP) rate schedule.

- The filter building is fed from the same overhead line as the High Service Pump Station #1, via an underground radial feed and a 1,000 kVA pad mounted transformer. The transformer is a loop feed, with the primary line continuing to Pump Station #2. This service is billed under the LP rate schedule.

- High Service Pump Station 2 is fed via the underground continuation of the circuit that feeds the filter building transformer, and a 1,500 kVA pad mounted transformer. This service is billed under the MPS rate schedule.

The electric use at each service covering the period from May 2006 through April 2007 is summarized in Table 2-8.

Due to the current billing structure, combining or otherwise reworking the electrical services would provide no benefit to the city. The electrical equipment at the high service pump stations and at the filter building is all operating properly and there are no deficiencies at these locations. The electric service entrance at the ozone building should be upgraded. The present automatic transfer switch is not rated for service entrance duty, and should not be used as such. The switchboard in the electrical room has been field modified in such a way that the UL listing no longer applies and the clearances inside that room are inadequate.

Table 2-8
Electrical Use by Service Connection
May 2006 – April 2007

Location	Rate Schedule	Maximum Electric Demand (kW)	Maximum Electric Usage (kWH)	Average Electric Billing Demand (kW)	Average Electric Usage (kW)
HSPS 1	MPS	741	200,100	455	148,458
Filter Building	LP	251	75,680	195	67,920
Ozone Facility	LP	435	238,500	382	142,850
HSPS 2	MPS	776	236,400	492	164,583

2.4.3 Instrumentation

The Programmable Logic Controllers (PLCs) at the ozone facility include a combination of Allen-Bradley PLC-5 and SLC 5/04. The rest of the plant includes a combination of Bristol Babcock Control Wave, Bristol 3330 and RTU 3305 hardware components. Figure 2-3 and Figure 2-4 depict the existing plant and ozone facility system architectures. As noted, the overall system consists of both proprietary and off the shelf PLC components communicating to Wonderware's Intouch based Human Machine Interface servers.

Off the shelf PLCs, such as the Allen-Bradley components currently in place can typically be programmed by several vendors which allows for enhanced price competition among firms providing integration and support services since the city is not limited to using a single vendor for proprietary software solutions. On the other hand, proprietary systems, such as Bristol, are typically sole sourced and can be difficult to find local support services. Although both types of systems have proven to be reliable for the plant, there are several advantages to maintaining a common platform. These include ease of maintenance and integration, reduced training for support staff, and minimized spare parts.

The SCADA system consists of an Ethernet based network and is comprised of both wired and wireless components. Within the Ozone facility, wired serial technology based on Allen-Bradley's Data Highway Plus protocol is in place. Communication between the Ozone facility and the existing water treatment plant utilizes wired Ethernet technology. Within the water treatment plant, Motorola Canopy wireless Ethernet radios are in place to transfer data from the various remote sites to the Wonderware SCADA servers. Although these Ethernet radios are highly reliable, they provide for a smaller data transfer rate that would otherwise be possible through a fiber or hard-wired Ethernet solution. Additionally, communications from the main control tower to all the remote sites is accomplished through the Canopy radio system. The one exception to this is the data transfer from the reservoir to the main control tower. For this radio path, there exists line of sight limitations between the main control tower and the reservoir; therefore, the data from the reservoir is routed to the Benton Road tank. The main control tower then reads the reservoir data via the Benton Road tank.

Bossier City has addressed their concerns for remote access to their SCADA system for possible support and updates. The city currently allows remote access through a dial-up modem. To eliminate unauthorized access, plant staff has opted to disconnect the phone line when not in use. Other options are available and can be evaluated during the detailed design that will allow the plant to grant remote users a higher speed access to the SCADA system automatically without relying on plant staff to connect the phone line. Enhanced security measures can be put in place to protect the integrity of the connection. A comparison of these options is provided in Section 5.

Figure 2-3
Existing Plant System Architecture

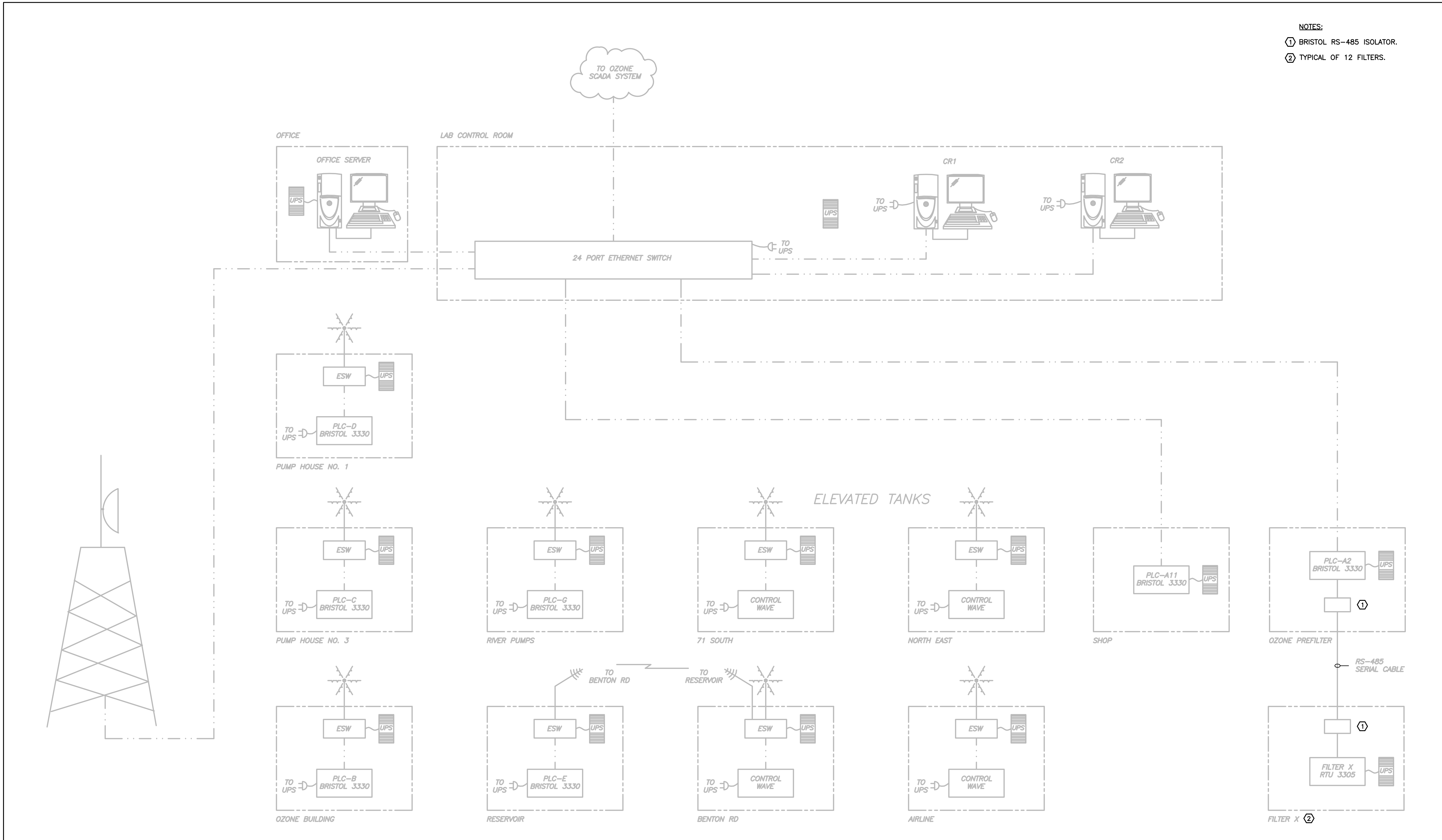

Figure 2-3
Existing Plant System Architecture

Figure 2-4

Existing Ozone Control System Architecture

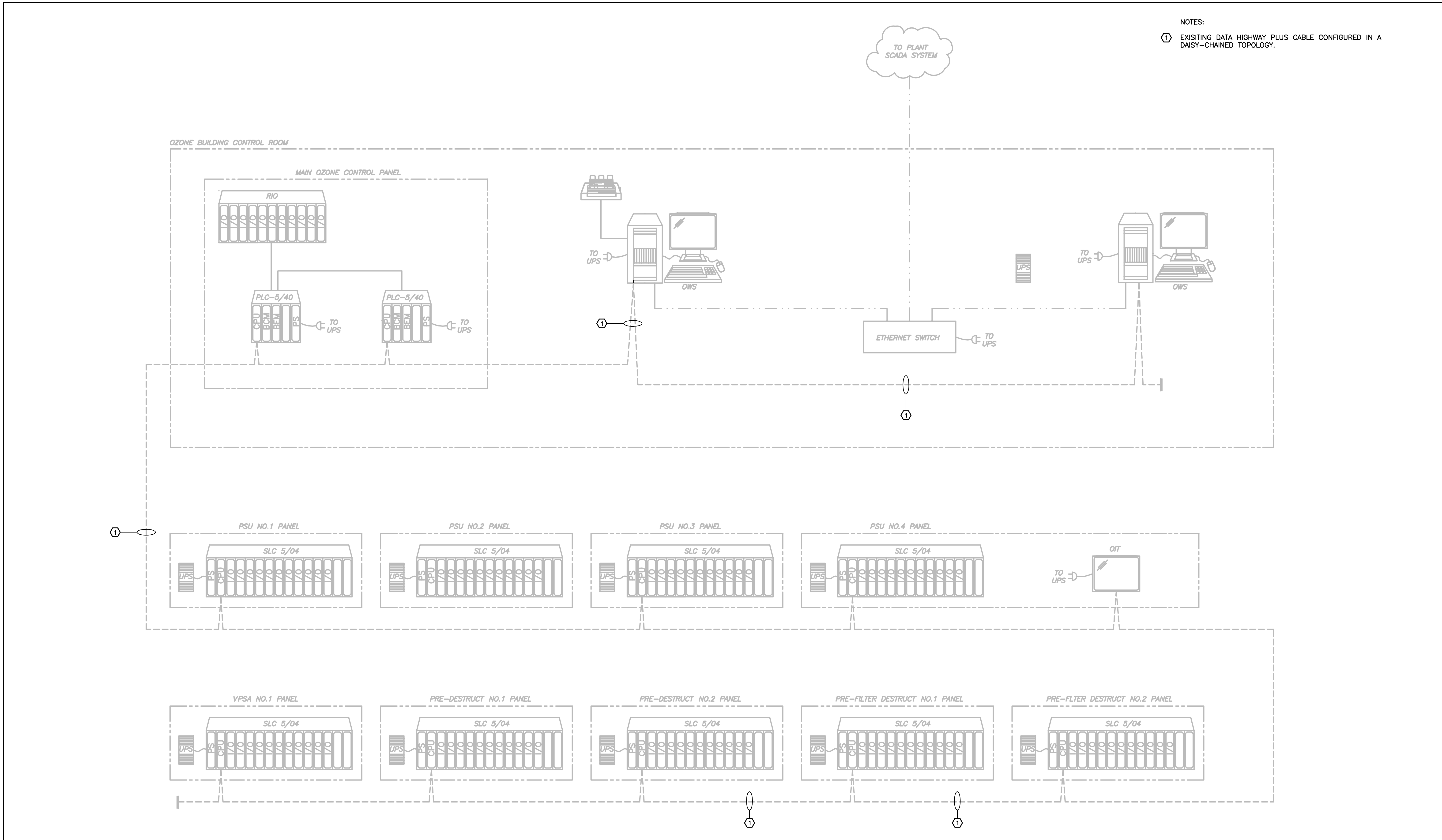

Figure 2-4
Existing Ozone Control System Architecture

Filter backwashing at Bossier City is currently being accomplished manually from a control console at each filter. Plant personnel expressed interest in providing automatic filter backwashing after manual operator initiation. There are several options that are available for providing a local filter control console that provides automatic backwashing with operator initiation. A comparison of these options is provided in Section 5.

2.4.4 Historical Finished Water Quality Data

Table 2-9 includes finished water quality from the Plant clearwell for the period 1998 to 2007. Table 2-10 contains disinfection by-product levels for the years 2002 through 2005. The latest analytical data is included in Appendix A.

Table 2-9
Historical Finished Water Quality Data
1998 to 2007

Parameter	Location	Average	Minimum	Maximum	Primary DWS	Secondary DWS
Turbidity, NTU	Clearwell	0.16	0.05	0.49	n/a	n/a
Alkalinity, mg/L as $CaCO_3$	Clearwell	92	13	198	n/a	n/a
pH	Clearwell	7.4	4.4	10.5	n/a	6.5-8.5
Hardness, mg/L as $CaCO_3$	Clearwell	187	33	340	n/a	n/a
Chlorides, mg/L	Clearwell	137	25	321	n/a	250 mg/L
Total Dissolved Solids, mg/L	Clearwell	376	154	778	n/a	500 mg/L

Another disinfectant by-product that is measured at the Bossier WTP is bromate. Bromate is formed when ozone is in contact with chlorides in the raw water. The EPA limit for bromate is 0.010 mg/L. Data for the years 2002 through 2005 indicate that bromate has been at or below the laboratory equipment detection limit of 0.05 mg/L. It is not expected that bromate will be an issue in the future.

Table 2-10
Total Trihalomethanes and Haloaccetic Acids, mg/L
2002 to 2007

	POE [1]		2007 Wakefield		3009 Donald		North Willow	
Date	**TTHM**	**HAA5**	**TTHM**	**HAA5**	**TTHM**	**HAA5**	**TTHM**	**HAA5**
03/25/02	0.0090	0.0210	0.0090	0.0190	0.0090	0.0200	0.0900	0.0220
06/03/02	0.0090	0.0150	0.0080	0.0210	0.0100	0.0180	0.0110	0.0170
09/08/02	0.0180	0.0080	0.0180	0.0130	0.0190	0.0050	0.0230	0.0110
02/24/03	0.0160	0.0120	0.0180	0.0130	0.0140	0.0270	0.0150	0.0250
06/03/03	0.0190	0.0120	0.0180	0.0160	0.0180	0.0100	0.0190	0.0100
08/25/03	0.0150	0.0080	0.0210	0.0070	0.0180	0.0100	0.0200	0.0070
10/06/03	0.0100	0.0170	0.0190	0.0170	0.0200	0.0210	0.0190	0.0010
02/02/04	0.0080	0.0100	0.0090	0.0100	0.0080	0.0110	0.0110	0.0100
05/24/04	0.0130	0.0115	0.0130	0.0096	0.0160	0.0125	0.0130	0.0425
09/27/04	0.0130	0.0090	0.0130	0.0100	0.0160	0.0010	0.0200	0.0100
10/18/04	0.0110	0.0100	0.0170	0.0110	0.0170	0.0070	0.0190	0.0120

Table 2-10, continued
Total Trihalomethanes and Haloaccetic Acids, mg/L
2002 to 2007

	POE [1]		2007 Wakefield		3009 Donald		North Willow	
Date	**TTHM**	**HAA5**	**TTHM**	**HAA5**	**TTHM**	**HAA5**	**TTHM**	**HAA5**
02/14/05	0.0030	0.0270	0.0080	0.0090	0.0080	0.0160	0.0060	0.0130
04/25/05	0.0060	0.0070	0.0100	0.0080	0.0100	0.0090	0.0120	0.0090
09/15/05	0.0120	0.0069	0.0140	0.0080	0.0180	0.0052	0.0180	0.0080
11/23/05	0.0098	0.0058	0.0110	0.0000	0.0120	0.0000	0.0130	0.0050
02/24/06	0.0080	0.0050	0.0080	0.0000	0.0099	0.0060	0.0087	0.0060
05/18/06	0.0070	0.0000	0.0097	0.0062	0.0110	0.0000	0.0130	0.0061
08/17/06	0.0270	0.0090	0.0220	0.0077	0.0220	0.0076	0.0230	0.0074
11/16/06	0.0078	0.0072	0.0100	0.0058	0.0120	0.0059	0.0130	0.0066
01/18/07	0.0038	0.0060	0.0033	0.0051	0.0048	0.0000	0.0064	0.0050
05/17/07	0.0050	0.0080	0.0080	0.0050	0.0070	0.0050	0.0090	0.0060
08/16/07	0.0056	0.0054	0.0060	0.0000	0.0080	0.0000	0.0090	0.0000
11/15/07	0.0046	0.0000	0.0048	0.0000	0.0054	0.0000	0.0061	0.0000
Average	0.0105	0.0096	0.0121	0.0088	0.0127	0.0086	0.0173	0.0104
Maximum	**0.0270**	**0.0270**	**0.0220**	**0.0210**	**0.0220**	**0.0270**	**0.0900**	**0.0425**
Minimum	0.0030	0.0000	0.0033	0.0000	0.0048	0.0000	0.0060	0.0000

1. POE = Point of entry to the distribution system

2.5 Storage Tanks

The City has four elevated water storage tanks connected to the pipe network.

- Airline Drive Tank – a 1.5 million gallon composite elevated tank located at 1200 Airline Drive which operates on-line with altitude valve shutoff. Its minimum water level is 297.93ft.; maximum, 332.93ft. It is located approximately 3.3 miles from the WTP. The tank was constructed in 1958. The inside of the tank was rehabilitated in 2002; the outside was rehabilitated in 1995. No improvements at the Airline Drive Tank are needed.

- North East Tank – a 2.0 million gallon composite elevated tank located at 5800 Shed Road which operates on-line with altitude valve shutoff. Its minimum water level is 292.93ft.; maximum, 332.93ft. It is located approximately 7.1 miles from the WTP. The North East Tank was constructed in 1978 and rehabilitated in 2002. No improvements are needed at this tank.

- Golden Meadows Tank – a 2.0 million gallon composite elevated tank located at 5298 Barksdale Boulevard which operates on-line with altitude valve shutoff. Its minimum water level is 292.93ft.; maximum, 332.93ft. It is located approximately 7.6 miles from the WTP. This tank was constructed in 1978 and rehabilitated in 2001. No improvements at the Golden Meadows Tank are needed.

- North Tank (or Benton Road Tank) – a 2.0 million gallon composite elevated tank located at 110 Cash Point Road which operates on-line with altitude valve shutoff. This tank was constructed in 2006. Its minimum water level is 194.00ft.; maximum, 332.93ft. It is located approximately 6.1 miles from the WTP. A chloramination station needs to be added to boost chlorine residuals in the line service customers including the Town of Benton.

The constant monitoring of tank levels, system pressures, and pump operation is a responsibility of the water treatment plant operator.

2.6 Distribution System

2.6.1 Service Area

The City of Bossier City owns and operates a distribution system for over 20,648 metered services (customers) and provides bulk delivery of water to two outlying private systems, City of Benton and Cypress Black Bayou Water System. The coverage to the direct customers is basically limited to the city limits, although there are some directly metered customers outside the city limits who are served because of their proximity to existing mains. City of Benton and Cypress Bayou Water System, both of whom receive delivery at one location, operate the private systems.

2.6.2 Distribution Network

The delivery of water to customers is accomplished through a piping network that dates back to the 1950s. This network has expanded as growth dictated and as treatment of water allowed. The sole source of water to the system has been located in the west part of town for approximately 50 years. The plant site lies just north of Texas Avenue (or US Hwy 71) along the Red River. Two primary mains lead from the high service pumps at the plant and travel north and south to feed the distribution system. These mains are 30-inch in size. The distribution lines extend to all areas of the city and form an interconnected grid. The system is not zoned; natural elevations within the city vary by only 10 feet from high to low. Operating pressures vary from a high of about 100 psi at the WTP to a low of 70 psi at the most remote delivery point during high demand conditions. The distribution system provides fire protection for the City of Bossier City and has been graded continuously since 2000 as a Class 1 system. It has been rated adequate in fire flow capacity, pressure, accessibility, operation, and reserve storage. The total length of mains broken out by size is as shown in Table 2-11.

Table 2-11
Quantities of Existing Transmission and Distribution Lines

Line Size (in)	Approximate Length (ft)
30	10,663
20	138,214
18	3,757
16	77,124
14	2,733
12	204,093
10	82,640
8	655,818
6	449,845
4	49,032
3	7,839
Less than 3 inches	38,965
Unknown Diameter	29,991
Total	**1,750,714 (or 332 miles)**

2.6.3 Leaks

There are no known leaks in the distribution system. As leaks are found, repairs are made quickly.

2.7 Pumping Stations

Bossier City does not have pumping stations in the distribution system. The high service pumps are located at the WTP and are covered under Section 2.4.

2.8 Personnel

The day to day operation of the City of Bossier City Water System falls under the Department of Public Utilities; the department head reports directly to the Mayor. Under the Public Utilities Director, the water system operation is broken into two divisions, Water Treatment and Water Distribution. Figure 2-5 illustrates the organization.

The Water Treatment Division, headed by its superintendent, is responsible for operation and maintenance of the water supply facilities, raw water transmission, water treatment, finished water storage and pumping, and water quality monitoring and reporting. The superintendent is responsible for assuring that plant operators are properly trained and possess the necessary certifications for the type water treatment plant functions carried out by the city. Many of the operators and maintenance staff have a long history of working for the city and exhibit a thorough knowledge of the existing facilities and treatment functions. The current staffing totals 16 full time employees and 0 part time employees. Because of the 24 hour per day operation, a minimum of three certified Class IV operators are required to meet the requirements; there are currently 12 on staff.

Figure 2-5 Bossier City Water Department Org. Chart

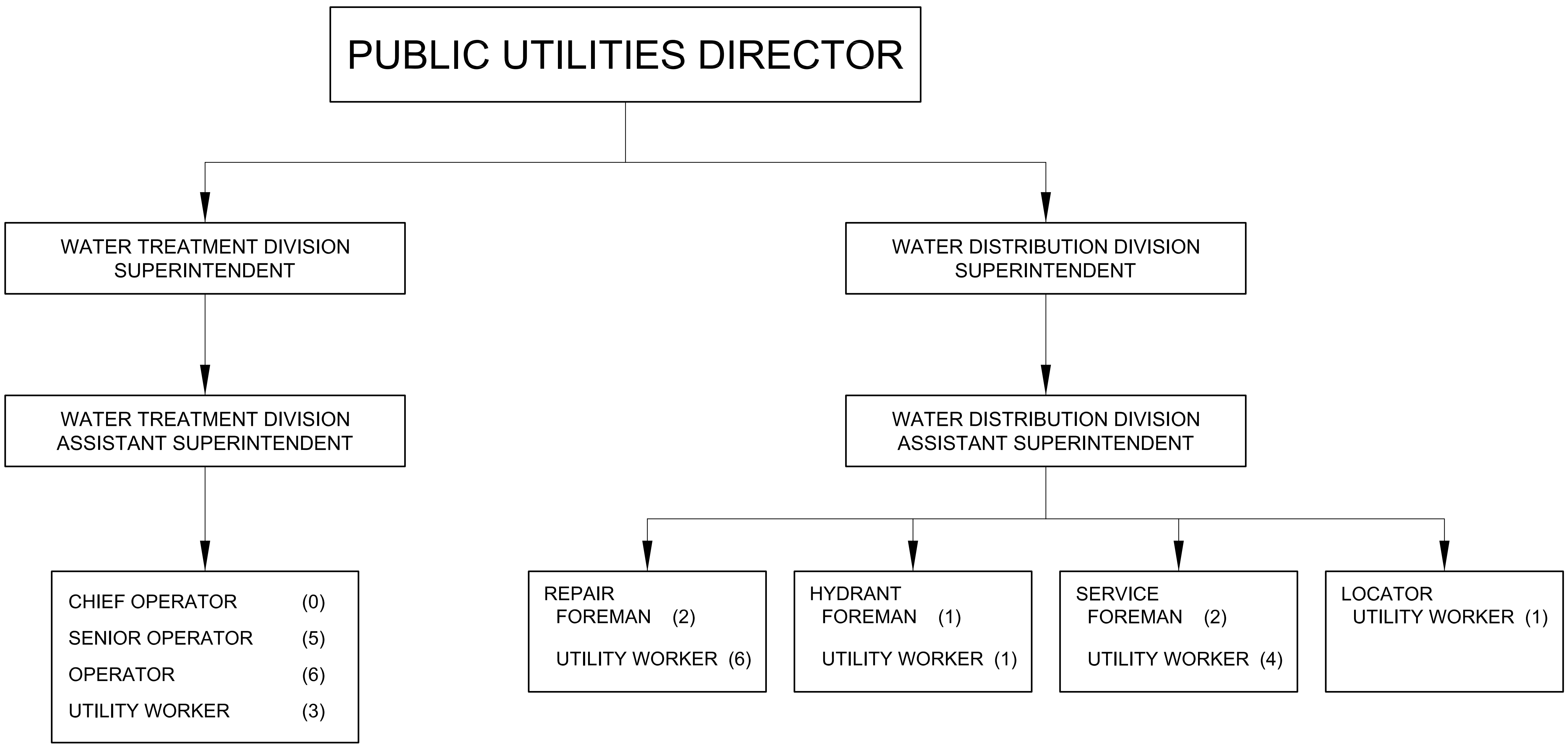

FIGURE 2-5
BOSSIER CITY WTP
ORGANIZATIONAL CHART

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The Water Distribution Division, headed by its superintendent, is responsible for operation and maintenance of the distribution network including piping, valves, fire hydrants, service lines, and meters. This division also provides field services for new service connections, cut-offs, and line locations; administrative responsibilities include mapping and manning of off-hours emergency "hot-line" (shared with sewer department). The Distribution Division Superintendent is responsible for training and maintaining certified personnel, qualified in the areas of pipeline disinfection, health and safety codes, cross connect and backflow prevention, and piping system installation practice. The current staffing level is 19 full time employees, which represents the minimum desirable complement. A minimum of three certified Class IV operators are required to meet the requirements.

The meter reading, billing, and collection of fees and revenue from sales is handled through the City's Department of Administration. This support staff also provides payroll services, material and supply purchasing, and employee benefit services to the rest of the Water Department

2.9 Compliance Status

The City of Bossier City is in compliance with all State and Federal drinking water regulations. The WTP has not had any excursions.

2.9.1 Administrative Orders and Boil Notices/Advisories

On October 30, 2007, a 16-inch water main broke along Airline Drive. A voluntary boil notice was issued. Repairs to the water main were made on the same day. The boil order was lifted on October 31, 2007.

2.9.2 Past DHH Survey Results

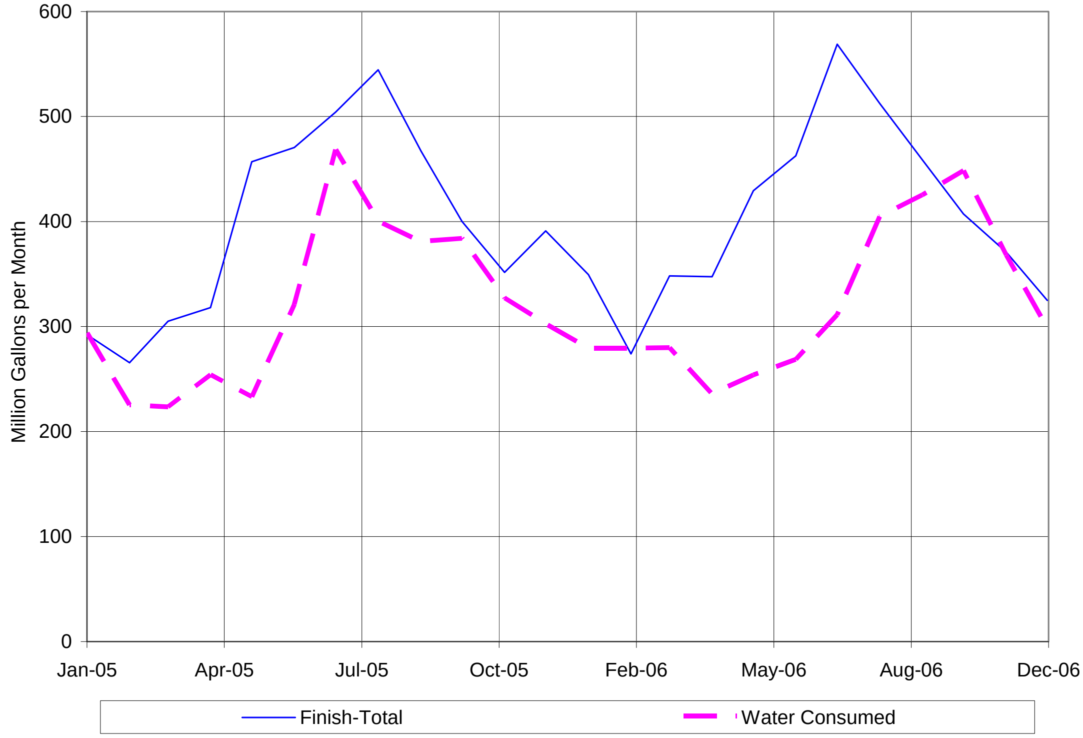
The most recent DHH survey is located in Appendix B. DHH conducted the survey on January 10, 2008. The Bossier WTP was found to be satisfactory.

2.10 Miscellany

2.10.1 Water Production and Consumption

Data was collected from the WTP production records and billing records. In addition, data collected for the *2002 Hydraulic Analysis and Master Plan* for the Bossier City Water System by Aillet, Fenner, Jolly & McClelland, Inc was also utilized. Figure 2-6 shows historical water production and water consumption for Bossier City. An average daily demand of about 13 mgd (2005-2006) and an average peak demand of 16 mgd (2005-2006). The per capita water use is 180 gallons per capita per day.

Figure 2-6
Historical Water Production and Consumption
2005-2006



2.10.2 Existing User Charge System

The current rate structure is a uniform volume rate structure coupled with the monthly flat fee. The rate structure does differentiate between inside city and outside city customers. The minimum monthly rate is the basis for the charge per customer, with no gallons per month included in the minimum rate. A usage charge is applied per thousand gallons, billed on a monthly basis. The rate structure is outlined in Table 2-12.

Table 2-12
Water Rates – Uniform Consumption Charges

Inside City – Individually Metered Units	
Flat Fee per Month	$8.54
Consumption Charge, per 1,000 gallons	$3.03
Outside City – Individually Metered Units	
Flat Fee per Month	$15.80
Consumption Charge, per 1,000 gallons	$4.55

2.10.3 Land Use and Development

The Bossier City-Parish Metropolitan Planning Commission along with Wilbur Smith and Associates developed the *Bossier Comprehensive Land Use and Development Master Plan* in 2003. This plan promotes a regional approach to land use planning and includes key land use development components such as transportation, utilities, and regional development/image goals. Figure 2-7 illustrates land use in the planning area.

Residential land occupies approximately 19.7 percent of the land in Bossier City. Single family development occurs along major arterials. The older sections of the City have a more heterogeneous character.

Industrial and commercial land use accounts for approximately 11.0 percent of the land in Bossier City. The largest concentrations of industrial lands are adjacent to rail transportation and along interstate highways.

Public and semi-public uses account for 40.9 percent of the land in Bossier City. Park and recreational facilities are located throughout the city. There are several schools within the Planning Area which serve the residents of the city. Bossier Parish has separate schools which are attended by residents of the Parish. This percentage also includes the portion of Barksdale Air Force Base (AFB) located with the city limits. Barksdale AFB is one of the largest military installations in the nation and by far the most significant employment generator in the planning area. The base accounts for 22,000 acres within the planning area. Additionally, areas within the Barksdale AFB Air Installation Compatibility Use Zone (AICUZ) limit type of development around the base.

2.10.4 Transportation

The interrelationship of land use planning and transportation planning is essential. Areas of commercial development, employment centers, and high-density residential land uses have a substantial impact on a transportation system. Conversely, major thoroughfare construction giving access to adjoining lands will generate pressure for more intensive types of land use. Principal streets and arteries are illustrated on Figure 2-8.

The most significant transportation facility in the City is the network of streets and highways used to carry through traffic and provide access to property. The planning

Figure 2-7 Land Use Map

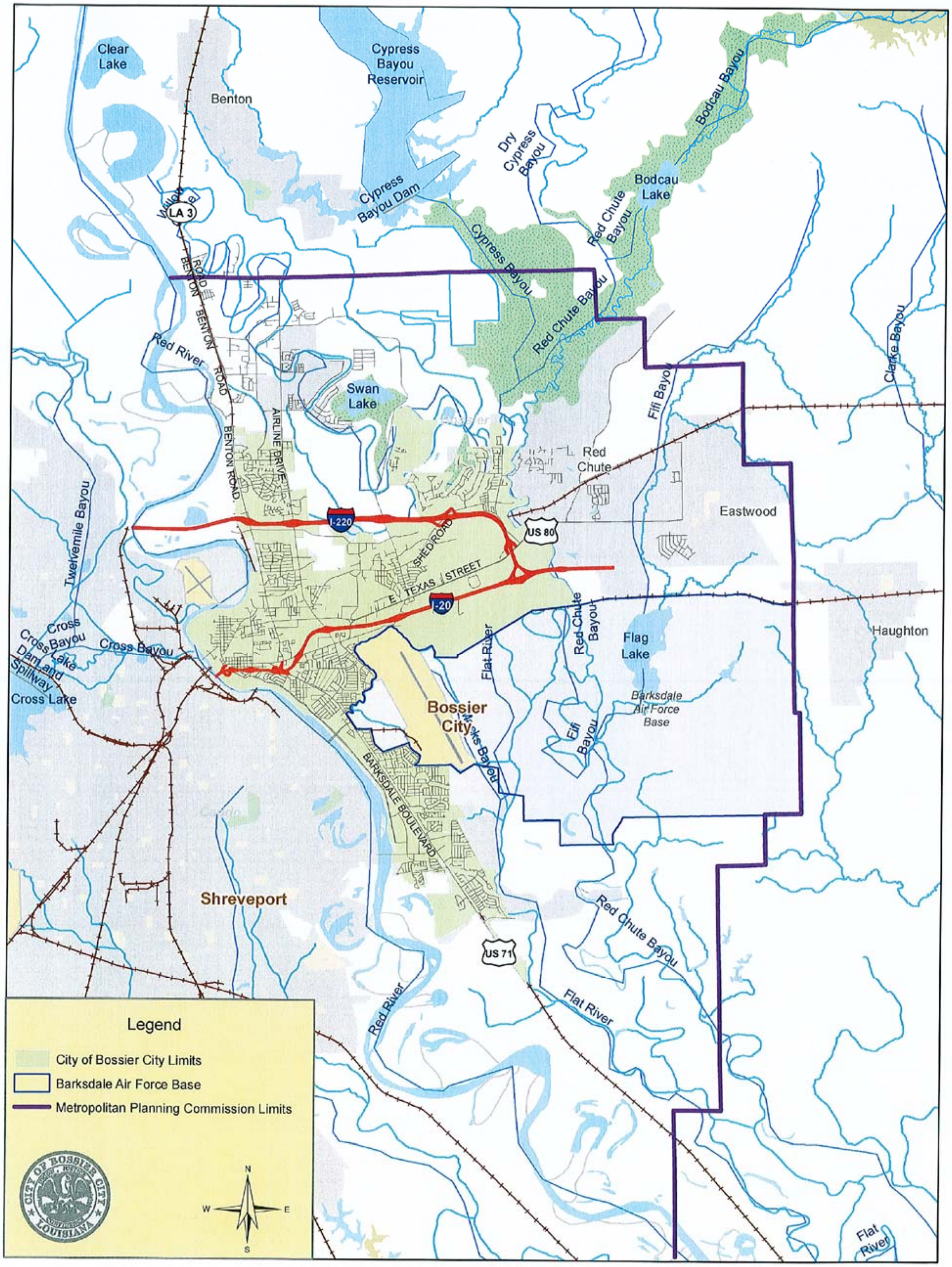


Figure No. 2-7
BOSSIER CITY
LAND USE

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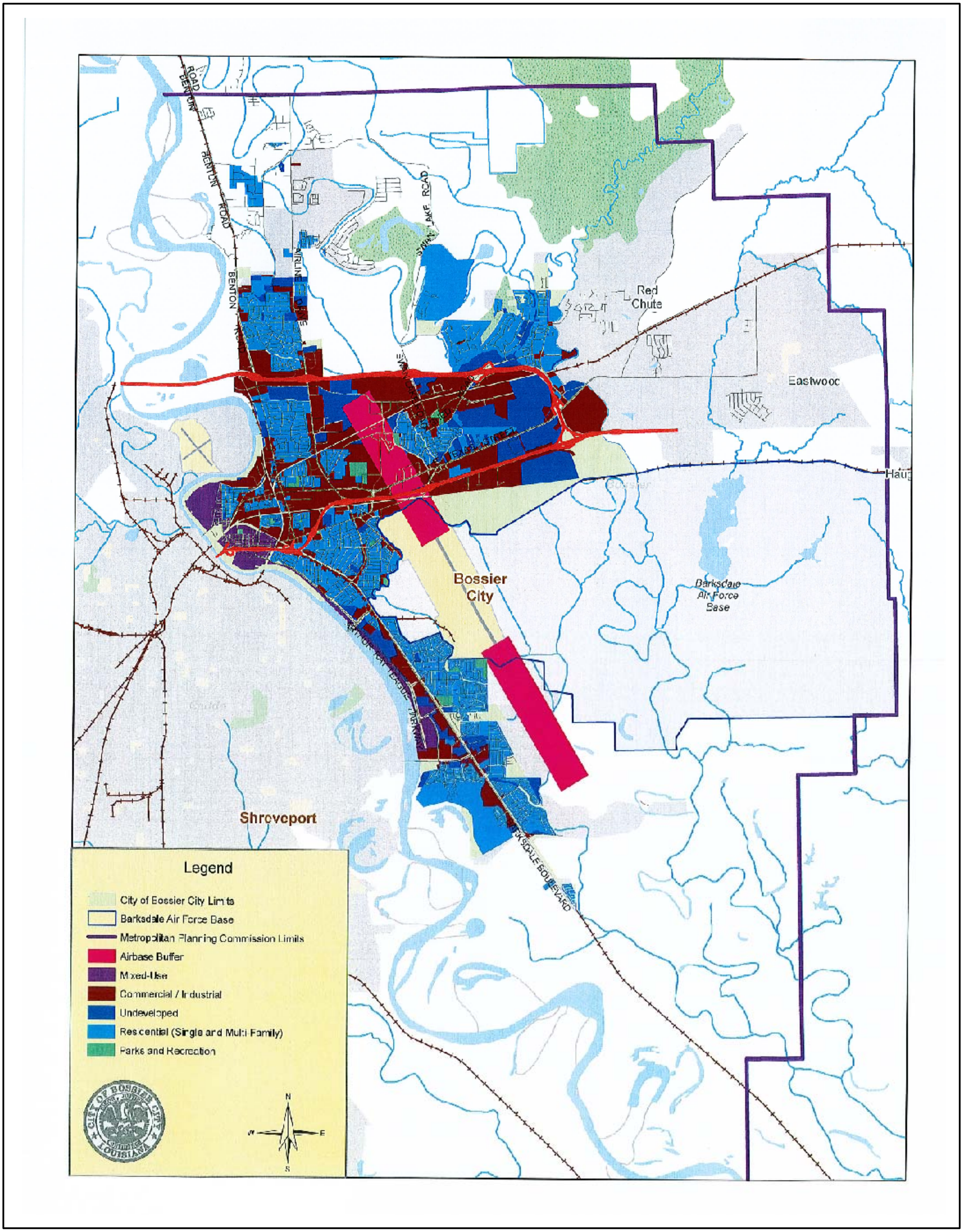
Figure 2-8 Principal Streets and Arterials



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 2-8 03/25/08 07:49 morenoma

Figure No. 2-8
BOSSIER CITY
PRINCIPAL STREETS

CDM

area is served by several Federal and State highways. These facilities constitute the main network of roadways in the area. The most significant of the facilities are Interstates 20, 49, and 220, U. S. Highways 71, 79, and 80. These highways connect the city with New Orleans Louisiana, Dallas Texas, Houston Texas, Jackson Mississippi, Little Rock Arkansas, and Memphis Tennessee. The future construction of Interstate 69, also known as NAFTA Trade Corridor, will enhance interstate mobility and commerce.

Union Pacific Railroad and Kansas City Southern Railroad operate three major lines throughout the city.

The major water transportation route is the Red River, which serves northwest Louisiana, Texas and Oklahoma. The Port of Shrevport-Bossier links customers throughout the Ark-La-Tex region as well as to the worldwide waterway transportation via the Mississippi River and the Gulf of Mexico.

Airway service to the planning area is provided by two civilian airports in Shreveport and one military airport at Barksdale AFB. Six airlines operate out of the Shreveport Regional Airport.

The Bossier City-Parish Metropolitan Planning Commission developed recommendations that improve pedestrian and bicycle transportation facilities.

2.10.5 Cultural Elements

2.10.5.1 Archaeological Site

The State Historic Preservation Officer (SHPO) has been contacted to determine whether there are any archaeological resources found within the facility Planning Area. The SHPO determined that there are no known archaeological sites in the planning area. See Appendix C for correspondence between the federal, state, and local agencies involved in providing information in this project.

2.10.5.2 Historical Resources

According to the 2003 *Bossier Comprehensive Land Use and Development Master Plan* (Wilbur Smith and Associates) and the Bossier Parish Library Historical Center, it is estimated that as early as 7,000 BCE the area was inhabited by Native Americans and specifically inhabited by the Caddo Indians beginning around 900 CE. There are many Caddoan sites in northwest Louisiana, however it is not anticipated that these sites will be disturbed by the proposed project.

Research has led to the discovery of a historic 19th Century shipwreck that may be the Confederate warship, the C.S.S. Grand Duke, across from the Cane's Landing park. The existence of Confederate defensive fortifications has been found in the same area and near Bossier High School and on East Texas Street.

The area of the first settlement in Bossier City was centered on the Long-Allen or Texas Street Bridge and extended east to Traffic Street. This area is now known as

"Old Bossier." As Bossier City grew, it developed first in an eastward axis along Texas Street and then north and south from this area. The earliest portion of the city's settlement changed character during the Great Depression and turned from commercial and industrial to residential. Currently, the area known as "Old Bossier" is undergoing redevelopment by the casinos and the River Walk Entertainment District.

There are four places on the National Register of Historic Places in the planning area. They are:

- Barksdale AFB formerly known as Barksdale Field Historic District, US Highway 71 and West Gate Drive, Bossier City.
- Bossier Arts Council formerly known as Bossier City Municipal Building, 630 Barksdale Boulevard, Bossier City.
- Bossier High School, 777 Bearcat Drive, Bossier City.
- Bossier City Elementary School formerly known as Bossier High School, 322 Colquitt Street, Bossier City.

Section 3
Future Conditions

This section documents the expected changes in the Planning Area for the next twenty years (2008 through 2028). These changes are expressed in projections of population, water system service area, water demand, and the effect this has on the ability of the existing treatment and distribution facilities to provide service.

3.1 Population Projection

Future population data for the City of Bossier City and metropolitan planning area are shown in Figure 3-1. The 1990 City of Bossier City population is consistent with the 1990 U. S. Census. The 2005 through 2020 population projections for the planning area were developed by the Metropolitan Planning Commission and extended to 2030 using a 6 percent growth rate. Bossier City is not anticipating growth by annexation however new industries associated with Barksdale AFB are expected to increase growth in the area. Bossier City's growth is limited by the Red River on the west; however there are undeveloped areas on other sides to allow for adequate growth.

3.2 Water Consumption Projection

Data was collected from the WTP production records and billing records. In addition, data collected for the *2002 Hydraulic Analysis and Master Plan* for the Bossier City Water System by Aillet, Fenner, Jolly & McClelland, Inc was also utilized. The data from the water plant consisted of treated water flows from the years 1995 through 2007. Billing record data included annual summaries of water consumption from 2002 through 2006. This data was used in conjunction with the water use projections from the *2002 Hydraulic Analysis and Master Plan* to predict future water consumption for average day demand, maximum-day demand and maximum-month demand. Present day minimum production rates were also established, which are necessary to properly size chemical feed and application facilities.

The existing total capacity of the WTP is 25 mgd. The performance of the WTP at high flow rates has warranted further discussion of de-rating the capacity of the existing plant to 20 mgd.

Figure 3-2 shows historical and projected water use for Bossier City. As noted above, a previous study was done in 2000 by AFJMc. This study projected water use out to 2025. Since the study was completed, the city and its water service area have continued to grow. This growth, along with recent hot, dry summers has placed a tremendous strain on the WTP. Figure 3-2 shows the previous projections from the 2000 study as well as updated water use for the last five years and demand projections through 2028.

Figure 3-1
Population Projections

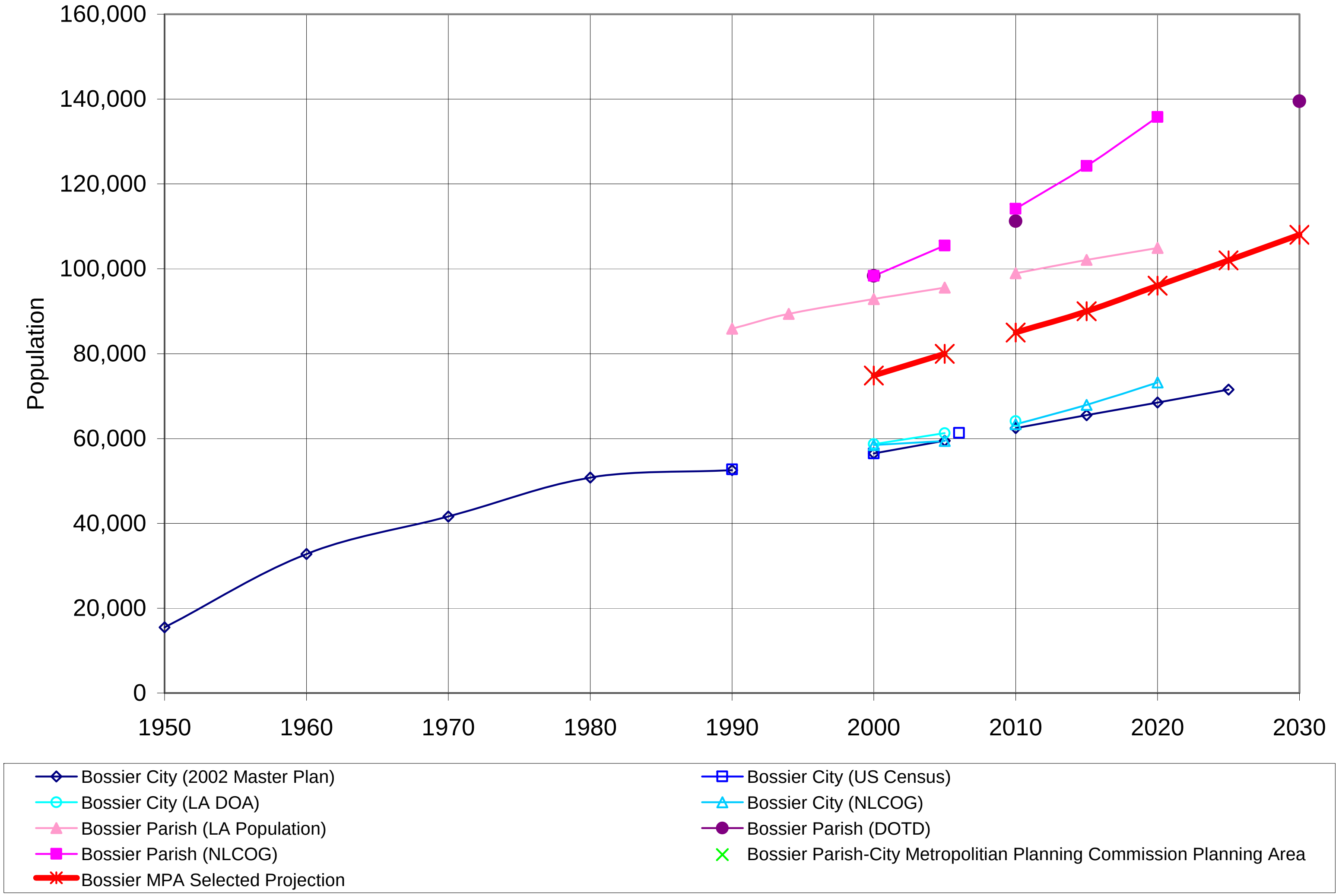
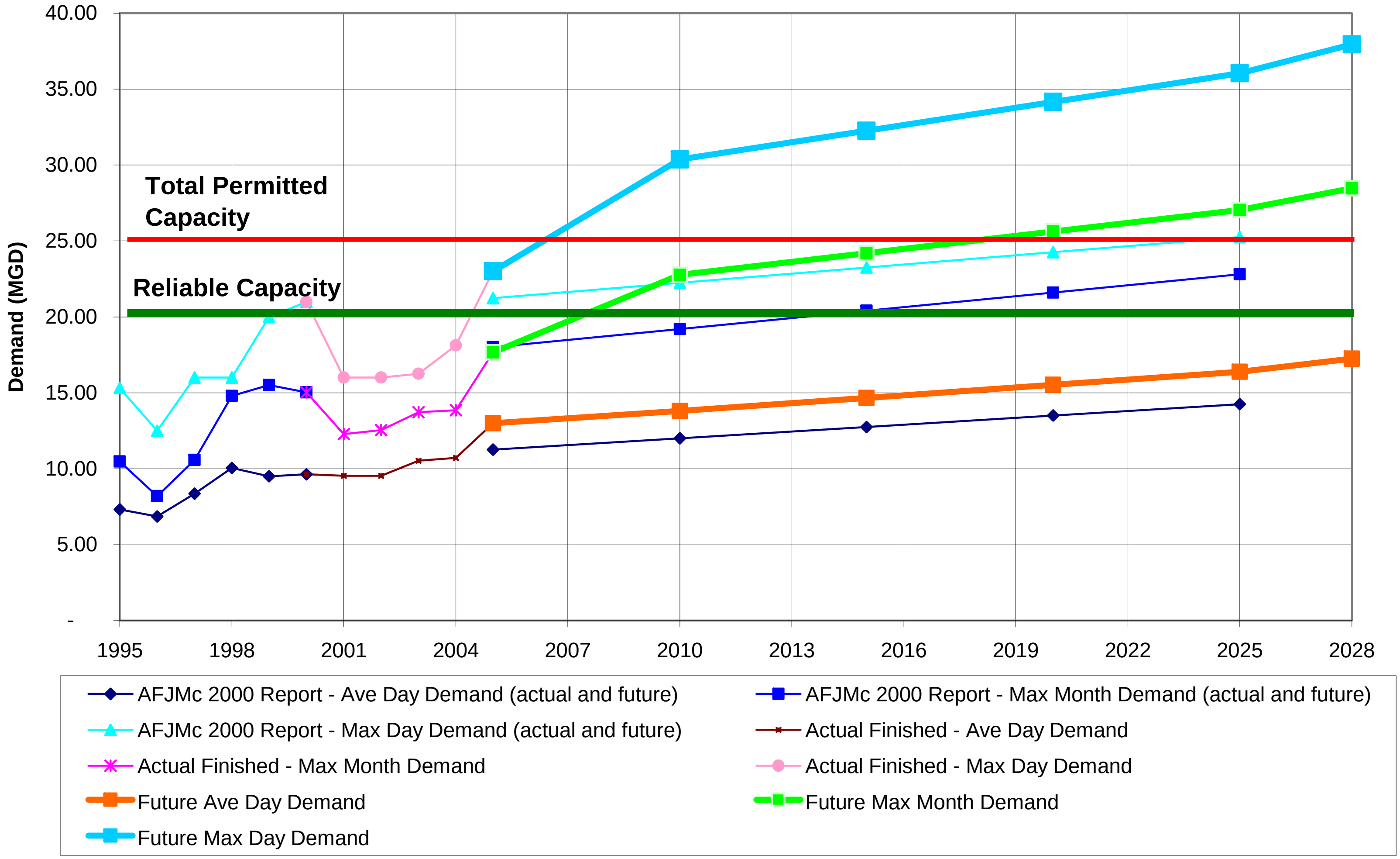


Figure 3-2
Water Demand Projections



The increase in base average daily flows was based on recent average daily flow data, as well as revised population projections from the *Comprehensive Land Use and Development Master Plan* that was completed in 2003. The increase in the average daily demand is approximately 15 percent higher than the previously projected numbers. Actual peaking factors of maximum month to average day and maximum day to average daily flows from historical data were used to project future maximum month and average daily flows. These are significantly higher than previous projections due to the effects of the recent hot, dry weather conditions that have occurred over the past several years. It is expected that this will remain a cyclical occurrence, but must be accounted for in the sizing of the plant expansion. The historical maximum month to average day peaking factor is approximately 165 percent while the maximum day to average day peaking factor is approximately 220 percent. Historical and projected water use is detailed in Table 3-1.

Table 3-1
Historical and Projected Water Demand
(million gallons per day)

Year	Average Day Demand	Max Month Demand	Max Day Demand
1995	7.3	10.5	15.3
1996	6.9	8.2	12.5
1997	8.4	10.6	16.0
1998	10.1	14.8	16.0
1999	9.5	15.5	20.0
2000	9.6	15.0	21.0
2001	9.5	12.3	16.0
2002	9.5	12.5	16.0
2003	10.5	13.7	16.2
2004	10.7	13.8	18.1
2005	13.0	17.7	23.0
2010	13.8	22.8	30.4
2015	14.7	24.2	32.3
2020	15.5	25.6	34.2
2025	16.4	27.0	36.1
2028	17.3	28.5	38.0

These numbers do not include any new large industrial demands on the city’s system. If a new industry with a large water requirement were to locate in or near Bossier City, the projected water demand would need to be adjusted accordingly.

Looking at the future demands with regard to sizing a new expansion, the plant must be capable of meeting the maximum day demand with a firm plant capacity as opposed to a total plant capacity. For planning purposes, the firm capacity of a new expansion would be the projected future demand of 36 mgd plus the capacity of a critical treatment train. Using the existing critical treatment train of half of Plant 2, this would equate to at total treatment capacity of 43.5 mgd. Since the design of the new facilities is not yet finalized to know the exact size of a critical treatment train, a future total capacity of 45 mgd is used for planning and evaluation purposes.

Section 4
Evaluation of Treatment Alternatives

4.1 Overview

The purpose of this section is to identify and discuss treatment system improvements and facility modifications necessary to meet the City's needs through 2028. Specifically, a plant expansion will be required to provide a sufficient future daily volume of drinking water. Demand projections are discussed in Section 3.

The existing conventional surface water treatment plant will be expanded to 45 mgd. This section examines three expansion alternatives. It will be necessary to rehabilitate certain existing processes, facilities, and equipment under this project to improve performance or to comply with current building code or DHH requirements.

4.1.1 Alternatives

Viable treatment alternatives for the plant expansion are discussed below. These alternatives were originally developed in the *Process Evaluation Report* completed in August 2006 and refined based on subsequent meetings with the city.

The water treatment plant expansion alternatives examined are:

- Alternative 1: Maintain the existing treatment plant with enhancements and provide the required expansion through the construction of a parallel 25 mgd low pressure and 25 mgd high pressure reverse osmosis membrane treatment plant. Finished water from the existing plant would be blended with finished water from the new membrane plant in the clearwells prior to introduction into the distribution system.

- Alternative 2: Maintain the existing treatment plant with enhancements and provide the required expansion through the construction of a parallel 12 mgd low pressure membrane treatment plant. Finished water from the existing plant would be blended with finished water from the new membrane plant in the clearwells prior to introduction into the distribution system.

- Alternative 3: Maintain the existing treatment plant with enhancements and provide the required expansion through the construction of a parallel 25 mgd low pressure membrane treatment plant. Finished water from the existing plant would be blended with finished water from the new membrane plant in the clearwells prior to introduction into the distribution system.

- Alternative 4: Maintain the existing treatment plant with enhancements and provide the required expansion through the construction of a parallel 25 mgd conventional treatment plant. Finished water from the existing plant would be blended with the finished water from the new conventional plant in the clearwells prior to introduction into the distribution system.

- Alternative 5: take no action. The recent population growth has put a strain on the City's infrastructure including the WTP. Since the population growth is expected to continue, taking no action to increase the capacity at the WTP is not a viable option and will not be considered further.

This section evaluates treatment process improvements in terms of the alternatives ability to meet Safe Drinking Water Act (SDWA) mandated treatment objectives, projected maximum day demands, flexibility of operation, reliability, maintenance requirements, and cost-effectiveness. The most suitable treatment process is recommended in Section 5.

The four alternatives presented above are preliminarily ranked and briefly summarized in Table 4-1.

Table 4-1
Treatment Alternative Summary *

No.	Description	Anticipated Construction Requirements	Preliminary Ranking
1	Construct a new parallel 25 mgd low pressure and 25 mgd high pressure reverse osmosis membrane plant and enhance the existing water plant to provide a total treatment capacity of 45 mgd.	▪ Raw water supply expansion to a firm capacity of 45 mgd ▪ New raw water blend / splitter structure ▪ Two new rapid mix basins ▪ Two new flocculation basins ▪ Two new sedimentation basins ▪ Five membrane filtration systems (microfiltration /ultrafiltration) ▪ Five membrane filtration system (reverse osmosis) ▪ Modifications to existing SCCs ▪ New chlorine storage and feed building, including chlorine scrubber ▪ Additional bulk chemical storage for LOX, primary polymer, filter aid polymer and ammonia ▪ Additional chemical feeders / pumps for all chemical systems ▪ High service station expansion to 45 mgd firm ▪ Plant lab and control room addition	3

Table 4-1 continued
Treatment Alternative Summary *

No.	Description	Anticipated Construction Requirements	Preliminary Ranking
2	Construct a new parallel 12 mgd low pressure membrane plant and enhance the existing water plant to provide a total treatment capacity of 32 mgd.	▪ Raw water supply expansion to a firm capacity of 45 mgd ▪ New raw water blend / splitter structure ▪ Two new rapid mix basins ▪ Two new flocculation basins ▪ Two new sedimentation basins ▪ Five membrane filtration systems (microfiltration /ultrafiltration) ▪ Two new ozone contactors ▪ Six new granular activated carbon contactors ▪ Modifications to existing SCCs ▪ New chlorine storage and feed building, including chlorine scrubber ▪ Additional bulk chemical storage for LOX, primary polymer, filter aid polymer and ammonia ▪ Additional chemical feeders / pumps for all chemical systems ▪ High service station expansion to 45 mgd firm ▪ Plant lab and control room addition	4
3	Construct a new parallel 25 mgd low pressure membrane plant and enhance the existing water plant to provide a total treatment capacity of 45 mgd.	▪ Raw water supply expansion to a firm capacity of 45 mgd ▪ New raw water blend / splitter structure ▪ Two new rapid mix basins ▪ Two new flocculation basins ▪ Two new sedimentation basins ▪ Five membrane filtration systems (microfiltration /ultrafiltration) ▪ Two new ozone contactors ▪ Six new granular activated carbon contactors ▪ Modifications to existing SCCs ▪ New chlorine storage and feed building, including chlorine scrubber ▪ Additional bulk chemical storage for LOX, primary polymer, filter aid polymer and ammonia ▪ Additional chemical feeders / pumps for all chemical systems ▪ High service station expansion to 45 mgd firm ▪ Plant lab and control room addition	1

Table 4-1 continued
Treatment Alternative Summary *

No.	Description	Anticipated Construction Requirements	Preliminary Ranking
4	Construct a new parallel conventional surface water treatment plant and enhance the existing mgd water plant to provide a total treatment capacity of 45 mgd.	▪ Raw water supply expansion to a firm capacity of 45 mgd ▪ New raw water blend / splitter structure ▪ Two new ozone contactors ▪ Two new SCCs ▪ One new recarbonation basin ▪ Two new pre-filter ozone contactors ▪ Six new rapid gravity filters ▪ One new air scour blower ▪ Modifications to existing SCCs ▪ One new elevated washwater supply tank ▪ New chlorine storage and feed building, including chlorine scrubber ▪ Additional bulk chemical storage for LOX, primary polymer, filter aid polymer and ammonia ▪ Additional chemical feeders / pumps for all chemical systems ▪ High service station expansion to 45 mgd firm ▪ Plant lab and control room addition	2

*This table includes the following assumptions: Current residuals handling processes will continue to be processed in the same manner; all residuals are assumed to be returned to the Red River; and membrane concentrate handling from the MF/UF plant will be handled in a similar manner.

4.1.2 Membrane Pilot Study

Between March and October 2007, a membrane pilot study was conducted to evaluate the feasibility of UF/MF and RO membranes treatment alternatives. Three membrane manufacturers participated in the pilot study: Siemens/Memcor (Memcor), Pall, and GE/Zenon (Zenon).

As noted in CDM's *Pilot Study Report* dated March 2008, each of the membrane pilot units completed the settled water pilot testing set forth in the challenge test. Membrane pilot unit data for this testing is summarized in Table 4-2.

Based on data obtained during the pilot study, Memcor and Pall are capable of adequately treating the settled water from the full-scale plant. (Zenon only participated in the coagulated water portion of the pilot study.)

Table 4-2
Membrane Pilot Test Settled Water Data Summary

Data Parameter	Memcor Submerged	Memcor Pressure	Pall
Instantaneous Flux Rate at ambient temperature, GFD	40	50	75
Instantaneous Flux Rate at 20° C, GFD	36	49	65
Net Flux Rate at ambient temperature (average), GFD	25	35	69
Net Flux Rate at 20°C (average), GFD	24	22	61
Recovery, %	96.2	97.8	97.9
Maintenance Wash Interval, hours	24	24	48
Maintenance Wash Chemical / Concentration	Chlorine / 200 mg/L	Chlorine / 200 mg/L	Chlorine / 500 mg/L
Backwash Interval (minutes) / Duration (seconds)	20/180	22/180	25/60
Water Temperature Range, °C	18-24		
Raw Water Turbidity Average / Range, NTU	19 / 2-51		
Feed Turbidity Average / Range, NTU	5 / 3-10		
Filtrate Turbidity, NTU (95th percentile)	0.01	0.03	0.01
TMP Range, psi	3-9	1-8	4-17

4.1.3 Regulations

State of Louisiana *Code of Regulations* Title 51, Public Health -Sanitary Code, Part XII Water Supplies governs design of water treatment facilities. The code references *Recommended Standards for Water Works, Ten State Standards.* The alternatives were evaluated based on these current regulations and upon anticipated future EPA regulations. Please note that if there are changes in future water quality requirements from those currently published, the alternatives discussed herein may be affected.

Current residuals handling practices will continue and will follow the current practice of disposal to the Red River through the existing outfall. It is assumed that membrane concentrate will be handled in the same manner. DEQ could require changes to the residuals handling practice; this would impact plant operation and annual costs significantly. Solids handling facilities are in place to deal with conventional treatment plant solids, but sit idle at this time. Facilities to deal with membrane concentrate would have to be developed should DEQ enforce a National Pollutant Discharge Elimination Permit (NPDES) on the plant's outfall.

4.2 Alternative 1 –Parallel 25 mgd Low Pressure MF and 25 mgd High Pressure RO Membrane Plant

Alternative 1 involves construction of a new 25 mgd low pressure microfiltration and 25 mgd high pressure reverse osmosis membrane filtration water treatment plant along with enhancements to the existing treatment plant. A schematic of the proposed treatment is shown in Figure 4-1. Blended Red River and reservoir water or water from either source will be used as the facility's source water. Finished water from the new WTP will be blended with finished water from the existing plant to introduction into the distribution system. Major water treatment processes for Alternative 1 are included in Table 4-1. Table 4-3 presents present worth costs for this alternative. Detailed opinion of probable cost for this alternative is included in Appendix D.

Table 4-3
Present Worth Cost for Alternative 1

	2007 Dollars
Capital Costs	
Raw Water Pumping Expansion Influent Blend Structure Enhancements to existing WTP Laboratory and control building High service pumping Parallel MF and RO membrane plant	
Total Capital Costs	**$141,536,000**
Annual O&M Costs for Parallel MF/UF and RO membrane plant [1]	
Power ($0.07/kWh)	$1,150,000
Chemicals	$550,000
Labor	$68,500
Membrane replacement [2]	$191,000
Total O&M Costs	**$1,959,500**
Present Worth O&M Costs [3]	**$24,419,700**

1. O&M for existing WTP will not be altered by enhancements. The O&M costs for Alternative 1 are incremental, with the existing electrical and chemical costs deducted from the total WTP O&M costs.
2. Assumes low pressure membrane replacement year 10 (annualized - $910,000/10 = $91,000 per year) and high pressure membrane replacement year 5 (annualized - $500,000/5 = $100,000 per year).
3. Assumes 20-year life cycle and 5% interest.

Figure 4-1 Schematic of RO Alternative

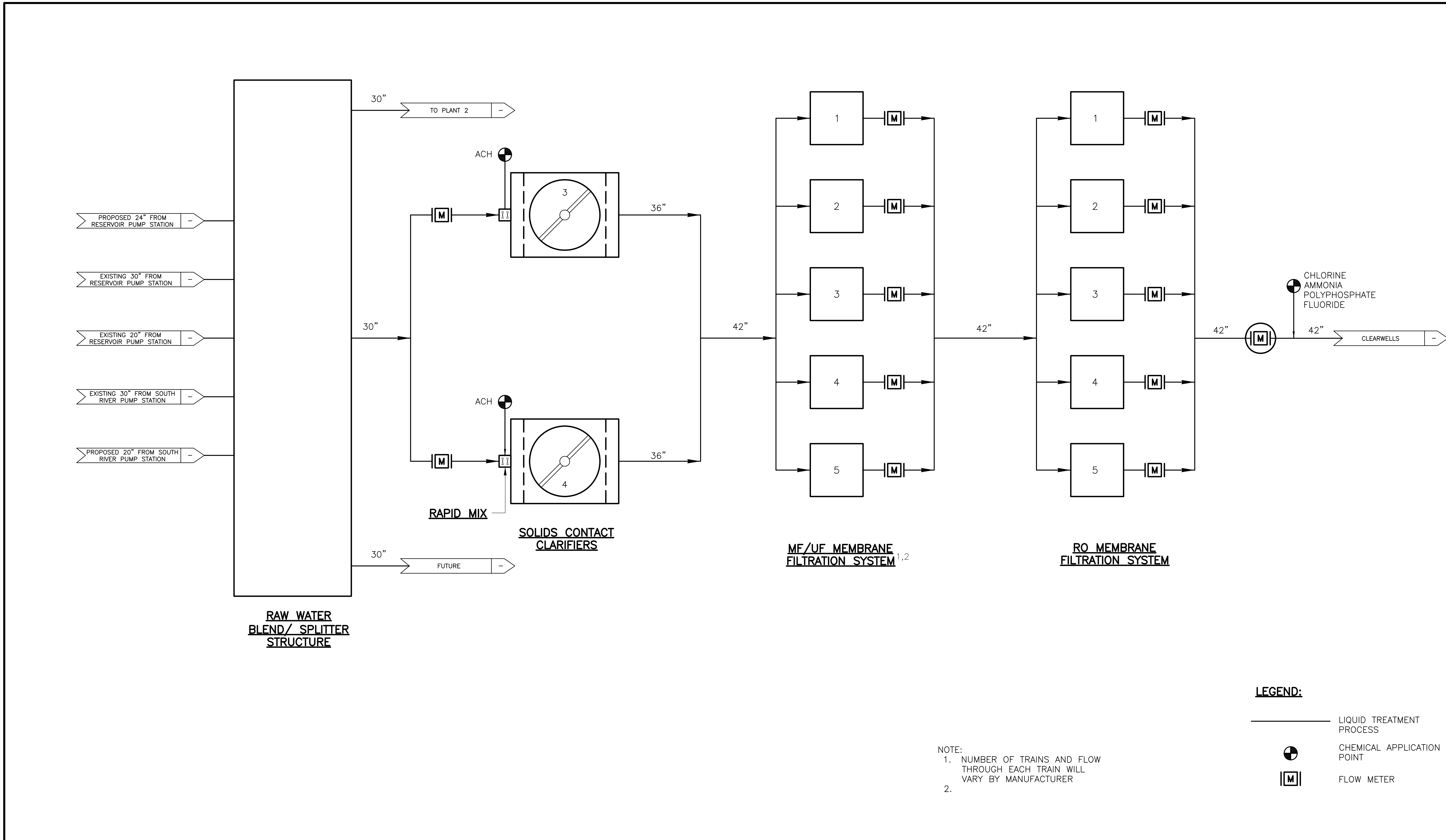


FIGURE 4-1
ALTERNATIVE 1: 25-MGD PLANT SCHEMATIC WITH MF/UF AND RO MEMBRANES TREATING SETTLED WATER
BOSSIER CITY WTP EXPANSION

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4.3 Alternative 2 –Parallel 12 mgd Low Pressure Membrane Plant

Alternative 2 involves construction of a new 12 mgd low pressure membrane filtration water treatment plant along with enhancements to the existing treatment plant. A schematic of the proposed treatment is shown in Figure 4-2. Blended Red River and reservoir water or water from either source will be used as the facility's source water. Finished water from the new WTP will be blended with finished water from the existing plant prior to introduction into the distribution system. Major water treatment processes for Alternative 2 are included in Table 4-1. Table 4-4 presents present worth costs for this alternative. Detailed opinion of probable cost for this alternative is included in Appendix D.

Table 4-4
Present Worth Cost for Alternative 2

	2006 Dollars
Capital Costs	
Raw Water Pumping Expansion Influent Blend Structure Enhancements to existing WTP Laboratory and control building High service pumping Parallel MF membrane plant	
Total Capital Costs	**$70,710,000**
Annual O&M Costs for Low Pressure MF/UF [1]	
Power ($0.07/kWh)	$650,000
Chemicals	$350,000
Labor	$0
Membrane replacement [2]	$45,000
Total O&M Costs	**$1,045,000**
Present Worth O&M Costs [3]	**$13,023,000**

1. O&M for existing WTP will not be altered by enhancements.
2. Assumes low pressure membrane replacement year 10 (annualized - $450,000/10 = $45,000 per year).
3. Assumes 20-year life cycle and 5% interest.

This alternative would provide sufficient treated water to meet the 2012 projected max day demands. However, additional expansions would be necessary to meet the 2028 demand.

Figure 4-2 Schematic of 12 MGD MF/UF alternative 2

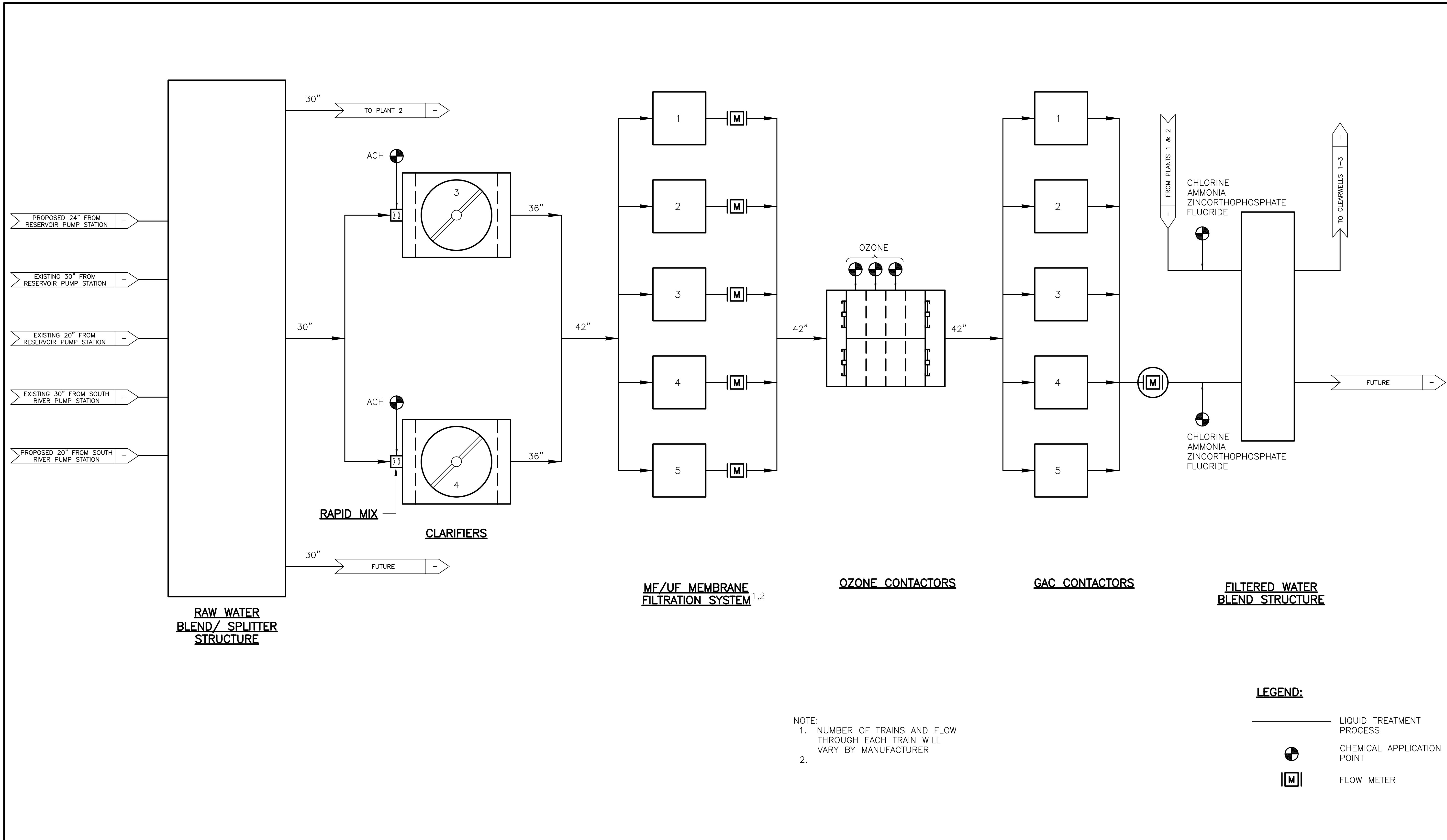

FIGURE 4-2
ALTERNATIVE 2: 12-MGD PLANT SCHEMATIC WITH MF/UF MEMBRANES TREATING SETTLED WATER
BOSSIER CITY WTP EXPANSION

CDM

4.4 Alternative 3 –Parallel 25 mgd Low Pressure Membrane Plant

Alternative 3 involves construction of a new 25 mgd low pressure membrane filtration water treatment plant along with enhancements to the existing treatment plant. A schematic of the proposed treatment is shown in Figure 4-3. Blended Red River and reservoir water or water from either source will be used as the facility's source water. Finished water from the new WTP will be blended with finished water from the existing plant prior to introduction into the distribution system. Major water treatment processes for Alternative 3 are included in Table 4-1. Table 4-5 presents present worth costs for this alternative. Detailed opinion of probable cost for this alternative is included in Appendix D.

Table 4-5
Present Worth Cost for Alternative 3

	2006 Dollars
Capital Costs	
Raw Water Pumping Expansion Influent Blend Structure Enhancements to existing WTP Laboratory and control building High service pumping Parallel MF membrane plant	
Total Capital Costs	**$83,032,000**
Annual O&M Costs for Low Pressure MF/UF [1]	
Power ($0.07/kWh)	$650,000
Chemicals	$350,000
Labor	$54,800
Membrane replacement [2]	$91,000
Total O&M Costs	**$1,145,800**
Present Worth O&M Costs [3]	**$14,279,200**

1. O&M for existing WTP will not be altered by enhancements.
2. Assumes low pressure membrane replacement year 10 (annualized - $910,000/10 = $91,000 per year).
3. Assumes 20-year life cycle and 5% interest.

Figure 4-3 Schematic of 25 MGD MF/UF alternative 3

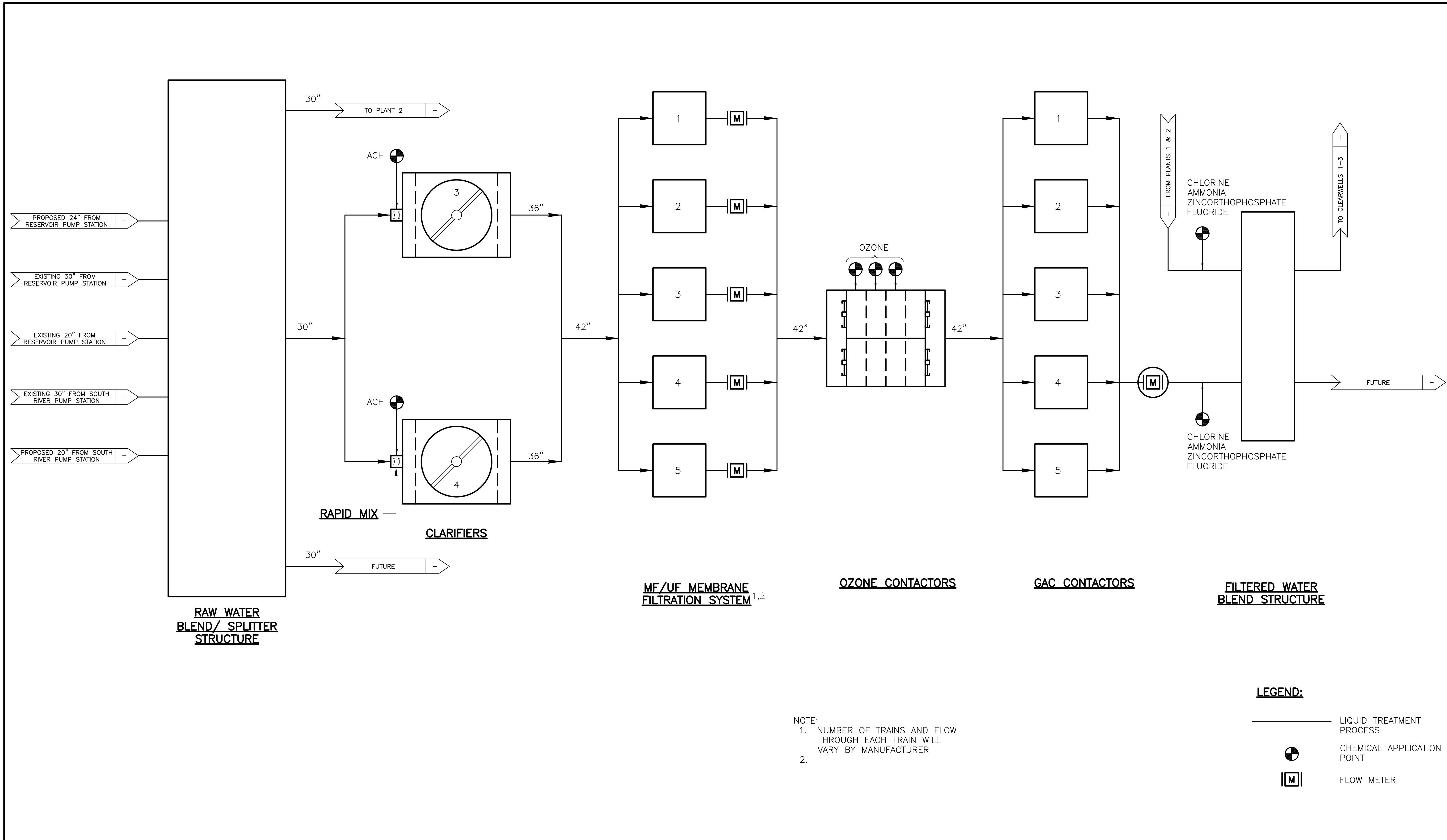

FIGURE 4-3
ALTERNATIVE 3: 25-MGD PLANT SCHEMATIC WITH MF/UF MEMBRANES TREATING SETTLED WATER
BOSSIER CITY WTP EXPANSION

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4.5 Alternative 4 –Parallel 25 mgd Conventional Treatment Plant

Alternative 4 involves construction of a new 25 mgd conventional water treatment plant along with enhancements to the existing treatment plant. A schematic of the proposed treatment is shown in Figure 4-4. Blended Red River and reservoir water or water from either source will be used as the facility's source water. Finished water from the new WTP will be blended with finished water from the existing plant prior to introduction into the distribution system. Major water treatment processes for Alternative 4 are included in Table 4-1. Table 4-6 presents present worth costs for this alternative. Detailed opinion of probable cost for this alternative is included in Appendix D.

Table 4-6
Present Worth Cost for Alternative 4

	2006 Dollars
Capital Costs	
Raw Water Pumping Expansion Influent Blend Structure Enhancements to existing WTP Laboratory and control building High service pumping Conventional Treatment Plant	
Total Capital Costs	**$94,159,000**
Annual O&M Costs for conventional treatment plant [1]	
Power ($0.07/kWh)	$0
Chemicals	$0
Labor	$0
Total O&M Costs	**$0**
Present Worth O&M Costs [2]	**$0**

1. O&M for existing WTP will not be altered by enhancements.
2. Assumes 20-year life cycle and 5% interest.

Figure 4-4 Schematic of 25 MGD Conventional Treatment alternative 4

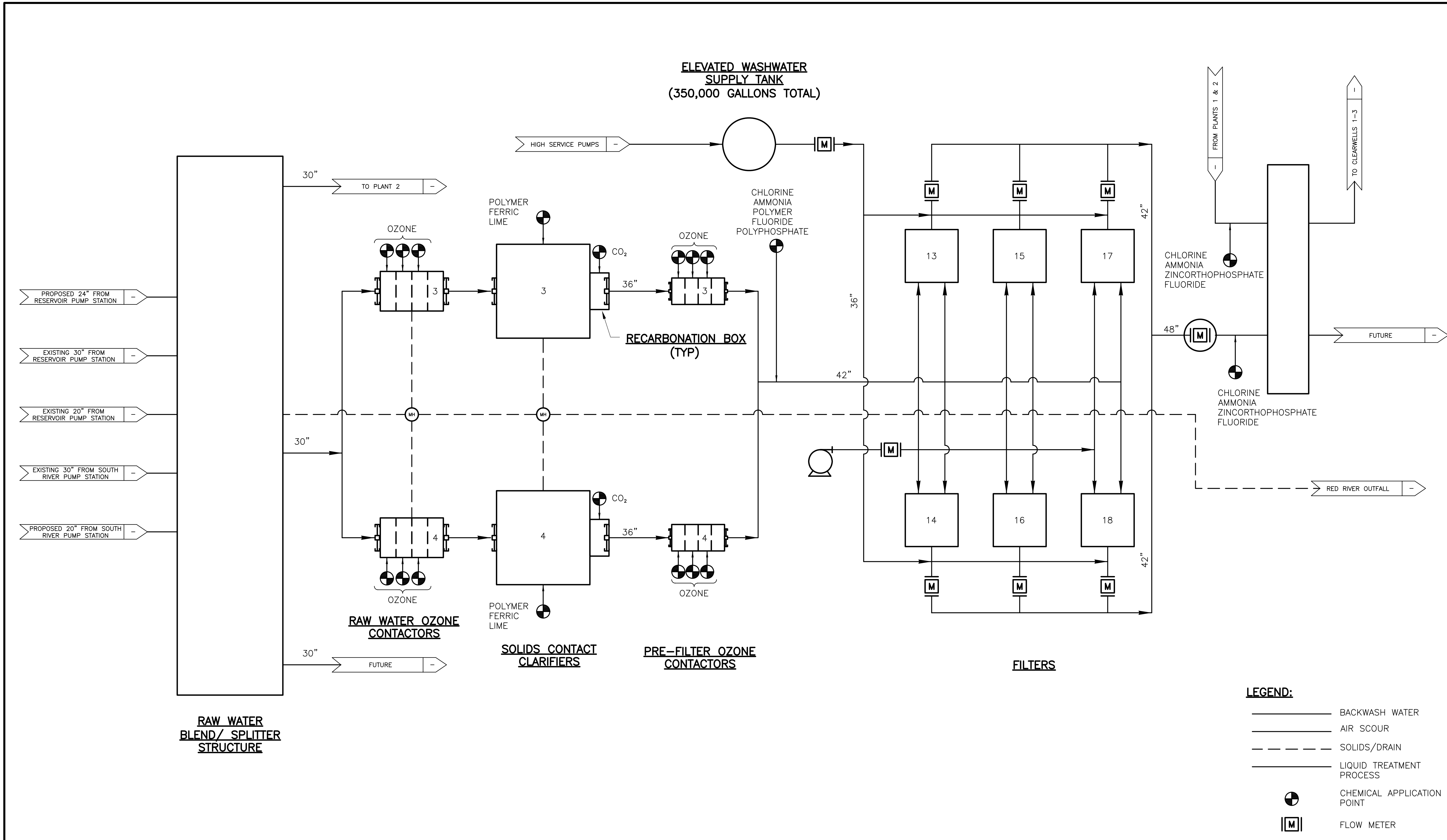

FIGURE 4-4
ALTERNATIVE 4: 25-MGD PLANT SCHEMATIC WITH CONVENTIONAL TREATMENT
BOSSIER CITY WTP EXPANSION

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4.6 Project Eligibility

All aspects of the above alternatives are eligible for federal funding under the Drinking Water Revolving Loan Fund (DWRLF). Modifications to the existing WTP and expansion are necessary to continue to provide adequate amount of treated water to customers and maintain compliance with existing regulations.

4.7 Economic Analyses

Comparing the present worth results of the four alternatives, Alternative 4 has the least cost present worth, however, the non-economic factors described in the next section offers further insight into the selection process. Table 4-7 presents a comparison of the present worth for the four alternatives.

Table 4-7
Comparison of Present Worth Costs - Four Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Capital Costs	$141,536,000	$70,710,000	$83,032,000	$94,159,000
Annual O&M Costs	$1,959,500	$1,045,000	$1,145,800	-
Present Worth O&M Costs	$24,419,700	$13,023,000	$14,279,200	-
Total Present Worth Costs	**$165,955,700**	**$83,733,000**	**$97,311,200**	**$94,159,000**

4.8 Other Considerations

This section evaluates non-economic factors for establishing alternative ranking. All options will utilize the existing WTP property and have no environmental impacts. Table 4-8 lists advantages and disadvantages for each alternative.

4.9 Recommendation

Based on the economic and non-economic analysis, CDM recommends that Bossier City pursue Alternative 3 to expand the treatment capacity using a parallel 25 mgd low pressure membrane plant.

Table 4-8
Treatment Alternative Evaluation

No.	Description	Advantages	Disadvantages
1	Construct a new parallel 25 mgd low pressure MF and 25 mgd high pressure reverse osmosis membrane plant and enhance the existing water plant to provide a total treatment capacity of 45 mgd.	■ Highest level of treatment ■ Ability to meet current and future turbidity regulations ■ Ability to remove giardia and cryptosporidium ■ Membrane systems easier to expand than conventional systems ■ High pressure membranes remove chlorides and TDS, which reduces corrosivity in distribution system ■ Removes hardness in water ■ Meets AWWA program standards consistently ■ Consistent water quality regardless of incoming water quality ■ Ability to deal with contamination or spills on Red River ■ High pressure membranes remove taste and odor constituents with no need for ozone ■ Ability to meet potential regulatory requirements better than other alternatives (Unregulated Contaminant Monitoring rule)	■ Highest Cost ■ Highest operating costs ■ No reduction in operating staff anticipated

Table 4-8 continued
Treatment Alternative Evaluation

No.	Description	Advantages	Disadvantages
2	Construct a new parallel 12 mgd low pressure membrane plant and enhance the existing water plant to provide a total treatment capacity of 32 mgd.	■ Ability to meet current and future turbidity regulations ■ Ability to remove giardia and cryptosporidium ■ Meets AWWA program standards consistently ■ Consistent water quality regardless of incoming water quality ■ Membrane systems easier to expand than conventional systems ■ High pressure membranes could be added in the future	■ Doesn't meet 20-year projected water demands ■ Higher capital costs ■ Higher operating costs ■ Will not remove chlorides or TDS ■ Typically will not remove taste and odor constituents ■ Must use lime to soften water ■ Must use ozone and GAC filters to reduce taste and odor ■ No reduction in operating staff anticipated
3	Construct a new parallel 25 mgd low pressure membrane plant and enhance the existing water plant to provide a total treatment capacity of 45 mgd.	■ Ability to meet current and future turbidity regulations ■ Ability to remove giardia and cryptosporidium ■ Meets AWWA program standards consistently ■ Consistent water quality regardless of incoming water quality ■ Membrane systems easier to expand than conventional systems ■ High pressure membranes could be added in the future	■ Higher capital costs ■ Higher operating costs ■ Will not remove chlorides or TDS ■ Typically will not remove taste and odor constituents ■ Must use lime to soften water ■ Must use ozone and GAC filters to reduce taste and odor ■ No reduction in operating staff anticipated
4	Construct a new parallel conventional surface water treatment plant and enhance the existing mgd water plant to provide a total treatment capacity of 45 mgd.	■ Lower Cost ■ Lower energy requirement ■ Plant staff is familiar with process ■ Historically has met all regulations	■ Cannot remove chlorides or Total Dissolved Solids (TDS) ■ Must use lime to soften water ■ Susceptible to process upsets due to variability in raw water quality ■ At times, regulatory limits have been approached

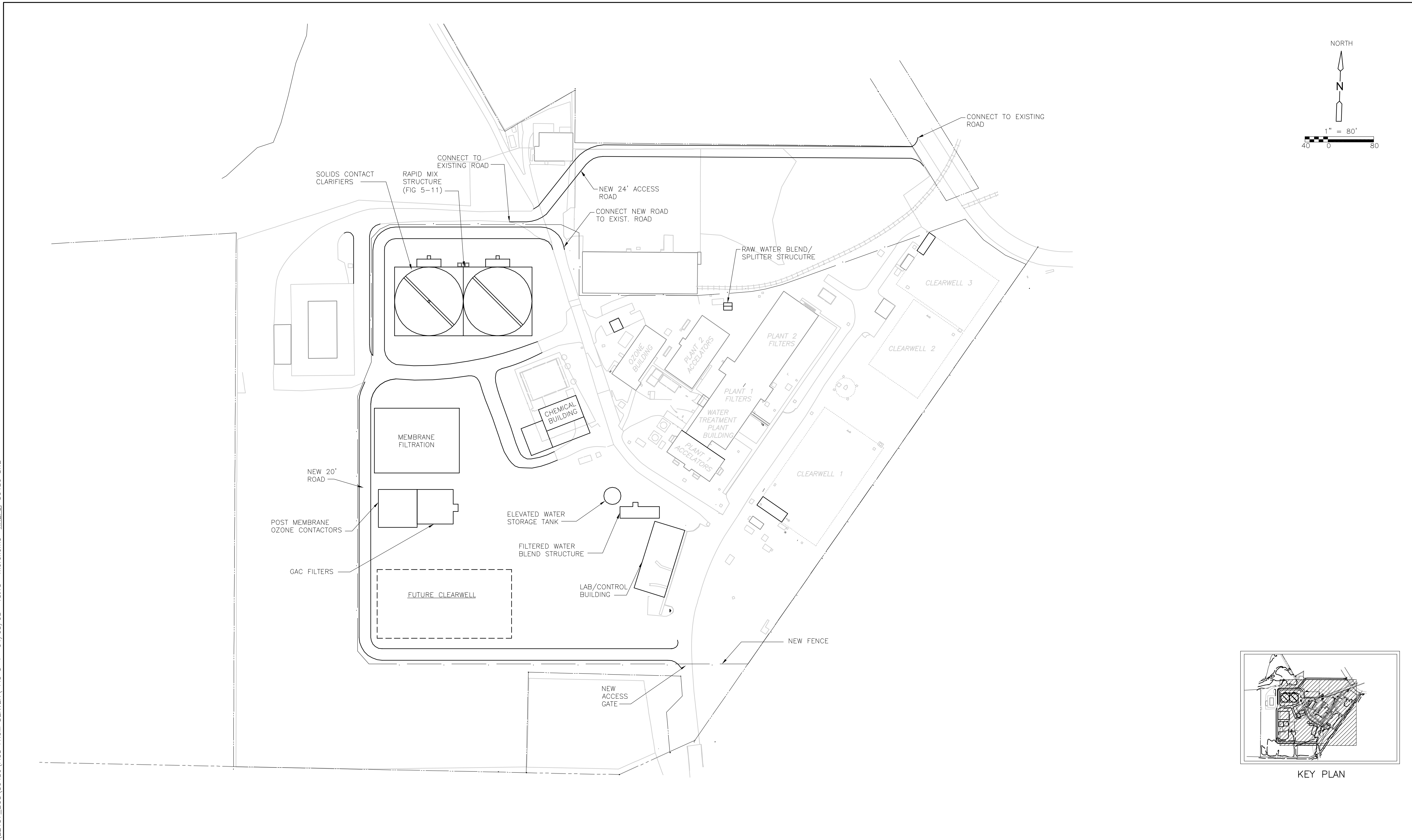
Section 5
Selected Plan Description
5.1 Selected Design
Alternative 3 involves construction of a new 25-mgd membrane filtration water treatment plant along with enhancements to the existing treatment plant. A site layout is shown in Figure 5-1. A schematic of the proposed treatment is shown in Figure 5-2. Blended Red River and reservoir water or water from either source will be treated. Finished water from the new WTP will be blended with finished water from the existing plant in the clearwells prior to introduction into the distribution system.

Major water treatment processes for the selected alternative include the following.

- Raw water supply expansion to 45 mgd firm
- New raw water blend/splitter structure
- Two new rapid mix basins
- Two new solids contact clarifiers
- Five new membrane filtration trains (microfiltration)
- Two new post-filter ozone contactors
- Six new granular activated carbon (GAC) contactors
- One new elevated water storage tank
- Modifications to existing ozone system
- Modifications to existing solids contact clarifiers
- Modifications to existing filters
- Additional chemical storage and feed capacity for all systems
- New filtered water blend structure
- High service pumping station expansion to 45 mgd firm

Table 5-1 presents design criteria for the proposed unit processes. The following paragraphs briefly describe the unit processes in this treatment train and their benefit in meeting water quantity and quality objectives.

Figure 5-1
Plant Layout



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-1 04/03/08 13:13 morenoma XREFS: 50486 SITE

CDM

Figure 5-1
SITE LAYOUT
Bossier City WTP Expansion

Figure 5-2
Plant Schematic

S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-2 04/03/08 13:24 morenoma

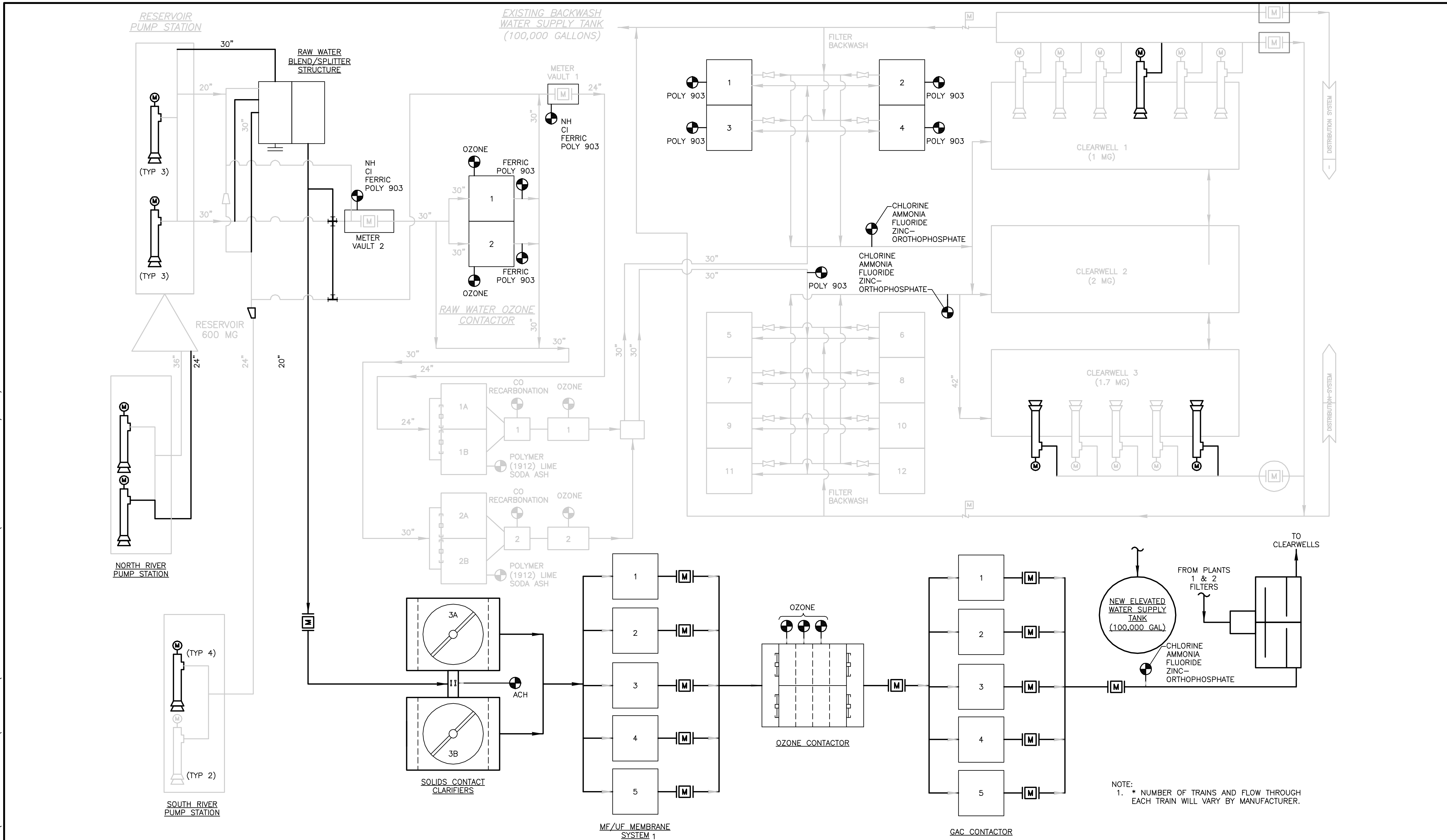


FIGURE 5-2
PLANT SCHEMATIC
BOSSIER CITY WTP EXPANSION

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Table 5-1
Bossier WTP Basis of Design Summary

Plant Component	Description
Plant Capacity	
Conventional Plant Design Flow	20 mgd
Membrane Plant Design Flow	25 mgd
Total Plant Capacity	*45 mgd*
Raw Water Blend/Splitter Structure	
Number of Units	1
Size (length x width x side water depth)	13 ft x 13 ft x 21 ft SWD
Flow Control Mechanisms	downstream gate valves
Number of Flow Splits	2,1 existing and 1 future
Rapid Mix at Membrane Plant	
Number of units	2
Size (length x width x side water depth), each	5.5 ft x 5.5 ft x 11 ft SWD
Capacity, each	12.5 mgd
Detention Time, each	30 seconds at average flow 17 seconds at max flow
Solids Contact Clarifiers at Membrane Plant	
System Description	Circular clarifiers installed in square basins
Number of Units	2
Design Criteria	0.5 gpm/ft^2 overflow rate 4 hours detention time
Capacity, each	12.5 mgd
Size (diameter x side water depth), each	120 ft x 20 ft SWD installed in 120 ft square basins
Detention time, hrs	4.1 hrs max flow 7.5 hrs at average flow
Post- Filter Ozone Contactors at Membrane Plant	
Number of units	2
Size (length x width x side water depth), each	20 ft x 60 ft x 20 ft SWD
Tank Volume, each	180,000 gallons
Design Baffling Coefficient	0.6
Applied Ozone Dosage	1 mg/L – 2 mg/L
Maximum Required Ozone Generation	420 lbs/day
Detention Time	15 min at max flow

Table 5-1
Bossier WTP Basis of Design Summary, continued

Plant Component	Description	
Membrane Filtration		
Number of units	5	
Description	Microfiltration membrane system in a submerged or pressure configuration	
Maximum Design Flux	Based on pilot test performed [1]	
Membrane Chemical Cleaning Interval	30-day minimum	
Membrane Cleaning Chemicals	Citric Acid Sodium Hypochlorite Sodium Hydroxide (neutralization) Sodium Bisulfite (neutralization)	
GAC Contactors at Membrane Plant		
Number of units	6	
Description	Gravity Filters	
Hydraulic Loading Rate	6 gpm/sf	
Empty Bed Contact Time (EBCT)	10 minutes at max daily flow (25 mgd)	
Raw Water Ozone Contactors at Conventional Plant		
Number of units	2	
Size (length x width x side water depth)	63 ft x 20 ft x 17.5 ft	
Tank Volume, total	330,000 gallons	
Baffling Coefficient for Evaluation	0.6	
Applied Ozone Dosage	3 to 5 mg/L, typical	
Solids Contact Clarifiers at Conventional Plant	*Plant 1*	*Plant 2*
Number of Units	2	2
Size (length x width x side water depth), each	43 ft x 43 ft x 15.5 ft	56 ft x 56 ft x 16.5 ft
Capacity, each at 20 mgd	3.7 mgd	6.3 mgd
Upflow Rate, each at 20 mgd	1.75 gpm/ft^2	1.75 gpm/ft^2
Recarbonation Boxes at Conventional Plant	*Plant 1*	*Plant 2*
Number of Units	1	1
Size (length x width x side water depth), each	12.5 ft x 12.5 ft x 12.5 ft	12.5 ft x 12.5 ft x 12.5 ft
Tank Volume	14,600 gallons	14,600 gallons
Detention Time, at 20 mgd	2.8 minutes	1.7 minutes
Pre-Filter Ozone Contactors at Conventional Plant	*Plant 1*	*Plant 2*
Number of Units	2	2
Size (length x width x side water depth), each	27 ft x 12 ft x 19 ft	32 ft x 12 ft x 19 ft
Tank Volume, total	94,000 gallons	113,000 gallons
Baffling Coefficient for Evaluation	0.6	
Applied Ozone Dosage	1 to 2 mg/L, typical	

Table 5-1
Bossier WTP Basis of Design Summary, continued

Plant Component	Description	
Filters at Conventional Plant	*Plant 1*	*Plant 2*
Number of Units	4	8
Type	Dual Media	
Size (length x width), each	25 ft x 28 ft	32 ft x 25 ft
Capacity, each at 20 mgd	1.5 mgd	1.8 mgd
Surface Area, each	700 ft^2	800 ft^2
Surface Loading Rate (all filters in operation)	1.6 gpm/ ft^2	1.6 gpm/ ft^2
Washwater Supply Tank at Conventional Plant		
Number of Units	1	
Capacity	100,000 gallons	
Washwater Supply Tank at Membrane Plant		
Number of Units	1	
Capacity	100,000 gallons	
Filtered Water Blend Structure		
Number of Units	1	
Flow Control Mechanisms	manual, adjustable weir gates	
Number of Flow Splits	3,2 existing and 1 future	
High Service Pumps	*HSPS at Clearwell 1*	*HSPS at Clearwell 3*
Number of Units	Total = 6 5 at 200 HP 1 at 300 HP	Total = 5 3 at 200 HP 2 at 300 HP
Design Capacity of Pumps	5 at 2,800 gpm at 215 ft 1 at 4,500 gpm at 215 ft	3 at 2,800 gpm at 215 ft 2 at 4,500 gpm at 215 ft
Type	Vertical Turbine	
Capacity, Total	52 mgd	
Capacity, Firm [2]	45 mgd	
Clearwell Storage		
Clearwell 1	1 MG	
Clearwell 2	2 MG	
Clearwell 3	1.7 MG	
Primary Polymer (903)		
Number of Storage Tanks	2	
Type	Bulk Tank	
Capacity	2,250 gallons, each 4,500 gallons, total	
Number of Feed Pumps	3	
Maximum Pump Capacity	23 gallons per hour, neat polymer 4,660 gallons per hour, dilution water	

Table 5-1
Bossier WTP Basis of Design Summary, continued

Plant Component	Description
Secondary Polymer (1912)	
Number of Storage Tanks	1
Type	Bulk Tank
Capacity	1,000 gallons
Number of Feed Pumps	2
Maximum Pump Capacity	4 gallons per hour, neat polymer 1,600 gallons per hour, dilution water
Ferric Sulfate	
Number of Storage Tanks	2
Type	Bulk Tank
Capacity	4,900 gallons, each 9,800 gallons, total
Number of Feed Pumps	3
Maximum Pump Capacity	38.5 gallons per hour, neat polymer
Ammonia	
Number of Storage Tanks	1
Type	Bulk Tank
Capacity	2,000 gallons
Number of Feed Pumps	4
Maximum Pump Capacity	300 pounds per day
Chlorine	
Number of Storage Tanks	22
Type	Ton Cylinders
Capacity	22 tons
Number of Chloinators	3
Maximum Pump Capacity	3,000 pounds per day
Lime	
Number of Storage Tanks	1
Type	Silo
Capacity	80 tons, 4,750 cubic feet
Number of Slurry Pumps	2
Maximum Pump Capacity	2,900 gallons per hour
Number of Mixers	1 at ¾ HP
Slurry Tank Capacity	400 gallons

Table 5-1
Bossier WTP Basis of Design Summary, continued

Plant Component	Description
Soda Ash	
Number of Storage Tanks	1
Type	Silo
Capacity	90 tons, 4,750 cubic feet
Number of Slurry Pumps	2
Maximum Pump Capacity	7,700 gallons per hour
Number of Mixers	1 at 2 HP
Slurry Tank Capacity	1,700 gallons
Carbon Dioxide	
Number of Storage Tanks	1
Type	Bulk Tank
Capacity	68,000 pounds, 8,560 gallons
Number of Carbonic Acid Feed Panels	2
Maximum Feed Capacity	160 pounds per hour
Aluminum Chlorohydrate	
Number of Storage Tanks	2
Type	Bulk Tank
Capacity	6,100 gallons, each 12,200 gallons, total
Number of Feed Pumps	3
Maximum Pump Capacity	12 gallons per hour
Fluoride	
Number of Storage Tanks	2
Type	Bulk Tank
Capacity	2,000 gallons, each 4,000 gallons, total
Number of Feed Pumps	2
Maximum Pump Capacity	12 gallons per hour
Zinc Orthophosphate	
Number of Storage Tanks	2
Type	Bulk Tank
Capacity	2,000 gallons, each 4,000 gallons, total
Number of Feed Pumps	2
Maximum Pump Capacity	12 gallons per hour

Table 5-1
Bossier WTP Basis of Design Summary, continued

Plant Component	Description
Ozone	
Number of Liquid Oxygen Storage Tanks	2
Type	Bulk Tank
Capacity	1 – 11,000 gallons and 1 – 15,000 gallons 26,000 gallons, total
Number of Ozone Generators	3
Capacity	1 at 600 lbs/day 2 at 1,200 lbs/day
North River Pump Station	
Number of Pumps	2
Type	Vertical Turbine
Design Capacity of Pumps	17,000 gpm (24.5 mgd) at 52 ft, 300 HP, each
Capacity, Total	43 mgd
Capacity, Firm [2]	22 mgd
Reservoir Pump Station	
Number of Pumps	6
Type	Vertical Turbine
Design Capacity of Pumps	3 at 3,500 gpm (5.0 mgd) at 125 ft, 150 HP, each 3 at 8,000 gpm (11.5 mgd) at 100 ft, 250 HP, each
Capacity, Firm [2]	48 mgd
South River Pump Station	
Number of Pumps	6
Type	Vertical Turbine
Design Capacity of Pumps	3 at 7,000 gpm (10 mgd) at 62 ft, 200 HP, each 3 at 11,000 gpm (16 mgd) at 83 ft, 300 HP, each
Capacity, Firm [2]	51 mgd

1. Refer to CDM Water Treatment Plant Pilot Study Report.
2. Firm capacity assumes that one, of the larger pumps if applicable, is out of service.

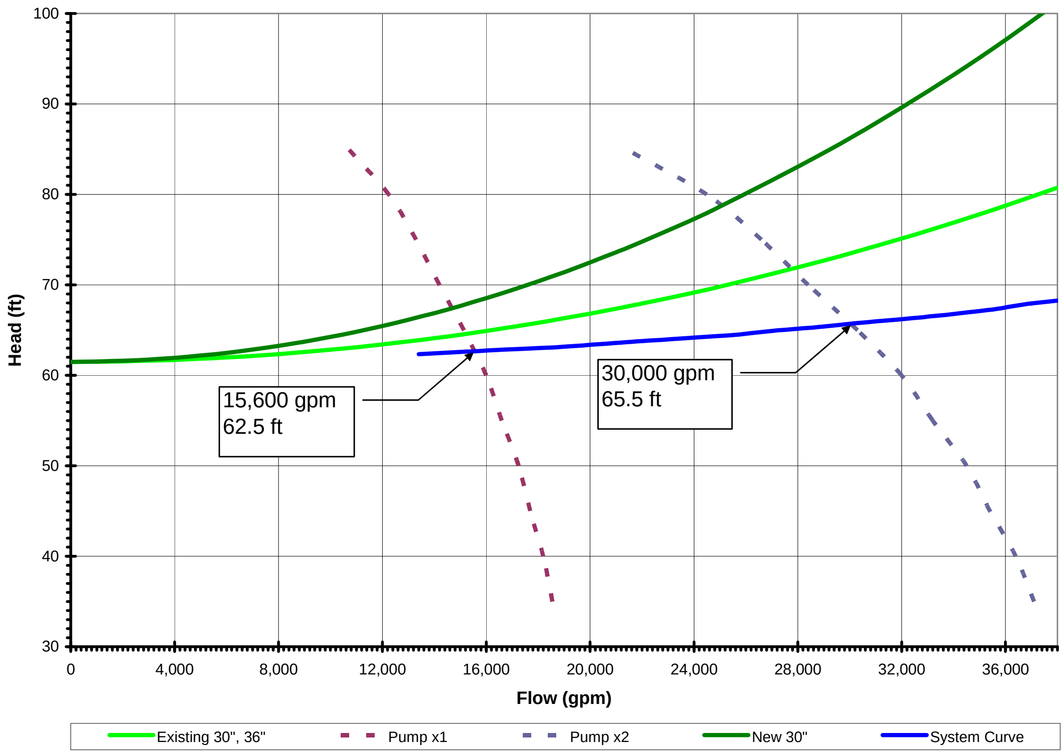
5.2 Raw Water Supply Expansion to 45 mgd

5.2.1 North River Pump Station Modifications

Due to the age of the existing pumps, CDM recommends that both pumps be replaced with new vertical turbine pumps with design capacity of 17,000 gpm at 52 feet of head. Since this pump station does not supply the WTP directly, the 22 mgd firm capacity of the North River Pump Station is adequate. CDM recommends installing a parallel 30-inch pipeline from the North River Pump Station to the reservoir. With both pumps in operation and utilizing the 20-inch and new 30-inch pipelines, approximately 43 mgd of raw water would be supplied to the reservoir as shown in Figure 5-3. A new monorail, hoist, and staircase are needed at the North River Pump

Station to replace existing equipment in poor condition. Modifications are shown in Figure 5-4.

Figure 5-3
North River Pump Station System Curve



5.2.2 Reservoir Pump Station Modifications

Recommended modifications to the Reservoir Pump Station are shown in Figure 5-5. Due to the age of the existing pumps, CDM suggests that all six pumps be replaced with new vertical turbine pumps. Three of the pumps would have a design capacity of 8,000 gpm at 100 feet of head while the other three pumps would have a design capacity of 3,500 gpm at 125 feet of head. CDM recommends installing a parallel 30-inch pipeline from the Reservoir Pump Station to the WTP in order to transport 45 mgd of raw water to the WTP. The firm capacity of the reservoir pump station with modifications recommended is 51 mgd as shown in Figure 5-6. A new monorail and hoist are needed at the Reservoir Pump Station to replace existing equipment in poor condition.

Figure 5-4
North River Pump Station Modifications

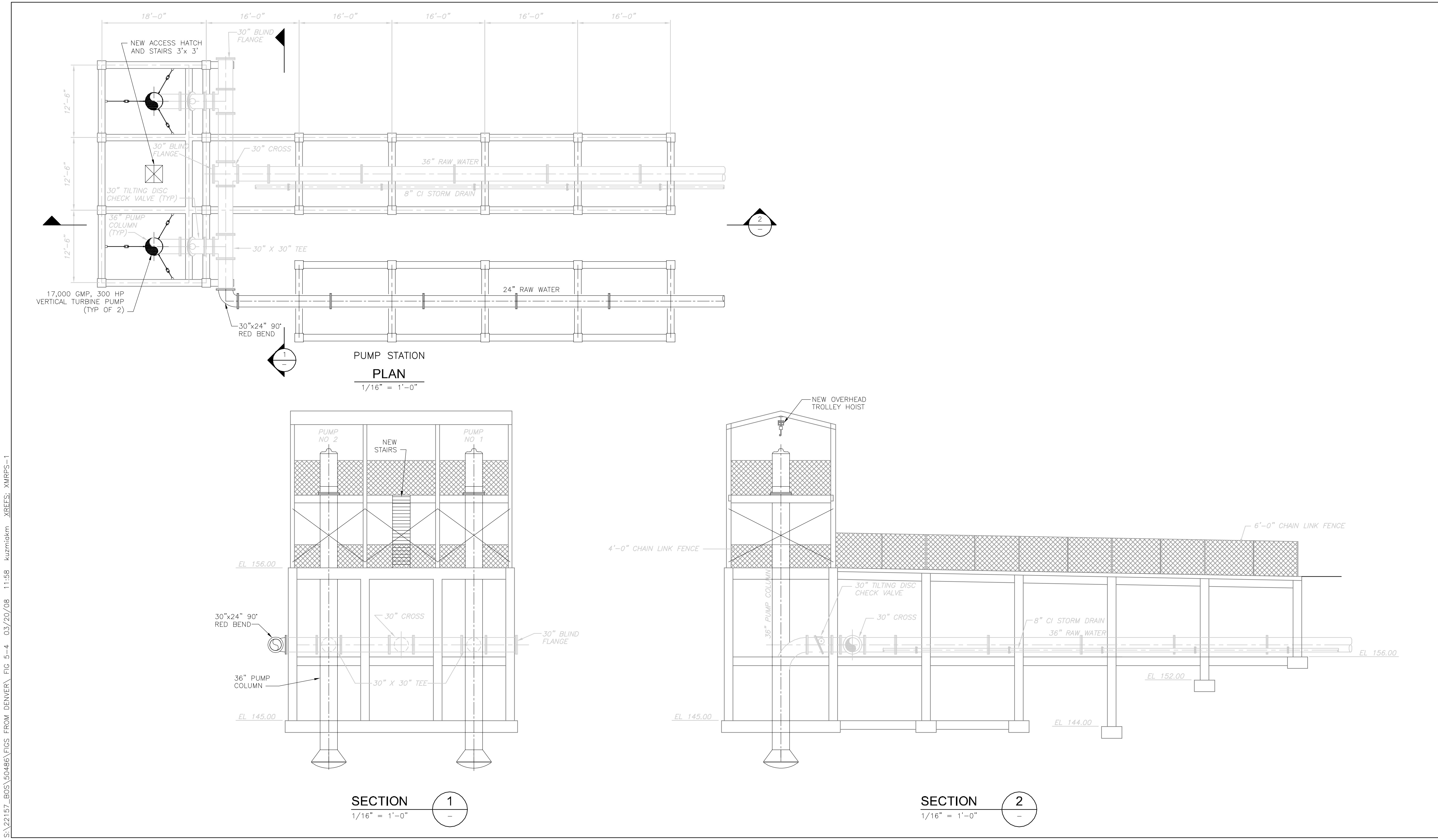
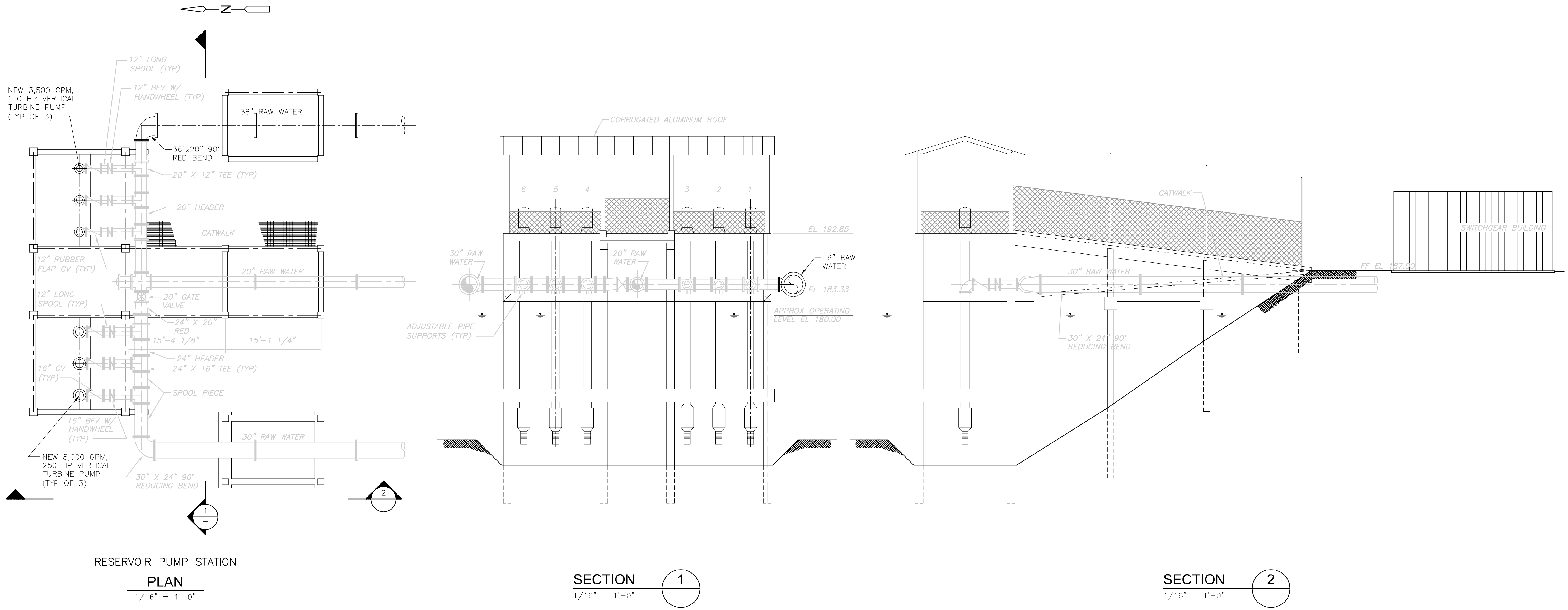


FIGURE 5-4
NORTH RIVER PUMP STATION
MODIFICATIONS PLANS AND SECTIONS
BOSSIER CITY WTP EXPANSION

Figure 5-5
Reservoir Pump Station Modifications



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-5 03/21/08 13:54 kuzmickm XREFS: XMRPS

FIGURE 5-5
RESERVOIR PUMP STATION
MODIFICATIONS PLANS AND SECTIONS
BOSSIER CITY WTP EXPANSION

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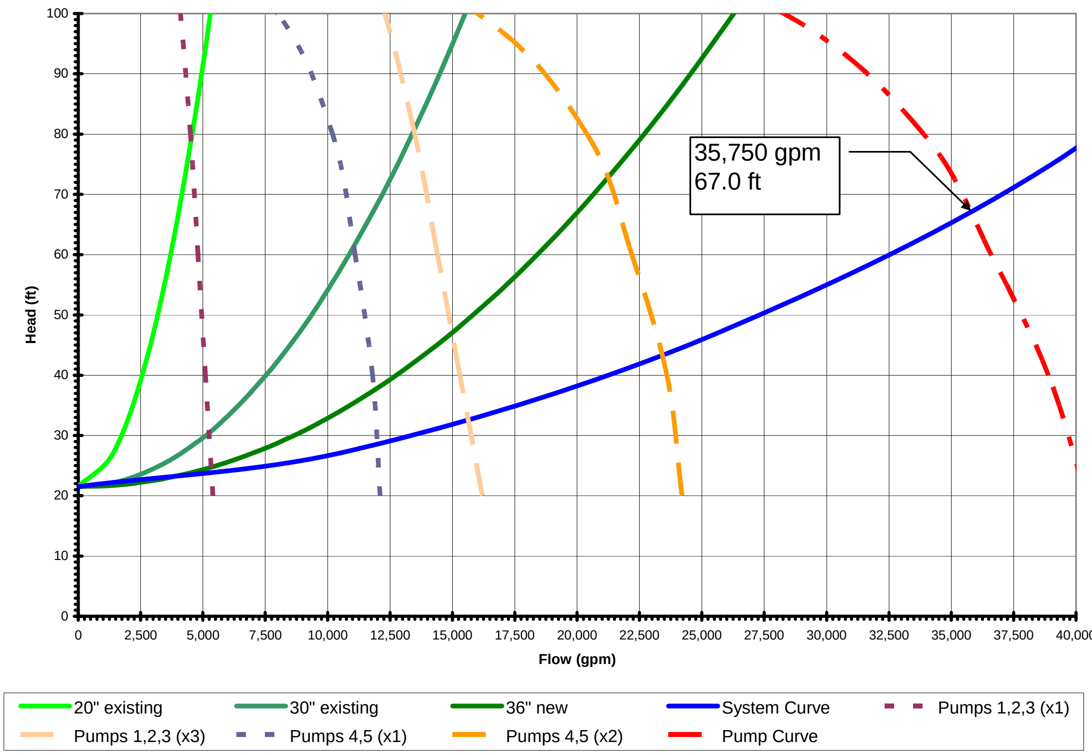
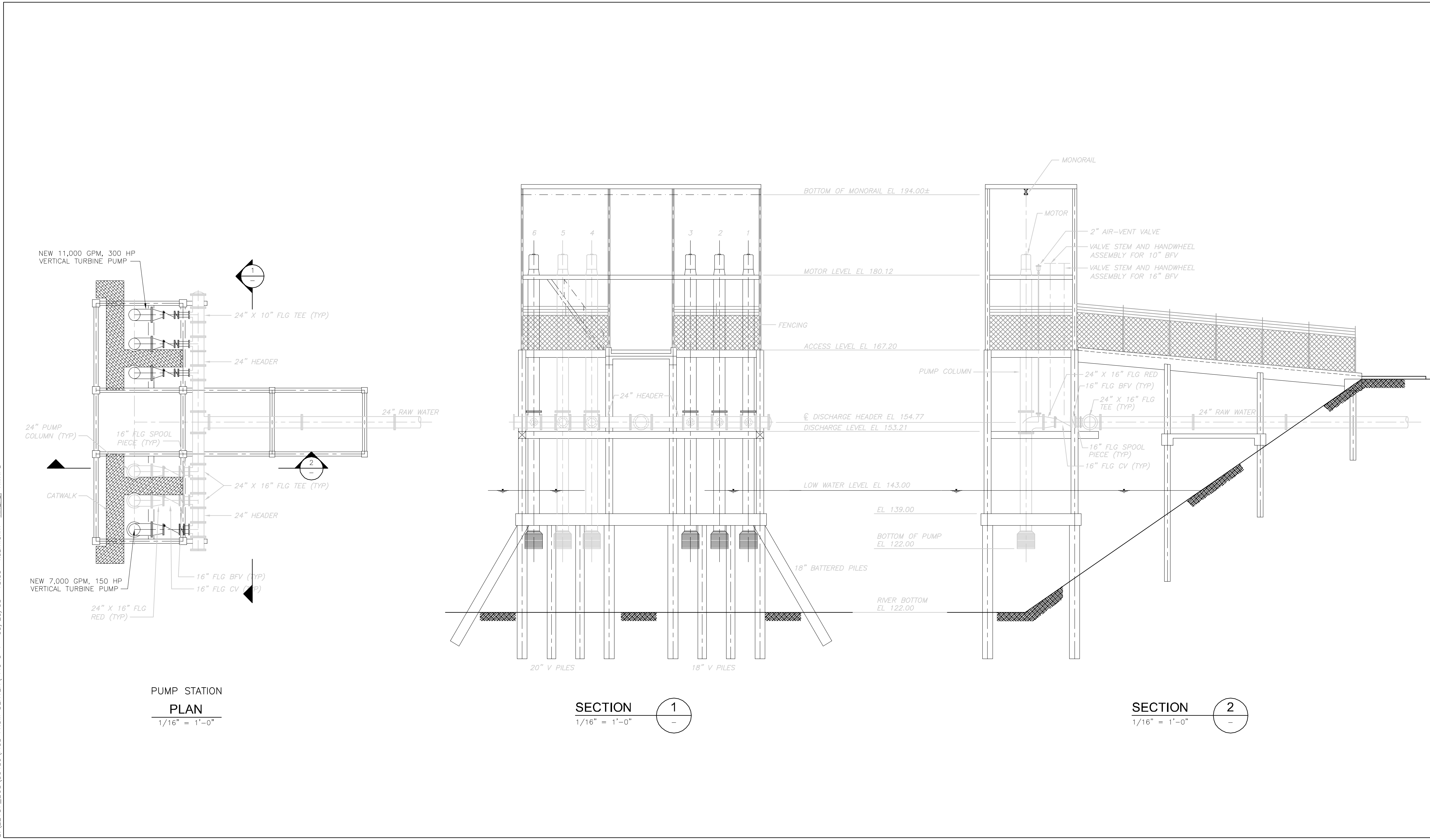
Figure 5-6
Reservoir Pump Station System Curve



5.2.3 South River Pump Station Modifications

Recommended modifications to the South River Pump Station are shown in Figure 5-7. Since these pumps were installed in 2002, replacement of the existing pumps is not necessary. CDM recommends that one additional vertical turbine pump with design capacity of 7,000 gpm at 62 feet of head and three additional vertical turbine pumps with design capacity of 11,000 gpm at 83 feet of head be installed to work with the existing two vertical turbine 7,000 gpm pumps. With all three of the 7,000 gpm pumps and two of the 11,000 gpm pumps in operation and utilizing the existing 30-inch pipeline, approximately 48 mgd of raw water could be supplied to the WTP as shown in Figure 5-8. A new monorail, hoist, and staircase are needed at the South River Pump Station to replace existing equipment in poor condition.

Figure 5-7
South River Pump Station Modifications



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-7 03/20/08 15:05 kuzmiakm XREFS: XMRPS

FIGURE 5-7
SOUTH RIVER PUMP STATION
MODIFICATIONS PLANS AND SECTIONS
BOSSIER CITY WTP EXPANSION

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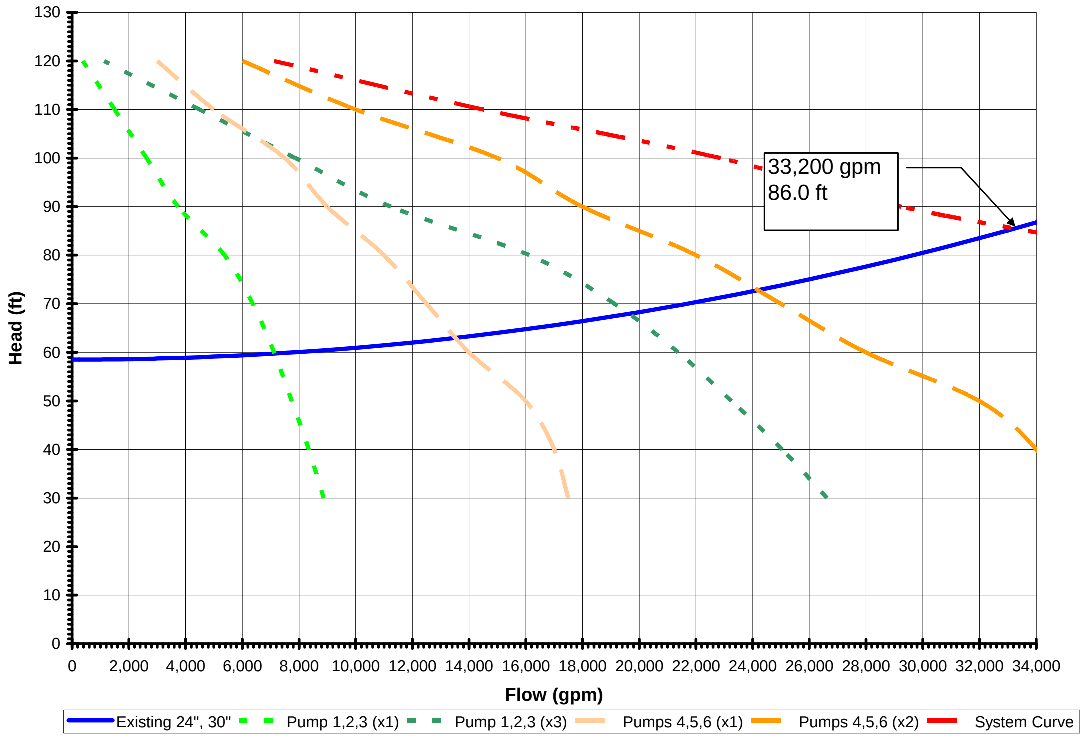
Figure 5-8
South River Pump Station System Curve

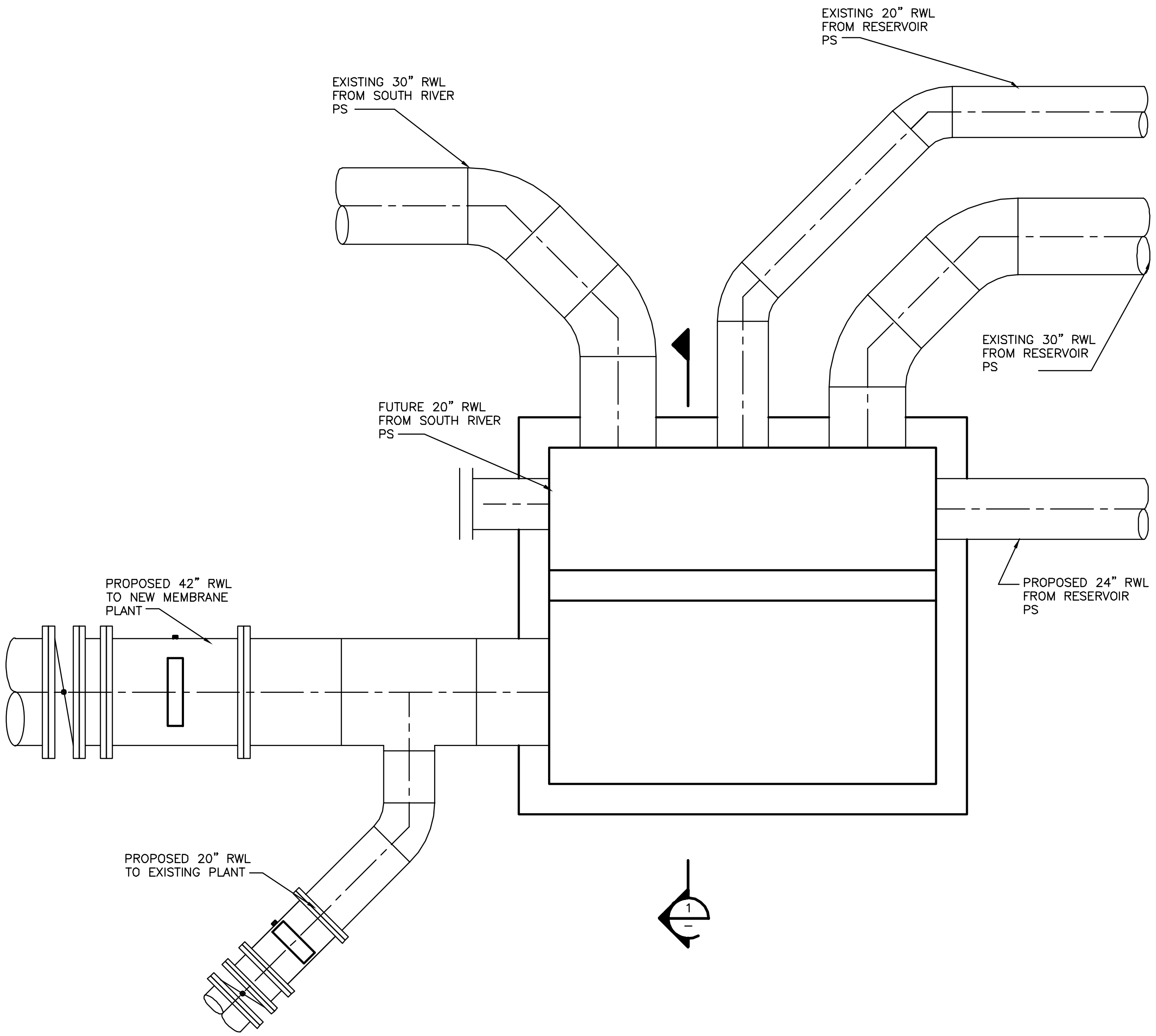


5.3 Raw Water Blend/Splitter Structure

Raw water will be pumped from two sources (i.e., the reservoir and directly from the Red River via South River Pump Station) with different water quality. The Raw Water Blend/Splitter Structure will produce a less variable water quality to send to the downstream processes. Currently, plant staff must limit flow from each of the raw water pump stations to prevent potential damage to pipes. The Raw Water Blend/Splitter Structure will allow the Reservoir and South River Pump Stations to operate independently.

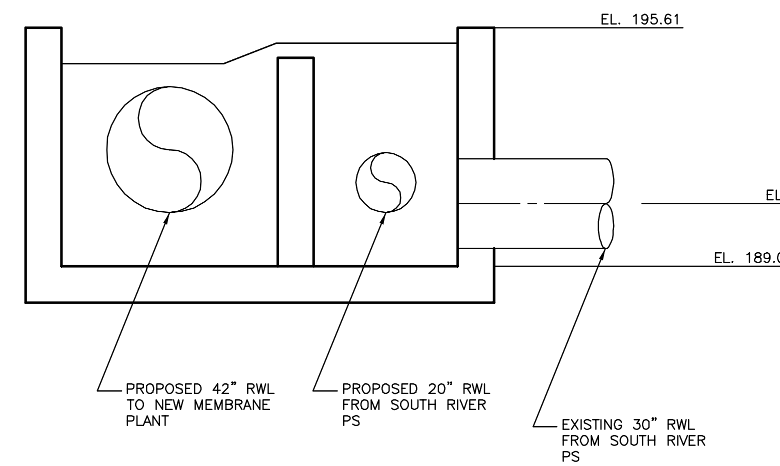
The raw water from both sources will enter near the bottom of the blending structure. To enhance additional mixing the raw water will then flow over a non-flow controlling weir wall. The water will be gravity fed from the structure and metered to ensure the plant flows will be proportionally split between the process trains. Figure 5-9 illustrates the Raw Water Blend/Splitter structure.

Figure 5-9
Raw Water Blend/Splitter Structure



BLENDING/SPLITTER STRUCTURE

PLAN
3/16" = 1'-0"



NOTE: RAW WATER PIPELINE LENGTHS ARE NOT DRAWN TO SCALE.

SECTION (1/–)
3/16" = 1'-0"

S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-9 04/04/08 10:03 morenoma XREFS: XMBLNDG_SPLTR

FIGURE 5-9
RAW WATER BLEND / SPLITTER STRUCTURE
BOSSIER CITY WTP EXPANSION

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5.4 Rapid Mix / Clarification at the Membrane Plant

Clarification will be accomplished in two 12.5-mgd parallel train rapid mix/clarification unit processes. Figures 5-10 and 5-11 show the rapid mix basin and clarifiers at the membrane plant.

5.4.1 Rapid Mix Basin at the Membrane Plant

Pilot testing by CDM demonstrated that coagulation with aluminum chlorohydrate (ACH) followed by sedimentation was the most successful pretreatment prior to membrane filtration. The new 25 mgd plant will not have the capability to soften but the existing 20 mgd plant will be provided with better softening capability. During times when raw water hardness levels are elevated, the finished water hardness levels in the blended water from the existing and new treatment facilities is expected to be at acceptable levels.

The Rapid Mix Basin design is based upon providing 30 seconds maximum detention time at average daily flow of 14 mgd. Two rapid mix basins, 5.5 ft by 5.5 ft with an 11 ft side water depth would be constructed with common wall construction. The basins will provide 17 seconds of detention time at a maximum flow of 25 mgd.

5.4.2 Solids Contact Clarifiers at the Membrane Plant

Two new clarifiers will be designed as circular clarifiers with filleted corners in square basins. The units are designed to provide:

- Overflow rate less than or equal to 0.5 gpm/ft^2
- Detention time of 4 hrs at maximum flow and 7.5 hrs at average flow
- Initial size: two basins, each 120 ft square by 20 ft side water depth

While the goal of the clarification process for this alternative is to be able to produce a settled water with a turbidity of 2 NTU or less.

5.5 Membrane Filtration

For the low pressure membrane system, at least five trains of membrane filtration will be provided. The purpose of the membrane filtration system is for the removal of residual suspended solids and microbial constituents. The membrane system meets all EPA requirements for achieving complete removal of *Giardia* and *Cryptosporidium*. Credit for virus removal is on a state-by-state basis and is typically not granted for low pressure membrane systems. Therefore, virus inactivation will be needed through other disinfection means at the plant (i.e.,ozone).

Figure 5-10
Rapid Mix and Solids Contact Clarifiers Plan View

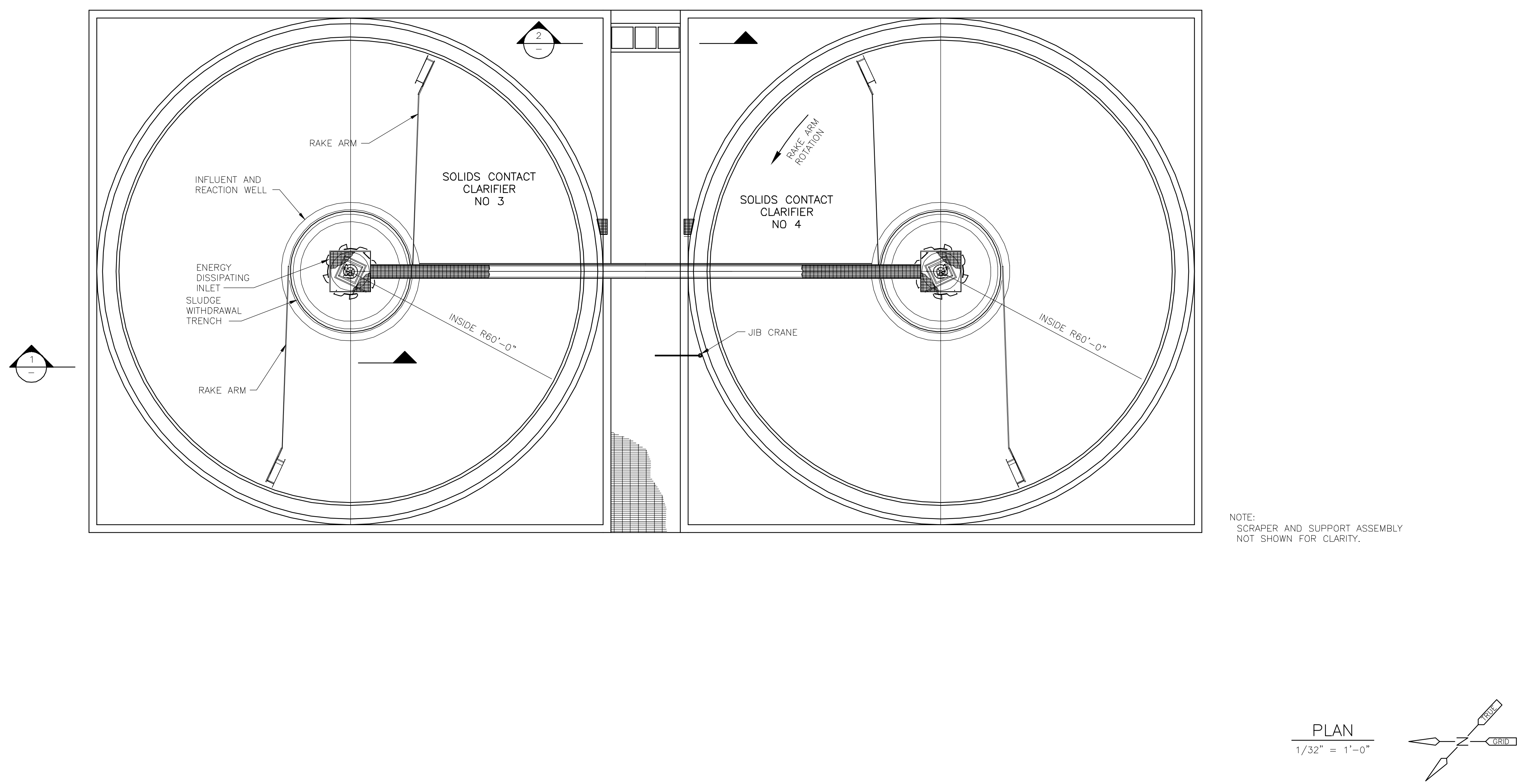

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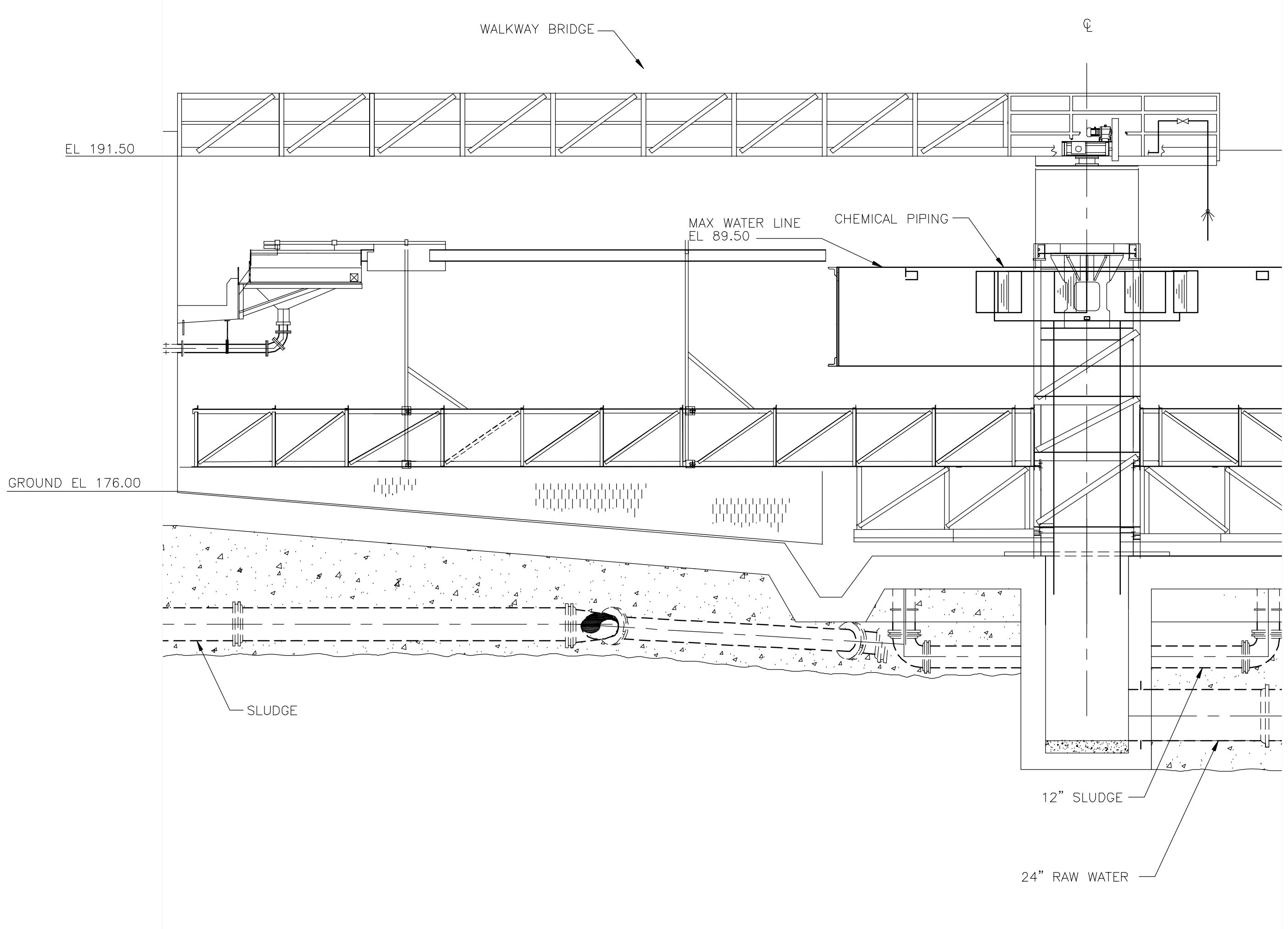
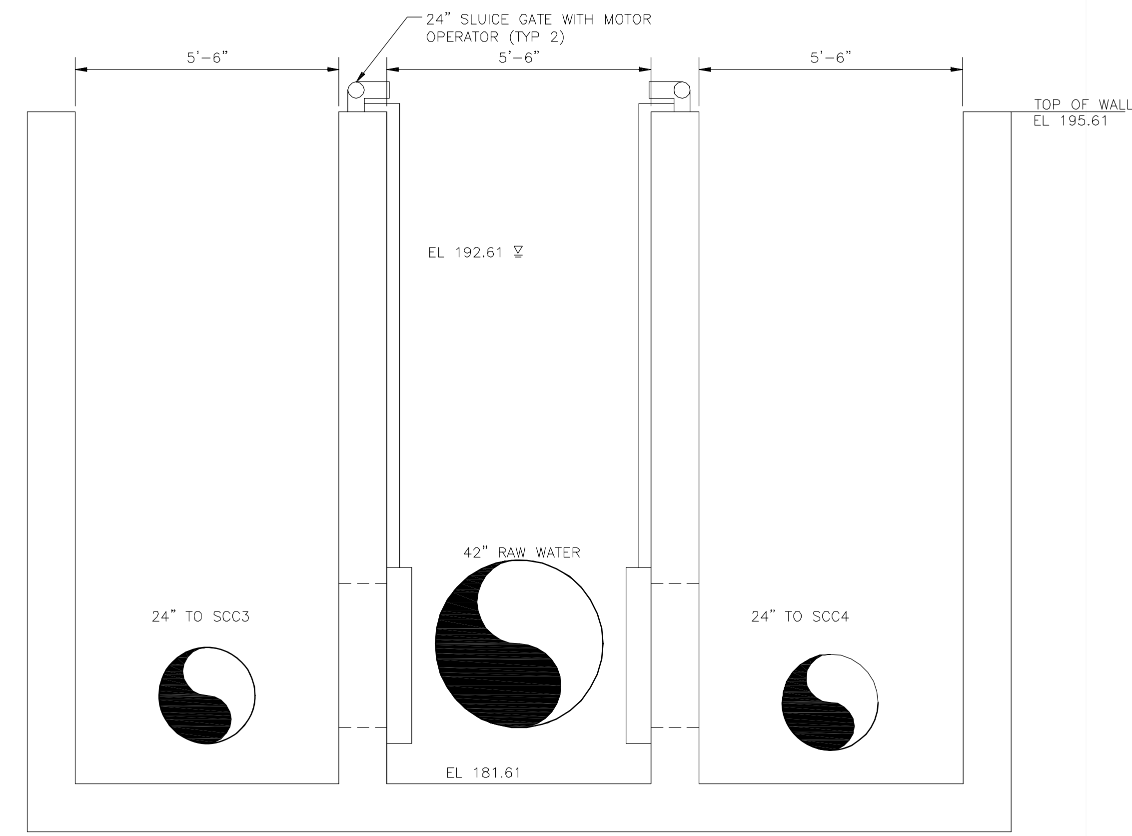
FIGURE 5-10
SOLIDS CONTACT CLARIFIERS PLAN VIEW
BOSSIER CITY WTP EXPANSION

CDM

Figure 5-11
Rapid Mix and Solids Contact Clarifiers Section



SECTION 1
3/32" = 1'-0" MK-2



RAPID MIX STRUCTURE
SECTION 2
1/4" = 1'-0" –

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FIGURE 5-11
SOLIDS CONTACT CLARIFIERS PROFILE VIEW
BOSSIER CITY WTP EXPANSION

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The membrane filtration system will include microfiltration (MF) or ultrafiltration (UF) membranes in the pressurized operating mode. The proposed membrane filtration system will generally consist of:

- Membrane modules
- Membrane skids or cells
- Filtrate or feed pumps
- Backwash system
- Chemical clean-in-place system
- Compressed air system
- Miscellaneous piping and valves
- Instrumentation and controls

Each of these subsystems is described briefly below, with general design criteria given for major system components.

5.5.1 Membrane Modules

The membrane modules (MF or UF) consist of hollow fiber membranes, manufactured from polyvinyl difluoride (PVDF) material. Three systems were pilot tested. The decision has been made to use the pressureized membranes, and the following membranes are approved to bid the project:

- Memcor UF CMF-L (pressurized) as manufactured by Siemens; and
- Pall MF (pressurized).

5.5.2 Membrane Skids or Cells

Membrane modules will be connected hydraulically and arranged into either pressurized membrane skids or submerged membrane cells. For pressurized systems, each skid will contain groups of modules with all required piping, valves, and supports for independent skid operation contained within the skid. Membrane modules will be easily removable from the skid. Water will be forced through the membranes under pressure using variable frequency driven feed pumps. Figures 5-12 and 5-13 show pressurized membrane layout.

The production rate for each unit of membrane area is commonly referred to as membrane flux, and is defined as the daily production from the membranes per unit of membrane surface area in gallons per square foot per day (gfd). The allowable flux is dependent on the results of the pilot test data and is also based on the feed water temperature.

Figure 5-12
Pressure Membranes Treating Settled Water Plan View

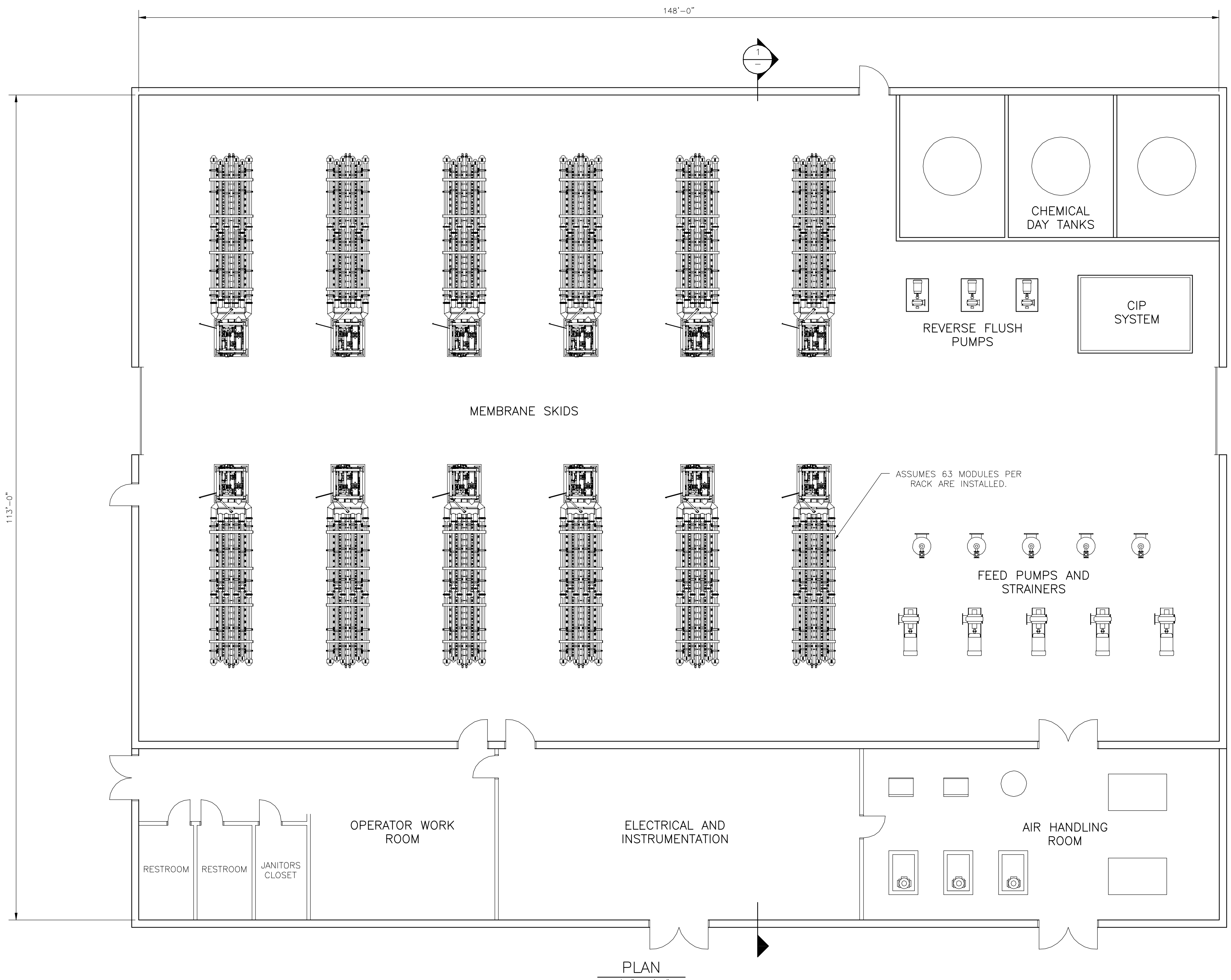

FIGURE 5-12
PRESSURE MEMBRANES TREATING SETTLED WATER - PLAN VIEW
BOSSIER CITY WTP EXPANSION

CDM

Figure 5-13
Pressure Membranes Treating Settled Water Cross Section

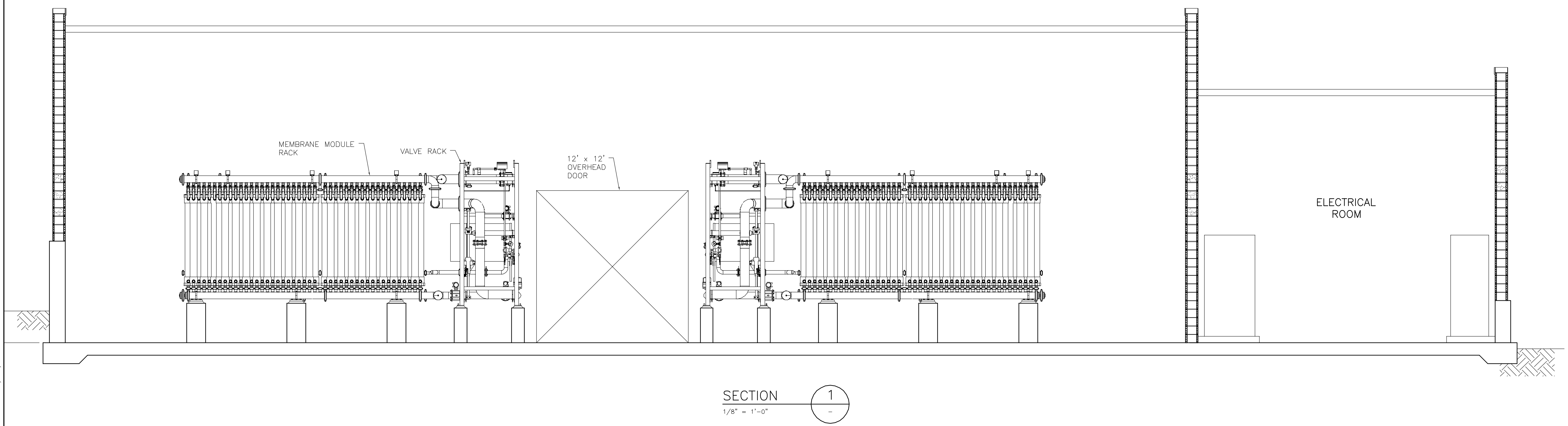

FIGURE 5-13
PRESSURE MEMBRANES TREATING SETTLED WATER - CROSS SECTION
BOSSIER CITY WTP EXPANSION

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5.5.3 Feed / Filtrate and Backwash Pumps

The feed/filtrate pumps provide the force to drive the water through the membranes. The backwash pumps push water backwards through the membrane to clean the membrane surface and lower the trans-membrane pressure. Backwashes are typically performed every 20 to 25 minutes for 1 to 3 minutes. Two backpulse pumps are provided to service all the membrane treatment trains, with one of the two being a redundant standby pump. The backwash processes will be carried out automatically through the membrane and plant control system.

Spent backwash water exiting the membrane cells or skids will be discharged in a controlled manner and routed to the head of the treatment plant. The backwash system will be designed such that no more than one cell or skid can be backwashing at any time.

5.5.4 Membrane Air Scour Blowers and Air Compressors

The membrane system also uses air during the backwash cycle to help clean the membrane surface. The membrane system will also include a compressed air system for the following applications:

- Operation of the pneumatic actuated valves associated with the membrane filtration system
- Operation of the membrane integrity test system
- Operation of all miscellaneous appurtenances, as applicable by the proposed MF/UF system supplier

Firm on-line standby capacity will be provided for the systems listed above. The system will include a complete compressed air system consisting of compressors, ASME-rate receiver refrigerated air dryer, controls, pressure relief valves, manual shutoff valves, pressure gauges, vibration mounts and all mounting hardware, inlet filter silencer, air regulator assemblies and air filters.

5.5.5 Membrane Cleaning System

When the trans-membrane pressure (TMP) exceeds the normal operating limits, the membranes require a chemical clean-in-place (CIP) to restore the membrane permeability. The membrane cleaning system includes a tank for heating up the water used in the chemical cleaning solution, CIP transfer pumps, concentrated chemical storage, inline chemical dosing pumps, and chemicals for neutralizing the spent cleaning solutions before disposal. The chemicals expected to be used for cleaning are citric acid and sodium hypochlorite, and the typical soaking time is approximately eight hours. Depending on the disposal requirements for spent chemical solutions, sodium hydroxide and sodium bisulfite chemicals and the necessary feed pumps are provided for neutralization.

Each membrane CIP chemical feed system will include duty and stand-by chemical metering pumps, valves, flow meters, pressure gauges and switches, flow confirmation switches and controls. The system will include CIP make-up water transfer pumps which transfer water from the CIP storage tank to the MF Cells or skids.

5.6 Post-Membrane Ozone Contactors

Two 12.5 mgd post-membrane ozone contactors will be constructed for the new facility. An applied ozone dose of between 1 to 2 mg/L is anticipated for this alternative, which is equivalent to between 208 to 418 lbs/day ozone.

Contactor size is based upon required volume to provide the necessary CT using a conservative design baffling coefficient of 0.6. Two units, each approximately 60 ft by 20 ft by 20-feet side water depth would provide the required volume for primary CT credit. Total pre-filter ozone contactor volume is 360,000 gallons with a hydraulic detention time of better than 15 minutes. Figures 5-14 and 5-15 illustrate the post-membrane ozone contactor. Modifications to the ozone supply system are discussed in Section 5.9.

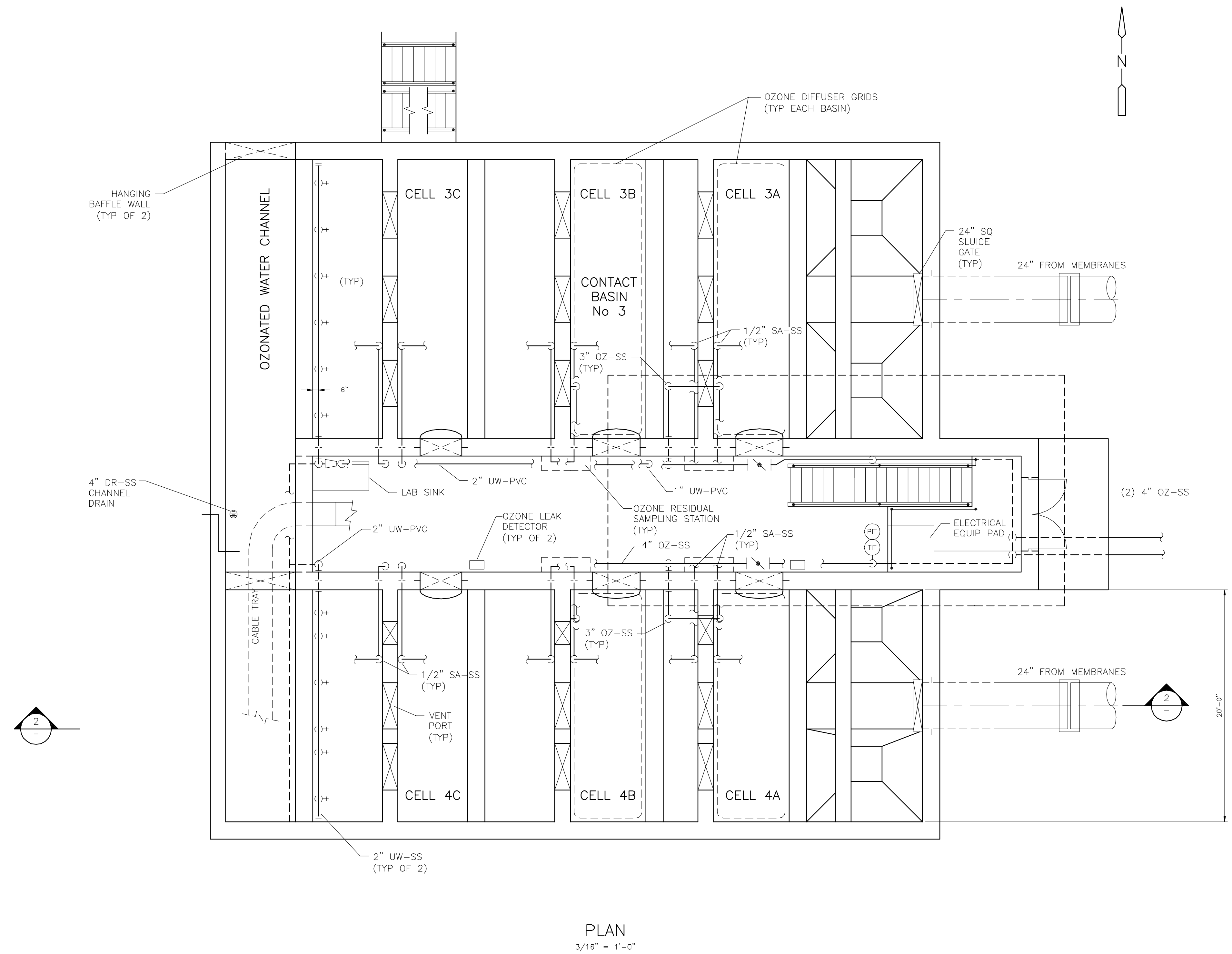
5.7 GAC Contactor System at the Membrane Plant

Granualar activated carbon (GAC) contactors will provide a biologically active polishing step for removal of assimiable organic carbon (AOC) as well as additional taste and odor control. The AOC levels in the treated water become elevated following ozonation. The biological process that occurs within the GAC contactors will reduce the AOC levels to acceptable levels in the finished water. This analysis, assumes that the GAC would not be replaced/regenerated on a frequent basis. The media would provide a medium for sustaining biofilms for AOC removal. For this analysis, replacement of GAC media every 10 years is assumed. The contact basins could be constructed of concrete using gravity flow with open top beds. The GAC contactors will be sized for a maximum loading rate of 6.0 gpm/sq ft to provide a minimum empty bed contact time (EBCT) of 10 minutes. Figure 5-16 shows the GAC contactor.

5.8 Elevated Water Storage Tank at the Membrane Plant

A 100,000 gallon elevated water storage tank will be provided as a water supply source for backwash of the GAC contactors. This elevated tank will be made of steel and have a diameter of approximately 30 feet. The tank will be filled using the high service pumps. Figure 5-17 shows the elevated water storage tank.

Figure 5-14
Post-Membrane Ozone Contactor Plan View



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-14 04/04/08 10:10 morenoma

FIG 5-14
POST MEMBRANE OZONE CONTACTOR
BOSSIER CITY WTP EXPANSION

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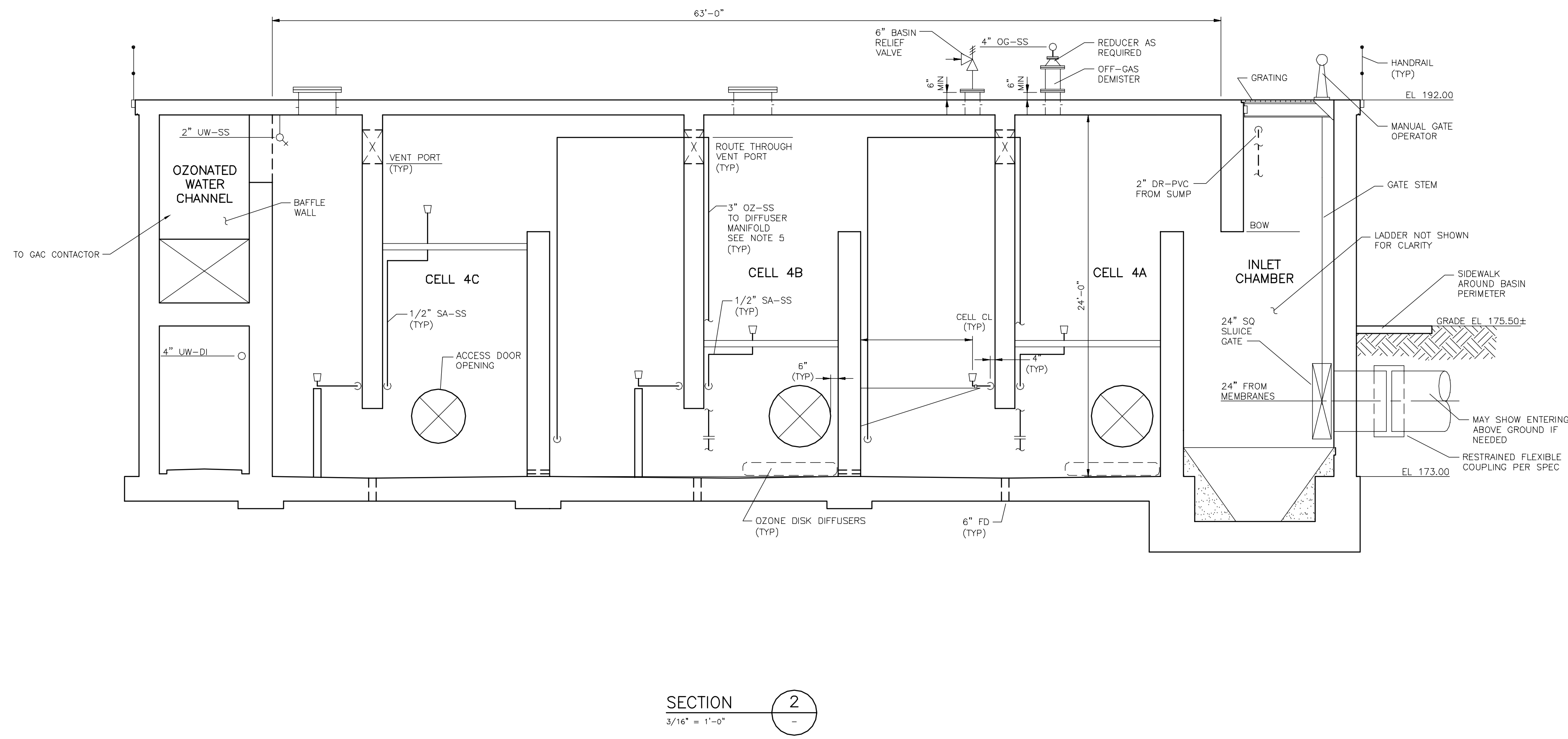
Figure 5-15
Post-Membrane Ozone Contactor Cross Section



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-15 04/04/08 10:09 morenoma

FIG 5-15
POST MEMBRANE OZONE CONTACTOR CROSS SECTION
BOSSIER CITY WTP EXPANSION

Figure 5-16
GAC Contactor

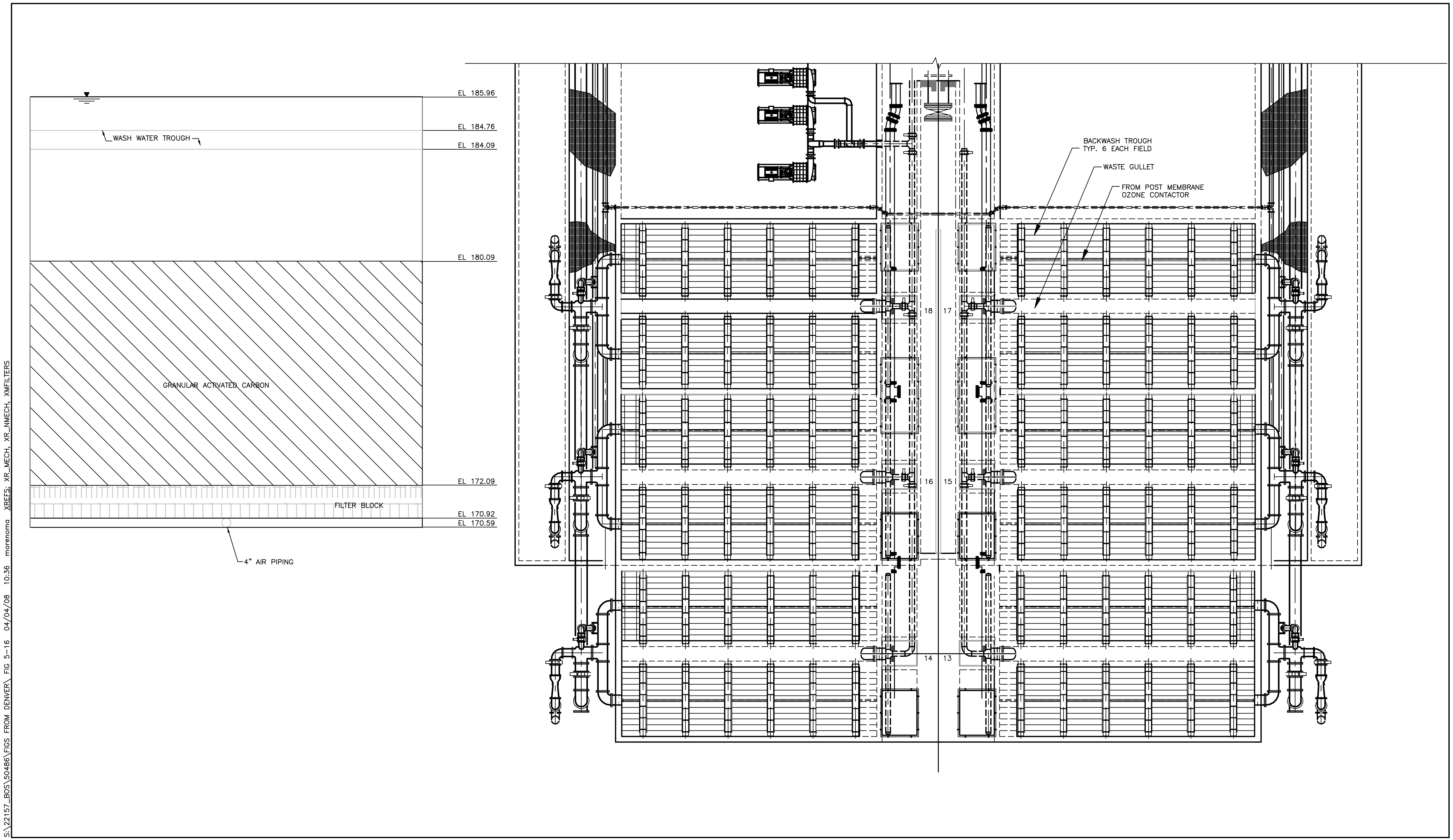


FIGURE 5-16
GRANULAR ACTIVATED CARBON CONTACTOR
BOSSIER CITY WTP EXPANSION

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Figure 5-17
Elevated Water Storage Tank at Membrane Plant

5.9 Modification to Existing Ozone System

Expansion of the Bossier City WTP, which includes rehabilitation of existing and construction of new facilities, will require corresponding modifications to the ozonation system. The ozonation system incorporates the following components:

- Liquid oxygen (LOX) storage and vaporization
- Ozone generation
- Ozone diffusion and contact basins
- Ozone off-gas destruction

The LOX storage and vaporization facility and the ozone generation system will serve the existing facility and the plant expansion. Separate ozone contact basins, diffusion systems, and off-gas destruct units will be included with the existing and expanded facilities. Modifications to the ozone system are shown in Figure 5-18 and 5-19.

Design of the ozonation system components will be based on the following criteria:

- Existing Plant Process

Maximum Flow Rate	20 mgd
Average Ozone Dose	6 mg/L
Maximum Ozone Dose	8 mg/L
Average Ozone Production	1,000 ppd
Maximum Ozone Production	1,340 ppd

- New Plant Process

Maximum Flow Rate	25 mgd
Average Ozone Dose	1.5 mg/L
Maximum Ozone Dose	2 mg/L
Average Ozone Production	315 ppd
Maximum Ozone Production	420 ppd

The design ozone in oxygen concentration will be 10% but an overall operating range of 6% to 12 % will be assumed. This concentration operating range is higher than current operating conditions, but will be typical following rehabilitation of the existing diffusion system.

Figure 5-18
Modifications to Ozone System Site Plan

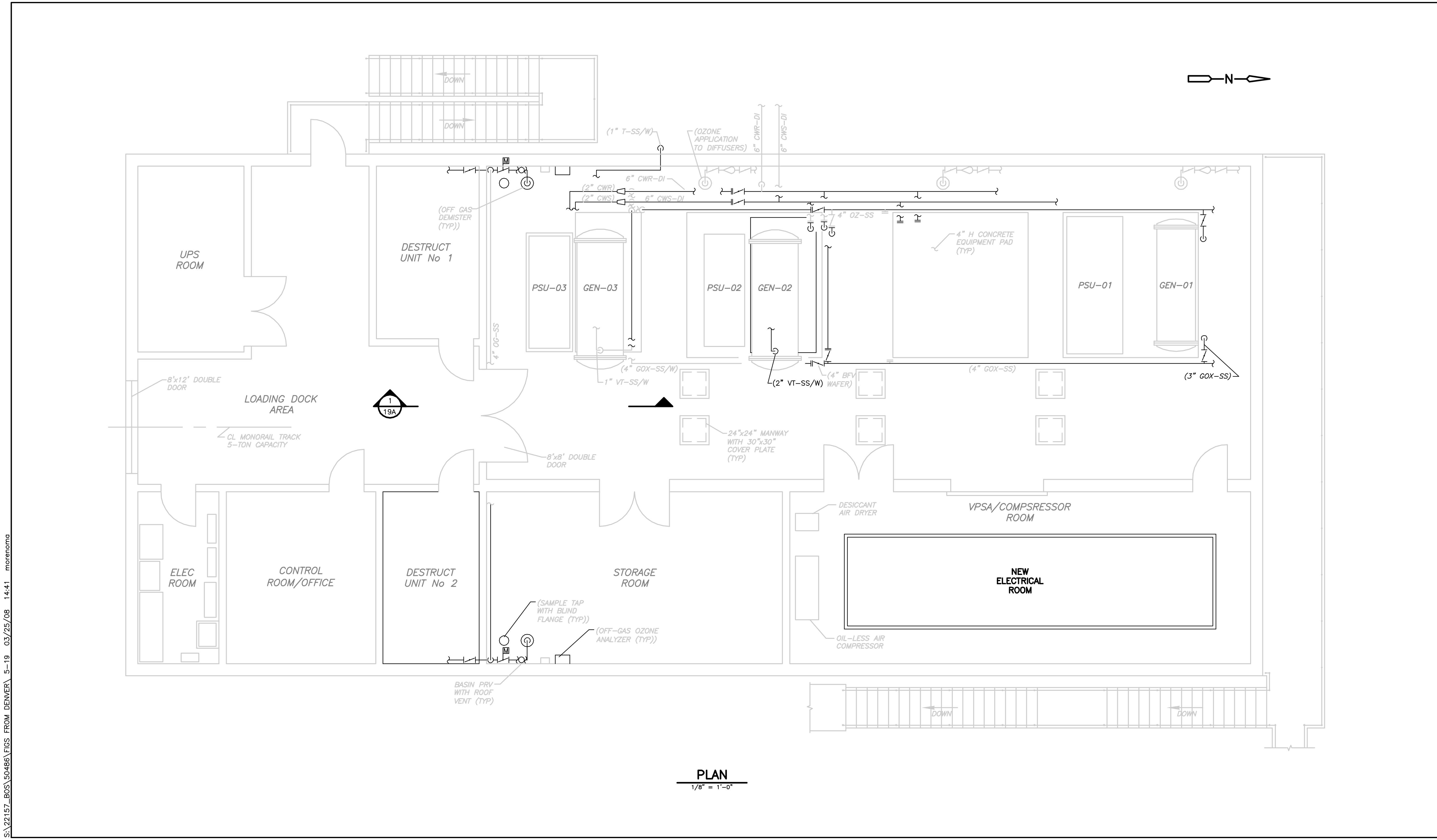

FIGURE 5-18
MODIFICATIONS TO RAW WATER OZONE CONTACT BASINS
BOSSIER CITY WTP EXPANSION

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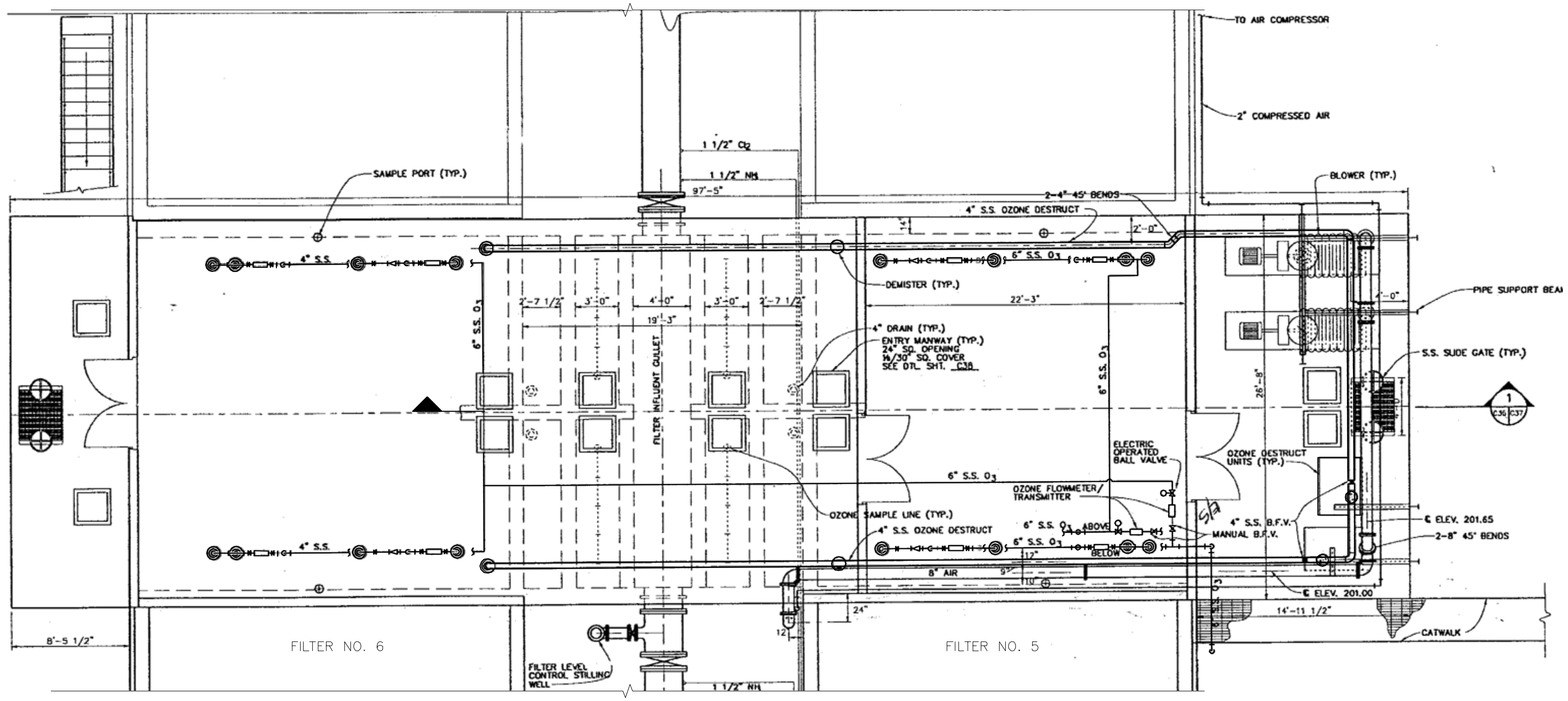
Figure 5-19
Modifications to Raw Water and Pre-Filter Ozone Contact Basins



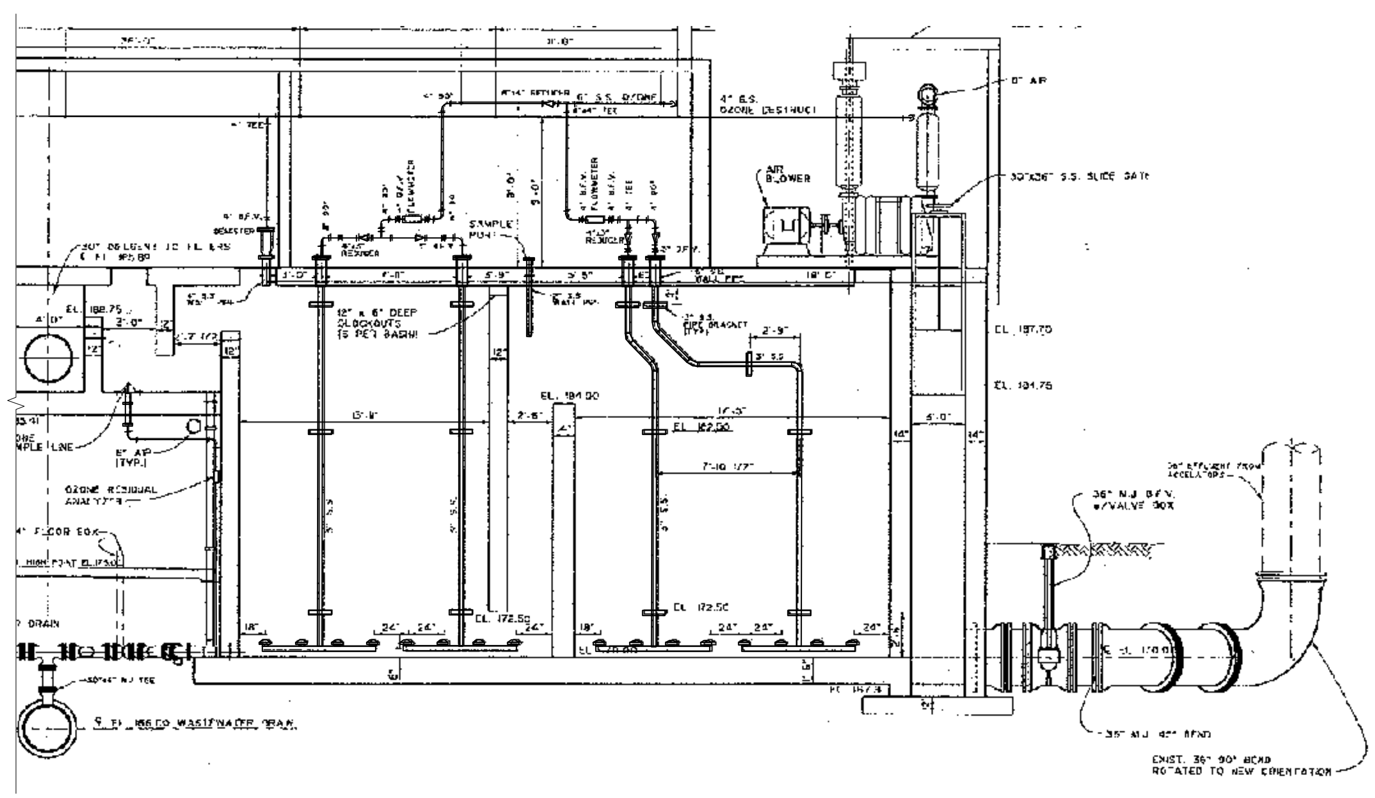


FIGURE 5-19
MODIFICATIONS TO PRE-FILTER OZONE CONTACT BASINS
BOSSIER CITY WTP EXPANSION

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S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-19 04/04/08 11:10 morenoma

5.9.1 LOX Storage and Vaporization

As mentioned above, the LOX storage and vaporization system will be expanded to provide sufficient gaseous oxygen (GOX) for the entire facility and overall system redundancy. Based on average ozone production requirements stated above, and assuming 8% ozone in oxygen concentration, approximately 26,000 gallons of LOX storage will be required. This storage requirement can be met by installation of a new 15,000 gallon tank in conjunction with the existing 11,000 gallon tank.

The vaporization system will be modified to deliver sufficient GOX for the entire facility's ozone production requirements. At minimum ozone in oxygen concentration (6%) and maximum ozone production (1,760 ppd) a total vaporization capacity of approximately 16,000 scfh will be required. Three new vaporizers will be installed to provide the necessary capacity and permit proper vaporizer sequencing.

The liquid oxygen supply will be delivered to the WTP with a minimum purity of 95% oxygen. However, to provide additional protection for the ozone generators a new in-line particulate cartridge filter will be installed with capacity in excess of the maximum GOX flow. Also, a new pressure regulating valve will be provided for regulation of GOX pressure prior to entering the ozone generators.

5.9.2 Ozone Generation

Required ozone generation capacity was determined based on historical operating data and also pilot data from the membrane evaluation. These doses are listed above in the noted design criteria. In comparison of the ozone dosages between the existing and new plant processes, it is noted that the combined raw and settled water ozonation process in the existing plant requires approximately four-times more ozone than that of the post-membrane ozonation process in the new plant. Consequently, the total average and maximum required ozone productions are 1,315 ppd and 1,760 ppd, respectively. Currently the ozone generation system is being expanded to include two generators of equivalent capacity. Each generator will have a capacity range of approximately 1,200 ppd at 12% concentration to 1,700 ppd at 8% concentration. However, additional production capacity in excess of that which is required can be achieved by lowering the concentration below 8%. Therefore, additional ozone generation capacity is not warranted to meet facility demands since a single generator can provide the required ozone production.

The ozone generation system is dependent upon supply of chilled cooling water to achieve the noted ozone generator capacities. The existing chilled water system has sufficient capacity to provide for a single generator, however, there is no standby capacity in the event the chilled water system fails. Therefore, additional chilled water capacity will be installed adjacent to the existing unit to provide redundancy and ensure ozone production capabilities.

5.9.3 Ozone Diffusion and Contact Basins

The existing ozone contact basins (raw water and pre-filter) will be rehabilitated as part of this project. The existing contact basins do not incorporate means for isolation and inspection, so these capabilities will be provided. Additionally, the existing ceramic-dome type diffusion system will be rehabilitated to ensure proper diffusion of ozone in the process stream. Design intent will be to inspect, repair and replace the existing diffusers and gaskets within each basin. However, alternative diffusion systems will be evaluated prior to finalizing the design.

As noted in Section 5.6, two new ozone contactors will be constructed to treat membrane filtered water. Diffusers and ancillary equipment will be needed. Ozone will be piped from the existing ozone building to the new contactors.

5.9.4 Ozone Off-Gas Destruction

Associated with rehabilitation of the existing ozone contact basins and construction of the new contact basins, a new ozone off-gas destruct unit will be installed with each basin. The destruct units will be thermal-catalytic units and sized to accommodate the maximum ozone application rates within each basin.

5.9.5 Additional Facility Improvements

Improvements to other existing system components will be incorporated as part of this project. All existing piping and valves will be inspected for leaks and the corresponding piping gaskets and seals will be replaced as required. Ozone analyzers for in-line, ambient and residual measurement will be inspected and rebuilt and/or replaced as needed to ensure proper system operation and provide proper safety for plant personnel.

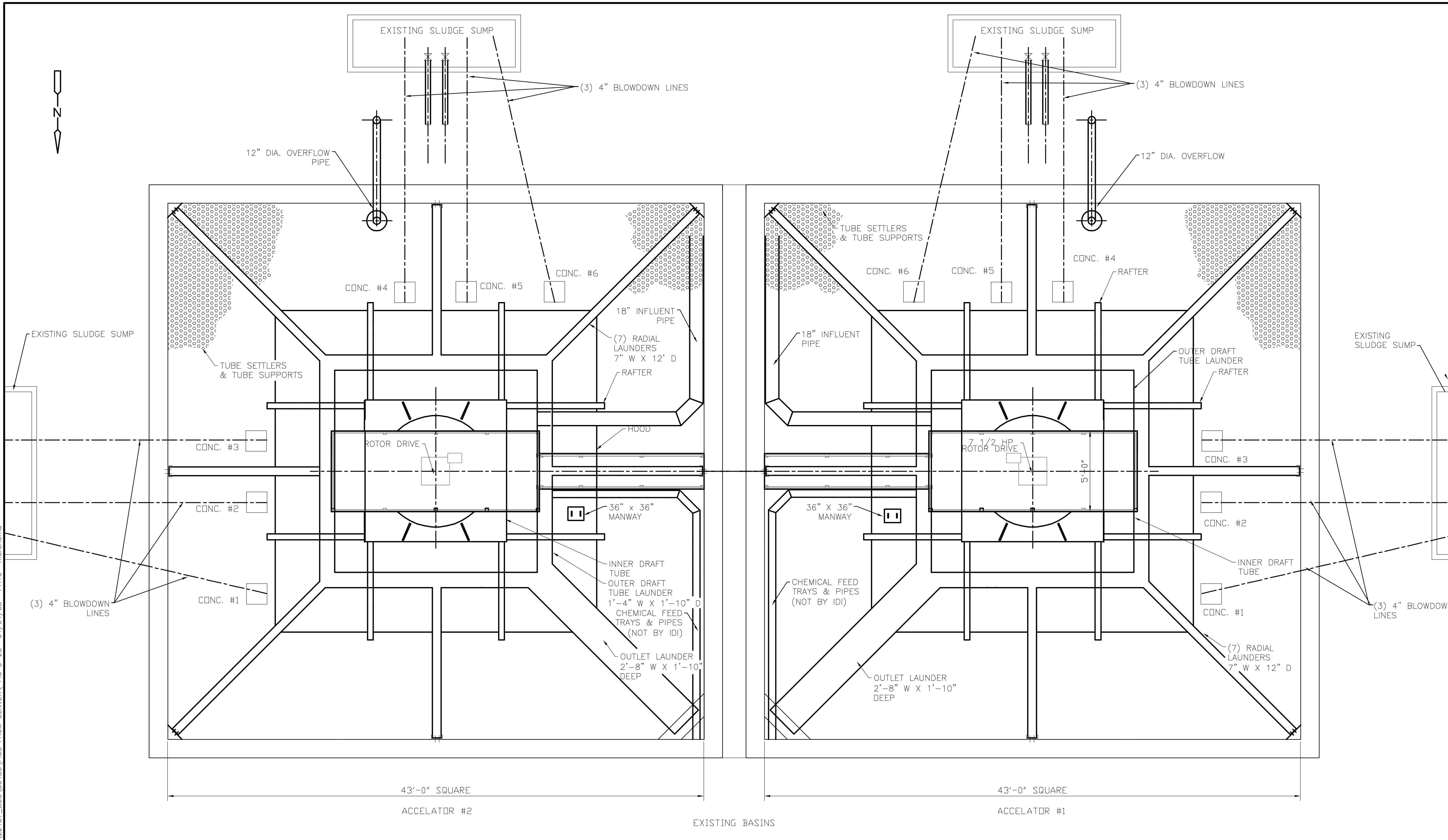
5.10 Modifications to Existing Accelator Clarifiers

As discussed previously, a design capacity of 20 mgd will be used for the existing solids contact clarifiers. Because of damage to existing tubes and tube supports, CDM recommends replacing all of the clarifier equipment. New equipment will include tube settlers, clarifier drive motors and impellers, effluent launders, hood plates, rafters, and the addition of solids recirculation and adjusting sludge blowdown cycles. Other improvements will be further investigated during design to optimize clarifier performance. Figures 5-20 through 5-23 show recommended modifications.

5.11 Modifications to Existing Filters

Based on the age of the under drain system and the use of an air scour system that penetrates through the media, CDM recommends that Filters 1-4 be rehabilitated completely. Rehabilitation includes replacement of under drain system with universal style modules, installation of air scour system, new backwash troughs, media, and gravel. Recommended modifications to Filters 1-4 are shown in Figure 5-24.

Figure 5-20
Modifications to Plant 1 Accelators Plan View



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-20 04/04/08 11:10 morenoma

FIGURE 5-20
MODIFICATIONS TO PLANT 1 ACCELATORS PLAN
BOSSIER CITY WTP EXPANSION

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Figure 5-21
Modifications to Plant 1 Accelators Cross Section

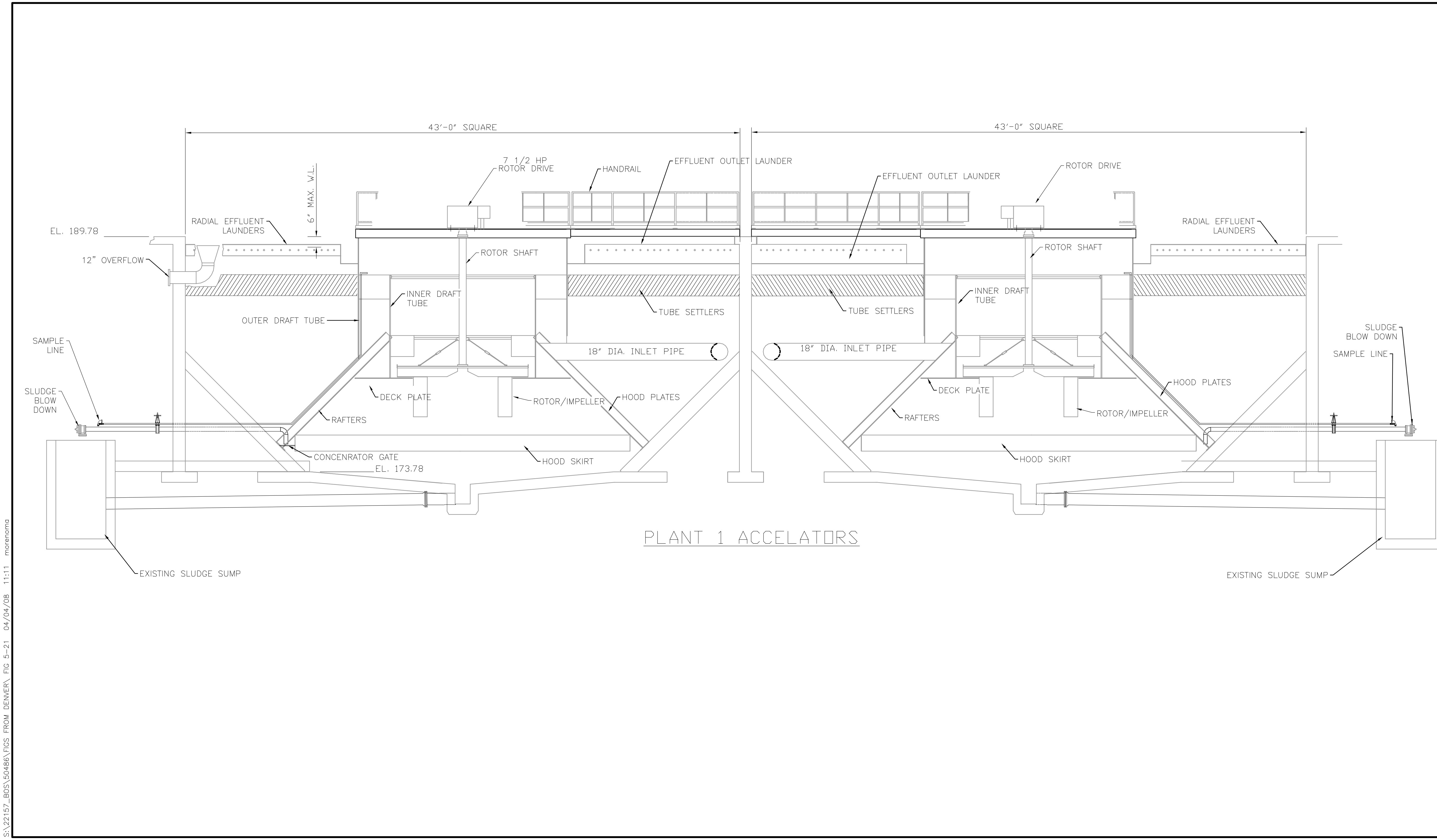


FIGURE 5-21
MODIFICATIONS TO PLANT 1 ACCELATORS ELEVATION
BOSSIER CITY WTP EXPANSION

CDM

Figure 5-22
Modifications to Plant 2 Accelators Plan View

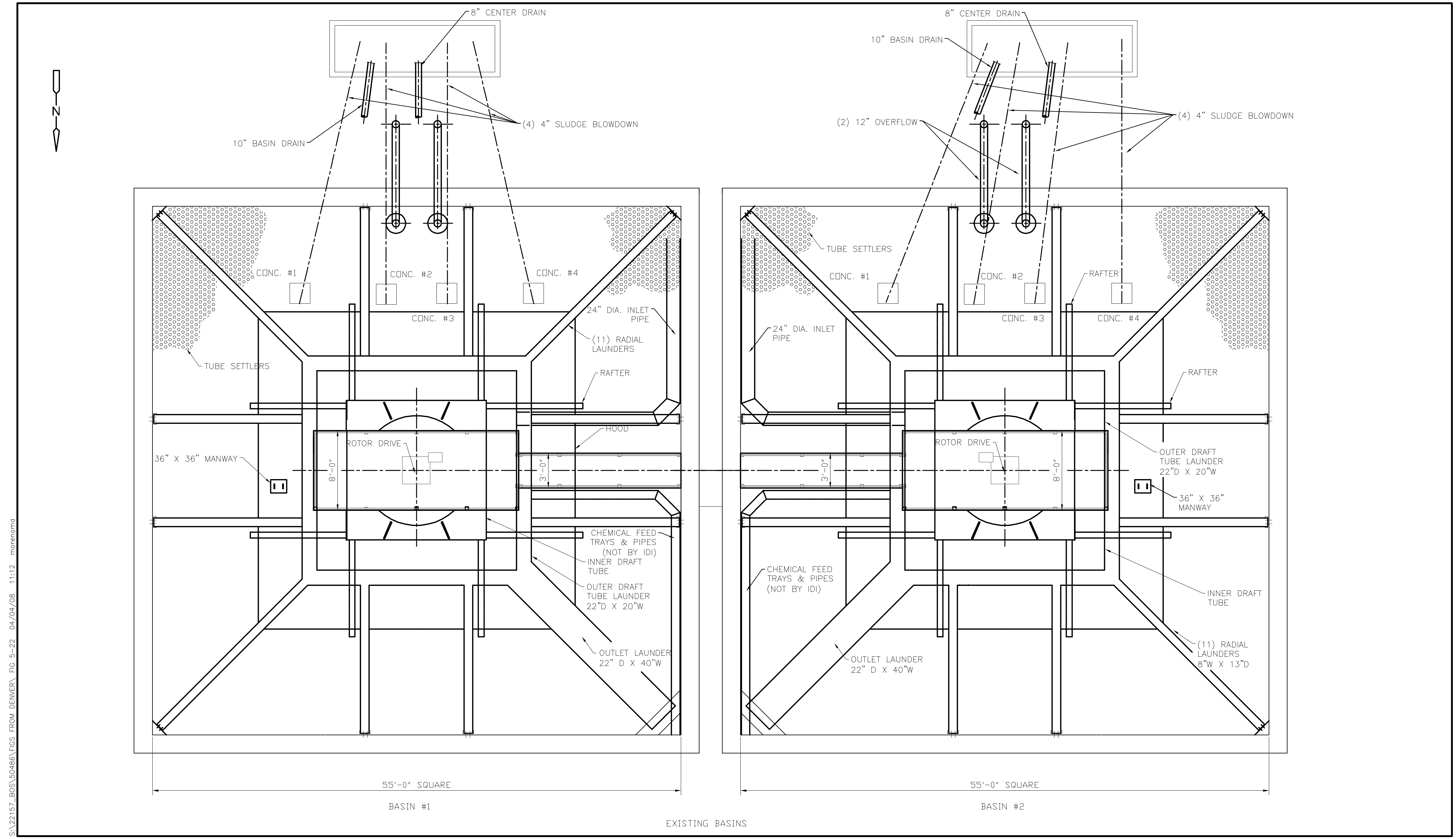
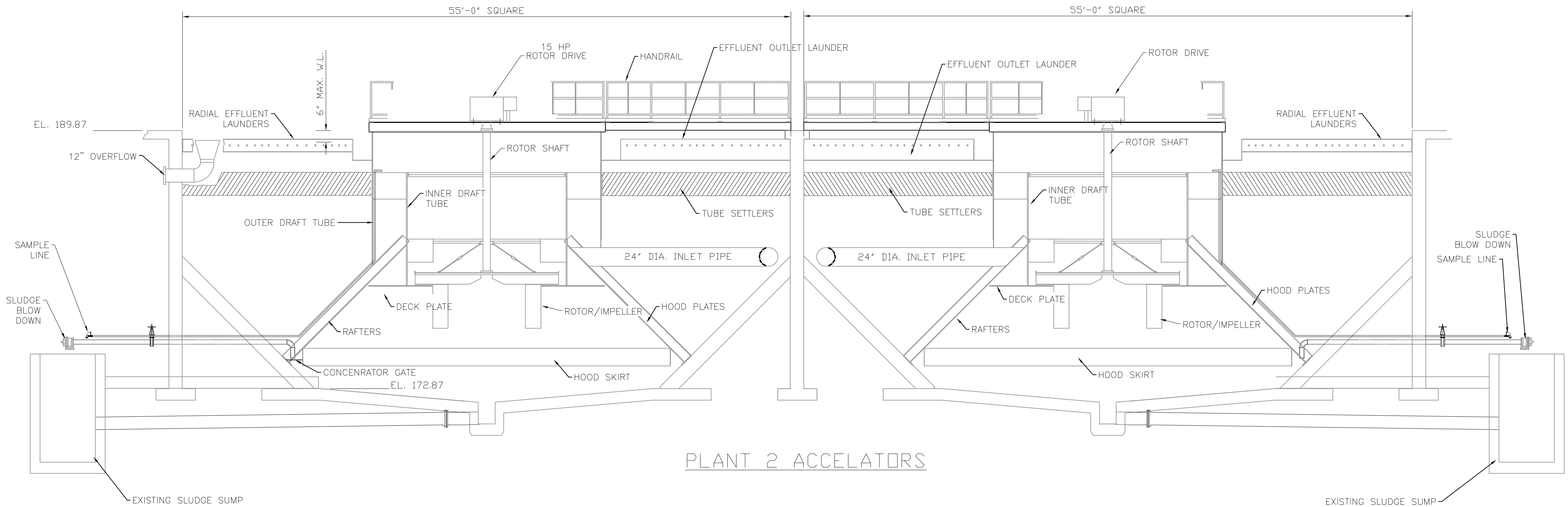


FIGURE 5-22
MODIFICATIONS TO PLANT 2 ACCELATORS PLAN
BOSSIER CITY WTP EXPANSION

CDM

Figure 5-23
Modifications to Plant 2 Accelators Cross Section



PLANT 2 ACCELATORS

S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-23 04/04/08 11:12 morenoma

FIGURE 5-23
MODIFICATIONS TO PLANT 2 ACCELATORS ELEVATION
BOSSIER CITY WTP EXPANSION

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Figure 5-24
Modifications to Filters 1-4

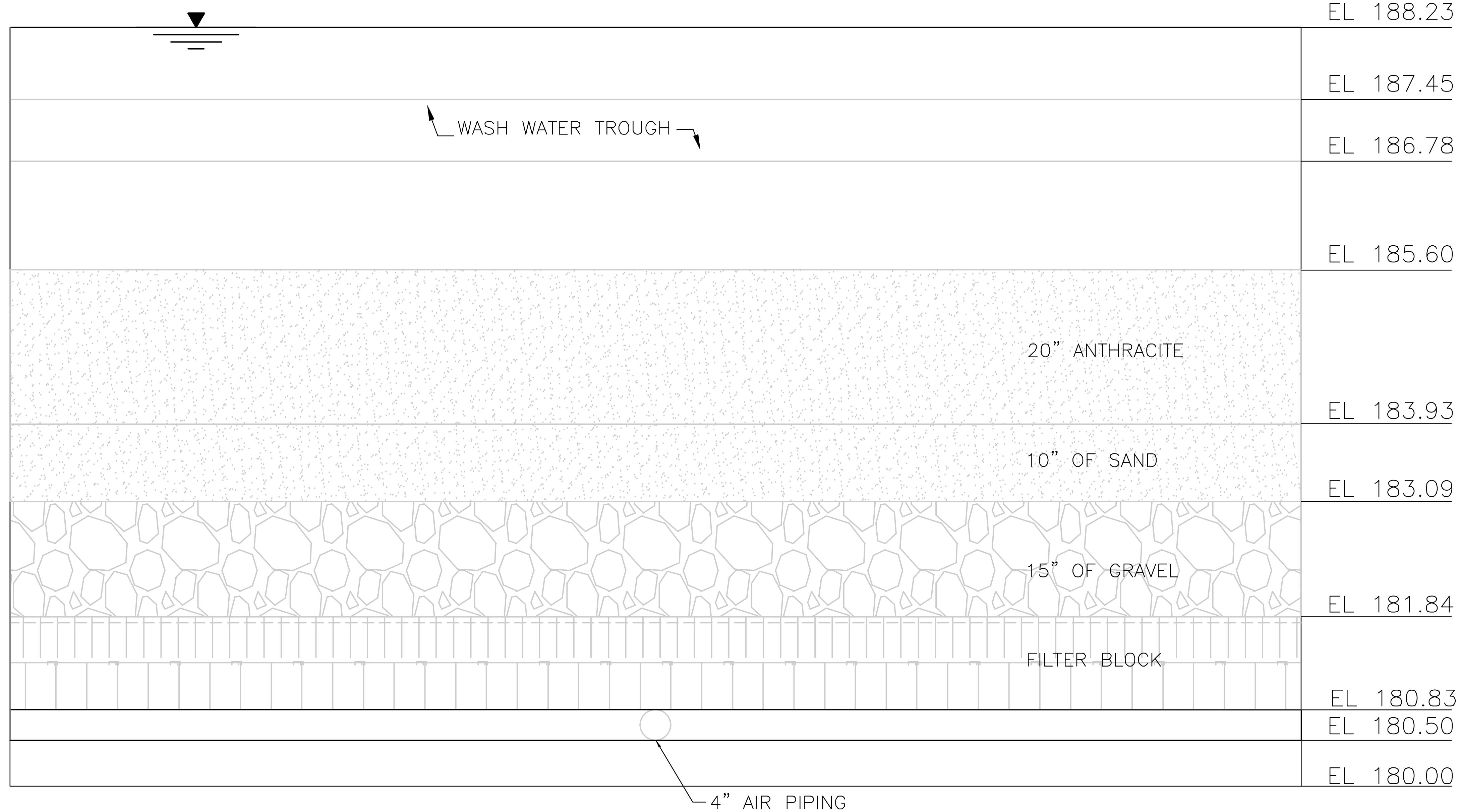

FIGURE 5-24
MODIFICATIONS TO EXISTING FILTERS 1-4
BOSSIER CITY WTP EXPANSION

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S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-24 04/04/08 11:13 morenoma XREFS: XMFILTERS

5.12 Modifications to Chemical Systems

The chemical feed systems at the Bossier WTP will be upgraded during the plant expansion. The chemical requirements of the existing plant are presented below with added capacity and feed systems to accommodate the plant expansion. For the purpose of consolidation and streamlining, the majority of the chemicals and feed equipment will be moved to a central location. The dosing locations of all existing chemicals will be modified with new diffusers/injectors during the expansion.

During the upgrade and expansion of the WTP a new building will be installed to house the majority of the chemicals required for the water treatment processes as well as the chemical feed systems. Chemicals to be located in this building include; Primary Polymer 903, Polymer Aid 1912, chlorine, fluoride, zinc orthophosphate, and ACH. Table 5-2 shows the chemicals to be used on-site as well as the dosing locations for these chemicals.

Table 5-2
Chemical Application Points

Chemical	Purpose	Application Point(s)
Primary Polymer (903)	Primary Filter Coagulation (Existing Plant)	Post Ozone Filters 1-4 Filters 5-12 Meter Vault No. 1 [A] Meter Vault No. 2 [A]
Secondary Polymer (1912)	Filter Aid (Existing Plant)	Solids Contact Clarifiers Plant No. 1 Solids Contact Clarifiers Plant No. 2
Ferric Sulfate	Coagulant (Existing Plant)	Post Ozone Contactors Meter Vault No. 1 [A] Meter Vault No. 2 [A]
Ammonia	Disinfection	Existing Plant Effluent (Pre-Finished Water Blend Structure) Membrane Plant Effluent (Pre-Finished Water Blend Structure) Meter Vault No. 1 [A] Meter Vault No. 2 [A]
Chlorine	Disinfection	Existing Plant Effluent (Pre-Finished Water Blend Structure) Membrane Plant Effluent (Pre-Finished Water Blend Structure) Meter Vault No. 1 [A] Meter Vault No. 2 [A]
Lime	Softening - Carbonate Hardness (Existing Plant)	Solids Contact Clarifiers Plant No. 1 Solids Contact Clarifiers Plant No. 2
Soda Ash	Softening - Non-carbonate Hardness (Existing Plant)	Solids Contact Clarifiers Plant No. 1 Solids Contact Clarifiers Plant No. 2
Carbon Dioxide	Recarbonation (Existing Plant)	Post solids contact clarifiers 1 & 2 Post solids contact clarifiers 3 & 4
Aluminum Chlorohydrate (ACH)	Membrane Plant Coagulant	Membrane Clarifier No. 3 Membrane Clarifier No. 4
Hydrofluosilic acid (Fluoride)	Health	Existing Plant Effluent (Pre-Finished Water Blend Structure) Membrane Plant Effluent (Pre-Finished Water Blend Structure)
Zinc orthophosphate	Corrosion Inhibitor	Existing Plant Effluent (Pre-Finished Water Blend Structure) Membrane Plant Effluent (Pre-Finished Water Blend Structure)

A. Non-primary dosing location.

The dosing and feed rates were calculated using historical dosing data from the WTP for those chemicals that are currently in use. The existing plant historical water quality data was utilized to determine dosing requirements for future flows. Average dose is based on a combined maximum month flow through the plants of 38 MGD. Maximum dose is based on the maximum design capacity of each plant. The calculated doses of each chemical are outlined in the Table 5-3.

Table 5-3
Chemical Dose and Usage

Chemical	Average Dose (mg/L)	Maximum Dose (mg/L)	Average Usage [A] (lb/day)	Maximum Usage [B] (lb/day)
Primary Polymer (903) as primary coagulant	6.5	18	922	3,002
Primary Polymer (903) as filter aid	1	8	142	1,334
Secondary Polymer (1912)	1	4	142	667
Ferric Sulfate	15	35	2,127	5,838
Ammonia	1.5	2.5	475	938
Chlorine	5	9	1,585	3,378
Lime [C]	25	63	3,567	10,492
Soda Ash [C]	36	90	5,110	15,029
Carbon Dioxide	18	44	2,495	7,339
Aluminum Chlorohydrate (ACH)	11	15	1,927	3,128
Hydrofluosilic acid (Flouride)	0.7	1	222	375
Zinc ortho-phosphate	3	5.5	951	2,064

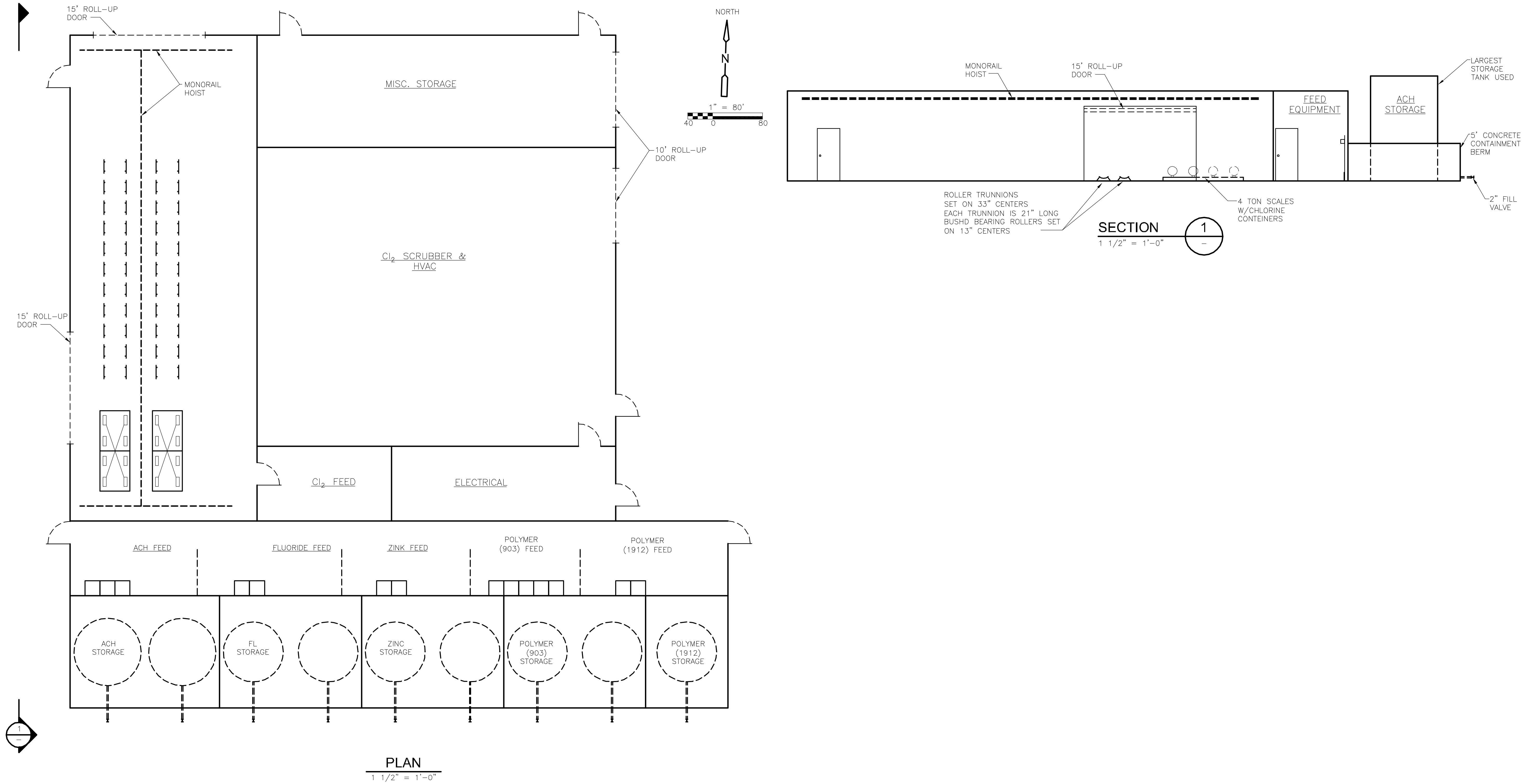
A. Average usage is determined by using average dose and maximum monthly flow (17 mgd at conventional plant and 21 mgd at membrane plant for total of 38 mgd).
B. Maximum usage is determined by using maximum dose and design flow (20 mgd at conventional plant and 25 mgd at membrane plant for total of 45 mgd).
C. Based on historical average hardness value of 188 mg/L. The average monthly dosing will soften the water to 120 mg/L of hardness. During hardness spikes above the average 188 mg/L hardness value the lime dosing will increase to approximately 43 mg/L with soda ash dose increasing to 76 mg/L.

On-site chemical storage is required for all chemicals. Storage of all chemicals excluding ferric sulfate, ammonia, lime, and soda ash will be housed, along with feed equipment, in a central location as shown in Figure 5-25. The sizing of chemical storage is based on the average dosing requirement for a maximum monthly flow rate. Chemical storage will accommodate a 30-day supply at these conditions unless noted otherwise.

5.12.1 Primary Polymer

Currently the polymer TMB-903 is used as the primary coagulant at the WTP. Existing dosing locations for this polymer include; meter vaults 1 and 2, downstream of the raw water ozone contactors, and dosing at the filters. All of these dosing points will be maintained during the plant expansion. The dosing of this polymer at the filters will be streamlined. Polymer 903 will be used only at the existing WTP.

Figure 5-25
Chemical Storage Building



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-25 04/04/08 11:13 morenoma XREFS: ChemStrg

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FIGURE 5-25
CHEMICAL STORAGE
BOSSIER CITY WTP EXPANSION

At the average dose of 6.5 mg/L as the primary coagulant and 1 mg/L for use at the filters, approximately 3,825 gallons of neat polymer will be used per month at a maximum monthly flow of 17 mgd. This polymer is mixed in a 0.5% solution of water before being sent to the injection points. The chemical storage facility will be large enough to store a minimum of 4,500 gallons of Polymer 903. The design parameters for the Polymer 903 feed system are listed In Table 5-4.

Table 5-4
Primary Polymer (903) Feed and Storage System

Number of Pumps	3
Max Pump Dilution Water Capacity	4,660 gallons per hour
Max Pump Neat Polymer Capacity	23 gallons per hour
System Voltage	115 Volts/1 Phase/60 Hz
Electricity Usage Estimate	83 kWH per day/per feed system
Storage Capacity	4,500 gallons
Tank Size	2 – 2,250 gallon tanks

The Polymer 903 feed system will be designed so that both storage tanks are piped to a common header. This set up will allow either of the storage tanks to feed any of the three feed systems. The feed pumps will also be connected to a common header. The use of valves will allow any of the feed pumps to feed any of the injection points, while also providing the capability to isolate and remove any of the pumps from service for repair or replacement. The process mechanical diagram for the Primary Polymer (903) feed system is shown in Figure 5-26.

5.12.2 Secondary Polymer

Polymer TMB-1912 is used as a coagulant aid at the existing WTP. This polymer is currently dosed at the solids contact clarifiers serving both plants 1 and 2. These two dosing points will be maintained during the plant expansion. The dosing locations for this polymer will be rehabbed during the plant expansion. Only the conventional treatment portion of the WTP will use the Polymer 1912.

The average monthly usage of Polymer 1912 will be approximately 510 gallons of neat polymer, to meet the average dosing of 1 mg/L and maximum monthly flow of 17 mgd. This polymer is mixed in a 0.5% solution of water before being sent to the injection points. The chemical storage facility will be large enough to store a minimum of 600 gallons of Polymer 1912. The design parameters for the Secondary Polymer (1912) feed system are listed in Table 5-5. The process mechanical diagram for the Polymer 1912 feed system is shown in Figure 5-27.

Table 5-5
Secondary Polymer (1912) Feed and Storage System

Number of Pumps	2
Max Pump Dilution Water Capacity	1,600 gallons per hour
Max Pump Neat Polymer Capacity	4 gallons per hour
System Voltage	115 Volts/1 Phase/60 Hz
Electricity Usage Estimate	41 kWH per day/per feed system
Storage Capacity	1,000 gallons
Tank Size	1 – 1,000 gallon tank

Figure 5-26
Modifications to Primary Polymer (903) System

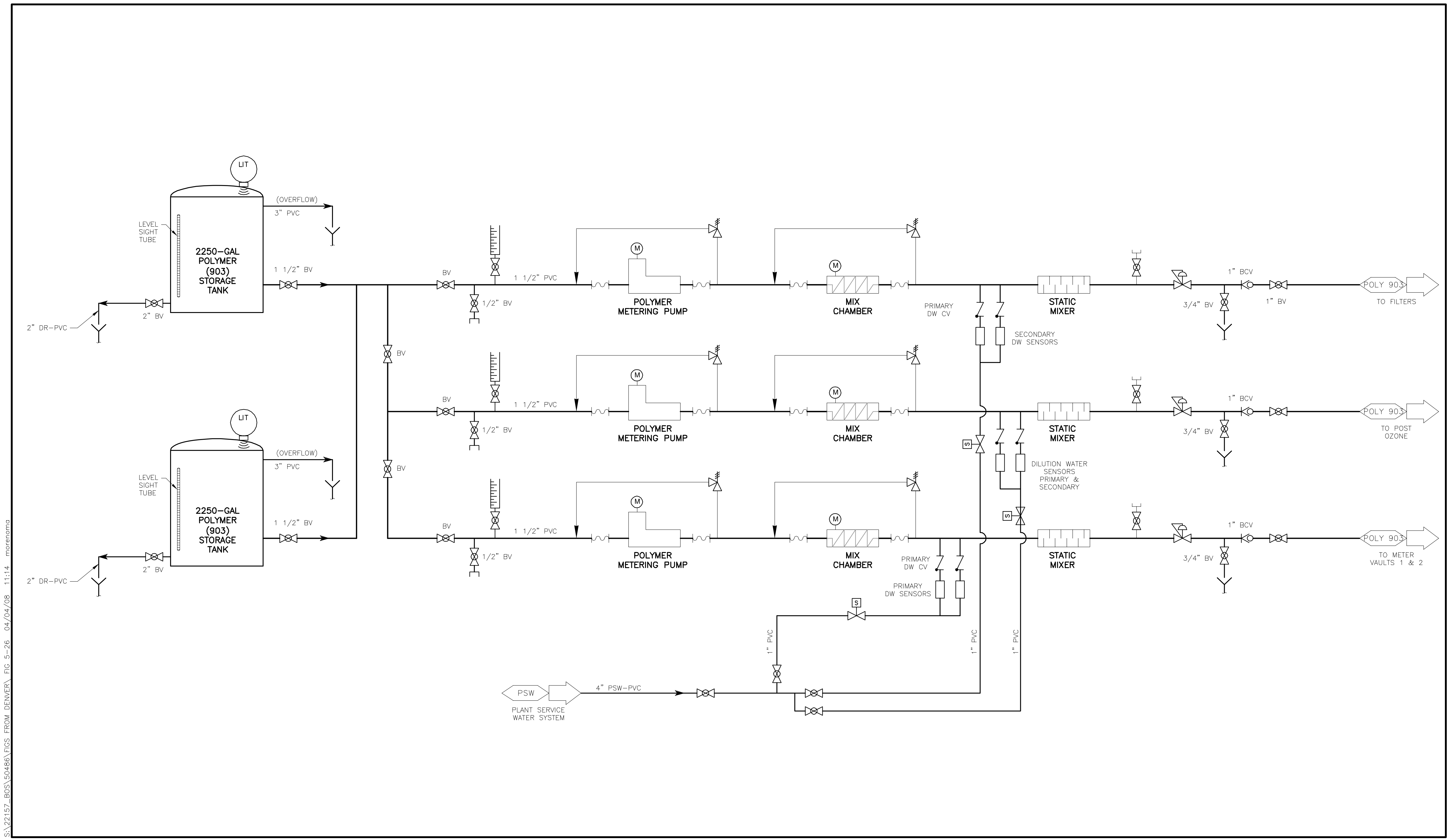

FIGURE 5-26
PRIMARY POLYMER FEED SYSTEM
BOSSIER CITY WTP EXPANSION

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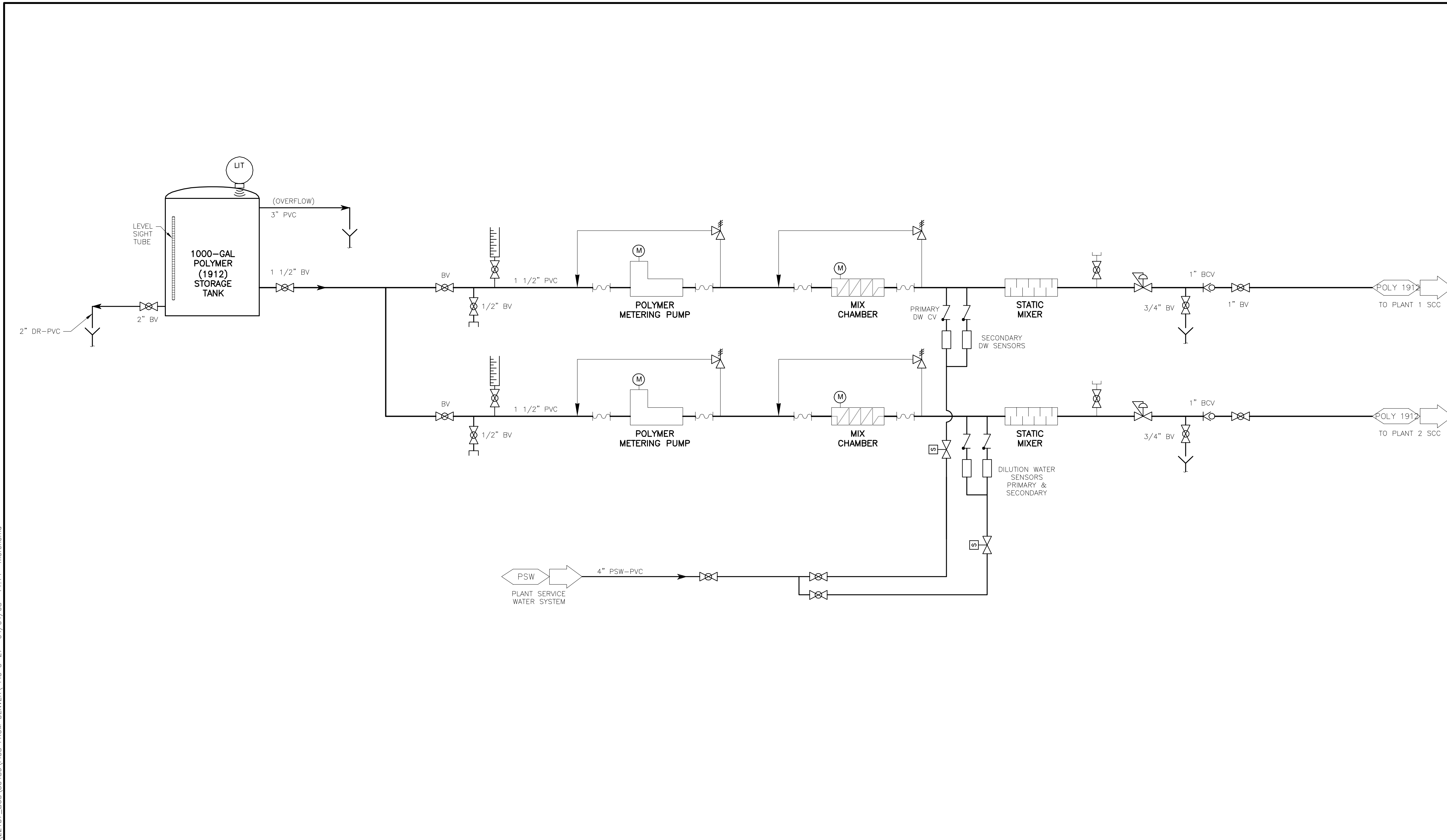
Figure 5-27
Modifications to Secondary Polymer (1912) System



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-27 04/04/08 11:14 morenoma

CDM

FIGURE 5-27
SECONDARY POLYMER FEED SYSTEM
BOSSIER CITY WTP EXPANSION

The Polymer 1912 feed system will be designed so that the one storage tank will feed either of the two pumps. The feed pumps will also be connected to a common header. Each feed pump is capable of providing feed to both injection points simultaneously. The use of valves will allow any of the feed pumps to feed either of the injection points, while also providing the capability to isolate and remove one of the pumps from service for repair or replacement.

5.12.3 Ferric Sulfate

Ferric sulfate is available at the existing WTP for occasional use as the primary coagulant. The ferric sulfate can currently be dosed in meter vault 1, meter vault 2, and directly after the raw water ozone contactors. These dosing locations will be rehabbed during the plant expansion. Ferric sulfate will not be required for the membrane plant.

With an average dose of 15 mg/L, the monthly usage of ferric sulfate at a maximum monthly flow of 17 mgd will require a minimum of 7,650 gallons to be stored on site. The design parameters for the ferric sulfate feed system are listed in Table 5-6.

Table 5-6
Ferric Sulfate Feed and Storage System

Number of Pumps	3
Pump Capacity	38.5 gallons per hour
Modified Pump Capacity	4:1 turndown; adjustable stroke length
Electricity Usage Estimate	75 KWh per day total system
Storage Capacity	9000 gallons
Tank Size	2 – 4900 gallon tanks Diameter – 12 feet Height – 8 feet 1 inch

The ferric sulfate feed system will be designed so that both storage tanks are piped to a common header. This set up will allow either of the storage tanks to feed any of the pumps. The feed pumps will also feed a common header system. The use of valves will allow any of the feed pumps to feed any of the three injection points, while also providing the capability to isolate and remove any of the pumps from service for repair or replacement. The process mechanical diagram for the ferric sulfate feed system is shown in Figure 5-28.

5.12.4 Ammonia

Ammonia is currently used at the water plant to increase the effectiveness of the chlorine. The use of ammonia in conjunction with chlorine forms more chloramines which disinfect the water while minimizing the formation of THMs. Ammonia dosing points are meter vault 1, meter vault 2, existing plant effluent and membrane plant effluent. The existing dosing locations will be rehabbed during the plant expansion.

Figure 5-28
Modifications to Ferric Sulfate System

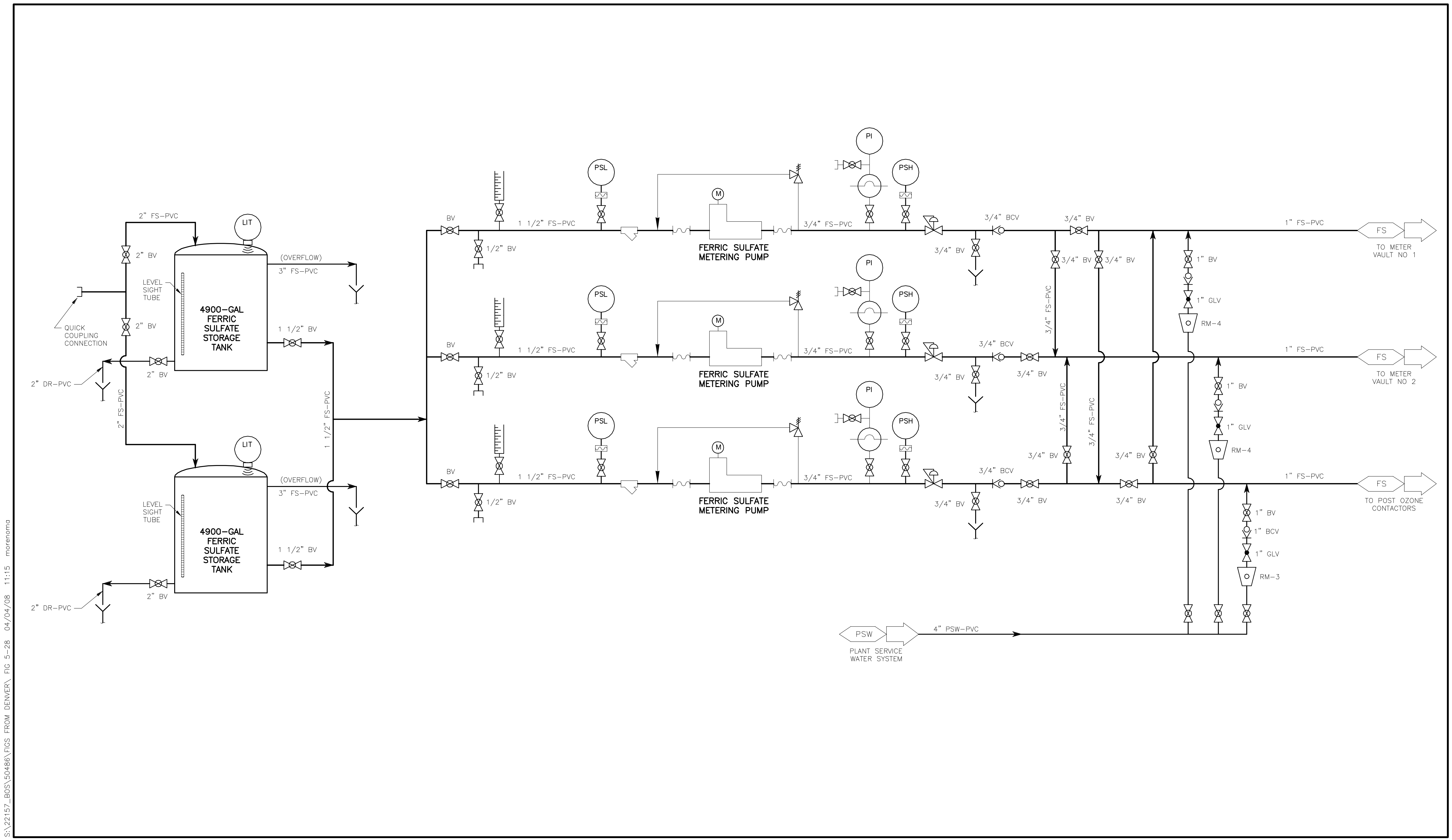


FIGURE 5-28
PM & ID FERRIC SULFATE FEED SYSTEM
BOSSIER CITY WTP EXPANSION

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The average dose required is 1.5 mg/L equating to an average monthly usage of 1,575 gallons of ammonia at a maximum monthly flow of 38 mgd. The design parameters for the ammonia feed system are listed Table 5-7.

Table 5-7 Ammonia Feed and Storage System	
Number of Pumps:	4
Max Pump Capacity:	300 pounds per day
Minimum Pump Capacity:	100 pounds per day
Electricity Usage Estimate:	31 KWh per day total system
Storage Capacity:	2,000 gallons
Tank Size:	One 2,000 gallon tank

The ammonia feed system will be designed so that one 3,000 ppd ammonia pressure reducing valve will draw from the storage tank. Four 4-20 ma feed control inputs will control the influent flow to four mass flow meters. Four more 4-20 ma feed control outputs will control the feed rate to the four injection diffusers. The piping will be valved to allow for any mass flow meter to feed any of the injection points, while also providing the capability to isolate and remove any of the flow meters from service for repair or replacement. The process mechanical diagram for the ammonia feed system is shown in Figure 5-29.

5.12.5 Chlorine

Chlorine is the secondary disinfectant used at the WTP. The existing plant has the capability to dose chlorine at meter vault 1, meter vault 2, and on both finished water lines. During the plant expansion the meter vault dosing points will be rehabbed and the two dosing points on the finished water will be moved to the finished water blend structure and limited to one dosing point. Another dosing point will be added to accommodate the finished water flow from the membrane treatment plant.

The average monthly usage for chlorine at a maximum monthly flow of 38 mgd will require a minimum of 24 tons to be stored on site, to meet an average dosing of 5 mg/L. The design parameters for the chlorine feed system are listed in Table 5-8.

Table 5-8 Chlorine Feed and Storage System	
Number of Chlorinators	3
Chlorinator Capacity	3,000 ppd
Chlorinator System Voltage	120V + 10%, 0.3 amps 60 Hz
Chlorine Gas Leak Monitor	85V, 1 amp 60 Hz
Estimated Electricity Usage	3 KWH per day total system
Storage Capacity	24 tons
Tank Size	24 – 1 ton cylinders

Figure 5-29
Modifications to Ammonia System

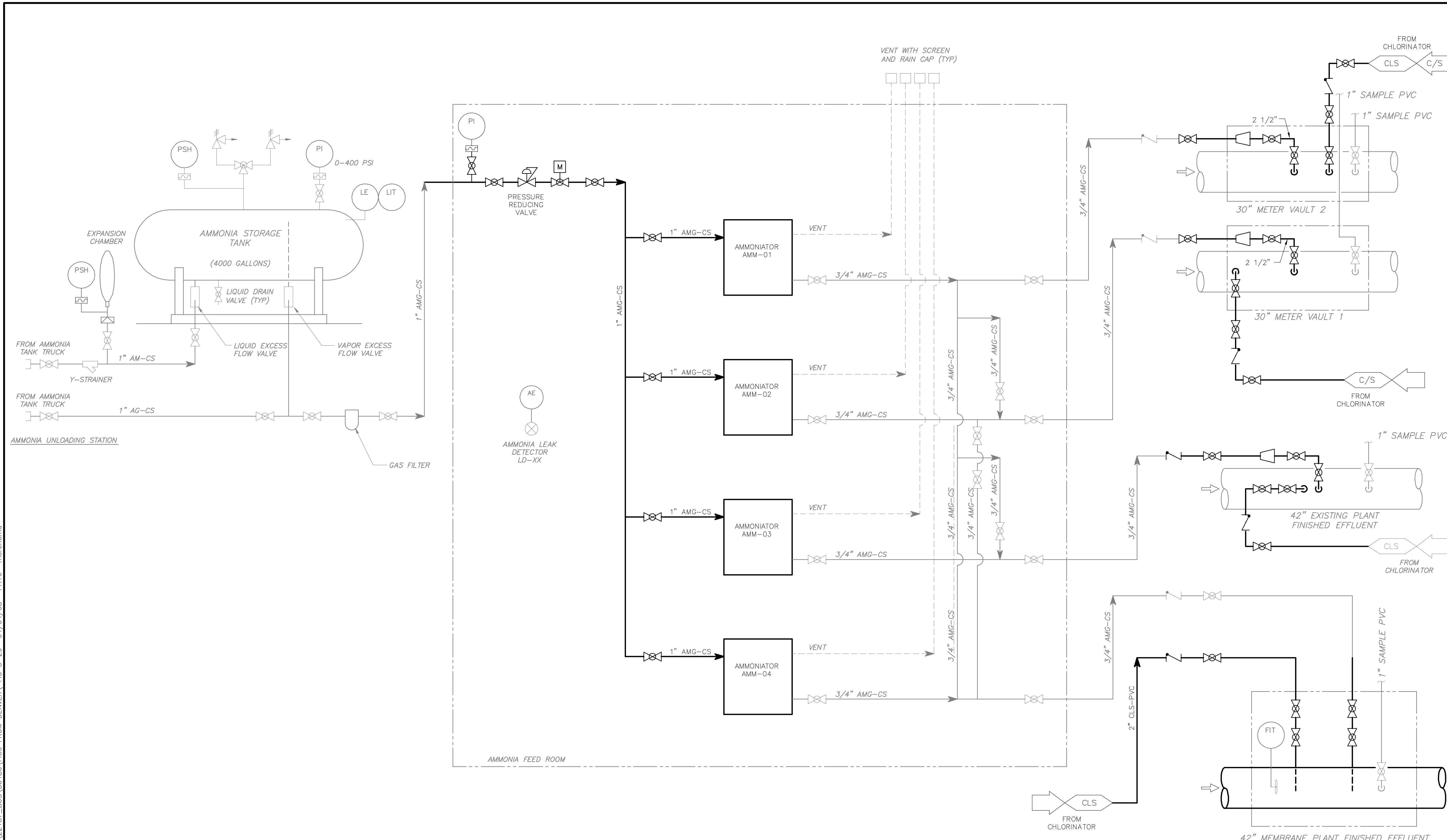

FIGURE 5-29
PM & ID AMMONIA FEED SYSTEM
BOSSIER CITY WTP EXPANSION

The chlorine feed system will be designed so that two 3,000 ppd automatic control chlorinators are piped to feed all four dosing locations. This leaves a third chlorinator as standby. The piping will be valved to allow for any chlorinator to feed any of the injection points, while also providing the capability to isolate and remove any of the chlorinators from service for repair or replacement. The process mechanical diagram for the chlorine feed system is shown in Figure 5-30.

5.12.6 Lime

Lime dosing and feed equipment is required at the existing WTP for the removal of carbonate hardness, referred to as water softening. This process is used seasonally. The water softening process takes place at the solids contact clarifiers dosed at two locations. During the WTP expansion, the entire lime dosing and feed system will be removed and replaced with and upgraded system. Water softening will not be required for the membrane plant.

The average monthly usage of lime at a maximum monthly flow of 17 mgd will be 54 tons at the average dosing of 25 mg/L. The chemical storage facility will be large enough to store a minimum of 80 tons of lime. The average monthly dosing will soften the water to an average of 120 mg/L of hardness. This calculation was performed using historical flow data and average hardness values. During hardness spikes above the average 188 mg/L hardness value the lime dosing will increase as per Table 5-3. The design parameters for the lime feed system are listed in Table 5-9.

Table 5-9
Lime Feed and Storage System

Number of Slurry Pumps	2
Max Pump Capacity	2,900 gph
Number of Mechanical Mixers	1 @ ¾ HP
Minimum Pump Capacity	Recirculation required; slurry measured with mag-meter
Slurry Pump	2 HP, 230V, 60 Hz, 3 ph
Estimated Electricity Usage	85 KWH per day total system
Storage Capacity	80 tons
Slurry Tank Capacity	400 gallon steel mix tank
Silo Dimensions	4,750 cu ft capacity Diameter – 12 feet Height – 58 feet overall

The lime feed system will be designed so that either of the two slurry pumps can feed both dosing locations. The lime will be fed from the silo into the 400 gallon mix tank where water will be added and mixed using a ¾ HP mechanical mixer to develop slurry. The slurry dosing will be controlled by a magnetic meter and the remaining slurry can be recirculated to keep the dosing lines from clogging. The process mechanical diagram for the lime feed system is shown in Figure 5-31.

Figure 5-30
Modifications to Chlorine System

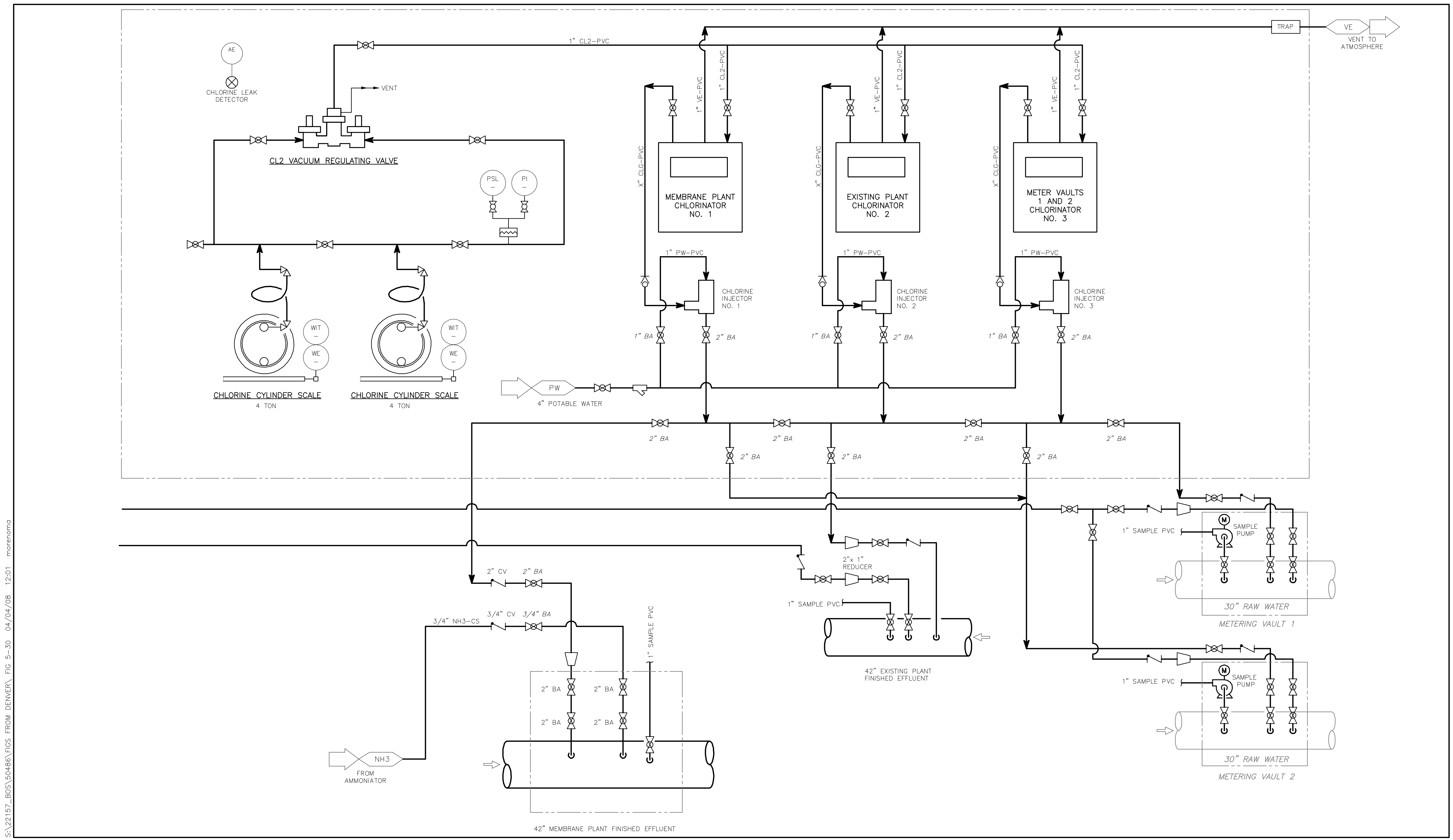

FIGURE 5-30
PM & ID CHLORINE FEED SYSTEM
BOSSIER CITY WTP EXPANSION

Figure 5-31
Modifications to Lime System

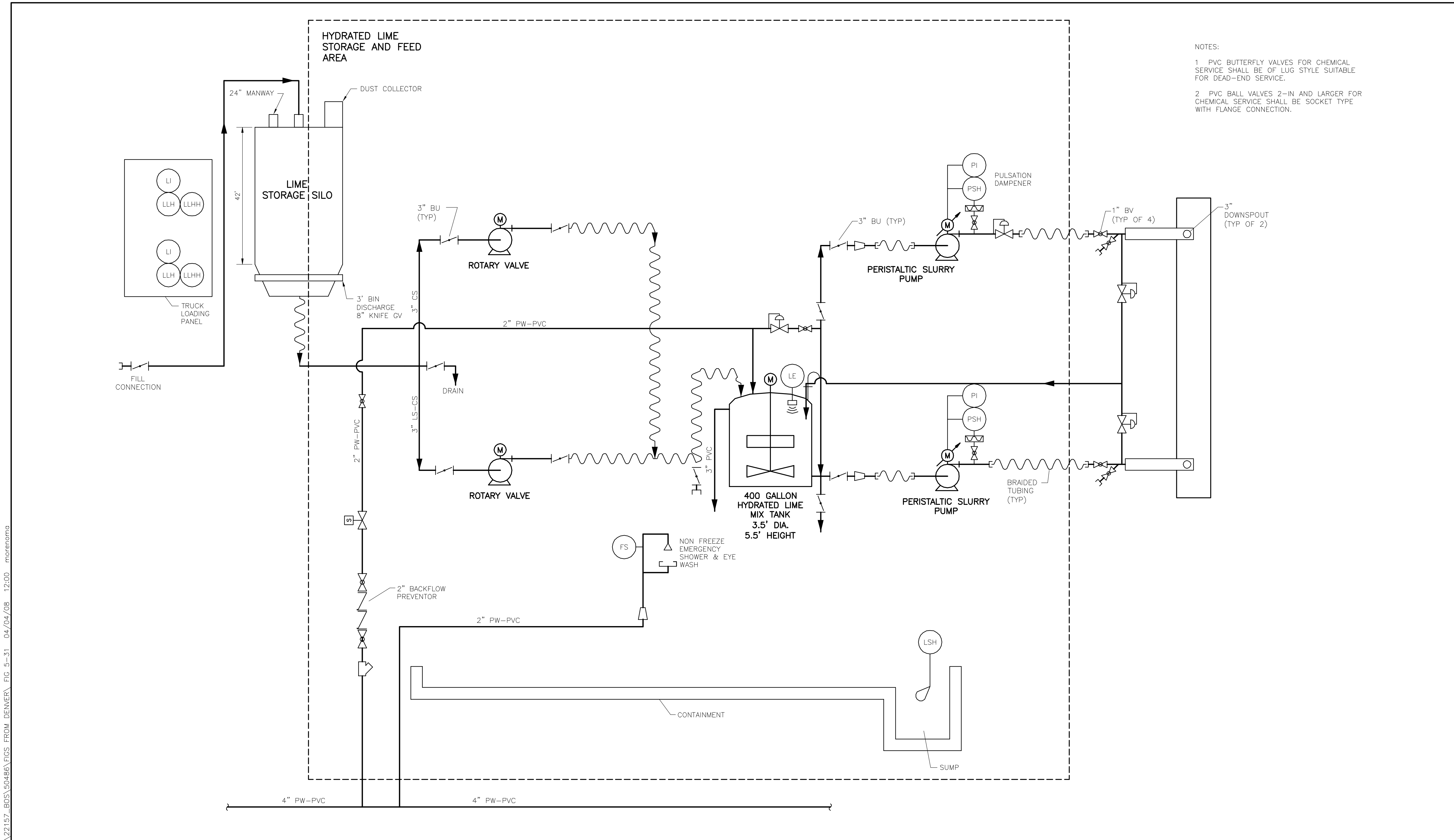

FIGURE 5-31
MODIFICATIONS TO LIME SYSTEM
BOSSIER CITY WTP EXPANSION

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5.12.7 Soda Ash

A soda ash dosing and feed system will be installed at the WTP. The soda ash system is required for additional water softening to remove the noncarbonated hardness. This process will also be used seasonally. The soda ash slurry will be dosed at the solids contact clarifiers at two locations. Soda ash dosing will not be required for the membrane plant.

The average monthly usage of soda ash at a max monthly flow of 17 mgd will be 77 tons at the average dosing of 36 mg/L. The chemical storage facility will be large enough to store a minimum of 90 tons of soda ash. The average monthly dosing will soften the water to hardness of 120 mg/L. This calculation was performed using historical flow data and average hardness values. During hardness spikes above the WTP average of 188 mg/L, the soda ash dosing will increase as per table 5-3.The design parameters for the soda ash feed system are listed in Table 5-10.

Table 5-10
Soda Ash Feed and Storage System

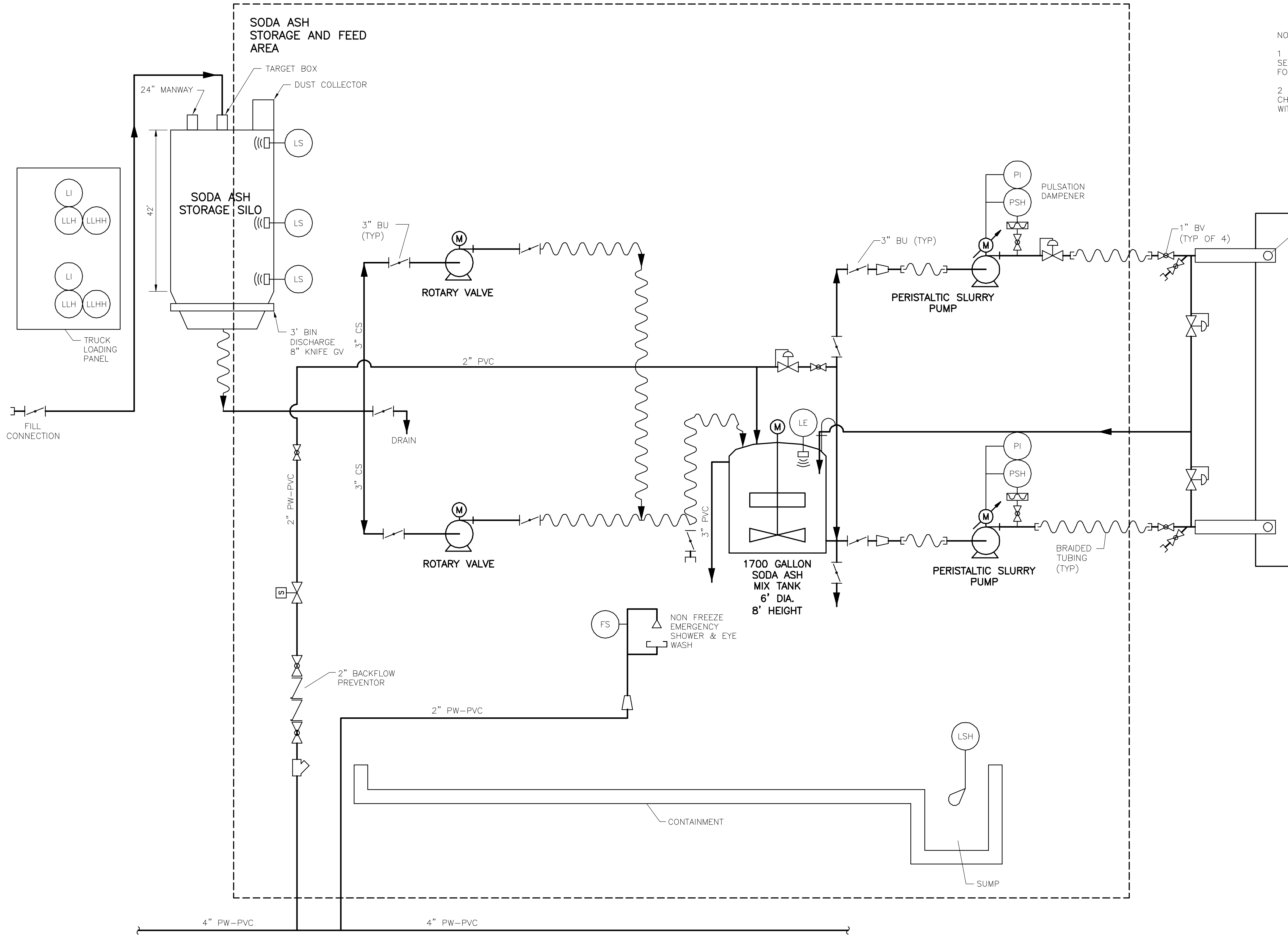
Number of Slurry Pumps	2
Max Pump Capacity	7,700 gph
Number of Mechanical Mixers	1 @ 2 HP
Minimum Pump Capacity	Recirculation required; slurry measured with mag-meter
Slurry Pump	10 HP, 230V, 60 Hz, 3 ph
Estimated Electricity Usage	395 KWH per day total system
Storage Capacity	90 tons
Slurry Tank Capacity	1,700 gallon steel mix tank
Silo Dimensions	1 silo – 4,750 cu ft capacity Diameter – 12 feet Height – 58 feet overall

The soda ash feed system will be designed so that either of the two slurry pumps can feed both dosing locations. The soda ash will be fed from the silo into the 1,700 gallon mix tank where water will be added and mixed with a 2 HP mechanical mixer to develop slurry. The slurry dose will be controlled by a magnetic meter and the remaining slurry can be recirculated to keep the dosing lines from clogging. The process mechanical diagram for the lime feed system is shown in Figure 5-32.

5.12.8 Carbon Dioxide

Carbon dioxide will be used to adjust the pH at the WTP after hardness adjustment. The existing plant has the capability to dose carbon dioxide at both Recarbonation basins which are directly upstream of the prefilter ozone. During the plant expansion the entire system will be rehabbed, including new diffusers/injectors. Carbon dioxide dosing will not be required at the membrane plant.

Figure 5-32
Modifications to Soda Ash System



NOTES:

1 PVC BUTTERFLY VALVES FOR CHEMICAL SERVICE SHALL BE OF LUG STYLE SUITABLE FOR DEAD-END SERVICE.

2 PVC BALL VALVES 2-IN AND LARGER FOR CHEMICAL SERVICE SHALL BE SOCKET TYPE WITH FLANGE CONNECTION.

FIGURE 5-32
SODA ASH SYSTEM
BOSSIER CITY WTP EXPANSION

The average monthly usage for carbon dioxide at a maximum monthly flow of 17 mgd will require a minimum of 8,976 gallons to be stored on site, too meet an average dosing of 17.6 mg/L. The design parameters for the carbon dioxide feed system are listed in Table 5-11.

Table 5-11
Carbon Dioxide Feed and Storage System

Number of Carbonic Acid Feed Panels:	2
Max Feed Capacity:	160 lb/hr per panel
Carrier Water Usage:	160 gpm per panel
Storage Capacity:	34 ton liquid capacity
Tank Size:	68,000 lbs

The carbon dioxide feed system will be designed so that two 160 lb/hr carbonic acid feed panels are piped to a common header that feeds both dosing locations. The piping will be valved to allow for either feed system to feed either of the injection points, while also providing the capability to isolate and remove either of the feed systems from service for repair or replacement. The process mechanical diagram for the carbon dioxide feed system is shown in Figure 5-33.

5.12.9 Aluminum Chlorohydrate

Aluminum Chlorohydrate (ACH) is required as a coagulant for the membrane treatment plant. The ACH will be dosed to the rapid mix basins just upstream of Solids Contact Clarifiers 3 and 4.

The average dosing requirement of 11 mg/L ACH are calculated using data from the membrane pilot study. The average monthly usage of ACH at a maximum monthly flow of 21 mgd will be 6,930 gallons. The chemical storage facility will be large enough to store a minimum of 12,000 gallons of ACH. The design parameters for the ACH feed system are listed in Table 5-12.

Table 5-12
ACH Feed and Storage System

Number of Pumps	3
Max Pump Capacity	12 gph
Modified Pump Capacity	4:1 turndown; adjustable stroke length
Electricity Usage Estimate	75 KWh per day total system
Storage Capacity	12,200 gallons
Tank Size	2 – 6,100 gallon tanks Diameter – 10 feet Height – 12 feet 8 inches

Figure 5-33
Modifications to Recarbonation System

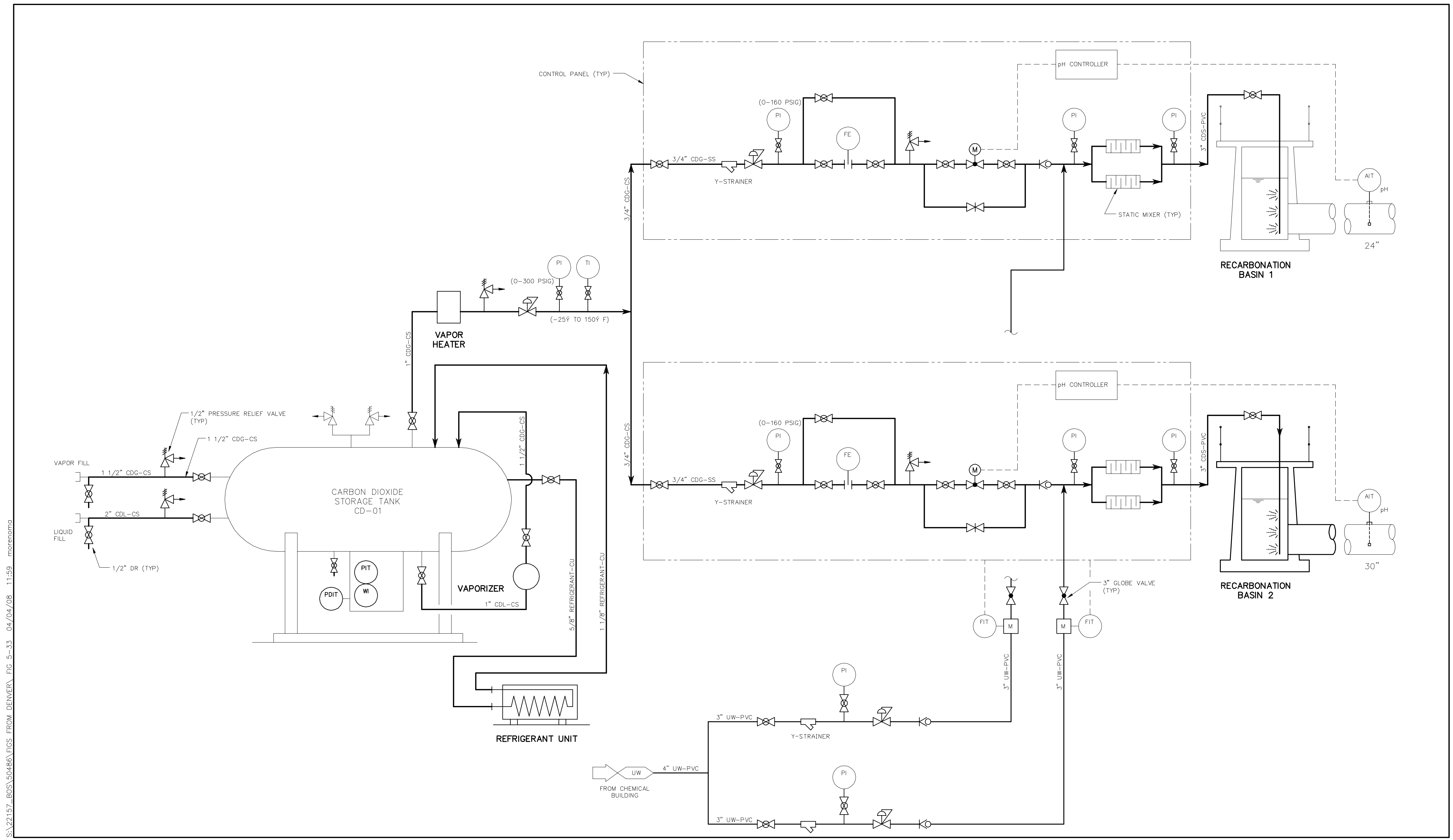


FIGURE 5-33
MODIFICATIONS OF RECARBONATION SYSTEM
BOSSIER CITY WTP EXPANSION

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The ACH feed system will be designed so that both storage tanks are piped to a common header. This set up will allow either of the storage tanks to feed any of the pumps. One feed pump will be dedicated to each of the two dosing points. The third metering pump will be piped with valves so as to allow for feeding either of the two dedicated pumps. This will provide the capability to isolate and remove any of the pumps from service for repair or replacement. The process mechanical diagram for the ACH feed system is shown in Figure 5-34.

5.12.10 Fluoride

Fluoride in the form of Fluorosilicic acid is added to the finished drinking water. The fluoride will be dosed to two points in the finished water stream. One dosing point will accommodate the finished water from the existing plant and the other will serve the finished water from the membrane plant. Both dosing points will be directly upstream of the finished water blend structure.

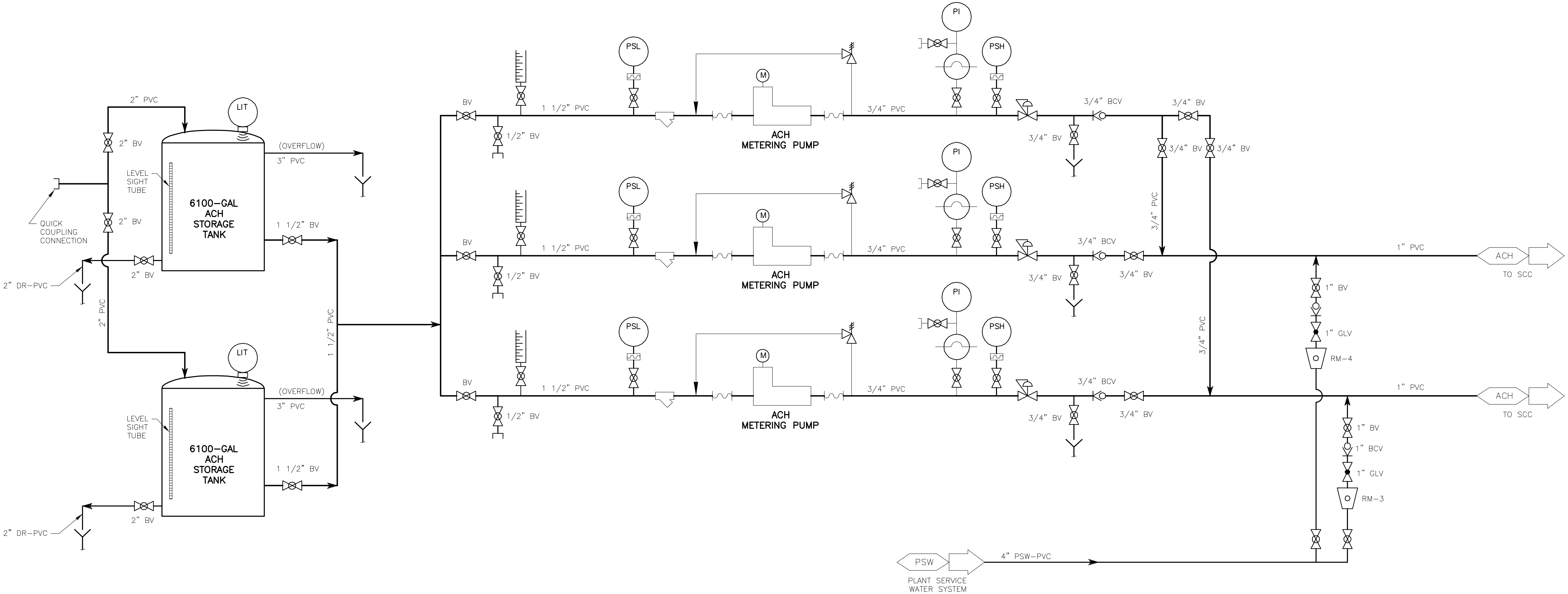
The average monthly usage for fluoride at a maximum monthly flow of 38 mgd will be 3,765 gallons at an average dose of 0.7 mg/L. The chemical storage facility will be large enough to store a minimum of 3,990 gallons assuming 20 percent solution. The design parameters for the fluoride feed system are listed in Table 5-13.

Table 5-13
Fluoride Feed and Storage System

Number of Pumps:	2
Max Pump Capacity:	12 gph
Modified Pump Capacity:	4:1 turndown; adjustable stroke length
Electricity Usage Estimate:	50 KWh per day total system
Storage Capacity:	4,000 gallons
Tank Size:	2 – 2,000 gallon tanks Diameter – 7 feet 1 inch Height – 8 feet 6 inches

The fluoride feed system will be designed so that both storage tanks are piped to a common header. This set up will allow either of the storage tanks to feed any of the pumps. The feed pumps will also feed a common header system. The use of valves will allow any of the feed pumps to feed either of the two injection points, while also providing the capability to isolate and remove any of the pumps from service for repair or replacement. The process mechanical diagram for the fluoride feed system is shown in Figure 5-35.

Figure 5-34
Modifications to Aluminum Chlorohydrate System



S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-34 04/04/08 11:58 morenoma

FIGURE 5-34
ACH FEED SYSTEM
BOSSIER CITY WTP EXPANSION

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Figure 5-35
Modifications to Fluoride System

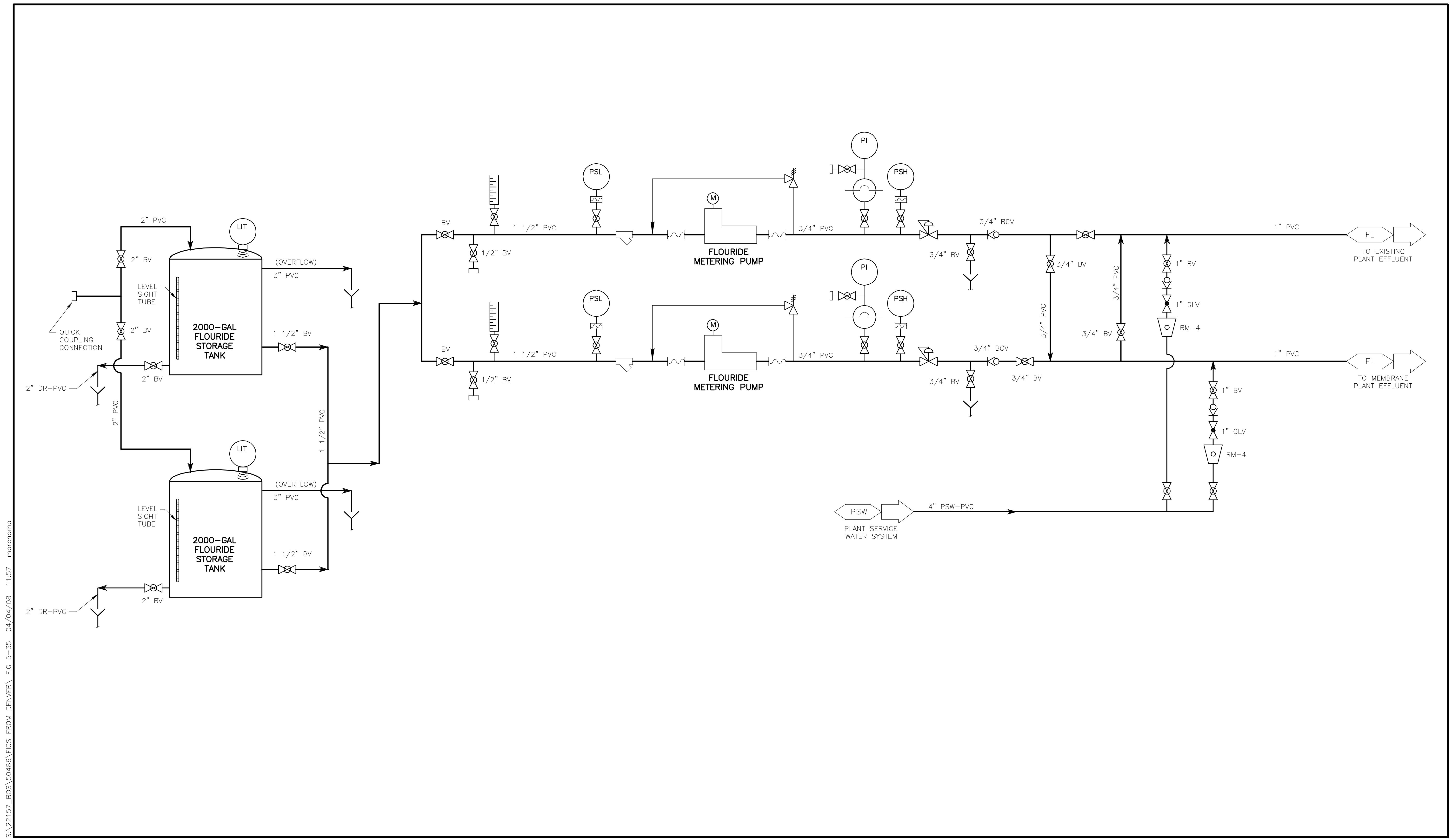

FIGURE 5-35
PM & ID FLOURIDE FEED SYSTEM
BOSSIER CITY WTP EXPANSION

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5.12.11 Zinc Orthophosphate

Zinc orthophosphate is dosed to the finished water to act as a corrosion inhibitor throughout the distribution system. The zinc orthophosphate will be dosed to two points in the finished water stream. One dosing point will accommodate the finished water from the existing plant and the other will serve the finished water from the membrane plant. Both dosing points will be directly upstream of the finished water blend structure.

The average monthly usage for zinc orthophosphate at a maximum monthly flow of 38 mgd will be 3,420 gallons, at an average dose of 3 mg/L. The chemical storage facility will be large enough to store a minimum of 4,000 gallons. The design parameters for the zinc orthophosphate feed system are listed in Table 5-14.

Table 5-14
Zinc Orthophosphate Feed and Storage System

Number of Pumps:	2
Max Pump Capacity:	12 gph
Modified Pump Capacity:	4:1 turndown; adjustable stroke length
Electricity Usage Estimate:	50 KWh per day total system
Storage Capacity:	4,000 gallons
Tank Size:	2 – 2,000 gallon tanks Diameter – 7 feet 1 inch Height – 8 feet 6 inches

The zinc orthophosphate feed system will be designed so that both storage tanks are piped to a common header. This set up will allow either of the storage tanks to feed any of the pumps. The feed pumps will also feed a common header system. The use of valves will allow any of the feed pumps to feed either of the two injection points, while also providing the capability to isolate and remove any of the pumps from service for repair or replacement. The process mechanical diagram for the zinc orthophosphate feed system is shown in Figure 5-36.

5.12.12 Ozone

Modifications to ozone system are described in Section 5.9.

5.13 Filtered Water Blend Structure

The Filtered Water Blend Structure will blend filtered water from the existing plant with that from the membrane plant. The filtered water blend structure will be baffled to prevent short circuiting. Figure 5-37 shows the layout of the Filtered Water Blend Structure. Assuming a conservative baffling factor of 0.6, approximately 2.5 minutes of detention will be provided for the membrane filtered water (assuming peak flow of 25 mgd) with an additional 3.4 minutes of detention time after the membrane and conventional filtered water combine (assuming peak flow of 45 mgd).

Figure 5-36
Modifications to Zinc Orthophosphate System

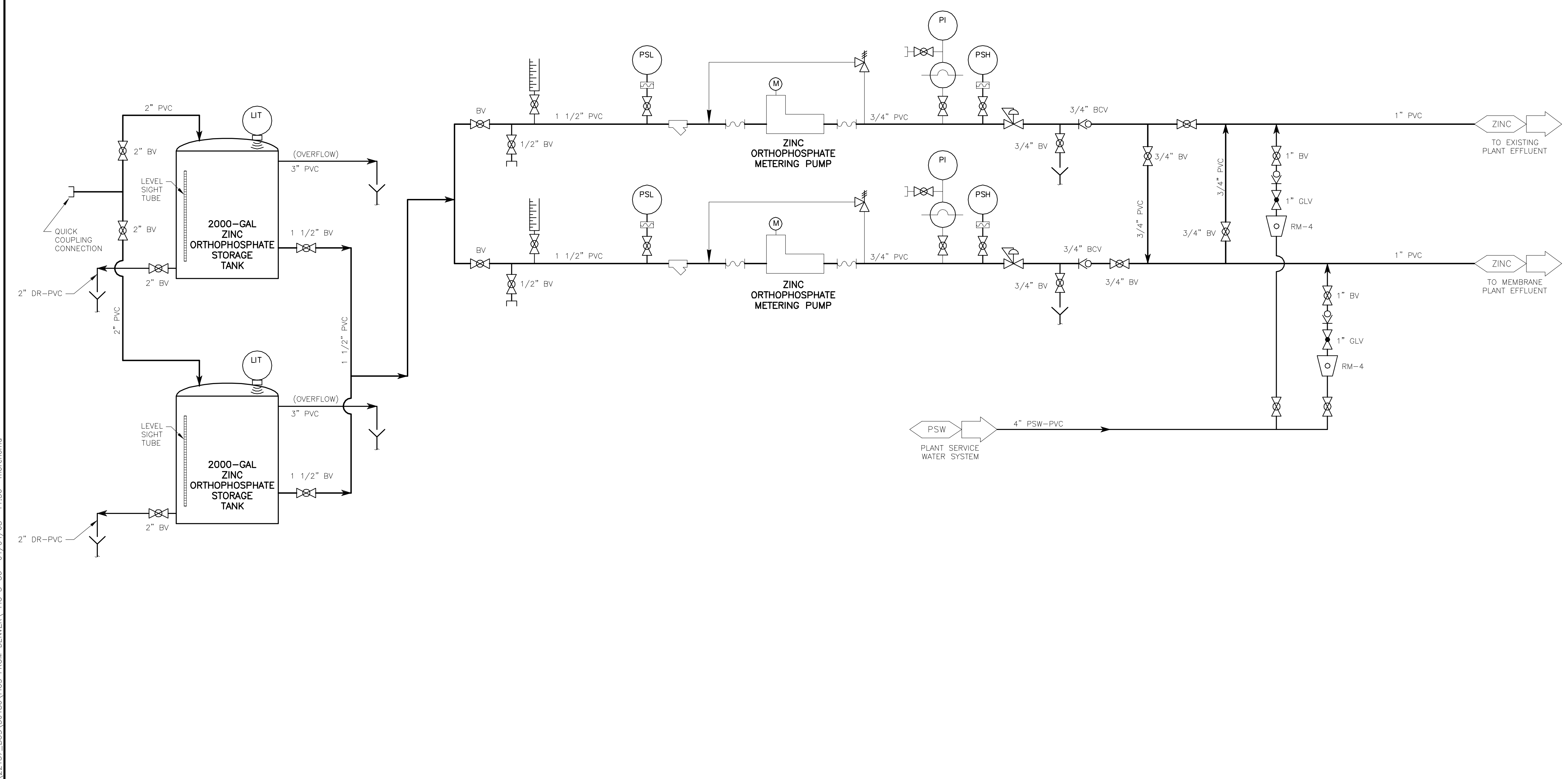

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FIGURE 5-36
PM & ID ZINC ORTHOPHOSPHATE FEED SYSTEM
BOSSIER CITY WTP EXPANSION

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Figure 5-37
Filtered Water Blend Structure

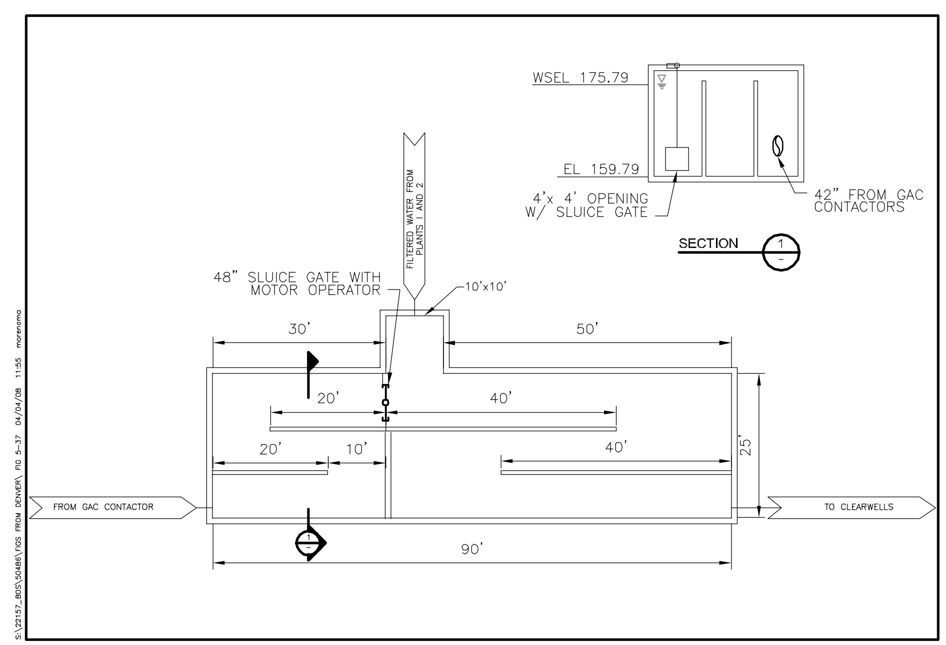

FIGURE 5-37
FILTERED WATER BLEND STRUCTURE
BOSSIER CITY WTP EXPANSION

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5.14 Clearwell Storage

The existing three clearwells have a total capacity of 4.7 MG. A general rule of thumb is to provide onsite storage equal to 10 percent of plant capacity. The current volume of the clearwells is adequate.

For the water distribution system, a general rule of thumb for storage is to provide system storage (includes onsite and offsite finished water storage) equal to the average daily flow of the plant. There currently is a combined storage volume of about 12 MG (4.7 MG in clearwells and 7.5 MG in elevated water storage tanks). During 2005-2007, the average daily finished water produced is between 12-13 mgd. The total system storage is approximately equal to the finished water produced by the plant. When the average daily flow approaches 15 mgd, another 3 MG of storage should be on line at either the WTP or out in the system or a combination of the two can be used (approximately by 2017). Figure 5-1 shows a location and the relative size of a new 2-MG clearwell located on the plant site.

5.15 High Service Pumping

With an estimated maximum hour of 45 mgd for the expanded WTP and a currently-available 39 mgd firm pumping capacity, an additional 6 mgd of firm pumping capacity is needed. CDM recommends the installation of one 4,500 gpm pump at Clearwell 1 and two 4,500 gpm pumps at Clearwell 3. This would provide a new firm capacity of 45 mgd and a total high service pumping capacity of 52 mgd. Figures 5-38 and 5-39 show recommended modifications.

Pump appurtenances for new pumps will match the existing units. A butterfly valve will be installed on the discharge side of each pump for isolation for routine maintenance and repair. Double door check valves will also be installed on the pump discharge laterals.

Specific surge control devices that may be required at the high service stations will be determined during final design.

Review of pumping station appurtenances including standby power, hoisting systems, test loops for measuring and analyzing pump capacities and performance, metering equipment, instrumentation and controls will be evaluated further during design.

Figure 5-38
Modifications to High Service Pump Station at Clearwell 1

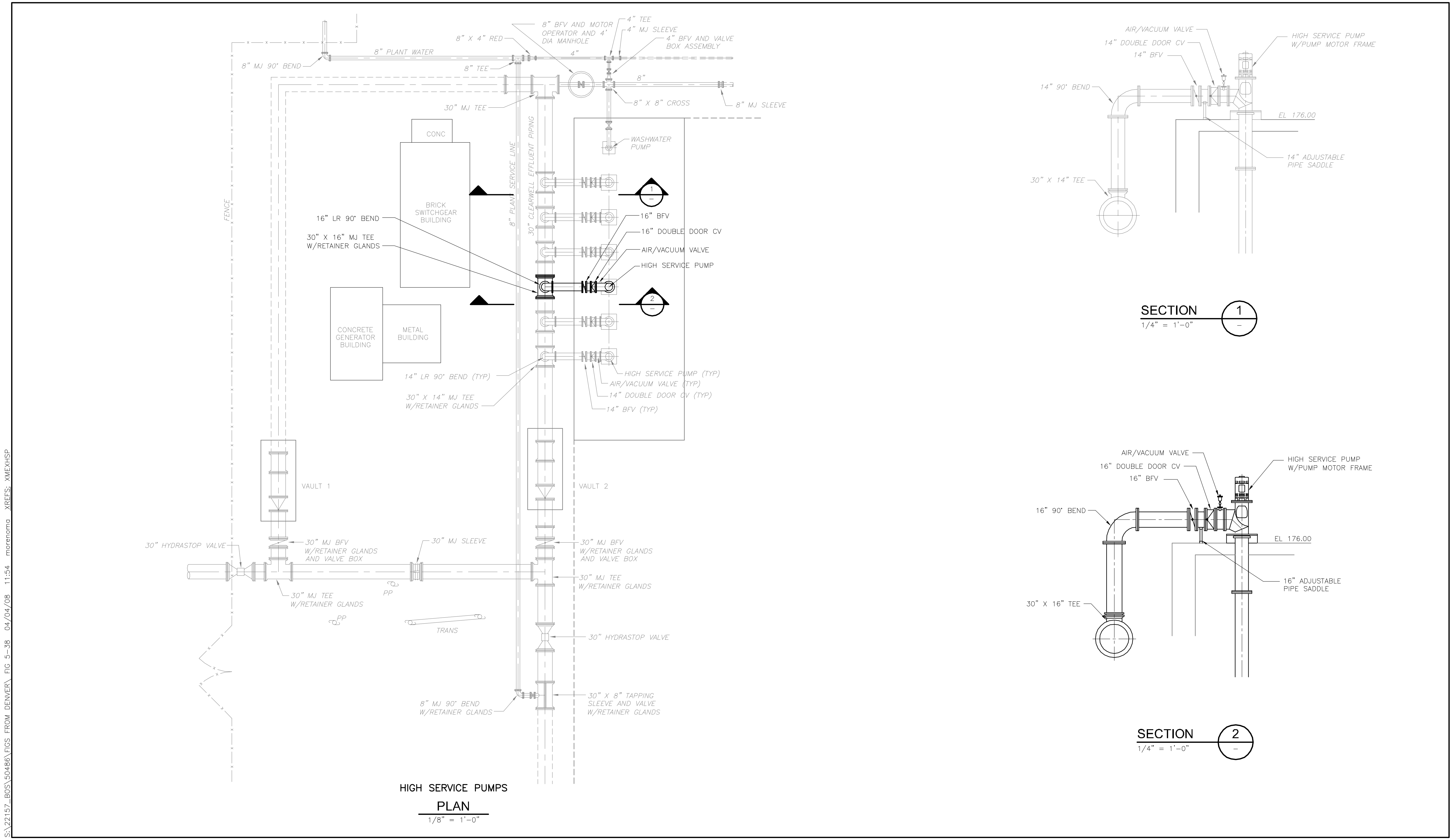

FIGURE 5-38
MODIFICATIONS TO HIGH SERVICE PUMP STATION AT CLEARWELL 1
BOSSIER CITY WTP EXPANSION

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Figure 5-39
Modifications to High Service Pump Station at Clearwell 3

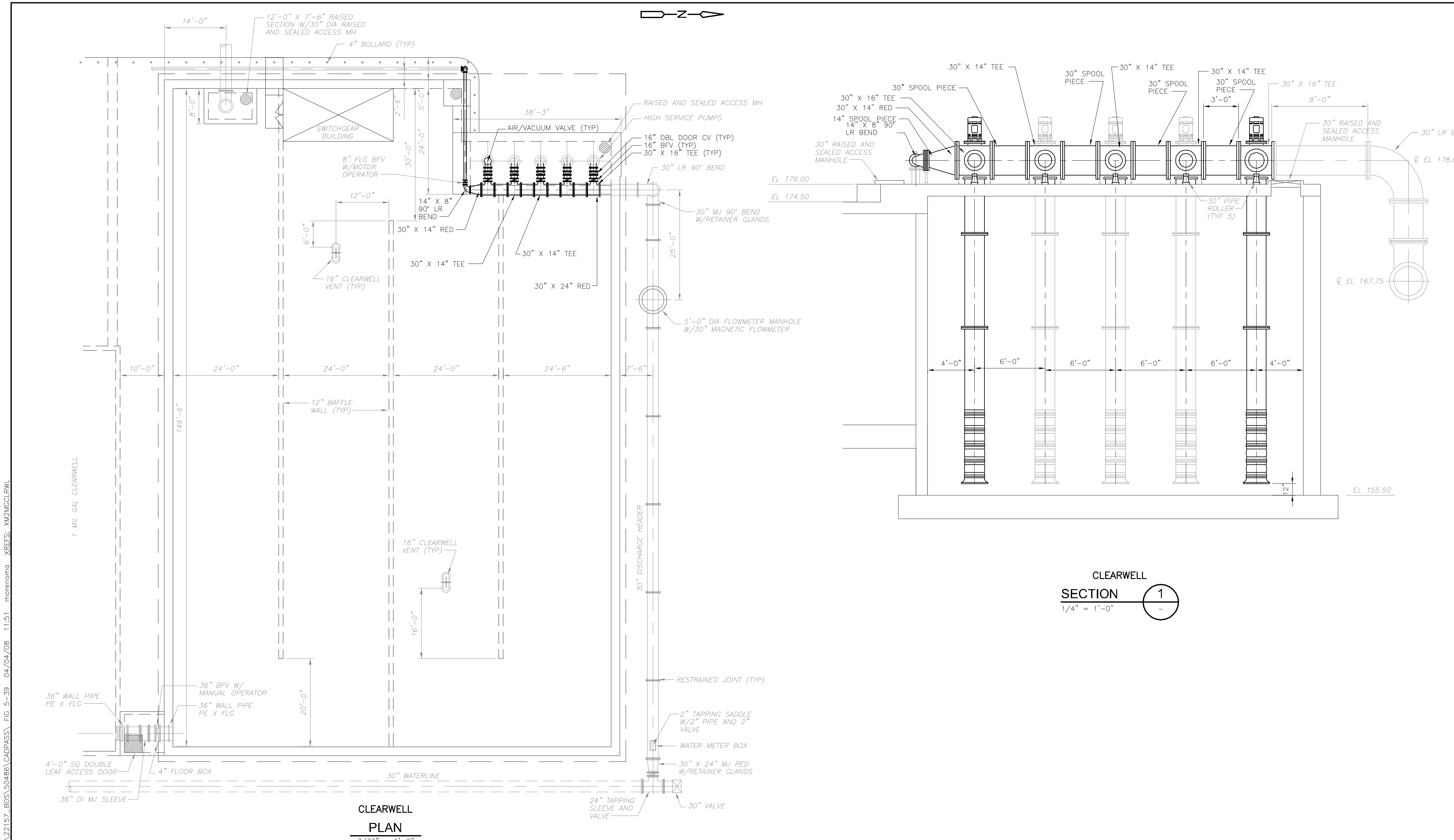

FIGURE 5-39
MODIFICATIONS TO HIGH SERVICE PUMP STATION AT CLEARWELL 3
BOSSIER CITY WTP EXPANSION

The *2002 Hydraulic Analysis* report included recommended distributions system improvements based on a projected average day demand of 14.25 mgd and maximum month demand of 20.4 mgd in 2025. As a result of faster implementation of the recommendations made in the *2002 Hydraulic Analysis* and a larger than projected increase in treatment capacity, the distribution system model needs to be updated to identify improvements required to accommodate the revised average day and maximum month demand projections of 17 mgd and 29 mgd respectively.

5.16 Disinfection

The current plant residual disinfection method shall be utilized for WTP expansion. Chlorine and ammonia will be fed prior to the clearwells. A new chlorine and ammonia chemical feed system will be required.

Chlorine and ammonia will continue to be added to the filtered water to form chloramines as the secondary disinfectant for the distribution system. It is recommended that a new chlorine system be built, including a ton container storage building, dual triple-scale manifolds, chlorine scrubber, chlorinators and evaporators. The existing chlorine system does not meet current fire and building codes. The rooms in use are not large enough to house larger equipment and different equipment is required by code. It does not have sufficient storage space to house a 30-day supply of chlorine.

The current disinfection practices will continue to provide low DBP levels. Ozonation for primary disinfection, followed by chloramination as the residual disinfectant, has served the City well with respect to controlling DBP formation and preventing regrowth in the distribution system. Its use should be continued largely unchanged.

Current regulatory requirements for disinfection include 4-log inactivation of viruses and 3-log inactivation of Giardia cysts. The proposed membrane treatment system has been demonstrated to provide up to 6-log removal or greater of Giardia cysts. As a result, there will be no additional requirements for inactivation of Giardia cysts. However, the use of ozone treatment will provide an additional disinfection barrier to Giardia cysts. The proposed membrane system for this alternative is less effective against removal of viruses. At this time, it is unknown how much disinfection credit for virus inactivation will be provided for Alternative 3. It is assumed that the treatment facility will receive 2 log virus removal credit that is typically provided for conventional treatment systems. The proposed ozone treatment system will be capable of providing the remaining 2-log virus inactivation, if required.

The proposed membrane filtration system is also capable of providing up to 6-log removal, or greater, of cryptosporidium cysts. As a result, the proposed system is expected to meet any requirements for cryptosporidium inactivation that may result following sampling for the EPA Long Term 2 Enhanced Surface Water Treatment Rule (LT2).

5.17 Hydraulic Profile

To determine a typical configuration, a hydraulic profile will be created using a maximum flow of 45 mgd. The hydraulic profile of the existing and new treatment trains are shown in Figure 5-40 and 5-41, respectively. The hydraulic profile for the new treatment train is based on:

- Two treatment trains
- 12.5 mgd through each the rapid mix basin/solids contact clarifiers
- 5.0 mgd through each membrane train (one out of service for backwashing)
- 12.5 mgd through each post-filter ozone contactor
- 5.0 mgd through each GAC contactor (one out of service for backwashing)

5.18 Process Waste Streams

The waste streams resulting from Alternative 3 include clarifier blowdown, membrane system wash water, and neutralized clean-in-place (CIP) waste from chemical cleaning. It is assumed that residual solids blowdown and neutralized CIP waste solutions will be directed to the Red River without additional treatment. Waste membrane wash water, will be also be directed to the existing process drain system without treatment. A new outfall structure on the Red River will be evaluated during the next design phase.

5.19 Electrical Modifications

Electrical power will need to be provided for the selected treatment alternative. The electrical service options are as follows.

5.19.1 Existing Services

The existing plant power system does not have the capacity to provide power for the new facilities. One of the service entrances could be upgraded to include sufficient capacity. Since this option would require significant plant disruptions, and would also require additional space for new electrical switchgear, it is not recommended.

5.19.2 Consolidation of Services

In general, primary metering electrical rates are less expensive than secondary metering. This would indicate that there would be cost savings for combining all electrical services under one account, instead of maintaining multiple accounts as with this facility. However, the MPS rate must be taken into consideration in this case. Since that particular rate may be applied only to pumping facilities, it would not apply to the treatment plant as a whole, under any combined service scenario. The MPS rate is significantly less expensive than any applicable general power (LP) rate schedule. Based on the period from May 2006 through April 2007, combining the four

Figure 5-40
Hydraulic Profile of Existing Plant

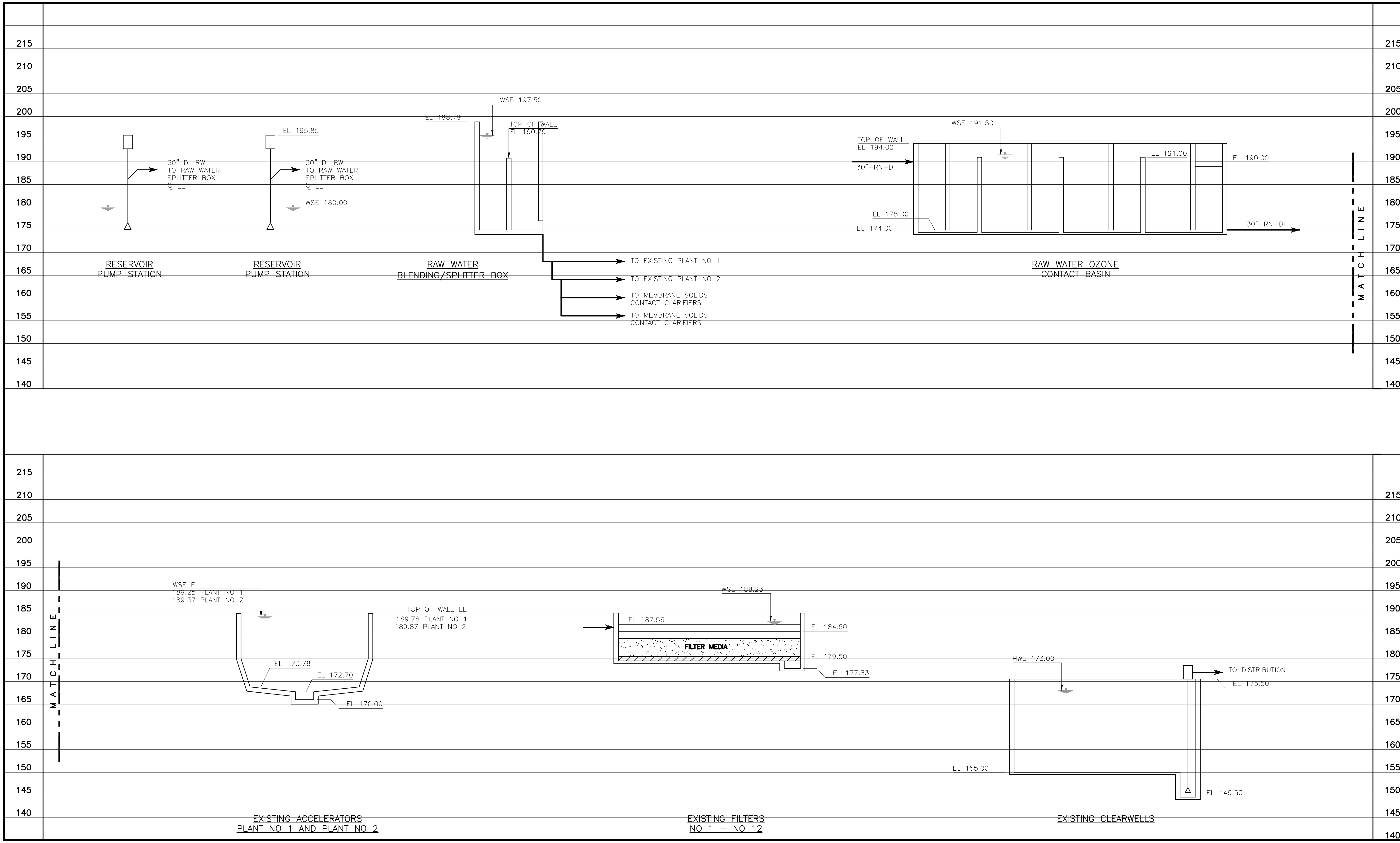

FIGURE 5-40
HYDRAULIC PROFILE EXISTING CONVENTIONAL WTP
BOSSIER CITY WTP EXPANSION

Figure 5-41
Hydraulic Profile of New Plant

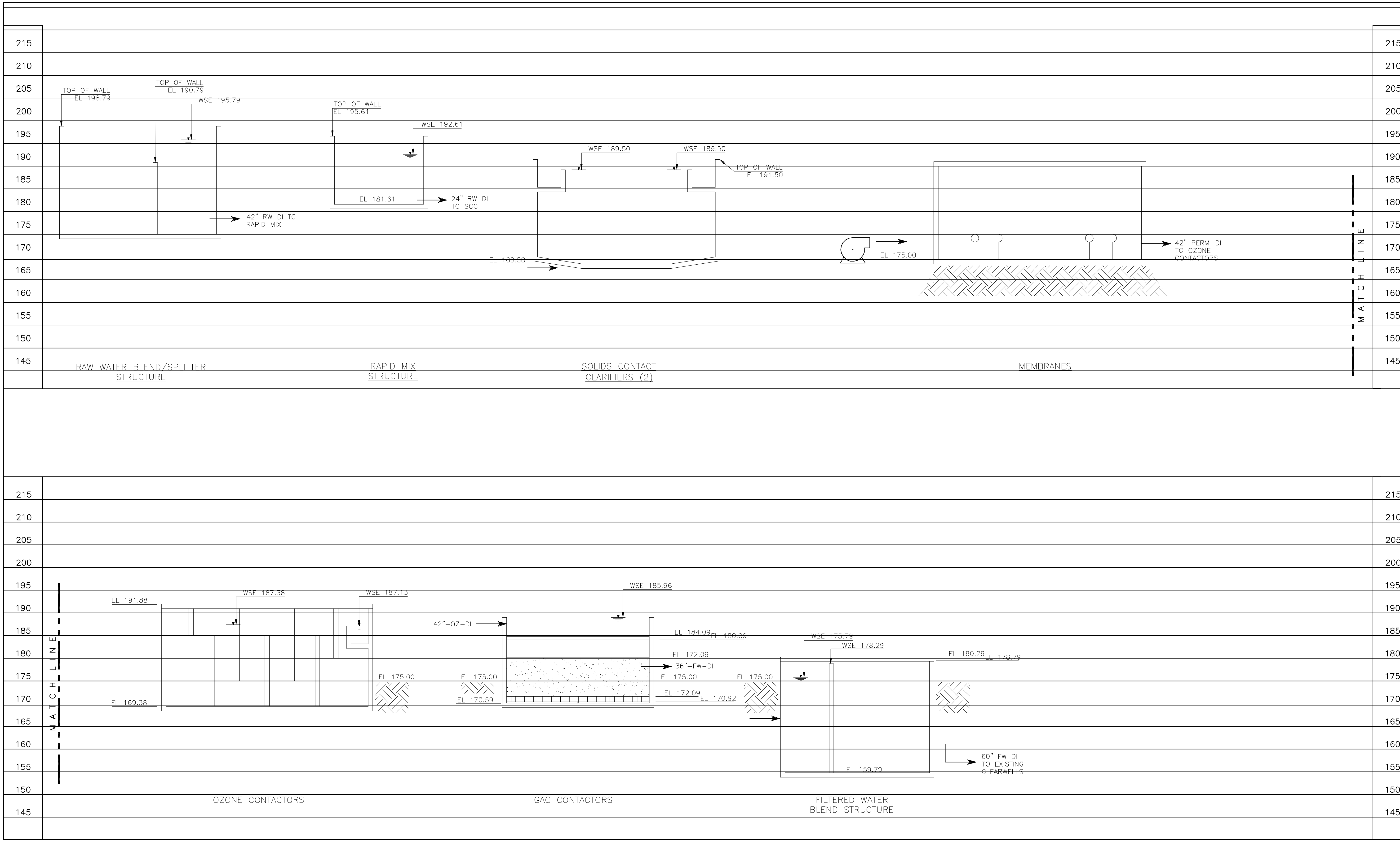

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FIGURE 5-41
HYDRAULIC PROFILE OF PROPOSED MEMBRANE WTP
BOSSIER CITY WTP EXPANSION

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billings under one rate and applying the primary metering clause of the rate schedule would result in increased costs of approximately 10%. In addition to this direct electrical cost, a primary metered facility would require Bossier WTP to own and maintain all electrical facilities on their side of the meter. The cost of purchase, installation, and maintenance of the distribution lines and transformers would make this option even more expensive, as well as exposing the plant personnel to more dangerous conditions (higher voltage equipment) and requiring the plant to have replacement equipment on hand or available on short notice. Due to these considerations, this option is not recommended.

5.19.3 New Service

AEP can provide a separate electrical service to the new facilities. This service would consist of an underground feeder to a pad mounted transformer, all owned and maintained by AEP, located near the main process building for the new facilities. This would be billed under a separate meter, using the LP rate. As this option provides least cost and least maintenance requirements to the plant, it is recommended.

5.19.4 Emergency Backup and Redundant Service

In the event of a power outage from AEP, the plant must continue to operate. To provide this emergency service, a natural gas or diesel powered generator is recommended. This generator will be sized to power the entire new facility. Preliminary indications place this in the 2.0 MW to 2.5 MW range. Due to the size of the generators, parallel operation with multiple generators and synchronizing switchgear may be most economical, and this option will be compared with single generator operation. The generator fuel source will be evaluated and a recommendation will be made after discussion with plant personnel and vendors.

In addition to onsite generation, the effects of power outages may be minimized if AEP provides a redundant power supply. This is usually accomplished by running a separate primary line from a different substation to the plant and installing an Automatic Throw-Over (ATO) system. The ATO system will need to be coordinated with the plant's onsite protective devices, and would provide backup power to the primary side of AEP's pad mounted transformer(s). The next level of redundancy that can be provided by AEP would include installing a second pad mounted transformer instead of the ATO. This would require a slightly different configuration of the main switchgear equipment for the new facilities. For all cases in which AEP installs anything beyond the single primary line to a single transformer, the plant will need to pay for all or part of the construction costs for the additional utility facilities. This alternative will be investigated with AEP, but due to the potential costs involved, is not recommended as the preferred method of providing plant reliability. Options for providing emergency electrical service are summarized in Table 5-15.

Table 5-15
Options for Providing Emergency Electrical Service

Reliability solution	Advantages	Disadvantages
Diesel generator	Lowest cost owner-provided option	Maintenance required by plant personnel
	Very high reliability	Diesel fuel storage and availability during emergency conditions
		Potential environmental, air, and noise requirements will increase cost
Natural gas fired generator	Highest reliability	Highest installation cost
	No fuel storage requirements	Maintenance by plant personnel, who may not be familiar with natural gas fired engines
	Clean burning fuel	Generator will need to be oversized if large motors are connected, due to lower performance under motor starting conditions
Redundant AEP facilities	No customer owned equipment or maintenance	Least reliable – A general emergency situation (tornado or other large storm, for example) could potentially take both sources out of service at the same time.
		Cost is undermined, will be set by AEP, and will not be subject to bidding or negotiation

5.20 Instrumentation Modifications

5.20.1 Overview

There are several advantages Bossier City will gain by implementing a standardized SCADA system. These include:

- Presentation of entire water system real-time data to the operator so that effective operational decisions can be made during both normal and emergency conditions.
- Storage of historical data for water systems and the capability to trend data for use in longer term operational and planning decisions.
- Optimization of process data acquisition methods and automatic generation of operational and state required reports.
- Remote operator initiated and automated control capabilities for processes resulting in greater operational flexibility and efficiency.
- Remote monitoring and data warehousing of equipment maintenance data, allowing personnel to take a more proactive approach towards maintenance.

- Better knowledge and understanding of the hardware and software by all instrumentation and operations personnel.

- Ease of implementing changes required for future expansion.

Based on CDM's experience and the needs, circumstances, and interest from Bossier City, it is recommended that a fiber optic loop communication system be implemented for SCADA system communications between the main plant, the ozone facility and the expansion plant, while leaving the canopy radio architecture in place. Fiber optic cabling provides a highly reliable and fast communications medium for the long term and the loop configuration will provide an enhanced level of redundancy.

Initially, the upgraded SCADA system will collect and process data for remote monitoring and control of water system processes. In the future, consideration will be given to expand the SCADA system to include collection and processing of data associated with the City's wastewater needs. SCADA system monitoring of equipment and processes will be through human machine interface (HMI) graphics screens. SCADA system monitoring will include real-time status of system processes and historical archiving of process data and alarms. Historical data will be used for generation of daily, monthly, and yearly reports.

5.20.2 System Architecture

It is recommended that the new SCADA system architecture consist of three subsystems. These are the HMI, PLC, and RTU subsystems. The HMI subsystem provides the interface to process monitoring and control, and consists of a data collection/historical data server and peripherals. The PLC subsystem will perform specific process control functions, I/O processing, calculations, and communicates data directly to the HMI subsystem via an Ethernet network. The RTU subsystem will communicate directly to the HMI subsystem via a radio system, perform process control functions, I/O processing, and calculations. Figure 5-42 illustrates two of the three subsystems recommended for the upgraded SCADA system and the locations of each within the City's water system.

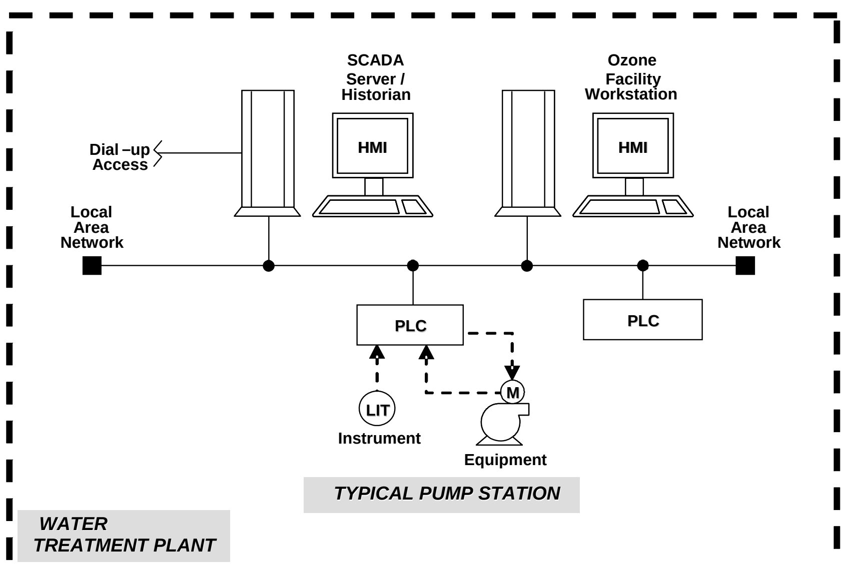


Figure 5-42
SCADA System Architecture

CDM recommends that all HMI, PLC, and RTU equipment are powered from uninterruptible power supply (UPS) units. UPS units will provide redundancy and conditioned power to the SCADA system components by correcting power failures, under-voltage (brownout), over-voltage, line noise, frequency variations, switching transients, and harmonic distortion. The additional cost of UPS units is well worth the greater reliability and power conditioning benefits. Figure 5-43, 5-44, and 5-45 depict the proposed SCADA system architecture including plant expansion.

5.20.2.1 SCADA System Controllers and I/O Interface Units

There are several types of SCADA system controllers and I/O interface units used in the water/wastewater industry for systems similar to what is required for Bossier City. These include hybrid Distributed Control Systems (DCS), Programmable Logic Controllers (PLC), and Remote Telemetry Units (RTU). Each platform has advantages and disadvantages with regards to design, costs, benefits, and overall limitations. In addition to the hardware aspects, consideration must be made for the network architecture and user requirements such as graphics, operation, reporting, system security, management, and regulatory needs. Another consideration is the amount of time and resources it takes to configure each of the systems. This section will briefly describe the advantages and disadvantages of these types of SCADA controllers used in the water/wastewater industry as they relate to the proposed Bossier City SCADA system.

A hybrid DCS system is designed for small to medium scale process control needs where advanced logic processing is required. Like PLC systems, hybrid DCS systems offer redundant controllers, networks, and I/Os at slightly higher costs as those of small PLC systems. However, unlike PLC and RTU systems, hybrid DCS systems have a single database central to the system. Hybrid DCS systems require more initial training than PLCs and RTUs, but have engineering tools built into the system that allow for simplified configuration efforts. Controller configuration and HMI software require use of manufacturer’s proprietary software. Some manufacturers have an open connectivity (OPC) protocol that can be used to connect to third party HMI software packages. Even though third party software can be implemented, it eliminates many of the advantages of purchasing a DCS system. Manufacturers offer long-term support for hybrid DCS systems; however, configuration support can sometimes be limited since there are fewer companies that are certified to sell and install these systems. This translates to the possibility of limited local support, depending on the proximity of the manufacturer’s offices. Support would likely be provided over the phone or the manufacturer would require a remote access service to be installed. Furthermore, this limited number of integration companies and distributors may be a concern to the city for future pricing since there are few options for competitive bids.

Figure 5-43
Proposed Plant System Architecture

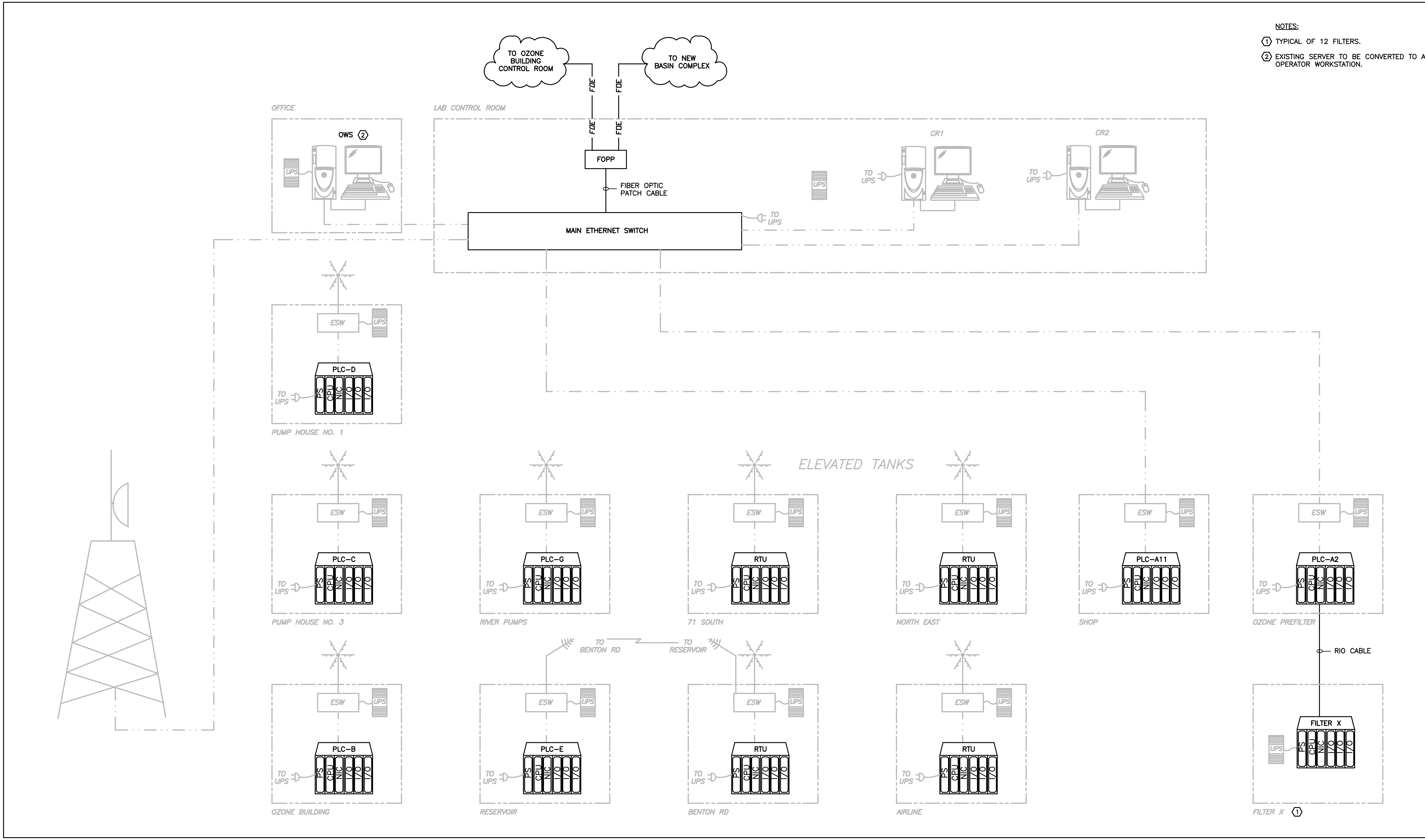
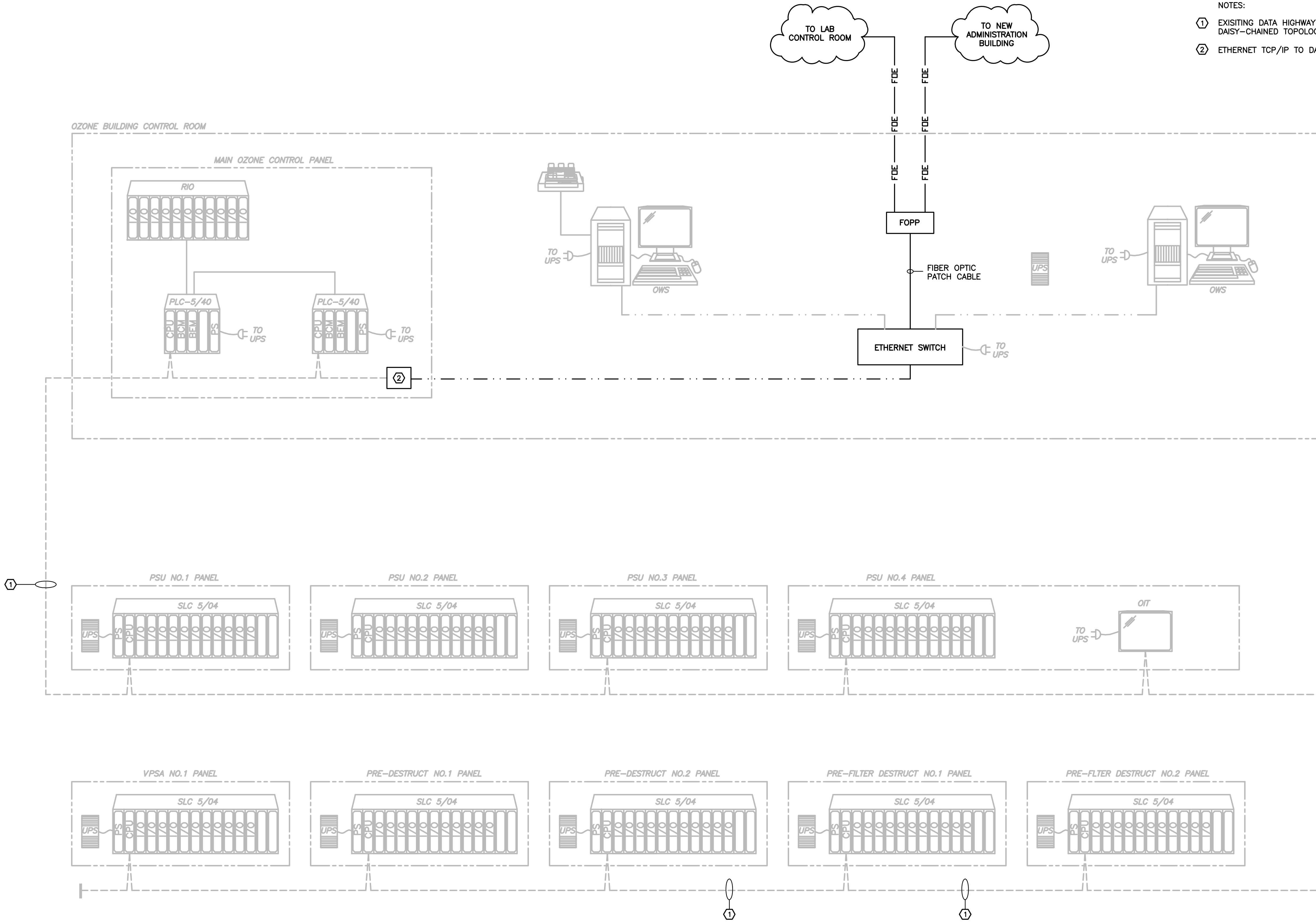


Figure 5-43
Proposed Plant System Architecture

Figure 5-44
Proposed Ozone Control System Architecture



NOTES:

1. EXISITING DATA HIGHWAY PLUS CABLE CONFIGURED IN A DAISY-CHAINED TOPOLOGY.
2. ETHERNET TCP/IP TO DATA HIGHWAY PLUS CONVERTER.

Figure 5-44
Proposed Ozone Control System Architecture

Figure 5-45
Proposed Expansion System Architecture

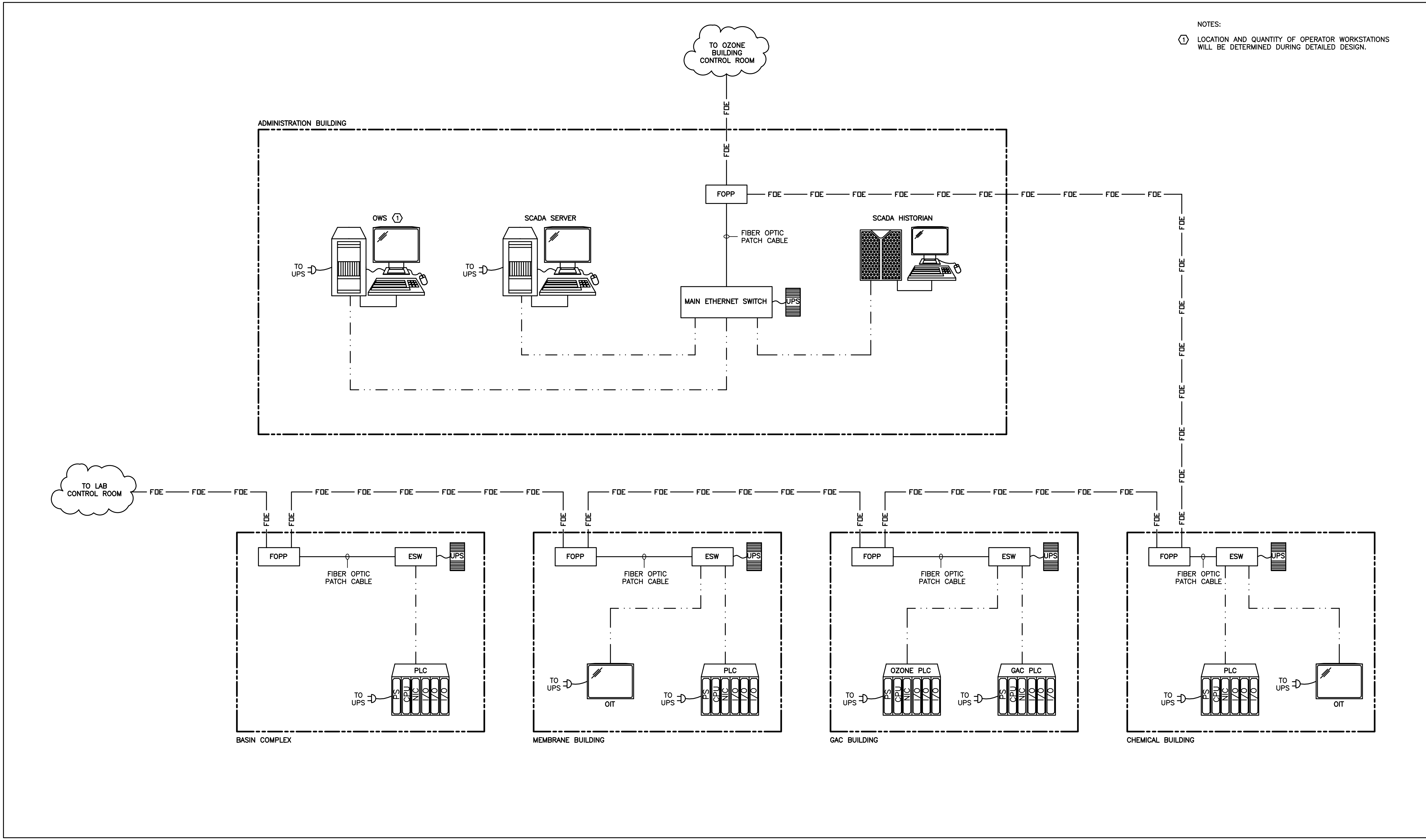


Figure 5-45
Proposed Expansion System Architecture

PLC systems offer the most flexibility and scalability of the SCADA systems. PLCs are available in both modular type and brick type styles. The modular type PLCs offer the option of component redundancy, future expansion, customizing of I/O module types, and advanced logic processing capability. Brick type PLCs offer a limited number of I/O channels built in to the chassis at a reduced cost. PLC controllers require configuration using manufacturer's proprietary software, but HMI software is not limited to manufacturer-specific software. Although, generally PLC systems have multiple databases, with each PLC/processor having its own database, some manufacturers have closed the gap and made their offerings more similar to the single database that is inherent to DCS type systems. Additionally, PLC systems have begun to provide features similar to those offered in DCS-based systems by offering numerous enhanced control logic functions. Since most PLC/RTU system HMI software packages offer the ability to load and run multiple equipment drivers, there are many choices available for HMI software that are compatible with multiple PLC/RTU types. These include HMI programs developed by PLC/RTU manufacturers and advanced HMI programs such as GE's Proficy iFix, Invensys' Wonderware, and Allen-Bradley's RSView. Advanced HMI software packages offer significant customization, configuration, and historical reporting tools. Additionally, PLC manufacturers are widespread throughout the nation allowing for multiple companies and vendors being knowledgeable in their products. This allows for multiple options for local PLC support from several companies.

RTU systems offer an affordable option for simple logic processing and I/O interface capabilities. RTUs are often similar to brick type PLCs with a limited number of I/O channels built in to the chassis. Often RTU's contain an embedded radio system or have built in connectivity to popular radio communication options. Generally, RTU controllers require configuration using manufacturer's proprietary software, and this software is more often than not included in the hardware purchase price. Like PLC systems, RTU systems have multiple databases and are compatible with most HMI software types. A RTU system is a good option at sites that have a small number of I/O signals and where little or no logic processing is required.

5.20.2.2 Software and Hardware

Based on analysis of SCADA system controllers in the previous sections and since the water system is equipped with hybrid DCS and PLCs, it is recommended that a single solution be selected for future use. This will simplify overall maintenance and support for the plant personnel. The water system is currently equipped with both Bristol Babcock and Allen-Bradley PLCs; therefore, re-use of this existing equipment and standardization on one of these manufacturer's products for future SCADA system PLC equipment would provide several benefits. The foreseen benefits of PLC standardization include, but are not limited to: gaining cost savings by eliminating the need to purchase multiple PLC programming software licenses; eliminating the need to provide training to City support staff for multiple PLC brands; minimizing the amount of PLC spare parts that are needed for maintenance purposes; and the potential reduction in costs for future support contracts since a standard PLC brand is used. However, it should be noted that standardizing on one PLC manufacturer would still allow the SCADA system to remain as an open architecture system since most HMI software packages can interface with multiple PLC types from different manufacturers.

Based on the existing PLC equipment, CDM recommends standardizing on the Allen-Bradley line of products as the basis for future SCADA needs. Allen-Bradley and Bristol Babcock both have equipment to produce viable options for the city's future SCADA system. However, as discussed earlier, Bristol Babcock may require more initial training than PLCs and RTUs and configuration support is limited since there are fewer companies that are certified to sell and install these systems. Additionally, the limited number of integration companies and distributors may be a concern for future pricing since there are few options for competitive bids. Finally, the existing Allen-Bradley PLCs have been programmed by the ozone manufacturer making it even more difficult and costly to replace than the Bristol Babcock line of products that are in place within the remainder of the plant

Based on the existing HMI software, it is recommended that Bossier City continue the use of Invensys' Wonderware to be utilized for the HMI software package. However, it is recommended that the current Worderware version be upgraded with consideration for future communication to the wastewater division as well as integration between the ozone facility and plant. This advanced HMI software package is commonly used throughout the water/wastewater market and offers open architecture compatibility, with more customization, configuration tools, historical reporting tools, and redundancy options than available from similarly priced HMI software packages by PLC/RTU manufacturers. Various levels of licensing options are available that will allow Bossier City to cost effectively meet its current needs and allow growth of the system to meet future needs. This HMI software package meets the open architecture criteria and will allow connectivity to both existing and future SCADA system components by use of the appropriate software drivers.

Bossier City's current HMI configuration includes two separate development nodes, one located at the ozone facility and one located at the plant. These servers act as stand-alone systems that monitor and control its specific portion of the plant. The options that are available to Bossier City to combine both systems are to configure one of the SCADA servers to gather the data from the other server. This would involve graphics, database, and I/O driver configuration. The other SCADA server could then be converted into a client workstation allowing plant staff to monitor and control the entire plant from both the server and the client workstation. Another option is to keep both SCADA servers, but convert them into a redundant set of servers. This would then involve graphics, database, I/O driver and scripting on both SCADA servers to support and allow for the redundancy. When combining the HMI subsystem, a more reliable data communications path, such as fiber or hard-wired Ethernet, is recommended.

HMI software security will be implemented with the use of user passwords to establish operator access for various operation and control functions. Logins, passwords, and automatic logouts from the system will prevent unauthorized access to the SCADA HMI software. Operation and control privileges are defined through the use of account types, with each account type only having access to pre-approved graphics functionality. Each user is assigned one account type to establish the monitoring and control functions available to that user. Account types will be based on functional capabilities and can be configured independently of whether the location of users is at the plant or at a remote site.

The SCADA system upgrade will include enhanced historical collection and reporting software and hardware for generation of plant reports and data management. Historical reporting software can be used to automatically generate daily, monthly, and yearly reports from data collected by the SCADA system. Report formats can be customized to match standard state forms or to match other forms used by operations personnel. Bossier City's present long term data storage is being done by InSQL with XL/Reporter as the application for generating reports.

Industrial SQL (InSQL) is a powerful data storage application that is bundled with Wonderware's products for ease of configuration and data retrieval. As an acceptable data collector, other applications that are on the market include Oracle and Microsoft SQL. However, it is recommended that InSQL, which is based on the Microsoft SQL Server, be implemented to minimize setup and configuration time.

The XL/Reporter package is ideal for producing and automatically generating reports. XL/Reporter can be used with Microsoft Excel to create customized reports that can be set up to generate on operator initiation or automatically based on a schedule. Other reporting packages include Crystal Reports and Microsoft Excel. Crystal Reports and Microsoft Excel can be used to create customized reports by retrieving data from the InSQL Server via the Open Database Connectivity (ODBC) standard. The advantage in obtaining XL/Reporter is for the scheduling of the reports to either print based on an automatic schedule. Automatic report printing can be accomplished through the use of Microsoft Excel but will require additional programming at the HMI.

5.20.2.3 SCADA Communications Alternatives

There are several communication methods available for transferring data long distances between system facilities. These include leased lines, fiber optic cabling, and radio systems. While all of these data transfer medium have been proven to be viable alternatives for similar sized systems such as what is being considered for Bossier City, fiber optics is generally considered the most reliable. Cost and data transfer rates vary significantly among these alternatives. Therefore, selection often is based on not only reliability, but also cost and transfer rates.

A leased line is a permanent fiber optic or telephone connection between two points set up by a telecommunications carrier. They can be used for telephone, data, or Internet services and requires modems to transfer data from site to site. Information sent through leased lines travels along dedicated secure channels at speeds ranging from 64 kbps (kilobits per second) to 45 mbps (megabits per second). A leased line can span long or short distances, and customers generally pay a flat monthly rate for the service depending on the data transfer rate (bandwidth) and distance between the two points. Costs for high bandwidth leased lines can be as high as $1,000 per month, but Fractional T1 lines which start at 128 kbps are much less expensive. Installation costs are typically the same as for ordinary telephone lines, which can be more than $4 per foot depending on installation method.

Fiber optic cabling is a highly reliable and fast communications medium that transmits data in the form of light waves through glass fibers. Single mode fiber optic cable can transmit data up to 3 kilometers (km) at rates of up to 10 gbps (gigabits per second), while multimode fiber optic cable can transmit data up to 2 km at rates of up to 200 mbps. Fiber optic cable also provides immunity to electromagnetic interference and electrical resistance to high voltage. Typically, the cost of fiber optic cables ranges from $0.50 per foot for indoor/outdoor jacketed type cable to $2 per foot for overhead plenum type cable. While the cost of fiber optic cable itself is not astronomical, higher total costs are due to installation services and the type of installation. For example, installation of fiber optic cables on overhead lines can be over $8 per foot, while installation in conduit or concrete encased conduit can be $40 per foot or more. Fiber optic networks also require modems, transceivers, or switches at each site to convert data signals to and from light waves.

Radio modems are available in licensed or license-free (spread spectrum) frequency bands, at various data rates, in both serial and Ethernet based Internet Protocol (IP) data networks. Unlicensed parts of the radio spectrum such as 900 MHz, 2.4 GHz, and 5.8 GHz do not promise exclusive use of a frequency band, but do eliminate the delay and expense of obtaining a FCC license. Additionally, unlicensed equipment, when compared to licensed equipment, is often less expensive to procure and install. Unlicensed operating frequencies at 2.4 and 5.8 GHz offer more bandwidth than the 900 MHz unlicensed operating frequency; however, 900 MHz radios offer greater range, interference immunity, and less path loss than 2.4 and 5.8 GHz radios. The FCC rules for unlicensed transmission limit the legal maximum range of devices such that, for the same allowed power, a higher frequency will have a shorter usable range. Bossier City currently utilizes unlicensed Ethernet radios to transfer data between the ozone facility and the plant. Considering the investment already is in place in these devices and considering they have proven to be reliable, it is recommend that this method of communication continue to be utilized for remote facilities.

5.20.2.4 SCADA Remote Access Alternatives

There are several proven methods available for setting up access for remote users. These methods often include remote access service and remote access software. While these remote access methods have been proven to be viable alternatives for similar sized systems such as what is being considered for Bossier City, remote access service is generally considered the most secure and reliable.

There are two methods in which the remote access service (RAS) can be utilized. One is with a dial-up Ethernet modem which connects to the network and the other is with a dial-up 56K modem which connects directly to a PC on the network. Currently, the plant is using the dial-up 56K modem solution for remote access. Both of these solutions have advantages and disadvantages that should be considered.

An implementation of the dial-up Ethernet modem solution would require the remote computer to dial into a modem, via a dedicated phone line, that is connected to the plant network. The remote user would need to a valid IP address to connect to the network. Once connected, the user would be able to monitor the entire plant process, collect data, and make program changes remotely. This can be a great advantage for trouble shooting or for monitoring/controlling the plant remotely. However, the risk with this solution is security. Allowing a remote user access to the entire plant requires a more thorough analysis of security measures to prevent unwanted actions. The dial-in Ethernet modems that are on the market today have built in security which would only allow authorized phone numbers to dial-in and would require a user name and password login account. Security is configurable to grant or prevent the users from accessing portions of the plant. If security is still a concern, plant staff have the option to disconnect the phone line, but may be inconvenienced to have to reconnect the phone line when it is needed.

Alternatively, a dial-in modem can be connected directly to a PC. With this setup, the remote user would only have access to the computer it is connected with. Once the computer connection is established, remote connection software such as remote desktop or Real VNC installed on the computer would allow access to the other machines on the network. Connection to the PLCs is only allowed if the PLC programming software resides on one of the computers on the network. The only disadvantage to the modem solution is the data transfer rate between the remote user and the plant is significantly slower than what is available via the Ethernet modem.

Remote access software is similar to remote access service but requires the PC to be connected to the Internet. The advantages to this method is that it does not require a separate phone line, data transfer rates are extremely high, and the software for the remote desktop connection is either already included with the PC or can be installed at minimal to no cost. The software would not only have to be installed on all the computer nodes on the plant, but the remote user would need similar software to be able to make the remote connection. A serious threat to this approach is that the plant network will be exposed to the Internet, which can make the computers susceptible to hackers and viruses. Additionally, remote support technicians will not have direct access to the PLCs, but may be able to access them through software already installed on one of the nodes. In an effort to prevent malicious attacks on the network, an enhanced security plan would be needed to maximize the network security. Some security measures that can be taken involve having a domain server present, which can act as a network cop preventing unauthorized access, and installing network monitoring software that notifies the system administrator of any suspicious activities.

5.20.2.5 Filter Control Console Alternatives

There are several options that are available for providing a local filter control console that provides automatic backwashing with operator initiation. These include a local filter control panel, laptop terminal or mobile workstation, and an operator interface terminal. While all of these filter control console options have been proven to be viable alternatives for similar sized systems such as what is being considered for Bossier City, the filter control panels are generally considered the most reliable.

Photo 5-1
Individual Outdoor Filter Control Panel

The local filter control panel solution can be accomplished through a number of different combinations. Depending on the location and spacing between each filter, a filter panel would be dedicated for every one to two filters. Photo 5-1 shows a series of filter control panels located at each individual filter. The control panel, located outdoors, is then hard-wired to the master control PLC in a centralized location.

Photo 5-2
Dual Indoor Filter Control Panel

Photo 5-2 shows a filter control panel for two filters next to each other. The control panel, located indoors, is then hard-wired to the remote PLC located in the lower part of the panel which then communicates back to the master PLC in a centralized location. The control and monitor functionality can be accomplished through push buttons and lights hard-wired to the PLC or from an operator interface terminal (OIT) communicating to the PLC. Depending on the system architecture, the OITs will interface directly with the Master Filter System PLC or to an individual Filter RTU to provide local monitoring and control of each filter and associated equipment.

Photo 5-3
Individual Indoor Filter
Control Panel with OIT

Photo 5-3 shows a filter control panel with an OIT panel dedicated to each filter. Both the hard-wired solution and the filter OIT solution is independent from the HMI system and allows continuous filter controls in the event that the HMI server is down, thus providing a more robust solution since additional redundancy is provided.

Each filter can also be controlled locally through individual operator workstations or laptop connection ports. The disadvantage to having individual operator workstations as filter control consoles includes the expense of the equipment as well as the HMI license. This disadvantage can be overcome by installing laptop connection ports at each filter control station. The laptop would be set up as a HMI node and would be connected to the network at the filter control station. Photo 5-4 shows a filter control panel located outdoors. The panel is equipped with a network connection, light, and enough space to set down a laptop. The operator is then able to open the filter graphic on the laptop to perform an automatic backwash in closer proximity to the filter. The disadvantage to this solution is that it is dependent on the HMI system and does not allow filter controls in the event that the HMI server is down.

Photo 5-4
Dual Outdoor Filter Control Workstation

5.21 Laboratory/Control Building

A new laboratory/control building located near the entrance gate is recommended. This 9,000 square foot building will house the WTP laboratory, control room, staff offices and meeting areas as shown in Figures 5-46, 5-47, and 5-48.

5.22 Other Miscellaneous Improvements

In addition to the changes discussed in previous sections, the following items will be evaluated during the next design phase for rehabilitation:

- Additional flow meters at existing WTP to measure flow through various processes.
- Additional sampling taps on filtered and finished water at existing WTP.
- Repair cracks and recoat of pipe gallery walls.
- Replace process waste gate that is leaking or permanently plug line.
- Re-hang doors and replace door hardware throughout the existing WTP.
- Install heaters in Filters 5-12 floor area.

Figure 5-46
Lab/Control Building – First Level Floor Plan

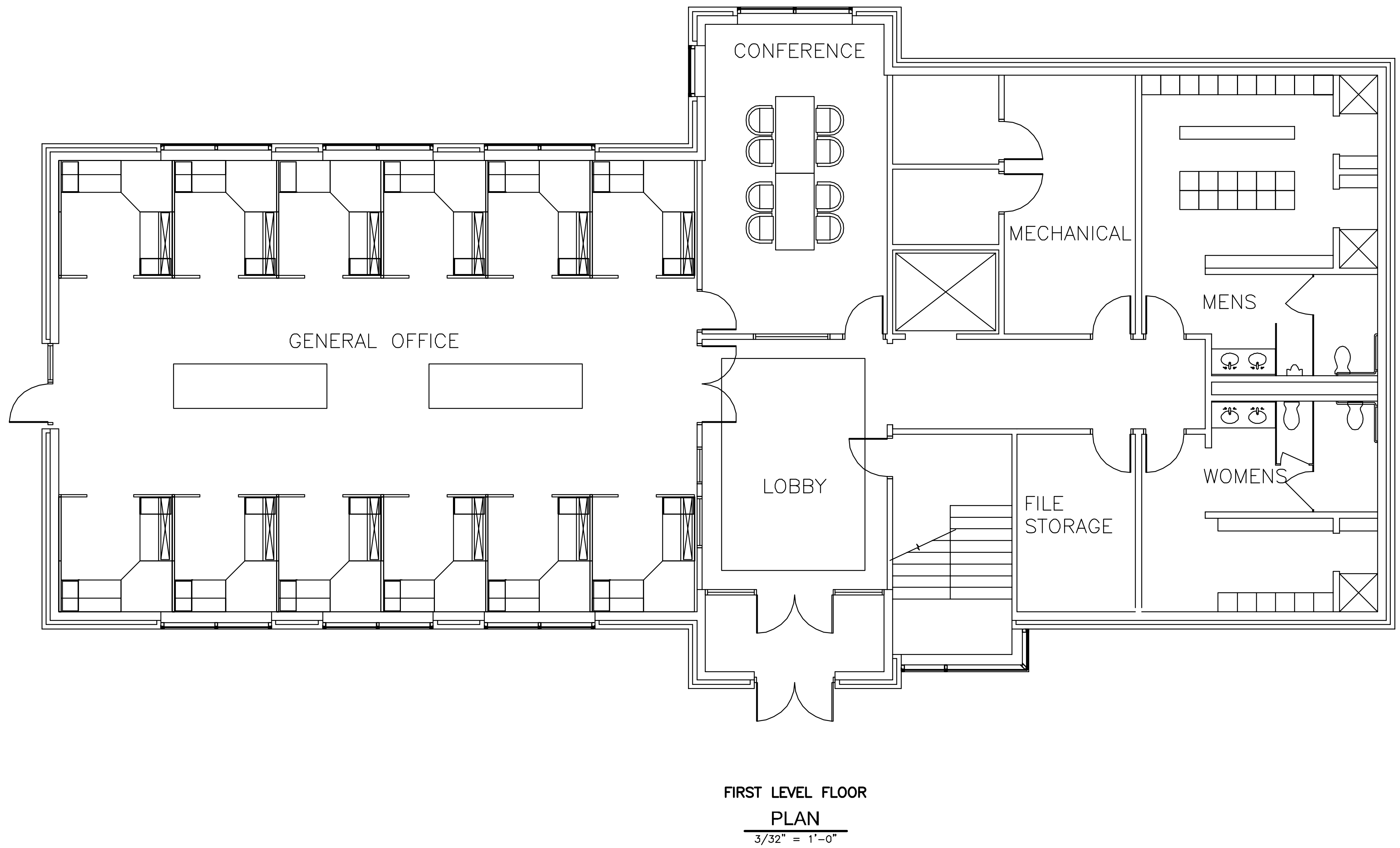
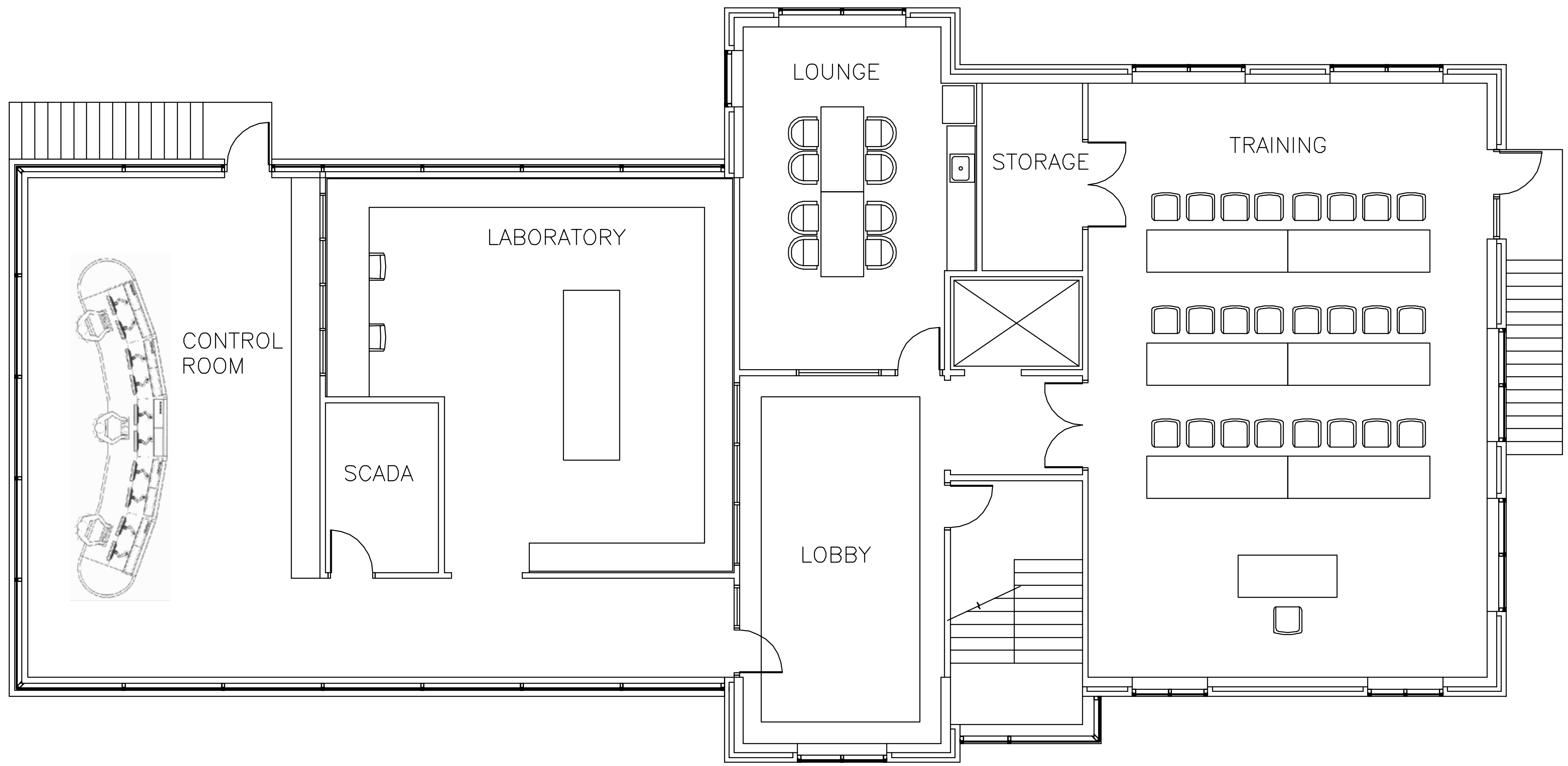


FIGURE 5-46
LAB/CONTROL BUILDING FIRST LEVEL FLOOR PLAN
BOSSIER CITY WTP EXPANSION

CDM

Figure 5-47
Lab/Control Building – Second Level Floor Plan



SECOND LEVEL FLOOR PLAN
3/32" = 1'-0"

FIGURE 5-47
LAB/CONTROL BUILDING SECOND LEVEL FLOOR PLAN
BOSSIER CITY WTP EXPANSION

CDM

Figure 5-48
Lab/Control Building – Elevation

SOIUTH
ELEVATION
3/32" = 1'-0"

S:\22157_BOS\50486\FIGS FROM DENVER\ FIG 5-48 04/04/08 13:45 morenoma XREFS: AADEL100

FIGURE 5-48
LAB/CONTROL BUILDING ELEVATION
BOSSIER CITY WTP EXPANSION

CDM

5.23 Recommended Water Treatment Plant Costs

The opinions of probable cost have been prepared by CDM for guidance in project evaluation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule, and other variable factors. Consequently, the final project costs will vary from the opinion of probable cost presented in this evaluation report. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

The level of accuracy for construction costs estimates varies depending on the level of detail to which the project has been defined. Feasibility studies and master plans represent the lowest level of accuracy, while pre-bid estimates based on detailed plans and specifications represent the highest level. The American Association of Cost Engineers has developed the following guidelines shown in Table 5-16. The opinions of probable cost presented within this report are considered the budget estimate level of accuracy.

Table 5-16
Cost Estimate Guidelines

Type of Estimate	Anticipated Accuracy
Order of Magnitude (Facility and Master Plans)	+50% to -30%
Budget Estimate (Pre-design Report)	+30% to -15%
Definitive Estimate (Pre-bid)	+15% to -15%

A phased approach to the Bossier City WTP expansion is recommended. Table 5-17 shows the opinion of probable costs for each of the projects. Detailed cost estimates are provided in Appendix E.

5.24 Total Costs to Users

Bossier City increased their water rates in 2007 in preparation for the large volume of capital projects required. It was estimated that the majority of the projects would be financed with SRF loans. The remaining projects will be funded by a combination of revenue bonds and cash generated from the water rate increases. Rather than phasing in the water rate increases, the rates adopted reflect the revenue required in 2012.

Table 5-17
Bossier City WTP Expansion Opinion of Probable Costs

Project Description	Opinion of Probable Cost
Membrane Treatment Plant Project Raw Water Blend/Splitter Structure Rapid Mix Basins Solids Contact Clarifiers Membrane Filtration Post-Membrane Ozone Contactors GAC Filters Elevated Water Storage Tank Filtered Water Blend Structure Modifications to Chemical Feed Systems [A] Modifications to Ozone System [B] Modifications to Electrical System Modifications to Instrumentation Laboratory/Control Building	$56,390,400
Existing Treatment Plant Rehabilitation Project Rehabilitation of Raw Water Ozone Contactors Rehabilitation of Accelators Rehabilitation of Pre-filter Ozone Contactors Rehabilitation of Filters 1-4 Modifications to Chemical Feed Systems [C] Modifications to High Service Pumping Miscellaneous Improvements	$20,687,000
Raw Water Pumping Rehabilitation Project [D] Rehabilitation of North River Pump Station Rehabilitation of Reservoir Pump Station Rehabilitation of South River Pump Station	$5,955,000
Raw Water Pipelines Project 30-inch Pipeline from North River PS to Reservoir 30-inch Pipeline from Reservoir to WTP	$9,398,500
TOTAL	**$92,430,900**

5.24.1 Capital Improvement Plan Costs

In addition to the improvements described above that are related to the major water treatment plant requirements, there are additional projects contained in the multi-year capital improvement plan (CIP). Table 5-18 presents a summary of the CIP estimated to be funded from either state revolving fund loans (SRF loans) or revenue bonds.

Table 5-18
Capital Improvements from SRF Loans and Revenue Bonds

CIP Financed	2008	2009	2010	2011
Water Treatment Plant	$56,390,400	$0	$20,687,000	$0
Raw Water PS & Transmission	$	$15,353,500		$0
Subtotals - SRF Loans	**$56,390,400**	**$15,353,500**	**$20,687,000**	**$0**
Distribution - Meters	$6,500,000	$0	$0	$0
Water Treatment Plant		-	-	-
Replace #2 Ozone Generator	800,000			
No Description	231,001			
N. Bossier Water Tower	1,560,219			
Transmission		-	1,000,000	-
Medical Dr. waterline	100,000			
Swan Lake Trunk Main	823,934			
N. of Wemple Rd. 20" Main	525,000			
Swan Lake - Legacy Elem to Duckwater	1,700,000			
Revenue Bond Projects	$12,240,154	$0	$1,000,000	$0
Less: Funds on Hand	(4,323,908)	-	-	-
Subtotals - Revenue Bonds	**$7,916,246**	**$0**	**$1,000,000**	**$0**

There are additional improvements required that are estimated to be cash funded. Table 5-19 presents a summary of the CIP to be funded from various cash funds.

Table 5-19
Capital Improvements from Cash Funds

CIP Cash Funded	2008	2009	2010	2011
Capital Improvement Assessment Fund				
Swan Lk - Airline to Legacy Elem	$465,000	$0	$0	$0
Contingency Fund				
Chlorine Feed - N. Bossier Tank	$1,200,000	-	-	-
Annual Water Rates				
Water Equipment Replacement	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Water Line Replacement	$200,000	$200,000	$200,000	$200,000
Subtotals - Cash Funded	**$2,865,000**	**$1,200,000**	**$1,200,000**	**$1,200,000**

5.24.2 Capital and Financing Costs

Table 5-20 presents the project costs for the design and construction of the expansion and upgrade of the existing WTP (Alternative 3) as well as the raw water pump station and transmission system improvements plus the estimated issuance costs. This amount was then used to calculate the annual debt service payment, assuming SRF loan funds were used to finance the improvements. The repayment period was 20 years with interest at 3.95%. It is assumed that the debt service reserve (equal to one annual payment) is to be funded from water revenues over a 5-year period.

Table 5-20
WTP Expansion and Upgrade, Raw Water PS & Transmission Financed Costs

CIP Financed	2008	2009	2010	2011
Project Costs	$56,390,400	$15,353,500	$20,687,000	$0
Issuance Costs	$563,900	$153,500	$206,900	$0
Principal Borrowed - SRF Loans	$56,954,300	$15,507,000	$20,893,900	$0
Annual Debt Service Payments	$4,172,300	$1,136,000	$1,530,600	$0

5.24.3 Operation and Maintenance Costs

The operation and maintenance costs that are related to the operation of the proposed improvements are given on Table 5-21 in addition to the annual debt service from Table 5-20. In addition to the debt service payment, a coverage factor of 15% is required for the SRF loan and is presented on Table 5-21. The fiscal year operation and maintenance costs were also included on Table 5-21, with the costs inflated at 4 percent per year for labor and 3% per year for all other costs. The water user fee revenue projected to be generated in fiscal years 2008 through 2013 is also presented.

5.24.4 Proposed Revenue Pledge

The preferred revenue pledge is that of the water and wastewater system net revenue. This pledge would then be consistent with existing revenue bond issues and provide consistency with current accounting reporting. There is currently sufficient net revenue projected from the water system, based on the projected revenue from the increase in the water rates. The existing net revenue is sufficient for the repayment of the debt service and applicable coverage requirements as well as ongoing capital needs.

Table 5-22 compares the financial plan for the selected plan with both SRF funding and revenue bond debt. The use of SRF loan money is estimated to provide an annual savings of $659,900 over the use of conventional financing with revenue bonds. The revenue bond debt service payments assumed the issuance costs were 1.4 percent and 6.45 percent debt service reserve with 5 percent interest and 20 year repayment.

It is not yet known whether SRF funding will be available for the projected program without other sources.

Table 5-21
Annual Cost of Selected Plan with SRF Financing

	2008	2009	2010	2011	2012	2013
Annual SRF Debt Service Payments	$0	$0	$3,960,100	$4,322,900	$5,391,800	$5,754,600
Coverage (15%)	-	-	594,000	648,400	808,800	863,200
Annual New Revenue Bond Debt Service	-	-	606,300	682,900	682,900	682,900
Existing Debt Service Payments	448,981	448,863	449,570	248,132	248,132	655,528
Coverage (20%)	89,800	89,800	211,200	186,200	186,200	267,700
Subtotal	**$538,781**	**$538,663**	**$5,821,170**	**$6,088,532**	**$7,317,832**	**$8,223,928**
Operation and Maintenance (O&M) Costs						
Existing O&M Costs	$4,885,277	$5,127,276	$5,276,174	$5,429,675	$5,587,931	$5,751,096
Incremental O&M	-	-	1,145,800	1,191,769	1,239,608	1,289,393
Subtotal - Revenue Requirements	**$5,424,058**	**$5,665,939**	**$12,243,144**	**$12,709,976**	**$14,145,371**	**$15,264,416**
Less: Interest & Other Revenue	(440,213)	(454,742)	(469,209)	(484,284)	(500,309)	(516,627)
Plus: Interest Expense During Construction	528,543	1,585,630	142,658	427,974	-	-
Plus: Capital Required from User Fees (net of coverage)	1,200,000	1,200,000	394,800	365,400	205,000	69,100
Plus: Transfer to SRF Reserve	-	-	396,014	1,260,599	1,078,359	1,150,917
Plus: Transfer to Contingency Fund	585,600	597,900	610,600	623,700	637,300	651,400
Net Total of Revenue Requirements	**$7,297,989**	**$8,594,727**	**$13,318,007**	**$14,903,365**	**$15,565,721**	**$16,619,206**
Projected Operating Revenue	**$14,552,040**	**$14,854,304**	**$15,166,804**	**$15,490,012**	**$15,824,429**	**$16,896,141**

Table 5-22
Annual Cost of Selected Plan - Comparison of SRF and Revenue Bonds

CIP Financed	**2008**	**2009**	**2010**	**2011**
Annual SRF Debt Service Payments	$4,172,300	$1,136,000	$1,530,600	$0
Cumulative SRF Loan Payments	$4,172,300	$5,308,300	$6,838,900	$6,838,900
Debt Service Coverage (15%)	$625,800	$796,200	$1,025,800	$1,025,800
Annual SRF Debt Service Requirement	**$4,798,100**	**$6,104,500**	**$7,864,700**	**$7,864,700**
Annual Revenue Bond Debt Service Payments	$4,588,300	$1,249,200	$1,683,200	$0
Cumulative Revenue Bond Payments	$4,588,300	$5,837,500	$7,520,700	$7,520,700
Debt Service Coverage (15%)	$688,200	$875,600	$1,128,100	$1,128,100
Annual R Bond Debt Service Requirement	**$5,276,500**	**$6,713,100**	**$8,648,800**	**$8,648,800**
Net Difference	**$478,400**	**$608,600**	**$784,100**	**$784,100**

Further financial analysis on Table 5-23, presents the impact of the debt service for the water system improvements on water customers. Table 5-23 presents no increase needed, given SRF funding and an increase of 8.32 percent given revenue bond funding.

Table 5-23
Debt Service Impact for Water System Improvements

	SRF Annual Costs 2013	R. Bond Annual Costs 2013
Annual SRF & R. Bond Debt Service Payments	$5,754,600	$8,648,800
Annual New R. Bond Debt Service	$682,900	$682,900
Coverage (15% and 20"%)	999,800	$1,433,900
Annual New Debt Service	**$7,437,300**	**$10,765,600**
Existing Debt Service Payments	$655,528	$655,528
Coverage (20%)	$131,100	$131,100
Subtotal	**$8,223,928**	**$9,975,428**
Operation and Maintenance (O&M) Costs		
Existing O&M Costs	$5,751,096	$5,751,096
Incremental O&M	$1,289,393	$1,289,393
Subtotal - Revenue Requirements	**$15,264,417**	**$18,592,717**
Less: Interest & Other Revenue	(516,627)	(516,627)
Plus: Interest Expense During Construction	-	-
Plus: Capital Required from User Fees (net of coverage)	69,100	0
Plus: Transfer to SRF Reserve	1,150,917	1,150,917
Plus: Transfer to Contingency Fund	651,400	651,400
Net Total of Revenue Requirements	**$16,619,207**	**$19,878,407**
Projected Operating Revenue	**$16,896,141**	**$16,896,141**
Percent Increase Required		**8.32%**

5.25 Needs Addressed

The selected plan addresses the needs of Bossier City through the year 2028 for adequate water treatment.

5.26 Public Hearing

A public hearing was held on _, at the City of Bossier City Complex, regarding selection and content of the recommended plan from this SIP and the Environmental Information Document. Appendix D contains the public notice, publishers' affidavit, minutes of the meeting, and attendance sheet.

Section 6
Arrangements for Implementation

Bossier City recently modified water rates in order to fund the needed upgrade and expansion to the WTP and needed distribution system improvements.

6.1 Detailed Implementation Plan - Overview

This section presents a detailed plan for implementing the recommended WTP improvements for the planning area. The implementation plan includes institutional arrangements, an implementation schedule, a management plan, and a financing plan. These aspects of the implementation plan are summarized as follows and discussed in more detail in the remainder of this section.

- Institutional Arrangements - Identifies entities responsible for the design, construction, financing, ownership, operation and maintenance of the project facilities; cites the legal, financial, and administrative relationship between the entities; and cites the associated laws, agreements, and resolutions which govern the ownership and operation of the recommended water treatment facility.

- Public Participation - An advertised public hearing will be held to encourage the public to learn about this program and the capital financing plan. The public will be encouraged to offer comments about the alternatives. A record of this public hearing will be kept for public record and review. The minutes from the hearing will be incorporated into this document.

- Implementation Schedule - Describes an orderly schedule of the actions that must be taken to initiate and complete the proposed project.

6.2 Institutional Agreements

The City of Bossier City is authorized to own and operate a water treatment system with the authority granted by Louisiana law. The planning, design, operation and maintenance of the City-owned water treatment facility is the responsibility of the Bossier City.

6.3 Authority of the City of Bossier City

Bossier City is governed by a City Council comprised of seven members; two are elected citywide while the other five are elected from districts throughout the City. The elected City Mayor serves as administrator for the City Council. The City Council has the authority to appropriate funds and assess penalties for violations of local ordinances as granted under the City Charter, Section __.

The daily routine of government is the responsibility of the Mayor, who heads the City Council. The Mayor carries out the policies developed by the City Council and implements the City Council's decisions. Department heads are appointed by the Mayor and must be confirmed by the City Council. All programs are administered by the departments staffed with competent professionals.

Through agreements with various customers, water service is provided by the City owned and operated water treatment plant and distribution system. Bossier City, through the powers of the City Council and the Mayor, has the ability and authority to own, operate, and maintain the water system. Through contracts executed with private water systems, bulk delivery is made to customers outside the City.

The operation and maintenance of the City water system is under the jurisdiction of the Public Utilities Department. The Water Treatment Division operates and maintains the treatment plant including monitoring of raw water source. The Distribution Division operates and maintains the distribution system. Each division is staffed with skilled qualified personnel and functions on a 24-hours per day basis.

6.3.1 Regulatory Agreements

The City of Bossier City operates its current water treatment plant and distribution system under permits granted by the Louisiana Department of Health and Hospitals (DHH).

As part of the review process for this plan and in order to qualify for the subsidized State Revolving Fund (SRF) loan, various additional governmental agencies must approve the manner in which the City of Monroe will implement the plan, in addition to DHH. Correspondence with these additional agencies is provided in Appendix C. Agencies that will have the opportunity to review and comment on the plan include:

- Louisiana Department of Environmental Quality
- Louisiana Department of Fish and Wildlife
- Louisiana State Historic Preservation Office
- Louisiana Department of Culture, Recreation and Tourism
- Louisiana Department of Natural Resources
- Louisiana Department of Transportation and Development
- U. S. Department of Agriculture, Forest Service
- U. S. Department of Interior, National Park Service & Bureau of Land Management
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- Federal Emergency Management Agency

6.3.2 City Ordinances and Resolutions

The city currently has all legal, institutional, and managerial resources on its permanent staff or the ability to contract for technical services required to complete and manage the construction, operation and maintenance, and fiscal management of the recommended water treatment alternative.

6.3.3 Requirements for Staffing

Bossier City will provide the required personnel to manage and operate the water treatment system and will require proper training and certification to meet the state requirements for operations. The city will hire only qualified personnel for any positions and will ensure existing employees are correctly trained in the operations and maintenance of any new facilities or equipment.

6.3.4 Summary of Public Participation

A public hearing was held on _________________ at ________________________ in the ____regarding the selection and content of the recommended alternative from the System Improvement Plan.

Appendix D contains the public notice, publisher's affidavit and minutes of the meeting.

6.4 Implementation Schedule

Immediate plans, as previously discussed are to proceed with the design and construction of a new 25 mgd water treatment plant expansion. Figure 6-1 shows the design, construction and start-up schedule for the recommended improvement.

6.5 Financial Arrangements

The primary funding source for the major improvements is assumed to be from the DHH State Revolving Fund (SRF) loan program. Table 6-1 presents the tasks and approximate dates required for the completion of funding and construction for the water treatment plant expansion and the raw water pumping and pipeline projects (Phase I). Table 6-2 presents the tasks and approximate dates required for the completion of funding and construction for the rehabilitation of the existing water treatment plant (Phase II).

In addition to the SRF loans, there is approximately $9 million in revenue bonds and/or commercial paper or leases (for water meters) as shown on Table 5-18 and annually cash funded projects on Table 5-19.

Figure 6-1
City of Bossier City Water System Improvement Plan

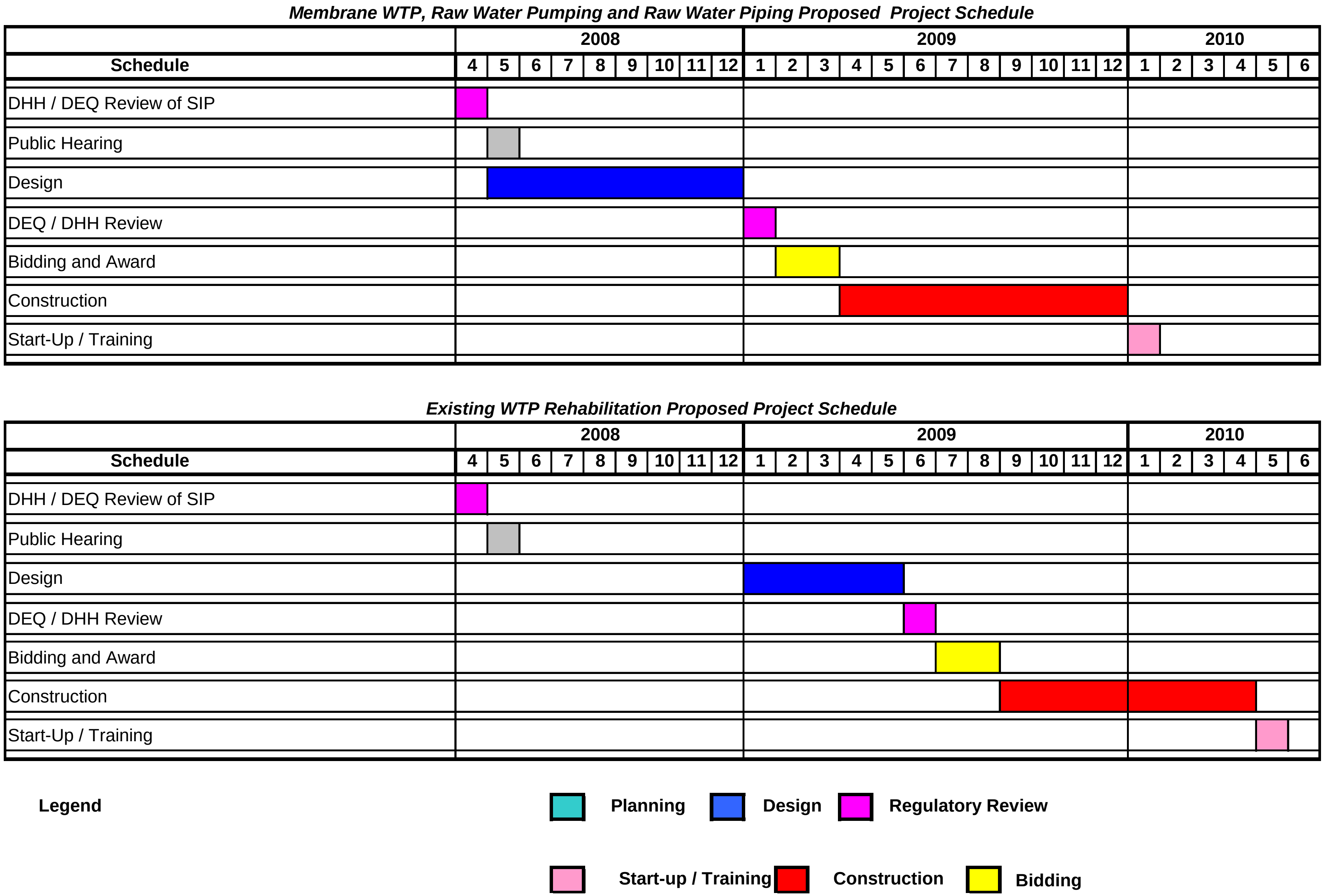


Table 6-1
City of Bossier City Financing Plan
Phase I Implementation Schedule - WTP Expansion
Raw Water Pipeline and Pump Stations

Item No.	Description	Completion or Submission Date
1.	Preliminary Application	On File
2.	System Improvement Plan (SIP)	Apr-08
3.	Public Hearing	May-08
4.	Permit Application	
5.	Plans & Specification Completion	Dec-08
6.	DEQ/DHH Review	Jan-09
7.	Advertise for Bids	Feb-09
8.	Loan Application Submittal	Feb-09
9.	Bid Opening	Mar-09
10.	Loan Closing	Mar-09
11.	Construction Award	Mar-09
12.	Notice to Proceed	Apr-09
13.	Substantial Completion and Start-up	Jan-10
14.	Final Completion	Apr-10
15.	First Year Operation Certificate	Apr-11

Table 6-2
City of Bossier City Financing Plan
Phase II Implementation Schedule - Existing WTP Rehabilitation

Item No.	Description	Completion or Submission Date
1.	Preliminary Application	On File
2.	System Improvement Plan (SIP)	Apr-08
3.	Public Hearing	May-08
4.	Permit Application	
5.	Plans & Specification Completion	May-09
6.	DEQ/DHH Review	Jun-09
7.	Advertise for Bids	Jul-09
8.	Loan Application Submittal	Jul-09
9.	Bid Opening	Aug-09
10.	Loan Closing	Aug-09
11.	Construction Award	Aug-09
12.	Notice to Proceed	Sep-09
13.	Substantial Completion and Start-up	May-10
14.	Final Completion	Aug-10
15.	First Year Operation Certificate	Aug-11