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SUBJECT: Western Wake Regional Wastewater Management Facilities
PER Technical Memorandum No. 21 – Chemical Storage and Feed Facilities

INTRODUCTION

This Technical Memorandum is one in a series of Technical Memoranda being prepared for the Preliminary Engineering Report for the Western Wake Regional Wastewater Management Facilities project. The purpose of this memorandum is to present the preliminary engineering information and data for the chemical storage and feed facilities.

The following chemicals will be required to treat wastewater at the Western Wake Water Reclamation Facility: methanol or acetic acid, ferric chloride or aluminum sulfate, sodium hydroxide and polymer. Methanol or acetic acid will be fed to the aeration (BNR) tanks and effluent filters as a carbon source for denitrification. Ferric chloride or alum will be provided upstream of the aeration tanks, upstream of the secondary clarifiers, and upstream of the filters as well as to the solids handling facilities for chemical phosphorus removal. Sodium hydroxide will be fed as needed upstream of the aeration tanks for alkalinity adjustment. Polymer will be added upstream of the secondary clarifiers to enhance settling.

The methanol/acetic acid and sodium hydroxide facilities will be deferred to a later phase because they are not expected to be needed to meet the anticipated effluent limits for the new WRF. Descriptions of facilities required for these chemicals are included in this memorandum; however, the cost estimate includes only facilities for ferric chloride and polymer.

PROCESS REQUIREMENTS

Chemical storage and feed requirements for the Western Wake Water Reclamation Facility are based on projected flow rates, which are summarized in Table 21-1 below. The table includes total plant flow and the corresponding flow to each of the three BNR tanks. Peaking factors for the Western Wake WRF are discussed in TM 06.

TABLE 21-1
FLOW CONDITIONS

CONDITION	PLANT FLOW, MGD	FLOW PER BNR TRAIN, MGD
Peak Flow	47.3	15.8
Maximum Month Flow	18.0	6.0
Annual Average Flow	15.3	5.1
Minimum Flow	3.0	1.0

Chemical facility sizing is also based on chemical doses determined using the BioWin model. Doses for the chemicals required for treatment at the Western Wake WRF are included in Table 21-2 below.

TABLE 21-2
CHEMICAL DOSES

CHEMICAL	MAXIMUM DOSE, MG/L	AVERAGE DOSE, MG/L	MINIMUM DOSE, MG/L
Methanol to Aeration Tanks	40	20	10
Acetic Acid to Aeration Tanks	56	28	14
Methanol to Effluent Filters	18	10	4
Acetic Acid to Effluent Filters	25.2	14.0	5.6
Ferric Chloride to Aeration Tanks	60	20	10
Aluminum Sulfate to Aeration Tanks	120	40	20
Ferric Chloride to Secondary Clarifiers	60	20	10
Aluminum Sulfate to Secondary Clarifiers	120	40	20

TABLE 21-2 (CONTINUED)
CHEMICAL DOSES

CHEMICAL	MAXIMUM DOSE, MG/L	AVERAGE DOSE, MG/L	MINIMUM DOSE, MG/L
Ferric Chloride to Filters	10	3.3	1.7
Aluminum Sulfate to Filters	20	6.7	3.3
Sodium Hydroxide to Aeration Tank Influent	72	24	16
Polymer to Secondary Clarifiers	2.0	1.0	0.5

The concentrations and resulting bulk densities of the chemicals to be fed at the Western Wake WRF are summarized in Table 21-3 below.

TABLE 21-3
CHEMICAL CONCENTRATIONS

CHEMICAL	CONCENTRATION	SPECIFIC GRAVITY	BULK DENSITY, LB/GAL
Methanol	100%	0.79	6.6
Acetic Acid	20%	1.03	1.7
Ferric Chloride	35%	1.41	4.1
Aluminum Sulfate	48%	1.33	5.3
Sodium Hydroxide	25%	1.25	2.6
Polymer*	100%	1.1	9.2

* Note: Polymer information is assumed for design purposes; however, bench testing must be performed before a specific polymer type can be recommended.

Storage facilities for each of the chemicals discussed herein are sized to provide 15 days of storage at maximum month flow and average chemical dose. For each chemical, 15 days of storage is considered sufficient. Methanol/acetic acid and ferric chloride/alum will not be fed to all application points simultaneously; one application point will typically be used for each chemical. Caustic will be fed to aeration tank influent only intermittently when alkalinity adjustment is needed. And polymer will be fed to secondary clarifiers to improve setting only in cases of process upset. Chemical storage tanks will be sized to hold a minimum of a full tanker truck load of chemical, plus the required volume of dilution water in the case of the caustic tanks. A minimum of two tanks will be provided for each chemical for redundancy.

Chemical feed equipment is sized to cover the full range of required feed rates. For each chemical, the maximum feed rate is calculated assuming maximum month flow and maximum chemical dose or peak flow and average chemical dose, whichever is greater. Minimum chemical feed rate is calculated assuming minimum flow and average chemical dose. Lower feed rates can be accommodated by manual stroke length adjustment during the early years of plant operation. One metering pump will be provided for chemical to be fed to each application point, and spare metering pumps will be provided for redundancy.

ALTERNATIVES EVALUATION

Both methanol and acetic acid can be used as a carbon source in the denitrification process. Likewise, both ferric chloride and alum can be used for chemical phosphorus removal. These chemicals are evaluated herein to determine which will be more cost effective for use at the Western Wake WRF.

Using maximum month flow and average doses, the required storage volumes for methanol and acetic acid are approximately 10,300 gallons and 55,600 gallons, respectively. The required capacities of metering pumps are equivalently greater for acetic acid versus methanol. The capital cost of acetic acid facilities would therefore be considerably higher than for methanol facilities to account for additional storage tanks and larger storage and feed facilities. Likewise, operating costs for acetic acid would be greater than operating costs for methanol. The current cost for a full tanker truck load of 100% methanol is approximately $1.08 per gallon, while the current cost for a full truck load of 20% acetic acid is approximately $0.51 per gallon. However, using maximum month flow and average dose, the chemical costs for methanol would be approximately $740 per day, while costs for using acetic acid would be approximately $1,890 per day. Methanol facilities will be considerably less expensive to construct and operate; therefore, methanol is recommended as the carbon source for denitrification.

The required storage volumes for ferric chloride and aluminum sulfate are approximately 29,600 gallons and 45,500 gallons, respectively, assuming maximum month flow and average dose. The required capacities of metering pumps are likewise greater for alum than for ferric chloride. The capital cost of alum storage and feed facilities would therefore be higher than for ferric chloride facilities because of the additional storage tank required and larger storage and feed facilities. Operating costs for alum would also be greater than operating costs for ferric chloride. The current cost for a full tanker truck load of 35% ferric chloride is approximately $0.885 per gallon, while the current cost for a full truck load of 48% alum is approximately $0.666 per gallon. However, using maximum month flow and average dose, the chemical costs for ferric would be approximately $1750 per day, while costs for using alum would be approximately $2,020 per day. Ferric chloride facilities will be considerably less expensive to construct and operate; therefore, ferric chloride is recommended over alum for chemical phosphorus removal.

PROPOSED FACILITIES

METHANOL

When effluent limits require additional denitrification, methanol facilities will be provided in a later phase of construction. Methanol will be fed to the second anoxic zone of the aeration tanks as well as to filter influent as a carbon source for denitrification. A total methanol storage volume of 10,300 gallons will be required for 15-day storage at maximum month flow and average dose. Two tanks will be provided for redundancy. Methanol is typically delivered in tanker trucks with a capacity of 7,200 gallons. Each storage tank will be sized to hold a minimum of a full tanker truck load of chemical. Two 8,000-gallon carbon steel tanks will therefore be provided for storage of methanol. The tanks will be designed for storage of flammable liquids, and all equipment items in the containment area will be explosion-proof. A transfer pump will be provided to transfer methanol from one tank to another, and a sump pump will be provided to pump washdown water or spilled chemical from the containment area.

Metering pumps will be provided to pump methanol to the second anoxic zone in each of the four aeration tanks (assuming one additional tank is provided) as well as to a common feed point upstream of the effluent filters. The required feed ranges to each application point are shown in Table 21-4 below.

TABLE 21-4
METHANOL FEED REQUIREMENTS

CHEMICAL	MAXIMUM FEED RATE, GPH	AVERAGE FEED RATE, GPH	MINIMUM FEED RATE, GPH	REQUIRED TURNDOWN
Methanol to Aeration Tanks	17	5.4	1.1	16:1
Methanol to Effluent Filters	25	8.1	2.0	16:1

Four 17-gph metering pumps will be provided for methanol feed to the four aeration tanks, and one 25-gph pump will be provided for feed to the effluent filters. One additional 25-gph pump will be provided for backup of all methanol metering pumps. Mechanically-actuated diaphragm metering pumps will be provided with accessories such as calibration columns, pulsation dampeners, backpressure valves, and pressure relief valves. Variable speed drives will be provided for each metering pump for PLC control of pump feed rate based on plant flow and nitrate concentration.

Figure 21-1 provides a preliminary equipment layout for the methanol facilities. The methanol storage tanks and metering pumps will be located under a canopy for weather protection, and an enclosed electrical room will be provided.

FERRIC CHLORIDE

Ferric chloride (ferric) will be provided for chemical phosphorus removal and will be fed upstream of the aeration tanks, upstream of the secondary clarifiers, upstream of the effluent filters, and in the future to the solids handling facilities. A total ferric storage volume of 29,600 gallons is required for 15-day storage at maximum month flow and average dose, including the future feed to solids handling. Two tanks will be provided for redundancy. Ferric chloride is typically delivered in tanker trucks with a capacity of 4,100 gallons. Two 15,000-gallon fiberglass-reinforced plastic tanks will be provided for storage of ferric. A transfer pump will be provided to transfer chemical from one tank to another, and a sump pump will be provided to pump washdown water or spilled chemical from the containment area.

Metering pumps will be provided to pump ferric to a common feed point upstream of the aeration tanks, to the influent of each of the three secondary clarifiers, and to a common feed point upstream of the effluent filters, and space will be provided for future pumps to feed ferric chloride to the fourth BNR train and to the solids handling facilities. The required feed ranges to each application point are shown in Table 21-5 below.

TABLE 21-5
FERRIC CHLORIDE FEED REQUIREMENTS

CHEMICAL	MAXIMUM FEED RATE, GPH	AVERAGE FEED RATE, GPH	MINIMUM FEED RATE, GPH	REQUIRED TURNDOWN
Ferric to Aeration Tanks	92	26	5.1	18:1
Ferric to Secondary Clarifiers	31	8.6	1.7	18:1
Ferric to Effluent Filters	15	4.3	0.8	18:1
Ferric to Solids Handling *	16.2			

* Note: A sidestream flow rate of 0.45 mgd and ferric dose of 425 mg/L are assumed for calculating solids handling ferric chloride requirements.

One 92-gph metering pump will be provided for ferric feed to the head of the aeration tanks, three 31-gph pumps (with space for a fourth in the future) will be provided for feed to the secondary clarifiers, one 15-gph pump will be provided for feed to filter influent, and two backup pumps, a 92-gph pump and a 31-gph pump, will also be provided. In addition, space will be provided for two 16-gph pumps to be supplied for feed to the solids handling facilities in the future. Mechanically-actuated diaphragm metering pumps will be specified with accessories such as calibration columns, pulsation dampeners, backpressure valves, and pressure relief valves. Variable speed drives will be provided for each metering pump for PLC control of pump feed rate based on plant flow and phosphorus loading.

Figure 21-2 provides a preliminary equipment layout for the ferric chloride storage and feed facilities. The ferric storage tanks will be located under a canopy for weather protection, and the metering pumps will be in an adjacent enclosed building.

SODIUM HYDROXIDE

When effluent limits are revised and alkalinity adjustment is required after chemical phosphorus removal, sodium hydroxide facilities will be provided in a future phase of construction. Sodium hydroxide (caustic) will be fed to the influent of the aeration basins for alkalinity adjustment. Caustic will be delivered at a concentration of 50% but then diluted to 25% for storage and feed to eliminate crystallization problems associated with handling 50% caustic. Storage facilities for caustic will be designed for 15-day storage at maximum month flow and average dose. A total caustic storage volume of 20,700 gallons will be required, and two tanks will be provided for redundancy. Caustic is typically delivered at 50% in tanker trucks with a capacity of 4,500 gallons. Approximately 7,000 gallons of water will be required to dilute the caustic to 25%; therefore, tanks should be sized to hold at least 11,500 gallons of caustic and dilution water. Two 12,000-gallon carbon steel tanks will be provided for storage of caustic. Steel tanks are required because of the heat generated by dilution of the chemical. Two horizontal centrifugal recirculation pumps, one duty and one backup, will be provided to mix the caustic with water. A pump capacity of 100 gallons per minute will be provided to recirculate the tank contents in approximately two hours. A sump pump will also be provided to pump washdown water or spilled chemical from the containment area.

Metering pumps will be provided to pump caustic to a common application point upstream of the four aeration tanks. The required feed range is shown in Table 21-6 below.

TABLE 21-6
CAUSTIC FEED REQUIREMENTS

CHEMICAL	MAXIMUM FEED RATE, GPH	AVERAGE FEED RATE, GPH	MINIMUM FEED RATE, GPH	REQUIRED TURNDOWN
Caustic to Aeration Tanks	173	49	10	18:1

Two 173-gph pumps, one duty and one backup, will be provided to cover the full range of flows. Mechanically-actuated diaphragm metering pumps will be specified with accessories as described above, and variable speed drives will be provided for each metering pump for PLC control of pump feed rate based on plant flow and alkalinity.

Figure 21-2 provides a preliminary layout for the future caustic equipment. The caustic storage tanks and recirculation pumps will be provided under a canopy for weather protection, and metering pumps will be located in the enclosed chemical feed building.

POLYMER

Polymer will be fed upstream of the three secondary clarifiers to enhance settling. The exact polymer type recommended for optimal performance must be determined by bench-scale testing after the plant is operational; however, design guidelines for a typical polymer feed system for enhanced clarification are included herein.

A polymer storage volume of approximately 2,200 pounds of polymer will be required for 15-day storage at maximum month flow and average dose. Because polymer use will be intermittent and polymer has a shelf life of only about 6 months, tote bins are recommended for polymer storage. Each polymer tote bin holds approximately 2,300 pounds of emulsion polymer; therefore, only one tote bin will be required for storage.

Three polymer blending systems will be provided to pump polymer to each of the three application points upstream of the secondary clarifiers. An approximate required feed range for an emulsion polymer is shown in Table 21-7 below.

TABLE 21-7
POLYMER FEED REQUIREMENTS

CHEMICAL	MAXIMUM FEED RATE, GPH	AVERAGE FEED RATE, GPH	MINIMUM FEED RATE, GPH	REQUIRED TURNDOWN
Polymer to Secondary Clarifiers	0.6	0.2	0.04	16:1

Four polymer blending systems, three duty and one backup, will be provided to feed polymer to the application points, and space will be provided for an additional feed system which will be required in the future when a fourth BNR train is constructed. Automatic feed rate control will be provided for each polymer blending unit for PLC control of the polymer feeders based on plant flow.

Figure 21-2 shows a preliminary layout for the polymer equipment. The tote bins and polymer blending/feeding systems will be located in the enclosed chemical feed building.

ELECTRICAL REQUIREMENTS

Electrical requirements for the chemical storage and feed facilities will include providing power to all transfer and recirculation pumps, sump pumps, metering pumps, instruments, HVAC equipment, and lighting. Emergency standby power will be provided to the chemical facilities.

INSTRUMENTATION AND CONTROLS

Monitoring and control of the chemical storage facilities will be provided as follows. Each storage tank will be provided with an ultrasonic level transmitter to monitor liquid level in the tank, and tank low and high level conditions will be indicated at each fill station and at the Operator Workstation. A motor-operated valve on the metering pump suction line from each tank will be used to automatically control which tank is in service. The sump in each chemical containment area will contain a locally-controlled sump pump and a float level switch to indicate a spill in the containment area. Recirculation and transfer pump operation will be controlled locally.

Instrumentation and controls for chemical feed facilities will be provided as follows. Each metering pump will be provided with a DC motor and SCR drive for automatic control of feed rate. Magnetic flow meters will be provided to monitor chemical feed to the application points. A nitrate analyzer will be provided for control of methanol feed, and flow signals will also be used to pace all of the metering pumps.

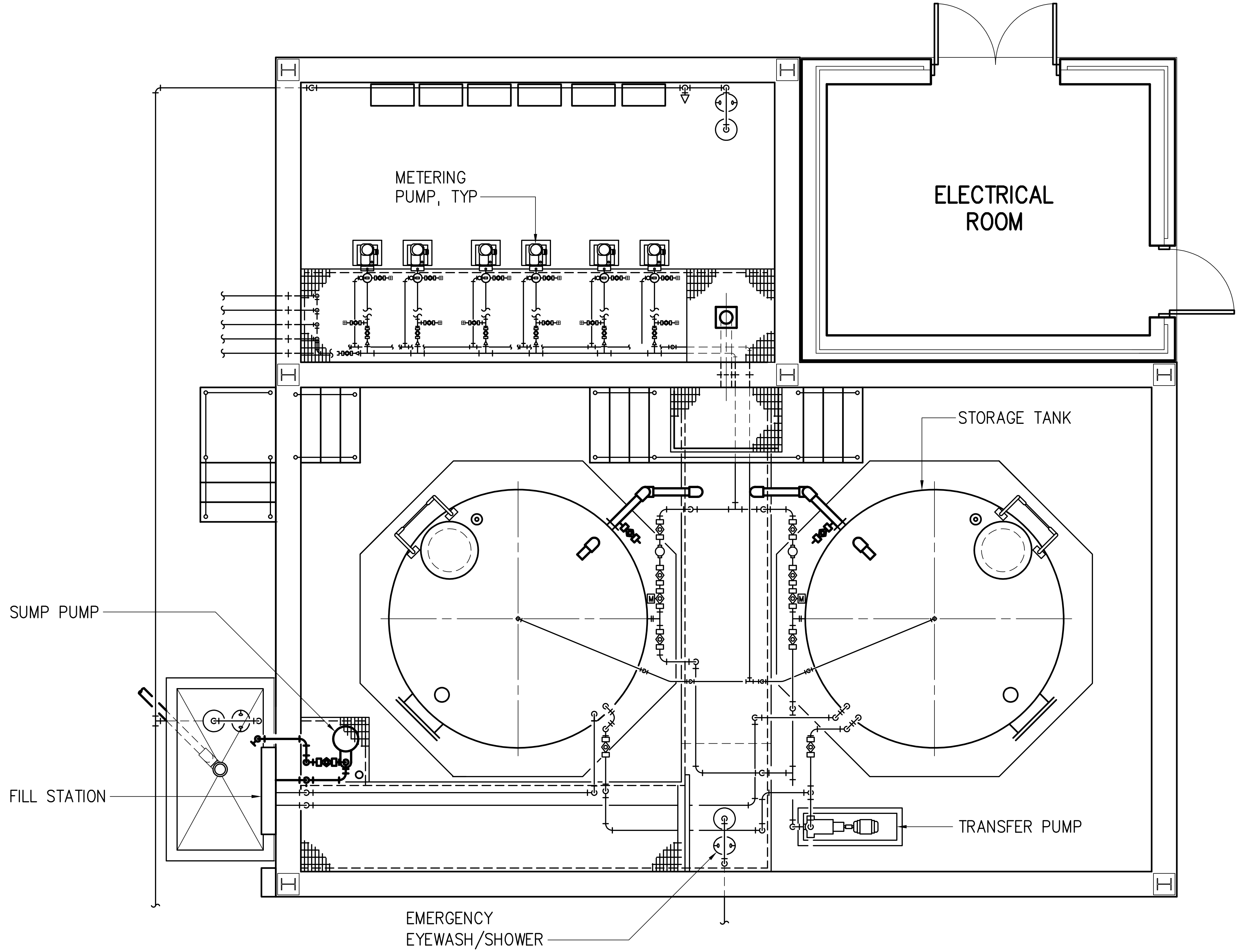
COST ESTIMATE

Estimated costs for the proposed facilities are included in Table 21-8 below. The costs include facilities for ferric chloride and polymer storage and feed only as caustic and methanol facilities will be deferred to a later phase.

TABLE 21-8
ESTIMATED CAPITAL COSTS

Item	Cost ($)
Sitework	$30,000
Structural	$143,200
Architectural	$225,000
Chemical Storage Tanks	$52,000
Transfer/Recirculation Pumps	$20,800
Metering Pumps	$171,600
Piping	$222,500
Miscellaneous Mechanical	$46,500
HVAC	$25,000
Electrical	$39,600
Instrumentation	$31,900
Subtotal	**$1,008,000**
Construction Contingencies (15%)	$151,000
Engineering and Construction Services (10%)	$116,00
Legal and Financial (5%)	$64,000
Total	**$1,339,000**

FIGURE 21-1



TOP PLAN

3/16"=1'-0"

CDM / HAZEN AND SAWYER

WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

TOP PLAN
FUTURE METHANOL FACILITY

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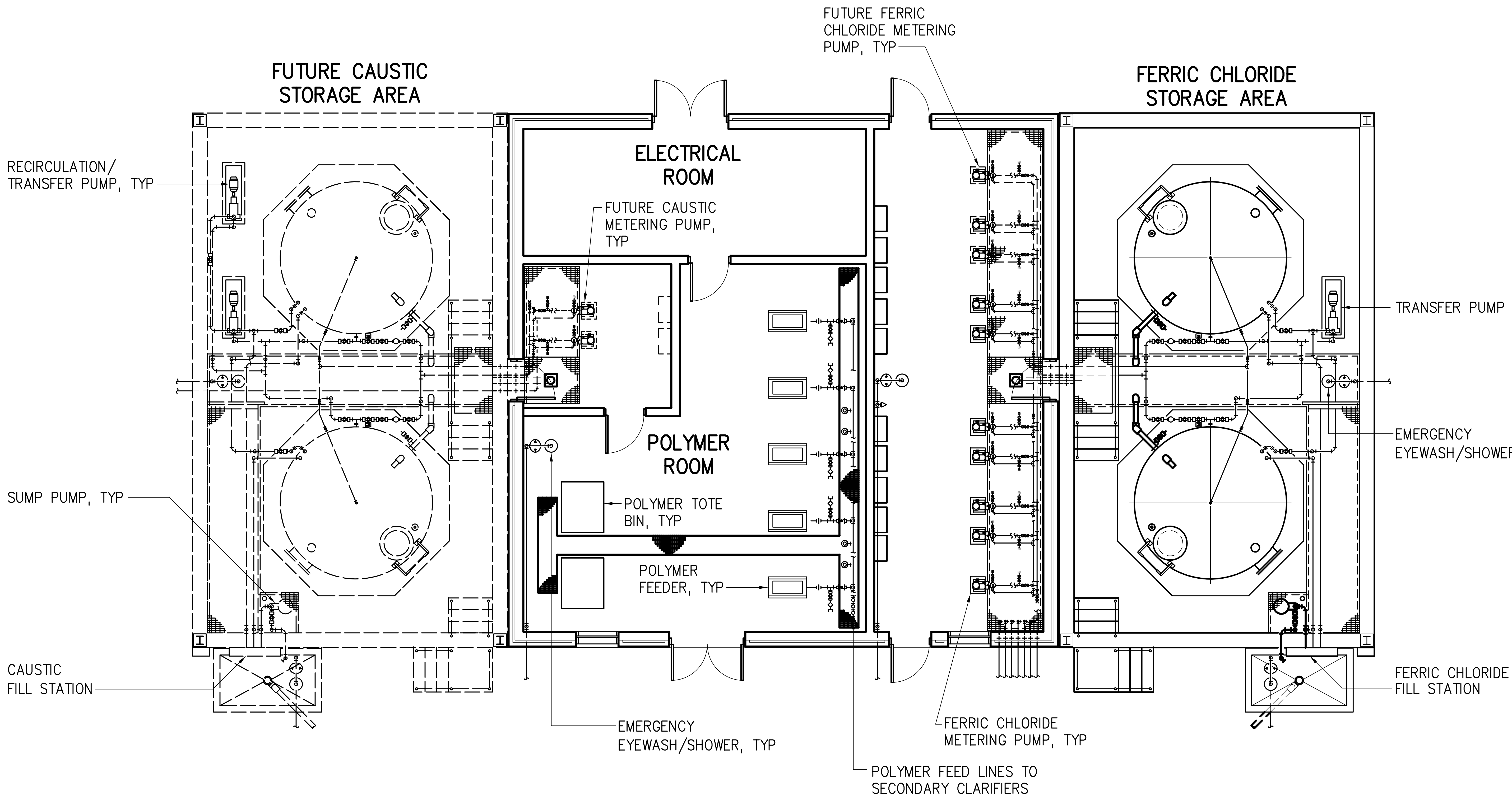
FIGURE 21-2



CDM / HAZEN AND SAWYER

TOP PLAN

1/8"=1'-0"

WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

FERRIC/POLYMER FACILITY
TOP PLAN