AECOM
19219 Katy Freeway, Suite 100
Houston, TX 77094
aecom.com

Project name:
Industrial Pretreatment Facilities Alternatives Analysis

Project ref:
Wastewater System Assessment

To:
Ms. Liz Fazio Hale
Executive Director
Riverbend Water Resources District
228 Texas Avenue, Suite A
New Boston, TX 75570

From:
AECOM

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Technical Memorandum

Executive Summary

Riverbend Water Resources District (Riverbend) operates an industrial pretreatment plant at the Red River Army Depot (RRAD) that consists of two treatment trains: phosphate and chrome. The phosphate treatment train, initially built in the 1950s, has significant corrosion, structural issues, and is at the end of its service life. Several pieces of equipment are so old that spare parts are no longer readily available; placing a huge burden on the Operations staff to both keep the plant running and to maintain the TCEQ permitted effluent quality. The operational problems in the phosphate system are exacerbated by cross-connections within the collection system that allow high aluminum sand from the chrome system to clog up the oil water separation system. While the chrome treatment train is much newer, having been installed in 2007, cross-contamination issues have been hindering the operation of this system as well. This is due to unmarked process drains in many of the buildings, so that wash-down water is diverted to the wrong process sewer system. Given the age of the system and problematic operating conditions, Riverbend tasked AECOM with performing an alternatives analysis to determine the best path forward for the industrial pretreatment plant. The alternatives include:

1. Do nothing and continue with long-term maintenance
2. Rehabilitate the existing facilities
3. Replace the existing equipment in kind
4. Decommission the existing plant and build a new treatment plant at a nearby Greenfield location.

AECOM compared each alternative based on the following criteria:

- Ability to meet effluent requirements
- Relative capital cost
- Relative operation and maintenance (O&M) cost
- Space requirements
- Operability
- Constructability

Alternative 1 has the lowest capital cost but the highest maintenance cost at $700,000 per year. The “do nothing” alternative does not address the end of service life for the phosphate side, the cross-connections/cross-contamination between the two collection systems, the electrical code non-compliance issues, environmental concerns (e.g., the lagoons do not appear to be lined in accordance with current Texas Commission on Environmental Quality (TCEQ) guidelines) or worker health and safety concerns. Therefore, Alternative 1 is not recommended.

The capital cost for Alternative 2 was not fully developed, as it relied upon structural inspection of existing equipment by a concrete rehabilitation consultant, which was not included in the scope of work. Based on AECOM’s experience and comparative costs, the capital cost would fall between Alternatives 1 and 3. While it would decrease maintenance costs and extend the service life of existing equipment by 5 to 10 years, it would not address the cross-connections/cross-contamination between the two collection systems, the electrical code non-compliance issues, environmental concerns, or worker health and safety concerns. Therefore, Alternative 2 is not recommended.

The estimated capital cost for Alternative 3 is $6.56 million. This will extend the service life of existing equipment by 10 years (for pumps) and 20 to 25 years for structural and mechanical equipment (such as clarifiers, rake drives, and secondary containment. This alternative would address the maintenance issues, electrical code, and most worker health and safety concerns. However, the cross-connections/cross-contamination, unlined lagoons, and uncovered used oil tank would still be present. If Alternative 4 is deemed too expensive with respect to capital costs, Alternative 3 could be implemented, although it is not the preferred alternative.

Although this option has the highest capital cost at ($8.9M to $10.9 M), AECOM recommends Alternative 4, which involves decommissioning the existing facility, constructing a lift station and force main and constructing a new plant on a Greenfield site. This option would address all of the aforementioned issues. This option is also expected to incur the lowest operation and maintenance costs which were estimated to be below $500,000 per year. In addition, the new wastewater treatment plant could handle flows and see increased revenue from a nearby, proposed industrial park.

Alternatives 1 through 3 would not solve the cross-connection or cross-contamination issues. Given the age of the collection system, the resources it would take to investigate and correct the issues, and the Army’s reluctance to pursue segregation of the two systems, it is not feasible to resolve this issue. This has not yet caused a permit excursion, but this is an environmental risk. Therefore, a single treatment plant would allow for all of the influent to the plant to be treated in series, regardless of the number of cross connections within the collection systems. TCEQ has also written a letter enquiring as to the design of the lagoons, which appear to be unlined and not in compliance with current regulations. The oil storage tank is open to the atmosphere, which is no longer considered an industry best practice.

In the interest of long term operations, the best course of action would be to decommission the existing industrial pretreatment plant and construct a new treatment plant that can manage all of the constituents of concern. By constructing the new plant on a Greenfield site, there will be no disruption to ongoing operations, and the ability to attract new users/potential for expansion can be an economic incentive. The RRAD could utilize the former WWTP sites for other uses. Pending the TCEQ permit process, the effluent from the new plant could be discharged into a nearby stream which would further reduce O&M costs associated with the existing system. Currently the effluent from the industrial pre-treatment plants is discharged into the sanitary collection system where it is treated again at the biological WWTP.

Background

Riverbend Water Resources District (Riverbend) operates an industrial pretreatment plant at the Red River Army Depot (RRAD) that was initially constructed in the 1950’s although some modifications have occurred since that time. The pretreatment plant actually consists of two different treatment trains called the phosphate side and the chrome side. Each treatment train has its own collection system and lift station, although there are numerous cross-connections between the two systems, and due to unmarked process drains, wash water may be introduced into the wrong collection system. The phosphate side treats oily waters through an oil-water separator, lagoons, and clarifiers before discharging into a sanitary collection system leading to an on-site biological wastewater treatment plant. Because of cross-connections and maintenance practices, high aluminum content sand gets washed into the phosphate side, and the aluminum is not removed from the wastewater. The chrome side removes metals through equalization, a chemical precipitation process, and filtration prior to discharge into the sanitary collection system leading to the same on-site biological wastewater treatment.

The age of the equipment and the limited availability of spare parts place a huge burden on the Operations staff. It requires many labor hours to keep the plant running, and their efforts have resulted in no permit excursions within the past several years.

Site visits were conducted on June 7, and September 24, 2018. Photographs from the September 2018 site visit have been included for informational purposes as Appendix A – Existing Electrical Conditions and Appendix B – Existing Process Conditions.

Phosphate Treatment Side

The phosphate treatment train treats oily waters through an oil-water separator, lagoons, chemical pretreatment, and clarifiers before discharging into a collection system that flows to the on-site biological wastewater treatment plant that is used to handle sanitary flows. The recovered oil is stored in an uncovered concrete tank until enough oil has accumulated for it to be removed by an outside contractor. Sludge is pumped to the dewatering beds.

Figure 1: Oil Water Separator, out of service basin

The oil-water separator (OWS), where one of the two trains is out of service due to the lack of availability of spare parts, includes a grit washer that sends the solids along an elevated pipeline to the sludge dewatering beds. The OWS effluent gravity flows to one of two, unlined influent lagoons. From the lagoons, wastewater is pumped to a rapid mix chamber and then to one of two clarifiers. Once the wastewater is treated in the clarifiers, it joins with the wastewater from chrome treatment train and is sent to the domestic wastewater plant.

Figure 2: Secondary clarifier, noting cracks

Figure 3: Equalization Lagoon

Chrome Treatment Side

The chrome treatment train removes heavy metals, including reducing chromium, using a system from UniPure. Influent is pumped from one of three equalization tanks into the reactor tank where ferrous iron chloride and caustic are used to precipitate the chromium. The influent gravity flows into an inclined plate clarifier, where polymer is added to enhance the settling of the floc. The effluent is decanted to a holding tank where it is pumped through three cartridge filters in series. The effluent pH is adjusted before being discharged into one of three open-topped above-ground storage tanks. Open-topped storage tanks are no longer considered a best practice, and severe cracks in the secondary containment were observed. Effluent from the storage tanks is discharged into the collection system where it mingles with the phosphate side effluent before making its way to the domestic wastewater treatment plant.

Figure 4: Chromium Reactor Tank

Sludge is pumped to one of two roll-off boxes, where it is allowed to dry. It takes approximately 6 months to fill one roll-off box, and two months to dry. Then the sludge is disposed at a hazardous waste landfill in Arkansas.

As previously mentioned, there are cross-connections between the two industrial collection systems and drains are not clearly marked. Therefore, detergents or other foaming agents can get washed into the chrome treatment collection (instead of the phosphate system), and this was observed in the reaction tank at the time of our September site visit.

Electrical Systems

The electrical system consists for four separate electrical services: the Chrome Building, the Solids Building, the Chrome Influent Lift Station, and the Phosphate Pump Building. The only service with backup power is the Phosphate Pump Building. A loss of utility power would result in a partial plant shutdown.

The service for the Chrome Building consists of motor control centers, 480V panelboards, low voltage transformers and 120V panelboards. All the electrical equipment in the Chrome Building is at or beyond its useful service life and does not meet current code requirements. Extensive corrosion was observed on the equipment beneath several layers of paint. Spare parts are not readily available from the manufacturer and refurbished parts from third party resellers are both limited and expensive. Due to the age and condition of the equipment, there is a risk of equipment failure causing a prolonged shutdown of the plant.

The service for the Solids Building consists of a 480V panelboard, a low voltage transformer and a 120V panelboard. The equipment is nearing the end of its useful service life. Some surface corrosion was observed, but the equipment is functional. The electrical service only feeds the building load and not any process equipment. Therefore, any potential equipment failures would not result in a plant shutdown.

The Chrome Influent Lift Station service consists of a wiring gutter with fused disconnects feeding the lift station pumps, pump control panel and a small transformer and panelboard that subfeeds another panelboard at the Finished Tanks. The lift station electrical equipment appears to be in good working order and has 15 to 20 years of service remaining. The risk of an equipment failure is very low and could be quickly rectified because spare parts are readily available.

The service for the Phosphate Pump Building consists of a 480V motor control center, low voltage transformers and panelboards as well as a standby generator and automatic transfer switch. The motor control center and panelboards are nearing the end of their useful service life. The equipment is functional, but spare parts are not readily available. The risk of equipment failure is low but could cause a plant shutdown. The automatic transfer switch and generator are in good working order, and with routine engine maintenance, have 10 to 15 years of useful service life remaining.

The plant has what is commonly referred to as a SCADA System. SCADA stands for Supervisory Control and Data Acquisition. The system at the plant is only used for monitoring. The SCADA system is not being used to its full potential since it is not being used to control any processes in the system. The system consists of four SCADA panels interconnected with a radio system. The system was recently installed. It has 15 to 20 years of service life remaining and spare parts are readily available. There is very low risk of equipment failure and since the system is only used for monitoring, a failure would not result in any shutdown of the process.

Basis of Design

AECOM based the design parameters on flows seen at the plant, and the flows and discharge criteria set by the TCEQ for the treatment plant's effluent. The TCEQ permit includes two phases of effluent criteria, depending on the expected flow of the plant. TCEQ identifies the industrial wastewater plant's outfall as "Outfall 101," and the domestic wastewater plant's outfall as "Outfall 001." Phase I is applicable when the facility discharges flow less than or equal to 0.317 MGD via the internal Outfall 101 and a flow less than or equal to 0.747 MGD through Outfall 001. Phase II is applicable when facility discharges flow greater than 0.317 MGD via the internal Outfall 101 and a flow greater than 0.747 MGD via Outfall 001. Based on the recorded flow rates at both the industrial and domestic outfalls, Phase I criteria apply. The Phase I effluent limitations are shown in Table 1.

Flows treated at the industrial pretreatment plants range from 0.2 to 0.4 MGD. The industrial pretreatment system should be capable of treating an average daily flow of 0.317 MGD and a peak flow of 0.70 MGD. For phase II, the plant should be expanded to 0.75 MGD and a daily maximum flow of 1.5 MGD. If Alternative 4 is selected (the new WWTP), then the plant should be initially designed for an average daily flow of 0.5 MGD and a peak flow of 1.0 MGD with the ability to expand by 0.5 MGD increments.

Table 1: TCEQ Outfall 101 Phase I Effluent Limitations

Effluent Characteristics	Daily Average lbs./day	Daily Maximum lbs./day	Single Grab Mg/L
Flow	0.75 MGD	1.5 MGD	N/A
Total Suspended Solids	80	159	60
Oil and Grease	43.5	64.0	23
Total Phosphate	24.3	48.6	10
Total Cadmium	0.206	0.471	0.178
Total Chromium	1.75	3.27	1.23
Total Copper	1.87	3.47	1.31
Total Cyanide	0.251	0.467	0.176
Total Lead	1.30	2.54	0.958
Total Nickel	3.13	6.00	2.26
Total Silver	0.199	0.380	0.143
Total Zinc	2.81	5.50	2.08
Total Toxic Organics	N/A	0.747	0.282

Alternatives Evaluation

Alternatives 1 through 4 are developed and evaluated in this section. Process Flow Diagrams (PFDs) for the existing system are located in Appendix C. These PFDs apply to Alternatives 1 through 3, as there are no significant process changes in these alternatives. The first three alternatives consist of no change, partial rehabilitation, or partial replacement in kind. AECOM has developed two conceptual designs for Alternative No. 4 - a new pretreatment system, and the proposed PFDs are located in Appendix D. Major equipment lists have been developed for each alternative, and these are included in Appendix E. The alternatives evaluation includes the following elements:

- A conceptual-level capital cost estimate based on factored budgetary quotes from equipment suppliers
- A conceptual level O&M estimate, based on vendor input and Riverbend input
- Advantages and disadvantages of each alternative
- A weighted ranking based on the following evaluation criteria:
  - Ability to meet discharge requirements
  - Reliability
  - Operability
  - Constructability
  - Space constraints
  - Safety
  - Total installed cost (TIC).

A detailed alternatives evaluation table for each of the four alternatives is located in Appendix F, and a summary table of the ranking and criteria is located in Table 7. Each alternative is described in the paragraphs below.

Alternative 1 – Do Nothing and Continue with Long Term Maintenance

This alternative is the base case, in that it does not include any rehabilitation or replacement of major equipment at the existing plant. The plant will continue to operate as it currently does, and the only costs attributed to this alternative are the annual, budgeted maintenance costs. While the industrial pretreatment plant has no recorded permit excursions, that is a risk, given the mixing of constituents between the two systems. In addition much of the plant is at or near the end of its service life.

Table 2: Alternative No. 1 Advantages and Disadvantages

Advantages	Disadvantages
• No initial cost investment since no equipment will be rehabilitated or replaced • Allows use of existing facilities so additional space will not be required	• Cross-contamination problems will still exist, resulting in increased operational costs and reduced water quality • Safety issues, electrical code violations, and process equipment near or at the end of its service life will not be addressed. • Aging equipment requires constant maintenance and spare parts are hard to find or unavailable. This leads to poor operability. • Any structural or mechanical deficiencies in the existing equipment and structures (such as the cracks observed in the clarifiers and secondary containment structures) would persist since they would not be corrected. • Uncovered, outdoor tanks do not meet best industry practices. Workers are exposed to vapors; rainfall is allowed to enter the tank, increasing O&M costs. • Due to the separate electrical services at the site, a majority of the site is without backup power generation. • Plant expansion to increase customer base is not feasible.

Alternative 2 – Rehabilitate Existing Facilities

This alternative is limited in scope to include only the structures and equipment that can be rehabilitated. Equipment or structures that are too damaged to be rehabilitated are not included in this alternative. For example, electrical rehabilitation is not included in this alternative because the old equipment cannot be rehabilitated and must be replaced instead. The status of the existing equipment and structures needs to be ascertained before rehabilitation can take place. A structural inspector will need to be brought to the plant to inspect the facility. A mechanical inspector would need to be brought to the site, or the existing equipment would need to be sent into a shop to determine if they can be rehabilitated. As this is a feasibility study, scope to perform this work was not included. If Riverbend chooses to pursue Alternative 2, then an evaluation and testing by certified rehabilitation specialists would be included in the next phase of the project.

For purposes of the feasibility study, AECOM based order of magnitude costs on visual inspection of equipment and structures. Again, this cost could increase based on further investigation (for example, submerged equipment could not be inspected, and concrete structures may require more repairs than what was observed during visual inspection).

Based on a visual inspection, the following equipment and facilities will require rehabilitation:

- Clarifier No. 1 – Recoat the interior concrete of the clarifier, repair cracks in the exterior concrete walls of the clarifier, rehabilitate flocculator drive unit and motor, rehabilitate clarifier electrical components and controls.
- Clarifier No. 2 – Recoat the interior concrete of the clarifier, repair cracks in exterior concrete walls of the clarifier.
- Oil-Water Separator – Recoat interior concrete of the oil-water separator, rehabilitate grit pumps, and rehabilitate skimmer drives if parts are available. (Note: one chamber is permanently out of service due to the lack of availability of spare parts).
- Used Oil Storage Tank – Inspect and recoat interior of concrete storage tank.
- Intermediate Pump Station – Rehabilitate intermediate pumps
- Chrome Treatment Train Lift Station – Recoat interior concrete of lift station
- UniPure Treatment System – Recoat interior and exterior of steel clarifier, rehabilitate tank feed pumps, rehabilitate tank mixers

- Chrome Treated Water Storage Tanks – Recoat interior and exterior of steel tanks, repairing cracks in base and ring beam of tank, repairing cracks in base of concrete containment area (Note: if cracks in concrete base of tanks are severe enough, wastewater could be leaching into the soil underneath
- Piping – Rehabilitate and recoat piping in phosphate and chrome treatment trains

Table 3: Alternative No. 2 Advantages and Disadvantages

Advantages	Disadvantages
• Minimal initial cost investment since no equipment will be replaced • Minimal disruption of operation • Rehabilitating the facility could extend the life of the equipment and structures by at least 10 years.	• Cross contamination problems will still exist, resulting in increased operational costs and reduced water quality • Safety issues and electrical code violations on the site will still be present • Equipment that is damaged beyond rehabilitation will still need to be replaced • Uncovered, outdoor tanks do not meet best industry practices. Workers are exposed to vapors; rainfall is allowed to enter the tank, increasing O&M costs. • Due to the separate electrical services at the site, a majority of the site is without backup power generation. • Plant expansion to increase customer base is not feasible. • Some operational downtime or reduced flow capacity may be necessary to rehabilitate the existing facilities Spare parts for the OWS and electrical equipment would still be difficult to obtain, continuing the current operational reliability problem.

Alternative 3 – Replace Existing Equipment in Kind

This alternative involves replacing major pieces of equipment in both treatment trains. Much of the equipment on the site has lasted long beyond its anticipated lifespan, particularly on the Phosphate Side. The cross-contamination problems in the system have also caused increased deterioration in the facilities, including corrosion. Along with the process equipment, the electrical equipment in the phosphate system is beyond its service life and would be replaced. The major pieces of equipment that will be replaced include:

- (2) – 55’-0” Flocculating Clarifiers
- (2) – Clarifier Chemical Feed Systems
- (1) – API Oil/Water Separator with Grit Pumps
- (2) - Intermediate Sludge Pumps
- (1) – UniPure Chrome Treatment System
- (3) Lift Station Pumps
- Electrical Systems
- Miscellaneous Piping and Valves

Table 4: Alternative No. 3 Advantages and Disadvantages

Advantages	Disadvantages
• Allows use of existing facilities so additional space will not be required • Replacing aging and/or damaged equipment would extend the service life of the plant dramatically • Improved operational reliability	• Large capital investment to replace the existing equipment • Cross-contamination problems will still exist, resulting in increased operational costs and reduced water quality • Safety issues and code violations on the site may still be present • Uncovered, outdoor tanks do not meet best industry practices. Workers are exposed to vapors; rainfall is allowed to enter the tank, increasing O&M costs. • Due to the separate electrical services at the site, a majority of the site is without backup power generation • Some operational downtime or reduced flow capacity will be necessary to replace existing equipment and/or structures • Not having current as-builts of the plant could result in increased construction costs due to unknown conditions • Minimal ability to increase customer base.

Alternative 4 – Construct New Industrial Pretreatment Plant on Greenfield Site

One of the primary reasons for the alternatives analysis was to determine if there was a better alternative to the current parallel treatment train system. This alternative will involve constructing a new industrial wastewater plant on a Greenfield site that will incorporate the two treatment trains into a single treatment train. A new force main approximately two miles long and lift station will be required to transport the influent to the new pretreatment plant. Since the new industrial pretreatment plant will be built on a Greenfield site, the plant can be designed for expansion to incorporate service from a future industrial park. Figure 5 shows the proposed location of the new WWTP, the existing WWTP and the proposed force main routing. RRAD could re-use the existing WWTP site if the old structures were demolished instead of abandoned in place.

An effluent pump station will also be required to transport the treated water to the domestic treatment plant, unless Riverbend decided to modify its discharge permit. The processes included in the treatment train will be similar to the existing treatment trains. AECOM looked at two different alternatives, 4A and 4B, with the major difference being the use of a Dissolved Air Floatation (DAF) unit in lieu of the clarifiers, in Alternative 4B. The major equipment required for these alternatives is summarized in Table 5. Refer to Appendix D for the process flow diagrams of the proposed industrial wastewater treatment plant.

Table 5: Alternative Nos. 4A and 4B Major Equipment List

Alternative 4A Equipment	Alternative 4 B Equipment
• Inlet Lift Station • API Oil/Water Separator • Used Oil Storage Tank • 3 Reactor Tanks and 4 Feed Pumps • 3 mechanical mixers • Chemical Feed System • (2) Flocculating Clarifiers • 3 Media filters skid (mounted) • Backwash Tank and Pumps • Sludge Handling Facilities • Electrical equipment • Effluent Pump Station	• Influent Lift Station • API Oil/Water Separator • Used Oil Storage Tank • 1 Equalization Tank • 3 Reactor Tanks and 4 Feed Pumps • 5 Mechanical mixers • 1 Neutralization Tank • Chemical Feed System • 1 Dissolved Air Flotation Unit • 3 Media filters skid (mounted) • Backwash Tank and Pumps • Sludge Handling Facilities • Electrical equipment • Effluent Pump Station

The new plant should be initially designed for an average daily flow of 0.5 MGD and a peak flow of 1.0 MGD (Phase I) with the ability to expand by 0.5 MGD increments (Phase II). For Alternative 4A, the estimated cost of construction of Phase I is

$12M, and the estimated Phase II expansion is $9.1 M. For Alternative 4B, the estimated cost of construction of Phase 1 is $8.9 M, and the Phase II expansion is estimated to cost $ 7.5 M.

Currently the treated effluent from the industrial wastewater treatment plant is combined with the flows from the sanitary wastewater treatment plant. The effluent from the industrial wastewater plant meets pretreatment standards dictated by the sanitary plant. This plant is permitted to discharge into Elliot Creek which eventually flows into Wright Putman Lake.

As previously described, Alternative 4 includes the relocation of the industrial wastewater treatment plant. The treated water could be pumped back to be discharged with the sanitary wastewater. An alternate (and more cost effective) option would be to discharge through a new outfall located in the vicinity of the new industrial treatment plant. A major permit amendment will have to be filed with the TCEQ to include the proposed outfall into the existing discharge permit. The TCEQ will assign permit limits to this new outfall based on the SIC code associated with the industrial facility and the nature of the receiving water body. Typically discharge into a perennial water body is the preferred destination since the discharge limits will get the benefit of the mixing and dilution. However, based on aerial maps of the area it seems like a perennial stream is some distance away. The nearest water body appears to be defined as an intermittent stream with limited flow. This will potentially lower the limits assigned in the revised permit. Discharges into intermittent streams have to be monitored more strictly because the flow from the plant makes up a large portion of the flows in the stream, thereby having a greater influence on the water quality of the stream. Small changes in the discharge could result in biomonitoring failures. Careful selection of polymers, coagulants, and other chemicals needs to be considered during the design phase to minimize the risk of toxicity aquatic life.

Table 6: Alternative No. 4 Advantages and Disadvantages

Advantages	Disadvantages
• Cross-contamination problems will be solved using a single treatment train • Safety issues and code violations will no longer be an issue with a new plant • A single treatment train will condense and simplify the treatment process, improve ease of operation and reliability • Building a new treatment plant on a Greenfield site can allow for future expansion • No operational downtime should be necessary, except when the transition to the new plant takes place since the existing plant can be used during construction • RRAD can repurpose the site of the old WWTP	• Large capital investment to construct a new treatment plant • Constructing a new treatment plant will require additional space on a Greenfield site

RIVERBEND WATER RESOURCES DISTRICT

INDUSTRIAL PRETREATMENT PLANT
ALTERNATIVES ANALYSIS

FIGURE 5: PROPOSED INDUSTRIAL
PRETREATMENT PLANT LOCATION MAP

FOR INFORMATION ONLY

LAST MODIFIED: Oct 25, 2018 – 11:30am BY USER: rolenc
DWG. LOCATION: P:_PWD\Riverbend\900 CADD – Working Docs\
DWG. NAME: Aerial.dwg

Cost Estimate

AECOM uses the Association for the Advancement of Cost Engineers (AACE) cost estimate classification system. AECOM developed a Class V (+/- 50%) total installed cost (TIC) capital cost estimates for each of the selected alternatives; this range of accuracy is appropriate for a feasibility study. These costs were based on budgetary quotes for major equipment items and AECOM's database of equipment costs. Other quantities were provided to estimating by engineering. Pricing for all commodities is current and based on index information supported by recent projects, vendor information or published data. MTO and design allowances are not included at this class of estimate, but are typically included in contingency. An allowance for design, engineering, and support services is included as a percentage of the Total Contract cost. Mark-ups and escalations (18%) include the following assumptions:

Insurance: This is included at 1% percent of the Total Contract Value
Taxes: This is included at 8.25% percent of Equipment and Materials
Bonds: This is included at 0.75% percent of the direct Field Cost (DFC) less Equipment material.
Escalation: This is included at 3% to bring the labor and material costs current to 2nd Qtr. 2017.
Freight: This is included at 5% percent of the total equipment and materials.

Exclusions include the following items:

- Owner's Cost such as permits. Costs are included by the Owner to account for cleaning out the existing tanks for Alternatives 3 and 4.
- No costs are included for camps in housing craft workers. AECOM assumes the workers are traveling from a close proximity such as Dallas, TX.
- Cost of potential hazardous materials and remediation costs.
- No site work costs are included in this estimate such as permanent roadways, fences, storm water drainage, etc. However, costs are included to backfill demolished, fine grade the area and include paving around the new equipment.
- The estimate excludes any cost for insulation and fireproofing.

Refer to Table 7 for a summary of the alternative costs.

Table 7: Capital Cost Estimates

	Alternative No. 1	Alternative No. 2	Alternative No. 3	Alternative No. 4A	Alternative No. 4B
Installed Equipment Costs	$0	$1,147,000	$3,910,000	$6,938,150	$5,150,000
Contractor Overhead (18%)	$0	$206,000	$704,000	$1,248,867	$ 927,000
Engineering Costs (10%)	$0	$115,000	$391,000	$693,815	$ 515,000
Contingency (35%)	$0	$514,000	$1,751,819	$3,108,291	$ 2,307,000
Total Capital Cost	**$0**	**$1,982,000**	**$6,757,017**	**$11,989,123**	**$8,899,000**

Conclusions and Recommendations

Riverbend's industrial pretreatment plant was originally constructed in the 1950s and was expanded to its current capacity in the late 1970s. Much of the equipment at the plant has exceeded its useful life, particularly on the phosphate side. The age of the plant, along with the operational problems has resulted in AECOM conducting an alternatives analysis for the plant. A summary of the alternatives evaluations is presented in Table 7 and included in Appendix F. The higher the score, the more preferred the alternative is.

Key conclusions and recommendations are listed below:

- Alternative No. 1 – This alternative would require no initial capital investment to complete, and there would be no need for operational downtime due to construction. This alternative would not solve the cross-contamination problems that are prevalent in both of the treatment trains. Equipment that is currently out of service due to age and inability to acquire spare parts would remain out of service in this option. This option also does not help to alleviate any structural, regulatory, or safety issues that may be present at the plant. This is the least recommended option.
- Alternative No. 2 – This alternative would involve having the existing equipment and structures inspected to determine the suitability of rehabilitation. Rehabilitating the existing facilities would help to extend the life of the rehabilitated equipment, but not all of the equipment at the plant can be rehabilitated. Some of the equipment on site is either too old or too damaged to be rehabilitated so this alternative would not help with those pieces of equipment. This alternative would also not solve the cross-contamination problem since the problem exists primarily due to the plant influent. This alternative is not recommended.
- Alternative No. 3 – This alternative would involve replacing the major pieces of equipment that are too old, in disrepair, or in violation of current regulations. Major pieces of equipment such as the clarifiers, API oil/water separator, and electrical systems would be replaced to help the efficiency of the plant and make operations easier. However, this alternative would require a significant capital investment to replace the existing equipment. If any structures need to be replaced, design and construction of the new structure would be difficult since no current plans exist for the site. This alternative also does not solve the problems of cross-contamination between the treatment trains. Due to the amount of equipment and structures that would need to be replaced to counteract the age of the plant, it would be more efficient to construct a new plant rather than replace pieces of equipment in kind.
- Alternative No. 4 – One of the primary reasons for the alternatives analysis was to determine a method for alleviating the problems caused by cross-contamination between the two treatment trains. This alternative would solve this problem by treating the wastewater in a single treatment train. Constructing a new treatment plant would eliminate the safety and regulatory issues that are present at the existing plant. A new plant would also reduce the yearly maintenance costs dramatically. The new plant could also be constructed in a way that would allow for expansion in the future. This alternative, however, would require the highest capital investment of any of the alternatives. Additional property would be needed to build the new plant. The existing plant would also need to be decommissioned once the new pretreatment plant is online. Despite the high capital investment, this alternative would alleviate the operational problems at the existing plant and allow for safe and efficient pretreatment of the wastewater for decades.

Table 7: Alternative Analysis Ranking by Criteria

	Alternative No. 1	Alternative No. 2	Alternative No. 3	Alternative No. 4
Meet Effluent Requirements	1	2	3	5
Relative Capital Costs	5	4	2	1
Relative O&M Costs	1	2	4	5
Space requirements	5	5	5	1
Operability	1	2	4	5
Constructability	5	3	2	5
Total Weighted Score	**37**	**37**	**40**	**49**

As a result of the alternatives evaluation, Alternative 4 is recommended. Further defining alternative 4, AECOM recommends Alternative 4B (with the DAF unit) for reasons of cost, maintenance, and flow equalization.

Appendix A

PHOTOGRAPHS

EXISTING ELECTRICAL CONDITIONS

Figure1: Chrome Building 480V Motor Control Center

Figure 2: Chrome Building 208V Motor Control Center, insufficient working space per NEC requirements

Figure 3: Chrome Building 480V panelboard with extensive corrosion

Figure 4: Electrical equipment in Chrome Building with insufficient working space per NEC requirements

Figure 5: Chrome Lift Station electrical equipment

Figure 6: Chrome Lift Station electrical equipment

Figure 7: Chrome Finished Tanks electrical equipment

Figure 8: Chrome Finished Tanks non-working motor actuated valve

Figure 9: Solids Building electrical equipment

Figure 10: Solids Building electrical equipment

Figure 11: Phosphate 480V Motor Control Center

Figure 11: Phosphate Panelboard

Figure 13: Phosphate Standby Generator

Figure 14: Phosphate Lift Station electrical equipment

Figure 15: Clarifier electrical equipment

Figure 16: Rehabilitated Clarifier control panel

Figure 17: SCADA Control Panel

Appendix B

PHOTOGRAPHS

EXISTING PROCESS CONDITIONS

DRAFT

Figure1: Chrome Treatment Train - Lift Station

Figure 2: Chrome Treatment Train - Lift Station

Figure 3: Chrome Treatment Train - Equalization Tanks

Figure 4: Chrome Treatment Train - Site Piping

Figure 5: Chrome Treatment Train - UniPure Treatment System

Figure 6: Chrome Treatment Train - Reactor Tank

Figure 7: Chrome Treatment Train – Top of Reactor Tank

Figure 8: Chrome Treatment Train - Inclined-Plate Clarifier

Figure 9: Chrome Treatment Train – Top of Inclined-Plate Clarifier

Figure 10: Chrome Treatment Train - pH Adustment Tank

Figure 11: Chrome Treatment Train – Top of pH Adjust Tank

Figure 11: Chrome Treatment Train - Clarifier Effluent Holding Tank

Figure 13: Chrome Treatment Train - Filters

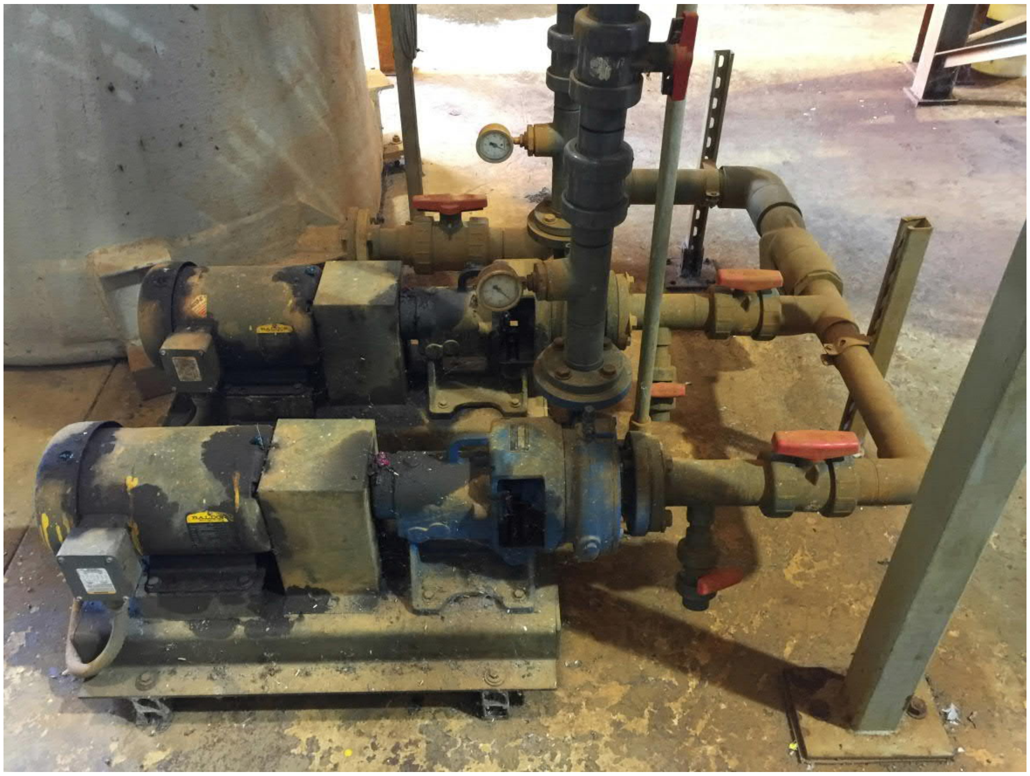


Figure 14: Chrome Treatment Train Filter Feed Pumps

Figure 15: Chrome Treatment Train Diaphragm Recycle Pumps

Figure 16: Chrome Treatment Train Tank Feed Pumps

Figure 17: Chrome Treatment Train - Chemical Storage Tanks

Figure 18: Chrome Treatment Train – Dewatering Beds

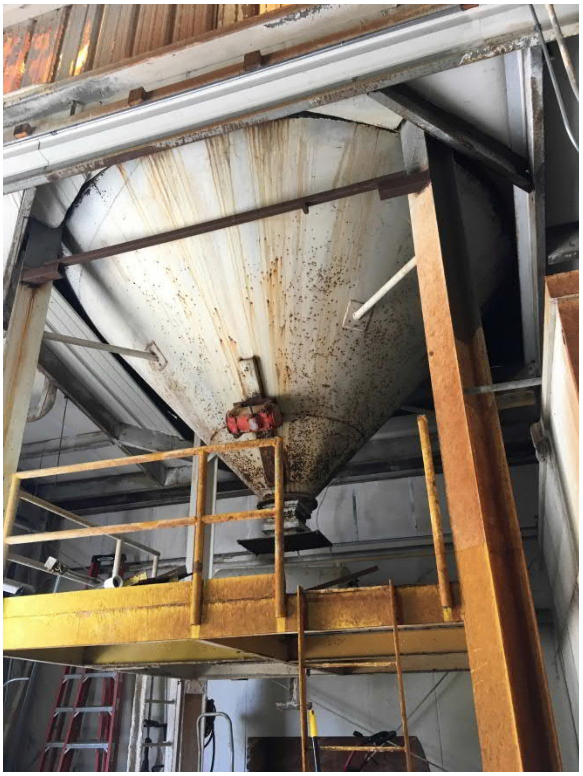


Figure 19: Unused Lime Hopper that is Full of Lime in Chrome Treatment Building

Figure 20: Chrome Treatment Train - Treated Water Storage Tanks

Figure 21: Chrome Treatment Train - Treated Water Storage Tanks

Figure 22: Chrome Treatment Train - Treated Water Storage Tanks Containment Area

Figure 23: Chrome Treatment Train - Treated Water Storage Tank Inlet

Figure 24: Chrome Treatment Train - Treated Water Storage Tank Overflow

Figure 25: Chrome Treatment Train - Treated Water Storage Tank Floor

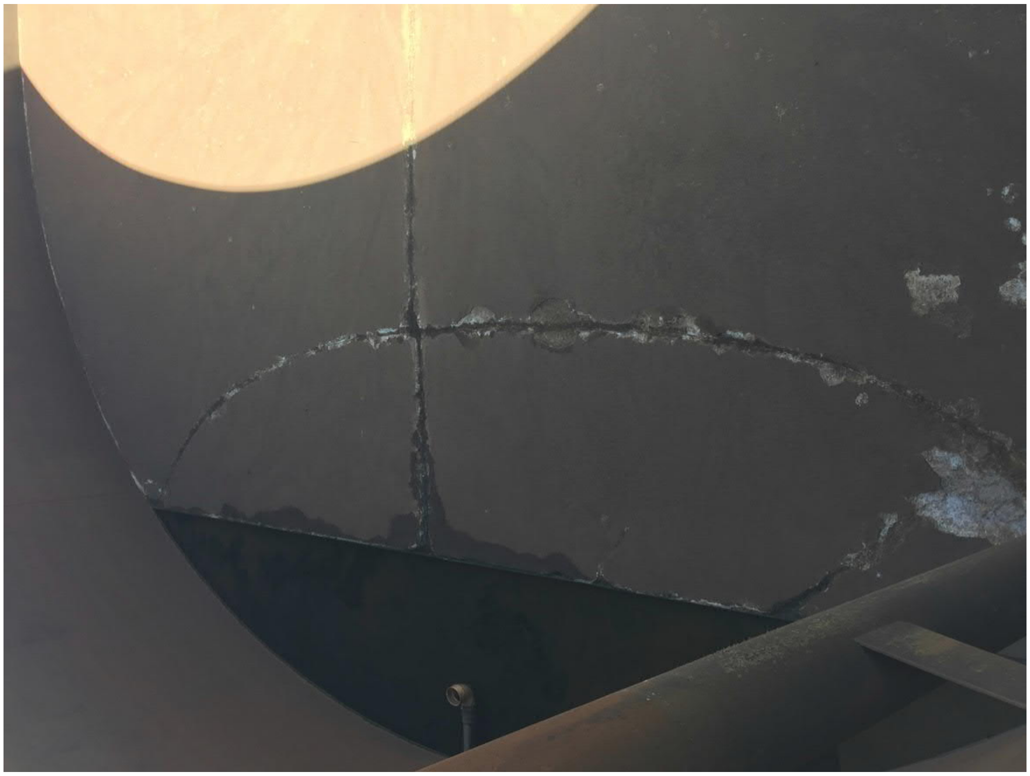


Figure 26: Chrome Treatment Train - Treated Water Storage Tank Floor

Figure 27: Phosphate Treatment Train - Influent Lift Station

Figure 28: Phosphate Treatment Train - Influent Lift Station

Figure 29: Phosphate Treatment Train - Influent Lift Station Spare Pump

Figure 30: Phosphate Treatment Train - Equalization Lagoon

Figure 31: Phosphate Treatment Train - Intermediate Pump Station Pump

Figure 32: Phosphate Treatment Train - Intermediate Pump Station Piping

Figure 33: Phosphate Treatment Train - Intermediate Pump Station

Figure 34: Phosphate Treatment Train - Oil-Water Separator

Figure 35: Phosphate Treatment Train - Oil-Water Separator

Figure 36: Phosphate Treatment Train - Oil-Water Separator Grit Pumps

Figure 37: Phosphate Treatment Train - Grit Wash Pipe Line to Dewatering Beds

Figure 38: Phosphate Treatment Train - Grit Wash Pipe Line to Dewatering Beds

Figure 39: Phosphate Treatment Train - Used Oil Storage Tank

Figure 40: Phosphate Treatment Train - Polymer Mixing Tower

Figure 41: Phosphate Treatment Train - Polymer Mixing Tower

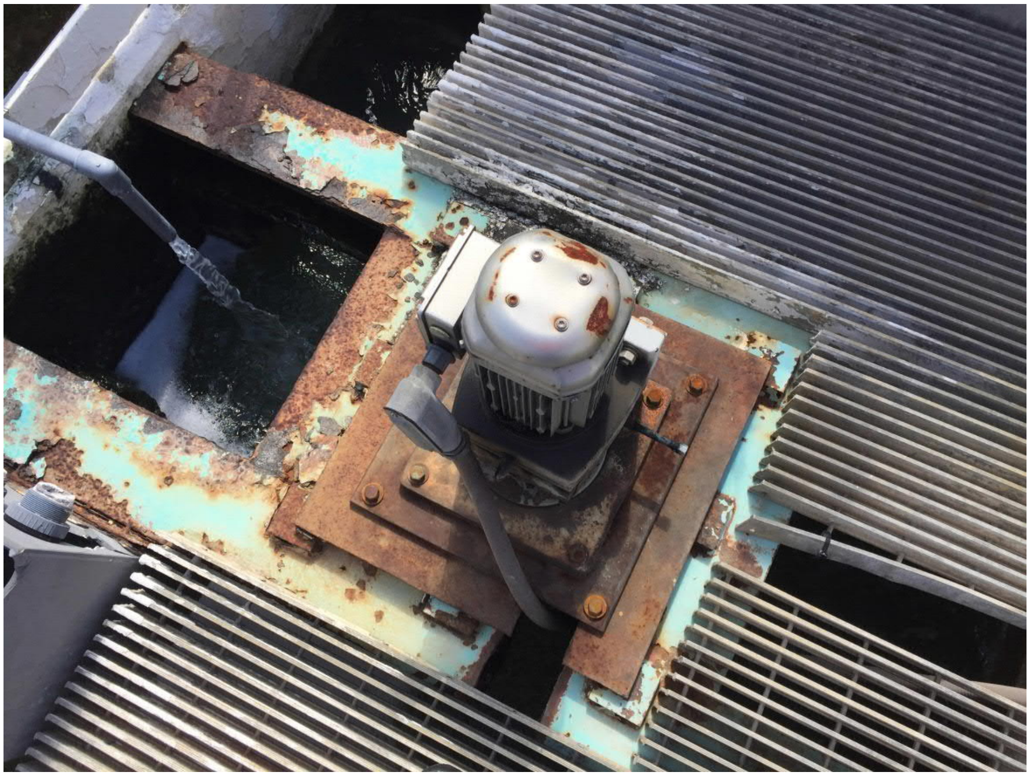


Figure 42: Phosphate Treatment Train - Polymer Mixer

Figure 43: Phosphate Treatment Train - Cracking in Clarifier Walls

Figure 44: Phosphate Treatment Train - Cracking in Clarifier Walls

Figure 45: Phosphate Treatment Train - Cracking in Clarifier Walls

Figure 46: Phosphate Treatment Train - Clarifier Bridge

Figure 47: Phosphate Treatment Train - Clarifier Center Well

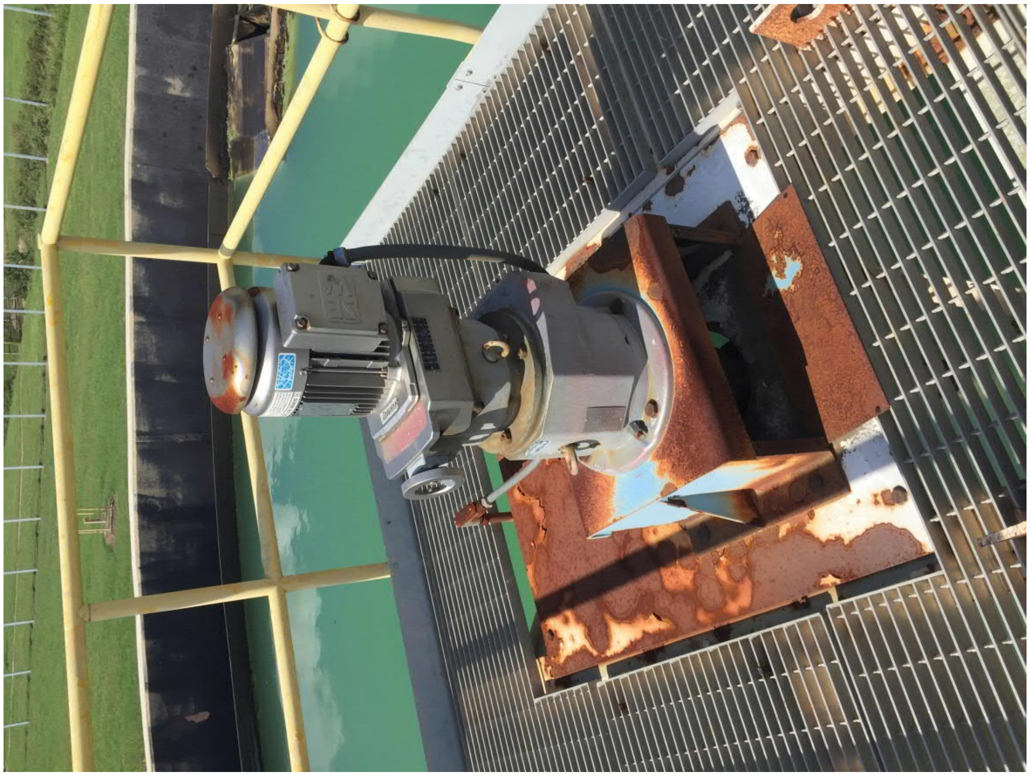


Figure 48: Phosphate Treatment Train - Clarifier Motor

Figure 49: Phosphate Treatment Train - Extreme Corrosion in Clarifier

Figure 50: Phosphate Treatment Train - Clarifier Effluent Tower

Figure 51: Phosphate Treatment Train - Crack in Clarifier Effluent Tower

Figure 52: Phosphate Treatment Train - Unused Sludge Storage Tank

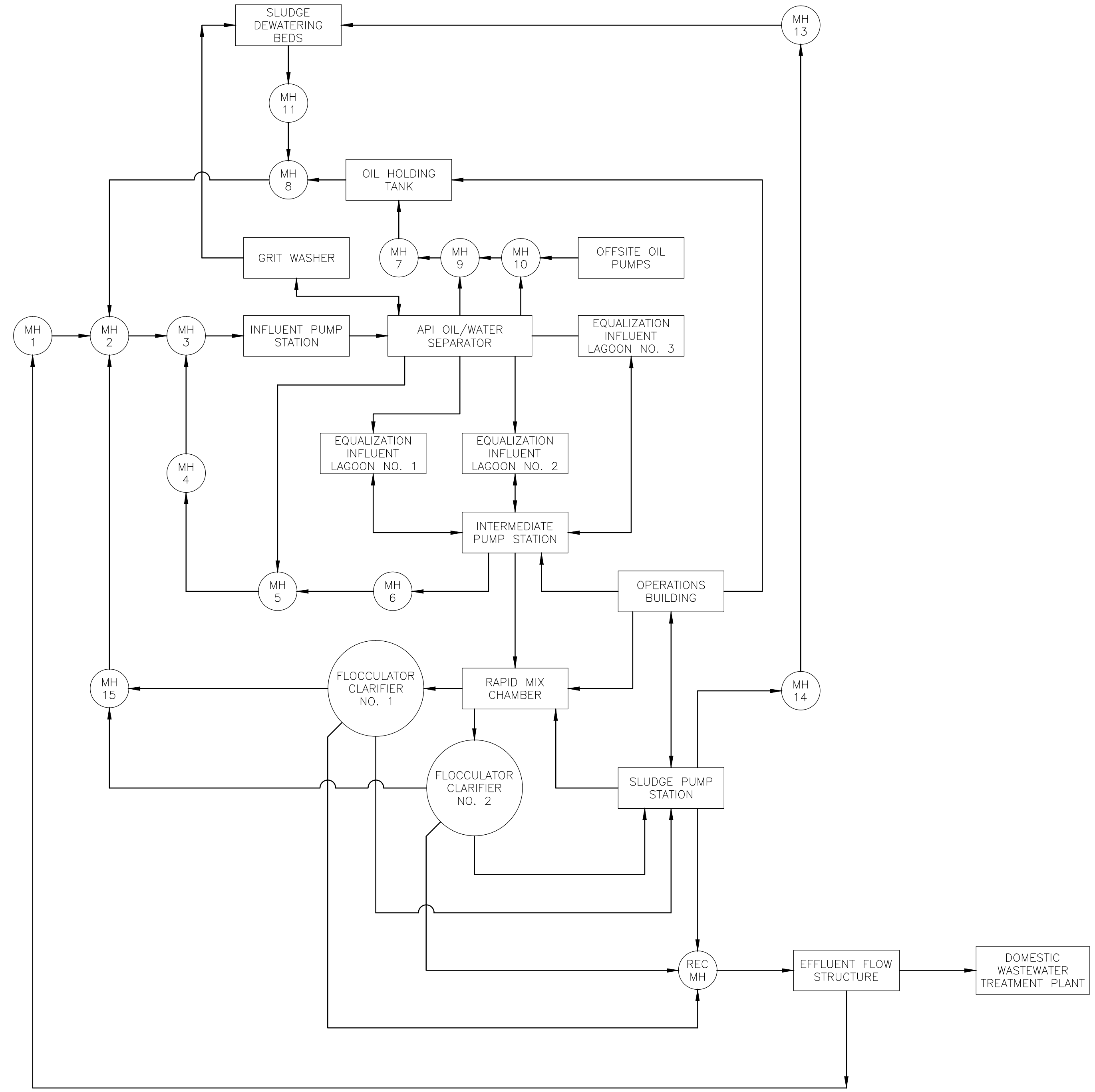
DRAFT

Figure 53: Phosphate Treatment Train – Sludge Pumps

Figure 54: Phosphate Treatment Train – Sludge Pumps

Appendix C

EXISTING PROCESS FLOW DIAGRAMS



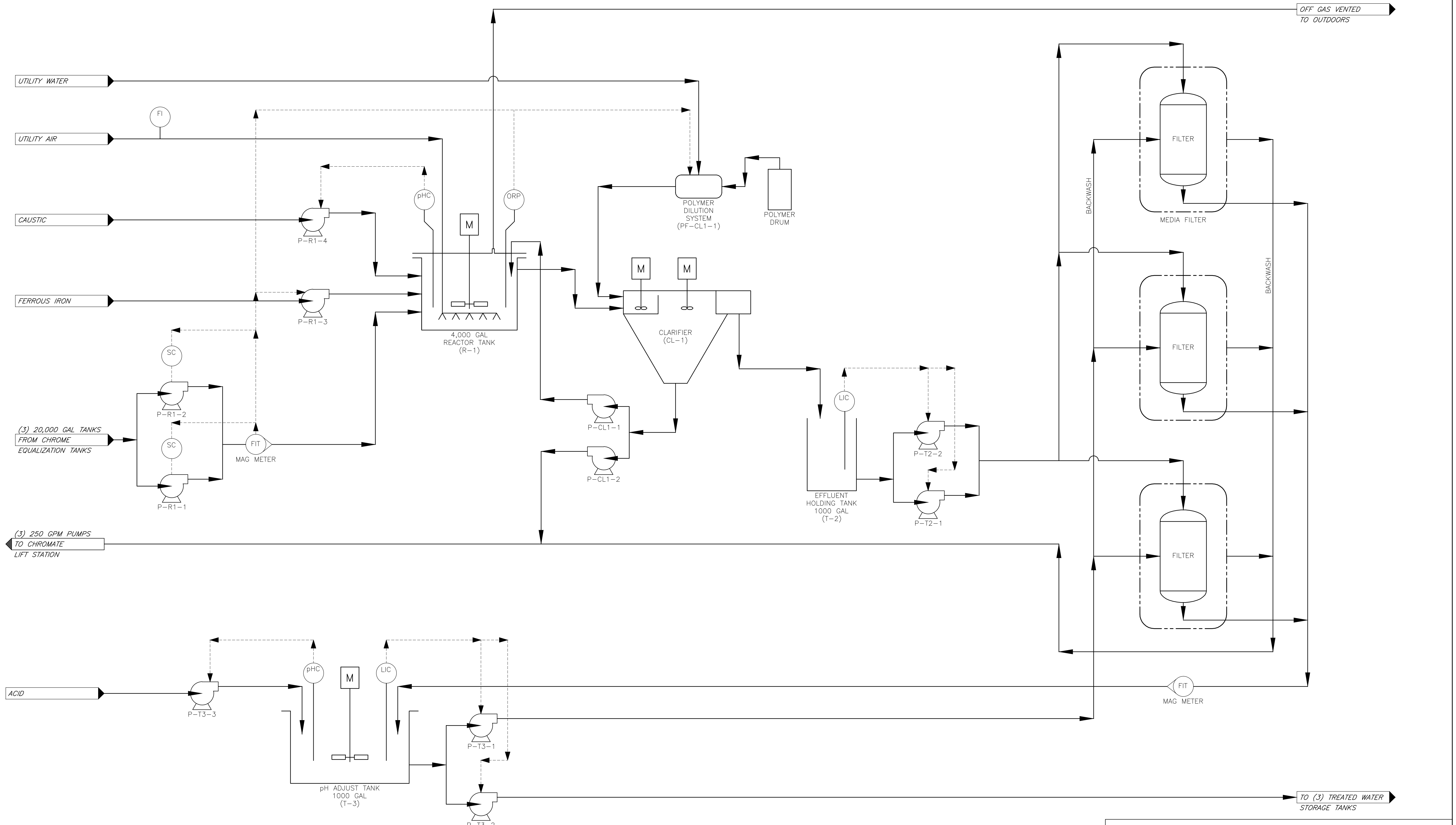
FOR INFORMATION ONLY

RIVERBEND WATER RESOURCES DISTRICT

INDUSTRIAL PRETREATMENT PLANT
ALTERNATIVES ANALYSIS

EXISTING PHOSPHATE TREATMENT
TRAIN PROCESS FLOW DIAGRAM

LAST MODIFIED: Oct 22, 2018 – 10:50am BY USER: rolenc
DWG. LOCATION: P:_PWD\Riverbend\900 CADD – Working Docs\
DWG. NAME: Phosphate PFD.dwg



RIVERBEND WATER RESOURCES DISTRICT

INDUSTRIAL PRETREATMENT PLANT ALTERNATIVES ANALYSIS

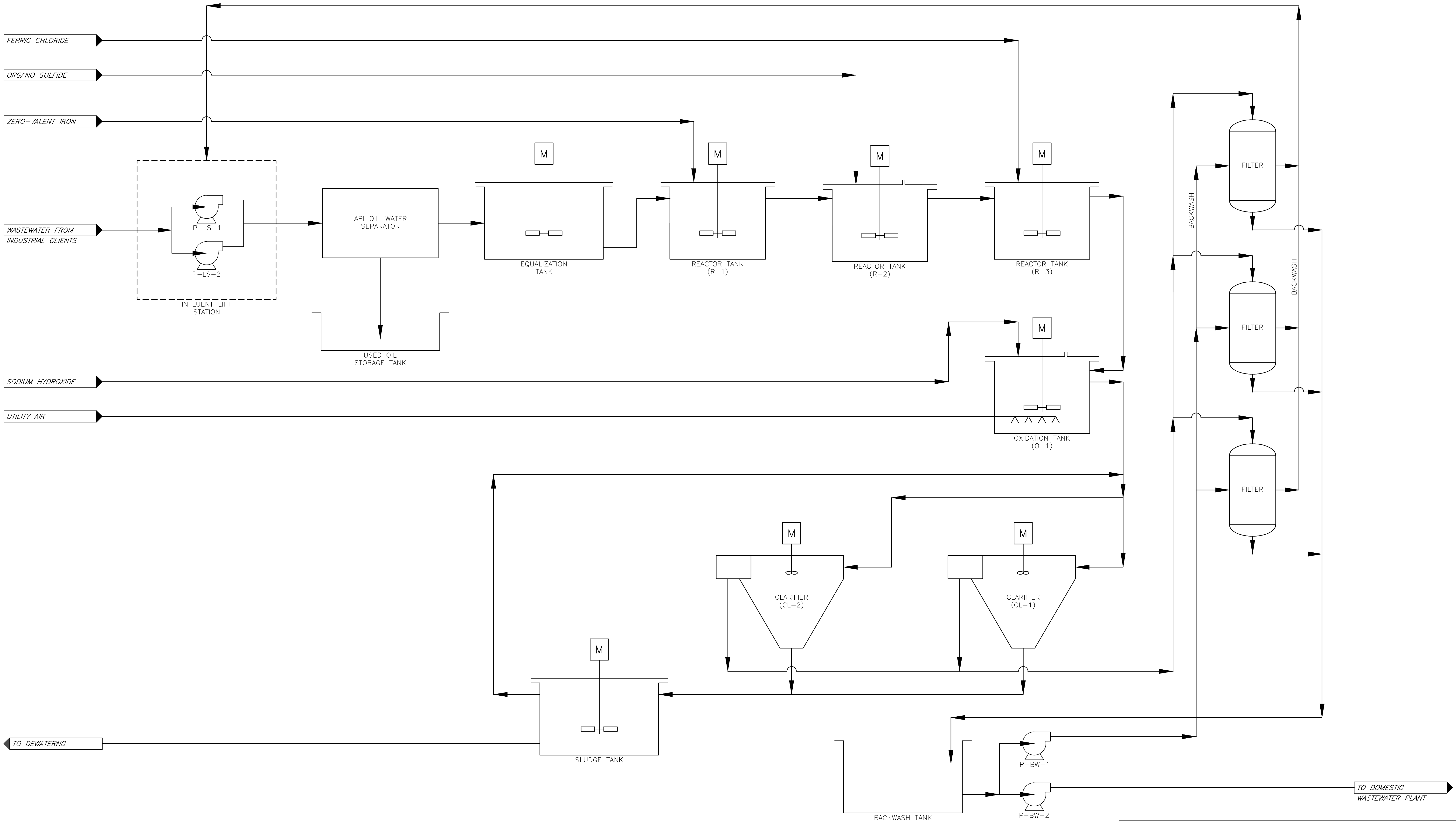
EXISTING CHROME TREATMENT TRAIN PROCESS FLOW DIAGRAM

FOR INFORMATION ONLY

LAST MODIFIED: Oct 22, 2018 – 10:47am BY USER: rolenc
DWG. LOCATION: P:_PWD\Riverbend\900 CADD – Working Docs\
DWG. NAME: Chrome PFD.dwg

Appendix D

PROPOSED PROCESS FLOW DIAGRAMS



RIVERBEND WATER RESOURCES DISTRICT

INDUSTRIAL PRETREATMENT PLANT
ALTERNATIVES ANALYSIS

PROPOSED INDUSTRIAL PRETREATMENT PLANT
PROCESS FLOW DIAGRAM

FOR INFORMATION ONLY ALT. 4A

LAST MODIFIED: Oct 23, 2018 - 5:04pm BY USER: rolenc
DWG. LOCATION: P:_PWD\Riverbend\900 CADD - Working Docs\
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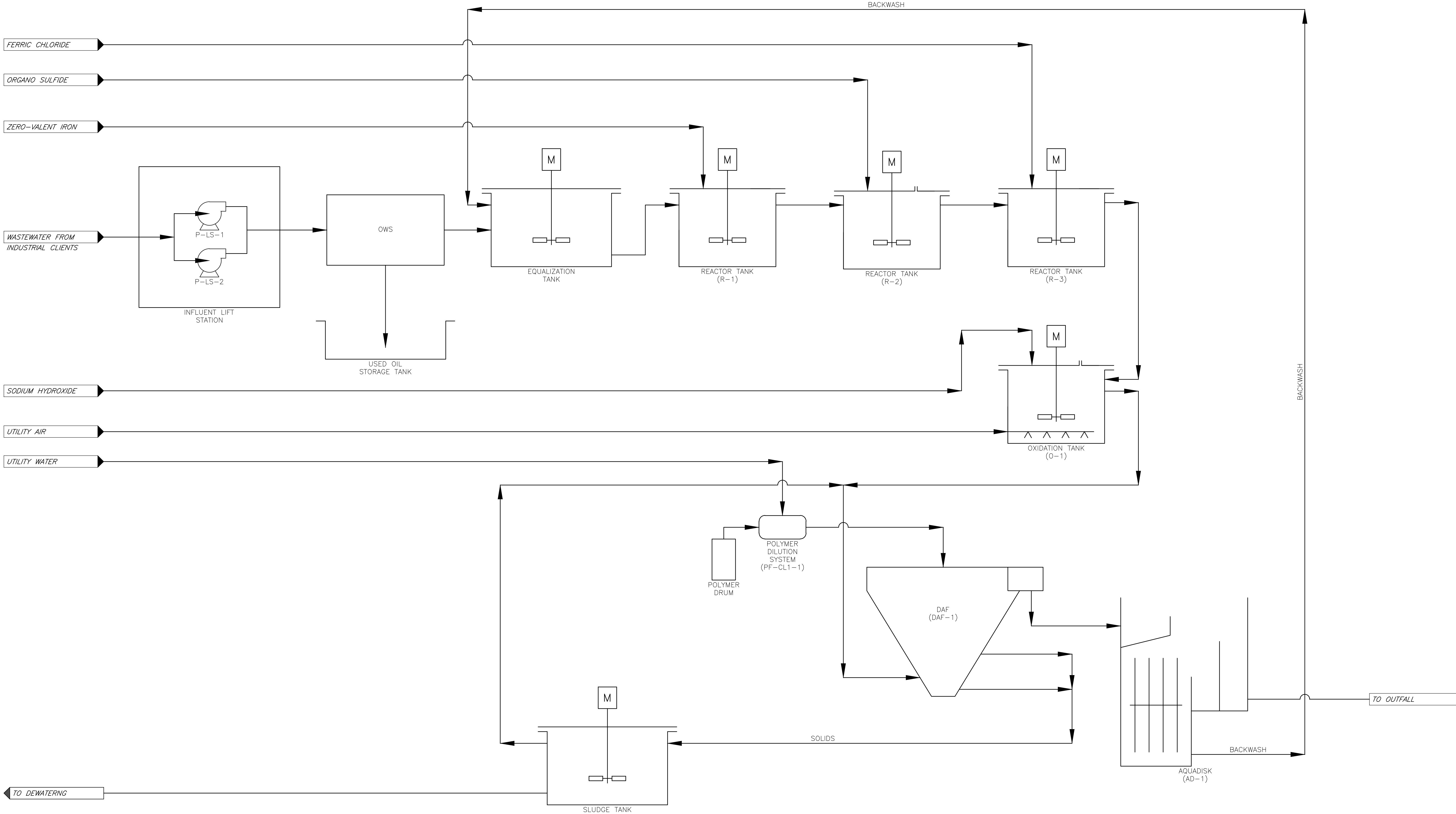

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RIVERBEND WATER RESOURCES DISTRICT

INDUSTRIAL PRETREATMENT PLANT
ALTERNATIVES ANALYSIS

PROPOSED INDUSTRIAL PRETREATMENT PLANT
PROCESS FLOW DIAGRAM

FOR INFORMATION ONLY ALT. 4B

Appendix E

PROPOSED EQUIPMENT LISTS

AECOM

CLIENT: Riverbend Water Resources District
LOCATION: New Boston, TX
PROJ. NO.: 60583724
DATE: 10/19/2018

Equipment List

Alternative No. 3

Number of Items	Equipment Description
Phosphate Treatment Train	
1	10'-0"W X 35'-0"L x 7'-2"H Oil-Water Separator
4	110 gpm Grit Pumps
2	55'-0" Diameter Flocculating Clarifier
2	Clarifier Chemical Feed System
2	20 hp Centrifugal Pump - Intermediate Pump Station
1	480V Motor Control Center, 600A, 5 Sections
1	480V Panelbaord
1	45KVA Low Voltage Transformer
1	120V Panelboard
1	Influent Lift Station Control Panel
Chrome Treatment Train	
3	250 gpm Lift Station Pump
2	125 gpm Centrifugal Feed Pumps
1	2" Influent Magnetic Flow Meter
1	2.5" Effluent Magnetic Flow Meter
1	4000 gallon UniPure Reactor Module
1	125 gpm UniPure Clarifier Module
1	1000 gallon Effluent Holding Tank
3	36" Diameter Media Filter Module
1	Centralized PLC Panel
1	480V Motor Control Center, 600A, 3 Sections
1	208V Motor Control Center, 600A, 6 Sections
2	480V Panelbaord
1	112.5 KVA Low Voltage Transformer
3	45KVA Low Voltage Transformer
4	120V Panelboard

Equipment List

Alternative No. 4A

Number of Items	Equipment Description
2	Submersible Lift Station Pumps
1	API Oil-Water Separator
1	Used Oil Storage Tank
1	Equalization Tank
3	Reactor Tanks
4	Reactor Tank Feed Pumps
1	Oxidation Tank
2	Flocculating Clarifier
2	Clarifier Chemical Feed System
3	Media Filter Modules
1	Sludge Tank
2	Sludge Pumps
2	Filtrate Recycle Pumps
1	Backwash Tank
2	Backwash/Effluent Pumps
2	480V Motor Control Center, 600A, 5 Sections
4	480V Panelbaord
4	45KVA Low Voltage Transformer
1	112.5 KVA Low Voltage Transformer
5	120V Panelboard
1	Centralized PLC Panel
1	Influent Lift Station Control Panel

Major Equipment List	
Alternative No. 4B	
Number of Items	**Equipment Description**
2	Submersible Lift Station Pumps
2	API Oil-Water Separator
3	12" Oil/Water Separator Gates
1	Used Oil Storage Tank (100,000 Gal, Horiz, Steel)
1	Concrete Secondary Containment
1	Equilization Tank (6,000 Gal, Painted Steel)
3	Reactor Tank with mixer (2,800 Gal, FRP)
3	Reactor Tank Feed System
1	Oxidation Tank (2,800 Gal, FRP) with mixer and NaOH and H2SO4 metering pumps
5	Mixer (5 HP)
1	4-Disk AquaDisk with cloth filter package
2	Dissilved Air Flotation Unit (1+1 standby)
1	Sludge Tank (8,000 Gal, FRP)
4	8" Sludge Pumps
2	Grit Pumps
2	Grit Pump Controls
2	480V Motor Control Center, 600A, 5 Sections
4	480V Panelbaord
4	45KVA Low Voltage Transformer
1	112.5 KVA Low Voltage Transformer
5	120V Panelboard
1	Instrumentations and Controls
1	Influent Lift Station Control Panel

Appendix F

ALTERNATIVES EVALUATION SUMMARY

AECOM

CLIENT: Riverbend Water Resources District
LOCATION: New Boston, TX
PROJ. NO.: 60583724
DATE: 10/19/2018

Table 2. Riverbend Industrial Pre-treatment WWTP Evaluation

Unit Operation		Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Industrial Pretreatment Facility		Do Nothing Alternative (Continue Budgeted Maintenance)		Rehabilitate Existing Facilities		Replace Existing Equipment in Kind		Construct new Industrial Wastewater Plant on Greenfield Site	
Evaluation Criteria	**Criteria Weight[a]**	**Comments**	**Score[b]**	**Comments**	**Score[b]**	**Comments**	**Score[b]**		**Score[b]**
Impact on WWTP ability to meet required effluent limits	3	High: The existing plant will continue to have cross connections and cross-contamination between the phosphate and chrome sides, which results in suboptimal performance of the phosphate treatment train.	1	Moderate: The existing plant will continue to have cross connections and cross contamination between the phosphate and chrome sides, which results in suboptimal performance of the phosphate treatment train. Rehabilitated equipment could increase reliability slightly, electrical systems would not meet current building code.	2	Moderate: Replacing the existing equipment in kind will not remove the cross contamination problems. However, newer equipment should improve overall system performance.	3	Low: New treatment plant will be constructed to meet all permit criteria and will eliminate the impacts of cross-connections.	5
Relative costs (capital)	3	Low: No new equipment required	5	Low to Moderate: The investment required depends on how extensive the rehabiliation that is required. Electrical equipment may still not meet current building code.	4	High: Major capital investment to replace the existing equipment in kind.	2	High: Major capital investment to construct a new wastewater treatment facility and decommission the existing facility.	1
Relative costs (O&M)	2	High: Plant requires constant maintenance due to age of equipment and cross connections between the two treatment systems.	1	Moderate : Rehabilitating existing equipment will decrease maintenance costs, but Riverbend will still face challenges obtaining spare parts. Cross connections will still exist between the two systems.	2	Moderate: Replacing existing equipment will decrease maintenance costs, but cross connections between the phosphate and chrome sides, which results in suboptimal performance of the phosphate treatment train.	4	Low: A new plant should minimize operation and maintenance costs.	5
Space requirements	1	Low: No new equipment	5	Low: No new equipment will be installed. The existing equipment will be rehabilitated.	5	Low: Equipment will be replaced in kind and additional space should not be required.	5	Moderate: A greenspace is available for the new plant.	1
Operability[c]	2	Age of plant requires significant maintenance work and involvement from the operators, but familiarity with the plant eases some of issues.	1	Age of plant requires significant maintenance work and involvement from the operators, but familiarity with the plant eases some of issues.	2	New equipment will help with the operation of the plant, but the cross contamination issues will still create additional operational problems.	4	Operator input will be included in the constrcution of a new plant, and new equipment will allow for ease of operation	5
Constructability[d]	2	No impact	5	Rehabilitation of clarifiers, etc will require some equipment to be temporarily off-line.	3	Replacing existing equipment will require certain pieces of equipment to be temporarily off-line. Construction may be more dificult due to the lack of accurate as-builts for the plant.	2	No conflicts are present since the plant will be constructed on a greenfield site.	5
Total Weighted Score[e]			37		37		40		49
Advantages		• No initial cost investment since no equipment will be rehabilitated or replaced • Allows use of existing facilities so additional space will not be required • No operational downtime or reduced flow capacity since no equipment will be taken down for construction		• Minimal initial cost investment since no equipment will be replaced • Allows use of existing facilities so additional space will not be required • Rehabilitating the facility could extend the life of the equipment and structures dramatically		• Allows use of existing facilities so additional space will not be required • Replacing aging and/or damaged equipment would extend the life of the plant dramatically		• Cross contamination problems will be solved using a single treatment train • Safety issues and code violations will no longer be an issue with a new plant • A single treatment train will condense and simplify the treatment process • Building a new treatment plant on a Greenfield site can allow for future expansion • No operational downtime should be necessary, except when the transition to the new plant takes place since the existing plant can be used during construction	
Disadvantages/ Challenges		• Cross contamination problems will still exist, resulting in increased operational costs and reduced water quality • Safety issues and code violations on the site will still be present • Aging equipment requires constant maintenance and spare parts are hard to find or unavailable. • Any structural or mechanical deficiencies in the existing equipment and structures would be allow to persist since they would not be detected • Uncovered outdoor tanks allow for contamination from external sources • Due to the separate electrical services at the site, a majority of the site is without backup power generation		• Cross contamination problems will still exist, resulting in increased operational costs and reduced water quality • Safety issues and code violations on the site will still be present • Equipment that is damaged beyond rehabilitation will still need to be replaced • Uncovered outdoor tanks allow for contamination from external sources • Due to the separate electrical services at the site, a majority of the site is without backup power generation • Some operational downtime or reduced flow capacity may be necessary to rehabilitate the existing facilities		• Large capital investment to replace the existing equipment • Cross contamination problems will still exist, resulting in increased operational costs and reduced water quality • Safety issues and code violations on the site may still be present • Uncovered outdoor tanks allow for contamination from external sources • Due to the separate electrical services at the site, a majority of the site is without backup power generation • Some operational downtime or reduced flow capacity will be necessary to replace existing equipment and/or structures • Not having current plans of the plant could result in increased construction costs due to change orders		• Large capital investment to construct a new treatment plan • Constructing a new treatment plant will require additional space on a Greenfield site • The existing industrial wastewater treatment plant will need to be decommissioned	

NOTES:

[a] **Criteria Weight** is from 1 to 3 with 3 being the highest weight.

[b] **Evaluation Criteria Score** is from 1 to 5 with 5 being the highest score.

[c] **Operability** is how easy the process is to operate, level of automation, operator involvement, operational safety

[d] **Constructability** is how easy the project is to construct/implement based on equipment lead times, specialized equipment, space constraints, access, clearance, etc.

[e] **Total Weighted Score** is the sum of the Criteria Weight multiplied by the Evaluation Criteria Score. A higher score is more favorable than a lower score