# City of St. Joseph, Missouri

# Facilities Plan

# Volume 2

# Wastewater Facilities Assessment Report

# Executive Summary

**By**

Black & Veatch

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# Wastewater Facilities Assessment Executive Summary

## 1.0 Introduction

The purpose of the Wastewater Facilities Assessment Executive Summary is to summarize the findings and conclusions of ten technical memoranda that were prepared for the St. Joseph, Missouri Wastewater Facilities Plan. The intent of the Wastewater Facilities Plan is to determine the collection system and treatment improvements required to meet regulatory requirements, improve system reliability, and support City growth needs. The Wastewater Facilities Plan serves as the basis for implementation of wastewater improvements within the Capital Improvements Program (CIP).

The following ten sections provide an executive summary of each of the Wastewater Facilities Plan technical memoranda. The complete technical memoranda and associated appendices are provided in Volume 2 of the Facilities Plan Report.

## 2.0 TM-WW-1: Existing Conveyance and Water Protection Facility Assessment

The City of St. Joseph is serviced by one Water Protection Facility (WPF) located in the southern portion of the City. The wastewater conveyance system contains a combined sewer system on the west and a separated system on the east. This technical memorandum provides an assessment of the existing WPF and associated conveyance system and will provide the basis for evaluating treatment facilities and conveyance systems for the remainder of the Wastewater Facilities Plan. An overview of the existing conveyance system and WPF is provided herein. The study area and existing conveyance system are shown in Figure 1.

This memorandum provides an analysis of historical WPF flow and load data for all flows entering the WPF including flows to the WPF headworks as well as flows from the wholesale industrial customers. Table 1 provides a summary of historical annual average influent flows and loads for the WPF.

| Table 1<br>Historical WPF Annual Average Influent Flows and Loads by Source | | | | |
|---|---|---|---|---|
| **Parameter** | **WPF Headworks** | **SSJISD** | **National Beef Leathers** | **Triumph Foods** |
| Flow, mgd | 15 | 2 | 1 | 2 |
| Total Suspended Solids, ppd | 38,342 | 3,439 | 568 | 1,262 |
| Biochemical Oxygen Demand, ppd | 28,434 | 10,491 | 215 | 2,561 |
| Ammonia Nitrogen, ppd | -- [1] | 568 | 4,726 | 1,772 |
| 1. The symbol "--" indicates data not available. | | | | |

A projection of future flows and loads from the existing service area was prepared based on a 20-year planning period with Year 2030 established as the planning year. Traffic analysis zone (TAZ) population data provided by the City as well as discussions with City staff were used to project populations within the service area over the 20-year planning period as shown in Table 2. Table 3 summarizes projected flows and loads to the WPF in Year 2030 based on the population projections for the existing service area.

| Table 2<br>Population Projections for 2010 and 2030 | | |
|---|---|---|
| | **Population** | |
| **Service Area** | **2010** | **2030** |
| Westside | 63,900 | 66,700 |
| Eastside | 13,400 | 17,400 |
| *Total* | *77,300* | *84,100* |

| Table 3<br>Projected 2030 WPF Annual Average Influent Flows and Loads by Source | | | | |
|---|---|---|---|---|
| **Parameter** | **WPF Headworks** | **SSJISD** | **National Beef Leather** | **Triumph Food** |
| Flow, mgd | 15.6 | 1.9 | 1.0 | 1.9 |
| Total Suspended Solids, ppd | 25,000 | 3,400 | 600 | 1,300 |
| Biochemical Oxygen Demand, ppd | 25,000 | 11,000 | 200 | 2,600 |
| Ammonia Nitrogen, ppd [1] | 2,500 | 600 | 2,400 [2] | 1,800 |

**Table 3**
**Projected 2030 WPF Annual Average Influent Flows and Loads by Source**

| Parameter | WPF Headworks | SSJISD | National Beef Leather | Triumph Food |
|---|---|---|---|---|
| TKN Nitrogen, ppd [1] | 3,000 | -- [3] | -- | -- |
| Phosphorus, ppd [1] | 400 | -- | -- | -- |

1. Loadings estimated by multiplying the per capita loadings by the 2030 population projections.
2. Projected ammonia nitrogen loading for National Beef Leathers assumes a 50% reduction from historical loadings based on the implementation of a $CO_2$ system currently in progress.
3. The symbol "--" indicates data cannot be determined at this time.

Based on this analysis, it appears the existing capacity of the WPF can process the projected 2030 annual average flows as the permitted design flow is 27 million gallons per day (mgd); however, process upgrades will be required to meet future regulatory requirements, such as the need for disinfection, ammonia removal, and phosphorus removal.

A capacity assessment of major process units indicates that portions of the WPF could potentially treat additional flow if bottlenecks, such as hydraulic restrictions at the grit basins, were removed. In addition, a preliminary assessment of the effluent hydraulic profile was conducted. This analysis suggests an effluent pump station will likely be necessary to meet the Missouri Department of Natural Resources' (MDNR) requirement that the WPF remain fully operational under conditions of the 25-year flood as additional process units, such as disinfection, are added to the WPF. The fact that temporary pumping of the WPF effluent is currently required to send effluent to the river during 100-year flood events offers further support that the facility's hydraulic profile is already constrained. Further investigation of the effluent pump station is included in TM-WW-7 – Hydraulic Analysis and Effluent Pump Station. The goal of any required effluent pumping improvements will be to minimize costs by relying on gravity flow whenever possible.

TM-WW-2 – Eastside Wastewater Service Assessment develops flow projections for the existing Eastside service area as well as City-identified service area extensions. TM-WW-2 also provides recommendations for potential dedicated Eastside infrastructure, including treatment and conveyance improvements.

## 3.0 TM-WW-2: Eastside Wastewater Service Assessment

The Eastside wastewater service area, located east of the Belt Highway in St. Joseph, has been highlighted as an area of potential future growth and economic development for the City. In addition, the existing wastewater conveyance facilities are beyond their useful life and require improvements in order to maintain adequate wastewater service for the current Eastside area. With the pending need to invest in Eastside infrastructure, it is prudent to take into account City growth over the next 20 years within an extended Eastside wastewater service area (Figure 2). Alternatives considered to expand wastewater service in the Eastside service area include either construction of a new WPF or construction of a wastewater pump station. Wastewater process technologies were evaluated and it was determined that biological nutrient removal (BNR) with filtration is the most cost effective process for the Eastside area if a new WPF is recommended. Two potential sites for future wastewater infrastructure were identified and evaluated (Figure 2). Three alternatives were developed to provide the conveyance and treatment of future wastewater flows on the Eastside. The following provides a summary of the elements of each alternative:

- **Alternative 1 – Eastside WPF at North Site** (Figure 3)
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Package pump station and 10 inch force main to route southern flows to North site
  - BNR with filtration WPF (6 mgd average flow)
  - Flow equalization basin (12 million gallons (MG))
  - North site land acquisition (320 acres assumed)
  - Decommissioning of Faraon Street and Easton Road Pump Stations
- **Alternative 2 – Eastside WPF at South Site** (Figure 4)
  - Interceptor and trunk sewers to route wastewater flow to South site
  - BNR with filtration WPF (6 mgd average flow)
  - Flow equalization basin (12 MG)
  - South site land acquisition (320 acres assumed)

- Decommissioning of Faraon Street and Easton Road Pump Stations

- **Alternative 3 – Eastside Pump Station at North Site** (Figure 5)
  - Interceptor and trunk sewers to route wastewater flow to North site
  - Eastside Pump Station (8 mgd to existing WPF, 16 mgd to flow equalization basin)
  - 24 inch force main from Eastside Pump Station to Mitchell Basin
  - 24 inch force main from Eastside Pump Station to flow equalization
  - Flow equalization basin (16 MG)
  - North site land acquisition (320 acres assumed for future WPF build-out)
  - Decommissioning of Faraon Street and Easton Road Pump Stations

A triple bottom line analysis was conducted to evaluate each of the alternatives, encompassing project capital investment, operation and maintenance (O&M) costs, net present worth, as well as social and environmental non-economic factors. Based on this analysis, Alternative 3 – Eastside Pump Station at North Site is recommended for implementation. Figure 6 presents the cumulative triple bottom line analysis score for each alternative. Table 4 presents the results of the project capital, O&M, and net present worth analysis for each of the alternatives.

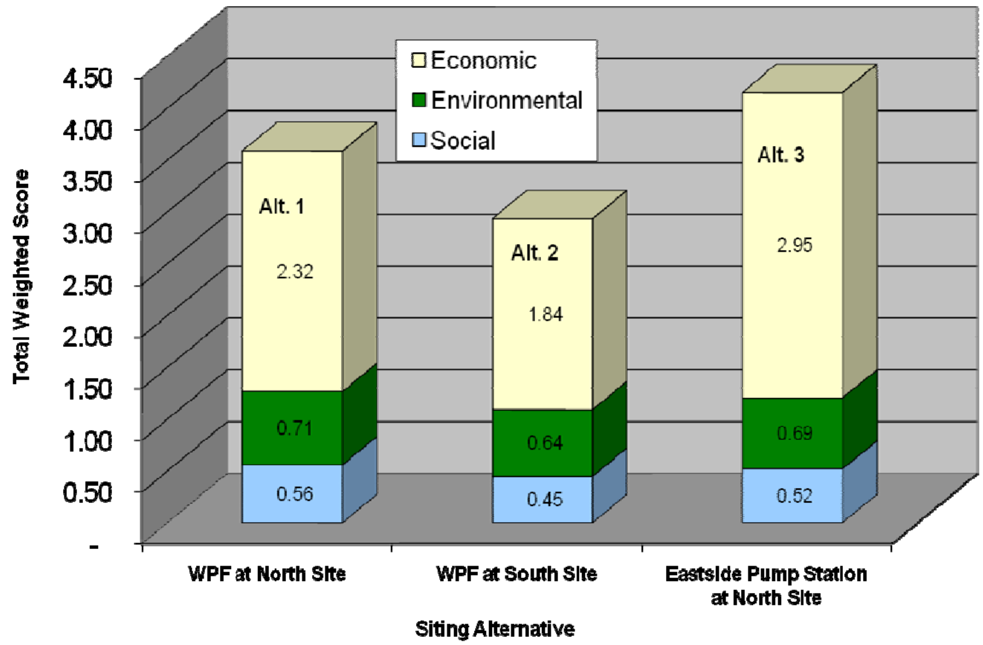


**Figure 6 - Eastside WPF Assessment Triple Bottom Line Analysis Scores**

**Table 4**
**Eastside Wastewater Service Alternatives**
**Total Project Net Present Worth [1]**

| | Alternative 1 WPF at North Site, $ | Alternative 2 WPF at South Site, $ | Alternative 3 Eastside Pump Station at North Site, $ |
|---|---|---|---|
| Net Project Capital Present Worth [2] | 167,258,000 | 197,577,000 | 127,759,000 |
| O&M Present Worth [3] | 36,228,000 | 37,893,000 | 27,693,000 |
| **Total Net Present Worth** | **203,486,000** | **235,470,000** | **155,452,000** |

1. Costs given in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest.
2. Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years.
3. O&M costs were assumed to escalate at 5% per year.

Triple bottom line scores for each of the alternatives are as follows: Alternative 1 – 3.59, Alternative 2 – 2.93, and Alternative 3 – 4.15. As demonstrated by the results of this analysis, Alternative 3 – Eastside Pump Station at North site is the highest ranking alternative, scoring over 13 percent higher than the next highest alternative. Alternative 3 is found to be more than 20 percent less than the next closest alternative from both a capital cost and an O&M cost standpoint. Similarly, Alternative 3 is the lowest cost option on the basis of net present worth. The net present worth of the new Eastside Pump Station alternative ($155 million) is approximately $48 million less expensive than the next closest alternative over the 20-year life cycle.

It is recommended that the City implement the following initial facilities for the North site. An approximate opinion of probable project cost for the initial phase is given in Table 5.

- North site land acquisition
- Eastside Pump Station (with pumps to flow equalization initially phased to match flow equalization size)
- Flow equalization basin (initially phased at 3 MG, no cover or odor control)
- 24 inch force main from Eastside Pump Station to existing Faraon Street force main (existing Faraon Street force main should be inspected once flow equalization basin is installed to determine condition of line)
- Interceptor and trunk sewers from Faraon Street and Easton Road Pump Stations to Eastside Pump Station
- Decommissioning of Faraon Street and Easton Road Pump Stations

**Table 5**
**Initial Phase of Eastside Pump Station**
**Summary of Opinion of Probable Project Costs [1]**

| Item | $ |
|---|---|
| Eastside Interceptor Sewer | 24,576,000 |
| Trunk Sewer from Existing Faraon Street Pump Station to Eastside Interceptor | 1,160,000 |
| Trunk Sewer from Easton Road Pump Station to Eastside Interceptor | 8,979,000 |
| Flow Equalization Basin (3 MG) | 3,750,000 |
| Eastside and Flow Equalization Basin Pump Station | 8,667,000 |
| Force Main from Eastside Pump Station to Existing Faraon Street Pump Station | 4,524,000 |
| Demolish Existing Pump Stations | 175,000 |

**Table 5**
**Initial Phase of Eastside Pump Station**
**Summary of Opinion of Probable Project Costs [1]**

| Item | $ |
|---|---|
| Flood Protection/Fill (placeholder) [2] | 296,000 |
| Site Remediation (placeholder) [2] | 0 |
| *Subtotal* | *52,127,000* |
| Electrical, I&C, Sitework, Utilities, and Contractor General Requirements [3] | 13,064,000 |
| *Subtotal* | *65,191,000* |
| Contingency [4] | 16,298,000 |
| Land Acquisition (placeholder) [2] | 4,000,000 |
| **Opinion of Probable Construction Cost** | **85,489,000** |
| Engineering, Legal, and Administration [5] | 17,098,000 |
| **Opinion of Total Project Cost** | **102,587,000** |

1. All costs presented in May 2009 dollars.
2. Site related costs are placeholders and must be revised following final siting study of the selected area. Land acquisition costs based on $12,500/acre as projected by City staff.
3. Electrical and instrumentation and controls (I&C) projected at 25% of the total of all equipment and structure costs. Sitework projected at 10% of the total of equipment, structures, electrical, and I&C costs. Utility projections based on Black & Veatch experience and distance to closest power connection as provided by KCP&L. Contractor general requirements projected at 12% of the total of equipment, structures, electrical, I&C, sitework, and utility costs. Sitework and electrical and I &C percentages only applied to WPF facilities, pump stations, and flow equalization basins; these multipliers were not applied to the conveyance improvements.
4. Project contingency is projected at 25% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, and site remediation costs.
5. Engineering, legal, and administration (ELA) costs are projected at 20% of the total of all equipment, structures, electrical, I&C, sitework, utilities, contractor general requirements, flood protection/fill, site remediation costs, contingency, and land acquisition.

Odor control issues at the current Faraon Street Pump Station are of significant concern to the City. Costs for the proposed Eastside Pump Station include the construction of a chemical calcium nitrate (BIOXIDE®) feed system for odor control. Prior to the design of the Eastside Pump Station, a pilot study of the BIOXIDE® feed system at the Faraon Street Pump Station is recommended to ensure odor control issues at the existing pump station are addressed in the design for the new station.

It is likely that construction of a new Eastside WPF may be warranted after 2030. The City should monitor residential, commercial, and industrial development throughout the City and determine when additional treatment capacity expansion is required. When additional treatment capacity is needed, the north site could be expanded to include a new

Eastside WPF. When a new WPF is implemented on the North site, the Eastside Pump Station can be reconfigured to serve as the influent pump station for the new WPF.

## 4.0 TM-WW-3: Screening and Grit Removal Facilities

The purpose of this assessment is to evaluate alternative screening and grit removal technologies and alternatives for both the WPF and the future high rate treatment (HRT) facility. In addition, grit removal was evaluated for flow from the Missouri Avenue Diversion Structure since WPF staff have expressed concerns about grit accumulation in the pipeline from the diversion structure to the In-plant Influent Pump Station.

The following groupings of alternatives were considered for the WPF and HRT flows:

- Alternative 1 – Provide a combined screening and grit removal facility for flows to both the WPF and HRT. Combined facilities offer the advantage of lower costs and single point handling of screenings and grit.
- Alternative 2 – Provide separate screening and grit removal facilities for the WPF and HRT. Separate facilities offer the advantage of being able to utilize existing WPF facilities or WPF property.
- Alternative 3 – Provide a combined screening facility for both the WPF and HRT, but separate grit removal facilities for each. This alternative offers the advantage of combining screening facilities while still utilizing some existing WPF facilities and property for grit removal.

The following alternatives were considered for the Missouri Avenue Diversion Structure flow:

- Alternative A – Provide pipeline improvements to address grit accumulation.
- Alternative B – Provide a dedicated grit facility for flows from the Missouri Avenue Diversion Structure.
- Alternative C – Provide a dedicated horizontal grit chamber for flows from the Missouri Avenue Diversion Structure.

- Alternative D – Provide for periodic cleaning of the pipeline to prevent grit build-up.

***WPF and HRT Flow***

Alternatives 1, 2, and 3 represent three configurations for screenings and grit removal covering a range from a combined facility to handle both WPF and HRT flow to completely separate facilities dedicated to the WPF and HRT to a combination of the two. Sub-alternatives as described below were developed for each configuration using grit removal technologies deemed by City staff as appropriate for further consideration. These technologies included the existing aerated grit basins, vortex type grit removal equipment such as Smith & Loveless PISTA, and grit removal equipment manufactured by Hydro International including the Eutek Headcell, Storm King, and Grit King. Figure 7 presents an overview of the existing WPF and indicates possible locations for the facilities. Final locations will be determined when a siting study is conducted and detailed design performed.

- Alternative 1A – Upgrade existing aerated grit basins to process all flow (88 mgd) and screening facility near the existing grit basins.
- Alternative 1B – Screening and grit removal facility in location of existing aerated grit basins to process all flow (88 mgd).
- Alternative 1C-1 – Screening and vortex grit removal facility at north property to process all flow (88 mgd).
- Alternative 1C-2 – Screening and Eutek Headcell grit removal facility at north property to process all flow (88 mgd).
- Alternative 2A – Upgrade existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) near the existing grit basins, and screening and grit removal facility to process HRT flow (61 mgd) in alternate location.
- Alternative 2B – Upgrade existing aerated grit basins to process HRT flow (61 mgd), screening facility to process HRT flow (61 mgd) near the

existing grit basins, and screening and grit removal facility to process WPF flow (34 mgd) in alternate location.

- Alternative 2C – Eutek Headcell grit removal facility retro-fitted in existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) at north property, screening and Storm King/Grit King grit removal facility to process HRT flow (61 mgd) at west property.
- Alternative 3A-1 – Screening to process all flow (88 mgd) at north property, vortex grit removal to process HRT flow (61 mgd) at north property, and vortex grit removal to process WPF flow (34 mgd) near existing grit basins.
- Alternative 3A-2 – Screening to process all flow (88 mgd) at north property, Storm King/Grit King grit removal to process HRT flow (61 mgd) at north property, and Eutek Headcell grit removal to process WPF flow (34 mgd) in existing grit basins.

Table 6 provides a summary of the sub-alternatives and the initial evaluation. After initial screening, the following five sub-alternatives were selected for further evaluation based on costs, present worth, and non-economic factors:

- Alternative 1C-1
- Alternative 1C-2
- Alternative 2C
- Alternative 3A-1
- Alternative 3A-2

Each of the five alternatives listed above was evaluated using the criteria of project capital investment, O&M costs, net present worth, and non-economic factors. Table 7 presents the results of the project capital, O&M, and net present worth analysis for each of the alternatives.

**Table 6**
**Screening and Grit Removal Alternatives**

| Alternative | Screens | Grit System | Location | Description | Potential Benefit | Preliminary Screening Action |
|---|---|---|---|---|---|---|
| 1A | Front Cleaned Bar Rack 1/2" opening | Aerated Grit System | Existing WPF grit basins | Upgrade existing aerated grit basins to process all flow (88 mgd), screening facility near the existing grit basins. | Maximize use of existing facilities. Locates operation in single spot nearest existing connection point. | Eliminated from further consideration due to poor performance of current aerated grit system and poor configuration of existing basins hindering performance at higher capacity. |
| 1B | Front Cleaned Bar Rack 1/2" opening | Vortex or Headcell | Existing WPF grit basin area | Screening and grit removal facility in location of existing aerated grit basins to process all flow (88 mgd). | New and better grit technology than existing aerated grit. Single spot location at nearest existing connection point to WPF. | Eliminated from further consideration. Initial facility layouts indicate 88 mgd cannot fit in this location. |
| 1C-1 | Front Cleaned Bar Rack 1/2" opening | Vortex | Alternate location | Screening and vortex grit removal facility at north property to process all flow (88 mgd). | New and better grit technology than existing aerated grit. Single spot location better for operation. Though somewhat limited, alternate sites provide more space for facilities. | Alternative was selected for further consideration. Location north of Administration Building selected. |
| 1C-2 | Front Cleaned Bar Rack 1/2" opening | Headcell | Alternate location | Screening and Eutek Headcell grit removal facility at north property to process all flow (88 mgd). | New and better grit technology than existing aerated grit. Single spot location better for operation. Though somewhat limited, alternate sites provide more space for facilities. | Alternative was selected for further consideration. Note that Storm King / Grit King not applicable for a combined facility approach. Location north of Administration Building selected. |
| 2A | Front Cleaned Bar Rack 1/2" opening | Aerated Grit System and Vortex or Storm King / Grit King | Existing WPF grit basins and alternate location for new facilities | Upgrade existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) near the existing grit basins, and screening and grit removal facility to process HRT flow (61 mgd) in alternate location. | Maximizes use of existing facilities. Locates grit and screen facility near each subsequent process (WPF or HRT). | Eliminated from further consideration due to poor performance of current aerated grit system and poor configuration of existing basins hindering performance at higher capacity. |
| 2B | Front Cleaned Bar Rack 1/2" opening | Aerated Grit System and Vortex or Headcell | Existing WPF grit basins and alternate location for new facilities | Upgrade existing aerated grit basins to process HRT flow (61 mgd), screening facility to process HRT flow (61 mgd) near the existing grit basins, and screening and grit removal facility to process WPF flow (34 mgd) in alternate location. | Maximizes use of existing facilities. | Eliminated from further consideration due to poor performance of current aerated grit system and poor configuration of existing basins hindering performance at higher capacity. |
| 2C | Front Cleaned Bar Rack 1/2" opening | Headcell and Storm King / Grit King | Existing WPF grit basins and alternate locations for new facilities | Eutek Headcell grit removal facility retro-fitted in existing aerated grit basins to process WPF flow (34 mgd), screening facility to process WPF flow (34 mgd) at north property, screening and Storm King / Grit King grit removal facility to process HRT flow (61 mgd) at west property. | Re-uses existing aeration basin structure. | Alternative was selected for further consideration. WPF screening facility located north of Administration Building and HRT screening and grit facility located west of WPF. |
| 3A-1 | Front Cleaned Bar Rack 1/2" opening | Vortex | Existing WPF grit basin area and alternate location for other new facilities | Screening to process all flow (88 mgd) at north property, vortex grit removal to process HRT flow (61 mgd) at north property, and vortex grit removal to process WPF flow (34 mgd) near existing grit basins. | Single spot location for screening. Utilizes existing WPF property at existing grit basins. | Alternative was selected for further consideration. Location north of Administration Building selected. |
| 3A-2 | Front Cleaned Bar Rack 1/2" opening | Headcell and Storm King / Grit King | Existing WPF grit basins and alternate location for other new facilities | Screening to process all flow (88 mgd) at north property, Storm King / Grit King grit removal to process HRT flow (61 mgd) at north property, and Eutek Headcell grit removal to process WPF flow (34 mgd) in existing grit basins. | Single spot location for screening. Utilizes existing grit basins for WPF grit removal equipment. | Alternative was selected for further consideration. Location north of Administration Building selected. |

**Table 7**
**Net Present Worth by Screening and Grit Removal Alternative [1]**

| | Alternative 1C-1 (Vortex Grit Removal), $ | Alternative 1C-2 (Hydro International Grit Removal), $ | Alternative 2C (Hydro International Grit Removal), $ | Alternative 3A-1 (Vortex Grit Removal), $ | Alternative 3A-2 (Hydro International Grit Removal), $ |
|---|---|---|---|---|---|
| Net Project Capital Present Worth [2] | 19,566,000 | 20,509,000 | 31,481,000 | 22,221,000 | 25,859,000 |
| O&M Present Worth [3] | 5,736,000 | 5,826,000 | 9,978,000 | 8,063,000 | 7,879,000 |
| **Total Net Present Worth** | **25,302,000** | **26,335,000** | **41,459,000** | **30,284,000** | **33,738,000** |

1. Costs are in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest.
2. Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years.
3. O&M costs were assumed to escalate at 5% per year.

From a project capital cost standpoint, both Alternatives 1C-1 (based on Smith & Loveless PISTA vortex equipment) and 1C-2 (Eutek Headcell) were found to be approximately equivalent. The O&M evaluation demonstrated that the two alternatives were also essentially the same. Likewise, the net present worth analysis showed that the two alternatives were the least expensive options on the basis of net present worth. The net present worth of Alternative 1C-2 ($26 million for the Eutek Headcell alternative) was about $4 million less expensive over the 20-year life cycle than the next closest alternative. On the basis of non-economic criteria, all alternatives were similar; however, the Eutek Headcell equipment is proprietary and would require sole source negotiations with the manufacturer.

Due to the proprietary issues with the Eutek Headcell equipment, it is recommended that the City initiate the design for the 88 mgd combined screening and grit removal facility to treat WPF and HRT flows based on a vortex type system such as Smith & Loveless PISTA. Figure 8 shows a general layout of the recommended Alternative 1C-1. Figures 9 and 10 show a conceptual plan and section of the proposed screening and vortex grit removal facility. Locations of facilities shown are preliminary. Locations may be changed when a siting study is conducted and during detailed design.

Construction of facilities and equipment should be phased in order to provide initial capacity for the WPF and then expanded in the future when the HRT is constructed. Based on conceptual layouts and equipment selection, phasing would initially include three screen channels and two screens and two grit removal basins. Exact numbers and sizes of equipment may change during detailed design.

***Missouri Avenue Diversion Structure Flow***

Operations personnel have noticed significant grit accumulation in the pipeline from the diversion structure to the In-plant Influent Pump Station. In addition, pump wear at the In-plant Influent Pump Station suggests possible grit impacts. The following alternatives to address the grit issue were evaluated.

Alternative A included a hydraulic evaluation of the pipeline which indicated that the pipeline has some sections with very shallow slopes resulting in low velocities during low flows. Given the low velocities, it is understandable that there would be grit settlement issues in the pipeline. If the pipeline were reconstructed to eliminate the shallow slope segments, the resulting slope would still be insufficient to prevent the accumulation of grit in the pipeline. The cost of reconstructing the line would be high due to the depth of the line and the amount of existing piping that is in the same general path of or crosses the current pipeline. Figure 11 shows the south end of the plant where the pipeline forms a "Z" shaped bend to connect to the Transfer Pump Station. This reversal in pipeline direction is a potential area where grit would accumulate. The reversal could be eliminated as indicated in Figure 11; however, eliminating the reversal would not solve the issues with the downstream shallow slopes.

Alternative B would include constructing dedicated screening and grit facilities for flows from the Missouri Avenue Diversion Structure. The depth of the pipeline from the diversion structure (approximately 16 feet) and the fact that there would be additional headloss through the grit system would require that a pump station be constructed to lift the flow to near grade level. The cost of this pump station along with the cost of the screening and grit facilities would be several million dollars.

Alternative C would include constructing two (one standby) dedicated horizontal grit chambers. The grit chambers would have to be located at the elevation of the pipeline (approximately 16 feet below grade). Grit chambers 2.5 feet wide and 90 feet long would be required in order to settle grit similar in size to the proposed WPF and HRT grit facilities. The grit chambers would need to be enclosed in a building and provided with odor control in order to prevent offsite odors. The cost of this grit chamber, building, and odor control would be several million dollars.

Alternative D provides for the periodic cleaning of the pipeline from the Missouri Avenue Diversion Structure. Preliminary quotes indicate that the cost of an initial cleaning for the line would be approximately $16,400 not including disposal. The cost of disposal of the grit is approximately $10,000. Subsequent cleaning of the line every one to two years would cost approximately $8,000.

Periodic cleaning of the Missouri Avenue pipeline on a biannual basis is recommended given the high cost of constructing the other alternatives.

## 5.0 TM-WW-4: Nutrient Removal Facilities

The MDNR established an ammonia limitation for the first time for the WPF in its National Pollutant Discharge Elimination System (NPDES) permit dated June 19, 2009. It is anticipated that future permits may impose more stringent ammonia limits and will, eventually, include total nitrogen and phosphorous limitations as well. Based on discussions with MDNR, it is anticipated that implementation of nutrient limits at the WPF may occur according to the approximate schedule shown in Table 8. This technical memorandum describes the evaluation of nutrient removal improvement alternatives and costs to meet the anticipated phasing of regulatory requirements.

**Table 8**
**Anticipated Phasing of Nutrient Removal Permit Limits [1]**

| Phase | Approximate Permit Cycle Timing | Limitation Added |
|---|---|---|
| I | 2010 | Ammonia Removal [2] |
| II | 2019 | Total Phosphorous Removal |
| III | 2029 | Total Nitrogen Removal |

1. Anticipated timing has been established for the purposes of phasing alternatives. Actual timing has not been determined by MDNR.
2. The current (June 19, 2009) WPF permit includes an effluent ammonia limit, which could become more stringent depending on the findings of the mixing zone study required by MDNR. The ammonia limits used for Phase I are more stringent than the current permit limits to account for the possibility that the mixing zone study could require more stringent limits.

Influent loading characteristics to the WPF were developed to determine nutrient removal configurations. The WPF receives significant influent nitrogen loadings, primarily from its wholesale industrial customers, including South St. Joseph Industrial Sewer District (SSJISD), National Beef Leathers (NBL), and Triumph Foods (TF). The significant nitrogen loading received by the WPF drives the need for complex nutrient removal facilities and considerable quantities of external carbon in order to meet anticipated regulatory limits in the future. The City is currently working with the wholesale customers as well as other industrial users to try to reduce nutrient loadings to the WPF, which could significantly reduce the complexity and cost of treatment facilities required to meet future regulations. For the purposes of this evaluation, alternatives for the nutrient removal improvements presented in this technical memorandum are based on the projected influent loads identified in this study, assuming no future reductions from the wholesale customers and industrial users.

For ammonia removal (Phase I requirement), only one evaluated alternative was deemed operationally stable and economically viable (Figure 12). In this alternative, industrial flow from the three wholesale customers receives additional treatment prior to being combined with the domestic flows in order to meet anticipated effluent ammonia limitations. The opinion of probable project cost for ammonia removal is $24.7 million. Similarly for total phosphorous removal (Phase II requirement), only chemical phosphorus removal was evaluated due to requirements for additional external carbon; purchase of external carbon is costly. The opinion of probable project cost for phosphorous removal is $3.3 million. In order to meet the Phase III total nitrogen requirements, both combined and separate treatment trains for the domestic and industrial flows were considered. The following nitrification/denitrification alternatives were evaluated:

- Alternative 1A – Activated sludge treatment for domestic flows, activated sludge treatment for wholesale industrial flows.
- Alternative 1B – Integrated fixed-film activated sludge (IFAS) treatment for domestic flows, activated sludge treatment for wholesale industrial flows.
- Alternative 1C – IFAS treatment for domestic flows, membrane bioreactor (MBR) treatment for wholesale industrial flows.
- Alternative 2A – Activated sludge treatment for combined flows.
- Alternative 2B – IFAS treatment for combined flows.

The analysis showed the separate treatment alternatives to be lower in cost when compared to the combined flow treatment alternatives. Alternative 2A was screened from consideration before cost development as it was space prohibitive. Based on the economic and non-economic evaluation, Alternative 1B – IFAS for Domestic Flows, Activated Sludge for Wholesale Industrial Flows is the recommended alternative (Figure 13). As shown in Table 9, the opinion of probable project cost for Alternative 1B is 15 percent less than the next lowest cost alternative. On both an O&M and net present worth basis, Alternative 1B is within 10 percent of Alternative 1A and is, therefore, considered equivalent for these economic criteria at this level of study. Table 10 provides a summary of the net present worth costs for each alternative. On a non-economic basis, Alternative 1B offers the best balance between reduced basin volume and ease of operability of the system of all the separate industrial and domestic treatment alternatives considered. With the existing influent loading characteristics, it is recommended that Alternative 1B be implemented to meet Phase III total nitrogen removal requirements.

**Table 9**
**Summary of Opinion of Probable Project Costs for Nitrification, Denitrification, and Total Phosphorous Removal [1]**

| Alternative 1A Domestic Activated Sludge, Industrial Activated Sludge, $ | Alternative 1B Domestic IFAS, Industrial Activated Sludge, $ | Alternative 1C Domestic IFAS, Industrial MBR, $ | Alternative 2B Combined IFAS, $ |
|---|---|---|---|
| 66,715,000 | 58,264,000 | 75,112,000 | 102,012,000 |

1. All costs presented in May 2009 dollars.

**Table 10**
**Net Present Worth for Nitrification, Denitrification, and Total Phosphorous Removal [1]**

| | Alternative 1A Domestic Activated Sludge, Industrial Activated Sludge, $ | Alternative 1B Domestic IFAS, Industrial Activated Sludge, $ | Alternative 1C Domestic IFAS, Industrial MBR, $ | Alternative 2B Combined IFAS, $ |
|---|---|---|---|---|
| Net Project Capital Present Worth [2] | 50,982,000 | 45,734,000 | 65,855,000 | 74,257,000 |
| O&M Present Worth [3] | 90,180,000 | 92,880,000 | 105,760,000 | 101,020,000 |
| Total Net Present Worth | 141,162,000 | 138,614,000 | 171,615,000 | 175,277,000 |

1. Costs given in May 2009 dollars. Present worth calculated with 20-year life cycle costs at 5% interest.
2. Net project capital present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year life cycle. Service life for determination of replacement frequency and salvage value was projected as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years.
3. O&M costs were assumed to escalate at 5% per year.

It is recommended that the City implement the nutrient removal program in the following phases. The actual date for implementation will be determined in the future by MDNR.

- Phase I (Year 2010) – Ammonia Removal (Nitrification)

- Wholesale industrial activated sludge basin modifications (reuse four existing aerobic digester basins (add diffusers) and raise basin walls a total of 4 feet – 2 feet for Phase I, 2 feet for Phase III).
- New wholesale industrial final clarifier and associated returned activated sludge (RAS)/waste activated sludge (WAS) pump station (increase clarifier size from 120 foot to 130 foot diameter to meet future Phase III needs).
- Existing aeration basin modifications (add diffusers).
- New centrifugal blowers within existing Blower Building.

- Phase II (Year 2019) – Total Phosphorous Removal
  - New chemical feed and storage system and building.

- Phase III (Year 2029) – Total Nitrogen Removal (Nitrification/ Denitrification)
  - New IFAS fine screen building.
  - Domestic oxic basins with IFAS media (reuse existing aeration basin volume).
  - Domestic anoxic basins (reuse existing aeration basin volume).
  - Wholesale industrial anoxic, oxic, post-anoxic, and reaeration volume (reuse six existing aerobic digester basins).
  - New methanol chemical feed and storage system and building (contiguous to chemical feed facilities for phosphorous removal).

Table 11 summarizes the opinion of probable project cost for the phased implementation of the recommended facilities.

**Table 11**
**Opinion of Probable Project Cost for Phased Implementation of Recommended Nutrient Removal Facilities [1]**

| Phase | Project Cost [2, 3], $ |
|---|---|
| I – Ammonia Removal | 24,740,000 |
| II – Total Phosphorous Removal | 3,314,000 |
| III – Total Nitrogen Removal | 30,498,000 |
| Total [4] | 58,552,000 |

1. Costs given in May 2009 dollars.
2. Project cost includes allowances for electrical, instrumentation and controls, sitework, general requirements, contingency, and engineering, legal, and administration.
3. Project costs do not include costs for standby power facilities. These costs are presented in TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.
4. Total cost includes Phase I piping not reused in Phase III.

An aeration system evaluation was completed to determine the anticipated aeration blower needs of future facilities to be installed at the WPF. This study also evaluated the use of centrifugal blowers to replace the existing positive displacement (PD) blowers when the existing PD blowers reach the end of their useful life or can no longer provide the needed airflow due to future aeration requirements.

A comparative life cycle cost analysis determined single-stage centrifugal blowers were the lowest life cycle cost option to meet future aeration needs at the WPF; however, the life cycle cost of multi-stage blowers with adjustable-frequency drives (AFDs) was within 10 percent of the lowest cost option. At this level of study, the two options are considered equivalent from a life cycle cost perspective. City staff has concerns with maintenance issues associated with AFDs. Therefore, the recommended replacement alternative for the existing PD blowers is five single-stage centrifugal blowers. During detailed design of the blower replacement project, evaluation of the use of multi-stage blowers with eddy current drives should be considered as an alternative to the single-stage blowers.

The existing PD blowers are unable to meet the anticipated aeration demands of the future nitrification or nitrification/denitrification (Phase I or Phase III) facilities as presented in this technical memorandum; however, City staff efforts to reduce the influent nitrogen loading from the wholesale customers and industrial users to the WPF could result in reduced air requirements. Prior to the construction of future Phase I or III facilities, air flow requirements should be revisited in light of any new WPF influent loading data. It is recommended that the existing PD blowers continue to be used to provide aeration until they reach the end of their service life or they are no longer able to meet the aeration needs of future facilities.

## 6.0 TM-WW-5: Disinfection Facilities

The MDNR NPDES permit for the WPF requires disinfection of effluent flow by December 31, 2013. Permit requirements mandate disinfection of treated effluent occurs from April 1 through October 31 each year. In addition to flows from the WPF, disinfection will be required for treatment of effluent from the future HRT facility to be constructed as part of Phase IA of the Combined Sewer Overflow (CSO) Control Facilities Assessment. This technical memorandum documents the results of disinfection technology screening to narrow the technologies and configurations for further evaluation as well as an economic assessment of the selected alternatives. The following alternatives were considered for disinfection of flows from the WPF and from the future HRT:

- Alternative 1 – Combined ultraviolet (UV) disinfection of WPF and HRT flows (108 mgd)
- Alternative 2 – Combined bulk sodium hypochlorite and sodium bisulfite disinfection of WPF and HRT flows (108 mgd)
- Alternative 3 – Combined on-site generation of sodium hypochlorite and bulk sodium bisulfite for disinfection of WPF and HRT flows (108 mgd)
- Alternative 4 – UV disinfection of WPF flows (54 mgd), bulk sodium hypochlorite and sodium bisulfite disinfection of wet weather flows from HRT (61 mgd)
- Alternative 5 – UV disinfection of WPF flows (54 mgd), on-site generation of sodium hypochlorite and bulk sodium bisulfite for disinfection of wet weather flows from HRT (61 mgd)

Based on an evaluation of each of the alternatives on the criteria of project capital investment, O&M costs, net present worth, and non-economic factors, Alternative 1 –

Combined UV disinfection of WPF and HRT flows is recommended for implementation. Table 12 presents the results of the project capital, O&M, and net present worth analysis for each of the alternatives.

**Table 12**
**Net Present Worth Costs by Disinfection Alternative [1]**

| | Alternative 1 108 mgd UV $ | Alternative 2 108 mgd Bulk Hypochlorite $ | Alternative 3 108 mgd On-site Generation $ | Alternative 4 54 mgd UV + 61 mgd Bulk Hypochlorite $ | Alternative 5 54 mgd UV + 61 mgd On-site Generation $ |
|---|---|---|---|---|---|
| Net Project Capital Present Worth [2] | 16,933,000 | 17,942,000 | 26,295,000 | 22,461,000 | 28,701,000 |
| O&M Present Worth [3] | 8,340,000 | 90,400,000 | 13,480,000 | 46,110,000 | 10,700,000 |
| **Total Net Present Worth** | **25,273,000** | **108,342,000** | **39,775,000** | **68,571,000** | **39,401,000** |

1. Costs given in May 2009 dollars. Present worth calculated on a 20-year project life at 5% interest.
2. Net present worth represents the present worth of project costs less the remaining value of facilities at the end of the 20-year project life. A 7% per year escalation rate was applied to capital costs. Service life for determination of replacement frequency and salvage value was estimated as follows: structures – 50 years; equipment, electrical, instrumentation and controls – 20 years.
3. O&M costs were assumed to escalate at 5% per year.

From a project capital cost standpoint, Alternative 1 was found to be approximately equivalent to the next lowest project capital cost alternative (Alternative 2 – 108 mgd bulk sodium hypochlorite). The O&M evaluation demonstrated that the combined UV alternative is the lowest cost alternative on the basis of annual O&M costs. Likewise, the net present worth analysis showed that Alternative 1 is the lowest cost option on the basis of net present worth. The net present worth of the 108 mgd UV alternative ($25 million) is about $14 million less expensive over the 20-year life cycle than the next closest alternative.

On the basis of non-economic criteria, UV disinfection is the highest ranking technology. UV disinfection does not require significant use of hazardous chemicals, is independent of the chemicals market, will not form disinfection byproducts, and is fairly straightforward to operate and maintain after initial training.

It is recommended that the City initiate the design for the 108 mgd combined UV disinfection facility to treat WPF and HRT flows. Figure 14 shows a conceptual layout of the proposed UV disinfection facility. The design should consider phasing of the UV equipment to treat HRT flows, based on the anticipated timing of the HRT construction.

## 7.0 TM-WW-6: Biosolids Facilities Evaluation

As part of the overall Facilities Plan, the current capacity of the existing WPF was analyzed. This technical memorandum discusses the capacity of the solids treatment facilities, including the following processes:

- Dissolved Air Flotation (DAF) Thickening
- Anaerobic Digestion (Thermophilic/Mesophilic System)
- Belt Filter Press (BFP) Dewatering

Future design conditions, as presented in TM-WW-4 – Nutrient Removal Facilities, were used to determine the capacity of the existing solids treatment equipment based on the original design parameters for each treatment process. Design flows from TM-WW-4 were used to calculate the solids quantities presented in Table 13. As shown in the table, two scenarios were evaluated. “Combined Influent Wastewater” would treat both municipal and wholesale industrial wastewater in the same liquid treatment process while “Separate Activated Sludge Systems” would provide separate liquid stream treatment for the municipal and wholesale industrial wastewater customers. Regardless of scenario, all solids generated through liquid stream treatment would be processed through the existing solids treatment equipment.

Table 13 includes both the projected solids production with and without chemical phosphorus removal. As the impact of chemical phosphorus removal results in a minimal increase in total dry solids, the production numbers without chemical phosphorus removal were used in this evaluation. Reduction in nutrient loading to the WPF might also allow biological phosphorus removal to be considered in lieu of chemical phosphorus removal.

**Table 13**
**Projected Solids Production**

| | Units | Combined Influent Wastewater | | Separate Activated Sludge Systems | |
|---|---|---|---|---|---|
| | | Maximum Month | Annual Average | Maximum Month | Annual Average |
| Plant Influent Flow | mgd | 34.2 | 20.4 | 34.2 | 20.4 |
| Primary Sludge | | | | | |
| Flow | mgd | 0.14 | 0.08 | 0.14 | 0.08 |
| Total Solids | % | 2.70 | 2.70 | 2.70 | 2.70 |
| Volatile Solids | % | 60.0 | 71.0 | 60.0 | 71.0 |
| Dry Solids | ppd | 30,410 | 18,760 | 30,520 | 18,980 |
| WAS (without chemical phosphorus removal) | | | | | |
| Flow | mgd | 0.42 | 0.43 | 0.38 | 0.37 |
| Total Solids | % | 0.82 | 0.39 | 0.92 | 0.44 |
| Volatile Solids | % | 82.0 | 82.0 | 78.0 | 78.0 |
| Dry Solids | ppd | 28,840 | 13,980 | 29,040 | 13,560 |
| Total Dry Solids (without chemical phosphorus removal) | ppd | 59,250 | 32,740 | 59,560 | 32,540 |
| WAS (with chemical phosphorus removal) | | | | | |
| Flow | mgd | 0.48 | 0.51 | 0.42 | 0.43 |
| Total Solids | % | 0.82 | 0.39 | 0.92 | 0.44 |
| Volatile Solids | % | 68.0 | 68.0 | 68.0 | 68.0 |
| Dry Solids | ppd | 33,100 | 16,450 | 32,060 | 15,830 |
| Total Dry Solids (with chemical phosphorus removal) | ppd | 63,510 | 35,210 | 62,580 | 34,810 |

Existing equipment capacities as presented in the 2003 Design Memorandum for the Wastewater Treatment Plant Improvements project (Camp Dresser & McKee, Inc. (CDM), Delich Roth & Goodwillie, P.A. (DRG), and Snyder & Associates) are shown in Table 14. Since construction of these improvements, the thermophilic digestion process has been modified to use two thermophilic digesters in series with Digester No. 3, originally a mesophilic digester, converted to a thermophilic digester. This operational change is reflected in Table 14.

**Table 14**
**Existing Equipment Capacities**

| Treatment Process | Value |
|---|---|
| Dissolved Air Flotation[1] | |
| Number of units | 2 |
| Design solids loading rate (each), ppd | 80,640 |
| Surface area (each), sf | 1,680 |
| Design solids loading rate, pph/sf | 2 |
| Hydraulic capacity (total), mgd | 5.7 |
| Feed solids concentration, % | 0.5 |
| Blend/Surge Tank | |
| Number of units | 1 |
| Volume (total), cf | 5,380 |
| Thermophilic Digesters | |
| Number of units (operated in series) | 2 |
| Active volume thermophilic digester (excluding cone), cf | 258,000 |
| Active volume Digester No. 3 (excluding cone), cf [2] | 155,000 |
| Design flow, mgd | 0.191 |
| Design volatile solids load, ppd | 40,590 |
| Design solids retention time thermophilic digester, days | 10 [3] |
| Design solids retention time Digester No. 3, days | 6 [3] |
| Mesophilic Primary Digesters | |
| Number of units | 2 [4] |
| Active volume per tank (excluding cone), cf | 155,000 |
| Design solids retention time per tank, days | 6 [2] |
| Two-tank design solids retention time, days | 12 [3] |
| Integrated Digestion System (thermo + meso) | |
| Design volatile solids destruction, % | 55 – 65 |
| Secondary Digester | |
| Number of units | 1 |
| Active volume per tank (excluding cone), cf | 155,000 |
| Belt Filter Press | |
| Design solids loading rate, pph/meter | 1,100 |
| Design cake solids, % total solids | 25 |
| Operating schedule | |
| Days per week | 3 to 4 |
| Hours per day | 6 |

1. Original DAF equipment has been replaced with EDUR pumped mix units.
2. Original design considered one thermophilic digester, three mesophilic digesters, and one spare/holding digester. Current operation is with two thermophilic digesters and one mesophilic digester.
3. Not identified in design documents. Value calculated by Black &Veatch.
4. Three mesophilic digesters are available; only one is currently in operation. One of the two units currently out of service is considered to be a secondary digester.

The capacity of the existing equipment plus the planned future additional BFP (budgeted for fiscal year 2013) was compared to the projected solids quantities at future conditions. The DAF thickening, thermophilic digestion, and BFP dewatering processes appear to have adequate capacity for the projected solids production, allowing for one spare DAF at annual average and maximum month conditions and one spare BFP at annual average conditions (three BFPs would be required at maximum month conditions). Based on two mesophilic tanks in service, the existing system cannot meet the original 18 day mesophilic solids retention time (SRT) as indicated in the 2003 CDM Design Memorandum at future conditions. However, with the current digester operating configuration, the actual mesophilic detention requirement may be less than the original 18 days. Total digestion SRT (thermophilic and mesophilic) is 24 days.

Several factors that impact the capacity of the digestion process include the primary and waste activated solids concentration and primary and secondary volatile solids. Part of the CSO control program will result in stormwater separation of two of the main wastewater collection system interceptors that contribute flow and inert material to the WPF. This separation will result in a change to volatile content of the primary solids. The exact impact of these changes cannot be fully determined at this time. This evaluation has been conducted using the lowest average historical primary solids concentration. Additional sampling will need to be completed as improvements are made to the wastewater collection system to confirm the primary volatile solids concentration. In addition, the City is working with both wholesale and other industrial users to reduce the flows and loads discharged to the WPF. Additional testing will need to be completed over time to verify the volatile content of the waste activated sludge as well.

A graphical comparison of process capacity and projected solids loadings (in terms of plant influent flow) is shown in Figure 15. As recommended in TM-WW-4 – Nutrient Removal Facilities, the City should continue to work with the wholesale industrial users to reduce loadings as well as conduct additional monitoring to verify future ammonia and nitrogen loadings as improvements are made at the WPF.

The capacity of the mesophilic digestion process is based on three tanks in service and the capacity of the belt filter press dewatering is based on three presses operating 5 days per week, 8 hours per day. Capacities for polymer equipment, pumps, equalization volumes, gas conveyance, heating and heat exchangers, and other ancillary equipment were assumed to match the capacities of the major process equipment and were not analyzed separately.

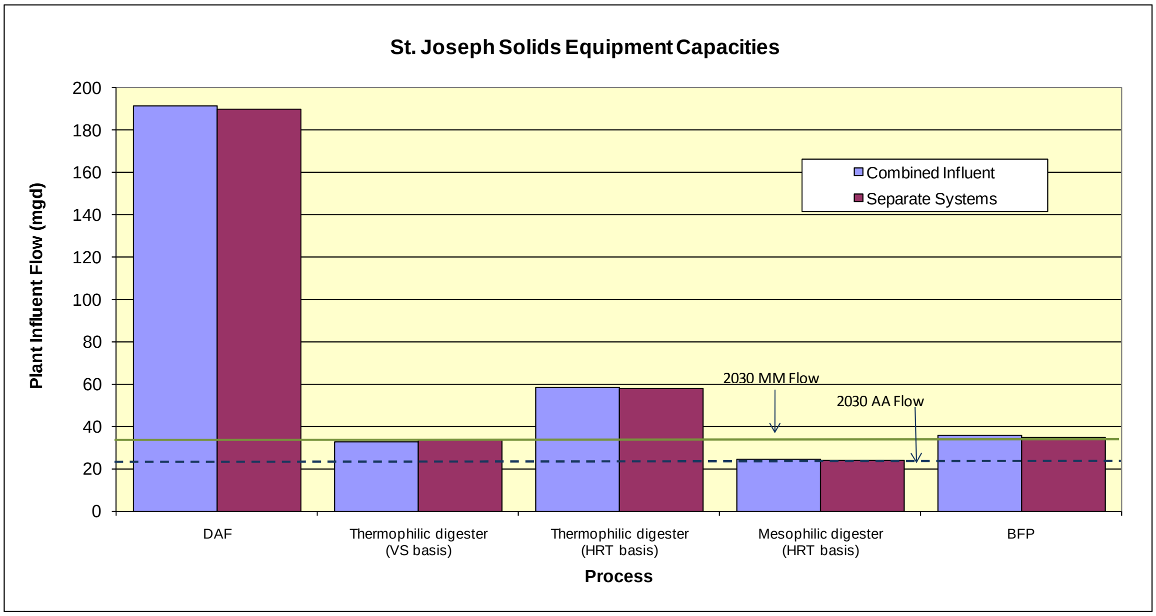


**Figure 15 – Existing Solids Process Capacity as Function of Plant Influent Flow**

## 8.0 TM-WW-7: Hydraulic Analysis and Effluent Pump Station

The purpose of this assessment is to perform hydraulic analyses for the proposed improvements at the WPF. The facilities evaluated include the following:

- Disinfection Facilities and Effluent Pump Station
- HRT Facility
- Phase I – Ammonia Removal Facilities
- Phase III – Total Nitrogen Removal Facilities

Phase II of the nutrient removal plan was not included in the evaluation as the addition of chemical for phosphorous removal does not have any significant impact on hydraulics.

For there to be sufficient hydraulic head for the proposed facilities and the required future flows, the following modifications must be made. The hydraulic issues are as noted.

- The Disinfection Facilities and Effluent Pump Station will require replacement piping and/or additional piping for the existing 60 inch pipe from the Final Clarifiers. Velocities in pipes from the Final Clarifiers to the Effluent Pump Station are low (0.9 feet per second at average flow); however this piping does not carry significant solids.
- The HRT Facility will require modifications (increased pump capacity and pressure) to the Whitehead Pump Station as described in TM-CSO-9 – Whitehead Pump Station Improvements.
- Phase I – Ammonia Removal Facilities will require raising the walls of the existing aerobic digesters by approximately 2 feet, to provide sufficient hydraulic head. Velocities in several pipes are low (0.4 to 1.2 feet per second), and the liquids in these pipes will contain significant solids. Weirs in the existing Industrial Primary Clarifier will be submerged at peak day flow. However, weirs at this location would be submerged at the peak day flow regardless of downstream hydraulics. The Industrial Primary Clarifier wall will not be overtopped at the peak day flow.
- Phase III – Total Nitrogen Removal Facilities will require raising the walls of the existing aerobic digesters by approximately 4 feet, to provide sufficient hydraulic head. Velocities in several pipes are low (0.4 to 0.7 feet per second), and the liquids in several of these pipes will contain significant solids. Weirs in the existing Industrial Primary Clarifier will be submerged at peak day flow. However, weirs at this location would be submerged at the peak day flow regardless of downstream hydraulics. The Industrial Primary Clarifier wall will not be overtopped at the peak day flow.

A plan, sectional plan, and section for the Effluent Pump Station are presented on Figures 16, 17, and 18. The Effluent Pump Station will operate approximately 6 percent of the time for the interim period on an annual basis. In the future, when the HRT is operating, the Effluent Pump Station will operate approximately 14 percent of the time with no dry weather treatment through the future HRT facility. The Effluent Pump Station will begin pumping when the Missouri River reaches an approximate stage of 18 feet (based on no more than 8 mgd upstream flow in the Missouri Avenue Outfall and a maximum of 54 mgd effluent flow from the plant). The opinion of probable project cost for the Effluent Pump Station will be developed as part of the design memorandum for the Disinfection Facilities and Effluent Pump Station project.

## 9.0 TM-WW-8: Instrumentation and Controls

This technical memorandum presents an instrumentation and controls (I&C) plan which documents the current I&C conventions at the WPF and provides recommended practices for future facility improvements.

The WPF previously utilized an Autocon system which has exceeded its useful life, is no longer supported by the manufacturer, and has been removed. This circumstance requires the operators to manually run the local facility except for the following systems: In-plant Influent Pump Station, Intermediate Pump Station, Industrial Primary Clarifier, Thermophilic and Mesophilic Digesters, Belt Filter Press, Boiler, and Gas Dryer. These systems utilize programmable logic controllers (PLCs) which operate in a stand-alone fashion with local operator interfaces (LOIs) and circular chart recorders. PLCs are also located at the following remote pump stations: Whitehead Pump Station, Brown’s Branch Pump Station, Faraon Street Pump Station, and SSJISD Pump Station. The PLCs are manufactured by Allen-Bradley and are capable of, or can be upgraded for, Ethernet communications. The facility utilizes instrumentation of the latest technology as existing systems are improved and new systems installed.

It is recommended that the City continue to install reliable, cost effective instruments of the latest technology and build upon the PLCs already installed by implementing a plant-wide supervisory control and data acquisition (SCADA) system as improvement projects are implemented. The SCADA system should utilize human-machine interfaces (HMIs), Allen-Bradley ControlLogix PLCs which support Ethernet protocol, LOIs, Ethernet switches, and a fiber optic cable backbone. The fiber optic cable backbone for these systems should be installed in conjunction with the upcoming nutrient removal and/or grit removal projects.

## 10.0 TM-WW-9: Site Considerations, Utility Improvements, and Ancillary Facilities

This technical memorandum documents work related to site considerations, utility improvements, and ancillary facilities. The objectives of this memorandum include:

- Develop an overall site figure that shows the footprint of proposed and future facilities based on recommendations in the technical memoranda.
- Conceptually evaluate existing utilities including power feeds, site power distribution, backup power, gas, water, nonpotable water, fiber, and telephone to support recommended facilities.
- Provide conceptual costs for any necessary upgrades to existing utility systems.
- Review with City staff the condition and capacity of support facilities including the administration and maintenance buildings.
- Provide conceptual costs for any necessary upgrades to support facilities.

Improvements are recommended within the Facilities Plan to upgrade the existing WPF treatment capabilities and reduce CSOs from the combined sewer system. The following projects were recommended at the WPF as part of the Wastewater Facilities Assessment or Phase IA of the CSO Control Facilities Assessment that require ancillary facilities:

- 88 mgd screening and grit removal facility
- Ammonia removal facilities (new industrial clarifier, new WAS/RAS pump station, and addition of diffusers to domestic activated sludge basins)
- 61 mgd HRT facility (compressible media filter building and blower building)
- 108 mgd UV disinfection facility

- 108 mgd effluent pump station and outfall

The following projects were recommended at the WPF as part of Phase II of the CSO Control Facilities Assessment:

- 20 foot diameter, 23,000 foot long, 54 million gallon MG deep storage tunnel
- 61 mgd deep tunnel pump station and deep tunnel screening and grit shaft

Figure 19 presents a conceptual layout of the aforementioned facilities at the WPF as recommended within the Facilities Plan.

Necessary ancillary facility improvements are also required at the WPF. Table 15 summarizes the ancillary improvements and the opinion of probable project costs.

**Table 15**
**Summary of Opinion of Probable Project Costs for Ancillary Facility Improvements [1]**

| Item | Description | Cost, $ |
|---|---|---|
| Maintenance Building | Two staff offices constructed within existing Maintenance Building and a 10,000 square foot spare parts/rolling stock maintenance storage facility. | 1,625,000 |
| Laboratory Expansion | Remodel of Administration Building to expand existing laboratory. | 882,000 |
| Power Upgrades | Redundancy upgrades to WPF power system to meet USEPA design criteria for critical facilities. | 2,089,000 |
| Nonpotable Water System Upgrades | Relocation of influent line to downstream of proposed UV facility. | 136,000 |
| SCADA Backbone | Installation of SCADA backbone to support WPF automation and remote sensing (see TM-WW-8 for details). | 462,000 |
| | **Total** | **5,194,000** |

1. All costs presented in May 2009 dollars.

The only regulatory mandated improvements included within the ancillary facility recommendations are the power redundancy upgrades. It is anticipated that the power redundancy upgrades will be incorporated as part of larger proposed WPF projects. The other ancillary improvement projects address specific needs stated by City staff or identified within the Facilities Plan. Upon review of the costs, City staff will determine the need and timing to incorporate the ancillary facility improvements.

## 11.0 TM-WW-10: Staffing Analysis

This technical memorandum presents the findings of the staffing analysis performed for the WPF staff. A meeting was held with WPF staff on December 10, 2009 to review existing laboratory, operations, and maintenance staffing levels. Both current and future staffing needs were considered and recommendations for the staffing levels are presented. Additional facilities, opinions of probable project costs, general layouts, and potential site locations of the proposed facilities are presented in the various technical memoranda throughout the Wastewater Facilities Assessment. Specific space requirements for the Administration Building (including the laboratory) and the Maintenance Building are presented in TM-WW-9 – Site Considerations, Utility Improvements, and Ancillary Facilities.

The WPF O&M staff levels currently appear to be adequate. The WPF O&M staff surpasses their peers in efficiency and consistently does more with less; however, this high efficiency is offset by a higher than average overtime percentage. With key staff members set for retirement in the next five years, regulatory oversight requirements, changing water quality criteria, and the need to upgrade facilities at the WPF, there are a number of important recommendations to assist WPF O&M staff in meeting these upcoming challenges.

In the short term (next five years), it is recommended that the City implement the following:

1. Develop a list of core competences and a training program to teach these competences.
2. Implement a "WPF Training Program" by late 2010.
3. Hire six new trainees by early 2011.
4. Designate a "maintenance worker" job family to eliminate the need for operator certification for staff members who are specifically assigned to perform maintenance work.

5. Develop a succession plan and identify key staff to receive additional certifications as needed to offset the coming loss of institutional knowledge due to retirements.

In the long term (five years and beyond), it is recommended that:

1. A review of staffing needs and training requirements be performed prior to the start-up of new processes.
2. Staff operators assist with the basic laboratory sampling, allowing laboratory staff to focus on the more complex and difficult analyses.
3. As additional processes are brought online, SCADA be used to assist in the operation and oversight of the more complex WPF treatment processes.
4. O&M staff be transitioned to focus on the daily WPF O&M needs leaving the larger long-term capital improvements projects for outside contractors. This will allow the WPF staff to address maintenance needs in a more proactive manner.

## 12.0 Biosolids Management Evaluation

The City of St. Joseph currently beneficially uses Class B biosolids generated at the Water Protection Facility (WPF) through land application. However, the City is interested in converting to a Class A program, either through generation of Class A cake or a heat dried product. The purpose of this evaluation is to review current biosolids disposal expenses incurred by the City and compare the costs and benefits of alternative biosolids management options. Four biosolids management alternatives were identified for evaluation, including both the current system and Class A systems. The four programs evaluated are as follows:

- <u>Base Alternative</u>. Continued hauling and land application by the City of a Class B product mirroring present operations.
- <u>Alternative 1</u>. Contracted hauling, permitting, off-site storage, and land application of the dewatered cake (Class B product). The City would maintain responsibility for the land applied material.

- Alternative 2. Thermal drying of digested biosolids to generate a Class A product. The heat dried product could be sold or given away.
- Alternative 3. Seek process to further reduce pathogens (PFRP) equivalency for the current thermophilic anaerobic digestion process through sampling, laboratory analyses, and certification with the Pathogen Equivalency Committee (PEC) and the United States Environmental Protection Agency (USEPA) Region 7. Final disposal of the Class A product would continue as the current hauling and land application operation by the City.

Solids quantities used for this evaluation were based on the solids quantities presented in Technical Memorandum (TM) TM-WW-6 – Biosolids Facilities. The projected solids production and resulting design dewatered cake projections are presented in Table 16 and Table 17.

**Table 16**
**Projected Solids Production [1]**

| **Parameter** | **Design Conditions (2030)** | |
|---|---|---|
| | **Annual Average** | **Maximum Month** |
| **Primary Solids** | | |
| Dry solids, ppd | 18,980 | 30,520 |
| Volatile Solids, % | 71 | 60 |
| **Waste Activated Sludge** | | |
| Dry Solids, ppd | 13,560 | 29,040 |
| Volatile Solids, % | 78 | 78 |
| **Total Dry Solids, ppd** | 32,540 | 59,560 |

1. Projected solids production without chemical phosphorus removal.

**Table 17**
**Design Dewatered Cake Projections (2030)**

| **Parameter** | **Units** | **Annual Average** | **Maximum Month** |
|---|---|---|---|
| Cake Production | ppd (dry) | 19,300 | 37,000 |
| | ppd (wet) | 77,200 | 148,100 |
| Cake Volume | cu yd/day | 48 | 93 |
| | cu yd/hr | 3.0 | 5.4 |

The opinion of probable capital and life cycle costs for the four alternatives considered are presented in Table 18.

**Table 18**
**Opinion of Probable Alternative Costs and Unit Prices**

| **Parameter** | **Alternative** | | | |
|---|---|---|---|---|
| | **Base (Present)** | **1 (Contract Hauling)** | **2 (Thermal Drying)** | **3 (PFRP Equivalency)[1]** |
| Capital (2010 $M) | $0.66 | $0 | $24.51 | $0.09 |
| Annual O&M ($) | $268,000 | $327,000 | $625,000 | $0 |
| Present Worth of Annual O&M ($M) | $3.34 | $4.08 | $7.79 | $0 |
| Total Present Worth ($M) | $4.41 | $4.08 | $31.02 | $0.09 |
| Unit Cost ($/dry ton) | $60 | $55 | $419 | $15 |

1. PFRP equivalency costs are in addition to the costs of the Base Alternative.

As presented in Table 18, the unit cost of the City's current operation of biosolids hauling and land application of a Class B product (Base Alternative) is nearly equivalent to the unit cost expected for contract operations of the same services (Alternative 1). If the City continues a cake land application program, it can choose between in-house or contracted operations based on non-economic issues, such as staffing requirements and desired level of control and oversight effort for the program. Regardless of ownership of the application process, the City would retain responsibility for all land applied biosolids.

Generation of dry biosolids through a thermal drying process (Alternative 2) would be desirable due to the Class A status, low weight, public acceptance, and ability to sell to other markets such as biomass combustion or compost generation; however, the unit cost is much higher than all other alternatives considered.

Achieving PFRP-Equivalency status for the current process (Alternative 3) is likely to require significant effort and cost, without guaranteed results. However, pathogen measurement can be used to meet Class A criteria as an alternative to obtaining PFRP status.

It is recommended that the City continue the current operation of biosolids hauling and land application of a Class B product unless non-economic issues by City staff favor a contract operation of the program. Space on the WPF site should be allocated for a future thermal dryer facility should evaluation factors change in the future, including availability of land for application and public acceptance of a Class B product.

## 13.0 Wastewater Facilities Implementation Plan

A coordinated wastewater implementation plan for the 20-year CIP was developed in coordination with the annual Report on Revenue Requirements and Cost of Service Rates (Rate Study), also prepared by Black & Veatch. The Rate Study sets annual rates based on cost of service principals and projects future rate adjustments that will be required to meet the utilities operating requirements and finance its Capital Improvement Program (CIP) while still meeting required financial metrics for debt service coverage and minimum operating reserves. One of the key components of the annual Rate Study is a schedule and financing plan for the detailed 5-year CIP. The last two years, a supplement to the Rate Study has been made to extend the CIP portion of the study to 20 years to reflect the elements of the Long Term Control Plan, regulatory upgrades, and major capital improvements anticipated during the first phase of the Long Term Control Plan. The Rate Study forecasts the mix of cash financing and bond financing that will fund the CIP along with the timing and magnitude of the bond. The following sections provide the details of the plan.

### 13.1 Mandated Regulatory Wastewater Projects

The WPF is regulated through the NPDES. NPDES permits are renewed every five years. Many times the permit renewals require more stringent effluent requirements. Two projects are recommended to meet current mandated regulatory requirements – constructing a new Disinfection Facility and a new Ammonia Removal Facility both located at the existing WPF site.

A preliminary implementation schedule and project costs for these regulatory projects are shown in Figure 20. The City is required by the regulatory agencies to complete the Disinfection Facility and its supporting infrastructure by December 31, 2013. Ammonia limits are already specified in the current NPDES permit; however, it is anticipated these limitations will become more stringent in the near future. The Ammonia Removal Facility would be required in order to meet the more stringent limits that are expected. The actual compliance deadline for this project will be negotiated with regulators.

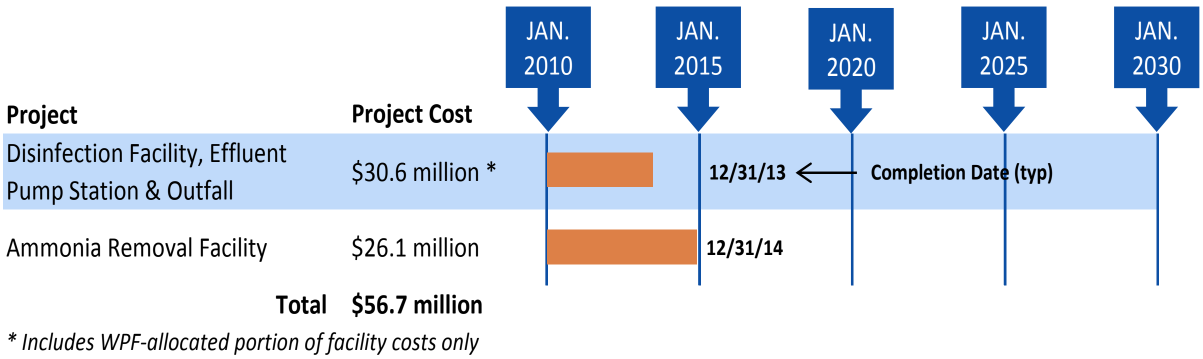


**Figure 20 – Water Protection Facility Schedule and Project Costs (in 2009 dollars)**

## 13.2 Additional Wastewater Projects

Additional wastewater projects, beyond the current mandated requirements, will be necessary for the WPF. These projects, the associated drivers, and the preliminary project costs are summarized in Table 19.

**Table 19**
**Additional Wastewater Facilities Assessment Projects, Costs, and Drivers**

| Project | Project Cost[1] | Project Driver |
|---|---|---|
| Screening & Grit Removal Facilities | $15. 5 million[2] | • Existing facilities are beyond their useful life<br>• Reduce operations & maintenance costs<br>• Required for future high rate treatment technology |
| Total Phosphorous Removal Facilities | $3.3 million | • Anticipated regulatory requirement |
| Total Nitrogen Removal Facilities | $31.2 million | • Anticipated regulatory requirement |
| Ancillary Facilities | $5.2 million | • KCP&L power upgrade provides redundancy<br>• Support facility upgrades required for recommended improvements |

**Table 19**
**Additional Wastewater Facilities Assessment Projects, Costs, and Drivers**

| Project | Project Cost[1] | Project Driver |
|---|---|---|
| Eastside Wastewater Improvements | $102.6[3] | • Faraon St. Pump Station is beyond its useful life<br>• Easton Rd. Pump Station is at capacity; location does not allow service to future industrial park<br>• Failure by either pump station to pump the required flow would result in a sanitary sewer overflow regulatory violation<br>• Provide infrastructure for growth in expanded Eastside service area |
| **Total** | **$157.8 million** | |

1. Project costs given in 2009 dollars.
2. Includes WPF-allocated portion of facility costs only.
3. Eastside Improvements represent only initial phase of the project. City will monitor growth to determine when the balance of the project should be implemented (additional $127 million).

## 13.3 Financial Capability Analysis

The United States Environmental Protections Agency (USEPA) utilizes a financial indicator to determine the economic burden on a community resulting from large, expensive CSO and wastewater program costs. The financial burden indicator is considered to be a “high burden” if the total CSO and wastewater costs are higher than 2 percent of the City’s median household income. USEPA therefore targets a value of 2 percent to determine an acceptable funding level.

For St. Joseph, the 2 percent indicator suggests the City is capable of spending approximately $270 million dollars on wastewater and CSO control improvements over a 20-year period (based on March 2010 analysis). As presented in the CSO Control Facilities Assessment, the Phase IA CSO improvements will require an expenditure of $152 million over 20 years. In order to remain within the 2 percent funding level, approximately $118 million dollars is left for all other utility costs, including routine operations and maintenance, replacement of aging infrastructure, and implementation of any regulatory driven or improvement projects.

If all of the Facilities Plan recommendations were implemented, the financial indicator would reach 2.73 percent. As a result, lower cost, interim solution projects were developed to address the most critical needs until funding allows all of the recommended Wastewater Facilities Assessment projects to be implemented. Table 20 summarizes the proposed interim solution project costs as compared with the full Facilities Plan recommendations discussed previously.

**Table 20**
**Interim Solution Wastewater Project Costs[1] Compared to Full Wastewater Facilities Plan Recommendations**

| Project | Project Cost (Full Facilities Plan Recommendations) | Project Cost (Interim Solution) |
|---|---|---|
| Screening & Grit Removal Facilities | $15.5 million [2] | $2.3 million |
| Total Phosphorous Removal Facilities | $3.3 million | $0.0 million |
| Total Nitrogen Removal Facilities | $31.2 million | $5.2 million |
| Ancillary Facilities | $5.2 million | $26.0 million |
| Eastside Wastewater Improvements | $102.6 million [3] | $27.0 million |
| **Total** | **$157.8 million** | **$33.5 million** |

1. Project costs given in 2009 dollars.
2. Includes WPF-allocated portion of facility costs only.
3. Eastside Improvements represent only initial phase of the project. City will monitor growth to determine when the balance of the project should be implemented (additional $127 million).

The existing grit basin equipment at the WPF is beyond its useful life, requiring frequent repairs, and resulting in increased downstream basin cleaning costs due to poor performance. The grit basin interim solution provides for replacement of equipment within the existing grit basins.

Eastside wastewater improvements are required in fiscal year 2011. The Faraon Street Pump Station has significant structural issues, while the Easton Road Pump Station is at full capacity. Failure by either of these stations to pump the required flow would result in a sanitary sewer overflow regulatory violation. The Faraon Street Pump Station needs odor control improvements to reduce odor problems in the downstream areas west of Interstate 29. The Easton Road Pump Station is not located far enough east to be able to serve the future portion of the industrial park in the southeast area. The interim solution provides structural rehabilitation and odor control improvements for the Faraon Street Pump Station, an interceptor sewer for a future growth area, and a new pump station located further east.

The interim solution wastewater projects presented in Table 20 will aid the City in maintaining a financial indicator value of 2 percent.

## 13.4 Summary of Wastewater Projects for Implementation within the 20-Year CIP

An overall cost summary of the projects recommended for implementation within the 20-year CIP for the Wastewater Facilities Assessment is presented in Table 21.

**Table 21**
**Summary of Wastewater Projects for Implementation within the 20-Year CIP**

| **Project** | **Project Cost[1]** |
|---|---|
| Disinfection Facility, Effluent Pump Station, and Outfall | $30.6 million[2] |
| Ammonia Removal Facility | $26.1 million |
| Screening & Grit Removal Facilities | $2.3 million[3] |
| Ancillary Facilities | $5.2 million |
| Eastside Wastewater Improvements | $26.0 million[3] |
| **Total** | **$90.2 million** |

1. Project costs are in 2009 dollars.
2. Project cost includes WPF-allocated portion of facilities only.
3. Project cost is for implementation of interim solution, not full Wastewater Facilities Plan recommendation.