Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Technical Feasibility of Satellite Treatment

Technical Memorandum
Original Date: August 9, 2001
Revision Date: June 25, 2003
Author: Tetra Tech MPS

Table of Contents

1. Objective 1
2. Summary 1
3. Approach 4
   - 3.1 Evaluation of Existing Wastewater Treatment Plants 4
   - 3.2 Evaluation of New Wastewater Treatment Plants 5
   - 3.3 Regulations 14
   - 3.4 Design Assumptions 15
   - 3.5 U.S. EPA Reliability Criteria 21
   - 3.6 Costing 22
4. Analysis of Wastewater Treatment Plants 25
   - 4.1 Current City of Pontiac Wastewater Treatment Plant 25
   - 4.2 Expansion of City of Pontiac Wastewater Treatment Plant 29
   - 4.3 Current City of Warren Wastewater Treatment Plant 45
   - 4.4 Expansion of City of Warren Wastewater Treatment Plant 48
   - 4.5 Current City of Mount Clemens Wastewater Treatment Plant 58
   - 4.6 Expansion of City of Mount Clemens Wastewater Treatment Plant 61
   - 4.7 Construction of New Plant Discharging to the Clinton River 74

Appendix A - Detailed Design Information for the Expanded and New WWTPs

Appendix B - Detailed Costing Information for the Expanded and New WWTPs

Technical Feasibility of Satellite Treatment

1. Objective

One of the alternatives being examined as part of the 50-year Wastewater Master Plan for the Detroit Water and Sewerage Department (DWSD) is the possibility of expanding treatment capacity outside of the current DWSD Wastewater Treatment Plant located at 9300 West Jefferson Avenue in Detroit. This alternative explores the possibilities of expanding the capacities of certain wastewater treatment plants in the suburban regions of the planning area. The wastewater plants considered for possible expansion are:

- The City of Pontiac Wastewater Treatment Plant
- The City of Warren Wastewater Treatment Plant
- The City of Mount Clemens Wastewater Treatment Plant

The building of a new wastewater treatment plant was another option considered under this alternative. The Clinton River and the Detroit River were the two watersheds considered to accept the discharge from a new wastewater plant.

2. Summary

Capital and annual operation and maintenance (O&M) costs were calculated for all of the options (expansion of an existing wastewater treatment plant and construction of a new wastewater treatment plant).

Table 1 shows the maximum capacity to be gained by expanding a current wastewater treatment plant or the capacity of a newly constructed wastewater treatment plant, capital costs, annual O&M costs, capital construction dollars per gallon/day costs, conveyance cost, conveyance cost per gallon/day and a total construction and conveyance cost per gallon/day.

Table 1. Alternatives Cost Summary

Alternative	Additional Capacity (Avg. MGD)	Degree of Treatment	Capital Costs (Million $, Apr 2002)	Annual O&M Costs (Million $, Apr 2002)	Capital Costs per gallon/day ($/gal./day)	Conveyance Cost (Million $, Apr 2002)	Conveyance Cost per gallon/day ($/gal./day)	Capital Cost and Conveyance Cost per gallon/day ($/gal./day)
Expansion of Pontiac WWTP								
Option 1	21.1	Tertiary	120.6	12.2	5.72	39.6	1.87	7.59
Option 1 w/o basin	21.1	Tertiary	96.4	9.3	4.57	36.0	1.70	6.27
Option 2	30.8	Tertiary	170.5	14.3	5.54	184.4	5.98	11.52
Option 2 w/o basin	30.8	Tertiary	137.5	13.1	4.46	169.0	5.49	9.95
Option 3	45.0	Tertiary	237.5	20.6	5.28	92.7	2.06	7.34
Option 3 w/o basin	45.0	Tertiary	185.7	18.7	4.13	72.0	1.60	5.73
Expansion of Warren WWTP								
Option 1	14.0	Tertiary	72.1	6.7	5.15	43.8	3.13	8.28
Option 2	40.0	Tertiary	144.7	15.4	3.62	10.2	0.25	3.87
Expansion of Mount Clemens WWTP								
Option 1	11.3	Tertiary	61.5	5.7	5.44	6.7	0.60	6.04
Option 2	35.9	Tertiary	155.4	16.2	4.33	31.4	0.87	5.20
Option 3	54.0	Tertiary	216.9	24.1	4.02	39.0	0.72	4.74
New WWTP discharging to Clinton River								
Option 1	21.1	Tertiary	96.5	9.3	4.57	14.5	0.69	5.26
Option 2	56.3	Tertiary	225.9	22.5	4.01	0	0	4.01
Option 3	62.2	Tertiary	241.9	24.8	3.89	37.5	0.60	4.49
New WWTP discharging to Detroit River								
Option 1	100.0	Secondary	256.3	27.5	2.56	0	0	2.56
Option 2	125.0	Secondary	297.3	33.4	2.38	0	0	2.38

Table 2 provides a list of recently expanded wastewater treatment plants. The capital costs shown include only the construction cost of the wastewater treatment plant, not any conveyance or other associated costs. The average capital costs per gallon/day for those plants designed for tertiary treatment are $4.52/gallon per day.

Table 2. Recently Expanded Wastewater Treatment Plants

Location	WWTP Name	Description	Degree of treatment	Capital Costs (Million $)	Additional Size (MGD)	Capital Costs per gallon/day ($/gal./day)
Norman, OK	South Plant	Expansion from 12.0 MGD to 21.5 MGD	Tertiary	40.54	9.5	4.27
Longmont, CO	City of Longmont WWTP	Expansion from 11.5 MGD to 22 MGD	Tertiary	24.60	10.5	2.34
Fairfax, VA	Norman M. Cole Jr. Pollution Control Plant	Expansion from 54 MGD to 67 MGD	Tertiary	104.00	13.0	8.00
Frederick County, MD	Ballenger Creek WWTP	Expansion from 2 MGD to 6 MGD	Tertiary	15.5	4.0	3.88
Ypsilanti, MI	YCUA	Expansion from 28.9 MGD to 46 MGD	Tertiary	70.1	17.1	4.10
Vancouver, WA	Marine Park WWTP	Expansion from 8 MGD to 16 MGD	Secondary	30.00	8.0	3.75
Gresham, OR	City of Gresham WWTP	Expansion from 15 MGD to 20 MGD	Secondary	25.00	5.0	5.00
Detroit, MI	City of Detroit WWTP	Addition of two 180 MGD primary clarifiers	Secondary	80.0	180.0	0.44

Table 3 provides a list of recently constructed or planned wastewater treatment plants. The capital costs shown include only the cost of the wastewater treatment plant not any conveyance or other associated costs. The average capital costs per gallon/day for those plants designed for tertiary treatment are $5.32/gallon per day.

Table 3. Recently Constructed or Planned Wastewater Treatment Plants

Location	WWTP Name	Description	Degree of treatment	Capital Costs (Million $)	Additional Size (MGD)	Capital Costs per gallon/day ($/gal./day)
Norman, OK	North Plant	New 4.5 MGD plant	Tertiary	32.52	4.5	7.23
Fayetteville, AR	Westside WWTP	New 10 MGD plant	Tertiary	49.75	10.0	4.98
Longmont, CO	New WWTP	New 22 MGD Plant	Tertiary	79.20	22.0	3.60
Davis, CA	UC-Davis WWTP	New 2.8 MGD plant	Tertiary	15.3	2.8	5.46

Wastewater treatment (on a $/gallon/day basis) may be slightly less at an expanded wastewater treatment plant than at a new wastewater treatment plant for several reasons. If an existing wastewater treatment plant was constructed to allow for future expansion, such things as site work, instrumentation and control, piping, filters, and building sizes could be included in the original construction to easily accommodate more capacity in the future. In this case, expansion of an existing wastewater treatment plant would be less expensive than a similar amount of capacity gained at a newly constructed wastewater treatment plant. Since the expansions of the wastewater treatment plants studied for technical feasibility in this report were not originally constructed to allow for expansions of the sizes being considered, the $/gallon/day cost of the expanded wastewater treatment plants is similar to that of the proposed new wastewater treatment plants.

3. Approach

3.1 Evaluation of Existing Wastewater Treatment Plants

In order to gather the information needed to determine the possibilities of expanding the three existing wastewater treatment plants, discussions were held with the three municipalities where the treatment plants are located to explain their potential involvement in the DWSD 50-year Wastewater Master Plan. It was explained that this study is solely to determine the technical feasibility of expansion. The technical feasibility included a review of the current flow and loadings to the wastewater treatment plant, wastewater treatment processes, biosolids management, operation and maintenance and other facets of wastewater treatment plant operations. This feasibility study in no way obligates the wastewater treatment plant or the municipality to implement the findings of this study. The City of Pontiac, the City of

Warren, and the City of Mount Clemens agreed to participate in this study and to supply the requested information.

In order to evaluate the technical feasibility of expanding the existing wastewater treatment plants, the following information was requested from the respective municipalities:

- Basis of Design – including any subsequent expansions or modifications.
- Stress Test Reports – if any such tests have been performed
- Monthly Operating Reports (MORs) – three to five years of data (in electronic format)
- Schematic of plant – including a diagram showing property boundary of current location
- Amount (if any) of City owned property near the current wastewater treatment plant
- Sludge Residuals Management Plans – including any sludge test results
- CSO plans and flows – current and future
- Future plans for wastewater treatment plant expansion
- Problems with current operation of wastewater treatment plant
- Copy of current NPDES permit – including any violations of permit limits
- Contact person with City to whom we can direct future information requests

3.2 Evaluation of New Wastewater Treatment Plants

The Clinton River and the Detroit River were considered as potential receiving streams for a new wastewater treatment plant. These two water bodies were chosen due to their relatively high base flows, location relative to the current DWSD interceptor system, and access to serve areas with substantial dry weather wastewater flows. Selecting potential sites along these water bodies necessitated looking at several factors. The three major components of any proposed wastewater treatment system are:

- The pipelines needed to convey the wastewater to the treatment plant.
- The treatment plant.
- The outfall pipe that will convey the treated effluent to the receiving water body.

The proposed wastewater treatment plant would need to be designed to meet several goals:

Environmental

- water quality
- Protect public health Avoid or minimize impacts to the natural environment
- Preserve and enhance

Technical

- Design the wastewater treatment, conveyance, and disposal system to be efficient and reliable.
- Balance cost with the risk of uncertainty and the flexibility to respond to changes in growth projections, technology, and regulations.
- Ensure the wastewater system is designed and constructed to meet regulatory requirements.

To identify possible land areas for a treatment plant, an analysis was performed using GIS (Geographical Information System) information, topographical maps, and recent aerial photographs. The GIS provided the land use projections for the planning area through the year 2020. The land use for the planning area was divided into the following categories:

- Agricultural\Rural Residential
- Commercial
- Industrial
- Institutional
- Low Density Residential
- Medium\High Density Residential
- Office
- Open Space\Conservation
- Other
- Transportation

3.2.1 Site Selection Criteria

The potential sites were screened using the following engineering and environmental constraints that would affect the construction or operation of a wastewater treatment plant:

- Only sites that were identified as Agricultural\Rural Residential, Commercial, Industrial, or Other by the GIS were selected for further investigation.
- Sites that were not within two miles of the current DWSD interceptors in Oakland and Macomb counties were eliminated.
- Sites that were not far enough down the interceptor system to provide an estimated 2050 average flow greater than 20 MGD were eliminated.
- Sites that were not within two miles of the Detroit River or within two miles of the Clinton River or one of the major Clinton River tributaries were eliminated.
- Sites had to be of sufficient area to accommodate the proposed facility and an appropriate buffer. For this study, the minimum area considered was 50 acres.
- The elevation of the sites should allow efficient conveyance of sewage to the plant and conveyance of treated effluent to the receiving water.
- Sites should have adequate vehicle access to and from major roadways.
- Sites should not have steep slopes.
- Sites should not be long and narrow in shape.
- Sites should not be in the vicinity of state parks, active airport operations, transmission towers, cemeteries, and conservation areas.

Table 4 summarizes the results of the site search. The size and current land use of these sites were verified by use of digitized color photographs obtained from MapQuest. Figure 1 shows the approximate locations of the sites considered for a new wastewater treatment plant. Figures 2, 3, 4, and 5 contain more detailed information on the selected sites.

Table 4. Proposed Sites

Site Number	Site Name	Area (acres)	Distance to Water Body	Jurisdiction	Current Land Use	Distance to nearest current DWSD interceptor
1	Oakland County Community College	63	3,450 ft to Clinton River	City of Auburn Hills	Fields and Forest	4,000 ft
2	FOMOCO Proving Grounds	211	Clinton River Middle Branch originates on site, and 4,900 ft to Clinton River	Shelby Township	Field in middle of track	1,800 ft
3	S of M-59	220	10,400 ft. to Clinton River	Sterling Heights	Forested	10,400 ft
4	Conner Creek	50	4,500 ft to Detroit River	City of Detroit	Parking Lot	Next to several pump stations

The area sizes shown in Table 4 represent the acreage of a parcel of land that is currently undeveloped. The sites selected in Table 4 were chosen only to provide locations to determine the technical feasibility of building a new wastewater treatment plant near the Clinton River. A more in-depth study of these sites and other potential sites would need to be performed to determine the current owner's future plans for the site, the economic/social/political impact of building a new wastewater treatment plant on the site, and the environmental impact of a new wastewater treatment plant at the site.

The detailed analysis of Site Number 4, Conner Creek, is contained in the "Expanded Facilities in Detroit" Technical Memorandum. The detailed analyses of the other sites are presented in Section 4.5 – Construction of New Plant Discharging to the Clinton River in this technical memorandum.

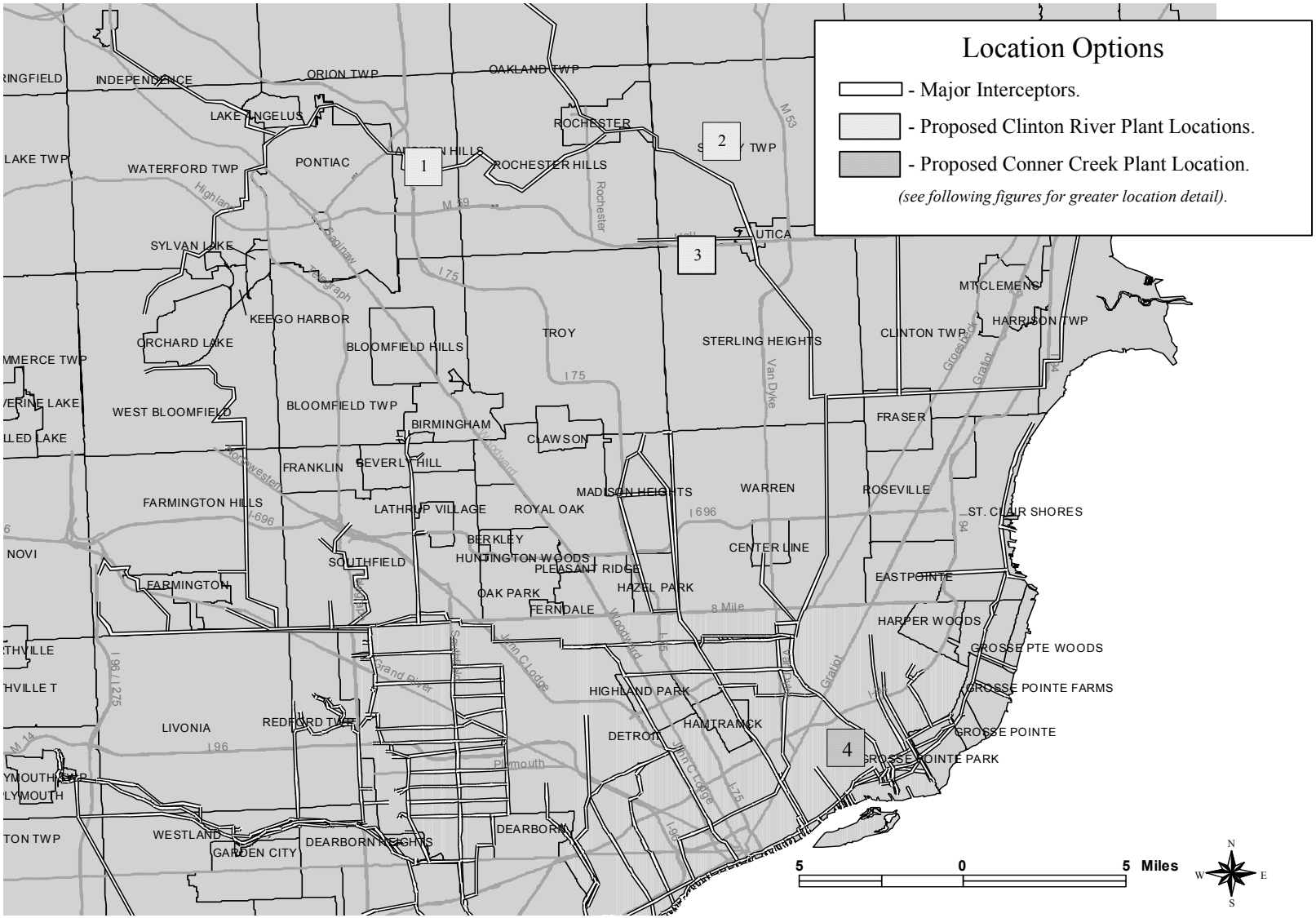


Figure 1. Locations of Potential Sites for a New Wastewater Treatment Plant

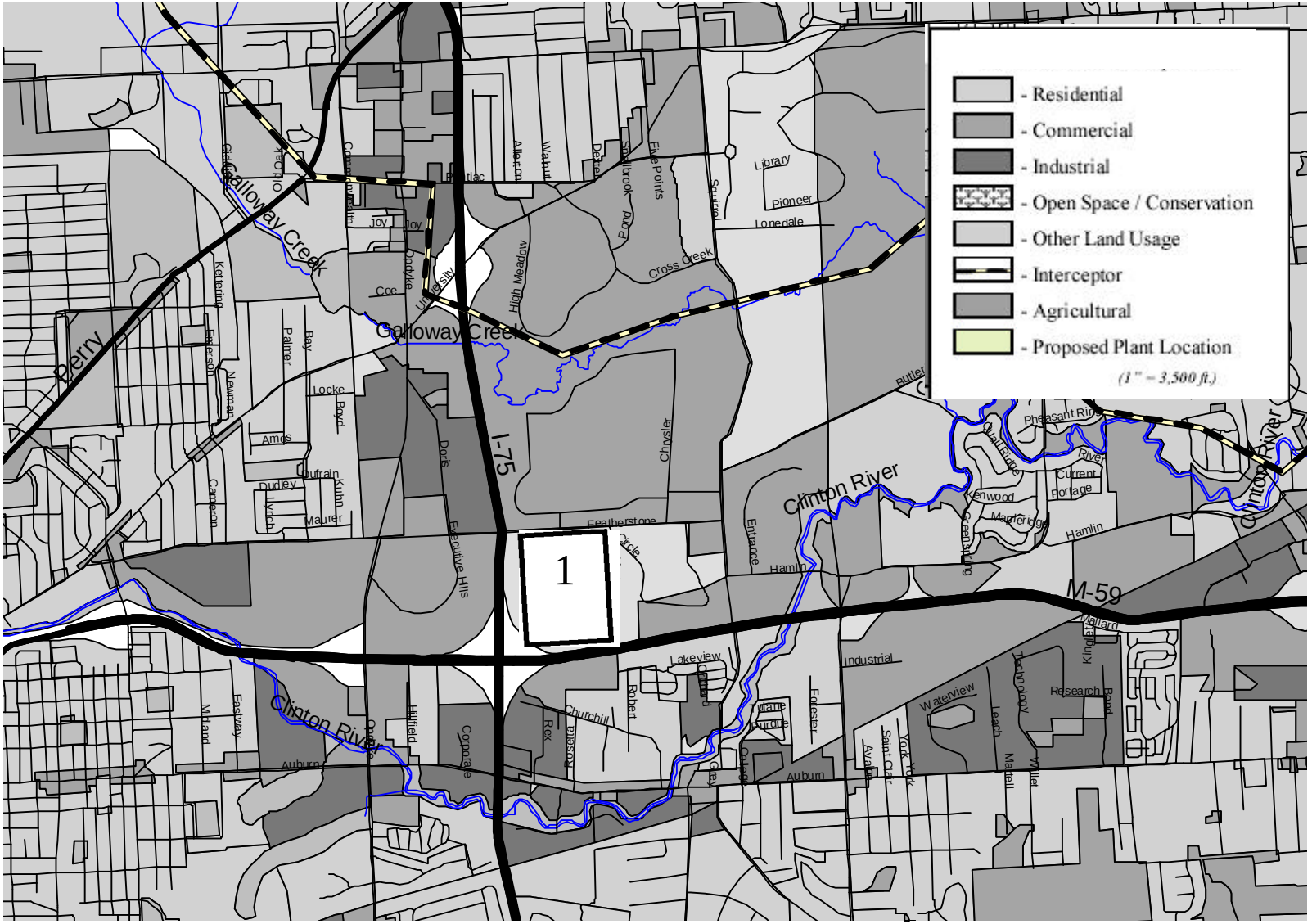


Figure 2. Location of Site 1 for a New Wastewater Treatment Plant



Figure 3. Location of Site 2 for a New Wastewater Treatment Plant



Figure 4. Location of Site 3 for a New Wastewater Treatment Plant

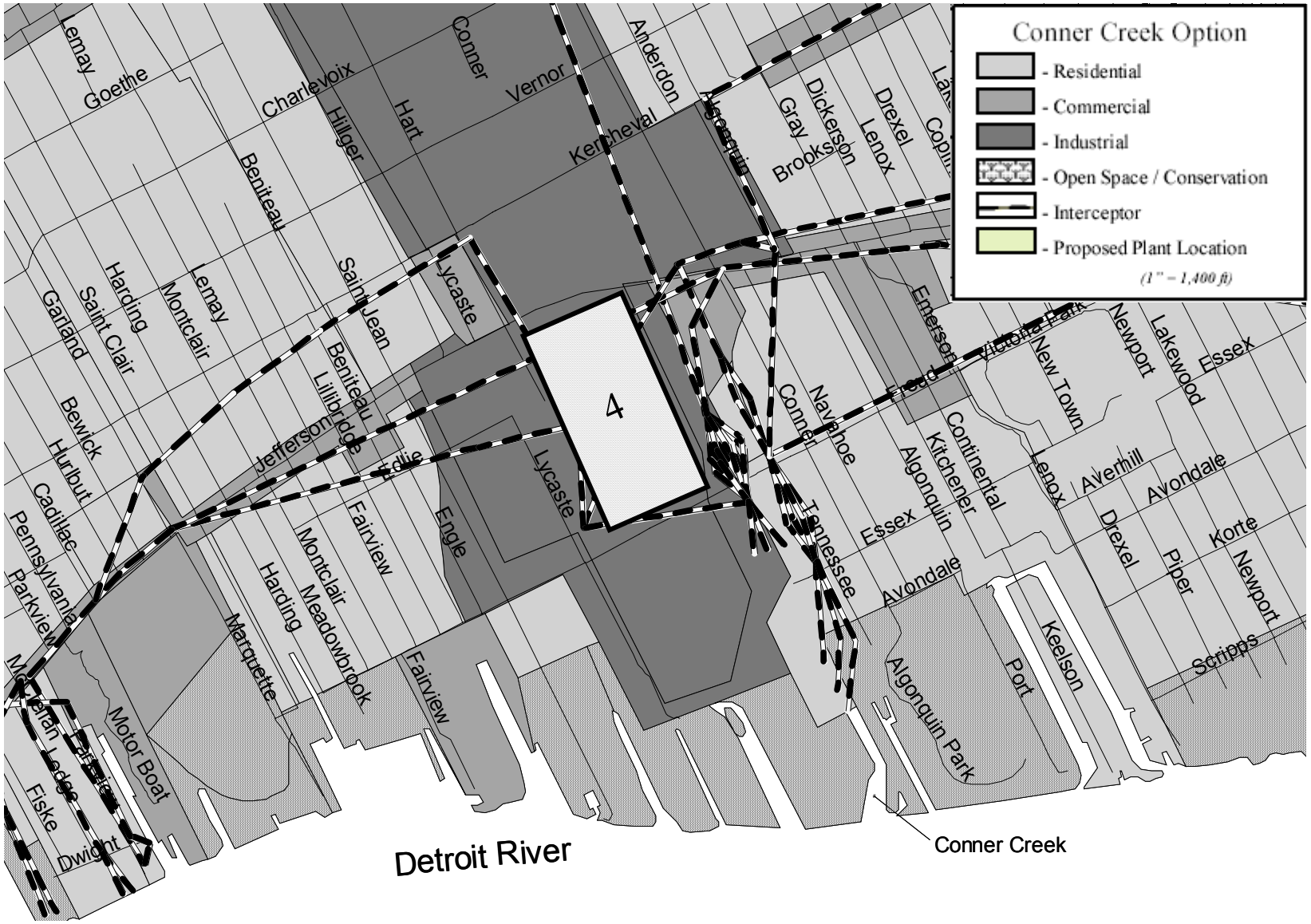


Figure 5. Location of Site 4 for a New Wastewater Treatment Plant

3.3 Regulations

3.3.1 New and Existing Wastewater Treatment Plant Regulatory Assumptions

In order to design the new and expanded wastewater treatment plants, the following assumptions were made:

- The NPDES discharge limitations for the additional flow would be the same as those applicable to current discharges in the same area.
- The water body to which the additional flow will be discharged has the assimilative capacity to handle the increased flow and loadings.

These assumptions may or may not be valid depending on an in-depth MDEQ analysis of the receiving water bodies and effluent quantity and quality. This analysis will determine if the proposed flow increase would be allowed, and if allowed, what the preliminary NPDES permit limits would be. The MDEQ analysis may change the loadings allowed to the Clinton or Detroit Rivers.

3.3.2 TMDLs

The MDEQ compiles a list of water quality-limited or threatened waters requiring the establishment of pollutant Total Maximum Daily Loads (TMDLs). These TMDLs are for water bodies that are not presently attaining water quality standards and waterbodies that are presently attaining water quality standards, but are expected not to meet water quality standards by April 2004. There currently are no TMDLs in effect on the Clinton or Detroit Rivers. However, several TMDLs are scheduled to be developed affecting these water bodies over the next 10 years. Table 5 lists the sections of the Clinton and Detroit Rivers that would be impacted by an expansion of a current wastewater treatment plant or the construction of a new wastewater treatment plant, the date the TMDL is scheduled to be developed, and the water quality standard that is in non-attainment.

Table 5. TMDLs

Water Body	Location	Distance	Problem	Year of TMDL Development
Clinton River				
Bear Creek	Red Run Drain confluence upstream to Mound Road in the vicinity of Warren.	2.5 Miles	Pathogens	2006
Main Branch	Yates Dam upstream to Pontiac WWTP outfall	10.7 Miles	Fish community rated poor.	2006
Main Branch	Lake St. Clair confluence upstream to Yates Park Dam	25 Miles	Pathogens	2006
Red Run Drain	Clinton River confluence upstream including all tributaries to Warren, Center Line, Madison Heights, Troy and Clawson.	6 Miles	Pathogens, Macro-invertebrate community rated poor	2006
Main Branch	Lake St. Clair confluence upstream to Yates Park Dam	25 Miles	PCBs	2010

Water Body	Location	Distance	Problem	Year of TMDL Development
Main Branch	Northbound Gratiot Avenue (S. Broadway Street), Mt. Clemens. One mile total reach (upstream and downstream of Gratiot Avenue)	1 Mile	Mercury	2011
Detroit River	Entire river from Lake St. Clair downstream to Lake Erie	28 Miles	Pathogens	2007
	Entire river from Lake St. Clair downstream to Lake Erie	28 Miles	PCBs, Dioxin	2008
	Entire river from Lake St. Clair downstream to Lake Erie	28 Miles	Mercury	2011

3.4 DESIGN ASSUMPTIONS

3.4.1 New and Existing Wastewater Treatment Plants

The expanded and new wastewater treatment plant processes were designed based upon the Recommended Standards for Wastewater Facilities, 1997 Edition published by the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers ('Ten States Standards'). More details regarding the design criteria used for each alternative and option are contained in Appendix A. Additionally, the expanded and new wastewater treatment plants were designed to meet Class I Reliability Criteria as defined by the EPA in the publication Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability.

The treatment processes considered for the expansion and building of a new wastewater treatment plant were:

- Preliminary Treatment
  - Coarse Bar Screens
    - Removes larger items from the wastewater
    - Protects equipment downstream
  - Grit Chamber - Aerated
    - Removes large and heavy solids
    - Decreases scouring of equipment located downstream
    - Decreases size of solids handling equipment required
  - Equalization Basin (if needed)
    - Decreases peak hourly flows, lowering the design flow for the facility.

- Primary Treatment
  - Primary Clarifiers - Circular
    - Removes approximately 60 percent of solids and approximately 30 percent of biochemical oxygen demand
- Secondary Treatment
  - Aeration Basin (only one of the two types listed below will be used at a facility)
    - Single Stage Nitrification
      - Removes biochemical oxygen demand and converts ammonia-nitrogen to nitrate-nitrogen
    - Conventional Activated Sludge
      - Removes biochemical oxygen demand
  - Secondary Clarifiers - Circular
      - Settles mixed liquor suspended solids
      - Aids in phosphorus removal when chemical addition occurs upstream of the unit
- Tertiary Treatment (if needed)
  - Tertiary Filters
      - Assumed single media sand filter
      - Removes total suspended solids and particulate phosphorus
- Ultraviolet Disinfection
- Biosolids Dewatering and Disposal
  - Gravity Belt Thickener
      - Assumed solids thickened to 8 percent
  - Centrifuge
      - Feed tank provides 4 days of storage
      - Assumed solids thickened to 20 percent

- Landfill
    - Solids can be stored for up to one week
    - Assumed solids suitable for landfilling

3.4.2 Differences Between Plant Design Alternatives

Ten States Standards requires that most equipment be sized based on the peak hourly flow, with the exceptions being aeration basins and solids handling facilities, which are sized based on the average flow. Due to the age of the collection systems in Pontiac and Warren, peak hourly flows are considerably higher than in newer communities. In order to decrease the sizes of the process equipment, equalization basins will be used to store wastewater in excess of the maximum day flow. As the flows decrease, wastewater will be released from the equalization basin. For design purposes, the maximum daily flow will be used as the peak hourly flow.

Several of the Pontiac wastewater treatment plant expansion alternatives include the construction of a retention or equalization basin upstream of the primary clarifiers. The Warren Wastewater Treatment Plant currently has a 50 million gallon equalization basin. It is assumed that the infiltration and inflow problem at Warren will be addressed prior to the proposed expansion. At that time, the equalization basin would be available to be used to equalize the flow at the expanded plant. The remaining alternatives do not include equalization basins, because the peak hourly flow to the plants will be limited by diverting only a certain amount of wastewater from an existing DWSD interceptor. Any excess flow would be allowed to continue to flow to the existing DWSD plant for treatment.

The City of Pontiac currently cosettles their sludge. That is, the waste activated sludge is returned to the primary clarifiers for removal. In order to simplify the operation of the wastewater treatment plant, the expansion was designed to include cosettling. For the other treatment plant alternatives, it was assumed that the primary and secondary sludges would be treated separately. In Pontiac, it was assumed that the cosettled sludge from the primary clarifiers would be treated in a gravity belt thickener to 8 percent solids, a centrifuge feed tank would be sized to provide four days of storage, the biosolids would be dewatered in a centrifuge to about 20 percent solids. A tank would be provided to store the sludge for up to seven days, and the biosolids would be landfilled.

The solids handling process at the other plants would be as follows: the sludge from the secondary clarifiers would be treated in the gravity belt thickeners, which would thicken the biosolids to 8 percent. The primary sludge and thickened secondary sludge would be mixed in the centrifuge feed tank. The centrifuge would thicken the sludge to about 20 percent. The dewatered sludge would then be landfilled.

It should be noted that Pontiac and Warren incinerate their sludge and dispose of the ash at a landfill. The costs in this report only include biosolids handling for the expansion at these plants. In addition, disinfection at both plants is currently accomplished by chlorination followed by dechlorination. The expansions propose that ultraviolet disinfection be used. As with the solids handling, the ultraviolet disinfection equipment has only been sized to the expansion flows at these facilities.

All plants discharging to the Clinton River will have to meet stable effluent limits, which are achieved through tertiary treatment. Therefore, all but the Conner Creek alternatives include single stage nitrification aeration basins and sand filters. The Detroit River has a significantly higher base flow than the Clinton River, which allows plants to meet secondary limits that are achievable using conventional activated sludge without sand filters.

Single stage nitrification requires a larger basin than conventional activated sludge to allow the microorganisms to convert ammonia-nitrogen to nitrate-nitrogen. Only certain microorganisms can use ammonia-nitrogen as a food source. In order to have a sufficient number in the aeration basin, a longer retention time is needed. A longer detention time is also needed, because carbon based food is metabolized before nitrification begins.

3.4.3 Ten States Design Standards

A summary of the design standards used to size the plant processes for the plant alternatives is provided in Table 6.

Table 6. Ten States Standards

WWTP Process	Design Standard
Raw Sewage Pumping Station	• Minimum of two pumps • Each capable of pumping peak hourly flow
Coarse Bar Screen	• Approach velocity > 1.25 ft/sec • Approach velocity < 3 ft/sec
Grit Chamber	• Detention time between 3 and 5 minutes at peak hourly flow[1] • Air rate of 3 to 8 cfm/ft of tank length[2]
Equalization Basin	• Sized to store the flow difference between peak hourly flow and maximum day flow[3]
Primary Clarifiers	Clarifiers not accepting Waste Activated Sludge (WAS): • Surface Overflow Rate (SOR) less than 1000 gpd/sf at average daily flow • SOR less than 1500 gpd/sf up to 3000 gpd/sf at peak hourly flow[4,5] Clarifiers accepting WAS (i.e. cosettling)[6]: • SOR less than 1200 gpd/sf at peak hourly flow[4]
Aeration Basin	Single Stage Nitrification: • Organic loading less than 15 lb./day/1000 cf • Food to Microorganism (F/M) Ratio between 0.05 and 0.1 lb. BOD/day per lb. Mixed Liquor Volatile Suspended Solids (MLVSS)

Secondary Clarifiers	• Mixed Liquor Suspended Solids (MLSS) between 3000 mg/L and 5000 mg/L[7] Conventional Activated Sludge[8]: • Organic loading less than 40 lb./day/1000 cf • Food to Microorganism (F/M) Ratio between 0.2 and 0.5 lb. BOD/day per lb. MLVSS • MLSS between 1000 mg/L and 3000 mg/L[7] Single Stage Nitrification: • Solids loading less than 35 lb./day at peak hourly flow[4] • SOR less than 1000 gpd/sf at peak hourly flow[4] Conventional Activated Sludge[8]: • Solids loading less than 50 lb./day at peak hourly flow • SOR less than 1200 gpd/sf at peak hourly flow
Tertiary Sand Filters	• Hydraulic loading less than 5 gpm/sf at peak hourly flow[4]
Ultraviolet Disinfection	• Transmittance greater than 65 percent • Dose at 254 nm of greater than 30,000 uW-sec/sq. cm[4]
Gravity Belt Thickener	• Sized for peak hourly flow[4] • BOD and TSS less than 30 mg/L • Specific design standards not provided
Centrifuge Feed Tank	• Provide storage for a minimum of 4 days
Centrifuges	• Specific design standards not provided
Landfill Storage Tank	• Provide storage for 7 days[9]

Notes:

1. Detention time of 4 minutes selected
2. Air rate of 5 cfm/ft of tank length selected
3. Not based on Ten State Standards. Applies to the Pontiac Wastewater Treatment Plant Expansion alternatives only
4. For plants with equalization basins, maximum day flow used
5. SOR less than 2000 gpd/sf selected
6. Applies to Pontiac Wastewater Treatment Plant expansion alternatives
7. MLSS of 3000 mg/L selected
8. Applies to Conner Creek wastewater treatment plant alternatives
9. Not based on Ten State Standards

3.4.4 Sizing of New and Expanded WWTPs

The size of the new and expanded WWTPs was dependent upon two factors. The first factor considered for the expanded WWTPs was the amount of land near the current plant that could be used to expand the plant or the land available at the new WWTP sites. The second factor examined was the volume of wastewater that could be delivered to the plant utilizing the current DWSD interceptor system. The volume of dry weather flow used for the various options was based upon the values and procedures presented in the Flow Projection Technical Memorandum. For areas not currently sewered but may be sewered in the future, the geography of the area was analyzed to predict which current DWSD interceptor could transport the wastewater. By utilizing the current DWSD interceptors, the need for new interceptor or pump station construction was minimized in all of the options for the new or expanded WWTPs. Either the land constraint or volume of wastewater flow that could be delivered would be the limiting element in the size of any of the expanded WWTPs. Land constraints were not a concern for the new WWTP sites since the sites were

large enough to treat most of the dry weather flow available from the nearby DWSD interceptors. The various options presented for the expanded WWTPs were based upon wastewater flows associated with different branches of the current DWSD interceptor system that may be able to de directed to the expanded plant.

3.5 U.S. EPA Reliability Criteria

The U.S. Environmental Protection Agency developed reliability criteria for wastewater treatment plants that were to be built using federal funds in the 1970's and 1980's. The Michigan Department of Environmental Quality has adopted the U.S. EPA Class I Reliability Criteria and has determined that they apply to all treatment plants that are subject to water quality standards. The dissolved oxygen water quality standard is used to develop permit limits for carbonaceous biochemical oxygen demand and ammonia-nitrogen. Therefore, all of the alternatives would be subject to the reliability criteria summarized in Table 7.

Table 7. Summary of Class I Reliability Criteria

WWTP Process	Reliability Criteria
Pumps	• Provide one backup pump for each set of pumps
Coarse Bar Screen	• Provide one backup screen • If only two screens, backup shall be manually cleaned
Grit Chamber	Not specifically listed
Equalization Basin	Not specifically listed
Primary Clarifiers	• With the largest unit out of service, remaining units should be able to treat 50 percent of the design flow to the unit process
Aeration Basin	• Provide a minimum of two equally sized basins
Secondary Clarifiers	• With the largest unit out of service, remaining units should be able to treat 75 percent of the design flow to the unit process
Tertiary Sand Filters	• With the largest unit out of service, remaining units should be able to treat 75 percent of the design flow to the unit process
Ultraviolet Disinfection	Not specifically listed
Gravity Belt Thickener	Not specifically listed
Centrifuge Feed Tank	• Can replace need for backup requirements of downstream equipment if sufficient storage provided for length of time required to fix process
Centrifuges	• Capable of treating the sludge design flow with one unit out of service or extending operating time of running units to make up for decreased capacity
Landfill Storage Tank	Not specifically listed

3.6 Costing

Preliminary costs for the new and expanded wastewater treatment plant options were prepared using the CAPDET Works Software developed by Hydromantis, Inc. in Ontario, Canada. The software contains icons for various wastewater treatment processes, which can be used to estimate the cost for different plant configurations. See Figure 6 for an example of the layout. The software was used to estimate both construction costs and annual maintenance, chemical, and electrical costs.

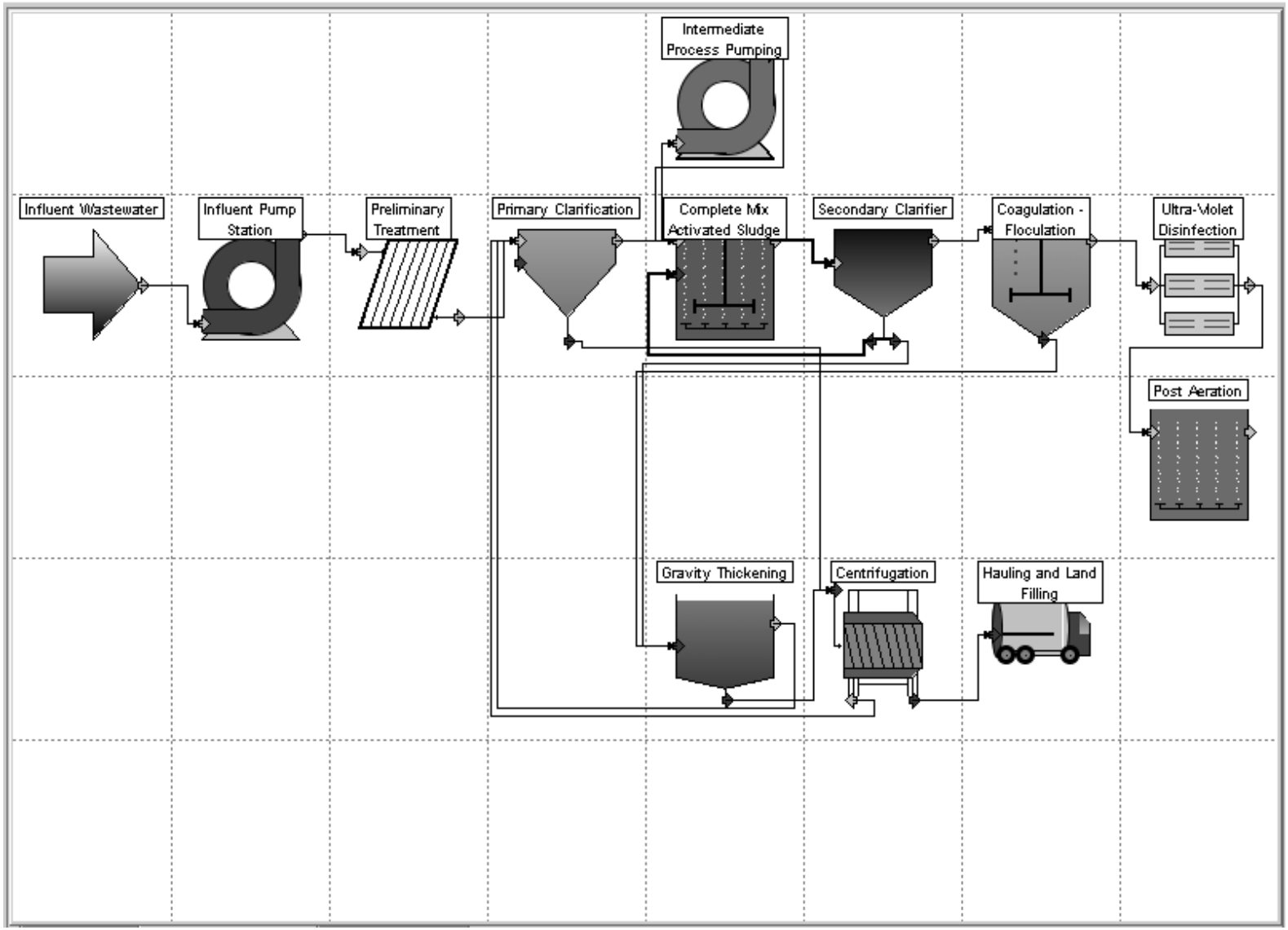


Figure 6. CAPDET Layout Example

The program contains a July 2000 cost database for the treatment processes. Three cost indices are used to adjust the July 2000 costs to present day dollars. The Marshall and Swift Index, Pipe, Valve and Fitting Cost Index, and the Engineering News Record 20-City Construction Cost Index were assigned to various pieces of equipment. In addition, costs that are likely to vary regionally, such as concrete or labor, can be entered manually. The database values for the equipment were used, adjusted to April 2002 dollars. Typical costs for estimating concrete and chemicals were entered in the program. The program uses standards for sizing of equipment from "Wastewater Engineering Treatment, Disposal, and Reuse – 3rd Edition" by Metcalf and Eddy, 1991. The equipment sizes and design parameters were manually entered to reflect Ten States Design Standards.

CAPDET includes costs associated with administration, laboratory, construction and operator labor, mobilization, site preparation, site electrical, yard piping, instrumentation and control, lab and administration buildings, equipment, and chemical use. The preliminary costs presented include a 30 percent engineering, legal, administrative and contingency fee, as well as a 15 percent confidence factor. The cost of purchasing additional land, if needed, was not included in any of the cost estimates. This was due to the wide variability in real estate prices within the planning area. However, the land cost would be a small percentage of the total cost of a plant.

The following costing variables were used to calculate capital and operation and maintenance costs:

- Life of Plant: 40 Years
- Construction: 3 Years for completion
- Interest Rate: 8%
- ENR Index: 6420 – April 2002
- Marshall and Swift Index: 1095 – April 2002
- Pipe Cost Index: 537 – January 2002
- Electrical and Instrumentation & Control: 16% of construction costs
- Mechanical: 19% of construction costs
- Labor: $50/hr including benefits
- Electricity: $0.08/kWh
- Building Cost: $90/sq. ft.
- Concrete

- Base Slab: $300/cu. yd. Approx. 3 ft. thick
- Wall: $550/cu. yd. Approx. 1 ft. thick
- Suspended Cover: $650/cu. yd. Approx. 18 in. thick

- Chemical Costs
  - Lime: $0.181/lb
  - Ferric Chloride: $0.222/lb
  - Polymer: $1.300/lb

Detailed cost information for both the expansion of the current wastewater treatment plants and the new wastewater treatment plants can be found in Appendix B.

4. Analysis of Wastewater Treatment Plants

4.1 Current City of Pontiac Wastewater Treatment Plant

The City of Pontiac operates two activated sludge wastewater treatment plants: the East Boulevard Plant, which was constructed in 1919, and the Auburn Plant, which was constructed in 1962. The combined wastewater treatment plants serve a population of approximately 72,200 people based on SEMCOG 2000 Census data.

The average daily wastewater treated by the City of Pontiac was 12.4 million gallons per day (MGD) in 2001. The Auburn Plant generally handles most of the flow while the East Boulevard Plant handles the rest. The combined plants have a total capacity of 25.5 mgd.

Most of the flow enters the wastewater treatment system through a 60-inch pipe at the East Boulevard Plant. At this point, the wastewater is sent through a bar grate and a series of slide gates to direct the flow to either wastewater treatment plant. In addition to the flow received from the East Boulevard Plant, the Auburn Plant receives flow directly from the Galloway, Opdyke and Murphy Park interceptors.

4.1.1 Treatment Process

East Boulevard Plant

Treatment at the East Boulevard Plant consists of screening, grit removal, primary treatment, secondary treatment, anaerobic digestion, and effluent disinfection. The sizes and capacities of these processes are shown in Table 8.

Table 8. Primary Treatment Process Sizes

Primary Treatment Process	Description	Capacity
Screening	2 – 5 ft wide bar screens with ¾ in. openings	36 MGD
Grit Removal	2 – 30 ft x 30 ft x 13 ft concrete tanks	57 MGD
Primary treatment	1 – 100 ft diam x 8.5 ft swd 1 – 100 ft diam x 10 ft swd	15.7 MGD
Flow Equalization	1 – 245 ft diam x 10.3 ft swd	3.5 MG

The secondary treatment consists of aeration and settling tanks. The treatment tanks in this process have been converted to an A/O biological phosphorus removal system; sizing shown in Table 9.

Table 9. Secondary Treatment Process Sizes

Secondary Treatment Process	Description	Capacity
Aeration	4 – 179 ft x 40 ft x 11 ft swd	10 MGD
Nitrification and A/O Biological Phosphorus Removal	4 – 101 ft x 33 ft x 9.5 ft swd	16 MGD

The treated secondary flow from the East Boulevard and Auburn Plants are combined before being treated at the tertiary sand filters at the Auburn Plant.

Solids generated from primary and secondary treatment are pumped to a series of two anaerobic digesters. Both digesters are 75 ft dia. x 27 ft swd. Digested solids from the first digester are gravity fed to the second digester. Digested solids from the second digester are pumped to the filter building at the Auburn Plant.

Auburn Plant

The Auburn Plant consists of grit removal, primary treatment, secondary treatment, anaerobic digestion, tertiary treatment, and effluent disinfection. Further detail is presented in Table 10.

Table 10. Primary Treatment Process Sizes

Primary Treatment Process	Description	Capacity
Screening	1 – 7.5 ft wide bar screen with 1 in. openings 1 – 6.0 ft wide bar screen with 1 in. openings	36 MGD
Grit Removal	2 – 20 ft x 30 ft x 15 ft concrete tanks	65 MGD
Primary treatment	2 – 100 ft diam x 8.5 ft swd 2 – 100 ft diam x 10 ft swd	31.4 MGD

The secondary treatment consists of aeration and settling. The process is designed to remove BOD and ammonia. The Auburn Plant uses ferrous chloride and anionic polymer for phosphorus removal. Table 11 shows the secondary process sizes.

Table 11. Secondary Treatment Process Sizes

Secondary Treatment Process	Description	Capacity
Aeration	2 – 209 ft x 73 ft x 12 ft swd 2 – 238 ft x 54 ft x 14.25 ft swd	22 MGD
Settling	2 – 90 ft diam x 8.5 ft swd 2 – 90 ft diam x 13 ft swd	25.4 MGD

Tertiary treatment is comprised of four rapid sand filters. Each sand filter consists of two cells. Each cell is 16 feet wide, 48 feet long with a filter depth of 4.75 feet. The treated secondary effluent from both the Auburn and East Boulevard Plants are treated in the sand filters. The maximum capacity of the sand filters is 44.2 mgd.

Sodium hypochlorite is added to provide disinfection of the tertiary wastewater in four concrete tanks. Each tank consists of two cells. Each cell is 10 feet wide, 100 feet long, and has a depth of 10 feet. The total capacity of the disinfection process is 43.1 mgd. Prior to discharge to the Clinton River, sodium bisulfite is added to dechlorinate the wastewater.

The solids treatment at the Auburn Plant uses anaerobic digesters, similar to those at the East Boulevard Plant.

The dewatering system at the Auburn Plant treats the digested solids from the Auburn and East Boulevard Plants. Dewatering is performed by two belt filter presses.

The dewatered solids are sent to a multiple hearth incinerator. The incinerator is operated about 16 days per month. The incinerated waste is hauled off-site to a landfill.

4.1.2 Flow information

The average daily flow into the wastewater treatment plant is 12.4 mgd. The maximum daily average flow is approximately 31.0 mgd.

The City of Pontiac has a separated sewer system. However, due to the age of the conveyance system, there is an appreciable amount of dry and wet weather inflow/infiltration (I/I). The City of Pontiac is in the process of complying with a Michigan Department of Environmental Quality (MDEQ) requirement to perform a study to identify and reduce the amount of I/I. It is estimated that the reduction of I/I flows will significantly reduce the wet weather flow into the plant.

The average dry weather flow into the treatment plant is approximately 47% domestic, 41% Commercial/Industrial, and 12% I/I, on an annual basis.

4.1.3 Land Availability

The East Boulevard Plant currently occupies approximately 18 acres. There is no City owned land in the vicinity of this site. However there is some space available where the abandoned trickling filters are located.

The Auburn Plant occupies approximately 18 acres. There are 40 acres of space available at the current site. Due to its close proximity to the Clinton River, all of the 40 acres may not be available due to potential flooding concerns.

4.1.4 Discharge Limits

The wastewater treatment plant discharges to the Clinton River. At the discharge point in the Clinton River, the 95% exceedance flow is 1.5 cubic feet per second. Due to the low flow and protected uses of the Clinton River, the wastewater treatment plant discharge has stringent limits on ammonia-nitrogen, phosphorus, CBOD and whole effluent toxicity. These limitations require tertiary treatment for the current and any proposed increased discharge. Tables 12 shows the current NPDES permit limits for the City of Pontiac Wastewater Treatment Plant.

Table 12. Current NPDES Permit Limits

Parameter	Average Effluent Discharge (mg/L)	Most Restrictive Monthly NPDES Discharge Limit (mg/L)	Most Restrictive Daily NPDES Discharge Limit (mg/L)
$CBOD_5$ (Five Day Carbonaceous Biochemical Oxygen Demand)	1.4	4	10
TSS (Total Suspended Solids)	3.78	20	30
Ammonia Nitrogen	0.32	0.5	2
Total Phosphorus	0.48	1	--
Chronic Toxicity		1	--
Acute Toxicity		--	1
Total Mercury		30 ng/L	--

4.2 Expansion of City of Pontiac Wastewater Treatment Plant

The expansion of the City of Pontiac Wastewater Treatment Plant was only considered at the Auburn Plant site due to a larger amount of land being available. It was assumed that the expansion would run in parallel to the existing treatment process, meaning the expanded treatment process would be independent of the current plant.

Three options were considered for the expansion of the Pontiac Wastewater Treatment Plant. The areas to be served by these various options are shown in Figure 7.

These options are:

- Option 1 involves intercepting the flow from the current Oakland Interceptor arm of the DWSD interceptor system (at a location near Perry Street) and a gravity sanitary sewer located within the existing Grand Trunk Western Railroad (GTWRR) property would deliver the flow to the Pontiac Wastewater Treatment Plant. A profile of the proposed gravity sewer is shown in Figure 9a.

- Option 2 includes the same area as Option 1, plus additional flow from the Paint Creek Interceptor. A gravity sewer would intercept the flow from the Paint Creek Interceptor (at Kern Road). This sewer would run south along Kern Road to Walton Blvd. From Walton, the flow would run from Perry Street west to a junction chamber located at Perry Street and the GTWRR. From the junction chamber a gravity sanitary sewer within the existing GTWRR property would deliver the flow (from both east and west) to the Pontiac Wastewater Treatment Plant. A profile of the proposed gravity sewer is shown in Figure 9b.

- Option 3 includes the same area as Option 1, plus additional flow that would be intercepted from the Clinton Oakland Interceptor after it collects the flow from Paint Creek Interceptor (west of the Oakland/Macomb counties border). From that location, a pump station and force main would direct the flow to a junction chamber located at Perry Street and the GTWRR. A proposed gravity sewer within the existing GTWRR property would deliver the flow (from both east and west) to the Pontiac Wastewater Treatment Plant. A profile of the proposed gravity sewer is shown in Figure 9c.

4.2.1 Flow

Average and peak dry weather flows for the alternatives of expanding Pontiac Wastewater Treatment Plant were projected for the target years 2000 and 2050.

The ratios used in the expanded treatment plant designs of maximum daily flow rate to the average daily flow rate for the three options are based on the ASCE curve as discussed in the Preliminary Flow Projections for Alternatives Analysis technical memorandum. Table 13 summarizes the flows for each alternative and the maximum day peaking factor.

Table 13. Pontiac Expansion Flow Information

Description	Population		Maximum Day Peaking Factor*		Flow			
					2000		2050	
	2000	2050	2000	2050	Average	Max. Day	Average	Max. Day
Pontiac Existing Flow	68,608	80,970	2.47	2.40	12.21	30.17	13.85	33.31
Option 1	145,449	164,837	2.18	2.14	18.43	40.19	21.10	45.07
Option 1 Total Flow to Pontiac	214,058	245,807	2.04	2.00	30.64	62.64	34.96	69.84
Option 2	189,457	233,726	2.09	2.01	25.33	52.84	30.78	62.01
Option 2 Total Flow to Pontiac	258,065	314,695	1.98	1.92	37.53	74.38	44.63	85.57
Option 3 Pumped Flow	111,937	149,951	2.28	2.17	18.82	42.87	23.90	51.85
Option 3	257,386	314,788	1.98	1.92	37.26	73.86	45.01	86.28
Option 3 Total Flow to Pontiac	325,994	395,757	1.91	1.85	49.47	94.28	58.86	108.62

Using the expected year 2050 population based wastewater flows from Table 13, Table 14 shows that the following expansion sizes are possible:

Table 14. Possible Expansion Sizes

Option	Expanded Plant Capacity (MGD)	Current Pontiac WWTP Capacity (MGD)	Total Capacity at Pontiac WWTP Site (MGD)
1	21.1	25.5	46.6
2	30.8	25.5	56.3
3	45.0	25.5	70.1

Table 15 shows the ratios used in the expanded treatment plant designs of maximum daily flow rate to the average daily flow rate for the three options are listed below:

Table 15. Peaking Factors

Option	Maximum Daily Flow / Average Daily Flow
1	2.14
2	2.01
3	1.92

A maximum peak hourly flow ratio of 3.5 was used for all three options. Due to the large difference in the peak hourly flow ratio and the maximum daily flow ratio, an equalization basin was designed to minimize the effect of the peak hourly flow rates on the treatment processes. Each option was sized with and without an equalization basin. For the options without an equalization basin, any flow greater than the maximum daily flow was assumed to continue down the interceptor system.

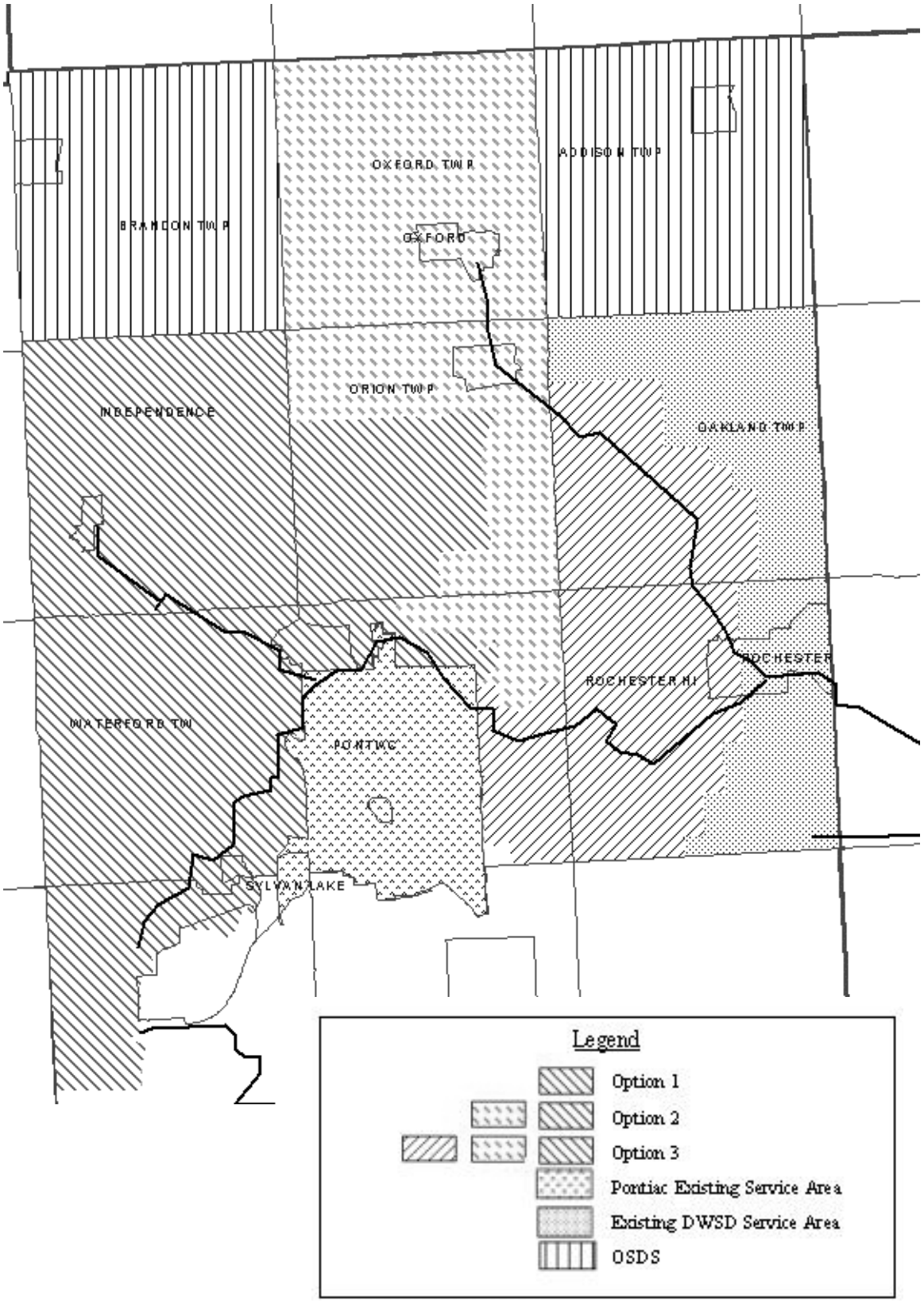


Figure 7. Areas to be served by expanded Pontiac Wastewater Treatment Plant options

4.2.2 Influent

The influent concentrations to the plant expansion were assumed to be similar to the existing water quality entering the City of Pontiac Wastewater Treatment Plant.

Table 16 shows the influent design concentrations used.

Table 16. Design Influent Concentrations

Parameter	Concentration	Unit
BOD 5 (Five Day Biochemical Oxygen Demand)	165	mg/L
TSS (Total Suspended Solids)	127	mg/L
Ammonia Nitrogen	15.8	mg/L
Total Phosphorus	3.0	mg/L

4.2.3 Treatment Process

Treatment at the expanded plant would consist of screening, grit removal, primary settling, aeration, secondary settling, filtration, and ultraviolet disinfection. Solids would be treated, dewatered, and disposed of in a landfill. For certain options, an equalization basin was sized to decrease the flow variations to downstream equipment. All treatment processes were designed to conform to Ten States Standards. The process layouts for these expansion plans are shown in Figures 8 and 8a.

Table 17 details the approximate sizes for the major treatment processes for the three options including an equalization basin.

Table 17. Expansion Treatment Process Sizes with an Equalization Basin

Treatment Process	Option 1 21.1 MGD	Option 2 30.8 MGD	Option 3 45.0 MGD
Primary Treatment			
Screening	Two – 7 ft. x 7 ft.	Two – 8 ft. x 8 ft.	Two – 9 ft. x 9 ft.
Grit Removal	45 ft. x 45 ft. x 15 ft. deep	55 ft. x 55 ft. x 15 ft. deep	65 ft. x 65 ft. x 15 ft. deep
Primary Settling	4 – 120 ft. diameter tanks	4 – 140 ft. diameter tanks	4 – 165 ft. diameter tanks
Equalization Basin	310 ft. x 310 ft. x 20 ft. deep (14.3 MG)	400 ft. x 400 ft. x 20 ft. deep (23 MG)	500 ft. x 500 ft. x 20 ft. deep (36 MG)

Table 17Continued. Expansion Treatment Process Sizes with an Equalization Basin

Treatment Process	Option 1 21.1 MGD	Option 2 30.8 MGD	Option 3 45.0 MGD
Secondary Treatment			
Aeration	4 – 115 ft. x 345 ft. x 15 ft. swd	4 – 125 ft. x 375 ft. x 15 ft. swd	4 – 160 ft. x 470 ft. x 15 ft. swd
Secondary Settling	4 – 140 ft. diameter tanks	4 – 160 ft. diameter tanks	4 – 190 ft. diameter tanks
Tertiary Treatment			
Filtration	6 cells – 40 ft. x 40 ft. each	6 cells – 40 ft. x 40 ft. each	6 cells – 50 ft. x 50 ft. each
UV Disinfection	130 ft. x 60 ft.	130 ft. x 60 ft.	150 ft. x 75 ft.
Solids Treatment			
Sludge Dewatering Storage	2 cells –30 ft. x 30 ft. x 10 ft. each	2 cells – 40 ft. x 30 ft. x 10 ft. each	2 cells – 50 ft. x 35 ft. x 10 ft. each
Sludge Storage Basins	4 cells – 10 ft. x 40 ft. x 10 ft. each	4 cells – 12 ft. x 40 ft. x 10 ft. each	4 cells – 15 ft. x 45 ft. x 10 ft. each

Table 18 shows the approximate treatment process sizes for the three options without an equalization basin.

Table 18. Expansion Treatment Process Sizes without an Equalization Basin

Treatment Process	Option 1 w/o basin 21.1 MGD	Option 2 w/o basin 30.8 MGD	Option 3 w/o basin 45.0 MGD
Primary Treatment			
Screening	Two – 7 ft. x 7 ft.	Two – 8 ft. x 8 ft.	Two – 10 ft. x 10 ft.
Grit Removal	35 ft. x 35 ft. x 15 ft. deep	40 ft. x 40 ft. x 15 ft. deep	50 ft. x 50 ft. x 15 ft. deep
Primary Settling	4 – 125 ft. diameter tanks	4 – 140 ft. diameter tanks	4 – 165 ft. diameter tanks
Secondary Treatment			
Aeration	4 – 110 ft. x 320 ft. x 15 ft. swd	4 – 125 ft. x 375 ft. x 15 ft. swd	4 – 155 ft. x 465 ft. x 15 ft. swd

Table 18 Continued. Expansion Treatment Process Sizes without an Equalization Basin

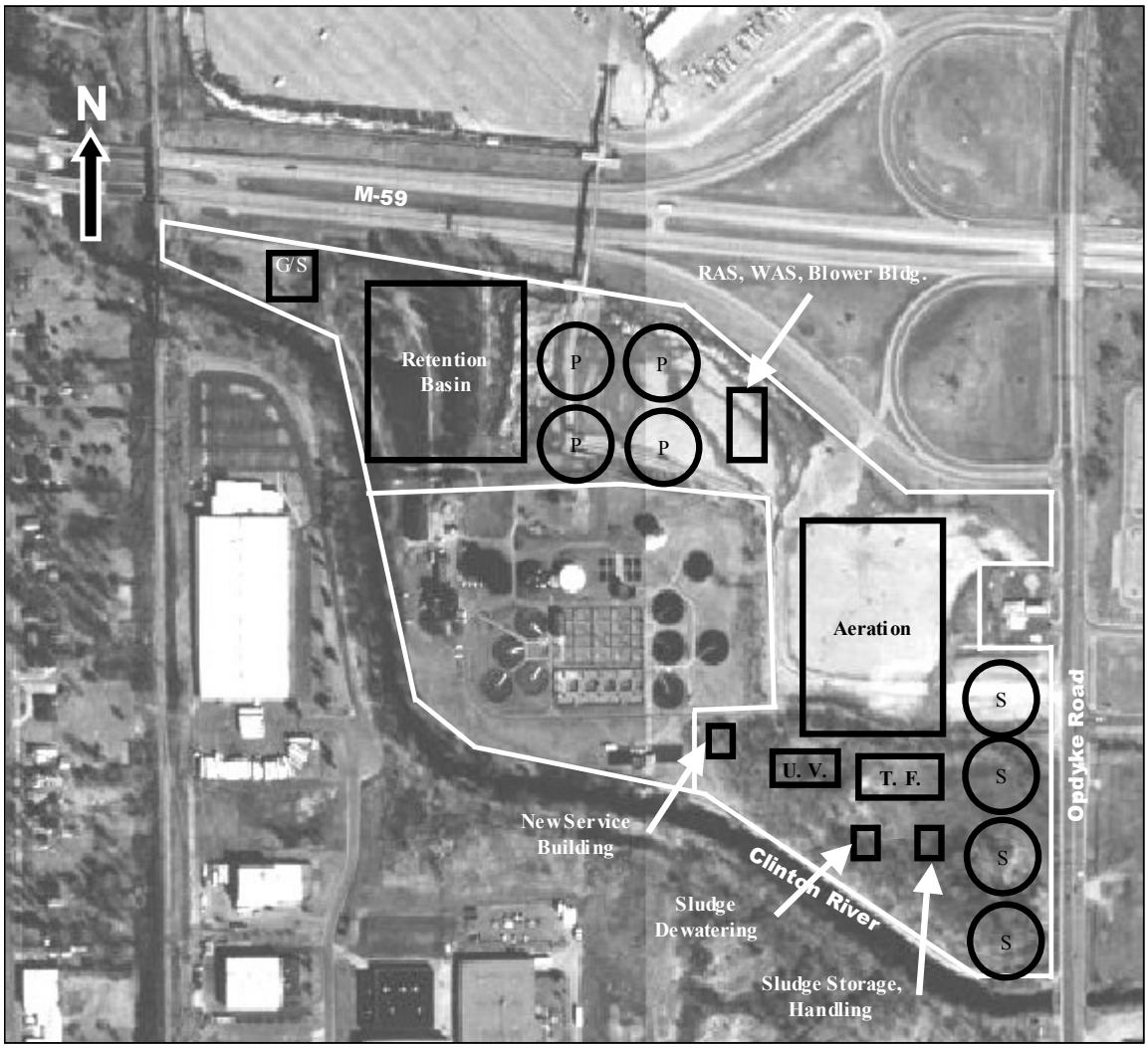
Treatment Process	Option 1 w/o basin 21.1 MGD	Option 2 w/o basin 30.8 MGD	Option 3 w/o basin 45.0 MGD
Secondary Settling	4 – 135 ft. diameter tanks	4 – 160 ft. diameter tanks	4 – 190 ft. diameter tanks
Tertiary Treatment			
Filtration	6 cells – 40 ft. x 40 ft. each	6 cells – 40 ft. x 40 ft. each	6 cells – 50 ft. x 50 ft. each
UV Disinfection	130 ft. x 60 ft.	130 ft. x 60 ft.	150 ft. x 75 ft.
Solids Treatment			
Sludge Dewatering Storage	2 cells – 30 ft. x 30 ft. x 10 ft. each	2 cells – 40 ft. x 30 ft. x 10 ft. each	2 cells – 30 ft. x 60 ft. x 10 ft. each
Sludge Storage Basins	4 cells – 10 ft. x 40 ft. x 10 ft. each	4 cells – 12 ft. x 40 ft. x 10 ft. each	4 cells – 15 ft. x 45 ft. x 10 ft. each

4.2.4 Discharge Limits and Effluent Quality

Table 19 shows what the expected discharge quality from the expanded plant would be.

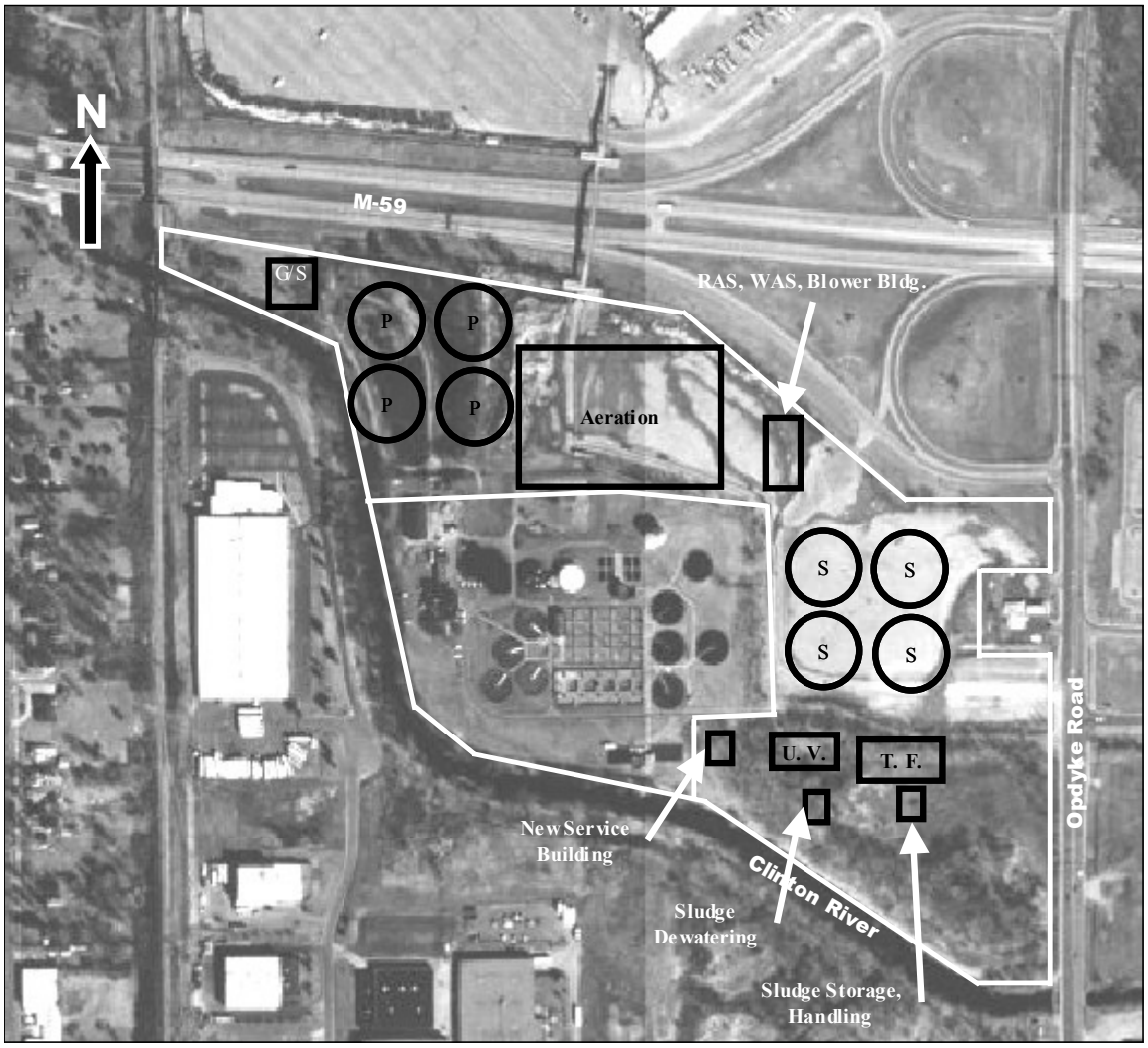
Table 19. Expected Effluent Quality

Parameter	Effluent Concentration (mg/L)	Current Pontiac WWTP NPDES Limits Monthly/Daily (mg/L)
CBOD5 (Five Day Carbonaceous Biochemical Oxygen Demand)	<4	4/10
TSS (Total Suspended Solids)	<10	20/30
Ammonia Nitrogen	<0.5	0.5/2
Total Phosphorus	<1	1/--



TOTAL MAXIMUM CAPACITY AT PONTIAC WWTP SITE: 74.2 MGD

Figure 8. Generic Layout of Expanded City of Pontiac WWTP with an Equalization Basin



TOTAL MAXIMUM CAPACITY AT PONTIAC WWTP SITE: 74.2 MGD

Figure 8a. Generic Layout of Expanded City of Pontiac WWTP without an Equalization Basin

4.2.5 Conveyance System Description and Cost

Figures 9a, 9b, and 9c illustrate the conveyance routes and sizes for the three expansion options. Below is a brief description of the conveyance options for delivering wastewater to the expanded City of Pontiac Wastewater Treatment Plant with an equalization basin.

- Option 1 involves installing a 60-inch pipe to deliver the wastewater from the current Oakland Interceptor arm of the DWSD interceptor system to the Pontiac Wastewater Treatment Plant site. This system would involve tunneling approximately 12,000 linear feet. The cost of this option is approximately $39.6 million.

- Option 2 involves installing four different segments of pipe to deliver wastewater from the current DWSD interceptor system to the Pontiac Wastewater Treatment Plant site. Segment 'A' involves 7,500 linear feet of 48-inch pipe. Segment 'B' involves 12,500 linear feet of 54-inch pipe. Segment 'C' involves 23,500 linear feet of 60-inch pipe. Segment 'D' involves 12,000 linear feet of 72-inch pipe. All of the segments would be located in a tunnel. The cost of this option is approximately $184.4 million.

- Option 3 involves installing an 84 MGD pump station, 52,000 linear feet of 72-inch force main and 12,000 linear feet of 72-inch gravity sewer to deliver the wastewater from the current DWSD interceptor system to the Pontiac Wastewater Treatment Plant site. This system would involve tunneling approximately 12,000 linear feet. The cost of this option is approximately $92.7 million.

Below is a brief description of the conveyance options for delivering wastewater to the expanded City of Pontiac Wastewater Treatment Plant without an equalization basin.

- Option 1 involves installing a 48-inch pipe to deliver the wastewater from the current Oakland Interceptor arm of the DWSD interceptor system to the Pontiac Wastewater Treatment Plant site. This system would involve tunneling approximately 12,000 linear feet. The cost of this option is approximately $36.0 million.

- Option 2 involves installing four different segments of pipe to deliver wastewater from the current DWSD interceptor system to the Pontiac Wastewater Treatment Plant site. Segment 'A' involves 7,500 linear feet of 36-inch pipe. Segment 'B' involves 12,500 linear feet of 48-inch pipe. Segment 'C' involves 23,500 linear feet of 48-inch pipe. Segment 'D' involves 12,000 linear feet of 60-inch pipe. All of the segments would be located in a tunnel. The cost of this option is approximately $169 million.

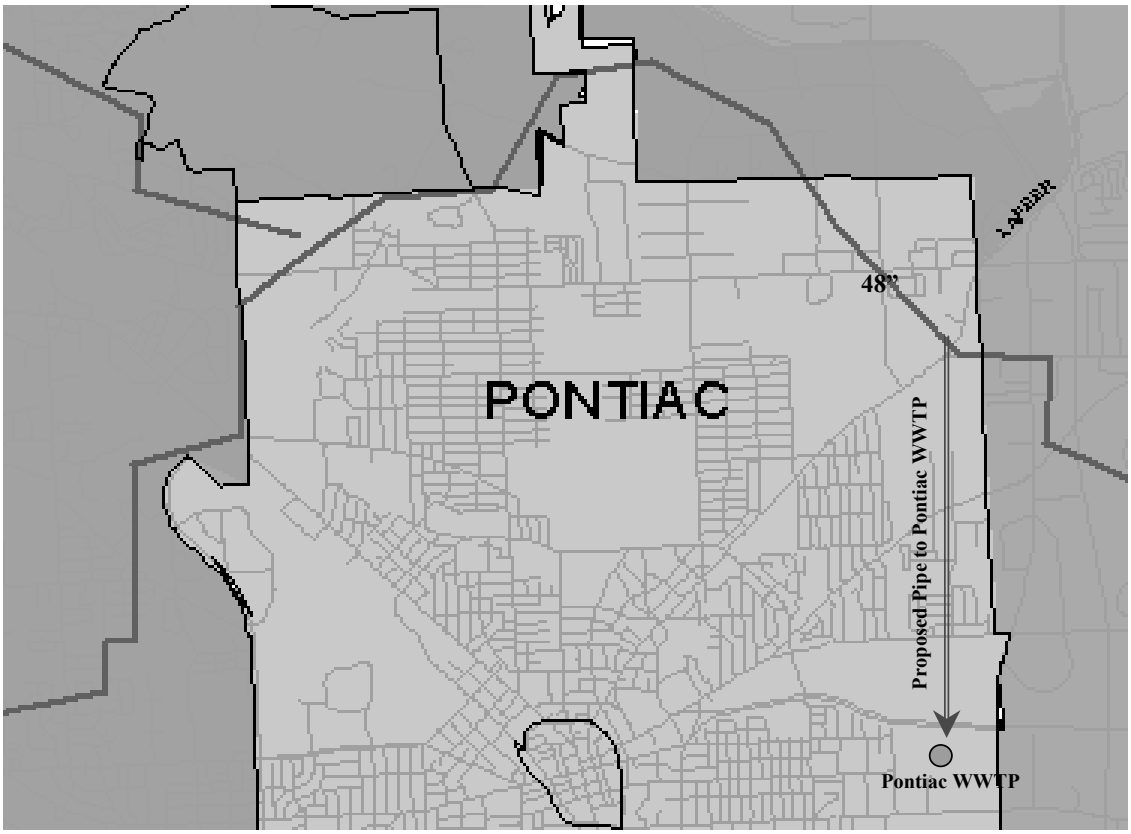
- Option 3 involves installing a 48 MGD pump station, 52,000 linear feet of 60-inch force main and 12,000 linear feet of 60-inch gravity sewer to deliver the wastewater from the current DWSD interceptor system to the Pontiac Wastewater Treatment Plant site. This system would involve tunneling approximately 12,000 linear feet. The cost of this option is approximately $72.0 million.

4.2.6 Cost Summary

Table 20 summarizes the cost associated with the various expansion options.

Table 20. Pontiac Cost Summary

Costs	Option 1 21.1 MGD	Option 1 w/o basin 21.1 MGD	Option 2 30.8 MGD	Option 2 w/o basin 30.8 MGD	Option 3 45.0 MGD	Option 3 w/o basin 45.0 MGD
Capital (Million $)	120.6	96.4	170.5	137.5	237.5	185.7
Annual O&M (Million $)	12.2	9.3	14.3	13.1	20.6	18.7
Conveyance (Million $)	39.6	36.0	184.4	169.0	92.7	72.0
Capital Cost per gallon/day ($/gal./day)	5.72	4.57	5.54	4.46	5.28	4.13
Capital and Conveyance Cost per gallon/day ($/gal./day)	7.59	6.27	11.52	9.95	7.34	5.73



Note: Pipe size shown on above figure is the existing interceptor diameter

Figure 9a. Conveyance Modification and Sewer Profile for the Expansion of the Pontiac Wastewater Treatment Plant - Option 1

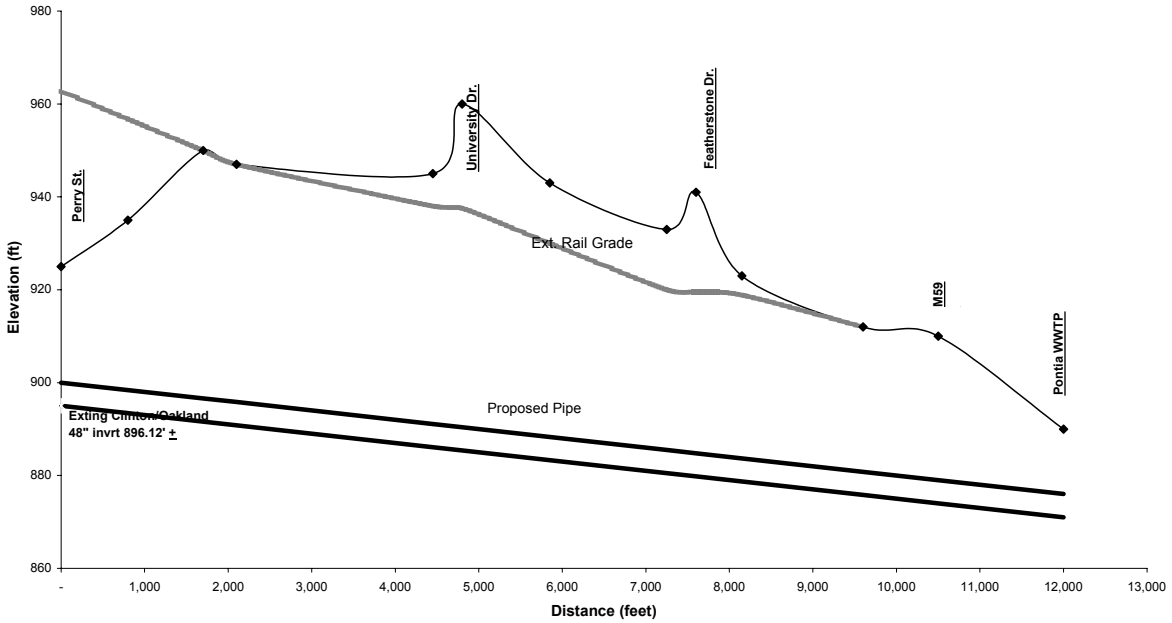
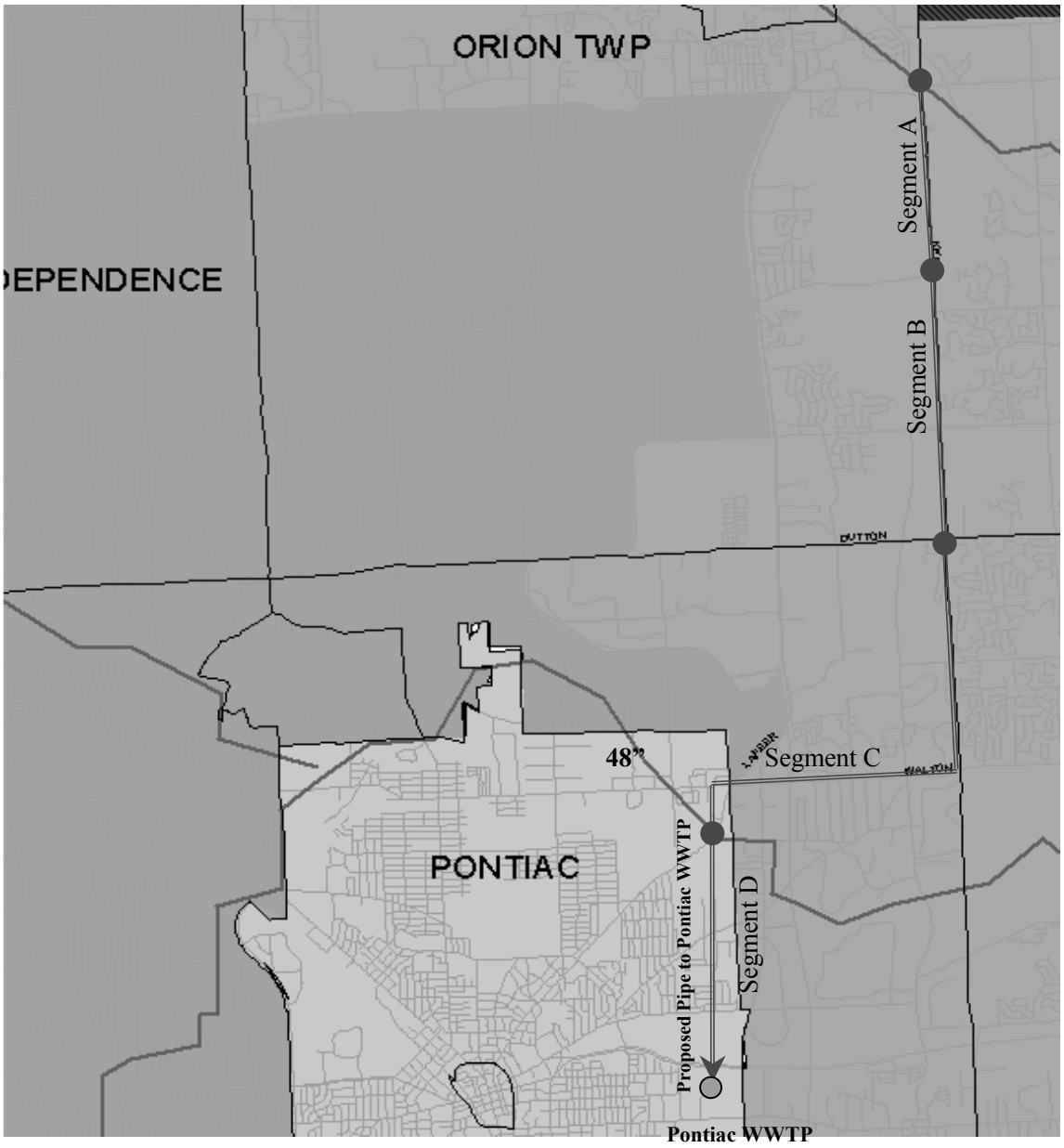
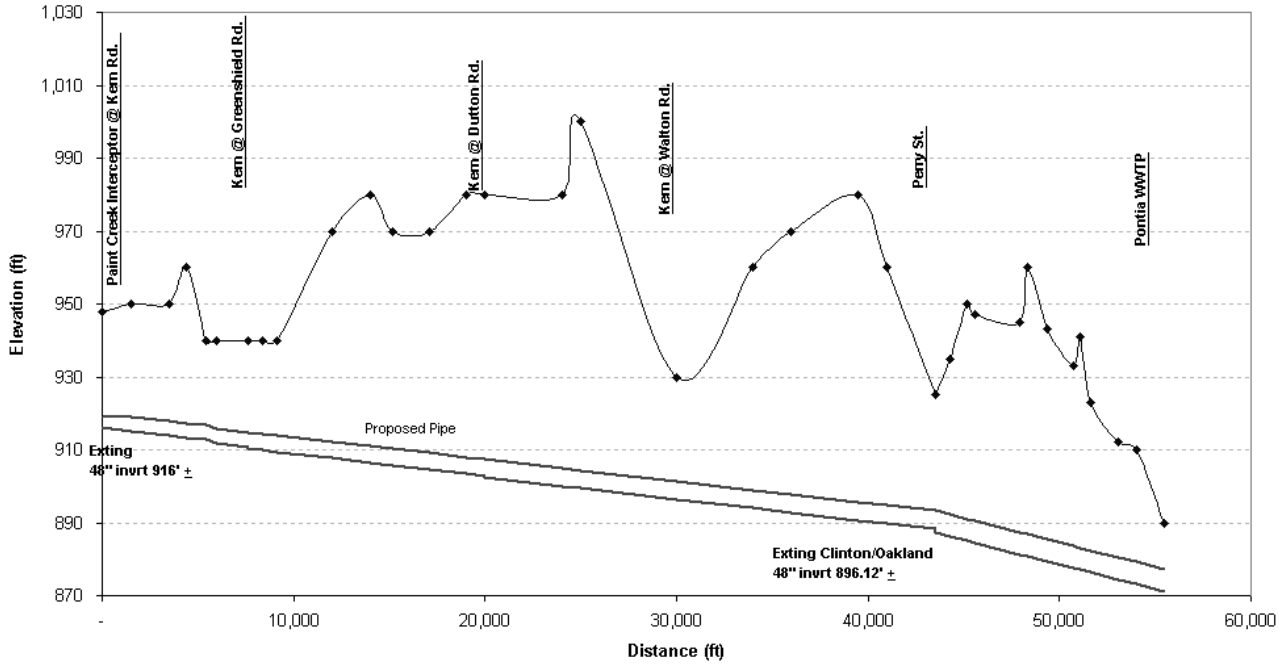


Figure 9a (cont). Conveyance Modification and Sewer Profile for the Expansion of the Pontiac Wastewater Treatment Plant - Option 1



Note: Pipe size shown on above figure is the existing interceptor diameter

Figure 9b. Conveyance Modification and Sewer Profile for the Expansion of the Pontiac Wastewater Treatment Plant - Option 2



Note: Pipe size shown on above figure is the existing interceptor diameter

Figure 9b (cont). Conveyance Modification and Sewer Profile for the Expansion of the Pontiac Wastewater Treatment Plant - Option 2

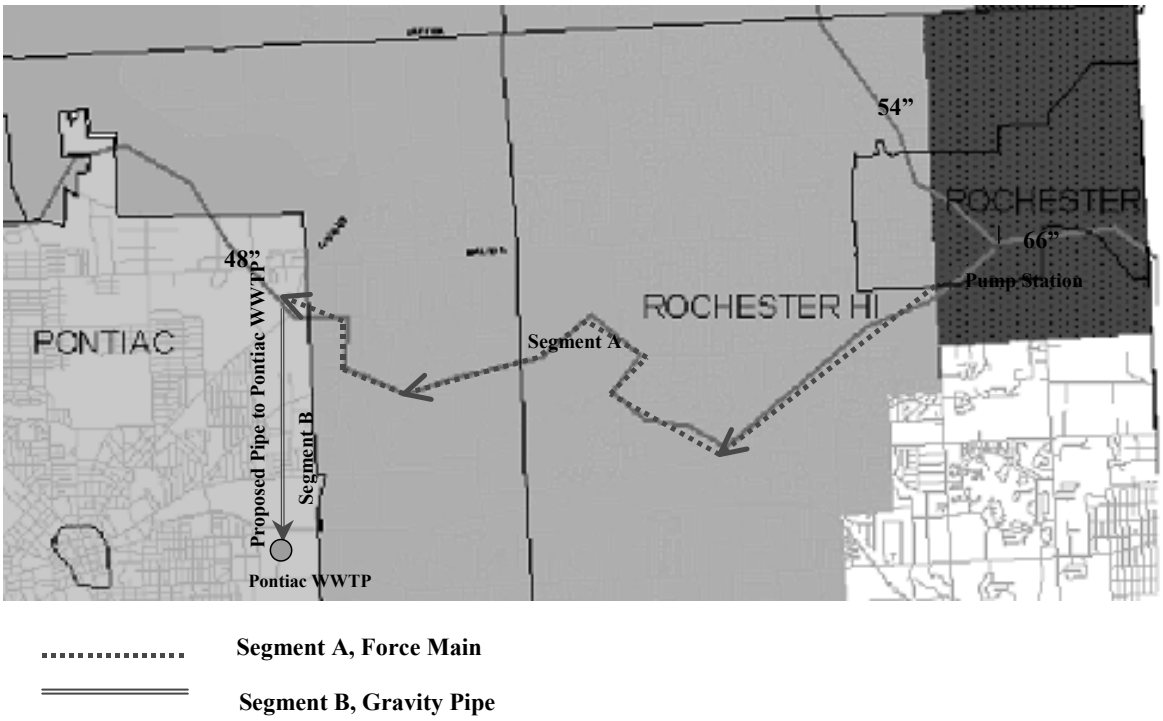


Figure 9c. Conveyance Modification and Sewer Profile for the Expansion of the Pontiac Wastewater Treatment Plant Option 3

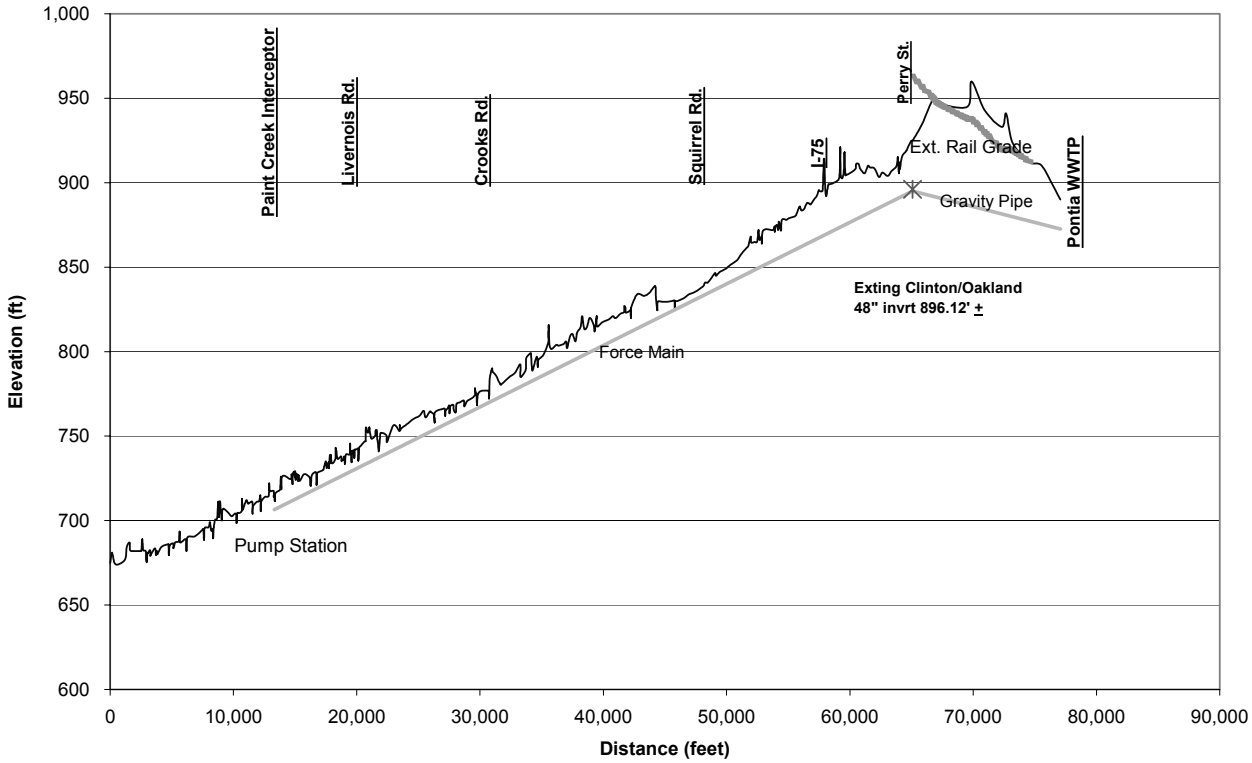


Figure 9c (cont). Conveyance Modification and Sewer Profile for the Expansion of the Pontiac Wastewater Treatment Plant - Option 2

4.3 Current City of Warren Wastewater Treatment Plant

The City of Warren Wastewater Treatment Plant was constructed in 1959 and was later expanded to the present capacity of 36 mgd. The wastewater treatment plant serves a population of approximately 132,877 people based on SEMCOG 2000 Census data.

The wastewater treatment plant is located in the northeast corner of the City of Warren. The raw wastewater is brought into the plant through an 84-inch and a 78-inch pipe. The treated wastewater is discharged into the Red Run Drain, which is a tributary to the Clinton River.

4.3.1 Treatment Processes

Treatment at the Warren Wastewater Treatment Plant consists of screening, flow equalization, grit removal, primary settling, aeration, secondary settling, mixed media filtering and effluent disinfection. Process sizes for primary treatment are shown in Table 21.

Table 21. Primary Treatment Sizes

Primary Treatment Process	Description
Screening	3 - 4 ft. x 9 ft.
Grit Removal	100 ft. x 40 ft.
Primary Settling	8 – 180 ft. x 20 ft. x 10 ft
Flow Equalization	1100 ft. x. 450 ft. x 14.5 ft

Secondary treatment consists of aeration and settling tanks. Phosphorus removal is performed in the aeration tanks by addition of ferrous chloride.

Table 22. Secondary Treatment Sizes

Secondary Treatment Process	Description
Aeration	6 – 75 ft. x 200 ft. x 17 ft.
Secondary Settling	8 – 100 ft diam x 12 ft swd

A portion of the filtered wastewater, approximately 220,000 gallons, is stored and used to backwash the filters. The wash water is returned to the aeration tanks.

Table 23. Tertiary Treatment Sizes

Tertiary Treatment Process	Description
Filters	12 – 24 ft. x 15 ft. x 13 ft.
Disinfection	110 ft. x 125 ft. x 13 ft.

The waste activated sludge is concentrated in four 250 sq. ft. thickening units. After the sludge is thickened, it is stored in two 204,000 gallon tanks. Sludge from the primary settling tanks is stored in four 68,000-gallon storage tanks. The two sludges are mixed in three 75,000 gallon blended sludge storage tanks. The blended sludge is dewatered in three 575 sq. ft. vacuum filters. The resulting sludge is conveyed to the sludge incinerator. The sludge incinerator is a 10-hearth 25-ft.-9-inch diameter incinerator. The ash from the incinerator is slurried using water from the scrubber system. The slurried ash is pumped to on-site ash settling lagoons. Overflow water from the lagoons is returned to the treatment plant. Dewatered ash is trucked from the ash lagoons to a landfill.

4.3.2 Flow Information

The average daily flow into the wastewater treatment plant is 23.2 mgd. During an average wet weather event, the wastewater flow increases to approximately 60.0 mgd. The wastewater treatment plant has an influent pump capacity of approximately 200 mgd. Occasionally the maximum influent pump capacity is utilized and the wastewater discharged is a blend of treated effluent.

The City of Warren has a separated sewer system. However, due to the age of the conveyance system, there is an appreciable amount of dry and wet weather inflow/infiltration (I/I). The average dry weather flow into the treatment plant on an annual basis is approximately 65% domestic, 23% Commercial/Industrial and 12% I/I.

4.3.3 Land Availability

The current Warren Wastewater Treatment Plant occupies approximately 60 acres; this includes the equalization basin and ash lagoons. There are approximately 25 acres of land available southwest of the current facility. The area is located south of Big Beaver Creek and north of the Red Run Drain.

4.3.4 Discharge Limits

The wastewater treatment plant discharges into the Red Run Drain, a tributary to the Clinton River. At the discharge point into the Red Run Drain, the 95% exceedance flow is 1.0 cubic foot per second. Due to the low flow and protected uses of the Red Run Drain, the wastewater treatment plant discharge has stringent limits on ammonia-nitrogen, phosphorus and CBOD. These limitations require tertiary treatment by the current and any proposed increased discharge.

The current NPDES permit limits for the City of Warren Wastewater Treatment Plant are shown in Table 24.

Table 24. Current NPDES Permit Limits

Parameter	Monthly (mg/L)	Daily (mg/L)
CBOD5 (Five Day Carbonaceous Biochemical Oxygen Demand)	4	10
TSS (Total Suspended Solids)	20	30
Ammonia Nitrogen	0.5	2
Total Phosphorus	1	--

4.4 Expansion of City of Warren Wastewater Treatment Plant

The expansion of the City of Warren Wastewater Treatment Plant was considered at the property located south of Big Beaver Creek and north of Red Run Drain. It was assumed that the expansion would run in parallel to the existing treatment process, meaning the expanded treatment process would be independent of the current plant.

Two options were considered for the expansion of the Warren Wastewater Treatment Plant. The areas to be served by these various options are shown in Figure 10. Figures 11 and 11a illustrate the conveyance routes for the two expansion options.

These options are:

- Option 1 is based on intercepting flow from the Dequindre Interceptor west of the Warren Wastewater Treatment Plant. The flow in the Dequindre Interceptor at 14 Mile Road is mostly from the City of Troy in the 12 Towns District. The flow from the Dequindre Interceptor would be directed to the Warren Wastewater Treatment Plant by gravity. Figure 11a shows the existing interceptor elevations, wastewater treatment plant wet well elevation, and ground profile along 14 Mile Road.

- Option 2 is based on intercepting a constant flow from the Corridor Interceptor of the Macomb Sanitary District system and delivering the wastewater to the Warren Wastewater Treatment Plant site. This Option would require a pump station, since the invert of the existing interceptor is below the wet well at the Warren Wastewater Treatment Plant, as seen in Figure 11a.

4.4.1 Flow

Average and peak dry weather flows for the alternatives of expanding the Warren Wastewater Treatment Plant were projected for the target years 2000 and 2050. The ratios used in the expanded treatment plant designs of maximum daily flow rate to the average daily flow rate for the two options are based on the ASCE curve as discussed in the "Flow Projections Technical Memorandum".

Table 25 summarizes the average and maximum day flows for each alternative and the maximum day peaking factor.

Table 25. Warren Expansion Flow Information

Description	Population		Maximum Day Peaking Factor*		Flow			
					2000		2050	
	2000	2050	2000	2050	Average	Max. Day	Average	Max. Day
Option 1 - Troy in 12 Town District	66,826	64,250	2.48	2.50	13.8	34.2	14.0	35.0
Option 2 –								
Flow in the Edison Corridor Interceptor by Warren (existing area)	677,157	850,243	1.69	1.62	90.4	152.8	109.2	176.9
Flow in the Corridor Interceptor by Warren (ultimate area)	751,412	1,034,936	1.66	1.57	100.1	166.2	128.7	202.1

*Peak Factor = 5 /P^(1/6), P is population in thousand

The flow for Option 2 is a constant 40 MGD intercepted from the Corridor Interceptor. As illustrated in Table 25, the flow in the interceptor for the existing and proposed service area exceeds 40 MGD.

Using the expected year 2050 population-based wastewater flows from Table 25, Table 26 shows that the following expansion sizes are possible.

Table 26. Possible Expansion Sizes

Option	Expanded Plant Capacity (MGD)	Current Warren WWTP Capacity (MGD)	Total Capacity at Warren WWTP Site (MGD)
1	14.0	36.0	50.0
2	40.0	36.0	76.0

The ratios of maximum to average daily flows for the two expanded treatment plant design options are listed in Table 27.

Table 27. Peaking Factors

Option	Maximum Daily Flow / Average Daily Flow
1	2.5
2	1.0

A maximum peak hourly flow ratio of 3.5 was used for option 1. Due to the large difference in the peak hourly flow ratio and the maximum daily flow ratio, the current equalization basin was assumed to be available to minimize the effect of the peak hourly flow rates on the treatment processes.

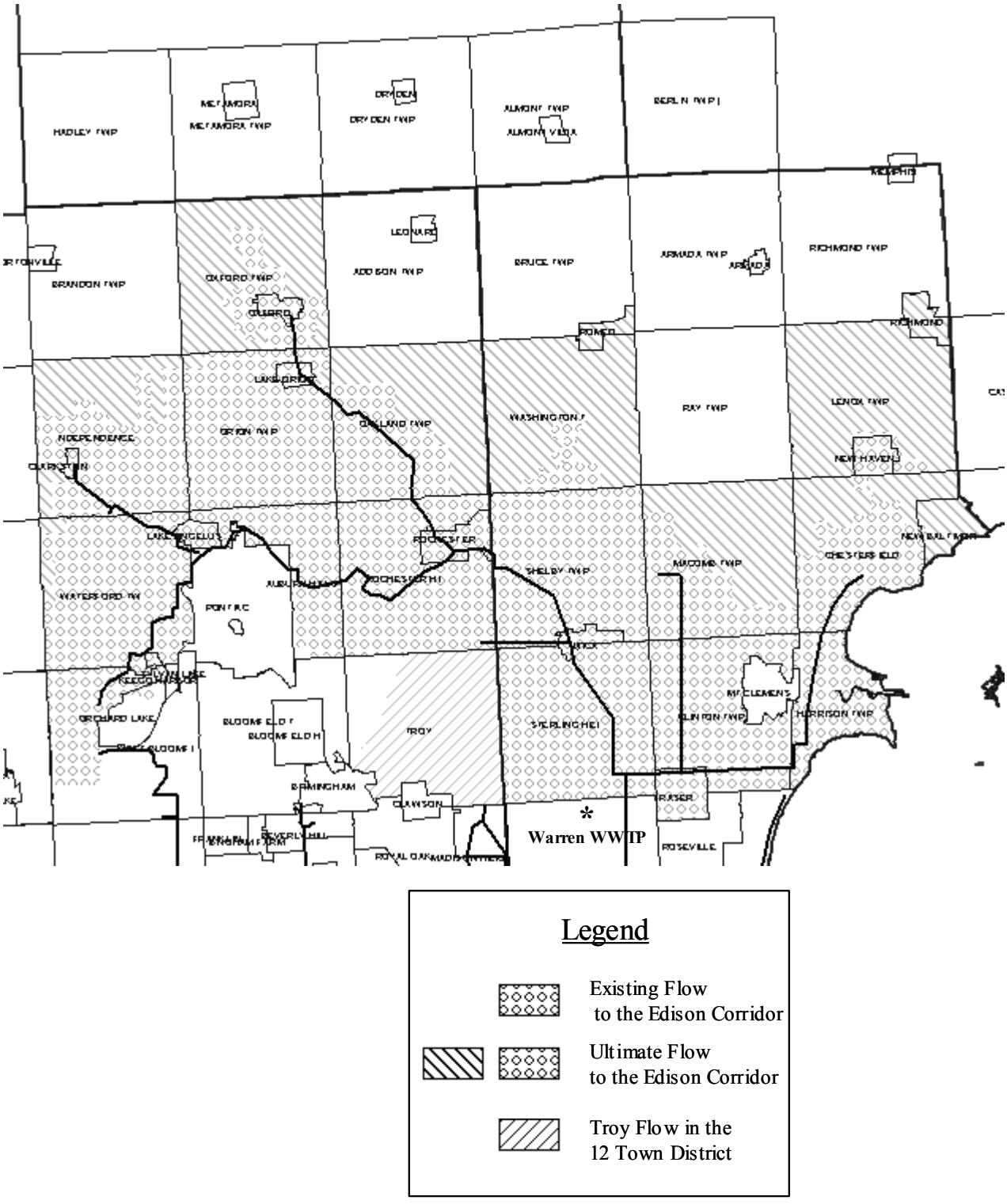


Figure 10. Areas to be served by expanded Warren WWTP options

4.4.2 Influent

The influent concentrations to the expanded plant were assumed to be similar to the existing water quality entering the City of Warren Wastewater Treatment Plant. Table 28 shows the influent design concentrations used.

Table 28. Design Influent Concentrations

Parameter	Concentration	Unit
BOD5 (Five Day Biochemical Oxygen Demand)	131	mg/L
TSS (Total Suspended Solids)	120	mg/L
Ammonia Nitrogen	13.9	mg/L
Total Phosphorus	4.7	mg/L

4.4.3 Treatment Process

Treatment at the expanded plant would consist of screening, grit removal, primary settling, aeration, secondary settling, filtration, and ultraviolet disinfection. Solids would be treated, dewatered, and disposed of in a landfill. All treatment processes were designed to conform to Ten States Standards. The process layout for these expansion plans are shown in Figure 12.

Table 29 shows the approximate sizes for the major treatment processes for the two options.

Table 29. Expansion Treatment Process Sizes

Treatment Process	Option 1 - 14 MGD	Option 2 - 40 MGD
Primary Treatment		
Screening	Two – 6 ft. x 6 ft.	Two – 5 ft. x 5 ft.
Grit Removal	35 ft. x 35 ft. x 15 ft. deep	35 ft. x 35 ft. x 15 ft. deep
Primary Settling	4 – 70 ft. diameter tanks	4 – 120 ft. diameter tanks
Secondary Treatment		
Aeration	4 – 75 ft. x 225 ft. x 15 ft. swd	3 – 95 ft. x 285 ft. x 15 ft. swd
Secondary Settling	4 – 115 ft. diameter tanks	4 – 130 ft. diameter tanks
Tertiary Treatment		
Filtration	4 cells –30 ft. x 45 ft. each	6 cells – 35 ft. x 35 ft. each
UV Disinfection	100 ft. x 50 ft.	100 ft. x 50 ft.
Solids Treatment		
Sludge Dewatering Storage	1 cell – 45 ft. x 45 ft. x 10 ft. each	2 cell – 50 ft. x 50 ft. x 15 ft. each
Sludge Storage Basins	4 cells – 10 ft. x 40 ft. x 10 ft. each	4 cells – 25 ft. x 40 ft. x 10 ft. each

4.4.4 Discharge Limits and Effluent Quality

The expected discharge quality from the expanded plant is shown in Table 30.

Table 30. Expected Effluent Quality

Parameter	Effluent Concentration (mg/L)	Current Warren WWTP NPDES Most Restrictive Limits Monthly/Daily (mg/L)
CBOD5 (Five Day Carbonaceous Biochemical Oxygen Demand)	<4	4/10
TSS (Total Suspended Solids)	<10	20/30
Ammonia Nitrogen	<0.5	0.5/2
Total Phosphorus	<1	1/--

4.4.5 Conveyance System Description and Cost

Figures 11 and 11a illustrate the conveyance routes and sizes for the two expansion options. Below is a brief description of the options.

- Option 1 involves intercepting the flow from the Dequindre Interceptor that is located west of the Warren Wastewater Treatment Plant. Bringing the wastewater to the expanded Warren Wastewater Treatment Plant would involve installing a 48-inch gravity sewer pipe of approximately 20,000 linear feet. The sewer pipe would have to be placed in a tunnel. The cost of this option would be approximately $43.8 million.

- Option 2 involves installing a 40 MGD pump station and 9,000 linear feet of 48-inch force main to deliver the wastewater from the Corridor Interceptor to the Warren Wastewater Treatment Plant site. The cost of this option would be approximately $10.2 million.

4.4.6 Cost Summary

Table 31 summarizes the cost associated with the various expansion options.

Table 31. Warren Cost Summary

Costs	Option 1 - 14.0 MGD	Option 2 - 40.0 MGD
Capital (Million $)	72.1	144.7
Annual O&M (Million $)	6.7	15.4
Conveyance (Million $)	43.8	10.2
Capital Cost per gallon/day ($/gal./day)	5.15	3.62
Capital and Conveyance Cost per gallon/day ($/gal./day)	8.28	3.87

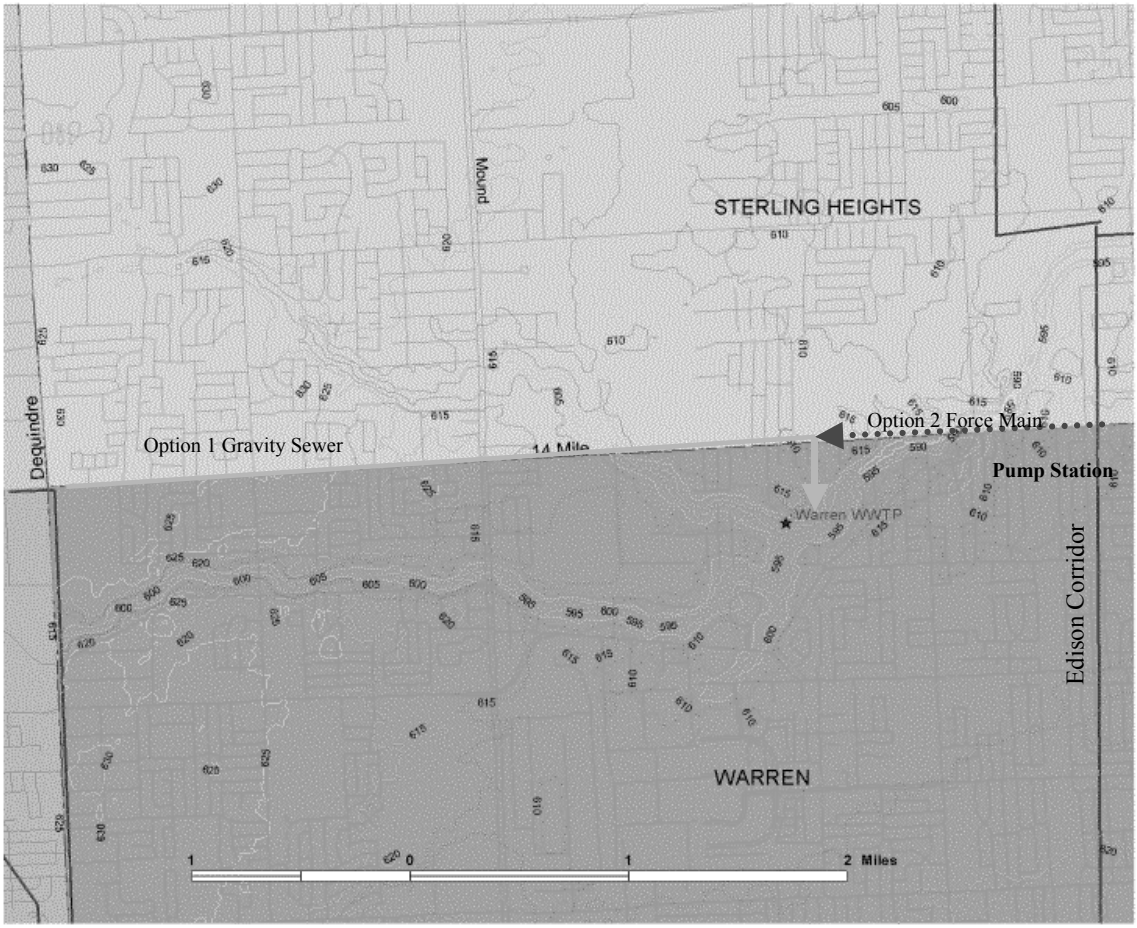


Figure 11. Conveyance Options for the Expansion of the Warren Wastewater Treatment Plant - Options 1 and 2

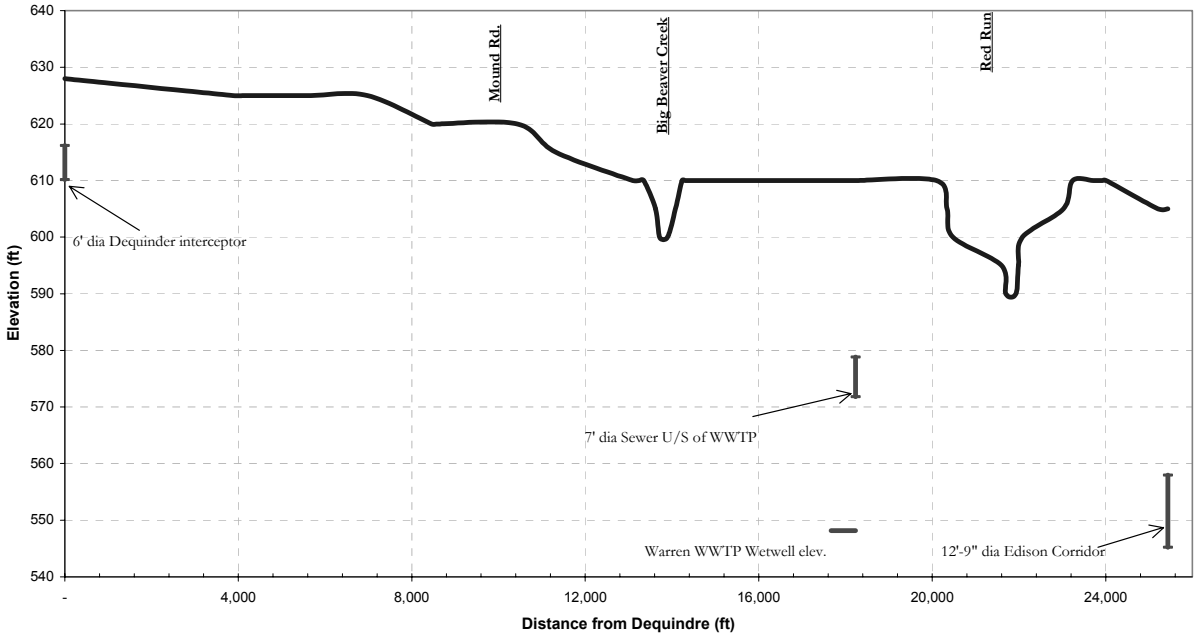
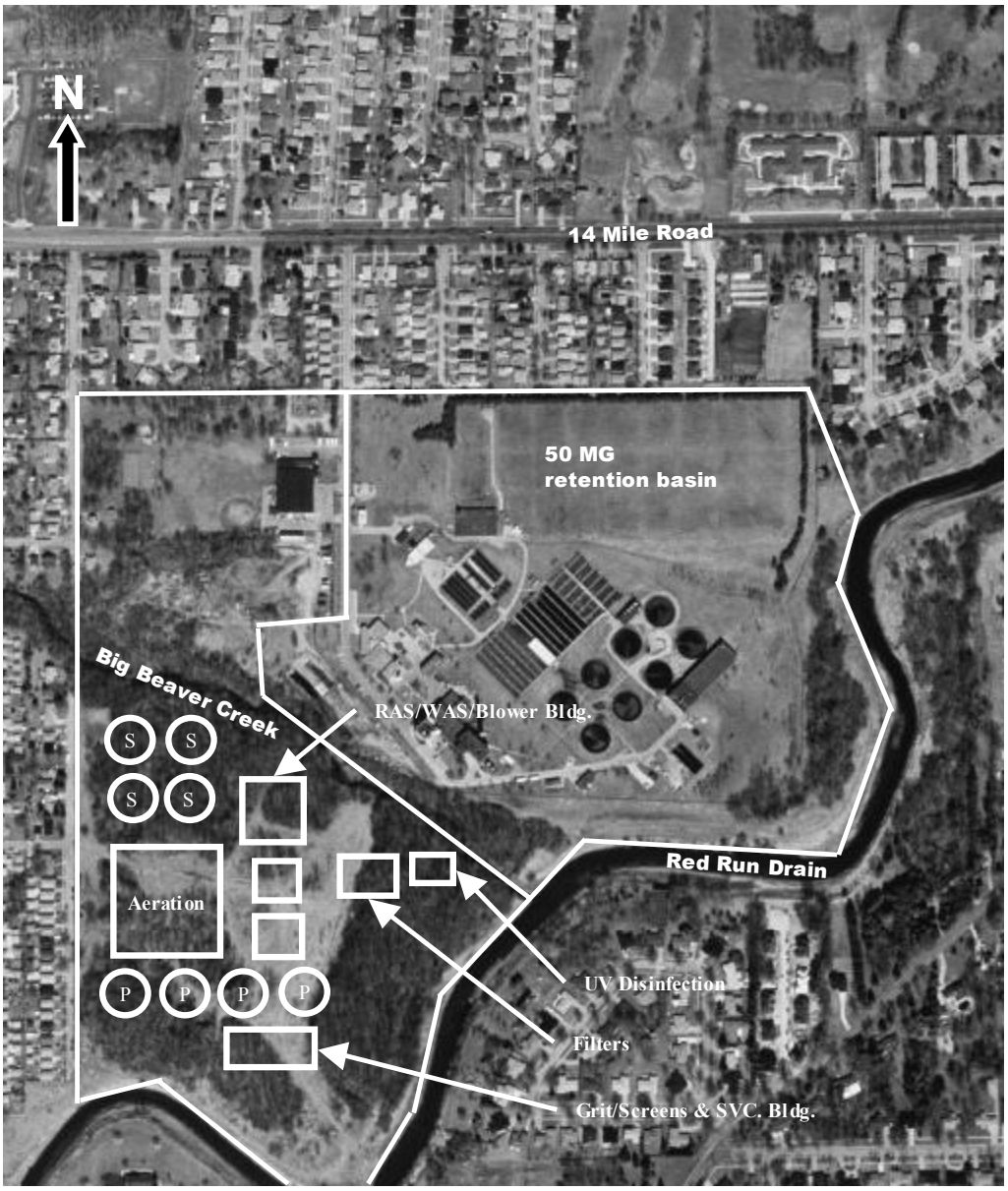


Figure 11a. Conveyance Option Profile for the Expansion of the Warren Wastewater Treatment Plant - Options 1 and 2



TOTAL MAXIMUM CAPACITY AT WARREN WWTP SITE: 76.0 MGD

Figure 12. Generic Layout of Expanded City of Warren - Wastewater Treatment Plant

4.5 Current City of Mount Clemens Wastewater Treatment Plant

The City of Mount Clemens Wastewater Treatment Plant was constructed in the 1920's and was later upgraded in the 1980's to the present capacity of 6.0 million gallons per day of tertiary treatment. The wastewater treatment plant serves a population of approximately 17,595 people based on SEMCOG 2000 Census data.

The wastewater treatment plant is located in the northeast corner of the City of Mount Clemens. The raw wastewater is brought into the plant through a 27-inch and a 36-inch pipe. The treated wastewater is discharged into the Clinton River.

Mount Clemens operates a 37 million gallon combined sewer overflow (CSO) retention basin. The basin is located across the Clinton River from the WWTP.

4.5.1 Treatment Processes

Treatment at the Mount Clemens Wastewater Treatment Plant consists of screening, grit removal, oxidation ditch, secondary settling, single media filtering, and effluent disinfection. Process sizes for primary treatment are shown in Table 32.

Table 32. Primary Treatment Sizes

Primary Treatment Process	Description
Screening	2 - 4 ft. x 5 ft. 4 in.
Grit Removal	2 - 21 ft. x 21 ft. x 14 ft. swd

Secondary treatment consists of an oxidation ditch and secondary settling. The oxidation ditch is comprised of a three channel oval shaped ditch. The wastewater enters the outer or middle channels of the ditch where it is given oxygen and velocity to circle within the oval channel by rotor-driven aeration disks. Phosphorus removal is performed in the oxidation ditch by addition of ferrous chloride. The oxidation ditch provides approximately 34 hours on contact time. Wastewater from the oxidation ditch goes to one of the two secondary clarifiers.

Table 33. Secondary Treatment Sizes

Secondary Treatment Process	Description
Oxidation Ditch	
Channel 1	903 ft. x 58 ft. x 12.75 ft.
Channel 2	588 ft. x 40 ft. x 12.75 ft.
Channel 3	329 ft. x 40 ft. x 12.75 ft.
Secondary Settling	2 – 120 ft diam x 14 ft swd

Wastewater from the secondary clarifiers in filtered through two single type media gravity sand filters. The filtered wastewater is disinfected by chlorine addition in two chlorine contact tanks with multiple pass chambers. The wastewater is then dechlorinated by addition of sulfur dioxide prior to discharge to the Clinton River.

Table 34. Tertiary Treatment Sizes

Tertiary Treatment Process	Description
Filters	2 – 16 ft. x 90 ft.
Disinfection	97 ft. x 54 ft. x 4.3 ft. 61 ft. x 20 ft. x 5.5 ft.

Sludge from the secondary clarifiers flows by gravity to the return sludge pump station, where it is either drawn off as waste activated sludge or returned to the oxidation ditch. The waste activated sludge is thickened in centrifuges and then sent to an aerobic sludge storage tank where it is mixed and injected with air. The thickened sludge can be pumped to trucks and delivered to agricultural sites for subsurface injection. Alternatively, the thickened sludge can be further dewatered by centrifuges, conveyed to a truck, and delivered to a landfill.

4.5.2 Flow Information

The average daily flow into the wastewater treatment plant is 3.8 mgd. The average daily design flow is 6.0 mgd. During wet weather flow, the wastewater flow increases to approximately 15.0 mgd.

The City of Mount Clemens has recently completed separation of the sanitary and storm sewer systems. However there is an appreciable amount of dry and wet weather inflow/infiltration (I/I).

4.5.3 Land Availability

The current Mount Clemens Wastewater Treatment Plant occupies approximately 34 acres.

There are approximately 100 acres of land east of the current facility that is currently used for industrial purposes. Thirty acres of the 100-acre area is currently undeveloped.

4.5.4 Discharge Limits

The wastewater treatment plant discharges into the Clinton River. At the discharge point into the Clinton River, the 95% exceedance flow is 110.0 cubic feet per second. Due to the protected uses of the Clinton River, the wastewater treatment plant discharge has stringent limits on ammonia-nitrogen, phosphorus and CBOD. These

limitations require tertiary treatment by the current and any proposed increased discharge.

The current NPDES permit limits for the City of Mount Clemens Wastewater Treatment Plant are shown in Table 35.

Table 35. Current NPDES Permit Limits

Parameter	Monthly (mg/L)	Daily (mg/L)
CBOD5 (Five Day Carbonaceous Biochemical Oxygen Demand)	4	10
TSS (Total Suspended Solids)	20	30
Ammonia Nitrogen	0.5	2
Total Phosphorus	1	--

4.6 Expansion of City of Mount Clemens Wastewater Treatment Plant

The expansion of the City of Mount Clemens Wastewater Treatment Plant was considered at the property located east of the current wastewater treatment plant. It was assumed that the expansion would run in parallel to the existing treatment process, meaning the expanded treatment process would be independent of the current plant.

Three options were considered for the expansion of the Mount Clemens Wastewater Treatment Plant. The areas to be served by these various options are shown in Figure 13. Figure 14 illustrates the conveyance routes for the three expansion options.

These options are:

- Option 1 is based on intercepting flow from the Lakeshore Interceptor east of the Mount Clemens Wastewater Treatment Plant. The flow in the Lakeshore Interceptor is mostly from Chesterfield Township, Clinton Township, Harrison Township, Lenox Township, and the City of New Haven. The flow from the Lakeshore Interceptor would be directed to the Mount Clemens Wastewater Treatment Plant by a lift station and new sewers. The new sewer will cross I-94. Figure 15a shows the existing interceptor elevation, wastewater treatment plant wet well elevation, and ground profile.

- Option 2 is based on intercepting flow from the Lakeshore Interceptor east of the Mount Clemens Wastewater Treatment Plant and the Garfield Interceptor west of the plant. The flow in the Lakeshore Interceptor is mostly from Chesterfield Township, Clinton Township, Harrison Township, Lenox Township, and the City of New Haven. The flow in the Garfield Interceptor is mostly from Bruce

Township, Macomb Township, Shelby Township, and Washington Township. The flow from the Lakeshore and Garfield Interceptors would be directed to the Mount Clemens Wastewater Treatment Plant by two independent lift stations and new sewers. The new sewer east of the plant will cross I-94. Figure 15b shows the existing interceptor elevations, wastewater treatment plant wet well elevation, and ground profile.

- Option 3 is based on intercepting flow from the 15 Mile Interceptor south of the Mount Clemens Wastewater Treatment Plant. The flow in the 15 Mile Interceptor west of Garfield is mostly from Bruce Township, Chesterfield Township, Clinton Township, the City of Fraser, Harrison Township, Lenox Township, Macomb Township, the City of New Haven, Shelby Township, the City of Sterling Heights, and Washington Township. The flow from the 15 Mile Interceptor would be directed to the Mount Clemens Wastewater Treatment Plant by a lift station and new sewers. Figure 15c shows the existing interceptor elevation, wastewater treatment plant wet well elevation, and ground profile.

4.6.1 Flow

Average and peak dry weather flows for the alternatives of expanding the Mount Clemens Wastewater Treatment Plant were projected for the target years 2000 and 2050. The ratios of maximum daily flow rates to the average daily flow rates for the two options are based on the ASCE curve as discussed in the "Flow Projections Technical Memorandum".

Table 36 summarizes the average and maximum day flows for each alternative and the maximum day peaking factor.

Table 36. Mount Clemens Expansion Flow Information

Description	Population		Maximum Day Peaking Factor*		Flow			
					2000		2050	
	2000	2050	2000	2050	Average	Max. Day	Average	Max. Day
Option 1 – Flow from Lakeshore Interceptor	54,120	106,528	2.57	2.30	6.8	17.5	11.3	25.8
Option 2 – Flow from Lakeshore and Garfield Interceptors	163,011	342,277	2.14	1.89	20.4	43.6	35.9	67.9
Option 3 – Flow from 15 Mile Interceptor	308,409	500,534	1.92	1.77	37.0	71.2	54.0	95.9

*Peak Factor = 5 /P^(1/6), P is population in thousand

Using the expected year 2050 population-based wastewater flows from Table 36, three expansion capacities were developed as indicated in Table 37.

Table 37. Possible Expansion Sizes

Option	Expanded Plant Capacity (MGD)	Current Mt. Clemens WWTP Capacity (MGD)	Total Capacity at Mt. Clemens WWTP Site (MGD)
1	11.3	6.0	17.3
2	35.9	6.0	41.9
3	54.0	6.0	60.0

*Peak Factor = 5 /P^(1/6), P is population in thousand

The ratios of maximum to average daily flows for the three expanded treatment plant design options are listed in Table 38.

Table 38. Peaking Factors

Option	Maximum Daily Flow / Average Daily Flow
1	2.3
2	1.9
3	1.8

A maximum peak hourly flow ratio of 3.5 was used for all the options. Due to the large difference in the peak hourly flow ratio and the maximum daily flow ratio, the current CSO basin was assumed to be available to minimize the effect of the peak hourly flow rates on the treatment processes.

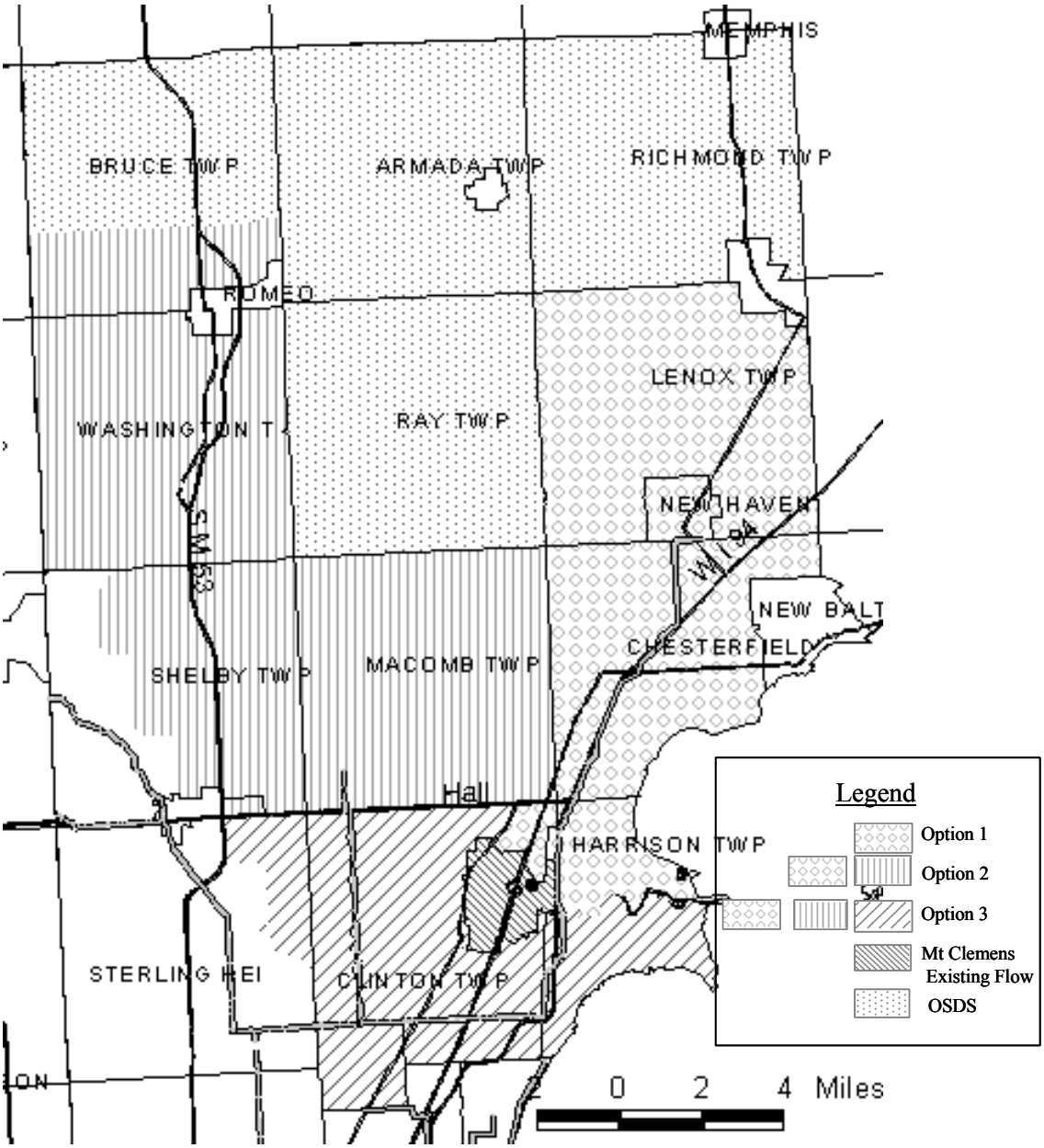


Figure 13. Areas to be served by expanded Mount Clemens WWTP options

4.6.2 Influent

The influent concentrations to the expanded plant were assumed to be similar to the existing water quality entering the City of Mount Clemens Treatment Plant. Table 39 shows the influent design concentrations used.

Table 39. Design Influent Concentrations

Parameter	Concentration	Unit
BOD5 (Five Day Biochemical Oxygen Demand)	131	mg/L
TSS (Total Suspended Solids)	120	mg/L
Ammonia Nitrogen	13.9	mg/L
Total Phosphorus	4.7	mg/L

4.6.3 Treatment Process

It was assumed that treatment at the expanded plant would consist of screening, grit removal, primary settling, aeration, secondary settling, filtration, and ultraviolet disinfection. Solids would be treated, dewatered, and disposed of in a landfill. All treatment processes were designed to conform to Ten States Standards. The process layouts for these expansion plans are shown in Figures 16a, 16b, and 16c.

Table 40 shows the approximate sizes for the major treatment processes for the three options.

Table 40. Expansion Treatment Process Sizes

Treatment Process	Option 1 11.3 MGD	Option 2 35.9 MGD	Option 2 54.0 MGD
Primary Treatment			
Screening	Two – 4 ft. x 6 ft.	Two – 5 ft. x 13 ft.	Three – 5 ft. x 10 ft.
Grit Removal	35 ft. x 35 ft. x 15 ft. deep	65 ft. x 65 ft. x 15 ft. deep	Two - 55 ft. x 55 ft. x 15 ft. deep
Primary Settling	4 – 100 ft. diameter tanks	4 – 155 ft. diameter tanks	6 – 145 ft. diameter tanks
Secondary Treatment			
Aeration	4 – 70 ft. x 220 ft. x 15 ft. swd	4 – 125 ft. x 375 ft. x 15 ft. swd	4 – 155 ft. x 465 ft. x 15 ft. swd
Secondary Settling	4 – 105 ft. diameter tanks	4 – 170 ft. diameter tanks	6 – 155 ft. diameter tanks
Tertiary Treatment			
Filtration	4 cells –35 ft. x 35 ft. each	6 cells – 45 ft. x 45 ft. each	6 cells – 52 ft. x 52 ft. each
UV Disinfection	45 ft. x 90 ft.	65 ft. x 130 ft.	80 ft. x 160 ft.
Solids Treatment			
Sludge Dewatering Storage	1 cell – 40 ft. x 40 ft. x 15 ft. each	1 cell – 70 ft. x 70 ft. x 15 ft. each	1 cell – 85 ft. x 85 ft. x 15 ft. each
Sludge Storage Basins	1 cell – 35 ft. x 35 ft. x 10 ft. each	1 cell – 62 ft. x 62 ft. x 10 ft. each	1 cell – 75 ft. x 75 ft. x 10 ft. each

4.6.4 Discharge Limits and Effluent Quality

The expected discharge quality from the expanded plant is shown in Table 41.

Table 41. Expected Effluent Quality

Parameter	Effluent Concentration (mg/L)	Current Warren WWTP NPDES Most Restrictive Limits Monthly/Daily (mg/L)
CBOD5 (Five Day Carbonaceous Biochemical Oxygen Demand)	<4	4/10
TSS (Total Suspended Solids)	<10	20/30
Ammonia Nitrogen	<0.5	0.5/2
Total Phosphorus	<1	1/--

4.6.5 Conveyance System Description and Cost

Figures 14, 15a, 15b, and 15c illustrate the conveyance routes and sizes for the three expansion options. Below is a brief description of the options.

- Option 1 involves intercepting flow from the Lakeshore Interceptor east of the Mount Clemens WWTP. Bringing the wastewater to the expanded Mount Clemens Wastewater Treatment Plant would involve installing a 26 MGD pump station, 500 linear feet of 42-inch force main to cross I-94, and a 42-inch gravity sewer pipe of approximately 4,000 linear feet. The cost of this option would be approximately $6.7 million.

- Option 2 is based on intercepting flow from both the Lakeshore Interceptor east of the Mount Clemens WWTP and the Garfield Interceptor west of the plant. Bringing the wastewater from the Lakeshore Interceptor to the expanded Mount Clemens Wastewater Treatment Plant would involve installing a 26 MGD pump station, 500 linear feet of 42-inch force main to cross I-94, and a 42-inch gravity sewer pipe of approximately 4,000 linear feet. Bringing the wastewater from the Garfield Interceptor to the expanded Mount Clemens Wastewater Treatment Plant would involve installing a 50 MGD pump station and 25,000 linear feet of 60-inch force main. The cost of this option would be approximately $31.4 million.

- Option 3 involves intercepting flow from the 15 Mile Interceptor south of the Mount Clemens WWTP. Bringing the wastewater from the 15 Mile Interceptor to the expanded Mount Clemens Wastewater Treatment Plant would involve installing a 96 MGD pump station and 35,000 linear feet of 72-inch force main. The cost of this option would be approximately $39.0 million.

4.6.6 Cost Summary

Table 42 summarizes the cost associated with the various expansion options.

Table 42. Mount Clemens Cost Summary

Costs	Option 1 11.3 MGD	Option 2 35.9 MGD	Option 3 54.0 MGD
Capital (Million $)	61.5	155.4	216.9
Annual O&M (Million $)	5.7	16.2	24.1
Conveyance (Million $)	6.7	31.4	39.0
Capital Cost per gallon/day ($/gal./day)	5.44	4.33	4.02
Capital and Conveyance Cost per gallon/day ($/gal./day)	6.04	5.20	4.74

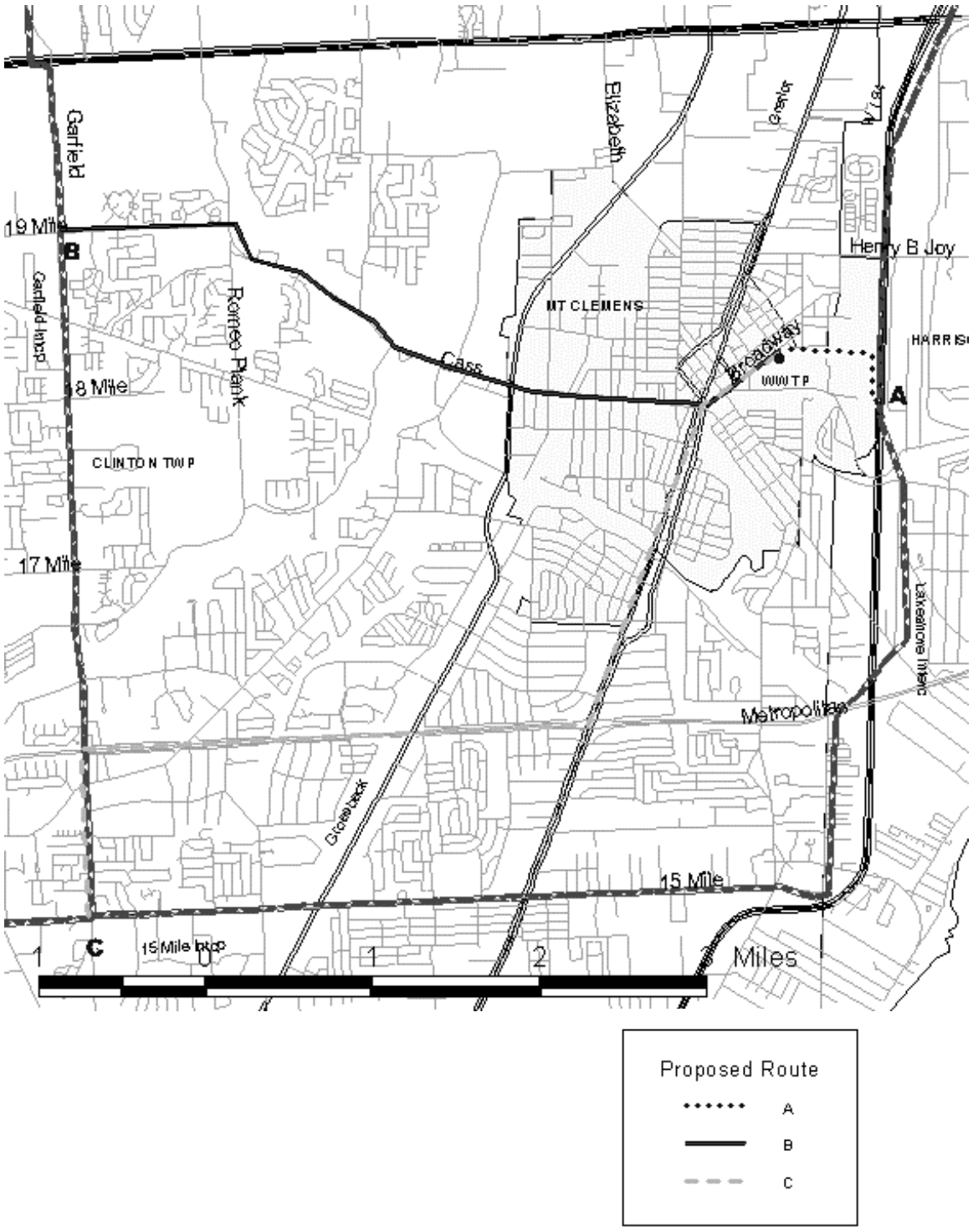


Figure 14. Conveyance Options for the Expansion of the Mount Clemens Wastewater Treatment Plant

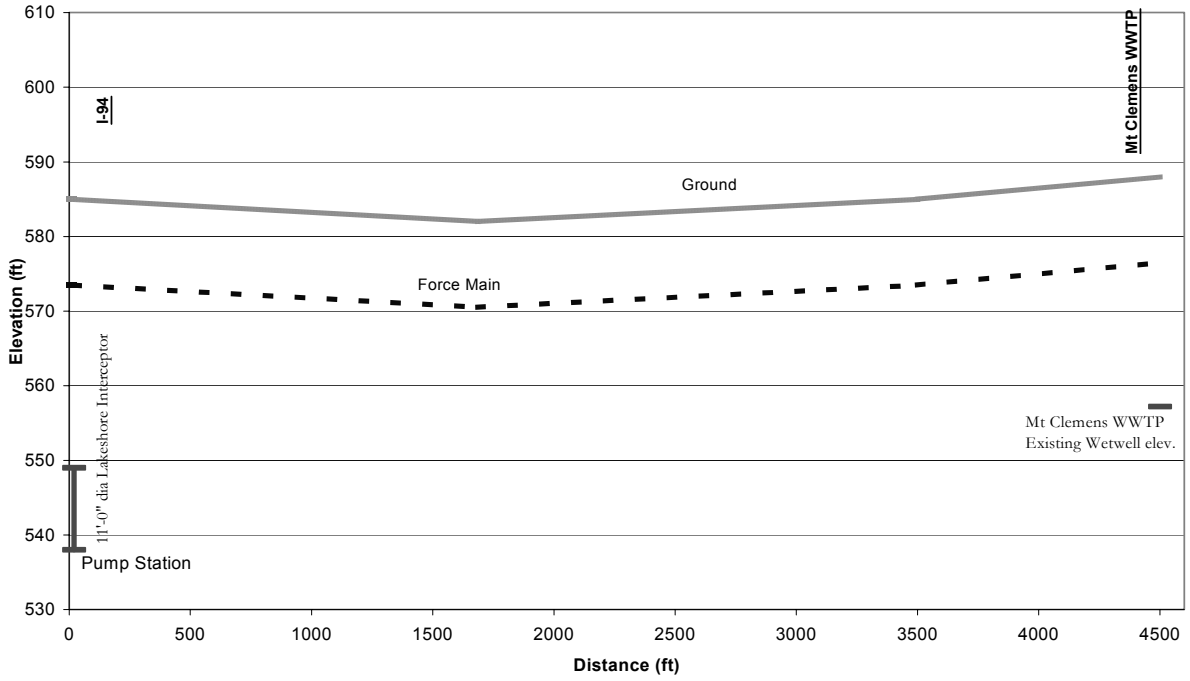


Figure 15a. Conveyance Options Profile Expansion of the Mount Clemens Wastewater Treatment Plant - Options 1 and 2, Route A

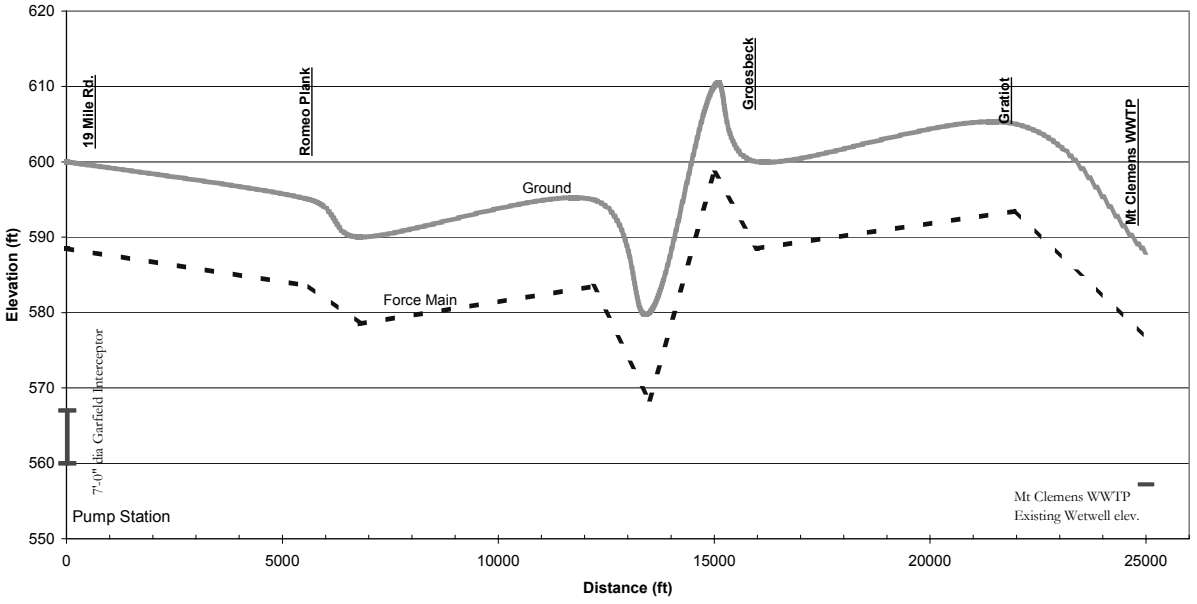


Figure 15b. Conveyance Options Profile - Expansion of the Mount Clemens Wastewater Treatment Plant, Option 2, Route B

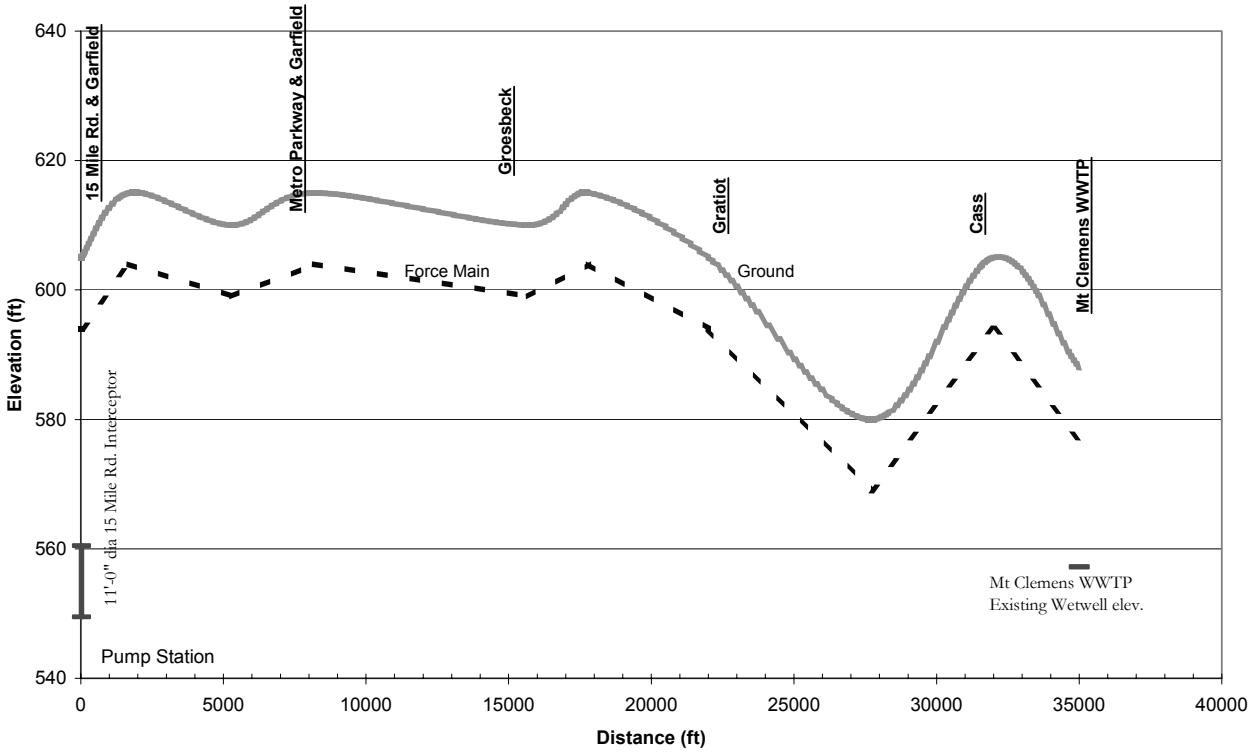


Figure 15c. Conveyance Options Profile - Expansion of the Mount Clemens Wastewater Treatment Plant, Option 3, Route C

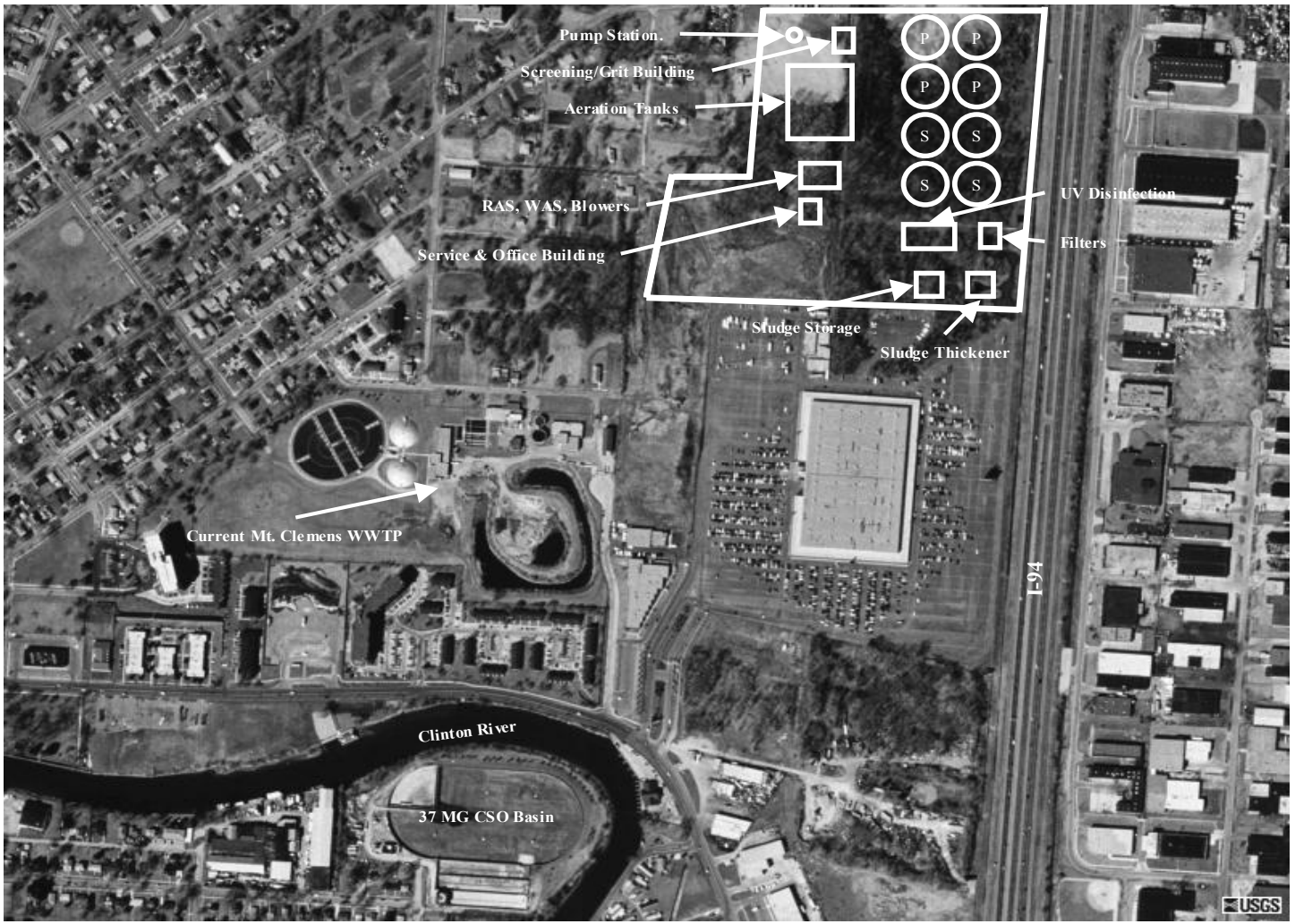


Figure 16a. Layout of Expanded City of Mount Clemens -11.3 MGD Wastewater Treatment Plant

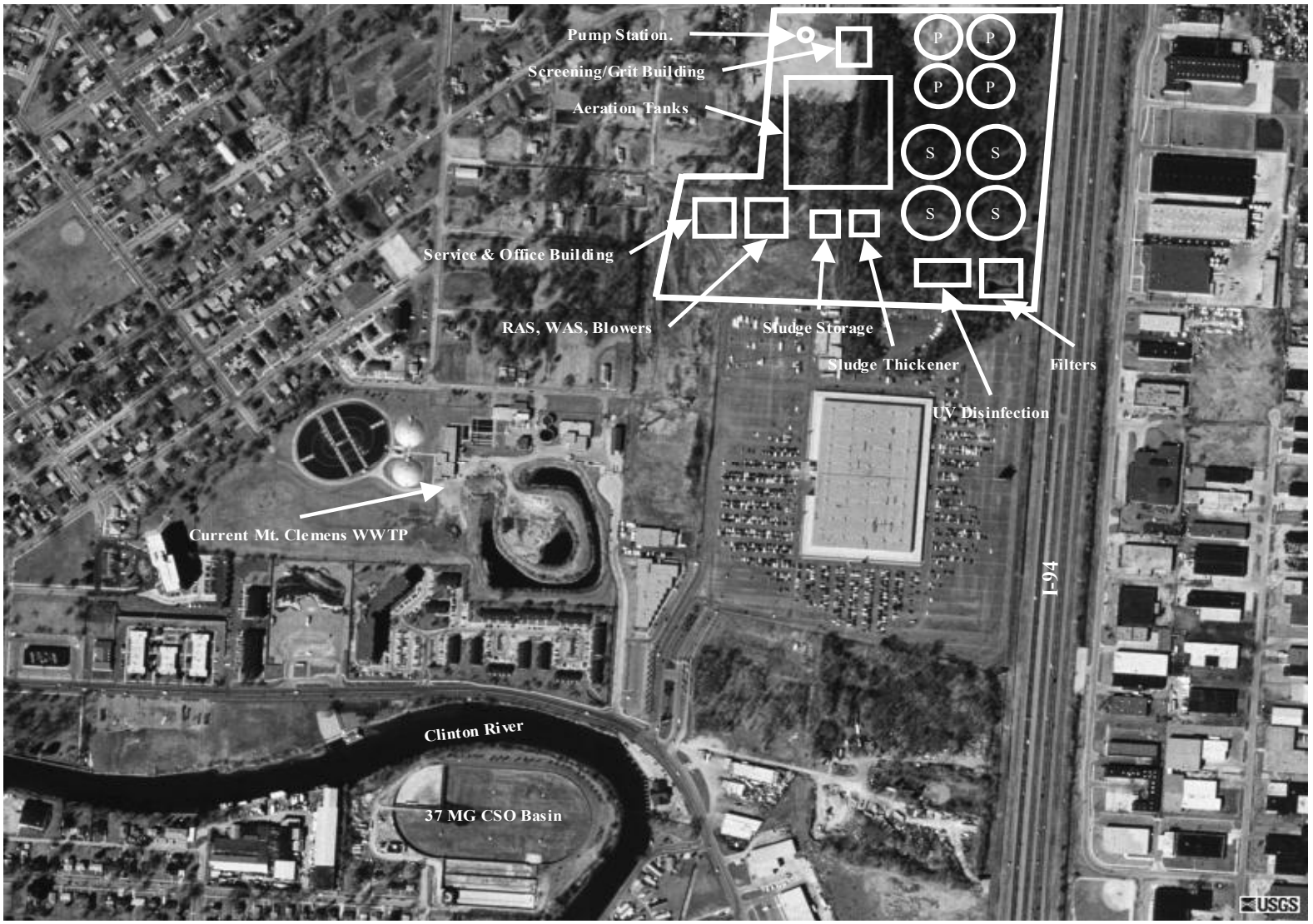


Figure 16b. Layout of Expanded City of Mount Clemens - 35.9 MGD Wastewater Treatment Plan

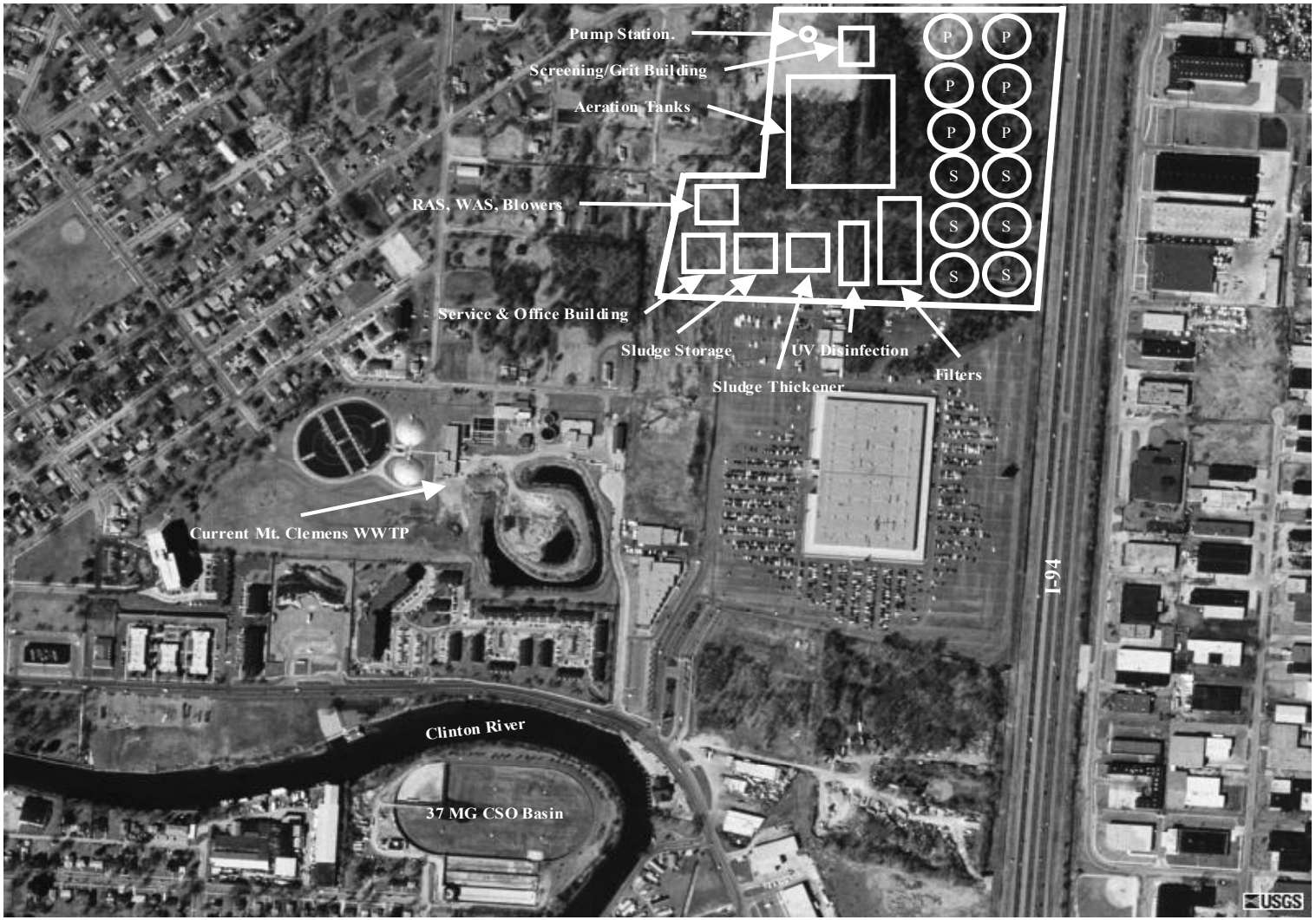


Figure 16c. Layout of Expanded City of Mount Clemens - 54.0 MGD Wastewater Treatment Plant

4.7 Construction of New Plant Discharging to the Clinton River

Possible locations for a new wastewater treatment plant that would discharge to the Clinton River were identified. Aerial photographs were used to identify undeveloped land that was located near the existing DWSD interceptors and the Clinton River. The chosen areas included undeveloped land near Oakland University, the Ford Motor Company Proving Grounds, and along M-59 east of the Macomb/Oakland County border.

The areas to be served by these various options are shown in Figure 17. Figures 18, 19, and 20 illustrate the conveyance routes for the three sites.

These options are:

1. Option 1 includes intercepting flow from the Clinton Oakland Interceptor and transporting it to a new wastewater treatment plant located south of the Chrysler Tech Center and East of I-75 at an undeveloped area near Oakland University. The flow from the interceptor would be pumped. A force main along Chrysler Drive going south and then east would carry the flow to the new wastewater treatment plant. A gravity sewer (effluent pipe) would discharge the treated flow to the Clinton River at a location by M-59 and East of Squirrel Road. Figure 18 shows the existing ground profile and the proposed influent and effluent pipes.

2. Option 2 includes intercepting flow from the Clinton Oakland Interceptor east of Dequindre and transporting it to a new wastewater treatment plant located east of Mound Road and north of 22 Mile Road at the Ford Motor Company Proving Grounds. The flow from the interceptor would be delivered to the new wastewater treatment plant by gravity flow. A gravity sewer (effluent pipe) would discharge the treated flow to the Clinton River. The proposed wastewater plant at this site would be located on or very close to the interceptor, so a profile was not developed for this option. Figure 19 shows the proposed conveyance system path.

3. Option 3 includes intercepting flow from the Oakland Arm and transporting it to a new wastewater treatment plant located south of M-59 and East of Dequindre Road. The flow from the interceptor would need to be pumped. A combination of a force main and a gravity sewer located south of M-59 would carry the flow to the new wastewater treatment plant. A gravity sewer effluent pipe would discharge the treated flow to the Clinton River. Figure 20 shows the existing ground profile and the proposed influent and effluent pipes.

Average and peak dry weather flows for the alternatives were projected for the target years 2000 and 2050. The ratios of maximum and average daily flow rates for the three options of the treatment plant designs are based on the ASCE curve as discussed in the "Flow Projections Technical Memorandum".

Table 43 summarizes the average and maximum day flows and the maximum day peaking factor for each alternative.

Table 43. Average and Peak Flow for Site Locations

Site Option	Description	Population		Maximum Day Peaking Factor*		Flow			
						2000		2050	
		2000	2050	2000	2050	Average	Max. Day	Average	Max. Day
1	Oakland University Area	145,449	164,837	2.18	2.14	18.4	40.2	21.1	45.1
2	Ford Motor Company Proving Grounds	305,805	405,735	1.93	1.84	44.7	86.2	56.3	103.5
3	East of Macomb/ Oakland Area (South of M59)	350,554	451,689	1.88	1.81	50.1	94.4	62.2	112.3

*Peak Factor = 5 /P^(1/6), P is population in thousand

Using the expected year 2050 population based wastewater flows from Table 43, Table 44 shows that the following expansion sizes are possible.

Table 44. Possible New Wastewater Treatment Plant Sizes

Location	Average Plant Capacity (MGD)	Maximum Plant Capacity (MGD)
Oakland University	21.1	45.1
FOMOCO Proving Grounds	56.3	104
East of Macomb/Oakland Co.	62.2	113

Table 45 shows the ratios of maximum daily to average daily flow used for the three new wastewater treatment plant options:

Table 45. Peaking Factors

Location	Maximum Daily Flow / Average Daily Flow
Oakland University	2.14
Ford Proving Grounds	1.84
East of Macomb/Oakland Co.	1.81

The same ratios were used to calculate the peak hourly flow. The system would be designed such that flow in the interceptor that exceeds the maximum design flow would travel past the new plant and be treated at a downstream plant or the existing DWSD Wastewater Treatment Plant.

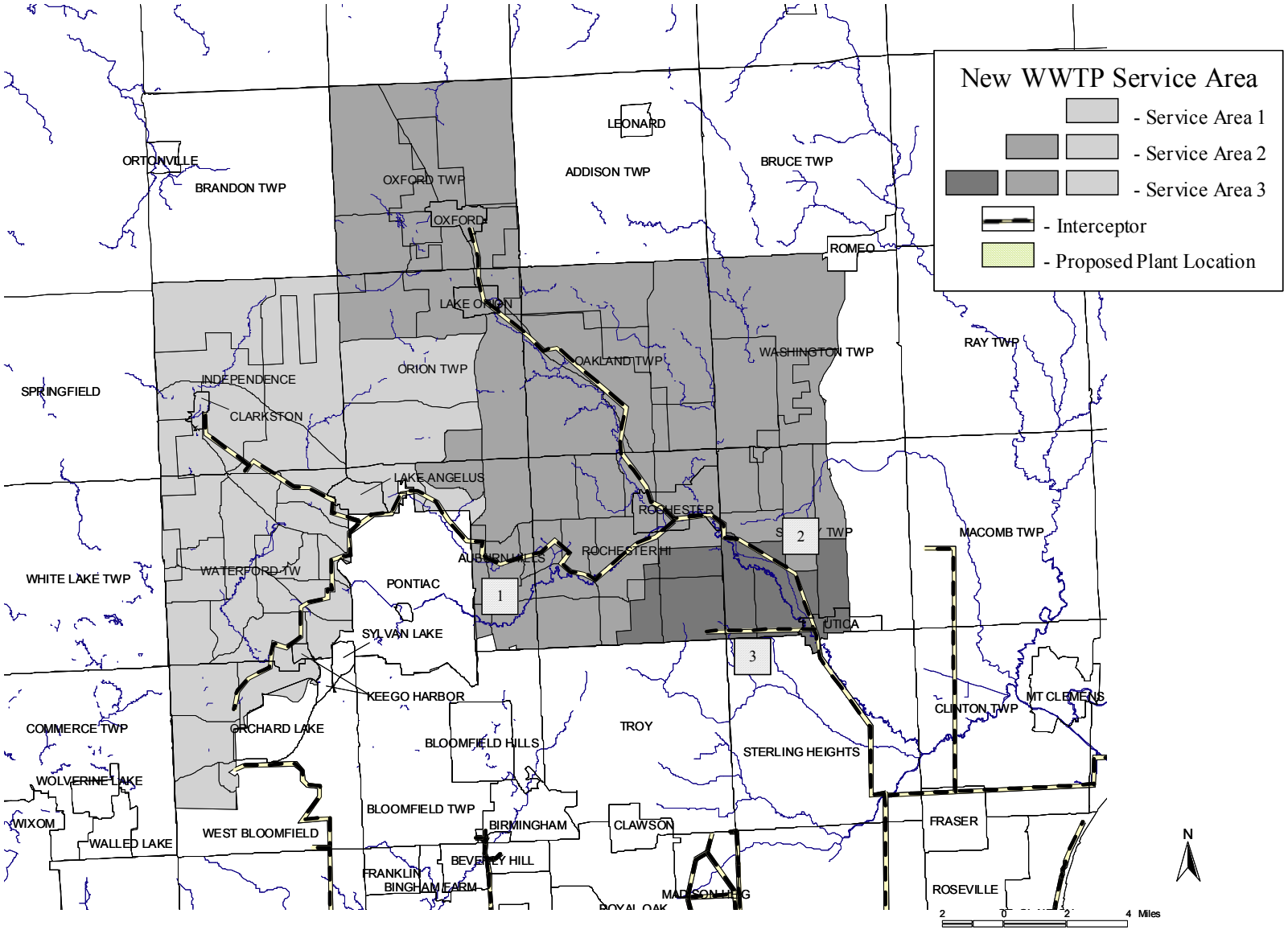


Figure 17. Areas to be served by new wastewater treatment plant discharging to Clinton River

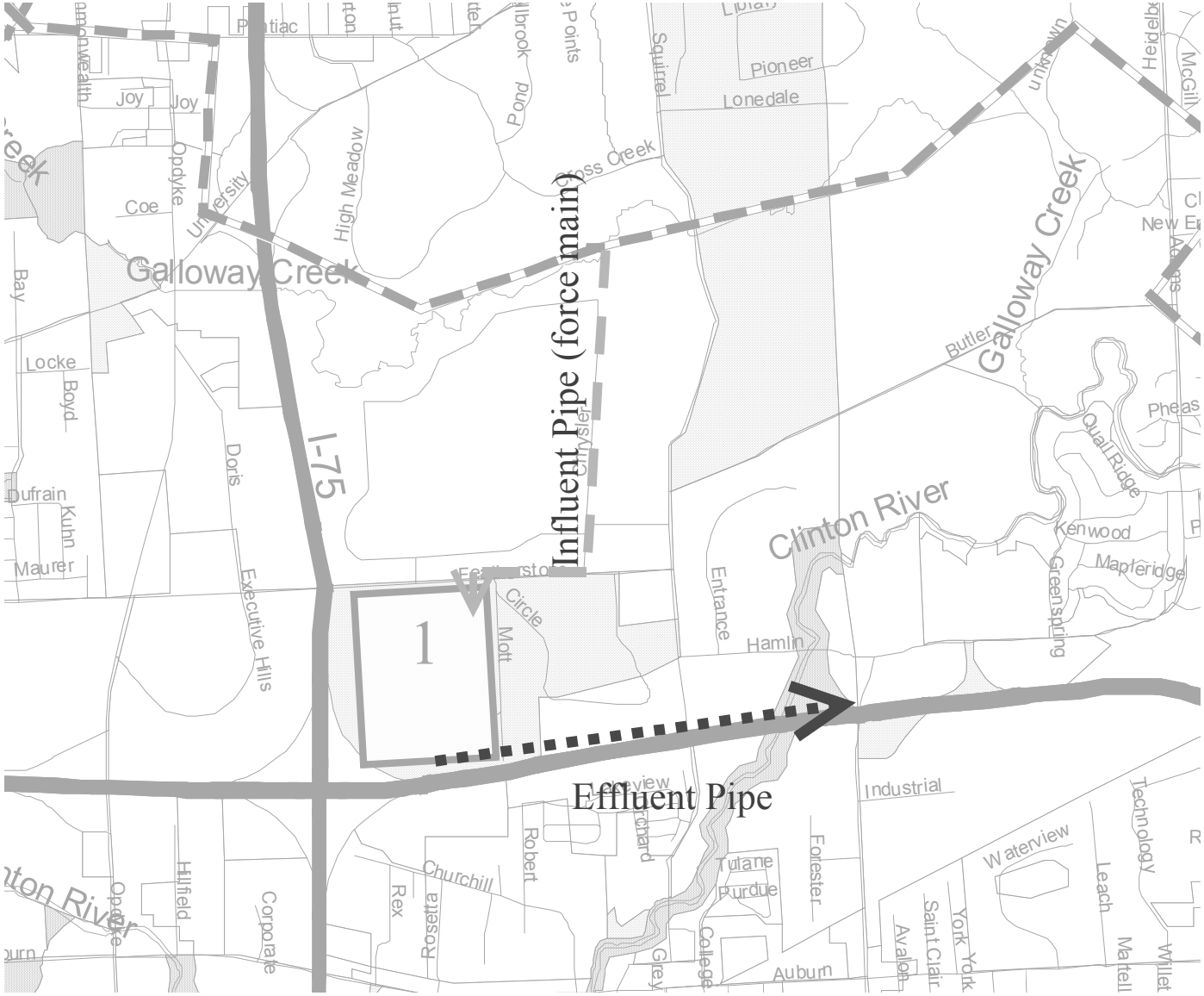
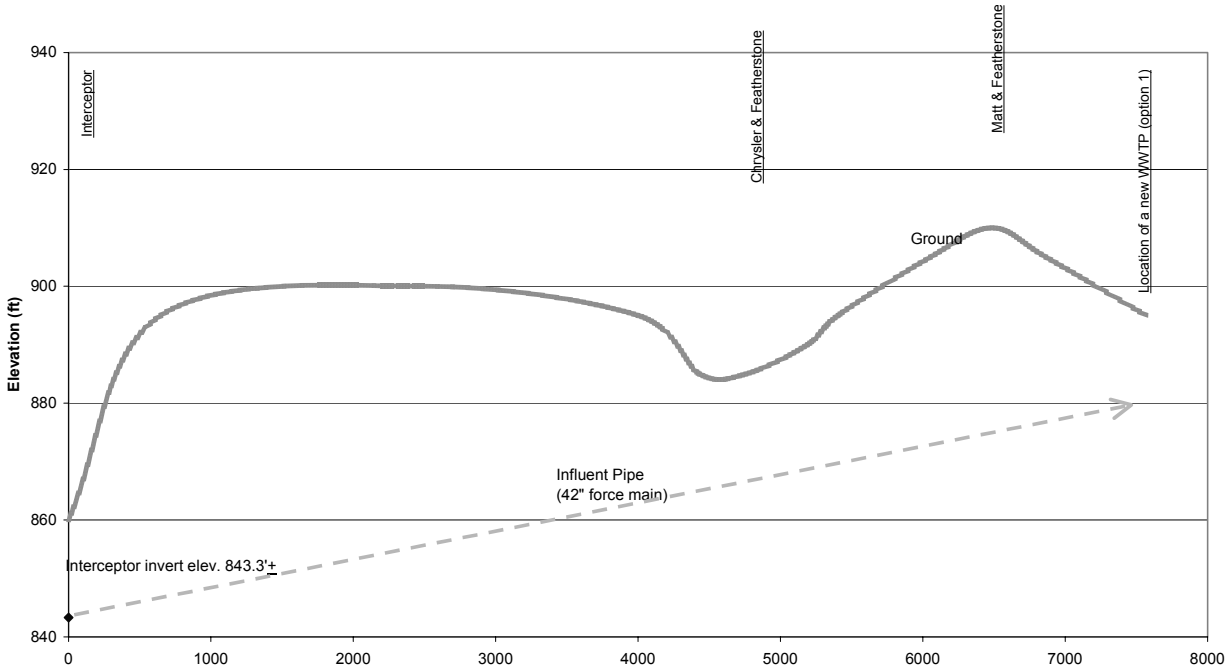


Figure 18. Conveyance Option for a New Wastewater Treatment Plant Site Along the Clinton River – Option 1

Influent Pipe



Effluent Pipe

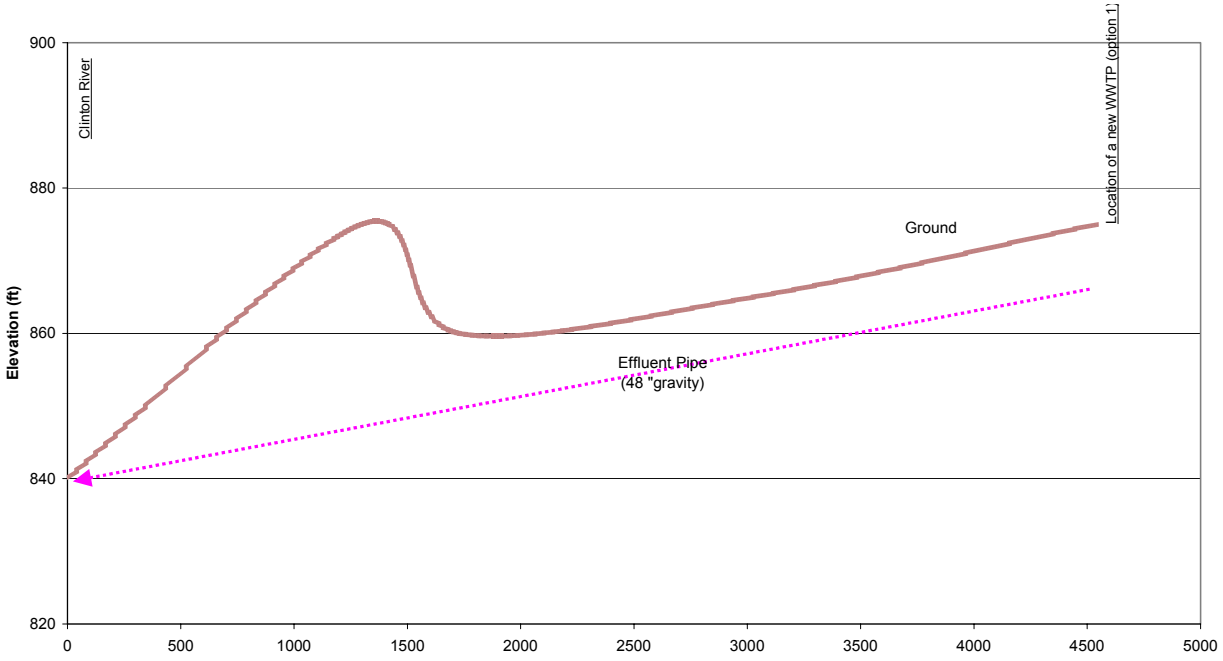


Figure 18 (cont). Conveyance Option for a New Wastewater Treatment Plant Site Along the Clinton River - Option 1

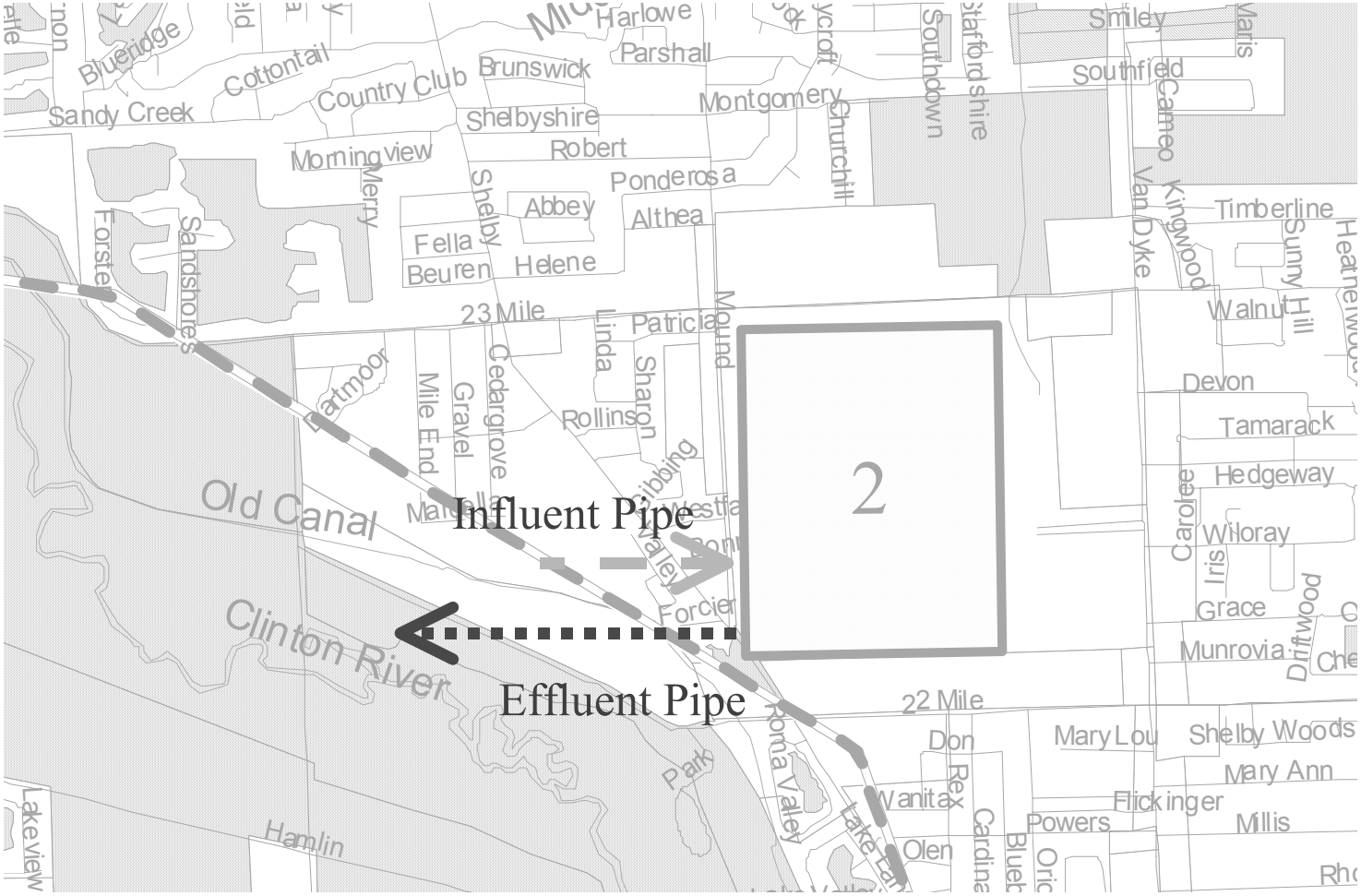


Figure 19. Conveyance Option for a New Wastewater Treatment Plant Site Along the Clinton River - Option 2



Figure 20. Conveyance Option for a New Wastewater Treatment Plant Site Along the Clinton River - Option 3

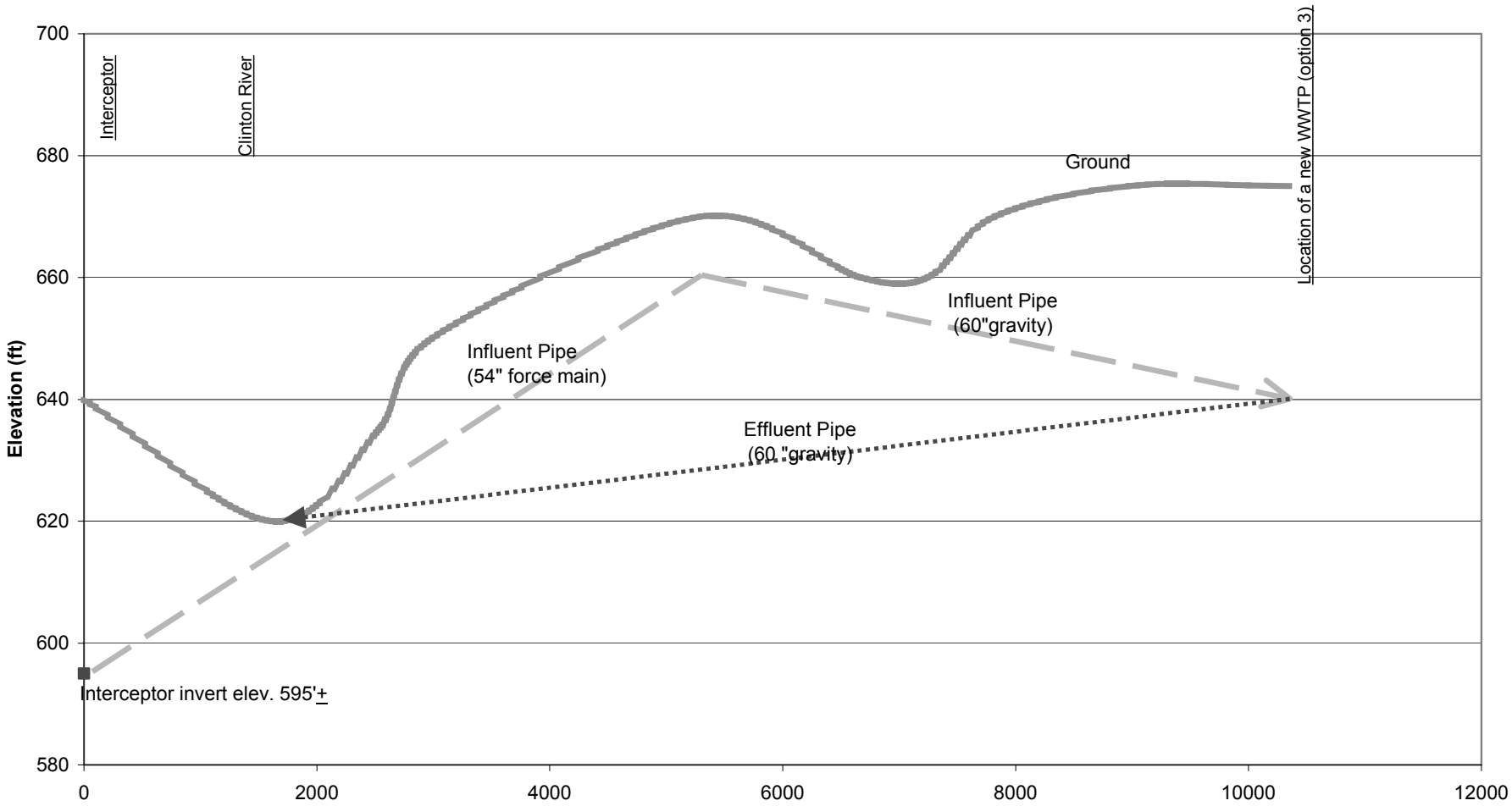


Figure 20 (cont). Conveyance Option for a New Wastewater Treatment Plant Site Along the Clinton River - Option 3

4.7.1 Influent

The influent quality to the new plant was assumed to be similar to what the current City of Pontiac Wastewater Treatment Plant is receiving.

Table 46 shows the influent design concentrations used.

Table 46. Design Influent Concentrations

Parameter	Concentration	Unit
BOD5 (Five Day Biochemical Oxygen Demand)	165	mg/L
TSS (Total Suspended Solids)	127	mg/L
Ammonia Nitrogen	15.8	mg/L
Total Phosphorus	3.0	mg/L

4.7.2 Treatment Process

Treatment at the new plants would consist of screening, grit removal, primary settling, aeration, final settling, filtration, and ultraviolet disinfection. Solids would be treated, dewatered, and disposed of in a landfill. All treatment processes were designed to conform to Ten States Standards. The process layouts for these plants are shown in Figures 21, 22, and 23.

Table 47 details the approximate sizes for the major treatment processes for the three options.

Table 47. New Wastewater Treatment Plant Treatment Process Sizes

Treatment Process	Oakland University 21.1 MGD	FOMOCO Proving Grounds 56.3 MGD	East of Macomb/ Oakland 62.2 MGD
Primary Treatment			
Screening	Two – 5 ft. x 5 ft.	Three – 7 ft. x 4 ft.	Three – 5 ft. x 6 ft.
Grit Removal	40 ft. x 40 ft. x 15 ft. deep	55 ft. x 60 ft. x 15 ft. deep	60 ft. x 60 ft. x 15 ft. deep
Primary Settling	4 – 125 ft. diameter tanks	6 – 150 ft. diameter tanks	6 – 155 ft. diameter tanks
Secondary Treatment			
Aeration	4 – 100 ft. x 290 ft. x 15 ft. swd	4 – 150 ft. x 450 ft. x 15 ft. swd	4 – 160 ft. x 460 ft. x 15 ft. swd
Secondary Settling	4 – 140 ft. diameter tanks	6 – 160 ft. diameter tanks	6 – 170 ft. diameter tanks
Tertiary Treatment			
Filtration	4 cells – 35 ft. x 35 ft. each	8 cells – 45 ft. x 45 ft. each	8 cells – 50 ft. x 50 ft. each
UV Disinfection	55 ft. x 115 ft.	85 ft. x 170 ft.	90 ft. x 180 ft.
Solids Treatment			
Centrifuge Feed Tanks	55 ft. x 55 ft. x 15 ft.	90 ft. x 90 ft. x 15 ft.	90 ft. x 90 ft. x 15 ft.
Sludge Dewatering / Storage Basins	4 cells – 12 ft. x 50 ft. x 10 ft. each	4 cells –20 ft. x 75 ft. x 10 ft. each	4 cells – 40 ft. x 40 ft. x 10 ft. each

4.7.3 Discharge Limits and Effluent Quality

The expected discharge quality from the expanded plant is shown in Table 48.

Table 48. Expected Effluent Quality

Parameter	Effluent Concentration (mg/L)	Expected NPDES Limits Monthly/Daily (mg/L)
CBOD5 (Five Day Carbonaceous Biochemical Oxygen Demand)	<4	4/10
TSS (Total Suspended Solids)	<10	20/30
Ammonia Nitrogen	<0.5	0.5/2
Total Phosphorus	<1	1/--

4.7.4 Conveyance System Description and Cost

Figures 18, 19, and 20 illustrate the conveyance routes and sizes for the three new wastewater treatment plant sites near the Clinton River. Below is a brief description of the options.

- Option 1 involves intercepting flow from the Clinton Oakland Interceptor and transporting it to a new wastewater treatment plant located south of Chrysler Tech Center and East of I-75 at undeveloped land near Oakland University. A 45 MGD pump station would pump the flow from the Interceptor. A 7560 linear foot section of 42-inch force main would carry the flow to the new wastewater treatment plant. A 4,540 linear foot section of 48-inch gravity sewer (effluent pipe) would discharge the treated flow to the Clinton River at a location by M-59 and East of Squirrel Road. The cost of this option is approximately $14.5 million.

- Option 2 involves intercepting flow from the Clinton Oakland Interceptor east of Dequindre and transporting it to a new wastewater treatment plant located east of Mound Road and north of 22 Mile Rd. at the Ford Motor Company Proving Grounds. A 48-inch gravity sewer would carry the flow from the Interceptor to the new wastewater treatment plant by gravity. A gravity sewer (effluent pipe) will discharge the treated flow to the Clinton River. The proposed wastewater plant at this site would be located on or very close to the Interceptor. Therefore, conveyance costs were not developed for this option.

- Option 3 involves intercepting flow from the Oakland Arm and transporting it to a new wastewater treatment plant located south of M-59 and East of Dequindre Road. A 113 MGD pump would pump the flow from the Interceptor. A 5,300 linear foot section of 54-inch force main and a 5,060 linear foot of 60-inch gravity sewer pipe located south of M-59 would carry the flow to the new wastewater treatment plant. A 8,700 linear foot section of 60-inch gravity sewer would

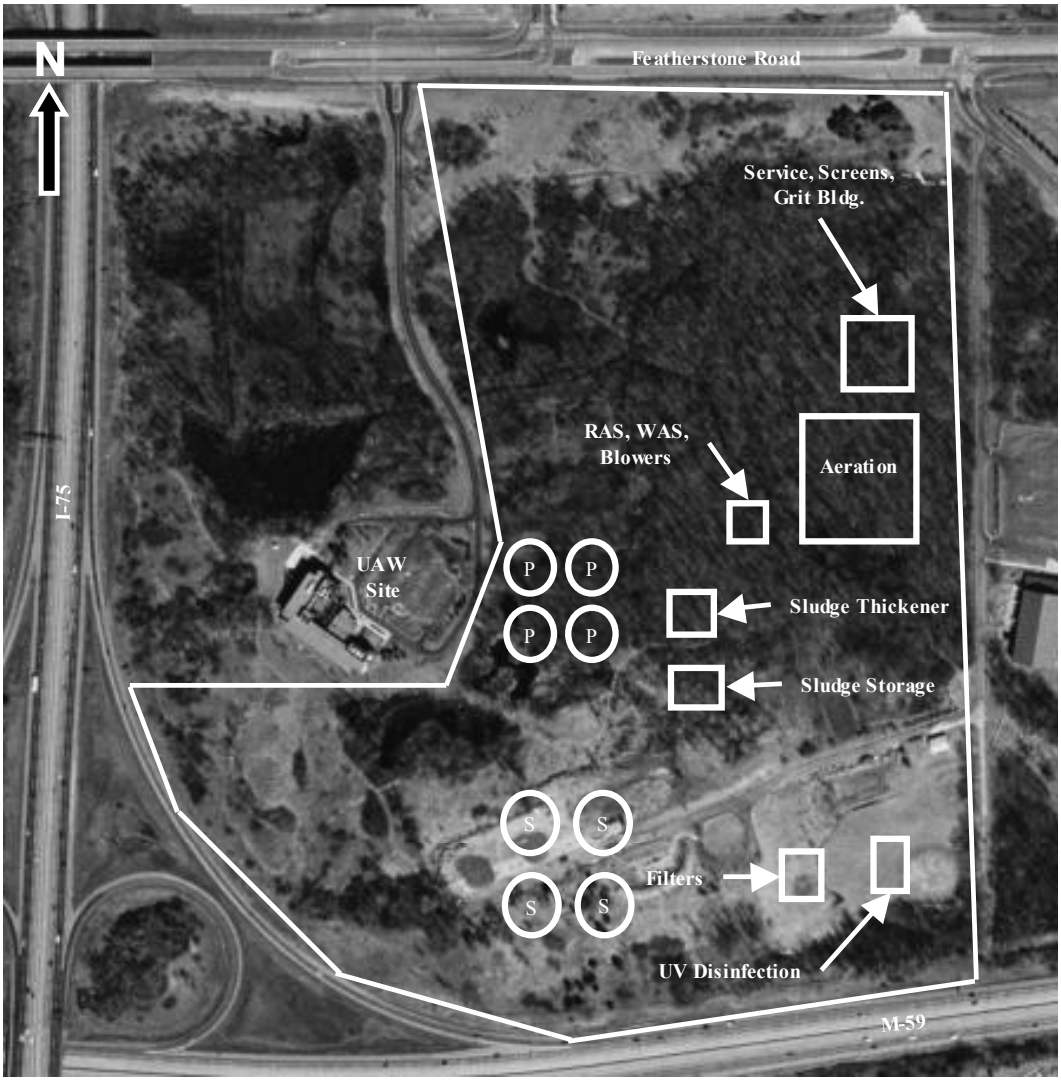
discharge the treated flow to the Clinton River. The cost of this option is approximately $37.5 million.

4.7.5 Cost Summary

Table 49 summarizes the cost associated with the various new wastewater treatment plant site options.

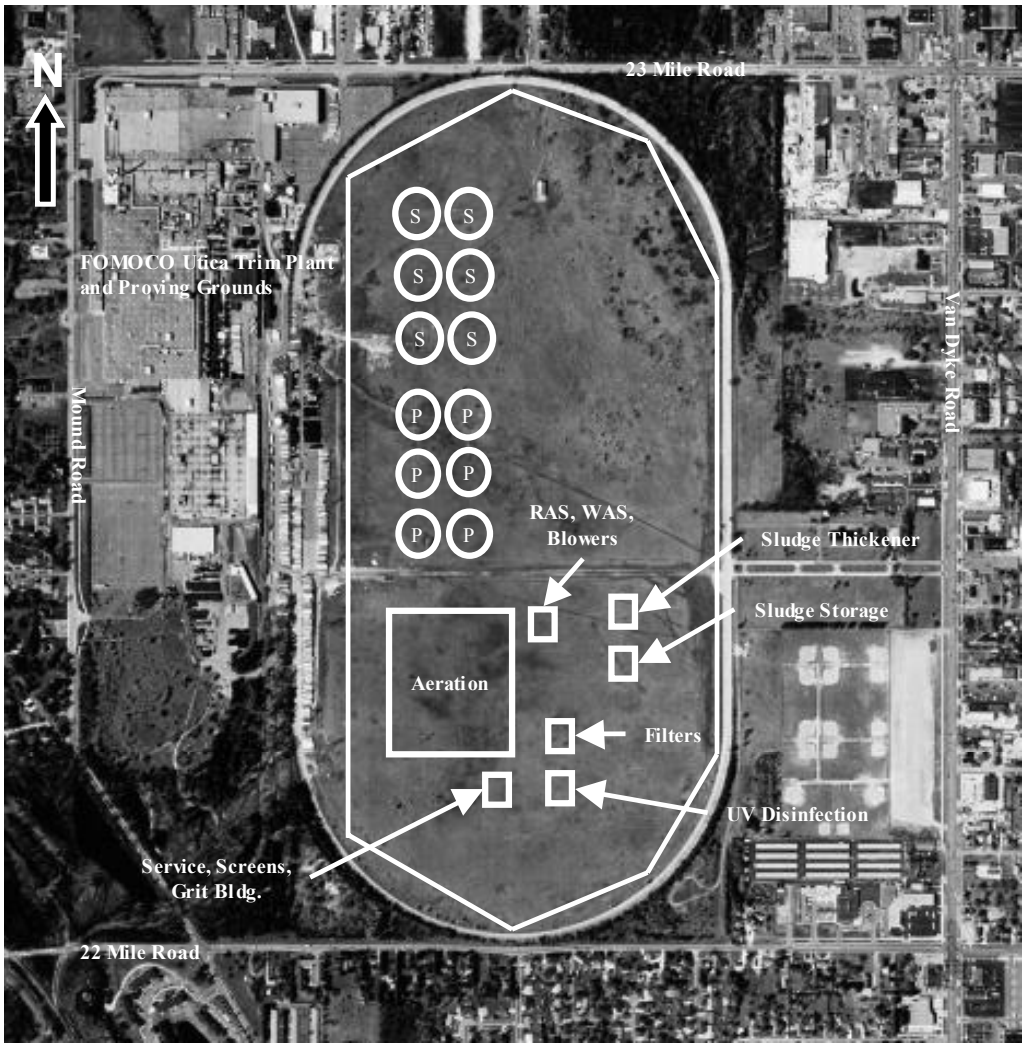
Table 49. New wastewater treatment plant along the Clinton River cost summary

Costs	Option 1 21.1 MGD	Option 2 56.3 MGD	Option 3 62.2 MGD
Capital (Million $)	96.5	225.9	241.9
Annual O&M (Million $)	9.3	22.5	24.8
Conveyance (Million $)	14.5	0	37.5
Capital Cost per gallon/day ($/gal./day)	4.57	4.01	3.89
Capital and Conveyance Cost per gallon/day ($/gal./day)	5.26	4.01	4.49



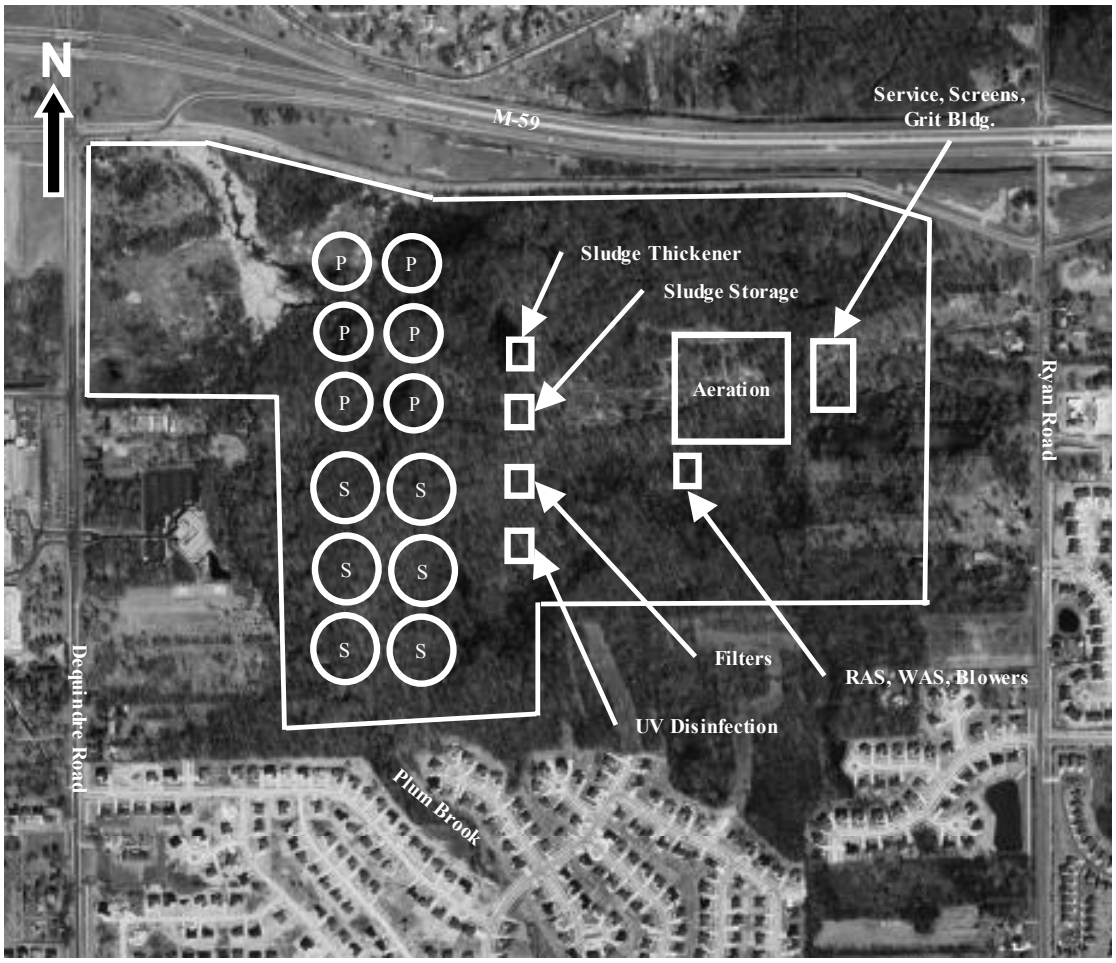
Option 1 -Vicinity of Oakland University - 21.1 MGD Capacity

Figure 21. Layout for new wastewater treatment plant discharging to the Clinton River - Option 1



Option 2 - Vicinity of Ford Proving Grounds - 56.3 MGD Capacity

Figure 22. Layout for new wastewater treatment plant discharging to the Clinton River - Option 2



Option 3 - East of Macomb/Oakland Area - 62.2 MGD Capacity

Figure 23. Layout for new wastewater treatment plant discharging to the Clinton River - Option 3

Appendix A

Detailed Design Information for the Expanded and New WWTPs

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	21.1	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	2.14	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	73.85	mgd
	Peak Hourly Flow Rest of Plant	45.15	
	Maximum Day Flow	45.15	mgd
	Peak Hourly Flow to be Equalized	73.85	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	16.3	sf		
Channel Length and Width	5	ft, if square		
Bar Screen Dimensions	10	ft by	5	ft

Reliability Criteria Class I requires that one backup unit be provided

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	205,139	gal
Rounded volume	205,200	gal
Volume	27,423	cf
Rounded volume	27,500	cf
Length and width	42.8	ft, if square
Rounded legth and width	43	ft, if square
Air rate	215	cfm

Equalization Basin

Store water between peak hour and maximum day for 12 hours.

Selected Depth	20	ft
Volume	14.348	million gallons
	1,918,054	cf
Rounded Volume	1,920,000	cf
Surface Area	96,000	sf
length and width	310	ft
Rounded	310	ft

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	y	(y or n)
Selected Design Peak Hourly Flow	n/a	gpd/sf
Waste Activated Sludge	0.5	mgd
Recycle Streams	4	mgd
Diameter	120	ft
Surface area	n/a	sf at design average flow
	41,378	sf at peak hourly flow
Controlling surface area	41,378	sf
Round surface area	42,000	sf
Number of clarifiers	3.71	
Rounded number of clarifiers	4	

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	40.7	mgd
50% of design flow	24.827	mgd
	OK	

Secondary Treatment

Aeration Basin - Extended Air

Extended Aeration - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed percent removal in primary clarifiers	30	percent
WAS BOD Concentration	n/a	mg/L
Recycle BOD Concentration	249	mg/L
Side Water Depth	15	ft
Number of Basins	4	
Length to width ration	3	

BOD Loading to Aeration Basins	29,659	lb./day
Rounded	30,000	lb./day
Total Volume of Basins	2,000,000	cf
Rounded	2,000,000	cf
Area	133,333	sf
Length	316.2	ft
Rounded	318	ft
Width	105.4	ft
Rounded	106	ft

Aeration

lb. O2/hp hr	2	
Oxygen requirements	101,807	lb. oxygen at peak hour conditions
Horsepower	2,121	hp
Rounded	2,200	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	10.55	mgd
1.5 * Qave	31.65	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	5.275	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	45,154	sf, based on surface overflow rate
	54,884	sf, based on solids loading rate
Controlling	54,884	sf
Rounded	54,900	sf
Diameter	132.2	ft
Rounded	133.0	ft

Reliability Criteria

Treatable Flow	41.7	
75% of design flow	33.9	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth	45	in.
Ration of length to width	1.5	
Surface Area	7,326	sf, based on average filtration rate
	6,271	sf, based on peak filtration rate
Controlling	7,326	sf
Rounded	7,400	sf
Width	35.1	ft
Rounded	36	ft
Length	54	ft
Rounded	54	ft

Reliability criteria

Capacity with one unit out of service	42.0	mgd
Required capacity	33.9	mgd
	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	1.75	mgd
Return should be less than	3.165	
	OK	

Chlorine Disinfection

Requires 15 minutes of detention time at peak hourly flow

Assumed depth	10	ft.
Number of tank	4	
Volume required	470,354	gal.
	62,877	cf
Rounded	63,000	cf
Surface area	6,300	sf total
Require 4 units with area of	2,100	sf each
If square	45.82576	
Rounded	46	ft

Ultraviolet Disinfection

Treat flow from entire facility. Assume East Boulevard abandoned.

Peak Flow	67.654	mgd	Max Day Flow from Expansion plus 9 mgd * 2.5
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Cosettled Sludge

Assumed Solids Removal	60	percent
Wasted Sludge	2	percent
Number of Landfill Storage Days	7	days
Centrifuge Thickened Solids	20	percent
Cosettled Sludge Production	22,408	lb./day
Rounded	23,000	lb./day
Sludge Flow	134,391	gpd
Rounded	140,000	gpd

Centrifuge

Number of Centrifuge Storage Days	4	days
Gravity Belt Thickened Solids	9	percent
Days of Centrifuge Operation	5	days/week
Hours of Operation per Day	8	hrs/day
Flow to Centrifuge	31,111	gpd
Rounded	31,200	gpd
Centrifuge Storage	124,800	gallons
	16,683	cf
Rounded	17,000	cf
Centrifuge Size	91	
Rounded	91	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
	7	
Flow to Storage Tank	14,040	gpd
Rounded	15,000	gpd
Storage Volume	98,280	gallons
	13,138	cf
Rounded	13,200	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	30.78	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	2.01	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	108.00	mgd
	Peak Hourly Flow Rest of Plant	61.87	mgd
	Maximum Day Flow	61.87	mgd
	Peak Hourly Flow to be Equalized	108.00	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	23.8	sf		
Channel Length and Width	5	ft, if square		
Bar Screen Dimensions	10	ft by	5	ft

Reliability Criteria Class I requires that one backup unit be provided

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	300,000	gal
Rounded volume	300,000	gal
Volume	40,104	cf
Rounded volume	40,200	cf
Length and width	51.8	ft, if square
Rounded legth and width	52	ft, if square
Air rate	260	cfm

Equalization Basin

Store water between peak hour and maximum day for 12 hours.

Selected Depth	20	ft
Volume	23.0661	million gallons
	3,083,497	cf
Rounded Volume	3,090,000	cf
Surface Area	154,500	sf
length and width	393	ft
Rounded	394	ft

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	y	(y or n)
Selected Design Peak Hourly Flow	n/a	gpd/sf
Waste Activated Sludge	0.625	mgd
Recycle Streams	5	mgd
Diameter	140	
Surface area	n/a	sf at design average flow
	56,244	sf at peak hourly flow
Controlling surface area	56,244	sf
Round surface area	57,000	sf
Number of clarifiers	3.70	
Rounded number of clarifiers	4	

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	55.4	mgd
50% of design flow	33.7	mgd
	OK	

Secondary Treatment

Aeration Basin - Extended Air

Extended Aeration - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed percent removal in primary clarifiers	30	percent
WAS BOD Concentration	n/a	mg/L
Recycle BOD Concentration	249	mg/L
Side Water Depth	15	ft
Number of Basins	4	
Length to width ration	3	

BOD Loading to Aeration Basins	41,316	lb./day
Rounded	41,400	lb./day
Total Volume of Basins	2,760,000	cf
Rounded	2,760,000	cf
Area	184,000	sf
Length	371	
Rounded	375	
Width	124	
Rounded	125	

Aeration

lb. O2/hp hr	2	
Oxygen requirements	138,382	lb. oxygen at peak hour conditions
Horsepower	2,883	hp
Rounded	2,850	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	15.39	mgd
1.5 * Qave	46.17	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	7.70	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	61,868	sf, based on surface overflow rate
	77,204	sf, based on solids loading rate
Controlling	77,204	sf
Rounded	77,300	sf
Diameter	156.9	ft
Rounded	157.0	ft
Reliability Criteria		
Treatable Flow	58.1	
75% of design flow	46.4	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth	45	in.
Ration of length to width	1.5	
Surface Area	10,688	sf, based on average filtration rate
	8,593	sf, based on peak filtration rate
Controlling	10,688	sf
Rounded	10,700	sf
Width	42.2	ft
Rounded	43	ft
Length	64.5	ft
Rounded	65	ft
Reliability criteria		
Capacity with one unit out of service	60.4	mgd
Required capacity	46.4	mgd
	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	2.52	mgd
Return should be less than	4.62	
	OK	

Chlorine Disinfection

Requires 15 minutes of detention time at peak hourly flow

Assumed depth	10	ft.
Number of tanks	4	
Volume required	644,456	gal.
	86,151	cf
Rounded	86,200	cf
Surface area	8,620	sf total

Need to provide 15 minutes storage with one unit out of service

Require 4 units with area of	2,873	sf each
If square	53.60348	
Rounded	54	ft

Ultraviolet Disinfection

Treat flow from entire facility. Assume East Boulevard abandoned.

Peak Flow	84.37	mgd	Max Day Flow from Expansion plus 9 mgd * 2.5
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Cosettled Sludge

Assumed Solids Removal	60	percent
Wasted Sludge	2	percent
Number of Landfill Storage Days	7	days
Centrifuge Thickened Solids	20	percent
Cosettled Sludge Production	30,809	lb./day
Rounded	31,000	lb./day
Sludge Flow	184,772	gpd
Rounded	185,000	gpd

Centrifuge

Number of Centrifuge Storage Days	4	days
Gravity Belt Thickened Solids	9	percent
Days of Centrifuge Operation	5	days/week
Hours of Operation per Day	8	hrs/day
Flow to Centrifuge	41,111	gpd
Rounded	41,200	gpd
Centrifuge Storage	164,800	gallons
	22,031	cf
Rounded	22,700	cf
Centrifuge Size	120	
Rounded	130	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	18,540	gpd
Rounded	15,000	
Storage Volume	129,780	gallons
	17,349	cf
Rounded	17,400	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	45.01	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	1.92	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	158.00	mgd
	Peak Hourly Flow Rest of Plant	86.00	
	Maximum Day Flow	86.00	mgd
	Peak Hourly Flow to be Equalized	158.00	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	34.8	sf		
Channel Length and Width	6	ft, if square		
Bar Screen Dimensions	12	ft by	6	ft

Reliability Criteria Class I requires that one backup unit be provided

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	438,889	gal
Rounded volume	438,900	gal
Volume	58,671	cf
Rounded volume	58,700	cf
Length and width	62.6	ft, if square
Rounded legth and width	63	ft, if square
Air rate	315	cfm

Equalization Basin

Store water between peak hour and maximum day for 12 hours.

Selected Depth	20	ft
Volume	36	million gallons
	4,812,513	cf
Rounded Volume	4,820,000	cf
Surface Area	241,000	sf
length and width	491	ft
Rounded	495	ft

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	y	(y or n)
Selected Design Peak Hourly Flow	n/a	gpd/sf
Waste Activated Sludge	0.973	mgd
Recycle Streams	7.784	mgd
Diameter	165	
Surface area	n/a	sf at design average flow
	78,964	sf at peak hourly flow
Controlling surface area	78,964	sf
Round surface area	79,000	sf
Number of clarifiers	3.69	
Rounded number of clarifiers	4	

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	77.0	mgd
50% of design flow	47.3785	mgd
	OK	

Secondary Treatment

Aeration Basin - Extended Air

Extended Aeration - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed percent removal in primary clarifiers	30	percent
WAS BOD Concentration	n/a	mg/L
Recycle BOD Concentration	249	mg/L
Side Water Depth	15	ft
Number of Basins	4	
Length to width ration	3	

BOD Loading to Aeration Basins	61,520	lb./day
Rounded	62,000	lb./day
Total Volume of Basins	4,133,333	cf
Rounded	4,140,000	cf
Area	276,000	sf
Length	455	
Rounded	465	
Width	152	
Rounded	155	

Aeration

lb. O2/hp hr	2	
Oxygen requirements	187,604	lb. oxygen at peak hour conditions
Horsepower	3,908	hp
Rounded	4,000	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	22.51	mgd
1.5 * Qave	67.52	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	11.25	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	86,000	sf, based on surface overflow rate
	109,702	sf, based on solids loading rate
Controlling	109,702	sf
Rounded	109,800	sf
Diameter	187.0	ft
Rounded	190	ft
Reliability Criteria		
Treatable Flow	85.1	
75% of design flow	64.5	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth	45	in.
Ration of length to width	1.5	
Surface Area	15,628	sf, based on average filtration rate
	11,944	sf, based on peak filtration rate
Controlling	15,628	sf
Rounded	15,700	sf
Width	51.2	ft
Rounded	52	ft
Length	78	ft
Rounded	78	ft
Reliability criteria		
Capacity with one unit out of service	87.6	mgd
Required capacity	64.5	mgd
	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	3.65	mgd
Return should be less than	6.75	mgd
	OK	

Chlorine Disinfection

Requires 15 minutes of detention time at peak hourly flow

Assumed depth	10	ft.
Number of tanks	4	
Volume required	895,833	gal.
	119,756	cf
Rounded	120,000	cf
Surface area	12,000	sf, total

Need to provide 15 minutes storage with one unit out of service

Require 4 units with area of	4,000	sf each
If square	63.2	
Rounded	64	ft

Ultraviolet Disinfection

Treat flow from entire facility. Assume East Boulevard abandoned.

Peak Flow	108.5	mgd	Max Day Flow from Expansion plus 9 mgd * 2.5
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Cosettled Sludge

Assumed Solids Removal	60	percent
Wasted Sludge	2	percent
Number of Landfill Storage Days	7	days
Centrifuge Thickened Solids	20	percent
Cosettled Sludge Production	46,116	lb./day
Rounded	47,000	lb./day
Sludge Flow	276,572	gpd
Rounded	280,000	gpd

Centrifuge

Number of Centrifuge Storage Days	4	days
Gravity Belt Thickened Solids	9	percent
Days of Centrifuge Operation	5	days/week
Hours of Operation per Day	8	hrs/day
Flow to Centrifuge	62,222	gpd
Rounded	62,300	gpd
Centrifuge Storage	249,200	gallons
	33,313	cf
Rounded	34,000	cf
Centrifuge Size	182	
Rounded	190	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	28,035	gpd
Rounded	15,000	
Storage Volume	196,245	gallons
	26,234	cf
Rounded	26,300	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	21.1	mgd
	Peaking Factor (Peak Hourly)	2.14	
	Maximum Day Peaking Factor	2.14	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	45.15	mgd
	Peak Hourly Flow Rest of Plant	45.15	
	Maximum Day Flow	45.15	mgd
	Peak Hourly Flow to be Equalized	45.15	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	16.3	sf		
Channel Length and Width	5	ft, if square		
Bar Screen Dimensions	10	ft by	5	ft

Reliability Criteria Class I requires that one backup unit be provided

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	125,428	gal
Rounded volume	125,500	gal
Volume	16,767	cf
Rounded volume	16,800	cf
Length and width	33.5	ft, if square
Rounded legth and width	34	ft, if square
Air rate	170	cfm

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow	Design Peak Hourly Flow
No WAS	1000 gpd/sf	1500 to 3000 gpd/sf
Accepts WAS		1200 gpd/sf

Tank receives WAS?	y	(y or n)
Selected Design Peak Hourly Flow	n/a	gpd/sf
Waste Activated Sludge	0.5	mgd
Recycle Streams	4	mgd
Diameter	120	ft
Surface area	n/a	sf at design average flow
	41,378	sf at peak hourly flow
Controlling surface area	41,378	sf
Round surface area	42,000	sf
Number of clarifiers	3.71	
Rounded number of clarifiers	4	

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	40.7	mgd
50% of design flow	24.827	mgd
	OK	

Secondary Treatment

Aeration Basin - Single Stage Nitrification

Extended Aeration - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed percent removal in primary clarifiers	30	percent
WAS BOD Concentration	n/a	mg/L
Recycle BOD Concentration	249	mg/L
Side Water Depth	15	ft
Number of Basins	4	
Length to width ration	3	

BOD Loading to Aeration Basins	29,659	lb./day
Rounded	30,000	lb./day
Total Volume of Basins	2,000,000	cf
Rounded	2,000,000	cf
Area	133,333	sf
Length	316.2	ft
Rounded	318	ft
Width	105.4	ft
Rounded	106	ft

Aeration

lb. O2/hp hr	2	
Oxygen requirements	101,807	lb. oxygen at peak hour conditions
Horsepower	2,121	hp
Rounded	2,200	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	10.55	mgd
1.5 * Qave	31.65	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	5.275	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	45,154	sf, based on surface overflow rate
	54,884	sf, based on solids loading rate
Controlling	54,884	sf
Rounded	54,900	sf
Diameter	132.2	ft
Rounded	133.0	ft

Reliability Criteria

Treatable Flow	41.7	
75% of design flow	33.9	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth	45	in.
Ration of length to width	1.5	
Surface Area	7,326	sf, based on average filtration rate
	6,271	sf, based on peak filtration rate
Controlling	7,326	sf
Rounded	7,400	sf
Width	35.1	ft
Rounded	36	ft
Length	54	ft
Rounded	54	ft

Reliability criteria

Capacity with one unit out of service	42.0	mgd
Required capacity	33.9	mgd
	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	1.75	mgd
Return should be less than	3.165	
	OK	

Chlorine Disinfection

Requires 15 minutes of detention time at peak hourly flow

Assumed depth	10	ft.
Number of tanks	4	
Volume required	470,354	gal.
	62,877	cf
Rounded	63,000	cf
Surface area	6,300	sf total
Require 4 units with area of	2,100	sf each
If square	45.82576	
Rounded	46	ft

Ultraviolet Disinfection

Treat flow from entire facility. Assume East Boulevard abandoned.

Peak Flow	67.654	mgd	Max Day Flow from Expansion plus 9 mgd * 2.5
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Cosettled Sludge

Assumed Solids Removal	60	percent
Wasted Sludge	2	percent
Number of Landfill Storage Days	7	days
Centrifuge Thickened Solids	20	percent
Cosettled Sludge Production	22,408	lb./day
Rounded	23,000	lb./day
Sludge Flow	134,391	gpd
Rounded	140,000	gpd

Centrifuge

Number of Centrifuge Storage Days	4	days
Gravity Belt Thickened Solids	9	percent
Days of Centrifuge Operation	5	days/week
Hours of Operation per Day	8	hrs/day
Flow to Centrifuge	31,111	gpd
Rounded	31,200	gpd
Centrifuge Storage	124,800	gallons
	16,683	cf
Rounded	17,000	cf
Centrifuge Size	91	
Rounded	95	gpm

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
	7	
Flow to Storage Tank	14,040	gpd
Rounded	14,100	gpd
Storage Volume	98,280	gallons
	13,138	cf
Rounded	13,200	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	30.78	mgd
	Peaking Factor (Peak Hourly)	2.01	
	Maximum Day Peaking Factor	2.01	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	61.87	mgd
	Peak Hourly Flow Rest of Plant	61.87	mgd
	Maximum Day Flow	61.87	mgd
	Peak Hourly Flow to be Equalized	61.87	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	23.8	sf		
Channel Length and Width	5	ft, if square		
Bar Screen Dimensions	10	ft by	5	ft

Reliability Criteria Class I requires that one backup unit be provided

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	171,855	gal
Rounded volume	171,900	gal
Volume	22,974	cf
Rounded volume	23,000	cf
Length and width	39.2	ft, if square
Rounded legth and width	40	ft, if square
Air rate	200	cfm

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow	Design Peak Hourly Flow
No WAS	1000 gpd/sf	1500 to 3000 gpd/sf
Accepts WAS		1200 gpd/sf

Tank receives WAS?	y	(y or n)
Selected Design Peak Hourly Flow	n/a	gpd/sf
Waste Activated Sludge	0.625	mgd
Recycle Streams	5	mgd
Diameter	140	
Surface area	n/a	sf at design average flow
	56,244	sf at peak hourly flow
Controlling surface area	56,244	sf
Round surface area	57,000	sf
Number of clarifiers	3.70	
Rounded number of clarifiers	4	

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	55.4	mgd
50% of design flow	33.7	mgd
	OK	

Secondary Treatment

Aeration Basin - Single Stage Nitrification

Extended Aeration - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed percent removal in primary clarifiers	30	percent
WAS BOD Concentration	n/a	mg/L
Recycle BOD Concentration	249	mg/L
Side Water Depth	15	ft
Number of Basins	4	
Length to width ration	3	

BOD Loading to Aeration Basins	41,316	lb./day
Rounded	41,400	lb./day
Total Volume of Basins	2,760,000	cf
Rounded	2,760,000	cf
Area	184,000	sf
Length	371	
Rounded	375	
Width	124	
Rounded	125	

Aeration

lb. O2/hp hr	2	
Oxygen requirements	138,382	lb. oxygen at peak hour conditions
Horsepower	2,883	hp
Rounded	2,850	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	15.39	mgd
1.5 * Qave	46.17	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	7.70	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	61,868	sf, based on surface overflow rate
	77,204	sf, based on solids loading rate
Controlling	77,204	sf
Rounded	77,300	sf
Diameter	156.9	ft
Rounded	157	ft
Reliability Criteria		
Treatable Flow	58.1	
75% of design flow	46.4	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth	45	in.
Ration of length to width	1.5	
Surface Area	10,688	sf, based on average filtration rate
	8,593	sf, based on peak filtration rate
Controlling	10,688	sf
Rounded	10,700	sf
Width	42.2	ft
Rounded	43	ft
Length	64.5	ft
Rounded	65	ft
Reliability criteria		
Capacity with one unit out of service	60.4	mgd
Required capacity	46.4	mgd
	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	2.52	mgd
Return should be less than	4.62	
	OK	

Chlorine Disinfection

Requires 15 minutes of detention time at peak hourly flow

Assumed depth	10	ft.
Number of tanks	4	
Volume required	644,456	gal.
	86,151	cf
Rounded	87,000	cf
Surface area	8,700	sf total

Need to provide 15 minutes storage with one unit out of service

Require 4 units with area of	2,900	sf each
If square	53.85165	
Rounded	54	ft

Ultraviolet Disinfection

Treat flow from entire facility. Assume East Boulevard abandoned.

Peak Flow	84.3678	mgd	Max Day Flow from Expansion plus 9 mgd * 2.5
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Cosettled Sludge

Assumed Solids Removal	60	percent
Wasted Sludge	2	percent
Number of Landfill Storage Days	7	days
Centrifuge Thickened Solids	20	percent
Cosettled Sludge Production	30,809	lb./day
Rounded	31,000	lb./day
Sludge Flow	184,772	gpd
Rounded	185,000	gpd

Centrifuge

Number of Centrifuge Storage Days	4	days
Gravity Belt Thickened Solids	9	percent
Days of Centrifuge Operation	5	days/week
Hours of Operation per Day	8	hrs/day
Flow to Centrifuge	41,111	gpd
Rounded	41,200	gpd
Centrifuge Storage	164,800	gallons
	22,031	cf
Rounded	23,000	cf
Centrifuge Size	120	
Rounded	120	gpm

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	18,540	gpd
Rounded	15,000	
Storage Volume	129,780	gallons
	17,349	cf
Rounded	17,400	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	45.01	mgd
	Peaking Factor (Peak Hourly)	1.92	
	Maximum Day Peaking Factor	1.92	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	86.00	mgd
	Peak Hourly Flow Rest of Plant	86.00	
	Maximum Day Flow	86.00	mgd
	Peak Hourly Flow to be Equalized	86.00	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	34.8	sf		
Channel Length and Width	6	ft, if square		
Bar Screen Dimensions	12	ft by	6	ft

Reliability Criteria Class I requires that one backup unit be provided

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	238,889	gal
Rounded volume	238,900	gal
Volume	31,935	cf
Rounded volume	32,000	cf
Length and width	46.2	ft, if square
Rounded legth and width	47	ft, if square
Air rate	235	cfm

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow	Design Peak Hourly Flow
No WAS	1000 gpd/sf	1500 to 3000 gpd/sf
Accepts WAS		1200 gpd/sf

Tank receives WAS?	y	(y or n)
Selected Design Peak Hourly Flow	n/a	gpd/sf
Waste Activated Sludge	0.973	mgd
Recycle Streams	7.784	mgd
Diameter	165	
Surface area	n/a	sf at design average flow
	78,964	sf at peak hourly flow
Controlling surface area	78,964	sf
Round surface area	79,000	sf
Number of clarifiers	3.69	
Rounded number of clarifiers	4	

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	77.0	mgd
50% of design flow	47.3785	mgd
	OK	

Secondary Treatment

Aeration Basin - Single Stage Nitrification

Extended Aeration - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed percent removal in primary clarifiers	30	percent
WAS BOD Concentration	n/a	mg/L
Recycle BOD Concentration	249	mg/L
Side Water Depth	15	ft
Number of Basins	4	
Length to width ration	3	

BOD Loading to Aeration Basins	61,520	lb./day
Rounded	62,000	lb./day
Total Volume of Basins	4,133,333	cf
Rounded	4,140,000	cf
Area	276,000	sf
Length	455	
Rounded	465	
Width	152	
Rounded	155	

Aeration

lb. O2/hp hr	2	

Oxygen requirements	187,604	lb. oxygen at peak hour conditions
Horsepower	3,908	hp
Rounded	4,000	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	22.51	mgd
1.5 * Qave	67.52	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	11.25	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	86,000	sf, based on surface overflow rate
	109,702	sf, based on solids loading rate
Controlling	109,702	sf
Rounded	109,800	sf
Diameter	187.0	ft
Rounded	190	ft
Reliability Criteria		
Treatable Flow	85.1	
75% of design flow	64.5	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth	45	in.
Ration of length to width	1.5	
Surface Area	15,628	sf, based on average filtration rate
	11,944	sf, based on peak filtration rate
Controlling	15,628	sf
Rounded	15,700	sf
Width	51.2	ft
Rounded	55	ft
Length	82.5	ft
Rounded	83	ft
Reliability criteria		
Capacity with one unit out of service	98.6	mgd
Required capacity	64.5	mgd
	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	4.11	mgd
Return should be less than	6.75	mgd
	OK	

Chlorine Disinfection

Requires 15 minutes of detention time at peak hourly flow

Assumed depth	10	ft.
Number of tanks	4	
Volume required	895,833	gal.
	119,756	cf
Rounded	120,000	cf
Surface area	12,000	sf, total

Need to provide 15 minutes storage with one unit out of service

Require 4 units with area of	4,000	sf each
If square	63.2	
Rounded	64	ft

Ultraviolet Disinfection

Treat flow from entire facility. Assume East Boulevard abandoned.

Peak Flow	108.5	mgd	Max Day Flow from Expansion plus 9 mgd * 2.5
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Cosettled Sludge

Assumed Solids Removal	60	percent
Wasted Sludge	2	percent
Number of Landfill Storage Days	7	days
Centrifuge Thickened Solids	20	percent
Cosettled Sludge Production	46,116	lb./day
Rounded	47,000	lb./day
Sludge Flow	276,572	gpd
Rounded	280,000	gpd

Centrifuge

Number of Centrifuge Storage Days	4	days
Gravity Belt Thickened Solids	9	percent
Days of Centrifuge Operation	5	days/week
Hours of Operation per Day	8	hrs/day
Flow to Centrifuge	62,222	gpd
Rounded	62,300	gpd
Centrifuge Storage	249,200	gallons
	33,313	cf
Rounded	34,000	cf
Centrifuge Size	182	
Rounded	185	gpm

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	28,035	gpd
Rounded	15,000	
Storage Volume	196,245	gallons
	26,234	cf
Rounded	26,300	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	14.04	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	2.5	
	Influent BOD	131	mg/L
	Influent TSS	120	mg/L
	Influent Ammonia-N	13.9	mg/L
	Influent Total P	4.7	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	49.14	mgd
	Peak Hourly Flow Rest of Plant	35.1	
	Maximum Day Flow	35.1	mgd
	Peak Hourly Flow to be Equalized	49.14	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	10.9	sf		
Channel Length and Width	4	ft, if square		
Bar Screen Dimensions	8	ft by	4	ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	49.14	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	136,500	gal
Rounded volume	136,500	gal
Volume	18,247	cf
Rounded volume	18,300	cf
Length and width	34.9	ft, if square
Rounded legth and width	35	ft, if square
Air rate	175	cfm

Retention Basin

Assume that existing 50 mgd retention basin will provide sufficient storage once infiltation and inflow reduction efforts have been completed.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	85		
Surface area	14040	sf at design average flow	
	17,550	sf at peak hourly flow	
Controlling surface area	17,550	sf	
Round surface area	17,600	sf	
Number of clarifiers	3.10		
Rounded number of clarifiers	4		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	34.0	mgd
50% of design flow	17.55	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order fo nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	2	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	4		
Length to width ratio	3		

BOD Loading to Aeration Basins	14,902	lb./day
Rounded	14,910	lb./day
Total Volume of Basins	994,000	cf
Rounded	1,000,000	cf
Area	66,667	sf
Length	224	ft
Rounded	225	ft each
Width	75	ft
Rounded	75	ft each

Aeration

lb. O2/hp hr	2	
Oxygen requirements	64,405	lb. oxygen at peak hour conditions
Horsepower	1,342	hp
Rounded	1,350	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	7.0	mgd
1.5 * Qave	21.1	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	3.5	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	35,100	sf, based on surface overflow rate
	40,132	sf, based on solids loading rate
Controlling	40,132	sf
Rounded	40,200	sf
Diameter	113.1	ft
Rounded	114	ft
Reliability Criteria		
Treatable Flow	30.6	
75% of design flow	26.3	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth		in.
Ratio of length to width	1.5	
Surface Area	4,875	sf, based on average filtration rate
	4,875	sf, based on peak filtration rate
Controlling	4,875	sf
Rounded	4,900	sf
Width	28.6	ft
Rounded	29	ft
Length	43.5	ft
Rounded	44	ft
Reliability criteria		
Capacity with one unit out of service	27.6	mgd 11.0
Required capacity	26.3	mgd 10.5
	OK	OK
Required Size	1,219	sf each
	3,656	sf total
	26.3	10.5
	FALSE	OK

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	0.82	mgd
Return should be less than	2.11	
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	117.9	mgd	Max Day Flow from Expansion plus 36 mgd * 2.3
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	8,428	lb./day
Flow for Primary Sludge	25,272	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb.. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	149	lb./day
	1.3	mg/L
Iron needed to remove 3.5 mg/L P	1,203	lb. Fe/day
Solids Produced	2,407	lb./day solids
Rounded	2,410	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	14,902	lb./day
Total Secondary Sludge	17,312	lb./day
	259,568	gpd

Gravity Belt Thickener Storage

Only secondary sludge undergoes gravity belt thickener storage

Number of Gravity Feed Storage Days	2	days
Storage Volume	519,135	gallons
	69,398	cf
Rounded	69,400	cf

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days	
Gravity Belt Thickened Solids	8	percent	
Days of Centrifuge Operation	5	days/week	
Hours of Operation per Day	8	hrs/day	
Primary Sludge Flow to Centrifuge	25,272	gpd at	4 percent solids
Secondary Sludge Flow to Centrifuge	25,957	gpd at	8 percent solids
Total Flow to Centrifuge	51,229	gpd	
Rounded	51,300	gpd	
Centrifuge Storage	205,200	gallons	
	27,431	cf	
Rounded	27,500	cf	
Centrifuge Size	150	gpm	
Rounded	150	gpm	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	15,437	gpd
Rounded	15,500	gpd
Storage Volume	108,060	gallons
	14,446	cf
Rounded	14,500	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	40	mgd
	Peaking Factor (Peak Hourly)	1	
	Maximum Day Peaking Factor	1	
	Influent BOD	131	mg/L
	Influent TSS	120	mg/L
	Influent Ammonia-N	13.9	mg/L
	Influent Total P	4.7	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	40	mgd
	Peak Hourly Flow Rest of Plant	40	
	Maximum Day Flow	40	mgd
	Peak Hourly Flow to be Equalized	40	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec
Selected angle from horizontal	30	degrees

Channel Area	30.9	sf	
Channel Length and Width	6	ft, if square	
Bar Screen Dimensions	12	ft by	6 ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	40	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	111,111	gal
Rounded volume	111,200	gal
Volume	14,853	cf
Rounded volume	15,000	cf
Length and width	31.6	ft, if square
Rounded legth and width	32	ft, if square
Air rate	160	cfm

Retention Basin

Assume that existing 50 mgd retention basin will provide sufficient storage once infiltation and inflow reduction efforts have been completed.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	125		
Surface area	40000	sf at design average flow	
	20,000	sf at peak hourly flow	
Controlling surface area	40,000	sf	
Round surface area	40,000	sf	
Number of clarifiers	3.26		
Rounded number of clarifiers	4		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	73.6	mgd
50% of design flow	20	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order fo nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	3.5	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	4		
Length to width ratio	3		

BOD Loading to Aeration Basins	37,875	lb./day
Rounded	38,000	lb./day
Total Volume of Basins	2,533,333	cf
Rounded	2,540,000	cf
Area	169,333	sf
Length	356.4	ft
Rounded	357	ft
Width	118.8	ft
Rounded	119	ft

Aeration

lb. O2/hp hr	2	
Oxygen requirements	76,718	lb. oxygen at peak hour conditions
Horsepower	1,598	hp
Rounded	1,600	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	20.0	mgd
1.5 * Qave	60.0	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	10.0	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	40,000	sf, based on surface overflow rate
	71,460	sf, based on solids loading rate
Controlling	71,460	sf
Rounded	71,500	sf
Diameter	150.9	ft
Rounded	155	ft
Reliability Criteria		
Treatable Flow	56.6	
75% of design flow	30.0	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth		in.
Ratio of length to width	1.5	
Surface Area	13,889	sf, based on average filtration rate
	5,556	sf, based on peak filtration rate
Controlling	13,889	sf
Rounded	13,900	sf
Width	48.1	ft
Rounded	49.0	ft each
Length	73.5	ft
Rounded	74	ft each
Reliability criteria		
Capacity with one unit out of service	78.3	mgd
Required capacity	30.0	mgd
	OK	
Backwash		
Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes

Backwash generated per day	3.26	mgd
Return should be less than	6	
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	122.8	mgd	Max Day Flow from Expansion plu
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	24,011	lb./day
Flow for Primary Sludge	72,000	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb.. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	379	lb./day
	1.1	mg/L
Iron needed to remove 3.6 mg/L P	3,566	lb. Fe/day
Solids Produced	7,132	lb./day solids
Rounded	7,140	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	37,875	lb./day
Total Secondary Sludge	45,015	lb./day
	674,928	gpd

Gravity Belt Thickener Storage

Only secondary sludge undergoes gravity belt thickener storage

Number of Gravity Feed Storage Days	2	days		
Storage Volume	1,349,856	gallons		
	180,450	cf		
Rounded	180,500	cf		

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days		
Gravity Belt Thickened Solids	8	percent		
Days of Centrifuge Operation	5	days/week		
Hours of Operation per Day	8	hrs/day		
Primary Sludge Flow to Centrifuge	72,000	gpd at	4	percent solids
Secondary Sludge Flow to Centrifuge	67,493	gpd at	8	percent solids
Total Flow to Centrifuge	139,493	gpd		
Rounded	139,500	gpd		
Centrifuge Storage	558,000	gallons		
	74,594	cf		
Rounded	74,600	cf		
Centrifuge Size	407	gpm		
Rounded	407	gpm		

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	41,397	gpd
Rounded	41,400	gpd
Storage Volume	289,780	gallons
	38,738	cf
Rounded	38,800	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	11.3	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	2.3	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	39.375	mgd
	Peak Hourly Flow Rest of Plant	25.875	mgd
	Maximum Day Flow	25.875	mgd
	Peak Hourly Flow to be Equalized	39.375	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec	
Selected angle from horizontal	30	degrees	
Channel Area	8.7	sf	
Channel Length and Width	3	ft, if square	
Bar Screen Dimensions	6	ft by	3 ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	39.375	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	109,375	gal
Rounded volume	109,400	gal
Volume	14,621	cf
Rounded volume	14,700	cf
Length and width	31.3	ft, if square
Rounded legth and width	32	ft, if square
Air rate	160	cfm

Retention Basin

Assume that existing 40 mgd retention basin will provide sufficient storage.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf
Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	70		
Surface area	11,250	sf at design average flow	
	12,938	sf at peak hourly flow	
Controlling surface area	12,938	sf	
Round surface area	13,000	sf	
Number of clarifiers	3.38		
Rounded number of clarifiers	4		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	23.1	mgd
50% of design flow	12.9375	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order for nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	1.2	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	4		
Length to width ratio	3		

BOD Loading to Aeration Basins	13,334	lb./day
Rounded	13,340	lb./day
Total Volume of Basins	889,333	cf
Rounded	890,000	cf
Area	59,333	sf
Length	211	ft
Rounded	213	ft each
Width	70	ft
Rounded	71	ft each

Aeration

lb. O2/hp hr	2	
Oxygen requirements	56,405	lb. oxygen at peak hour conditions
Horsepower	1,175	hp
Rounded	1,180	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	5.6	mgd
1.5 * Qave	16.9	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	2.8	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf	
Peak Solids Loading Rate	35	lb./day/sf	
Minimum side water depth is 12 ft			
Assumed MLSS	3,000	mg/L	
Number of clarifiers	4		
Surface area	25,875	sf, based on surface overflow rate	
	30,549	sf, based on solids loading rate	
Controlling	30,549	sf	
Rounded	30,600	sf	
Diameter	98.7	ft	
Rounded	99	ft	
Reliability Criteria			
Treatable Flow	23.1		
75% of design flow	19.4		
	OK		

Tertiary Filters

Average filtration rate	2	gpm/sf	
Peak filtration rate	5	gpm/sf	
Number of filters	4		
Depth		in.	
Ratio of length to width	1.5		
Surface Area	3,906	sf, based on average filtration rate	
	3,594	sf, based on peak filtration rate	
Controlling	3,906	sf	
Rounded	3,910	sf	
Width	25.5	ft	
Rounded	26	ft	
Length	39	ft	
Rounded	39	ft	
Reliability criteria			
Capacity with one unit out of service	21.9	mgd	8.8
Required capacity	19.4	mgd	8.4
	OK		OK
Required Size	977	sf each	
	2,930	sf total	
	21.1	8.4	
	OK	OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	0.66	mgd
Return should be less than	1.69	mgd
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	33.925	mgd	Max Day Flow from Expansion plus 3.5 mgd * 2.3
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	7,147	lb./day
Flow for Primary Sludge	21,431	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	133	lb./day
	1.4	mg/L
Iron needed to remove 3.5 mg/L P	444	lb. Fe/day
Solids Produced	888	lb./day solids
Rounded	890	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	13,334	lb./day
Total Secondary Sludge	14,224	lb./day
	213,266	gpd

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days	
Gravity Belt Thickened Solids	8	percent	
Days of Centrifuge Operation	5	days/week	
Hours of Operation per Day	8	hrs/day	
Primary Sludge Flow to Centrifuge	21,431	gpd at	4 percent solids
Secondary Sludge Flow to Centrifuge	21,327	gpd at	8 percent solids
Total Flow to Centrifuge	42,758	gpd	
Rounded	42,800	gpd	
Centrifuge Storage	171,200	gallons	
	22,886	cf	
Rounded	22,900	cf	
Centrifuge Size	125	gpm	
Rounded	125	gpm	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	12,817	gpd
Rounded	12,900	gpd
Storage Volume	89,718	gallons
	11,994	cf
Rounded	12,000	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	35.9	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	1.89	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	125.65	mgd
	Peak Hourly Flow Rest of Plant	67.851	mgd
	Maximum Day Flow	67.851	mgd
	Peak Hourly Flow to be Equalized	125.65	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	27.8	sf		
Channel Length and Width	6	ft, if square		
Bar Screen Dimensions	12	ft by	6	ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	125.65	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	349,028	gal
Rounded volume	349,100	gal
Volume	46,658	cf
Rounded volume	46,700	cf
Length and width	55.8	ft, if square
Rounded legth and width	56	ft, if square
Air rate	280	cfm

Retention Basin

Assume that existing 40 mgd retention basin will provide sufficient storage.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	115		
Surface area	35,900	sf at design average flow	
	33,926	sf at peak hourly flow	
Controlling surface area	35,900	sf	
Round surface area	35,900	sf	
Number of clarifiers	3.46		
Rounded number of clarifiers	4		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	62.3	mgd
50% of design flow	33.9255	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order for nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	3.6	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	4		
Length to width ratio	3		

BOD Loading to Aeration Basins	42,072	lb./day
Rounded	42,080	lb./day
Total Volume of Basins	2,805,333	cf
Rounded	2,810,000	cf
Area	187,333	sf
Length	375	ft
Rounded	375	ft each
Width	125	ft
Rounded	125	ft each

Aeration

lb. O2/hp hr	2	
Oxygen requirements	149,176	lb. oxygen at peak hour conditions
Horsepower	3,108	hp
Rounded	3,110	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	18.0	mgd
1.5 * Qave	53.9	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	9.0	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	67,851	sf, based on surface overflow rate
	86,968	sf, based on solids loading rate
Controlling	86,968	sf
Rounded	87,000	sf
Diameter	166.4	ft
Rounded	167	ft
Reliability Criteria		
Treatable Flow	65.7	
75% of design flow	50.9	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth		in.
Ratio of length to width	1.5	
Surface Area	12,465	sf, based on average filtration rate
	9,424	sf, based on peak filtration rate
Controlling	12,465	sf
Rounded	12,470	sf
Width	45.6	ft
Rounded	46	ft
Length	69	ft
Rounded	69	ft
Reliability criteria		
Capacity with one unit out of service	68.6	mgd
Required capacity	50.9	mgd
	OK	
Required Size	3,116	sf each
	9,349	sf total
	67.3	
	OK	

27.4	
26.9	
OK	
26.9	
OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	2.10	mgd
Return should be less than	5.39	mgd
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	74.466	mgd	Max Day Flow from Expansion plus 3.5 mgd * 1.89
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	22,807	lb./day
Flow for Primary Sludge	68,390	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	421	lb./day
	1.4	mg/L
Iron needed to remove 3.5 mg/L P	1,432	lb. Fe/day
Solids Produced	2,863	lb./day solids
Rounded	2,870	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	42,072	lb./day
Total Secondary Sludge	44,942	lb./day
	673,837	gpd

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days	
Gravity Belt Thickened Solids	8	percent	
Days of Centrifuge Operation	5	days/week	
Hours of Operation per Day	8	hrs/day	
Primary Sludge Flow to Centrifuge	68,390	gpd at	4 percent solids
Secondary Sludge Flow to Centrifuge	67,384	gpd at	8 percent solids
Total Flow to Centrifuge	135,773	gpd	
Rounded	135,800	gpd	
Centrifuge Storage	543,200	gallons	
	72,615	cf	
Rounded	72,700	cf	
Centrifuge Size	396	gpm	
Rounded	397	gpm	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	40,631	gpd
Rounded	40,700	gpd
Storage Volume	284,420	gallons
	38,021	cf
Rounded	38,100	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	54.0	mgd
	Peaking Factor (Peak Hourly)	3.5	
	Maximum Day Peaking Factor	1.77	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	189.07	mgd
	Peak Hourly Flow Rest of Plant	95.6154	mgd
	Maximum Day Flow	95.6154	mgd
	Peak Hourly Flow to be Equalized	189.07	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec		
Selected angle from horizontal	30	degrees		
Channel Area	41.8	sf		
Channel Length and Width	7	ft, if square		
Bar Screen Dimensions	14	ft by	7	ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	189.07	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	525,194	gal
Rounded volume	525,200	gal
Volume	70,208	cf
Rounded volume	70,300	cf
Length and width	68.5	ft, if square
Rounded legth and width	69	ft, if square
Air rate	345	cfm

Retention Basin

Assume that existing 40 mgd retention basin will provide sufficient storage.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	140		
Surface area	54,020	sf at design average flow	
	47,808	sf at peak hourly flow	
Controlling surface area	54,020	sf	
Round surface area	54,100	sf	
Number of clarifiers	3.51		
Rounded number of clarifiers	4		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	92.4	mgd
50% of design flow	47.8077	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order for nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	6	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	4		
Length to width ratio	3		

BOD Loading to Aeration Basins	64,523	lb./day
Rounded	64,530	lb./day
Total Volume of Basins	4,302,000	cf
Rounded	4,310,000	cf
Area	287,333	sf
Length	464	ft
Rounded	465	ft each
Width	155	ft
Rounded	155	ft each

Aeration

lb. O2/hp hr	2	
Oxygen requirements	212,808	lb. oxygen at peak hour conditions
Horsepower	4,434	hp
Rounded	4,440	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	27.0	mgd
1.5 * Qave	81.0	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	13.5	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	95,615	sf, based on surface overflow rate
	126,231	sf, based on solids loading rate
Controlling	126,231	sf
Rounded	126,300	sf
Diameter	200.5	ft
Rounded	201	ft
Reliability Criteria		
Treatable Flow	95.2	
75% of design flow	71.7	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth		in.
Ratio of length to width	1.5	
Surface Area	18,757	sf, based on average filtration rate
	13,280	sf, based on peak filtration rate
Controlling	18,757	sf
Rounded	18,760	sf
Width	55.9	ft
Rounded	56	ft
Length	84	ft
Rounded	84	ft
Reliability criteria		
Capacity with one unit out of service	101.6	mgd 40.6
Required capacity	71.7	mgd 40.5
	OK	OK
Required Size	4,689	sf each
	14,068	sf total
	101.3	40.5
	OK	OK

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	3.17	mgd
Return should be less than	8.10	mgd
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	101.8104	mgd	Max Day Flow from Expansion plus 3.5 mgd * 1.77
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	34,318	lb./day
Flow for Primary Sludge	102,908	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	645	lb./day
	1.4	mg/L
Iron needed to remove 3.5 mg/L P	2,118	lb. Fe/day
Solids Produced	4,235	lb./day solids
Rounded	4,240	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	64,523	lb./day
Total Secondary Sludge	68,763	lb./day
	1,030,986	gpd

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days	
Gravity Belt Thickened Solids	8	percent	
Days of Centrifuge Operation	5	days/week	
Hours of Operation per Day	8	hrs/day	
Primary Sludge Flow to Centrifuge	102,908	gpd at	4 percent solids
Secondary Sludge Flow to Centrifuge	103,099	gpd at	8 percent solids
Total Flow to Centrifuge	206,007	gpd	
Rounded	206,100	gpd	
Centrifuge Storage	824,400	gallons	
	110,207	cf	
Rounded	110,300	cf	
Centrifuge Size	601	gpm	
Rounded	602	gpm	

Landfill Storage

Assumed	7	days
Centrifuged Sludge	20	percent
Flow to Storage Tank	61,821	gpd
Rounded	61,900	gpd
Storage Volume	432,747	gallons
	57,850	cf
Rounded	57,900	cf

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	21.1	mgd
	Peaking Factor (Peak Hourly)	2.14	
	Maximum Day Peaking Factor	2.14	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	45.154	mgd
	Peak Hourly Flow Rest of Plant	45.154	
	Maximum Day Flow	45.154	mgd
	Peak Hourly Flow to be Equalized	45.154	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec	
Selected angle from horizontal	30	degrees	
Channel Area	16.3	sf	
Channel Length and Width	5	ft, if square	
Bar Screen Dimensions	10	ft by	5 ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	45.154	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	125,428	gal
Rounded volume	125,500	gal
Volume	16,767	cf
Rounded volume	16,800	cf
Length and width	33.5	ft, if square
Rounded legth and width	34	ft, if square
Air rate	170	cfm

Retention Basin

Retention basin will not be necessary because excess wastewater flow will remain in interceptor and be treated at the existing DWSD WWTP.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	90		
Surface area	21100	sf at design average flow	
	22,577	sf at peak hourly flow	
Controlling surface area	22,577	sf	
Round surface area	22,600	sf	
Number of clarifiers	3.55		
Rounded number of clarifiers	4		25446.9

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	38.2	mgd
50% of design flow	22.577	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order fo nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	2	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	4		
Length to width ratio	3		

BOD Loading to Aeration Basins	24,486	lb./day
Rounded	24,490	lb./day
Total Volume of Basins	1,632,667	cf
Rounded	1,640,000	cf
Area	109,333	sf
Length	286	ft
Rounded	288	ft each
Width	95	ft
Rounded	96	ft each

Aeration

lb. O2/hp hr	2	
Oxygen requirements	98,169	lb. oxygen at peak hour conditions
Horsepower	2,045	hp
Rounded	2,050	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	10.6	mgd
1.5 * Qave	31.7	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	5.3	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	4	
Surface area	45,154	sf, based on surface overflow rate
	54,884	sf, based on solids loading rate
Controlling	54,884	sf
Rounded	54,900	sf
Diameter	132.2	ft
Rounded	133	ft
Reliability Criteria		
Treatable Flow	41.7	
75% of design flow	33.9	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	4	
Depth		in.
Ratio of length to width	1.5	
Surface Area	7,326	sf, based on average filtration rate
	6,271	sf, based on peak filtration rate
Controlling	7,326	sf
Rounded	7,400	sf
Width	35.1	ft
Rounded	36	ft
Length	54	ft
Rounded	54	ft
Reliability criteria		
Capacity with one unit out of service	42.0	mgd
Required capacity	33.9	mgd
	OK	
Required Size	1,832	sf each
	5,495	sf total
	39.6	15.8

16.8	
15.8	
OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	1.24	mgd
Return should be less than	3.17	
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	127.954	mgd	Max Day Flow from Expansion plus 36 mgd * 2.3
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	13,404	lb./day
Flow for Primary Sludge	40,196	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb.. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	245	lb./day
	1.4	mg/L
Iron needed to remove 3.5 mg/L P	849	lb. Fe/day
Solids Produced	1,697	lb./day solids
Rounded	1,700	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	24,486	lb./day
Total Secondary Sludge	26,186	lb./day
	392,620	gpd

Gravity Belt Thickener Storage

Only secondary sludge undergoes gravity belt thickener storage

Number of Gravity Feed Storage Days	2	days	
Storage Volume	785,240	gallons	
	104,972	cf	
Rounded	105,000	cf	

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days	
Gravity Belt Thickened Solids	8	percent	
Days of Centrifuge Operation	5	days/week	
Hours of Operation per Day	8	hrs/day	
Primary Sludge Flow to Centrifuge	40,196	gpd at	4 percent solids
Secondary Sludge Flow to Centrifuge	39,262	gpd at	8 percent solids
Total Flow to Centrifuge	79,458	gpd	
Rounded	79,500	gpd	
Centrifuge Storage	318,000	gallons	
	42,511	cf	
Rounded	42,600	cf	1065
			32.63434
Centrifuge Size	232	gpm	
Rounded	232	gpm	

Landfill Storage

Assumed	7	days	
Centrifuged Sludge	20	percent	
Flow to Storage Tank	23,744	gpd	
Rounded	23,800	gpd	
Storage Volume	166,207	gallons	
	22,219	cf	557.5
Rounded	22,300	cf	23.61144

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	56.31	mgd
	Peaking Factor (Peak Hourly)	1.84	
	Maximum Day Peaking Factor	1.84	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	103.610	mgd
	Peak Hourly Flow Rest of Plant	103.610	
	Maximum Day Flow	103.610	mgd
	Peak Hourly Flow to be Equalized	103.610	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec
Selected angle from horizontal	30	degrees

Channel Area	43.6	sf	
Channel Length and Width	7	ft, if square	
Bar Screen Dimensions	14	ft by	7 ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	103.6104	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	287,807	gal
Rounded volume	287,900	gal
Volume	38,474	cf
Rounded volume	38,500	cf
Length and width	50.7	ft, if square
Rounded legth and width	51	ft, if square
Air rate	255	cfm

Retention Basin

Retention basin will not be necessary because excess wastewater flow will remain in interceptor and be treated at the existing DWSD WWTP.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow	Design Peak Hourly Flow
No WAS	1000 gpd/sf	1500 to 3000 gpd/sf
Accepts WAS		1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	100		
Surface area	56310	sf at design average flow	
	51,805	sf at peak hourly flow	
Controlling surface area	56,310	sf	
Round surface area	56,400	sf	
Number of clarifiers	7.18		
Rounded number of clarifiers	8		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	110.0	mgd
50% of design flow	51.8052	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order fo nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	2	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	8		
Length to width ratio	3		

BOD Loading to Aeration Basins	58,391	lb./day
Rounded	58,400	lb./day
Total Volume of Basins	3,893,333	cf
Rounded	3,900,000	cf
Area	260,000	sf
Length	312	ft
Rounded	315	ft each
Width	104	ft
Rounded	105	ft each

Aeration

lb. O2/hp hr	2	
Oxygen requirements	218,023	lb. oxygen at peak hour conditions
Horsepower	4,542	hp
Rounded	4,550	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	28.2	mgd
1.5 * Qave	84.5	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	14.1	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	8	
Surface area	103,610	sf, based on surface overflow rate
	134,399	sf, based on solids loading rate
Controlling	134,399	sf
Rounded	134,400	sf
Diameter	146.3	ft
Rounded	147	ft
Reliability Criteria		
Treatable Flow	118.8	
75% of design flow	77.7	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	8	
Depth		in.
Ratio of length to width	1.5	
Surface Area	19,552	sf, based on average filtration rate
	14,390	sf, based on peak filtration rate
Controlling	19,552	sf
Rounded	19,600	sf
Width	40.4	ft
Rounded	41	ft
Length	61.5	ft
Rounded	62	ft
Reliability criteria		
Capacity with one unit out of service	128.1	mgd 51.2
Required capacity	77.7	mgd 42.2
	OK	OK
Required Size	2,095	sf each
	6,285	sf total
	105.6	42.2
	OK	OK

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	1.41	mgd
Return should be less than	8.45	
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	186.4104	mgd	Max Day Flow from Expansion plus 36 mgd * 2.3
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	35,773	lb./day
Flow for Primary Sludge	107,271	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb.. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	584	lb./day
	1.2	mg/L
Iron needed to remove 3.5 mg/L P	2,473	lb. Fe/day
Solids Produced	4,947	lb./day solids
Rounded	4,950	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	58,391	lb./day
Total Secondary Sludge	63,341	lb./day
	949,693	gpd

Gravity Belt Thickener Storage

Only secondary sludge undergoes gravity belt thickener storage

Number of Gravity Feed Storage Days	2	days			
Storage Volume	1,899,386	gallons			
	253,912	cf			
Rounded	254,000	cf			

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days			
Gravity Belt Thickened Solids	8	percent			
Days of Centrifuge Operation	5	days/week			
Hours of Operation per Day	8	hrs/day			
Primary Sludge Flow to Centrifuge	107,271	gpd at	4	percent solids	
Secondary Sludge Flow to Centrifuge	94,969	gpd at	8	percent solids	
Total Flow to Centrifuge	202,240	gpd			
Rounded	202,300	gpd			
Centrifuge Storage	809,200	gallons			
	108,175	cf			
Rounded	108,200	cf			2705
					52.00961
Centrifuge Size	590	gpm			
Rounded	591	gpm			

Landfill Storage

Assumed	7	days			
Centrifuged Sludge	20	percent			
Flow to Storage Tank	59,442	gpd			
Rounded	59,500	gpd			
Storage Volume	416,093	gallons			
	55,624	cf			
Rounded	55,700	cf			1392.5
					37.31622

Sizing Based on Ten State Standards and Reliability Criteria

Assumptions:	Average Flow	62.2	mgd
	Peaking Factor (Peak Hourly)	1.81	
	Maximum Day Peaking Factor	1.81	
	Influent BOD	165	mg/L
	Influent TSS	127	mg/L
	Influent Ammonia-N	15.8	mg/L
	Influent Total P	3	mg/L
	Effluent BOD	4	mg/L
	Effluent TSS	20	mg/L
	Effluent Ammonia-N	0.5	mg/L
	Effluent Total P	1	mg/L
	Reliability Class (1,2,3)	1	
	Most facilities are Class 1		
	Peak Hourly Flow at Headworks	112.582	mgd
	Peak Hourly Flow Rest of Plant	112.582	
	Maximum Day Flow	112.582	mgd
	Peak Hourly Flow to be Equalized	112.582	mgd

Calculations:

Preliminary Treatment

Coarse Bar Screen

Approach velocity greater than 1.25 ft/sec, less than 3 ft/sec at average flow

Selected approach velocity	2	ft/sec	
Selected angle from horizontal	30	degrees	
Channel Area	48.1	sf	
Channel Length and Width	7	ft, if square	
Bar Screen Dimensions	14	ft by	7 ft

Reliability Criteria Class I requires that one backup unit be provided

Raw Sewage Pumping Station

Minimum of 2 pumps capable of pumping peak hourly flow

Number of Pumps	2	minimum
Size of Pumps	112.582	mgd each

Grit Chamber

Detention time of 3 to 5 minutes at peak hourly flow
Air rate of 3 to 8 cfm/ft of tank length

Number of units (exclude bypass)	1	
Selected detention time	4	minutes
Selected air rate	5	cfm/ft
Selected depth	15	ft
Volume	312,728	gal
Rounded volume	312,800	gal
Volume	41,806	cf
Rounded volume	41,900	cf
Length and width	52.9	ft, if square
Rounded legth and width	53	ft, if square
Air rate	265	cfm

Retention Basin

Retention basin will not be necessary because excess wastewater flow will remain in interceptor and be treated at the existing DWSD WWTP.

Primary Clarifiers

Minimum depth is 10 ft. SWD

Surface Overflow Rates	Design Ave. Flow		Design Peak Hourly Flow
No WAS	1000	gpd/sf	1500 to 3000 gpd/sf
Accepts WAS			1200 gpd/sf

Tank receives WAS?	n	(y or n)	
Selected Design Peak Hourly Flow	2,000	gpd/sf	
Waste Activated Sludge	0	mgd	
Recycle Streams	0	mgd	Recycled to Aeration Basins
Diameter	105		
Surface area	62200	sf at design average flow	
	56,291	sf at peak hourly flow	
Controlling surface area	62,200	sf	
Round surface area	62,200	sf	
Number of clarifiers	7.18		
Rounded number of clarifiers	8		

Reliability criteria

With largest unit out of service, should be able to treat 50 percent of the total design flow

Capable flow treatment	121.2	mgd
50% of design flow	56.291	mgd
	OK	

Secondary Treatment

Aeration Basin with Nitrification

In order fo nitrification to occur - Aeration Tank Organic Loading is 15 lb./day/1000 cf
Freeboard Requirements: 18 in. for diffusers
3 ft. for surface aerators

Assumed BOD percent removal in primary clar.	30	percent	
WAS BOD Concentration	3000	mg/L	
Recycle BOD Concentration	250	mg/L	Est.
Recycle Flow	2	mgd	Est.
Side Water Depth	15	ft	
Number of Basins	8		
Length to width ratio	3		
BOD Loading to Aeration Basins	64,062	lb./day	
Rounded	64,070	lb./day	
Total Volume of Basins	4,271,333	cf	
Rounded	4,280,000	cf	
Area	285,333	sf	
Length	327	ft	
Rounded	330	ft each	
Width	109	ft	
Rounded	110	ft each	

Aeration

lb. O2/hp hr	2	
Oxygen requirements	236,418	lb. oxygen at peak hour conditions
Horsepower	4,925	hp
Rounded	4,930	hp

Reliability criteria will be met as long as there are a minimum of 2 equally sized basins

RAS Pumps

RAS pumps must be able to pump between 0.5 and 1.5 times the design average flow

0.5 * Qave	31.1	mgd
1.5 * Qave	93.3	mgd

WAS Pumps

Minimum of 25 percent of average flow

0.25 * Qave	15.6	mgd

Secondary Clarifiers

Overflow rate at Design Peak Hourly Flow	1,000	gpd/sf
Peak Solids Loading Rate	35	lb./day/sf
Minimum side water depth is 12 ft		
Assumed MLSS	3,000	mg/L
Number of clarifiers	8	
Surface area	112,582	sf, based on surface overflow rate
	147,123	sf, based on solids loading rate
Controlling	147,123	sf
Rounded	147,200	sf
Diameter	153.1	ft
Rounded	154	ft
Reliability Criteria		
Treatable Flow	130.4	
75% of design flow	84.4	
	OK	

Tertiary Filters

Average filtration rate	2	gpm/sf
Peak filtration rate	5	gpm/sf
Number of filters	8	
Depth		in.
Ratio of length to width	1.5	
Surface Area	21,597	sf, based on average filtration rate
	15,636	sf, based on peak filtration rate
Controlling	21,597	sf
Rounded	21,600	sf
Width	42.4	ft
Rounded	43	ft
Length	64.5	ft
Rounded	65	ft
Reliability criteria		
Capacity with one unit out of service	140.9	mgd
Required capacity	84.4	mgd
	OK	
Required Size	2,314	sf each
	6,942	sf total
	116.6	
	OK	

56.3	
46.7	
OK	
46.7	
OK	

Backwash

Backwash rate	15	gpm/sf
Minutes of backwash	15	minutes
Backwash generated per day	1.56	mgd
Return should be less than	9.33	
	OK	

Ultraviolet Disinfection

Treat flow from entire facility.

Peak Flow	195.382	mgd	Max Day Flow from Expansion plus 36 mgd * 2.3
Transmittance	65	percent	
Dose	32,500	uW-sec/cm2	

Sludge Handling

Primary and Secondary Sludge Handled Separately

Primary Sludge

Assumed solids removal	60	percent
Assumed percent solids	4	percent
Mass Solids for Primary Sludge	39,514	lb./day
Flow for Primary Sludge	118,491	gpd

Secondary Sludge

Chemical Sludge

Assumed Iron Dose Dose:	3	mg Fe/mg P
Assumed Non-Chemical P Removal	0.01	lb./ P removed per lb.. BOD removed

Assumed 2 lb. FSS produced for each lb. Iron removed

P removed prior to chemical	641	lb./day
	1.2	mg/L
Iron needed to remove 3.5 mg/L P	2,745	lb. Fe/day
Solids Produced	5,490	lb./day solids
Rounded	5,500	lb./day solids

Waste Activated Sludge

Assumed 1 lb. WAS produced per lb. BOD removed

Assume WAS is	0.8	percent solids
Mass Solids from WAS	64,062	lb./day
Total Secondary Sludge	69,562	lb./day
	1,042,976	gpd

Gravity Belt Thickener Storage

Only secondary sludge undergoes gravity belt thickener storage

Number of Gravity Feed Storage Days	2	days			
Storage Volume	2,085,952	gallons			
	278,852	cf			
Rounded	278,900	cf			

Centrifuge

Both primary and secondary sludge are centrifuged

Number of Centrifuge Storage Days	4	days			
Gravity Belt Thickened Solids	8	percent			
Days of Centrifuge Operation	5	days/week			
Hours of Operation per Day	8	hrs/day			
Primary Sludge Flow to Centrifuge	118,491	gpd at	4	percent solids	
Secondary Sludge Flow to Centrifuge	104,298	gpd at	8	percent solids	
Total Flow to Centrifuge	222,789	gpd			
Rounded	222,800	gpd			
Centrifuge Storage	891,200	gallons			
	119,136	cf			
Rounded	119,200	cf			2980
					54.58938
Centrifuge Size	650	gpm			
Rounded	650	gpm			

Landfill Storage

Assumed	7	days			
Centrifuged Sludge	20	percent			
Flow to Storage Tank	65,417	gpd			
Rounded	65,500	gpd			
Storage Volume	457,921	gallons			
	61,215	cf			
Rounded	61,300	cf			1532.5
					39.14716

Appendix B

Detailed Costing Information for the Expanded and New WWTPs

Expansion of City of Pontiac WWTP Option 1 – 21.1 MGD with Retention Basin

Cost Summary

Layout Name	Project ($)	Oper. ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Pontiac Opt. 1 w/ Ret. Basin	$135,000,000	$2,260,000	$770,000	$6,730,000	$435,000	$2,000,000	$4,300,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$3,050,000	$81,500	$61,200	$21,400	$0	$53,100	$270,000
Preliminary Treatment	$1,500,000	$178,000	$74,500	$0	$0	$5,250	$126,000
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$8,000,000	$71,200	$70,200	$7,250	$0	$658,000	$690,000
Primary Clarification	$3,490,000	$123,000	$62,900	$34,900	$0	$1,570	$301,000
Nitrification - Suspended Growth	$17,300,000	$328,000	$207,000	$270,000	$0	$1,010,000	$1,410,000
Iron Feed System	$152,000	$34,600	$0	$3,040	$0	$0	$12,700
Coagulation - Flocculation	$0	$0	$0	$0	$427,000	$0	$0
Secondary Clarifier	$4,430,000	$139,000	$71,300	$44,300	$0	$1,770	$386,000
Intermediate Process Pumping	$1,680,000	$39,300	$30,300	$11,800	$0	$109,000	$0
Filtration	$7,070,000	$22,000	$14,100	$165,000	$0	$12,400	$667,000
Ultra-Violet Disinfection	$2,040,000	$0	$29,900	$20,400	$8,280	$77,200	$167,000
Post Aeration	$142,000	$40,700	$17,700	$2,300	$0	$10,400	$12,500
Blower System	$1,120,000	$0	$0	$0	$0	$0	$93,800
Gravity Thickening	$693,000	$69,600	$39,500	$6,930	$0	$1,050	$62,400
Centrifugation	$2,930,000	$598,000	$91,500	$125,000	$0	$61,000	$0
Hauling and Land Filling	$1,060,000	$121,000	$0	$6,020,000	$0	$0	$104,000
Other Direct Costs	$79,900,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	3800	hrs/yr
Laboratory Labor Hours	4090	hrs/yr
Estimated Land for Construction Requirement	29.	acres
Estimate Administration Labor Cost	$190,000	$/yr
Estimated Laboratory Labor Cost	$225,000	$/yr
Mobilization	$1,120,000	$
Site Preparation	$1,360,000	$
Site Electrical	$4,370,000	$
Yard Piping	$10,400,000	$
Instrumentation and Control	$4,370,000	$
Lab and Administration Buildings	$2,430,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$25,400,000	$

Total Unit Process Construction Cost	$54,600,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$80,100,000	$

Miscellaneous Costs	$8,010,000	$
Legal Costs	$0	$
Engineering Design Fee	$16,000,000	$
Inspection Costs	$0	$
Contingency	$16,000,000	$
Technical	$0	$
Total Indirect Costs	$40,000,000	$

Total Cost of Land	$0	$
Interest during Construction	$14,400,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$3,030,000	$/yr
Total Annual O&M Costs	$12,200,000	$/yr
Total Annual Amortization Costs	$4,300,000	$/yr
Total Project Cost	$135,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
60-inch Pipe inside Tunnel	12,000	LF	$2,200	$26,400,000
Subtotal				$26,400,000
Miscellaneous Costs				$2,640,000
Engineering Design Fee				$5,280,000
Contingency				$5,280,000
Total Conveyance Cost				$39,600,000

Expansion of City of Pontiac WWTP Option 1 – 21.1 MGD without Equalization Basin

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Pontiac Opt. 1 w/o Ret. Basin	$108,000,000	$1,970,000	$649,000	$4,910,000	$434,000	$1,320,000	$3,390,000

Process Summary

Process	Construction ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$2,510,000	$69,600	$53,700	$17,600	$0	$60,100	$222,000
Preliminary Treatment	$1,110,000	$178,000	$73,500	$0	$0	$5,250	$92,700
Primary Clarification	$3,490,000	$123,000	$62,100	$34,900	$0	$1,570	$301,000
Nitrification - Suspended Growth	$17,300,000	$328,000	$204,000	$271,000	$0	$1,010,000	$1,410,000
Iron Feed System	$152,000	$34,600	$0	$3,040	$0	$0	$12,700
Coagulation - Flocculation	$0	$0	$0	$0	$427,000	$0	$0
Secondary Clarifier	$4,430,000	$139,000	$70,400	$44,300	$0	$1,770	$386,000
Intermediate Process Pumping	$1,380,000	$39,300	$29,900	$9,690	$0	$109,000	$0
Filtration	$6,210,000	$22,000	$13,900	$146,000	$0	$12,400	$586,000
Ultra-Violet Disinfection	$1,750,000	$0	$25,300	$17,500	$7,100	$66,200	$143,000
Post Aeration	$142,000	$40,700	$17,400	$2,300	$0	$10,400	$12,500
Blower System	$1,120,000	$0	$0	$0	$0	$0	$93,800
Gravity Thickening	$555,000	$53,400	$31,200	$5,550	$0	$945	$50,200
Centrifugation	$2,220,000	$443,000	$67,200	$89,000	$0	$44,400	$0
Hauling and Land Filling	$788,000	$85,700	$0	$4,270,000	$0	$0	$81,400
Other Direct Costs	$65,200,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	3800	hrs/yr
Laboratory Labor Hours	4090	hrs/yr
Estimated Land for Construction Requirement	29.	acres
Estimate Administration Labor Cost	$190,000	$/yr
Estimated Laboratory Labor Cost	$225,000	$/yr
Mobilization	$1,120,000	$
Site Preparation	$1,360,000	$
Site Electrical	$3,450,000	$
Yard Piping	$8,190,000	$
Instrumentation and Control	$3,450,000	$
Lab and Administration Buildings	$2,430,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$21,400,000	$

Total Unit Process Construction Cost	$43,100,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$64,500,000	$

Miscellaneous Costs	$6,450,000	$
Legal Costs	$0	$
Engineering Design Fee	$12,900,000	$
Inspection Costs	$0	$
Contingency	$12,900,000	$
Technical	$0	$
Total Indirect Costs	$32,300,000	$

Total Cost of Land	$0	$
Interest during Construction	$11,600,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$2,620,000	$/yr
Total Annual O&M Costs	$9,280,000	$/yr
Total Annual Amortization Costs	$3,390,000	$/yr
Total Project Cost	$108,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
48-inch Pipe inside Tunnel	12,000	LF	$2,000	$24,000,000
Subtotal				$24,000,000
Miscellaneous Costs				$2,400,000
Engineering Design Fee				$4,800,000
Contingency				$4,800,000
Total Conveyance Cost				$36,000,000

Expansion of City of Pontiac WWTP Option 2 – 30.8 MGD with Retention Basin

Cost Summary

Layout Name	Project ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Pontiac Opt. 2 w/ Ret. Basin	$191,000,000	$2,650,000	$978,000	$7,040,000	$637,000	$3,010,000	$6,280,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$3,790,000	$118,000	$85,600	$26,500	$0	$59,200	$335,000
Preliminary Treatment	$1,910,000	$248,000	$101,000	$0	$0	$6,260	$160,000
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$12,700,000	$90,900	$98,800	$10,500	$0	$1,030,000	$1,090,000
Primary Clarification	$4,500,000	$148,000	$77,400	$45,000	$0	$1,880	$386,000
Nitrification - Suspended Growth	$22,600,000	$396,000	$268,000	$321,000	$0	$1,530,000	$1,840,000
Iron Feed System	$156,000	$38,100	$0	$3,110	$0	$0	$13,000
Coagulation - Flocculation	$0	$0	$0	$0	$624,000	$0	$0
Secondary Clarifier	$5,800,000	$170,000	$89,000	$58,000	$0	$2,150	$504,000
Intermediate Process Pumping	$2,090,000	$37,400	$34,900	$14,600	$0	$159,000	$0
Filtration	$9,210,000	$27,300	$17,900	$212,000	$0	$17,900	$867,000
Ultra-Violet Disinfection	$3,310,000	$0	$49,300	$33,100	$13,400	$125,000	$270,000
Post Aeration	$182,000	$43,300	$20,200	$2,690	$0	$15,200	$16,200
Blower System	$7,440,000	$0	$0	$0	$0	$0	$624,000
Gravity Thickening	$708,000	$71,000	$40,900	$7,080	$0	$1,060	$63,700
Centrifugation	$2,990,000	$613,000	$95,400	$129,000	$0	$62,600	$0
Hauling and Land Filling	$1,090,000	$124,000	$0	$6,180,000	$0	$0	$107,000
Other Direct Costs	$113,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	5100	hrs/yr
Laboratory Labor Hours	4840	hrs/yr
Estimated Land for Construction Requirement	35.	acres
Estimate Administration Labor Cost	$255,000	$/yr
Estimated Laboratory Labor Cost	$266,000	$/yr
Mobilization	$1,450,000	$
Site Preparation	$1,680,000	$
Site Electrical	$6,280,000	$
Yard Piping	$14,900,000	$
Instrumentation and Control	$6,280,000	$
Lab and Administration Buildings	$3,030,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$35,500,000	$

Total Unit Process Construction Cost	$78,500,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$114,000,000	$

Miscellaneous Costs	$11,400,000	$
Legal Costs	$0	$
Engineering Design Fee	$22,800,000	$
Inspection Costs	$0	$
Contingency	$22,800,000	$
Technical	$0	$
Total Indirect Costs	$57,000,000	$

Total Cost of Land	$0	$
Interest during Construction	$20,500,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$3,620,000	$/yr
Total Annual O&M Costs	$14,300,000	$/yr
Total Annual Amortization Costs	$6,280,000	$/yr
Total Project Cost	$191,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
Segment A - 48-inch Pipe inside Tunnel	7,500	LF	$2,000	$15,000,000
Segment B - 54-inch Pipe inside Tunnel	12,500	LF	$2,100	$26,250,000
Segment C - 60-inch Pipe inside Tunnel	23,500	LF	$2,200	$51,700,000
Segment D - 72-inch Pipe inside Tunnel	12,000	LF	$2,500	$30,000,000
Total Conveyance Cost				$122,950,000
Miscellaneous Costs				$12,300,000
Engineering Design Fee				$24,590,000
Contingency				$24,590,000
Total Conveyance Cost				$184,430,000

Expansion of City of Pontiac WWTP Option 2 – 30.8 MGD without Equalization Basin

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Pontiac Opt. 2 w/o Ret. Basin	$154,000,000	$2,550,000	$841,000	$7,100,000	$633,000	$1,950,000	$4,880,000

Process Summary

Process	Construction ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$3,150,000	$94,600	$69,800	$22,100	$0	$69,700	$279,000
Preliminary Treatment	$1,350,000	$248,000	$99,800	$0	$0	$6,260	$113,000
Primary Clarification	$4,500,000	$148,000	$76,500	$45,000	$0	$1,880	$386,000
Nitrification - Suspended Growth	$22,600,000	$396,000	$264,000	$321,000	$0	$1,530,000	$1,840,000
Iron Feed System	$156,000	$38,100	$0	$3,110	$0	$0	$13,000
Coagulation - Flocculation	$0	$0	$0	$0	$624,000	$0	$0
Secondary Clarifier	$5,800,000	$170,000	$87,900	$58,000	$0	$2,150	$504,000
Intermediate Process Pumping	$1,680,000	$37,400	$34,500	$11,700	$0	$159,000	$0
Filtration	$7,900,000	$27,300	$17,700	$183,000	$0	$17,900	$745,000
Ultra-Violet Disinfection	$2,280,000	$0	$33,600	$22,800	$9,240	$86,200	$186,000
Post Aeration	$182,000	$43,300	$19,900	$2,690	$0	$15,200	$16,200
Blower System	$7,440,000	$0	$0	$0	$0	$0	$624,000
Gravity Thickening	$723,000	$72,100	$40,900	$7,230	$0	$1,060	$64,900
Centrifugation	$3,040,000	$623,000	$95,800	$131,000	$0	$63,600	$0
Hauling and Land Filling	$1,100,000	$127,000	$0	$6,290,000	$0	$0	$108,000
Other Direct Costs	$92,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	5100	hrs/yr
Laboratory Labor Hours	4840	hrs/yr
Estimated Land for Construction Requirement	35.	acres
Estimate Administration Labor Cost	$255,000	$/yr
Estimated Laboratory Labor Cost	$266,000	$/yr
Mobilization	$1,450,000	$
Site Preparation	$1,680,000	$
Site Electrical	$4,950,000	$
Yard Piping	$11,800,000	$
Instrumentation and Control	$4,950,000	$
Lab and Administration Buildings	$3,030,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$29,700,000	$

Total Unit Process Construction Cost	$61,900,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$91,600,000	$

Miscellaneous Costs	$9,160,000	$
Legal Costs	$0	$
Engineering Design Fee	$18,300,000	$
Inspection Costs	$0	$
Contingency	$18,300,000	$
Technical	$0	$
Total Indirect Costs	$45,800,000	$

Total Cost of Land	$0	$
Interest during Construction	$16,500,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$3,390,000	$/yr
Total Annual O&M Costs	$13,100,000	$/yr
Total Annual Amortization Costs	$4,880,000	$/yr
Total Project Cost	$154,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
Segment A - 36-inch Pipe inside Tunnel	7,500	LF	$1,900	$14,250,000
Segment B - 48-inch Pipe inside Tunnel	12,500	LF	$2,000	$25,000,000
Segment C - 48-inch Pipe inside Tunnel	23,500	LF	$2,000	$47,000,000
Segment D - 60-inch Pipe inside Tunnel	12,000	LF	$2,200	$26,400,000
Subtotal				$112,650,000
Miscellaneous Costs				$11,270,000
Engineering Design Fee				$22,530,000
Contingency				$22,530,000
Total Conveyance Cost				$168,980,000

Expansion of City of Pontiac WWTP Option 3 – 45.0 MGD with Retention Basin

Cost Summary

Layout Name	Project ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Pontiac Opt. 3 w/ Ret. Basin	$266,000,000	$3,500,000	$1,310,000	$10,300,000	$927,000	$4,530,000	$8,740,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$6,020,000	$173,000	$122,000	$42,100	$0	$64,200	$531,000
Preliminary Treatment	$2,420,000	$346,000	$137,000	$0	$0	$7,460	$203,000
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$19,600,000	$114,000	$137,000	$15,000	$0	$1,600,000	$1,690,000
Primary Clarification	$6,190,000	$186,000	$99,600	$61,900	$0	$2,340	$530,000
Nitrification - Suspended Growth	$32,300,000	$497,000	$354,000	$416,000	$0	$2,340,000	$2,610,000
Iron Feed System	$182,000	$43,000	$0	$3,640	$0	$0	$15,300
Coagulation - Flocculation	$0	$0	$0	$0	$911,000	$0	$0
Secondary Clarifier	$8,070,000	$214,000	$115,000	$80,700	$0	$2,680	$696,000
Intermediate Process Pumping	$2,810,000	$51,900	$45,600	$19,700	$0	$232,000	$0
Filtration	$12,300,000	$33,900	$22,900	$278,000	$0	$25,900	$1,160,000
Ultra-Violet Disinfection	$3,830,000	$0	$58,400	$38,300	$15,500	$145,000	$313,000
Post Aeration	$237,000	$46,100	$23,100	$3,160	$0	$22,100	$20,900
Blower System	$8,920,000	$0	$0	$0	$0	$0	$748,000
Gravity Thickening	$927,000	$95,900	$53,700	$9,270	$0	$1,210	$82,800
Centrifugation	$4,420,000	$861,000	$136,000	$205,000	$0	$89,600	$0
Hauling and Land Filling	$1,530,000	$183,000	$0	$9,120,000	$0	$0	$144,000
Other Direct Costs	$156,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	6870	hrs/yr
Laboratory Labor Hours	5730	hrs/yr
Estimated Land for Construction Requirement	44.	acres
Estimate Administration Labor Cost	$343,000	$/yr
Estimated Laboratory Labor Cost	$315,000	$/yr
Mobilization	$1,880,000	$
Site Preparation	$2,090,000	$
Site Electrical	$8,800,000	$
Yard Piping	$20,900,000	$
Instrumentation and Control	$8,800,000	$
Lab and Administration Buildings	$3,780,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$48,700,000	$

Total Unit Process Construction Cost	$110,000,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$158,000,000	$

Miscellaneous Costs	$15,800,000	$
Legal Costs	$0	$
Engineering Design Fee	$31,700,000	$
Inspection Costs	$0	$
Contingency	$31,700,000	$
Technical	$0	$
Total Indirect Costs	$79,200,000	$

Total Cost of Land	$0	$
Interest during Construction	$28,500,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$4,810,000	$/yr
Total Annual O&M Costs	$20,600,000	$/yr
Total Annual Amortization Costs	$8,740,000	$/yr
Total Project Cost	$266,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
84 MGD Pumping Station	1	--	$11,000,000	$11,000,000
Segment A - 72-inch Force Main	52,000	LF	$400	$20,800,000
Segment B - 72-inch Gravity Sewer in Tunnel	12,000	LF	$2,500	$30,000,000
Subtotal				$61,800,000
Miscellaneous Costs				$6,180,000
Engineering Design Fee				$12,360,000
Contingency				$12,360,000
Total Conveyance Cost				$92,700,000

Expansion of City of Pontiac WWTP Option 3 – 45.0 MGD without Equalization Basin

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Pontiac Opt. 3 w/o Ret. Basin	$208,000,000	$3,360,000	$1,110,000	$10,400,000	$924,000	$2,870,000	$6,540,000

Process Summary

Process	Construction ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chemicals ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$4,440,000	$134,000	$96,700	$31,100	$0	$78,900	$392,000
Preliminary Treatment	$1,650,000	$346,000	$136,000	$0	$0	$7,460	$139,000
Primary Clarification	$5,940,000	$181,000	$95,500	$59,400	$0	$2,270	$508,000
Nitrification - Suspended Growth	$31,800,000	$492,000	$346,000	$409,000	$0	$2,290,000	$2,570,000
Iron Feed System	$182,000	$43,000	$0	$3,640	$0	$0	$15,300
Coagulation - Flocculation	$0	$0	$0	$0	$911,000	$0	$0
Secondary Clarifier	$8,070,000	$214,000	$113,000	$80,700	$0	$2,680	$696,000
Intermediate Process Pumping	$2,430,000	$51,900	$45,100	$17,000	$0	$232,000	$0
Filtration	$10,400,000	$33,900	$22,600	$237,000	$0	$25,900	$979,000
Ultra-Violet Disinfection	$3,060,000	$0	$46,100	$30,600	$12,400	$116,000	$250,000
Post Aeration	$237,000	$46,100	$22,900	$3,160	$0	$22,100	$20,900
Blower System	$8,840,000	$0	$0	$0	$0	$0	$741,000
Gravity Thickening	$944,000	$97,400	$53,800	$9,440	$0	$1,220	$84,200
Centrifugation	$4,500,000	$877,000	$137,000	$209,000	$0	$91,300	$0
Hauling and Land Filling	$1,560,000	$187,000	$0	$9,300,000	$0	$0	$147,000
Other Direct Costs	$124,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	6870	hrs/yr
Laboratory Labor Hours	5730	hrs/yr
Estimated Land for Construction Requirement	44.	acres
Estimate Administration Labor Cost	$343,000	$/yr
Estimated Laboratory Labor Cost	$315,000	$/yr
Mobilization	$1,880,000	$
Site Preparation	$2,090,000	$
Site Electrical	$6,730,000	$
Yard Piping	$16,000,000	$
Instrumentation and Control	$6,730,000	$
Lab and Administration Buildings	$3,780,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$39,700,000	$

Total Unit Process Construction Cost	$84,100,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$124,000,000	$

Miscellaneous Costs	$12,400,000	$
Legal Costs	$0	$
Engineering Design Fee	$24,700,000	$
Inspection Costs	$0	$
Contingency	$24,700,000	$
Technical	$0	$
Total Indirect Costs	$61,900,000	$

Total Cost of Land	$0	$
Interest during Construction	$22,300,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$4,480,000	$/yr
Total Annual O&M Costs	$18,700,000	$/yr
Total Annual Amortization Costs	$6,540,000	$/yr
Total Project Cost	$208,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
48 MGD Pumping Station	1	--	$6,000,000	$6,000,000
Segment A - 60-inch Force Main	52,000	LF	$300	$15,600,000
Segment B - 60-inch Gravity Sewer in Tunnel	12,000	LF	$2,200	$26,400,000
Subtotal				$48,000,000
Miscellaneous Costs				$4,800,000
Engineering Design Fee				$9,600,000
Contingency				$9,600,000
Total Conveyance Cost				$72,000,000

Expansion of City of Warren WWTP Option 1 – 14.0 MGD

Cost Summary

Layout Name	Project ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Warren Option 1	$80,700,000	$1,570,000	$533,000	$3,570,000	$254,000	$807,000	$2,460,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$2,060,000	$57,300	$45,700	$14,400	$0	$45,400	$182,000
Preliminary Treatment	$1,170,000	$125,000	$53,200	$0	$0	$4,340	$97,800
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$23,500	$58,700	$52,800	$636	$0	$9,400	$2,750
Primary Clarification	$2,030,000	$81,300	$40,100	$20,300	$0	$1,050	$180,000
Nitrification - Suspended Growth	$11,200,000	$248,000	$145,000	$195,000	$0	$565,000	$912,000
Iron Feed System	$152,000	$30,100	$0	$3,040	$0	$0	$12,700
Coagulation - Flocculation	$0	$0	$0	$0	$249,000	$0	$0
Secondary Clarifier	$3,800,000	$116,000	$57,400	$38,000	$0	$1,480	$332,000
Intermediate Process Pumping	$1,060,000	$34,600	$26,000	$7,390	$0	$74,300	$0
Filtration	$5,040,000	$17,600	$10,900	$120,000	$0	$8,530	$477,000
Ultra-Violet Disinfection	$1,280,000	$0	$18,100	$12,800	$5,180	$48,300	$104,000
Post Aeration	$134,000	$38,200	$15,300	$2,400	$0	$15,500	$12,100
Blower System	$786,000	$0	$0	$0	$0	$0	$66,000
Gravity Thickening	$319,000	$29,500	$18,800	$3,190	$0	$734	$29,300
Centrifugation	$2,440,000	$331,000	$49,800	$92,200	$0	$32,600	$0
Hauling and Land Filling	$546,000	$61,500	$0	$3,060,000	$0	$0	$53,400
Other Direct Costs	$48,700,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	2750	hrs/yr
Laboratory Labor Hours	3650	hrs/yr
Estimated Land for Construction Requirement	24.	acres
Estimate Administration Labor Cost	$138,000	$/yr
Estimated Laboratory Labor Cost	$201,000	$/yr
Mobilization	$842,000	$
Site Preparation	$1,070,000	$
Site Electrical	$2,560,000	$
Yard Piping	$6,080,000	$
Instrumentation and Control	$2,560,000	$
Lab and Administration Buildings	$1,920,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$16,000,000	$

Total Unit Process Construction Cost	$32,000,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$48,000,000	$

Miscellaneous Costs	$4,800,000	$
Legal Costs	$0	$
Engineering Design Fee	$9,610,000	$
Inspection Costs	$0	$
Contingency	$9,610,000	$
Technical	$0	$
Total Indirect Costs	$24,000,000	$

Total Cost of Land	$0	$
Interest during Construction	$8,650,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$2,100,000	$/yr
Total Annual O&M Costs	$6,730,000	$/yr
Total Annual Amortization Costs	$2,460,000	$/yr
Total Project Cost	$80,700,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
Pavement Removal (Assume 5" Thick)	0.80	SY	$5	$4
Excavation	5.50	CY	$9	$49.5
Sheeting	60.00	SF	$20	$1,200
Granular Fill	4.80	CY	$6	$28.80
Pipe	1.00	LF	$140	$140
Tee-Manholes (400' Spacing)	0.0025	EA	$3,500	$8.75
Aggregate Base Under Bituminous, 12"	0.80	SY	$8	$6.40
Bituminous Mixture	0.18	TN	$45	$8.10
Traffic Control	1.00	LS	$5	$5
Mobilization	1.00	LS	$10	$10
COST PER LINEAR FOOT				$1,460.55
48-inch Pipe	20,000	LF		
Subtotal				$29,211,000
Miscellaneous Costs				$2,921,000
Engineering Design Fee				$5,842,000
Contingency				$5,842,000
Total Conveyance Cost				$43,816,000

Expansion of City of Warren WWTP Option 2 – 40.0 MGD

Cost Summary

Layout Name	Project ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Warren Option 2	$162,000,000	$2,880,000	$880,000	$8,970,000	$718,000	$1,950,000	$4,850,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$3,810,000	$120,000	$86,400	$26,600	$0	$76,100	$336,000
Preliminary Treatment	$1,030,000	$312,000	$122,000	$0	$0	$7,070	$86,100
Primary Clarification	$3,700,000	$129,000	$66,800	$37,000	$0	$1,650	$324,000
Nitrification - Suspended Growth	$22,600,000	$388,000	$258,000	$300,000	$0	$1,450,000	$1,810,000
Iron Feed System	$164,000	$39,400	$0	$3,290	$0	$0	$13,800
Coagulation - Flocculation	$0	$0	$0	$0	$712,000	$0	$0
Secondary Clarifier	$6,280,000	$168,000	$86,900	$62,800	$0	$2,120	$543,000
Intermediate Process Pumping	$1,220,000	$47,900	$41,600	$8,570	$0	$212,000	$0
Filtration	$9,190,000	$32,100	$21,000	$212,000	$0	$23,700	$866,000
Ultra-Violet Disinfection	$1,530,000	$0	$22,600	$15,300	$6,210	$57,900	$125,000
Post Aeration	$273,000	$45,400	$21,800	$3,730	$0	$38,800	$24,800
Blower System	$6,430,000	$0	$0	$0	$0	$0	$539,000
Gravity Thickening	$581,000	$57,100	$33,800	$5,810	$0	$970	$52,600
Centrifugation	$6,150,000	$770,000	$118,000	$278,000	$0	$79,600	$0
Hauling and Land Filling	$1,370,000	$161,000	$0	$8,020,000	$0	$0	$130,000
Other Direct Costs	$97,500,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	6260	hrs/yr
Laboratory Labor Hours	5430	hrs/yr
Estimated Land for Construction Requirement	41.	acres
Estimate Administration Labor Cost	$313,000	$/yr
Estimated Laboratory Labor Cost	$299,000	$/yr
Mobilization	$1,740,000	$
Site Preparation	$1,950,000	$
Site Electrical	$5,150,000	$
Yard Piping	$12,200,000	$
Instrumentation and Control	$5,150,000	$
Lab and Administration Buildings	$3,530,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$32,000,000	$

Total Unit Process Construction Cost	$64,400,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$96,300,000	$

Miscellaneous Costs	$9,630,000	$
Legal Costs	$0	$
Engineering Design Fee	$19,300,000	$
Inspection Costs	$0	$
Contingency	$19,300,000	$
Technical	$0	$
Total Indirect Costs	$48,200,000	$

Total Cost of Land	$0	$
Interest during Construction	$17,300,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$3,760,000	$/yr
Total Annual O&M Costs	$15,400,000	$/yr
Total Annual Amortization Costs	$4,850,000	$/yr
Total Project Cost	$162,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
40 MGD Pumping Station	1	--	$5,000,000	$5,000,000
48-inch Force Main	9,000	LF	$200	$1,800,000
Subtotal				$6,800,000
Miscellaneous Costs				$680,000
Engineering Design Fee				$1,360,000
Contingency				$1,360,000
Total Conveyance Cost				$10,200,000

Expansion of City of Mount Clemens WWTP Option 1 – 11.25 mgd

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Mt. Clemens Option 1	$68,900,000	$1,380,000	$468,000	$2,870,000	$266,000	$698,000	$2,110,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$1,960,000	$47,300	$39,300	$13,700	$0	$41,400	$174,000
Preliminary Treatment	$1,020,000	$103,000	$44,800	$0	$0	$3,930	$85,200
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$23,500	$58,900	$52,600	$636	$0	$9,400	$2,750
Primary Clarification	$1,530,000	$64,400	$31,400	$15,300	$0	$868	$136,000
Nitrification - Suspended Growth	$10,400,000	$234,000	$134,000	$191,000	$0	$500,000	$847,000
Iron Feed System	$152,000	$30,500	$0	$3,040	$0	$0	$12,700
Coagulation - Flocculation	$0	$0	$0	$0	$262,000	$0	$0
Secondary Clarifier	$3,050,000	$97,700	$47,900	$30,500	$0	$1,260	$267,000
Intermediate Process Pumping	$734,000	$32,200	$24,000	$5,140	$0	$60,000	$0
Filtration	$3,930,000	$15,600	$9,530	$94,900	$0	$6,930	$372,000
Ultra-Violet Disinfection	$912,000	$0	$12,800	$9,120	$3,700	$34,500	$74,400
Post Aeration	$114,000	$36,800	$14,200	$2,170	$0	$12,500	$10,200
Blower System	$718,000	$0	$0	$0	$0	$0	$60,200
Gravity Thickening	$278,000	$25,800	$16,700	$2,780	$0	$678	$25,600
Centrifugation	$2,050,000	$270,000	$40,400	$74,000	$0	$26,400	$0
Hauling and Land Filling	$438,000	$48,800	$0	$2,430,000	$0	$0	$43,000
Other Direct Costs	$41,700,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	2330	hrs/yr
Laboratory Labor Hours	3540	hrs/yr
Estimated Land for Construction Requirement	22.	acres
Estimate Administration Labor Cost	$116,000	$/yr
Estimated Laboratory Labor Cost	$195,000	$/yr
Mobilization	$726,000	$
Site Preparation	$951,000	$
Site Electrical	$2,180,000	$
Yard Piping	$5,190,000	$
Instrumentation and Control	$2,180,000	$
Lab and Administration Buildings	$1,690,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$13,800,000	$

Total Unit Process Construction Cost	$27,300,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$41,000,000	$

Miscellaneous Costs	$4,100,000	$
Legal Costs	$0	$
Engineering Design Fee	$8,210,000	$
Inspection Costs	$0	$
Contingency	$8,210,000	$
Technical	$0	$
Total Indirect Costs	$20,500,000	$

Total Cost of Land	$0	$
Interest during Construction	$7,380,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$1,840,000	$/yr
Total Annual O&M Costs	$5,680,000	$/yr
Total Annual Amortization Costs	$2,110,000	$/yr
Total Project Cost	$68,900,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
26 MGD Pumping Station	1	--	$3,500,000	$3,500,000
42-inch Force Main	500	LF	$200	$100,000
42-inch Sewer	4,000	LF	$210	$840,000
Subtotal Conveyance Cost				$4,440,000
Miscellaneous Costs				$440,000
Engineering Design Fee				$890,000
Contingency				$890,000
Total Conveyance Cost				$6,660,000

Expansion of City of Mount Clemens WWTP Option 2 – 35.9 MGD

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Mt. Clemens Option 2	$174,000,000	$2,990,000	$1,070,000	$9,220,000	$843,000	$2,070,000	$5,280,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$4,510,000	$138,000	$98,800	$31,600	$0	$61,300	$398,000
Preliminary Treatment	$2,100,000	$284,000	$114,000	$0	$0	$6,720	$176,000
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$23,500	$122,000	$148,000	$636	$0	$9,400	$2,750
Primary Clarification	$3,240,000	$117,000	$61,300	$32,400	$0	$1,490	$284,000
Nitrification - Suspended Growth	$24,200,000	$401,000	$273,000	$330,000	$0	$1,550,000	$1,950,000
Iron Feed System	$175,000	$41,000	$0	$3,510	$0	$0	$14,700
Coagulation - Flocculation	$0	$0	$0	$0	$833,000	$0	$0
Secondary Clarifier	$7,120,000	$183,000	$96,600	$71,200	$0	$2,310	$615,000
Intermediate Process Pumping	$1,860,000	$43,600	$39,400	$13,000	$0	$190,000	$0
Filtration	$8,440,000	$30,200	$20,000	$196,000	$0	$21,300	$795,000
Ultra-Violet Disinfection	$2,550,000	$0	$38,300	$25,500	$10,400	$96,600	$208,000
Post Aeration	$260,000	$44,600	$21,400	$3,660	$0	$39,800	$23,800
Blower System	$7,440,000	$0	$0	$0	$0	$0	$624,000
Gravity Thickening	$609,000	$59,800	$35,700	$6,090	$0	$988	$55,000
Centrifugation	$6,200,000	$787,000	$123,000	$282,000	$0	$81,500	$0
Hauling and Land Filling	$1,400,000	$165,000	$0	$8,220,000	$0	$0	$133,000
Other Direct Costs	$104,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	5750	hrs/yr
Laboratory Labor Hours	5180	hrs/yr
Estimated Land for Construction Requirement	38.	acres
Estimate Administration Labor Cost	$288,000	$/yr
Estimated Laboratory Labor Cost	$285,000	$/yr
Mobilization	$1,610,000	$
Site Preparation	$1,840,000	$
Site Electrical	$5,610,000	$
Yard Piping	$13,300,000	$
Instrumentation and Control	$5,610,000	$
Lab and Administration Buildings	$3,310,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$33,300,000	$

Total Unit Process Construction Cost	$70,100,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$103,000,000	$

Miscellaneous Costs	$10,300,000	$
Legal Costs	$0	$
Engineering Design Fee	$20,700,000	$
Inspection Costs	$0	$
Contingency	$20,700,000	$
Technical	$0	$
Total Indirect Costs	$51,700,000	$

Total Cost of Land	$0	$
Interest during Construction	$18,600,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$4,060,000	$/yr
Total Annual O&M Costs	$16,200,000	$/yr
Total Annual Amortization Costs	$5,280,000	$/yr
Total Project Cost	$174,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
Lakeshore Interceptor				
26 MGD Pumping Station	1	--	$3,500,000	$3,500,000
42-inch Force Main	500	LF	$200	$100,000
42-inch Sewer	4,000	LF	$210	$840,000
Garfield Interceptor				
50 MGD Pumping Station	1	--	$6,500,000	$6,500,000
60-inch Force Main	25,000	LF	$400	$10,000,000
Subtotal				$20,940,000
Miscellaneous Costs				$2,090,000
Engineering Design Fee				$4,180,000
Contingency				$4,180,000
Total Conveyance Cost				$31,390,000

Expansion of City of Mount Clemens WWTP Option 3 – 54.0 MGD

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Mt. Clemens Option 3	$243,000,000	$4,090,000	$1,470,000	$14,200,000	$1,270,000	$3,120,000	$7,390,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$6,350,000	$208,000	$145,000	$44,400	$0	$66,500	$558,000
Preliminary Treatment	$2,700,000	$405,000	$159,000	$0	$0	$8,120	$227,000
Wastewater Splitter	$0	$0	$0	$0	$0	$0	$0
Equalization	$23,500	$156,000	$209,000	$636	$0	$9,400	$2,750
Primary Clarification	$4,520,000	$142,000	$76,200	$45,200	$0	$1,800	$398,000
Nitrification - Suspended Growth	$35,300,000	$508,000	$364,000	$434,000	$0	$2,400,000	$2,840,000
Iron Feed System	$208,000	$51,200	$0	$4,160	$0	$0	$17,400
Coagulation - Flocculation	$0	$0	$0	$0	$1,250,000	$0	$0
Secondary Clarifier	$10,400,000	$229,000	$124,000	$104,000	$0	$2,860	$895,000
Intermediate Process Pumping	$2,470,000	$62,100	$52,600	$17,300	$0	$286,000	$0
Filtration	$11,800,000	$38,200	$26,000	$268,000	$0	$31,700	$1,110,000
Ultra-Violet Disinfection	$3,400,000	$0	$52,400	$34,000	$13,800	$129,000	$278,000
Post Aeration	$363,000	$47,700	$24,900	$4,600	$0	$59,900	$33,300
Blower System	$8,950,000	$0	$0	$0	$0	$0	$750,000
Gravity Thickening	$830,000	$84,900	$49,000	$8,300	$0	$1,130	$74,300
Centrifugation	$9,210,000	$1,160,000	$184,000	$454,000	$0	$123,000	$0
Hauling and Land Filling	$2,150,000	$257,000	$0	$12,800,000	$0	$0	$204,000
Other Direct Costs	$145,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	7920	hrs/yr
Laboratory Labor Hours	6210	hrs/yr
Estimated Land for Construction Requirement	49.	acres
Estimate Administration Labor Cost	$396,000	$/yr
Estimated Laboratory Labor Cost	$341,000	$/yr
Mobilization	$2,140,000	$
Site Preparation	$2,320,000	$
Site Electrical	$7,900,000	$
Yard Piping	$18,800,000	$
Instrumentation and Control	$7,900,000	$
Lab and Administration Buildings	$4,200,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$46,100,000	$

Total Unit Process Construction Cost	$98,700,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$145,000,000	$

Miscellaneous Costs	$14,500,000	$
Legal Costs	$0	$
Engineering Design Fee	$29,000,000	$
Inspection Costs	$0	$
Contingency	$29,000,000	$
Technical	$0	$
Total Indirect Costs	$72,400,000	$

Total Cost of Land	$0	$
Interest during Construction	$26,100,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$5,550,000	$/yr
Total Annual O&M Costs	$24,100,000	$/yr
Total Annual Amortization Costs	$7,390,000	$/yr
Total Project Cost	$243,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
96 MGD Pumping Station	1	--	$12,000,000	$12,000,000
72-inch Force Main	35,000	LF	$400	$14,000,000
Subtotal				$26,000,000
Miscellaneous Costs				$2,600,000
Engineering Design Fee				$5,200,000
Contingency				$5,200,000
Total Conveyance Cost				$39,000,000

New WWTP along Clinton River – Option 1- Oakland University Area – 21.1 MGD

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Oakland University Area	$108,000,000	$1,920,000	$610,000	$5,100,000	$382,000	$1,240,000	$3,210,000

Process Summary

Process	Construction ($)	Oper. ($/yr)	Maint. ($/yr)	Mat. ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$2,510,000	$69,600	$53,500	$17,600	$0	$60,100	$222,000
Preliminary Treatment	$1,110,000	$178,000	$73,200	$0	$0	$5,250	$92,900
Primary Clarification	$2,210,000	$87,100	$43,500	$22,100	$0	$1,120	$196,000
Nitrification - Suspended Growth	$16,000,000	$313,000	$192,000	$252,000	$0	$916,000	$1,310,000
Iron Feed System	$152,000	$33,500	$0	$3,040	$0	$0	$12,700
Coagulation - Flocculation	$0	$0	$0	$0	$375,000	$0	$0
Secondary Clarifier	$4,870,000	$139,000	$70,000	$48,700	$0	$1,770	$423,000
Intermediate Process Pumping	$1,410,000	$39,600	$30,000	$9,840	$0	$112,000	$0
Filtration	$6,220,000	$22,300	$14,000	$146,000	$0	$12,700	$588,000
Ultra-Violet Disinfection	$1,750,000	$0	$25,200	$17,500	$7,100	$66,200	$143,000
Post Aeration	$167,000	$40,800	$17,500	$2,700	$0	$20,500	$15,100
Blower System	$1,060,000	$0	$0	$0	$0	$0	$88,700
Gravity Thickening	$396,000	$35,800	$22,300	$3,960	$0	$808	$36,100
Centrifugation	$4,160,000	$456,000	$68,800	$168,000	$0	$45,700	$0
Hauling and Land Filling	$810,000	$88,500	$0	$4,410,000	$0	$0	$83,200
Other Direct Costs	$64,900,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	3800	hrs/yr
Laboratory Labor Hours	4090	hrs/yr
Estimated Land for Construction Requirement	29.	acres
Estimate Administration Labor Cost	$190,000	$/yr
Estimated Laboratory Labor Cost	$225,000	$/yr
Mobilization	$1,120,000	$
Site Preparation	$1,360,000	$
Site Electrical	$3,430,000	$
Yard Piping	$8,150,000	$
Instrumentation and Control	$3,430,000	$
Lab and Administration Buildings	$2,430,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$21,300,000	$

Total Unit Process Construction Cost	$42,900,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$64,200,000	$

Miscellaneous Costs	$6,420,000	$
Legal Costs	$0	$
Engineering Design Fee	$12,800,000	$
Inspection Costs	$0	$
Contingency	$12,800,000	$
Technical	$0	$
Total Indirect Costs	$32,100,000	$

Total Cost of Land	$0	$
Interest during Construction	$11,500,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$2,530,000	$/yr
Total Annual O&M Costs	$9,250,000	$/yr
Total Annual Amortization Costs	$3,210,000	$/yr
Total Project Cost	$108,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
56 MGD Pumping Station	1	--	$7,000,000	$7,000,000
42-inch Force Main	7,560	LF	$200	$1,512,000
48-inch Sewer	4,540	LF	$260	$1,180,400
Subtotal				$9,692,400
Miscellaneous Costs				$969,200
Engineering Design Fee				$1,938,400
Contingency				$1,938,400
Total Conveyance Cost				$14,538,400

New WWTP along Clinton River – Option 2 - Ford Proving Grounds – 56.3 MGD

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Ford Proving Grounds	$253,000,000	$3,830,000	$1,210,000	$13,500,000	$1,020,000	$2,970,000	$7,590,000

Process Summary

Process	Construction ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$5,940,000	$165,000	$116,000	$41,600	$0	$84,100	$524,000
Preliminary Treatment	$1,860,000	$421,000	$162,000	$0	$0	$8,280	$156,000
Primary Clarification	$5,190,000	$150,000	$79,600	$51,900	$0	$1,900	$458,000
Nitrification - Suspended Growth	$36,800,000	$490,000	$343,000	$447,000	$0	$2,220,000	$2,960,000
Iron Feed System	$189,000	$45,300	$0	$3,790	$0	$0	$15,900
Coagulation - Flocculation	$0	$0	$0	$0	$1,000,000	$0	$0
Secondary Clarifier	$11,500,000	$239,000	$127,000	$115,000	$0	$2,980	$996,000
Intermediate Process Pumping	$2,770,000	$64,400	$53,200	$19,400	$0	$298,000	$0
Filtration	$12,200,000	$39,100	$26,300	$277,000	$0	$33,000	$1,150,000
Ultra-Violet Disinfection	$3,830,000	$0	$58,000	$38,300	$15,500	$145,000	$313,000
Post Aeration	$358,000	$48,000	$24,800	$4,480	$0	$54,600	$32,600
Blower System	$8,600,000	$0	$0	$0	$0	$0	$722,000
Gravity Thickening	$768,000	$78,000	$45,000	$7,680	$0	$1,100	$68,900
Centrifugation	$10,700,000	$1,100,000	$171,000	$519,000	$0	$116,000	$0
Hauling and Land Filling	$2,030,000	$241,000	$0	$12,000,000	$0	$0	$194,000
Other Direct Costs	$150,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	8180	hrs/yr
Laboratory Labor Hours	6320	hrs/yr
Estimated Land for Construction Requirement	50.	acres
Estimate Administration Labor Cost	$409,000	$/yr
Estimated Laboratory Labor Cost	$348,000	$/yr
Mobilization	$2,200,000	$
Site Preparation	$2,370,000	$
Site Electrical	$8,240,000	$
Yard Piping	$19,600,000	$
Instrumentation and Control	$8,240,000	$
Lab and Administration Buildings	$4,300,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$47,900,000	$

Total Unit Process Construction Cost	$103,000,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$151,000,000	$

Miscellaneous Costs	$15,100,000	$
Legal Costs	$0	$
Engineering Design Fee	$30,100,000	$
Inspection Costs	$0	$
Contingency	$30,100,000	$
Technical	$0	$
Total Indirect Costs	$75,300,000	$

Total Cost of Land	$0	$
Interest during Construction	$27,100,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$5,040,000	$/yr
Total Annual O&M Costs	$22,500,000	$/yr
Total Annual Amortization Costs	$7,590,000	$/yr
Total Project Cost	$253,000,000	$

Conveyance Cost

There are no conveyance costs associated with this option.

New WWTP along Clinton River – Option 3 - M-59 East of Macomb/Oakland Areas – 62.2 MGD

Cost Summary

Layout Name	Project ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
East of Mac./Oak. Area	$271,000,000	$4,130,000	$1,300,000	$14,900,000	$1,120,000	$3,250,000	$8,130,000

Process Summary

Process	Construction ($)	Operation ($/yr)	Maint. ($/yr)	Materials ($/yr)	Chem. ($/yr)	Energy ($/yr)	Amort. ($/yr)
Influent Pump Station	$6,090,000	$181,000	$127,000	$42,600	$0	$86,300	$537,000
Preliminary Treatment	$1,960,000	$459,000	$175,000	$0	$0	$8,670	$164,000
Primary Clarification	$5,600,000	$159,000	$85,000	$56,000	$0	$2,010	$494,000
Nitrification - Suspended Growth	$39,300,000	$516,000	$366,000	$467,000	$0	$2,440,000	$3,180,000
Iron Feed System	$197,000	$47,800	$0	$3,950	$0	$0	$16,500
Coagulation - Flocculation	$0	$0	$0	$0	$1,110,000	$0	$0
Secondary Clarifier	$12,400,000	$252,000	$136,000	$124,000	$0	$3,140	$1,080,000
Intermediate Process Pumping	$3,040,000	$70,200	$57,100	$21,300	$0	$329,000	$0
Filtration	$13,500,000	$41,400	$28,000	$301,000	$0	$36,400	$1,270,000
Ultra-Violet Disinfection	$4,100,000	$0	$62,500	$41,000	$16,600	$155,000	$335,000
Post Aeration	$388,000	$48,800	$25,700	$4,730	$0	$60,300	$35,400
Blower System	$8,950,000	$0	$0	$0	$0	$0	$751,000
Gravity Thickening	$830,000	$84,500	$48,400	$8,300	$0	$1,130	$74,300
Centrifugation	$11,900,000	$1,200,000	$188,000	$591,000	$0	$127,000	$0
Hauling and Land Filling	$2,220,000	$267,000	$0	$13,300,000	$0	$0	$210,000
Other Direct Costs	$161,000,000	$0	$0	$0	$0	$0	$0

Design Output Data

Description	Value	Units
Administration Hours	8850	hrs/yr
Laboratory Labor Hours	6610	hrs/yr
Estimated Land for Construction Requirement	53.	acres
Estimate Administration Labor Cost	$442,000	$/yr
Estimated Laboratory Labor Cost	$363,000	$/yr
Mobilization	$2,360,000	$
Site Preparation	$2,510,000	$
Site Electrical	$8,800,000	$
Yard Piping	$20,900,000	$
Instrumentation and Control	$8,800,000	$
Lab and Administration Buildings	$4,550,000	$
non-Ocean Outfall	$0	$
Total Other Direct Costs	$51,100,000	$

Total Unit Process Construction Cost	$110,000,000	$
Profit	$0	$
Total Construction Costs (w/ Profit)	$162,000,000	$

Miscellaneous Costs	$16,200,000	$
Legal Costs	$0	$
Engineering Design Fee	$32,300,000	$
Inspection Costs	$0	$
Contingency	$32,300,000	$
Technical	$0	$
Total Indirect Costs	$80,800,000	$

Total Cost of Land	$0	$
Interest during Construction	$29,100,000	$

PROJECT SUMMARY

Total Annual Labor Costs	$5,430,000	$/yr
Total Annual O&M Costs	$24,800,000	$/yr
Total Annual Amortization Costs	$8,130,000	$/yr
Total Project Cost	$271,000,000	$

Conveyance Cost

Description	Quantity	Unit	Unit Amount	Total Amount
113 MGD Pumping Station	1	--	$14,000,000	$14,000,000
54-inch Force Main	5,300	LF	$250	$1,325,000
60-inch Sewer, 10’ Deep	5,060	LF	$310	$1,568,600
60-inch Sewer, 40’ Deep	8,700	LF	$930	$8,091,000
Subtotal				$24,984,600
Miscellaneous Costs				$2,498,500
Engineering Design Fee				$4,997,000
Contingency				$4,997,000
Total Conveyance Cost				$37,477,100