

# Technical Memorandum

## SMCSD Headworks, Primary and Secondary Treatment Pre-Design

**Subject:** TM 1: Design Criteria  
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The purpose of this technical memorandum (TM) is to present the design flows for the new headworks, primary and secondary treatment facilities and to summarize the overall flow schematic and design criteria for the Sausalito-Marín City Sanitary District (SMCSD) Wastewater Treatment Plant (WWTP). This TM is intended to be included as an appendix to the Recommended Project Summary, which includes a summary of major recommendations. All drawings referenced in this TM are bound together as a separate attachment. The TM is organized in the following sections:

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### 1 Summary of Findings

SMCSD is evaluating process improvements to its WWTP including the addition of a headworks, a new primary clarifier and secondary upgrades including tertiary polishing. Recommended design flows and design criteria were developed for the treatment plant upgrades. Individual process upgrades are discussed in detail in their respective TMs; the design criteria for each progress upgrades have been compiled in this TM.

Historically, influent flows to the SMCSD treatment exceed 6.0 MGD infrequently and for short durations (on average 7 times per year with a total duration of 29.9 hours). The new treatment facilities at SMCSD should be designed to process flow up to 6.0 MGD while providing hydraulic capacity to handle peak wet weather events. Therefore, it is recommended that:

- Flows up to 6.0 MGD be routed through new screening facilities with flows above 6 MGD routed through a manual bar screen
- All flows, including those above 6 MGD, be routed through new grit removal facilities
- Flows up to 6.0 MGD be split equally between the new primary clarifier and the existing primary clarifier
- Hydraulic capacity of the new headworks and primary treatment facilities be 13 MGD to avoid flooding or overflows at the treatment plant up to the 10 year wet weather flow event
- Flows to the secondary be limited to 9.0 MGD with the addition of 0.6 MG of equalization
- Secondary treatment capacity be increased to 9.0 MGD to minimize blending

- Tertiary treatment be upgraded to 6.0 MGD to provide additional polishing treatment capacity during wet weather.

Based on recent conveyance system modeling by RMC, the peak wet weather flow from a 5-year event is 12.3 MGD. The peak 12.3 MGD flow will be handled without the need for blending by increasing the secondary treatment capacity to 9.0 MGD and with the addition of on-site equalization storage. Influent flows greater than the 12.3 MGD 5-year event will require blending.

## 2 Design Flow and Loadings

The existing WWTP includes the following treatment units: primary clarifiers, fixed film reactors (FFR), secondary clarifiers, effluent screens, side-stream granular media filters (up to 1 MGD), chlorine contact basins, and an outfall which discharges to San Francisco Bay. The treatment plant was designed to provide treatment for 1.8 MGD of average dry weather flow, 6.0 MGD of peak day flow and 10 MGD peak instantaneous hydraulic flow.

### 2.1 Current and Potential Flows

Design flows for the treatment plant were developed based on the Wet Weather Treatment and Conveyance System Evaluation (RMC, February 2008) and review of 15-minute flow data from 2002 through 2006. A more detailed discussion of how the influent flow values were developed can be found in the Wet Weather Treatment and Conveyance System Evaluation Report (Wet Weather Report).

Subsequent to the Wet Weather Report, additional conveyance system modeling was performed to develop information for the 5-year peak wet weather event as part of the “Sewage Spill Reduction Action Plan, Vol. III”. The 5-year peak wet weather event was developed to identify conveyance system improvements. The 5-year peak wet weather event correlates to the actual inflow experienced at the SMCSD treatment plant on December 31, 2005. Current typical influent flow rates based on historical data are presented in Table 1, along with the estimated peak flows from the 5-year and the 10-year events. There are no plans for infill or future growth in the SMCSD service area. Therefore, influent flow to the treatment plant is not expected to increase. The minimum influent flow to the plant is approximately 0.25 MGD which typically occurs during the late evening or early morning on dry weather days.

**Table 1: Influent Flow Rates**

| Condition   | Influent Flow (MGD) |
|---|---------------------|
| Minimum Diurnal Flow                              | 0.25                |
| Average Day Dry Weather Flow (ADWF)               | 1.5                 |
| Peak Day Dry Weather Flow (PDWF)                  | 3.2                 |
| Average Day Wet Weather Flow (AWWF)               | 1.8                 |
| Peak Day Wet Weather Flow (PWFF)                  | 6.2                 |
| 5-Year Event Instantaneous Peak Wet Weather Flow  | 12.3                |
| 10-Year Event Instantaneous Peak Wet Weather Flow | 13.0                |

## 2.2 Design Loadings

The design of the new headworks and primary treatment will be based on hydraulic capacity. Therefore, influent loading from BOD, TSS, and other constituents will not have a significant impact on equipment selection or sizing. For the secondary process upgrades, the primary objective is to provide additional hydraulic capacity to handle peak wet weather flows while meeting NPDES permit effluent limits. The majority of wet weather flow can be attributed to inflow and infiltration which would not provide a substantial increase in influent BOD and TSS mass loadings. Therefore, a constant mass loading was assumed during wet weather. Influent loadings to the treatment plant used for the preliminary design are presented in Table 2.

**Table 2: Typical Influent Loadings**

| Constituent       | Average Concentration <sup>1</sup><br>(mg/L) | Wet Weather Mass Loadings <sup>2</sup><br>(lbs/day) |
|-------------------|--|---|
| cBOD <sub>5</sub> | 219  | 6,000   |
| TSS               | 327  | 6,500   |

<sup>1</sup>Values taken from the “Operational Audit Preliminary Design Report” by CH2MHILL, March 2006.

<sup>2</sup>For weather flow, a constant mass loading was assumed based on a review of recent loadings during wet weather events.

## 2.3 Current Process Capacity

An evaluation of the SMCSD treatment plant process capacity during peak wet weather events was completed using an approach similar to the average dry weather flow analysis completed by CH2M Hill (*Operational Audit Preliminary Design Report*, March 2006). The initial evaluation included comparing current process operating parameters during wet weather against the original plant design criteria and typical design criteria. The process criteria comparison is presented in Table 3.

Table 3: Current Design Process Loading

| Process                                      | Units                                | Average Day | Peak Day Wet Weather | 5-Year Event Instantaneous Peak | Typical Peak Flow Design Value <sup>a</sup> |
|--|--------------------------------------|-------------|----------------------|---------------------------------|---|
| <u>Flow</u>                                  |                                      |             |                      |                                 |   |
| Influent Flow                                | MGD                                  | 1.5         | 6.0                  | 12.3                            | ---   |
| <u>Primary Clarifiers</u>                    |                                      |             |                      |                                 |   |
| Units  | --                                   | 1           | 1                    | 1                               | --  |
| Side Water Depth                             | ft                                   | 9.5         | 9.5                  | 9.5                             | 14  |
| Surface Area                                 | ft <sup>2</sup>                      | 2,376       | 2,376                | 2,376                           | --  |
| Surface Overflow Rate                        | gal/day- ft <sup>2</sup>             | 631         | 2,525                | 5,177                           | 2,000-3,000                                 |
| <u>Fixed Film Reactors (FFR)<sup>b</sup></u> |                                      |             |                      |                                 |   |
| Surface Area All Units                       | ft <sup>2</sup>                      | 2,514       | 2,514                | 2,514                           | ---   |
| Organic Loading Rate                         | lbs BOD/day-<br>1000 ft <sup>3</sup> | 23.9        | 52.2                 | 52.2                            | 37-200                                      |
| Hydraulic Loading Rate                       | gal/min-ft <sup>2</sup>              | 1.66        | 1.66                 | 2.49                            | 1.0 - 2.0                                   |
| <u>Secondary Clarifiers</u>                  |                                      |             |                      |                                 |   |
| Total Surface Area                           | ft <sup>2</sup>                      | 3,520       | 3,520                | 3,520                           | ---   |
| Surface Overflow Rate                        | gal/day-ft <sup>2</sup>              | 426         | 1,705                | 2,557                           | 1,000-1,200                                 |
| Solids Loading Rate <sup>c</sup>             | lbs TSS/day-<br>ft <sup>2</sup>      | 0.70        | 1.24                 | 1.11                            | 2   |
| <u>Granular Media Filters<sup>d</sup></u>    |                                      |             |                      |                                 |   |
| Total Surface Area                           | ft <sup>2</sup>                      | 256         | 256                  | 256                             | ---   |
| Surface Loading Rate                         | gal/min-ft <sup>2</sup>              | 2.7         | 2.7                  | 2.7                             | 2-8   |

Notes:

<sup>a</sup>Typical design criteria taken from Metcalf and Eddy, Inc, *Wastewater Engineering Treatment, Disposal and Reuse*, 3<sup>rd</sup> edition.

<sup>b</sup>The current maximum flow through the Fixed Film Reactors (FFRs) is 6.8 MGD. Flow greater than 6.8 MGD would be routed around the FFRs, treated with a wet weather treatment step and recombined with the secondary clarifier effluent prior disinfection.

<sup>c</sup>Estimated based on assumed solids removal through the primary clarifier and solids produced from the FFRs.

<sup>d</sup>The granular media filters were added as a side stream treatment process after the secondary treatment plant was constructed. Maximum flow through the granular media filters is 1.0 MGD

## 2.4 Wet Weather Blending

During peak wet weather events, the influent flow to the treatment plant can exceed the process capacity of the fixed film reactors. Although the fixed firm reactors were designed for a 6.0 MGD peak flow, currently the maximum flow to the FFRs is 6.8 MGD which is the maximum capacity of the FFR feed pump station. Above 6.8 MGD, primary effluent is passively routed around the FFRs and directed to the secondary clarifiers. The operational strategy of mixing primary effluent and secondary effluent is commonly referred to as “blending” and is currently allowed under SMCSD’s NPDES permit. However, when the WWTP is blending, additional sampling, data collection and record keeping is required. In addition, the Regional Water Quality Control Board (RWQCB) has required SMCSD to look at alternatives to blending including adding equalization, increasing secondary treatment capacity, and/or

adding treatment specifically for blended flows. A summary of recent flow events above 6.8 MGD is presented in Table 4.

**Table 4: Flow Events Above 6.8 MGD - Annual Totals**

| Wet Weather Year                         | Frequency (# of Events/ Year) <sup>a</sup> | Cumulative Duration (Hours/Year) | Cumulative Volume (MG/Year) |
|--|--|----------------------------------|-----------------------------|
| 2002-03                                  | 6  | 4.3                              | 0.1                         |
| 2003-04                                  | 5  | 16.8                             | 0.8                         |
| 2004-05                                  | 2  | 12.3                             | 0.7                         |
| 2005-06                                  | 8  | 43.5                             | 2.7                         |
| 2006-07 <sup>b</sup>                     | 1  | 4.3                              | 0.1                         |
| <b>Average (not including 2006-2007)</b> | <b>5.3</b>                                 | <b>19.2</b>                      | <b>1.1</b>                  |

Notes:

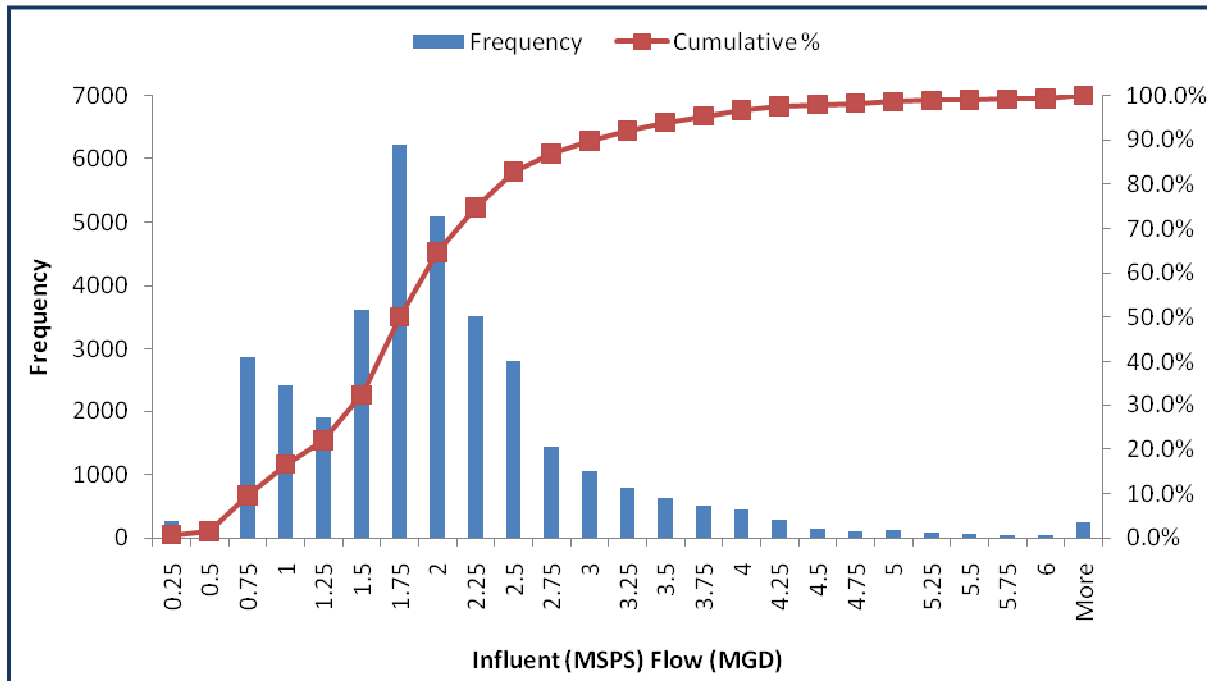
<sup>a</sup> Unique events above 6.8 MGD were defined based on one hour intervals (i.e. influent flows below 6.0 MGD for 1 hour followed by flow above 6.8 MGD was counted as a new above 6.8 MGD event)

<sup>b</sup> 2006-07 wet weather season includes influent flow data through January 24, 2007

Flow events over 6.8 MGD occur on average 5.3 times per year. Flows above 6.8 MGD typically last for a short duration (average 3.6 hours per event) and result in a relatively small volume in excess of 6.8 MGD (average 0.21 MG per event). Based on the average frequency of events above 6.8 MGD and the volume of these events, 99.8 percent of the annual flow into the SMCSD treatment plant occurs at influent flow rates less than 6.8 MGD.

A more detailed picture of the overall influent flow range, a histogram of 15-minute influent flow data from July 2005 through June 2006 is presented as Figure 1.

**Figure 1: Influent (MSPS) Flow Histogram (Based on 15-minute flow data from 7/2005 - 6/2006)**



As shown in Figure 1, approximately 90% of the flow from July 2005 through June 2006 occurs at a flow rate of 3.0 MGD or less and 99.3% of the flow occurs at a flow rate of 6.0 MGD or less. The minimum influent flow to the plant is approximately 0.25 MGD which typically occurs during the late evening or early morning during dry weather.

### **3 Design Criteria**

The following design criteria are recommended to improve plant operation, reliability, performance and to reduce wet weather blending events.

#### **3.1 Design Flows**

Based on the estimated influent flows to the SMCSD WWTP, it is recommended that the new headworks and primary treatment facilities be designed to treat 6.0 MGD with hydraulic accommodation for peak wet weather flows up to 13.0 MGD.

Design of the new processes was based on the projected flow data presented in Table 1. The design flows for the treatment plant improvements are summarized below:

- The mechanical screens at the headworks are designed to handle the future maximum day flow of 6.0 MGD. The addition of a manual bar screen allows screening of the current maximum instantaneous peak flow of 13 MGD.
- The grit process is sized to handle the future maximum day flow of 6.0 MGD. Depending on the actual sizing and configuration of the grit basin(s), the grit process should be designed to hydraulically handle up to the peak instantaneous flow of 13 MGD.
- The new primary treatment process is designed to match the existing primary clarifier and is nominally designed for a peak flow of 6.0 MGD. Using the new primary clarifier in conjunction with the existing primary clarifier will allow primary treatment of the current maximum instantaneous peak flow of 13 MGD. However, with the addition of equalization, the peak flow to the primary treatment process will be 9.0 MGD.
- The new on-site equalization is sized to provide 0.6 MG of storage and limit flow to the secondary process to 9.0 MGD.
- The FFR pump station is sized to pump 9.0 MGD to the fixed film reactors.
- The FFR reactor media is being replaced to address aging infrastructure and to accommodate the additional hydraulic loading of up to 9.0 MGD.
- Replace the existing sand filters with 6.0 MGD of rotating disk filtration capacity to address aging infrastructure and increase treatment capacity during wet weather.

#### **3.2 New Process Design Loadings**

The revised process loadings based on the recommend process improvements are presented in Table 5.

Table 5: New Design Process Loading

| Process                                      | Units                            | Average Day | Future Max. Secondary Capacity | 5-Year Event Instantaneous Peak | Typical Peak Flow Design Value <sup>a</sup> |
|--|----------------------------------|-------------|--------------------------------|---------------------------------|---|
| <u>Flow</u>                                  |                                  |             |                                |                                 |   |
| Influent Flow                                | MGD                              | 1.5         | 9.0                            | 12.3                            | ---   |
| <u>Primary Clarifiers</u>                    |                                  |             |                                |                                 |   |
| Units  | --                               | 1           | 2                              | 1                               | --  |
| Side Water Depth                             | ft                               | 9.5         | 9.5                            | 9.5                             | 14  |
| Surface Area                                 | ft <sup>2</sup>                  | 2,376       | 4,752                          | 4,752                           | --  |
| Surface Overflow Rate                        | gal/day-ft <sup>2</sup>          | 631         | 1,894                          | 2,588                           | 2,000-3,000                                 |
| <u>Fixed Film Reactors (FFR)<sup>b</sup></u> |                                  |             |                                |                                 |   |
| Surface Area All Units                       | ft <sup>2</sup>                  | 2,514       | 2,514                          | 2,514                           | ---   |
| Organic Loading Rate                         | lbs BOD/day-1000 ft <sup>3</sup> | 23.9        | 52.2                           | 52.2                            | 37-200                                      |
| Hydraulic Loading Rate                       | gal/min-ft <sup>2</sup>          | 1.66        | 2.49                           | 2.49                            | 1.0 - 2.0                                   |
| <u>Secondary Clarifiers</u>                  |                                  |             |                                |                                 |   |
| Total Surface Area                           | ft <sup>2</sup>                  | 3,520       | 3,520                          | 3,520                           | ---   |
| Surface Overflow Rate                        | gal/day-ft <sup>2</sup>          | 426         | 1,705                          | 2,557                           | 1,000-1,200                                 |
| Solids Loading Rate <sup>c</sup>             | lbs TSS/day-ft <sup>2</sup>      | 0.70        | 1.24                           | 1.11                            | 2   |
| <u>Rotating Disk Filters</u>                 |                                  |             |                                |                                 |   |
| Total Surface Area                           | ft <sup>2</sup>                  | 1280        | 1280                           | 1280                            | ---   |
| Surface Loading Rate                         | gal/min-ft <sup>2</sup>          | 0.82        | 3.25                           | 3.25                            | 2-6   |

Notes:

<sup>a</sup>Typical design criteria taken from Metcalf and Eddy, Inc, *Wastewater Engineering Treatment, Disposal and Reuse*, 3<sup>rd</sup> edition.

<sup>b</sup>The maximum flow through the Fixed Film Reactors (FFRs) is 9.0 MGD. In the future, flow greater than 9.0 MGD would be routed around the FFRs, treated with a wet weather treatment step, and recombined with the secondary clarifier effluent prior disinfection.

<sup>c</sup>Estimated based on assumed solids removal through the primary clarifier and solids produced from the FFRs.

### 3.3 Process Flow Schematic and Hydraulic Profile

The overall process flow schematic is attached as Drawing G-4. The updated treatment plant hydraulic profile is attached Drawing G-5.

### 3.4 Process Design Criteria

The basis for the process design criteria presented in this section is available in the individual process TMs. A summary of the recommended design criteria for the process equipment for the new headworks/primary treatment facility is presented in Table 6.

Table 6: Process Design Criteria Summary

| Criteria                           | Value                        | Unit |
|------------------------------------|------------------------------|------|
| <b>Headworks</b>                   |                              |      |
| <u>Mechanical Screens</u>          |                              |      |
| Type                               | Sieve auger screen           | -    |
| Number                             | 2                            | -    |
| Openings                           | 1/4                          | inch |
| Capacity                           | 3 to 4                       | MGD  |
| <u>Manual Screen</u>               |                              |      |
| Type                               | Bar                          | -    |
| Number                             | 1                            | -    |
| Screen Opening Width               | 1                            | inch |
| Capacity                           | 10                           | MGD  |
| <u>Screenings Washer Compactor</u> |                              |      |
| Number                             | 1                            | -    |
| Compactor Motor Size               | 3                            | HP   |
| Grinder Motor Size                 | 10                           | HP   |
| <u>Grit Chamber</u>                |                              |      |
| Type                               | Vortex                       | -    |
| Number                             | 2                            | -    |
| Diameter                           | 7 to 8                       | ft   |
| Capacity                           | 4( process), 7 (hydraulic)   | MGD  |
| <u>Grit Pumps</u>                  |                              |      |
| Type                               | Air Lift                     | -    |
| Number                             | 2                            | -    |
| Capacity                           | 200                          | gpm  |
| <u>Grit Handling</u>               |                              |      |
| Type                               | Huber Coanda (or Equivalent) | -    |
| Number                             | 2                            | -    |
| <u>Influent Metering</u>           |                              |      |
| Type                               | Mag Meters                   | -    |
| Number                             | 3                            | -    |
| Diameter                           | 12                           | inch |
| <b>Equalization</b>                |                              |      |
| <u>EQ Storage Tank</u>             |                              |      |
| Compartments                       | 2                            | -    |
| Volume (Total)                     | 0.6 (min)                    | MG   |
| <u>EQ Return Pumps</u>             |                              |      |
| Type                               | Centrifugal                  | -    |
| Number                             | 2                            | -    |
| Capacity (Each)                    | 695                          | gpm  |
| TDH                                | 45                           | feet |
| Motor Size                         | 15                           | HP   |

**SMCSD Headworks, Primary and Secondary Treatment Pre-Design**

TM 1: Design Criteria

| Criteria   | Value                | Unit                             |
|--|----------------------|----------------------------------|
| <b>Primary Treatment</b>   |                      |                                  |
| <u>Primary Clarifier</u>   |                      |                                  |
| Number   | 2 (1 new/1 existing) | -                                |
| Type   | Circular             | -                                |
| Maximum Design Flow (each)   | 6 to 7               | MGD                              |
| Diameter   | 55                   | feet                             |
| Side Water Depth   | 9.5                  | feet                             |
| Surface Area (Each Tank)   | 2,376                | ft <sup>2</sup>                  |
| Overflow Rate at Average Dry Weather Flow (1.5 MGD)                              | 631                  | gpd/ft <sup>2</sup>              |
| Overflow Rate at 5-Year Peak Wet Weather Flow (12.3 MGD with 2 Units in Service) | 2,588                | gpd/ft <sup>2</sup>              |
| <u>Primary Sludge/Scum Pumps</u>   |                      |                                  |
| Type   | Progressive Cavity   | -                                |
| Number   | 2                    | -                                |
| Capacity   | 100                  | gpm                              |
| TDH  | 20                   | feet                             |
| Motor Size   | 5                    | HP                               |
| <b>Secondary Treatment</b>   |                      |                                  |
| <u>FFR Feed Pumps</u>  |                      |                                  |
| Type   | Centrifugal          | -                                |
| Number   | 3                    | -                                |
| Capacity (Each)  | 3,125                | gpm                              |
| TDH  | 62                   | feet                             |
| Motor Size   | 75                   | HP                               |
| <u>Fixed Film Reactor</u>  |                      |                                  |
| Media Type   | Cross Flow           | -                                |
| Media Surface Area/Volume  | 32                   | ft <sup>2</sup> /ft <sup>3</sup> |
| Reactor Surface Area (Total)   | 2,514                | ft <sup>2</sup>                  |
| Media Depth  | 32                   | ft                               |
| Volume (Total)   | 81,060               | ft <sup>3</sup>                  |
| <b>Tertiary Treatment</b>  |                      |                                  |
| <u>Filter Feed Pumps</u>   |                      |                                  |
| Type   | Centrifugal          | -                                |
| Number   | 3                    | -                                |
| Capacity (Each)  | 2,085                | gpm                              |
| TDH  | 20                   | feet                             |
| Motor Size   | 20                   | HP                               |

**SMCSD Headworks, Primary and Secondary Treatment Pre-Design**TM 1: Design Criteria

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| Criteria                                | Value         | Unit                |
|---|---------------|---------------------|
| <u>Tertiary Filtration</u>              |               |                     |
| Type                                    | Rotating Disk | -                   |
| Units                                   | 2             | -                   |
| Disks Per Unit                          | 12-18         | -                   |
| Filter Area Per Disk                    | 54-60         | ft <sup>2</sup>     |
| Total Submerged Filter Area             | 1,280         | ft <sup>2</sup>     |
| Design Loading Rate                     | 3.25          | gpm/ft <sup>2</sup> |
| Maximum Loading Rate                    | 6.0           | gpm/ft <sup>2</sup> |
| Maximum Backwash<br>(% of average flow) | 5             | %                   |
| <u>Filter Backwash Pumps</u>            |               |                     |
| Type                                    | Centrifugal   | -                   |
| Number                                  | 2             | -                   |
| Capacity (Each)                         | 150           | gpm                 |
| TDH                                     | 20            | feet                |
| Motor Size                              | 5             | HP                  |

**Drawings**

Drawing G-4

Drawing G-5