Technical Memorandum

SMCSD Headworks, Primary and Secondary Treatment Pre-Design

Subject: **TM 3: Screening**

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Date: October 12, 2011

Reference: 0055-003

The purpose of this technical memorandum (TM) is to present the evaluation and preliminary design of the screening facilities to be implemented within the new headworks at the Sausalito-Marin 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:

1 Summary Findings and Conclusions

Headworks screening facilities typically consist of the following basic components:

- Channel screen to remove screenable material from the raw wastewater flow stream
- Grinder to reduce the size of objects that can harm/clog downstream equipment
- Rake/auger/traveling screen to move the material from the channel up to the operating deck
- Screening washer/compactor that washes screenings, removes excess water and reduces the amount of organic material collected with the screenings

There are a number of headworks screening equipment selection and arrangement options available. Based on the specific requirements of the SMCSD facility and RMC's experience with similar facilities, RMC has developed and evaluated of a range of options.

The basic criteria that are used to determine the screening system that provides the best combination of reliability and cost effectiveness are:

- **Flow capacity and redundancy criteria:** RMC recommends two separate and automated screening channel systems, each with a capacity of 3 to 4 MGD, and one passive manual coarse bypass screen with a capacity of 10 MGD. This approach would allow one screen unit to handle peak dry weather flows, with one redundant screen. A manual bypass screen with 10 MGD capacity would also allow instantaneous peak wet weather flows of up to 14 MGD to be screened with one screen out of service.

- **Screen opening:** It is recommended that the screen opening width be ¼ inch, and maximum vertical height be 1 inch (or ¼ inch perforated plate design). Openings much larger than these can allow significant material through the screen that would eventually accumulate in the digester. A ¼ inch opening screen will collect more organic material with the screenings, therefore screening washing is recommended to minimize odor generation.

The following alternative screening systems were evaluated:

- Grinder/Sieve Auger Screen
- Climber Screen
- Aquaguard
- Sieve/Auger Screen

A summary of the comparison of the screen systems is presented in Table 1.

Table 1: Screen Comparison

Screen Type	Advantages	Disadvantages
Channel Grinder/Sieve/Screen/Auger	• Combined grinding, screening, conveying, washing, dewatering and compaction • Good organic separation • Good screening material removal	• Grinder maintenance • Limited washing of screenings
Climber Screen	• Robust equipment • Above-water operation • Easy maintenance (unless influent contains significant amount of grease)	• Coarse-vertical slot • Headroom (height) • Separate screenings washing/compaction required
Aquaguard	• High capture rates	• Plastic teeth break • Below water bearings • Separate screenings washing/compaction required
Sieve/Auger Screen	• Combines screening, conveying, washing, dewatering, and compaction • Good screening material removal	• Limited washing of screenings • No grinder upstream to aid with organic separation

Recommendation

The sieve auger screen is recommended due to better removal of screenings and better washing of screenings. It is recommended that the sieve auger screens have ¼ inch openings and will be designed to handle a minimum combined flow of 6 MGD (3 MGD each). The manual bar rack and bypass channel will be used during flows above 6 MGD, or if a filter screen is out of service during peak wet weather flow. Manual bar screening for flows above 6 MGD should be adequate as most of the debris in the collection system would have flushed into the treatment facility before flow levels rise above 6 MGD.

Without an inflow grinder, a separate washer/compacter/grinder unit will be provided to after the screens. Cleaned and washed screenings from the washer/compacter will be discharged directly to the grit bin.

2 Design Criteria

The design criteria for the screenings process is presented in the following sections.

2.1 Flow Capacity

A summary of the key design flows for the screening process at current influent flows are presented in Table 1.

Table 1: Design Flow Criteria

Flow Parameter	Flow
Average Dry Weather Flow (ADWF)	1.5 MGD
Minimum Diurnal Flow	0.25 MGD
Peak Day Dry Weather Flow (PDWF)	3.2 MGD
10-Year Event Instantaneous Peak Wet Weather Flow (PWWF)	13 MGD

A detailed discussion of the design flows for the new headworks/primary treatment facility and summary of the overall flow schematic can be found in TM 1: Design Criteria. The new headworks will need to accommodate peak flows without equalization because on-site equalization would be located downstream of the headworks processes.

In designing the screening system a balance needs to be struck between the channel velocity and screen headloss. Screens are more effective with relatively low velocity through the opening, meaning the wetted area of the screen needs to be relatively large. The consequence of the larger wetted screen area is a relatively large channel area with relatively slow channel velocity, and potential deposition of solids. Channel aeration/agitation could be provided to periodically move the material downstream to the grit chamber.

2.2 Screen Opening Size

The screen opening size is an important design factor which determines the amount of materials removed from the raw sewage flow. The smaller openings remove more of the inert materials that are not broken down in the treatment system and which end up in the digester and biosolids. However, the smaller openings also remove biodegradable materials that are putrescible and potentially odorous. In addition, the smaller the screen opening, the larger the screen area needs to be to minimize headloss through the screen.

The shape of the opening is also important factor. Several screen types have vertical bars separated by ½ to ¾ inch, but can have over 6 inches between horizontal bars, resulting in a number of common objectionable materials passing through the screen. Perforated holes can remove nearly all of the materials, but can also remove more biodegradable materials. It is recommended that the screens have a width of ¼ inch, and length of 1 inch, or ¼ inch diameter round holes.

2.3 Redundancy

The following redundancy criteria are recommended for the screening facilities:

- For normal flow conditions including modest wet weather events, provide a completely redundant screen channel system (isolation gate, screen, screening conveyance).
- For extreme wet weather events no standby automated screen, but have a passive manual bypass screening channel system.
- Two separate automated screening channel systems each with a capacity of 3 to 4 MGD, and one passive manual coarse bypass screen with a capacity of 10 MGD. This arrangement would provide a peak hydraulic capacity of 14 MGD even if one automated screen is inoperable.

3 Screening Equipment Selection

Headworks screening facilities typically consist of the following basic components:

- Channel screen to remove the material from the raw wastewater flow stream
- Grinder to reduce the size of objects that can harm/clog downstream equipment
- Rake/auger/traveling screen to move the material from the channel up to the operating deck
- Screening washer/compactor that removes excess water and reduces the amount of organics collected with the screened material

3.1 Basic Types of Equipment

The types of screens that were evaluated include:

- Channel Grinder/Sieve Screen /Auger
- Climber Screen
- Aquaguard
- Sieve/Auger Screen

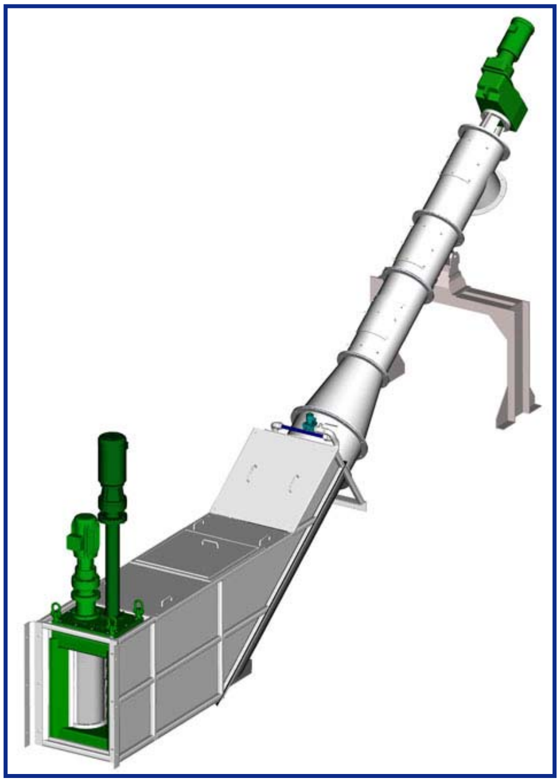
These types of screens differ in the type of screen provided, the manner in which they wash and compact the screenings, and the inclusion or exclusion of an integral grinder. The different types of screens are discussed in detail in the following sections.

3.2 Channel Grinder/Sieve Screen/Auger

The channel grinder/sieve screen/auger, as produced by JWC and Franklin Miller, combines a channel grinder and a sieve screen auger. An example of this type of screen is shown in Figure 1. These types of screens are able to provide two functions: grind large objects that might clog pumps, and minimize the amount of putrescible material removed by downstream screens.

In the case of the new SMCSD headworks, where all the influent flow is pumped to the headworks thereby preventing large objects from reaching the plant, the principal advantage of this type screen is the minimization of putrescible material removed by the downstream screens.

Figure 1: JWC Screen and Grinder Unit



The channel grinder/sieve screen/ auger has an integrated screenings washer compactor that delivers compacted screenings up to the operating deck. Depending on the final manufacturer/unit chosen, the grinder unit design may include an adjacent rotating drum screen that rotates to move materials caught on the screen into the grinder. Both the channel grinder screen (if included) and the sieve screen have relatively small openings (approx ¼ inch diameter or larger) that remove nearly all of the objectionable materials from the raw wastewater. Locations where a grinder/sieve/auger unit is in operation in a similar application are Ripon WWTP, San Quentin Prison, Pelican Bay State Prison, and Yolo County Jail.

3.2.1 Rock/Grit Impacts to Grinder

Based on discussion with SMCSD staff, the plant occasionally experiences significant grit and rock loads with larger influent flows. There is concern regarding the impact grit/rocks would have on a grinder located in a raw wastewater flow stream. This issue is addressed further in the Screening Equipment Selection section below.

The grinder is subjected to all the materials pumped from the Main Street Pump Station and the Fort Baker Pump Station. During extreme flow periods there is potential for heavy grit/rocks to impact the grinder. JWC and Franklin Miller, two grinder manufacturers, were contacted to address the concern regarding the grit/rock load. JWC has stated that occasional rocks and grit will not be a problem other than a little increased wear on the unit. They noted that the grinder is typically offset a few inches from the channel floor, so very heavy rocks could potentially settle out in front of the grinder. In addition, an upstream rock trap could be installed to capture rocks. JWC also offers a service agreement that includes all wear items. The agreement typically is for an initial term length of 5 years (with optional extension) and includes provisions for a temporary replacement unit while the original unit is removed from the channel shipped for maintenance at JWC's southern California facility.

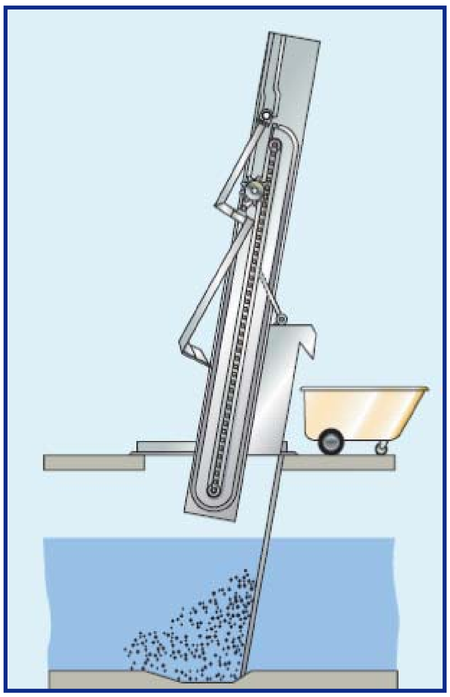
The Central Contra Costa Sanitary District (CCCSD) has several JWC Muffin Monster grinders in their sewage pump stations, including locations that experience high grit loads. Their operations staff indicated that they entered into a service agreement with JWC and that they are happy with the performance of the grinders and the service provided by JWC. At CCCSD's pump station with the highest grit load, they have a several units installed and they rotate between units on a weekly basis to reduce wear on any single unit.

An upstream rock trap would help in preventing rocks and heavy grit from entering the grinder and causing wear. Provisions would need to be provided for removing and disposing of the contents of the rock trap, which could be accomplished with a vactor truck.

3.3 Climber Screen

Climber Screens are a commonly used type of screen that was developed to provide a low maintenance screening solution without submerged rotating parts such as sprockets and bearings. The Climber Screen is robust and can remove large objects without an upstream grinder. The Climber Screen does not have an integral screenings washing and compaction unit. Therefore, a separate piece of equipment would be required to follow this type of screen. A disadvantage of this screen is the long vertical slot of the bar screen that allows considerable volumes of objectionable materials to pass through the screen and clog downstream processes. There are multiple manufacturers of a climber screen including IDI, FMC, and Vulcan. A typical climber screen can be seen in Figure 2. Locations where climber screens are in operation for similar applications include East Bay Municipal Utilities District (EBMUD), Vallejo Sanitation and Flood Control District (VSFCD), and CCCSD.

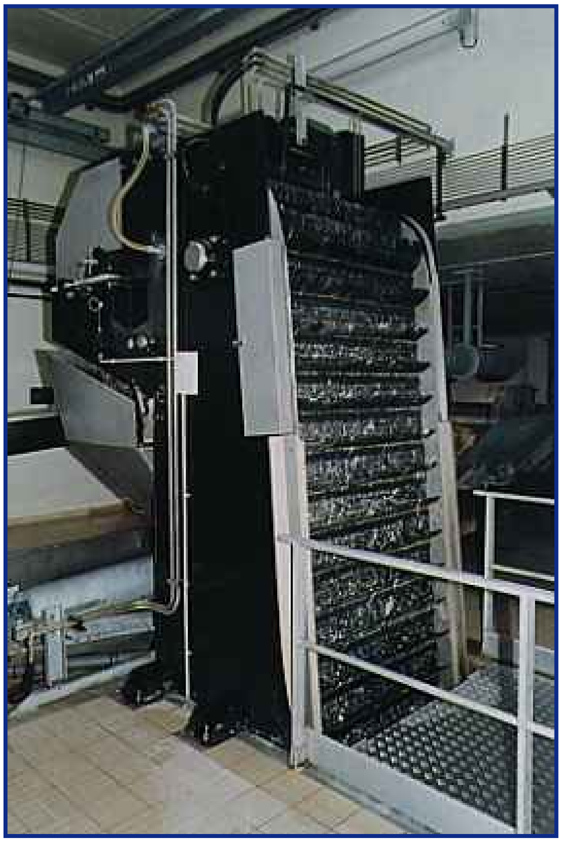
Figure 2: Climber Screen



3.4 Aquaguard

The Aquaguard screen is a self-cleaning, in-channel screening device that utilizes a filter-element system designed to automatically remove a wide range of floating and suspended solids from wastewater. The filter elements are mounted on a series of parallel shafts to form an endless moving belt that collects, conveys and discharges solids greater than the element spacing. Spacings from 1/8 inch to ¾ inch are available. There are various manufacturers of Aquaguard type screens, including Parkson and Westech. A typical Aquaguard screen can be seen in Figure 3.

Figure 3: Aquaguard Screen



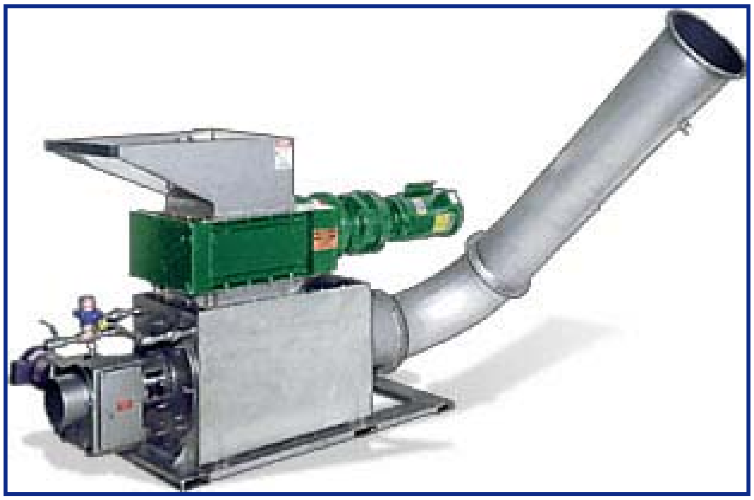
Movement of the screen can be continuous or intermittent. However, intermittent operations are recommended, which allows a mat of solids to build on the filter-rake elements which increases the solids capture rate. An Aquaguard screen does not have an integral screenings washing and compaction unit. Therefore, a separate piece of equipment would be required to follow this type of screen as discussed below.

Aquaguard screens are a widely used type of screen. Some local installations with an Aquaguard include Novato Sanitary District (NSD), Delta Diablo Sanitation District (DDSD), and Central Marin Sanitation Agency (CMSA).

3.5 Separate Screening Washer Compactor

For both the Climber Screen and Aquaguard screen, a separate washer compactor would be required. There are various manufacturers of screenings washers and compactors, including JWC, Parkson, and Huber. A typical screenings washer and compactor unit can be seen in Figure 4.

Figure 4: Screenings Washer and Compactor

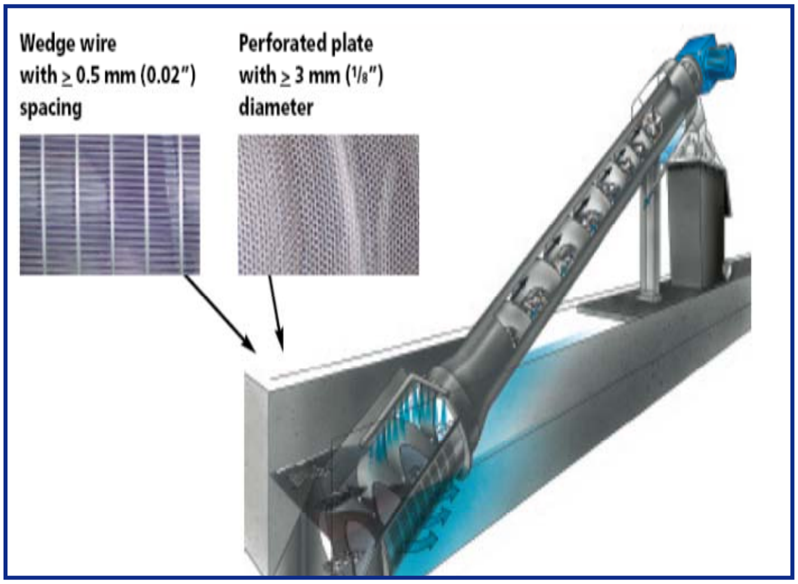


3.6 Sieve/Auger Screen

The Sieve/Auger Screen is a static circular perforated plate screen with a screw auger that performs screening, washing, conveying, compaction and dewatering of screenings in a single unit. It can be installed in a channel or container with an inclination of 35 degrees. Wastewater flows into its open front end and out through the perforation of the screening drum. Floating and suspended materials larger than the perforations are retained. The retained screenings are removed by an auger that conveys the screenings up into a compaction zone to remove free water, and discharge the compacted screenings up to the operating deck. Water sprays are used to provide some separation of organics for the inert screenings.

The primary advantages of this equipment are that it is highly efficient (due to the small screen opening) and that it is a relatively simple mechanism. The primary disadvantages of this equipment include the somewhat limited ability to separate organics from inert screenings (since there is no upstream grinder to break up materials), and the inability to handle larger objects. As materials are captured on the screen, the headloss through the screen increases as does the upstream water level. When the upstream water level reaches a certain height, the auger screw begins to rotate. Nylon brushes attached to the auger screw remove material from the screen and move the material up the auger where material is washed and subsequently compacted before being discharged to a dumpster. With the sieve/auger screen as separate washer/compactor would be required. A typical Sieve/Auger screen can be viewed in Figure 5.

Figure 5: Sieve/Auger Screen



Some locations where a Sieve/Auger screen is in operation in similar applications are in Eugene, Oregon where it is being used on sluice screenings, and in San Mateo where it is being used on dilute primary sludge (un-screened and un-degritted).

3.7 Screenings Storage and Handling

There are several options for the storage, handling, and disposal of the screenings. These options are shown in the Drawing TM 6-1 (attached). One storage option is to have individual bins for screenings from each channel and, when full, the bins would be manually emptied into the grit bin. Another option is to convey the screenings from the screens to a common disposal bin with the grit. This option would likely require at least one, possibly two, screenings conveyor screws. The advantage of combing the screenings and grit is that double handling of the screenings would be eliminated. The disadvantage is that the screenings conveyor screw is another piece of mechanical equipment that requires periodic maintenance. The practicality of this option will be dependent on the siting limitations of the screen and grit facilities.

Additional discussion of materials handling and disposal options can be found in the TM 6: Materials Handling, Storage and Disposal and TM 3: Grit.

4 Recommendations

The sieve auger screen is recommended due to better removal of screenings and better washing of screenings. It is recommend that the sieve auger screens have ¼ inch openings and be designed to handle a minimum combined flow of 6 MGD (3 MGD each). The manual bar rack and bypass channel will be used during flows above 6 MGD, or if a filter screen is out of service during peak wet weather flow. Manual bar screening for flows above 6 MGD should be adequate as most of the debris in the collection system would have flushed into the treatment facility before flow levels rise above 6 MGD. Without an inflow grinder, a separate washer/compacter/grinder unit will be provided after the screens. Cleaned and washed screenings from the washer/compacter will be discharged directly to the grit bin. Screenings will be transfered to the screenings washer/compactor via a conveyor screw.

4.1 Design Criteria

The recommended design criteria for the screening process are presented in Table 2.

Table 2: Grit Process Design Criteria

Criteria	Value	Units
Screening Process		
Mechanical Screens		
Type	Sieve auger screen/integral compactor	-
Number	2	-
Openings	1/4	inch
Capacity	3 to 4	MGD
Manual Screen		
Type	Bar	-
Number	1	-
Screen Opening Width	1	inch
Capacity	10	MGD
Screenings Washer Compactor		
Number	1	-
Compactor Motor Size	3	HP
Grinder Motor Size	10	HP

4.2 Layout and Arrangement Options

There are various options for the layout and arrangement of the screening equipment and overall headworks treatment train. Each option is discussed in the TM 2: Siting and TM 6: Materials Handling, Storage and Disposal. Layout and arrangement alternatives are provided as Drawings M-11, M-12 and M-13.

4.3 Screening System Cost

The estimated construction cost for the screening facilities is approximately $0.79 million depending on the siting and equipment selections. See the project cost estimate in the Recommended Project Summary TM for more details.

4.4 Operation and Maintenance (O&M)

The addition of screening process facilities will require increased operation and maintenance labor as well as power consumption to run the equipment. Operation and maintenance associated with the screening process and equipment is presented in the following sections.

4.4.1 O&M Labor

Some annual maintenance will be required for normal servicing and infrequent failures. However, the additional labor is expected to be minor because the systems are automated and rugged. The addition of screens is also expected to reduce labor in other areas of the plant, primarily in the solids system, because there will be less pump clogging and digester cleaning required. Therefore, it is anticipated that the additional process facilities would improve overall plant performance. The estimated impact on SMCSD labor is presented in Table 3.

Table 3: Estimated Required Process Labor

Labor Type	Process Labor (Hours/week)	Process Labor (Hours/Year)
Operation	4	208
Maintenance	2	104
Total	6	312

4.4.2 O&M Cost Estimate

Adding screening facilities to the SMCSD plant will have a small impact on the O&M costs relating to the following items:

- Operation and maintenance labor
- Screenings disposal (covered in TM 6: Materials Handling, Storage and Disposal)
- Energy
- Repair parts and service

The estimated O&M cost associated with the screening process are presented in Table 4.

Table 4: Estimated O&M Costs

O&M Items	Quantity	Units	Unit Cost	Total Cost	Notes
Consumables					
Equipment Consumables	$355,000		1.0%	$3,600	% of Equipment Purchase Cost
Mechanical Consumables	$30,000		1.0%	$300	% of Mechanical Purchase Cost
Subtotal Consumables				$3,900	
Power					
Screens	6467	kwh	$0.15	$1,000	
Aeration Blowers	32335	kwh	$0.15	$4,900	
Screening Washer	10778	kwh	$0.15	$1,600	
Subtotal Power				$7,500	
Labor					
Operator	4	hr/week	$45	$9,400	
Maintenance	2	hr/week	$45	$4,700	
Subtotal Labor				$14,000	
Chemicals					
None				$-	
Subtotal Chemicals				$-	
Total Annual O&M Cost				**$25,500**	

Drawings

Drawing TM 6-1

Drawing M-11

Drawing M-12

Drawing M-13