FINAL

TM 4.1 SCREENING AND GRIT MANAGEMENT

NEW Water

B&V PROJECT NO. 402658

PREPARED FOR

NEW Water
The brand of the Green Bay Metropolitan Sewerage District

Green Bay Metropolitan Sewerage District

JULY 2021

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1.0 Introduction

As part of a full-plant facility plan, determining how to develop improved screenings and grit removal is critical to ensuring the adequate treatment of wastewater and maintaining condition of existing equipment. The purpose of Technical Memorandum 4.1 (TM 4.1) was to summarize and present the most feasible alternatives for the Green Bay Metropolitan Sewerage District (NEW Water) Facility Plan screening and grit removal management. The specific objectives of TM 4.1 are:

1. Define existing screening and grit removal system limitations and deficiencies, identify equipment for updating existing system, and develop design criteria.
2. Assess potential alternatives for screening and grit removal at the Green Bay Facility (GBF) and the De Pere Facility (DPF).
3. Provide projected infrastructure capital costs for each alternative.
4. Recommend which alternative should be further investigated going forward.

The Green Bay Metropolitan Sewerage District, operated under the brand name of NEW Water, collects and treats wastewater from 15 communities in a service area encompassing over 285 square miles with an estimated population of approximately 237,000 in 2019. The NEW Water facility is comprised of the GBF and the DPF. The NEW Water treatment facilities receive domestic, commercial, industrial wastewater, and hauled-in waste (HW)/high strength waste (HSW). NEW Water administers an industrial pretreatment program that regulates industrial contributors.

The GBF treated an average of 36.6 mgd of total wastewater in 2019 with a liquid treatment train consisting of influent pumping, screening, primary clarification, primary sludge grit removal, activated sludge configured for enhanced biological phosphorus removal (EBPR), secondary clarification, and is disinfected with sodium hypochlorite and dechlorinated with sodium bisulfite. The solids handling treatment train includes sludge thickening with gravity belt thickeners, a thickening centrifuge and gravity thickeners followed by anaerobic digestion with co-digestion of high strength waste (HSW), centrifuge dewatering, and ending with solids drying and incineration. The GBF receives hauled waste (HW), which is screened and discharged to the plant influent and HSW, which is fed to the digesters. Industrial wastewater flow from both Procter and Gamble and Green Bay Packaging flows by gravity in the mill interceptor to the GBFand Fox River Fiber wastewater is pumped to either the DPF or the GBF.

The DPF treated an average of 8.8 mgd in 2019 of wastewater with a treatment train consisting of screening, influent pumping, grit removal, activate sludge configured for enhanced biological phosphorus removal (EBPR), intermediate clarification, final clarification, tertiary sand filters, and ultraviolet disinfection. An industrial force main pumps waste from the Fox River Fiber industrial customer downstream of grit removal. Waste activated sludge (WAS) is pumped to the GBF in a force main for biosolids processing. In addition, there is an interplant transfer forcemain to the GBF, which provides some flexibility to send up to 5 mgd of DPF influent to the GBF interceptor system for treatment at the GBF.

Screening and grit removal facilities remove gross material that can clog equipment and grit material that can corrode equipment. The overall goal of updating the screening and grit removal systems is to improve removal and capture to improve operation performance, reduce maintenance in downstream processes, handle peak flows, and provide reliable low maintenance equipment with 20 years of reliable service. In addition, the system should assist downstream processes, such as thickening, pumping, digestion, and solids handling, to meet quality requirements.

This initial evaluation, conducted as part of the Facility Plan, indicated that screening and grit equipment improvements are necessary at both the GBF and DPF. Screening and grit removal equipment upgrades will reduce operation and maintenance on downstream equipment and improve overall liquid treatment and solids management performance. Discussions with plant staff at both GBF and DPF indicated that increased maintenance time was required to clean equipment of material that was supposed to have been removed by the existing influent screening equipment. Staff also commented that decreased performance and capacity was observed in both the liquid and solids sides of the treatment plants due to the deposition of grit in aeration basins and digesters.

As part of this evaluation, both existing equipment and equipment performance at each facility, as well as alternative equipment, were considered. The equipment evaluations will not specifically name vendors or manufacturers. Alternative packages were prepared to address the individual needs of both the GBF and DPF as well as the initial capital costs for each alternative. Each alternative addressed the current and future average day flow and loads, peak flow management, as well as limitations of the existing headworks facilities. Generalized solution packages were prepared, and further evaluations will be required to complete a multi-attribute analysis of the alternatives.

1.1 Fundamental Objectives for Screening and Grit Removal Improvements

During the planning horizon of the facility plan, there are several fundamental objectives for screening and grit removal improvements:

- Industrial user growth at the GBF: expansion of Green Bay Packaging is currently under construction, and will increase influent flows and solids production by 2025
- Equipment age and condition: the existing influent pumps, screens, and grit removal are over 20 years old and lack adequate treatment capacity and reliability
- Operational limitations: the screening and grit removal systems have proved to have operational issues by allowing debris and grit through the influent screening and headworks causing downstream issues in the solids and liquids stream requiring updates with more reliable equipment
- Peak flow management and limitation within the existing headworks of both facilities allow for screening material bypass during wet weather flow events requiring evaluation of flow capabilities and developing alternatives that can treat peak hourly flow
- Growth in the DPF service area: residential growth will be occurring in the DPF service area over the next 10 to 20 years, increasing influent flows and loadings

Assessment of improvements to these objectives were developed to provide NEW Water with increased flexibility, as well as required capacity, for the next 20 years. Several screening and headworks packages were developed.

1.2 Improvement Assessment

Assessment of improvements to these objectives were developed to provide NEW Water with increased flexibility, as well as required capacity, for the next 20 years. Several process configurations were developed. To assess improvements, the following steps are recommended:

- Identify process configurations for screening and grit removal operation.
- Develop configurations to ensure complete liquids and solids flow screening and grit removal.
- Evaluate equipment solutions to provide required capacity, that are flexible, and maintainable.
- Develop capital costs for full infrastructure packages.
- Recommend screening and grit removal packages for further evaluation.

1.3 Relationship to Overall Facility Plan

This TM has been developed as part of Task 4 of the Facility Plan. Task 1 of the Facility Plan is related to project management at execution. Task 2 of the Facility Plan focused on developing the existing conditions for the NEW Water facilities. In Task 2, the following components are tied to the overall screening and grit removal management evaluation:

- TM 2.1: Flows and Loads – the future conditions for both the DPF and GBF are used for solids projections
- TM 2.3: Process Model – the process model was used to develop projections for solids production at both facilities in the future
- TM 2.4: Gap Analysis – infrastructure gaps identified in the solids thickening area will be addressed as part of the thickening improvements

Task 3 of the Facility Plan is currently being completed to identify future objectives for NEW Water. Within Task 4, solutions are being developed to address the gaps identified in Task 2 along with the vision developed in Task 3. There will be several evaluations in Task 4 that are impacted by decisions presented for thickening. As the Facility Plan progresses, these additional evaluations will be completed to develop a comprehensive Facility Plan. Key related infrastructure evaluations that are impacted by thickening decisions are:

- Thickening management
- Aeration system and nutrient removal improvements
- Whole plant odor control
- Whole plant nutrient and energy balance
- De Pere long term vision

The recommendations developed as part of the TM, and other Task 4 efforts, will be combined as part of Task 5 to develop a comprehensive capital improvements plan and infrastructure roadmap for NEW Water.

2.0 Process Design Criteria

This section described the constraints associated with implementing proposed improvements to the screening facility at the GBF and the DPF. TM 2.1 Flows and Loads detailed the future average and peak hourly 2040 projected flow rates. The following information details the design criteria for each facility including the projected flow rates and defined equipment design criteria for the influent bar screens, influent fine screens, and grit removal. Design considerations were collected from the Water Environment Federation (WEF) Manual of Practice No. 8 (MOP 8) Sixth Edition (WEF, 2018).

- GBF Flows
  - 2040 Peak Hourly Flow: 148.8 mgd
  - 2040 Average flow: 43.2 mgd
- DPF Flows
  - 2040 Peak Hourly Flow: 57.3 mgd
  - 2040 Average flow: 11.0 mgd
- Bar Screen (“Trash Rack”) Performance
  - Bar Separation: maximum of 2 inches
  - Screen Retention: NA – protect pumps from large debris
  - Estimated Screenings Production: range of 1.0 to 10 cf/MG with an average of 4.5 cf/MG (MOP 8)
- Fine Screening Performance
  - Screen Perforation Size: 6 mm or less
  - Screen Retention: 65% to 75% for front entry perforated plate screens and 75% to 85% for center flow perforated plate screens (MOP 8)
  - Estimated Screening Production: range of 6.5 to 12 cf/MG with an average of 9.0 cf/MG with 6.0 mm opening (MOP 8)
- Grit Removal Performance
  - Grit Removal Performance: 95% Removal ≥ 105 microns (MOP 8)
  - Grit Quantity: 0.5 to 20 cf/MG (MOP 8)

3.0 Green Bay Facility Evaluation

The existing influent pumping, screening, and grit removal processes at GBF consists of influent bar screens (trash racks), dry-pit centrifugal pumps, fine bar screens with washer/compactors, and primary sludge (PS) grit removal and handling (Figure 3-1). Currently, the GBF has encountered several issues with the existing bar screens and fine screens including:

1. Passing trash materials through the screens due to equipment failures
2. Hydraulic capacity limitations
3. Clogging of downstream equipment

The operational age of the equipment is a concern along with the significant performance limitations (both from a material and hydraulic standpoint) and issues with downstream equipment. Staff report having to spend significant hours to remove material and replace portion of equipment from pumps, mixers, and treatment equipment. There are also future hydraulic capacity limitations due to increased peak flow events. The 2040 peak hourly flow estimated in TM 2.1 was 149 mgd with an average day flow of 43.2 mgd. The following sections will describe the existing equipment, process performance issues, and the solution alternatives.

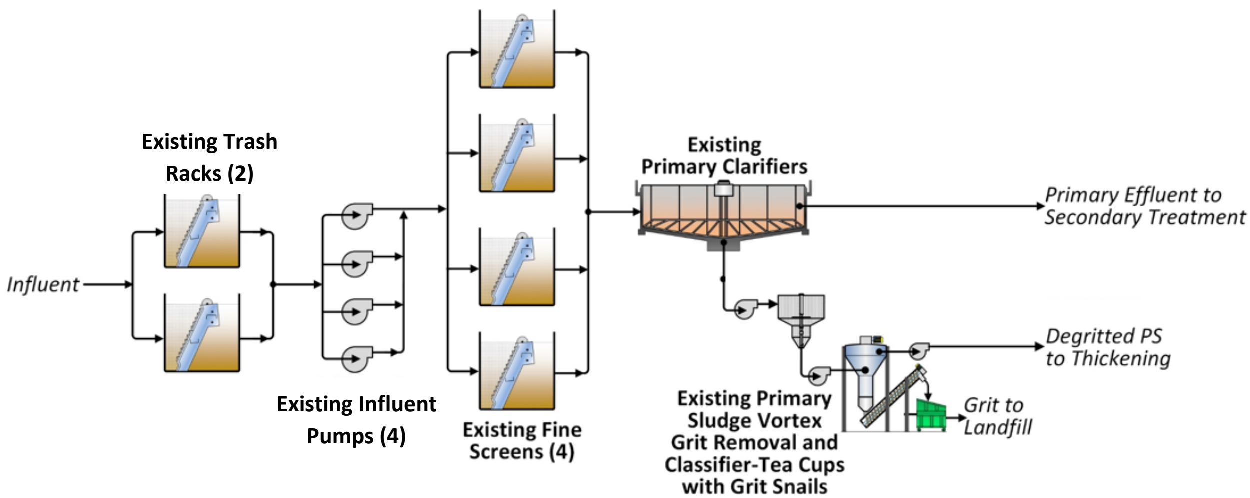

Figure 3-1 GBF Existing Screening and Grit Removal Process Flow Diagram

3.1 Screening Pumping and Grit Removal Performance Evaluation

3.1.1 Influent Bar Screens, Screening Washer Compactors, and Conveyor

The existing bar screen and influent pumps are located on the east side of the facility grounds in the influent pump station building (Figure 3-2). The system includes two bar screens (“trash racks”) upstream of the influent pumps with a spacing of 2-inches between the bars meant to protect the influent pumps from large debris. The screens have a width of 8-ft and a length of 77.5 ft to convey the screenings to grade elevation. The layout of the system requires both units to be in service. If one screen is taken out of service, one side of the wetwell would also be taken out of service, except in a short duration event. Each screen has a capacity of 120 million gallons per day (mgd) which provides sufficient capacity. This system is not designed as an n+1 facility and as such the total screening capacity is 240 mgd. Plant staff indicated the existing bar screens have reliability issues due to cables on the units stretching and breaking. Plant staff have indicated that a more reliable screening technology with adequate self-cleaning mechanism is needed to improve the performance of the plant.

Figure 3-2 Influent Pump Station

3.1.2 Influent Pumps

Influent pumping consists of 4 dry-pit centrifugal pumps (3 in service, 1 standby) located in the Pump Station Building with a total capacity (if all 4 pumps are in service) to pump 160 mgd and a firm capacity of 120 mgd. Although the influent pumps have been capable of keeping up with capacity needs, their firm capacity of 120 mgd does not provide sufficient capacity for the identified 2040 peak hour flow of 149 mgd. Additionally, the pumps are aged and at the end of their useful life and are recommended for replacement. Therefore, pumping improvements will need to be made to address the 2040 flow conditions. The two buried 48-inch force mains routed between the Pump Station and Headworks are carbon steel and subject to corrosion over time. There are no identified deficiencies with the force main piping; however, they provide critical hydraulic conveyance and visual observance of pipe condition is limited to the exposed ends at the structures. It is recommended that a separate condition assessment be conducted to assess pipe condition and identify any refurbishment or replacement activities for the planning period. This condition assessment will require a contractor that specializes in testing buried pipe systems.

3.1.3 Fine Screens

The GBF has four existing influent fine screens with ¼” (6 mm) spacing located in the Headworks Building. The screens are step screens with a 4 ft width installed in a channel with a depth of about 8 ft. Although this is a common bar spacing for wastewater fine screens, conversations with plant staff indicate this screening facility is experiencing many issues with the screens not capturing a significant amount of rags, plastics, and other trash due to hydraulic limitations from elevated flow velocities in the channels. The existing fine screens have a design capacity with all units in service of 110 mgd and any higher flows will exceed the fine screen upstream velocity as well as the required velocity through the screens. The 110 mgd design flow rate is the total flow design, this is lower than the design flow for the trash racks and the influent pumps.

Manufacturers report screen approach velocities within the channel should be less than 2 feet per second (fps) while maximum velocity through the screen spaces should be less than 5 to 6.5 fps for appropriate screening. The higher velocity due to increase of flow rates pushes materials through the screen bar spaces resulting in more material being transferred downstream. The existing system has a channel approach velocity closer to 4 fps at peak flow and as a result the screens will blind at peak flow conditions and result in material being moved through the screens as well as not fully removed as part of the screening process. Additionally, elevated water level in the channels (the facility has observed flows above 140 mgd) cause overflow into the two available bypass channels (set to overflow at 110 mgd), which have no screening capability.

The GBF has two washer/compactors receiving screenings. The units provide some washing and removal of captured organics along with compaction to dewater the screenings before discharging into the dumpster. Treatment plant staff have reported the existing units plugging and having performance issues. Plugging issues tend to occur at peak flows.

Along with the previously identified issues the facility has reported the following need to be addressed:

- Headworks Building HVAC system requires replacement
- Valves for mill waste upstream of fine screens require review and likely replacement
- Isolation gates in the Headworks channels do not have enough freeboard to prevent overtopping during elevated flows likely due to the gates not being tall enough
- Wall joints in bypass channel structures are leaking
- Gravity thickener effluent piping to the headworks requires replacement from the thickening wet wells to headworks. Note: This piping replacement project has been awarded. Construction is scheduled for the fall and winter of 2021.

Due to the hydraulic issues with the screens as well as the bypassing debris, it is recommended to replace the existing mechanical bar screens and reevaluate the layout of the headworks screenings facility. This could be accomplished by either (1) replacing the four existing screens and building modified bypass channels to add two additional fine screens or (2) building a new headworks facility sized for the projected 2040 peak hourly flow of 149 mgd.

3.1.4 Grit Removal and Handling

Grit removal at the GBF consists of six PS pumps, PS grit removal with four TeaCup® Hydrocyclone grit removal systems (sized for 400 gpm continuous flow each) paired with two GritSnail® classifiers. The purpose for PS grit removal is to separate the grit from the PS. The TeaCup® systems were initially installed in 1996. The TeaCup® systems have since been modified to become SlurryCup® systems which are a more appropriate technology for sludge grit removal.

The existing system does not adequately remove grit to protect downstream thickening equipment, pumps, and anaerobic digestion. The plant staff question the effectiveness and the performance of the grit removal as a result of grit appearing in anaerobic digestion, destroying pump stators and rotors, and the increased maintenance of the PS centrifuge. Original operation of this system included pumping 380 gpm from each primary clarifier through the TeaCups®. However, that operation was changed to alternating pump cycles from each clarifier every 30 minutes to achieve the appropriate PS concentration and make downstream flows more manageable on the thickening processes. After making this change, the grit capture in the TeaCups® has significantly decreased indicating it is remaining in the

PS and causing damage downstream in thickening and pumping processes. The limited performance, age, and poor condition (due to corrosion and damage due to grit) of the grit removal and grit pumping equipment is of concern for the facility.

The thickened PS pumping, which uses progressive cavity pumps, has seen a great deal of wear and tear due to the impact of grit. The facility switched to softer stators to improve this issue, but replacement of rotors and stators continues to be a maintenance issue. Plant staff reported needing to replace the rotors approximately every 6-months. Grit build-up in the digesters decreases overall volume and hinders digestion processes. The deposition of grit may result in increased cleaning of the digesters. As a result of the presence of grit in the solids flow stream, the facility has also had to make changes in the thickening processes to combat grit related issues in the thickening centrifuge including sending PS to four of the older gravity thickeners. Currently, the thickening centrifuge is used for WAS thickening only due to issues with wear from PS grit. Therefore, the existing thickening strategy was intended to include co-thickening PS and WAS with the GBTs; however, due to the presence of rags, grit, and grease in the PS, the operators began finding extreme wear on the sludge pumps and since they have separated the thickening processes and only thicken PS in the old gravity thickeners.

Two grit removal approaches were considered as part of this study. First, for influent grit removal, vortex grit removal and multi-tray settling were evaluated. Second, a high velocity hydrocyclone type grit removal was evaluated for PS grit removal.

3.2 Design Criteria for Potential Future Equipment

The following provides the design criteria for potential equipment that will be installed to mitigate the existing GBF system issues presented in Section 0. This includes mechanical bar screens (trash racks), influent pumps, influent fine screens in the existing facility, PS grit removal, new facility fine screens, new facility influent grit removal, PS screening, and WAS screening.

3.2.1 Mechanical Bar Screen Design Requirements

- Number of units: 2
- Bar Spacing: Maximum of 2-inches
- Screen Channel Width: 8 ft
- Screen Depth: 77.5 ft
- High Water Level Depth: 25.5 ft
- Low Water Level: 6.5 ft
- Required Flow Capacity: 120 mgd each

3.2.2 Influent Pump Requirements

- Number of units: 4 / 5
- Type: Dry-pit Centrifugal
- Flow Capacity, each: 34,700 gpm (50 mgd) / 26,500 gpm (38 mgd) (n+1 arrangement)
- Head: 84 ft

3.2.3 Fine Screen Design Requirements (Existing Facility Expansion and Replacement)

- Number of units: 6
- Perforated Plate Opening: ¼" (6 mm)
- Screen Channel Width: 4 ft
- Screen Channel Depth: approximately 7.3 ft
- Required Flow Capacity: 29.8 mgd each with all in use at peak hourly flow of 149 mgd

3.2.4 PS Grit Removal System Design Requirements

- Number of units: 4
- Each unit receives flow from one primary clarifier
- Flow Capacity: determined by manufacturer from provided PS mass loadings
    - 50th Percentile Mass Loadings: 40,862 ppd
    - 90th Percentile Mass Loadings: 51,809 ppd
    - TS%: 1.0
    - PS flow: 400 gpm each unit, 2.3 mgd total

3.2.5 Fine Screen Design Requirements (New Facility)

- Number of units: 4
- Perforated Plate Openings: ¼" (6 mm)
- Screen Channel Width: dependent upon manufacturer; ranges from 4 to 6.5 ft
- Screen Channel Depth: dependent upon manufacturer; ranges from 8 to 12 ft
- Required Flow Capacity: 38 mgd each with all in service at peak hour flow
- Included Screenings Wash Press System

3.2.6 Influent Grit Removal System Design Requirements (New Facility)

- Number of units: 4 or manufacturer recommended
- Receives all influent flow after influent screening and pumping
- Flow Capacity: 149 mgd at peak hour flow with max flow rate per chamber of 50 mgd
- Grit Capture Rate: 95% grit > 105 micron
- Chamber diameter: dependent upon manufacturer

3.2.7 PS Sludge Screening Design Requirements

- Number of units: 2
- Perforated Plate or Similar Openings: ¼" (6 mm)
- Channel Width / Unit Size: selected by manufacturer
- Water levels / Unit Size: selected by manufacturer

- Primary Sludge Flow capacity each: range of 400 gpm to 1,600 gpm
    - Primary Sludge Concentration (TS%): 1.0

3.2.8 WAS Sludge Screening Design Requirements

- Number of units: 2
- Perforated Plate or Similar Spacing: ¼” (6 mm)
- Channel Width / Unit Size: selected by manufacturer
- Water levels / Unit Size: selected by manufacturer
- WAS Flow capacity each: range of 400 gpm to 1,600 gpm
- WAS Concentration (TS%): 0.6

3.3 Screening and Grit Removal Equipment Options

Various approaches were examined to determine:

1. Equipment function
2. Advantages and disadvantages of screening and grit equipment
3. Overall reliability for the required updates at both facilities

This evaluation included the review of influent coarse bar screens, influent fine screens, grit removal and handling, and sludge screening for potential installation at GBF.

3.3.1 Influent Bar Screens

Screening is the first unit operation used at wastewater treatment plants. There are several types of influent screens that could be evaluated including cable/chain driven, reciprocating rake, continuous self-cleaning, arc screens, continuous element, multiple rake, and band screens. These types of screens can be used in either a coarse or fine screen configuration. Coarse screens remove large solids including rags and other trash that may cause clogging and mechanical wear leading to increased maintenance. The types of coarse screens evaluated here included multi-rake bar screens and a reciprocating rake bar screen. Coarse screens typically have opening of 0.25 to 1.5 inches, while trash racks have openings greater than 1.5 in. These openings can either be porous plates or slots established by metal tines. Coarse screens are cleaned mechanically. Screening equipment is typically paired with a screen washer and compactor to reduce the amount of water trapped in the removed material.

Based on an initial review of available screening technologies with plant staff, the multi-rake and reciprocating screens will be considered for the coarse screen alternative. Coarse screen is defined for this project as a 0.25 inch (6 mm) or larger opening depending upon the technology.

3.3.1.1 Multi-Rake Bar Screen

Multi-rake bar screens have vertical bars with evenly spaced openings to remove large debris. The screen is equipped with multiple rakes to increase the rate at which material that is captured on the rake bars. A set of rakes with teeth mounted on drive chains pull the screenings to the top of the screen then use a wiper or scraper mechanism to empty then into a conveyor (Figure 3-3). This type of screen is typically set at an angle of 75 to 90 degrees in the channel. One advantage of this screen is its ability for rapid material removal and as a result this type of screen has a higher screening loading rate. Multi-rake screens generally have a lower headroom requirement and can tolerate much higher approach velocities (maximum 4 feet per second (fps)). A few disadvantages for this type of screen include a lower screenings capture of longer materials that can pass through the narrow bar spacing and the potential for grease blinding. Utilities with this type of screen have found the units to be rugged and dependable. One screening vendor is now offering the multi-rake in a center-flow configuration. These would not provide an increase in screening capture.

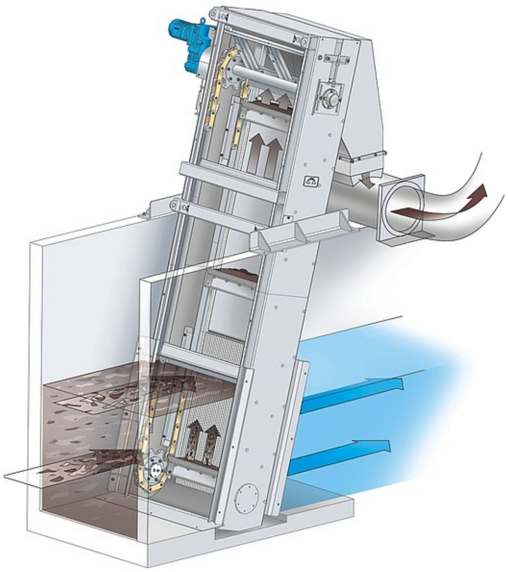

Figure 3-3 Multi-Rake Bar Screen ***(“HUBER Multi-Rake Bar Screen RakeMax® - Huber Technology Inc.,” n.d.)***

3.3.1.2 Reciprocating Rake Bar Screen

A reciprocating rake bar screen consists of vertical bars with evenly spaced openings. The rake assembly travels down and up the equipment to collect screenings (Figure 3-4). The screenings are removed by a wiper or scraper mechanism. The existing bar screens in the pump station are reciprocating rake screens. These bar screens are also installed at angles typically ranging from 75 to 90 degrees in the channel. Advantages of the reciprocating rake bar screen include having no critical submerged components and some models allow for a pivot to allow the unit to be removed from the channel. Vendors indicate the advantages include the ability to handle a large flow capacity range and are have proven to be durable The challenges these present include a lower screening loading rate compared to other screening systems, the rate of screenings removal (based on the speed of the reciprocating system), and a lower screening capture as longer material can pass through the bar spacing. These screens would provide no increase in screening capture.

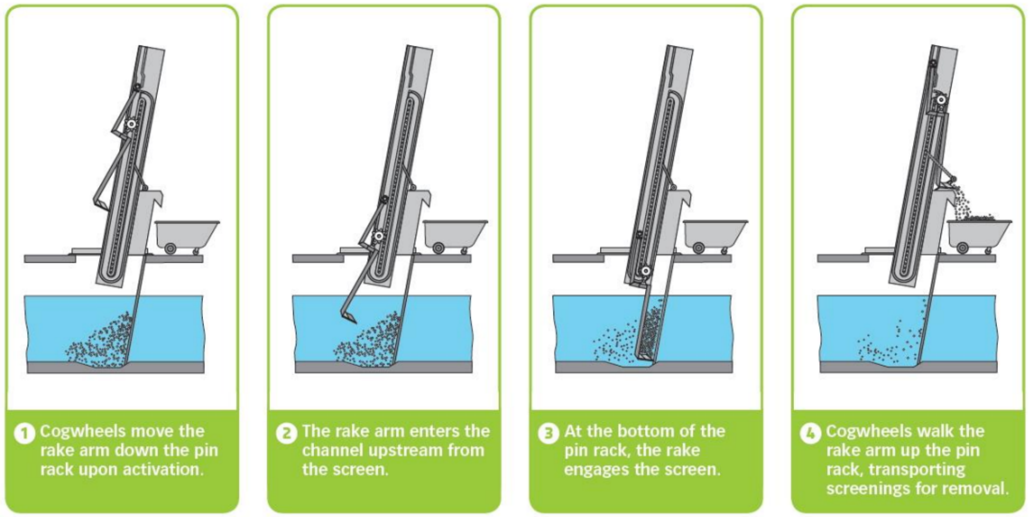

Figure 3-4 Reciprocating-Rake Bar Screen *(Sutari, 2018)*

3.3.1.3 Influent Fine Screens

Influent fine screens are used to remove finer materials that can cause operation and maintenance issues in downstream treatment processes. Typically, these types of screens are for membrane bioreactors to protect the hair and organic matter that could plug the membranes. Fine screens can remove a higher degree of debris than coarse screens because they have smaller openings ranging from 0.05 (1 mm) to 0.25 inches (6mm). Often, they are installed downstream of a coarse screen so the quantity of material removed can be impacted by upstream screening processes. Fine screens provide another barrier to capture material to prevent maintenance issues downstream. The openings of fine screens can be a continuous porous plate, bar rack, or a steel mesh. One vendor offers a 3mm bar rack fine screen as an influent screen. Fine screens can remove larger debris and fine/smaller debris that can make its way through the upstream coarse screen like rags, wipes, strings, hair, plastics and organic matter. A disadvantage of fine screens is the potential of damage from upstream material or material that was not collected from upstream screens. Fine screens have a more elaborate cleaning mechanism because of the smaller openings and organic matter that can buildup on the screen surface. The smaller the opening the more critical the cleaning performance is for operation. Fine screens usually have water spray or brushes used for cleaning similar to some coarse screens. Fine screens are usually paired with a washer compactor like coarse screens. For this evaluation, fine screens with openings less than 0.25 in (6mm) will be considered.

3.3.1.4 Fine Screen Technology Options for Influent Flow

Fine screens technologies available include continuous element, multi-rake, stair, band, drum, and static screens. This evaluation reviewed the use of through-flow band screens and center-flow band screens for the fine screen applications. These technologies may be used in coarse screen applications but are often used in fine screens. Through-flow and center-flow band screens with perforated plates were considered for fine screen applications based on discussions with plant staff.

3.3.1.4.1 Through-Flow Band Screens

The through-flow band screen (Figure 3-5) may consist of a continuous perforated plate, mesh, fine bar rake screen element (Figure 3-6) driven by side conveyor chains. The filter panels are shaped as circular segments cleaned by a rotary brush and/or spray bar that is located at the top of the screen. Typically, lifting tines allow for larger heavier objects to be removed. The typical setting angle for these screens in the channel ranges from 60 to 75 degrees but can go up to 90 degrees. The through-flow band screens with perforated plates have shown to have excellent screenings capture with a rate three times greater than the standard fine bar screens. In addition, most versions of this screen offer a pivot design so the screen can be rotated out of the channel for easy maintenance or prevention of damage. This type of screen generally has a higher headloss requirements compared to other types of fine screens. According to vendors, fats, oils and grease are often difficult to remove for this type of equipment. A major disadvantage is the potential for material carry over or re-introduction of material downstream of the screen during the cleaning process. A washer compactor would be required in conjunction with the screen, similar to the other screens evaluated.

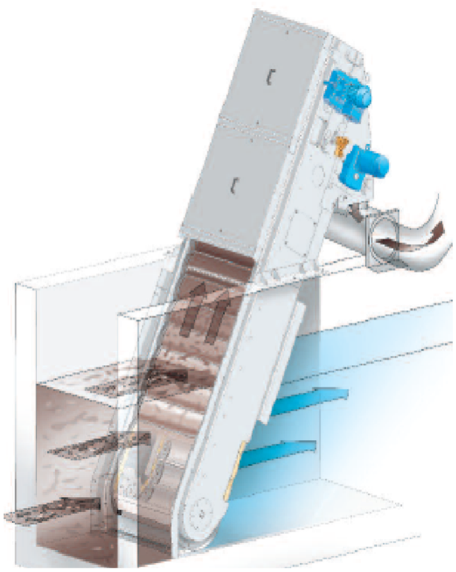

Figure 3-5 Perforated Plate Screen *("HUBER Belt Screen EscaMax® - Huber Technology Inc.," n.d.)*

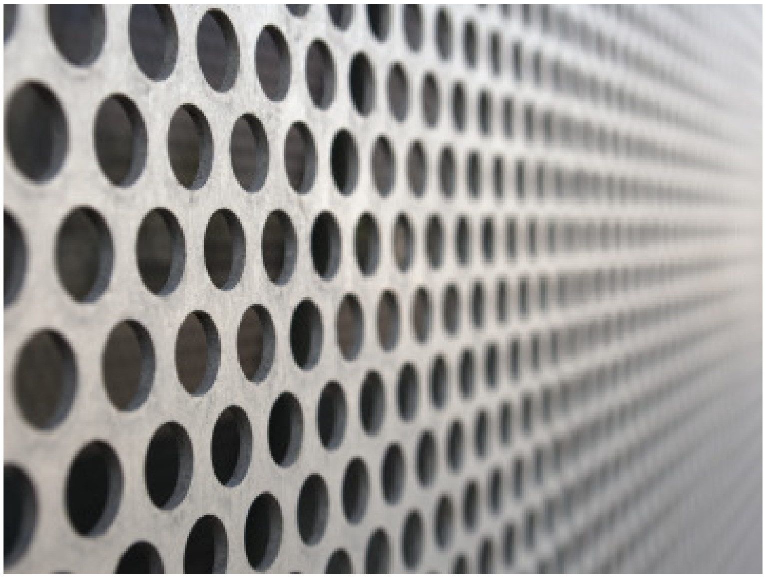

Figure 3-6 Perforated Plate used on a Perforated Plate Screen *("Aqua Guard® PF - Perforated Plate Screen | Parkson Corporation," n.d.)*

3.3.1.4.2 Center-Flow Perforated Plate Band Screens

A center-flow band screen is similar to the through-flow except the plates are parallel with the flow of water as opposed to perpendicular (Figure 3-7). The wastewater will flow into the open front side of the screen and out through the screening elements on the left and right sides. The screenings are retained on the inner surface of the screen. Since water can exit both sides of the screen, this configuration has lower screening carry over as well as ability to expand hydraulic capacity without increasing the existing channel size. The plates circulate, carrying the screenings upward and out of the channel. The upper part of the screen includes a spray nozzle bar that sprays water onto the screens from the outside to remove the screenings from the surface and flush them into a trough where they are discharged by gravity. The screenings are then sluiced to a washer/compactor. The setting angle is 90 degrees with 3 to 6 mm perforations in the continuous plate. Center-flow screens carry some major benefits including a lower footprint, about three times the screenings capture compared to typical fine bar screens, as well as a reduction in hydraulic requirements. Some disadvantages include special provisions for removing the screen from the channel, difficult to access and maintain, and removal of trapped debris inside the plates.

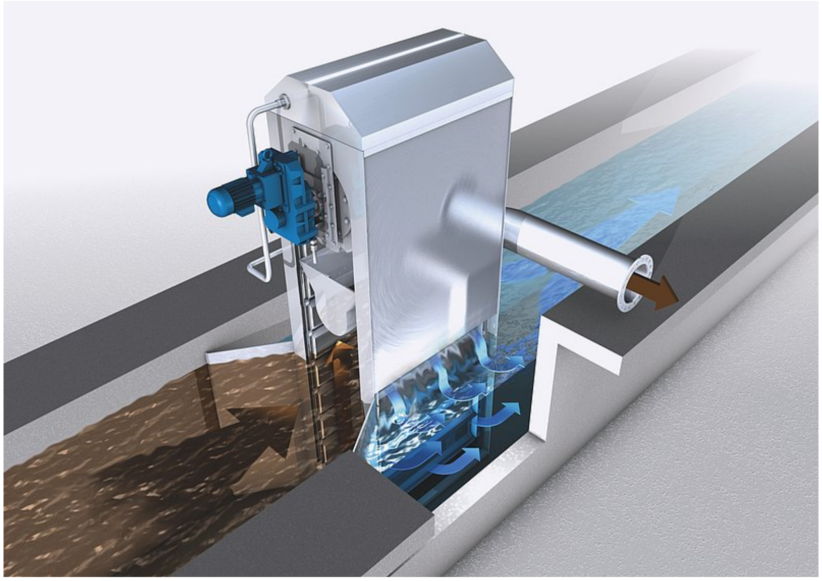

Figure 3-7 Center-Flow Band Screen *("HUBER Band Screen CenterMax® - Huber Technology Inc.," n.d.)*

3.3.2 Grit Removal and Handling

Grit removal systems are an important process during wastewater treatment to protect downstream equipment and tankage from abrasion. Grit removal will prevent grit deposition in downstream unit processes, such as primary clarifiers, aeration basins, and anaerobic digesters resulting in less hydraulic detention time and increased maintenance. The deposition of grit results in operational issues that will require maintenance and add additional costs due to cleaning. The removal of grit reduces potential wear and tear of mechanical equipment in residuals flow, such as thickening centrifuges, sludge pumps, digester recirculation pumps, and sludge dewatering pumps. According to the Environmental Protection Agency (EPA) grit loadings can range from 0.5 to 30 cubic feet per million gallons (cf/MG) (*Wastewater Technology Fact Sheet Screening and Grit Removal*, 2003) depending upon the system with an average of 4 ft/MG is typically used for grit quantification (Wang, Hung, & Shammas, 2005). There are various alternatives for grit removal treatment, either grit removal can be upfront of primary clarification treating all forward flow or grit removal can be performed on PS. The GBF facility removes grit only from the PS, relying on primary clarification to adequately settle grit during clarification. The DPF facility removes grit from the detritor tanks after influent pumping and screening.

Grit removal and capture is highly dependent upon the hydraulic retention time in the basin and the grit density which is a part of what controls the settling velocity based on Stoke's law. The major types of grit removal alternatives include:

1. Chain and flight or gravity settling
2. Detritor tanks
3. Aerated grit
4. Forced vortex
5. Free vortex
6. Multi-tray plate settling

Issues that have plagued many grit removal systems are a result of the grit being coated with grease and other light organics that hinder settling and removal. Due to these site-specific issues with grit it is recommended that testing be conducted on the grit to determine the density of the grit, settling velocity, and quantity of grit to properly size the removal and capture system. For the purpose of this study, a simple evaluation of equipment was conducted but it is recommended for future design to evaluate further. The equipment reviewed for the GBF and DPF included forced vortex grit removal, free vortex grit removal, multi-tray settling, and the use of detritor tanks at DPF only and are referred to as preliminary treatment units (PTUS).

3.3.2.1 Grit Removal Technology Options for Influent Flow and Primary Sludge

3.3.2.1.1 Vortex Grit Removal

Vortex grit basins are categorized into two subcategories including forced vortex and free vortex. Forced vortex grit removal systems (Figure 3-8) use a slow circular pattern to create a quiescent zone where the grit will migrate to the center where it deposits in a bottom chamber and is removed. Forced vortex basins use stirring paddles to control the velocity within the chamber to lift out organics that may attempt to travel to the quiescent zone. Free vortex grit removal systems (Figure 3-9) use centrifugal force to move the grit particle against the side walls of the basin, forcing them to travel down the walls and into the bottom of the tank. Typically, headloss for these type of systems ranges from 4- to 12-inches and can maintain a consistent grit removal efficiency over a wide range of flow rates. This system has a small footprint compared to other grit removal systems depending upon if grit removal is for influent flow or PS. As a result, this system is typically energy efficient, although many designs are proprietary and reliant on vendors. Both forced (Figure 3-8) and free vortex (Figure 3-9) grit basins were examined for this alternative. Typical removal efficiencies are 95 percent of 105-micron grit, which is dependent of the distribution of the grit entering the basin.

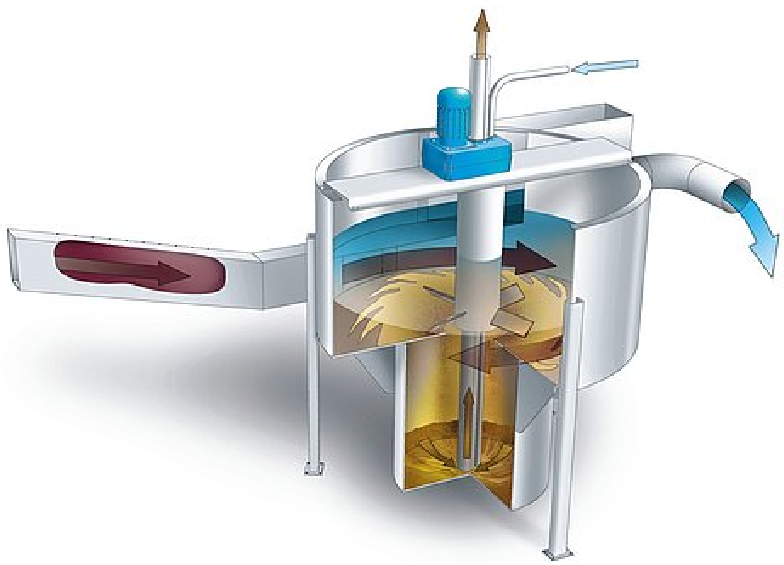

Figure 3-8 **Forced Vortex Grit Removal** ***("HUBER Vortex Grit Chamber VORMAX - Huber Technology Inc.," n.d.)***

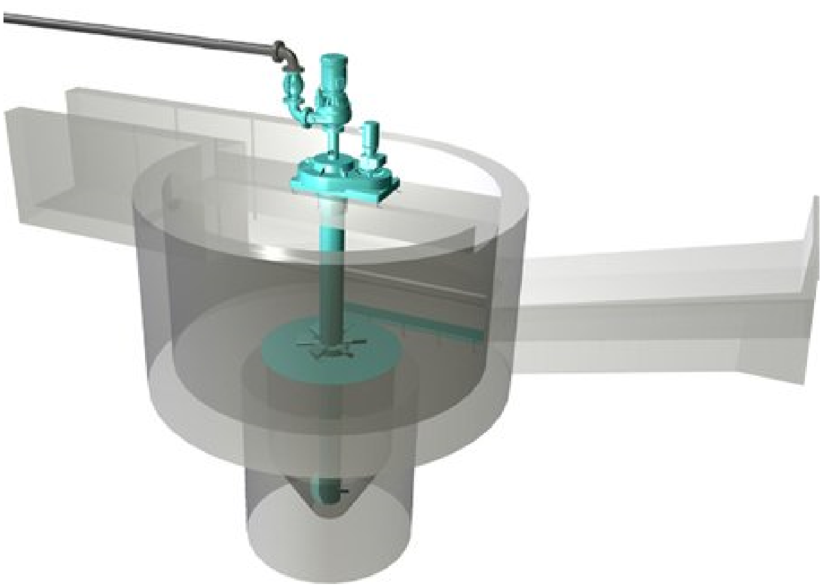

Figure 3-9 **Free Vortex Grit Removal** ***("PISTA® 360° or 270° Non-Baffled Grit Chambers | Smith & Loveless Inc.," n.d.)***

3.3.2.1.2 Multi-Tray Settler System

The multi-tray settling system is a modular, hydraulic grit separator and concentrator, which uses a forced vortex flow and a stacked plate or tray design to efficiently capture and settle grit (Figure 3-10). The system accomplishes this efficiently via large surface areas in a compact space with short settling distances enhancing overall removal. Multi-tray settling units are typically installed in the process flow stream after screening. They typically have a higher headloss requirement compared to vortex systems. There is no external power source required and the system has no moving parts and is self-cleaning. Plate settler systems can retain greater than 95 percent of grit 75 micron or larger depending on the depth of the trays as well the distribution of the grit entering the treatment facility.

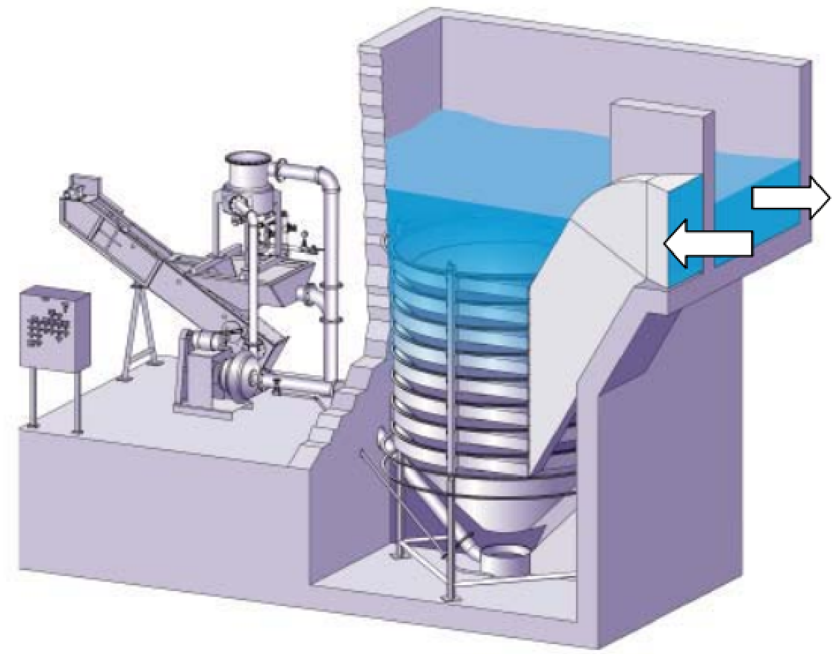

Figure 3-10 Multi-Tray Settler System for Grit Removal

3.3.3 Sludge Screening

In addition to potentially upgrading the existing screens, one alternative reviewed in this analysis was to screen PS and waste activated sludge (WAS). The purpose of sludge screening is to remove fine screenings and trash from the PS and WAS before it is transferred to thickening and the remainder of the solids processes. Sludge screening equipment is used to capture screenings not removed in the plant forward flow screening equipment. Removing screenings will reduce wear and tear on downstream equipment, preserving its useful life and reducing equipment down time due to cleaning and repairs. The PS will have separate sludge screens from the WAS. The technologies reviewed were through-flow band screens, drum screens, and strain presses.

3.3.3.1 Technologies for Primary Sludge and Waste Activated Sludge Screening

3.3.3.1.1 Through-Flow Band Screen

See section above for a description of the technology. This option would require the construction of a channel to install the screens in. This system would be easy to retrofit, provide easy cleaning, and great capture efficiency. Some utilities have used this equipment successfully for removal of material that is “carried over” with the influent screens.

3.3.3.1.2 Drum Screen

Drum screens, or rotary drum screens, are internally fed rotary cylindrical screens typically using a perforated plate material or a mesh (Figure 3-11). The screen will retain the debris from the solids stream and allow screened sludge to pass through to thickening. The screenings are caught inside the cylinder and liquid passes through the screen to further treatment. The screenings move along the drum to the discharge. There is a variety of screen mediums available for drum screens to allow a certain solids size to pass. Drum screens are typically equipped with spray bars to clean the screen.

Figure 3-11 Rotary Drum Screen ***("JWC's IPEC Rotary Drum Screens for Industrial Wastewater Applications," n.d.)***

3.3.3.1.3 Strain Press

A strain press is a horizontal cylindrical material separator (Figure 3-12). The equipment is a pressure-fed in-line system for sludge screening. The strain press has a high capture efficiency and has been shown to dewater the screenings material to 40 percent (no need for separate washer/compactor). The benefits of using a strain press include compact footprint, capable of handling high solids loading, completely enclosed, and operates from differential pressure. The system requires continued maintenance and has a higher energy consumption.

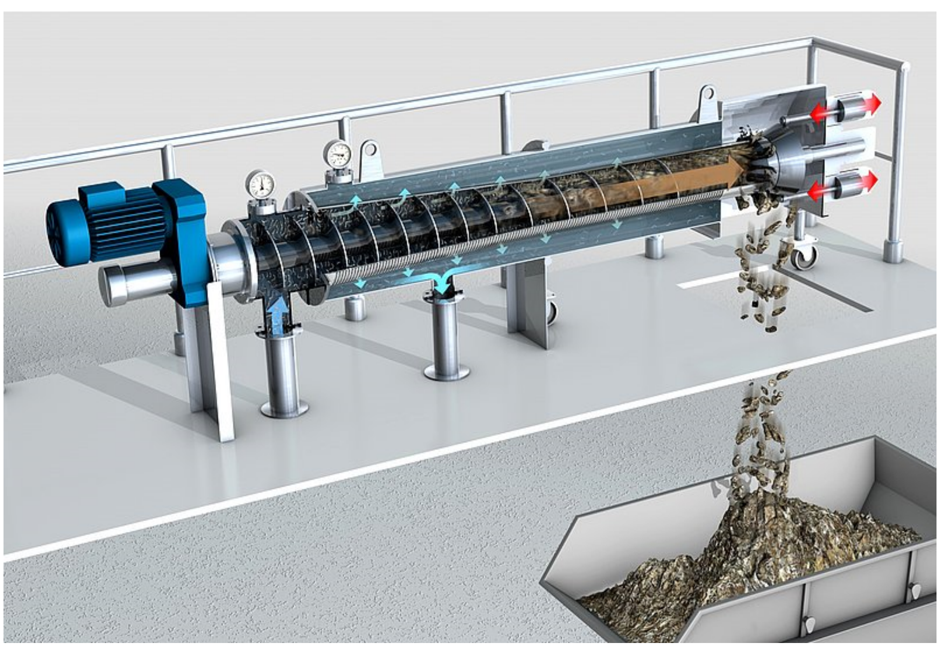

Figure 3-12 Strain Press ***("HUBER Sludgecleaner STRAINPRESS® - Huber Technology Inc.," n.d.)***

3.4 GBF Screening and Grit Management Packages

1. A number of packages were developed to address the fundamental objectives for screening and grit removal management at the GBF. The objectives for screening and grit management were identified as the following:
2. Address the age and condition of equipment to provide a useful life through the 20 year planning period
3. Address peak flow management
4. Reduce liquid stream screenings and grit carry-over to minimize associated downstream operation and maintenance effort

The following section outlines the package options identified for upgrades to the screening and grit removal systems at the GBF. Table 3-1 summarizes which packages address the removal of screenings and grit in the liquid stream and solids stream (all packages address peak flow management). Note that for the influent screening and grit removal packages, the GBF improvements would address the screening and grit material in the GBF solids. Any screening and grit material in the DPF WAS would still be present in the transferred flow to GBF unless influent screening and grit improvements are also made at the DPF.

Table 3-1 Summary of GBF Proposed Alternatives

Package	Major Improvements	Influent Pump Station	Liquid Stream		Solids Stream	
			Screenings and Peak Flow	Grit	Screenings	Grit
GBF Baseline Package	• Influent Pumps • Bar Screens	New influent pumps and influent bar screens	-	-	-	-
GBF Package 1 Build New Headworks	• New Headworks • New Fine Screens • Influent Grit Removal Systems • New Grit Handling	✓ Included in Baseline Package	✓ New Fine Screens	✓ New Influent Grit Removal	✓ Completed through Influent Screening	✓ Completed through Influent Grit Removal
GBF Package 2A Replace and Expand Existing	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling	✓ Included in Baseline Package	✓ Replace and Expand Existing Fine screens	Continue PS degritting	Rely on Influent Fine Screens	✓ Replace Existing PS Grit Removal and Handling

Package	Major Improvements	Influent Pump Station	Liquid Stream		Solids Stream	
			Screenings and Peak Flow	Grit	Screenings	Grit
GBF Package 2B Replace and Expand Existing plus add PS and WAS Screening	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling • Two PS Screens • Two WAS Screens	✓ Included in Baseline Package	✓ Replace and Expand Existing Fine screens	Continue PS degritting	✓ New PS and WAS Screening	✓ Replace Existing PS Grit Removal and Handling
GBF Package 3 Rehabilitate Existing plus add PS and WAS Screening	• In Existing Headworks • Four Influent Fine Screens • Four PS Grit Removal Systems • Two PS Screens • Two WAS Screens	✓ Included in Baseline Package	Screens bypassed during peak flow	Continue PS degritting	✓ New PS and WAS Screening	✓ Replace Existing PS Grit Removal and Handling

3.4.1 GBF Baseline Package (Additional Improvements). Bar Screens and Influent Pumps

3.4.1.1 Upgrade Influent Pump Station with New Influent Bar Screens and Influent Pump Upgrades

The baseline package includes upgrading the influent bar screens and influent pumps located in the influent pump station. See Figure 3-13 for the process flow diagram for the Baseline Package and Figure 3-14 for a conceptual layout. The new system will be installed with two mechanical screens in the existing influent channels that have a width of 8 ft. Replacing the screens at 120 mgd means there will not be redundancy, but the system will be able to handle a total flow of 240 mgd. They will either be a through-flow multi-rake screen or a through-flow reciprocating rake screen. Additional upgrades with the Baseline Package include the replacement of the valves for the mill waste and thickener overflow piping. Additionally, future consideration for the diversion of the plant return sewer to a dedicated pump station or mill waste wet well.

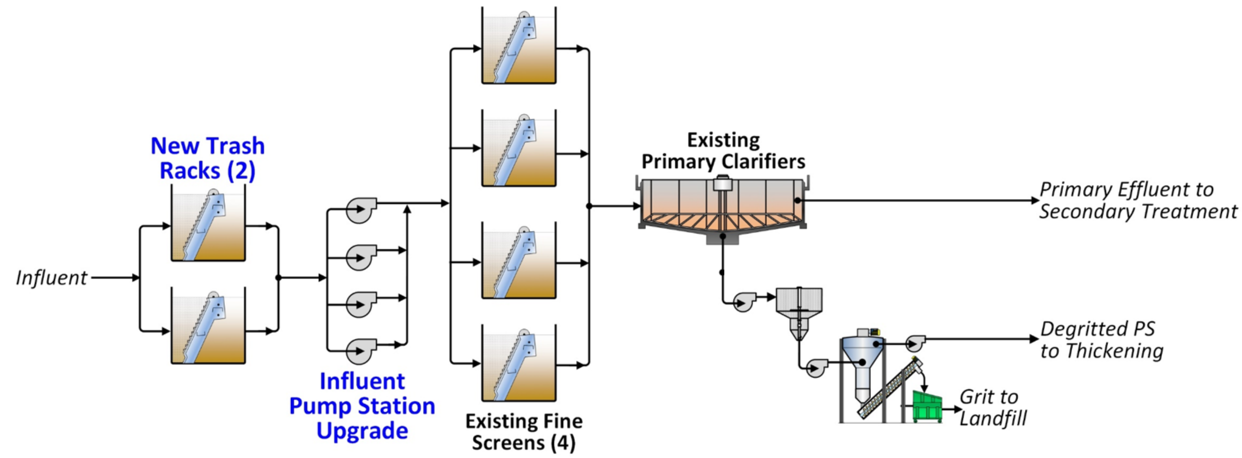

Figure 3-13 **GBF Baseline Package to Upgrade the Influent Bar Screens and Influent Pumps Process Flow Diagram**

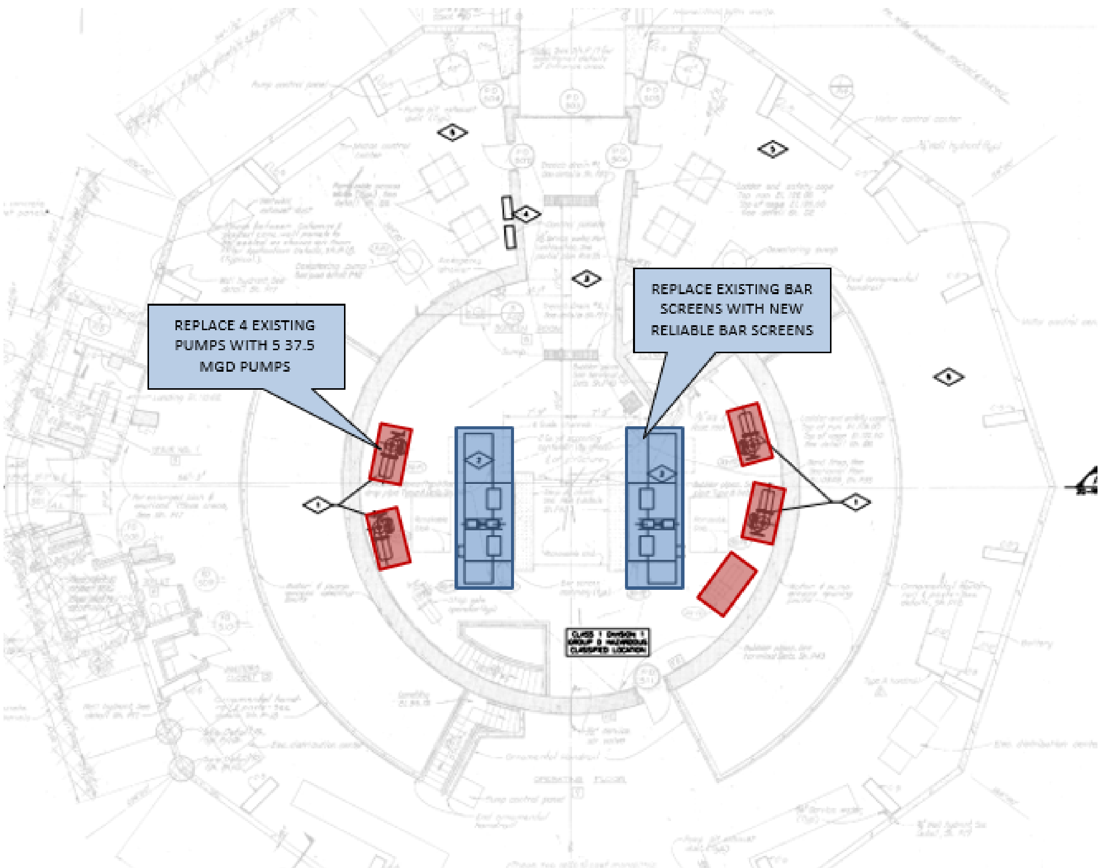

Figure 3-14 **Influent Pump Station Updates**

3.4.1.2 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates for this system mainly for the influent screens (Table 3-2). The values are a summary (average) of the information provided. The cost presented is the greatest cost for each technology from the manufacturers. A through-flow multi-rake bar screen and through-flow reciprocating rake screen proposal has been provided. Each were paired with a washer/compactor/conveyor.

Table 3-2 Influent Bar Screen Manufacturer Information GBF Baseline Package

Influent Bar Screening	
Multi-Rake Screen with Conveyor/Compactor	
Install Angle (deg)	90
Material	304 SSTL
Screen Motor	5 HP with VFD
Max Washer/Compactor Capacity	99 cf/hr
Approximate Equipment Cost[1]	$1,100,000
Reciprocating Rake Screen with Washer/Compactor	
Install Angle (deg)	90
Material	304 SSTL
Screen Motor	Submersible explosion-proof 5 HP
Max Washer/Compactor Capacity	106 cf/hr
Approximate Equipment Cost[1]	$1,400,000
[1]Does not include costs for concrete tanks and structural support. Cost is for equipment only provided by manufacturer.	

3.4.1.3 Performance Impacts

As illustrated in Table 3-1, the Baseline Package was developed to meet the age and condition improvement objectives to reduce operations and maintenance within the influent pump station at the GBF. The Baseline Package includes upgrading the influent pumps and trash racks in the influent pump station to improve reliability of the systems and increase capacity to meet the projected peak flow. This package will be a recommended upgrade irrelevant of which overall liquid and solids stream package is selected.

3.4.2 GBF Package 1: New Headworks Facility

3.4.2.1 New GBF Headworks Facility with New Fine Screens and Grit Removal and Grit Classifiers for Forward Flow

This package includes the construction of a completely new headworks facility that will provide adequate capacity for influent fine screens and grit removal (Figure 3-15). The costs for this package will include the Baseline Package for influent bar screens and influent pumping. The new structure will include the costs for the new building, the cost for new influent fine screening, gates, screenings washpress and conveyor, structural and concrete costs for vortex grit removal tanks, the costs of all grit removal and handling ancillary equipment, and the existing headworks equipment removal. The equipment evaluated for the influent fine screens were perforated plate through-flow and center-flow screens. The equipment evaluated for the influent grit removal system included a free vortex grit removal system, a forced vortex grit removal system, and a multi-tray settler system.

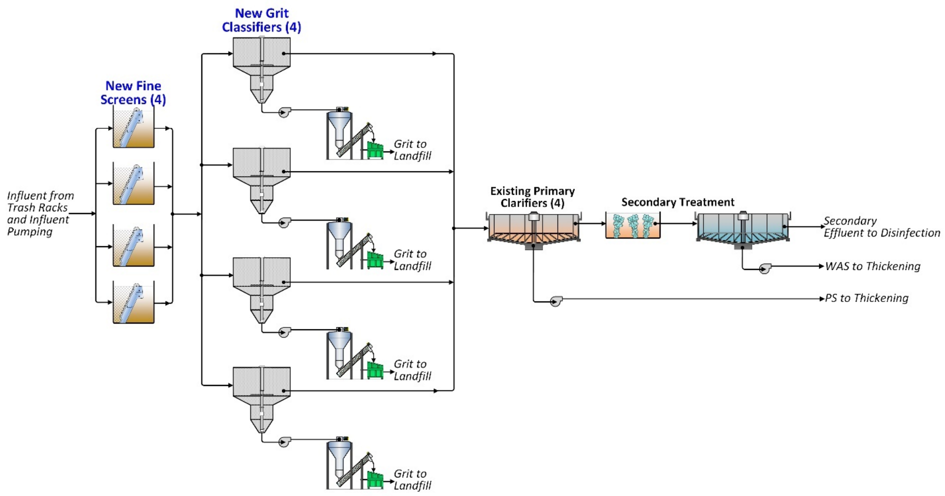

Figure 3-15 GBF Package 1 New Headworks Facility Process Flow Diagram

3.4.2.2 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates for Package 1, including costs for the fine screen alternatives and the influent grit removal and handling. The cost presented is the greatest cost for each technology from the manufacturers. The manufacturer information for a through-flow perforated plate screen and center-flow perforated plate screen is provided in Table 3-3, each includes costs for a washer/compactor/conveyor. The equipment evaluated for the influent grit removal system included a free vortex grit removal system, a forced vortex grit removal system, and a plate settler system and is summarized in Table 3-4.

Table 3-3 Influent Fine Screen Manufacturer Information for GBF Package 1

Influent Fine Screening	
Through-Flow Perforated Plate Screen with Washer/Compactor	
Install Angle	45 deg
Material	304 SSTL
Screen Drive Motor	3.0 HP
Washer Compactor Motor	10.0 HP
Approximate Equipment Cost[1]	$1,721,000
Center-Flow Perforated Plate Screen	
Install Angle	90 deg
Material	304 SSTL
Screen Motor	1.0 HP, VFD
Washer Compactor Motor	10.0 HP max
Approximate Equipment Cost[1]	$1,350,000
[1]Does not include costs for concrete tanks and structural support. Cost is for equipment only provided by manufacturer.	

Table 3-4 Influent Grit Removal and Handling Manufacturer Information

Influent Grit Removal	
Free Vortex Grit Removal System with Grit Handling	
Number of Units	3 to 4
Size	20 to 24 ft in diameter depending upon units
Material	304 SSTL
Performance Guarantee for Vortex Unit	95% removal of all grit (SG 2.65) ≥ 75 microns
Design Flow per Unit	50 mgd for 3 units, 38 mgd for 4 units
Number of Dewatering Units	2
Capacity of Dewatering Unit	3.0 cy/hr
Performance Guarantee for Dewatering Unit	-
Approximate Equipment Cost[1]	$1,000,000

Influent Grit Removal	
Forced Vortex Grit Removal	
Number of Units	4
Size	20 ft
Material	varies
Performance Guarantee for Vortex Unit	95% grit capture > 300 microns
Design Flow per Unit	400 gpm
Number of Dewatering Units	4
Capacity of Dewatering Unit	1.6 cy/hr
Performance Guarantee for Dewatering Unit	95% capture of 105 micron
Approximate Equipment Cost[1]	$1,500,000
Multi-Tray Settler System	
Number of Units	4
Size	12’ diameter
Number of Trays per unit	12
Material	304 SSTL Structure with Polyethylene Trays
Performance Guarantee for Vortex Unit	95% removal of all grit (SG 2.65) ≥ 75 microns
Design Flow per Unit	38 mgd with 12” headloss
Number of Dewatering Units	4
Capacity of Dewatering Unit	3 cy/hr
Performance Guarantee for Dewatering Unit	95% removal of all grit (SG 2.65) ≥ 75 microns
Approximate Equipment Cost	$1,800,000
[1]Does not include costs for concrete tanks and structural support cost is for equipment only provided by manufacturer.	

3.4.2.3 Performance Impacts

As illustrated in Table 3-1, the improvements identified in Package 1 meet the fundamental objectives needed to address peak flow management and reduce liquids and solids stream screening and grit carryover to downstream processes at the GBF. To accomplish this Package 1 a new headworks facility. The new fine screens will be installed to accommodate the 2040 peak hour flow. Perforated plate fine screens will provide robust removal of screenings in the liquid and solids stream. Package 1 includes new vortex grit removal systems for the liquid flowstream, which will minimize grit carryover to the liquid stream processes and solids handling processes.

3.4.3 GBF Package 2A and 2B: New Fine Screens and New Primary Sludge Grit Removal and Handling

3.4.3.1 Package 2A Rehabilitate and Expand Existing Headwork's with New Fine Screens and New Primary Sludge Grit Removal and Classification

Package 2A includes rehabilitating the existing headworks facility through the replacement of the existing four fine screens and the addition of two new fine screens and channels in the location of the existing bypass channels (Figure 3-16). The addition of two channels is required in order to reduce velocity through the channels at peak flows. This is because the existing four channels exceed the recommended velocity through the approach channel and the screen itself at the identified peak hour flow of 149 MGD. This would also accommodate redundancy and the peak hourly flow while maintaining appropriate channel and through-screen velocities. Pivoting screens should be investigated during design to potentially provide the flexibility for bypassing flow through a channel in the event the screen in that channel fails. See Figure 3-17 for the approximate location of the four new screens in the existing screening channels and the newly added fine screen channels within the existing bypass channels. The advantage of this approach is that all flow is screened. If additional channels are not included the maximum capacity of the system would be limited to a total treatment flow of 110 mgd. Perforated plate screens were evaluated for this alternative, both the through-flow and center flow. This option will also replace the existing PS grit removal and classification systems to handle the 2040 PS flow and loading estimates (Figure 3-18).

Additional equipment included in Package 2A include screening washpress, conveyor, grating and catwalks, PS grit pumps, and associated valves and piping. The mill waste valve costs are included in packages that replace influent fine screens.

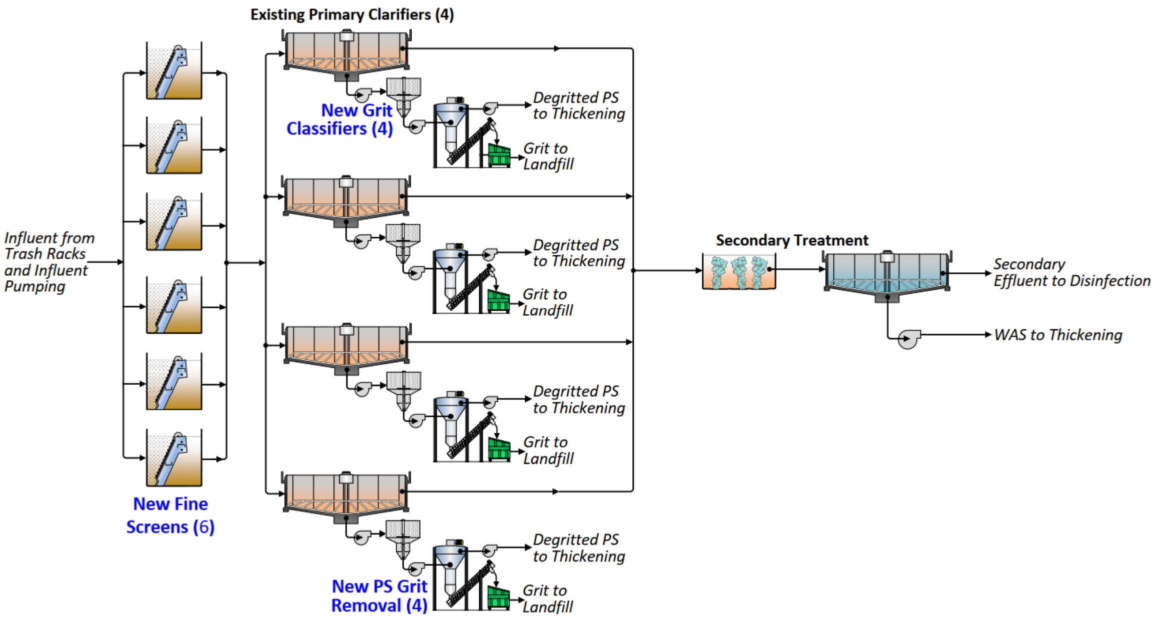

Figure 3-16 GBF Package 2A New Fine Screens and PS Grit Removal System in Existing Headworks Process Flow Diagram

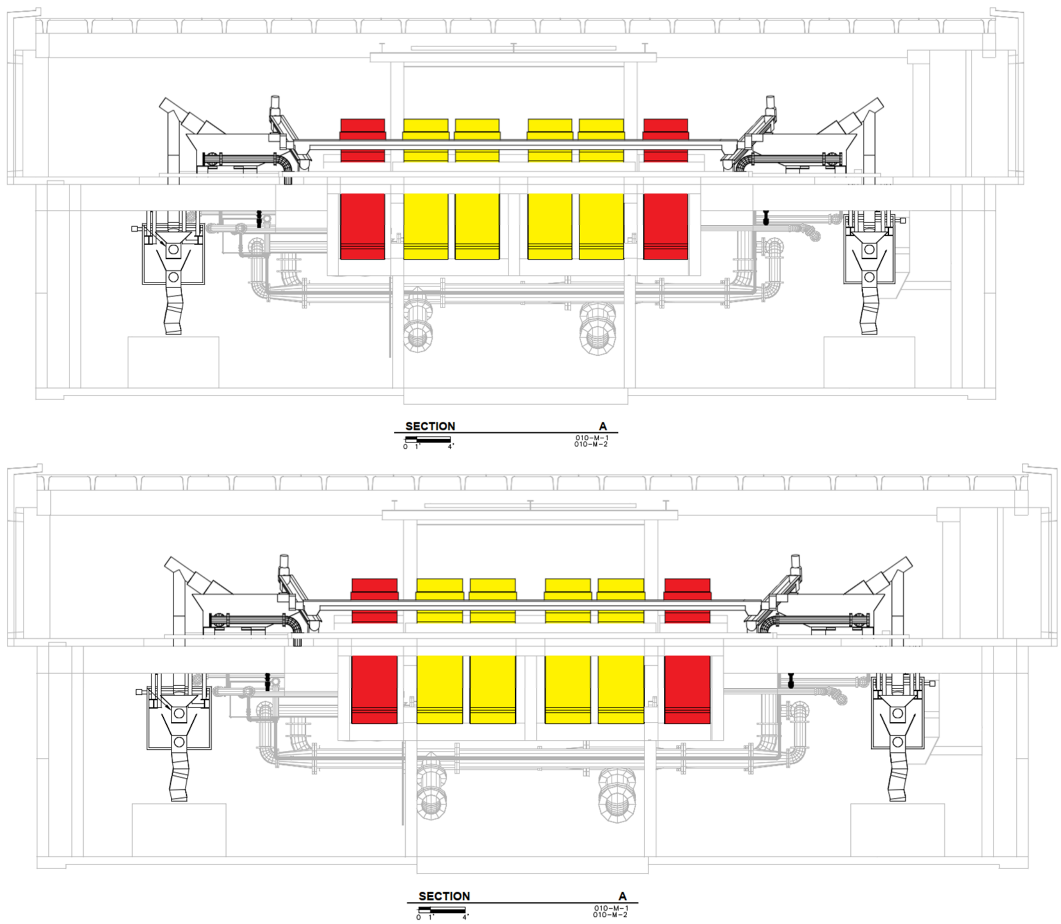

Figure 3-17 Headworks Fine Screen Channels with New Screens and Two New Channels

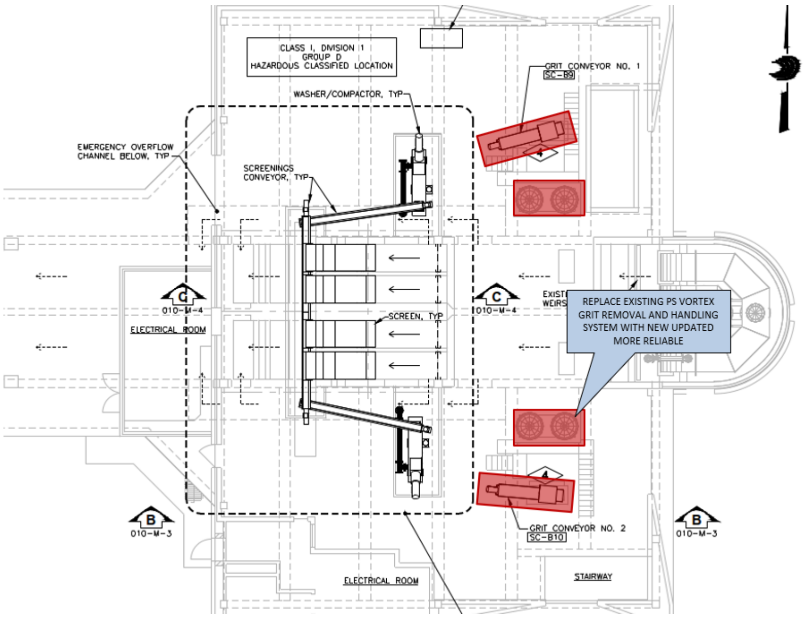

Figure 3-18 Replace Existing Primary Sludge Degritting and Grit Handling System

3.4.3.2 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates for Package 2A, including costs for the fine screen alternatives and the PS grit removal and handling replacement. The cost presented is the greatest cost for each technology from the manufacturers. A through-flow perforated plate screen and center-flow perforated plate screen proposal has been provided (Table 3-5), each of the cost ranges (high and low from all manufacturers) includes the of costs for washer/compactors and conveyors.

Table 3-5 Perforated Plate Screen Manufacturer Information for GBF Package 2A

Influent Fine Screening	
Through-Flow Perforated Plate Screen with Washer/Compactor	
Install Angle	60 deg
Screen Capacity	24-30 mgd
Material	304 SSTL
Screen Drive Motor	1.0 HP
Washer Compactor Motor	5.0 HP
Approximate Equipment Cost[1]	$1,030,000

Influent Fine Screening	
Center-Flow Perforated Plate Screen	
Install Angle	90 deg
Screen Capacity	25 mgd
Material	304 SSTL
Screen Motor	1.0 HP, VFD
Washer Compactor Motor	10.0 HP max
Approximate Equipment Cost[1]	$1,900,000
[1]Does not include costs for concrete tanks and structural support. Cost is for equipment only provided by manufacturer.	

The PS grit removal alternative evaluation assessed the costs and size for a high-efficiency free vortex unit paired with a grit washing and classification unit. Multiple vendors were used, however, only one manufacturer was able to provide costs for this equipment. See Table 3-6 for the manufacturer information.

Table 3-6 Primary Sludge Grit Removal Manufacturer Information for GBF Package 2A

Primary Sludge Grit Removal	
Free Vortex Grit Removal	
Number of Vortex Units	4
Size	42" diameter
Material	304 SSTL
Performance Guarantee for Vortex Unit	95% removal of all grit (SG 2.65) ≥ 75 microns
Design Flow per Unit	400 gpm with 85" Headloss
Number of Dewatering Units	2
Capacity of Dewatering Unit	3.0 cy/hr
Performance Guarantee for Dewatering Unit	95% removal of all grit (SG 2.65) ≥ 75 microns; grit in the dumpster shall contain ≥ 60% TS and ≤ 20% VS
Approximate Equipment Cost[1]	$800,000
[1]Does not include costs for concrete tanks and structural support. Cost is for equipment only provided by manufacturer.	

3.4.3.3 Performance Impacts

As illustrated in Table 3-1, the improvements identified in Package 2A are meant to meet the fundamental objectives needed to improve peak flow management and reduce liquids and solids stream screening and grit carryover to downstream processes at the GBF. To accomplish this, Package 2A will include structural modifications to the headworks building channels to remove the fabricated metal bypass channels and construct two additional screen channels. Six new fine screens will be installed in the four existing and two new channels. The captured screenings will be conveyed to two new washer/compactor units. All four primary sludge grit removal systems will be replaced with new systems. The manufacturer of these systems has communicated that the new systems will be more reliable and effective at grit removal. Although there may be guarantees from manufacturers for a specific screening's removal in the forward flow, this may not ensure that all solids handling processes are protected. For this reason, a B version of this alternative was identified to include adding primary sludge and WAS screening to the improvements to fully address solids handling protection.

3.4.3.4 Package 2B Rehabilitate and Expand Existing Headwork's with New Fine Screens in Existing Channels and New Primary Sludge Grit Removal and Classification and Addition of PS and WAS Screening

Package 2B will include all the improvement identified in Package 2A and the addition of PS and WAS screening (Figure 3-19). The purpose of the PS and WAS screening will be to remove screenings not removed in influent screening before it is discharged to thickening and digestion. A new structure will house the additional screening equipment and an approximate location is depicted in Figure 3-20.

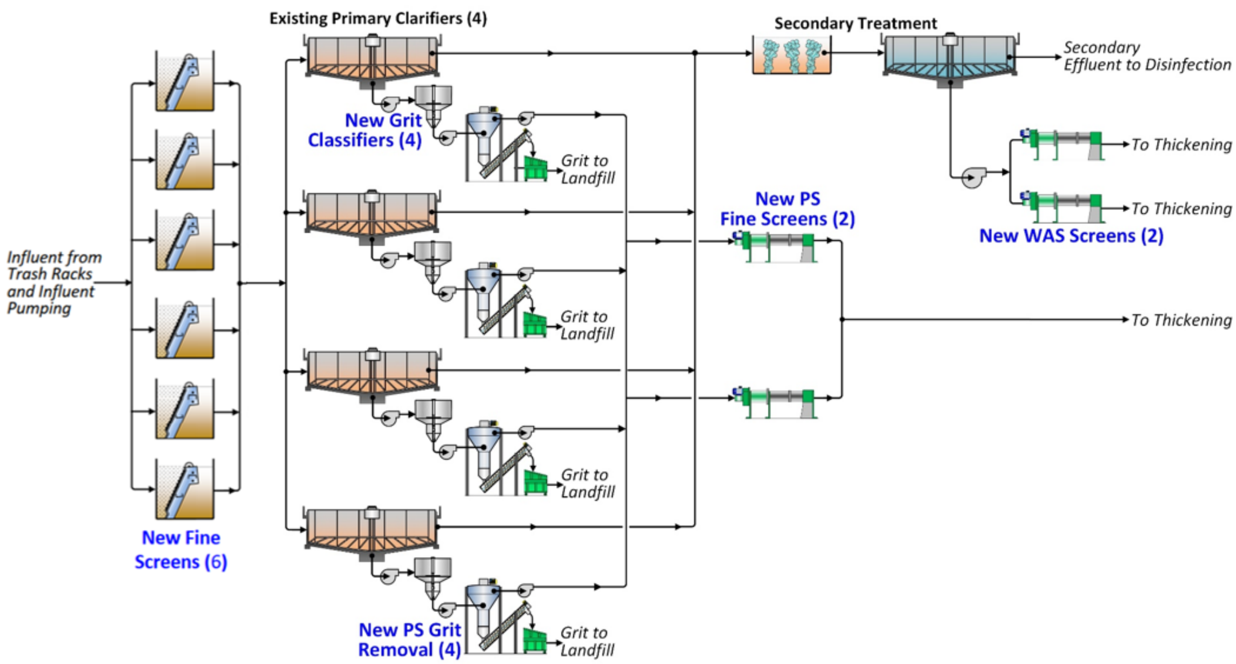

Figure 3-19 GBF Package 2B New Fine Screens and PS Grit Removal System in Existing Headworks and New PS Grit Removal with Separate PS and WAS Thickening Process Flow Diagram

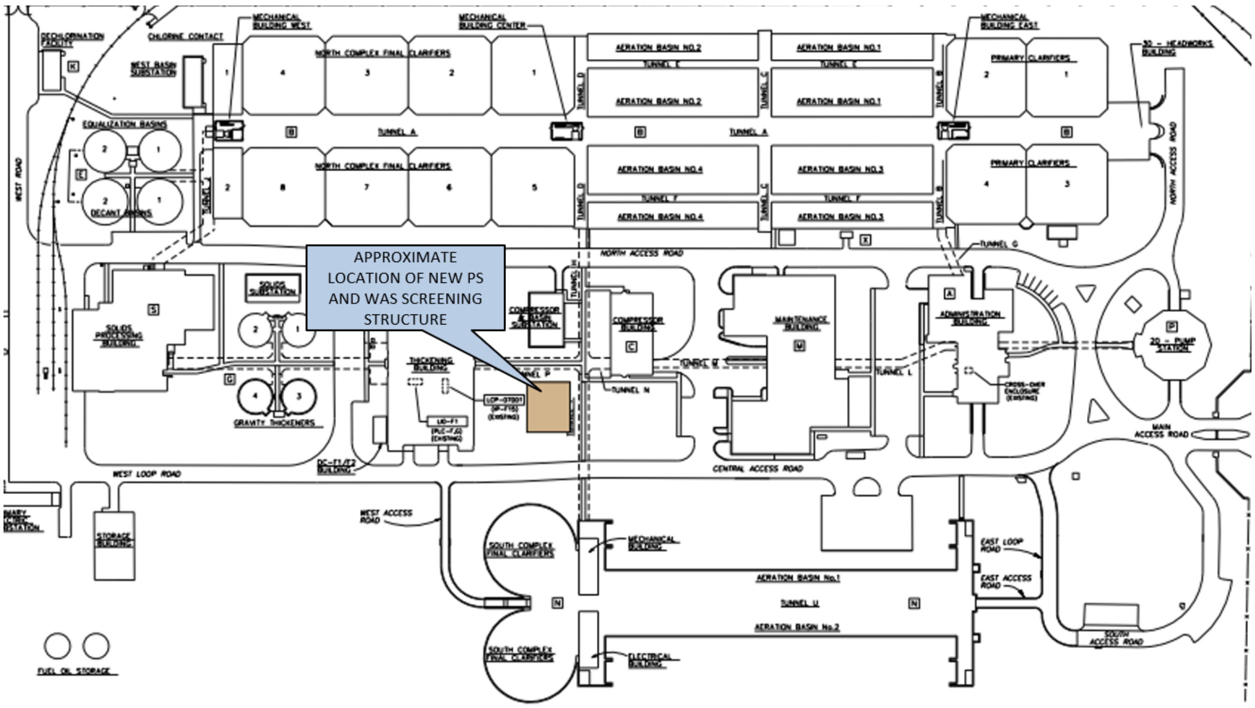

Figure 3-20 Approximate Location of PS and WAS Screening Building

3.4.3.5 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates for Package 2B, including options for including costs for the fine screen alternatives, the PS grit removal and handling replacement, and the addition of PS and WAS Screening. The fine screen alternatives and the PS grit removal and handling replacement was already evaluated in Package 2A, Table 3-5 and Table 3-6 include the manufacturer information for these upgrades. The sludge screening equipment evaluated included a drum screen and an in-line strain press. The manufacturer information for these sludge screening options are presented in Table 3-7 and Table 3-8 for PS and for WAS. The drum screen incorporates a fully self-cleaning, dual drive.

Table 3-7 PS Screen Manufacturer Information for GBF Package 2B

PS Fine Screening	
Drum Screen	
Number of Units	2
Capacity per unit	800 gpm
Performance	-
Perforated Screen Openings	6 mm
Drive Motor	2 HP
Material	304 SSTL
Approximate Equipment Cost[1]	$450,000
In-Line Sludge Strain Press	
Number of Units	4
Capacity per unit	317 @2.5 Solids; 453 gpm @ 2.5%
Performance	35 to 45% Dry Solids
Perforated Screen Openings	3 mm
Drive Motor	5.0 HP
Material	304 SSTL
Approximate Equipment Cost[1]	$665,000
[1]Does not include costs for concrete tanks and structural support cost is for equipment only provided by manufacturer.	

Table 3-8 WAS Screen Manufacturer Information for GBF Package 2B

WAS Fine Screening	
Drum Screen	
Number of Units	2
Capacity per unit	800 gpm
Performance	-
Perforated Screen Openings	6 mm
Drive Motor	2 HP
Material	304 SSTL
Approximate Equipment Cost[1]	$450,000
In-Line Sludge Strain Press	
Number of Units	4
Capacity per unit	317 @2.5 Solids; 453 gpm @ 2.5%
Performance	35 to 45% Dry Solids
Perforated Screen Openings	3 mm
Drive Motor	5.0 HP
Material	304 SSTL
Approximate Equipment Cost[1]	$665,000
[1]Does not include costs for concrete tanks and structural support cost is for equipment only provided by manufacturer.	

3.4.4 GBF Package 3: New PS Grit Removal with Separate PS and WAS Screening

3.4.4.1 New Primary Sludge Grit Removal with Separate Primary Sludge and Waste Activated Sludge Screening Before Being Sent to Thickening

Package 3 includes the rehabilitation of the existing headworks facility through the replacement of the existing four fine bar screens and PS grit removal system to a more reliable and effective system, and the addition of PS and WAS screening (Figure 3-21). The purpose of the PS and WAS screening will be to remove screenings from the sludge flow streams that were not removed in influent screening before it is discharged to thickening and digestion. This system is required in Package 3 because the headworks fine screens will have a portion of peak flow bypass in the bypass channels (the four headworks fine screens have a peak flow rating of 110 mgd and the identified peak hour flow is 149 mgd)A new structure will house the additional sludge screening equipment and an approximate location is depicted in Figure 3-20.

The fine screens will be sized for the PS and WAS flow and designed to achieve a high screenings capture. The PS grit removal was evaluated in the same method as in Package 2A and 2B, which reviewed the use of a free vortex grit removal system paired with a dewatering unit. The PS and WAS screening systems were evaluated in the same method as in Package 2B.

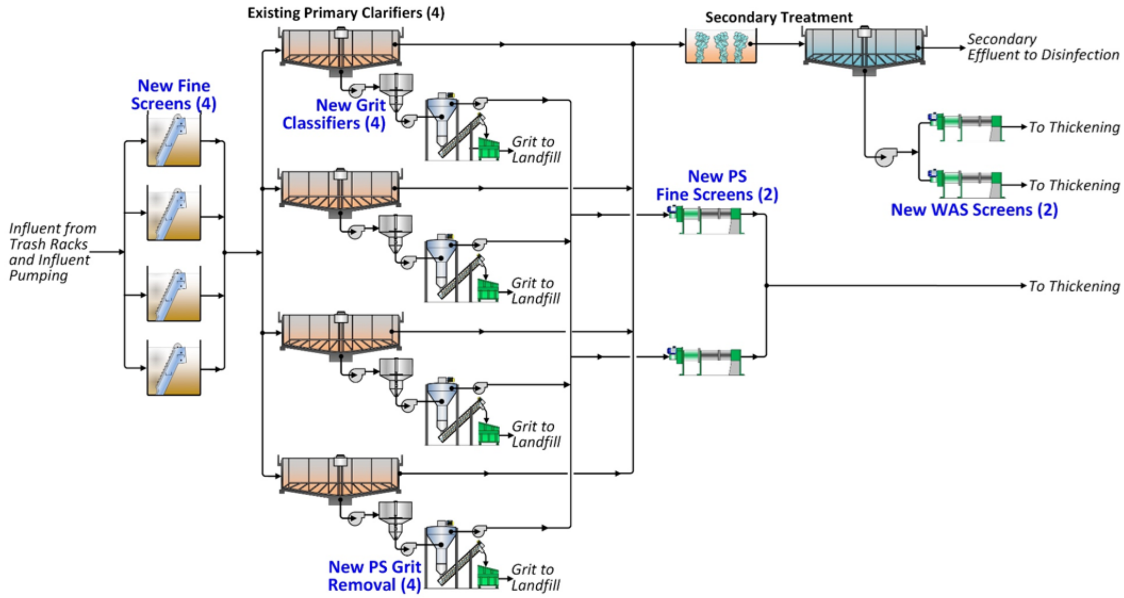

Figure 3-21 GBF Package 3 New PS Grit Removal with Separate PS and WAS Thickening Process Flow Diagram

3.4.4.2 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates for Package 3, including options for upgrading the influent fine screens and PS grit removal and the addition of PS and WAS Screening. The manufacturer information for a through-flow perforated plate screen and center-flow perforated plate screen was evaluated in Package 2A and 2B. Manufacturer information is provided in Table 3-5. The PS grit removal alternative evaluation assessed the costs and size for a high-efficiency free vortex unit paired with a grit washing and classification unit. One manufacturer provided costs for this operation. Because this was already evaluated in Package 2A and 2B, Table 3-6 includes the manufacturer information. The sludge screening equipment evaluated included a drum screen and an in-line strain press. Because this was already evaluated in Package 2B, the manufacturer information for these sludge screening options are presented in Table 3-7 for PS and Table 3-8 for WAS.

3.4.4.3 Performance Impacts

As illustrated in Table 3-1, Package 3 will improve the solids stream screening and grit removal. Package 3 includes new PS grit removal and handling which will meet the objective to improve solids stream grit carryover. This package also includes PS and WAS screening. PS and WAS screening along with PS degritting processes would ensure robust protection of the solids handling processes. This package would not meet liquid stream screening fundamental objective due to bypassing being required at peak hour flow. During discussions at review workshops it was unclear whether reduced screening capture is tied to peak flow events or is occurring through normal flow conditions. An applied research project will be recommended to gather additional data and information.

4.0 De Pere Facility

The existing screening and grit removal treatment consists of fine bar screens, influent pumping, PTUs, and grit handling (Figure 4-1). The future 2040 design peak hourly flow determined in TM 2.1 was 57.3 mgd with an average day flow of 11.0 mgd. The following sections will describe each process, the existing equipment, process performance issues, and the solution alternatives.

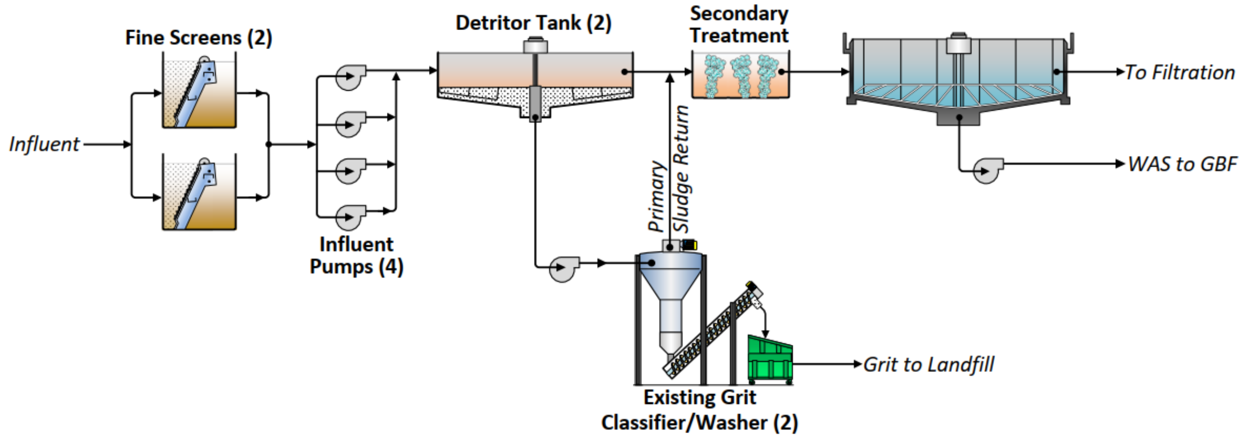

Figure 4-1 DPF Existing Screening and Grit Removal System Process Flow Diagram

4.1 Screening and Pumping

4.1.1 Existing Equipment and Equipment Performance

4.1.1.1 Fine Screens, Screening Washer Compactors, and Conveyor

The DPF influent pump station houses the screening and pumping operations at the plant. The system consists of two fine bar screens with 6 mm bar spacing each with a capacity of 27.5 mgd within 5.5-foot-wide channels. Screening is accompanied with two screenings washer compactors with a continuous capacity of 30 cubic feet per hour (cf/hr) and intermittent capacity of 12 cf/hr paired with a screenings screw conveyor. The facility has encountered the following issues with the fine screens:

- Hydraulic bypass issues during high flow events
- The side panels of the screens get clogged with rags and debris
- Teeth break off from large debris
- Large debris cause issues in the screw conveyors and washer compactors
- Screen maintenance is difficult in the lower channels and requires confined space entry

Ideally, a more robust, reliable, and less prone to clogging technology would be more appropriate in this setting.

To minimize these issues and improve overall screenings capture, a new screening technology is recommended. For fine screen upgrades, through-flow band screens and center-flow band screens were evaluated.

4.1.1.2 Influent Pumping

There are 6 dry-pit centrifugal pumps (five 10 mgd pumps and one 5 mgd pump) with a capacity, if all 6 pumps are in service, to pump 55 mgd (firm capacity of 50 mgd with the smallest out of service). Three pumps are located on each side of the wetwell. The DPF to GBF transfer pumps send approximately 5 mgd to GBF. Plant staff report that the pumps have encountered normal rebuilds over the years after their installation. The knife gate valves in this area are very difficult to open and close and require excessive manual labor and need to be replaced. The facility has reported issues with the piston sampler at the influent pump discharge. Given the existing wet well and interceptor system arrangement, there is not a large ‘storage’ volume for wastewater during wet weather events, so peak flow rates have a more immediate pumping impact than the GBF.   The influent pump system is undersized for the 2040 peak hourly design flow (57.3 mgd), at the end of its useful life and are recommended for replacement along with the replacement of the associated knife gate valves.

4.1.1.3 Grit Removal and Handling

Grit removal at the DPF includes two PTUs (detritor tanks) that have 50 ft sides with 12 ft of side-water-depth (SWD). The PTUs are sized for a peak flow of 30 mgd total (at a detritor tank surface overflow rate of 3,000 gpd/cf). Data provided by the plant indicates it is possible to pass greater flow rates through the detritor tanks. The PTUs can operate as a primary clarifier at flowrates of 15 mgd or less (based on a maximum surface overflow rate of 3,000 gpd/ft^2 provided by 10 States Standards). Therefore, at average flow and at the 2040 average design flow the tanks are capable of grit and PS removal. However, for future design an analysis of the grit distribution needs to be completed. Grit handling for the PTUs consists of two grit washers with a capacity of 250 gpm each and two 12-inch grit classifiers with a capacity of 250 gpm. The grit handling does not perform as well as the plant would have expected and allows carryover of grit into downstream processes.

Several solutions were evaluated to mitigate these screening and grit removal issues including replacing the existing grit removal PTUs with a vortex grit removal system or a multi-tray settling system, and the grit handling system with a new classifier and conveyor or washer and conveyor. Finally, an option to rehabilitate the mechanisms and tanks of the PTUs was examined.

4.1.1.4 Design Criteria

The following section defines the design criteria for potential equipment that may be evaluated to mitigate the existing DPF system screening and grit removal deficiencies. This includes updates for a new facility influent fine screens, new facility influent grit removal, influent pumps, PTU mechanism replacement, PS grit removal, fine screen design requirements in existing facility, and update existing grit and handling.

4.1.1.4.1 Fine Screen Design Requirements (new facility)

- Number of Units: 2 or selected by manufacturers
- Perforated Plate Spacing: 4 mm perforated plate
- Screen Channel Width: dependent upon manufacturer; ranges from 5 to 5.5 ft
- Screen Channel Depth: dependent upon manufacturer; 8 ft
- Peak Hourly Flow Capacity: 30 mgd each with all in use at peak hour flow
- Included Screenings Wash Press System

4.1.1.4.2 Influent Grit Removal System Design Requirements (New Facility)

- Number of Units: 2
- Receives All Influent Flow After Influent Screening and Pumping
- Flow Capacity: 60 mgd at peak hour flow with flow rate per chamber of 30 mgd
- Grit Capture Rate: 95% grit > 105 micron
- Chamber Diameter: dependent upon manufacturer

4.1.1.4.3 Influent Pump Design Requirements

- Number of units: 4
- Pump Type: Dry-pit centrifugal with VFD
- Maximum Flow Rate Per Pump: 20 mgd
- Head: 67 ft

4.1.1.4.4 PTU Mechanism Replacement Design Requirements

- Number of Tanks: 2
- Dimensions: 50 ft x 50 ft with 12 ft SWDC
- Existing Tanks: Sized for 15 mgd

4.1.1.4.5 PS Grit Removal and Handling Design Requirements

- Sized to handle grit flow from PTUs
- Number of Units: Manufacturer recommended

4.1.1.4.6 Fine Screen Design Requirements (Replace Existing)

- Number of units: 2
- Perforated Plate Spacing: 6 mm perforated plate
- Screen Channel Width: 5.5 ft
- Screen Height: 24.25 ft
- Peak Hourly Flow Capacity: 30 mgd each with all in use at peak hour flow
- Included Screenings Wash Press System

4.1.1.4.7 Grit Removal and Handling Design Requirements (Replace PTUs in Existing Tanks)

- Number of Units: 2
- Receives all influent flow from the influent pumping and screening
- Flow Capacity:
- Grit Capture Rate: 95% grit > 105 micron
- Chamber Diameter: dependent upon manufacturer
- Provide washer

4.2 Screening and Grit Removal Equipment Options

Various approaches were examined to determine:

1. Equipment function
2. Advantages and disadvantages of screening and grit equipment
3. Overall reliability for the required updates at both facilities

This evaluation included the review of influent fine screens and grit removal and handling at the DPF.

4.2.1 Influent Fine Screens

See the GBF section for influent fine screens technology review for through-flow and center-flow band screens.

4.2.2 Grit Removal and Handling

See the GBF section for the grit removal and handling description and technology review for vortex grit removal and multi-plate settling. For the DPF system, detritor tanks were additionally reviewed.

4.2.3 Grit Removal Technology Options for Influent Flow

4.2.3.1 Detritor Tank (PTUs)

A detritor tank is a continuous flow, constant level, short detention settling tank in which the grit settles due to gravity and the wastewater overflows through the outlet weirs on the opposite side. The settled grit is scraped by means of a scraper mechanism to the center and pumped to grit handling. The detritor works on the principals of velocity and Stoke's law and is designed so only grit settles while organic matter overflows and leaves in the forward flow. However, at low flows typically a large amount of organic material is settled with the grit. The settled grit is pumped to grit washing and handling. Grit washing is required for this type of grit removal to adequately separate grit from organic solids.

Figure 4-2 Detritor Tank Interior *(Limited, 2009)*

4.3 De Pere Screening and Grit Management Packages

Several packages were developed to address the fundamental objectives for screening and grit removal management at the DPF. The objectives for screening and grit management were identified as the following:

1. Address the age and condition of equipment to provide a useful life through the 20 year planning period
2. Address peak flow management
3. Reduce liquid stream screenings and grit carry-over to minimize associated downstream operation and maintenance effort
4. Reduce solids stream screening and grit carry-over to minimize associated downstream operation and maintenance effort

The following section outlines the package options for the upgrading of the screening and grit removal and handling systems at the GPF. Table 4-1 summarizes the fundamental objectives these packages will cover (all packages cover peak flow management). Note that for the influent screening and grit removal packages, the DPF improvements would address the screening and grit material in the DPF solids. Any screening and grit material in the GBF solids would still be present unless influent screening and grit improvements are also made at the GBF.

Table 4-1 Summary of DPF Proposed Alternatives

Package	Major Improvements	Influent Pump Station	Liquid Stream		Solids Stream	
			Screenings and Peak Flow	Grit	Screenings	Grit
DPF Package 1 Build New Headworks	• New Headworks • New Fine Screens • New Influent Pumps • New Grit Removal • New Grit Handling	✓ New influent pumps and Fine Screens	✓ Influent Fine Screens	✓ New Grit Removal System	✓ Influent Fine Screens (DPF solids, but not GBF)	✓ New Grit Removal (DPF solids, but not GBF)
DPF Package 2 Rehab Existing Screening and PTUs	• In Existing Facility • New Fine Screens • New Influent Pumps • New PTU Tank Mechanisms and Rehab • New Grit Handling	✓ New influent pumps and Fine Screens	✓ Influent Fine Screens	Upgrade PTUs with New Mechanisms Detritors lack adequate peak flow capacity	✓ Influent Fine Screens (DPF solids, but not GBF)	✓ PTU Rehab (DPF solids, but not GBF)

Package	Major Improvements	Influent Pump Station	Liquid Stream		Solids Stream	
			Screenings and Peak Flow	Grit	Screenings	Grit
DPF Package 3 Rehab Existing Screening and PTUs with PS Grit Removal	• In Existing Facility • New Fine Screens • New Influent Pumps • New PTU Tank Mechanisms and Rehab • PS Grit Removal • New Grit Handling	✓ New influent pumps and Fine Screens	✓ Influent Fine Screens	Upgrade PTUs with New Mechanisms Detritors lack adequate peak flow capacity	✓ Influent Fine Screens (DPF solids, but not GBF)	✓ PTU Rehab and PS Grit Removal (DPF solids, but not GBF)
DPF Package 4 Rehab Existing Screens and New Grit Removal in PTUs	• In Existing Facility • New Fine Screens • New Influent Pumps • New Grit Removal Retrofitted into PTUs • New Grit Handling	✓ New influent pumps and Fine Screens	✓ Influent Fine Screens	✓ New Grit Removal System	✓ Influent Fine Screens (DPF solids, but not GBF)	✓ New Grit Removal Located in PTU Tanks (DPF solids, but not GBF)

4.3.1 Package 1 – New Headworks and New Equipment

4.3.1.1 New Headworks Building with New Influent Fine Screens, Influent Pumps, Grit Removal System, Grit Pumps, and Grit Classifiers/Washers

This package includes the construction of a completely new headworks facility that will provide adequate capacity for influent screening, pumping, and the new grit removal and handling (Figure 4-3). The costs for this package will include the costs for the new building, fine screens, influent pumping, structural and concrete costs for vortex grit removal tanks, the costs of all grit removal and handling ancillary equipment, screenings washpress and conveyor, and the existing equipment removal. Replacing the existing PTU system with a vortex or multi-tray settling grit removal system will improve grit capture compared to the current equipment. The equipment evaluated for the influent fine screens were perforated plate through-flow and center-flow screens. The equipment evaluated for the influent grit removal system included a free vortex grit removal system, a forced vortex grit removal system, and a plate settler system.

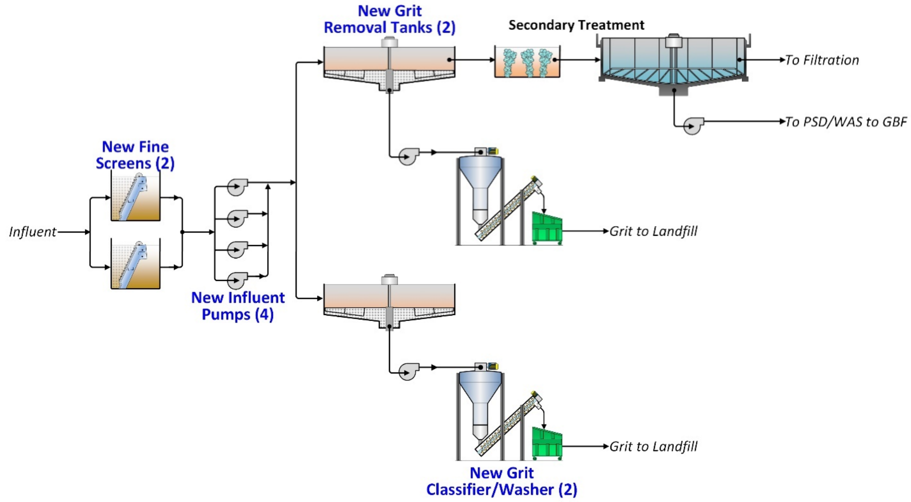

Figure 4-3 DPF Package 1 New Headworks and Grit Removal and Handling Process Flow Diagram

4.3.1.2 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates for Package 1, including costs for the fine screen alternatives and the influent grit removal and handling. The cost presented is the greatest cost for each technology from the manufacturers. The manufacturer information for a through-flow perforated plate screen and center-flow perforated plate screen is provided in Table 4-2, each includes costs for a washer/compactor/conveyor. The equipment evaluated for the influent grit removal system included a free vortex grit removal system and a multi-tray settler system and is summarized in Table 4-3, no forced vortex system was proposed by manufacturers.

Table 4-2 Influent Fine Screen Manufacturer Information for DPF Package 1

Influent Fine Screening	
Through-Flow Perforated Plate Screen with Washer/Compactor	
Install Angle	60 – 75 deg
Material	304 SSTL
Screen Drive Motor	1.0 to 3.0 HP
Washer Compactor Motor	7.5 to 10.0 HP
Approximate Equipment Cost[1]	$840,000
Center-Flow Perforated Plate Screen	
Install Angle	90 deg
Material	304 SSTL
Screen Motor	1.0 HP, VFD
Washer Compactor Motor	7.5 HP max
Approximate Equipment Cost[1]	$775,000
[1]Does not include costs for concrete tanks and structural support. Cost is for equipment only provided by manufacturer.	

Table 4-3 Influent Grit Removal and Handling Manufacturer Information for DPF Package 1

Influent Grit Removal	
Free Vortex Grit Removal System	
Number of Units	2
Size	20 ft in diameter depending upon units
Material	304 SSTL and concrete
Performance Guarantee for Vortex Unit	95% removal of all grit (SG 2.65) ≥ 105 microns
Design Flow per Unit	30 mgd
Number of Dewatering Units	2
Capacity of Dewatering Unit	3.0 cy/hr
Performance Guarantee for Dewatering Unit	-
Approximate Equipment Cost[1]	$575,000
Multi-Tray Settler System	
Number of Units	2
Size	12’ diameter
Number of Trays per unit	12
Material	304 SSTL Structure with Polyethylene Trays
Performance Guarantee for Vortex Unit	95% removal of all grit ≥ 105 microns
Design Peak Flow per Unit	28.7 mgd with 12” headloss
Number of Dewatering Units	2
Capacity of Dewatering Unit	2 cy/hr
Performance Guarantee for Dewatering Unit	95% removal of all grit (SG 2.65) ≥ 75 microns; grit in the dumpster shall contain ≥ 60% TS and ≤ 15% VS
Approximate Equipment Cost[1]	$870,000
[1]Does not include costs for concrete tanks and structural support. Cost is for equipment only provided by manufacturer.	

4.3.1.3 Performance Impacts

As illustrated in Table 4-1, Package 1 will meet the required fundamental objectives for age and equipment condition, peak flow management, liquid stream screening and grit removal, and solids stream screening and grit removal. This will be accomplished in Package 1 by providing a brand new facility to house new influent pumps able to handle the 2040 peak hourly flow, providing new fine screens able to accommodate peak flow and improve overall screenings by using perforated plate technology, constructing new grit removal tanks in the lawn for improve influent grit removal, and providing new grit handling technology. Overall, this will improve the performance at the DPF by keeping unwanted grit and screening out of biological treatment processes while providing peak flow treatment and reducing required operation and maintenance costs.

4.3.2 Package 2 – Rehabilitate Existing Headworks

4.3.2.1 Rehabilitate Headworks with New Fine Screens, New Influent Pumps, Rehabilitate PTUs, New Grit Pumps and Classifier/Washers

Package 2 includes the rehabilitation of the existing headworks (Figure 4-4). This will include the replacement of the influent pumps, the influent fine screens, new PTU tank mechanisms, new grit pumps, and new grit classifier/washers. The costs for this package will include upgrading the existing influent fine screens and screening washpress new fine screenings conveyors, new grating and required catwalks, installing new influent pumps, structural and concrete costs for upgrading and rehabilitating the PTUs, replacement of PTU mechanisms, the costs of all grit removal and handling ancillary equipment, screenings washpress and conveyor, and the existing equipment removal. Replacing the existing grit washers is anticipated to improve grit capture compared to the current equipment. It should be noted that this alternative would not provide adequate grit removal capacity at the projected peak hour flow of 57 mgd. The detritors are sized for a peak hour flow of 30 mgd. The equipment evaluated for the influent fine screens were perforated plate through-flow and center-flow screens. The mechanism replacement equipment will be a grit collector mechanism to create upflow of organics while allowing for grit settling.

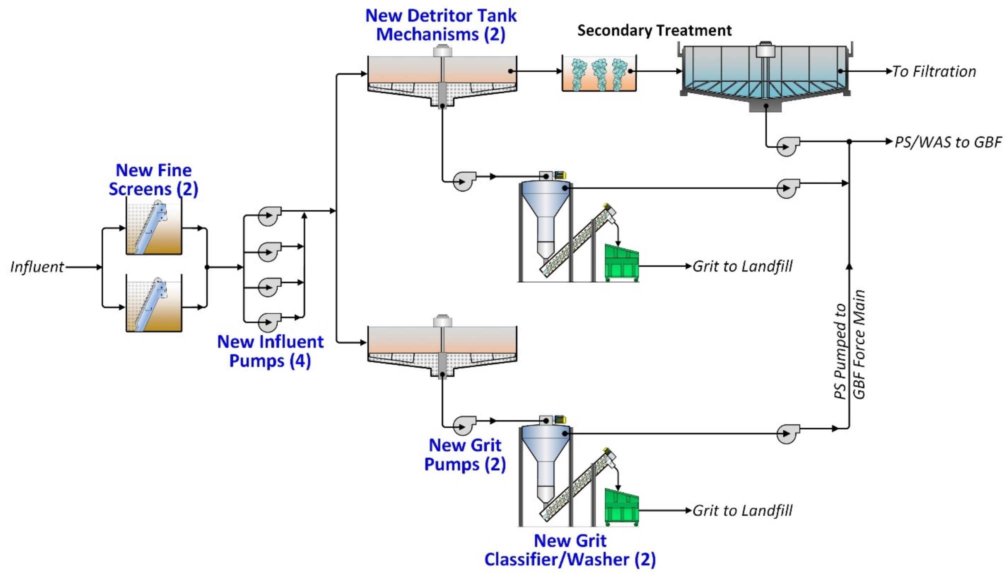

Figure 4-4 DPF Package 2 Rehabilitation of the Existing Headworks, PTU Tank Mechanisms, and Grit handling Process Flow Diagram

4.3.2.2 Performance Impacts

As illustrated in Table 4-1, Package 2 will meet the required fundamental objectives for age and equipment condition, liquid stream screening and grit removal, and solids stream screening and grit removal. However, peak flow management is not accomplished with this package. This alternative is eliminated from further consideration.

4.3.3 DPF Package 3 – Rehabilitate Existing Headworks, Upgrade PTUs, and New Grit Handling

4.3.3.1 Rehabilitate Existing Headworks with New Fine Screens, Rehabilitate PTUs, New Primary Sludge Grit Removal for the Separation of Primary Sludge to Pump into WAS Forcemain to GBF

DPF Package 3 is similar to Package 2 as it also rehabilitates the existing headworks but adds new PS grit removal to separate PS. After grit and PS separation the PS is pumped into the WAS forcemain to the GBF (Figure 4-5). As with Package 2, Package 3 includes the replacement of the influent pumps, the influent fine screens, new PTU tank mechanisms, new grit pumps, new PS grit removal systems, and new grit handling systems. The cost for this package will include upgrading the existing influent fine screens and screening washpress new fine screenings conveyors, new grating and required catwalks, installing new influent pumps, structural and concrete costs for upgrading and rehabilitating the PTUs, replacement of PTU mechanisms, screenings washpress and conveyor, the installation and equipment costs associated with PS grit removal and handling ancillary equipment, and the existing equipment removal. The equipment evaluated for the influent fine screens were perforated plate through-flow and center-flow screens. The mechanism replacement equipment will be a grit collector mechanism allowing for PS and grit settling. The grit separation technology evaluated for this application was a high efficiency free vortex grit removal system paired with a washer/dewatering unit.

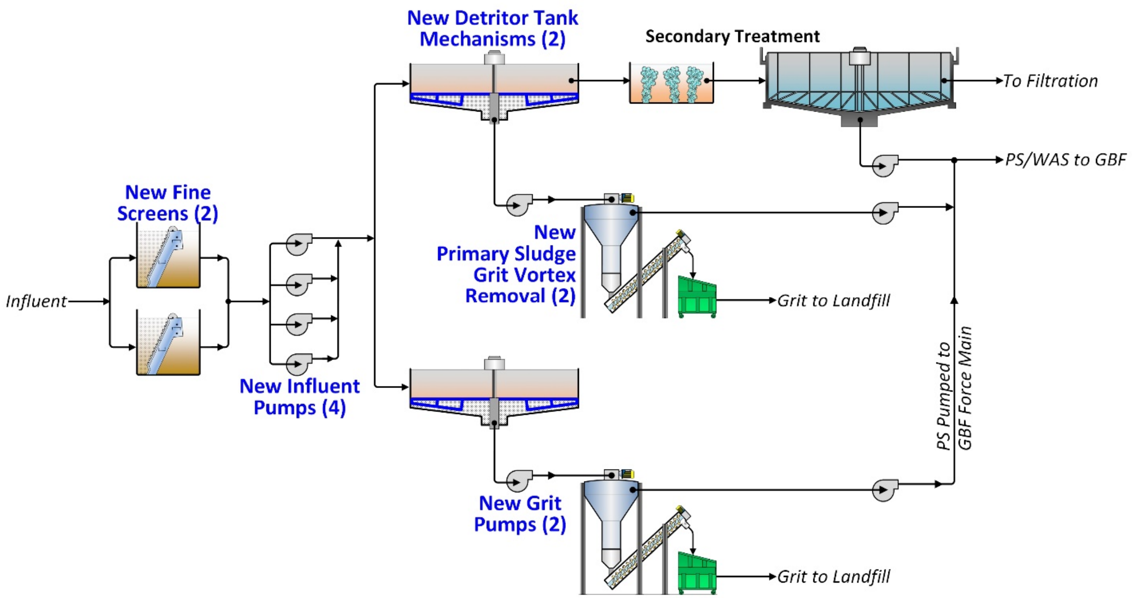

Figure 4-5 DPF Package 3 - Rehabilitate Existing Headworks, Upgrade PTUs, and New Grit Handling Process Flow Diagram

4.3.3.2 Performance Impacts

As illustrated in Table 4-1, Package 3 will meet the fundamental objectives for age and equipment condition, liquid stream screening and grit removal, and solids stream screening and grit removal. Additionally, this option will reduce grit sent to the GBF. However, peak flow management is not accomplished with this package. This alternative is eliminated from further consideration.

4.3.4 Package 4 – Rehabilitate Existing Headworks and New Grit Removal and Handling

4.3.4.1 Rehabilitate DPF with New Fine Screens, Construct New Grit Removal Tanks Inside PTU Tank Structure, and New Grit Classifier/Washers

Package 4 includes replacing the influent pumps, influent screens, retrofitting the PTU tanks with new vortex grit removal systems, replacing the grit handling systems in the existing structure, and providing new grit pumps Figure 4-6. The purpose of this Package was to install new more reliable equipment in the existing influent pump station and provide an efficient and reliable grit removal technology. The grit removal technology will be installed in the existing PTUs (Figure 4-7) after the removal, rehabilitation and structural improvements have occurred for the new grit removal systems. This would be a phased construction to allow for continued use of one tank. The new grit removal systems will be accompanied with grit classifiers and washers in the existing grit handling room.

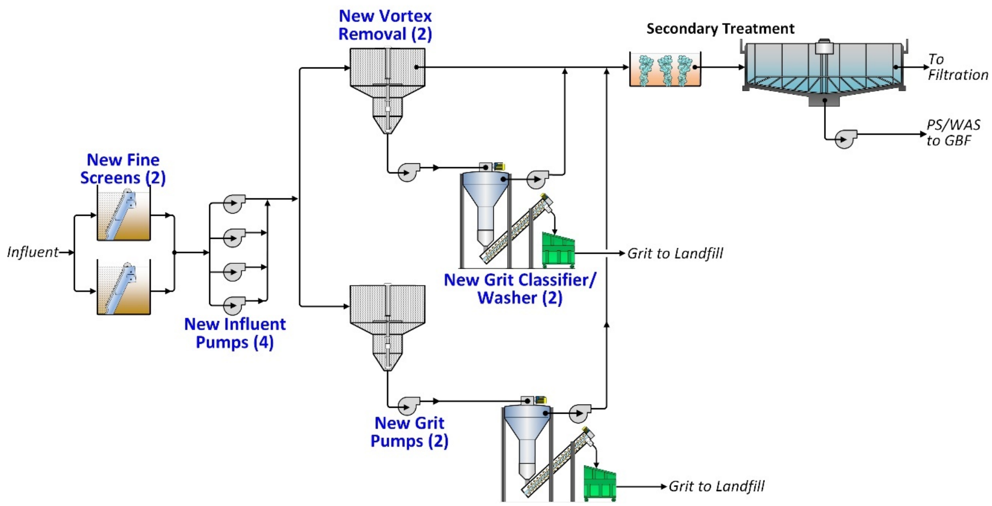

Figure 4-6 DPF Package 4 Rehabilitate Existing Headworks with New Grit Removal and Handling Process Flow Diagram

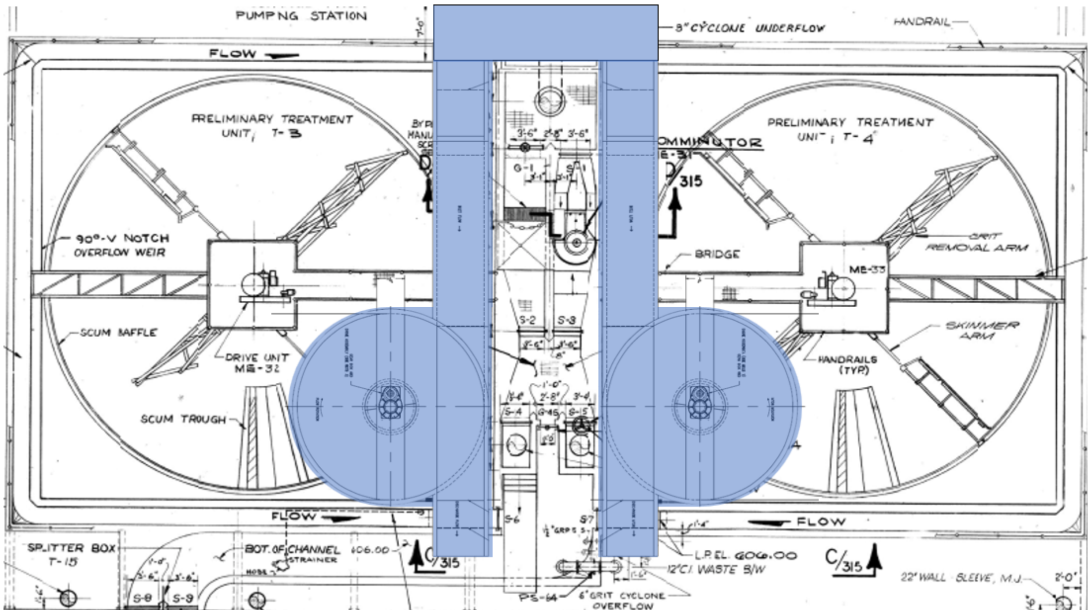

Figure 4-7 **Potential Layout of Vortex Grit Removal in Existing PTUs**

4.3.4.2 Manufacturer Equipment Comparison

Several manufacturers provided cost estimates and design information for the major upgrades suggested for DPF Package 4. The cost presented is the greatest cost for each technology from the manufacturers. The manufacturer information for the influent fine screens in the existing influent pump station was evaluated in Package 2.. The design information for the grit removal systems that are to be retrofitted in the existing PTU tanks are the same as were provided in DPF Package 1. The Package will include additional structural improvements to the existing PTU tanks to house the new grit removal system which will be included in the total initial capital costs.

4.3.4.3 Performance Impacts

As illustrated in Table 4-1, Package 4 will meet the fundamental objectives for age and equipment condition, peak flow management, liquid stream screening and grit removal, and solids stream screening and grit removal. This will be accomplished by rehabilitating the existing headworks facility with new influent pumps able to handle the 2040 peak hourly flow, new fine screens able to accommodate peak flow and improve overall screenings by using perforated plate technology, rehabilitate the existing PTUs to retrofit new grit removal tanks in them, and provide new grit handling technology. Overall, this Package will improve the performance at the DPF by keeping unwanted grit and screening out of biological treatment processes while providing peak flow treatment and reducing required operation and maintenance costs.

5.0 Infrastructure Package Capital Cost Estimates

The full cost of an upgrade requires consideration of non-equipment costs (e.g., piping, electrical, and labor). Using the feasible alternatives identified above, full infrastructure package capital costs were estimated.

5.1 Basis for Infrastructure Packages

For each facility various different infrastructure packages were developed for screening and grit removal management. The fundamental objectives focused on for screening and grit management were the age and condition of equipment, peak flow management, reducing liquid stream screenings and grit carry over, and reduced solids stream screening and grit carryover. Not all packages for the GBF were capable of attending to each fundamental objective (Table 5-1) but were considered to possibly take on a phased approach to mitigate the most crucial treatment problems first. Table 5-1 and Table 5-2 illustrate which package option manages which fundamental objectives for GBF and DPF, respectively. It should be noted that DPF Packages 2 and 3 do not fully address peak flow capacity, since the PTUs are only sized for 30 mgd and were removed from further consideration.

Table 5-1 Summary of GBF Proposed Alternatives

Package	Major Improvements	Age and Condition of Influent Pump Station	Liquid Stream			Solids Stream	
			Peak Flow Management	Screening	Grit	Screening	Grit
GBF Baseline Package	• Influent Pumps • Bar Screens	✓	✓				
GBF Package 1	• New Headworks • New Fine Screens • Influent Grit Removal Systems • New Grit Handling	✓	✓	✓	✓	✓ (Partial; still required DPF improvements)	✓ (Partial; still required DPF improvements)
GBF Package 2A	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling	✓	✓	✓	✓	✓ (Partial; still required DPF improvements)	✓ (Partial; still required DPF improvements)
GBF Package 2B	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling • Two PS Screens • Two WAS Screens	✓	✓	✓	✓	✓	✓
GBF Package 3	• In Existing Headworks • Four Influent Fine Screens • Four PS Grit Removal Systems • Two PS Screens • Two WAS Screens	✓				✓	✓

Table 5-2 Summary of DPF Proposed Alternatives

Package	Major Improvements	Age And Condition of Influent Pump Station	Liquid Stream			Solids Stream	
			Peak Flow Management	Screening	Grit	Screening	Grit
DPF Package 1	• New Headworks • New Fine Screens • New Influent Pumps • New Grit Removal • New Grit Handling	✓	✓	✓	✓	✓ (Partial; still required GBF improvements)	✓ (Partial; still required GBF improvements)
DPF Package 2	• In Existing Facility • New Fine Screens • New Influent Pumps • New PTU Tank Mechanisms and Rehab • New Grit Handling	✓	✓	✓	Detritors lack adequate peak flow capacity	✓ (Partial; still required GBF improvements)	✓ (Partial; still required GBF improvements)
DPF Package 3	• In Existing Facility • New Fine Screens • New Influent Pumps • New PTU Tank Mechanisms and Rehab • PS Grit Removal • New Grit Handling	✓	✓	✓	Detritors lack adequate peak flow capacity	✓ (Partial; still required GBF improvements)	✓ (Partial; still required GBF improvements)
DPF Package 4	• In Existing Facility • New Fine Screens • New Influent Pumps • New Grit Removal Retrofitted into PTUs • New Grit Handling	✓	✓	✓	✓	✓ (Partial; still required GBF improvements)	✓ (Partial; still required GBF improvements)

5.2 Capital Cost Estimates

Total capital costs were determined using the percentages listed in Table 5-3. The multipliers presented are consistent with those used for the thickening memo, TM 4.2. The cost estimates include the major infrastructure indicated, with additional factors included in Table 5-4 for GBF and Table 5-5 for DPF. The potential capital cost range represents the range of project costs as defined for a Class 3 cost estimate (AACE International Recommended Practice No. 18R-97), with the range representing 85 percent to 125 percent of that most probable capital cost.

The installed equipment cost reflects the greatest manufacturer cost estimate but not the specific technology chosen as further evaluation is required to determine the appropriate technology summed with all ancillary equipment costs. For detailed equipment and building cost opinions please see **Appendix A.**

Table 5-3 Multipliers Used to Determine Total Capital Costs

Component	Multiplier	Value Multiplied Against
Installation	30%	Equipment
Mechanical	20%	Equipment + Installation
Electrical and I&C	20%	Equipment + Installation
Site Civil	0 to 5%	Equipment + Installation
HVAC and Plumbing	5 to 10%	Equipment + Installation
Contractor Overhead and Profit	25%	Installed equipment cost
Contingency	50%	Installed cost + Overhead
Engineering	25%	Installed cost + Overhead + Contingency

Table 5-4 GBF Capital Costs Estimates for the Main Infrastructure Packages

Package	Major Infrastructure	Capital Cost Range	Most Probable Cost
GBF Baseline Package	• Influent Pumps • Bar Screens	$16.0 to $23.5M	$18.8M
GBF Package 1	• New Headworks • New Fine Screens • Influent Grit Removal Systems • New Grit Handling	$49.1 to $72.2M	$57.8M
GBF Package 2A	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling	$21.7 to $31.9M	$25.5M
GBF Package 2B	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling • Two PS Screens • Two WAS Screens	$30.6 to $44.9M	$35.9M
GBF Package 3	• In Existing Headworks • Four Influent Fine Screens • Four PS Grit Removal Systems • Two PS Screens • Two WAS Screens	$26.4 to $38.8M	$31.0M

Table 5-5 DPF Capital Costs Estimates for the Main Infrastructure Packages

Package	Major Infrastructure	Capital Cost Range	Most Probable Cost
DPF Package 1	• New Headworks Building • Two New Fine Screens • Four New Influent Pumps • Two New Grit Removal Systems • Two New Grit Handling Systems	$32.2M to $47.4M	$37.9M
DPF Package 4	• In Existing Facility • Two New Fine Screens • Four New Influent Pumps • Two New Grit Removal Systems Retrofitted into PTUs • Two New Grit Handling Systems	$21.0 to $30.9M	$24.7M

6.0 Infrastructure Package Summary and Recommendations

6.1 GBF Package Cost Analysis Summary and Recommendations

One Baseline Package and four major infrastructure packages were developed and compared for GBF upgrades in terms of initial capital costs for the installation of each package, the achievement of facility requirements, and a qualitative assessment of the risks associated with the fundamental upgrade objectives. These facility upgrades are intended to improve the overall performance and capacity of the influent pumping, screenings, and grit removal of the existing influent pump station and headworks. The overall costs comparison summary is provided in Table 6-1.

Table 6-1 GBF Package Summary of Initial Capital Costs for Each Package Plus the Baseline Package Cost

Package	Major Infrastructure	Capital Cost Range	Most Probable Cost
GBF Baseline Package	• Influent Pumps • Bar Screens	$16.0 to $23.5M	$18.8M
GBF Package 1 + Baseline Package	• New Headworks • New Fine Screens • Influent Grit Removal Systems • New Grit Handling	$65.1 to $95.7M	$76.6M
GBF 2A Package + Baseline Package	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling	$37.7 to $55.4M	$44.3M
GBF 2B Package + Baseline Package	• In Existing Headworks • Six Influent Fine Screens • Four PS Grit Removal Systems • Grit Handling • Two PS Screens • Two WAS Screens	$46.6 to $68.5M	$54.8M
GBF 3 Package + Baseline Package	• In Existing Headworks • Four Influent Fine Screens • Four PS Grit Removal Systems • Two PS Screens • Two WAS Screens	$42.4 to $62.3M	$49.8M

Package GBF 1 provides a solution that meets the fundamental objectives needed to provide reliable grit removal in the liquid and solids forward flow, address peak flow capacity issues in the headworks, and improve overall solids stream performance. However, due to the construction of a high capital cost is associated with this package. These additional costs do not provide sufficient benefit and there is limited ability for phasing and flexibility with Package GBF 1.

The lowest initial capital cost package (including the Baseline Package) is Package GBF 2A. Package GBF 2A includes the expansion of the fine screens through the addition of two new channels in the headworks providing adequate screening and the replacement of the existing PS grit removal and handling system. Although Package 2A will reduce the risks associated with the fundamental objectives of peak flow capacity in the headworks, screenings in the liquid flow stream, and grit removal in the PS, it cannot ensure protection of the solids handling systems from screenings that pass through the headworks. Therefore, this system could potentially transport screenings downstream to end up in the solids handling train. To fully address screening and grit removal issues in solids handling, PS and WAS screens may be required (Package 2B). During discussions at review workshops it was unclear whether reduced screening capture is tied to peak flow events or is occurring through normal flow conditions. An applied research project is recommended to gather additional data and information.

Package GBF Package 2B provides reliable overall grit removal in the liquid and solids forward flow, address peak flow capacity issues in the headworks, and improve overall solids stream performance. Although this Package upgrades are capable of minimizing the existing and future maintenance and capacity issues at the plant, the higher capital cost compared to Package 2A should be further evaluated and justified through an applied research project as part of a phasing plan.

Package GBF 3 provides a solution to some of the fundamental objectives, including improving solid streams performance for GBF through improved grit removal and screening prior to thickening and digestion, it would not address the influent fine screen capacity, the screen channel overflow into the bypass channels during peak flow events. One major advantage of Package 3 is the sludge screening process (also included in Package 2A) will ensure removal of screening material from the solids stream and thus protection of downstream solids handling processes. However, the major risk in this package would be leaving the liquid flow vulnerable to peak flow events, and carryover of screenings.

6.2 DPF Package Cost Analysis Summary and recommendations

Two packages were developed and compared in terms of initial capital costs for the installation of each option for and upgraded system, achievement of facility requirements, and a qualitative assessment of the risks associated with the fundamental upgrade objectives. These facility upgrades are intended to improve the overall performance and capacity of the influent pumping, screenings, and grit removal of the existing influent pump station and headworks. The overall Package cost comparison summary is provided in Table 5-5.

The lowest cost option is Package 4, which would replace the influent pumping and fine screening processes in the existing headworks building and construct a new vortex grit removal process in the footprint of the PTU tanks. Operators mentioned the wetwell in the influent pump station was not deep enough and did not provide enough storage at peak flows; however, upgrading the influent pumps and screens may assist with this issue.

6.3 Combined Infrastructure Packages

The combined solution for NEW Water will need to consider whole system improvements to address screening and grit management challenges at both the GBF and the DPF. This requires the combination of packages. Two potential combinations are summarized in Table 6-2. These two packages were identified because they fully address all of the liquid stream and solid stream screening and grit accumulation challenges at GBF and DPF.

Table 6-2 Potential Package Combinations to Address Screening and Grit Management Challenges for NEW Water

Description	Infrastructure Packages	Capital Cost Range	Most Probable Cost
New headworks for full liquids and solids screening and grit management	GBF Baseline + GBF 1 + DPF 1	$97.3 to $143.1M	$114.5M
Rehabilitated and expanded headworks for peak flow liquids and solids, screening and grit management	GBF Baseline + GBF 2B + DPF 4	$67.6 to $99.4M	$79.5M

Determining the full benefits of these combined infrastructure packages will require the multi-attribute utility analysis (MUA). The MUA will occur as part of Task 5.

6.4 Recommendation and Phasing of DPF and GBF Project

Multiple review workshops were held to discuss MUA results with the project team. Since the MUA involves combined alternatives from multiple technical memoranda, these results will be presented and discussed in the Facility Plan Report. Based on the MUA, identified priorities, and construction phasing flexibility, it is recommended to rehabilitate and expand the headworks for peak flow liquids and solids, screening and grit management (line two in Table 6-2). This package combination includes GBF Baseline Package, GBF Package 2B, and DPF Package 4. The high initial capital cost requires a phasing plan which is summarized in Table 6-3. Phasing projects included thickening, headworks, screening impact assessment, degritting, and sludge screening. Further decisions for implementation will be made after the applied research project results are known.

Table 6-3 NEW Water Project Phasing Descriptions and Cost

Project	Phasing Description	Capital Cost
Project 1: Thickening	(See TM 4.2)	
Project 2: DPF Headworks	• Address DPF maintenance, operations, performance concerns • Address DPF WAS quality of R2E2	$24.7M (DPF Package 4)
Project 3: GBF Headworks	• Plan for capacity increase, continue to evaluate during preliminary design rehab package based on applied research	$35.0M
Applied Research 1: Screening Impact	• Assess impacts of DPF and GBF screening, pilot sludge screens • Are sludge screens required?	$150,000
Project 4: GBF Degritting	• Address aging infrastructure	$9.3M
Project 5: Sludge Screens	• Plan farther in the future after assessing impacts of GBF Project 2B	$10.4M

7.0 References

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Appendix A. GBF and DPF Cost Opinions

NEW Water
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		Template
Subtotal	-	$ 4,683,500
Contractor Overhead and Profit	25%	$ 1,170,900
Subtotal	-	
Contingency	50%	$ 2,927,200
Total Construction Cost	-	**$ 8,782,000**
Engineering	25%	$ 2,195,500
Total Cost	-	$ 10,978,000

Assumptions:
No odor control included at this time - separate evaluation and TM

Contractor Overhead and Profit	25%
Contingency	50%
Engineering	25%

Quantity Estimate

	Units	Rate	Notes
Sitework			
Sitework for buildings	SF	$ -	
Excavation	CY	$ -	
Backfill	CY	$ -	
	CY	$ -	
	SF	$ -	
Steel and Concrete			
Building Cost "large"	SF	$ 200	Approximat
Building Cost "small"	SF	$ 250	Approximat
	CY	$ -	
	SF	$ -	
Equipment			
	EA	$ -	
	EA	$ -	
	EA	$ -	
	EA	$ -	

NEW Water
Green Bay Facility Package Summary
Facility Plan

OPCC

GBF Baseline Package. Bar Screens and Influent Pumps

Upgrade Influent Pump Station with New Trash Racks and Influent Pump Upgrades

Subtotal	-	$	8,028,900
Contractor Overhead and Profit	25%	$	2,007,225
Subtotal	-	$	10,036,125
Contingency	50%	$	5,018,063
Total Construction Cost	-	$	15,054,188
Engineering	25%	$	3,763,547
Total Cost	-	$	18,818,000

GBF Package 1. New Headwork's Facility

New GBF Headwork's Facility with New Fine Screens and Grit Removal and Grit Handling and then to Forward Flow

Subtotal	-	$	24,638,200
Contractor Overhead and Profit	25%	$	6,159,550
Subtotal	-	$	30,797,750
Contingency	50%	$	15,398,875
Total Construction Cost	-	$	46,196,625
Engineering	25%	$	11,549,000
Total Cost	-	$	57,746,000

GBF Package 2A. New Fine Screens and New Primary Sludge Grit Removal and Handling Sized for Peak Flow

Rehabilitate Existing Headwork's with new fine screens in existing channels and new primary grit removal and classification. Plus modify structure to add two screen channels (6 total screens) sized for screening of full peak flow.

Subtotal	-	$	10,891,000
Contractor Overhead and Profit	25%	$	2,722,750
Subtotal	-	$	13,613,750
Contingency	50%	$	6,806,875
Total Construction Cost	-	$	20,421,000
Engineering	25%	$	5,105,000
Total Cost	-	$	25,526,000

GBF Package 2B. New Headwork's Facility

Rehabilitate Existing Headwork's with new fine screens in existing channels and new primary grit removal and classification and new PS and WAS Screening. Plus modify structure to add two screen channels (6 total screens) sized for screening of full peak flow.

Subtotal	-	$	15,336,400
Contractor Overhead and Profit	25%	$	3,834,100
Subtotal	-	$	19,170,500
Contingency	50%	$	9,585,250
Total Construction Cost	-	$	28,755,750
Engineering	25%	$	7,189,000
Total Cost	-	$	35,945,000

GBF Package 3. New Fine Screens and New PS Grit Removal at Current Sizing and New PS and WAS Screening

Rehabilitate existing headwork's with new fine screens in existing channels and new primary grit removal and classification. Plus new primary sludge and waste activated sludge screening before being sent to thickening

Subtotal	-	$	13,232,600
Contractor Overhead and Profit	25%	$	3,308,150
Subtotal	-	$	16,540,750
Contingency	50%	$	8,270,375
Total Construction Cost	-	$	24,811,125
Engineering	25%	$	6,203,000
Total Cost	-	$	31,014,000

NEW Water
Green Bay Facility and De Pere Facility
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GBF Influent Pump Station Bar Screens
OPCC

General Description

The influent bar screens are to be updated to eliminate current issues the facility has experienced with the exiting system. The system will be upgraded with two new more reliable bar screens that will not allow large materials to pass through or rags to clog the screens. The new screens will be accompanied by an added washer/compactor. Each screen will be capable of handling 120 mgd each.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal	15	ea	$ 380	$ 10,000
Total				**$ 10,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Concrete for equipment and rehab	20.0	CY	$ 1,501	$ 30,019
Total				**$ 30,019**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Influent Bar Screens	2	ea	$ 620,000	$ 1,240,000
Conveyor Compactor	4	ea	$ 250,000	$ 1,000,000
Mill Waste Valves - electrically actuated - 16"	2	ea	$ 32,500	$ 65,000
Mill Waste valves - manual - 16"	5	ea	$ 9,100	$ 45,500
Install			30%	$ 705,150
Subtotal				$ 3,095,669
Mechanical			20%	$ 619,133.84
Electrical & I&C			20%	$ 619,133.84
Site Civil			0%	$ -
HVAC and Plumbing			10%	$ 309,566.92
Total				**$ 4,643,504**
Subtotal				**$ 4,683,500**
Contractor Overhead and Profit			25%	$ 1,170,900
Subtotal				$ 5,854,400
Contingency			50%	$ 2,927,200
Total Construction Cost				**$ 8,782,000**
Engineering			25%	$ 2,195,500
Total Cost				**$ 10,978,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Influent Pump Upgrades
OPCC

General Description

The influent pumps are aged and nearing their end of useful life. The system will be upgraded with 4 new more reliable dry-pit centrifugal pumps. The pumps will be capable of handling the 2040 peak hour design flow with a firm capacity of 149 mgd. Three of the pumps will be used with one for redundancy.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal	64	ea	$ 380	$ 24,400
Total				**$ 24,400**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Concrete for equipment and rehab	30	CY	$ 1,501	$ 45,029
Total				**$ 45,029**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Influent Pumps - 50 mgd at 84 ft	4	ea	$ 420,000	$ 1,680,000
Install			30%	$ 504,000
Subtotal				$ 2,184,000
Mechanical			20%	$ 436,800.00
Electrical & I&C			20%	$ 436,800.00
Site Civil			0%	$ -
HVAC and Plumbing			10%	$ 218,400.00
Total				**$ 3,276,000**
Subtotal				**$ 3,345,400**
Contractor Overhead and Profit			25%	$ 836,400
Subtotal				$ 4,181,800
Contingency			50%	$ 2,090,900
Total Construction Cost				**$ 6,273,000**
Engineering			25%	$ 1,568,300
Total Cost				**$ 7,841,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Influent Grit Removal
OPCC

General Description

A new grit removal system will be constructed to remove grit from the influent flow as opposed to removing grit in the primary sludge.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal (4 laborers)	150	ea	$ 380	$ 57,000
Total				**$ 57,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Concrete for equipment	800	CY	$ 1,700	$ 1,360,000
Grit Removal Tanks constructed in lawn	4	ea	$ 725,000	$ 2,900,000
Total				**$ 4,260,000**
Mechanical (large diameter piping)				
60" DI Pipe Grit System Conveyance	1	LS	$ 500,000	$ 500,000
Total				**$ 500,000**
Equipment				
Grit Removal System	4	ea	$ 130,000	$ 520,000
Grit Classifier	4	ea	$ 130,000	$ 520,000
Grit Washer	4	ea	$ 125,000	$ 500,000
Grit Pumps	8	ea	$ 50,000	$ 400,000
Install			30%	$ 582,000
Subtotal				$ 2,522,000
Mechanical			20%	$ 504,400
Electrical & I&C			20%	$ 504,400
Site Civil			5%	$ 126,100
HVAC and Plumbing			5%	$ 126,100
Total				**$ 3,783,000**
Subtotal				**$ 8,600,000**
Contractor Overhead and Profit			25%	$ 2,150,000
Subtotal				$ 10,750,000
Contingency			50%	$ 5,375,000
Total Construction Cost				**$ 16,125,000**
Engineering			25%	$ 4,031,300
Total Cost				**$ 20,156,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Primary Sludge Grit Removal and Handling
OPCC

General Description

A new primary grit removal system will be installed in the exisitng location to replace the existing TeaCup® system to continue to remove grit from primary sludge. This system would also include new washer/compactor packages.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal (4 laborers)	64	ea	$ 360	$ 24,000
Total				**$ 24,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Concrete for equipment and rehab	15	CY	$ 1,501	$ 22,514
Total				**$ 22,514**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Grit Removal System (4 classifiers, 2 washers)	1	LS	$ 1,016,600	$ 1,016,600
Grit Pumps	4	ea	$ 250,000	$ 1,000,000
Valves	1	LS	$ 20,000	$ 20,000
Grating/Catwalks/Stands, etc.	1	LS	$ 50,000	$ 50,000
Install			30%	$ 625,980
Subtotal				$ 2,712,580
Mechanical			20%	$ 542,516
Electrical & I&C			20%	$ 542,516
Site Civil			0%	$ -
HVAC and Plumbing			5%	$ 135,629
Total				**$ 3,933,241**
Subtotal				**$ 3,979,800**
Contractor Overhead and Profit			25%	$ 995,000
Subtotal				$ 4,974,800
Contingency			50%	$ 2,487,400
Total Construction Cost				**$ 7,462,000**
Engineering			25%	$ 1,865,500
Total Cost				**$ 9,328,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Grit Handling
OPCC

General Description

A new primary grit handling system will be installed to support the new grit removal systems. This was not use in any estimate.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal (4 laborers)	64	ea	$ 360	$ 24,000
Total				**$ 24,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Concrete for equipment and rehab	15	CY	$ 1,501	$ 22,514
Total				**$ 22,514**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Grit Classifier	4	ea	$ 80,000	$ 320,000
Grit Washer	4	ea	$ 250,000	$ 1,000,000
Grit Pumps	8	ea	$ 50,000	$ 400,000
Valves	1	LS	$ 20,000	$ 20,000
Grating/Catwalks/Stands, etc.	1	LS	$ 50,000	$ 50,000
Gates (Influent and Effluent)	8	ea	$ 15,000	$ 120,000
Install			30%	$ 573,000
Subtotal				$ 2,483,000
Mechanical			20%	$ 496,600
Electrical & I&C			20%	$ 496,600
Site Civil			5%	$ 124,150
HVAC and Plumbing			5%	$ 124,150
Total				**$ 3,724,500**
Subtotal				**$ 3,771,000**
Contractor Overhead and Profit			25%	$ 942,800
Subtotal				$ 4,713,800
Contingency			50%	$ 2,356,900
Total Construction Cost				**$ 7,071,000**
Engineering			25%	$ 1,767,800
Total Cost				**$ 8,839,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Fine Screens in Existing Headworks Facility
OPCC

General Description

This upgrade will replace the existing fine screens, conveyors, and washpress in the existing structure. The structure will be modified to remove the bypass channels and construct two additional screen channels. Six new screens will be capable of screening the full peak flow without bypassing. Addtionally, the mill waste valves will be replaced as the facility reported these to be leaking and not functioning properly.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal & Relocation Work	1	LS	$ 300,000	$ 300,000
Total				**$ 300,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Channel Rehab - Add two channels	400	CY	$ 2,600	$ 1,040,000
Total				**$ 1,040,000**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Perforate Plate Belt Screen	6	ea	$ 215,000	$ 1,290,000
Screening Washpress	4	ea	$ 250,000	$ 1,000,000
Conveyor	2	ea	$ 120,000	$ 240,000
Screen extension	2	ea	$ 75,000	$ 150,000
Bagging System	2	ea	$ 6,000	$ 12,000
Grating/Catwalks	1	LS	$ 75,000	$ 75,000
Gates	6	ea	$ 15,000	$ 90,000
Install			30%	$ 857,100
Subtotal				$ 3,714,100
Mechanical			20%	$ 742,820
Electrical & I&C			20%	$ 742,820
Site Civil			5%	$ 185,705
HVAC and Plumbing			5%	$ 185,705
Total				**$ 5,571,150**
Subtotal				**$ 6,911,200**
Contractor Overhead and Profit			25%	$ 1,727,800
Subtotal				$ 8,639,000
Contingency			50%	$ 4,319,500
Total Construction Cost				**$ 12,959,000**
Engineering			25%	$ 3,239,800
Total Cost				**$ 16,199,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Fine Screens in Existing Headworks Facility
OPCC

General Description

This upgrade will replace the existing fine screens, conveyors, and washpress in the existing structure. The four screens will be replaced with four new screens. Peak flows above 120 MGD will bypass the screens using the existing bypass channels. Addtionally, the mill waste valves will be replaced as the facility reported these to be leaking and not functioning properly.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal	1	LS	$ 35,000	$ 35,000
Total				**$ 35,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Channel Rehab	75	CY	$ 1,310	$ 98,235
Total				**$ 98,235**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Perforate Plate Belt Screen	4	ea	$ 215,000	$ 860,000
Screening Washpress	4	ea	$ 250,000	$ 1,000,000
Conveyor	2	ea	$ 120,000	$ 240,000
Screen extension	2	ea	$ 75,000	$ 150,000
Bagging System	2	ea	$ 6,000	$ 12,000
Grating/Catwalks	1	LS	$ 75,000	$ 75,000
Gates	4	ea	$ 15,000	$ 60,000
Install			30%	$ 719,100
Subtotal				$ 3,116,100
Mechanical			20%	$ 623,220
Electrical & I&C			20%	$ 623,220
Site Civil			5%	$ 155,805
HVAC and Plumbing			5%	$ 155,805
Total				**$ 4,674,150**
Subtotal				**$ 4,807,400**
Contractor Overhead and Profit			25%	$ 1,201,900
Subtotal				$ 6,009,300
Contingency			50%	$ 3,004,700
Total Construction Cost				**$ 9,014,000**
Engineering			25%	$ 2,253,500
Total Cost				**$ 11,268,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Fine Screens in New Headworks Facility
OPCC

General Description

Fine screens in a completely new headworks facility to replace the existing fine screens not capable of handling high peak flows.

	Qtny	Units	Rate		Cost
Demolition					
Existing Equipment Removal	160	ea	$ 360	$	58,000
Total				**$**	**58,000**
Sitework					
			$ -	$	-
Total				**$**	**-**
Concrete					
New Building (95 x 100 ft)	9,500	sq. ft.	$ 1,150	$	10,925,000
Total				**$**	**10,925,000**
Mechanical (large diameter piping)					
60" DI Pipe Grit System Conveyance	1	LS	$ 500,000	$	500,000
Total				**$**	**500,000**
Equipment					
Perforate Plate Belt Screen	4	ea	$ 250,000	$	1,000,000
Screening Washpress	4	ea	$ 250,000	$	1,000,000
Conveyor	1	ea	$ 120,000	$	120,000
Screen extension/Trough/Flume	1	ea	$ 75,000	$	75,000
Bagging System	1	ea	$ 6,000	$	6,000
Grating/Catwalks	1	LS	$ 75,000	$	75,000
Gates	4	ea	$ 15,000	$	60,000
Install			30%	$	700,800
Subtotal				$	3,036,800
Mechanical			20%	$	607,360
Electrical & I&C			20%	$	607,360
Site Civil			5%	$	151,840
HVAC and Plumbing			5%	$	151,840
Total				**$**	**4,555,200**
Subtotal				**$**	**16,038,200**
Contractor Overhead and Profit			25%	$	4,009,600
Subtotal				$	20,047,800
Contingency			50%	$	10,023,900
Total Construction Cost				**$**	**30,072,000**
Engineering			25%	$	7,518,000
Total Cost				**$**	**37,590,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

GBF Primary Sludge and WAS Screening
OPCC

General Description

This system will add sludge screening to screen PS after primary sludge grit removal to remove unwanted debris that has passed through screening and grit removal prior to the sludge going to thickening. This system will also add sludge screening for WAS sludge to remove unwanted debris that has passed through screening, biological treatment, secondary clarification, and grit removal prior to the sludge going to thickening.

	Qtny	Units	Rate	Cost
Demolition				
			$ -	$ -
Total				**$ -**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Concrete for equipment and rehab	20	CY	$ 1,501	$ 30,019
New Building for sludge screening (65 ft x 70 ft)	4,500	sq. ft	$ 400	$ 1,800,000
Total				**$ 1,830,019**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
PS and WAS Sludge Screen with control panel	4	ea	$ 175,000	$ 700,000
Sludge Pumps	4	ea	$ 50,000	$ 200,000
Piping	870	LF	$ 185	$ 160,950
Valves - Plug	22	ea	$ 7,500	$ 165,000
Flow meters	6	ea	$ 12,000	$ 72,000
Install			30%	$ 389,385
Subtotal				$ 1,687,335
Mechanical			20%	$ 337,467
Electrical & I&C			20%	$ 337,467
Site Civil			5%	$ 84,367
HVAC and Plumbing			10%	$ 168,734
Total				**$ 2,615,369**
Subtotal				**$ 4,445,400**
Contractor Overhead and Profit			25%	$ 1,111,400
Subtotal				$ 5,556,800
Contingency			50%	$ 2,778,400
Total Construction Cost				**$ 8,335,000**
Engineering			25%	$ 2,083,800
Total Cost				**$ 10,419,000**

NEW Water
De Pere Facility Package Summary
Facility Plan

OPCC

Package 1. New Headworks and New Equipment		
Entirely new headworks building with new influent fine screens, influent pumps, grit removal tanks, grit pumps, and grit classifiers/washers		
Subtotal	-	$ 16,185,600
Contractor Overhead and Profit	25%	$ 4,046,400
Subtotal	-	$ 20,232,000
Contingency	50%	$ 10,116,000
Total Construction Cost	-	**$ 30,348,000**
Engineering	25%	$ 7,587,000
Total Cost	-	$ 37,935,000

Package 2. Rehabilitate Existing Headworks		
Rehabilitate headworks with new fine screens, new influent pumps, rehabilitate detritor tanks (PTUs), new grit pumps and classifier washers		
Subtotal	-	$ 10,586,400
Contractor Overhead and Profit	25%	$ 2,646,600
Subtotal	-	$ 13,233,000
Contingency	50%	$ 6,616,500
Total Construction Cost	-	**$ 19,850,000**
Engineering	25%	$ 4,963,000
Total Cost	-	$ 24,813,000

Package 3. Rehabilitate Existing Headworks, Upgrade PTUs, and New Grit Handling		
Rehabilitate existing headworks with new fine screens, rehabilitate detritor tanks (PTUs), new primary sludge grit removal, and separation of primary sludge to pump into WAS forcemain to GBF		
Subtotal	-	$ 14,256,600
Contractor Overhead and Profit	25%	$ 3,564,150
Subtotal	-	$ 17,820,750
Contingency	50%	$ 8,910,375
Total Construction Cost	-	**$ 26,731,000**
Engineering	25%	$ 6,683,000
Total Cost	-	$ 33,414,000

DPF Package 4. Rehabilitate Existing Headworks, New Grit Removal, and New Grit Handling		
Rehabilitate DPF with new fine screens, construct new grit removal tanks inside detritor tank structure, and new grit classifier/washers		
Subtotal	-	$ 10,532,900
Contractor Overhead and Profit	25%	$ 2,633,225
Subtotal	-	$ 13,166,125
Contingency	50%	$ 6,583,063
Total Construction Cost	-	**$ 19,749,000**
Engineering	25%	$ 4,937,000
Total Cost	-	$ 24,686,000

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Influent Pumps
OPCC

General Description

The influent pumps are aged and nearing their end of useful life. The system will be upgraded with 4 new more reliable dry-pit centrifugal pumps. The pumps will be capable of handling the 2040 peak hour design flow with a firm capacity of 58 mgd. Three of the pumps will be used with one for redundancy.

	Qtny	Units	Rate		Cost
Demolition					
Existing Equipment Removal	48	ea	$ 360	$	18,000
Total				**$**	**18,000**
Sitework					
			$ -	$	-
Total				**$**	**-**
Concrete					
Concrete for equipment and rehab	10	CY	$ 1,501	$	15,010
Total				**$**	**15,010**
Mechanical (large diameter piping)					
			$ -	$	-
Total				**$**	**-**
Equipment					
Influent Pumps - 20 mgd at 67 ft	6	ea	$ 222,000	$	1,332,000
				$	-
				$	-
				$	-
				$	-
				$	-
Install			30%	$	399,600
Subtotal				$	1,731,600
Mechanical			20%	$	346,320
Electrical & I&C			20%	$	346,320
Site Civil			0%	$	-
HVAC and Plumbing			10%	$	173,160
Total				**$**	**2,597,400**
Subtotal				**$**	**2,630,400**
Contractor Overhead and Profit			25%	$	657,600
Subtotal				$	3,288,000
Contingency			50%	$	1,644,000
Total Construction Cost				**$**	**4,932,000**
Engineering			25%	$	1,233,000
Total Cost				**$**	**6,165,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Fine Screens in Existing Headworks Facility
OPCC

General Description

This upgrade will replace the existing fine screens, conveyors, and washpress in the existing structure.

	Qtny	Units	Rate		Cost
Demolition					
Existing Equipment Removal	48	ea	$ 380	$	19,000
Total				**$**	**19,000**
Sitework					
			$ -	$	-
Total				**$**	**-**
Concrete					
Channel Rehab, coating, etc.	250	sq ft	$ 900	$	225,000
Total				**$**	**225,000**
Mechanical (large diameter piping)					
			$ -	$	-
Total				**$**	**-**
Equipment					
Perforate Plate Belt Screen	2	ea	$ 250,000	$	500,000
Screening Washpress	4	ea	$ 250,000	$	1,000,000
Conveyor	1	ea	$ 120,000	$	120,000
Screen extension	1	ea	$ 36,000	$	36,000
Bagging System	1	ea	$ 6,000	$	3,000
Grating	1	LS	$ 50,000	$	50,000
Install			30%	$	512,700
Subtotal				$	2,221,700
Mechanical			20%	$	444,340
Electrical & I&C			20%	$	444,340
Site Civil			0%	$	-
HVAC and Plumbing			10%	$	222,170
Total				**$**	**3,332,550**
Subtotal				**$**	**3,576,600**
Contractor Overhead and Profit			25%	$	894,200
Subtotal				$	4,470,800
Contingency			50%	$	2,235,400
Total Construction Cost				**$**	**6,706,000**
Engineering			25%	$	1,676,500
Total Cost				**$**	**8,383,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Fine Screens in New Facility
OPCC

General Description

This upgrade will replace the existing fine screens, conveyors, and washpress in the existing structure. This option would include combining this option with the influent pump alternative for a completely new building with screen and pumps.

	Qtny	Units	Rate		Cost
Demolition					
Existing Equipment Removal	240	ea	$ 760	$	183,000
Total				**$**	**183,000**
Sitework					
			$ -	$	-
Total				**$**	**-**
Concrete					
New Building	6,500	sq. ft.	$ 950	$	6,175,000
Total				**$**	**6,175,000**
Mechanical (large diameter piping)					
				$	-
Total				**$**	**-**
Equipment					
Perforate Plate Belt Screen	2	ea	$ 212,000	$	424,000
Screening Washpress	4	ea	$ 250,000	$	1,000,000
Conveyor	1	ea	$ 120,000	$	120,000
Screen extension	1	ea	$ 36,000	$	36,000
Bagging System	1	ea	$ 3,000	$	3,000
Grating/Catwalk	1	LS	$ 50,000	$	50,000
Install			30%	$	489,900
Subtotal				$	2,122,900
Mechanical			20%	$	424,580
Electrical & I&C			20%	$	424,580
Site Civil			5%	$	106,145
HVAC and Plumbing			10%	$	212,290
Total				**$**	**3,290,495**
Subtotal				**$**	**9,648,500**
Contractor Overhead and Profit			25%	$	2,412,100
Subtotal				$	12,060,600
Contingency			50%	$	6,030,300
Total Construction Cost				**$**	**18,091,000**
Engineering			25%	$	4,522,800
Total Cost				**$**	**22,614,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Grit Removal in New Facility
OPCC

General Description

This alternative would include the installation of brand new grit removal systems installed within a completely new structure. The washer classifer would go in the existing location.

	Qtny	Units	Rate		Cost	
Demolition						
Existing Equipment Removal	160	ea	$	360	$	58,000
Total					**$**	**58,000**
Sitework						
			$	-	$	-
Total					**$**	**-**
Concrete						
Concrete for equipment	400	CY	$	1,700	$	680,000
Grit Removal Tanks constructed in lawn	2	EA	$	700,000	$	1,400,000
Mechanical (large diameter piping)						
					$	-
Total					**$**	**-**
Equipment						
Grit Removal System	2	ea	$	300,000	$	600,000
Grit Washer, Classifier, Concentrator	4	ea	$	250,000	$	1,000,000
Grit Pumps	2	ea	$	75,000	$	150,000
Grating and Catwalk	1	LS	$	50,000	$	50,000
316 SSTL Adder	1	LS	$	50,000	$	50,000
Gates (Influent and Effluent)	4	ea	$	15,000	$	60,000
Install				30%	$	573,000
Subtotal					$	2,483,000
Mechanical				20%	$	496,600
Electrical & I&C				20%	$	496,600
Site Civil				5%	$	124,150
HVAC and Plumbing				10%	$	248,300
Total					**$**	**3,848,650**
Subtotal					**$**	**3,906,700**
Contractor Overhead and Profit			25%		$	976,700
Subtotal					$	4,883,400
Contingency			50%		$	2,441,700
Total Construction Cost					**$**	**7,325,000**
Engineering			25%		$	1,831,300
Total Cost					**$**	**9,156,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Grit Removal in Existing PTUs
OPCC

General Description

This alternative would include the installation of brand new grit removal systems installed within the existing PTU structures. The washer classifer would go in the existing location.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal	56	ea	$ 360	$ 21,000
Total				**$ 21,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
PTU Rehabilitation	2	EA	$ 185,000	$ 370,000
Grit Removal Tanks constructed in PTUs	2	EA	$ 450,000	$ 900,000
Total				**$ 1,270,000**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
Grit Removal System	4	ea	$ 250,000	$ 1,000,000
Grit Washer, Classifier, Concentrator	2	ea	$ 150,000	$ 300,000
Grit Pumps	2	ea	$ 75,000	$ 150,000
Grating and Catwalk	1	LS	$ 50,000	$ 50,000
316 SSTL Adder	1	LS	$ 50,000	$ 50,000
Gates (Influent and Effluent)	4	ea	$ 15,000	$ 60,000
Install			30%	$ 483,000
Subtotal				$ 2,093,000
Mechanical			20%	$ 418,600
Electrical & I&C			20%	$ 418,600
Site Civil			0%	$ -
HVAC and Plumbing			5%	$ 104,650
Total				**$ 3,034,850**
Subtotal				**$ 4,325,900**
Contractor Overhead and Profit			25%	$ 1,081,500
Subtotal				$ 5,407,400
Contingency			50%	$ 2,703,700
Total Construction Cost				**$ 8,111,000**
Engineering			25%	$ 2,027,800
Total Cost				**$ 10,139,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Preliminary Treatment Units Upgade with New Grit Handling
OPCC

General Description

This alternative would include the rehabilitation of the existing PTUs includings recoating mechanisms, replacing mechanism drives, and rehabilitating concrete. This would include replacing the washer, classifier, and concentrator and that equipment would remain in its existing location.

	Qtny	Units	Rate	Cost
Demolition				
Remove existing equipment	180	ea	$ 380	$ 69,000
Total				**$ 69,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
Rehab, concrete, injection, and coating	2	ea	$ 185,000	$ 370,000
Total				**$ 370,000**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
PTU Upgrades - Mechanisms and baffles	2	ea	$ 250,000	$ 500,000
Grit Pumps	4	ea	$ 250,000	$ 1,000,000
Grating and Catwalk	1	LS	$ 50,000	$ 50,000
316 SSTL Adder	1	LS	$ 50,000	$ 50,000
Valves	4	ea	$ 5,000	$ 20,000
Install			30%	$ 486,000
Subtotal				$ 2,106,000
Mechanical			20%	$ 421,200
Electrical & I&C			20%	$ 421,200
Site Civil			0%	$ -
HVAC and Plumbing			5%	$ 105,300
Total				**$ 3,053,700**
Subtotal				**$ 3,492,700**
Contractor Overhead and Profit			25%	$ 873,200
Subtotal				$ 4,365,900
Contingency			50%	$ 2,183,000
Total Construction Cost				**$ 6,549,000**
Engineering			25%	$ 1,637,300
Total Cost				**$ 8,186,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF Preliminary Treatment Units Upgade with New Grit Handling
OPCC

General Description

This alternative would include the rehabilitation of the existing PTUs includings recoating mechanisms, replacing mechanism drives, and rehabilitating concrete. This would include replacing the washer, classifier, and concentrator and that equipment would remain in its existing location.

	Qtny	Units	Rate		Cost
Demolition					
Remove existing equipment	75	ea	$ 380	$	29,000
Total				**$**	**29,000**
Sitework					
			$ -	$	-
Total				**$**	**-**
Concrete					
Total				**$**	**-**
Mechanical (large diameter piping)					
			$ -	$	-
Total				**$**	**-**
Equipment					
Grit Washer, Classifier, Concentrator	2	ea	$ 227,500	$	455,000
Install			30%	$	136,500
Subtotal				$	591,500
Mechanical			20%	$	118,300
Electrical & I&C			20%	$	118,300
Site Civil			0%	$	-
HVAC and Plumbing			5%	$	29,575
Total				**$**	**857,675**
Subtotal				**$**	**886,700**
Contractor Overhead and Profit			25%	$	221,700
Subtotal				$	1,108,400
Contingency			50%	$	554,200
Total Construction Cost				**$**	**1,663,000**
Engineering			25%	$	415,800
Total Cost				**$**	**2,079,000**

NEW Water
Green Bay Facility and De Pere Facility
Facility Plan

DPF PS Grit Removal in New Facility
OPCC

General Description

This alternative would include the addition of grit removal to separate grit and primary sludge from the PTU settled sludge. The PS sludge would then be sent to thickening at the GBF. This would include a smaller grit removal system. This equipment would likely not fit in the existing grit handling facility and would require an addition to that structure. This alternative would also require the rehabiliation of the PTUs.

	Qtny	Units	Rate	Cost
Demolition				
Existing Equipment Removal	56	ea	$ 360	$ 21,000
Total				**$ 21,000**
Sitework				
			$ -	$ -
Total				**$ -**
Concrete				
New Structure for PS Grit Removal	1,250	CY	$ 250	$ 312,500
Total				**$ 312,500**
Mechanical (large diameter piping)				
			$ -	$ -
Total				**$ -**
Equipment				
PS Grit Removal System	2	ea	$ 450,000	$ 900,000
Grit Pumps	4	ea	$ 250,000	$ 1,000,000
Grating and Catwalk	1	LS	$ 50,000	$ 50,000
316 SSTL Adder	1	LS	$ 50,000	$ 50,000
PS Pumps	3	ea	$ 32,000	$ 96,000
Install			30%	$ 628,800
Subtotal				$ 2,724,800
Mechanical			20%	$ 544,960
Electrical & I&C			20%	$ 544,960
Site Civil			5%	$ 136,240
HVAC and Plumbing			10%	$ 272,480
Total				**$ 4,223,440**
Subtotal				**$ 4,556,900**
Contractor Overhead and Profit			25%	$ 1,139,200
Subtotal				$ 5,696,100
Contingency			50%	$ 2,848,100
Total Construction Cost				**$ 8,544,000**
Engineering			25%	$ 2,136,000
Total Cost				**$ 10,680,000**