PREPARED FOR: Western Wake Partners

FROM: CDM/Hazen and Sawyer

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DATE: July 22, 2005

SUBJECT: Western Wake Regional Wastewater Management Facilities
Western Wake Water Reclamation Facility
PER Technical Memorandum No. 10 – Preliminary Treatment Facility

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INTRODUCTION

This technical memorandum (TM) is one in a series of TMs being prepared for the Preliminary Engineering Report for the Western Wake Regional Wastewater Management Facilities project. The purpose of this TM is to present the preliminary engineering information and data for the Preliminary Treatment Facility. A new Preliminary Treatment Facility including fine screens and grit removal facilities is proposed as part of the Western Wake Water Reclamation Facility (WRF).

PROCESS REQUIREMENTS

Fine screens and grit removal facilities are recommended for the Western Wake WRF to remove particulate matter that could cause equipment wear and nuisance problems and to provide a higher quality biosolids product. Grit removal equipment improves the quality of plant biosolids, as well as reducing wear and tear on pumps and other mechanical equipment. The following are design aspects that were taken into consideration for the preliminary design of the Preliminary Treatment Facility:

1. Provide equal flow and solids distribution to all units;
2. Provide automatic bypass of flows if mechanical screens are blinded;
3. Keep solids in suspension in channels;
4. Limit the velocity through the bar screen openings to approximately 4 feet per second at peak instantaneous flows;
5. Design facilities to be easily expandable in the future.

Table 10-1 shows design flow rates, which are described in more detail in TM 09 - Hydraulic Design. Specific aspects of the design are detailed in later sections of this technical memo.

TABLE 10-1
DESIGN FLOWS

PHASE 1	
Annual Average Flow, mgd	15.3
Maximum Month Flow, mgd	18.0
Hydraulic Peak Flow, mgd	47.3
PHASE 2	
Maximum Month Flow, mgd	30.0*
Hydraulic Peak Flow, mgd	78.8

* The mechanical equipment within the Preliminary Treatment Facility would be designed to accommodate current design flows. However, it is recommended that the Preliminary Treatment Facility structure be designed to hydraulically handle the 30-mgd future maximum month flow rate. This would result in a minor increase in the initial cost of the facility, but would lower the overall cost of the upgrade in the future.

PROPOSED FACILITIES – MECHANICAL SCREENS

The new screening facilities would consist of four channels, two of which would be equipped with mechanical, center flow band screens, one of which would be designed for a future mechanical screen, and one of which would be equipped with a manually-cleaned coarse bar screen. Figures 10-1 and 10-2 show a proposed top plan and section of the screens, screenings compactors, and screen channels.

Center flow band screens with ¼” inch circular apertures are recommended for this application due to their superior fine screening with minimal head loss. This type of screen had the highest capture rate in a full-scale evaluation of screens from different screen manufacturers and different screen types in tests performed by the UK Water Industry Research Limited. Influent flow enters the center of the screen and splits to pass through both sides of the screen. The additional screen panel area available with the center flow band screen (versus a flow through design) decreases head loss. When the head loss differential across the screen increases to a particular operator-selected setpoint, the screen band rotates, exposing clean portions of the band to the influent flow. The blinded portions of the band are then cleaned.

Screenings would be washed from the screen band and transferred to a screw compactor via a covered flume. The Preliminary Treatment Facility would be aboveground due to hydraulic constraints. Therefore, compacted screenings can be deposited into dumpsters located on grade without the need for conveyors. The site would be designed to allow the screenings and grit dumpsters to be accessed by truck for trouble-free dumpster exchange.

In order to maintain a low project cost, the Preliminary Treatment Facility is proposed to be designed without a superstructure to enclose the screens, compactors, and grit classifier. Exposed plant water piping would be heat-traced and insulated to reduce the possibility of screen washwater freezing. The structure would be designed such that it can be enclosed during a future project, if desired. However, odor control facilities would be provided to scrub the covered screen channels. All channels in the Preliminary Treatment Facility would be protected from hydrogen sulfide corrosion by installing a PVC liner system. The liner would cover all exposed concrete in the channels (side walls and bottom of the top slabs).

The screens and associated channels would be designed to maintain optimum screen and channel velocities. Each mechanical screen and associated channel would be designed to handle Phase 1, maximum month, and future Phase 2 maximum month conditions (refer to Table 10-1) with one screen out of service and without the use of the bypass channel. The peak flow condition would require the use of both screens (Phase 1) or the use of the bypass channel. In the future (Phase 2), the peak flow would require three screen channels. At that time, the “future channel” would be equipped with a mechanical screen.

A manual screen would be installed in the bypass channel. If a mechanical screen is blinded or removed from service during a peak flow condition, the excess flow would enter the bypass channel. The bypass channel would maintain acceptable water levels in the channels during high flow events. The bypass channel would be designed to carry the future peak flow of 78.8 mgd with two screens out of service.

PROPOSED FACILITIES – GRIT REMOVAL SYSTEM

A grit removal system is proposed for the new Western Wake WRF. This system would be located downstream of the mechanical screens. Removing grit early in the treatment process would keep grit from depositing in the aeration tanks or secondary clarifiers. Settled grit in downstream processes causes increased maintenance and increased wear on equipment, as well as reductions in tank volumes.

The Town of Cary has aerated grit removal systems at both the North and South Cary WRFs. An aerated grit removal system can be installed at the new Western Wake WRF and would remove an adequate quantity of grit from the plant flow (WEF Manual of Practice 8 estimates approximately 95% of grit 80 mesh and larger). However, as influent flows fluctuate, the air rate must be modulated to maintain equal grit removal efficiency. Experience at other treatment plants has shown that this equilibrium is difficult to maintain. Another disadvantage of the aerated grit removal system is the required additional equipment, and the associated high maintenance and power costs. Blowers would add maintenance and operation costs, and the submerged grit removal augers would also require increased maintenance.

Vortex-type grit collectors are becoming the generally accepted standard for grit removal in the waste water industry and are recommended as the grit removal system for this project. Vortex grit collectors capture grit by inducing a spiraling flow within the tank that aids in settling grit while keeping the lighter organic particles suspended. The stirred vortex grit collector is composed of a bull gear, a torque tube and an impeller. The equipment relies on the shape of the tank and the impeller to induce the centrifugal forces necessary to separate the grit. The grit settles into a grit sump at the center of the tank and is then pumped to a grit classifier for dewatering. The dewatered grit is then deposited into a dumpster. The most popular type of vortex grit removal system is the mechanically stirred-type vortex grit tanks.

There are advantages of using a vortex-type grit removal system in lieu of an aerated grit removal system. The stirred vortex grit collectors have fewer moving parts, which would result in less maintenance and greater energy efficiency than an aerated grit removal system. Also, the stirred vortex-type equipment has proven to consistently remove fine grit over a much wider range of flows than the aerated grit-type tanks.

Experience with this type of grit removal system has shown that increasing the size of the grit removal tank would increase the grit removal efficiency. Vortex grit collector manufacturers specify the grit removal efficiency at the recommended maximum flow for the unit to be 95% of grit greater than 50 mesh, 85% of grit between 50 and 70 mesh, and 65% of grit between 70 and 100 mesh. Hazen and Sawyer specifies this as a minimum removal efficiency, but has found in past designs that greater removal is possible with oversized tanks. It is therefore Hazen and Sawyer's standard to derate the tanks to 25% of the manufacturer's design capacity. Hazen and Sawyer has had success with this design philosophy at numerous plants.

One stirred vortex grit collector would be constructed as part of this project. The grit collector would be 24 feet in diameter, with a manufacturer's process rated capacity of 70 mgd. As discussed above, it is recommended the grit collectors be derated by a factor of 4 to 1 of the manufacturer's rated capacity relative to maximum monthly flow (18mgd). The 70-mgd units would be the appropriate size under this design philosophy. In the future, an additional unit is recommended for redundancy and required to handle the future hydraulic peak flow.

Slide gates would be used to isolate the grit tank. The grit collector influent and effluent channels would be designed to minimize head loss but also to maintain adequate velocities to keep solids in suspension.

The grit removed in the vortex grit collector would be pumped to a grit classifier located abovegrade close to the screenings compactor discharge. Two grit pumps are recommended: one duty pump and one standby pump. These pumps would be located in a pump station below the Preliminary Treatment Facility's top slab. The pumps would have flooded suctions and the suction piping would be designed to be isolated such that cleaning of the suction piping is possible, if necessary. A sparge water line with a solenoid valve would be provided for the grit collection tank hopper. The solenoid valve would open to fluidize the grit sump prior to the grit pump turning on.

There would be a screw-type classifier equipped with a cyclone for separation of organics from the grit. The grit classifier would be manufactured of stainless steel and would be provided with a two-speed motor to provide for two operational modes: low speed for average flow conditions and high speed for high flow conditions. The classifier/cyclone would be covered by a canopy to protect it from the elements. The dewatered grit would discharge from the classifier into the grit dumpster located directly below the classifier. The grit dumpster would be easily accessible by truck. Figures 10-1 and 10-2 illustrate the grit removal facilities design.

ELECTRICAL, INSTRUMENTATION, AND CONTROLS REQUIREMENTS

All motors would be 460 V, 3 phase, 60 Hz. Motor starters, etc. would be located in an Electrical Room adjacent to the screen channels.

Screens would be controlled by a timer in a manufacturer provided control panel. Ultrasonic level sensors would be provided upstream and downstream of the screens to measure differential level. High differential level would override the timer and turn on the bar screen. Manual controls would be provided at the screen for maintenance and troubleshooting. Screenings compactor operation would be interlocked with the mechanical screens. The screens and compactors would provide run and fail status and differential level to the SCADA system. Remote start/stop control would be provided for the equipment through the SCADA system.

The grit collector would be provided with local start/stop controls and a H-O-A switch on the starter at the respective MCC. Run and fail status would be sent to the SCADA system. Remote start/stop control would be possible through the SCADA system. The grit pumps would be operated either with manual on/off controls or would be started and stopped by a timer function in the PLC. The grit classifier would be interlocked with the grit pumps. Manual controls would be provided for maintenance and troubleshooting.

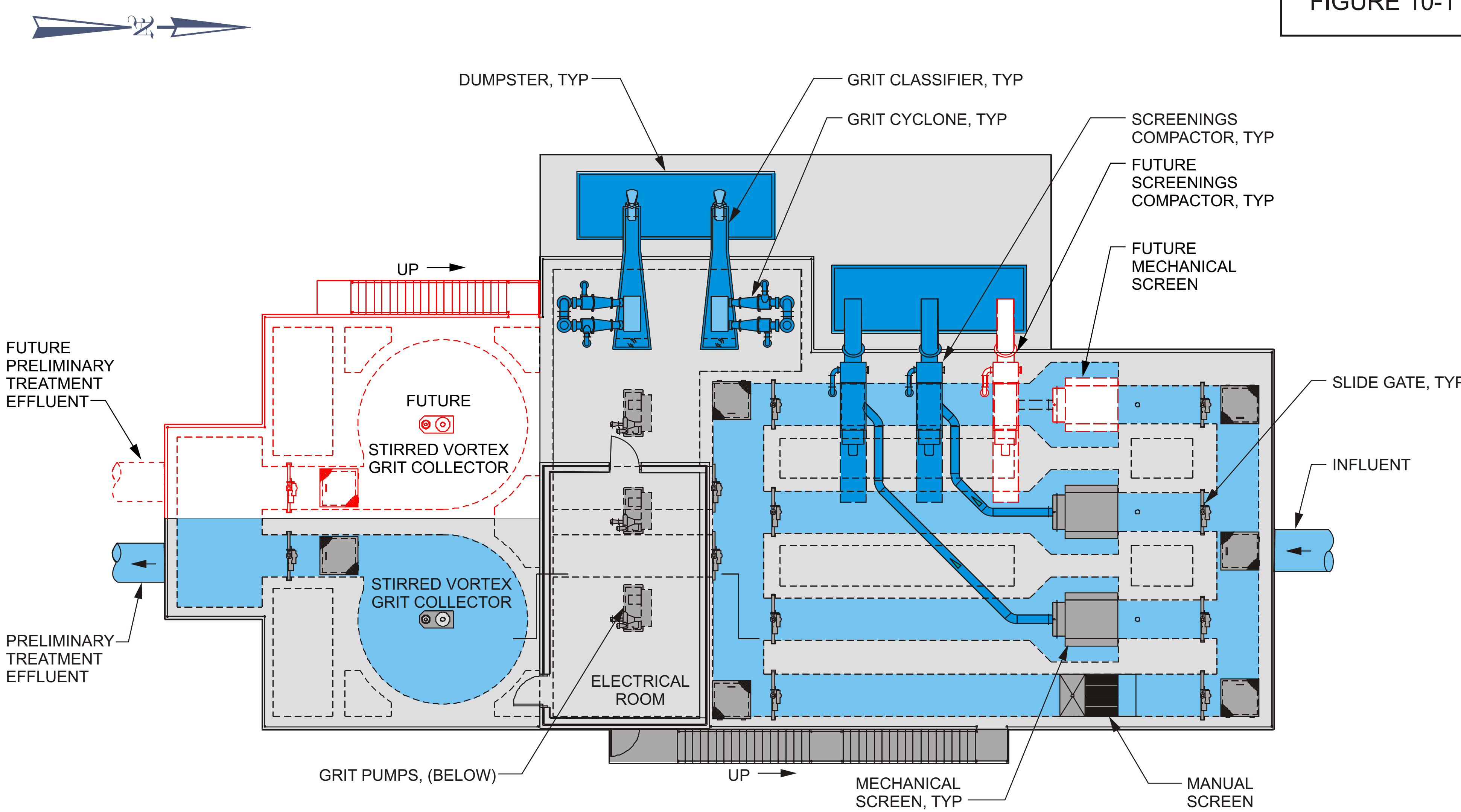
ESTIMATED CAPITAL, OPERATION AND MAINTENANCE COSTS

The estimated cost for the Preliminary Treatment Facility is as follows:

TABLE 10-2
ESTIMATED CAPITAL COST

Sitework	$60,000
Structural	$1,115,000
Architectural/HVAC	$100,000
Mechanical Band Screens and Compactors	$645,000
Manual Bar Screen	$20,000
Vortex Grit Collectors	$100,000
Grit Pumps	$100,000
Grit Classifiers/Cyclones	$90,000
Gates and Electric Actuators	$190,000
Misc. Mechanical	$145,000
Odor Control	$48,000
Electrical and Instrumentation	$312,800
Subtotal	***$2,925,800***
Construction Contingencies	$438,870
Engineering and Construction Services	$336,470
Legal and Financial	$185,060
Total Construction Cost	**$3,886,200**

FIGURE 10-1



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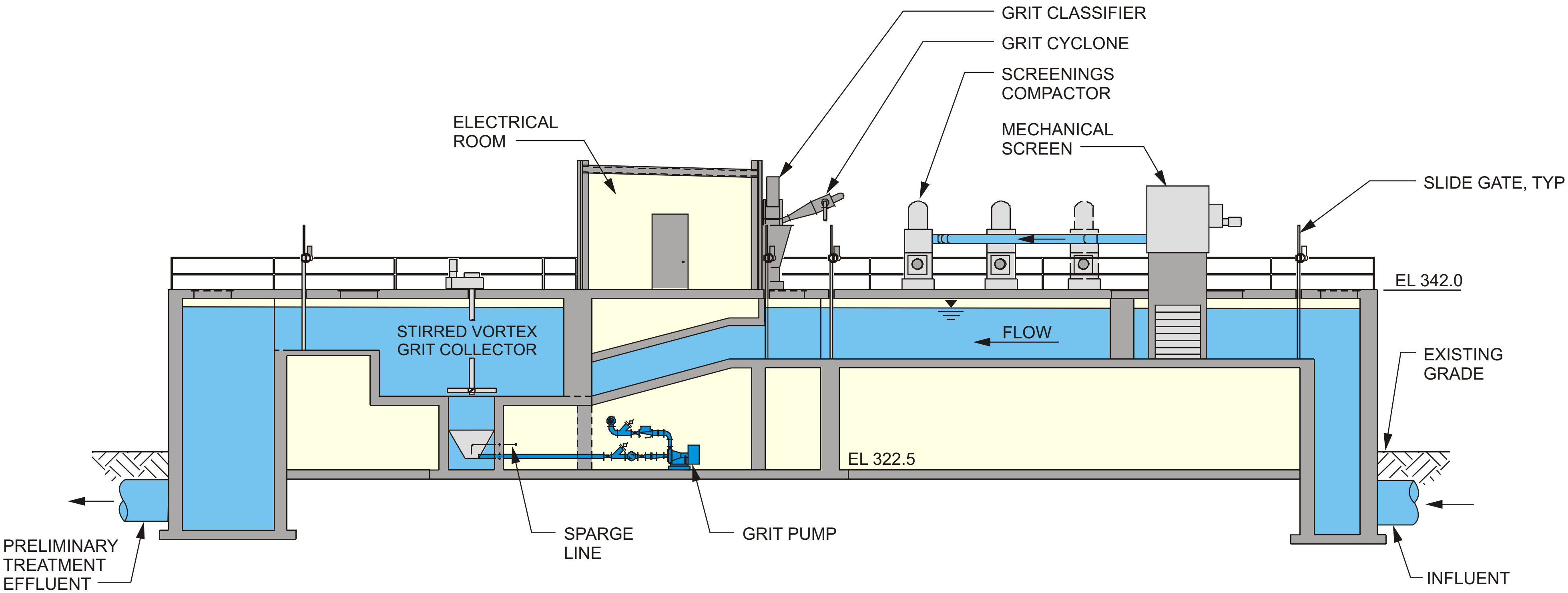
WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

PRELIMINARY TREATMENT FACILITY
TOP PLAN

FIGURE 10-2



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WESTERN WAKE REGIONAL
WASTEWATER MANAGEMENT FACILITIES

PRELIMINARY TREATMENT FACILITY
SECTION