PREPARED FOR: Western Wake Partners

FROM: CDM/Hazen and Sawyer

PREPARED BY: Thomas C. Esqueda

DATE: July 22, 2005

SUBJECT: Western Wake Regional Wastewater Management Facilities
Western Wake Water Reclamation Facility
PER Technical Memorandum No. 24 – Odor Control Facilities

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, data and costs for odor control facilities for the Western Wake Water Reclamation Facility (WRF).

For the Western Wake WRF, it is proposed to provide odor control facilities at two locations:

1) Preliminary Treatment Facility
2) Aerated sludge holding tanks

For the Preliminary Treatment Facility, it is anticipated that the predominant odor contaminant will be hydrogen sulfide. For the aerated sludge holding tanks, it is anticipated that the predominant odor contaminant will be a complex nitrogen-based nuisance odor compound.

PROCESS REQUIREMENTS

The selection of an odor control technology is dependent on the following factors:

1) Characteristics and strength of odorous air
2) Airflow rates
3) Contaminant loading patterns (fluctuations with diurnal flow patterns)
4) Treatment objectives
5) Operations and maintenance considerations

ALTERNATIVES EVALUATION

In general, there are two alternatives for addressing the generation and release of nuisance odors at wastewater management facilities:

- Reduce or eliminate the generation and release of nuisance odor compounds by chemical addition, process modification, or structural modification (to reduce turbulence)

- Contain the nuisance odor compounds prior to the compounds being released to the atmosphere, and then ventilate the foul air to an odor control treatment or dispersion/dilution device.

CHEMICAL ADDITION ALTERNATIVES

The Western Wake Regional Wastewater Management Facilities project will include provisions for adding chemical dosing stations in the future at the West Cary Pump Station. At this pump station, chemicals will be added to the raw wastewater streams to reduce the generation of dissolved sulfides in the wastewater, and reduce the magnitude of hydrogen sulfide releases at the Preliminary Treatment Facility at the Western Wake WRF.

CAPTURE AND TREAT ALTERNATIVES

To address nuisance odor releases at the Western Wake WRF, two capture and treat alternatives have been considered:

- Packed-tower wet scrubbers, and
- Biofiltration

PACKED-TOWER WET SCRUBBERS

Hydrogen sulfide is the predominant odorant emitted from raw sewage. Packed-tower wet scrubbers are well suited to headworks facilities because the expected removal efficiency for hydrogen sulfide is in excess of 95 percent. In a packed-tower wet scrubber, odorous air containing hydrogen sulfide is ventilated up through a column packed with media, and a water/chemical mixture is sprayed over the top of the column to provide contact between the water/chemical mixture and the odorous air. Once in contact with the odorous air, the hydrogen sulfide becomes entrained within the water droplets and the recirculation liquid. Once the nuisance odor compound is contained in the recirculation liquid, the hydrogen sulfide is typically oxidized using a sodium hydroxide (caustic) solution.

Packed-tower wet scrubbers can be loaded at a face velocity of 300 to 400 feet per minute. Typical chemicals used in a packed-tower wet scrubber to oxidize hydrogen sulfide are sodium hypochlorite and sodium hydroxide. The oxidation reactions are dependent on pH, with the optimum scrubber solution pH being in the 9.5 to 10.5 range. The concentrations of the recirculation liquid are automatically controlled by monitoring the liquid solution pH and ORP. A pH probe and controller maintain the proper pH by regulating the rate at which sodium hydroxide is added to the solution. An ORP probe and controller maintain the proper chlorine residual by regulating the rate sodium hypochlorite is added to the solution. Make-up water is continuously fed to the scrubber to force contaminants that accumulate in the sump out the overflow.

The operation of a packed-tower wet scrubber is more complex than the operation of a biofilter. The ORP and pH probes must be calibrated frequently, and the chemical feed pumps require routine inspection and maintenance.

BIOFILTERS

Biofilters are well suited to sludge management facilities because they can simultaneously remove reduced sulfur and reduced nitrogen species at high efficiency levels. In a biofilter, nuisance odor compounds are absorbed onto a layer of moisture on the media particles, and the nuisance odor compounds are then oxidized by microbial activity. Moisture is essential to capture the pollutants and support microbial life. Moisture is supplied by a combination of pre-humidification of the air and irrigation of the biofilter surface. The simplest effective pre-humidification system consists of an air atomizing nozzle in the duct feeding a fine mist of water. Since biofilter performance decreases sharply when the air temperature is below 55 degrees F, a pre-conditioning stage is generally included to heat the air.

An in-ground biofilter generally has a single layer of organic media – typically a mixture of leaf compost, bark mulch and wood chips. It can be loaded at face velocities of 3 to 5 feet per minute – thereby requiring a larger footprint than packed-tower wet scrubbers.

A packaged biofilter generally has two layers of media or two stages. The first stage typically has inorganic media and operates at low pH, to remove any hydrogen sulfide that might be present. The second stage may have organic media and operates at a neutral pH to remove organic pollutants. A totally enclosed proprietary biofiltration system can be loaded at approximately 10 cfm/sq. ft.

The advantage of a packaged biofilter system is that it has a smaller footprint than an in-ground biofilter. However, the packaged biofilter will have a much greater capital cost. Operating costs are similar for both types of biofilter. Since sufficient land is available, an in-ground biofilter will be considered for further evaluation.

REGULATORY COMPLIANCE REQUIREMENTS

There are no regulatory requirements for the odor control systems planned for the Western Wake WRF. Rather, the Project Partners have determined that odor control facilities will be provided to reduce the migration of nuisance odors offsite from the Western Wake WRF.

The odor control system for the Preliminary Treatment Facility will be designed to provide 95 percent removal of hydrogen sulfide released at the facility. The nuisance odor control system for the aerated sludge holding tanks will be designed to provide 95 percent removal of nuisance odor released from the aerated sludge holding tanks.

PROPOSED FACILITIES

The odor control for the new Preliminary Treatment Facility will utilize a single-stage packed-tower scrubber. The estimated hydrogen sulfide concentrations for the Preliminary Treatment Facility will range from 5 to 15 ppm, depending upon the diurnal flow fluctuations. The packed-tower wet scrubber will be supplemented with caustic injection for pH adjustment and sodium hypochlorite for cleaning. All odor control equipment, chemical storage tanks, and chemical metering pumps will be installed on a slab adjacent to the Preliminary Treatment Facility. The odor control facilities will be provided with a canopy for protection from weather and sunlight. Chemical storage areas associated with the odor control systems will be outdoors, and will not require heating or ventilation. However, the sodium hydroxide storage and feed facilities must be insulated and heat traced. It is highly recommended that sodium hydroxide be purchased at 25 percent solution strength to reduce viscosity and heat requirements. All exposed water piping will be insulated and heat traced. The odor control facility will be a packaged odor control system.

Given that the Preliminary Treatment Facility will be an open-air structure (i.e., no building), all open channels will be covered and the headspace under the covers will be ventilated at 12 air changes per hour. Areas to be covered and treated include the influent channel, screen channel, grit removal facilities, and effluent channel of the Preliminary Treatment Facility. The foul air will be routed to the packed-tower wet scrubber. The packed-tower wet scrubber will be sized to treat 10,000 scfm of foul air.

BIOFILTRATION

All four of the aerated sludge-holding tanks will be constructed with dome covers. The headspace under each cover will be ventilated and the odorous air routed to an in-ground biofiltration odor control system.

An in-ground biofilter sized for approximately 15,000 cfm will have an active treatment area of 5,000 square feet and a total footprint of about 80 feet by 150 feet, including the berms. The biofilter will be located in close proximity to the aerated sludge holding tanks. The biofilter will consist of a bed of moist organic medium placed over a plenum that distributes the air uniformly through the medium. The medium will be approximately 4 feet deep. The plenum may consist of perforated air distribution laterals fed from a header and placed in a bed of washed stone. There will be a geomembrane liner under the stone to capture leachate. An alternative plenum consists of perforated support blocks on a hard level surface. The blocks are fed from an air header.

The proposed ventilation rate will provide sufficient ventilation to remove the heat generated by the microbial activity and the aeration system. An energy balance was completed under maximum summer heat load conditions. It was assumed that the temperature of the sludge will not be allowed to exceed 120 degrees F. It was also assumed that the maximum temperature of the air vented from the covers will not exceed 100 degrees F, because this is the maximum temperature at which the biofilter can operate efficiently.

The required ventilation rate is approximately 12,600 cfm or 4,200 cfm per aerated sludge holding tank. To ensure odor control during all probable conditions, the odor control system will be designed for a capacity of 5,000 cfm per aerated sludge holding tank.

ELECTRICAL REQUIREMENTS

The electrical requirements for the odor control system include the following connected loads:

- Four 3/4-horsepower motors for the chemical metering pumps for the chemical feed systems for the packed-tower wet scrubber
- Three 5-horsepower motors for the scrubber recirculation pumps
- One 50-horsepower fan for the packed-tower wet scrubber
- One 50-horsepower fan for the in-ground biofilter system

INSTRUMENTATION & CONTROLS

The packed-tower wet scrubber system will use the programmable logic controller (PLC) at the Preliminary Treatment Facility to allow staff to monitor and control the exhaust fan, chemical feed pumps, scrubber recirculation pumps, chemical storage tank levels, water supply, pH, and ORP. All signals for the packed-tower wet scrubber system will be added to the SCADA system.

The in-ground biofiltration odor control system will have a local control station for energizing and de-energizing the exhaust fan. The signal for the exhaust fan will be added to the SCADA system.

ESTIMATED CAPITAL COSTS

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

TABLE 24-1
PRELIMINARY COST ESTIMATE
PRELIMINARY TREATMENT FACILITY ODOR CONTROL

Odor Control Equipment	$250,000
Channel Covers and Ductwork	$125,000
Instrumentation	$50,000
Electrical	$97,000
General Civil/Site/Concrete	$75,000
Subtotal	***$597,000***
Construction Contingencies	$89,600
Engineering and Construction Services	$68,700
Legal and Financial	$37,800
Total Construction Cost	**$793,100**

The estimated cost for the odor control for the aerated sludge holding tanks is as follows:

TABLE 24-2
PRELIMINARY COST ESTIMATE
AERATED SLUDGE STORAGE ODOR CONTROL

Odor Control Equipment (fans and biofilter)	$500,000
Covers and Ductwork	$200,000
Instrumentation	$25,000
Electrical	$175,000
General Civil/Site/Concrete	$75,000
Subtotal	***$975,000***
Construction Contingencies	$146,300
Engineering and Construction Services	$112,100
Legal and Financial	$61,700
Total Construction Cost	**$1,295,100**